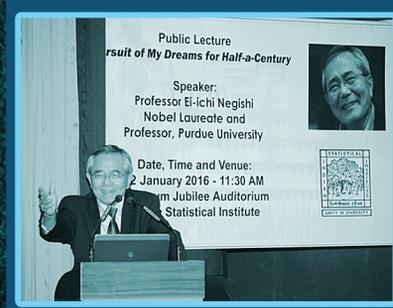


ANNUAL REPORT

2015-2016



Indian Statistical Institute

PRESIDENT OF THE INSTITUTE, CHAIRMAN AND OTHER MEMBERS OF THE COUNCIL AS ON MARCH 31, 2016

President: Dr. C. Rangarajan
Chairman, Madras School of Economics, Chennai

1. Chairman: Dr. Arun Shourie, A-31, West End, New Delhi – 110 021.
2. Director: Prof. Sanghamitra Bandyopadhyay.

Representatives of the Government of India

3. Shri S.K. Singh, Additional Secretary and Financial Advisor, Govt. of India, Ministry of Statistics and Programme Implementation, New Delhi.
4. Smt. Amarjeet Kaur, DG, CSO (I/C), Ministry of Statistics & P.I., New Delhi.
5. Shri Arvinder Singh Sachdeva, Adviser, Govt. of India, Ministry of Finance, Department of Economic Affairs, New Delhi.
6. Dr. Praveer Asthana, Adviser/Scientist-G, Head (AI and Mega Sci Prog.) & Mission Director (Nano Mission), Government of India, Ministry of Science and Technology, New Delhi.
7. Shri G. Mahalingam, Executive Director, Reserve Bank of India, Mumbai.
8. Shri Amarjeet Sinha, Additional Secretary (TE), Government of India, Ministry of Human Resource Development, New Delhi.

Representative of the ICSSR

9. Prof. Ramesh Dadhich, Member-Secretary, Indian Council of Social Science Research, New Delhi.

Representatives of the INSA

10. Prof. R. Balasubramanian, FNA, Director, The Institute of Mathematical Sciences, Chennai.
11. Prof. Rahul Mukerjee, FNA, Professor of Statistics, Indian Institute of Management, Calcutta.
12. Prof. S.K. Saidapur, FNA, Plot No. 108, Sripad Nagar, Saptapur, Dharwad - 580 001.
13. Prof. Rohini M Godbole, FNA, Centre for High Energy Physics, Indian Institute of Science, Bangalore.

Representative of the Planning Commission

14. Dr. Savita Sharma, Adviser, Perspective Planning Division, Planning Commission, New Delhi.

Representative of the University Grants Commission

15. Prof. Jagdish Saran, Head, Department of Statistics, University of Delhi, New Delhi.

Scientists co-opted by the Council

16. Prof. R. L. Karandikar, Director, Chennai Mathematical Institute, Tamil Nadu.
17. Prof. Vidyandand Nanjundiah, Professor, Centre for Ecological Sciences, Indian Institute of Science, Bangalore.

Elected representatives of the Institute members not employed in the Institute

18. Prof. Shibdas Bandyopadhyay, Kolkata.
19. Prof. Rajkumar Roychoudhury, Kolkata.
20. Prof. Siddani Bhaskara Rao, C.R. Rao Advanced Institute of Mathematics, Statistics and Computer Science, Hyderabad.

Elected representatives of the employees of the Institute

21. Dr. Kuntal Ghosh, Representative of the Scientific Workers.
22. Shri Gouri Sankar Acharya, Representative of the Non-scientific Workers.

Officers of the Institute

23. Prof. Anish Sarkar, Professor-in-Charge, Theoretical Statistics and Mathematics Division.
24. Prof. Anup Dewanji, Professor-in-Charge, Applied Statistics Division.
25. Prof. Manoranjan Pal, Professor-in-Charge, Social Sciences Division.
26. Prof. Barnana Roy, Professor-in-Charge, Physics and Earth Sciences Division.
27. Prof. Saurabh Ghosh, Professor-in-Charge, Biological Sciences Division.
28. Prof. Dipti Prasad Mukherjee, Professor-in-Charge, Computer and Communication Sciences Division.
29. Shri Amitava Bandyopadhyay, Head, SQC & OR Division.
30. Prof. Abhay G. Bhatt, Officiating Head, Delhi Centre.
31. Prof. T.S.S.R.K. Rao, Head, Bangalore Centre.
32. Prof. S. Ponnusamy, Head, Chennai Centre.
33. Prof. Pradipta Bandyopadhyay, Dean of Studies.

Non-Member Secretary

Col. S. Chakraborty, Chief Executive (Administration & Finance).

INDIAN STATISTICAL INSTITUTE

Annual Report April 2015 – March 2016



203 Barrackpore Trunk Road
Kolkata – 700 108
(<http://www.isical.ac.in>)

**INDIAN STATISTICAL INSTITUTE
EIGHTY FOURTH ANNUAL REPORT
April 2015 – March 2016**

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Director's Report

It is my proud privilege and pleasure to present the Annual Report of the Indian Statistical Institute for the year 2015-16, the first one since I assumed charge as the Director of the Institute on August 1, 2015.

The year saw some new initiatives in the Institute which I hope will be the harbinger of many more to come in the near future. The Post Graduate Diploma course in Business Analytics conducted jointly with Indian Institute of Management, Kolkata and Indian Institute of Technology Kharagpur, saw its first batch this year. This course has been designed keeping in mind the global requirement for professionals in Business Analytics in the coming years. The Institute also celebrated its 50th Convocation during the period where we had Prof. Ei-ichi Negishi, Nobel Laureate in Chemistry as Chief Guest and Shri N.R. Narayana Murthy, Co-founder of Infosys and one of the icons of modern India, as special guest. On this occasion a compendium on the activities of the Institute named "Vibrant" was published.

True to the tradition of the Institute, a number of prestigious awards and honours have been received by some of our scientists during the period for significant contributions in their respective fields. Dr. Ritabrata Munshi won the prestigious Shanti Swarup Bhatnagar award for Mathematics, Dr. Jyotishman Bhowmick and Dr. Tanvi Jain received the INSA Young Scientist Medal 2015, Dr. Krishanu Maulik was selected for the Young Researcher Award 2015 of the International Indian Statistical Association and Dr. Swagatam Das received the 2015 Thomson Reuters Research Excellence India Citation Award in Engineering and Computer Science. Dr. Chetan Ghate was awarded the Mahalanobis Memorial (Gold) Medal 2014 from the Indian Econometric Society that was announced in November 2015 and Dr. Rajendra Bhatia received the prestigious Hans Schneider Prize, 2016. Dr. Debashish Goswami and Dr. Siva Athreya were elected Fellows of the Indian Academy of Science while Dr. B.V. Rajarama Bhat was elected Fellow of the Indian National Science Academy. Dr. T.S.S.R.K. Rao received the Fullbright Academic and Professional Excellence Award 2015-16 and Prof. Abhirup Sarkar was named Chairman of the 6th Pay Commission by the Government of West Bengal. Dr. Nikhil R. Pal received the 2015 IEEE Computational Intelligence Society Fuzzy Systems Pioneer Award, INAE Chair Professorship in 2015, and was selected as IEEE CIS Distinguished Lecturer for 2016-18. Dr. Sankar K. Pal received the S.N. Mitra Memorial Award from Indian National Academy of Engineering, the Raja Ramanna Fellowship from DAE, Government of India and became IEEE Life Fellow. Dr. Bidyut B. Chaudhuri was selected for INAE Distinguished Professor for a period of three years effective January, 2016.

The Institute undertook a large number of externally funded projects as a part of its academic activity. At present there are about 72 ongoing externally funded projects in the Institute. The major funding agencies are Government of West Bengal, DST, DGCIS, DAE, DBT, RBI, UGC, DRDO Metro Rail, Kolkata, Ministry of Tourism, Government of India, IBM (USA), Intel Corporation (USA), Samsung (Korea), London School of Economics and European Union Commission. MoUs have been signed with Infosys Limited, Tata Consultancy Services, Hitachi India Private Limited, BRAC Institute of Government and Development, and Szechenyi Istvan University, Hungary. Besides this the Institute undertook a large number of training and consultancy projects benefitting Government officials, industry and academia. Notable among these are training programmes of the Sampling and Official Statistics Unit for Indian Statistical Service officials and Reserve Bank of India. As in the past all scientific units of the Institute conducted several workshops and schools in the North Eastern part of the country.

During the period, the Institute was proud to host eminent personalities like General Dr. V.K. Singh, Minister of State, In-Charge of Ministry of Statistics and Programme Implementation, Dr. V.K. Saraswat, Padma Bhusan, Member, NITI Ayog, Professor Remco van der Hofstad, Frank den Hollander and Professor Takashi Gojobori. The Parliamentary Committee on Finance under the Chairmanship of Shri M. Veerappa Moily visited the Headquarters and held a review meeting with the officials.

Director's Report

Major construction and renovation activities are lined up at Kolkata, Chennai, Tezpur and Bangalore. In particular constructions are expected to start soon in Tezpur and Chennai. It is hoped that in another two to three years the campuses will have the requisite space for academic activities that they need. Construction for the R.C. Bose Centre for Cryptology & Security is going on in full swing in the Kolkata Campus. We also plan to renovate Amrapali the historic residence of our founder Late Professor Prasanta Chandra Mahalanobis and modernize the Museum and Archives.

As is well known, ISI has always been aligned with national priorities and societal needs to meet the challenges ahead. As the nation surges forward with a focus on technology led initiative, I am proud to say that Indian Statistical Institute is future ready. Indian Statistical Institute is committed to be a partner in building a new, vibrant and resurgent India.

I am extremely grateful to Dr. C. Rangarajan, Padma Vibhusan, President of the Institute and Dr. Arun Shourie, Padma Bhusan, Chairman of the Institute for providing their valuable advice at various stages for the smooth functioning of the Institute. I also thank Dr. T.C.A. Anant, Secretary, Ministry of Statistics and Programme Implementation and all other officials of the Ministry of Statistics and Programme Implementation, Government of India and Members of the Section 8(1) Committee for their active support. Finally, I thank all the scientific and non-scientific workers, students and well-wishers of the Institute for extending their cooperation for the all-round development of the Institute.

With thanks to one and all.

March 31, 2016

Sanghamitra Bandyopadhyay



INDIAN STATISTICAL INSTITUTE

203 B. T. Road Kolkata 700108.



Founder

Professor Prasanta Chandra Mahalanobis

The Indian Statistical Institute, a premier and internationally acclaimed research, teaching and training institute, founded in 1931, is recognized as an institute of national importance by an act of Parliament in 1959.

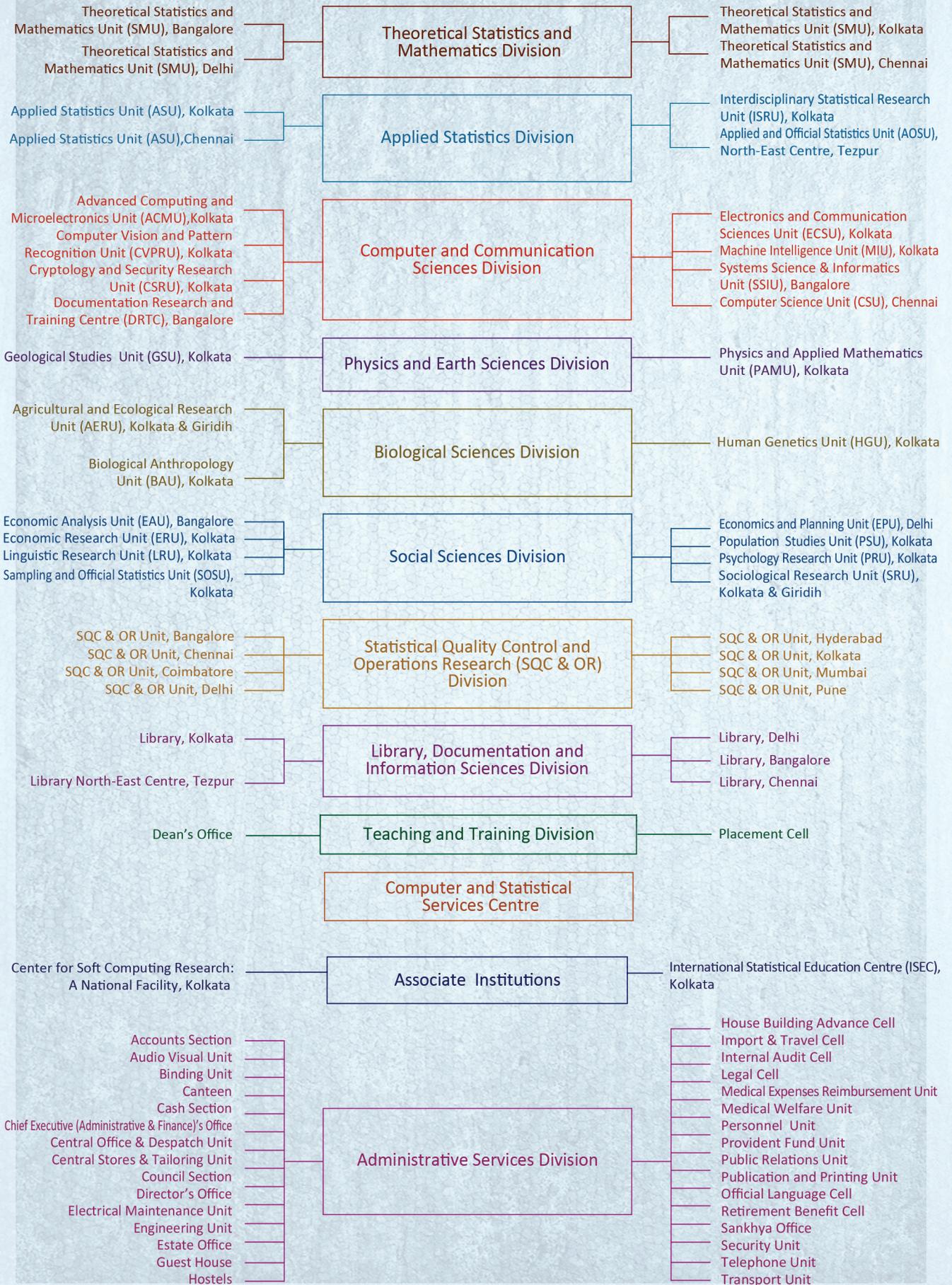
The Institute has distinguished faculty in statistics, mathematics, computer science, economics and other disciplines of natural and social sciences. Many of them are fellows of Indian National Science Academy, Indian Academy of Sciences, Indian National Academy of Engineering, National Academy of Sciences, India, Institute of Electrical & Electronics Engineers (IEEE) and many other distinguished scientific societies in India and abroad, and also recipients of prestigious awards like S.S. Bhatnagar Prize, Homi Bhaba Award etc.

The Institute offers -

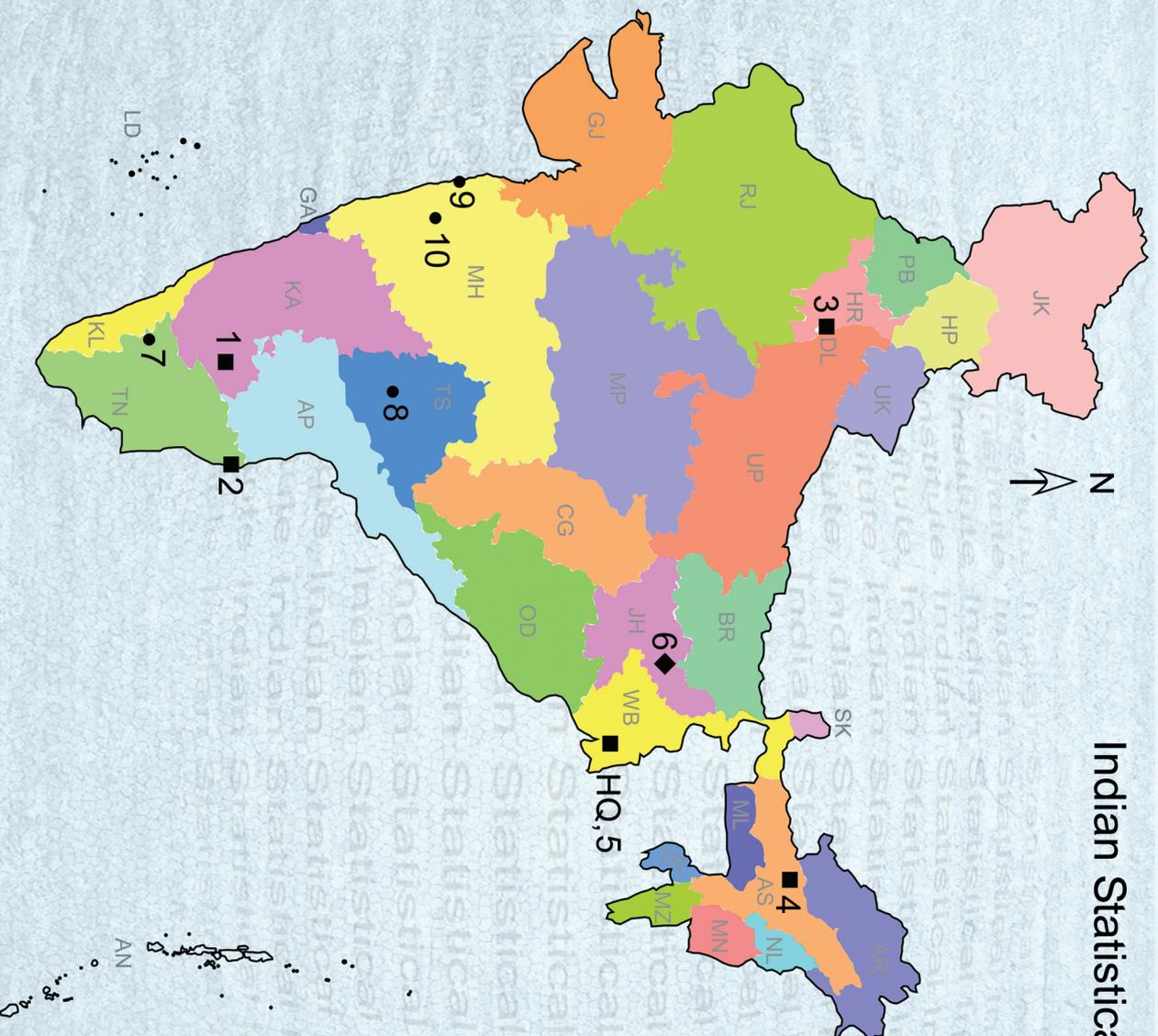
- B.Stat.(Hons.), B.Math.(Hons.), M.Stat., M.Math., M.S. in Quantitative Economics, M.S. in Quality Management Science, M.S. in Library and Information Science, M.Tech. in Computer Science, M.Tech. in Quality, Reliability and Operations Research
- Post Graduate Diploma in Statistical Methods and Analytics
- Post Graduate Diploma in Business Analytics (PGDBA) jointly with IIT Kharagpur and IIM Calcutta
- Post Graduate Diploma in Computer Applications (PGDCA)
- Junior/Senior Research Fellowships in several areas of natural and social sciences
- Statistical Training Diploma for students from developing countries (through International Statistical Education Centre)
- Ph.D. degrees in Statistics, Mathematics, Quantitative Economics, Computer Science and Quality, Reliability & Operations Research

The Institute also confers D.Sc. (Honoris Causa).

Organization of ISI by Divisions, Constituent Units and Associate Institutions



Indian Statistical Institute: Locations



Head Quarter (HQ)	Kolkata
Centres	■
1. Bangalore	
2. Chennai	
3. Delhi	
4. North-East (Tezpur)	
5. RC Bose	
Branch	◆
6. Giridih	
Outlying SAC & OR Units	●
7. Coimbatore	
8. Hyderabad	
9. Mumbai	
10. Pune	

Map: Not to the scale



General V. K. Singh, Minister, Govt. of India, Ministry of Statistics and Programme Implementation, visiting ISI Kolkata on 20 January 2016



Workshop on Computational Statistics organized by ISRU during 22-26 February 2016



Felicitation of Shri V. K. Saraswat, former director of DRDO at 122nd P.C.M. Birth Anniversary at ISI, Kolkata on 29 June 2015



Winter School on Application of Statistical Methods in Medicine organized by ASU during 7-18 March 2016



Prof. Takashi Gojobori, Director, National Institute of Genetics, Japan at the 'Distinguished Lecture in celebration of the 30th Anniversary of Department of Bio Technology' jointly organized by NIBMG and ISI on 04 November 2015



Prof. Francois Bourguignon, Emeritus Professor, former Chief Economist of the World Bank at a Lecture, organized by SOSU on 27 April 2015



ISI Delhi Centre



Dr. Asis Kumar Basak, Oncology Surgeon on International Women's Day at ISI, Kolkata on 8 March 2016



6th Workshop on Digital Pictorial Photography organized by Reprography and Photography Unit during 4 - 5 January 2016



Shri Mani Shankar Aiyar, lighting the Lamp at ISI Integration on 22 January 2016



Ritabrata Munshi, recipient of S. S. Bhatnagar Award delivering lecture at ISI, Kolkata on 9 November 2015



17th International Workshop on Combinatorial Image Analysis (IWICIA-2015) organized by ACMU during 24 - 27 November 2015



Prof. Mihir K Chaudhuri, Vice-Chancellor, Tezpur University, delivering Lecture at the School on Analysis and Topology at the ISI North East Centre, Tezpur during 22 February - 4 March 2016



Prof. Asit Chakravarti, Vice Chancellor, BCKV speaking at India Biodiversity meet organized by AERU during 16 - 18 November 2015



Prof. C. Rangarajan, President, ISI, Prof. S. Bandyopadhyay, Director, ISI and Col. S. Chakraborty, CE(Admin. & Fin) at ISI Annual General Meeting on 16 November 2015



Mr. Kaisar Alam speaking at the Hindi Pakhwada at ISI Delhi Centre on 14 September 2015



Inauguration of S. R. Ranganathan Archival Museum at ISI Bangalore Centre



Workshop on Achieving Breakthrough Quality organized by SQC & OR Unit, Coimbatore on 29 June 2015



Programme of Swachh Bharat Mission at ISI Kolkata on 5 October 2015



Symposium on Disaster Management & Risk Analytics under Big Data Paradigm organized by SQC & OR Unit, Kolkata in collaboration with National Institute of Disaster Management on 20 February 2016



5th Basic Adobe Photoshop Training Programme (for School Students) organized by Reprography and Photography Unit during 18 January - 5 February 2016



Workshop on Growth Curve Model at ISI Giridih Branch during 28 - 29 March 2016



Celebration of 124th Birth Anniversary of Dr. B. R. Ambedkar organized by ISI SC/ST/BC Employees' Co-ordination Council on 02 March 2016



Blood Donation Camp organized by ISI club on 21 January 2016



● Celebration of Republic Day 2016 at ISI Kolkata



● Workshop on Use of Open Source Integrated Library Management Software Koha organized by ISI Library during 29 February - 4 March 2016



● 64th Annual Sports at ISI on 4 February 2016



● Certificate programme for Six Sigma Black Belt organized by SQC & OR Unit, Hyderabad in June 2015



● Audio Drama Competition organized by ISI club on 17 March 2016



● ISI Chennai Centre

A BRIEF HISTORY OF THE INSTITUTE

In the 1920's, Prasanta Chandra Mahalanobis, then a Professor at Presidency College, Calcutta conducted several studies employing statistical methods with results that vindicated his ideas about the efficacy and possibilities of the emerging science of Statistics. In a meeting on 17th December 1931 presided by Sir R.N. Mukherjee, the first President of the Institute, the Indian Statistical Institute (ISI) was formally established and Prasanta Chandra Mahalanobis was appointed the Honorary Secretary. The Indian Statistical Institute was registered on 28th April, 1932, as a non-government and non-profit distributing learned society under the Societies' Registration Act No. XXI of 1860. The Institute is now registered under the West Bengal Societies Registration Act XXVI of 1961, amended in 1964. It has the following objectives:

- (i) To promote the study and dissemination of knowledge of Statistics, to develop statistical theory and methods, and their use in research and practical applications generally, with special reference to problems of planning for national development and social welfare;
- (ii) To undertake research in various fields of natural and social sciences with a view to the mutual development of Statistics and these sciences;
- (iii) To provide for, and undertake, the collection of information, investigations, projects, and operational research for purposes of planning and the improvement of efficiency of management and production.
- (iv) To undertake any other ancillary activities in fulfillment of the objectives (i), (ii) and (iii).

The Institute started functioning initially from a room of the Presidency College with enduring support from a number of distinguished personalities and devoted scholars in Kolkata. Over the first two decades, which turned out to be a glorious chapter in the annals of Indian science and institution building, the ISI embarked upon a series of pioneering programmes involving the application of Statistics in search of solution of the urgent and live problems of the country. Such programmes included innovative projects on sample surveys of yield and land utilisation of crops, socio-economic after-effects of Bengal famine and problems of flood research. These innovations and methodological research have since become classics in Statistics. At the same time, the training of scientific personnel began to grow. This also encouraged high level research and brought into focus the need for publication of the research results, for which *Sankhyā*, the first international journal of the country in Statistics, came into being in 1933.

Apart from the impact made in the world of Statistics, the Institute held a pivotal role in the task of nation building, when India became independent, through the brilliant choice of the area of surveys, which were socially and nationally relevant. The patronage and invaluable contribution of Sir Ronald A. Fisher played an important role. Led by Professor Mahalanobis and a very able group of younger statisticians including R.C. Bose, S.N. Roy and C.R. Rao, the Institute was poised to take on the larger role. The Institute is proud to have C.R. Rao, who is among the world leaders in statistical science over the last six decades and still active at the age of 93 as the Director of the Center for Multivariate Analysis at Pennsylvania State University, USA, in its list of alumni.

The 1950s saw the Institute establishing (i) a full fledged research and training school in Statistics and Probability, with its application in natural and social sciences, (ii) a planning wing entrusted with the formulation of the Second Five-Year Plan of India, (iii) publication of *Sankhyā*, (iv) the National Sample Survey wing engaging in comprehensive socio-economic data collection for the nation, (v) a string of Statistical Quality Control units for promoting the quality movement at various industrial centres in the country, (vi) a collaboration with the International Statistical Institute to train Government statisticians from Asia and Africa, and (vii) an Electronic Computer Laboratory that was responsible for developing (a) the 1st mechanical hand computing machine, (b) the 1st Analog computer, (c) the 1st

Brief History

Punched Card storing machine and (d) the 1st Solid State Computer in India, to name some of the principal activities. In 1954 Pandit Jawaharlal Nehru, the then Prime Minister of India, entrusted Professor Mahalanobis and ISI with the responsibility of preparing the draft Second Five-Year Plan for the country. The draft submitted by Prasanta Chandra Mahalanobis and the planning models formulated by him and his colleagues have since been regarded as major contributions to economic planning in India. In 1956, the Institute installed the first electronic computer in the country. In 1961, the ISI, in collaboration with Jadavpur University, undertook the design, development and fabrication of a fully transistorized digital computer, called ISI-JU-1, which was commissioned in 1966. The Institute, from its formative period till present times, received as guests eminent scientists, some of whom were Nobel Laureates. Besides Ronald A. Fisher, J.B.S. Haldane and Walter A. Shewhart, the luminaries included Frederic and Irene Curie, Neils Bohr, A.N. Kolmogorov, P.M.S. Blackett, J.D. Bernal, Joan Robinson, Genichi Taguchi and George Akerlof, 2001 Nobel prize winner in economics and a visiting professor of ISI during 1967-68. In recent times, the visit of Amartya K. Sen, Robert Aumann, Lotfi A. Zadeh, Joseph E. Stiglitz, Sir James A. Mirrlees, Eric Maskin, Ei-ichi Negishi and S.R.S. Varadhan, 2007 Abel Prize winner for his contributions to probability theory and an alumnus of the institute, may be specially mentioned.

The formal recognition came in December 1959, when Pandit Jawaharlal Nehru piloted in the Parliament the enactment of the Indian Statistical Institute Act of 1959, which designated ISI as an 'Institution of national importance'. The activities steadily grew, existing interests became more broad-based and a number of science units were created in the interest of live interaction between Statistics and Natural and Social Sciences. Empowered by the Act to award degrees, the Institute started the B. Stat. and M. Stat. courses. An excellent library was founded at Kolkata and the Documentation Research and Training Centre began functioning in Bangalore. Other developments in infrastructure also began.

During 1971-72, two decisions of the Government of India produced serious repercussions on the functioning of the ISI. One was de-linking of the Institute from the Perspective Planning Division of the Planning Commission in 1971, while the other was the separation of National Sample Survey from the ISI and its take-over by the Central Government in 1972. Professor Mahalanobis passed away on 28th June, 1972. It was a critical period for the Institute. To overcome the problem, the ISI sought to strike a judicious balance between the individual academic work on truly fundamental problems and the work that called for a greater engagement with the social and economic problems of the country. The members of the Institute, under the Chairmanship of Shri P.N. Haksar, held a Special General Body Meeting on 26th July, 1974 and amended the Memorandum of Association and the Regulations of the Institute, encouraging more inter-disciplinary research and enhancing active participation of the scientists of the ISI in decision-making process of the Institute. The organisational amendments were implemented, with the concurrence of Government of India, in August, 1976. The various research units in natural, social and computer sciences were grouped under a number of scientific Divisions.

Over the decades diversity in research thrusts began to grow manifold, with emphasis on Computer Science and application of Statistics in the new areas of research in natural and social sciences. Two centres, one at Delhi and one at Bangalore were created with full-fledged research and teaching programmes. The Delhi Centre, initially housed within the Planning Commission premises, was started in 1974, and shifted to its present campus in 1975. The Bangalore Centre was conceived by Prof. P.C. Mahalanobis during 1960s. With the Statistical Quality Control unit functioning in Bangalore from 1956, and Documentation Research and training Centre from 1962, Professor Mahalanobis thought of starting a centre of ISI around the mid-sixties. However, the activities of the Bangalore Centre started in September 1978 in a rented building under the Directorship of Professor G. Kallianpur. The various units moved to the present campus in May 1985 and in September 1996, the Bangalore Centre was formally declared as a Centre of ISI. The Chennai centre of the Institute came into being on 26th July, 2008 and has to its credit several theoretical and applied research work in Statistics and Mathematics, and many of the projects undertaken have been breakthrough applications. A North-East Centre of the Institute has been established at Tezpur, Assam on 23rd July, 2011 and it is also expected to focus on such diversity of teaching, training and research. This centre is currently housed in Tezpur

University campus. The Institute has started offering a one-year Postgraduate Diploma in Computer Applications (PGDCA) since the year 2014-15 at its Giridih Branch. A two-year full time diploma programme, Post Graduate Diploma in Business Analytics (PGDBA) is being jointly offered by ISI, IIT Kharagpur and IIM Calcutta since 2015 with 51 students in the first batch.

The Institute is fully funded by the Ministry of Statistics & Programme Implementation, Govt. of India. The support and encouragement of the Ministry of Statistics & Programme Implementation, Govt. of India are among the major factors which are helping the Institute to sustain its academic growth and excellence. The Ministry provides funds to the Institute under Plan & Non-Plan budget as per the recommendations of a committee set up for the purpose by the Ministry of Statistics & Programme Implementation, Govt. of India under Section 8(1) of the "Indian Statistical Institute Act. 1959, No. 57 of 1959" based on the programme of research, teaching, training and various academic activities. The grants-in-aid provided by the Ministry of Statistics & Programme Implementation, Govt. of India to the Institute includes the funds required for construction of buildings, hostels, guest house, purchase of equipments, hiring manpower etc. The Ministry plays a pivotal role in expansion of the research & training activities of the Institute by way of opening its new Centres in various parts of the country. The North-East Centre at Tezpur, Assam which was inaugurated by Shri Pranab Mukherjee, the then Finance Minister, Govt. of India and the then Chairman, Indian Statistical Institute Council in the presence of Shri Srikant Jena, Hon'ble Union Minister for Ministry of Statistics & Programme Implementation, Govt. of India; Shri Tarun Gogoi, Hon'ble Chief Minister, Govt. of Assam; Dr. T.C.A. Anant, Secretary, Ministry of Statistics & Programme Implementation, Govt. of India and other dignitaries. In July 2012, the Ministry of Statistics & Programme Implementation, Govt. of India approved establishment of R.C. Bose Centre for Cryptology and Security as a separate Centre of the Institute.

The present structure of eight divisions has been arrived at through some further changes. Recently there have been some changes. Systems Science and Informatics Unit (SSIU) has been started as a part of the Computer and Communication Sciences Division (CCSD) at ISI Bangalore centre in August 2009. The Documentation Research and Training Centre (DRTC) has been made a part of CCSD. Cryptology and Security Research Unit (CSRU) also became a part of CCSD since April, 2014. Which is an integral component of R.C. Bose Centre for Cryptology and Security, Kolkata, a national hub for cryptographic requirements. The Indian Statistical Institute Act of 1959 was amended by the Parliament in 1995 to empower the Institute to award Degrees/Diplomas not only in Statistics, but also in Mathematics, Quantitative Economics, Computer Science and such other subjects related to Statistics as may be determined by the Institute from time to time. Several new courses have also been added since: M. Tech. in Computer Science, M. Tech. in Quality, Reliability and Operations Research, M.S. in Quantitative Economics, B. Math. and M. Math.

In conclusion, a list of the distinguished scientists and statesmen who have served the Institute during the 82 years of its existence in the capacities of President, Chairman or Director is presented. A list of recipients of the honorary D. Sc. degree given by the Institute is also provided.

Presidents of the Institute

1	Sir Rajendra Nath Mookerjee	1932-35
2	Shri E.C. Benthall	1936-37
3	Shri James Reid-Kay	1938
4	Shri Badridas Goenka	1939-41
5	Dr. Nalini Ranjan Sarkar	1942-43
6	Dr. Chintaman D. Deshmukh	1944-63
7	Shri Y.B. Chavan	1964-66
8	Prof. Satyendra Nath Bose	1967-75
9	Shri Subimal Dutt	1976-89
10	Prof. M.G.K. Menon	1990-2012
11	Dr. C. Rangarajan	2012-till date

Brief History

Chairmen of the Institute

1	Shri B. Rama Rao	1954
2	Shri D.N. Mitra	1955-63
3	Shri K.P.S. Menon	1964-70
4	Shri S.C. Roy	1971
5	Dr. Atma Ram	1972
6	Shri. P.N. Haksar	1973-97
7	Dr. Bimal Jalan	1998-2001
8	Dr. N.R. Madhava Menon	2002-03
9	Shri Pranab Mukherjee	2004-12
10	Shri A.K. Antony	2012-14
11	Dr. Arun Shourie	2014-till date

Directors of the Institute

1	Prof. P.C. Mahalanobis	Dec 1931	-	June 1972
2	Prof. C.R. Rao	July 1972	-	June 1976
3	Prof. G. Kallianpur	July 1976	-	Sept 1978
4	Prof. B.P. Adhikari	Aug 1979	-	Oct 1983
5	Prof. Ashok Maitra	April 1984	-	Jan 1987
6	Prof. J.K. Ghosh	Jan 1987	-	Jan 1992
7	Prof. B.L.S. Prakasa Rao	Jun 1992	-	Feb 1995
8	Prof. S.B. Rao	July 1995	-	July 2000
9	Prof. K.B. Sinha	Aug 2000	-	July 2005
10	Prof. S.K. Pal	Aug 2005	-	July 2010
11	Prof. Bimal K. Roy	Aug 2010	-	July 2015
12	Prof. Sanghamitra Bandyopadhyay	Aug 2015	-	till date

List of persons awarded the D.Sc. (Honoris Causa) by the Institute

February 1962	Prof. Satyendra Nath Bose, Prof. Ronald A. Fisher, Pandit Jawaharlal Nehru, Dr. Walter A. Shewhart
April 1962	Prof. A.N. Kolmogorov
May 1965	Dr. Chintaman Dwarkanath Deshmukh
December 1974	Prof. Raj Chandra Bose, Dr. M.V. Keldysh, Prof. Jerzy Neyman
February 1977	Prof. Harald Cramer
February 1978	Shri Morarji Desai, Prof. L.V. Kantorovich
December 1989	Prof. C.R. Rao
January 2001	Prof. Gopinath Kallianpur
February 2004	Prof. S.R. Srinivasa Varadhan
March 2006	Prof. L.A. Zadeh
December 2006	Dr. Manmohan Singh
February 2011	Dr. Subhas Mukherjee (Posthumously)
January 2013	Prof. K.R. Parthasarathy, Prof. Jayanta Kr. Ghosh, Prof. Pranab Bardhan

Summary of Activities at a Glance

- **MoU with other Organisations (12 Nos.)** : Hitachi India Pvt. Ltd.;
Ericsson India Pvt. Ltd.;
National Research University, Russia;
Szechenyi Istvan University, Hungary;
Indian Institute of Technology, Madras;
Eastern Africa Statistical Training Centre,
Tanzania;
Airport Authority of India;
Tata Consultancy Services Ltd.;
BRAC University, Bangladesh;
State University of New York, USA;
London School of Economics, UK;
Tata Institute of Social Sciences.

- **Number of books published** : 23

- **Number of papers published** : 667

- **Number of Conferences, Workshops and Seminars held (Total – 468)** : 28 (Conference)
156 (Workshop)
284 (Seminar)

- **Prestigious Awards and Honours**
 - **Neena Gupta (Stat-Math Unit, Kolkata)** : A.K. Agarwal Award, IMS, 2015;
 - **Rajendra Bhatia (Stat-Math Unit, Delhi)** : Hans Schneider Prize,
International Linear Algebra Society;
 - **Tanvi Jain (Stat-Math Unit, Delhi)** : INSA Young Scientist Award, INSA;
 - **T.S.S.R.K. Rao (Stat-Math Unit, Bangalore)** : Fulbright Academic & Professional
Excellence Award, 2015-16;
 - **Ashis Sen Gupta (ASU, Kolkata)** : Distinguished Statistician Award,
Indian Society for Probability & Statistics, 2015;
 - **Chetan Ghate (EPU, Delhi)** : Mahalanobis Memorial (Gold) Medal,
The Indian Econometric Society;
 - **S.K. Pal (CSCR, Kolkata)** : Prof. S.N. Mitra Memorial Award, 2015.

- **Regional Mathematical Olympiad (RMO), 2015**
 - **Date** : 06 December, 2015
 - **Participants** : 207 (West Bengal),
1848 (Karnataka)
 - **Successful Students** : 35 (West Bengal),
44 (Karnataka)

- **Indian National Mathematical Olympiad (INMO), 2016**
 - **Date** : 17 January, 2016
 - **Participants** : 50

- **International Statistical Education Centre (ISEC)**
 - **Founded** : 1950
 - **Commencement date of 69th Term (2015-16)** : 03 August, 2015
 - **Number of Trainees** : 17
 - **Countries participated** : Fiji, Ghana, Laos, Malaysia, Mongolia
and Myanmar.

1. TEACHING AND TRAINING

A brief account of teaching and training activities of the Teaching and Training Division during the academic session **2015-2016** is given below.

Degree and Training Courses

During the academic session **2015-2016**, a total of **19767** candidates applied for admission and were called for written selection tests for various courses offered by the Institute, viz., B. Stat. (Hons.), B. Math. (Hons.), M. Stat., M. Math., Master of Science (M.S.) in Quantitative Economics, Master of Science (M.S.) in Quality Management Science, Master of Science (M.S.) in Library and Information Science, M. Tech. in Computer Science, M. Tech. in Quality, Reliability and Operations Research, Post Graduate Diploma in Statistical Methods and Analytics, Post Graduate Diploma in Computer Applications, Post Graduate Diploma in Business Analytics, **Research Fellowships** in Statistics, Mathematics, Quantitative Economics, Computer Science, Quality, Reliability and Operations Research, Physics and Applied Mathematics, Agriculture & Ecology, Biological Anthropology, Psychology, Geology, Sociology, Library and Information Science, and Development Studies. Admission tests were conducted at **35** different centres. A total of **13328** candidates finally appeared for admission tests and a total of **1395** candidates qualified in the written tests, and were called for interviews. Based on the performance in the written tests, interview and the academic records, **450** candidates were offered admission to various courses during the academic session under review.

The annual examinations for all the regular courses during 2014-2015 academic session were held during May 2015. The 2015-16 academic session commenced from **July, 2015**.

The number of candidates admitted to the different degree, Diploma programmes and in Junior Research Fellowship during 2015-2016 and the number of students who passed the annual examinations in 2015, are given in **Table 1**.

Till **31st March, 2016**, **92** trainees of Engineering and Technology courses from various Universities/Institutions (A. K. Choudhury School of Information Technology; Aliah University; Amity University, Rajasthan; Amity University, Noida; BMS College of Engineering, Bangalore; Burdwan University; Calcutta School of Tropical Medicine; Chennai Mathematical Institute; DAV Institute of Engineering and Technology, Jalandhar; Department of Biochemistry (CU); Department of Geology (CU); Doon University, Dehradun; Dr. B. R. Ambedkar National Institute of Technology, Jalandhar; Government College of Engineering and Ceramic Technology; Haldia Institute of Technology; Heritage Institute of Technology; Indian Institute of Engineering, Science and Technology- Shibpur; Indian Institute of Information Technology and Management, Kerala; Indian Institute of Science Education and Research, Kolkata; Indian Institute of Technology, Guwahati; Indian Institute of Technology, Kharagpur; Indian School of Mines, Dhanbad; Indian Statistical Institute; Institute of Engineering and Management; Jalpaiguri Government Engineering College; K.L. University, Vijayawada; Manipal Institute of Technology; Narula Institute of Technology; National Institute of Technology, Durgapur; Osmania University; RCC Institute of Information Technology; Ramakrishna Mission Vivekananda University; S. N. Pradhan Centre for Neurosciences (CU); SRM University; St. Xavier's College; Thapar University, Patiala; University of Calcutta; University of Kalyani; West Bengal University of Technology, Salt Lake) received four weeks/six weeks/two months/three months/four months and six months Project training in different Units of the Institute, viz., ACMU, AERU, ASU, BAU, BAU (HYDERABAD), CVPRU, DEAN'S OFFICE, ECSU, ERU, GSU, HGU, LRU, MIU, PAMU and SQC & OR under the guidance of different faculty members of the Institute.

Convocation

The **50th Convocation** of the Indian Statistical Institute was held on **15th January, 2016 at 2.00 P.M.** It was started with The Vedic Hymn by ISI Club, followed by a welcome address by Dr. C. Rangarajan, President, ISI, annual review by Prof. Sanghamitra Bandyopadhyay, Director, ISI, and Chairman's Address by Dr. Arun Shourie, Chairman of ISI Council, followed by a Convocation Address by Professor Ei-ichi Negishi, Nobel Laureate, Purdue University. The degrees and diploma were awarded to students by Dr. C. Rangarajan. . The Convocation was closed by Dr. C. Rangarajan, President, ISI, after a vote of thanks by Prof. Pradipta Bandyopadhyay, Dean of Studies, ISI and the National Anthem by ISI Club. The list of recipients of various medals and prizes is given below.

Prasanta Chandra Mahalanobis Gold Meda for the most outstanding performance in **M. Stat.** students (2013-2015) was given to:

Promit Ghosal

ISI Alumni Association **Mrs. M.R. Iyer Memorial Gold Medals** for outstanding performances were given to:

B. Stat. (Hons.): Suyash Gupta & Sohom Bhattacharya **M. Stat.** : Sourav Sarkar
M. S. (Q.E.) : Sneha Agrawal **M. Tech. (QROR):** Abhishek Maity

ISI Alumni Association **Rashi Ray Memorial Medals** for outstanding performance in **M. Tech. (CS)** (2013-2015) was given to:

Sebati Ghosh

ISI Alumni Association **P.C. Panesar Gold Medal** for outstanding performance in **M. Math.** (2013-2015) was given to:

Satyaki Mukherjee

D. Basu Memorial Gold Medal for outstanding performance in **B. Stat. (Hons.)** (2012-2015) was given to:

Suyash Gupta

Nikhilesh Bhattacharya Memorial Gold Medal for the best student in **B. Stat. (Hons.)** (2012-2015) was given to:

Suyash Gupta

S.H. Aravind Gold Medal for outstanding performance in **B. Math. (Hons.)** (2012-2015) was given to:

Abhra Abir Kundu

Sunity Kumar Pal Gold Medal for the best dissertation in **M. Tech. (CS)** (2013-2015) was given to:

Ashwin Jha

TCS award for the best dissertation in **M. Tech. (CS)** (2013-2015) was given to:

Archan Ray

Dr. N.S. Iyenger Award for best student of **Econometrics** (2015) was given:

Leena Kumar

Sabyasachi Roy Memorial Gold Medal for the best project work in second year of **M. Stat.** (2013-2015):

Shubhadeep Chakraborty

In addition to regular teaching duties in various academic programmes of the Institute, the faculty members of the Institute offer research courses in consultation with the research fellow advisory committees of respective divisions for the research fellows of the Institute.

Table – 1

**Number of students who passed during 2015 and
number of existing students/fellows during 2015-2016**

Sl. No.	Courses	Number of students who passed the Annual Examination		
		In 2015	During the year 2015-16	
01.	B. Stat. (Hons.) (Offered at Kolkata)	1 st year	23	35 ^{⊛⊛⊛}
		2 nd year	23	24 [⊛]
		3 rd year	16	24 [§]
02.	B. Math. (Hons./Pass) (Offered at Bangalore)	1 st year	23	24 [⊛]
		2 nd year	14	25 ^{⊛⊛}
		3 rd year	13	15 [⊛]
03.	M. Math. (Offered at Kolkata & Bangalore- in alternative year)	1 st year	23	17
		2 nd year	10	26 = (23+2 ^{⊛⊛} +1 [^])
04.	M. Stat. (Offered at Kolkata, Delhi & Chennai)	1 st year	48 ^{##} = (26+14+8)	32 ^{##} = (16+8+8 ^{⊛⊛})
		2 nd year	46	48
05.	M.S. (QMS) (Offered at Bangalore)	1 st year	12	11
		2 nd year	-	12
06.	M.S.(QE) (Offered at Kolkata & Delhi)	1 st year	34 [#] = (11+23)	37 [#] = (15+22)
		2 nd year	28 [#] = (08+20)	34 [#] = (11+23)
07.	M. Tech. (CS) (Offered at Kolkata)	1 st year	30	26
		2 nd year	23	30
08.	M. Tech. (QROR) (Offered at Kolkata)	1 st year	14	16
		2 nd year	17	14
09.	M.S. (Library and Information Science) (Offered at Bangalore)	1 st year	06	07
		2 nd year	10	06
10.	Post-Graduate Diploma in Statistical Methods and Analytics (Offered at North-East Centre, Tezpur)	1 st year	08	08
11.	Post-Graduate Diploma in Computer Applications (Offered at Giridih)	1 st year	03	07
12.	Post Graduate Diploma in Business Analytics (Offered at Kolkata)	1 st Semester	Results not yet declared	51
13.	Junior & Senior Research Fellows in different disciplines (Offered at Kolkata, Delhi, Bangalore, Chennai & Hyderabad)		34	164 ^{***}
Grand Total			458	693

⊛ One student repeating a year, ⊛⊛ Two students repeating a year, ⊛⊛⊛ Three students repeating a year

[^] One student result pending,

[§] One student in exchange programme,

[#] Total number including Kolkata and Delhi,

^{##} Total number including Kolkata, Delhi and Chennai,

^{***} JRF & SRF at Kolkata

Table 2

Ph. D degree awarded by the Institute in the 50th Convocation held on 15.01.2016

Sl. No.	Name of the Fellow	Title of the Thesis	Subject	University / Institute	Name of the Supervisor(s)
1.	Shashwat Raizada M. Tech. (CSE) (Indian Institute of Technology, Kanpur)	Some Results On Analysis And Implementation Of HC-128 Stream Cipher.	Computer Science	ISI	Prof. Subhamoy Maitra, ASU, Kolkata
2.	Mrinal Nandi Master of Statistics (Indian Statistical Institute)	Coverage and Detection in Wireless Sensor Networks.	Computer Science	ISI	Prof. Bimal Kumar Roy, ASU, Kolkata
3.	Subhadeep Banik M. Tech. (Automation and Computer Vision) (Indian Institute of Technology, Kharagpur)	Some Studies on Selected Stream Ciphers. Analysis, Fault Attack & Related Results.	Computer Science	ISI	Prof. Subhamoy Maitra, ASU, Kolkata
4.	Tanmay Basu MCA (Jadavpur University)	On Supervised and Unsupervised Methodologies for Mining of Text Data.	Computer Science	ISI	Prof. C.A. Murthy, MIU, Kolkata
5.	Somindu Chaya Ramanna M. Tech. (Computer Science) (Indian Statistical Institute)	Efficient and Adaptively Secure Constructions of Identity-Based Cryptographic Primitives.	Computer Science	ISI	Prof. Palash Sarkar, ASU, Kolkata
6.	Sahadev Bera M. Tech. (Computer Science) (Indian Statistical Institute)	Digital Circles and Balls: Characterization, Properties, and Applications to Image Analysis.	Computer Science	ISI	Prof. Bhargab B. Bhattacharya, ACMU, Kolkata
7.	Sanjay Bhattacharjee M. Tech. (Computer Science) (Indian Statistical Institute)	Tree-Based Symmetric Key Broadcast Encryption.	Computer Science	ISI	Prof. Palash Sarkar, ASU, Kolkata
8.	Partha Pratim Kundu Master of Engineering (West Bengal University of Technology)	Some Issues in Unsupervised Feature Selection Using Similarity.	Computer Science	ISI	Prof. Sushmita Mitra, MIU, Kolkata
9.	Shyamsundar Sahoo M. Sc. (Statistics) (University of Kalyani)	Graphical Tests and Model Diagnostics for Lifetime Data.	Statistics	ISI	Prof. Debasis Sengupta, ASU, Kolkata

Teaching and Training

10.	Abhik Ghosh Master of Statistics (Indian Statistical Institute)	Robust Minimum Divergence Inference using Density Power Divergence and its Extensions.	Statistics	ISI	Prof. Ayanendranath Basu, ISRU, Kolkata
11.	Arunangshu Biswas M. Sc. (Statistics) (Indian Institute of Technology Kanpur)	On the analysis of some recursive equations in Probability.	Statistics	ISI	Prof. Gopal Basak, SMU, Kolkata
12.	Tanushree Haldar Master of Statistics (Indian Statistical Institute)	The Statistical Battle between Population-based Genetic Association Analyses and Family-based Transmission Disequilibrium Tests with Special Emphasis on Quantitative Traits.	Statistics	ISI	Prof. Saurabh Ghosh, HGU, Kolkata
13.	Sedigheh Mirzaei Salehabadi Master's Degree in Statistics (Isfahan University of Technology, Iran)	Inference on time-to-event distribution from retrospective data with imperfect recall.	Statistics	ISI	Prof. Debasis Sengupta, ASU, Kolkata
14.	Raju Maiti M. Sc. (Statistics) (Indian Institute of Technology Kanpur)	Discrete-valued Time Series and Coherent Forecasting.	Statistics	ISI	Prof. Atanu Biswas, ASU, Kolkata
15.	T.S. Vignesh Master of Statistics (Indian Statistical Institute)	Some contemporary issues in software reliability.	Statistics	ISI	Prof. Bimal Kumar Roy and Prof. Anup Dewanji, ASU, Kolkata
16.	Munmun Biswas Master of Statistics (Indian Statistical Institute)	Some distribution-free two-sample tests applicable to high dimension, low sample size data.	Statistics	ISI	Dr. Anil Kumar Ghosh, SMU, Kolkata
17.	Debleena Thacker M. S. in Mathematical Science (Indian Institute of Science, Bangalore)	Infinite Color Urn Models	Mathematics	ISI	Prof. Antar Bandyopadhyaya, SMU, Delhi

Teaching and Training

18.	Neha Hooda M. Sc. (Mathematics) (Indian Institute of Technology, Delhi)	On Rational Subgroups of Exceptional Groups.	Mathematics	ISI	Prof. Maneesh Thakur, SMU, Delhi
19.	Soumalya Joardar M. Sc. (Mathematics) (Indian Institute of Technology Bombay)	Quantum Symmetries of Classical Manifolds and their Cocycle Twists.	Mathematics	ISI	Prof. Debashish Goswami, SMU, Kolkata
20.	Kaushik Majumder M. Sc. (Mathematics) (University of Burdwan)	Maximal Intersecting Families of Finite Sets.	Mathematics	ISI	Prof. Bhaskar Bagchi, SMU, Bangalore
21.	Suprio Bhar Master of Mathematics (Indian Statistical Institute)	Semi-martingales and Stochastic Partial Differential Equations in the scope of Tempered Distributions.	Mathematics	ISI	Prof. B. Rajeev, SMU, Bangalore
22.	Sauvik Mukherjee M. Sc. (Mathematics) (Indian Institute of Technology Bombay)	Foliations with Geometric Structures: An approach through <i>h</i> -principle.	Mathematics	ISI	Prof. Mahuya Datta, SMU, Kolkata
23.	Mihir Bhattacharya M. A. (Economics) (Delhi School of Economics, Delhi University)	Essays in Political Economy and Voting.	Quantitative Economics	ISI	Prof. Arunava Sen, EPU, Delhi
24.	T.C.A. Madhav Raghavan M. A. (Economics) (Delhi School of Economics, Delhi University)	Essays on Efficiency, Fairness and Strategy- Proofness in Allocation Problems with Exact Capacity Constraints.	Quantitative Economics	ISI	Prof. Arunava Sen, EPU, Delhi
25.	Soham Sahoo M. A. (Economics) (Jadavpur University)	Essays on the Economics of Education.	Quantitative Economics	ISI	Dr. Abhiroop Mukhopadhyay, EPU, Delhi
26.	Ridhima Gupta M.Sc. (Economics) (Warwick University)	Essays on Air Pollution, Global Warming & Agricultural Productivity.	Quantitative Economics	ISI	Prof. E. Somanathan, EPU, Delhi
27.	Anuradha Saha M. A. (Economics) (Delhi School of Economics, Delhi University)	Services Sector and Non- balanced Growth.	Quantitative Economics	ISI	Prof. Satya P. Das, EPU, Delhi

28.	Pawan Gopalakrishnan M. A. (Economics) (Delhi School of Economics, Delhi University)	Essays in Dynamic Macroeconomics and Fiscal Policy.	Quantitative Economics	ISI	Prof. Chetan Ghate, EPU, Delhi
29.	Abdul Quadir M. A. (Economics) (Jawaharlal Nehru University)	Essays on Auctions and Mechanism Design.	Quantitative Economics	ISI	Prof. Debasis Mishra, EPU, Delhi
30.	Soumendu Sarkar M. A. (Economics) (Visva Bharati)	Mechanism Design for Land Acquisition.	Quantitative Economics	ISI	Prof. Arunava Sen, EPU, Delhi
31.	Sonal Yadav M.A. (Economics) (Delhi School of Economics, Delhi University)	Essays on Strategy Proofness and Implementation.	Quantitative Economics	ISI	Prof. Arunava Sen, EPU, Delhi
32.	Dushyant Kumar M. A. (Economics) (Jawaharlal Nehru University)	Essays on Conflict and Organisation Theory.	Quantitative Economics	ISI	Prof. Prabal Roy Chowdhury, EPU, Delhi
33.	Bhargav Pratim Bhattacharya Master of Statistics (Indian Statistical Institute)	Essays on Inequality, Polarization and Contests.	Quantitative Economics	ISI	Prof. Satya Ranjan Chakravarty, ERU, Kolkata
34.	Kushal Banik Chowdhury M. Sc. (Economics) (University of Calcutta)	Modelling the Links between Inflation, Output Growth, Inflation Uncertainty and Output Growth Uncertainty in the Frameworks of Regime-Switching and Multiple Structural Breaks: Evidence from the G7 Countries.	Quantitative Economics	ISI	Prof. Nityananda Sarkar, ERU, Kolkata
35.	Sandip Sarkar M. Sc. (Economics) (The University of Burdwan)	Complete and Partial Ordering Approaches in the Context of Poverty Ordering and on the Impacts of Growth and Inequality on Poverty: A Study on India.	Quantitative Economics	ISI	Prof. Manoranjan Pal, ERU, Kolkata

Teaching and Training

36.	Rajit Biswas M. Sc. (Economics) (University of Calcutta)	Essays on International Economics in Presence of Economies of Scale and Monopolistic Competition.	Quantitative Economics	ISI	Dr. Brati Sankar Chakraborty, ERU, Kolkata
37.	Kanika Mahajan M.A. (Economics) (Jawaharlal Nehru University)	Essays on Economics of Gender and Labour Market.	Quantitative Economics	ISI	Prof. Bharat Ramaswami, EPU, Delhi

Table 3

Research Fellows who have been awarded Ph. D degree by Academic Bodies other than ISI during 2015 for work done in the ISI

Sl. No.	Name of the Fellow	Title of the Thesis	University	Name of the Supervisor (s)
1.	Shivani Santosh	Cognitive Self-Efficacy In Schizophrenia.	University of Calcutta	Dr. Debdulal Dutta Roy, PRU, ISI, Kolkata
2.	Uposoma Sinha	Urban Living And Health Among The Elderly Of Kolkata.	University of Calcutta	Prof. Barun Mukhopadhyay, BAU, ISI, Kolkata
3.	Namrata Tomar	Development of In Silico Methods for Analysis of Integrated Biochemical Pathways.	University of Calcutta	Dr. Rajat Kumar De, MIU, ISI, Kolkata
4.	Somnath Tagore	Mining Certain Pathways in Metabolomics.	Jadavpur University	Dr. Rajat Kumar De, MIU, ISI, Kolkata and Dr. Nirmalya Chowdhury, Jadavpur University
5.	Samyadeb Bhattacharya	Quantum Tunneling in Dissipative Systems and its Applications.	University of Calcutta	Prof. Sisir Roy, PAMU, ISI, Kolkata
6.	Haradhan Maity	Turbulence Statistics of Flow over Obstacle marks: an Experimental and Theoretical Study.	University of Calcutta	Prof. Bijoy Singha Mazumder, PAMU, ISI, Kolkata
7.	Debashree Chowdhury	Theoretical Study of Quantum Spin Transport.	University of Calcutta	Prof. Banasri Basu, PAMU, ISI, Kolkata
8.	Rimpal Kar	Study of the Quaternary Sediments in the foredeep of Darjeeling Himalaya and its bearing on Tectonics and Climate Changes.	Jadavpur University	Dr. Tapan Chakraborty, GSU, ISI, Kolkata

Teaching and Training

9.	Uma Jyothi Kommoju	Identification of Susceptibility Genes Associated with Type 2 Diabetes Mellitus in the Population of Andhra Pradesh, India.	Andhra University, Visakhapatnam	Prof. B. M. Reddy, Molecular Anthropology Group, BAU, ISI, Hyderabad
10.	Sukalpa Chanda	A Computational Forensic Approach to the Analysis of Questioned Document Fragments.	Gjøvik University College, Norway	Prof. Katrin Franke, Gjøvik University College, Norway and Prof. Umapada Pal, CVPRU, ISI, Kolkata
11.	Nabin Sharma	Multi-lingual Text Processing from Video.	Griffith University	Prof. Michael Blumenstein, Griffith University, Australia and Prof. Umapada Pal, CVPRU, ISI, Kolkata
12.	Anirban Mukherjee	Automatic Diagram Drawing based on Natural Language Text Understanding.	Indian Institute of Engineering, Science and Technology (IIST), Shibpur	Dr. Utpal Garain, CVPRU, ISI, Kolkata and Dr. Arindam Biswas, IIST, Shibpur
13.	Shamsher Singh	Access to Basic Amenities: A Sociological Study of Villages in Selected States of India.	University of Calcutta	Dr. Molly Chattopadhyay, SRU, ISI, Kolkata and Prof. Madhura Swaminathan, EAU, ISI, Bangalore
14.	Tridip Sardar	Models and data studies on two important communicable diseases: Cholera and Dengue.	University of Calcutta	Prof. Joydev Chattopadhyay, AERU, ISI, Kolkata
15.	Sourav Kumar Sasmal	Mathematical studies on Allee effect in interactive population.	University of Calcutta	Prof. Joydev Chattopadhyay, AERU, ISI, Kolkata and Dr. Yun Kang, Arizona State University, USA
16.	Santosh Biswas	Disease in ecological systems and its control: A model based theoretical approach.	Jadavpur University	Prof. Joydev Chattopadhyay, AERU, ISI, Kolkata
17.	Amiya Ranjan Bhowmick	An extended family of density dependent growth curve models and related ecological issues.	University of Calcutta	Dr. Sabyasachi Bhattacharya, AERU, ISI, Kolkata
18.	Nikhilesh Sil	Insight of mathematical models of several disease: Deterministic and stochastic approach.	Jadavpur University	Dr. Sabyasachi Bhattacharya, AERU, ISI, Kolkata and Dr. Priti Kumar Roy, Jadavpur University, Kolkata

Teaching and Training

19.	Anindita Chatterjee	Study of an invasive plant: <i>Alternanthera philoxeroides</i> with special reference to its Adaptive Potential & Phenoplasticity.	University of Calcutta	Prof. Anjana Dewanji, AERU, ISI, Kolkata
20.	Bhubon Mohan Das	Health status and health behavior of Santals: Study of urban and rural groups.	University of Calcutta	Prof. Subrata K. Roy, BAU, ISI, Kolkata
21.	Shouvik Mitra	Carbon dots and zinc oxide nanostructures: Synthesis, fabrication, biological and biomedical applications.	Jadavpur University	Prof. Arunava Goswami, AERU, ISI, Kolkata

Number of candidates who were awarded degrees in the 50th Convocation of the Institute held on 15th January, 2016

Degree /Diploma	Number of candidates
Doctor of Philosophy (Ph.D.)	58 *
Master of Technology (M. Tech.) in Computer Science	23
Master of Technology (M. Tech.) in Quality, Reliability and Operations Research	17
Master of Statistics (M. Stat.)	46
Master of Mathematics (M. Math.)	10
Master of Science (M.S.) in Quantitative Economics	28
Master of Science (M.S.) in Library and Information Science	10
Bachelor of Statistics (Honours) [B.Stat. (Hons.)]	16
Bachelor of Mathematics (Honours) [B.Math. (Hons.)]	13
Post-Graduate Diploma in Statistical Methods and Analytics	08
Post-Graduate Diploma in Computer Applications	03
Total	232

* (Including those who worked in the Institute but were awarded Ph.D. degree by other academic bodies.)

International Statistical Education Centre (ISEC)

The International Statistical Education Centre (ISEC) was founded in 1950 at the initiative of Professor P.C. Mahalanobis. The Centre opened at Kolkata through an agreement between the International Statistical Institute and the Indian Statistical Institute (ISI). At present, the Centre is run by the Indian Statistical Institute under the auspices of the Government of India. The Centre functions under a joint Board of Directors. In its history of more than 60 years, Prof. P.C. Mahalanobis was the Chairman of the Board of Directors since the inception of the Centre in 1950 until his death in 1972. Since then, Professor C.R. Rao had been the Chairman of the Board till 2015. Currently, Prof. S.P. Mukherjee is the Chairman of the Board.

The Centre aims to provide training in theoretical and applied statistics at various levels to selected participants from countries of the Middle East, the South and the South-East Asia, the Far-East and the commonwealth countries of Africa. The primary training programme is a 10-month regular course in Statistics leading to a Statistical Training Diploma. In addition, special courses on different topics of varying duration are also organized.

The commencement date of the 69th Term of the ISEC Regular Course (2015-2016) was August 3, 2015. There were 17 trainees from six countries, namely, (1) Fiji, (2) Ghana, (3) Laos, (4) Malaysia, (5) Mongolia and (6) Myanmar. Ten trainees were supported by fellowships under the ITEC/SCAAP of the Government of India, four trainees were supported by fellowships of the Asian Development Bank and three were supported by the Central Bank of Sri Lanka. They will be awarded the Statistical Training Diploma in the Convocation, scheduled on May 30, 2016. Prof. Bikash Sinha, Visiting Scholar, Arizona State University, USA and ex-Professor of the ISI will be delivering the convocation address.

The ISEC in its totality has shifted now to the first floor in a new building, named Deshmukh Bhavan, at 202, B.T. Road, Kolkata 700108, having four class rooms, one computer laboratory, one library and number of rooms for the Member-Secretary, the Programme Coordinator and the faculty members with all modern amenities including scope for interactive presentations. It has now its independent logo indicating the Indian objective of making learning an area of international cooperation. Professor Sanghamitra Bandyopadhyay, Director, ISI has taken special interest in enhancing the international image of the ISEC courses and the infrastructure. The trainees have been provided with computer facilities and internet connections in the Computer Laboratory and in the ISEC hostel. They have also access to the books at the ISI library. Teachers at the headquarter of the Indian Statistical Institute and officers of the Government of India at the National Statistical Systems Training Academy, the National Sample Survey Office and various ministries have been participating in teaching the Regular Course during this year. Till now, nearly 1600 trainees from about 84 countries have received the Statistical Training Diploma.

2. RESEARCH AND OTHER SCIENTIFIC ACTIVITIES

The major thrust of the Institute is on research in various disciplines comprising Theoretical and Applied Statistics, Mathematics, Computer Sciences, Biological Sciences, Economics and other Social Sciences, Physics and Earth Sciences, Statistical Quality Control and Operations Research, and Library and Information Sciences. Scientists of the Institute carry out independent research in their own basic discipline and also undertake interdisciplinary research in collaboration with other units within the Institute and also with outside organizations. The Institute also takes up various internally and externally funded projects in diverse fields on challenging live problems of national and international importance. As a part of research activities, scientists of the Institute are involved in consultancy work as well. This section gives a brief account of the principal areas of work over the past year of the scientific divisions of the Institute, namely, the Divisions of:

Theoretical Statistics and Mathematics

Applied Statistics

Computer and Communication Sciences

Physics and Earth Sciences

Biological Sciences

Social Sciences

Statistical Quality Control and Operations Research

Library, Documentation and Information Sciences

In addition, there is a report each from the 'Center for Soft Computing Research: A National Facility' and the 'Computer and Statistical Services Centre'.

Theoretical Statistics and Mathematics Division

Stat-Math Unit, Kolkata

Cryptography

Attribute-Based Encryption: We continue with our work on Attribute Based Encryption. We obtain Functional Encryption (FE) schemes for finite languages from standard static assumption. We have obtained 2 schemes. Both the schemes are shown to be secure in the standard model.

Rana Barua and Tapas Pandit

Commutative Algebra

A general method has been described for construction of a pair of 4-dimensional seminormal affine domains which are 2-stably isomorphic but not 1-stably isomorphic; and concrete examples have been displayed over the field of complex numbers and real numbers.

T. Asanuma and Neena Gupta

A necessary and sufficient condition has been discovered for the threefold defined by $x^m y = F(z, t)$ to be the kernel of a $k[X_1]$ -linear locally nilpotent derivation of the polynomial ring $k[X_1, X_2, X_3]$,

X_4]. It has also been established that the affine threefold $xy=f(z, t)$ over a field of characteristic zero is isomorphic to the affine 3-space if and only if $f(z,t)$ is a variable in $k[z,t]$.

S.M. Bhatwadekar, Neena Gupta and Swapnil Lokhande

The cancellation property of the polynomial ring in 2 variables over any arbitrary field k (not necessarily perfect) has been established.

S.M. Bhatwadekar and Neena Gupta

A survey around the Epimorphism Problem has been made highlighting the known partial results and open questions on the epimorphism problem for higher dimensions, closely related problems on affine spaces like the problem of affine fibrations, cancellation problems and linearization problems, and using the theory of affine fibrations, an earlier theorem of Neena Gupta on the embedding of certain classes of hypersurfaces in the affine 4-space over a field has been extended to a large class of integral domains.

A.K. Dutta and Neena Gupta

Non-Commutative Geometry

Quantum isometry Groups: D. Goswami and A. Mandal: We continue our study of quantum isometry groups of spectral triples on group C^* algebras and made more computations. Levi-civita problem in noncommutative geometry: J. Bhowmick, D. Goswami and S. Joardar. We formulated a definition of metric and corresponding Levi civita connection for noncommutative manifolds given by spectral triples and proved the existence and uniqueness of such connections in several interesting cases. Non-existence of genuine quantum symmetry: D. Goswami, A. Mandal, P. Etingof (MIT, USA), C. Walton (MIT, USA): We proved some no-go results for noncommutative Hopf algebra co-actions on certain commutative algebras in a purely algebraic framework.

Debashish Goswami

Geometry and Topology

a) We studied Nambu structure on manifolds. We introduced a notion of 'Weak Lie-Filippov bialgebroid' and show that manifolds which admits Nambu structure of order greater than 2 naturally yields such structures. Conversely, if a smooth manifold admits a Weak Lie-Filippov bialgebroid structure then the base manifold is a Nambu-Poisson manifold. This extends a result known for Poisson manifolds.

b) We introduced a notion of modular class of a Leibniz algebroid extending the notion of a Lie algebroid. We compute this modular class for the Leibniz algebroid associated to a Nambu-Poisson manifold. It turns out that this modular class is a constant multiple of the modular class of the Nambu-Poisson manifold. Our result extends results known for Poisson manifolds.

Apurba Das and Goutam Mukherjee

Measure on the space of isometric maps of \mathbb{R} into \mathbb{R}^3 . The problem of associating a measure to the solution space of a differential equation has been mentioned by M. Gromov in the literature. This question has been investigated in the context of Nash technique for obtaining isometric C^1 - immersions. Starting from a short map $f_0: I \rightarrow \mathbb{R}^3$ on the unit interval, a random isometric map f_n has been constructed for each positive integer n , such that the difference $f_n - f_0$ goes to zero (in C^0 norm). It has been observed that the distribution of $n^{1/2} (f_n - f_0)$ converges (weakly) to a white noise measure on the function space.

Amites Dasgupta and Mahuya Datta

Convex hypersurfaces in 5-dimensional Contact manifolds Convex surfaces were characterized by Giroux for contact 3 manifolds. It was also shown that convex surfaces are generic. In this work, convexity condition on hypersurfaces in 5-dimensional Contact manifolds M has been characterized in terms of dividing sets which are necessarily contact 3-manifolds. Such surfaces are not generic unlike

Research Activities

in dimension 3. It has been, however, observed that a generic surface S in a contact 5-fold is convex away from a 2-dimensional submanifold Σ .

Mahuya Datta and Dheeraj Kulkarni

Harmonic Analysis

Dynamics of the multiplier operators on Riemannian symmetric spaces: A multiplier is a translation invariant linear operator acting on the function spaces (e.g. on the Lebesgue spaces). By function spaces we usually mean measurable complex valued functions defined on an n -dimensional Euclidean space. However the definition makes sense if we substitute Euclidean space by a manifold with a given group action and a Borel measure which is invariant under the action. We have established the following non-Euclidean phenomenon for the Riemannian symmetric spaces of noncompact type. Given any multiplier T which is bounded on a Lebesgue space of exponent $p > 2$ of such a manifold, there are complex scalars c such that cT will have chaotic dynamics on that Lebesgue space.

Swagato K Ray and Rudra Sarkar

A classical result states that if orbit of a bounded function under the "action" of the Laplacian remains uniformly bounded then the function is an eigenfunction of Laplacian with the eigenvalue of absolute value one. This is a normalized version of the fact that growth of such an orbit of a function can determine if the function is an eigenfunction of the Laplacian, in other words one can characterize eigenfunction through the boundedness of the orbit in an appropriate normed space. This Euclidean result was generalized to hyperbolic spaces in recent years for real eigenvalues. However the method used there is not tenable for complex eigenvalues. This motivates to take up the following programmes for Riemannian symmetric spaces and in particular for hyperbolic spaces.

1. Characterize the eigenfunction of Laplacian with complex eigenvalues.
2. Looking at action of Laplacian as a multiplier, generalize the result for other multipliers.
3. Investigate relation between eigenfunction of a multiplier and that of the Laplacian.

Muna Naik and Rudra Sarkar

We are continuing our research related to *Uncertainty principles in Harmonic Analysis*. We are currently working with some classical uncertainty principles related to works of A.E. Ingham, N. Levinson and Paley-Wiener. Roughly speaking, these results say that if an integrable function vanishes on a positive measure set then its Fourier transform cannot have a very rapid decay at infinity. The main ingredients of these results are certain classical results regarding quasianalytic functions which are available only in the context of real line or the circle. We have extended some of these results to the Euclidean spaces and the Torus. Our next attempt was to extend these results to noncommutative, noncompact Lie groups. So far, we have succeeded in extending some of these results to two step Nilpotent Lie groups (whose prototype is the Heisenberg groups) and connected, noncompact semisimple Lie groups with finite center (a prototype is $SL(2, \mathbb{R})$). We were also able to relate these uncertainty principles with the problem of unique continuation of solutions of the Schrodinger equation on Euclidean spaces, Nilpotent Lie groups and Riemannian symmetric spaces of noncompact type.

Mithun Bhowmik, Swagato K. Ray and Suparna Sen (Inspire fellow)

Number Theory

A result on gaps between nonzero coefficients of cusp forms was extended in a special case for forms of level larger than one. It was observed that the quantum Unique Ergodicity conjecture holds on average for the cocompact case which is still open (for individual forms). Both are joint work with Soumya Das.

Satadal Ganguly

I continued working on the subconvexity problem for higher degree L-functions. Also in collaboration with Roman Holowinsky and Zhi Qi, we worked on the cancellation of additive twists of $GL(3)$ Fourier coefficients. In another vein, with T.D. Browning, we obtained the asymptotic for the density of rational points on certain cubic hypersurfaces.

Ritabrata Munshi

Statistics and Probability

This work develops a test for intercept homogeneity in fixed-effects one-way error component models assuming slope homogeneity. We show that the proposed test works equally well when intercepts are assumed to be either fixed (non-stochastic) or random. Moreover, this test can also be used to test for random effect vs. fixed effect although in the restrictive sense. The test is shown to be robust to cross-sectional dependence; for both weak and strong dependence. The proposed test is shown to have a standard χ^2 limiting distribution and is free from nuisance parameters under the null hypothesis. Monte Carlo simulations also show that the proposed test delivers more accurate finite sample sizes than existing tests for various combinations of N and T . Simulation study shows that F -test is either over-sized or under-sized depending on the pattern of cross-sectional dependence.

G.K. Basak and S. Das (ERU)

Adaptive Markov Chain Monte Carlo (AMCMC) is a class of MCMC algorithms where the proposal distribution changes at every iteration of the chain. In this case it is important to verify that such a Markov Chain indeed has a stationary distribution. In this paper we discuss a diffusion approximation to a discrete time AMCMC. This diffusion approximation is different when compared to the diffusion approximation as in Gelman, Gilks and Roberts (1997) [5] where the state space increases in dimension to ∞ . In our approach the time parameter is sped up in such a way that the limiting process (as the mesh size goes to 0) approaches to a non-trivial diffusion process.

G. K Basak and Arunangshu Biswas

Regulated industries and antitrust law. We examine the merits of subjecting an incumbent supplier of regulated services to antitrust review. We show that antitrust review can harm consumers even when the review entails no direct costs of implementation. The consumer harm arises in part because imperfect antitrust review can crowd out more effective regulatory oversight. More generally, antitrust review can usefully complement regulatory oversight, but affects the nature of the optimal regulatory policy. Free probability, large dimensional random matrices and large dimensional time series. These three are major current topics and we connect them probabilistically for statistical purposes. Free probability is a natural analogue of usual probability when the underlying variables are non-commutative (such as matrices). We use free probability in an asymptotic sense to establish limit spectral distribution of certain random matrices. These results in turn are used to develop statistical inference procedures in high dimensional linear time series models.

Arup Bose

Non-parametric statistics, Rates of convergence in Central Limit Theorem (CLT), Law of iterated logarithms (LIL) and Characterization theorems. Growth Curve Model and plant sensitivity, Applications of Statistics to Industrial quality control, Physics, Sociology, Agriculture, Education and other natural sciences.

Ratan Dasgupta

In the last one year I have worked on various aspects of random matrices, Gaussian free field and branching random walk. In random matrices, we have shown that in Wigner matrices one can take long range dependent entries from the Gaussian process and the eigenvalue statistics changes remarkably due to the presence of dependence. In application of this result we have shown that regularity properties in free convolutions can be derived. In Gaussian free fields we have studied fractal properties of the cut-offs for the fields and derived the Hausdorff dimension. We have general universality results which can be applied to various well known ultraviolet cut-offs used in conformal field theory. In discrete Gaussian free field we have studied that maxima of the Gaussian fields in higher

Research Activities

dimensions and shown its scaling limits which was an open conjecture. In Branching random walk the theory of topmost particle is a well studied object but when displacements of branching random walks are heavy tailed nothing much is known in the literature. We have now developed the theory to study the rescaled configurations of a branching random walk in the heavy tailed regime. The limiting point process satisfies certain stability property which was conjectured by two physicists Brunet and Derrida. In our work prove the conjecture in the heavy tailed set-up.

Rajat Subhra Hazra

In a joint work with Vicky Fasen, Karlsruhe Institute of Technology, it was established by Parthanil Roy that the large deviations issues for point processes induced by stable random fields depends heavily on the length of memory and hence on the ergodic theoretic nature of the underlying group action. In another work, two related conjectures of two statistical physicists were proved to be true for branching random walks having power law displacements.

Ayan Bhattacharya, Rajat Subhra Hazra and Parthanil Roy

Stat-Math Unit, Delhi

A New Approach to Classical and Modern Pólya Urn Schemes

In two earlier works, we introduced a new generalization of balanced Pólya urn schemes for infinite, but countably many colors. In this work, we further extends the study of the infinite color balanced Pólya urn models for color set indexed by any Polish space (so can be uncountable) and for general replacement kernels. The major contribution of the work is to embed the sequence of randomly selected color into a branching Markov chain on the (infinite) random recursive tree. We call this embedding the Grand Representation of the Urn. We use this representation as the key tool to study the asymptotic properties of various urn schemes for both finite and infinite colors, and show that all the classical results can be re derived easily and new results can be obtained for non-classical urns.

Antar Bandyopadhyay and Thacker Debleena

Negatively Reinforced Urn Schemes

In this work we consider general negatively reinforced urn schemes with finitely many colors. We will call an urn scheme *negatively reinforced*, if the selection probability for a color is proportional to the weight w of the color, where w is a decreasing function. Under some assumptions on w , such as, w is strictly decreasing continuously differentiable on $(0,1)$ and $w(0) < \infty$, we obtain almost sure convergence of the random configuration of the urn for a general replacement matrix R . We show that depending on the function w and the replacement matrix R , the limit may be a constant or a random variable. However, if R is double stochastic, in particular, if R is symmetric, then the limit is uniform. For certain weight functions we show that Gaussian scaling limit of the deviations from the limiting behavior can also be obtained after subtracting the limiting constant.

Antar Bandyopadhyay and Gursharn Kaur

Matrix Analysis

Studies on positive definite matrices and positive definite functions were continued. Symplectic eigenvalues of positive definite matrices have been of importance in mechanics, optics, and recently in quantum information. Variational principles, perturbation theorems and relations between symplectic eigenvalues of matrix functions were established. Oscillation properties of eigenvalues of some structured matrices were studied. Criteria for positive definiteness of some function were established.

R. Bhatia and Tanvi Jain

Fundamental Theorem of Asset Pricing

Research Activities

A concept of 'No Approximate Arbitrage with Controlled Risk- NAACR' was introduced and it was shown to be equivalent to the existence of equivalent martingale measure (EMM. This seems to be the only result characterising EMM in terms of absence of (suitable notion of) arbitrage in the class of simple strategies.

Abhay Gopal Bhatt and Rajeeva Laxman Karandikar

Bootstrap based estimation in binary regression in presence of partially misclassified responses using pseudo likelihood.

Arindam Chatterjee, Tathagata Bandyopadhyay and Sumanta Adhya

Pseudo-likelihood based estimation naturally arises when responses are partially misclassified in a binary regression framework. We provide a rigorous and clear study of the asymptotic properties of the pseudo likelihood estimator in this set up and further establish that the bootstrap consistently estimates the asymptotic distribution of the pseudo likelihood estimator.

Arindam Chatterjee

Nonparametric Estimation of Quantile Density Function using wavelets

Isha Dewan, Christophe Chesneau and Hassan Doosti

Associated Random Variables - Probabilistic and Inferential aspects

Isha Dewan and Mansi Garg

Current-Status Data- some testing problem under competing risks,

Isha Dewan, P.G. Sankaran and E.P. Sreedevi

Worked on the irreducibility of a general family of classical orthogonal polynomials, particularly Hermite-Laguerre polynomials and got some interesting results generalizing an earlier result of Schur and also obtained results on their associated Galois groups.

Shanta Laishram, S. Nair and T.N. Shorey

Worked on Laguerre polynomials $L^{(q)}(x)$ and $L^{(q)}(x^d)$ with $q \in \{\frac{1}{3}, \frac{2}{3}, \frac{1}{4}, \frac{3}{4}\}$, where d is the denominator of q , are irreducible for every n except when $q = \frac{1}{4}$, $n=2$ where we give the complete factorization. In fact we proved much more general results.

Shanta Laishram and T.N. Shorey

Worked on exponential diophantine equations involving sums of products of consecutive integers. Proved finiteness results and gave some explicit results when the number of terms is at most 10.

Shanta Laishram, J Hajdu and S. Tengely

Worked continued to prove that there are only finitely many perfect powers in products of terms of elliptic divisibility sequences and gave an explicit method to find those perfect powers.

Shanta Laishram, L. Hajdu and M. Szikszai

Worked on upper lower bounds for occurrence of Rectangles Of Non-visible Lattice Points.

Shanta Laishram and F. Luca

Worked on some interesting applications of an explicit version of abc-conjecture due to Baker to the perfect powers in products of terms of arithmetic progression.

Shanta Laishram and T.N. Shorey

Worked on to showed that Waring's problem is a consequence of an explicit version of abc-conjecture.

Shanta Laishram

Research Activities

Worked on exponential diophantine equations involving terms of binary recurrence sequences.

Shanta Laishram and P Das

Super efficient estimator for fundamental frequency model

An algorithm has been developed to estimate the nonlinear parameter in fundamental frequency model. The proposed algorithm is basically a modified version of Newton-Raphson algorithm. The estimator has same rate of convergence as the least squares estimator. In addition the asymptotic variance is less than that of the least squares estimator.

Swagata Nandi and Debasis Kundu

Burst Signal in stationary noise

Burst signal model can be used to analyze signals, having burst type features like ECG or EEG signals, under certain conditions. The least squares method is studied to estimate the unknown parameters in case of stationary error. We show that the least squares estimators are strongly consistent and find their asymptotic distribution as Gaussian.

Swagata Nandi

Structure of the L_2 space of the quantum $SU(3)$ group

We prove a decomposition theorem for the natural representation of the C^* -algebra $C(SU_q(3))$ on the L_2 space of $SU_q(3)$ for $q \neq 0$. In particular, this involves a deeper understanding of the C^* -algebra $C(SU_q(3))$ at $q=0$. This is part of an ongoing work that aims to investigate the representation of $C(SU_q(n+1))$ on $L_2(SU_q(n+1))$, which would lead to a better insight into the geometry of type A compact quantum groups. The present work is an extremely important but a baby step towards that goal.

Arup K. Pal and Partha Sarathi Chakraborty

Isomorphism between certain quantum homogeneous spaces

The quotient space $SP(2n)/SP(2n-2)$ is the quaternion sphere H^{2n} . It is well-known that the quaternion sphere H^{2n} is homeomorphic to the odd dimensional sphere S^{4n-1} . We prove a noncommutative counterpart of this result. We first prove that the C^* -algebra $C(SP_q(2n)/SP_q(2n-2))$ is finitely generated. Making use of the generators obtained in the course of the proof, we then use the theory of homogeneous C^* -extensions due to Pimsner, Popa and Voiculescu to show that this algebra is isomorphic to the odd dimensional quantum sphere S_q^{4n-1} for all $q \in [0,1)$. One very interesting and useful consequence of this is that the C^* -algebras $C(SP_q(2n)/SP_q(2n-2))$ for different values of $q \in [0,1)$ are all isomorphic.

Bipul Saurabh

Worked on the asymptotic properties of the rank of random matrices, both Ginibre and Wigner matrices. This work improved on the order in which the rank approaches 1. Also it holds not only when the entries are i.i.d. Bernoulli, but arising from any random variable which admits a jump. In particular, the rate is a function of the largest jump of the random variables forming the matrix.

Rahul Roy

Worked on drainage networks and the Brownian web. Here we obtained a mathematical derivation of the empirically observed Hack's law in drainage networks. This was done via a diffusive scaling of the random graph which constitutes the drainage network.

Rahul Roy, Anish Sarkar and Kumarjit Saha

Worked on developing an alternate criteria for convergence to Brownian Web for lattice models with non-crossing paths.

Anish Sarkar and Kumarjit Saha

I have continued my research on the Kneser-Tits problem for groups of type E_8 and E_7 with anisotropic kernel of type E_6 . This problem is of interest because of its connections with simple groups. If G is a simple, simply connected algebraic group, defined and isotropic over a field k , and if Kneser-Tits conjecture holds, then the group $G(k)$ is projectively simple. This also connects with a geometric property called R -triviality.

Maneesh Thakur

We have proved this conjecture for groups of type E_8 and E_7 whose anisotropic kernel comes from Albert division algebras of first kind. We have proved that the underlying varieties of these groups are retract k -rational.

Maneesh Thakur

Embeddings of rank-2 tori in algebraic groups:

In this paper, I investigated cohomological conditions under which certain rank-2 tori embed in a given group of type G_2 , F_4 or A_2 . I also derived some interesting applications to my results.

Maneesh Thakur and Neha Hooda

Worked on rational subgroups of exceptional groups

Maneesh Thakur and Neha Hooda

Stat-Math Unit, Bangalore

Push-forward at the level of Chow groups

The relation of monodromy and algebraic cycles has been discussed and further it has been understood how to detect the kernel of the push-forward using the relation with monodromy. Also research has been carried out to understand algebraic cycles on symmetric powers of an algebraic variety, blow ups and base changes of symmetric powers. The first result is useful to approach conjectures like the Bloch's conjecture on the surfaces of general type. The second one is very important to understand the geometry of symmetric powers.

Kalyan Banerjee

Constructed crystallizations of mapping tori. These crystallizations are genus minimal for most of the cases. In particular, it was proved that there exists an orientable 4-manifold with regular genus 6, other than the topological product of projective space and circle, which disproves a conjecture of Spaggiari. Gave the characterization a class of 3-regular colored graphs and using this, presented a simple proof of the classification of closed surfaces.

Biplab Basak

Symmetric homomorphisms and completely bounded maps

Continued work on symmetric homomorphisms on C^* -algebras. These are homomorphisms which are not $*$ -preserving but nevertheless have certain regularity or symmetry properties. We use them to get structure theorems for completely bounded maps.

Nirupama Mallick and Sumesh K.

Williamson form

Initiated a new approach to the study of normal operators on real Hilbert spaces. This would be useful in obtaining Williamson forms of Gaussian covariance matrices in infinite dimensions.

B.V. Rajarama Bhat and Tiju Cherian John

Extendability for Gaussian states

We study extendability and complete extendability for bipartite Gaussian states. It is seen that complete extendability is equivalent to separability even in the Gaussian case. This is a joint work with Ritabrata Sengupta and K R Parthasarathy of ISI Delhi and was internally funded by 'Advances in Non-Commutative Mathematics Project' approved through PPEC.

B.V. Rajarama Bhat

Rational homotopy of maps between certain complex Grassmann manifolds

In this work, conditions which imply that any continuous map between two distinct complex Grassmann manifolds $G_{n,k}$ and $G_{n,l}$ is rationally null homotopic, have been studied.

Prateep Chakraborty and Shreedevi K. Masuti

Factorizations of the Characteristic Functions

Let \mathcal{H} and \mathcal{K} be Hilbert spaces and $L \in \mathcal{B}(\mathcal{H}, \mathcal{K})$ be a contraction. Then the *Julia-Halmos matrix* J_L corresponding to L is the unitary matrix

$$J_L = \begin{bmatrix} L^* & D_L \\ D_{\{L^*\}} & -L \end{bmatrix}.$$

The Julia-Halmos matrix has long played an important role in the theory of contraction operators on Hilbert spaces, for example, it appears in the factorizations of the characteristic functions of contractions with invariant subspaces (Sz.-Nagy-Foias Theory). In this work, it was obtained that the similar factorizations results in multi-variable set-up for the characteristic functions of noncommutative row contractions and of constrained row contractions with joint invariant subspaces. Moreover, it has established the converses to these results. Regularity properties of factorizations were also discussed.

Kalpesh Haria, Jaydeb Sarkar and Amit Maji

Orbifold curves and orbifold bundles

Formal orbifolds curves, their fundamental groups and orbifold bundles in positive characteristic were defined and studied.

Manish Kumar and A.J. Parameswaran

Orbifold bundles are related to parabolic bundles in characteristic zero. In positive characteristic, the right analogue is being investigated.

Manish Kumar and Souradeep Majumdar

The étale fundamental groups of curves over pseudo algebraically closed field is being studied.

Manish Kumar and Lior Bary-Soroker

Formal orbifolds to higher dimension and their étale fundamental group in positive characteristic and arithmetic situation are being introduced and studied.

Manish Kumar

In Grothendieck duality, an important task is to relate the abstract construction of the twisted inverse-image pseudofunctor to the concrete aspects of duality such as those involving differential forms. Over smooth maps of noetherian schemes, Verdier's isomorphism gives a starting point for such an endeavour. In our research we develop ways of explicitly describing Verdier's isomorphism in terms of residues of differential forms and use this to explicate other relations that occur in situations involving compositions of maps, e.g., when both maps are smooth, or when a smooth map is factored as a regular immersion into a smooth map.

Suresh Nayak and Pramath Sastry

Works on distal actions is continued. New properties for affine actions are explored.

C.R.E. Raja

Work has been completed on a paper titled 'Martingale Chaoses' and submitted for publication. The main results are a definition of multiple stochastic integrals for a class of Continuous martingales and associated chaos expansions. We study the relationship between chaos expansions and the martingale representation theorem.

B. Rajeev

Continuing the ongoing study of ruin problem for a multidimensional insurance network, a notion of multidimensional ladder height distribution was defined, an expression for the same was obtained, and a Pollaczek-Khinchine formula for the ruin probability was proved. One-dimensional ladder height distribution had been defined by Feller about 50 years back.

S. Ramasubramanian

Much water has flown ever since Milnor's discovery of non-equivalent smooth structures on a topological 7-sphere in 1959. In the thesis, the effect of taking connected sum on the smooth structures of Hyperbolic Manifolds and Projective Spaces was considered. Following this work, also considered the effect of taking connected sum on the smooth structures of a closed $(n - 1)$ -connected $2n$ -manifold M^{2n} , where $n = 4, 8$, and the real projective 7-space $\mathbb{R}P^7$. In particular, gave a diffeomorphism classification of closed smooth manifolds in the tangential homotopy type of M^{2n} in a paper titled "Homotopy **Inertia Groups and Tangential Structures**". In a paper titled " **Smooth Structures on a Fake Projective Space**", it was showed that the group of smooth homotopy 7-spheres acts freely on the set of smooth manifold structures on a topological manifold M which is homotopy equivalent to the real projective 7-space. It was also showed that M has, up to diffeomorphism, exactly 28 distinct differentiable structures with the same underlying PL structure of M and 56 distinct differentiable structures with the same underlying topological structure of M .

Ramesh Kasilingam

Geometry of the Multiplicatively Closed Sets Generated by at most Two Elements and Arbitrarily Large Gaps

In this article, using an explicit construction of arbitrarily large integer intervals with a known prime factorization of the end points of the intervals which do not contain any element from a multiplicatively closed set, existence of arbitrarily large gaps is proved in the case of the multiplicatively closed set generated by at most two elements. By using a geometric correspondence between maximal singly generated multiplicatively closed sets and points of the space $\mathbb{P}F_{\mathbb{Q}_{\geq 0}}^{\infty}$, a criterion is given, as to, when a finitely generated multiplicatively closed set gives rise to a doubly multiplicatively closed line. In the appendix section another constructive proof for arbitrarily large gap intervals where the prime factorization is not known for the right end-point is given unlike the constructive proof of the main result of the article in the case of multiplicatively closed set $\{p_1^i p_2^j \mid i, j \in \mathbb{N} \cup \{0\}\}$ with $p_1 < p_2, \text{Log}_{p_1}(p_2)$ irrational for which the prime factorization is known for both the end-points of the gap interval via the stabilization sequence of the irrational $\frac{1}{\text{Log}_{p_1}(p_2)}$.

On the Surjectivity of Certain Maps

In this article the surjectivity of three maps has been proved by the author. Firstly the surjectivity of the chinese remainder reduction map associated to projective space of an ideal with a given factorization into ideals whose radicals are pairwise distinct maximal ideals has been proved. Secondly the surjectivity of the reduction map of the strong approximation type for a ring quotiented by an ideal which satisfies unital set condition has been proved. Finally for a dedekind domain, for $k \geq 2$, the map from k -dimensional special linear group to the product of projective spaces of k -mutually comaximal ideals associating the k -rows or k -columns is surjective has been proved.

Various types of approximation properties and the 3-space problems, stability results for them were studied. A notion of extremely strict ideals was introduced and a cancellation theorem for these ideals in the context of injective tensor products was obtained. It was shown that the classical separable Gurariy spaces are the only ones which are almost isometric ideals in every embedding in a superspace. In collaboration with Dr Sudeshna Basu, the notion of ball small combination of slice property was introduced and the relation to M -ideal, strict ideals and directsums was investigated.

T.S.S.R.K. Rao

- (1) A concrete parameterization of wandering subspaces in several variables has been obtained.
- (2) Uniqueness property of Arveson's dilation for n -tuples of commuting operators has been established.
- (3) For a large class of pair of commuting contractions, a sharper version of non Neumann inequality, in terms of distinguished variety, has been obtained. Along the way, an explicit version of Ando's dilation has been obtained.
- (4) Analytic characterizations of polynomial characteristic functions has been obtained.
- (5) Connection between factorizations of operator valued analytic functions and upper triangular representations of contractions have been established in several variables.

Jaydeb Sarkar

Almost complex Structures

A necessary condition was obtained for having an almost complex structure on the product $S^{2m} \times M$, where M is a connected orientable closed manifold. It has been shown that if the Euler characteristic $\chi(M) \neq 0$, then except for finitely many values of m , do not have almost complex structure on $S^{2m} \times M$. In the particular case when $M = \mathbb{C}\mathbb{P}^n$, $n \neq 1$, it was proved that if $n \not\equiv 3 \pmod{4}$ then $S^{2m} \times \mathbb{C}\mathbb{P}^n$ has an almost complex structure if and only if $m = 1, 3$. As an application, conditions on the nonexistence of almost complex structures on Dold manifolds were obtained.

Ajay Singh Thakur and Prateep Chakraborty

Group actions and non-Kähler complex manifolds

New class of non-Kähler complex manifolds were constructed using proper actions of reductive complex Lie groups on complex manifolds. In particular, non-Kähler complex manifolds associated to effective complex analytic orbifolds were constructed.

Ajay Singh Thakur and Mainak Poddar

Limit theory for geometric statistics of clustering point processes

In an ongoing project with B. Blaszczyzyn (ENS-INRIA, Paris) and J. Yukich (Lehigh University, USA), proved weak laws, variance asymptotics and central limit theorem for geometric functionals of general point processes under a weak asymptotic independence condition known as clustering. Such limit theorems were either earlier known for linear statistics of clustering point processes or non-linear statistics of specific point processes. The general results greatly extend this to non-linear statistics of more general point processes including the recent interesting examples of zeros of Gaussian entire functions and determinantal point processes. Illustrative of specific applications, this general result can be used to obtain central limit theorem for U-statistics of zeros of Gaussian entire functions or intrinsic volumes of the Boolean model on determinantal point processes. Highlight of this work is that, a central limit theorem for edge-lengths of the k -nearest neighbour graphs on determinantal point processes with an exponentially decaying kernel can be obtained. En route, a key step is the proof of clustering of mixed moments using a series expansion via factorial moments and it is believed that these results might be of independent interest in proof of moderate deviations and other limit theorems for geometric functionals of general point processes. Considered another interesting feature of the

various geometric statistics and that is their asymptotic variance is at most of volume order and if it is not of volume order, it is at most surface order.

D. Yogeshwaran

Persistent Betti Numbers of a point process

In an ongoing project with Primoz Skraba (JSI, Slovenia), investigating random measures generated by persistent Betti numbers of the Boolean model. Persistent Betti numbers are important topological signatures of the point process and have been a key tool in the emerging area of topological data analysis. When the underlying point process is random, the measures induced by the Persistent Betti numbers is a random measure in the plane. Asymptotics of linear statistics of this random measure as the observation window of the point process is enlarged is looked at. Proved a strong law and are currently working towards the proof of a central limit theorem. Apart from extending the recent work of the author on limit theorems for Betti numbers to the more complicated statistic of Persistent Betti numbers, these results are also some of the first results on Persistent Betti numbers of point processes. With the usage of these statistics in topological data analysis, the probabilistic results might serve as null hypothesis in various statistical applications.

D. Yogeshwaran

Stat-Math Unit, Chennai

Extreme points method and univalent harmonic mappings: In Complex Analysis and Dynamical Systems IV

We consider the class of all sense-preserving complex-valued harmonic mappings f defined on the unit disk with the standard normalization with the second complex dilatation ω . sufficient conditions on the analytic part of f and that of ω that would imply the univalence of harmonic mappings f are discussed. Several examples are illustrated and a few open problems are also stated.

Y. Abu Muhanna and S. Ponnusamy

Turán type inequalities for general Bessel functions

Turán type inequalities for the general Bessel function, monotonicity and bounds for its logarithmic derivative are derived. Moreover the series representation and the relative extrema of the Turánian of general Bessel functions are obtained. The key tools in the proofs are the recurrence relations together with some asymptotic relations for Bessel functions.

Á. Baricz, S. Ponnusamy and S. Singh

Turán type inequalities for confluent hypergeometric functions of the second kind

Some tight Turán type inequalities for Tricomi confluent hypergeometric functions of the second kind are deduced, which in some cases improve the existing results in the literature. Alternative proofs for some already established Turán type inequalities are given. Moreover, by using these Turán type inequalities, some new inequalities for Tricomi confluent hypergeometric functions of the second kind are established. The key tool in the proof of the Turán type inequalities is an integral representation for a quotient of Tricomi confluent hypergeometric functions, which arises in the study of the infinite divisibility of the Fisher-Snedecor F distribution.

Á. Baricz, S. Ponnusamy and S. Singh

Linear connectivity, Schwarz-Pick lemma and univalence criteria for planar harmonic mappings

Schwarz-Pick lemma for higher-order derivatives of planar harmonic mappings is obtained and this is applied to obtain univalence criteria. Distortion theorems, Lipschitz continuity and univalence of planar harmonic mappings defined in the unit disk with linearly connected images are discussed.

Sl. Chen, S. Ponnusamy, A. Rasila and X. Wang

On quasismetry of quasiconformal mappings and its applications

The main purpose here is to establish nine equivalent conditions for a bounded domain, which is quasiconformally equivalent to a bounded and simply connected uniform domain, to be a John domain. This result is a generalization of the main result of Heinonen proved in 1989.

M. Huang, S. Ponnusamy, A. Rasila and X. Wang

Maximal area integral problem for certain class of univalent analytic functions

One of the classical problems concerns the class of analytic functions f on the open unit disk $|z| < 1$ which have finite Dirichlet integral $\Delta(1, f)$, where

$$\Delta(r, f) = \iint_{|z| < r} |f'(z)|^2 dx dy \quad (0 < r \leq 1)$$

The extremal problem of determining maximum of $\Delta(r, z/f)$ as a function of r is solved when f belongs to certain families of conformal mappings that was studied extensively. This settles the question raised by Ponnusamy and Wirths in 2013. Also, one of the particular cases includes solution to a conjecture of Yamashita which was settled recently by Obradović et. al (2014).

S. Ponnusamy, S.K. Sahoo and N.L. Sharma

Julia's lemma on the hyperbolic disk

An extension of the Julia-Miller-Mocanu's lemma for holomorphic functions defined on the unit disk endowed by the hyperbolic metric is proved. The extension is made by following on the one hand the way of the differential subordinations theory and on the other hand the method of Lagrange multipliers, like in an extension of the Julia-Miller-Mocanu lemma for holomorphic mappings of functions of n -dimensional Euclidean spaces C^n .

Á. Baricz, S. Ponnusamy and C. Varga

The univalence criteria, Lipschitz-type spaces on pluriharmonic mappings

Properties of pluriharmonic mappings defined in the unit ball are investigated. In particular, relationships between the univalence of pluriharmonic mappings and linearly connected domains are discussed and Lipschitz-type spaces for pluriharmonic mappings are studied.

Sh. Chen, S. Ponnusamy and X. Wang

The quasiconformal subinvariance property of John domains in R^n and its applications

A complete solution to one of the open problems, raised by Heinonen from 1989, concerning the subinvariance of John domains under quasiconformal mappings in R^n is proved. As application, the quasismetry of quasiconformal mappings is discussed.

M. Huang, Y. Li, S. Ponnusamy and X. Wang

Sections of stable harmonic convex functions

The family of normalized stable harmonic convex mappings of the unit is considered. The problem of determining r such that every section of functions in this family map sub disk $|z| < r$ onto a domain convex or close-to-convex are addressed. Also, properties of harmonic convolution functions from two different geometric families of functions are discussed. In particular, slanted half-plane mappings or an asymmetric vertical strip mappings are used to derive several new results.

L. Li and S. Ponnusamy

Uniformly starlike and uniformly convex harmonic mappings

Necessary and sufficient conditions for a sense-preserving harmonic function to be univalent and uniformly starlike (resp. uniformly convex) in the open unit disk are presented.

S. Ponnusamy, J. K. Prajapat and A. Sairam Kaliraj

Constants and characterization for certain classes of univalent harmonic mappings

Growth, covering, integral representation, and area theorems for certain families of sense-preserving univalent harmonic functions which are close-to-convex in the unit disk are obtained. Representation of minimal surface associated with this class is also given whenever the second complex dilatation is a square of an analytic function. Also, a sufficient condition for a sense-preserving harmonic function to be univalent and close-to-convex is determined. Finally, the disk of univalence and close-to-convexity of certain classes of harmonic functions are also examined.

S. Ponnusamy and A. Sairam Kaliraj

On the coefficient conjecture of Clunie and Sheil-Small on univalent harmonic mappings

The coefficient conjecture of Clunie and Sheil-Small for a class of univalent harmonic functions which includes functions convex in some direction is proved. Growth and covering theorems and some related results are obtained. Finally, two conjectures are stated. An affirmative answer to one of which would then imply, for example, a solution to the conjecture of Clunie and Sheil-Small.

S. Ponnusamy and A. Sairam Kaliraj

Applied Statistics Division

The Applied Statistics Division came into being in September 1996 in place of the Applied Statistics, Survey and Computing Division. The Computer Science Unit was renamed as the Applied Statistics Unit and the Biometry Unit was transferred to the Biological Science Division. Till 2005-2006, the Applied Statistics Division consisted solely of the Applied Statistics Unit. In 2006, a new unit, namely, the Bayesian and Interdisciplinary Research Unit was created within this Division. It was subsequently renamed Interdisciplinary Statistical Research Unit in October 2014. The following are the research and other activities of the Applied Statistics Division during the year.

Applied Statistics Unit, Kolkata

Scientists of the Applied Statistics Unit (ASU) are involved in various teaching, training, research and development activities. This unit regularly conducts teaching/training programmes like North-east Workshops and Winter/Summer Schools for researchers/teachers/other users of statistics on topics of general interest. Scientists of the unit conduct research in various areas of statistics, mathematics and computer science, including cryptology, with special emphasis on applications. Some members collaborate with other units of ISI on joint projects and also with scientists from other Universities/Institutions. The major research interests of the Unit faculty include Sample Surveys, Design of Experiments, Combinatorial Methods and their Applications, Multivariate Analysis, Reliability and Survival Analysis, Clinical Trials, Asymptotic Theory of Statistics, Bayesian Statistics, Model Selection, Multiple Hypothesis Testing, Analysis of Directional Data, Environmental Statistics, Time Series Analysis, Cryptology, Mathematical Genomics. A brief account of the current research activities and studies is given below.

Design of Experiments

The problem of optimal allocation of units with fixed covariate values into two or more treatment groups was investigated and an algorithmic approach was suggested to arrive at a near-optimal solution. This solution was found to give the exact optimal solution for small sample sizes. The

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proposed algorithm was found to have an application in solving the Travelling Salesman's Problem (TSP).

Anup Dewanji

Reliability

Standard models for software reliability often do not take into account the fact that debugging may take place periodically, rather than continuously. Based on a discrete model adapted to periodic debugging data, a method for specifying the reliability of a software has been developed. Different identifiability issues under dynamic Stress-Strength models have been studied; some work on estimation of model parameters based on specific data configurations have also been considered. An investigation into defining a broad class of failure time models based on the stress-strength mechanism is on. Some work on optimal censoring scheme in the context of progressive hybrid censoring and Reliability Acceptance Sampling Plan (RASP) have been carried out. This is being extended to some special cases of random censoring.

Anup Dewanji

Stress Dependent Strength probability distributions

New Stress Dependent Strength probability distributions were derived and related inference problems were studied.

Ashis SenGupta

Survival Analysis

Some work on nonparametric estimation of competing risks with current status data was in progress.

Anup Dewanji

Multiple Testing and Minimax Estimation

Exact asymptotic optimality of a multiple hypothesis testing rule based on a general class of normal scale mixture prior has been established. This class of priors includes the important global-local scale mixture prior, namely the Horseshoe prior. Exact minimax rate optimal estimation under sparsity using one-group shrinkage priors has been established.

Arijit Chakrabarti and Prasenjit Ghosh

Directional Statistics

Possibly asymmetric and multimodal probability distributions on Smooth Manifolds were constructed and applied to real-life data. Multivariate Cylindrical and Toroidal Regression were constructed with applications. Matching priors for Bayesian inference were studied for several circular distributions in the context of their mean directions.

Ashis SenGupta

Circular-circular regression and spherical-spherical regression problems were studied.

Atanu Biswas

Discrete-valued time series

Modeling, analysis and coherent forecasting were done for discrete-valued time series data. In particular, both categorical and count data were considered in the Bayesian setup. Some Bayesian methods are under investigation.

Atanu Biswas

Group Sequential Design

Some problems on inverse sampling based group sequential design were studied in the context of odds ratio.

Atanu Biswas

A new group sequential design for both early acceptance and early rejection was constructed and its optimality properties were studied.

Ashis SenGupta

Response-adaptive designs

Research on optimal response-adaptive designs was carried out under different types of constraints.

Atanu Biswas

Financial Statistics

Models for high volatility multivariate financial data and related inference were studied.

Ashis SenGupta

Survey Sampling

For non-linear functions of finite population totals, appropriate estimators based on large-scale surveys are taken as the same functions of respective unbiased estimators of the totals for which variance estimators are derived through Taylor-series expansions. This fails in case of Spearman's rank correlation coefficient. But results have been derived covering instead Kendall's rank correlation coefficient, with necessary innovative adjustments. In case of Randomized Response Techniques (RRT) usually RR's are derived by classical Bernoulli trials. Recently results have appeared showing efficacy of Inverse Bernoulli trials. Further useful applications with necessary adjustments have been shown to be useful.

Arijit Chaudhuri, Kajal Dihidar (SOSU) and Purnima Shaw

Spatio-temporal Health Statistics

In order to identify (i) spatial clusters and (ii) changes in the spatio-temporal pattern of risk prevalence of Tuberculosis, Log Empirical Bayesian Kriging methods were used for spatio-temporal mapping of Tuberculosis. Variation in pattern, shape and number of clusters of New Smear Positive Tuberculosis were observed over space and time in North 24 Parganas District in West Bengal. Log Empirical Bayesian Kriging methods resulted more accurate prediction. Visual identification of changing pattern of risk prevalence help in targeted prevention. Ordinary Kriging Model was also used for Spatial Mapping of New Smear Positive Tuberculosis. Proportion of New Smear Positive Patients (NSPP) initiated on **treatment during 2nd Quarter 2010 in 22 Tuberculosis Units (TUs) in the North 24 Parganas District in West Bengal** were used as study variables. The best-fit-line in the semivariogram of the Ordinary Kriging Model was used to predict attribute values at locations where attribute had not been measured. Hot spots of risk prevalence were found across the varied geographical regions in the district. Clusters with higher prevalence were mostly observed along the border of Bangladesh. Visual identification of Hot spot help to monitor the risk prevalence.

Kasturi Basu

Cryptology

Bi-affine and Quadratic equations for S-Boxes Based on Power Mappings have been obtained. Research has been done on Cryptographically significant MDS matrices.

Kishan Gupta

For almost a decade, the design and cryptanalysis of stream ciphers has been considered in this unit. Most of the state-of-the-art commercial stream ciphers have been cryptanalyzed. These works have

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been quite well accepted in international scenario. In particular, the cryptanalysis on RC4 opened a new direction that finally made RC4 so vulnerable that it is now being considered to be discontinued from SSL. In addition to this, public domain stream ciphers such as Grain, HC-128, Salsa, ChaCha and other eSTREAM portfolio ciphers have also been analysed. The stream ciphers can actually be seen as pseudo-random number generators. Towards cryptanalysis, the main targets are to obtain the initial seed and/or specific non-randomness of the output sequences. This could be successfully achieved in a series of works in this area that had been published in top international journals and conferences.

Subhamoy Maitra

Research was conducted on Authenticated Encryption (AE), Symmetric Key Domain Extension and Hardware implementation of newly proposed AE and universal hash functions which are very important components of AE. Several existing AE have been analyzed.

Mridul Nandi

Research was carried out in different areas of cryptography and cryptanalysis including identity-based broadcast encryption, symmetric key broadcast encryption, discrete logarithm problem on different algebraic structures, formal statistical/probabilistic analysis of block cipher cryptanalysis and modes of operations of block and stream ciphers.

Palash Sarkar, Sanjay Bhattacharjee, Somindu C. Ramanna, Shashank Singh,
Subhabrata Samajder and Sebati Ghosh

Mathematical Genomics

(i) Degeneracy of genetic code as reflected in the codon table has been explained with the help of a mathematical parameter named 'Impression' of amino acids, which has also been used successfully to classify a given family of proteins.

(ii) A 2D graphical representation of DNA sequence has been derived from mathematical denotation of DNA sequences based on dual nucleotides (DN). The data sets are mainly Olfactory Receptor of *Homo sapiens* and its three homologs. Further, Protein-Protein Interactions (PPIs) of two different proteins ABCB11 and ADA have been studied, especially to find the factors that regulate the PPIs across two species namely *Homo sapiens* and *Mus musculus*. The interaction of a protein with different set of proteins in different species is also being studied.

(iii) In the context of the Carry Value Transformation (CVT), which is a modification of the Integral Value Transformation (IVT) and falls within the category of discrete dynamical systems, multi-number CVT and XOR operations were used for multi-number arithmetic in any base system.

Pabitra Pal Choudhury

Interdisciplinary Statistical Research Unit, Kolkata

Mean Square Error Estimation in Randomized Response Surveys

Warner (1965) pioneered the Randomized Response Technique (RRT) to collect information on a sensitive qualitative character. Following Rao (1979) and Chaudhuri and Stenger (2005) an attempt has been made to derive an exact expression for the mean square error of ratio estimator, regression estimator, separate and combined ratio estimator, separate and combined regression estimator in stratified random sampling and the generalized regression estimator in case of randomized response surveys dealing with a sensitive quantitative characters, like expenditure on consumption of alcohol, expenditure on gambling, and so on. Also an exact expression for an unbiased estimator of the mean square error of each of the above estimators has been derived.

Arun Kr. Adhikary

Content-based Image Retrieval

Having formulated the Content-based Image retrieval (CBIR) problem with relevance feedback as a classification-like problem, efficient retrieval algorithms had earlier been developed by combining

conventional and statistical classification techniques (such as discriminant analysis, CART and Support Vector Machines) which yielded significant improvement in retrieval performance. Subsequently, investigations were made to study the robustness of these approaches with respect to rotation and noise. Also, performance of the proposed algorithms with standard MPEG-7 features as well as with alternative similarity measures like the earth-mover's distance was investigated. Repeated experimentation with a number of image databases revealed that MPEG-7 features like the Color Structure Descriptor (CSD) and Edge Histogram Descriptor (EHD) were the most effective, particularly with larger databases.

Amita Pal and Smarajit Bose

Robust Speaker Identification

The conventional GMM-MFCC based speaker identification algorithms fails miserably for noisy speech recordings. This algorithm can be viewed as a comparison between the estimated densities of the training and test utterances based on the Kullback-Liebler divergence. Algorithms based on robust statistical procedures involving other divergence measures have been developed. The results showed the effectiveness of the proposed algorithms. Combining another set of features called PLPC with MFCC further improved the results. Finally, employing the principal component transformation and ensemble classification techniques, substantial improvement in classification accuracy was recorded.

Smarajit Bose, Ayanendranath Basu and Amita Pal

A semiparametric method for discriminating between elliptically symmetric distributions

The conventional discriminant analysis techniques assume multivariate normal distributions for the features coming from different classes. This assumption has been generalized to include other elliptically symmetric distributions. The proposed technique seems to adapt well in case of non-normal elliptically symmetric data.

Smarajit Bose, Subir Kumar Bhandari and Amita Pal

Extreme points of copulas

To get all extreme points of set of copulas in distribution theory has been an open problem for quite some time. The set of extreme points have been found and it has been observed that any copula can be represented as a mixture of its elements.

Subir Kumar Bhandari and Partha Pratim Ghosh

Multiple hypothesis-testing under sparsity

For multiple hypothesis-testing under sparsity in an equi-correlated multivariate normal setup, the optimal selection of significant hypotheses has been an open problem [J.K. Ghosh et. al., Ann. Stat., 2011] and several solutions have been attempted under the Bayesian approach. An asymptotically optimal solution has been proposed using a subset selection approach.

Subir Kumar Bhandari and Anupam Kundu

Critical sets in a pair of Orthogonal Sudokus

Orthogonal mates for a 8×8 Sudoku having a 2×4 blocked pattern and a 9×9 Sudoku having a 3×3 block pattern have been constructed using Galois field. The combined critical set for such an orthogonal pair of Sudokus has been identified. It is observed that the cardinality of such critical sets is much less than the sum of the cardinality of critical sets for individual Sudokus. Work is under process to establish bounds on the cardinality of the combined minimal critical set, based on the order and size of the blocks in a Sudoku.

Ilene H. Morgan and Rita SahaRay

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Chromatic number of a Sudoku

An investigation is under way to sharpen the bound on the list Chromatic number of a Sudoku.

Rita SahaRay and Dinesh Sarvate

Classical and Bayesian asymptotics in stochastic differential equations with random effects distributed as Gaussian mixtures

Systems of stochastic differential equations with random effects have been considered, and the asymptotic theory, both classical and Bayesian, has been provided when the random effects are distributed as Gaussian mixtures. This significantly broadens the scope of the asymptotic theories of previous work in this field because of the versatility of mixtures and their ability to approximate arbitrary distributions.

Trisha Maitra and Sourabh Bhattacharya

Asymptotics related to classical and Bayesian inference in stochastic differential equations with time-varying covariates

Earlier work on systems of stochastic differential equations has been extended by incorporating time-varying covariates in the system and by developing the asymptotic theory for both classical and Bayesian paradigms, for both fixed and random effects set-ups.

Trisha Maitra and Sourabh Bhattacharya

Classical and Bayesian asymptotics in state space stochastic differential equations

A novel state space model based on stochastic differential equations has been proposed and the asymptotic theory for both classical and Bayesian inference has been developed. The asymptotic theory, for both classical and Bayesian paradigms, has also been developed in the case of systems of state space stochastic differential equations.

Trisha Maitra and Sourabh Bhattacharya

A Bayesian approach to determination of convergence, divergence and oscillation of infinite series with application to Riemann hypothesis

A novel Bayesian theory for investigation of convergence, divergence and oscillation of infinite series has been developed and it has been shown, through several examples, how this theory can be applied to study convergence properties of infinite series. Most importantly, the (in)famous Riemann hypothesis has been investigated using this theory; and the findings do not completely support the Riemann hypothesis.

Sucharita Roy and Sourabh Bhattacharya

Modeling multiple time-varying related groups: a dynamic hierarchical Bayesian approach

For the analysis of panel data, it is often of interest to group individuals based on certain important characteristics. In addition, it is not uncommon for the individuals to switch group membership across time. One drawback of existing Bayesian nonparametric approaches is a lack of flexibility in characterizing this “dynamic” group structure to accommodate the scenario of a subject belonging to different groups at different times. Motivated by a real example from an aging population, a novel dynamic hierarchical matrix stick-breaking process (DH-MSBP) has been proposed to borrow information over multiple time-varying (related) groups. In particular, the matrix stick-breaking process priors have been extended by sharing the parameters across the groups and time. The dynamic time dependence, whereby stronger dependence is expected among the data temporally close to each other, has been imposed by assuming a dynamic hierarchical Dirichlet process on the random atoms of the stick-breaking process. For the aging application which has zero-inflated longitudinal responses, the proposed DH-MSBP prior has been used on group specific temporal trajectories, an MSBP prior

has been used for non-time-varying regression coefficients to allow shrinkage, and a DP prior has been used for the probability of a non-zero response. Operating characteristics of the proposed model are examined through simulations and the model is used to draw inference from the aging population study.

Kiranmoy Das, Pulak Ghosh and Michael J. Daniels

Simultaneous State Estimation of Cluster Based Wireless Sensor Networks

Most of existing work on the state estimation of wireless sensor networks (WSNs) is based on the dynamic state-space model via Kalman Filter or similar Markov models. A Bayesian non-parametric approach has been proposed for addressing the issue of information exchange in the context of state estimation of WSNs. A cluster-based wireless sensor network has been considered and a discrete-time linear Markov model for estimating the state values of the sensor nodes over time has been proposed. For measuring the amount of information shared by the model parameters across different clusters, non-parametric matrix stick-breaking priors have been considered on the cluster-specific model parameters. The usefulness of the proposed model in locating an immobile anomalous node in the network has been demonstrated, and the time to locate the foreign object as well as the false positive rate of the proposed approach has been computed. Simulation studies have been performed to assess the operating characteristics of the proposed model. Which is expected to be useful in emergency monitoring, medical genetics, geosciences and many other disciplines where WSNs are used frequently for the purpose of decision making?

Kiranmoy Das and Aditi Chatterjee

A Bayesian approach for analyzing incomplete zero-inflated longitudinal data using partially varying coefficients model

There is a rich literature on the analysis of longitudinal data with missing values. However, the analysis becomes more complex for zero-inflated longitudinal response with many missing responses and covariates. A semi-varying coefficients regression model has been proposed for predicting the out-of-pocket medical cost for an aging population. A two-part model has been used where, in the first part, a dynamic model has been proposed for accounting a zero or a non-zero response and, in the second part; a second dynamic model has been used for estimating the mean function of the non-zero responses. The missing covariates are imputed repeatedly and the missing response values are also imputed using the working model under different restrictions. Data from the Health and Retirement Study (HRS) has been analyzed for subjects belonging to different insurance groups and inference has been drawn. The operating characteristics of the proposed approach are examined through extensive simulation studies.

Jayabrata Biswas and Kiranmoy Das

Applied Statistics Unit, Chennai

Non-infinite-divisibility of some Inverse Subordinators

A tail probability bound has been determined for a class of inverse subordinators and, from that, the non-infinite divisibility of many of the inverse subordinators used in literature has been established. Further, it has been proven that a renewal process time-changed by an inverse stable subordinator is not infinitely divisible.

R. Sen and Arun Kumar

Effect of trade-liberalization on employment share of women

Using a panel of industries from the Annual Survey of Industries (ASI), the impact of the 1991 trade liberalization episode in India on the employment share of women has been studied. Industry-level

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data at 3-digit National Industrial Classification (NIC) from 1988 to 2007 has been used for this purpose. Input and output tariffs were used as a measure of trade liberalization. Functional data analysis and functional regression techniques have been used to study how the employment share curve varies with trade liberalization effect curve for different industries.

R. Sen and A. Gupta

Spectral distribution of High Dimensional covariance matrix and extension for Hayashi's estimator

The problem of estimation of integrated covariance for high dimensional financial stock price process has been considered. As the stock price data is nonsynchronous it seemed worthwhile to consider Hayashi's method of estimation (Hayashi, Yoshida 2004) in this context. The asymptotic results for small dimension is already established (Hayashi, Yoshida 2007). However, in a high-dimensional setup when the dimension p and observation frequency grow at the same rate, this estimator is no longer a consistent estimator of integrated covariance. The empirical spectral distribution and its limit, when dimension is increasing with same order with sample size, have been obtained.

R. Sen and A. Chakrabarti

Quantile-based tests for exponentiality against DMRL and NBUE alternatives

Quantile-based tests for exponentiality against DMRL and NBUE classes of alternatives have been proposed. The exact null distribution of the test statistic has been derived when the alternative class is DMRL. The asymptotic properties of the test statistics have been studied. In particular, it has been shown that the tests are consistent and have asymptotic normal distribution. The performance of the proposed tests has been examined through simulation study. Finally, the test procedure has been illustrated using a real data.

Sudheesh, K.K., G. Asha and N. Sreelaksmi

A unified approach to the generalized moment identity and its applications

A generalized moment identity has been obtained for the case when the distributions of the random variables are not necessarily purely discrete or absolutely continuous. The proposed identity is useful to find the generator which has been used for the approximation of distributions by Stein's method. A new approach has been discussed for the approximation of distributions by Stein's method. The characterization based on the relationship between conditional expectations and hazard measure has been brought into the proposed unified framework. As an application, a new lower bound to the mean-squared error has been obtained and has been compared with Bayesian Cramer–Rao bound.

Sudheesh, K.K. and Isha Dewan (Stat-Math Unit, Delhi)

Fractional Brownian motion time-changed by gamma and inverse gamma process

Many real time-series exhibit behavior adequate to long range dependent data. Additionally, very often these time-series have constant time periods and also have characteristics similar to Gaussian processes although they are not Gaussian. Therefore, there is need to consider new classes of systems to model such empirical behavior. With this motivation, two processes, which exhibit long range dependence property and have additional interesting characteristics which may be observed in real phenomena, have been analyzed. Both have been constructed as the superposition of fractional Brownian motion (FBM) and other process. In the first case, the internal process, which plays the role of time, is the gamma process while, in the second case, the internal process is its inverse. Their main properties have been presented in detail, paying main attention to the long-range dependence property. Moreover, the problems of simulation of these processes and estimation of their parameters have also been considered. A novel method based on rescaled modified cumulative distribution function has been proposed for estimation of parameters of the second process. This method has been found to be very useful in description of rounded data, like waiting times of

subordinated processes delayed by inverse subordinators. The effectiveness of the proposed estimation procedures has been demonstrated by using the Monte Carlo method.

Arun Kumar, A. Wyomanska, R. Poloczanski and S. Sundar

An introduction to copula-based bivariate reliability concepts

Several attempts have been made in the literature to generalize the notions based on univariate quantiles to higher dimensions. As quantile-based reliability concepts are receiving much attention, it is important to address these problems in the field of Reliability Theory. Motivated by this, bivariate reliability concepts using the dependence structure have been introduced, and their properties and characterizations have been presented, including the characterization based on the relationship between bivariate hazard rate and bivariate mean residual life. The bivariate reliability concepts in reversed time have also been studied.

Sudheesh, K.K., and N. Sreelaksmi

Applied and Official Statistics Unit, North-East Centre, Tezpur

Determinants of Healthy Life Expectancy

In continuation of collaboration with researchers from the Stress Research Institute, Stockholm University, Stockholm on a project "Determinants of Healthy Life Expectancy" using the Integrated Data in Europe on Ageing Research (IDEAR) of the countries, Sweden, UK, France, Denmark, and Finland, advanced statistical techniques have been identified for estimating the healthy life expectancies (HALE) across the countries involved. Analysis has been completed for the four countries, namely Sweden, Finland, France, and UK to estimate HALE across different categories of work characteristics using the multistate life table stochastic approach.

Holendro Singh Chungkham, Hugo Westerlund, Linda Magnusson Hanson
and Loretta G. Platts

Computer and Communication Sciences Division

Advanced Computing and Microelectronics Unit, Kolkata

The research activities of the Advanced Computing and Microelectronics Unit (ACMU) comprise theoretical and applied research in the areas of high-performance computing, pervasive and mobile computing, wireless and sensor networks, VLSI design tools and electronic design automation, logic synthesis and testing, error correction and fault-tolerance, physical design of microchips, embedded systems, microfluidic lab-on-a-chip, system-on-a-chip, low-power architectures, discrete and computational geometry, algorithms and data structures, computational biology, hardware for image processing, nano-technology and giga-scale integration techniques, hardware and software validation. During the period 2015-2016, the faculty members of the unit were engaged in different research projects. Brief reports of those projects are presented below.

Intelligent Transportation System

In this project, our aim was to provide a real-time navigation service to the individual vehicles during a natural disaster for reaching destination points through the best possible route (not necessarily the shortest route) so that, i) the maximum time taken by any vehicle to reach the destination is minimized to keep it always within a given value, and also ii) the average time to reach the desired destinations (considering all vehicles) is minimized. These two requirements may be mutually conflicting with each other, e.g., it is possible that an individual vehicle may not reach its destination within the maximum allowable time although the average time is minimized. We have found a simple analytical solution for

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a road network with a Manhattan grid structure, where two farthest corner points are considered as the source and the destination, respectively. To minimize the total time of flight of a vehicle to reach its destination both in the worst case and the average case, we have shown that the time to reach the destination will be minimum when the total traffic per unit time is uniformly distributed over all cross-points at every flow-front. The proposed method also shows that the average time of flight of all the vehicles in the network will be minimized when the traffic distribution on each flow-front is uniform. Next, we have extended our above strategy for multiple source points and a single destination. Towards this goal, we have so far considered only two source points S_1 and S_2 and optimized the total average time of travel without any deadlock situation. We have verified our proposed solution through a linear programming formulation of the problem and then using MATLAB APM toolbox to solve it.

Energy Optimization in Wireless Networks Based on QFNS Encoding

We have proposed an energy-efficient communication scheme for low-power wireless networks is proposed which is based on encoding the messages in a new number system, called the Quint Fibonacci number system (QFNS), followed by using a concept of Silent Communication. The proposed scheme employs a simple hybrid modulation/demodulation technique using non-coherent FSK and ASK, which leads to the design of a low-power, low-cost wireless communication system that will particularly be suitable for remote/ rural healthcare applications. We show that with Additive White Gaussian Noise (AWGN) in channel, our scheme offers about 39.6% energy savings at the transmitter and about 52% energy savings at receiver on an average over the conventional Binary Frequency Shift Keying (BFSK) system, for equal likelihood of all possible strings of binary messages. However, simulation results with different types of messages from various healthcare and agricultural sensor data applications show that we get about 29.82% to 36.23% energy savings at the transmitter and about 56.42% to 64.29% energy savings at the receiver over conventional BFSK.

MRBNS-based Source Coding for Energy-Efficient Communication

A new energy-efficient communication scheme has been proposed based on a novel source coding technique called Modified Redundant Binary Number System (MRBNS), along with the idea of silent communication, so that the frequencies of occurrences of different symbols in the encoded message become very asymmetric. Keeping the symbol period with the highest frequency of occurrence as silent during transmission, we achieve substantial savings of transmitter and receiver energies by using a hybrid FSK-ASK modulation/demodulation technique. We also design the corresponding protocols for transmission and reception of messages and evaluate their performances to compare with other existing techniques. Our results demonstrate that for additive white gaussian noise in channels, on an average, the transmitter side energy is reduced by about 53%, while at the receiver side there is about 17.2% savings. Due to the savings of transmitter and receiver energies, our proposed scheme is particularly suitable for multi-hop communication in low power wireless networks.

Dynamic Microtask Scheduling Approach for Human- augmented Computing

Current machine algorithms for qualitative analysis of unstructured data (in the form of social media posts, audio and video, among others) do not perform well and show low accuracies due to the need for human-like intelligence. However, machines are easily scalable, fast and the quality of their output is predictable. On the other hand, though humans are much better than machine algorithms at image and video analysis, natural language text and speech processing, they are unfortunately unpredictable, slower and can be erroneous or even malicious as computing agents. Therefore, a task execution engine which can enable human-augmented cloud computing by intelligently orchestrating machine and human computing resources would be able to provide richer and superior analytics on unstructured data than either of the two types of computing agents in isolation. We believe that a key aspect of enabling such analytics would be to provide guaranteed service level objectives, in terms of accuracy, time and budget. In this work, we present a microtask scheduler with integrated service level objectives (SLO) management. With this goal, we have introduced two new decision parameters: H-M ratio and microtask completion rate. An early prototype has been built and validated through simulation

with actual performance data collected from anonymous crowd workers on Amazon Mechanical Turk. Machine computation was done using Hewlett Packard's Autonomy IDOL while ground truth was established through the use of known, expert workers. To the best of our knowledge, ours is the first work that attempts to simultaneously attempt to address the three SLO parameters of accuracy, budget and deadline for data-parallel microtasks.

Channel Allocation in Cognitive Radio Networks

In conventional wireless systems, unless a contiguous frequency band with width at least equal to the required bandwidth is obtained, multimedia communication can not be effected with the desired Quality of Service. We have proposed here a novel channel allocation technique to overcome this limitation in a Cognitive Radio Network which is based on utilizing several non-contiguous channels, each of width smaller than the required bandwidth, but whose sum equals at least the required bandwidth. We have presented algorithms for channel sensing, channel reservation and channel deallocation along with transmission and reception protocols with two different implementations based on FDM-FDMA and OFDM-FDMA techniques. Simulation results for both these implementations show that the proposed technique outperforms the existing first-fit and best-fit allocation techniques in terms of the average number of attempts needed for acquiring the necessary number of channels for all traffic situations ranging from light to extremely heavy traffic. Further, the proposed technique can allocate the required numbers of channels in less than one second with FDM-FDMA even (4.5 second with OFDM-FDMA) for 96% traffic load, while the first-fit and best-fit techniques fail to allocate any channel in such situations.

Anti-Jamming Protocol

We have proposed an anti-jamming technique which is based on a secret reallocation of the jammed channels. Jamming is defined to be a deliberate use of radio noise or signals in an attempt to disrupt communications. We have presented suitable algorithms to be executed by a transmitting and a receiving node, assuming the possible presence adversaries acting as jammers. In our proposed algorithm, for a network with n jammed channels out of m simultaneously active communications, the average number of attempts to find n free channels is equal to $1/f$, where f is the fraction of free channels out of total of C channels, and hence, is independent of both m and n . Simulation results of our proposed approach on random networks also show that our proposed anti-jamming protocol is quite effective in counteracting jamming attacks.

B.P. Sinha

Holy Grail of Error-Resilient Bio-Assays on a Lab-on-a-Chip (HERBAL)

In recent times, microfluidic lab-on-chip devices (also called biochips) are emerging as an attractive technology for automatically orchestrating the reactions needed for clinical diagnostics, parallel DNA analysis, polymerase chain reaction (PCR) and other laboratory procedures involving molecular biology. The present design flow of biochips is semi-automated and a number of steps in the design flow are handled manually. This entails the possibility of design errors. In addition, various defects may occur during the production phase of such chips, and when they are being used in the field. Digital microfluidic chips are envisioned for extensive usage in safety-critical applications. Hence, detection and elimination of such errors and defects will be of utmost importance. Note that while the checking for design errors needs a formal verification procedure, the detection of manufacturing or field defects requires functional testing or error-tolerant schemes. In the later generation of cyber-physical biochips, output errors are detected online and appropriate corrective measures are taken in real time. This mandates a systematic design and validation method for guaranteeing performance and correct behavior of microfluidic devices. There have been some recent efforts in automating the biochip design process by formally specifying protocol requirements in high-level formalisms. This project aims to explore the possibility for applying formal methods for systematic synthesis and validation of regular, error-resilient, and cyber-physical biochips. In the first year of this project, we have studied and implemented the following two problems: (i) We have studied the fault detection and diagnosis

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problem for blockage and leakage faults in flow-based biochips, and (ii) automated mix-split error correction during sample preparation with droplet-based biochips followed by designing an error-resilient cyber-physical platform. We have developed new algorithms for solving these challenges and conducted extensive experiments for validation. The results of our investigation have appeared in the journals IEEE TCAD 2016 and in ACM TODAES 2016. Also two related United States Patents have been recently granted (one in September 2015, and the other in December 2015). Furthermore, another work that deals with the errors that may arise during technology-ramp in digital microfluidics is currently being investigated based on formal modeling of bio-chemical protocols.

Bhargab B. Bhattacharya

Massive Data algorithms

Two-center problem in streaming model: Given a convex polygon P with n vertices, the two-center problem is to find two congruent closed disks of minimum radius such that they completely cover P . We propose an algorithm for this problem in the streaming setup, where the input stream is the vertices of the convex polygon. It produces a radius r satisfying $r \leq 2r_{opt}$ using $O(1)$ space, where r_{opt} is the optimum solution. Next, we show that in non-streaming setup, we can improve the approximation factor by $r \leq 1.84r_{opt}$, maintaining the time complexity of the algorithm to $O(n)$, and using $O(1)$ extra space in addition to the space required for storing the input. Density, Threshold and Emptiness Queries for Intervals in the Streaming Model: Here the input is a stream S of n points in the real line R and a floating closed interval W of width α . The specific problems we consider are as follows.

Maximum density: find a placement of W in R containing the maximum number of points of S .

Threshold query: find a placement of W in R , if it exists, that contains at least Δ elements of S .

Emptiness query: find, if possible, a placement of W within the extent of S so that the interior of W does not contain any element of S .

The stream S , being huge, does not fit into main memory and can be read sequentially at most a constant number of times, usually once. The problems studied here in the geometric setting have relations to frequency estimation and heavy hitter identification in a stream of data. We provide lower bounds and results on trade-off between extra space and quality of solution. We also discuss generalizations for the higher dimensional variants for a few cases.

Subhas C. Nandy

GP-GPU Computing for Large Scale Networks

For large scale complex networks, we address the following problems:

Community detection problem: An easily parallelizable sequential algorithm has been developed for community detection based on communication modularity and diameter of each community. Its parallel implementation on CUDA platform is under study. Information Diffusion Model: Three stochastic competitive models have been proposed and studied by simulation on GPU platform (NVIDIA Tesla C20175). Subnetworks from Facebook and Twitter social networks available in SNAP databases have been used for simulation. For speed-up, parallel algorithms are developed and implemented on GP-GPU (General Purpose Graphic Processor Unit) platform. The effect of community structures on information diffusion and virality is under study.

Project-Linked Personnel and Scholars:

1. Dibakar Saha, PLP, ISI
2. Chirag Gupta, Student, ISI
3. Arnab K. Ghosal, Ramkrishna Mission Vidyamandir. (Non-ISI).
4. Punyasha Chatterjee, J.U.(Non-ISI)
5. Avirup Das, CU
6. Srabani Kundu, Guru Nanak Inst. of Technology

Nabanita Das

Logic Synthesis for Quantum Computing (QCS)

Quantum algorithms have super-polynomial speed-up over their classical counterparts for many problems. As quantum computing systems are error-prone, designing these to execute these algorithms is a major challenge. In this project, considering the constraints of quantum logic circuits which are markedly different from classical one, we have designed the following efficient algorithms for: (i) placement and swap-based routing to realize the benchmark blocks for most quantum algorithms, with fault tolerance (ii) estimation of the probability of error for a given circuit obtained by logic optimization and minimizing the extra resources for quantum error correction. In addition to binary quantum logic, synthesis methodologies to reduce the cost of circuits to realize ternary and quaternary quantum logic benchmarks have been developed. Modeling of errors in ternary circuits and designing a quantum error correcting code have been done.

Susmita Sur-Kolay

A framework for collaborative application execution for mobile cloud computing (MCC): 2015 – 2018

The growing market for smart devices has led to several proposals of Mobile Cloud Computing (MCC) consisting of a mobile grid and a back-end cloud infrastructure for collaborative execution for executing compute-intensive workflows. The MCC paradigm has attracted considerable attention both in academia and industrial community in recent times. However, several challenges remain to engage a mobile device as part of a computing infrastructure. Some of these challenges are bandwidth, energy constraints, memory capacity, intermittent availability, fault tolerance, security, privacy, which need to be dealt with, before MCC can be adopted as an accepted paradigm. The objective of this project is to explore this evolving paradigm and address some of these challenges, and build an effective MCC framework for widespread and effective usage for diverse workflows.

In the last year, we have come up with a framework for collaborative application execution for mobile applications. In particular, we have developed a collaborative framework for computation offloading which incrementally offloads each application method to the cloud or executes it locally depending on the network conditions, the residual battery level and the time to completion. We are currently trying to build an application to submit to the open-source community that can implement our research. With many research articles being reported in mobile-cloud offloading in recent times, there are quite a number of similar research offerings in this direction. This prompted us to look into more innovative ways of offloading computation to other devices in order to use the local resources of a smartphone more effectively. Offloading can be done to servers in the cloud, to nearby access points with high computational capabilities or even to other smartphones in the proximity. To this effect, we have formulated an auction-based econometric framework and wish to develop an Android application to offload mobile computation to appropriate devices. The application discovers and shows the devices that can be used to offload computation from a given smartphone. Each remote device (seller) willing to execute the computation auctions its compute power for which the user (buyer) of the service must submit a bid. Our plan is to analyze different auction algorithms and its variants at the seller side to select the buyer. We expect that this scheme will perform better than local computation or a non-econometric approach to computation offloading.

Ansuman Banerjee

Efficient vertical handover techniques in heterogeneous wireless networks

Heterogeneous wireless networks represent the new scenario of next generation network, where different technologies (e.g., UMTS, GSM, LTE, and WLAN) co-exist and offer an overlapped wireless coverage. These networks are becoming increasingly popular for providing seamless Internet access to the users at anytime and anywhere. Nowadays users are equipped with multiple reconfigurable network interfaces and hence able to operate in heterogeneous environment where many networks co-exist. To provide the seamless mobility to the users when they roam around different networks, the vertical handover (handover between two different networks) must be completed as quickly as

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possible. Traditional handover techniques in heterogeneous networks follow the procedure of hard handover where the connection with one network is terminated first, followed by establishing a connection with the target network. This project aims to develop analytical framework as well as vertical soft handover schemes for heterogeneous networks where the mobile can simultaneously maintain connections with multiple access networks, thus achieving improved the data rate and reduction in packet loss and unnecessary handovers. We would like to investigate both the mobile and network assisted handover schemes for this purpose. This is a challenging task since different access network provides different levels of bandwidth, coverage and throughput to the end user. Moreover, signals are modulated using different schemes in heterogeneous networks and hence they cannot be combined simply at the receiver stage by conventional maximal ratio combining as in the case of homogenous networks. This project aims to resolve some of these issues and develop an efficient and practical soft vertical handover schemes for heterogeneous networks.

Sasthi C. Ghosh

Visibility with diffuse reflections: bounds and algorithms (Visibility DifRef): (2013-2017)

We studied the diffuse reflection diameter and diffuse reflection radius problems for convex-quadrilateralizable polygons. In the usual model of diffuse reflection, a light ray incident at a point on the reflecting surface is reflected in all possible inward directions. A reflected ray from a polygonal edge may graze that reflecting edge but an incident ray cannot graze the reflecting edge. The diffuse reflection diameter of a simple polygon P is the minimum number of diffuse reflections that may be needed in the worst case to illuminate any target point t from any point light source s inside P . We show that the diameter is upper bounded by $(3n-10)/4$ in the usual model of diffuse reflection for convex-quadrilateralizable polygons. We also show that the diffuse reflection radius of a convex-quadrilateralizable simple polygon with n vertices is at most $(3n-10)/8$ under the usual model of diffuse reflection. In order to establish these bounds for the usual model, we first show that the diameter and radius are $(n-4)/2$ and $\lfloor (n-4)/4 \rfloor$ respectively, for the same class of polygons for a relaxed model of diffuse reflections; in the relaxed model an incident ray is permitted to graze a reflecting edge before turning and reflecting off the same edge at any interior point on that edge. We also show that the worst-case diameter and radius lower bounds of $(n-4)/2$ and $\lfloor (n-4)/4 \rfloor$ respectively, are sometimes attained in the usual model, as well as in the relaxed model of diffuse reflection. Let s be a source point and t be a destination point inside an n -vertex simple polygon P . Euclidean shortest paths and minimum-link paths between s and t inside P have been well studied. Both these kinds of paths are simple and piecewise-convex. However, computing optimal paths in the context of diffuse or specular reflections does not seem to be an easy task. A path from a light source s to t inside P is called a diffuse reflection path if the turning points of the path lie in the interiors of the boundary edges of P . A diffuse reflection path is said to be optimal if it has the minimum number of turning points amongst all diffuse reflection paths between s and t . The minimum diffuse reflection path may not be simple. The problem of computing the minimum diffuse reflection path in low degree polynomial time has remained open. In our quest for understanding the geometric structure of the minimum diffuse reflection paths vis-a-vis shortest paths and minimum link paths, we define a new kind of diffuse reflection path called a constrained diffuse reflection path where (i) the path is simple, (ii) it intersects only the eaves of the Euclidean shortest path between s and t , and (iii) it intersects each eave exactly once. For computing a minimum constrained diffuse reflection path from s to t , we present an $O(n(n+d))$ time algorithm, where $d = O(n^2)$ in the worst case. Here, d depends on the shape of the polygon. We also establish some properties relating minimum constrained diffuse reflection paths and minimum diffuse reflection paths. Constrained diffuse reflection paths introduced in this paper provide new geometric insights into the hitherto unknown structures and shapes of optimal reflection paths. Our algorithm demonstrates how properties like convexity, simplicity, complete visibility, etc., can be combined in computing and understanding diffuse reflection paths that are optimal or close to optimal. We also proved combinatorial bounds on the constrained diffuse reflection diameter of a simple polygon.

Arijit Bishnu

Computer Vision and Pattern Recognition Unit, Kolkata

Document Analysis

Use of multiple scripts for information communication through various media is quite common in a multi-lingual country. Optical character recognition of such document images or videos assists in indexing them for effective information retrieval. Hence, script identification from multi-lingual documents/images is a necessary step for selecting the appropriate OCR, due the absence of a single OCR system capable of handling multiple scripts. Script identification from printed as well as handwritten documents is a well-researched area, but script identification from video frames has not been explored much. Low resolution, blur, noisy background, to mention a few are the major bottle necks when processing video frames, and makes script identification from video images a challenging task. We have examined the potential of Bag-of-Visual Words based techniques for word-wise script identification from video frames. Two different approaches namely, Bag-Of-Features (BoF) and Spatial Pyramid Matching (SPM), using patch based SIFT descriptors were considered for the current study. SVM Classifier was used for analysing the three popular south Indian scripts, namely Tamil, Telugu and Kannada in combination with English and Hindi. A comparative study of Bag-of-Visual words with traditional script identification techniques involving gradient based features (HoG) and texture based features (LBP) is presented. Experimental results shows that patch-based features along with SPM out-performed the traditional techniques and promising accuracies were achieved on 2534 words from the five scripts. The study reveals that patch-based feature can be used for scripts identification in-order to overcome the inherent problems with video frames.

Nabin Sharma, Ranju Mandal, Rabi Sharma, Umapada Pal and Michael Blumenstein

Noise detection in online handwritten text is an important task for data acquisition. Such noise occurs in online handwritten text in various ways. For example, crossing out the previously written text due to misspelling. Also repeated writing of the same stroke several times following a slightly different trajectory and simply writing corrections over other text are very common. Detection of those unwanted regions is a crucial pre-processing step in automatic text recognition. Currently detection and removal/correction of such regions are often done manually after collecting the data. Particularly for large databases, this can turn into a tedious and costly procedure. Consequently, we have focused on noise detection for database creation and proposed to use different density-based features to distinguish between “relevant” and “unwanted” (or noisy) parts of writing. Using a 2-class HMM based classifier we get encouraging detection rate of unwanted regions from online handwritten text.

Nilanjana Bhattacharya, Volkmar Frinken, Umapada Pal and Partha Pratim Roy

Many handwritten text recognition systems use the baseline information for better recognition of text line characters. Improper baseline detection reduces the performance of the recognition. We have proposed a novel baseline detection scheme for unconstrained handwritten text lines of multilingual documents. For baseline detection of a text line, at first, we detect the set of significant contour points (S-points) of the text line. Every non-singleton subsets of S-points forms a curve. The orientation invariant features of the curve determine whether the curve can construct a probable baseline of the input text line or not. It is determined by an SVM, trained using the orientation invariant features of the curves. The curves classified as probable baselines, are sorted according to their relative positions in ascending order to get the optimal baseline. We tested our method on different handwritten text lines of Bangla(Bengali), English(Roman), Kannada, Oriya, Devnagari and Persian scripts and obtained good results.

Dibyayan Chakraborty and Umapada Pal

We have proposed a novel approach towards handwritten Indic text recognition using zone-wise information. Because of complex nature due to compound characters, modifiers, overlapping and touching, etc., character segmentation and recognition is a tedious job in Devanagari, Bangla, Gurmukhi, and other similar scripts. To avoid character segmentation in such scripts, HMM-based sequence modeling has been used earlier in holistic way. We propose an efficient recognition framework by segmenting the handwritten word images horizontally into three zones (upper, middle

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and lower) and recognize the corresponding zones. The components in middle zone where characters are mostly touching are modeled using HMM. As a by-product of this zone segmentation approach, we reduce the number of distinct component classes compared to total number of classes in character set. After the recognition of middle zone, HMM based Viterbi forced alignment is applied to mark the left and right boundaries of the characters. Next, the residue components, if any, in upper and lower zones in their respective boundary are combined to achieve the final word level recognition. Water reservoir feature has been integrated in this framework to improve the zone segmentation and character alignment defects while segmentation. A novel sliding window-based feature, called Pyramid Histogram of Oriented Gradient (PHOG) is proposed for middle zone recognition. PHOG features has been compared with other existing features and found robust in Indic script recognition. An exhaustive experiment is performed on two Indic scripts namely, Bangla and Devanagari for the performance evaluation. From the experiment, it has been noted that proposed zone-wise recognition improves accuracy with respect to the traditional way of Indic word recognition.

Partha Pratim Roy, Ayan Kumar Bhunia, Ayan Das,
Prasenjit Dey and Umapada Pal

There are only a few studies undertaken in developing automatic assessment systems using handwriting recognition, even though a successful system would undoubtedly benefits the education system as schools and universities in many countries still employ paper-based examinations. There is no existing work on an automatic off-line short answer assessment system comprising a student identification component. Hence, we propose a system towards this where a new feature extraction technique called the Enhanced Water Reservoir, Loop and Gaussian Grid Feature, as well as other enhanced feature extraction techniques were utilised. Artificial Neural Networks and Support Vector Machines were employed as the classifiers. They were used for the investigation and comparison of recognition and the accuracy rates of the proposed assessment and identification systems and the feature extraction techniques. The proposed assessment system achieved a recognition rate of 87.12% with 91.12% assessment accuracy.

Hemmaphan Suwanwivat, Umapada Pal and Michael Blumenstein

Administrative Document Analysis

Automatic detection of Logo, Seal and Signature part from a document involves a difficult challenge due to their different complexities like multi-oriented nature, arbitrary shape, overlapping parts with text, noise, etc. We have proposed a novel technique for segmentation of entities like Logo, Seal and Signature parts from a document for automatic processing of administrative documents based on these entities.

Tamaltaru Pal, Satish Chandra, Ranju Mondal, Partha Pratim Roy and Umapada Pal

Biometrics

Among all of the biometric authentication systems, handwritten signatures are considered as the most legally and socially accepted attributes for personal identification. The objective of this investigation is to present an empirical contribution towards the understanding of a signature identification technique involving multi-script off-line signatures. In our experiment, SIFT (Scale-Invariant Feature Transform) descriptors with Spatial Pyramid Matching (SPM)-based approaches have been used for feature extraction of signatures written in multiple scripts. Support Vector Machines (SVMs) are employed as the classifier in this experiment. 300 classes from the publicly available GPDS[16] dataset consisting of 7200 (300 × 24; 24 signature samples in each class) genuine signatures, 300 classes from a Devnagari signature dataset consisting of 7200 (300 × 24) genuine signatures and 200 classes from Bangla signature dataset consisting of 4800 (200 × 24) genuine signatures have been considered for this experiment. The signature identification experiment is conducted on these three datasets separately as well as 800 classes from a combined dataset of English, Devnagari, and Bangla signatures. The identification accuracy on the datasets is encouraging and 99.32% accuracy was obtained on the combined dataset of signatures, while 99.95%, 99.25% and 99.57% accuracy were achieved on experiments conducted separately on English, Devnagari, and Bangla signature datasets.

Srikanta Pal, Ranju Mondal, Umapada Pal and Michael Blumenstein

There is no good sclera dataset available to the researchers. For this purpose we have prepared a multi-angle sclera dataset (MASD version 1). It is comprised of 2624 RGB images taken from both the eyes of 82 identities. In other words, it consists of images of 164 (82x2) different eyes. Moreover, we have prepared a manual segmentation mask of these images to create the baseline. We have also organized a competition (SSBC-2015) on this developed dataset during the Seventh IEEE International Conference on Biometrics: Theory, Applications and Systems (BTAS 2015). The MASD version 1 dataset will also be freely available for research purposes from the organizer's website.

Abhijit Das, Umapada Pal, Miguel A. Ferrer and Michael Blumenstein

Affiliation Analysis of Academic Papers

The DBLP contains a comprehensive index of Computer Science papers published in major conferences and journals. However, the author's affiliation at the time of publishing the paper is not available from the DBLP dataset. Recently, Microsoft has released a dataset pertaining to their academic search platform containing the author affiliation information for some papers. The initial aim of our work is to design an algorithm to fill the author affiliation information for each paper by actually querying some external source (such as ACM digital library, IEEE explore, Springer) to get the required information for some papers and propagate the available information to fill many other affiliation information with high confidence. A previous work (GeoDBLP) to find the author's Geographical information in a similar way was conducted, but there was no work done to create a dataset including author affiliations. Once created, such dataset can be used to perform several interesting analysis, such as, how researchers move from one institute to another, how institutes are connected by collaboration network and many more. Currently a subset of the authors have been chosen from the Microsoft dataset to choose only authors related to Computer Science domain. An algorithm optimizing the tradeoff between information gain vs required input has been designed. Experiments to verify our algorithm and subsequently releasing the dataset with author affiliation would be the goal for the coming year.

Amit Yadav and Debapriyo Majumdar

Query Suggestion without Query Logs

Interactive query suggestion is a common feature in all commercial search engines nowadays. Most large scale search engines which has a huge number of users can rely on query logs to provide the base candidate set for suggested queries. However, for smaller scale engines query logs are not available and corpus based suggestions are required. Bhatia, Majumdar and Mitra (SIGIR 2011) proposed a first of a kind approach to provide corpus based suggestions. However, the proposed approach was not efficient enough to be interactive for any large dataset. Furthermore, due to the absence of any standard test data, conducting a reproducible evaluation of systems such as ours is a challenge. In this project, we have designed a special prefix-phrase index to generate meaningful and diverse query suggestions efficiently. Experiments on noisy datasets show that our method is able to generate query suggestions that are much more meaningful and diverse than the state-of-the-art corpus-based query suggestion system, despite being orders of magnitude faster. We have also designed a novel, deterministic and reproducible automated evaluation method using the Google Suggest API as a gold standard. The experimental results based on this evaluation method establish that our system is much closer in performance to the query log based suggestion systems (gold standard) than the state-of-the-art.

Jayasree Saha and Debapriyo Majumdar

Natural Language Processing (NLP) for Indian Languages: During the last one year, several new algorithms have been designed for natural language processing for Indic languages (IL). Anaphora resolution has been studied for Bengali. Neural network-based lemmatizers have been developed for both Bengali and Hindi. A Novel algorithm for named entity recognition (NER) has been designed and evaluated for several Indic languages. The method makes use of Wikipedia and Web information

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mash up techniques. Recently introduced word embedding technique has been studied and used for solving NER and lemmatization problem in Bengali and Hindi. The BenLem (a system for lemmatizer for Bengali) has been further improved and a Trie-based method is incorporated.

Utpal Garain, Abhisek Chakrabarty, Akshay Chaturvedi, Kamlesh Nayak, Arjun Das, Apurbalal Senapati, Debasis Ganguly, Suchismita Maiti, Arnab Dhar and Sankar De

Biomedical Natural Language Processing (BioNLP)

The task of trigger detection and event classification is addressed for Biomedical literature. The recent advances in natural language processing have been explored in order to avoid the existing tedious feature selection phase. As the domain specific literature is limited for learning efficient word vectors, the concept of transfer learning is used. The word vectors are initially learned from a general purpose English corpus and then refined using the limited amount of domain specific training samples. The experiment shows that the word vectors refined in this way serve as very efficient feature vectors for the classification problem. The results obtained by this experiment outperform the previous ones by a large margin. A novel multi-task multi-layer perceptron is also explored for the classification task.

Utpal Garain and Debjyoti Paul

Psoriasis Image Analysis

Under a joint research collaboration with Human Genetics Unit of ISI, a machine assisted analysis of psoriasis disease. A novel image segmentation algorithm has been designed for segmenting the diseased parts from skin images. A new mixture model known as Joint Linear-Circular Mixture Model (JLCMM) has been designed to deal with linear-circular data coming from different color spaces. A set of forty-five images have been annotated so that segmentation accuracy can be evaluated quantitatively. In another research, about seven hundred images have been graded based on their severity level. Next, a deep convolutional neural network (DCNN) has been designed for severity grading which has been viewed as a multi-task learning problem.

Utpal Garain, Anabik Pal, Akshay Chaturvedi, Raghunath Chatterjee, Aditi Chandra, Anandarup Roy and Swapan Senapati

Language Identification from Handwritten Documents

A novel approach is designed for identification of language from handwritten documents. The approach is based on script identification followed by character recognition. BLSTM-CTC based handwriting recognizers have been used and the OCR output is fed to a statistical language identifier for detecting the language of the input handwritten document. Documents in two scripts (Latin and Bengali) and four languages (English, French, Bengali and Assamese) are considered for evaluating the method. Several alternative frameworks have been explored, effects of handwriting recognition and text length on language detection have been studied. It is observed that with some empirical restrictions it is very much possible to achieve more than 80% language detection accuracy and based on the current research practical systems can be designed.

Utpal Garain, Luc Mioulet, Clement Chatelain, Philippine Barlas and Thierry Paquet

A Recurrent Neural Net based Bengali Handwriting Recognizer

A pioneering method has been designed for developing a recurrent neural net based connectionist system for unconstrained Bengali offline handwriting recognition. The major challenge in configuring a such classification system for a complex script like Bengali is to effectively define the character classes. A novel way of defining character classes is introduced in order to make the recognition problem suitable for using a recurrent model. Indeed, it has to deal with more than nine hundred character classes for which the occurrence probability is very skewed in the language. An off-the-shelf BLSTM-CTC recognizer is used. A new open-source dataset is developed for unconstrained Bengali

offline handwriting recognition. The dataset contains 2338 handwritten text lines consisting of about 21,000 words. Experiment shows that with the new definition of character classes the BLSTM-CTC framework provides an impressive performance for unconstrained Bengali offline handwriting recognition. The character level recognition accuracy is 75.40% without doing any post-processing on the BLSTM-CTC output. Among the 24.60% character level errors, the substitution, deletion and insertion errors are 18.91%, 4.69% and 0.98%, respectively.

Utpal Garain, B. B. Chaudhuri, Luc Mioulet, Clement Chatelain and Thierry Paquet

Searching into OCR'd Comic Collection

This paper investigates a novel technique for word searching in an OCR'd collection. Instead of attempting OCR error correction, query expansion method is followed. OCR errors are analyzed and the analysis result is used as feedback for expanding a query. Predictions are made on how a query word may appear in the OCR'd documents. The predicted words are formed by corrupting the clean query word as per the nature of OCR errors. Later, these predicted words are also searched into the collection along with the error-free clean word. Two different models namely, single error model (SEM) and multiple error model (MEM), are used for query expansion. Experiments are conducted on the comic collection known as eBDtheque. Evaluation shows that when a list of eighteen (18) query words is searched in the OCR'd collection consisting of 3; 537 text documents, simple string matching method is 47% accurate in locating the intended query words in OCR'd collection. However, after query expansion this accuracy is improved by a significant margin. SEM improves the accuracy to 55.6% whereas MEM further improves to 57%. The statistical significance test shows that this 21% profit (47% to 57%) in searching words in the OCR'd collection is statistically significant.

Utpal Garain, Arjun Das, Christophe Rigaud,
Jean-Christophe Burie, and Jean-Marc Ogier

Computational Forensics

In the domain of computational forensics two different areas have been explored. One work is on authentication of paper of a printed security document. Paper pulps play a crucial role in characterizing a paper material. These pulps are visible in the UV scanned image of the document. The pulp identification is done by borrowing ideas from rice grain detection method. Shape and color features are extracted from the identified pulps. Paper pulps coming from fake documents are significantly different from those of genuine documents in their shapes and colors. Using the shape and color features, a multilayer back propagation neural network is used to discriminate paper pulps as genuine or fake. The method is tested with Indian banknote samples and experiment shows that consideration of paper pulps is one of the crucial tests for authenticating paper money. The second work presents a new inverse half toning method for reconstructing low resolution line halftone images. This reconstruction is done in order to authenticate an image in question. The reconstructed image is compared with its original image in terms of standard image quality metrics such as peak signal to noise ratio (PSNR) and structural similarity index measure (SSIM). A comparative study shows that the new method outperforms many existing inverse halftone techniques while dealing with line halftone images.

Utpal Garain, Biswajit Halder, Ankush Roy and David Doermann.

Dataset for Evaluating Online Handwritten Mathematical Expressions

The shared task, Competition on Handwritten Mathematical Expression Recognition (CROHME), is continued in collaboration with labs in France and USA. Four editions of CROHME were organized. The training dataset was expanded to contain 8836 expressions (matrices are included now) and a new test set containing 986 expressions was developed. Several new tools were developed for evaluating performance at the level of strokes as well as expressions and symbols. Data and tools used for the competition have been made publicly available through IAPR TC-11 site.

Utpal Garain, Harold Mouchere, Christian Viard-Gaudin and Richard Zanibbi

Automatic Analysis of Sentiments in the Telecom Domain

The opinion of other people is often a major factor influencing our decisions. For a consumer it affects purchase decisions and for a producer or a service provider it helps in making business decisions. Companies spend a lot of money and time on surveys for gathering the public opinion on products and services. Now-a-days the web has become a hotspot for finding user opinions on almost anything under the sun. Both money and time can be saved by mining opinions from the web. Each opinion generally expresses positive, negative or neutral sentiment. We have recently made an in-depth study of automatic analysis of user sentiments in the Telecom domain based on opinions available in the web. Due to the unavailability of any public dataset, a benchmark dataset is prepared with comments crawled from the web. The main problem with the textual data obtained from the web is that it is extremely noisy and such data cannot be used directly for automatic analysis of sentiments. Hence, a lexicon based preprocessing algorithm is proposed for noise reduction. A novel technique based on Cosine Similarity measure is proposed for classifying sentiments into a five-point scale of -2 (highly negative) to +2 (highly positive). We obtained 82.09% accuracy for the two-class problem of identifying positive and negative sentiments and 71.5% accuracy for the five-class sentiment classification problem with an accuracy of 71.5%. The same classifier is also used for categorizing each user comment into six different Telecom specific categories with 68.46% accuracy.

S. Bhattacharjee, A. Das, U. Bhattacharya, S. K. Parui and S. Roy

CNN Based Common Approach to Handwritten Character Recognition of Multiple Scripts

There are many scripts in the world, several of which are used by hundreds of millions of people. Handwritten character recognition studies of several of these scripts are found in the literature. Different handcrafted feature sets have been used in these recognition studies. However, convolutional neural network (CNN) has recently been used as an efficient unsupervised feature vector extractor. Although such a network can be used as a unified framework for both feature extraction and classification, it is more efficient as a feature extractor than as a classifier. In a recent study, we performed certain amount of training of a 5-layer CNN for a moderately large class character recognition problem. We used this CNN trained for a larger class recognition problem towards feature extraction of samples of several smaller class recognition problems. In each case, a distinct Support Vector Machine (SVM) was used as the corresponding classifier. In particular, the CNN of the present study is trained using samples of a standard 50-class Bangla basic character database and features have been extracted for 5 different 10-class numeral recognition problems of English, Devanagari, Bangla, Telugu and Oriya each of which is an official Indian script. Recognition accuracies are comparable with the state-of-the-art.

D. S. Maitra, U. Bhattacharya and S. K. Parui

Script Independent Online Handwriting Recognition

The most general form of handwriting style is mixed cursive and this is the most difficult type in view of its automatic recognition. Similar handwriting styles are prevalent in various scripts such as English, Arabic, Bengali etc. Handwriting recognition for such a script gets further difficult whenever its alphabet consists of a large number of characters like Bengali, which has around 350 characters. Hidden Markov models (HMM) are the most popularly used architectures for similar recognition problems. However, the task becomes easy if the underlying lexicon depending upon the specific application is provided. In such situations, holistic or word-based recognition approach is adopted which does not require recognition of the constituent characters. On the other hand, the same task gets complicated as the lexicon size increases and / or it consists of many similar shape words. In a similar recognition problem, we have used a fully connected non-homogeneous HMM where its observation sequence is generated through explicit segmentation of the input word. In the present study, we have explored that the performance of this HMM-based recognition scheme is independent of both the script and the particular intelligent segmentation strategy. We implemented a novel segmentation scheme based on

an existing Discrete Curve Evolution algorithm and two other existing segmentation methods on standard databases of English, Arabic and Bangla to arrive at the above conclusion. Statistical hypothesis testing of the simulation results further confirm the above claim.

O. Samanta, A. Roy, U. Bhattacharya and S. K. Parui

Offline Handwritten Devanagari Word Recognition

Information Fusion at Feature and Classifier Levels: We have recently studied a strategy for fusion of information at feature and classifier output levels for improved performance of offline handwritten Devanagari word recognition. In this study, we considered two state-of-the-art features, viz., Directional Distance Distribution (DDD) and Gradient-Structural-Concavity (GSC) features along with multi-class SVM classifiers. We studied various combinations of DDD features along with one or more features from the GSC feature set. We experimented by presenting different combined feature vectors as input to SVM classifiers. Also, the output vectors of different SVM classifiers fed with different feature vectors are combined by another SVM classifier. The combination of the outputs of two SVMs each being fed with a different feature vector provides superior performance to the performance of a single SVM classifier fed with the combined feature vector. Experimental results are obtained on a large handwritten Devanagari word sample image database of 100 Indian town names. The recognition results on its test samples show that SVM recognition output of DDD features combined with the SVM output of GSC features improves the final recognition accuracy significantly.

B. Shaw, U. Bhattacharya and S. K. Parui

Multilingual Scene Character Recognition with Co-occurrence of Histogram of Oriented Gradients

Automatic machine reading of texts in scenes is largely restricted by the poor character recognition accuracy. In a recent study, we extended the Histogram of Oriented Gradient (HOG) and proposed two new feature descriptors: Co-occurrence HOG (Co-HOG) and Convolutional Co-HOG (ConvCo-HOG) for accurate recognition of scene texts of different languages. Compared with HOG, which counts orientation frequency of each single pixel, the Co-HOG encodes more spatial contextual information by capturing the co-occurrence of orientation pairs of neighboring pixels. Additionally, ConvCo-HOG exhaustively extracts Co-HOG features from every possible image patches within a character image for more spatial information. The two features have been evaluated extensively on five scene character datasets of three different languages including three sets in English, one set in Chinese and one set in Bengali. Experiments show that the proposed techniques provide superior scene character recognition accuracy and are capable of recognizing scene texts of different scripts and languages.

S. Tian, U. Bhattacharya, S. Lu, B. Su, Q. Wang, X. Wei, Y. Lu and C. L. Tan

South Asian Face database

This project aims to create a standardized face database for various South Asian ethnicities and then make face recognition and other psychophysical assays out of them for research and screening purposes.

Garga Chatterjee and Neloy Chakraborty

Effect of Internet of brain structure

This project is looking at the effect of internet usage by naive subjects on the structure of their brains, especially certain areas of the cortex. Brain imaging and behavioral testing is done simultaneously.

Garga Chatterjee, Priyanka Ghosh, Ryota Kanai and Himadri Datta

Studying the phenomenon of disgust with reference to genetic contribution using twins

The first South Asian database of twins is being built. This will be used as a platform for behavioral

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online experiments involving twins, looking at genetic contribution to behavior.

Garga Chatterjee and Dhairyya Singh

The cognitive architecture of face-processing – understanding the separation of information streams

Various kinds of facial information like identity, age, gender, attractiveness, etc are present. How are they related to each other in the realm of cognitive information is being explored in this project where tests of various types of facial information are being created.

Garga Chatterjee, Nelay Chakraborty and Lakshmi S.

Human face and body skin tone and their relationship with various biological and social parameters

This project explores the possible relationship between social attitudes, social indicators, human face characteristics and dermatological characteristics like body skin tone. This involved skin colorimetry and survey based behavioral assays.

Garga Chatterjee, Nelay Chakraborty and Lakshmi S

Image and Video Quality Analysis

Objective image quality assessment is an important area of research which is of use for quality of service determination, image restoration etc. Algorithms have been proposed for reduced reference and no reference approaches for image quality assessment which does not require the original undegraded image for this measurement. The approaches also identify the cause and amount of degradation --- noise, blurring or compression (JPEG and JPEG2000) which are the major sources of image quality loss. Extensive experimentation with a large number of images and video sequences from standard databases establish the usefulness of the proposed algorithms. The identification and rectification of tampered images has been attempted in both the spatial and frequency domains. Digital watermarking has been employed as a tool in preprocessing of these images. Multiple watermarking has produced encouraging results in both producing good quality restoration as well as proper identification of the tampered area.

Dipabali Sarkar, Sarbani Palit and Ankan Bhattacharya

Image Encryption

Partial encryption is one of the viable solutions for low power, high speed, real time secure multimedia communication where, along with operational complexity, computation time also plays an important role. A chaotic tent map based selective bitplane encryption technique has been proposed for both gray scale and color images along with a flexible threshold. After decomposing the original image into eight bitplanes, each bitplane is classified into either significant or non significant category by defining a flexible threshold value of 0.3, deduced experimentally, considering the trade-off between computational complexity and security aspects. It is shown that the proposed partial encryption scheme along with the soft-threshold saves around 35% of computation on the entire image database used here. Following this segregation, only the significant bitplanes are encrypted with the key stream sequences generated by a chaosbased pseudo-random binary number generator. The cipher image is then transmitted through public channel. The scheme has the novelty of transmitting the encrypted image along with the information of significant bitplanes through public channel since residual intelligence is almost absent in the cipher image. Different types of attacks against this scheme are also analyzed to prove the robustness of this approach.

Sukalyan Som, Abhijit Mitra, Sarbani Palit and B.B. Chaudhuri

Electronics and Communication Sciences Unit, Kolkata**Video processing**

Recognizing human activity from video data is an active field of research in computer vision. It needs to consider different types of features. Combining different features to form a single decision parameter is a classic problem. A novel method for representing features and defining similarity measure on them using Riemannian manifold is developed. The proposed method is applied on video clips of regular or routine activities like running, walking, jogging, handwaving, etc. This has given very good result. This is also applied on Indian classical dance data to recognize different dance styles or schools like Odissi, Bharathanatyam, etc.

B. Chanda

Image processing and Analysis

Sometimes presence of undesired objects reduces clarity of the scene. An image inpainting method using pLSA-based search space estimation is developed to solve this problem. The proposed algorithm produces reliable output with low computational cost. Use of biometrics for security and other purpose are well known. Iris recognition is an important biometric based system, because of its stability and authenticity. A novel set of features based on morphology and a new texture measure provide reliable signature of iris image that is used to develop a robust iris recognition system. This produces better result compared to state-of-the-art systems.

B. Chanda

Bioinformatics

Identification of gene-gene interactions with respect to a disease is a very important problem in genetics. We have proposed a novel approach for identifying synergistic gene interactions directly from the continuous expression labels, using a minimum spanning tree based algorithm. We have used this approach to find pairs of synergistically interacting genes in prostate cancer. The advantages of our method are that it does not need any discretization and it can be extended straight way to find synergistically interacting sets of genes having three or more elements as per the requirement of the situation. We have demonstrated the relevance of synergistic genes in cancer biology.

N. R. Pal

Fuzzy Sets

We have proposed an useful framework for clustering of mixed data which contains both numerical and categorical attributes. Our formulation is inspired by the Fuzzy c-means algorithm (for dealing with numerical data), mixture models (for dealing with categorical data) and the collaborative clustering framework for aggregation of the two. It is an integrated approach that judiciously uses all three components. We use our algorithm on a few commonly used datasets and compare our results with those by some methods.

N. R. Pal

Histopathological grading of cancer not only offers an insight to the patients' prognosis but also helps in making individual treatment plans. Mitosis counts in histopathological slides play a crucial role for invasive breast cancer grading using the Nottingham grading system. Pathologists perform this grading by manual examinations of a few thousand images for each patient. Hence, finding the mitotic figures from these images is a tedious job and also prone to observer variability due to variations in the appearances of the mitotic cells. We propose a fast and accurate approach for automatic mitosis detection from histopathological images. We employ area morphological scale space for cell segmentation. The scale space is constructed in a novel manner by restricting the scales with the maximization of relative entropy between the cells and the background. This results in precise cell

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segmentation. The segmented cells are classified in mitotic and non-mitotic category using the random forest classifier. Experiments show at least 12% improvement in F-score on more than 450 histopathological images at 40x magnification.

D.P. Mukherjee

Secured Query Processing for Semantic Web Applications

Continuing the excavation to the access control model of semantic data, the current research focus has been extended from a single-user entity to a user-group mapping. Significantly, the introduction of User-Group hierarchy along with object hierarchy, has increased the degree of complexity. Furthermore, the digital library metadata access control model has been evolved from an individual user's facility towards the users' group based authorization systems. However, this improvement has inevitably increased the administrative and maintenance flexibility over the previous model. The underline structure of digital library includes poly-hierarchy and represented by the DAG rather than the tree. This assumption has raised the importance of Separation of Duties (SOD) and conflict resolution mechanism. Nonetheless, the policy rules have been developed for handling the conflict resolutions and the safety property. Further, the model has been extended from the single graph to multiple graphs. Several problems of semantic web can be resolved using multiple graph structures. For example, any query for searching information from a social network takes a lot of time, due to its colossal structure as well as presence of circles in the directed graph. From that single convoluted graph we implemented several DAG graphs, on which if we run a query, it will take a lesser time than the previous one. Data analytics is a well-known platform for case study of different domains. Data computing for accessing and manipulate data is one of them. We have implemented an algorithm in case of online social network (Facebook) to restrict the information access of an user using the theories of graph analytics. Due to unavailability of the large linked data set, a simulation data for multi-graph has been prepared by utilising "Stanford Large Network Dataset Collection" (4,847,571 nodes and 68,993,773 edges). Also, XACML 2.0 based policy repository has been set up for replying authorisation queries. Further, an Ontology repository based on Virtuoso (Open source repository) has been set up. Algorithms have been developed for ontology to update model for individual user.

P. Pal

Video Scene Segmentation and Classification

Video scene segmentation and classification are two fundamental tasks to design an intelligent multimedia retrieval and browsing system. Representation of the video as a group of semantic units ensures efficient indexing and retrieval. We have developed scene detection methods using shot level key-frames following two approaches: one method splits the key-frame sequence into scenes, while the other, merges the key-frames to form the scenes. Both the methods rely on the observation that shots appear in a quasi-periodic pattern in a scene. The methods are tested on benchmark datasets. Present research activity includes the analysis of scene contents to identify their categories such as comedy, horror, action, dialogue, sports, commercial, etc.

P.P. Mohanta

Evolutionary Computing and Swarm Intelligence

Efficient variants of the Differential Evolution algorithm have been derived to provide elegant solutions of dynamic single and multi-objective optimization problems, where the nature of the functional landscape changes with time. Inter-agent communication, search dynamics and the chaotic dynamical characteristics of certain simulated swarms have been investigated both analytically and experimentally to gain better insight into the coordinated swarm control observed in nature. Some new metaphors like the democratic societal structure has been used to improve the search mechanism of the particle swarm optimizer.

S. Das

Machine Intelligence Unit, Kolkata

Pattern Recognition

One of the important problems in pattern recognition, machine learning, and data mining is the dimensionality reduction by attribute or feature selection. In this regard, a feature selection method, based on interval type-2 fuzzy-rough sets, has been proposed where the features are selected by maximizing both relevance and significance of the features. By introducing the concept of lower and upper fuzzy equivalence partition matrices, the lower and upper relevance and significance of the features are defined for type-2 fuzzy approximation spaces. Different feature evaluation criteria such as dependency, relevance, and significance are presented for attribute selection task using interval type-2 fuzzy-rough sets. The performance of interval type-2 fuzzy-rough sets has been compared with that of some existing feature evaluation indices including classical rough sets, neighborhood rough sets, and type-1 fuzzy-rough sets. The effectiveness of the proposed interval type-2 fuzzy-rough set based attribute selection method, along with a comparison with existing feature selection and extraction methods, has been demonstrated on several real life data.

P. Maji

A weighted version of the well-known Maximal Relevance Minimal Redundancy criterion, for the purpose of feature selection, has been proposed. The weight of the average redundancy of the candidate feature against all the selected features is continuously incremented with respect to the number of features already selected, while the weight of the class relevance of the candidate feature is kept fixed. An existing variant of normalized mutual information score is utilized for the first time to compute both the relevance as well as the average redundancy. The performance of the proposed approach is demonstrated to be superior to those of several conventional mutual information based feature selection techniques as well as some of the state-of-art feature selection approaches based on analyses on some real-life high dimensional datasets.

S. Bandyopadhyay

An unsupervised feature selection algorithm is proposed using an improved version of a recently developed Differential Evolution technique called MoDE. The proposed algorithm produces an optimal feature subset while optimizing three criteria, namely, the average standard deviation of the selected feature subset, the average dissimilarity of the selected features, and the average similarity of non-selected features with respect to their first nearest neighbor selected features. Normalized mutual information score is employed for computing both the similarity as well as the dissimilarity measures. The experimental results confirm the superiority of the proposed algorithm over other state-of-the-art unsupervised feature selection algorithms for eight different kinds of datasets with the number of points ranging from 80 to 6238 and the number of dimensions ranging from 30 to 649.

S. Bandyopadhyay

An unsupervised feature selection technique is proposed, using maximum information compression index as the dissimilarity measure and the well-known density-based cluster identification technique DBSCAN for identifying the largest natural group of dissimilar features. The algorithm is fast and less sensitive to the user-supplied parameters. Moreover, the method automatically determines the required number of features and identifies them. We used the proposed method for reducing dimensionality of a number of benchmark data sets of varying sizes. Its performance was also extensively compared with some other well-known feature selection methods.

S. Bandyopadhyay

Optimal selection of features is important to avoid redundancy, over-fitting and better interpretability of the concerned model. In the case of online learning, new instances are periodically discovered, and the respective model is tactically retrained as required. Similarly, in real-life situations hundreds of new features are discovered periodically, and the existing model needs to be retrained or tested for its performance improvement. Supervised selection of feature subset usually requires creation of multiple suboptimal models, thus incurring time-intensive computations. Unsupervised selections, although

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faster, largely rely on some subjective definition of feature relevance. We proposed a score is for online feature selection scenarios. It has low time complexity and ability to interpret performance improvement of the current model after the addition of a new feature, without invoking a retraining.

S. Bandyopadhyay

Multi-objective Optimization

A comprehensive and critical survey of the multitude of multiobjective evolutionary clustering techniques (existing in the literature) has been proposed. The techniques are classified according to the encoding strategies adopted, objective functions, evolutionary operators, strategy for maintaining nondominated solutions, and the method of selection of the final solution. The pros and cons of the different approaches are mentioned. Finally, we have discussed some real-life applications of multiobjective clustering in the domains of image segmentation, bioinformatics, web mining, and so forth.

S. Bandyopadhyay

A novel way of determining the value of dominance, which is different for each objective function, based on the correlation between them, has been proposed. We call this approach Priority Based (PBE) as the method in the MOEA. PBE is incorporated in an archived simulated annealing based MOO technique called AMOSA. AMOSA has been earlier shown to outperform several well-known MOO techniques especially for many objective optimization. PBE based AMOSA, referred to as PBE-AMOSA, is found to comprehensively outperform AMOSA, MOEA/D-DE, the conventional AMOSA and MOEA/D-DE both in case of benchmark test problems and 0/1 knapsack problem.

S. Bandyopadhyay

A new framework based on multiobjective optimization (MOO), namely FeaClusMOO, is proposed which is capable of identifying the correct partitioning as well as the most relevant set of features from a data set. Here features and cluster centers are encoded in the form of a string. As the objective functions, two internal cluster validity indices measuring the goodness of the obtained partitioning using Euclidean distance and point symmetry based distance, respectively, and a count on the number of features are utilized. These three objectives are optimized simultaneously using AMOSA (Archived multiobjective simulated annealing) in order to detect the appropriate subset of features, appropriate number of clusters as well as the appropriate partitioning. Points are allocated to different clusters using a point symmetry based distance. Since AMOSA, like any other MOO technique, provides a set of solutions on the final Pareto front, a technique based on the concept of semi-supervised classification is developed to select a solution from the given set. The effectiveness of the proposed FeaClusMOO in comparison with other clustering techniques like its Euclidean distance based version where Euclidean distance is used for cluster assignment, a genetic algorithm based automatic clustering technique (VGAPS-clustering) using point symmetry based distance with all the features, K-means clustering technique with all features is shown for seven higher dimensional data sets obtained from real-life.

S. Bandyopadhyay

Bioinformatics

DNA reassembling is an NP-hard problem. We have developed a locally guided global learning system to solve the problem of genome reassembling. We have used a reference DNA sequence which is 99 % similar to an unknown DNA sequence. Two different sequences from the same organism generally have around 99 % similarity. We have considered different DNA sequences from NCBI website. Then we have simulated the tasks of cloning the sequence, followed by shearing the clones to a number of short reads. In our algorithm, we have introduced a new concept in the task of DNA reassembling using Ant Colony Optimization, where pheromone concentration is proportional to the score of assembled DNA fragments with some known reference sequences within the same organism. Unlike local overlapping, we have used here local alignment score of short reads with some known local

reference region as the heuristic information. The result shows that our algorithm is capable of reassembling at par with the state-of-the-art. Due to lack of appropriate computational resources, we had to confine ourselves to deal with the sequences of length up to ~105bp. We have considered 22 sequences of different organism, including Homo sapiens BRCA1 (127429bp) gene. For large sequences, we have applied hierarchical BAC-by-BAC sequencing, to stitch the individual segments to retrieve the original DNA sequence.

R.K. De

Copy number variation (CNV) is a form of structural alteration in the mammalian DNA sequence, which are associated with many complex neurological diseases as well as cancer. The development of next generation sequencing (NGS) technology provides us a new dimension towards detection of genomic locations with copy number variations. We have developed an algorithm for detecting CNVs, which is based on depth of coverage data generated by NGS technology. In this work, we have used a novel way to represent the read count data as a two dimensional geometrical point. A key aspect of detecting the regions with CNVs, is to devise a proper segmentation algorithm that will distinguish the genomic locations having a significant difference in read count data. We have designed a new segmentation approach in this context, using convex hull algorithm on the geometrical representation of read count data. To our knowledge, most algorithms have used a single distribution model of read count data, but here in our approach, we have considered the read count data to follow two different distribution models independently, which adds to the robustness of detection of CNVs. In addition, our algorithm calls CNVs based on the multiple sample analysis approach resulting in a low false discovery rate with high precision.

R.K. De

An index, called Gaussian fuzzy index (GFI), based on the notion of fuzzy set theory for validating the clusters obtained by a clustering algorithm, has been formulated. GFI is then used for the identification of genes that have altered quite significantly from normal state to carcinogenic state with respect to their mRNA expression patterns. The effectiveness of the methodology has been demonstrated on three gene expression cancer datasets dealing with human lung, colon and leukemia. The performance of GFI is compared with 19 exiting cluster validity indices. The results are appropriately validated biologically and statistically. In this context, we have used biochemical pathways, p-value statistics of GO attributes, t-test and zscore for the validation of the results. It has been reported that GFI is capable of identifying high-quality enriched clusters of genes, and thereby is able to select more cancer-mediating genes.

R.K. De

Detection of human protein complexes by developing a multi-objective framework, has been focused. For this large human PPI network is partitioned into modules which serves as protein complex. For building the objective functions we have utilized topological properties of PPI network and biological properties based on Gene Ontology semantic similarity. The proposed method is compared with that of some state-of-the-art algorithms in the context of different performance metrics. Additionally, we have performed an analysis to associate resulting protein complexes with 22 key disease classes. Two bipartite networks are created to clearly visualize the association of identified protein complexes with the disorder classes. Identified protein complexes are found to be associated with several disorders classes like 'Cancer', 'Endocrine' and 'Multiple'. This analysis uncovers some new relationships between disorders and predicted complexes that may take a potential role in the prediction of multi target drugs.

S. Bandyopadhyay

A computational rule mining framework, StatBicRM (i.e., statistical biclustering-based rule mining) to identify special type of rules and potential biomarkers using integrated approaches of statistical and binary inclusion-maximal biclustering techniques from the biological datasets, has been proposed. First, a novel statistical strategy has been utilized to eliminate the insignificant/low-significant/redundant genes. The data is then discretized and post-discretized, consecutively. Thereafter, the biclustering technique is applied to identify maximal frequent closed homogeneous

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itemsets. Corresponding special type of rules are then extracted from the selected itemsets. Proposed rule mining method saves elapsed time, and can work on big dataset. Pathway and Gene Ontology analyses are conducted on the genes of the evolved rules using David database. Frequency analysis of the genes appearing in the evolved rules is performed to determine potential biomarkers. Furthermore, we classify the data based on evolved rules and compare the average classification accuracy with other rule-based classifiers. Statistical significance tests are performed for verifying the statistical relevance of the comparative results. Finally, we have also included the integrated analysis of gene expression and methylation for determining epigenetic effect on gene expression level.

S. Bandyopadhyay

With the advances in experimental technology, increasing methodologies are available to measure more complex relationships in gene expression data. Multiple types of experimental conditions like cell cycle, heat shock, and diauxic shift are available for same set of genes. The similarity measures like Pearson correlation and Euclidean distance cannot capture the variation of ranges for different experimental conditions. These measures cannot take advantage of the existing functional annotation information available for many genes. Moreover, gene expression data are generally noisy and not very reliable because many factors affect the measurements during experiments. In this situation, investigations are going on to incorporate biological knowledge (functional annotation) in the similarity measure to take care of the above mentioned limitations to some extent.

S.S. Ray

Computational Systems Biology

An algorithm, for growth analysis of four metabolic pathways involved in Type 1 Diabetes Mellitus, has been developed. It has three modules, pattern finding, interaction identification and growth detection. The first module identifies patterns using Community structures using Hamming distances and Tanimoto coefficient. We have performed functional analysis by representing patterns using ODEs, and identified Stoichiometric, Gradient and Jacobian matrices. The second module identifies interactions among patterns using cut-sets and network-partitioning by 'Divide-and-conquer'. The third module identifies functions of patterns using interactions, thereby highlighting their nature of growth. We have observed that metabolites that are genetically robust and resist alterations against stable state during evolution, account for emergence of a scale-free network.

R.K. De

A model, based on the state space equations of classical control theory along with an order reduction technique to mimic the actual dynamic behavior of mammalian central carbon metabolic (CCM) pathway in normal cells, has been developed. Michaelis Menten kinetic equation has been modified to incorporate feedback mechanism along with perturbations and cross talks associated with a metabolic pathway. Furthermore, we have perturbed the model to reduce the mitochondrial oxidative phosphorylation. Proportional-integral (PI) controller(s) have been connected with the model for tuning it to behave like the CCM pathway of a cancer cell. This methodology allows one to track the altered dynamics mediated by different enzymes. The model successfully mimics all the probable dynamics of the CCM pathway in normal cells. Moreover, experimental results demonstrate that in cancer cells, a coordination among enzymes catalyzing pentose phosphate pathway and intermediate glycolytic enzymes along with switching of pyruvate kinase (M2 isoform) plays an important role to maintain their altered dynamics.

R.K. De

Association mining is a well explored topic applied to various fields. In this investigation, the associations among the genes have been identified from microarray gene expression data. A methodology, called Fuzzy Correlated Association Mining (FCAM), has been developed for identifying the associations among the genes that have altered quite significantly from normal state to diseased state with respect to their expression patterns. This idea leads to predict the disease mediating genes along with their altered associations. The methodology involves generation of fuzzy gene sets, construction of fuzzy items, computation of fuzzy support for fuzzy items and fuzzy correlation

coefficient of a pair of fuzzy items, generation of associations, and identification of altered associations from normal to diseased state. The concept of finding fuzzy correlation between two groups of items, generation of altered associations among the items (groups of items) and then rank these items (groups of items) according to their importance are the novel contribution of the work. The effectiveness of the methodology has been demonstrated on five gene expression data sets dealing with human lung cancer, colon cancer, sarcoma, breast cancer and leukemia. As a result, some possible genes, like *igfbp3*, *erbb2*, *tp53*, *hbb*, *kras*, *pten*, *calca*, *cdkn2a*, have been found as important genes that may mediate the development of various cancers considered here. For comparison, we have considered 11 existing association rule mining algorithms. The results have been appropriately validated in terms of gene–gene interactions, functional enrichment, biochemical pathways, and using NCBI database.

R.K. De

Protein–protein interaction (PPI) networks are believed to be important sources of information related to biological processes and complex metabolic functions of the cell. Identifying protein complexes is of great importance for understanding cellular organization and functions of organisms. In this work, a method is proposed, referred to as MIPCE, to find protein complexes in a PPI network based on mutual information. MIPCE has been biologically validated by GO-based score and satisfactory results are obtained. We have also compared our method with some well-known methods and obtained better results in terms of various parameters such as precision, recall and F-measure.

A. Ghosh

Medical Imaging

A novel two-stage region of interest (ROI) segmentation has been developed for detecting glioblastoma multiforme (GBM) tumors from brain magnetic resonance images (MRIs). The method involves multi-level thresholding followed by post-processing. Initially discrete curve evolution (DCE) identifies multiple intervals around the significant (or visually critical) points, with a threshold being selected in each such interval using Otsu's method or Li and Lee's entropy. Next a post-processing on the segmented image, based on connected-component analysis and flood-fill operation, helps to extract each refined ROI around a single seed inserted by the user. The segmented ROI is more accurate, both quantitatively and qualitatively, as compared to related methods – in spite of using only a single seed. This is evaluated (i) visually, (ii) in terms of the Jaccard and Dice indices (on the ROI), and (iii) over time complexity of the algorithm. The experimental results on contrast enhanced T1-weighted MRI slices of 25 patients, each having the corresponding ground truth about the tumor regions; establish the effectiveness of our algorithm.

S. Mitra

The segmentation of brain MR images into different tissue classes is an important task for automatic image analysis technique, particularly due to the presence of intensity inhomogeneity artifact in MR images. In this regard, the proposed work presents a novel approach for simultaneous segmentation and bias field correction in brain MR images. It integrates judiciously the concept of rough sets and the merit of a novel probability distribution, called stomped normal (SN) distribution. The intensity distribution of a tissue class is represented by SN distribution, where each tissue class consists of a crisp lower approximation and a probabilistic boundary region. The intensity distribution of brain MR image is modeled as a mixture of finite number of SN distributions and one uniform distribution. The proposed method incorporates both the expectation-maximization and hidden Markov random field frameworks to provide an accurate and robust segmentation. The performance of the proposed approach, along with a comparison with related methods, has been demonstrated on a set of synthetic and real brain MR images for different bias fields and noise levels.

P. Maji

One of the important problems in medical diagnosis is the segmentation and detection of brain tumor in MR images. The accurate estimation of brain tumor size is important for treatment planning and therapy evaluation. In this regard, a new method, termed as SoBT-RFW, has been proposed for

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segmentation of brain tumor from MR images. It integrates judiciously the merits of rough-fuzzy computing and multiresolution image analysis technique. The proposed method starts with a simple skull stripping algorithm to remove non-cerebral tissues such as skull, scalp, and dura from brain MR images. To extract the scale-space feature vector for each pixel of brain region, the dyadic wavelet analysis has been used, while an unsupervised feature selection method, based on maximum relevance-maximum significance criterion, has been used to select relevant and significant textural features for brain tumor segmentation. To address the uncertainty problem of brain MR image segmentation, the proposed SoBT-RFW method uses the robust rough-fuzzy c-means algorithm. After the segmentation process, asymmetry is analyzed by using the Zernike moments of each of the tissues segmented in the brain to identify the tumor. Finally, the location of the tumor is searched by a region growing algorithm based on the concept of rough sets. The performance of the proposed SoBT-RFW method, along with a comparison with related approaches, has been demonstrated on a set of synthetic and real brain MR images using standard validity indices.

P. Maji

Video Processing

An efficient moving cast shadow segmentation technique is devised that separates out the moving objects from their shadows casted on the background. It follows two major steps: background separation and shadow detection. For background separation, initially a background model is built. For a particular pixel location we construct the background model by taking the median of pixel values at the corresponding pixel locations in the temporal direction. To suppress the effects of quick change in illumination, and color frequency variation of texture background, in the proposed scheme we have extracted the RGB color features and ten local features at each pixel location in the considered target image frame and the constructed reference image frame. For background separation, a difference image is generated by considering pixel by pixel absolute difference of the thirteen dimensional target image frame and the constructed background model. This is followed by a spatial MRF constrained fuzzy clustering to find the moving regions in the considered scene. The maximum a posteriori probability (MAP) estimate of the fuzzy statistic based MRF are obtained by fuzzy clustering. The MAP of the MRF constrained fuzzy clustering provides a binary image, where the moving objects with the moving cast shadow are identified as one group and the background is obtained as another group. To segment the moving object from its shadow we explore a three stage shadow analysis technique. It uses analysis of rg color chrominance property of shadow, local gray level co-occurrence based shadow processing followed by boundary refinement to separate out the regions corresponding to the moving cast shadow and moving objects.

A. Ghosh

Text Mining

New classification and clustering algorithms for text mining are developed. The developed methods are found to provide better results than the existing methods. K nearest neighbor decision rule is modified so that the prior knowledge of the value of k is not needed while implementing the classification scheme.

C.A. Murthy

We have proposed two measures based on Hausdorff-metric, one is a measure of roughness and the other one is a measure of granulation for rough sets. The main advantage of the proposed measures over the existing ones are that the proposed measures deal with the quantities, that is the value of the data points. This has been demonstrated by a case study. Therefore, the proposed measures, H-roughness and H-granulation, would be very useful in classification (i.e. in pattern recognition applications) using rough sets where numerical values of data points are important. The objective behind the proposed definitions is to quantify "how close a set is to its lower approximation and upper approximation". The word "close" may be defined in terms of either "distance", or "symmetric difference" or any such measure. We have used "distance" for defining closeness, and the most widely

used set distance is Hausdorff-metric. It is seen that Hausdorff-metric is indeed providing satisfactory results, as substantiated by the case study.

B. Uma Shankar and C. A. Murthy

A few attempts are made to find experts for question routing in community question answering (CQA) services. The first one is concerned with the incorporation of theme in query likelihood language (QLL) model. Users' activeness is taken into account in another expert finding scheme. Effectiveness of term familiarity in QLL model is established for the expert finding process for a new question. The expert finding process is improved further by a new user profile creation scheme. The performances of the proposed processes are verified on a number of real-world datasets (obtained from Yahoo! Answers) and they are found to be quite encouraging.

D.P. Mandal

Machine Vision and Perception

The Oriented Difference of Gaussian (ODOG) filter of Blakeslee and McCourt has been employed to explain several brightness perception illusions which include illusions of both brightness-contrast type, for example, Simultaneous Brightness Contrast and Grating Induction and the brightness-assimilation type, for example, the White effect and the shifted White effect. We have demonstrated some limitations of the ODOG filter in predicting perceived brightness by comparing the ODOG responses to various stimuli (generated by varying two parameters, namely, test patch length and spatial frequency) with experimental observations of the same. Work is presently continuing in search of an alternative computational model based on spatial filtering.

K. Ghosh

Social Network Analysis

Fast Overlapped Community Search (FOCS), an algorithm that accounts for local connectedness in order to identify overlapped communities, has been proposed. FOCS is shown to be linear in number of edges and nodes. It additionally gains in speed via simultaneous selection of multiple near-best communities rather than merely the best, at each iteration. FOCS outperforms some popular overlapped community finding algorithms in terms of computational time while not compromising with quality.

S. Bandyopadhyay

Speech Mining

A speech recognition system is developed by applying our proposed approximate string matching' and 'theme matching' schemes for the formation of words and sentences respectively. The proposed system is being verified on 'Shruti', a Bengali speech dataset developed in IIT Kharagpur.

D.P. Mandal and S. Maiti

Documentation, Research and Training Centre, Bangalore

The main areas of research in which the different faculty members of the DRTC were engaged during the period, are furnished below:

Knowledge Organization

The focus of Knowledge Organization has transformed substantially in the last one decade as a direct consequence of the emergence of digital resources, digital libraries and the World Wide Web. Knowledge organization, today, has to meet the twin objectives of facilitating organization of information resources for effective retrieval while at the same time look at ways and means of effective tagging of the huge volume of digital resources to support retrieval at acceptable levels of precision.

Digital Libraries and Semantic Web

Research is carried out in faceted ontologies in social and media research. Study of Wordnet for semantic compatibility as part of EU funded FET Living Knowledge Project, was undertaken. The main objective of the project is to develop ontologies using faceted approach, in order to provide folksonomies which should facilitate visualizations to the end-user. DRTC is actively pursuing research in web ontologies using RDF (Resource Description Framework), OWL (Web Ontology Language) and SKOS (Simple Knowledge Organization system). The ultimate goal is to develop context based search mechanisms combined with inference engines. Domain based ontologies in LK format are being built. Work on producing faceted Music Ontology, Food and Recipes is ongoing.

Devika P. Madalli

Development Universal Knowledge Core

DRTC has a long history in its contribution to Knowledge Modeling and management for systems in libraries. The principled approach of analytico synthetic classification is now applied to semantic web especially to developing faceted ontologies. The work in the past few years has lead to an international team working towards development the Universal Knowledge Core (UKC). Under this, refinement and application of DERA framework for different domains is being carried out.

Devika P. Madalli and Biswanath Dutta

Multilingual data in Indian languages for Universal Decimal Classification

Coordination and supervision of translation and mapping of concepts for Universal Decimal Classification in Indian languages such as Hindi, Kannada, Tamil, Telugu, Marathi and Punjabi is being pursued. Presently work on Urdu and Malayalam is ongoing.

Devika P. Madalli

Library and Information Technology

In the recent past, several technology applications to library and information work have been demonstrated. As a part of this kind of research, a LiveCD called Liblivecd has been released. It is preconfigured with DSpace digital library software + Koha, Library Management Software + PKP Harvester (which collects metadata from various digital/institutional repositories to provide a single stop search engine) + dbwiz, a federated search engine which facilitate searches across e-journals and online databases. The Liblivecd is hosted on <http://sourceforge.net/projects/liblivecd>. The updated version has been made available.

A. R. D. Prasad

Data Repositories

Data is ubiquitous. The Government of India has mandated all the organisations and research funded by Gol, should make the data generated available as open data. This has been the case with many a country. However, a study conducted internally by DRTC has shown that there have been no standards in publishing data on the Web which makes it impossible to have the data interoperable and reusable, which is the very notion behind Linked Open Data (LOD). Prof. A.R.D Prasad and Prof. Devika P. Madalli have been preparing 'UNESCO Guidelines for Data Publishing and Data Repositories'. Tim Burners-Lee envisaged that semantic web will be a data web. To realize semantic web and to make data discoverable and machine processable, it is essential to have metadata and ontology in place. As the existing metadata schema do not support such activity, DRTC has been working on a home-grown metadata schema called 'PROMIS' (Processing Metadata Schema Initiative) and made a presentation at an event on Big Data in Beijing. In addition, we have conducted

an International workshop and also an International Conference on Big Data and Knowledge Discovery (ICBK-2016).

A.R.D. Prasad and Devika P. Madalli

Big Data

As more and more data is available on the Internet organising retrieving and handling big data has become essential for scientific research and e-governance. DRTC is working on implementation of tools for big data including Hortonworks, Cloudera, which include a cluster of tools like Hadoop, Hive, Pig, Zookeeper etc. DRTC is exploring the possibilities of developing models using home grown Analytico Synthetic Approach to Graph Database.

A.R.D. Prasad

Institutional repositories and Open Access to Information

In the 1990's a movement was started to enhance public access to scholarly journal articles through pre-print servers. In these servers, authors would deposit pre-prints of articles. It thus provided readers worldwide with a quick access to research outputs. These types of servers began as informal vehicles for the dissemination of preliminary research and literature. However, the last decade witnessed the rapid evolution of such resources into increasingly important media for dissemination of research results in certain fields. Broadly known as "Open Access to Information". In keeping with International and national importance of the area of Open Access to Information at DRTC the following contributions were made:

1. Comparative study of open source tools for digital repositories
2. Study the Feasibility of designing and developing an appropriate prototype Institutional Repository (IRs) model using open source software easily implementable in all the universities in India.
3. Study the adequacy of existing standards in this regard especially for scholarly material in Indian languages and scripts.
4. Design an end user interface for browsing, navigating through and searching the Institutional

DRTC has initiated process of networking Open Access initiatives in Asia through Asia OA forum.

A.R.D. Prasad and Devika P. Madalli

Information seeking behavior

The term *information seeking* often serves as an umbrella overarching a set of related concepts and issues. In the library world, discussions of database construction and management, community information needs, reference services, and many other topics resonate with the term. Yet, a single, serviceable definition remains elusive. Like any other complex concept, information seeking means different things in different contexts. In the simplest terms, information seeking involves the search, retrieval, recognition, and application of meaningful content. This search may be explicit or implicit, the retrieval may be the result of specific strategies or serendipity, the resulting information may be embraced or rejected, the entire experience may be carried through to a logical conclusion or aborted in midstream, and there may be a million other potential results. Information seeking has been viewed as a cognitive exercise, as a social and cultural exchange, as discrete strategies applied when confronting uncertainty, and as a basic condition of humanity in which all individuals exist. In fact, *information behavior* may be a more appropriate term, rather than information seeking, to best describe the multi-faceted relationship of information in the lives of human beings, a relationship that can include both active searching through formal information channels and a variety of other attitudes and actions, including skepticism and ambivalence (Pendleton & Chatman 1998). While addressing some aspects of these many alternatives, this paper uses *information seeking* to denote experiences or situations in which content is accessed, used, and synthesized into personal knowledge.

M. Krishnamurthy

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Digital Libraries

Digital libraries (DLs) have become a major part of the mainstream library landscape, and open source software (OSS) has become a worldwide phenomenon. According to the Digital Library Federation (DLF) digital libraries are: Organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use by a defined community or set of communities (Digital Library Federation, 1998). The DLF was founded in the USA in 1995 with the aim of providing its member libraries with leadership and support for new research, standards development, and project start-ups, meetings for reporting developments, and sharing experiences in developing and managing electronic resources and an e-mail listserv. Recent advances in information technology have provided new ways of dealing with information in academic libraries.

M. Krishnamurthy

Ontology Modelling and Evaluation

The work focuses on modelling various domain ontologies based on DERA Framework (a domain knowledge modelling framework) and YAMO (an ontology design methodology) that we built in our earlier work. All the domains that we build as part of this work, ultimately will be plugged into the Universal Knowledge Core (UKC), an initiative to build a large scale faceted knowledge base under the joint research programme ITPAR-III between Indian Statistical Institute, India and University of Trento, Italy. We are also working on ontology evaluation techniques. Some of this research results are already available in the public domain.

Biswanath Dutta

Study of Linguistic Phenomena in Knowledge Organization

The research focuses on finding the various linguistic phenomena (e.g., complementary polysemy, contrastive polysemy, metonymy, metaphor) that are present in WordNet, a large scale lexical database highly used for the Natural Language Processing (NLP) tasks. Besides resolving the linguistic phenomena issues, we are also working on adding semantics into it by making structural changes applying the knowledge organization techniques. The goal is to make WordNet a truly useful resource for NLP tasks, for instance, word sense disambiguation, relationship extraction, annotation, abstract construction, question answering. Some of this research results are already available in the public domain.

Hakim Abdel Freihat and Fausto Giunchiglia

Metadata

This research focuses on designing metadata vocabulary for description and publication of data and information. As part of this research, we have developed and published a metadata vocabulary, called MOD for ontology description and publication. The result of this result is also published in an international conference. At present, we are working on its further refinement.

Biswanath Dutta

Ontology matching

The research focuses on ontology matching. At present, we are working on matching based on the semantic similarity measurement between the nodes of a single ontology. We have designed an Information Content (IC) calculator, which is based on the information theoretic model. We further aim to extend this work by measuring the semantic relatedness between the nodes based on the designed IC calculator. We want extend the work by applying our algorithms on cross ontologies. At present, we are experimenting with WordNet, but we also want to apply the algorithms on domain specific ontologies. Some of this research results are already available in the public domain.

Abhjit Adhikari and Animesh Dutta

Social Networking Data

The focus of this research is to analyse and derive the insight of the data. The goal is to automatically find the nodes who are strong in information diffusion in the network and also to find out the essential buyers of the information. We have analysed a big set of data extracted from Twitter and also the data we generated randomly through a system we developed. We have already made some progress in identifying the influential nodes in a network. We are further working on this.

Amrita Namtirtha and Animesh Dutta

Systems Science and Informatics Unit, Bangalore

Visualizing Image Segmentation and Filtering Algorithms in Optimization Framework

Image segmentation and filtering are prominent problems in Image Analysis and Computer Vision. There exist several techniques in literature to address these problems, most of which are based on heuristic principles. One example is the watershed-based segmentation methods which are based on 'drop of water principle'. Water-snakes were first introduced to show the watershed segmentation as an energy minimization problem. In the similar direction, by viewing the image as an edge-weighted grid graph with the weights reflecting the similarity in the intensities, recently power watersheds have been introduced: It was shown that watershed cuts can be obtained as a limit of minimizers of a sequence of energy functions. We build a theoretical basis to the existing algorithms on segmentation and filtering that are currently based on heuristics by showing them as energy optimization problems. We also work on developing fast algorithms based on power watersheds to improve the computational cost for such problems.

Sravan Danda, Laurent Najman and B.S. Daya Sagar

Mathematical Morphology on General Data

Mathematical Morphology is the first consistent non-linear study of signal processing. Accordingly, it gained a lot of importance as an image processing tools in the last few decades. Also, in the last few years Machine learning and Pattern recognition has gained a lot of popularity as well. One of the important aspects of our research is to extend the Morphological operators used in Image processing to general data as well. In particular, the operators are designed to be useful to the problem of clustering and classification.

Aditya Challa and B.S. Daya Sagar

Development of mathematical morphology-based algorithms for generation of contiguous cartograms from point-data and, for modelling the spatiotemporal behaviour of varied phenomena via cartograms

Models developed via analytical means limit our understanding as it is hard to visualize the spatiotemporal behavior. However, modelling the spatiotemporal behavior of a phenomenon via proper visualization across spatial and temporal scales enhances our understanding. In conventional Geographical Information Science (GISci), development of models to visualize the spatiotemporal behavior is strictly by using choropleth raster maps. This modeling approach has various limitations as we employ some indicators such as color, shade, hatching, label to represent the strength of a variable. But it is proposed to develop variable-specific cartogram, in which the strength of the variable reflects in terms of area occupied by the unit. Employing such variable-specific cartograms of varied related phenomena is more appropriate to develop models to understand the spatiotemporal behavior of a phenomenon, as well as to understand the spatial relations between the cartograms of varied phenomena. The main objectives of this study include: (i) to develop efficient mathematical morphology-based algorithms to generate variable-specific cartograms that preserve global, topological and local shapes with minimum area-errors, (ii) to develop cartogram-based models to

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characterize spatio-temporal behavior of time-varying geographic phenomena of varied types, and (iii) to show the spatial relationships among the varied types of geographic variables that are visualized in the forms of cartograms and to demonstrate the potential of cartograms-based relationships.

B.S. Daya Sagar and Sampriti Soor

Morphing of Grayscale DEMs via Morphological Interpolations

We compute morphological medians hierarchically between the spatial fields (e.g. Digital Elevation Models) represented with similar sizes via grayscale morphology-based interpolations. These hierarchically generated sequential morphological medians facilitate construction of morphing-like sequence between the source and target spatial fields to visualize the spatiotemporal changes that have occurred between discrete time-intervals or episodic intervals. Two DEMs of similar sizes but belonging to two different regions are considered as source and target spatial fields further to (i) demonstrate morphology-based algorithm to generate all possible sequential morphological medians, and (ii) create morphing depicting source-DEM transforming into target-DEM. Application of morphological interpolation to DEM morphing is shown for the first time.

B.S. Daya Sagar and Lim Sin Liang

Granulometric and Fractal Analyses for Feature (Shape-Size-Orientation) Based Classification of Planar and Grayscale Basins Hierarchically Decomposed from CARTOSAT-I DEMs

Remotely sensed satellite data and Digital Elevation Models (DEMs) act as main sources to map various units of terrestrial relevance. These units possessing varied shapes, sizes and orientations are of varied spatial complexities possessing. It is hypothesized that the classification based on the three features (shape, size and orientations) of the phenomena (e.g., geophysical basins, water bodies) would be a way forward to relate the two distinct phenomena possessing similar features. Morphological constitutions of geophysical and geomorphologic phenomena have direct relationship with their function and process. Hence, feature-based (shape-size-orientation) categorization of such phenomena that could be mapped from varied data sources would be a step forward in geographical information science related research. With this motivation, automatic feature-based classification of such mapped units via binary and grayscale granulometric and fractal analyses is subsequently addressed on both binary and grayscale images depicting planar and grayscale basins.

S. Ashok Vardhan and B.S. Daya Sagar

Variable-Specific Classification of Zones, Pairs of Zones, and Clusters of a Spatial System via Modified Gravity Model

Hierarchical structures include spatial system (e.g. continent), clusters of a spatial system (e.g. countries of a continent), zones of a cluster (e.g. states of a country), and so on. Variable-specific classification of the zones (X_i) of a cluster of zones (X) within a spatial system is the main focus of this paper. Variable-specific (e.g. GDP, population, trade, resources, economic activity etc) classification of zones is done by computing the levels of interaction between the i th and j th zones. Based on a heuristic argument, we proposed a modified gravity model for the computations of levels of interaction between the zones. This argument is based on the following two facts: (i) the level of interaction between the zones X_i and X_j , with masses mX_i and mX_j is direction-dependent, and (ii) the level of interactions between the zones X_i and X_j , with masses mX_i and mX_j , situated at strategically insignificant locations would be much different (lesser) from that of the zones X_i and X_j with similar masses mX_i and mX_j but situated at strategically highly significant locations. With the support of this argument, we provide a modified gravity model by incorporating the $dX_{ij} \neq dX_{ji}$, and the product of location significance indexes ($\phi X_i \phi X_j$) of the corresponding zones. This modified

gravity model yields level of interaction between the two zones that satisfies $FX_{ij} \neq FX_{ji}$. We demonstrate this modified gravity model on the 28 states of India, whereby the areal extents of each state is considered as a parameter mass. The levels of interactions are shown for all possible pairs of states.

B. S. Daya Sagar

Pattern Recognition, Machine learning, Image Processing

The objective was to develop a new concept of granular neural networks and establish a solid framework as to the underlying ideas of information granules and their role in the construction of neural networks. Our intent was also to analyze how the level of granularity of the available data may impact the learning in the networks as well as influence their resulting performance. Several main approaches were described to the design of information granules. A number of fundamental issues were tackled including specificity of information granules vis-a-vis learning complexity in the neural networks along with their generalization features. A list of architectures of granular neural networks have been provided and elaborated on the associated training (learning) scenarios.

Saroj K. Meher and D. Arun Kumar

Neural Information Processing

Working on neural information processing under a DBT funded project and an ISI funded project. In both the projects human depth EEG signals are being studied. For the time being only epileptic seizures are being studied with the help of various nonlinear combinations of differential operators in order to understand the seizure onset and offset dynamics. Also patterns in digitized signals are being studied for a possible coding scheme in order to algebraically encode the seizure patterns in the depth EEG signals.

Kaushik Majumdar

Computer Science Unit, Chennai

On Acyclic Edge-Coloring of Complete Bipartite Graphs

An acyclic edge-coloring of a graph is a proper edge-coloring without bichromatic cycles. The acyclic chromatic index of a graph G , denoted by $a'(G)$, is the least integer k such that G admits an acyclic edge-coloring using k colors. Let $\Delta = \Delta(G)$ denote the maximum degree of a vertex in a graph G . A complete bipartite graph with n vertices on each side is denoted by $K_{n,n}$. In this work, we showed that $a'(K_{n,n}) = n+2 = \Delta+2$ for $n = 2p-1$, where p is an odd prime.

Ayineedi Venkateswarlu and Santanu Sarkar

Revisiting (Nested) Roos Bias in RC4 Key Scheduling Algorithm

RC4 is one of the most popular stream cipher with wide industrial applications, it has received serious attention in cryptology literature in the last two decades. In 1995, Roos pointed out that the elements $S_N[y]$ of the permutation S_N after the Key Scheduling Algorithm for the first few values of y are biased to certain combinations of secret key bytes. In this work, we presented a detailed analysis of Roos Bias. We provided a more accurate formula for the correlation probabilities. We further studied nested Roos type biases.

Santanu Sarkar and Ayineedi Venkateswarlu

On the Construction of Recursive MDS Matrices

MDS matrices allow to build optimal linear diffusion layers in the design of block ciphers and hash functions. There has been a lot of study in designing efficient MDS matrices suitable for software and/or hardware implementation. In particular recursive MDS matrices are considered for resource

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constrained environments. Such matrices can be expressed as a power of companion matrices. In this work, we provide a method for the direct construction of recursive MDS matrices using quasi-cyclic BCH codes.

Kishan Chand Gupta (ASU), Sumit Kumar Pandey and Ayineedi Venkateswarlu

Human strategic reasoning in dynamic games: Experiments, logics, cognitive models

This work considers results from a game-theoretic experiment that deals with strategic reasoning of people playing dynamic perfect information games. We explore several ways of segregating these participants into groups to see whether and how they can be divided into reasonable "player types". A logical language is proposed, expressing different kinds of strategies that people applied in the game-theoretic experiment, and also the different possible 'reasoning types' these players may belong to, as analysed through the experimental findings. Algorithms for computational cognitive (ACT-R) models are presented, which are developed based on the logic formulas that correspond to people's reasoning strategies and reasoning types. The aim is to achieve better understanding and better modelling of human strategic reasoning.

Sujata Ghosh, Tamoghna Halder, Khyati Sharma and Rineke Vebrugge

Reliability based preference dynamics

This work continues a line of research that studies individual preference upgrades in order to model situations akin to a process of public deliberation in collective decision making. It proposes a general upgrade policy, presenting its semantic definition and a corresponding modality for describing its effects as well as a complete axiom system.

Sujata Ghosh and Fernando R. Velazquez-Quesada

Preference based reliability dynamics

This work studies the dynamics of how reliable agents might consider each other, and formalizes certain possibilities (from the preference perspective) which can be instrumental for such changing reliabilities. The models consist of a preference ordering over some domain and a reliability ordering over the agents themselves. A two-dimensional hybrid language is proposed to describe such processes, and unanimity and stability of preferences under such dynamics are being studied.

Sujata Ghosh and Katsuhiko Sano

Games with communication: A logic approach

Imperfect information in games is generally modelled in terms of information partitions for players. Each player is associated with an equivalence relation over the set of game positions. There are models for imperfect information games where the players' information partitions are generated explicitly by means of communication. In this work we study one such model, propose a logic framework for reasoning about strategies and announcements, and investigate for a complete axiom system for the proposed logic.

Sujata Ghosh and Neethi Konar

Study of parameterized algorithms for connectivity augmentation

The problem of connectivity augmentation deals with the question of whether the connectivity of an input graph can be increased by adding at most k edges. Even the problem is known to be polynomial-time solvable if there is no restriction on the edges that can be added, it is NP-complete if only edges from a set of potential edges (given as input) are allowed to be added. But this problem is FPT if k is considered to be a parameter. A more general problem is to specify a set of vertices as part of the input and the aim is to increase the connectivity only between pairs of vertices from this set. We studied the special case of this problem where the connectivity among the specified vertices was to be increased to 2 from 1 and were able to obtain some partial results.

Manu Basavaraju and Mathew C. Francis

Investigation of a special class of boxicity 2 graphs

Graphs that can be represented as the intersection graph of axis-parallel rectangles on the plane are called boxicity 2 graphs. The problem of recognizing boxicity 2 graphs is known to be NP-complete. We study a restricted class of boxicity 2 graphs, called 2-SIG graphs, which have an intersection model using axis-parallel rectangles each of which intersect one of two lines parallel to the X-axis. The status of the recognition problem for 2-SIG is open as of now. We were able to show that if the input graph is a block graph, then we can determine in polynomial time whether the graph is a 2-SIG graph or not.

Dibyayan Chakraborty (ACMU), Sandip Das (ACMU), Mathew C. Francis and Sagnik Sen (ACMU)

Algorithms for computing the maximum uniquely restricted matching in special classes of graphs

A matching in a graph is said to be a uniquely restricted matching if there is no other matching in the graph that has the same set of matched vertices. We settled a 15 year old open problem by developing a polynomial-time algorithm that computes a uniquely restricted matching of maximum cardinality in an input interval graph. We were also able to construct linear-time algorithms for the problem in proper interval graphs and bipartite permutation graphs.

Mathew C. Francis, Dalu Jacob and Satyabrata Jana

Properties of contact graphs of L-shapes in the plane

We constructed a new proof for the fact that contact graphs of L-shapes in the plane are 2-degenerate if two Ls are not allowed to meet at their end-points and 3-degenerate otherwise. Our proof does not use the machinery of Schnyder woods and is quite elementary.

H.A. Ananya, Mathew C. Francis and Krishna Vaidyanathan

VPG and EPG representations of Halin graphs

A representation of a graph G in which every vertex is represented using a path in a grid graph in such a way that two vertices are adjacent in G if and only if their corresponding paths in the grid graph share at least one common vertex is called a VPG representation of the graph. If the paths in the grid graph are such that two vertices in G are adjacent if and only if they share a common edge, then the representation is said to be an EPG representation of G . The VPG (EPG) bend number of G is the minimum integer k such that it has a VPG (EPG) representation in which every path has at most k bends. We showed that for any Halin graph, the VPG bend number is at most 1 and the EPG bend number is at most 2. These bounds are tight.

Mathew C. Francis and Abhiruk Lahiri

Weighted Independent Sets in Graph Classes

The Maximum Weight Independent Set (MWIS) problem on graphs with vertex weights asks for a set of pairwise nonadjacent vertices of maximum total weight. MWIS is well known to be NP-complete, and hard to approximate. We focused on MWIS problem in certain graph classes that are defined by forbidden induced subgraphs. The complexity of the MWIS problem for H -free graphs, where $H \in \{P_6, S_{1,1,3}, S_{1,2,2}\}$ is unknown. We have shown that the MWIS problem can be solved in polynomial time for some subclasses of H -free graphs, where $H \in \{P_6, S_{1,1,3}, S_{1,2,2}\}$ by deriving the structure of these classes of graphs. These results extend some known results in the literature.

Frederic Maffray and T. Karthick

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Weighted Efficient Domination in Graph Classes

In a graph G , an *efficient dominating set* is a subset D of vertices such that D is an independent set and each vertex outside D has exactly one neighbor in D . The *Minimum Weight Efficient Dominating Set (Min-WED)* problem asks for an efficient dominating set of total minimum weight in a given vertex-weighted graph; the *Maximum Weight Efficient Dominating Set (Max-WED)* problem is defined similarly. The Min-WED/Max-WED is known to be NP-complete for P_7 -free graphs, and is known to be polynomial time solvable for P_5 -free graphs, its complexity was an open question for P_6 -free graphs. Recently, Lokshtanov et al. and independently, Brandstadt and Mosca showed that the Min-WED/Max-WED is solvable in polynomial time for P_6 -free graphs. We showed that Min-WED/Max-WED can be solved in polynomial time in some subclasses of P_6 -free graphs. Also, the time bound achieved for Min-WED/Max-WED on these classes are much better than in the P_6 -free case.

A. Brandstädt and T. Karthick

Metal-Insulator transitions and Many-Body Localization in 2-d electronic systems

We discovered the first theoretical instance of metal-insulator transition in a 2-d interacting and disordered electronic system in the form of Many Body Localization, the interacting generalization of Anderson localization using state-of-the-art Quantum Monte Carlo simulation.

S. Kunwar, Prabuddha B. Chakraborty and Rajesh Narayanan

BCS-BEC crossover in the disordered attractive Hubbard model

We developed a novel theoretical method, the dynamic phase Monte Carlo to investigate the BCS-BEC crossover in the disordered attractive Hubbard model.

Kanika Pasrija, Prabuddha B. Chakraborty and Sanjeev Kumar

Cryptography and Security Research Unit, Kolkata

Attribute-Based Encryption

We obtain Functional Encryption (FE) schemes for finite languages from standard static assumption, viz., and Decisional Linear (DLIN) assumption. These finite languages are described by Deterministic Finite Automata (DFAs). We have obtained 2 schemes. Our first scheme is ciphertext-policy functional encryption (CP-FE), where a key is labeled with a string w over a fixed alphabet and a ciphertext C is associated with a DFA M over the same alphabet. The key can extract the message from the ciphertext C if the DFA M accepts the string w . We obtain our second adaptively secure FE scheme in key-policy flavor from DLIN assumption. Both the schemes are shown to be secure in the standard model.

Rana Barua and Tapas Pandit

Stream Ciphers

After a series of results on RC4 cryptanalysis in flagship cryptology conferences and journals, one of the most significant recent attacks on the cipher has been the discovery of vulnerabilities in the SSL/TLS protocol, by AlFardan et al. (USENIX 2013). Through extensive computations, they identified some new significant short-term single-byte biases in RC4 keystream sequence, and utilized those, along-with existing biases, towards the TLS attack. The current work proves these new and unproved biases in RC4, and in the process discovers intricate non-randomness within the cipher. In this connection, we also prove the anomaly in the 128th element of the permutation after the key scheduling algorithm. Finally, the proof for the extended key-length dependent biases in RC4 keystream sequence, a problem attempted and partially solved by Isobe et al. in FSE 2013, has also been completed in this work. This has been published in *Designs, Codes and Cryptography Journal*. We have also analyzed some weaknesses in Salsa stream cipher.

Goutam Paul, Sourav Sen Gupta, Subhamoy Maitra (ASU), Santanu Sarkar and Willi Meier

Crypto hardware

Block ciphers are the most prominent symmetric-key cryptography kernels, serving as fundamental building blocks to many other cryptographic functions. This work presents RunFein, a tool for rapid prototyping of a major class of block ciphers, namely product ciphers (including Feistel network and Substitution permutation network-based block ciphers). RunFein accepts the algorithmic configuration of an existing/new block cipher from the user through a GUI to generate a customized software Implementation. Using RunFein, we have successfully implemented some well-known product ciphers and benchmarked their performance without significant degradation against their published hand-crafted implementations in literature. Moreover, for the first time we propose an efficient hardware accelerator design for SOSEMANUK, one of the finalists of the eSTREAM stream cipher competition in the software category. Since SOSEMANUK combines the design principles of the block cipher Serpent and the stream cipher SNOW 2.0, we make our design flexible to accommodate the option for independent execution of Serpent and SNOW 2.0. The best throughput achieved by the combined design is 67.84 Gbps For SOSEMANUK, 33.92 Gbps for SNOW 2.0 and 2.12 Gbps for Serpent. Our design outperforms all existing hardware (as well as software) designs of Serpent, SNOW 2.0 and SOSEMANUK, along with those of all other eSTREAM Candidates.

Goutam Paul, Anupam Chattopadhyay and Ayesha Khalid

Provable Security

The first provably secure symmetric AKE was proposed by Bellare and Rogaway (BR) in CRYPTO 1994 and so far this stands out as the most prominent one for symmetric key setting. We propose a stronger model than the BR model. We assume that the adversary can launch active attacks. In addition, the adversary can also obtain long term secret keys of the parties and the internal states of parties by getting access to their ephemeral secrets (or internal randomness) by means of appropriate oracle queries. We give a new construction of a symmetric key AKE in our new security model that is provably secure under the CDH assumption in the Random Oracle Model.

Goutam Paul, Suvradip Chakraborty and C. Pandurangan

Quantum Information

We describe a protocol for quantum information splitting (QIS) of a restricted class of three-qubit states among three parties Alice, Bob and Charlie, using a pair of GHZ states as the quantum channel. There are two different forms of this three-qubit state that is used for QIS depending on the distribution of the particles among the three parties. There is also a special type of four-qubit state that can be used for QIS using the above channel. We explicitly construct the quantum channel, Alice's measurement basis and the analytic form of the unitary operations required by the receiver for such a purpose. We also present a scheme to generate three particle hyper-entanglement utilizing polarization and orbital angular momentum (OAM) of a photon. We show that the generated state can be used to teleport a two-qubit state described by the polarization and the OAM. The proposed quantum system has also been used to describe a new efficient quantum key distribution (QKD) protocol. We give a sketch of the experimental arrangement to realize the proposed teleportation and the QKD.

Goutam Paul, Kaushik Nandi, Chithrabhanu P, Aadhi A, Salla Gangi Reddy, Shashi Prabhakar, G.K. Samanta and R.P. Singh

Quantum Cryptography

A rational secret sharing scheme is a game in which each party responsible for reconstructing a secret tries to maximize his utility by obtaining the secret alone. Quantum secret sharing schemes, either derived from quantum teleportation or from quantum error correcting code, do not succeed when we assume rational participants. This is because all existing quantum secret sharing schemes consider that the secret is reconstructed by a party chosen by the dealer. In this work, for the first time, we

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propose a quantum secret sharing scheme which is resistant to rational parties. The proposed scheme is fair (everyone gets the secret), correct and achieves strict Nash equilibrium.

Goutam Paul and Arpita Maitra

Bitcoins

Earlier, we identified several problems in the existing Proof-of-Work protocol for Bitcoin mining and proposed an alternative solution to generate blocks containing valid transactions. In our earlier scheme, each miner generates a hash value locally and then the miners engage in a distributed computation of the minimum of the hashes to select the winner. We claimed that this will eliminate the advantage of the miners with more computational resources and therefore would be more democratic. However, in this work we show that the new scheme is also subject to the same weakness in the sense that a miner with more computational resources can do some local computation in order to increase its winning probability. We also discuss possible remedies to this problem and their implications. We have designed new Proofs of Work (PoW) for Bitcoin protocol, and proposed an alternative cryptocurrency called Retricoin which replaces PoW with proofs of space.

Goutam Paul and Sushmita Ruj

Key Management in Wireless Sensor Networks

We propose a hybrid key management scheme for Hierarchical WSN. In this scheme, the resource constrained sensor nodes use symmetric key cryptographic schemes using polynomials for secure communication. The clusterheads which are more powerful and can communicate using public key cryptographic schemes. We use an onion routing based scheme for anonymous routing across cluster heads. The computation and communication costs of the proposed hybrid scheme are better than existing results.

Sushmita Ruj, Kouichi Sakurai and Laltu Sardar

Cloud Security

We propose a new decentralized access control scheme for secure data storage in clouds that supports anonymous authentication. In the proposed scheme, the cloud verifies the authenticity of the server without knowing the user's identity before storing data. Our scheme also has the added feature of access control in which only valid users are able to decrypt the stored information. The scheme prevents replay attacks and supports creation, modification, and reading data stored in the cloud. We also address user revocation. Moreover, our authentication and access control scheme is decentralized and robust, unlike other access control schemes designed for clouds which are centralized. The communication, computation, and storage overheads are comparable to centralized approaches. We are studying Proofs of Retrievability and proofs of data possession for outsourced storage. We proposed efficient auditing schemes using secure network coding. In the second problem we provide cloud security services using crowd sourcing.

Sushmita Ruj, Sourya Joyee De, Binanda Sengupta, Ayan Das, Kouichi Sakurai,
Junpei Kawamoto, Hiroaki Anada, Takahashi Nishide
Rohit Verma and Rajat Saxena

Security and Fault Tolerance in Smart Grids and IoT

We model smart grids as complex interdependent networks, and study targeted attacks on smart grids for the first time. A smart grid consists of two complex networks: the power network and the communication network, which are interconnected. Occurrence of failure/attack on one network triggers failure in the other and propagates in cascades across the networks. Such cascading failures can result in disintegration of either of the networks. Earlier works considered only random failures. In practical situations, an attacker is more likely to compromise nodes selectively. We study cascading failures in smart grids, where an attacker selectively compromises the nodes with probabilities proportional to their degrees; high degree nodes are compromised with higher probability. We

mathematically analyze the sizes of the giant components of the networks under attack, and compare them with the sizes in random attacks. We show that networks disintegrate faster for targeted attacks compared to random failures. A targeted attack on a small fraction of high degree nodes disintegrates one or both of the networks, whereas, both the networks contain giant components for random attack on the same fraction of nodes.

Sushmita Ruj, Abriti Paul, Yogesh Dorbala, Zhen Huang, Amiya Nayak,
Arindam Pal and Misuk Huh

Physics and Earth Sciences Division

Geological Studies Unit, Kolkata

Numerical models of fluid flow in Cuddapah basin

Talcification process in Cuddapah basin is strongly dependent on dolomite dissolution rate and is proportional with the temperature of the metasomatic fluid. Talcification of dolomite is enhanced moderately by the increase in talc saturation. Results of the numerical model suggest that at metasomatic fluid temperature of 400°C and talc saturation of atleast 10.0, it would take approximately 1.09 Ma to 0.15 Ma for the formation of two meters thick, volume retentive talc zone. The result obtained closely matches with the estimated time taken for hydrothermal Cu, Pb – Zn and Au mineralization. Mass balance calculations show that the minimum fluid flux required for iso-volumetric conversion of dolomite to talc is of the order of 1.32×10^6 L/m³.

Amlan Banerjee, S.P. Deb and D. Saha

Cataclasis, shear heating and clay mineral reconstitution

XRD analysis of selected samples of Gondwana and Siwalik rocks occurring between Tipi thrust and MBT (Bomdila thrust) in the Sub-Himalayan Doimukh-Potin (DP) section show common occurrence of chlorite, smectite, illite-muscovite, kaolinite, quartz and plagioclase feldspar. Except one sample of Gondwana shale, the Kubler index (KI ~ inverse of illite crystallinity) is <0.25, implying temperature around 300°C and maximum burial depth of ~12 km, assuming mineral reconstitution by burial alone. Taking into account the sample locations in relation to the major dislocations, namely Tipi thrust, MBT1 and MBT2, the results suggest lower KI values close to the fault lines or fold cores. Localized hydrothermal alterations may have affected clay mineralogy in the DP samples, but enhanced cataclasis of the Gondwana and Siwalik rocks either in the proximity of the main faults or fold cores favours influence of localized shear heating in clay mineral reconstitution.

Dilip Saha, Abhijit Patra, Amlan Banerjee and Sk. Md. Equeenuddin

Fluid enhanced mineralogical/chemical changes along Main Boundary Thrust (MBT), Eastern Himalaya

Fault rock samples collected from the vicinity of MBT northern strand, show marked decrease in SiO₂ content, and increase in FeO^T, Al₂O₃, (Na₂O+K₂O) and marginal increase in CaO, and \sum REE abundance in the strongly foliated thrust zone samples compared to weakly deformed Gondwana sandstone samples. Change in bulk chemistry corresponds well with increase in modal phyllosilicate content, foliation parallel chlorite grains and pronounced chlorite rich beard structure at pressure fringes of quartz or altered feldspar porphyroclasts. The chemical/mineralogical changes are possibly due to episodic mass transfer assisted by multiple passes of advective hydrothermal circulation preferentially along the fault zone. In contrast the chemical changes are minimal in Siwalik rock samples with common deformation bands and cataclasite from near MBT southern strand, resembling deformation in poorly consolidated sandstone along known seismogenic faults.

Dilip Saha and Abhijit Patra

Post-orogenic Kanigiri granite from the Nellore schist belt (NSB)

The A-type Kanigiri granite, intrusive into the NSB, is a two mica granite with very high annite/phlogopite ratio, and marked by LREE enrichment, strong negative Eu anomaly, as well as negative Ba-, Sr-, P-, Ti- and Yb anomaly, indicating feldspar, apatite and ilmenite/magnetite fractionation. Discrimination on the basis of relative Nb-Y-Ce abundances, show that the peraluminous, alkali-calcic to calc alkaline granite is A₁ subtype, possibly representing a felsic residue derived from fractional crystallization of Ocean Island Basalt type magma. Strongly flattened magmatic fabric together with superimposed, relatively high- to moderate- temperature crystal plastic deformation fabric in Kanigiri granite is similar to fabrics reported from late to post-orogenic granites elsewhere. Mesoproterozoic subduction-accretion represented by the Kanigiri ophiolitic melange is intruded by the late- to post-orogenic Kanigiri granite.

Dilip Saha and Arnab Sain

Field study of flow, salinity and sedimentation-erosion patterns in the Sundarbans estuarine system.

The study carried out in the Matla-Bidyadhari interfluvium (tidal range- 5-8 m, average elevation- 3 m) reveals that the pattern of channel network and tidal flow path is extremely complex leading to extensive bank erosion, breaching of embankments and overbank flooding. The area receives sediments (silt, clay with little sand) mainly from the sea during flood tide. Parts of the sediments settle down during stand-still phase to form mid-channel shoals and bank attached bars which are submerged during high water stage of tide and emerge at low water stage. Some of them, however, remain submerged even at low water stage. Measurement of salinity (TDS) of groundwater collected from tube wells (depth ~300 m) reveal maximum salinities close to 700 ppm (mg/l), that decrease towards north reaching a minimum value of 450 ppm (mg/l). The values are higher than the prescribed value suitable for drinking.

Chandan Chakraborty

Sedimentation in the Himalayan foreland basin

Study of the Himalayan foreland basin in the Tista Valley has revealed presence of Mio-Pliocene precursor of Ganges delta. Although not reported earlier, existence of the deltaic succession imply presence of a marine embayment in this area and all the mountain drainages recorded in the western Himalaya flowed into this embayment forming the delta. A number of marine trace fossils and presence of brackish water tolerant spore-pollen provides the additional evidences for this sedimentological study. This reconstruction provides a more complete source-to-sink view of the Himalayan foreland basin from its mountainous source to deep sea Bengal fan during Mio-Pliocene. The sedimentological data generated in this project provides a template to consider aspects of sea-level fluctuation and basin tectonics of the Himalayan foreland basin. A preliminary analysis of field data from Kameng River section indicates a transition from marine to a major axial drainage system in the far-eastern part of the basin.

Tapán Chakraborty, S. Taral, S. Mullick, and A. Debnath,

Stratigraphic analysis of the Cuddapah, Bhima and Kaladgi successions

An integrated analysis of stratigraphy, depositional processes, depositional systems, and provenance of the Chattisgarh, Cuddapah, Bhima and Kaladgi basins is in progress. The analysis is in tune with recent approaches in stratigraphic and sedimentological analysis with a regional perspective. The stratigraphy of the Cuddapah and the Chattisgarh basins have been interpreted in terms of tectonic evolution and the stratigraphic-tectonic approach can be a model for tectonic analysis of other Purana basins. Facies analysis in the Neoproterozoic Kerur Formation of the Badami Group, Kaladgi Basin, established that tide and storm played an important role in the development of sequences of

sedimentary structures in the Kerur shelf. Deposition involved repetitive cycles of tide-dominated to wave-dominated sedimentation, possibly within macrotidal range, stacking tidal dunes into sand ridges. Bipolar, bimodal distribution of foreset azimuths, with the modes between NE and SW indicate that these sandbodies developed as transverse to shore parallel bars and ridges. Physical and chemical aspects of carbonate depositional systems and their potential in predicting climatic changes on regional scale are in progress.

Sarbani P. Deb, D. Saha, T. Majumder, S. De and S. Saha

Sedimentology of the Early Jurassic Kota Limestone: a record of carbonate wetland in a continental rift basin of India

The Pranhita-Godavari basin is one of the major rift basins of peninsular India that was actively filled with sediments when the Indian landmass was a part of the Gondwanaland. In the Early Jurassic a freshwater carbonate deposit characterized by a 20-30m thick alternation of limestone and shale beds was formed in this basin. Numerous fossils of animals (including dinosaurs) and plants that thrived in this locality have been found within these sedimentary rocks. This research aimed to characterize the prevailing physical environment from a study of the sedimentological features. It has been found that two main depositional domains existed: a palustrine paleoenvironment and a shallow lake to pond paleoenvironment. The events of carbonate influx resulting in precipitation or clastic accumulation and sub-aerial modification of the sediments took place repeatedly. The presence of dinosaur footprints, plant roots, and the absence of deep basinal facies as well as repetitive stacking of sediments formed in shallow to subaerial conditions indicates that the depositional environment was more akin to a modern wetland.

Parthasarathi Ghosh and S. Goswami

Late Triassic sedimentation in the Pranhita-Godavari Rift Basin, India

The Late Triassic Maleri Formation is a part of the syn-rift sedimentary rock succession that formed in the Pranhita-Godavari continental rift basin. Its sedimentology provides important clues for reconstructing rift basin configuration and climate. However, due to the dominance of red mudrocks the depositional environment of the Maleri fluvial sediments remained poorly constrained. This study shows that most of the mudrocks were not formed due to slow settling of fine-grained clastics but were deposited by poorly confined, moderate to high-energy flows transporting sand- to silt-sized pedogenic mud-aggregates under traction load. In the Late Triassic a sheet-flood dominated environment characterized the axial system of the rift basin. Intensely weathered, shale-rich Proterozoic sedimentary rocks at the rift shoulders possibly supplied a copious amount of mud-aggregates to the Maleri system. The system also received carbonate grains derived from the coeval deposits of springs and ponds occurring on the footwall block. The basinal configuration was similar to that of a syn-rift, marked by discontinuous, low-relief margins and a steady subsidence.

Parthasarathi Ghosh, S.N. Sarkar and S. Dasgupta

Tracking the migration of the Indian continent using the carbonate clumped isotope technique on Phanerozoic soil carbonates

Approximately 140 million years ago, the Indian plate separated from Gondwanaland and migrated ~90 latitudes to its current location, forming the Himalayan-Tibetan system. Large discrepancies exist in the rate of migration of Indian plate during Phanerozoic. This study developed a new methodology for paleo-latitudinal reconstruction based on simultaneous determination of carbonate formation temperature and $\delta^{18}\text{O}$ of soil carbonates, constrained by the abundances of ^{13}C - ^{18}O bonds in palaeosol carbonates. Weighted mean annual rainfall $\delta^{18}\text{O}$ water values measured at several stations across the southern latitudes are used to derive a polynomial equation: $\delta^{18}\text{O}_w = -0.006 \times (\text{LAT})^2 - 0.294 \times (\text{LAT}) - 5.29$ and used for latitudinal reconstruction. The results show that the Indian plate was located at $46.8 \pm 5.8^\circ\text{S}$ in the Permian (269 M.y.), at $30 \pm 11^\circ\text{S}$ in the Triassic (248 M.y.), at $14.7 \pm 8.7^\circ\text{S}$ during the Early Cretaceous (135 M.y.), and at $28 \pm 8.8^\circ\text{S}$ in the Late Cretaceous (68 M.y.).

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These estimates are consistent with the paleo-magnetic records which document the position of Indian plate prior to 135 ± 3 M.y.

P. Ghosh, M.V. Vasiliev, Parthasarathi Ghosh, S.N. Sarkar, S. Ghosh, K. Yamada, Y. Ueno, N. Yoshida and C.J. Poulsen

The community structure and diversity of the Mesozoic terrestrial vertebrates of the Gondwana basins of Peninsular India.

A detailed study of the Triassic non-marine tetrapod communities of the world and that of peninsular India indicate that Indian Triassic non-marine vertebrates are Pangaeian in distribution. They have many key faunal elements of the Triassic but are less diverse than some other Triassic non-marine fauna of the world. New Middle Triassic archosaur taxa including a unique horned taxon, collected from central India, had been studied. The Jurassic communities on the other hand had different sauropod dinosaurs and sphenosuchians among others. The effects of Permian -Triassic and Carnian - Norian (both Late Triassic) biotic extinctions are noted in the non-marine vertebrate fauna of India.

Dhurjati P. Sengupta and S. Bandyopadhyay

Stratigraphy of the Upper Gondwana formations of Satpura basin, central India

A high resolution geological map with stratigraphic revisions had been done on the western sector of the Upper Gondwana formations of the Satpura Gondwana Basin. Incidentally, a new archosaur taxon had been unearthed from the mapped area. The eastern part of the same basin had also been studied in detailed. Revised lithostratigraphic and biostratigraphic schemes were worked out for the Denwa Formation.

Dhurjati P. Sengupta and S. Bandyopadhyay

Shape analysis of vertebrate fossil bones

Shape analysis of the skull roof bones of the Triassic temnospondyl amphibians had been done using "R" language. 30 possible shapes of different taxonomically important dermal skull-roof bones (example, the lachrymal of the metoposauroid amphibians) had been generated using already existing samples. It had been noted that the lachrymal shapes as well as the skull shapes of the metoposauroids are highly variable and should not be considered as a key character state for taxonomic purposes. The skull shapes of lcthyosaurs, tricertopsian and hadrosaurid dinosaurs had also been studied to show that their morphospace varies minutely and high disparity is possible in their skull and body shapes.

Dhurjati P. Sengupta and S. Bandyopadhyay

Vertebrate microfossils from the Tiki Formation of the Rewa Gondwana basin

Five vertebrate microfossil localities were identified from the Upper Triassic Tiki Formation and lithologs were constructed to ascertain the position of the fossil-bearing horizon. Altogether 495 vertebrate microfossil specimens were collected, of which 90% are isolated teeth, and only 10% constituted skeletal specimens such as skull and mandibular fragments, vertebrae and partial limb bones. Among the total collected specimens of vertebrate microfossils, about 180 isolated teeth had been identified to belong to the freshwater chondrichthyans of which 90 are of hybodont sharks. A new genus with five new species was identified on the basis of distinct morphological features. The other 90 specimens were identified as belonging to the xenacanthiforms. The most important recent findings were several morphotypes of saurischian teeth especially that of the theropods which were identified on the basis of recurved crown and rectangular denticles attached perpendicular to the crown margin. Besides the microvertebrates, a new and large traversodontid cynodont *Ruberodon roychowdhurii* had also been described from this formation on an ontogenetic series of five partial lower jaws.

S. Bandyopadhyay and S. Ray

Relationships of the Indian Phytosaur *Parasuchus hislopi* Lydekker, 1855

The neotype skull of the Indian phytosaur *Parasuchus hislopi* Lydekker, 1855 has been re-evaluated and compared with the type material of other basal phytosaurs. This form is very similar to species previously placed in *Paleorhinus* (*P. bransoni* and *P. angustifrons*), sharing with them such characters as a series of nodes on the lateral surface of the jugal, paired ridges on the squamosal and a frontal depression. *Parasuchus hislopi* represents a valid species which is distinguished from *P. bransoni* by a relatively low narial eminence and *P. angustifrons* by the absence of paired nasal depressions. *Parasuchus* is considered the senior synonym of *Paleorhinus* and *Arganarhinus* and considered to include *P. hislopi*, *P. angustifrons*, *P. bransoni* and *P. magnoculus*. It has a broad circum-Pangaeian distribution, with species occurring in the south-western United States, Morocco, central Europe and India. On the basis of higher-level taxonomy Parasuchidae has been redefined to include 'Paleorhinus-grade' phytosaurs and the later-diverging Mystriosuchinae (the group formerly known as Phytosauridae), and Pseudopalatinae is renamed Mystriosuchini for reason of priority.

C.F. Kammerer, R.J. Butler, S. Bandyopadhyay and M.R. Stocke

Vertebrate faunal assemblage of the Jurassic Kota Formation, Pranhita-Godavari basin, India

Geological fieldwork as well as the systematic fossil exploration carried out in the Jurassic Kota Formation of the Pranhita-Godavari basin revealed a new prospective sauropod fossil site in the mudstone unit of the near Metpalli village. Systematic excavation and collection comprises several axial and apendicular elements including vertebrae, complete and partial ribs, girdle bones and digit bones. One of the girdle bones has been obtained from the interface of sandstone-mudstone heterolithic unit of the lower part of the Kota Formation intercalated with a 0.5 m thick calcirudite horizon. The collected specimens were encrusted with hard matrices, and are presently undergoing rigorous mechanical and chemical processing for removal of the matrix. To reveal the systematic palaeontology of these newly collected sample set, a comparative study based on the osteology of the limb, girdle and digit bones of the *Barapasaurus tagorei* has been initiated. Along with the study of the sauropod dinosaurs work on systematic paleontology and taxonomy is going on for several crocodylomorph cranial specimens collected from the upper unit of the Kota Formation and the preliminary study reveals that there are two distinct morphotypes in the collection, which are characterized by a long snout (Morphotype 1) and a short snout (Morphotype 2). Each of these morphotypes incorporates multiple individuals of varying ontogenetic stages. Presently the main focus of the research work is to reveal the systematic palaeontology of these crocodylomorph fossil specimens based on osteology and phylogeny.

Debarati Mukherjee and S. Bandyopadhyay

Jurassic Gondwana vertebrates of India

In order to understand the functional morphology of the limb bones of *Barapasaurus tagorei*, different anatomical parameters have been measured; documented and preliminary statistical analyses have been carried out. A rock core drilling technology is modified under the current project to extract cores from fossil bone specimens for the first time in India and is being implemented on Indian sauropods. Several fossil cores have been extracted from *Barapasaurus* limb bones for thin section preparation and palaeobiological study. In addition, osteological study of the available limb bones of *B. tagorei* is carried out to corroborate the size class variation of the taxa obtained from the various statistical analyses to reveal the taphonomic history of the *Barapasaurus* death assemblage.

Debarati Mukherjee

Growth strategy of the Indian Middle Triassic capitosaurids as deduced from osteohistology

Bone microanatomy of several limb bones of Indian capitosaurids from the Middle Triassic Denwa Formation of Satpura basin, Madhya Pradesh, reveals that the limb bones are of different ontogenetic stages ranging from juveniles to adults as deduced from their gross morphologies. The osteohistological analysis indicates presence of a well vascularised fibrolamellar bone (FLB) tissue as the primary

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cortical tissue that resemble the earlier report of FLB in trematosaur, a characteristic feature of higher vertebrates. Site specific occurrence of radially arranged vascular channels is noted in the cortices. In general, the growth strategy of these taxa as deduced from bone histology suggests rapid osteogenesis and a fast growth during most part of ontogeny. Continuous growth was indicated by the absence of growth rings in most of the limb bones examined. Inter-elemental histovariability is evident, which includes thickness of the cortices, differing bone tissue types, arrangement of the primary osteons, and extent of secondary reconstruction. However, growth slowed down considerably in later ontogeny. Differing life style adaptations for the Middle Triassic capitosaur from India has been deduced from bone histology.

Debarati Mukherjee, Dhurjati P. Sengupta and S. Ray

Low drilling frequency values for the western Indian gastropod assemblages during Miocene

Spatiotemporal distribution of Miocene drilling predation is well known. Temporally, drilling frequency (DF) achieved its peak during the Miocene. Spatial distribution is widely spread, ranging from about 47°N to 5°N. Gastropod drilling predation on the lower Miocene gastropod assemblages (62 species) from Kutch, western India (20°N) has been documented. The assemblage level DF from unbiased samples is 6.12% (N=5865 complete shells) which is very close to the lowest DF ever recorded from the Miocene. The present assemblages belonged to the Aquitanian (intertidal) and the Burdigalian (subtidal) stages. The DFs are 5.60% (N=2393) and 6.48% (N=3472) for the two stages which are not statistically significantly different ($p > 0.05$). Previous works suggested an increase in drilling frequency with latitude. But in the present study low DF has been found from the lower latitude. It is argued that instability of environment and paleobiogeographic constraints might have caused this low DF values for the Indian gastropod assemblages.

Shiladri S. Das

Physics and Applied Mathematics Unit, Kolkata

Astro Optics

In an effort to analyze an interstellar dust extinction spectrum by use of extended MRN model comprising graphite, silicate (Large), PAHs and ultra-small silicate, analytic formulas have been obtained to provide with fluency and elegance in model building. This year, an extinction formula for ultra-small silicate grains has been worked out and various galactic interstellar dust extinction spectra data are being analyzed by employing our analytic formulas. However, there seems to be a scope for some additional improvements – viz. finding out extinction efficiency formulae for the graphite and silicate (Large) grains so that the analytic framework become more generally useful. As a result, the work is being continued in this direction.

Ashim K. Roy, R. Gupta, S.K. Sharma and P. Ranadive

Cosmology

Primordial non-Gaussianities

Possibility of having large primordial non-Gaussianities from single field inflation has been investigated. By taking into account a representative model of potential-driven single field DBI Galileon inflation, primordial non-Gaussian features have been studied in details. The bispectrum have been computed explicitly by calculating the three-point correlation function considering all possible cross-correlations between the scalar and tensor modes of the proposed setup. Further, the trispectrum has also been investigated in somewhat details from a four-point correlation function considering the contribution from contact interaction, and scalar and graviton exchange diagrams in the in-in picture. Finally, the non-Gaussian consistency conditions from the four-point correlator have been obtained. This results in partial violation of the Suyama–Yamaguchi four-point consistency relation. The analysis further leads to the conclusion that sufficient primordial non-Gaussian ties can be obtained even from

single field inflation, which was believed to be otherwise until recently. The results thus obtained have also been fitted with latest observational bounds.

Supratik Pal and S. Choudhury

Quantum gravity Effect in torsion driven inflation

In the Einstein-Cartan-Kibble-Sciama theory of gravity, if the quantum gravity effect in the early universe is taken into account, an effective potential for inflation can be derived in terms of the scalar field hidden in the torsion. In this effective field theory, using the Planck+WMAP9 best fit cosmological parameters, the estimate of the bound on the CP violating term in the early Universe has also been obtained.

B. Basu, S. Choudhury, B.K. Pal and P. Bandyopadhyay

Quantum Foundation and Quantum Information Theory

Cryptographic protocol secured by quantum correlation

Quantum mechanics has provided secure communication by using laws of nature. Anonymous Veto (AV) and Dining cryptographers (DC) are two basic cryptographic primitives where the main aim is to hide the identity of the senders of the messages. These can be achieved by classical methods where the security is based either on computational hardness or on shared private keys. In this regard, a secure quantum protocol for both DC and AV has been provided by exploiting the GHZ correlations. A generalized version of the DC problem with the help of multiparty GHZ state is provided which then assures a secure quantum protocol also for the AV. Securities for both the protocols rely on some novel and fundamental features of GHZ correlations related to quantum nonlocality.

Guruprasad Kar and R. Rahaman

Fundamental nature of quantum indeterminism

If quantum mechanics is considered to be correct then randomness in measurement results is irreducible. The question whether indeterminism in quantum measurement outcomes is fundamental or is there a possibility of constructing a finer theory underlying quantum mechanics that allows no such indeterminism, has been debated for a long time. Within the class of ontological models due to Harrigan and Spekkens, it has been shown that satisfying preparation-measurement reciprocity must allow indeterminism of the order of quantum theory. Our result implies that one can design quantum random number generator, for which it is impossible, even in principle, to construct a reciprocal deterministic model.

Guruprasad Kar, Arup Roy, Some Sankar Bhattacharya, Amit Mukherjee, R. Rahaman, S. Ghosh, S. Bandyopadhyay, A. Majumdar and Manik Banik

Quantum Coherence

Various measures for the quantification of coherence in a quantum state have been investigated recently. In our work some features of trace distance measure of coherence were studied. It was shown that this measure is a strong monotone for all qubit and X states. An expression for the trace distance coherence for all pure states and a semidefinite program for arbitrary states was provided. The relation between l_1 norm and relative entropy based measures of coherence was also explored. In addition, both l_p norm and Schatten $-p$ -norm based measures were shown to violate the strong monotonicity condition.

Preeti Parashar, Swapan Rana and Maciej Lewenstein

Quantum Field Theory

Theoretical Fluid Dynamics

Research Activities

A covariant first order Hamiltonian formulation is constructed for perfect fluid interacting with a gauge field. Detailed study of the current algebra and the Schwinger condition has been performed.

Subir Ghosh, R. Banerjee and A.K. Mitra

AdS- CFT correspondence

Extension of the AdS-CFT correspondence in noncommutative geometry and its effect on holographic superconductors was carried out. Our findings indicate that noncommutative effects tend to destabilize the superconducting phase.

Subir Ghosh, S. Pramanik and S. Das

Quantum Mechanics

Relation between electrostatic fields induced zero energy states in graphene and N-soliton solutions of the modified Kortweg-de Vries equation, has been investigated. Appearance of PT symmetry in this system has also been studied. Some new electrostatic potential which produces zero energy states in graphene have been found. BdG equation in the presence of modulated Fermi velocity has been studied and bound states as well as bound states in continuum have been found.

Pinaki Roy, D. Nath, O. Panella and C.L. Ho

Theoretical Condensed Matter Physics

Electron vortex beams in a laser field

The theory of electron vortex beams (EVBs), a fast developing research field with theoretical and technological applications, plays an important role in probing nano-materials to study their magnetic properties in greater detail. In the context of the interaction of the EVBs with laser light a physical mechanism has been proposed that unveils the dynamics of the shift of the centre of the laser affected beam with respect to the center of the laser free beam. The analysis suggests that the shift in case of paraxial beams will always be larger than that in the nonparaxial beams.

B. Basu, D. Chowdhury and P. Bandyopadhyay

Electron transport in a quantum ring

Localization of electrons in a quantum (nano) ring is analytically modeled to understand the results in quasi-one and higher dimensions in the absence as well as presence of coulomb interaction. With an understanding of these results the analytic solution could be of direct use to investigate other phenomena connected with the electronic transportation in a quantum ring.

Ashim K. Roy and P. Singh Deo

Quantum transport of interacting electrons in low-dimensional systems

Several phenomena in the field of electron transport in molecular junctions and related nano-systems have been explored. Circular currents (both voltage driven and magnetic field induced; the latter can take place in isolated ring conductors and are referred to as Persistent currents) are a manifestation of quantum coherent phenomena, and by their nature are strongly sensitive to magnetic interactions. Our previous studies of these phenomena in the limit of non-interacting quantum particles have been extended to models that include electron-electron and spin-orbit interactions, and particular attention has been given to the interplay between voltage and magnetic field driving, to the effect of dephasing and inelastic interactions and to the possibility to control electronic transport in and through different quantum systems by external magnetic fields.

S.K. Maiti, M. Patra, M. Saha, S.N. Karmakar, S. Sil,
M. Dey, P. Dutta and S. Saha

Ultra-thin Topological Insulator

Topological insulators (TIs) form a new class of compounds with strong spin-orbit interaction. Ultra-thin 3D TIs provide a stage to study the surface physics of such materials by minimizing the bulk contribution where the snowflake like structure of the Fermi surface leads to a hexagonal warping term. Treating the warping term as a perturbation, in the presence of a magnetic field, the study of quantum capacitance and the Hall coefficient provides some interesting new results.

B. Basu, A. Menon and D. Chowdhury

Applied Mathematics

Chimera states in bursting neurons

The existence of chimera states in pulse-coupled networks of bursting Hindmarsh-Rose neurons with nonlocal, global, and local (nearest neighbor) couplings has been reported. Through a linear stability analysis, the behavior of the stability function in the incoherent (i.e., disorder), coherent, chimera, and multichimera states has been discussed. The chimera and multichimera states occurred even using local nearest neighbor interaction in a network of identical bursting neurons alone. This was in contrast with the existence of chimera states in populations of nonlocally or globally coupled oscillators. A chemical synaptic coupling function was used which plays a key role in the emergence of chimera states in bursting neurons.

D. Ghosh, M. Lakshmanan and Bidesh Kumar Bera

PT symmetric nonlinear optical lattice

The dynamics of nonlinear modes in optical lattice (involving gain and loss at the linear level) which is characterized by a class of PT-symmetric potentials and spatially inhomogeneous nonlinearity has been studied. Exact analytical expressions for the nonlinear modes have been obtained. The regions of stability of these solutions can be controlled by tuning the values of real and imaginary parts of the linear refractive index modulation profile as well as by tuning the real parts of nonlinearly modulated spatial distribution.

B. Roy, D. Nath and R. Roychoudhury

Targeting engineering synchronization in chaotic systems

A method of targeting engineering synchronization states in two identical and mismatch chaotic systems has been explained in details. The method has been proposed using linear feedback controller coupling for engineering synchronization such as mixed synchronization, linear and nonlinear generalized synchronization and targeting fixed point. The general form of coupling design to target any desire synchronization state under unidirectional coupling with the help of Lyapunov function stability theory has been derived analytically. A scaling factor is introduced in the coupling definition to smooth control without any loss of synchrony. Numerical results are done on two mismatch Lorenz systems and two identical Sprott oscillators.

D. Ghosh and Sourav K. Bhowmick

Transition from homogeneous to inhomogeneous steady states in oscillators under cyclic coupling

Transition from homogeneous steady state to inhomogeneous steady state has been discussed in coupled oscillators, both limit cycle and chaotic, under cyclic coupling and diffusive coupling as well when an asymmetry is introduced in terms of a negative parameter mismatch. Such a transition appears in limit cycle systems via pitchfork bifurcation as usual. Especially, for chaotic systems, the

Research Activities

transition follows a transcritical bifurcation for cyclic coupling while it is a pitchfork bifurcation for the conventional diffusive coupling.

D. Ghosh, Bidesh Kumar Bera, Chittaranjan Hens,
Ramat Gan, Sourav K. Bhowmick and Pinaki Pal

The combined effects of optimal control in cancer remission

A mathematical model depicting the nonlinear dynamics of immunogenic tumors as envisioned by using optimal treatment strategy has been investigated. To understand the dynamics under what circumstances the cancer cells can be eliminated, the theory of optimal control has been implemented. Two types of optimal external treatment strategies have been designed: one Adoptive Cellular Immunotherapy and another interleukin-2. The existence of an optimal control by using the boundedness of solutions has been derived. The uniqueness of optimal control of the assigned problems is also analyzed. The numerical illustrations that the optimal treatment policy reduces the tumor burden under different scenarios have been demonstrated.

D. Ghosh and Subhas Khajanchi

Interdisciplinary Research - Fluvial Mechanics Laboratory

Analogue Hawking Effect in a Flume

Data collection has been started for analysis of the experiment concerning (white hole analogue) horizon formation in a flume where waves are being imposed on an opposing flow. The effects of horizon on bed profiles have also been studied.

Subir Ghosh, P. Das, D. Chatterjee and B.S. Majumdar

Live-bed scour around bridge pier

As the installation of the sediment-feeder was completed in March 2016, only some of the experiments were performed at the fixed-bed conditions over a sand-bed. A number of experiments were also conducted over a sand bed around a circular cylinder placing it vertically over the fixed sand bed. These fixed-bed data can be used further as a reference for comparing the data with live-bed conditions over sand bed and at different scouring conditions. A set of experiments were conducted over a gravel bed ($d_{50} = 2.5$ mm) with two circular cylinders placed laterally over it. 3-D velocities were captured at the upstream and downstream of the cylinders ($D = 2.5$ cm) up to 12 times the diameter of the cylinders. The velocity measurements were also done with respect to the lateral direction over the bed. Some measurements will also be conducted with different diameters of cylinders for a detailed study of turbulent flow past circular cylinders.

Sankar Sarkar and S. Dey

Biological Sciences Division

Agricultural and Ecological Research Unit, Kolkata

The Unit has been pursuing both internally and externally funded research projects on diverse areas such as practices for sustainable agriculture with regard to rice and other field crops; the use of nanotechnology in targeting crop pests, ecological aspects like the role of allelopathy in structuring aquatic ecosystems, characterization of SSR markers in some mangroves for their effective conservation; as well as mathematical and statistical modeling on predation and co-operative recovery mechanisms among many other connected issues. A brief account of the some of the Unit's research activities are listed below.

Development of Information on Agricultural and Horticultural Production and their Marketing using RS and GIS in some district of West Bengal

Agricultural marketing is a major problem in India. An attempt has been made to study the opportunities of different rural Hats and Markets using survey methodology along with GIS and RS tools. Four districts namely, Cochin, Murshidabad, Purulia and 24 Parganas of West Bengal have been selected for the study. The spatial data analysis was done on road networking system, market map, accessibility, etc. with the primary survey data related to local huts and markets. At the same time, the opportunities of growing different crops are also studied on those districts.

P. Banik, P.K. Ghosal, A.K. Banerjee and A. Sarker

Fantastic yields in the system of rice intensification: fact or fallacy?

Recent years there is a lot of controversy regarding System of Rice Intensification (SRI). The question Does SRI Works? Two major rice ecosystems of eastern states are the irrigated and rainfed. The eastern part of the plateau is almost entirely rainfed with very low agricultural productivity. On the other hand, West Midnapore district of West Bengal comes under irrigated rice ecosystem. Rice is the main crop in the eastern Indian region and grown in rainfed situation, particularly at Kharif season. The experiments have been carried out at Giridih, the rainfed rice ecosystem and at 7 villages of Debra block, West Midnapore district and Deganga of North 24 Parganas and Baruipur of South 24 Parganas of West Bengal, the irrigated rice ecosystem to identify the effect of different SRI component on the rice yield.

P. Banik

Competition or facilitation between two invasive plants

Invasive species are known to severely impact native plant biodiversity. In order to understand interactions among multiple co-existing invader species on community composition, observational field studies as well as experimental greenhouse experiments have been set up. The two focal invasive species in the study region were found to be *Mikania micrantha* and *Alternanthera philoxeroides* from extensive field surveys. A significant reduction in native species richness was observed in sites with monospecific growths of *M. micrantha* as well as in those with joint occurrence of *M. micrantha* and *A. philoxeroides*. When percent cover (estimate of spread) of the two species was considered, Poisson log-linear models identified *M. micrantha* to be the dominant invader.

A. Dewanji, S. Bhattacharya, P. K. Ghosal, C. Medda, A.K. Banerjee, P. Jha and S. Chatterjee

Surface Functionalized Porous Nanomaterial Loaded Micronutrient Fertilizers for Gangetic Alluvial Soils

Nanominerals and mineral nanoparticles are common, widely distributed throughout atmosphere, oceans, ground and surface waters, soils, in most living organisms, and even proteins like ferritin. In 2010, our laboratory observed biological nanoparticles are ~4-14 nm in diameter and nanoparticle act as activation site. ~4500 mineral species, under influence of abiotic, biotic processes, go through nano-phase stage. Where nucleation and growth rates are high and slow respectively, aggregated growth of bio-nano-minerals (BNM) and mineral nanoparticles (MN) (via mineral weathering generating primary or secondary nano-phases) will persist. BNM and MN exist in all rocks, soil and influence deep earth processes, like landslides, where it has been studied in detail. Overall mass distribution of BNM and MN in earth system impart huge influence on global biogeochemical consequences. As a part of exploratory study, we made zero valent Zn, Cu-NP arrays, Mn, aminated carbon dots etc. nanoparticles and tested them in *Vignaradiata* and Chloroplast model system. We observed Mn nanoparticle works better when Ca is present in PS-II and increases the photosynthesis. We have studied the mechanism of action of zero valent Mn nanoparticle in detail.

A. Goswami, S. Barik and S. Pradhan

SYL-MNS-CEA-ZAAL-BER/API nanocomposite drug for Mongpa tribe neonates: Innovation from anthropo-cultural knowledge base

Recent study commissioned by Ministry of minority affairs and conducted under supervision of Indian Council of Social Science Research (ICSSR) clearly showed that infant and under-five mortality rate is higher among Monpa children living in West Kameng district of Arunachal Pradesh. It was also reported that the causes for death are neo-natal diarrhea, dysentery, antibiotic induced dysentery etc. We have done extensive survey work in the Bomdila, Arunachal Pradesh with the District Agricultural Officer (DAO) and a NGO (recommended by DAO), specializes in medicinal plant conservation and has also trade license. We have collected 5 medicinal plants. Bio-chemical analyses for extraction of alkaloids present in these plants were carried out to isolate pure and virgin forms of alkaloids. SYL-MNS-CEA-ZAAL-BER/API nanocomposites were prepared and their loading and release kinetics were done using HPLC-MS, NMR etc.

A. Goswami, S. Barik and J. Singh

Development of natural food preservatives from spices and herbs

Food-borne disease is an increasingly major public health problem all over the world. Microbial contamination and food oxidation are the two most important factors for developing food-borne diseases and food spoilage. Prevention of microbial contamination and food oxidation is usually achieved by synthetic food preservatives. These synthetic food preservatives can be categorized mainly into two general types, antimicrobials that inhibit the growth of microbes, and antioxidants that slow the air oxidation of fats and oils in foods which lead to rancidity. But these synthetic food preservatives are harmful to human health and have many side effects. An attempt has therefore been made for the development of safe and effective natural food preservatives from spices and herbs. For this purpose the possible synergistic interactions on antibacterial and antioxidant efficacy of essential oils of some selected spices and herbs [bay leaf, black pepper, coriander (seed and leaf), cumin, garlic, ginger, mustard, onion and turmeric] in combination have been evaluated along with their cytotoxic potential if any. Results showed that among the possible combinations tested only coriander/cumin seed oil combination showed synergistic interactions both in antibacterial and antioxidant activities. A positive correlation between total phenolic content and antibacterial activity against most of the studied bacteria as well as antioxidant capacity was also observed. The coriander/cumin seed oil combination did not show any cytotoxic effect in brine shrimp lethality assay. The results provide evidence that coriander/cumin seed oil combination might indeed be used as a potential source of safe and effective natural antimicrobial and antioxidant agents in pharmaceutical and food industries. Further studies are in progress.

R. R. Chattopadhyay

Phytonematode problems of rice in Jharkhand: density, diversity and pathogenesis

Phytonematodes pose a major threat to rice production in Jharkhand. The objective of the present study is to understand the density, diversity and spatial distribution of *Meloidogyne graminicola* (rice root knot nematodes) and *Aphelenchoides besseyi* (rice white tip nematode), two major phytoparasitic nematodes infesting rice crops in Jharkhand. In addition, largescale screening of rice germplasms including local land races also will be conducted to identify resistant materials against these nematodes. Field surveys across Giridih district to documented infestation of *A. besseyi* revealed in every block, proportion density (number of nematodes / 100 rice grain) was significantly higher than the ETL (economic threshold level = 30 nematodes /100 grains)

A. Mukherjee, S. Mondal and M.R. Khan

Biorational management of rice pests and diseases: evaluation of nanoparticle based and endophyte-mediated approaches

Over the years scientists have evaluated a number of biorational approaches to achieve effective management of agriculture pests and diseases with limited or lack of non-target. Among the latest

lines of technological innovations, nanotechnology and plant-endophyte mediated control of agriculture pests occupies a prominent position in transforming agriculture and food production with novel tools for the management of diseases, rapid disease detection, enhancing the ability of plants to absorb nutrients, among others. The overarching goal of this project is to evaluate the efficiency of nanoparticle based and endophyte-mediated biorational approaches as an alternative management tool for the major pests and diseases of rice. Laboratory protocols for surface sterilization, extraction of metagenome and isolation of rice endophytes have been standardized. Rice plant samples (n = 5) were collected from Pathar Pratima Block, 24 Parganas (S) and metagenome were extracted in duplicates using Mo Bio Plant DNA Isolation Kit. Using 27F and 1492R universal primers, full length 16S rRNA gene of bacteria was amplified.

A. Mukherjee, P. Dhal, P. Kunda and M. Thapa

Study of soil carbon dynamics through integrated nutrient management in different agroecosystems of Assam

Tea plants (*Camellia sinensis* L.) are perennial shrubs cultivated mainly in acidic soils of the subtropics. In India, most of the tea-growing areas are acidic-leached red earths with poor amounts of available nutrients. Tea leaves also contains trace elements. The main source of toxicity in tea leaves or in tea soils are due to indiscriminate use of fertilizers and pesticides. The link between soil quality and tea biochemical quality determination is the future strategy of soil health studies for improving productivity and quality of perennial crops like tea. By determination of soil quality, it is possible to understand and manipulate the working of farming systems. Under the light of these arguments, when we notice the tea gardens of India, we find very little research articles on soil quality specially its microbiological part in tea soil. In this context, the proposed study aims to find out a suitable strategy to develop a nutrient management in Tea garden soils of Assam.

P. Bhattacharya and K. Charan

Parallel analysis of transport of contaminants in soil-plant systems in different soil types of eastern India: a sustainable approach

Coal ash (CA) may be defined as the residue of combustion in different coal fired plants that enter the flue gas stream. Generation of huge amount of coal residues presents several problems. Hence the urgent and imperative needs to overcome these problems not only through safe disposal but also through gainful utilization of the material cannot probably be over emphasized. Apart from thermal power stations, substantial amount of CAs are also produced by other energy intensive industries like tea processing factories, brick making factories etc. There is dearth of authentic information on CAs produced in brick making factories in the literature. The objective of the research is to utilize BKA in agriculture as a source of essential plant nutrients by vermicomposting technology.

P. Bhattacharya and A. Mandal

Generation and characterization of SSR marker for some mangroves of Sundarbans, India

It is a prime issue to the Biologists to explore a proper restoration policy of the mangrove vegetation in the present threats of climatic change. Hence, a knowledge of the fundamental genetic evidences of the mangrove species are vital for understanding their extent of adaptability to climate change. Authentication of genetic diversity at the molecular level of some mangrove species, particularly those who are in precarious existence, would be the direction towards restoration policy. The simple sequence repeats or SSR (microsatellite) are short tandem repeats of mono- to tetra-nucleotide repeats, which are assumed to be randomly distributed in the genome. Such SSRs are relatively abundant and have high mutational rates in comparison to other markers and focused in population studies. They are highly polymorphic because of their frequent variation in the number of tandem repeats and are inherited as co-dominant markers which could be easily detected with polymerase chain reaction (PCR). The conserved flanking regions can also be used as potential molecular markers for related genomes. An enormous advantage for SSR is that the exact designation of alleles

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(their length) to a known locus allows homogenizing evidence spatial occurrence thereby making fully integrative worldwide.

S. Das and N. Dasgupta

A study on yield performance of Sweet Sorghum crop (*Sorghum bicolor* L.) at different location and fertility levels for maximization of bio-fuel production in West Bengal

The research is being conducted at different districts of West Bengal based on different soil types. This year (2015-16) cultivar "Madhura" is selected out of many varieties namely ICSU93046, ICSU25280, Madhura and ICSU25274. Seeds were collected from Dry land cereals Research Programme, ICRISAT, Patancheru, Andhra Pradesh. The proposed locations were at Basirhat of North 24-Pgs., Nimpith of South 24-Pgs. Sriniketan of Birbhum and Panskura of East Midnapore district. Total treatment combinations were 32. Fertilizer Nitrogen (N) 4 level (N1) 0 Kg (N2) 40 Kg (N3) 80 Kg and (N4) 120 Kg/ha: Phosphorous (P) 2 level (P1) 0 Kg and (P2) 60 Kg/ha: Potassium (K) 4 level (K1) 0 Kg (K2) 30 Kg (K3) 60 Kg and (K4) 90 Kg/ha. ($N_4 \times P_2 \times K_4 = 32$). These 32 treatment combinations replicated thrice with Randomised Block Design (RBD) for all experimental sites. Various yield data such as Green biomass Yield (t/ha), Grain Yield (Kg/ha), Sugar Concentration (%) and Sugar Yield (t/ha) were collected every 20 days interval starting from 80 days after sowing and up to 140 days after sowing. It has been observed from the experiment that the green biomass Yield (t/ha) was highest 62.89 t/ha given by treatment $N_{120}P_{60}K_{60}$ kg/ha. 1148.23 kg/ha grain yield was given by the treatment $N_{120}P_{60}K_{90}$ kg/ha and from the same treatment combination 9.26 % of sugar concentration was observed. Whereas, sugar yield of 3.44 t/ha was given by the treatment $N_{80}P_{60}K_{90}$ kg/ha. All the data placed here only at 140 days after sowing (DAS) harvest.

S. Barik

Determination of functional response under selective predation through experimentation and modeling

Functional response is indispensable for every interactive dynamical system. The frequently used functional responses are generally derived mechanistically. These functional responses may not be suitable for all dynamical systems. This year, a new functional response was derived which is suitable for an interactive prey-predator model when predator population possesses a selective mechanism criteria. The proposed functional response was validated using the abundance data obtained from the lab experiment with two preys *Chaetoceros gracilis* (nontoxic strain) and *Microcystis aeruginosa* (toxic strain) and one predator *Artimia salina*. Frost (1977) showed that adult females of *Calanus pacificus* generally go for size selective predation. They reported that the copepod indiscriminately filters suspensions of food particles but captures, handles and ingests large particles more efficiently than thus small particle. However as far as our knowledge goes the selectivity criterion was not incorporated in the formation of functional responses. In the laboratory culture we found that Artemia went for selective predation and preferred non toxic phytoplankton (NTP) than toxic producing phytoplankton (TPP) and a new functional response was formulated accordingly. We also inferred that the functional response should be derived phenomenological.

J. Chattopadhyay, S. Bhattacharya, B. Saha, J. Pal and I. Mukhopadhyay (HGU)

A simple approximation of moments of the quasi-equilibrium distribution of an extended stochastic theta-logistic model with non-integer powers applicable to ecological data

The stochastic versions of the logistic and extended logistic growth models are applied successfully to explain many real-life population dynamics and share a central body of literature in stochastic modeling of ecological systems. To understand the randomness in the population dynamics of the underlying processes completely, it is important to have a clear idea about the quasi-equilibrium distribution and its moments. Bartlett et al. (1960) took a pioneering attempt for estimating the moments of the quasi-equilibrium distribution of the stochastic logistic model. Matis and Kiffe (1996) obtain a set of more accurate and elegant approximations for the mean, variance and skewness of the

quasi-equilibrium distribution of the same model using cumulant truncation method. The method is extended for stochastic power law logistic family by the same and several other authors (Nasell, 2003; Singh and Hespanha, 2007). Cumulant truncation and some alternative methods e.g. saddle point approximation, derivative matching approach can be applied if the powers involved in the extended logistic set up are integers, although plenty of evidence is available for non-integer powers in many practical situations (Sibly et al., 2005). This year, a set of new approximations for mean, variance and skewness of the quasi-equilibrium distribution under more general family of growth curves were developed. This is applicable for both integer and non-integer powers. The deterministic counterpart of this family of models captures both monotonic and non-monotonic behavior of the per capita growth rate, of which theta-logistic is a special case. The approximations accurately estimate the first three order moments of the quasi-equilibrium distribution. The proposed method is illustrated with simulated data and real data from global population dynamics database.

S. Bhattacharya, A.R. Bhowmick, S. Bandyopadhyay and S. Rana

Biological Anthropology Unit, Kolkata

Health status and survival strategy of the tea garden labourers of locked tea gardens of Jalpaiguri district, West Bengal

The research hypothesis was as follow: 1) Health of the unemployed tea garden labourers would be worse than the employed tea garden labourers; 2) Socioeconomic condition of the unemployed tea garden labourers would be worse than the employed tea garden labourers; and 3) Physical fitness of the unemployed tea garden labourers would be better than the employed tea garden labourers. Little amount of data have been collected, which includes- Demographic data including fertility, mortality and morbidity. Some socio-economic data have also been collected including household expenditure per month and education level of each of the individuals of the household has been completed.

S.K. Roy, A. Mallik and A. Bhattacharya

Living with Age: An Investigation on the Urban Poor Elderly Women

The aim of the study is to address the impact of socio-economic status on the varied health issues of the elderly residing in stressful environment. The specific objectives of the study is (a) to evaluate their quality of life through self-reported accounts; (b) to assess their physical and psychological health in terms of morbidity patterns including general disabilities, chronic illnesses, psychological illnesses [both self-reported and observed morbidities]; and (c) to find out the relationship between socio-economic conditions and physical as well as psycho-social vulnerability and health status of slum dwelling elderly people of Kolkata.

S. Mukhopadhyay and A. Ghosh

Identification of susceptible genetic variants associated with Coronary Artery Disease in the population of Andhra Pradesh, India

As part of this project, 1025 (509 cases and 516 controls) samples were collected and genotyped for 96 SNPs in the 11q23.2 region. Additional 96 SNPs, 34 from 9p21.3 chromosomal region and 62 SNPs related to metabolic traits across the genome were also genotyped. The first set of 96 SNPs is being analyzed currently. As part of this, two papers based on comprehensive review of literature in this area have been drafted and one of which is already published. The other paper is in the process of publication.

Molecular Genetic Dimensions of Tribal Health in Andhra Pradesh: Complex Genetic Disorders in the background of urbanisation and changing lifestyles

As part of this cross sectional study, 684 individuals from Yanadi tribe in Nellore district, aged above 40yrs, were recruited and examined for blood pressure, obesity and biochemical parameters such as

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lipid profile, complete blood picture, fasting plasma glucose. These individuals were genotyped for 96 SNPs in the 11q23.3 region. Additional 96 SNPs, 34 from 9p21.3 chromosomal region and 62 SNPs related to metabolic traits across the genome were also genotyped on a subset of these individuals. We are trying to analyse the association of these genetic markers with riskfactors of CVD. Further, we plan to test the hypothesis of increasing effects of these risk factors with increasing urbanisation, assuming genetic homogeneity of the transitional groups (rural, semiurban and urban) of the Yanadi tribe.

Identification of susceptible genetic variants associated with Coronary Artery Disease in the population of Andhra Pradesh, India

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B.M. Reddy

Human Genetics Unit, Kolkata

The Unit has been pursuing research projects, both internally and externally funded. During the year under review, scientists of this unit published –Br: 5, RC: 5, IM: 1, SG: 6 papers in various scientific journals. They have also been participating in teaching activities in the Institute and other Institutions. Brief accounts of research activities are provided below:

Genomic and Epigenetics Studies on Common Diseases in Indian Populations

The focus of these studies is to understand the genomic and environmental contributions to common diseases in India.

Mitochondrial Mutation study of oral cancer

Several studies reported that mtDNA mutation play important roles in carcinogenesis although mechanism is not clear yet. Most of the studies compared mutations in tumor with those of normal tissues from different individuals ignoring inter-individual variations. This study investigated total SNPs and somatic mutations in 8 oral cancer tissues with respect to reference (rCRS) and adjacent normal mtDNA sequences, respectively, using Ion-PGM next generation sequencing method. A total of 271 SNPs, 7 novel SNPs (SNVs) and 15 somatic mutations were detected by Ion-PGM next generation sequencing method. Most of the sequence variations (76 SNPs and one somatic) are present in D-loop region followed by *Cyb* (36 SNPs), *ATP6* (24 SNPs), *ND5* (17 SNPs and 5 somatic), *ND4* (18 coding and 2 somatic) and other non-coding and coding DNA sequences. A total of 53 and 8 non-synonymous SNPs and somatic mutations, respectively, were detected in tumor tissues and some of these variations may have damaging/deleterious effects on the protein function as predicted by bioinformatic analysis. Moreover, significantly low mtDNA contents and expression of several mitochondrial genes in tumor compared to adjacent normal tissues may also affect mitochondrial functions. Taken together this study suggests that mtDNA mutations as well as low expression of mtDNA coded genes may play important roles in tumor growth. Although the sample size is low, important aspect of the study is use of adjacent control tissues to find out somatic mutations by Ion-PGM with an average depth of ~240x and expression of mitochondrial genes to rule out inter-individual and inter-tissue variations which are important issues in the study of mitochondrial genomics.

B. Roy

Association of DNA sequence variation at mitochondrial DNA polymerase with mitochondrial DNA synthesis and risk of oral cancer. Enzymes responsible for mitochondrial (mt) DNA synthesis and transcription are encoded by nuclear genome and inherited mutations in these genes may play important roles in enhancing risk of precancer and cancer. Here, genetic variations in 23 functionally relevant tagSNPs in 6 genes responsible for mtDNA synthesis and transcription were studied in 522 cancer and 241 precancer (i.e. leukoplakia) patients and 525 healthy controls using Illumina Golden Gate assay to explore association with risk of oral precancer and cancer. Two SNPs, rs41553913 at *POLRMT* and rs9905016 at *POLG2*, significantly increased risk of oral leukoplakia and cancer, respectively, at both genotypic and allelic levels. Gene-environment interaction models also revealed that tobacco habits and SNPs at *POLG2* and *TFAM* may modulate risk of both leukoplakia and cancer. *In silico* analysis of published data-set also revealed that variant heterozygote (*TC*) significantly increased transcription of *POLG2* compared to wild genotype ($p=0.03$). Cancer tissues having variant allele genotypes (*TC+CC*) at *POLG2* contained 1.6 times ($p<0.01$) more mtDNA compared to cancer tissues having wild genotype (*TT*). In conclusion, polymorphisms at *POLG2* and *POLRMT* increased risk of oral cancer and leukoplakia, respectively, probably modulating transcription and activity of the enzymes. Enhanced synthesis of mtDNA in cancer tissues may have implication in carcinogenesis, but, mechanism is yet to be explored.

B. Roy

Epigenetic studies on Oral Cancer

Genome-wide CpG methylation confirmed the abnormal and dynamic variations in CpG promoters in various cancer genomes. They also revealed that the CpG methylation status (either hypo or hyper) of promoters affected the expression of protein coding genes and various noncoding RNAs. We conducted global DNA methylation in discovery cohort samples of oral squamous cell carcinoma (OSCC) patients using the 450K array which allows methylation-specific hybridization to an array of 485,000 CpG sites across the entire human genome. DNA was isolated and subject to sodium bisulfite treatment to generate methylation-specific base changes before hybridization. Methylation values for individual CpG sites in each sample were measured as β -values. Significant variations in the distribution of differentially methylated regions were observed in the involved tissues in comparison to the adjacent normal tissue of the same individual. Several novel promoters were also determined to be differentially methylated. Expression profile of these genes also suggested the gene repression by this epigenetic modification. We validated these findings in a validation cohort. Now, we are in the process of validating these results in the easily accessible saliva of same patients and exploring the possibility to use these as a potential biomarker for OSCC diagnosis.

R. Chattopadhyay

Genetic and epigenetic studies on Psoriasis

Psoriasis has been studied as a separate skin disease since the early nineteenth century; but the exact mechanism of disease trigger is still largely unknown. In the present study, for the first time, we have determined the involvement of all five LCE3 (LCE3A, 3B, 3C, 3D and 3E) genes in the pathogenesis of psoriasis among Indian patients. We have analyzed the association of three SNPs within LCE3 cluster and the LCE3C-3B deletion among the psoriasis patients in India. The association of LCE3 gene cluster was significant only for the psoriasis patients who carried HLA-Cw6 allele. Expressions of all LCE3 genes were upregulated in psoriatic skin lesions, while only LCE3A showed significant upregulation for the patients with the risk allele in comparison to the non-risk allele carriers. Significant upregulation of LCE3A mRNA was observed in the involved skin of patients with both HLA-Cw6 and LCE3A risk allele carriers in comparison to the patients who were HLA-Cw6 negative but LCE3A risk allele carriers. Other LCE3 genes showed increased expression in presence of HLA-Cw6 allele but did not reach the level of significance. Due to existing LD in the LCE3 region, non-deleted LCE3C-3B is present when non-risk haplotype of LCE3A, LCE3D and LCE3E is present. Here again both LCE3B and LCE3C showed upregulation in presence of HLA-Cw6, however, only LCE3B was significantly over-expressed. Taken together, our data determined the combined effect of HLA-Cw6

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and the LCE3 cluster in psoriasis patients of India, and presented a functional validation of the combined effect of HLA-Cw6 and the LCE3 cluster.

R. Chattopadhyay

A comprehensive study of genetics and functional genomics of Pancreatic cancer in Indian patient population

Genome-wide analysis of DNA methylation profile in pancreatic ductal adenocarcinoma

Epigenetics *via* DNA methylation, histone acetylation or interacting regulative microRNAs (miRNAs) could essentially be linked to different morphological and genetic changes during pancreatic carcinogenesis. Extensive investigations are being carried out on epigenetic changes in pancreatic cancer precursor lesions, indicating that heterogeneous, non-linked pathways of carcinogenesis are regulated by epigenetics. 450K DNA methylation microarray for 6 pairs of PDAC samples have been completed. Analysis to find the differentially methylated regions (DMR) in PDAC are currently being done with respect to normal tissue type.

Somatic mutational profile of EGFR Protein Kinase Domain of Gall Bladder carcinoma from Indian patient population

Gall bladder cancer (GBC) is most frequent malignant tumor of biliary tract and fifth most common cancer of the digestive tract. Despite recent advances in the diagnosis and management of gastrointestinal cancers, GBC remains a rare and challenging tumour with a poor overall prognosis. Presenting symptoms are vague, so diagnosis commonly occurs at an advanced metastatic stage. So far, 56 primary GBC samples from Calcutta Medical College and Hospital have been collected and several reported and novel mutations in exon 20 and exon 21 of *EGFR* gene in GBC have been observed. No mutation(s) were detected in exon 19 of *EGFR* gene in our study cohort. In exon 20, one silent somatic mutation or variant, was found at codon 787 of *EGFR* gene (c.CAG>CAA; p.Q787) in 11 GBC tumor samples out of 28 (39%) tumors of GBC.

Somatic mutational profile of 412 cancer targeted genes of Pancreatic Ductal and Periampullary Adenocarcinoma in Indian patient population

Pancreatic Ductal Adenocarcinoma (PDAC), is the most common primary malignant disease of the pancreas and the periampullary region, and accounts for about 75% of all nonendocrine tumors arising in this region. So far, 110 primary PDAC and PAC samples have been collected from Calcutta Medical College and Hospital. Blood samples have also been collected from patients who did not get the blood transfusion from other sources. Simultaneously demographic and clinic-pathological data were also collected from each patient sample.

N. Sikdar

Statistical Genomics

The focus of these studies is to critically analyze existing statistical methodologies and to develop new methodologies for human genetics, especially for gene-mapping and genotype-environment interactions.

Statistical Methods for Analysis of Complex Traits

The focus of these studies is to analyze critically existing statistical methodologies and to develop new methodologies for human genetics, especially for gene-mapping and genotype-environment interactions.

Statistical Methods for Analysis of Complex Traits:

Some novel statistical methods have been developed for association analyses of complex genetic traits. These include

- (a) Transmission Disequilibrium tests for quantitative traits using sibship data and transmission information from both parents.
- (b) Developing a method for association mapping of count phenotypes using a generalized Poisson regression model.
- (c) Transmission-based tests for mapping multivariate traits comprising continuous and categorical traits.
- (d) Developing asymptotic distribution kernel based statistic for multilocus genetic association using longitudinal phenotype data
- (e) Developing KBAT type statistic for family data to study multilocus genetic association
- (f) Developing a test for gene-gene interaction and SNP-SNP interaction for case-control data
- (g) A new clustering method for clustering mixed type data arising in medical diagnosis
- (h) Methodological development on integrating SNP data and eQTL data in genetic association study

Analyses were performed on alcohol related phenotypes.

S. Ghosh and I. Mukhopadhyay

Social Sciences Division

Economic Research Unit, Kolkata

This year the scientific workers of the Unit are extensively involved in research, teaching, training, consultancy and academic administration. The research is carried out both at individual and collaborative/interdisciplinary levels. These include theoretical as well as empirical research in economics and econometrics.

The topics of different dimensions of researches in the unit are as follows:

Achievement and Shortfall Inequality Indicators with Applications to Health Economics, Reference Groups and the Poverty Line: An Axiomatic Approach with an Empirical Illustration, Measuring the Impact of Vulnerability on the Number of Poor: A New Methodology and an Empirical Illustration Based on Asian Data, A Poverty Line Contingent on Reference Groups: Implications for the Extent of Poverty in Some Asian Countries, Multidimensional Indicators, Analyzing Multidimensional Well-Being: A Quantitative Approach; Tariff and Unemployment; Global and Country Poverty Rates, Welfare Rankings of the Regions and Purchasing Power Parities: How Robust Are the Results?, The World Bank's Poverty Enumeration: How Transparent is the Process, how Sound is the Methodology and how Reliable are the Numbers?, Preferences, Purchasing Power Parity and Inequality: Analytical Framework, Propositions and Empirical Evidence, Gender Bias in Education in West Bengal, Gender Bias in Household Education Expenditure: The case of West Bengal; Growth Theory, Development Economics; Socioeconomic Determinants of Iron-Deficiency Anemia Among Children Aged 6 to 59 Months in India, Temporal Trend of Anemia among Reproductive-Aged Women in India, Global Warming and the Pattern of Overall Climate Changes in Sub-Himalayan Assam Region of North-East India, Women Autonomy in Health Care, Declining Patterns of Average Height of Adult Indians, Diversity Index, Measurements of Poverty and Gender Bias, Variation of Adult Heights and Weights in India, Predictions of Voting Patterns; Incentives for Product and Process Innovations: A Case for the Drug Industry, Operational Externalities and Counter-Terrorism; Ethnic Conflict, Linguistic Conflict and Linguistic Justice; A characterization of the symmetrically balanced VCG rule in the Queueing Problem, Bidding rings-A bargaining Approach, Games and Economic Behavior, Privatization, Underpricing and Welfare in the Presence of Foreign Competition; Is the Hybrid New Keynesian Phillips Curve Stable?, Convergence of Foodgrains Productivity in Indian Agriculture, Differential Effects of Relative Price Variability on REIT Returns; Various Issues in Panel Data Models with Cross Sectional Dependence; Auctions, Bargaining, Contracting, Contingent Choices; Mechanism Design;

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World Economic Recession and Stabilization Programmes; Inequality in Educational Opportunity in India: Evidence and Consequence of Social Exclusion, Variations in Income Elasticity: An Analysis of Indian Household Budget Data; Gender Studies.

The details of the applied and theoretical researches in Economic Research Unit are given below:

Achievement and Shortfall Inequality Indicators with Applications to Health Economics

Satya R. Chakravarty, Nachiketa Chattopadhyay (SOSU) and Conchita D'Ambrosio

Reference Groups and the Poverty Line: An Axiomatic Approach with an Empirical Illustration

Satya R. Chakravarty, Nachiketa Chattopadhyay (SOSU), Joseph Deutsch, Zoya Nissanov and Jacques Silber

Measuring the Impact of Vulnerability on the Number of Poor: A New Methodology and an Empirical Illustration Based on Asian Data

Satya R. Chakravarty, Nachiketa Chattopadhyay (SOSU), Jacques Silber and Guanghua Wan

A Poverty Line Contingent on Reference Groups: Implications for the Extent of Poverty in Some Asian Countries

Satya R. Chakravarty, Nachiketa Chattopadhyay (SOSU) and Jacques Silber

Multidimensional Indicators

Satya R. Chakravarty and Maria Ana Lugo

Analyzing Multidimensional Well-Being: A Quantitative Approach

Satya R. Chakravarty

Tariff and Unemployment

Brati Sankar Chakrabarti

Global and Country Poverty Rates, Welfare Rankings of the Regions and Purchasing Power Parities: How Robust Are the Results?

This four-part study examines the sensitivity of poverty estimates, regional composition of the 'extremely poor' population, and regional rankings to the Purchasing Power Parities (PPPs) used. The first part compares PPPs that use the price information collected by the ICP but follow a different methodology and, also, from a procedure that avoids the need for price information altogether. The second part examines sensitivity of poverty rates, poverty trends and regional composition of the poor to PPPs. In the third part, the study finds that PPPs and inequality, both, have a positive effect on poverty. Finally, the paper proposes a methodology that uses the price and expenditure information and a welfare criterion due to Sen (1976) to rank regions, and examines the sensitivity of the rankings, and their temporal changes, to PPP.

Amita Majumder, Ranjan Ray and Sattwik Santra

The World Bank's Poverty Enumeration: How Transparent is the Process, how Sound is the Methodology and how Reliable are the Numbers?

The reduction of global poverty features prominently in both the Millennium Development Goals (MDG) and Sustainable Development Goals (SDG). With the 'Global Commission of Poverty' set up by the World Bank due to report in April, 2016, evidence on the subject of global poverty has apparently

acquired an urgency that has triggered off a spate of poverty studies. This paper reports evidence of non-robustness of the magnitude and trends in world and regional poverty reported in Ferreira et al. (2015) to using different Purchasing Power Parities (PPP) to those that were used in that study. On the way, a much simpler method than the complex, highly expensive, multilateral PPP estimation procedure adopted by the International Comparison Program (ICP) to estimate PPPs is proposed.

Amita Majumder, Ranjan Ray and Sattwik Santra

Preferences, Purchasing Power Parity and Inequality: Analytical Framework, Propositions and Empirical Evidence

This paper makes analytical, methodological and empirical contributions to the literature on Purchasing Power Parity (PPP). This paper introduces a preference based analytical framework that departs from the conventional Balassa Samuelson framework in deriving empirically verifiable propositions on the link between PPP and exchange rates, and between PPP and inequality. The paper also provides an alternative methodology for calculating PPPs that are benchmarked against the 2011 ICP PPPs. As this study shows, the alternative methodology is capable of easy implementation on readily available data sets. The benchmarking exercise suggests that the 2011 ICP generally understates the PPP and overstates the GDP, and that the PPPs vary across expenditure percentiles. The study reports regional variation in the direction of the difference between the two PPPs. The empirical evidence is supportive of the positive association between inequality and PPP derived in the paper.

Amita Majumder, Ranjan Ray and Sattwik Santra

Gender Bias in Education in West Bengal

This paper attempts to capture gender bias at two different levels of education, namely, below class-10 and above class-10 using NSSO 64th round education expenditure data on West Bengal. The analysis for the below class-10 level involves an intra household framework and Heckman's two step model. Further, for this section the analysis is split up into classes 1-8 and classes 9-10 in view of the Right to Education act (2005). For above class-10 level, gender bias has been captured through a multinomial logit model for selection of subjects across households.

Amita Majumder and Chayanika Mitra

Gender Bias in Household Education Expenditure: The case of West Bengal

This study aims at detecting gender bias in education expenditure on 'students', which include children and young adults, in a household in the rural and the urban sectors of West Bengal. Outlay equivalent ratios have been calculated using the Engel curve approach, where the budget share function is log quadratic in income, to identify items relating exclusively to education of school/ college going students. The 68th round (July 2011 to June 2012) household level consumption expenditure survey data of the National Sample Survey Organisation (NSSO) have been used for the analysis.

Amita Majumder and Chayanika Mitra

Growth Theory, Development Economics

Manash Ranjan Gupta

Socioeconomic Determinants of Iron-Deficiency Anemia among children aged 6 to 59 months in India

The extent of anemia and its socioeconomic determinants among the preschool children (6- 59 months old) in India have been studied in this article. Relevant data are taken from the third round of the National Family Health Survey. The initial analysis reveals some interesting features. The most affected children are in the age-group of 6 to 23 months. Beyond this age a decreasing trend is observed up to the age of 48 to 59 months. The highest and the lowest prevalence of anemia have been found to be in the central and the northeast zones, respectively. The vulnerable groups are the

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children of illiterate parents and those belonging to the poor families in the rural areas. Categorical logistic regression also confirms that status of literacy and wealth of parents has strong negative association with the status of anemia of the children.

Susmita Bharati (SRU), Manoranjan Pal, Suman Chakrabarty and Premananda Bharati (BAU)

Temporal Trend of Anemia among Reproductive-Aged Women in India

The main objective of the study is to determine the temporal trend of anemia among reproductive-aged women of age 15-49 years. The study uses data from second and third rounds of the National Family Health Surveys (NFHS-2, 1998-1999, and NFHS-3, 2005-2006), conducted by the International Institute for Population Sciences. Anemia was most prevalent in the east zone for both the periods. The changes at the all India level were not much, but the north-east zone improved very well, whereas the south zone deteriorated drastically. The occurrence of severely anemic women in India varied between 1% and 2%. The highest prevalence rates were observed among women who were 15 to 24 years of age, illiterate, from non-Christian scheduled tribes (STs), unmarried, and whose standard of living was low. Rates of anemia have increased over time except in the case of Buddhists, Parsees, Jains, and the STs. From the viewpoint of our study, illiteracy and low standard of living may be the main causes of anemia among women in India. It is also necessary to take appropriate steps to curb anemia in women in their early adulthood.

Susmita Bharati (SRU), Manoranjan Pal, Suparna Shome (SRU) and Premananda Bharati (BAU)

Global Warming and the Pattern of Overall Climate Changes in Sub-Himalayan Assam Region of North-East India

This paper examines the changing pattern of climatic factors in Sub-Himalayan Assam region during last four decades. Sub-regional variation in climate indicators and their relation with the anthropogenic human activities like deforestation, mining and industrial developments is analysed. Also, inter-relation among the variation in major climatic components precipitation, temperature and humidity has been explained through various time series methods. The analysis reveals a growing uncertainty and erratic nature of yearly and seasonal rainfall, which is accompanied by significant inter-regional variations. The monsoon rainfall has been declining significantly, while the proportion of pre and post monsoon months' rainfall has been rising. Both maximum and minimum temperature has been increasing and trend rate of minimum temperature has been higher than that of maximum temperature and the rate is more during winter season. There is also uncertain variation in maximum-minimum gap of temperature over the years. Finally, significant cointegrated relation exists among all the climate variables.

Utpal Kumar De, Manoranjan Pal and Kamal Badosa

Is Women Autonomy an Issue in Health Care? Evidences from Central and Eastern India

The focus of the study is to see whether women autonomy has any role in controlling the health status of members in the family. An index is computed through women decision making authority. A comparative analysis has been carried out using data from four states in India – Madhya Pradesh (MP) and Chhattisgarh in Central region and Bihar and Jharkhand in Eastern region. The tribal concentration is high in these states. The data have been taken from the National Family Health Survey (NFHS-3) of 2005–2006. The result shows that women's household decision making authority does not always significantly affect the health status, rather socio-economic factors play more significant role in improving both women and child health status in the four states of India.

Suparna Shome (SRU), Manoranjan Pal and Premananda Bharati (BAU)

Declining Patterns of Average Height of Adult Indians Between 20 and 49 Years: State Wise Trends and Influence of Socioeconomic Factors

In the present study, changes in the average height over ages among women and men have been studied through third round National Family Health Survey data. It is also aimed to study the extent of influence of the different socio-economic variables on such changes. The study shows that negative

changes occur in the heights over the successive age-groups for men and women separately. The changes are found to be negative in all the zones and most of the states in India though it varies in its intensities. It is also an interesting feature to note that the maximum of absolute growth occurs among the men and women in urban areas, among the richest families, higher educated persons and professionals, while it is not so pronounced among the manual labourers, and scheduled tribes. Is it because of the changing life styles of most of the urban families and some of the rural families?

Susmita Bharati (SRU), Manoranjan Pal and Premananda Bharati (BAU)

Incentives for Product and Process Innovations: A Case for the Drug Industry

We consider an interaction of competing firms in an integrated world market and study their R&D incentives under each of product patent and process patent regimes. We follow a framework generally observed in the drug industry. We show that product patent regime leads to a larger R&D investment. Consumers may also benefit from product patenting. However, if the number of goods is large enough, the choice of patent regime loses significance with respect to R&D incentives.

Aditya Bhan and Tarun Kabiraj

Operational Externalities and Counter-Terrorism

Ramifications for counter-terrorism policy are analyzed in situations where the terror activities of any outfit impose externalities on the cost of terror operations of another. This is achieved using a structure involving two independent terror outfits operating in a country, each seeking to maximize its own payoff. The outcomes of their optimization exercises are utilized to study possible implications for counter-terrorism strategy. The results so obtained are viewed against the backdrop of the benchmark case without externalities. *Inter alia*, the magnitude and nature of operational externalities are found to be crucial determinants of the effectiveness of different counter-terrorism measures.

Aditya Bhan and Tarun Kabiraj

Ethnic Conflict

Indraneel Dasgupta and Dripto Bakshi

Linguistic Conflict and Linguistic Justice

Indraneel Dasgupta and Ranajoy Guha- Neogi

A characterization of the symmetrically balanced VCG rule in the Queueing Problem

We characterize the symmetrically balanced VCG rule in the queueing problem using the axioms of outcome efficiency, budget balance, equal treatment of equals, Pareto indifference, together with a weakening of strategy-proofness, upward-invariance.

Manipushpak Mitra, Youngsub Chun and Suresh Mutuswami

Bidding rings- A bargaining Approach, Games and Economic Behavior

We address the issue of bidder ring formation in single and multi-unit Vickrey auctions. In the single unit case, we show that the equilibrium coalition structure can only be an order preserving r -ring, that includes the winner and the top $(r-1)$ losers. In the multiple units case, we identify single winner ring with free riding, where exactly one winner colludes with all the losers and generates maximum possible bidders' surplus, and, depending on the protocol, the remaining winners free ride either by staying alone or by colluding in pairs.

Manipushpak Mitra, Kalyan Chatterjee and Conan Mukherjee

Privatization, Underpricing and Welfare in the Presence of Foreign Competition

We analyze privatization in a differentiated oligopoly setting with a domestic public firm and foreign profit-maximizing firms. In particular, we examine pricing below marginal cost by the public firm, the

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optimal degree of privatization, and the relationship between privatization and foreign ownership restrictions.

Manipushpak Mitra, Arghya Ghosh and Bibhas Saha

Is the Hybrid New Keynesian Phillips Curve Stable? Evidence from Some Emerging Economies

One of the central issues in macroeconomics is the relationship between inflation and unemployment / output gap, called the 'Phillips curve'. Of the several versions of this relationship, the latest one is known as 'hybrid new Keynesian Phillips curve' (HNKPC). The primary focus of this paper is to check whether the HNKPC holds or not for four important emerging economics viz., Brazil, Russia, India and South Africa. This has been empirically examined after testing for the structural stability of this relationship so that it can be studied accordingly with due consideration to this important issue. Some of the econometric issues like the unit root tests and estimation of output gap have also been done appropriately. Our findings suggest that the HNKPC is not stable for all the four countries. Finally, the analysis based on the two sub-periods thus formed clearly shows mixed evidence in respect of holding of this relationship.

Nityananda Sarkar and Kushal Banik Chowdhury

Convergence of Foodgrains Productivity in Indian Agriculture

Debabrata Mukhopadhyay and Nityananda Sarkar

Differential Effects of Relative Price Variability on REIT Returns

This work investigates the possible differential effects of relative price variability over two states on output as represented by industrial production and real estate investment trust (REIT) returns by applying the MSVAR model. Attempt is then made to explain the hitherto observed anomalous negative or insignificant relationship between REIT returns and inflation by examining the causal relationship involving REIT returns, inflation and relative price variability. It is found that the relationship between relative price variability and inflation is neither positive nor linear. The results further indicate that the effect of relative price variability on REIT returns is not symmetric across the two states, and that the generally observed negative relationship between REIT returns and inflation is, in fact, a proxy for the effectiveness of relative price variability on REIT returns and output growth.

Nityananda Sarkar and Mahamitra Das

Various Issues in Panel Data Models with Cross Sectional Dependence

Samarjit Das

Discrete-valued time series

Modeling, analysis and coherent forecasting are done for discrete valued time series data. In particular, both categorical and count data are considered. Zero-inflated count data is also considered for this purpose.

Samarjit Das

Auctions, Bargaining, Contracting, Contingent Choices

Priyadarshi Banerjee

Mechanism Design

Mechanism design deals with designing rules (such as a selling procedure in case of exchange problem) where strategic agents can interact. My research work concerns with the implementation of a deterministic allocation rule using transfers in quasi-linear private values environments. This is a general problem of mechanism design. I have shown that in multidimensional single peaked type

spaces, an allocation rule is implementable if and only if it satisfies a familiar and simple condition called 2-cycle monotonicity.

Souvik Roy

World Economic Recession and Stabilization Programmes

Recession has become a world-wide and long-term phenomenon today. Most of the major capitalist countries are in the grip of long-term recession, which shows no sign of abatement. The recession in Japan started in 1990. The slump in the USA and Europe began since the second half of 2007. The recession has spread to developing countries such as India and China as well. Currently, I am trying to unravel the cause of this recession and its persistence despite substantial policy interventions on the part of the governments of the affected countries.

Chandana Ghosh

Inequality in Educational Opportunity in India: Evidence and Consequence of Social Exclusion

With alarming statistics of UNESCO, that millions of Indian children are still out-of school, this study intends to address three issues in Indian context, viz., (i) to measure inequality in educational opportunities across sex, regions and income groups; (ii) to identify the responsible demand and supply side variables with estimating their explanatory power too, and (iii) to check if empowering of adult women, in terms of education and workforce participation, appears as effective means in improving school attendance rates of Indian children. The study finds an inequality driven school attendance rates for Indian children.

Saswati Das

Variations in Income Elasticity: An Analysis of Indian Household Budget Data

The study estimates expenditure elasticity for seventeen commodities across different expenditure classes, separately for the rural and the urban sectors for fifteen major states and All India, for two NSS rounds, viz. the 50th and 55th rounds. The result of the analysis reveals substantial variations in income elasticity of a commodity across expenditure classes, states, and sectors. Local consumption habits and cultural differences along with income differentials may explain this variation. Variation in the urban sector exhibits a more systematic pattern than its rural counterpart.

Saswati Das

Gender Studies

Chaiti Sharma Biswas

Linguistic Research Unit, Kolkata

During the period (from April 2015 to March 2016) the Linguistic Research Unit of the Institute has been engaged in programmes of research in the areas of Cognitive Linguistics, Corpus Linguistics, Computational Linguistics, Language Technology, Sociolinguistics, Field Linguistics and Descriptive Linguistics.

Substantivist Lexicological Study of Bangla

A substantivist study of conceptual networks on the basis of *Whole Word Morphology* is in progress. Earlier work has demonstrated a connection between this inquiry and the linguistics of lexico-phrasal difficulty. The work now being done is part of a long-term exercise in the domain of conceptual structure studies with reference to the lexicon. The purpose is to develop empirical base for a corpus-based electronic lexicon for Bangla. A corpus-based electronic lexicon is an indispensable resource for research and application in Language Technology (LT) and Natural Language Processing (NLP). This type of resource is of use in machine translation, information extraction, word-sense disambiguation,

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semantic net, ontology, etc. Also, it has direct academic relevance in electronic dictionary and thesaurus development, language teaching (first and second language), discourse analysis, lexical semantics, and language cognition. The Electronic Lexicon envisaged in this research will be the first work of its kind for Bangla, and the enterprise may be extended to other Indian languages if corpora are available. The utility of the work is further enhanced by two specific features. First, the proposed Lexicon is of the Differentiated type in the sense of Dasgupta, Misra and Datta (2002). In a Differentiated Lexicon, the asymmetry between peripheral and kernel items drives intra-lexical glossing, and the artificial metalanguage Esperanto serves as the glossing mediator, on cognitive-scientific grounds provided in Dasgupta (2006). Second, the proposed Lexicon not only uses frequency within the corpus to determine the kernel-periphery boundary but also provides specific frequency data for each lexeme. This will be the first electronic lexicon for Bangla.

Probal Dasgupta

Interlexical Study of Asamiya in a Substantivist Framework

The purpose of this project is to develop the empirical base for electronic lexical resources for Asamiya. Electronic lexical resources are an essential presupposition for other sectors in research within the domains of Language Technology (LT) and Natural Language Processing (NLP). This type of resource is of use in machine translation, information extraction, word-sense disambiguation, semantic net, ontology, etc. Also, it has direct academic relevance in electronic dictionary and thesaurus development, language teaching (first and second language), discourse analysis, lexical semantics, and language cognition. The proposed lexical resources will set a precedent for Asamiya, and the enterprise may be extended to other Northeastern Indian languages for which background descriptive material is available on a similar scale. The utility of the project is further enhanced by the fact that it extends the advances in interlexical understanding attained in the context of earlier research on Asamiya, Boro and Bangla.

Probal Dasgupta

Sociolinguistics

The unit has taken up studies in linguistic (lexical and syntactic) difficulty in the context of the study of cognition and discourse. The sociolinguistic dimension of linguistic difficulty has been studied within single languages, in relation to the mapping between the full conceptualization system and its basic level kernel, and across languages in the Indian context. Here one major background factor determining the format of inquiry has been the place of English in the sociolinguistic landscape of India.

Probal Dasgupta

Corpus Based English Language Teaching (C-BELT) System

LRU is working towards developing a generic model for Corpus-Based English Language Teaching (C-BELT) for the Bangla speakers. It has been observed that the idea of teaching English language to learners with direct reference to English Language Corpora (ELC) is a more useful strategy, as data and information obtained from modern ELC provide authenticity and reliability towards the process of teaching English as a second language to the learners. We propose to access and utilize the English Language Corpora directly in classroom situation with information obtained from corpora through utilization of corpus processing techniques, such as, concordance, lemmatization, POS tagging, morphological processing, bilingual lexical databases, etc. for teaching English to the Indian learners. We also propose to encourage Indian learners to extract relevant linguistic data, examples, and information from the English Language Corpora to increase their knowledge in the language as well as enhance their communicative competence and communication skill in English in various interactional environments. Furthermore, we envisage English Language Corpora as an authentic source of data and linguistic information, which may be directly utilized for developing ELT text books, bilingual dictionaries, dictionary of idioms, phrases and proverbs, graded vocabulary, and primary and advanced grammar books for the Indian learners. We are planning to generate a lexical database of

basic and graded vocabulary of English from the English Language Corpora to be used in the development of a C-BELT system for the Indian learners.

Niladri Sekhar Dash

Domain-Specific Parallel Translation Corpora from Hindi to Bangla

We are developing a Hind-Bangla parallel translation corpus keeping Hindi as the source language and Bangla as the target language. The second phase of the project (ILCI-2) has so far produced 35,000 Hindi-Bangla parallel sentences covering two domains of information sharing: Agriculture and Entertainment. Each sentence has an average length of sixteen (16) or more words in the target language output. The most vital feature of this bilingual parallel sentence database is that parallelism between the two languages (Hindi and Bangla) is maintained and preserved at both semantic and syntactic level (i.e., structural and thematic parallelism) – making the translation corpus an indispensable resource for cross-lingual information retrieval, bilingual lexical database generation, bilingual dictionary compilation, bilingual wordnet development, word sense disambiguation, domain-specific lexical database generation, translational equivalent extraction, core grammar development, machine translation, language teaching and cross-cultural research. The second phase (ILCI-2) has started in April 2012 and is scheduled to end in September 2015.

Niladri Sekhar Dash

Bangla Web Corpus (a Multidisciplinary Monolingual Bangla Corpus with Web Texts)

As an important component of Indian Languages Corpora Initiative (ILCI-2) project, we are developing a multidisciplinary and multidirectional monolingual Bangla corpus (Bangla Web Corpus) with text data retrieved from internet, digital portals, and web pages. At present it contains more than 30,000 sentences obtained in equal proportion from the domains of games and sports, tourism, economics, art & culture, entertainment, literature, and politics & public administration. We have tried to address the methods and strategies that we applied for this purpose; the issues that have cropped up in the act of generating the whole corpus database; and the major problems that we faced at the time of creating the corpus. Fishing language data from the web and harvesting the Bangla web corpus may be treated as a milestone in the history of Bangla corpus development, which holds tremendous potentials for opening up new avenues for web crawling and language corpus building in the wider spectrum of language technology, and applied linguistics. An on-line version of the corpus will contribute towards building an interface where language users will be allowed to navigate through the web-enabled corpus to address their linguistic needs. Along the side of corpora generated from printed texts, the corpus produced from web texts may be used in natural language processing, linguistic resource development, cross-lingual communication, globalization of linguistic profiles and language resources, digital lexical database, computational lexicography, language planning and E-governance. Here lies the theoretical relevance, empirical pertinence, and functional importance of this work which seeks to propose a makeshift guideline for the new generation of corpus developers in Indian languages.

Niladri Sekhar Dash

POS Tagging of Bangla Words in the Bangla Corpus

We have developed a well-planned and hierarchical POS tagset for the Bangla text called the “BIS Bangla Tagset” (for the Bureau of Indian Standard) as a benchmark standard to be used in POS tagging of Bangla text of all types. We have used this POS tagset to develop a POS tagged corpus of 50,000 Bangla sentences relating to health and tourism domains as well as 10 thousand sentences from the Bangla web corpus. An important bi-product of this work is the generation of POS tagged digital lexical database for Bangla which is now being used to compile digital Bangla dictionaries, thesauruses and wordnet. The database can also be used in some other NLP works such as information retrieval, grammar development, machine learning, language teaching, word sense disambiguation, lemmatization, morphological analysis, and in mainstream and applied linguistics. The POS tagset as well as the POS tagged Bangla corpus is available at the TDIL Data Centre, Govt. of India homepage.

Digital WordNet for Bangla

We have developed a WordNet for Bangla that stands parallel to other wordnets developed for other Indian languages, e.g., Hindi, Sanskrit, Marathi, Konkani, Urdu, Oriya, Gujarati, Kashmiri, Tamil, Telugu, and Malayalam, etc. We have adopted an intricate interface of lexical structure made of synsets (i.e., set of synonyms) where semantic relations of words, in which synsets act as sets of synonyms to refer to similar or near similar concepts, are linked up with one another in implicit dichotomies of semantic relations like hypernymy and hyponymy (is-a relation), meronymy and holonymy (part-of relations), and troponymy (manner-of relations), etc. expressible through their conceptual linkages in the wordnet. In the act of Bangla wordnet creation, the central focus is concentrated not on the words but on the concepts the word(s) are capable of denoting. Based on the idea of covering a large number of senses within a generic frame, we have used the Expansion Approach, since our primary goal is to link up the Bangla synsets with the synsets of other geographically, genealogically and typologically related Indian languages along with English wordnet. So far we have completed 36,000 synsets and are on the process of creating more than 1000 Language Specific Synset (LSS) that are meant to represent the uniqueness of Bangla life, living, language, people, and culture in the WordNet.

Niladri Sekhar Dash

SHELL System for Teaching English to Bangla Learners

Think of a situation when English is being reintroduced in Bangla after a gap of nearly 20 years at the primary level. At the crucial stage of reintroduction of English at primary level in West Bengal it is noted that there is neither suitable textbooks, nor good ELT resources, nor trained teachers who can make this mission successful. That means there is no academic support of any kind that can be accessed and utilized for fruitful execution of ELT courses in the state. Keeping this state of affairs and the target learners in mind we have proposed a strategy for developing ELT textbooks in such a way that the target learners are able to learn English, at least at the initial stage of learning, at their own ways through direct utilization and assistance of their mother tongue. Since there no one to help them learn English, the learners will help themselves in this process of learning. Therefore, we call this strategy as the Self Help English Language Learning (SHELL) system. This new strategy is adopted in an experimental basis for developing text books and learning materials for the new generation of Bangla learners who are being exposed to English for the first time in life at the primary level. Let it be assumed that the target learners, for which this method is being proposed, have acquired some kind of linguistic efficiency in their mother tongue, and are now sent to primary schools to learn English as a second language. It has been also assumed that these students receive no academic help or tutorial support from their parents in the act of learning English, since these students are mostly first generation learners. What they can expect is a kind of passive help or guidance from their teachers only at school hours. At present, we have completed the task for developing resource that can guide Bangla children to learn orthographic forms, pronunciations, and usage variations of the English vowels and consonants with direct use of their mother tongue – Bangla. Now we are trying to develop the GUI for the application purpose.

Niladri Sekhar Dash

Field Linguistic Survey at Linguistic Field Surveys in Jharkhand

We have conducted Linguistic Field Surveys at four villages in the district of Ranchi, Hazaribagh, and Ramgarh in the state of Jharkhand among the native Khortha speakers for the purpose of elicitation of samples of spoken data in the form of lexical list, sentence list, and free discourse speech along with some recordings of local songs, lullabies, riddles, death songs, birth songs, marriage songs and other socio-cultural events and narrations thereof. The primary purposes of this survey are to digitally record and document the linguistic details of the language and its speech community for its preservation and promotion. The utilization of the Khortha speech database may be realized in understanding the

general as well as special linguistic features and phenomena of the language, recording its separate linguistic identity with regard to the standard variety and other sister varieties; developing general and special lexicon of Khortha; writing descriptive grammars; producing texts and study materials; compiling dictionaries and thesauruses; and producing information for standardization of Khortha. The Khortha speech corpus is now available for other branches of social science like anthropolinguistics, ethnolinguistics, sociology, demography, history, sociolinguistics, psycholinguistics, ecolinguistics, culture studies, etc.

Niladri Sekhar Dash

Bangla Pronunciation Dictionary in Electronic Form

The objective of this project is to develop a Bangla pronunciation dictionary in electronic and printed form with the lexical database obtained from a corpus of modern Bangla texts. It will become an indispensable resource for research and application in applied linguistics, lexicography, speech technology, language technology, and language processing. Till date, we have collected a lexical database of 60,000 words from a printed Bangla dictionary and from a large lexical database of the modern Bangla text corpus. The wordlist includes all Tatsama, Tadbhava, Deshi, and foreign words of different forms and part-of-speech. These words are being used in the pronunciation dictionary in their lemmatized and alphabetically sorted form. To avoid linguistic controversies, the spelling of the words is fixed following the proposal of the *Pashchimbanga Bangla Akademi, Kolkata*. Each word is being transliterated in Indic Roman tagged with diacritics for all types of end users. Accepted pronunciation of *Standard Colloquial Bangla (SCB)* is adopted for the words, and this is presented in standard Bangla script for those people who know Bangla script but do not know IPA; as well as in IPA for those people who know IPA but do not know Bangla script, particularly the learners of Bangla at various universities and institutes in Europe, USA, and other countries. The meaning for each word is given for sense disambiguation and pronunciation determination, which is particularly useful for those homographic and homophonous homonyms (words having similar orthographic forms or pronunciation but different meanings). The audio output of pronunciation of the words will be available in sentence-free and sentence-bound contexts. At present, pronunciation details of the vowel-initiated words are complete. We are working on the remaining words included in the dictionary. The work of project will continue for next three years.

Niladri Sekhar Dash

Linguistic Field Survey in West Bengal:

We have conducted linguistic field Survey for language documentation of an unrecorded local language variety used in the east part of West Medinipur district in the state of West Bengal India. Started on 6 March and ended on 11 March 2016. We covered 8 villages (Kankrajit, Kesramba, Khandarui, Shabra, Kariya, Atanga, Kukai, Gaganeswar), 50+ informants, covering an area of nearly 50 square kilometers. Collected audio text, video text, word lists, sentence lists, Free Discourse Text, songs, stories, folk tales, mantras, hymns, riddles, lullabies, dance, narratives, cultural texts, heritage, history, anecdotes, and all other verbal texts of the communities. Total data: 40 GB+. The database is being processed for speech transcription, text analysis, lexical resource generation, digitization. The speech corpus is available for other branches of social science like anthropolinguistics, ethnolinguistics, sociology, demography, history, sociolinguistics, psycholinguistics, ecolinguistics, culture studies, etc.

Population Studies Unit, Kolkata

Inequality in child mortality in the North Eastern States of India

The impact of socio economic inequality adversely affects children and for this a significant proportion of infant and child deaths occur during childhood. Maternal deprivation and malnutrition immediately affect the health status of mother and subsequently that of the newborn, which can be traced across

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the entire life cycle of the child. The inequalities among different social groups lead to deprivation in various aspects in their lives. It is a fact that infants belonging to disadvantaged group are certainly at higher risk of mortality than those born in advantaged group. The present study concentrates on how do these disparities differ from state to state within the north eastern states of India? As a measure of inequality and to compare the disparities between different states of north eastern India, concentration curves and indices are constructed from infant and under five mortality data classified under different quintiles of wealth index from the National Family Health Survey (NFHS-3) data. The result shows that, the states may be classified into different groups according to the level of inequality in infant and under-five mortalities.

Partha De

Statistical surveys during the British period and its importance to construct socioeconomic histories in India

India has a long history of keeping records on statistical information on land and people even at the village and town levels from the ancient period. Towards the end of the eighteenth century Britishers also felt the necessity of conducting extensive surveys for administrative purposes in their territorial possessions. Although the basic objective of these past surveys was to collect information for revenue extraction but these surveys devoted their considerable time in developing and improving the survey methodologies and, also for the collection of socioeconomic and demographic information about the tracts under survey. The methodological aspects along with the scientific and cultural information collected by these surveys definitely contributed to build up socioeconomic and demographic histories in India.

Partha De

Health and Economic Consequences of Malnutrition in a backward district of West Bengal

The causal relationship of early nutritional status to physical and cognitive development has been acknowledged for a long time. It is true that, diminished physical and cognitive capacity reduces the productivity of individuals and may be considered as a constraint on economic development. That is why agencies like, UNICEF, promoting the health and welfare of children, by investing on nutritional aspects. However, the fact that anthropometric status of children measures the sum of influences on growth and development may be used as a summary indicator of well-being. The aim of this study is to assess the spatial distribution of nutritional status of developmentally challenged children through Z-scores of height-for-age, weight-for-height and weight-for-age by demographic characteristics in the District of Purulia, West Bengal. Indices of nutritional status are calculated based on the WHO Child Growth Standards. The result shows that under-nutrition is a severe problem with vulnerable children in rural area who suffer from developmental delay.

Partha De

Efficiency and Equity in immunization status of children aged 0-5 years across Indian states

The study using three rounds of National Family Health Survey (NFHS) data (1992-93 to 2005-06), a nationally representative sample survey conducted by the International Institute for Population Sciences, Mumbai, assesses whether improvement in immunization rates (levels) were accompanied by distributional improvements, or whether inequalities were reduced at the expense of overall achievement, the study applies a methodology (developed by Wagstaff et al. 2002) to calculate an inequality adjusted achievement index that captures performance both in terms of efficiency (change in levels) and equity (distribution by wealth quintiles) for the states in India. The measure – Wagstaff's extended achievement index – provides a method to assess performance looking both at efficiency and equity using variable levels of inequality aversion.

Subhash Barman

Inequality and inequity change in health utilization in India: A decomposition Analysis

The concentration indexes (CI) and horizontal equity index (HI) are the statistical tools which are commonly used to measure inequality and inequity in health care utilization. Using National Family Health Survey (NFHS) data (1992-93 to 2005-06), this study applies a simple method to decompose the difference between two CIs and two HIs into two factors: one factor reflects the difference between the means, and other factor reflects the difference between the distributions. The concentration index (CI) measures only the income –related inequality in the observed health care utilization, on the other hand, the analysis of equity in health care utilization requires the adjustment for underlying needs. The indirect need-standardization based horizontal inequity (HI) index (by Wagstaff and Van Doorslaer) is a convenient measure for the evaluation of inequity (HI) in health care utilization. Together with CI, it may be applied extensively to international and inter-temporal comparisons on inequality and inequity in the delivery of health care.

Subhash Barman

Gender difference in nutritional status of children in India: a causal analysis approach using three rounds of NFHS data

The study, using three rounds of National Family Health Survey (NFHS) data (1992-93 to 2005-06), analyzes nutritional status of children and gender disparity. NFHS provide information on three summary indices of nutritional status: weight-for-age, height-for-age, and weight-for-height. These indices of nutritional status are expressed in standard deviation units (z-score) from the median for the international reference population. Ratio of female to male children of 0-5 years of age will be used to measure gender difference in nutritional status among children. Gender difference will be studied in terms of some socio-economic and demographic characteristics. This study undertakes the casual analysis approach in investigating gender differences in nutritional status of children. As such, the use of causal analysis approach would certainly help to have a deeper and better understanding of gender differences in nutritional status of children. Conceptualizing what role various factors may play in the relation between our main exposure and outcome variables would lead to the casual analysis framework.

Subhash Barman

Women's autonomy, education and birth intervals in India: visiting the less familiar

Using data from the third National Family Health Survey (NFHS-3) on currently married fecund women this study examines the less researched association between women's autonomy and birth-to-conception intervals in India. It also examines whether women's autonomy mediates or moderates the relationship between education and birth-to-conception interval. Our results indicate that after adjusting for demographic and socioeconomic factors, women's autonomy was a significant predictor of birth-to-conception intervals. This study did not provide any support to the general perception that women's autonomy mediates the association between women's education and birth-to-conception interval.

Samba Siva Rao Pasupuleti

Effect of nativity and duration of residence on chronic health conditions among Asian immigrants in Australia: a longitudinal investigation

This study examined the effect of Asian nativity and duration of residence in Australia on the odds of reporting a chronic health condition (cancer, respiratory problems, cardiovascular disease (CVD) and diabetes mellitus). Data were from waves 3, 7 and 9 of the Household Income and Labour Dynamics in Australia (HILDA) longitudinal survey, and multi-level group-mean-centred logistic regression models were used for the analysis. On the whole this study found that health advantage, existence of healthy immigrant effect and subsequent erosion of it with increasing duration of residence among Asian immigrants depends upon the chronic health condition.

Samba Siva Rao Pasupuleti

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Hindu-Muslim fertility differentials in India: a cohort approach

This study investigated cohort fertility patterns among Hindus and Muslims and the causes of the relatively higher level of fertility among Muslims. Data from the three National Family Health Surveys conducted in India since the early 1990s were analyzed using a six-parameter special form of the Gompertz model and multiple linear regression models. The results show a gap of more than 1.3 children per woman between those Muslim and Hindu women who ended/will end their reproductive period in the calendar years 1993 to 2025. The socioeconomic and demographic characteristics of Muslims explain 31.2% of the gap in fertility between Muslims and Hindus, while the desire for more children among Muslims explains an additional 18.2% of the gap in fertility.

Samba Siva Rao Pasupuleti

Maternal Exposure to Intimate Partner Violence and Child Health in India: Evidence of an association from NFHS-3

Using data from the third National Family Health Survey (NFHS-3-2005-2006) on currently married women with at least one child, this study examines the little known association between women's exposure to intimate partner violence (IPV) and child health in India. We considered three child health outcome measures namely, height-for age, weight-for-height and weight-for-age. Our results indicate that after adjusting for potential confounders, women's experience of any violence and or physical violence was strongly and significantly associated with increased odds of stunting and underweight of her children. Our results have public health implications for improving child nutrition in developing countries including India.

Samba Siva Rao Pasupuleti

Psychology Research Unit, Kolkata

The unit has been pursuing research in the area of school, educational, cognitive and health psychology. Two workshops and five scientific seminars were organised. Besides these, an Elective course on Psychology in the B.Stat. (3rd Year) program is taught by faculty of this unit. The unit also provides training on research methodology to the research fellows. A brief account of the research topics is given below:

Rabindrik Value Orientations of War Returned Senior Rank Police Officers

Functions of police are to protect people and policy of the nation. They assist in maintaining law and order in the community. There is limited empirical evidence focusing on value orientation of police. Rabindrik value system is composed of both path and goal oriented values. The path – oriented values are instrumental to goal oriented values. This study has two objectives: (a) to determine value hierarchy of police officers and (b) to determine extent of profile similarity between value orientation of police and the common people. Data were collected 18 war returned senior rank police officers through Rabindrik value scale. The scale measures orientation to path and goal values. Results revealed that Police officers preferred self- understanding, cleanliness, active self-awakening, no work-family conflict values. With respect to goal oriented values, they preferred more family security, self-respect, positive feeling, inner harmony and peace. When compared with comparison group, results show high similarity in path oriented values suggesting unique development of human values in the police officers. Finally, some suggestions like positive feeling, feedback and public – police interface were given to design value based training for the police officers.

Debdulal Dutta Roy

Flow across Layers of consciousness: Indian model of health psychology

Consciousness is composed of three layers – Murto, Raaga and Saraswat. Murto layer is the locus of sensory and perceptual discrimination. It is the first layer where in individual senses different attributes

of stimulus. The attributes are scattered in nature. They are not integrated. Raaga is the locus of our feeling or emotion the stimulus attributes. When stimulus experience reaches at Raaga layer, it tends to be integrated in different orders and creates different emotions. This continues for long time until it reaches at Saraswat Layer. Saraswat is the area where in individual experiences harmony between the stimulus and it's surroundings. Change across the layers can be understood through flow. Flow is the movement impulses or information across layers of consciousness. Performing art based Psychotherapy like Rabindrik Psychotherapy is useful paradigm to understand different characteristics of flow. Some characteristics are flow quotient, flow field, buoyant force, saturation, flow enclosure and flow association. Mental image of same stimulus changes with flow across layers. Positive change in mental image provides feelings of happiness, motivation to goal settings, regulating self and developing resilience. The paper will focus on (a) topography of consciousness; (b) flow dynamics and its effect on change in mental health through some therapeutic case studies.

Debdulal Dutta Roy

Verbal reasoning of the Visually challenged

Verbal reasoning is a form of problem solving based around words and language. It involves thinking about texts, solving words problems, following written instructions to come up with a solution. Words provide a mental picture that help to make inference about the similarities about the objects or events. Visually challenged people have some sensory deficit that may interfere with the reasoning process. On the background current study aims at examining verbal reasoning patterns of visually challenged children. Verbal reasoning test battery was administered to 15 visually challenged 9th and 10th grades boys of one recognised institute individually. The test battery includes five subtests namely reasoning for similarities, analogies, syllogistic, data sufficiency and coding. By matching their age and grades the same battery was administered to the sighted students for the purpose of comparison. Results revealed that subtest scores of reasoning test battery for similarities and data sufficiency was higher for the sighted children although with less difference between the two groups. The visually challenged performed with less difference for syllogistic reasoning. In case of analogies and coding the sighted students performed distinctly better than the visually challenged counterparts. The findings are important for psycho-education of the visually challenged children.

Debdulal Dutta Roy

A Study on Innovative Self-efficacy of School Teachers

Innovative self-efficacy refers to the belief in one's own capability to perform innovative task effectively in order to attain certain desired goals. In school, teachers with high innovative self-efficacy perform some innovative tasks like designing novel teaching strategies; implementing new ideas; experimenting teaching pedagogies; exploring sources of new information and following flexibility in teaching. In this research one five-point scale with 25-items was developed to assess innovative self-efficacy in teaching. Data were collected from 400 secondary school teachers of 28 schools (both government and private) at Kolkata. Participants were administered the following measures: a) Innovative Work Behaviour Scale, b) Innovative Self-efficacy scale and c) Neo Five Factor Inventory, d) Perceived School Climate. Results revealed significant relation of innovative self-efficacy with innovative work behavior, school climate and personality. Innovative self efficacy emerged as relatively most important predictor of innovative work behavior. Mediation analysis revealed that innovative self-efficacy acts as a mediator between the relationship of certain personality traits (openness and extraversion) and innovative work behavior. Further hierarchical regression revealed that perceived school climates acts as a moderator between innovative self-efficacy and innovative work behavior of the teachers. Findings have practical implications in designing teaching pedagogy, teacher training programs and designing innovative school climate.

D. Dutta Roy and Anurupa Kundu

A study on Visuospatial reasoning ability of adolescent school students

Visuospatial reasoning (VSR) is the *ability to manipulate visuospatial information* so as to reason out *logical inferences* based on the given information. There are four basic visuospatial reasoning abilities

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namely, (a) rotation-based reasoning, (b) orientation-based reasoning, (c) visualization-based reasoning and (d) dynamic visualization. Objective of the study is to assess the Visuospatial Reasoning ability of pre-adolescents and adolescents, age ranging from 7-16 years in connection with their working memory as also their home environment. After initial data collection by administering paper-pencil tests, appropriate stimuli suitable for specific age levels were recognized. Based on the findings, further computerized tests were developed with novel ways of assessing the abilities. Presently, the visuospatial reasoning test battery is being administered to children of age 7 yrs. to 16 yrs., along with a Digit Span test and Corsi n-block tapping test for assessing Working Memory and the Raven's Standard Progressive Matrices for assessing their intellectual capability. Objective of this study is to examine the association between the Visuospatial Reasoning ability and General Intellectual capability as also how much working memory accounts for this association across age groups. In the next phase of the study the test battery will be revised as required. Further, the next study will examine the association between Visuospatial reasoning, Working Memory and Home Environment across the different age groups.

D. Dutta Roy and Sumona Datta

Self-care efficacy in Diabetes management

Objectives of the study are (a) to explore principal components of Diabetes self-care efficacy Scale (DSCE-Scale) developed for the study and (b) to relate scores of Diabetes self-care efficacy Scale (DSCE-Scale) with the measures of diabetes self-care activities and glycemic control. Data were collected from 300 diabetic patients from IPGMER and SSKM hospitals in Kolkata. Principal component analysis extracted three components of diabetes self-care efficacy. Reliability coefficients ranged from 0.79 to 0.87. The components are significantly correlated with different diabetes self-care activities and glycaemic control as measured through fasting blood sugar (FBS), post prandial (PP) and glycosylated haemoglobin (HbA_{1c}).

D. Dutta Roy and Sravanti Adhkari

Metamemory: A brief review

Metamemory, a type of metacognition, is both the introspective knowledge of one's own memory capabilities and the processes involved in memory self-monitoring. By reviewing prior studies, some gaps of researches are identified. These are (i) weak correlation coefficient between metamemory and actual memory performance; (ii) inadequate information about metamemory of the school going Adolescents; (iii) different domains of metamemory and their interrelations.

D. Dutta Roy and Murshida Khatoun

Development and Validation of a Cognitive measure for Juvenile Delinquent in Indian Context

The aim of the present project is to develop battery of test in order to understand the cognitive deficit present among juvenile delinquents. Past research reveals that attention, language and emotion processing and behavioural inhibition are the three major domains, where the juvenile delinquent has poor processing abilities. Based on these findings, an attempt has been taken to develop a test battery suitable for Indian context that can be used towards identification, intervention and prevention of juvenile delinquency in India. The test battery has been developed under the domains, namely attention, language processing and behavioural inhibition. Initial pilot study of the test was completed and necessary changes were made in the final test. Data collection has been completed from the delinquent participants and remaining data collection from the matched control group is in process.

Anjali Ghosh and Tanushree Moitra

Spirituality and Self-esteem among adolescent boys and girls of H.S. School, Kolkata

Spiritual beliefs are very important in human life. These are positively related to moral development educational achievement, purpose and goal attainment, mental health, life satisfaction and happiness etc. We know that adolescence stage is a transition period from childhood to adulthood. So the aim of

the present study is to explore the influence of spiritual beliefs and self-esteem among adolescent boys and girls of H.S. school, at Kolkata. Literature suggests that there is a relation between spirituality and self-efficacy. The data collection is going on from different schools of Kolkata using Standardized questionnaire.

Himani Bhattacharya

Loneliness and social adjustment in old age

People are different. They live in a variety of situations and they do not feel the same way about their life and the world around them. From a practical point of view, it is important to know how different persons feel loneliness and social adjustment in old age with regard to their day-to-day concerns. Such knowledge is necessary for an improvement in the quality of life of these people. Objective of the study is to examine the relationship between loneliness and social adjustment of senior people. Data collection process is going on from different old age homes of Kolkata.

Himani Bhattacharya

Sampling and Official Statistics Unit, Kolkata

Redefining Dependency Ratio: Illustration of Its Change for Selected States in India

The study attempts to develop a method of estimating more precisely the dependency ratio. It illustrates the method by using census data on Maharashtra, Kerala, Madhya Pradesh, Bihar and Uttar Pradesh for 1981, 1991, 2001 and 2011. It shows that the existing measure of the dependency ratio over-estimates the economic dependency of children and older adults on the remaining population.

Prasanta Pathak

Analysis of Pattern of Expenditures in Broad Categories of Food and Non-food Items by Varying Economic Status of Households in India

Based on NSS 66th Round data, the study attempts at identifying the patterns of expenditures in broad categories of food and non-food items with varying economic status of households, determined based on per capita monthly consumption expenses. It suggests appropriate techniques for classifying the items and shows how the expenditure patterns for different classes of items vary with upgrading of household economic status. The findings call for more in-depth research into rational pricing of consumption goods with greater detailing of classification of its consumption patterns.

Prasanta Pathak

What Drives Politicians' Behaviour: Intrinsic Motivation or Self-Interest?

Decentralization of responsibility for the production and distribution of public services and programmes to local politicians has become widespread in the developing world. In democratic settings, decentralised systems are subject to electoral pressure and often to careful scrutiny by local citizens. Despite extensive research to improve public programme and service delivery, it is not well understood *why*, rather than *how*, the efforts of local politicians vary across regions within the same decentralised political system. This suggests that decentralisation may not be sufficient to ensure cost-effective and efficient resource allocation at the local level. We intend to address this critical issue here: to what extent can local politicians motivations and social preferences explain such variation in performance?

Sandip Mitra, Kunal Sen and Prasenjit Banerjee

Study on Self Help groups

Recent work on local governance identifies that, in addition to market failures and government failures, an important barrier to the goal of inclusive and participatory economic development is civil society failure, whereby groups are unable to undertake welfare-enhancing collective action. Self-help groups

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(SHGs) have been widely deployed as a tool to address such civil society failures, especially through women's empowerment. The theory of change is for SHGs to empower women from poor households by providing access to capital, building knowledge, social capital and leadership skills, so as to help them utilize their rights and entitlements to development programs, and to foster new social norms. Our study will use a rigorous evaluation design to address several specific questions about the formation, functioning and impact of SHGs

Sandip Mitra, Anandi Mani and Lakshmi Iyer

Resource Transfers to Local Governments: Political Manipulation and Voting Patterns in West Bengal

The study examines how electoral competition in parliamentary constituencies affects allocation of resources to local governments and subsequent impacts on voter behaviour. We examine the consequences of treating the 2007 redistricting of electoral boundaries in rural West Bengal. Using electoral victory margins in the previous 2004 election as a measure of political competition, we find that resource transfers to GPs were motivated by electoral considerations. Stronger changes were exhibited for recurring private benefits compared to one-time private benefits and local public goods. The evidence is consistent with models of electoral opportunism based on pork-barrel politics and/or clientelistic relational contracts between parties and voters, particularly the latter.

Sandip Mitra, Pranab Bardhan, Dilip Mookherjee and Anusha Nath

Distributive Impacts of Agent-Intermediated Microcredit

This project builds on previous work on trader-agent intermediated loans (TRAIL, Maitra et al. 2015), and investigates how the impacts of the loans varied by borrower characteristics. In particular, we study how the impacts varied by borrower landholding, caste/religion and gender. The analysis accounts for the fact that borrower selection was endogenous to the trader-agent, and asks the hypothetical question. Preliminary results suggest that TRAIL increased farm value-added mainly for households with 0.5 to 1 acre of land. It increased the time men spent in agricultural self-employment, and reduced the time women spent employed by others.

Sandip Mitra, Sujata Visaria, Dilip Mookherjee and Pushkar Maitra

Quality Consideration in Rice Markets

It is well known that agricultural commodity prices vary across markets and across qualities. However, limited numbers of studies have been undertaken considering the quality in agricultural market. Attempts are being made in this context to study market integration based on the available data in respective rice markets of India.

Sandip Mitra and Kishor Das

Estimating sensitive population proportion by generating randomized response following direct and inverse hypergeometric distribution

Estimation of sensitive population proportion is considered in this study by generating randomized responses with direct and negative hypergeometric distribution. We consider sampling of respondents by general sampling schemes having the positive inclusion probabilities for single and paired population units. Essential theoretical derivation for unbiased estimator, variance and variance estimators are presented in this study. Two approaches are compared here with a numerical illustration.

Kajal Dihidar

Estimating sensitive population proportion by generating randomized response with a modified unrelated question model by direct and inverse mechanism

Estimation of sensitive population proportion by generating randomized responses with direct and inverse mechanisms are being studied in the randomized response literature. However, the inverse procedure for unrelated question model is very difficult to tackle. For getting rid of the problem, some modification of usual unrelated question model is suggested in this paper. Essential theoretical derivation for unbiased estimator, variance and variance estimators for direct and inverse approach of this modified model are being studied in this paper under the consideration that the respondents are chosen by general sampling schemes. Two approaches are compared with a numerical illustration.

Kajal Dihidar

Estimation of demand for banknotes and coins

Indian Statistical Institute was asked by Reserve Bank of India to estimate the demand for banknotes and coins at aggregate and denomination levels as well as at national and regional levels, carry out validation analysis of the RBI methodology for the same and assess demand-supply mismatch of currency at national and regional levels. The work involved examination of the concept of demand for currency, study and application of various univariate and multivariate econometric modelling techniques, devising a sampling plan for collection data on demand-supply mismatch at various stages of circulation of currency, preparation of the study report, etc. The study report has been submitted to RBI. There is scope for further research in the area depending upon the response awaited from RBI.

Asit Baran Chakraborty, Probal Chaudhuri (SMU, Kolkata),
Debasis Sengupta (ASU, Kolkata) and Nachiketa Chattopadhyay

Estimation of the variability of prices

A study on estimation of the variability of the prices for different items of consumption expenditure across different states/districts have been undertaken based on the unit value data obtained from the NSS consumer expenditure surveys. For compilation of price indices in India, such variability in prices of different commodities should be an important determinant of the number of price quotations collected in order to minimise sampling error. In the absence of publicly available price quotations database used for construction of price indices in India, this issue is being examined using the district level average price data for various items compiled from the unit level NSSO consumption expenditure survey database. The findings can be utilised for improving the sampling strategy for compilation of price indices in India.

Asit Baran Chakraborty and Prabir Chaudhury

Using unit level data to throw light on data collection practices in NSS consumption surveys

While concern over the length of the NSS consumer expenditure schedule is rising, little attention has been paid to the double effort of obtaining both quantity and value of consumption for food items. But do households report quantities and values, or quantities and prices? In the 68th round unit level data on vegetables consumption, there is evidence that *reporting of usual price paid*, along with quantity, is now a very common practice. Another finding is that the within-first-stage-unit variation in unit value of each vegetable is quite low. It follows that the survey data collection can be simplified by (a) recording, instead of both quantity and value, either price and quantity, or price and value, and (b) going a step further and recording the usual price at village/block level only.

Prabir Chaudhury

Sociological Research Unit, Kolkata

Survival Strategy of elderly headed households of rural West Bengal: An SNA approach

In course of daily life of rural people, situations often arise when a need is faced by a household which it has to fulfil immediately even by taking help from others; households have gradually built up (and thus they gradually) social networks among themselves to meet these situations effectively. These social networks (work) are marshalled at household level and play an important role as a kind of

Research Activities

survival strategy for the rural people. Several gerontologists have studied on both involuntary and voluntary ties of elderly people from the point of their well-being (of), including their mental and physical health. In West Bengal, socio-economic and political / organizational changes have been brought about (taken place) by redistribution of land through land reforms, increase of wage rate and effective functions of Gram Panchayat, effecting changes in the life opportunities of (have been as a source for the) rural people in West Bengal. A study on the survival strategy of elderly (≥ 50 yrs.) headed households in rural West Bengal was conducted applying SNA approach to capture the changes. The findings would serve as useful inputs to policy-makers by reckoning the importance of elderly heads of the rural households in social networks found in their survival strategy.

Rabindranath Jana, Rangasamy Maruthakutti and Anil Kumar Choudhuri

Social Networks in the Context of Community Response to Disaster: Study in an Aila- affected Community in Coastal West Bengal, India

Resilience of individual and community needs social assistance in the form of information, material, services and support. These assistances are embedded in social networks constituted of family, neighbourhood, workplace, and the community itself through which assistance flow. The strength and effectiveness of such social networks influence the ability of communities to cope up and recover from disaster events. Social Network Analysis (SNA) provides excellent scope of analysing such complex networks in disaster-hit communities. We describe the application of SNA in a disaster-hit community and show the changing pattern of evolving networks during and after the disaster. This is a study on a disaster-hit community in southern West Bengal that sustained significant damage due to cyclone Aila (severe cyclonic storm followed by prolonged inundation with saline water) in 2009. The disaster was conceptually divided into four distinct phases namely by extreme event (Phase 1) by community response (Phase 2), by relief (Phase 3) and rehabilitation (Phase-4), through a series of focus group discussions with the community. Network data for all these four stages was collected through personal interview from the affect households located besides the river bund. For all the four phases, unique networks were found with different central nodes, although few nodes remained central throughout the four phases. The analysis illustrates the interactions within and between community networks, and may initiate situational awareness, efficient planning, and optimal resources allocation for disaster preparedness, community resilience, and response.

Sanchayeeta Misra, Rupak Goswami, Tandra Mondal and Rabindranath Jana

Sociological Research Unit, Giridih

Contract farming Participation and Emerging Trend in Agrarian Relation: The Case of potato Growers in West Bengal

The farmers in West Bengal have embraced contract farming for growing potatoes under Frito Lays model. Many scholars consider this practice as a new agribusiness model or supply chain management, and they may find this practice as both productive and efficient. Sociologists on the other hand are interested to understand the perspectives of contract farming in evolving new form of agrarian relations and the mode of production in the wake of contract farming (Singh, 2005; Key and Runsten, 1999). Contract farming practice in West Bengal, unlike in many other states of India, is not formally associated with legal and institutional arrangements. The present attempts to identify the socio-economic factors that influenced the farmers' participation in contract farming. In addition, it is important to understand how new form of agrarian relations emerged due to the contract farming practice by a study in West Bengal with special focus on Frito Lays model. The study will primarily deal with the potato growing farmers under contract farming to study the nature of relations established both at the micro (within the community) and macro level (beyond community periphery). Moreover, noncontract farmers will be part of the study to clearly identify the differential progress of the potato growers under contract and non-contract farming.

Hari Charan Behera

Economics and Planning Unit, Delhi

The Economics and Planning Unit faculty has, as in the past, continued to work on the cutting edge of economic research, both in theory, as well as empirical analysis.

Research in trade theory has integrated international trade in commodities and international trade in services. Research in the area of agriculture economics has looked at the effect of non-farm employment on farm wages in India, as well as the impact of climate change on welfare outcomes in the agriculture sector. Research in mechanism design and auction theory, long a strength of the unit, continues. The links between education, health, and other public goods and the distribution of income has been investigated theoretically. Social capital and collective action in the Himalayas, agricultural fires and air pollution, and climate change and electricity demand in India are some of the environmental issues in India on which empirical research has been conducted. Empirical research on schooling and labor force participation continues to be an exciting area of work. In macroeconomics, endogenous growth theory and optimal taxation continues to be active areas. Fiscal policy in small open economies is also an area of ongoing work. Research exploring the links between distortions in the agriculture sector and monetary policy is also ongoing work. In Microfinance ongoing work examines the institutional aspects behind success/failure of micro-finance. Other fundamental issues in the micro-finance literature, such as group vs. individual lending, various aspects of dynamic incentives, and the effect of competition have also been examined.

Here is a more detailed break-down of research interests:

Area of Research by the members of the unit

(1) Female Labour Force Participation and Child Education in India: Evidence from the National Rural Employment Guarantee Scheme, (2) Women Political Leaders, Corruption and Learning: Evidence from a Large Public Program in India (3) The Mixture as Before? Student Responses to the Changing Content of School Meals in India (4) School Feeding Programs and Classroom Performance; (5) Electoral Competition and Corruption; (6) Women and Work in Rural India; (7) Social Identity, Networks and Labor Productivity.

Farzana Afridi

Public finance and macroeconomics that incorporate pension, education and taxes on inheritance.

Monisankar Bishnu

Micro finance, Conflict, Holdup and bargaining and vertical product differentiation with behavioural assumptions.

Prabal Roy Chowdhury

Analysis of the efficacy of different types of counter-terrorism policies in different scenarios. A novel theoretical framework, which distinguishes and at the same time integrates international trade in commodities and international trade in services, is built.

Satya P. Das

(1) The nexus between fiscal policy, growth, income distribution, and macroeconomic stability. (2) Indian monetary theory and policy in the context of NK-DSGE Models.

Chetan Ghate

(1) "Women and Democracy", (2) the role of democracy and economic welfare; (3) The study of efficient utilisation of resources and welfare economics in healthcare (a joint project with AIIMS).

Mudit Kapoor

Research Activities

Mechanism design, a subfield of game theory: main focus is on designing mechanisms with multidimensional private information of agents and study their structure under various incentive constraints. Research is done on settings where transfers are permitted (like auctions) and where transfers are not permitted (like voting, matching etc.).

Debasis Mishra

Education: understanding inequality of access of teacher and constructing algorithms for local teacher transfers. Also studied how private schools locate themselves in the state of Andhra Pradesh NREGS: the impact of NREGS on borrowing of households, the political economy of NREGS,

Abhiroop Mukhopadhyay

Food supply chains, world food markets, welfare effects of trade liberalization, experimental economics.

Bharat Ramaswami

Mechanism design theory: Two specific areas are: (i) the structure of incentive-compatible random outcome functions in dichotomous domains and (ii) the implementability of social choice correspondences via un-dominated strategies and bounded mechanisms.

Arunava Sen

Impact of climate change on the agricultural and manufacturing sectors.

E. Somanathan

(1) Persistence of Caste System in India, (2) Informal and Formal Credit Markets, (3) Public versus Private Provisioning: Role of Education and Political Participation, (4) Financing Higher Education: Comparing Alternative Policies, (5) Education Financing Policy: Income Contingent Loans and Educational Poverty Traps, And (6) Inequality, Neighbourhoods and Welfare of the Poor.

Tridip Ray

Economic Analysis Unit, Bangalore

Research on Asset inequality in rural India

This research examines the level and composition of assets owned by households in selected villages categorised by caste and socio-economic class. It brings out the extremely high inequality in ownership of assets in rural India. Ownership of assets or wealth shows clear differences along the axes of socio economic class and caste. An examination of the composition of assets showed that landlords, big farmers and rich peasants controlled not only the most crop land in each village, but also had the best and most of other assets including livestock and non-agricultural assets. The asset ownership of a household is built on the ownership of land and inequalities in land holdings get translated in to inequalities in other assets as well.

Madhura Swaminathan

Research on Socioeconomic study of three villages of Karnataka

This study examines statistical data collected through detailed village census surveys to study differences across rural households in a range of variables including land, assets, incomes, crop production, employment, indebtedness, schooling and housing.

Madhura Swaminathan, V.K. Ramachandran and Biplab Sarkar

Research on Women's role in the livestock economy

This study examines the nature of women's work participation in animal husbandry activities in rural areas. It examines both secondary and primary data. We argue that the features of work involved in

animal care are such as to contribute to the undervaluation of women's work, both in terms of employment or occupation (and being counted as a worker) and in terms of contribution to household income.

Madhura Swaminathan and Yoshifumi Usami

Research on State of agrarian relations in India today

This is a long term book project and attempts to identify features of contemporary agrarian relations. It argues that the problems of post-liberalisation agriculture represented an exacerbation of certain long standing trends in the economy; it also represented qualitatively new and unprecedented policy measures with regard, for example, to systems of administrative pricing, investment, international trade, the privatisation of different stages of production, storage and marketing, land reform and land use, research and extension, and intellectual property rights. Nevertheless, any view that the two-decade period from 1991 to the present was a period of *undifferentiated* crisis -- that is, of deceleration, a general absence of dynamism and even retrogression across *all* classes, regions, crops and years – is not supported by direct observation or statistical data.

V.K. Ramachandran

Research on Seeds and seed policy

This research examines issues in seed diversity and seed cost in the context of the agrarian crisis in India. It does so using data from secondary and primary sources.

V.K. Ramachandran

Research on Aspects of proletarianisation of the peasantry

This research is concerned specifically with aspects of the peasantry in contemporary India. Peasant households, whose members work on all or some of the major manual operations on the land, constitute the sector of petty producers that lies between landlords and big capitalist farmers on the one hand, and manual workers on the other. The peasantry is a tenacious, enduring social category, having existed continually under different historical social formations. The transition from a peasantry that was essentially engaged in subsistence cultivation, in pre-capitalist and early capitalist epochs, to one whose chief characteristic is its subjugation to the market (and indeed both types exist concurrently in different parts of the world) is a process that has spanned centuries and historical epochs. The research examines an aspect of the process of proletarianisation of the peasantry, that is, "the concentration of production in the hands of a minority [and] the forcing of the majority into the ranks of the proletariat."

V.K. Ramachandran

Research on data anomaly in Indian Mining sector

Evaluating the gender gap in official statistics in relation to the number of miners and their wages in India assumes importance, considering the pivotal role of the mining sector in the Indian economy, both for research and policy-making. Data on number of miners in India is collected by Annual Survey of Industries, Director General of Mines Safety, and Indian Bureau of Mines based on returns submitted by the mining companies (both public and private). On the other hand, based on household data, number of miners is also available from population censuses and National Sample Survey Organisation's (NSSO) employment-unemployment surveys. Issue of gender mainstreaming in the mining sector is important since gender disparities are observed in size of employment, status of employment and in entitlement to social security benefits. Since gender equality and empowerment of women is an important Millennium Development Goal, the empowerment of women is possible only when they are seen as legitimate members of the workforce.

Molly Chattopadhyay

Research Activities

Research on occupational segregation and impact on wage

Using data from NSSO following NCO-68 from 1993-94 to 2004-05 gender wage gap and segregation in post-liberalisation regime it is found that wage gap (relative) is quite high; it decreased by only one per cent from 0.42 to 0.41 from 1993-94 to 2004-05. In explaining gender wage gap, whether it is due to gender composition of occupations or due to earning gap, it is seen that as a whole, gender composition between occupations plays a more important role than earning gap within occupations, though there are variations. It can be said that despite sectoral variations, increase in gender ratio has not resulted in decreased segregation and decreased wage gap.

Molly Chattopadhyay and Sonali Chakraborty (SRU, Kolkata)

Research on gender segmentation in organized and unorganized manufacturing sector of India

A comparison between organized and unorganized manufacturing sector of India, the quality of female labour force participation, gender segregation, influence of female share in wage rate and employment structure based on Annual Survey of Industries (2005-06) that covers registered enterprises and National Sample Survey that (2007-08 & 2011-12) covers unorganized manufacturing sector is undertaken. The results point out that the segregation of workforce is mainly observed among own account manufacturing in unorganized sector. From regression analysis, it is found that male workers are preferred to female workers in larger type of enterprises. The female share seems to reduce the output factor 'gross value added' per enterprise and the total wage received per worker per enterprise.

Molly Chattopadhyay and Sonali Chakraborty (SRU, Kolkata)

Research on women workers of coffee industry using official statistics

This study deals with gender distribution of coffee workers in the coffee curing and manufacturing sector of India in terms of employment size, enterprise type, social security benefits and wage. Based on unit level data from Employment-Unemployment Survey (2011-12) conducted by National Sample Survey Organisation (NSSO). Following National Industrial Classification, 2008 (code 10792, coffee curing and manufacturing of coffee) based on usual principal status, it is found that 34 per cent of the total workers are women. Only 50 per cent of male workers belong to formal sector while no female worker belongs to formal sector. The appalling condition of female workers is evident from the female to male wage ratio of 0.43. In conclusion, it can be said that overwhelming number of female workers who are mainly casual workers are deprived of all sorts of social security benefits.

Molly Chattopadhyay and Jesim Pais (ISI, Delhi)

Research on Computation of spatial autocorrelation indices for various variables of socio-economic demographical-environmental relevance

Various variables of socio-demographic-economic-environmental relevance are collected for the hierarchically decomposed political units such as states of a country, divisions of a state, districts of a division and taluks of a district and so on. For each unit, the variable-specific spatial-autocorrelation index is computed with an aim to understand the degree of disparities across the units in a hierarchical manner. This work would provide insights for preparing spatial policies.

H.M. Rajashekara and B.S. Daya Sagar

Research on Computing Mahalanobis Distance for finding a measure of distance between various variables of socio-economic-demographical-environmental relevance

Establishing relationship between the groups in terms of multiple variables of socio-economic demographical-environmental relevance across time periods is a challenging study. This study attempts to classify and cluster the group with respect to multiple variables mostly of relevance to demography. Mahalanobis Distance equations are employed to cluster and classify the groups. This study aims at providing spatial maps that provide clues for proper prioritization.

H.M. Rajashekara and B.S. Daya Sagar

Research on International Passengers Survey 2015-16

International Passengers Survey 2015: Working as Nodal Co-ordinator for Bengaluru. This Survey is commissioned by Ministry of Tourism and conducted by the Indian Statistical Institute (ISI), Kolkata. The survey is being conducted at 12 Airports in India which includes the Airport of Bengaluru. The purpose of the Project is to collect information of International Passengers including Indians. The information being collected are the general details about (i) Entry & exit, (ii) Travel, (iii) Accommodation, (iv) Expenditure, (v) Places of visit, etc. Field Investigators on temporary basis have been appointed for conducting the Survey.

Ashis Sengupta (ASU, Kolkata) and H.M. Rajasekhara

Statistical Quality Control and Operations Research Division

The Division comprises of eight SQC & OR Units located at Bangalore, Chennai, Coimbatore, Delhi, Hyderabad, Kolkata, Mumbai and Pune and the Central SQC (CSQC) Office located in the main campus at Baranagore. The CSQC Office functions as the office of the elected Head of the Division and co-ordinates various activities of the Division.

The activities of the division consist of consultancy and training, research with a focus on the applied one, academic teaching including conducting M.Tech. (QROR) programme at Kolkata, M.S. (QMS) programme at Bangalore and Part-Time Certificate Course at Bangalore and Hyderabad. The faculty members of the division also teach in other academic programmes like B.Stat. and M.Stat. Supervision of Ph.D. thesis along with the dissertation and project work by M.Tech. (QROR) and M.Stat. students are another part of the responsibilities discharged by the divisional members.

The activities of the Division under different headings are furnished in the following.

SQC and OR Unit, Kolkata

Monte Carlo comparison of tests of exponentiality against NWBUE alternatives

The problem of testing of exponentiality (which essentially captures no aging) against non-monotonic aging captured by the fairly large class of new worse than better than used in expectation (NWBUE) alternatives is explored. Three different tests are reviewed; these tests are based on three different characteristics of the NWBUE distributions, namely the moment characteristic, the scaled TTT (total time on test)-transformation and the centered form of the scaled TTT-transformation. They are compared with respect to size and power. The empirical size and empirical power of the tests are obtained by Monte Carlo simulations. The small sample critical points based on simulation are given for the "most useful" test.

M.Z. Anis and A. Ghosh

Assessing lifetime performance index of Weibull distributed products using progressive type II right censored samples

The lifetime of an item/product denoted by a random variable X is considered to be satisfactory if X exceeds a given lower specification limit, say L . The probability of a satisfactory item, defined as $P_r = P(X \geq L)$, is called the conforming rate. In manufacturing industries, the lifetime performance index, say C_L , is used to measure the performance of the product. There exists a relationship between the conforming rate (P_r) and the lifetime performance index (C_L) when the random variable X follows a parametric distribution. This study constructs various point and interval estimators of the lifetime performance index based on progressive type II right censored data for Weibull distribution with

Research Activities

respect to both classical and Bayesian set up. Further, hypothesis testing problems concerning C_L are proposed. Monte Carlo simulations are performed to compare the performances of the maximum likelihood and Bayes estimates of C_L under different censoring schemes. Finally, the potentiality of the model is analyzed by means of a real data set and a simulated sample.

S. Dey, V.K. Sharma, M.Z. Anis and B. Yadav

Estimation of Reliability of Multicomponent Stress-Strength for a Kumaraswamy Distribution

This study deals with the Bayesian and non-Bayesian estimation of multicomponent stress-strength reliability by assuming the Kumaraswamy distribution. Both stress and strength are assumed to have a Kumaraswamy distribution with common and known shape parameter. The reliability of such a system is obtained by the methods of maximum likelihood and Bayesian approach and the results are compared using MCMC technique for both small and large samples. Finally, two data sets are analyzed for illustrative purposes.

S. Dey, J. Mazucheli and M.Z. Anis

Bayes design of hybrid censored life testing experiments

This work considers Bayes design of life testing experiments under hybrid censoring. A posterior variance based design criteria is proposed. The Weibull lifetime distribution with gamma priors is considered for illustration. A large sample approximation method is considered for computation of optimum life testing plans.

Ritwik Bhattacharya and Biswabrata Pradhan

Estimation of $P[Y > X]$ for generalized half logistic distribution

This work considers estimation of $P[Y > X]$ for generalized half logistic distribution based on complete and Type-II censored data. It is assumed that X and Y are independently distributed generalized half logistic random variables. The maximum likelihood estimator (MLE) and the uniformly minimum variance unbiased estimator of $P[Y > X]$ are obtained for both complete and Type-II censored data. An exact 95% MLE-based confidence interval is also provided. Furthermore, various Bayesian point and interval estimators are obtained under both the subjective and non-informative priors. The performance of these point and interval estimators is judged through a simulation study. A real data set is also analyzed for the purpose of illustration.

Soumya Roy, Gijo E.V. (SQC & OR Unit, Bangalore) and Biswabrata Pradhan

On the asymptotic properties of the MLEs based on progressively type-I interval censoring data

This work considers the asymptotic properties of the MLE are based on progressive Type-I interval censored data. The consistency and asymptotic normality of the MLEs are established under certain regularity conditions.

Sonal Budhiraja, Biswabrata Pradhan and Debasis Sengupta (ASU, Kolkata)

Optimum life testing plan under progressively type-I interval censoring

A cost minimization based optimality criterion is proposed for determination of optimum life testing plan. It is shown that the proposed cost function is scale invariant. Optimum life testing plans are obtained under different scenario.

Sonal Budhiraja and Biswabrata Pradhan

Classification and Estimation of phase structure of multi-phase steel using Image Processing Technique

Maintaining the proportions of different phases is important for quality assurance of dual phase steel. State-of-the-art procedure for manual calculation of proportion of different phases is time consuming and dependent on operator efficiency. The efficacy of the proposed optimal random forest classifier approach is demonstrated through the best classification accuracy of different phases of steel microstructures with minimum number of trees and a novel theoretical upper limit of it. Codes are handed over for trial runs. The automation is in progress with Tata Steel R&D.

D.P. Mukherjee (ECSU), A. Pal and Prasun Das

Identifying Opportunities for Improvement in Higher Education in Provincialised Colleges under Assam University, Silchar (AUS)

The quality debate in higher education is an issue of foremost importance in the age of globalization, growing competition among institutions, emergence of new technologies and changing socio-economic profiles of nations. The questionnaire based survey followed by focus group interview of different groups of stakeholders based on many technical parameters related to higher education of north-east region were carried out to develop Stakeholder Satisfaction Indices, reveal several administrative issues, admission irregularities, infra-structural problems, human resource issues, improper examination system and socio-economic environment responsible for low quality of education in north-east India. These findings are already addressed in two journal publications (QHE, TQM&BE) and extension of this collaborative research is being explored in Tripura and other north-eastern parts of India as well.

Prasun Das and et al.

Combined Arrival-Departure Scheduling of Aircrafts with Different Weight Classes and Multiple Runways (IIST, Trivandrum & AAI, Mumbai Airport)

This joint research project considers real-life parameters and other operational constraint based on the air traffic control operations at Mumbai Airport and presents a generalized optimization model of aircraft's combined arrival-departure sequencing and scheduling using a hybrid ant colony optimization based metaheuristic approach. Performance comparisons, with the results obtained by solving the MILP formulation of the test instances, reveal that the proposed algorithm is effective in solving the problem in reasonable computational time. This work has been accepted in IEEE CEC 2016 conference (paper-id: 16898). The future research work, in collaboration with AAI & DGCA, would be to develop a dynamic simulation model that considers new arrival/departures over a period of time along with uncertainties in the target landing/take-off time and ground operations so as to emulate the real-life scenario.

B.S. Girish, D. Mishra and Prasun Das

Development of Cleanliness Index

Measurement of cleanliness poses a major challenge as cleanliness is subjective as well as multi-dimensional. Further, the cleanliness of an area needs to be looked at with respect to its complexity in terms of various factors like population density, economic activities, availability of infrastructure and so on. In this research we aim at developing an objective assessment instrument to observe and quantify the level of cleanliness. We also look at development of instruments to measure the complexity of the place. Both instruments have been developed and attempts are being made to try them in practice. It has been decided to develop methodologies to group regions with respect to complexity so that regions within a group may be compared with respect to their observed cleanliness and intergroup measures may be developed. This study is currently being carried out with the Government of Tamil Nadu.

Amitava Bandyopadhyay, Amit Biswas, Ranjan Sett and Dipak Manna

Research Activities

Development of Methodology to Estimate the Quantum of Counterfeit Currency Notes in Circulation

Counterfeit currency notes pose a serious security hazard to any country. India faces a huge threat as the counterfeit currency notes may be used for terror funding. Effective strategies to counter this menace require a scientific and reasonably accurate estimate of the quantum of counterfeit notes in circulation. The existing systems of estimation are based upon sampling and are very difficult to implement in practice. In this research, we have developed a method of estimation based upon the available data. Methods have been developed to take care of the cases of non-reporting and also procedures to assess the quantum of fake notes being infused were developed. The estimates and the methods were presented to the government and have been accepted. Specific recommendations have been made to reduce the quantum of fake notes in circulation.

Abhijit Gupta, Amitava Bandyopadhyay, Ranjan Sett, Dipak Manna and Arup K Das

SQC and OR Unit, Delhi

Mathematical Programming, Linear Complementarity Problem (LCP) and its generalizations, Optimization problem in graph theory, Matrix Theory (Study of Matrix Classes useful in Complementarity, Optimization and Game Theory), Non-cooperative games, Algorithms for Stochastic Games.

S.K. Neogy

Design of Experiments – Static Characteristics, Dynamic Characteristics and Categorical Characteristics in a multi response processes.

Rina Chakravorty

SQC and OR Unit, Bangalore

Development of Six-Sigma project selection guideline sector wise (manufacturing, service, health care, software, etc); Application of DMAIC methodology of Six-Sigma in the areas of incidence analysis, near-miss analysis; Development of relationship between the critical success factors (CSFs) and the business process parameters.

Sanjit Ray

Optimal censoring plans for life testing; Inference and optimum life testing plans under progressive Type-I interval censoring.

Gijo EV

Design and development of a methodology for controlling critical sub processes in software development life cycle to achieve software quality and reliability goals.

Boby John

Development of a methodology to study the main effects and pair wise interaction effects using minimum run two level designs.

BobyJohn and Ripunjoy Guhain

Text Analytics and its application in Quality Management

K.K. Chowdhury and Sourav Maji

SQC and OR Unit, Coimbatore

Textile Sector

Improving laborefficiency of operatorsin spinning using six sigma methodology; Process optimizationforhigherproductivityinspinning; Kaizen in recession period for textile industry; Institutionalizing the performance evaluation metrics in Quality Management System; Finding a method to reduce CV% through statistical diagnostics

A. Rajagopal

AutomobilesSector

Design Optimization in BoosterTandemMasterCylinder assembly; Reducing leadtime of PO Release in a valve manufacturer; Diagnose and Eliminate the Leakage Issues at PowerPlants; Identificationof Castingsdesign characteristics of involutesprofileof Turbine Housing.

A. Rajagopal

Software Sector

PlanningfortheIncidenceofAbends(Abnormalityofprogramcrash/errormessages) in SoftwareInsurance Domain; Reducing errors in names of patients in Multinational electronic medical record

A. Rajagopal

HealthCare Sector

Improvingtheconfidence level of patientsby minimizing diagnosticwaitingtimeat a hospital; Diagnostic and Statistical measures in sampling and testing of Duchenne Muscular Dystrophy (MDM); Reducing medication error in a multi specialty hospital

A. Rajagopal

SQC and OR Unit, Hyderabad

Areas of research: Statistical Modelling, Credit Risk Modelling, Linear Complementarity Problem, Decision Support Systems, Fixed Point Theorems in Fuzzy Metric Spaces, Six Sigma, DOE, SPC, Text Data Mining, Generalized Gaussian Distributions (GGD).

G.S.R. Murthy, A.L.N. Murthy, G. Murali Rao and S.M. Subhani

SQC and OR Unit, Pune

Six Sigma- Integration of approaches to synergies growth of an Organisation; Design for Six Sigma; Reliability and Data Analytics.

S. Rath

Library, Documentation and Information Sciences Division

The Library, Documentation and Information Science Division comprises

- Central Library, Kolkata
- ISI Delhi Centre Library, Delhi
- ISI Bangalore Centre Library, Bangalore
- ISI Chennai Centre Library, Chennai
- ISI North-East Centre Library, Tezpur
- Prasanta Chandra Mahalanobis Memorial Museum and Archives, Kolkata

The Division is perhaps the most important central facility of the Institute.

Research Activities

Central Library, Kolkata

The Central Library occupies a unique place in academic and research activities of the Institute. The Central Library moved to its present location in 1978, and it occupies 5 floors (60000sq.ft) of a ten-storied building at Calcutta. The Central Library seeks to:

- Meet the informational, educational, recreational, and cultural interests and needs of the user community by providing timely access to print and non-print resources appropriate to those needs.
- Encourage and facilitate reading, literacy and lifelong learning by supplying resources in a variety of formats designed to interest, inform, and enlighten.
- Protect the public's right to know by providing equal access to information needed for informed and effective daily living, decision making, problem solving and thoughtful participation in civic/community affairs.
- Provide the highest quality service and to organize and display the collection for easy, open access by all.
- Maintain publication exchange programme of the Institute with regional, international, national, and foreign institutions and organizations.
- Continue to function as the Eastern Regional Library of the National Board of Higher Mathematics [NBHM], Department of Atomic Energy, Government of India since 1989.

Over the years, the ISI Central Library has attained the distinction of being one of the richest libraries in India in the areas of mathematics, statistics, economics, theoretical computer science and related areas. To achieve the goals of the Library, following activities were undertaken during the year under report:

Professor Bimal Kumar Roy, Director inaugurated the Centre for Research on Micro Census Data at 4th floor of the Central Library on 10 March 2015.

Collection Development

The Library maintains an excellent collection of books, journals, reports, rare and special collection, government publications, data-books, theses and other documents/ materials in print and electronic formats. During the year under report, the library accessioned 1047 books purchased from ISI budget and 119 books were received on complimentary basis. 3 CD and 23 theses were added during the period. Added 22 book to the project collection. The Library also accessioned more than 2000 bound volumes of journals and subscribed to 550 scholarly journal titles in print. More than 52 journal titles were received as complimentary and 97 titles in exchange with Sankhya. The library received and processed more than 4000 loose issues of journals. It classified and catalogued 1500 new books etc.. It also processed 45 titles on government reports/data-books etc. more. Beside this, the library has added a collection of 60+ books, mainly in English, Bengali and Hindi on literature, humanities, travel, health and recreation in its Statistical Workers' Circulating Library. In addition to this, the library has about 32000 reprints.

E-Resources

The library has a good collection of electronic resources on different media and has access to several online journals/databases. During the year under report, the library has added 1 subscription based eBook database containing more than 120000 ebooks, a few CD/DVD on statistical data. The library has provided the online access to about 2500+ full-text journals. It has renewed the online database like MathSciNet, ScienceDirect, and Springer Link through consortia. It has also subscribed to the IEL online of the IEEE/IEE publications, ACM Digital Library and Current Index to Statistics (CIS) on Web. The library has also subscribed to few statistical data sources available on CDs. Central have added Online Journal Archives: Mathematics and Statistics of Springer-Verlag and Taylor and Francis.

Publications Exchange Programme

The library maintains the publication exchange programme of 'Sankhya - the Indian Journal of Statistics' with 57 national and 23 international institutions/organizations. The 23 international agencies are from various countries of the world such as Bangladesh, Belgium, Brazil, Canada, China, Taiwan, Croatia, Czech Republic, Denmark, France, Hungary, Italy, Japan, Pakistan, Poland, Romania, Russia, Slovakia, Spain, Switzerland, Thailand, UK, and USA. In exchange Library has received 97 titles during the reporting period.

Membership

Membership of the ISI-Library is restricted to persons with post-graduate or equivalent academic qualification, interested in the objectives of the Institute. Faculty members, research scholars, students, research associates, visiting scientists, ISEC trainees, project-linked staff, project assistants, ISI-employees, outside students and the Institute members are eligible for the membership of the Institute Library. However, they have to apply for the membership of the library and receive a bar-coded Library Card. During this period, library membership was given to 278 persons and 965 readers were given special permission to use the library for a short period.

Services

The ISI-Library, since its inception has been providing a variety of library and information services to its users. The services presently being provided include:

Web-OPAC: Members use this facility to browse and search the database to see the status of a document including their own transactions.

Document Delivery Service: About 50000 books and other documents were issued to the user on loan and reference. Publications from Government of India and other International Organization and data CDs, were issued to users for reference purpose. Provided 3000 pages of reprints and 20000 soft copies from different full text database /journals. It provided email-based reminder services like 7-day advance alert, long overdue notice and check-in information. 14500 books were circulated from the workers' circulating library.

Inter-library loan: 20 Books and journals were borrowed from other libraries, while 93 books and journals were lent to other libraries.

Current Awareness Service: 12 monthly lists of current additions to the library were made available online.

Self-Photocopying Service: The library provided the Self-photocopying service in its periodical section, which was available everyday throughout the library hours. During this period 12000 pages were photocopied from the journals.

Preservation: 10 books were laminated and 173 books were fumigated.

Electronic Document Delivery Service: Full-text articles and/or bibliographical data were provided through email from online resources. Besides electronic document delivery, 12000 pages of printouts were also supplied against demand.

Online Full-Text Access to Journals/ Database: During the period under review, the library has provided services from more than 2500+ online journals and major databases like MathSciNet, Econlit, ScienceDirect, Springer Link, IEL Online (IEEE/IEE Electronic Library), ACM Digital Library, CIS on WEB, OUP journal online consortia: JSTOR (Life science). The online access is available through campus-wide network.

Research Activities

1. Euclid Prime <http://www.projecteuclid.org/>
Euclid Prime is a growing collection of high-impact, peer-reviewed titles in theoretical and applied mathematics and statistics hosted by Project Euclid. Euclid Prime also includes complimentary access to archival content of certain journals. The restricted portion of this content (content published in the last 5 years) is only available to current Prime subscribers.
2. Project Muse: Social Sciences Collection http://muse.jhu.edu/browse/social_sciences
Project MUSE is a unique collaboration between libraries and publishers providing full-text, affordable and user-friendly online access to high quality humanities, arts and social science journals from scholarly publishers.
3. EconLit with Full Text <http://search.ebascohost.com>
It is the World's foremost full-text source of references to Economic Literature. This database contains all of the indexing available in EconLit in addition to full text for hundreds of journals including the American Economic Association journals with no embargo (American Economic Review, Journal of Economic Literature, and Journal of Economic Perspectives). This database also contains many non-English full-text journals in economics & finance and volume and issue browsing is available for all full-text journals.
4. IEEE Xplore Digital Library <http://ieeexplore.ieee.org/Xplore/home.jsp>
The IEEE Xplore digital library is a powerful resource for discovery and access to scientific and technical content published by the IEEE (Institute of Electrical and Electronics Engineers) and its publishing partners. The content in IEEE Xplore comprises over 160 journals, over 1,200 conference proceedings, more than 3,800 technical standards, over 1,000 eBooks and over 300 educational courses. Approximately 25,000 new documents are added to IEEE Xplore each month.
5. ACM Digital Library <http://dl.acm.org/>
The ACM Digital Library (DL) is the most comprehensive collection of full-text articles and bibliographic records in existence today covering the fields of computing and information technology. The full-text database includes the complete collection of ACM's publications, including journals, conference proceedings, magazines, newsletters, and multimedia titles. In addition to the full-text database, the *ACM Digital Library* is heavily integrated with and includes unrestricted access to the Guide to Computing Literature bibliography.
6. EBSCO eBook Academic Subscription Collection <http://search.ebscohost.com>
The EBSCO eBook Academic Subscription Collection offers cross-searchable access to a multidisciplinary library of over 126,000 high qualities, unlimited user ebooks from over 450 publishers. New titles are added monthly at no extra charge. Access is via EBSCOhost which offers sophisticated yet intuitive functionality, and a wide range of customisation options, to support the needs of the widest possible range of users. A mobile interface is also available.

Archive

7. JSTOR <http://www.jstor.org>
JSTOR is a digital library of academic journals, books, and primary sources. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations.

Secondary Databases

8. MathSciNet <http://www.ams.org/mathscinet>

It is an electronic publication offering access to a carefully maintained and easily searchable database of reviews, abstracts and bibliographic information for much of the mathematical sciences literature. Over 100,000 new items are added each year, most of them classified according to the Mathematics Subject Classification.

9. Current Index to Statistics <https://www.statindex.org/CIS/psqlQuery>
The **Current Index to Statistics** is a bibliographic index to publications in statistics, probability, and related fields. The on-line **CIS Extended Database (CIS-ED)** indexes the entire contents of over 160 "core journals", in most cases from 1975 (or first issue if later) to the current end year, and pre-1975 coverage for some, selected articles with statistical content since 1975 from about 1200 additional journals (cumulatively) in related fields, and about 11,000 books in statistics published since 1975.

Numerical Databases

10. Indiastat.com <http://www.indiastat.com>
Indiastat.com is a cluster of 57 sites including India-specific, Sector specific, Region specific and State specific sites rendering its dedicated services to the research fraternity from academic, professional and corporate world with authentic and comprehensive compilation of secondary level socio-economic statistical data about India and its states, Region and Sector on more than 35 variables.
11. Economic Outlook-CMIE <http://economicoutlook.cmie.com>
The Economic Outlook provides CMIE's view on where the Indian economy stands and where it is likely headed. This view is derived from a careful and continuous monitoring of all new data releases. New data releases are analysed in real-time in the context of the historical trends and in the context of other current data releases. Economic Outlook therefore provides a comprehensive and integrated view of the Indian economy.
12. State of India-CMIE <http://statesofindia.cmie.com/>
States of India is a comprehensive compilation of state-level statistics. The data is sourced from each of the 23 major states and 12 minor states or union territories. The central agencies provide most of the state level data, while district statistics are released by different agencies of the states. CMIE's own monitoring information generates a lot of state-level data. CMIE compiles all of these from different sources and weaves them into one cohesive and seamless offering.
13. India Premium Database-CEIC Data <http://webcdm.ceicdata.com>
MACROECONOMIC AND INDUSTRY-SPECIFIC TIME SERIES DATA FOR INDIA. The CEIC India Premium Database is one of CEIC's standalone BRIIC country databases, delivering a wide range of macroeconomic and industry-specific time series data for India. The database covers over 163,000 time series with historical data from as early as 1951 and offers a wide range of dataset frequencies, from daily to annual. CEIC's India Premium Database classifies time series into 15 macroeconomic sectors and 13 industrial sectors, enabling both a macro-perspective of the Indian economy and sector-specific analysis for a comprehensive set of industries.
14. Global 130 Country Database <http://webcdm.ceicdata.com>
Coverage on 130 countries. This database is unique with respect to having official data from local country sources as well as key indicators from World Bank and IMF.
15. Daily Database <http://webcdm.ceicdata.com>
High frequency data covering interest rates, inflation, deposit rates, exchange rate, swap rates, monetary etc.

Research Activities

16. Sector Database <http://webcdm.ceicdata.com>

It is a unique database covering top 10 companies and their financials for Asian and non-Asian countries covering 15 key sectors

Central has added Online Journal Archives: Mathematics and Statistics of Springer-Verlag and Taylor and Francis. EBSCO Academic Book Collection is also available for access.

Plagiarism: Central Library, Indian Statistical Institute is subscribing iThenticate services. iThenticate is plagiarism detection software that is designed to be used by researchers to screen written work for originality. The service allows researchers to easily upload and scan documents, manuscripts, research and other professional works into iThenticate which compares the work against 14 billion web pages and 110 million content items from leading academic publications. Utilization of iThenticate prior to publications is optional, but highly encouraged.

If you want to access it, please send your request to library@isical.ac.in. For instructions, visit <http://www.ithenticate.com/products/faqs>

Remote access to ISICAL licensed E-Journals & Databases: Faculty members and research scholars of the Institute can now access most of our electronic resources when they are away from the campus/country. In order to avail this facility, one should use his/her isical.ac.in email id as user name. For details, contact library@isical.ac.in

Reprographic & Photographic Service: During this period the Repro-Photo Unit has carried out its regular works of photocopying of more than 674800, graphic designing of more than 800 scientific projects and other works like color print, lamination, spiral binding, photo coverage, development of photo albums etc. Besides these regular works the Unit has developed the Digital Photo Archive of ISI. It has digitized all very rare photographs of ISI since its inception. Works relating to photo resizing, photo restoration, image processing through software, identification, tagging of the large collection of photos are in process. The Unit has also developed a digital archival repository comprising of ISI's old documents like ISI council proceedings, library's accession register, administrative documents, old letters of ISI's distinguished persons etc. that are preserved in microfilm.

General Enquiry Assistance & Consultation Service: Assistance extended to 251 external visitors including participants of the Winter School, NBHM Nurture Programme, Summer Research School and visiting students of different institutions.

Special Initiatives

Consortia arrangements: During the reporting year, the Library has further strengthened the consortia initiative to enhance the electronic collection and online access to scholarly resources to cope up with the increasing subscription cost and diminishing budget.

Preservation and conservation: Completed binding of more than 900 physical volumes of journals. Lamination and de-acidification of 6 rare books of 1000 pages were completed, fumigated 10 books, and photocopied rare and out-of-print books.

Institutional Repository (IR): A prototype of IR of ISI has been created. Currently it covers scientific writings of Professor P.C. Mahalanobis, full-text of 3000+ ISI research papers, full text of all convocation addresses, ISI Annual Report from 1933 to 2008 and 300 Ph. D theses.

Digitization: 15 theses were digitized. These will be made available on the Web after the completion of the work.

Library, Delhi

About the Library

The Indian Statistical Institute, Delhi Centre, maintains an academic Library, which aims to be a leading Library in the fields of Economics, Mathematics, Statistics, Operations Research and Statistical Quality Control. The Library caters mainly to the needs of bonafide students, scholars and staff of the Institute. However, it is also open for reference to academic and research users of other educational and scientific institutions of the city and its neighboring regions. It is one of the modern Library with an extensive collection of books, journals, CDs, reports, government publications and other documents in print and electronic formats. The ISI Delhi Centre Library also act as one of the NBHM regional Library of northern India and provides information resources to support academic and research activities in the areas of Mathematics, and allied subject ares. Some of the main activities of the Library during the period under review were as under:

Collection Development

Books: The Library accessioned 231 new books and 22 bound volumes during the year under report from the ISI and NBHM funds. The Library also received 96 books as gift from different sources. Thus raising the current Library stock both books and bound journals to 50,794 volumes.

Journals: During the period under review 286 journals, both foreign as well as Indian have been renewed. 22 journals on gratis and 10 journals in exchange are being received in the Library from various sources.

Online Resources: The Library also participated consortia based subscription to electronic resources and provided users more than 800 fulltext electronic journals access including EconLit, SIAM journals, Current Index to Statistics, MathSciNet, IAOR, Science@Direct, SpringerLink, J-STOR, Oxford Journals, Taylor & Francis, IEEE, INFORMS, AMS, IMS, Sankhya and many others.

CDs: The Library has more than 600 CDs of different reference books, journals and databases.

Exchange Programme

Exchange program established with seven scientific institutions in the regions of China, Korea, Netherlands, Poland, Spain and Vietnam for getting their publications in exchange to our journal 'Sankhya'- Indian Journal of Statistics and "Texts and Readings in Mathematics".

Library Services

1. **Circulation services:** During the period April 1st 2015 to March 31st 2016, total 175 members, availed the lending facilities as permanent members of the Library, whereas more than 475 users availed reference facilities of the Library. More than 3975 publications have been circulated among the members.
2. **Reprographic services:** During the period under review more than 7101 pages have been Xeroxed and made available to users of the Library and outsiders. Xerox facilities were also provided to research scholars of neighboring institutes under NBHM programme.
3. **Electronic document delivery service:** In addition to Xerox facilities, more than 2710 fulltext articles (PDF files) were provided to the users.
4. **Current awareness service:** The following lists were brought out regularly from the Library:
 - a) Monthly list of current periodicals
 - b) New additions of books

Research Activities

5. **Web-OPAC Facility:** The Library Web Online Public Access Catalogue can be accessed on Intranet and Internet. Users can search all bibliographic records that are available in the Library through a web-based search interface (Web-OPAC).
6. **Web Enable Library Services:** The Library web site contains information about the Library, its collection, services, rules, list of journals, catalogues, databases, telephone directories, and online requisition forms etc. The contents of Library web pages are regularly updated to serve the internal and external needs of users.
7. **Wi-Fi/Internet Browsing Facility:** The Library is connected to Internet & Wi-Fi. Internet browsing service is providing to students and users.
8. **Extended Hours Library Service:** As per the demand of students, reading and internet browsing facility were provided on the Library extended hours i.e. 6:00 p.m. to 9:00 p.m. on working days.

Other Physical facilities

Locker facility

The Library provided Lockers facility for students/scholars to keep their personal belongings in the Library hours.

Union Catalogue of Serials

The Indian Statistical Institute Delhi Centre Library has developed this Union Catalogue of Serials database with a view to promote the new improved access to journal holdings among the users. The database stored the serial holdings information of 3 ISI Libraries i.e. Kolkata, Delhi and Bangalore. The tool provides a web based central access point to all print and electronic journal holdings information and can be search under Journal title, Keywords, ISSN, Item types, Alphabetical browse (A-Z) or even Library wise serial holdings.

Library, Bangalore

Indian Statistical Institute Bangalore Centre Library is aiming to be identified as a model library in the Indian academic scenario. The Library is providing many modern library services using internet and they are popularly known as web based information services. ISI Bangalore Centre Library has also initiated interactive applications for its users. The library has developed a very distinguished collection in different knowledge domains such as Mathematics, Statistics, Systems Science, Information Sci, Economics, Quality Management & Operations Research, Library & Information Science, Computation & Artificial Intelligence and so on. Various services are designed to meet the information needs of the faculty members, students, research scholars and visiting scientists. Walk-in users from the other institutions are also permitted to use the library. The following activities were undertaken by the library during the period October 2015 – March 2016.

Collection Development

The library purchased 104 Books, received 139 Books as gift during this period. The library subscribed to 352 Journal titles, 16 journal titles were subscribed from NBHM grants. Additionally, library has subscribed to IEL ONLINE, giving access to journal and technical reports published by IEEE. The Library has 39 E-Books from world scientific publishing.

Library Collection

Total no of Books are 30,297 and Bound Volumes are 18595.

Membership

More than 184 registered users enjoyed the library facilities and the services during the year. In addition, facilities were extended to around 660 walk-in users during this period.

Current Content Service: Content pages of around 900 journals have been scanned.

Circulation Service: Around 4093 books and 360 journals were circulated during this period. 120 loose issues of journals were issued to users overnight.

Inter-library Loan Service

Due to good liaison amongst the local libraries, the library has been involving itself in providing inter-library loan service.

Document Delivery Service: Under this service around 600 documents in pdf format were downloaded and supplied to the registered users.

Reprographic Service: During this period 12718 photo copies were supplied to the library users.

Web based Library Services: The library has devised various services using World Wide Web. They are all accessible at <http://www.isibang.ac.in/library>. Full text online journals were accessed through this website. The library also provides access to various Abstracting and Indexing services.

Library, Chennai

Academic Library for Indian Statistical Institute Chennai Centre (ISIC) was started in 2011 to cater to the information needs, adding to the existing library of SQC & OR unit, at Taramani. This evolving library aims to a vibrant collection in the fields of Statistics, Applied Statistics, Mathematics, Computer Science, Statistical Quality Control and Operation Research making it prototypical in functioning, administration and unique in collection. Various services are provided for an efficient usage of library facilities by the students, faculty members, visiting scientists and research scholars. Researchers from other institutions are offered reference service.

Collection Development

The Library maintains an excellent collection of books, journals, magazines, question papers, multimedia resources etc. During April 2015 – March 2016, 410 books were added raising the collection to 3398 books. Around 16 International online journals and 16 magazines were subscribed.

Technical Processing

Around 450 books were classified during the period April 2015 – March 2016. Database entry in KOHA Library Automation software were updated in Z39.50 Standard bibliographic format for all the books. Web OPAC with accessibility and users' details were updated in the library database. Other services like Inter-Library Loan, content service, reprography service and document delivery service are initiated.

Web based library services

It has remote access to more than 2000 e-journals accessible through ISI Kolkata Library procured under ISI Consortia.

Membership

ISIC library has restricted access to postgraduate students, research scholars, faculty members and visiting scientists totaling to around 35. Institutional Membership were renewed with Indian Institute of Technology, Madras (IITM) and Interlibrary Loan with other ISI Centers and Units were activated.

Research Activities

Library Services

Lending and document delivery service: Around 600 documents were delivered during the period April 2015 – March 2016, showing the active participation of the users. Automation of library with full setup of RFID was fully completed. Database was completed for ISI Chennai Centre Library, Taramani, SQC&OR Unit Library, Aminjikarai and ISI Chennai Centre Hostel library totaling to 5600 books. Full automation of library was completed.

Library, Tezpur

ISINE Library has started functioning from July, 2011. The library aims to provide quality service to its users by developing quality documents in the field of Statistics and Mathematics. The library has limited collection in the fields of Computer Science, Soil Science, Geography and Library Science. The library has also started to procure books. The library has installed the software Koha in the year 2013 all the circulation works done through it. In October, 2015 ISINE Library has upgraded its koha version from 3.02 to 3.20.

Collection Development

In order to cater the requirements of the user, the library has procured 314 books in different fields during the 2015-16 session. Total Books accessioned 2573. The ISINE Library has subscribed 18 Indian and foreign journals and 4 Newspapers and 2 magazines in this period from Globe Publication.

Membership

The main users of this library are the students, scholars and faculty members of the institute. Total number of members is 20.

Library Services

Circulation Service: Around 350 books were circulated in this period.

Technical Processing: All the purchased books are technically processed.

Web Opac: Library members use this facility to browse and search the database of the library and check the status of documents including their own transactions.

Document Delivery Service: Around 50 documents in pdf format were downloaded and provided against demand.

Web Based Service: Library has remote access to e journals from ISI Kolkata general access.

Prasanta Chandra Mahalanobis Memorial Museum and Archives

The Museum and Archives carried out regular up keeping programme for 752 exhibits through 91 panels and a collection of artifacts related to Professor. Mahalanobis displayed in the ground floor, chatal, and Professor's residence along with the pest control programme for the whole building of Amrapali. Among other programmes a new project on 'Arrangement and description of archival collection of P.C. Mahalanobis Memorial Museum & Archives' with three year duration has been initiated from the month of July to continue the development of archival record management system. Under the project over 2,500 photographic documents and above six hundred letters, manuscripts etc. has been identified, sorted and listed.

The work of the proposed new gallery on Rabindranath Tagore and Prasanta Chandra has nearly been completed with two interactive kiosks. One is with facilities for visually impaired persons. Contributed in the exhibition on 'Statistics At Work', inaugurated on 30th June, 2014 organized by Birla Industrial and Technological Museum on the occasion of 'Statistics Day' of India. A customized browser based cross platform software has been developed through agency to develop the reader and researcher area comprising their activities, data sharing policy, cataloguing and integration of xml and parsed PDF files and also to develop extended administrative area for creation of entity like network user and creation/modification of accession register, PDF security and stamp/watermark implementation to showcase the archival metadata with proper retrieval procedure maintaining the standard of existing archival system.

Center for Soft Computing Research: A National Facility, Kolkata

Moving Object Segmentation from Video Images

Automatic analysis of digital video sequences for surveillance requires segmentation of regions of interest (ROI) from the background scene (i.e., background subtraction) based on motion characteristics present in video. Most related techniques operate in the pixel-domain using a fully decoded/uncompressed information about each pixel. However, most digital video sequences today are stored/transmitted in compressed form such as MPEG-x, H.264, and HEVC, which require a significant decoding overhead prior to the application of pixel-based approaches. In order to reduce computation, we propose feature extraction methods utilizing information already available in various coded forms. We have shown our method to be competitive in terms of segmentation performance while maintaining a high processing speed in case of H.264 (both Baseline and High profile) and High Efficiency Video Coding (HEVC) standards.

B. Dey and M.K. Kundu

Rough Sets in Video Tracking

Moving object detection and tracking from video sequences have been an important task in computer vision. There are several approaches to solve it, e.g.: based on some prior knowledge, based on background estimation. Our aim is developing different methodologies and algorithms demonstrating applications of granular computing and rough sets to unsupervised video tracking. The tasks that are considered include unsupervised video tracking, occlusion/ overlap handling, and providing quantitative measures for performance evaluation. Rough sets, rough-fuzzy sets, neighborhood rough sets, flow graph are used, among others, as paradigms for dealing with uncertainty. The concepts of 3-D granules, spatio-temporal neighborhood granules, granular rough rule-base, rough flow graph, neighborhood rough filter, neighborhood rough entropy are introduced over videos to make the processing faster and more accurate. The new hybridized tools are proven to be more effective in dealing uncertainties over the existing ones. Gray, Color or R-G-B and R-G-B-D video sequences are used as input data.

D. Chakraborty and S.K. Pal

Regional covariance based appearance model for object tracking

A regional covariance based appearance model is proposed for tracking of moving objects in complex scenario. The main motivation of this algorithm is to capture local features of the object that is invariant to sudden illumination changes, in plane rotation of object during occlusion, occlusion of the object by other similar object(s), noise and partial camouflage. To achieve this goal, we divide object into a number of patches/ regions where the number of patches is decided based on entropy optimization. The covariance matrix based appearance model is constructed for each patch which in turn is used for matching the object in subsequent frames. The optimized match is achieved by minimizing total sum of the generalized eigen values of the corresponding pairs of covariance matrices of each patch for describing the object in the target and the target candidate frame. The appearance

Research Activities

model is updated using the average of covariance matrices of the patches of the target frame except during full occlusion.

S.J. Choudhury and A. Ghosh

Gibbs–Markov random field for detecting moving objects

A moving objects detection scheme is proposed using Gibbs–Markov random field (GMRF) and Hopfield-type neural network (HTNN) in expectation maximization (EM) framework for video sequences captured by static camera. In the considered technique, the background model is built by considering a running Gaussian average over few past frames. The change vector analysis (CVA) scheme is followed on the considered target frame and the constructed reference frame to generate a difference image. The moving objects in target frame are detected by segmenting the difference image into two classes: changed and unchanged, where the changed class represents moving object regions and the unchanged class the background regions. For segmentation, we have modeled the CVA generated difference image with GMRF and the segmentation problem is solved using the maximum *a posteriori* probability (MAP) estimation principle. The MAP estimator is found to be exponential in nature; and thus a modified HTNN is exploited for estimating the MAP. The parameters of the GMRF model are estimated using EM algorithm.

B.N. Subudhi and A. Ghosh

Remote Sensing Image Analysis

In conventional space, the limitation of parametric feature extraction for high dimensional problems is that if the within class covariance matrix is singular, then it will show poor performance for classification. In such cases, the spectral space of hyperspectral images is used for feature extraction. In Hyperspectral images, the neighbouring bands are generally strongly correlated. So these types of bands will give similar response in spectral space. Thus a supervised band extraction technique is proposed for extraction of the bands. Initially, the complete set of bands is partitioned into several highly correlated subgroups and then a linear transformation is performed using maximal margin criterion over each subgroup. Here, the drawbacks of Fisher's linear discriminant analysis based band extraction methods are addressed and a proposal is made to overcome it.

A. Datta and A. Ghosh

Domain adaptation using compressive sensing for land classification

A new strategy is proposed to perform domain adaptation using a compressive sensing (CS) approach for classifying images at large spatial scales (continental mapping). In particular, the “most confusing” training samples in the target domain are collected by exploiting plenty of training samples available in the source domain under the transfer learning framework. For assessing the proposed method, experiments are performed on three remotely sensed images captured by the Landsat 8 satellite in different regions of India.

A. Ghosh

Image Co-segmentation

Image Co-segmentation refers to simultaneous segmentation of similar regions from two (or more) images. An image co-segmentation technique using the dual active contour model is developed to extract meaningful common objects in different images. This method has an advantage that it can integrate global shape information, thus guides the contour into an appropriate shape. Thus, it reduces the misclassification of the regions in the images and extract out the common objects from the images more accurately.

S. Bandyopadhyay and A. Ghosh

Granular Computing

A new way of granular computing (information granules) using fuzzy-rough set based on fuzzy reflexive relation which are integrated with neural network technique, using multi layer perception back propagation algorithm based on gradient–descent method, to develop new granular neural network for classification of real life data sets. A fuzzy rough granular self organization map is also developed for clustering with various quantitative indices. A new notion to fuzzy rough set is proposed. The concepts of fuzzy rough set are employed in developing granular neural network for unsupervised feature selection. Based on the same concepts, a new fuzzy rough boundary is defined and is used in self-organizing map for clustering the gene expression data. Selection of genes is made with help of the resultant clusters.

A. Ganivada, S.S. Ray and S.K. Pal

Network Mining

Link prediction for evolving networks

An important problem for a social network analysis is to predict future links based on the structural information of the network. An online social network evolves over time. However, most of the available algorithms for link prediction are designed with static snapshots of networks. A study is being conducted to understand whether these methods are capable of predicting future links for an evolving network or not. The objective of the study is to develop methodologies which can predict future links for evolving networks more accurately. Data acquisition from different social network applications for the research is under way. The *fuzzy granular social network* which models the uncertainties of a network more appropriately as compared to graph will be used in the investigation.

S. Kundu and S.K. Pal

Understanding the Dynamics of User Interaction in Social Networks

Online social networks have an enormous impact on the lives of billions of people all over the world, as it provides the popular infrastructure of communication, interaction and information sharing in the internet. According to previous observations, the social links are not the valid indicators of user interactions. The aim of the proposed work is to design a proper user interaction graph, and deeper understanding of user interaction requiring formulation of generative model, which can capture the processes that drive users to different interaction events. The model is important for studying how the pairwise user interaction and social network evolve together. Such a model not only enhances our understanding of social network, but it would also be useful for providing advanced social applications, and prediction of the future aspects of network and marketing of products and service.

A. Kundu and S.K. Pal

Bio-informatics

micro RNA Analysis

A fuzzy mutual information based miRNA selection (FMIMS) methodology is developed which automatically selects the most relevant miRNAs for a particular type of cancer. MiRNAs are initially grouped by using an SVM based algorithm; then the group with highest relevance is determined and the miRNAs in that group are finally ranked and selected according to their redundancy. While 12 out of 15 selected miRNAs corroborate with those of biological investigations, three of them are possible novel predictions by FMIMS.

J.K. Pal, S.S. Ray and S.K. Pal

Quantum Inspired Evolutionary Computing

Quantum computing is a novel computing paradigm which explores quantum mechanical phenomena like superposition of states and entanglement to achieve significant speed advantage over classical

Research Activities

computer. Although a significant number of quantum algorithms are already proposed, a functional quantum computer is yet to be developed. To leverage the advantage of quantum computing in a classical computer, quantum inspired versions of conventional algorithms are derived. Quantum inspired evolutionary computing is a new class of heuristics drawing their inspiration from both biological evolution and unitary evolution of quantum system. Research in this field is motivated to solve problems faced by conventional evolutionary algorithms like slow convergence and local optimization, and reducing the time complexity through incorporation of the quantum parallelism concept. Certain issues in this direction are being investigated in the initial phase which includes optimum initialization and dynamic adjustment of the parameters of quantum inspired evolutionary algorithms.

S. Das and S.K. Pal

Cognitive Vision

We propose that the Magno (M)-channel filter, belonging to the extended classical receptive field (ECRF) model, provides us with “vision at a glance”, by performing smoothing with edge preservation. We compare the performance of the M-channel filter with the well-known bilateral filter in achieving such “vision at a glance” which is akin to image pre-processing in the computer vision domain. We find that at higher noise levels, the M-channel filter performs better than the bilateral filter in terms of reducing noise while preserving edge details. The M-channel filter is also significantly simpler and therefore faster than the bilateral filter. Overall, the M-channel filter enables us to model, simulate and arrive at a better understanding of some of the initial mechanisms in visual pathway, while simultaneously providing a fast, biologically inspired algorithm for digital image pre-processing.

K. Ghosh

Computing With Words (CWW) and Artificial General Intelligence (AGI)

Envisioning the role of CWW in natural language understanding, our study on Z-number based CWW highlighted its capability of subjective semantic-summarization of a sentence; operators and procedures for these mechanisms were formulated as well. This study led to the design of a methodology based on Shannon’s and Bayes’ theorems for text granulation and extraction of context-sensitive relevant sentences for faster processing. The results of these investigations have now been assimilated into the conceptualization of a cognitive machine-mind framework for natural language comprehension, and extension of the Z-numbers (the Z*-numbers) into perceptual symbols for enhanced subjectivity-encapsulation of the real-world. We are currently investigating the role of the Z*-numbers in endogenous thought-production in the framework. Our work is envisioned to support man-machine symbiosis.

R. Banerjee and S.K. Pal

Climateinformatics

Machine learning perspectives in atmospheric science are presently investigated to have further understanding of extreme weather events over Indian region. In the present study, a random forest based algorithm with K-means clustering technique is utilized to model the lightning behavior of different regions of Indian subcontinent and assessing the sensitivity of different atmospheric parameters in controlling the lightning. A random forest based short term forecasting model of heavy precipitation over Kolkata is also developed. The result highlights the important role of boundary layer meteorology in heavy precipitation events and the strong topographic and seasonal dependence of the lightning activity on various atmospheric parameters. In particular, the finding points to the crucial role of human activity on modulating the lightning features over Indian region.

S. Das

Computer and Statistical Services Centre, Kolkata

The IT infrastructures of the Institute have been updated/ developed by the CSSC. The Giridhi Unit of the Institute was connected to CSSC by 10 mbps Point to Point connection managed by the CSSC. The outlying Centres (Delhi, Chennai, Tezpur and Bengaluru) of the Institute were connected with Site-to-Site VPN (Virtual Private Network). The IT infrastructure of the Institute including server's virtualization (cloud), software (Vmware (esxi and Vcenter), Matlab, Mathematica, ArcGis, R etc), Network (wired and wifi), Network and Internet security, IP Telephones, Video conferencing facility, e-library and internet facilities (NKN - 1 gbps) were managed by the CSSC and used by all the Centers of the Institute as a LAN. The meetings including Academic Council meetings among the Institute's Centers (Delhi, Bengaluru, Chennai and Tezpur) and Giridhi Unit through Video conferencing facilities were managed by the CSSC. The cloud infrastructure with virtualization software, Cisco UCS servers (304 cores/608 threads) and the EMC 260 TB storage were installed in the CSSC, providing the computing facility to the users of the Institute. The classes (M.Tech. in Computer Science and PGDA of ISI Tezpur) through video conferencing facilities were organized by the CSSC throughout the year. The CSSC arranged to provide Laptops and Desktops to the faculties, scientific staff and research scholars of the Institute. The CSSC also arranged to provide technical support to the Institute by Computer Trainees trained by the CSSC.

CSSC provided statistical and numerical consultancy services to scientists and research scholars, including non-ISI scientists. Members of CSSC took part in teaching different courses of the Institute and also supervised project work of non-ISI students studying MCA, B.Tech. etc. In addition, it organized the following activities.

- i **Regular course of M. Tech and B.Stat.:** Lab class on MySql and PHP
- ii **Regular Course of PGDCA ISI, Giridih:** Teaching several Courses of Semester I and II
- iii **Staff Training Program:** Under Professional Training & Development Scheme of ISI throughout of the year.

3. PROJECTS

Internally Funded Projects

Ongoing Projects

Sl. no.	Name of the project	Principal Investigator(s)	Unit(s) involved
Theoretical Statistics and Mathematics Division			
1.	ISI Lectures on Probability	Antar Bandyopadhyay & Krishanu Maulik	Stat-Math Unit, Delhi & Kolkata
2.	Advances in Non Commutative Mathematics (ANCM)	B.V. Rajarama Bhat	Stat-Math Unit, Bangalore
Applied Statistics Division			
1.	Understanding the classification of various protein families and protein–protein interaction networks	Pabitra Pal Choudhury	ASU, Kolkata
Computer and Communication Sciences Division			
1.	Logic Synthesis for Quantum Computing	Susmita Sur-Kolay	ACMU
2.	Localizability Testing for Wireless Sensor Networks	Krishnendu Mukhopadhyaya	ACMU
3.	Voronoi Game	Sandip Das	ACMU
4.	Massive Data Algorithms	Subhas C. Nandy	ACMU
5.	Visibility with diffuse reflections: bounds and algorithms	Arijit Bishnu	ACMU
6.	Intelligent Transportation System	B.P. Sinha	ACMU
7.	GP-GPU Computing for Large Scale Networks	Nabanita Das	ACMU
8.	A framework for Collaborative Application Execution for Mobile cloud Computing	A. Banerjee	ACMU
9.	Holy Grail of Error-Resilient Bio-Assay on a Lab-on-a-chip	B.B. Bhattacharya	ACMU
10.	The QoS improvement through internetworking of WLAN and UMTS networks	S.C. Ghosh	ACMU
11.	Administrative Document Analysis	T. Pal	CVPR
12.	Development of Methodologies Towards Robust Reading of Old Degraded Bangla Printed Documents	S.K. Parui	CVPR
13.	Separation of information streams in face image processing	G. Chatterjee	CVPR
14.	Video Text Understanding	U. Pal	CVPR
15.	South Asian Face database	G. Chatterjee	CVPR
16.	Unsupervised algorithms for deriving insights from text data and building intelligent query suggestion systems	D. Majumdar	CVPR

17.	User Adaptive Online Handwriting Recognition	U. Bhattacharya	CVPR
18.	Algorithms for blind quality assessment of images, tamper detection and correction.	S. Palit	CVPR
19.	Biomedical Natural Language Processing	U. Garain	CVPR
20.	Biometric System Design using Bio-hashing Approach	B. Chanda	ECSU
21.	Development of Nature Inspired Metaheuristics for Large Scale Engineering Optimization in Dynamic Environments	S. Das	ECSU
22.	Video Scene Segmentation and Classification	P.P. Mohanta	ECSU
23.	Eulerian Magnification of Video of Biomedical Interest	D.P. Mukherjee	ECSU
24.	Computational Intelligence approaches for finding Synergy Networks from Gene Expression Data	N.R. Pal	ECSU
25.	Secured Query Processing for Semantic Web Applications	P. Pal	ECSU
26.	Non-monotonic Reasoning using Disposition: An Approach to Common Sense Reasoning	K.S. Ray	ECSU
27.	Integrating CT Images with Gene Expressions using Soft Computing	S. Mitra	MIU
28.	Development of Rough Set Based Approaches for Identification of Co-Expressed miRNAs	P. Maji	MIU
29.	Tracking of moving Objects from Video Scene using Pattern Classifiers	A. Ghosh	MIU
30.	Indian Language Spoken Document Retrieval.	D.P. Mandal	MIU
31.	Computational Model of Brightness Perception in Images	K. Ghosh	MIU
32.	Binary code for the brain	Kaushik Majumdar	SSIU
33.	Strategic reasoning in a dynamic world	Sujata Ghosh	CSU
34.	Intersection representations for graphs	Mathew C. Francis	CSU
Physics and Earth Sciences Division			
1.	Numerical models of fluid flow in Cuddapah basin: Implication for Mineralization	Amlan Banerjee	GSU
2.	Field study of flow, salinity and sedimentation-erosion patterns in the Sundarban estuarine system	Chandan Chakraborty	GSU
3.	Sedimentology and stratigraphy of the Siwalik succession of eastern Himalaya and its bearing on the evolution of the Neogene foreland basin in the eastern Himalaya	Tapan Chakraborty	GSU
4.	Implications of biotic events present within the Mesozoic non-marine vertebrates of the Gondwana basins of peninsular India	D.P. Sengupta & S. Bandyopadhyay	GSU

Projects

5.	Study of Caenozoic molluscan diversity from western India with special emphasis on systematics, evolutionary trends and palaeoecological interactions	Shiladri S. Das	GSU
6.	Fault zones, fractals and crustal deformation in the Western Himalaya	Dilip Saha	GSU
7.	Sedimentological and geochemical characteristics of the Late Triassic – Middle Jurassic formations in a Gondwana succession of Pranhita-Godavari Valley Basin – clues for changes in depositional environment and palaeoclimate	Parthasarathi Ghosh	GSU
8.	Stratigraphic analysis of the Cuddapah, Bhima and Kaladgi successions: implications for Palaeoproterozoic to Neoproterozoic lithospheric dynamics	S. Patranabis-Deb	GSU
9.	A comprehensive study on vertebrate faunal assemblage of Jurassic Kota Formation, Pranhita-Godavari basin, India	Debarati Mukherjee	GSU
10.	Simulation of Hawking effect in analogue (fluid) gravity model	Subir Ghosh	PAMU
Biological Sciences Division			
1.	Competition or facilitation between two invasive plants?	A. Dewanji	AERU
2.	Generation of SSR marker in some mangroves from Sunderbans, India	S. Das	AERU
3.	A study on yield performance of Sweet Sorghum crop (<i>Sorghum bicolor</i> L.) at different location and fertility levels for maximization of bio-fuel production in West Bengal	S. Barik	AERU
4.	Fantastic yields in the system of rice intensification: fact or fallacy?	P. Banik	AERU
5.	Development of natural food preservatives from spices and herbs	R. Chattopadhyay	AERU
6.	Phytonematode problems of rice in Jharkhand: density, diversity and pathogenesis:	A. Mukherjee	AERU
7.	Biorational management of rice pests and diseases: evaluation of nanoparticle based and endophyte-mediated approaches	A. Mukherjee	AERU
8.	Study of soil carbon dynamics through integrated nutrient management in different agroecosystems of Assam	P. Bhattacharyya	AERU
9.	Parallel analysis of transport of contaminants in soil-plant systems in different soil types of eastern India: a sustainable approach	P. Bhattacharyya	AERU
10.	Surface Functionalized Porous Nanomaterial Loaded Micronutrient Fertilizers for Gangetic Alluvial Soils	A. Goswami	AERU
11.	SYL-MNS-CEA-ZAAL-BER/API nanocomposite drug for Mongpa tribe neonates: Innovation from anthropo-cultural knowledge base	A. Goswami	AERU

Projects

12.	Determination of functional response under selective predation through experimentation and modeling	J. Chattopadhyay & S. Bhattacharya	AERU
13.	Living with Age: An Investigation on the Urban Poor Elderly Women	S. Mukhopadhyay	BAU, Kolkata
14.	Health status and survival strategy of the tea garden labourers of locked tea gardens of Jalpaiguri district, West Bengal	S.K. Ray	BAU, Kolkata
15.	Identification of susceptible genetic variants associated with Coronary Artery Disease in the population of Andhra Pradesh, India	B.M. Reddy	BAU, Hyderabad
16.	Molecular Genetic Dimensions of Tribal Health in Andhra Pradesh: Complex Genetic Disorders in the background of urbanisation and changing lifestyles	B.M. Reddy	BAU, Hyderabad
17.	Identification of susceptible genetic variants associated with Coronary Artery Disease in the population of Andhra Pradesh, India	B.M. Reddy	BAU, Hyderabad
18.	Study of expression of OXPHOS related mitochondrial and nuclear genes from normal, leukoplakia and cancer tissues of oral cavity and importance in progression of disease	B. Roy	HGU
19.	Genetic Mapping of rare variants, multivariate and longitudinal phenotypes	S. Ghosh	HGU
20.	On integrating several data sources in genetic association study	I. Mukhopadhyay	HGU
21.	Role of epigenetics in psoriasis: Identification of DNA methylation biomarker	R. Chatterjee	HGU
22.	Identification of epigenetic biomarkers in the cell free nucleic acids of the Oral Potentially Malignant Disorder (OPMD) and Oral Squamous Cell Carcinoma (OSCC) patients from eastern India	R. Chatterjee	HGU
Social Sciences Division			
1.	Bayesian Incentive Compatible Mechanism Design	Souvik Roy	ERU
2.	Bangla Pronunciation Dictionary	Niladri Sekhar Dash	LRU
3.	Contribution of the unpaid family labour in the handloom sector of textile industry	Sonali Chakraborty	SRU & SOSU
4.	Where do private schools locate themselves	Abhiroop Mukhopadhyay, Pushkar Maitra (Monash University) & Soham Sahoo	EPU
5.	What drives career choice in urban India	Abhiroop Mukhopadhyay, Tarun Jain (ISB) & Nishith Prakash (U. Conn)	EPU
6.	Identity, Networks and Labor Productivity	Farzana Afridi, Amrita Dhillon (King's College) & Sherry Xin Li	EPU

Projects

		(University of Texas, Dallas)	
7.	Evaluating the Consumption Effect of Trade Liberalization	Bharat Ramaswami & Sutirtha Bandhopadhyay	EPU
8.	A field-experiment on labour productivity in an Indian garment factory	Farzana Afridi, Amrita Dhillon (Kings College) & Vegard Iversen (University of Manchester)	EPU
9.	Council Characteristics of Gram Panchayats and Local Public Good Provision	Bharat Ramaswami & Sabyasachi Das (Yale University)	EPU
10.	Gender and Labour: A Study of Coffee Industry of Karnataka	Molly Chattopadhyay	EAU
Statistical Quality Control and Operations Research Division			
1.	Development of Risk Analytics towards Multidisciplinary Big-Data Study of Humanitarian Logistics for Disaster Response [PPEC approved]	Prasun Das & M.Z. Anis	SQC & OR Unit, Kolkata
2.	Archiving / Digitisation of Reports/Documents	Somnath Ray	SQC & OR Unit, Bangalore
3.	Time Series Project	D. Sampangi Raman	SQC & OR Unit, Chennai
4.	Project with Government of Tamil Nadu to develop Index to Measure Cleanliness of Cities / Towns	Amit Biswas	SQC & OR Unit, Chennai & SQC & OR Unit, Kolkata
Library, Documentation and Information Sciences Division			
1.	Restitution, Indexing and Editing of Old Photographs of ISI for historical illustrations	Tapas Kumar Basu	Repro-Photo Unit, Library, Kolkata
2.	An Annotated Chronological History of Indian Statistical Institute	N. Ganguly	Repro-Photo Unit, Library, Kolkata
3.	Arrangements and descriptions of archival materials	Krishna Bhattacharyay	PCM Memorial Museum & Archives, Library, Kolkata

Completed Projects

Sl. No.	Name of the project	Principal Investigator(s)	Unit(s) involved
Theoretical Statistics and Mathematics Division			
1.	Workshop on operator Theory and operator Algebras	Jyotishman	Stat-Math

		Bhowmick	Unit, Delhi & Kolkata
Applied Statistics Division			
1.	Understanding genes and genomes through the Fractals and Mathematical Morphology	Pabitra Pal Choudhury	ASU, Kolkata
2.	Robust Speaker Identification	Smarajit Bose	ISRU
3.	Application of Classification Techniques in Content Based Image Retrieval	Amita Pal	ISRU
4.	An Interdisciplinary Study of the Arsenic Contamination Problem in Bengal Delta	Ayanendranath Basu	ISRU & GSU
5.	Mental Health Problems in Conflict Situation: A Pilot Study at Khordak Village, Loktak Lake Area, Manipur	H.S. Chungkham & H.S. Sharma	AOSU, Tezpur
Computer and Communication Sciences Division			
1.	The QoS improvement through internetworking of WALN and UMTS networks (HybridUMTS-WALN)	Sasthi C. Ghosh	ACMU
2.	Development of Computational Methods for Analyzing Biochemical Pathways as Integrated Systems	R.K. De	MIU
3.	Improving the Learning Methodologies in Text Mining	C.A. Murthy	MIU
4.	Network Analysis of Biomolecules for Disease Therapeutics	S. Bandyopadhyay	MIU
5.	Development of mathematical morphology based via cartograms	B.S. Daya Sagar	SSIU
Physics and Earth Sciences Division			
1.	Numerical models of Fluid flow in Cuddapah basin: Implication for Mineralization	Amlan Banerjee	GSU
2.	Sedimentology of the Triassic mud-dominant fluvial systems	Parthasarathi Ghosh	GSU
3.	A study of Neogene and Quaternary successions of eastern Himalayan foreland basin	Tapan Chakraborty	GSU
4.	Precision cosmology using combined dataset of CMB, lensing and SNIa	Supratik Pal	PAMU
5.	Spatially-averaged turbulent flow characteristics over a gravel-bed	Sankar Sarkar	PAMU
Biological Sciences Division			
1.	Allelopathy in an Aquatic and neighbouring Ecosystem and the role of allelochemicals in community structure	S. Mandal Biswas	AERU
2.	Health of Stone Quarry Workers of Birbhum District, West Bengal	S.K. Roy	BAU
3.	Eating Behaviors and Weight Concerns in Relation to Socio-economic and Psychosocial Factors among Urban Adolescent Girls	S. Mukhopadhyay	BAU

Projects

Social Sciences Division			
1.	Mechanism Design in Internet Economics	Souvik Roy	ERU
2.	Biaxial Study of Bangla Lexicosyntax	Probal Dasgupta	LRU
3.	Developmental Challenges in Children and Associated Socioeconomic Factors: A Study in the Purulia District of West Bengal	Partha De	PSU
4.	Direct & Indirect Role of Various Socio Economic & Demographic Factors, Health and Family Welfare	Prasanta Pathak	SOSU
5.	Persistence of Dowry in West Bengal	Prabal Roy Chowdhury, Shyama Lal Chowdhury (University of Sydney) & Indrani Roy Chowdhury (Jamia Millia Islamia)	EPU
6.	Women and Work in Rural India	Farzana Afridi, Abhiroop Mukhopadhyay, Kanika Mahajan (ISI, Delhi) & Taryn Dinkelmann (Dartmouth College)	EPU
7.	The Role of R & D in Firm Transformation	Farzana Afridi (ISI, Delhi), Susan Thomas (IGIDR) & Renuka Sane (ISI, Delhi)	EPU
8.	The Quantity – Quality Trade-off in Education Outcomes: Evidence from the Right to Education Act in India	Abhiroop Mukhopadhyay (ISI, Delhi), Nishith Prakash (University of Connecticut) & Elizabeth Kaletski (University of Connecticut)	EPU
Statistical Quality Control and Operations Research Division			
1.	Optimization and Reliability Modeling	Biswabrata Pradhan	SQC & OR Unit, Kolkata; Delhi & ASU, Kolkata
Library, Documentation and Information Sciences Division			
1.	Data creation for Official Statistics Collection	Bhomra Chatterjee	Library, Kolkata

Externally Funded Projects

Ongoing Projects

Sl. no.	Name of the project	Principal Investigator(s)	Unit(s) involved	Funded by
Theoretical Statistics and Mathematics Division				
1.	Non Commutative Geometry groups and non-Commutative probability	Debashish Goswami	Stat-Math Unit, Kolkata	DST
2.	J.C.Bose Fellowship	Arup Bose	Stat-Math Unit, Kolkata	DST
3.	Risk Analysis, Ruin and Extremes (RARE)	Krishanu Maulik & Parthanil Roy	Stat-Math Unit, Kolkata	Marie Curie Research Staff Exchange Fellowship from the 7 th European Community Framework Programme
4.	J.C. Bose Fellowship	R.B. Bapat	Stat-Math Unit, Delhi	DST, Govt. of India
5.	J.C. Bose Fellowship	Rajendra Bhatia	Stat-Math Unit, Delhi	DST, Govt. of India
6.	Diophantine Equations With Product of integers in Arithmetic Progressions	Shanta Laishram	Stat-Math Unit, Delhi	Ministry of Defence, Government of India
7.	Exponential Diophantine Equations: Resolution of some well-known Diophantine equations	Shanta Laishram	Stat-Math Unit, Delhi	Ministry of Defence, Government of India
8.	Implementation of the Attacks on Elliptic Curve Discrete Log Problem	Shanta Laishram	Stat-Math Unit, Delhi	Ministry of Defence, Government of India
9.	BOBASIO Region Airspace Safety Assessment Study	Antar Bandyopadhyay	Stat-Math Unit, Delhi & Kolkata	Airport Authority of India
10.	SERB Women Excellence	Tanvi Jain	Stat-Math Unit, Delhi	SERB
11.	E_0 -semigroups: classification and invariants	B.V. Rajarama Bhat & Daniel Markiewicz	Stat-Math Unit, Bangalore	UGC
12.	Uniqueness for Stochastic Partial Differential Equations	Siva Athreya & Leonid Mytnik	Stat-Math Unit, Bangalore	UGC
13.	Etale Fundamental groups	Manish Kumar & Lior Bary-Soroker	Stat-Math Unit, Bangalore	UGC

Projects

14.	Mathematical Examination of a Load Forecasting Model	Mohan Delampady	Stat-Math Unit, Bangalore	Hitachi India Limited, Bangalore
15.	Indo Russian Project	S. Ponnusamy	Stat-Math Unit, Chennai	DST-RFBR
16.	INSPIRE Faculty Award – Metric geometry of domains in C^n	G.P. Balakumar	Stat-Math Unit, Chennai	Department of Science and Technology
Applied Statistics Division				
1.	International Passenger Survey	Ashis SenGupta & S.M. Subhani	ASU, Kolkata & SQC & OR Unit, Hyderabad	Ministry of Tourism, Govt. of India
2.	Methodological Study Towards Compilation and Forecasting of Services Trade Statistics	Ashis SenGupta	ASU, Kolkata	DGCI&S, Ministry of Commerce and Industry, Govt. of India
3.	Indo-German DST Project	Mridul Nandi & Sanjit Chatterjee	ASU, Kolkata	IISc. Bangalore
4.	Changes in pattern of irrigation, cultivation and livelihood of rural Bengal: The experience of Jamalpur block of Bardhaman	Debasis Sengupta	ASU, Kolkata	Department of Science & Technology, Govt. of West Bengal.
5.	Collaborative research project	Debasis Sengupta	ASU, Kolkata	GE Aviation, Bangalore
Computer and Communication Sciences Division				
1.	Automatic Sample Preparation and Validation of Biochemical Assays on a microfluidic Lab-on-a-chip (LOC)	B.B. Bhattacharya	ACMU	India-Tiwan Joint Research Programme in Science & Technology
2.	Delay Fault Modeling and Test Generation for Power Supply Noise	S. Sur-Kolay & B.B. Bhattacharya	ACMU	Intel Corporation, USA
3.	Design for Manufacturability aware Global Routing	S. Sur-Kolay	ACMU	IBM, USA
4.	Lithography Aware Physical Design for Below 20nm Process Technology	S. Sur-Kolay	ACMU	Indo-Taiwan joint Research Programme in Science & Technology
5.	IBM University Relations	A. Banerjee	ACMU	IBM University Relations

Projects

6.	Unrestricted Research Grant	K. Maulik & A. Banerjee	SMU & ACMU	Microsoft Research India
7.	A Formal Verification Framework for Verifying Real Time Dependencies on Data Validity and Safety Logics	A. Banerjee	ACMU	Advanced Systems Lab Hyderabad, DRDO, Govt. of India
8.	An Equivalence Checking Framework for Vulnerability Assessment for FPGA-based design flows	A. Banerjee	ACMU	Centre for Artificial Intelligence and Robotics, DRDO, Govt. of India
9.	Development of Cross Lingual Information Access System (CLIA) - Phase II	M. Mitra	CVPR	DIT, Govt. of India
10.	The cognitive architecture of face-processing – understanding the separation of information streams	G. Chatterjee	CVPR	DST - INSA
11.	Development of Online Handwriting Recognition System for Indian Languages – Phase II	S.K. Parui	CVPR	DIT, Govt. of India
12.	Dependency Parser for Bengali	U. Garain	CVPR	Society for Natural Language Technology Research (SNLTR)
13.	Analysis, Recognition and Synthesis of Facial Expressions	S. Agarwal & D.P. Mukherjee	ECSU	DST
14.	Digital Image Reconstruction of Indian Cultural Heritage with focus on Hampi Ruins	B. Chanda	ECSU	DST
15.	Emotional Expression analysis from the Video of Face Images	D.P. Mukherjee	ECSU	Qualcomm, USA
16.	Planogram Image Matching	D.P. Mukherjee	ECSU	TCS
17.	Analysis and Modelling of Atmospheric Pollutant over Indo Gangetic Plain	S. Pal	ECSU	CSIR
18.	Recognition of Antinuclear Antibodies by Automated Hep-2 Cell IIF Image Analysis for Diagnosis of Connective Tissue Disease	P. Maji	MIU	Department of Science and Technology
19.	Big Data for Energy Management (A Big Data Perspective for Energy Management in Smart-Grids and Dwellings)	S. Bandyopadhyay	MIU	Indo-French Centre for the Promotion of Advanced Research (IFCPAR/CEFIPRA)
20.	A collection of projects under Visvesvaraya Ph. D Scheme for Electronics and Information Technology	R.K. Dey	MIU	Department of Electronics and Information Technology (DEITY)
21.	Land Cover Classification of Remote Sensing Images Using Granular Computing Methodologies	Saroj K. Meher	SSIU	DST-SERB, Govt. of India

Projects

22.	Quantitative Characterization of Complex Topologically Prominent Components of Porous Media derived from Rocks of Petrologic Significance via Mathematical Morphology and Fractal Geometry	B.S. Daya Sagar	SSIU	DST-SERB, Govt. of India
23.	Quantification of neural information and subsequent coding scheme	Kaushik Majumdar	SSIU	DBT
24.	Automatic detection of micro-seizures and a study on how they evolve into macro-seizures	Kaushik Majumdar and Florian Mormann (Department of Epileptology, University of Bonn, Germany)	SSIU	DBT and German Ministry of Education
25.	INSPIRE Faculty Award – Structural & algorithmic study of some geometric intersection graph classes	Mathew C. Francis	CSU	Department of Science and Technology
26.	Indo-Japan Cooperative project	Sushmita Ruj & Kouichi Sakurai	CSRU	DST-JSPS
27.	Samsung GRO	Sushmita Ruj	CSRU	Samsung Electronics, Korea
Physics and Earth Sciences Division				
1.	Vertebrate microfossils from the Tiki Formation of the Rewa Gondwana basin: an integrated study on Upper Triassic biodiversity	Saswati Bandyopadhyay	GSU	SERB, DST
2.	Jurassic Gondwana Vertebrates of India: An Integrated Study on Palaeobiology	Debarati Mukherjee	GSU	SERB, DST
3.	Synchronization, Clustering and death in Networks of Complex Systems (Theory and Application to Biology and Neurophysiology)	Dibakar Ghosh	PAMU	DST, New Delhi and Russian Federation of Basic Research (RFBR), Russia
Biological Sciences Division				
1.	Development of information on Agricultural and Horticultural production using RS and GIS technology in some district of West Bengal	P. Banik	AERU	DST Govt. of WB
2.	Studies on keeping quality of different types of tea (Black, Green, Oolong & White) and their biochemical aspects & antioxidant properties	S. Das	AERU	National Tea Research Foundation
3.	Evidence theory based uncertainty analysis of ground water flow and contaminant transport	I. Mukhopadhyay	HGU	DOAE, Govt. of India

Projects

4.	Statistical methods to detect epistasis and gene-environment interactions in genetic association study	I. Mukhopadhyay	HGU	DST, Govt. of India
5.	Non-invasive identification and validation of Epigenetic biomarker in saliva for early detection of Oral pre-cancer and cancer patients in India.	R. Chatterjee	HGU	CSIR, Govt. of India
6.	A comprehensive genomic and genetic characterization of pancreatic cancer in Indian patient population	N. Sikdar	HGU	DBT, Govt. of India
Social Sciences Division				
1.	Evaluation Study on Boarder Area (BADP) Cluster – B	Buddhadeb Ghosh	ERU	Planning Commission, Government of India
2.	Evaluation Study on Boarder Area (BADP) Cluster – C	Buddhadeb Ghosh	ERU	Planning Commission, Government of India
3.	Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA): Himachal Pradesh, Jammu & Kashmir and Uttarakhand	Buddhadeb Ghosh	ERU	Planning Commission, Government of India
4.	Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA): All India Coordination Report	Buddhadeb Ghosh	ERU	Planning Commission, Government of India
5.	Informal Insurance Under Group Lending with Individual Liability: Evidence from India	Abhirup Sarkar	ERU	IGC, London School of Economics, London
6.	Gender Violence in India: Its Roots, Nature and Extent	Chaiti Sharma Biswas	ERU	ICSSR, Government of India
7.	Indian Language Corpora Initiative-Bangla-2 (ILCI-2)	Niladri Sekhar Dash	LRU	DeitY, MCIT, Govt. of India
8.	Poverty and Aspiration	Sandip Mitra	SOSU	ESRC grant through CAGE,Warwick
9.	DFID-ESRC Growth Research Programme	Sandip Mitra	SOSU & Dean of Studies	ESRC, DFID
10.	Reviewing the existing system of compilation of trade indices	Nachiketa Chattopadhyay	SOSU	DGCI&S, Govt. of India.
11.	Estimation of demand for banknotes and coins	Nachiketa Chattopadhyay	SOSU	Reserve Bank of India
12.	ISI-RBI collaboration research project	Diganta Mukherjee	SOSU	Reserve Bank of India
13.	Women and Work in Rural India	Farzana Afridi & Abhiroop Mukhopadhyay	EPU	IGC
14.	Terms of Trade Shocks and Monetary Policy in India	Chetan Ghate	EPU	IGC
15.	Contractual efficiency and preferences in groundwater markets of India	E. Somanathan	EPU	EEU/CECFEE

Projects

16.	Climate Change and Agricultural Yield in Karnataka	Madhura Swaminathan & T. Jayaraman (TISS, Mumbai)	EAU	Karnataka Govt.
Statistical Quality Control and Operations Research Division				
1.	Development of Talent and Solutions in Business Analytics at Infosys Technologies Ltd.	Amitava Bandyopadhyay & Bobby John	SQC & OR Unit, Kolkata & Bangalore	Infosys Technologies Ltd. Bangalore
2.	Development of Talent and Solutions in Business Analytics at L&T Infotech Ltd.	Amitava Bandyopadhyay, Bobby John & Ashok Sarkar	SQC & OR Unit, Kolkata, Bangalore, & Mumbai	L&T Infotech Ltd. Mumbai
3.	Normalization of marks in Board examinations	Ashis Kumar Chakraborty	SQC & OR Unit, Kolkata	Government of Gujarat
4.	ITC – PSPD, Six Sigma Training and Projects	Ashis Kumar Chakraborty	SQC & OR Unit, Kolkata, Bangalore, Hyderabad & Chennai	ITC, PSPD
5.	Six Sigma Green Belt	Sanjit Ray & U.H. Acharya	SQC & OR Unit, Bangalore	Emirates Integrated Telecommunication Company (du) - Dubai
6.	Six sigma Training & Implementation	U.H. Acharya, K.K. Chowdhury, A.R. Chowdhury & E.V. Gijo	SQC & OR Unit, Bangalore	TVS Motors, Hosur
7.	Six Sigma Training & Implementation	A.R. Chowdhury, Somnath Ray & Sanjit Ray	SQC & OR Unit, Bangalore	ITC, Bollaram, Hyderabad & ITC, Kovai
8.	Six Sigma Training & Implementation	Sanjit Ray	SQC & OR Unit, Bangalore	Mother Dairy, Delhi
9.	Six Sigma Green Belt Training	Somnath Ray, A.R. Chowdhury & E.V. Gijo	SQC & OR Unit, Bangalore	HAL Academy, Bangalore
10.	Audits of Quality Management Systems	P.K. Perumallu	SQC & OR Unit, Bangalore	NVT Quality Certification Private Limited, Bangalore
11.	Six Sigma Black Belt Program	Bobby John & K.K. Chowdhury	SQC & OR Unit, Bangalore	Hinduja Global Solutions, Bangalore
12.	Business Analytics Program	Bobby John & K.K. Chowdhury	SQC & OR Unit, Bangalore	Deloitte Consulting India, Hyderabad
13.	Six Sigma Black Belt	D. Sampangi Raman	SQC & OR Unit, Chennai	ITC, PDPC
14.	Six Sigma Yellow Belt	D. Sampangi Raman	SQC & OR Unit, Chennai	e4e Healthcare Business Service

Projects

				Pvt Ltd
15.	General Training Programme on Six Sigma Green Belt and Black Belt including Project Guidance at Office	A. Rajagopal	SQC & OR Unit, Coimbatore	Participants
16.	General Training Programme on Six Sigma Green Belt and Black Belt including Project Guidance at Office	A. Rajagopal	SQC & OR Unit	Participants
17.	Design for Six Sigma for Process and Product Design in Brakes Manufacturing	A. Rajagopal	SQC & OR Unit	TVS Brakes, Chennai
18.	Quality System Implementation at mining	A. Rajagopal	SQC & OR Unit	SRC Projects, Salem
19.	Increasing the outsourcing and vendor identification for meeting the excessive order in Govt. school uniforms	A. Rajagopal	SQC & OR Unit	TCTP, Erode
20.	Cost of Poor Quality and Stock per frame day analysis	A. Rajagopal	SQC & OR Unit	MYK, Hyderabad
21.	Predicting cotton price in recessive period	A. Rajagopal	SQC & OR Unit	Shiva Teyarn Ltd Unit-II, Coimbatore
22.	Software KPO MSAKAPPA analysis	A. Rajagopal	SQC & OR Unit	Caresoft Global Pvt Ltd, Chennai
23.	ISO 9001:2015 – Risk Assessment	A. Rajagopal	SQC & OR Unit	GCAS, Dubai
24.	Failure Mode Effect Analysis for OEM manufacturers	A. Rajagopal	SQC & OR Unit	LMW, Coimbatore
25.	International training programme on ISO 9001 and Six Sigma	A. Rajagopal	SQC & OR Unit	FCRI, Palaghat
26.	Study on Business Process Improvement (Retail Analytics)	A. Rajagopal	SQC & OR Unit	Ramachandra Textile, Trivandrum
27.	Revision of QMS and ISO 9001 -2015 standards	A. Rajagopal	SQC & OR Unit	Bannari Amman, Dindigul
28.	Design & Development of Risk Based Sampling Methodology	G. Murali Rao & A.L.N. Murthy	SQC & OR Unit, Hyderabad	SBI Associate Banks
29.	Six Sigma Implementation (In-house training and guidance)	Ashis Chakraborty & S.M. Subhani	SQC & OR Units, Hyderabad & Kolkata	ITC Limited, Bollaram
30.	DoE for QbD	A.L.N. Murthy & G. Murali Rao	SQC & OR Unit, Hyderabad	Sai Life Sciences Limited
31.	Design & Development of Risk Based Sampling Methodology for Internal Verification Audit	A.L.N. Murthy & G. Murali Rao	SQC & OR Unit, Hyderabad	State Bank of India
32.	Six Sigma Implementation	A. Sarkar	SQC & OR Unit, Mumbai	Larsen & Toubro Ltd
33.	Training on Reliability	A. Sarkar	SQC & OR Unit, Mumbai	NAI (Indian Navy)
34.	Training on SPC	A. Sarkar	SQC & OR Unit, Mumbai	TATA Aeronautical Ltd.
35.	Six Sigma Green Belt Training	Sagar Sikder	SQC & OR	Coats India Pvt. Ltd.

Projects

			Unit, Mumbai	
36.	Six Sigma Green Belt Training	A. Sarkar	SQC & OR Unit, Mumbai	NAI (Indian Navy)
37.	Statistics for BB	A. Sarkar	SQC & OR Unit, Mumbai	Equate Petrochemical, Kuwait
38.	Workshop on Forecasting	A. Sarkar	SQC & OR Unit, Mumbai	UPL Limited
39.	Workshop on Forecasting	A. Sarkar	SQC & OR Unit, Mumbai	Larsen & Toubro Ltd.
40.	Six Sigma Tools Training	A. Sarkar	SQC & OR Unit, Mumbai	Aditya Birla Management Corporation
41.	Workshop on SPC	A. Sarkar	SQC & OR Unit, Mumbai	Aditya Cement Works Chittorgrah, Rajasthan
42.	Six Sigma Green Belt Training	A. Sarkar	SQC & OR Unit, Mumbai	XIM, Bhubaneswar
43.	Six Sigma Green Belt Training	A. Sarkar	SQC & OR Unit, Mumbai	L&T Mysore
44.	Statistical Techniques for Trend Analysis	A. Sarkar	SQC & OR Unit, Mumbai	Engine Overhaul Facility, Air India Ltd.,
45.	Workshop on SPC	A. Sarkar	SQC & OR Unit, Mumbai	Vedanta Limited, Korba
46.	Workshop on Data Analytic	A. Sarkar	SQC & OR Unit, Mumbai	INSMA, Navy
47.	DFSS implementation	S. Rath	SQC & OR Unit, Pune	Technova Imaging Systems Ltd
48.	Six Sigma Implementation	S. Rath	SQC & OR Unit, Pune	Balasure Alloys limited, Balasure
49.	Data Analytic Program	S. Rath	SQC & OR Unit, Pune	Red Hat, Pune
50.	Data Analytic Program	S. Rath	SQC & OR Unit, Pune	Vodafone International
51.	Six Sigma Green-Belt Program	S. Rath	SQC & OR Unit, Pune	Hitachi Consulting Software Services India Private Ltd
52.	Training Program on Statistics for R&D	S. Rath	SQC & OR Unit, Pune	Marico Ltd., Mumbai
53.	Six Sigma Green-Belt Programs	S. Rath	SQC & OR Unit, Pune	Symbiosis Institute of Business Management
54.	Six Sigma Black-Belt Program	S. Rath	SQC & OR Unit, Pune	Gallagher Support Services
Centre for Soft Computing Research: A National Facility				
1.	J.C. Bose Fellowship	S.K. Pal	CSCR	DST, Govt. of India
2.	DAE Raja Ramanna Fellowship	S. K. Pal	CSCR	Department of Atomic Energy, Govt. of India

Projects

3.	Erasmus Mundus External Cooperation Window (EMECW)	A. Ghosh	CSCR	European Commission
4.	DST INSPIRE Faculty Award	S. Das	CSCR	DST, Govt. of India

Completed Projects

Sl. no.	Name of the project	Principal Investigator(s)	Unit(s) involved	Funded by
Applied Statistics Division				
1.	Predictive Analytics	R. Sen & Sreelakshmi	ASU, Chennai	Lucid Technologies
Computer and Communication Sciences Division				
1.	Multilingual Word Spotting for Degraded Documents	U. Pal	CVPR	Indo French Centre for the Promotion of Advanced Research
2.	RADIOMICS	S. Mitra	MIU	Maastricht University
3.	Rough-Fuzzy Computing and Multiresolution Image Analysis for Segmentation of Brain Tumor from Magnetic Resonance Images	P. Maji	MIU	Indian National Science Academy, New Delhi
5.	agINFRA	A.R.D. Prasad & Devika P. Madali	DRTC	European Commission
6.	ITPAR	A.R.D. Prasad & Devika P. Madali	DRTC	DST/University of Trento, Italy
7.	DST-SERB Summer School on Mathematical Morphology in Geosciences	B.S. Daya Sagar	SSIU	DST-SERB
Physics and Earth Sciences Division				
1.	Assessing the global pattern of the deadliest mass extinction in Earth history: explorations for fossil vertebrates in the early Triassic beds of India	S. Bandyopadhyay & D.P. Sengupta	GSU	National Geographic
Social Sciences Division				
1.	The Diagnostic Survey of Closed Industrial under Micro & Small Scale Enterprises, West Bengal	Pulakesh Maiti	ERU	Government of West Bengal
2.	Efficient Allocation of Funds and Performance Evaluation of Urban Local Bodies: A Case for West Bengal	Amita Majumder	ERU	4 th State Finance Commission, West Bengal

Projects

3.	Accountability of Local Governments in West Bengal: A pilot study on Gram Panchayats, Government of West Bengal	Sandip Mitra	SOSU	State Finance Commission, Govt. of West Bengal
4.	Setting up of Workstation at the Indian Statistical Institute, Kolkata, for Research on Micro-Data from Census, Office of Registrar General & Census Commissioner	Diganta Mukherjee	SOSU	ORGI
Statistical Quality Control and Operations Research Division				
1.	Classification and Estimation of phase structure of multi-phase steel using Image Processing Technique	Prasun Das & D.P. Mukherjee	SQC & OR Unit, Kolkata & ECSU	Tata Steel, Jamshedpur
2.	Estimation of the Quantum of Fake Indian Currency Notes in circulation	Abhijit Gupta	SQC & OR Unit, Kolkata	NIA, Ministry of Home Affairs
3.	ITC – PSPD, Six Sigma Training and Projects	Ashis Kumar Chakraborty	SQC & OR Unit, Kolkata; Bangalore; Hyderabad & Chennai	ITC, PSPD
4.	Normalization of marks in Board examinations	Ashis Kumar Chakraborty	SQC & OR Unit, Kolkata	Government of Gujarat
5.	Normalization of marks in Board examinations	Ashis Kumar Chakraborty	SQC & OR Unit, Kolkata	Government of Maharashtra
6.	Program on Business Analytics	Sanjit Ray, Bobby John & Amitava Banerjee	SQC & OR Unit, Bangalore & Kolkata	Alchemy Solutions, Bangalore
7.	Six Sigma Training & Implementation	Sanjit Ray	SQC & OR Unit, Bangalore	Madura Fashion Limited, Bangalore
8.	Six Sigma Green Belt Training	K K Chowdhury & Bobby John	SQC & OR Unit, Bangalore	Huawei Technologies, Bangalore
9.	Program on Business Analytics	Bobby John & K.K. Chowdhury	SQC & OR Unit, Bangalore	Tata Consultancy Services, Bangalore
10.	Program on Total Quality Management	Bobby John & K.K. Chowdhury	SQC & OR Unit, Bangalore	Tractors India Pvt. Ltd., Kolkata
11.	Program on Advanced Data Analysis	Bobby John	SQC & OR Unit, Bangalore	Wipro Limited, Bangalore
12.	Design of Experiments	Bobby John & K.K. Chowdhury	SQC & OR Unit, Bangalore	Hical Technologies, Bangalore

Projects

13.	Design of Experiments	A.R. Chowdhury	SQC & OR Unit, Bangalore	TVS Srichakra Ltd., Madurai
14.	Training on Statistical Techniques	E.V. Gijo, A.R. Chowdhury & Somnath Ray	SQC & OR Unit, Bangalore	Biocon Ltd., Bangalore
15.	Six Sigma Training	U.H. Acharya & Somnath Ray	SQC & OR Unit, Bangalore	AT & S India, Nanjungud
16.	Six Sigma Training	U.H. Acharya	SQC & OR Unit, Bangalore	New Mill-GTS India, Madura Coats Private Limited, Madurai
17.	Quality Control Tools	U.H. Acharya	SQC & OR Unit, Bangalore	Fiat India Limited, Pune
18.	Six Sigma Green Belt Training	Somnath Ray & E.V. Gijo	SQC & OR Unit, Bangalore	Alstom, Durgapur
19.	Facilitation and guidance for statistical modelling	Boby John	SQC & OR Unit, Bangalore	Hewlett Packard, Bangalore
20.	Project on Statistical Modelling	Boby John & K K. Chowdhury	SQC & OR Unit, Bangalore	Wipro Technologies, Bangalore
21.	In-house training on Quality & Reliability Engineering and Six Sigma Green Belt	G. Murali Rao	SQC & OR Unit, Hyderabad	Defence Institute of Advanced Technology (DIAT), Pune
22.	Six Sigma Training and Guidance on Six Sigma Projects	A.L.N. Murthy & G. Murali Rao	SQC & OR Unit, Hyderabad	ITC Limited – PSPD, Bhadrachalam
23.	In-house training on Integrated Management Systems	S.M. Subhani	SQC & OR Unit, Hyderabad	GMR International Airport, Hyderabad
24.	In-house training program on Statistical Methods	G. Murali Rao	SQC & OR Unit, Hyderabad	NTT Data Global Delivery Services Private Limited
25.	Six Sigma Black-Belt Public Program	S. Rath	SQC & OR Unit, Pune	Participants
26.	Six Sigma Black-Belt Public Program	S. Rath	SQC & OR Unit, Pune	Participants
Centre for Soft Computing Research				
1.	Center for Soft Computing Research	S.K. Pal	CSCR	Department of Science & Technology, Govt. of India

Projects

North East Projects

Ongoing Projects

Sl. no.	Name of the project	Principal Investigator(s)	Unit(s) involved
Social Sciences Division			
1.	The Biaxial Syntax of Inflected Clauses in Assamese and Bangla	Probal Dasgupta	LRU
2.	Livelihoods, homestead farming and human development in Tripura	Madhura Swaminathan & V.K. Ramachandran	EAU

Completed Projects

Sl. no.	Name of the project	Principal Investigator(s)	Unit(s) involved
Computer and Communication Sciences Division			
1.	Graph Algorithms with Special Focus to Applications in Networks and VLSI 2016	Faculty Members	ACMU
2.	North East Project	Faculty Members	MIU
Social Sciences Division			
1.	Third North-East Workshop on Official Statistics	Prasanta Pathak & Sandip Mitra	SOSU
2.	Workshop on Data Analysis	Diganta Mukherjee	SOSU

4. SYMPOSIA, CONFERENCES, WORKSHOPS, LECTURES AND SEMINARS ORGANISED

Symposia and Conferences

Conference on “*Analysis and Probability*”: Stat-Math Unit, Delhi, November 27-29, 2015.

Symposium on “*Probability and Stochastic Processes X*”: Stat-Math Unit, Bangalore, in collaboration with Department of Mathematics, Indian Institute of Science, Bangalore, held at Indian Institute of Science, Bangalore, December 13-16, 2015.

Symposium by Doctoral and Post-Doctoral Fellows (2015), Stat-Math Unit, Bangalore, August 6-7, 2015.

Conference on “*Complex Geometry and Operator Theory*”: Stat-Math Unit, Bangalore, December 1-3, 2015.

Conference on “*Algebraic Geometry*”: Stat-Math Unit, Bangalore, December 10-16, 2015.

Symposium on “*Advances in Noncommutative Mathematics (ANCM)*”: Stat-Math Unit, Bangalore, January 18-22, 2016.

Symposium on “*Geometric Function Theory – III*”: Stat-Math Unit, Chennai, January 26, 2016.

Symposium on “*An Introduction to Several Complex Variables*”: Stat-Math Unit, Chennai, December 18-23, 2015.

Symposium on “*Complex Analysis*”: Stat-Math Unit, Chennai, in collaboration with IIT Indore, December 04, 2015.

9th IEEE International Conference on “*Advanced Networks and Telecommunication Systems (ANTS)*”: ACMU, Kolkata, December 15-18, 2015.

29th International Conference on “*VLSI Design*” and 15th International Conference on “*Embedded System*”: ACMU, Kolkata, January 04–08, 2015.

7th Symposium on “*Information Retrieval Evaluation (FIRE 2015)*”: CVPR, Kolkata, in collaboration with DAIICT, Gandhinagar and Information Retrieval Society of India, December 4-6, 2015.

Symposium on “*Celebrating a Life on Pattern Recognition and Beyond: Workshop in honour of Professor B.B. Chaudhuri*”: CVPR, Kolkata, December 18, 2015.

International Conference on “*Big Data and Knowledge Discovery (ICBK)*”: DRTC, Bangalore, March 9-11, 2016.

International Conference on “*Quantum Disordered Systems*”: CSU, Chennai in collaboration with IMSc and IIT Madras, March 01-04, 2016.

5th Topical Conference on “*Gravity, Cosmology, Astronomy and Astrophysics – Eastern Region (TCGCA-ER5)*”: PAMU, Kolkata, March 19, 2016.

3rd International Conference on “*India Biodiversity Meet, 2015*”: AERU Kolkata in collaboration with Biomathematical Society of India, November 16–18, 2015.

Conferences and Seminars

Conference on “*Urbanization Industrialization and Development: The Case of West Bengal*”: ERU, Kolkata, March 17, 2016.

11th Annual Conference on “*Economic Growth and Development*”: EPU, Delhi, December 17-19, 2015.

Conference on “*Honour of Prof. Bhaskar Dutta’s 65th Birthday*”: EPU, Delhi, December 20-21, 2015.

Symposium on “*Disaster Management and Risk Analytics under Big Data Paradigm*”: SQC & OR Unit, Kolkata, February 20, 2016.

Mini Symposium on “*Complementarity and Game Theory models*”: SQC & OR Unit, Delhi, January 20-21, 2016.

Symposium on “*Six Sigma Symposium*”: SQC & OR Unit, Chennai, July 2-3, 2015.

Symposium on “*Achieving Breakthrough Quality– Edition 5*”: SQC & OR Unit, Coimbatore, held at Sardar Vallabhbhai Patel International School of Textiles & Management, Coimbatore, June 29, 2015.

Symposium on “*Ultimate in Quality*”: SQC & OR Unit, Coimbatore, held at Indian Chamber of Commerce and Industries Hall, Coimbatore, December 22, 2015.

Symposium on “*Six Sigma Entrepreneur Skills, Opportunities and Challenges*”: SQC & OR Unit, Coimbatore, held at Indian Chamber of Commerce and Industries Hall, January 29, 2016.

International Seminar on “*Museums: an Expression of National Identity with special focus on Biographical Museum*”: PCM Memorial Museum and Archives, Library, Documentation and Information Science Division, Kolkata, March 28-29, 2016.

International Conference on “*IndKoha 15*”: Library, Documentation and Information Science Division, Kolkata, in collaboration with Bengal Library Association, Kolkata; Bose Institute, Kolkata and Indian Institute of Management, Kolkata, January 23-24, 2016.

Workshops and Training Programmes

Workshop on “*Growth Curve Model (GCM)*”: Stat-Math Unit, Kolkata held at Indian Statistical Institute, Giridih Branch, Jharkhand, March 28-29, 2016.

7th Workshop on “*Big Data Benchmarking*”: Stat-Math Unit, Delhi, in collaboration with Center for Large-Scale Data Systems, Supercomputer Center, University of California, San Diego and Indian Institute of Public Health, Hyderabad, held at India Habitat Centre, New Delhi, December 14-15, 2015.

Training on “*Elliptic Curves & Attacks on ECC based Schemes*”: Stat-Math Unit, Delhi, in collaboration with DRDO, March 30- April 8, 2015.

Winter School on “*Application of Statistical Methods in Medicine*”: ASU, Kolkata in collaboration with Department of Community Medicine, IPGME&R, Kolkata & State Medical Colleges, Govt. of West Bengal, March 7-18, 2016.

Winter School on “*Computational Statistics*”: ISRU, Kolkata, February 22-26, 2016.

Workshop on “*Statistical Methods in Finance*”: ASU, Chennai, July 13-17, 2015.

School on “*Analysis and Topology*”: AOSU, Tezpur, jointly with Stat-Math Unit, Kolkata, February

22- March 04, 2016.

17th International Workshop on “*Combinatorial Image Analysis (IWCIA – 2015)*”: ACMU, Kolkata, November 24–27, 2015.

Indo-US Bilateral Workshop on “*Large Scale Complex Network Analysis (LSCNA 2015)*”: ACMU, Kolkata, December 19-20, 2015.

1st Workshop on “*Proactive Information Retrieval: Anticipating Users’ Information Need*”: CVPR, Kolkata, in collaboration with 38th European Conference on Information Retrieval, Padua, Italy, March 20, 2016.

2nd Summer School on “*Computer Vision, Graphics and Image Processing*”: ECSU, Kolkata, May 25–July 06, 2015.

Workshop on “*40 Years of Fuzzy Sets in Indian Statistical Institute*”: MIU, Kolkata, September 15, 2015.

Annual Workshop on “*Machine Intelligence and Applications*”: MIU, Kolkata, March 30, 2016.

Workshop on “*Brainstorming Session-UNESCO Guidelines to Open Data and Open Data Repositories*”: DRTC, Bangalore in collaboration with UNESCO, Paris, December 18-19, 2015.

Summer School on “*Mathematical Morphology in Geosciences*”: SSIU, Bangalore in collaboration with DST-SERB, March 24-April 08, 2015.

International School and Workshop on “*Quantum Disordered Systems*”: CSU, Chennai in collaboration with IMSc and IIT Madras, February 24-29, 2016.

Short Term Course on “*Cryptography and Security*”: CSRU, Kolkata, November 2, 2015-February 28, 2016.

Short Term Course on “*Cryptography and Security*”: CSRU, Kolkata, May 9-August 25, 2015.

Summer School on “*Quantum Correlation; Foundation, Information Processing and Various Applications*”: PAMU, Kolkata, June 22–July 03, 2015.

Winter School on “*Nonlinear Dynamics (WSND-2015)*”: PAMU, Kolkata, December 09–18, 2015.

Winter School on “*Cosmology (WSC)*”: PAMU, Kolkata, December 28–January 06, 2016.

Winter School on “*Condensed Matter Physics*”: PAMU, Kolkata, January 11–22, 2016

Workshop on “*Statistical Methods and R Programming*”: AERU, Kolkata held at Institute of Chemical Technology, Mumbai, February 10–15, 2016.

1st Winter School on “*Research Methods in Biological Anthropology*”: BAU, Kolkata, January 13-20, 2016.

Workshops on “*Experimental Economics*”: ERU, Kolkata, March 15, 2016.

Workshops on “*Doctoral Students*”: ERU, Kolkata in collaboration with Indira Gandhi Institute of Development Research, Mumbai and Centre for Development Studies, Trivandrum, March 21-23, 2016.

Conferences and Seminars

Workshop on "*Language Technology and Cognitive Science (LTCS-2016)*": LRU, Kolkata, February 10-12, 2016.

Training Workshop on "*Mental Health Data Analytics (MHDA)*": PRU, Kolkata, August 17- 19, 2015.

Workshop on "*Life contingency table for estimating mortality and morbidity of patients suffering from mental diseases*": PRU, Kolkata, February 16-17, 2015.

Training Programme on "*Sample Survey Methodology and Estimation*" (for ISS Probationers): SOSU, Kolkata in collaboration with NSSTA/MOSPI, September 21-October 2, 2015.

Course on "*Official Statistics and Data Analysis*" (for BRAC-Bangladesh Officials): SOSU, Kolkata, November 16-21, 2015.

Workshop on "*Use of R for NSSO data*": SOSU, Kolkata in collaboration with NSSO, Kolkata, November 23-27, 2015.

Training in "*Official Statistics*" (for Officers of RBI-DSIM): SOSU, Kolkata in collaboration with RBI, December 2-11, 2015.

Workshop on "*5th West Bengal Growth*": SOSU, Kolkata in collaboration with IGC, December 26-27, 2015.

Training Programme on "*Handling of Unit level Data and Data Analysis*" (for in-service ISS officers-Refresher Course): SOSU, Kolkata, in collaboration with NSSTA, January 18-22, 2016.

Training Programme on "*Sample Survey Methodology and Estimation*" (for ISS Probationers): SOSU, Kolkata, in collaboration with NSSTA, January 25-February 5, 2016.

Course on "*Basic and Official Statistics*" (for officials of DES, Chhattisgarh): SOSU, Kolkata, March 14-18, 2016

Course on "*Basic Demographic Techniques*": SOSU, Kolkata in collaboration with ORGI, March 31-April 13, 2016.

Workshop on "*Financial Inclusion and Rural Empowerment in Jharkhand: Issues, Progress and Prospects*", SRU, Giridih in collaboration with NARARD, Jharkhand, March 21-22, 2016.

4th Workshop on "*Delhi Macroeconomics*": EPU, Delhi, October 30, 2015.

Training Program on "*Macro and Micro Economics*" (for ISS Probationers): EPU, Delhi, April 06-17, 2015.

Training Program on "*Macro and Micro Economics*" (for ISS Probationers): EPU, Delhi, March 28- April 8, 2016.

Summer School on "*Development Economics*", EPU, Delhi in collaboration with IGC, July 16-20, 2015.

Workshop on "*Static and Dynamic Mechanism Design*": EPU, Delhi, August 01-04, 2015.

Workshop on "*Climate Change, Agriculture and Rural Energy in India*": EAU, Bangalore, March 28, 2016.

Workshop on "*Design and Analysis of Experiments*" (for Scientists and Researchers from Research Laboratories and R&D Establishments): SQC & OR Unit, Kolkata, November 30–December 05, 2015.

Conferences and Seminars

Workshop on "*Industrial Experiments*" (for Undergraduate Engineering Students): SQC & OR Unit, Kolkata, February 17-19, 2016 and March 16-18, 2016.

Training Programme on "*Six Sigma Green Belt*": SQC & OR Unit, Delhi, April 22–24, 2015.

Training Programme on "*Six Sigma Green Belt*": SQC & OR Unit, Delhi, July 28–30, 2015.

Programme on "*Six Sigma Black Belt 1st Module*": SQC & OR Unit, Delhi, August 19–21, 2015.

Training Programme on "*Six Sigma Green Belt*": SQC & OR Unit, Delhi, September 16–18, 2015.

Programme on "*Six Sigma Black Belt 2nd Module*": SQC & OR Unit, Delhi, September 22–25, 2015.

Programme on "*Six Sigma Black Belt 3rd Module*": SQC & OR Unit, Delhi, October 12–15, 2015.

Programme on "*Six Sigma Black Belt 4th Module*": SQC & OR Unit, Delhi, November 18-20, 2015.

Training Programme on "*Six Sigma Green Belt*": SQC & OR Unit, Delhi, December 2-4, 2015.

Training Programme on "*Six Sigma Green Belt*": SQC & OR Unit, Delhi, January 27–29, 2016.

Programme on "*Six Sigma Master Black Belt*": SQC & OR Unit, Delhi, February 15-19, 2016, March 14-18, 2016.

Training Programme on "*Problem Solving using Design of Experiments*": SQC & OR Unit, Bangalore, July 22-24, 2015.

Training Programme on "*Business Analytics*": SQC & OR Unit, Bangalore, held at Hotel Royal Orchid Central, Bangalore, September 24–26 and October 9–10, 2015.

Certification Programme on "*Six Sigma Green Belt (GB-33)*": SQC & OR Unit, Bangalore, November 16–21, 2015.

Certification Programme on "*Statistical Techniques for Advanced Data Analysis*": SQC & OR Unit, Bangalore, held at Kochi, Kerala, December 10–12, 2015.

Certification Programme on "*Six Sigma Master Black Belt (MBB-24)*": SQC & OR Unit, Bangalore, January 4–16, 2016.

Training Programme on "*Annual Six Sigma Conference and Case Study Presentation*": SQC & OR Unit, Bangalore, held at Hotel Atria, Bangalore, February 12-13, 2016.

Training Programme on "*Statistical Techniques for Business Analytics*": SQC & OR Unit, Bangalore, February 18–20 and 27–28, 2016.

Certification Programme on "*Six Sigma Black Belt (BB-21)*": SQC & OR Unit, Bangalore, January 25–30 and February 22–27, 2016.

Certification Programme on "*Six Sigma Green Belt (GB-33)*": SQC & OR Unit, Bangalore, March 7–12, 2016.

Training Programme on "*Six Sigma Black Belt*": SQC & OR Unit, Chennai, June–August, 2015.

Training Programme on "*Business Analytics*": SQC & OR Unit, Chennai, August, 2015.

Conferences and Seminars

Training Programme on “*Time Series with R Applications*”: SQC & OR Unit, Chennai, March 2016.

Training Programme on “*ISO 9001- 2015 Standard Introduction*”: SQC & OR Unit, Coimbatore, held at FCRI, Palakkad, Coimbatore, 7 May, 2015.

Training Programme on “*ISO 9001- 2015 Risk Assessment in Textile mills*”: SQC & OR Unit, Coimbatore, held at MYK Spinning Mills, Hyderabad, 26 October, 2015.

Training Programme on “*Process Control for Middle Management*”: SQC & OR Unit, Coimbatore, held at GHCL, Madurai, June 15-16, 2015.

Training Programme on “*SME’s performance evaluation*”: SQC & OR Unit, Coimbatore, held at Valluva Consultancy, Coimbatore, August 11-12, 2015.

Training Programme on “*Framework on patient waiting time and queuing model technique for master health checkup patients*”: SQC & OR Unit, Coimbatore held at KG Hospital, Coimbatore, April 27-28, 2015 and July 13, 2015.

Training Programme on “*Failure Mode Effect Analysis(FMEA) in Ring Frame Machine*”: SQC & OR Unit, Coimbatore, held at LMW, Kaniyur, October 10,13-14 and 17, 2015.

Training Programme on “*TVS DFSS Training*”: SQC & OR Unit, Coimbatore, held at TVS BrakesIndia, Chennai, October 28-30, 2015.

Training Programme on “*Retail Analytics*”: SQC & OR Unit, Coimbatore, held at Sree Ramachandra Textiles, Thiruvananthapuram, April 21-22, 2015 and July 27, 2015.

Training Programme on “*M. Tech (QROR)*“ (for the students of 1st yr. and 2nd yr. from Kolkata): SQC & OR Unit, Coimbatore, held at Field Training, March 23-June 30, 2015 and May 12-July 21, 2015.

Training Programme on “*Six Sigma Black Belt*”: SQC & OR Unit, Coimbatore, February 7-June 24, 2016.

Training Programme on “*Predictive Modeling in Scientific Experimentation*”: SQC & OR Unit, Coimbatore, held at PSGCAS, Coimbatore, September 15-16, 2015.

Certification Programme on “*Six Sigma Black Belt*”: SQC & OR Unit, Hyderabad held at ITC Limited, PSPD, Bhadrachalam, June 2, 3, 14-15, 2015; July 29-30, 2015; August 19-20, 2015; October 14-15, 2015; November 16-17, 2015 and February 3, 2016.

Certification Programme on “*Six Sigma Green Belt (Batch I)*”: SQC & OR Unit, Hyderabad held at ITC Limited, PSPD, Bhadrachalam, May 25, 2015; June 23, 2015; July 8, 2015; August 19, 2015; December 3-4, 2015 and February 2, 2016.

Certification Programme on “*Six Sigma Green Belt (Batch II)*”: SQC & OR Unit, Hyderabad held at ITC Limited, PSPD, Bhadrachalam, May 26, 2015; June 24, 2015; July 9, 2015; August 20, 2015; September 8-9, 2015 and March 19, 2016.

Certification Programme on “*Six Sigma Yellow Belt (Batch I)*”: SQC & OR Unit, Hyderabad held at M/s. ITC Limited, PSPD, Bhadrachalam organized, November 24–25, 2015.

Certification Programme on “*Six Sigma Black Belt*”: SQC & OR Unit, Hyderabad, June 5-7, 12-14, 19-21 and 27-29, 2015.

Conferences and Seminars

Certification Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Hyderabad, September 07-11, 2015.

Training Programme on “*Quality & Reliability Engineering and Six Sigma Green Belt*”: SQC & OR Unit, Hyderabad held at Defence Institute of Advanced Technology, Pune, August 31, 2015; September 4, 2015; October 27-30, 2015 and December 16-20, 2015.

Certification Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Hyderabad, October 17-21, 2015.

Training Programme on “*IMS (ISO 9000 / ISO 14001 / OHSAS 18001)*”: SQC & OR Unit, Hyderabad held at GMR Rajiv Gandhi International Airport, Hyderabad, June 12 & 15, 2015.

Training Programme on “*Design of Experiments for Quality by Design*”: SQC & OR Unit, Hyderabad held at SAI Life Sciences, Hyderabad, November 5-6, 2015 and December 11-12, 2015.

Training Programme on “*Statistics for Management*”: SQC & OR Unit, Hyderabad held at M/s. NTT DATA Global Delivery Services Limited, Hyderabad conducted, October 18–20, 2015 and March 21–22, 2016.

Training Programme on “*Six Sigma Yellow Belt*” (in Telugu): SQC & OR Unit, Hyderabad held at M/s. ITC Limited, Bollaram organized, November 05-07, 2015.

Training Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Hyderabad held at ITC Limited, Bollaram, November 17-18, 2015.

Training Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Hyderabad held at ITC Limited, Bollaram, January 18-19, 2016.

Certification Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Hyderabad, February 8–12, 2016.

Training Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Hyderabad held at ITC Limited, Bollaram, February 8-12, 2016.

Certification Programme on “*Six Sigma Yellow Belt (Batch I)*”: SQC & OR Unit, Hyderabad held at ITC Limited, PSPD, Bhadrachalam organized, March 18–19, 2016.

Training Programme on “*Six Sigma Master Black Belt (MBB)*”: SQC & OR Unit, Mumbai, April 6-11, 2015 and May 25-30, 2015.

Training Programme on “*Statistics for Six Sigma Black Belt*”: SQC & OR Unit, Mumbai, held at Equate Petrochemical, Kuwait, April 26-May 2, 2015.

Training Programme on “*Forecasting*”: SQC & OR Unit, Mumbai, held at L&T, Mumbai, May 10-11, 2015.

Training Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Mumbai, held at YWCA conference hall, May 15-17 and 23-24, 2015.

Training Programme on “*Forecasting*”: SQC & OR Unit, Mumbai, held at UPL, Mumbai, May 22, 2015.

Training Programme on “*Data mining for business analytics (DBMA)*”: SQC & OR Unit, Mumbai, held at hotel Atithi conference hall, June 5-7 and 20-21, 2015.

Conferences and Seminars

Training Programme on “*Reliability and defect prevention*” (for Naval Armaments Inspection): SQC & OR Unit, Mumbai, held at Karanja, June 08-09 and 11-12, 2015.

Training Programme on “*Statistical Process control (SPC)*” (for TATA Aeronautics Limited): SQC & OR Unit, Mumbai, held at Nagpur, July 09-11, 2015.

Training Programme on “*Statistics for Six Sigma Master Black Belt*”: SQC & OR Unit, Mumbai, held at ABMC, Mumbai, July 14-16, 2015.

Training Programme on “*Six Sigma Green belt*” for L&T EBG: SQC & OR Unit, Mumbai held at Mumbai, June 16-18 and July 23-25, 2015.

Training Programme on “*Data Analytics*”: SQC & OR Unit, Mumbai, held at ABRL, Mumbai, August 6 & 20, 2015 and September 10, 2015.

Training Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Mumbai, held at YWCA conference hall, August 01-02 and 07-09, 2015.

Training Programme on “*SPC*”: SQC & OR Unit, Mumbai, held at Aditya Cement, Jodhpur, August 10-12, 2015.

Training Programme on “*Six Sigma Green belt*” (for Coats Indian Pvt. Ltd.): SQC & OR Unit, Mumbai held at Panoli & Faridabad, August 3-5, 2015 and September 7-8, 2015.

Training Programme on “*Six Sigma Black Belt*”: SQC & OR Unit, Mumbai, August 24-28; September 21-24 and October 26-30, 2015.

Training Programme on “*Six Sigma Green belt*” (for XIMB): SQC & OR Unit, Mumbai held at Bhubaneswar, September 18-20 and October 09-11, 2015.

Training Programme on “*Six Sigma Green belt*” (for L&T): SQC & OR Unit, Mumbai held at Viskapattanam, September 01-03 and October 12-14, 2015.

Training Programme on “*Statistics for Six Sigma Black Belt*”: SQC & OR Unit, Mumbai, held at Grasim, Bharuch, October 23-24, 2015.

Training Programme on “*Statistics for Six Sigma Black Belt*”: SQC & OR Unit, Mumbai, held at Grasim, Bharuch, October 30-31, 2015.

Training Programme on “*Data Analytics*”: SQC & OR Unit, Mumbai, held at INSMA, Navy, Mumbai, November 03-06 2015.

Training Programme on “*Six Sigma Green belt- module 1*” (for Hindalco): SQC & OR Unit, Mumbai held at Hirakud, November 14-16 and December 28-30, 2015.

Training Programme on “*Six Sigma Green belt*” (for ABSTC): SQC & OR Unit, Mumbai held at Mumbai, November 18-20 and December 28-30, 2015.

Training Programme on “*Statistics for Six Sigma Black Belt*”: SQC & OR Unit, Mumbai, held at Grasim, Bharuch, November 25-26, 2015.

Training Programme on “*Six Sigma Green belt*” (for HDFC Deposit): SQC & OR Unit, Mumbai held at Mumbai, September 26; October 16 and November 21 & 28, 2015.

Conferences and Seminars

Training Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Mumbai, held at YWCA conference hall, December 05-06 and 11-13, 2015.

Workshop on “*Statistical techniques for Research Methodology*”: SQC & OR Unit, Mumbai, held at YWCA conference hall, December 14-18, 2015.

Training Programme on “*Statistics for Six Sigma Master Black Belt*”: SQC & OR Unit, Mumbai, held at ABMC, Mumbai, January 11-14, 2016.

Training Programme on “*Six Sigma Master Black Belt (MBB)*”: SQC & OR Unit, Mumbai, January 18-23 and February 15-20, 2016.

Training Programme on “*Six Sigma Green Belt*” (for Naval Armaments Inspection): SQC & OR Unit, Mumbai, held at Karanja, February 09-11 and 15-16, 2016.

Training Programme on “*SPC*”: SQC & OR Unit, Mumbai, held at BALCO, Korba, February 20-05, 2016.

Training Programme on “*Data mining for business analytics (DBMA)*”: SQC & OR Unit, Mumbai, held at hotel Atithi conference hall, March 04-06 and 19-20, 2016.

4th Training Programme on “*Adobe Photoshop: a Basic Course*”: Library, Kolkata, October 28–November 30, 2015.

6th Workshop on “*Digital Pictorial Photography*”: Library, Kolkata, January 4-8, 2016.

Training Programme “*Multimedia*” (for the students of Economically Challenged Background Family): Library, Kolkata, January 18-February 5, 2016.

National Workshop on “*Open Source Integrated Library Management Software Koha*”: Library, Documentation and Information Science Division, Kolkata, February 29–March 04, 2016.

National Workshop on “*Capacity Building in Handling Library Resources using Koha*”: Library, Kolkata, jointly organized by Library, Documentation and Information Science Division, ISI in collaboration with NERIST, Arunachal Pradesh, March 21-25, 2016.

North-East Workshops and Training Programmes

Workshop on “*Analysis and Probability (NE-SWAP 2015)*”: Stat-Math Unit, Bangalore, held at Tripura University, Agartala, June 27-30, 2015.

Workshop on “*Survival Analysis*”: ASU, Kolkata, held at Tripura University, Tripura, December 17-18, 2015.

Workshop on “*Cryptology*”: ASU, Kolkata, held at Indian Statistical Institute, Kolkata, January 21-27, 2016.

Workshop on “*Data Analysis for Biological Sciences*”: ASU, Kolkata, held at Assam University, Silchar, Assam, March 28-30, 2016.

Workshop on “*Statistical Methods for the Agriculture Sciences*”: ISRU, held at Assam Agriculture University, Jorhat, Assam, September 07-10, 2015.

Workshop on “*Statistical Data Analysis Methods*”: ISRU, held at Tripura University, Agartala,

Conferences and Seminars

Tripura, November 18-24, 2015.

Workshop on "*Graph Algorithms with special focus on Applications to Networks and VLSI*": ACMU, Kolkata, held at Assam University, Silchar, February 22-24, 2016.

2nd Workshop on "*Pattern Analysis and Applications (PAA)*": CVPR, Kolkata, held at Rajiv Gandhi University, Doimukh, Arunachal Pradesh, November 16–20, 2015.

3rd Workshop on "*Pattern Analysis and Applications (PAA)*": CVPR, Kolkata, held at Bodoland University, Kokrajhar, Bodoland, Assam, March 7-11, 2016.

18th Workshop on "*Computational Information Processing, Dasaratha Deb Memorial College (DDMC)*": ECSU, Kolkata, Khowai, Tripura, February 4-5, 2016.

Winter School on "*Soft Computing Methodologies in Bioinformatics*": MIU, Kolkata, held at Department of Agricultural Statistics, Assam Agricultural University, Jorhat, Assam, December 4-8, 2015.

National Workshop on "*Mathematical Methods in Physical Sciences*": PAMU, Kolkata, held at NIT Silchar, January 29–31, 2016.

Workshop on "*System Biology and Sustainable Development*": AERU Kolkata, held at Department of Horticulture, School of Life Sciences, Sikkim University, Gangtok, March 17–19, 2016.

Workshop on "*Statistical and Computing methods for Life Science Data Analysis*": BAU in collaboration with and held at Department of Anthropology, Dibrugarh University, February 08-12, 2016.

Workshop on "*Statistical and Computing methods for Life Science Data Analysis*": BAU in collaboration with and held at Department of Information Technology and Department of Human Physiology, Tripura University, March 14-19, 2016.

Workshop on "*Human Genetics: Techniques and Statistical Analyses*": HGU held at Mizoram University, Aizawl, September 8-12, 2015.

Workshop on "*Human Genetics: Techniques and Statistical Analyses*": HGU held at Gauhati University, March 27-29, 2016

Workshop on "*Official Statistics*": SOSU, Kolkata held at Kohima Science College, Jotsoma, Kohima, Nagaland, November 1-4, 2015.

Workshop on "*Data Analysis*": SOSU, Kolkata, held at Arya Vidyapeeth College, Guwahati, Assam, November 4-7, 2015.

Workshop on "*Dimensions on Quality of Higher Education and its Allied Quantitative Techniques*": SQC & OR Unit, Kolkata held at Assam University, Silchar, November 26-28, 2015.

Workshop on "*Techniques for Mathematical Optimization*": SQC & OR Unit, Kolkata held at Sikkim University, Gangtok, Sikkim, March 29-30, 2016.

Certification Program on "*Six Sigma Green Belt*": SQC & OR Unit, Bangalore held at ISI Kolkata, during January, 2016.

Certification Program on "*Six Sigma Green Belt*": SQC & OR Unit, Bangalore held at Tezpur University in collaboration with Department of Business Administration, Tezpur University, Assam, March 18-21, 2016.

Lectures and Seminars

Theoretical Statistics and Mathematics Division

Stat-Math Unit, Kolkata

Asanuma, T., Toyama University (04.03.2016): Finiteness conditions in a genus formula of algebraic curves.

Baier, Stephan, IISER Thiruvananthapuram (15.02.2016): Manins conjecture for a Del Pezzo surface of degree 2.

Banerjee, Arindam, University of Virginia, USA (26.06.2015): Algebra of Graphs.

Banerjee, Debargha, IISER, Pune (04.11.2015): Eisenstein elements inside the space of modular symbols.

Banerjee, Tathagata, Dept of Mathematics, University of Goettingen (08.02.2016): Coarse Geometry for noncommutative spaces.

Bannerjee, Debargha, IISER Pune (11.02.2016): Uniform boundedness theorem for elliptic curves over number fields.

Basu, Riddhipratim, Stanford University (10.12.2015): Evolving Voter Model on Dense Random Graphs.

Belton, Alex, University of Lancaster, U.K. (07.12.2015): Matrix positivity preservers in fixed dimension.

Bhattacharya, Rabi, University of Arizona, Tucson (23.11.2015): Differential Geometry and Statistics: Examples and Applications.

Bhattacharya, Soumya, CIRM, Trento (06.04.2015): Factorization of Holomorphic Eta Quotients.

Biswas, Arunangshu, Presidency University (19.06.2015): On some recursive equations in Probability & Statistics.

Chakraborty, Anirvan, Ecole Polytechnique Federale de Lausanne (EPFL) (07.01.2015): Hybrid regularization for functional linear regression.

Chandgotia, Nishant, University of British Columbia (29.07.2015): Homotopy of Paths on Graphs.

Chandgotia, Nishant, University of British Columbia (26.08.2015): Entropy Minimality and Four-Cycle Free Graphs.

Chaudhuri, Sanjay, National University of Singapore (10.07.2015): Hamiltonian Monte Carlo in Bayesian empirical likelihood computation.

Chéritat, Arnaud, Université Toulouse III - Paul Sabatier (21.03.2016): Straightening the square (MC).

Choudhury, Utsav, RKMU, Belur (16.09.2015): Hodge Theory.

Choudhury, Utsav, RKMVU (12.08.2015): Hodge Theory.

Conferences and Seminars

Cipriani, Alessandra, WIAS, Berlin, Germany (08.04.2015): Thick points for generalized Gaussian fields with different cut-offs.

Das, Soumya, IISc., Bangalore (16.11.2015): Koecher-Maass series of Siegel modular forms.

Ghosh, Anish, TIFR, Mumbai (19.08.2015): Dynamics on homogeneous spaces of Lie groups and number theory.

Ghosh, Sourav, Universite Paris Sud (02.09.2015): Thermodynamics of Margulis Space Time.

Ghosh, Sourav, Universite Paris Sud (09.09.2015): Thermodynamics of Margulis Space Time.

Goswami, Subhajit, University of Chicago (20.01.2016): Percolation of averages in the stochastic mean field model: the near-supercritical regime.

Hollander, Frank den, Universiteit Leiden, the Netherlands (19.01.2016): Breaking of Ensemble Equivalence in Complex Networks.

Holowinsky, Ohio State University (07.12.2015): The development of the delta method.

Holowinsky, Roman, Ohio State University (07.12.2015): The development of the delta method.

Jana, Subhajit, Department of Mathematics, University of British Columbia (08.06.2015): Eigen function estimate on congruence hyperbolic manifolds.

Kulkarni, Dheeraj, RKMVU, Belur (11.01.2016): Relative Symplectic Caps, 4-Genus and Fibered Knots.

Madan, Shobha, Department of Mathematics and Statistics, IIT, Kanpur (11.09.2015): On the rationality of spectra.

Mandal, Satya, University of Kansas (18.03.2016): Complete Intersections.

Miron, Paulo, Cesar, Manrique, CIMAT, Mexico (17.04.2015): On the singularity of random matrices.

Mohanty, Parasar, IIT, Kanpur (07.03.2016): Bird's-eye view of A_2 conjecture- Now a Theorem (MC).

Mohanty, Parasar, IIT, Kanpur (08.03.2016): Boundedness of one-sided maximal function without covering theorems.

Mukherjee, Sumit, Columbia University (11.01.2016): Inference in Ising Models.

Paul, Debashis, University of California, Davis (04.09.2015): Nonparametric estimation of dynamics of monotone trajectories.

Poddar, Mainak, Universidad de los Andes, Colombia (04.06.2015): Toric principal bundles.

Rajan, C.S, TIFR Mumbai (22.03.2016): Can one almost hear the shape of a drum.

Singh, Saurabh, Kumar, School of Mathematics TIFR, Mumbai (15.01.2016): Elementary sieve Method.

Spreer, Jonathan, School of Mathematics and Physics University of Queensland, Australia (05.11.2015): Algorithms and complexity for Turaev-Viro invariants.

Vershik, Anatoly, Laboratory of Representation Theory and Dynamical Systems, St. Petersburg Department of Steklov Institute of Mathematics Russia (13.01.2016): Decreasing filtrations of the sigma-fields and notion of standardness.

Vinayak, Jawaharlal Nehru University (17.02.2016): Wishart Models of the Random Matrix Theory.

Stat-Math Unit, Delhi

Beer, Gerald, California State University Los Angeles (22.04.2015): Graphical convergence of continuous functions.

Bhatnagar, Gaurav, Educomp Solutions Ltd. (31.07.2015): How to prove Ramanujan's q- continued fractions.

Brug, Tim van de, VU University Amsterdam (02.03.2016): Random walk loop soups and conformal loop ensembles.

Camia, Federico, New York University and VU University Amsterdam (24.02.2016): Limit Theorems and Random Fractal Curves in Statistical Mechanics.

Chandgotia, Nishant, University of British Columbia (15.09.2015): Entropy Minimality and Four-Cycle Free Graphs.

Chaudhuri, Ritwik, IBM Research (10.11.2015): Non-Gaussian semi-stable distributions and their statistical applications.

Dalawat, Chandan, Harish-Chandra Research Institute (19.02.2016): Higher reciprocity laws.

Dalawat, Chandan, Harish-Chandra Research Institute (17.02.2016): The general reciprocity law.

Goyal, Sarika, Indian Institute of Technology, Delhi (08.04.2015): Nehari Manifold and Fibration map analysis for Elliptic Partial Differential Equations.

Guin, Satyajit, Indian Statistical Institute Delhi (02.09.2015): On the differential calculi of Connes and Frohlich et al in Noncommutative Geometry.

Gupta, Ankit, ETH Zurich (19.01.2016): Understanding the long-term behavior of stochastic biochemical reaction networks: Analysis and Applications.

Hofstad, Remco van der, Eindhoven University of Technology (05.11.2015): Scale-free percolation.

Hofstad, Remco van der, Eindhoven University of Technology (04.11.2015): Recent progress in high-dimensional percolation.

Hofstad, Remco van der, Eindhoven University of Technology (02.11.2015): The structure of complex networks.

Hollander, W. T. Frank den, Leiden University (07.01.2016): How porous is a Brownian Motion?

Hollander, W. T. Frank den, Leiden University (06.01.2016): Metastability for Interacting Particle Systems.

Krishnapur, Manjunath, Indian Institute of Science (30.09.2015): Collisions between random walks.

Conferences and Seminars

Krishnapur, Manjunath, Indian Institute of Science (29.09.2015): Gap probability in Gaussian processes.

Kumar, Chaman, Ramjas College (05.08.2015): Tamed Euler schemes of SDES (SDDDES) driven by Levy noise.

M, Aneesh, Indian Institute of Technology Kanpur (09.09.2015): Hypercyclicity and Frequent Hypercyclicity.

Patankar, Vijay M., Jawaharlal Nehru University (16.09.2015): Pairs of elliptic curves and their Frobenius fields.

Pazuki, Fabien, University of Copenhagen (21.10.2015): Bad reduction of curves with CM jacobians.

Ramakrishnan, B., Harish-Chandra Research Institute (16.03.2016): On modular forms of half-integral weight.

Sepulchre, Rodolphe, University of Cambridge (20.01.2016): The geometry of algorithms with rank and positivity constraints.

Shorey, T.N., IIT Bombay (01.09.2015): Product of factorials being a factorial.

Sofi, M.A., Kashmir University (13.01.2016): In search of infinite dimensional analogues of certain finite dimensional properties in Banach spaces.

Trihan, Fabien, Sophia University (22.02.2016): On the BSD and Iwasawa conjecture over global field of characteristic $p > 0$.

Varadhan, S. R. Srinivasa, New York University (15.02.2016): Large Deviations for Brownian local times. A second look.

Vershik, Anatoly, Steklov Institute of Mathematics and St. Petersburg State University (25.01.2016): The problem about invariant measures in probability theory and algebra.

Waldschmidt, Michel, Université Pierre et Marie Curie, Paris (VI) (22.12.2015): Linear recurrence sequences and Diophantine questions.

Stat-Math Unit, Bangalore

Banerjee, Tathagata, University of Goettingen, Germany (21.12.2015): Coarse geometry for noncommutative spaces.

Belton, Alexander, University of Lancaster, UK (21.12.2015): Matrix positivity preservers in fixed dimension.

Bhosle, Usha, IISc., Bangalore, (21.05.2015): Higgs bundles on singular curves.

Camia, Federico, NYUAD, UAE (29.02.2016): Non-backtracking Loops and Statistical Mechanics on Spin Networks.

Chandgotia, Nishant, The University of British Columbia, Canada (17.08.2015): Entropy Minimality in Dynamical systems.

Chatterjee, Pralay, IMSc., Chennai (20.08.2015): Abstract homomorphisms of linear algebraic groups.

Das, Omprakash, TIFR, Mumbai (26.11.2015): Higher Dimensional Minimal Program (MMP) or Mori Program in Characteristic $p > 0$.

Dorazio, Robert M., U.S. Geological Survey and University of Florida, USA (17.12.2015): Using Bayesian Methods in the Analysis of Ecological Data-Opportunities and Challenges.

Gandolfi, Alberto, NYUAD, UAE and University of Firenze, Italy (29.02.2016): Correlation functions of Brownian loops based conformal operators.

Giri, Sumit, IMSc., Chennai (15.09.2015): Distribution of a Prime Counting Function Corresponding to Elliptic Curves.

Gopalan, Aditya, IISc., Bangalore (12.10.2015): Sequential decision making in stochastic environments.

Gopalaswamy, Arjun, University of Oxford, UK (15.03.2016): Big Cats but Little Questions.

Hofstad, Remco van der, Eindhoven University of Technology, Netherlands (09.11.2015): Metric convergence of critical scale-free random graphs.

Hollander, Frank den, Mathematical Institute, Universiteit Leiden, Netherlands (11.01.2016, 13.01.2016 and 14.01.2016): How does a charged polymer Collapse? and a mini-course on Large Deviations.

Jana, Subhjit, University of British Columbia, Canada (18.08.2015): Eigen function estimate on congruence hyperbolic manifolds.

Joseph, Mathew, University of Sheffield, UK (30.07.2015): Longest increasing path within the critical strip.

Jurczynski, Mateusz, Lancaster University, UK (01.10.2015): Multiple quantum Wiener integrals in noncommutative probability.

Koestler, Claus, University College Cork, Ireland (09.12.2015): Characterization of extremal characters of the Thompson group F .

Kulakarni, S.H., IIT, Chennai (15.06.2015): The Null space theorem.

Maddaly, Krishna, IMSc., Chennai (18.06.2015): Eigenvalue statistics.

Mishra, Manish, University of Heidelberg, Germany (16.11.2015): Hecke algebras and Langlands program.

Mukherjee, Ritwik, TIFR, Mumbai (04.12.2015): Enumerative Geometry of rational cuspidal curves on del-Pezzo surfaces.

Mukunda, N., IISc., Bangalore (22.03.2016): Developments of quantum mechanics – a story of people, places and philosophies.

Ouknine, Youssef, Cadi Ayyad University, Morocco (06.08.2015): On the study of processes of classes $\Sigma(H)$ and $\Sigma_g(H)$.

Conferences and Seminars

Parameswaran, A.J., TIFR, Mumbai (28.05.2015): Auto-duality for compactified Jacobian of a nodal curve.

Patnaik, Manish, University of Alberta, Canada (11.08.2015 and 13.08.2015): Automorphic Forms on Loop Groups.

Pera, Keerthi Madapusi, University of Chicago, USA (10.09.2015 and 18.09.2015): Periods and L -functions & an averaged version of a conjecture of Colmez.

Reddy, Nanda Kishore, IISc., Bangalore (14.03.2016): Asymptotic equality of eigenvalues and singular values for products.

Rollin, Adrian, National University of Singapore, Singapore (19-06.2015): Fundamentals of Stein's Method.

Sebastian, Ronnie M., IISER, Pune (24.06.2015 and 29.06.2015): Lectures on a paper by M.Nori : Algebraic cycles and Hodge theoretic connectivity.

Sampath, Kannappan, Queens University, Canada (07.07.2015): Asymptotic formula for the Fourier coefficients of the j -function.

Shorey, T.N., IIT-Bombay, Mumbai (23.09.2015): The product of two factorials being a factorial.

Thoppe, Gugan, TIFR, Mumbai (25.08.2015): A concentration bound for stochastic approximation via Alekseev's formula.

Tyagi, Himanshu, IISc., Bangalore (27.04.2015): Estimation of Renyi Entropy.

Vanchinathan, P., VIT University, Chennai (25.02.2016): Chinese Remainder Theorem in Mathematics, Radars and Cryptography.

Verma, Kaushal, IISc., Bangalore (16.04.2015): An introduction to quadrature domains.

Winter, Anita, University of Duisburg-Essen, Germany (12.10.2015): Evolving phylogenies of trait-dependent branching with mutation and competition.

Stat-Math Unit, Chennai

Dolai, Dhriti Ranjan, Institute of Mathematical Sciences, Chennai. (24.08.2015): Spectral Statistics of Random Schrodinger Operators with Unbounded Potentials.

Ganesh, Department of Statistics, Pondicherry University (13.05.2015): A Mathematical Programming View in solving Multi Criteria Decision Aid problems.

Janardhanan, Jaikrishnan, Indian Institute of Technology Madras (25.06.2015): The Jordan--Schoenflies Theorem and Applications.

Jayanta Kumar Ghosh, Department of Statistics, Purdue University U.S.A, (19.02.2016): History of ISI.

Manuel, Amal Dev, University of Warsaw (04.02.2016): Combinatorial expressions and lower bounds.

Raut, Laxmi Kant, Office of Policy, Division of Economic Research, USA(19.02.2016): Intergenerational long-term effects of preschool-structural estimates from a discrete dynamic programming model.

Sankaranarayanan, Rajesh, Indian Institute of Technology Madras, Chennai (04.06.2015): Fixed point theorems for commuting family of isometry mappings.

Sharma, Arun, Indian Institute of Technology Madras (23.11.2015): Subordinated Stochastic Processes.

Sahoo, Swadesh Kumar, IIT Indore (23.03.2016): On quasihyperbolic metric and its importance.

Applied Statistics Division

Applied Statistics Unit, Kolkata

Alfred Menezes, Department of Combinatorics & Optimization, University of Waterloo, Waterloo, Ontario, Canada (21.03.2016): An Introduction to Isogeny-Based Cryptography.

Banerjee, Moulinath, Department of Statistics, University of Michigan, Ann Arbor, MI, USA (01.09.2015): Inference for Monotone Functions under Short and Long Range Dependence: Confidence Intervals and New Universal Limits.

Basu, Analabha, National Institute of of Biomedical Genomics, Kalyani, Nadia, India (01.03.2016): Extant ethnic populations of India: Genetic history of their ancestry, admixture and endogamy.

Bhattacharjee, Arnab, School of Management & Languages; Accountancy, Economics and Finance, Heriot-Watt University, Edinburgh, UK (19.12.2015): Spatially Varying Regression Over Irregularly Shaped Regions: Application to a Hedonic House Price Model.

Bhattacharjee, Sanjay, ENS-Lyon, France (08.10.2015): Tree-based symmetric key broadcast encryption.

Datta, Somnath, Department of Biostatistics, University of Florida, FL, USA (18.12.2015): A nonparametric analysis of waiting times from a multistate model using a novel linear hazards model approach.

Dey, Tanujit, Department of Quantitative Health Sciences, Cleveland Clinic, Cleveland, OH, USA (12.05.2015): Variable Screening, Selection and Prediction in High Dimensions.

Ghosh. Malay, Department of Statistics, University of Florida, FL, USA (14.12.2015): Bayesian Multiple Testing for Monotone Polynomial-Tailed Distributions.

Ghoshal, Subhashis, Department of Statistics, North Carolina State University, Raleigh, NC, USA (17.12.2015): A Bayesian Quantile Regression Analysis of Severity of Atlantic Hurricanes and US Urbanization.

Hassan, Sk. Sarif, International Centre for Theoretical Sciences, Tata Institute of Fundamental Research, Data Assimilation & Dynamical Systems group, Bangalore, India (19.05.2015): Complex Dynamics of Nonlinear Difference Equations.

Kundu, Subrata, Department of Statistics, George Washington University, Washington, DC, USA

Conferences and Seminars

(04.08.2015): Some Remarks on Generalizations of the Likelihood Function and the Likelihood Principle.

Paul, Debashis, Department of Statistics, University of California, Davis, CA, USA (05.01.2016): Modeling tangential vector fields on the sphere.

Roy, Sandipan, Department of Statistical Science, University College London, UK (28.07.2015): Change-point Estimation in High-dimensional Markov Random Fields.

Interdisciplinary Statistical Research Unit, Kolkata

Banerjee, Mousumi, Department of Biostatistics, University of Michigan, Ann Arbor, MI, USA (11.02.2016): Understanding treatment delivery for kidney cancer using trees and forest.

Basu, Pallavi, University of Southern California, Los Angeles, CA, USA (27.08.2015): Weighted False Discovery Rate Control in Large-scale Multiple Testing.

Dutta, Susmita, Department of Biostatistics, University of Florida, FL, USA (18.12.2015): Improved Protein Inference from Tandem Mass Spectrometry Data.

Hazra, Arnab, Department of Statistics, North Carolina State University, Raleigh, NC, USA (25.06.2015): A Covariate-dependent Bayesian Spatial Model for Left-Censored Arsenic Contamination Data.

Hazra, Arnab, Department of Statistics, North Carolina State University, Raleigh, NC, USA (29.12.2015): The "Sorrow of Bengal" and an Unsolved Problem: A Bayesian Multivariate GEV Model Analysis of Extreme River Inflow at a Reservoir-Network.

Kumar, Arun, University of Pennsylvania, Philadelphia, PA, USA (05.01.2016): Revisiting Huber's M-Estimator: Uniform Asymptotics.

Lahiri, Ananya, Chennai Mathematics Institute, Chennai, India (14.05.2015): On estimation of model parameter of multicomponent chirp signal.

Shmueli, Galit, National Tsing Hua University, Taipei, Taiwan (08.02.2016): Information Quality: A Framework for Evaluating Empirical Studies.

Applied Statistics Unit, Chennai

Ganesh, Department of Statistics, Pondicherry University, Puducherry (13.05.2015): A Mathematical Programming View in solving Multi Criteria Decision Aid problems.

Ghosh, Jayanta Kumar, Department of Statistics, Purdue University, Purdue, IN, USA (19.02.2016): History of ISI.

Gupta, Ashmita, Indian Statistical Institute, Chennai Centre (09.07.2015): The effect of trade liberalization on gender inequality: the case of India.

Raut, Laxmi Kant, Office of Policy, Division of Economic Research, U. S. A. (19.02.2016): Intergenerational long-term effects of preschool-structural estimates from a discrete dynamic programming model.

Sharma, Arun, Indian Institute of Technology Madras, Chennai (23.11.2015): Subordinated Stochastic Processes.

Computer and Communication Sciences Division

Advanced Computing and Microelectronics Unit, Kolkata

Bhattacharya, Binay K., Simon Fraser University, Canada (29.02.2016): Facility locations in dynamic networks.

Chandgotia, Nishant, University of British Columbia (27.08.2015): Finite Diameter of the path space in Graphs.

Gaur, Daya Ram, University of Lethbridge, Canada (18.11.2015): Approximation Algorithms for Cumulative VRP with Stochastic Demands'.

Mishra, Prabhat, Department of Computer Information Science and Engineering, University of Florida, (05.08.2015): Energy-Aware Computing: Dynamic Reconfiguration in Real-Time Systems'.

Potluri, Seetal, Dept. Of EE, IIT Madras (21.04.2015): 'A Scan Chain design technique for thermal control during digital chip testing'.

Roy, Shaibal, Co-Founder& CEO, Applied Research Works. Ph.D., (CS) Stanford University (30.10.2015): Big Data for A very Big Problem.

Roy, Nirmalya Assistant Professor, University of Maryland Baltimore County (UMBC) (15.01.2016): May I live independently with IoT and Machine Learning.

Sanyal, Debarshi Kumar, School of Computer Engineering KIIT University, Bhubaneswar (05.02.2016): Performance Enhancement of Wireless Networks Using Game Techniques.

Computer Vision and Pattern Recognition Unit, Kolkata

Eskenazi, Sébastien, Campus Numérique et Système d'Informations, l'Université de la Rochelle, France (22.02.2016): On the stability of document and image analysis algorithms.

Joshi, Amitabh, JNCASR, Bengaluru (04.12.2015): Evolutionary biology in the laboratory: a tale of two densities.

Lladós, Josep, Computer Vision Center, Universitat Autònoma de Barcelona, Spain (12.09.2015): Word spotting tools in genealogy retrieval from historical handwritten records

Ogier, Jean-Marc, Campus Numérique et Système d'Informations, l'Université de la Rochelle, France (22.12.2015): Document Engineering-From Image Processing to Semantic Analysis and Indexing.

Electronics and Communication Sciences Unit, Kolkata

Basak, A., Carnegie Mellon University, USA (20.01.2016): Scalable Causal Learning for Predicting Adverse Events – A Machine Intelligence.

Brunvand, E., School of Computing, University of Utah, USA (07.01.2016): Computational Thinking Meets Design Thinking: Technology and Arts Collaborations.

Conferences and Seminars

Chakraborty, R., University of Florida (21.12.2015): Recursive Computation of the Riemannian Center of Mass on Riemannian Manifolds.

Chattopadhyay, A., School of Computing, University of Leeds, UK (13.04.2015): Topological Data Analysis and Certified Geometry.

Majumdar, A., Indraprastha Institute of Information Technology, Delhi (23.12.2015): Representation Learning a.k.a Deep Learning & Dictionary Learning.

Saha, B. N., CIMAT, Monterrey, Mexico (22.12.2015): Automated Histopathological Image Analysis to Predict Breast Cancer Disease survival and Recurrency.

Machine Intelligence Unit, Kolkata

Chakraborty, Debjani, Indian Institute of Technology, Kharagpur (15.09.2015): Fuzzy Geometry In Solving Multi Criteria Decision Making(MCDM) Problems.

Chaudhury, Santanu, Indian Institute of Technology, Delhi (15.09.2015): Hybrid Deep Learning.

Datta, Biswa Nath, IEEE Fellow Distinguished Research Professor, Northern Illinois University DeKalb, Illinois 60115 USA (10.11.2015): Recent Advances on Computational and Optimization Methods for Active Vibration Control and Finite Element Model Updating : Linking Mathematics to Engineering.

Hanmandlu, Madasu, Indian Institute of Technology, Delhi (15.09.2015): A journey from Fuzzy Sets to Information Sets.

Mohanty, Debasisa, National Institute of Immunology, Delhi (30.03.2016): In silico Analysis of Protein Interaction Networks Using Multi-scale Modelling Approach.

Mishra, Gaurav, Enterprise Business Head – North and East, Nvidia (30.07.2015): An interactive seminar/meeting on GPU Computing by Nvidia.

Mitra, Pabitra, Indian Institute of Technology, Kharagpur (30.03.2016): Deep Learning.

Mitra, Suman K., DA-IICT, Gandhinagar, Gujrat (30.03.2016): 2-Dimensional Orthogonal Locality Preserving Projection and its Application to Image Denoising.

Panda, Ganapati, Indian Institute of Technology, Bhubaneswar (15.09.2015): Novel Applications of Soft and Evolutionary Computing Techniques.

Touati, Corinne, LIG Lab UMR 5217, INRIA, Grenoble, France (01.01.2016): Game theory and Potential games: A short introduction.

Tiago, José Carlos, University of Evora, Portugal (06.04.2015): The five-fold way from arts to mathematics.

Documentation Research and Training Centre, Bangalore

Banerjee, Indrajit, Director, Knowledge Societies Division (CI/KSD), Communication and Information Sector (CI), UNESCO, Paris (04.01.2016): The Role of International Organizations in Building Knowledge Societies.

Conferences and Seminars

Keizer, Johannes, Strategic Partnership Lead GODAN Secretariat, UNFAO, Rome, Italy (07.10.2015): Global Open Data in Agriculture and Nutrition, a new frontier for achieving food security.

Kim, Eungi, Assistant Professor, Dept. of Library and Information Science, Kei-Myung University, Daegn, South Korea (08.06.2015): Learning and Using Regular Expression.

Neupane, Bhanu R., Programme Specialist, Communication and Information Sector (CI), UNESCO, Paris (19.03.2016): Information Related Activities of UNESCO.

Oh, Dong-Geun, Professor and Chairperson, Dept. of Library and Information Science, Kei-Myung University, Daegn, South Korea (08.06.2015): Why the Library Customers Complain to the Libraries?

Ritter, Waltraut, Knowledge Dialogues, Applied Knowledge Society Research Hong Kong and Berlin, Germany (25.08.2015): Libraries as Public Innovation Spaces; (14.01.2016): Open Data in Asia; (18.1.2016): Data Ownership and Valuation of Big Data.

Sahoo, Bibhuti Bhusan, Deputy Librarian, IIT, Bhubaneswar (19.02.2016): Vision for Developing a World Class Library System.

Systems Science and Informatics Unit, Bangalore

Melba, M. Crawford, Purdue University, USA (27.02.2016): Adaptive Manifold Learning for Classification of Hyperspectral Data.

Melba, M. Crawford, Purdue University, USA (27.02.2016): Active Learning Strategies for Classification of Hyperspectral Data.

Paul, Rosen, Jet Propulsion Laboratories (JPL), NASA-Caltech, USA (23.11.2015): Big Mission, Big Data, Big Science: The NASA-ISRO SAR Mission and the Use of Statistical and Machine Learning Techniques for Science and Data Analytics.

Computer Science Unit, ISI Chennai

Altland, Alex A., University of Cologne (26.02.2016): Topological Anderson insulators.

Dolai, Dhriti Ranjan, Institute of Mathematical Sciences, Chennai (24.08.2015): Spectral Statistics of Random Schrodinger Operators with Unbounded Potentials.

Ganesh, Department of Statistics, Pondicherry University (13.05.2015): A Mathematical Programming View in solving Multi Criteria Decision Aid problems.

Janardhanan, Jaikrishnan, Indian Institute of Technology Madras (25.06.2015): The Jordan--Schoenflies Theorem and Applications.

Jayanta Kumar Ghosh, Department of Statistics, Purdue University U.S.A, (19.02.2016): History of ISI.

Manuel, Amal Dev, University of Warsaw (04.02.2016): Combinatorial expressions and lower bounds..

Raut, Laxmi Kant, Office of Policy, Division of Economic Research, U. S. A. (19.02.2016): Intergenerational long-term effects of preschool-structural estimates from a discrete dynamic programming model.

Conferences and Seminars

Sankaranarayanan, Rajesh, Indian Institute of Technology Madras, Chennai (04.06.2015): Fixed point theorems for commuting family of isometry mappings.

Sharma, Arun, Indian Institute of Technology Madras (23.11.2015): Subordinated Stochastic Processes.

Sahoo, Swadesh Kumar, IIT Indore (23.03.2016): On quasihyperbolic metric and its importance.

Physics and Earth Sciences Division

Geological Studies Unit, Kolkata

Ezcurra, Martin. D., University of Birmingham, U. K. (13.05.2015): Chilesaurus: an enigmatic plant-eating dinosaur from the Jurassic of South Africa.

Gierlowski-Kordesch, Elizabeth, Department of Geological Sciences, Ohio University, USA. (13.01.16) Carbonates in Provenance Analysis; (14.01.16) Sedimentology of Lacustrine and Palustrine Carbonates.

Marczewski-Newman, Tess, Lancaster University, U. K. (20.04.2015): Nitrate and phosphate pollution: are the East Kolkata wetland being overloaded with nutrients?

Physics and Applied Mathematics Unit, Kolkata

Basu, Rudranil, IISER, Pune (18.09.2015): Flat space holography: field theory and gravitational aspects.

Chatterjee, Arindam, Harish Chandra Research Institute (HRI), Allahabad (15.09.2015): Search for Supersymmetry: Some avenues less explored.

Das, Prasanta Kumar, Department of Physics, BITS-Pilani, K K Birla Goa (01.06.2015): Associated Higgs production with a Z boson in the Non-commutative standard model.

Ghosh, Somnath, Centre of Advanced Study in Radio Physics & Electronics, University of Calcutta (27.04.2015): Exploring novel quantum phenomena in photonic settings: from fundamentals to technological applications.

Ghosh, Sibasish, Institute of Mathematical Sciences, Chennai, (13.05.2015): Universal detection of bipartite entanglement in measurement-device independent way.

Ghosh, Sibasish, Institute of Mathematical Sciences, Chennai (21.03.2016): Qubit thermalization in the presence of two-qubit interactions; (22.03.2016): A necessary condition for local distinguishability of two-qudit maximally entangled states completely characterizes that of the generalized Bell states for $d=4$.

Lakshmanan, M., Centre for Nonlinear Dynamics, Bharathidasan University, Tiruchirapalli (24.04.2015): Generating finite dimensional integrable nonlinear dynamical systems and their quantization.

Conferences and Seminars

Modak, K. Sujoy, KEK High Energy Accelerator Research Organization, Japan (21.12.2015): Dynamical state reduction models: pedagogic introduction and advantages.

Parmananda, Punit, Department of Physics, Indian Institute of Technology, Bombay (08.07.2015): Collective dynamics of non-linear oscillators.

Raychaudhuri, Sreerup, Department of Physics, Tata Institute of Fundamental Research (TIFR), Mumbai (06.01.2016): Colloquium on 'The v Story'.

Sinha, Anjana, Department of Instrumentation Science, Jadavpur University, Kolkata (11.05.2015): PT symmetric optical lattices: some intriguing features.

Social Sciences Division

Economic Research Unit, Kolkata

Banerjee, Anurag, Department of Economics, University of Durham, United Kingdom (14.07.2015): What has the Afghanistan War to do with Soccer? The Endgame.

Bhattacharyya, Aditi, Department of Economics and International Business, Sam Houston State University, USA (16.07.2015): A Generalized Stochastic Frontier Analysis of Technical Efficiency of Rice Farming: A Case Study from Assam, India.

Bhattacharjee, Arnab, Professor of Economics and Director, Spatial Economics & Econometrics Centre (SEEC), Heriot-Watt University, Edinburgh, United Kingdom (07.01.2016, 20.01.2016 & 21.01.2016): Spatial Econometrics: Introduction and Recent Developments.

Basu, Deepankar, Department of Economics, University of Massachusetts, Amherst, MA 01003, USA (28.01.2016): Social Hierarchies and Public Distribution of Food in Rural India.

Bhaskar, Umang, Tata Institute of Fundamental Research, Mumbai (28.03.2016): Optimal Signaling in Bayesian Games.

Chatterjee, Kalyan, Department of Economics, The Pennsylvania State University, USA (09.07.2015): Bilateral Trading with Incomplete Information and Outside Options.

Chatterjee, Somdeep, Department of Economics, University of Houston (21.05.2015): Do People Vote to Make a Statement? Theory and Evidence of Expressive Voting from India.

Dixit, Avinash, Department of Economics, University Professor of Economics Emeritus, Princeton University, USA (15.12.2015): Dynamics of Rent-Sharing to Avoid Violence.

Ghosh, Arghya, School of Economics, UNSW Business School, University of New South Wales, Sydney, NSW 2052, Australia (23.07.2015): Voting on Infrastructure Investment: The Role of Product Market Competition.

Kejriwal, Mohitosh, Department of Economics, Krannert School of Management, Purdue University, USA (22.01.2016): Asymptotics for Estimators Dating the Origination and Termination of Explosive Behavior in a Time Series.

Konar, Abishek, Department of Economics, Observer Research Foundation (11.02.2016): Peer Effects and Farmer Heterogeneity in Tillage Choice.

Conferences and Seminars

Lahiri, Kajal, Distinguished Professor of Economics, Department of Economics, University of Albany, SUNY (19.01.2016): ROC Curve, Forecast Combination and Prediction of Rare Events.

Mohapatra, Debi Prasad, Department of Economics, Cornell University/University of Massachusetts at Amherst, MA 01003, USA (29.02.2016): Price Control and Access to Drugs: The Case of India's Malarial Market.

Mukherjee, Sacchidananda, National Institute of Public Finance and Policy (NIPFP), New Delhi (01.06.2015): Estimation of Unaccounted Income using Transport as a Universal Input: A Methodological Note.

Nandeibam, Shasikant, Department of Economics, University of Bath, United Kingdom (20.07.2015): Menu Contracts in Teams.

Roy, Jaideep, Department of Economics, Murdoch University, Australia (13.07.2015): Evaluating Expert Talent by Setting.

Sarkar, Agnirup, Durham Business School, United Kingdom (09.12.2015): Market Capitalisation, Growth and Inflation in a New-Keynesian Framework.

Yadav, Sonal, Universidad Carlos III de Madrid (13.08.2015): The Equivalence between Adjacent Non-Manipulability and Strategy-Proofness in Voting Domains: A Sufficiency Result.

Linguistic Research Unit, Kolkata

Claudia Lange, Institut für Anglistik und Amerikanistik, Technische Universität Dresden, Germany (18.02.2016): Indian English as a Linguistic Epicentre: The Evidence so far.

Population Studies Unit, Kolkata

Ghosh, Swati, Associate Professor, Department of Economics, Rabindra Bharati University (06.01.2016): Gender and Migration: From Feminist Theory Perspective.

Haldar, Sushil Kumar, Department of Economics, Jadavpur University, Kolkata (29.02.2016): Demographic Transition, Demographic Dividend and Economic Growth in India: Some Emerging Policy Issues.

Mukherjee, S.P., Former Professor, Department of Statistics, Calcutta University (16.02.2016): Population Estimation, Projection and Prediction.

Mukherjee, Simantini, Assistant Professor in Economics, Institute of Developmental Studies, Kolkata (27.01.2016): Intersectional Inequalities in Child Nutrition in India.

Sampling and Official Statistics Unit, Kolkata

Bhattacharjee, Arnab, Spatial Economics & Econometrics Centre (SEEC), School of Management and Languages, Heriot-Watt University, Edinburgh EH14 4AS, UK (14.01.2016): Spatial Diffusion of Fertility in Portugal: A Bayesian Approach for Spatial Clustering of Curves.

Das, Kishore Kumar, Guwahati University (29.07.2015): Quality Consideration in Rice Markets of West Bengal.

Gupta, Ashmita, Presidency College, Kolkata (15.10.2015): Effect of Trade Liberalization on Gender Inequality: The Case of India.

Mookherjee, Dilip, Boston University (24.07.2015): Political Competition and Clientelism in West Bengal Local Governments: Evidence from a Natural Redistricting Experiment.

Pal, Sarmistha, Department of Finance, University of Surrey, Guilford GU2 7XH, UK (27.07.2015): Public Pain and Private Gain: An Analysis of Moonlighting of Public Health Professionals.

Subramanian, Sreenivasan, ICSSR National Fellow, Madras Institute of Development Studies (06.04.2015): Group Inequalities and 'Scanlan's Rule': Two Apparent Conundrums and How We Might Address Them.

Economics and Planning Unit, Delhi

Abreu, Dilip, Princeton University, USA (31.07.2015): Bargaining with One-Sided Asymmetric Information and Non-stationary Behavioral Types.

Banerjee, Shraman, Southern Methodist University, USA (11.09.2015): Asymmetric Dynamic Price Mechanism for Symmetric Buyers.

Basak, Deepal, NYU, USA (03.02.2016): Transparency and Delay in Bargaining.

Bhattacharjee, Swagata, University of Texas, Austin, USA (22.01.2016): Contracting for Innovation under Ambiguity.

Bhattacharyya, Aditi, Sam Houston State University, USA (28.07.2015): A Generalized Stochastic Frontier Analysis of Technical Efficiency of Rice Farming: A Case Study from Assam, India.

Bloch, Francis, Universite Paris 1 and Paris School of Economics (18.03.2016): Dynamic assignment of objects to queuing agents.

Bond, Eric, Vanderbilt University, USA (13.11.2015): Bargaining over entry with a compulsory license deadline: Price spillovers and surplus expansion.

Bradford, Scott, Brigham Young University, USA (23.07.2015): A Global Analysis of Immigration Barriers' Effects on Poverty, Wages, and Output.

Burnett, Johann Caro, Yale University, USA (04.03.2016): Optimal Voting Rules in International Organizations, with an Application to the United Nations.

Chatterjee, Somdeep, University of Houston, USA (12.02.2016): Effects of Agricultural Credit Reforms on Farming Outcomes: Evidence from the Kisan Credit Card Program in India.

Chaturvedi, Rakesh, IIM, Udaipur (28.08.2015): Efficient Coalitional Bargaining with Noncontingent Offers.

Chaudhuri, Arka Roy, University of British Columbia, Canada (07.08.2015): Mandated Political Representation and Development Outcomes: Evidence from India.

Coffey, Diane, RICE Institute, USA (20.11.2015): Sanitation, disease and anemia: Evidence from Nepal.

Conferences and Seminars

De, Sankar, Shiv Nadar University (18.09.2015): Financial Development and Domestic Conflict: Can Finance Combat Conflict?

Deshpande, Ashwini, DSE (09.10.2015): Caste Identity and Institutions: Perceptions About Remunerative Earnings from Self-Employment in India.

Dhillon, Amrita, King's College London, U.K. (21.08.2015): The natural resource curse revisited: theory and evidence from India.

Dimri, Aditi, CORE, Université catholique de Louvain and Paris School of Economics (29.01.2016): Patrilocality Norm & Household decision-making: Does the presence of in-laws affect married women in India?

Dubey, Ram Sewak, Montclair State University, USA (24.07.2015): Ramsey Equilibrium with Liberal Borrowing.

Dutta, Bhaskar, Warwick University, UK (2.09.2015): Rumours.

Dutta, Prajit K., Columbia University, USA (27.01.2016): Unique and Optimal Perfect Equilibrium.

Khwaja, Ahmed, Yale University, USA (14.08.2015): Firm Expansion, Size Spillovers and Market Dominance in Retail Chain Dynamics.

Kishor, Kundan, University of Wisconsin – Milwaukee, USA (15.01.2016): The Role of Inflation Expectations, Core Inflation, and Slack in Real-Time Inflation Forecasting.

Krishnaswamy, Karuna, GIZ, Germany (05.02.2016): An experimental evaluation of IFMR Rural Channel's financial education programme.

Kumar, Rishabh, The New School, USA (23.03.2016): Aggregate demand and long run limits to wealth concentration.

Manghnani, Ruchita, UNC, Chapel Hill, USA (16.03.2016): Exports and Productivity: The Role of Imported Inputs and Investment in R & D.

Narayanan, Abhinav, University of Georgia, USA (19.02.2016): Understanding informal employment in India: Competitive choice or a result of labor market segmentation?

Prakash, Nishith, University of Connecticut, USA (09.03.2016): Do Criminally Accused Politicians Affect Economic Outcomes? Evidence from India.

Sander, Frederico Gil, World Bank (04.12.2015): India Development Update October 2015: Fiscal Policy for Equitable Growth.

Serizawa, Shigehiro, Osaka University, Japan (10.03.2016): Efficiency and strategy-proofness in object assignment problems with multi-demand preferences.

Sethi, Rajiv, Barnard College, Columbia University, USA (23.06.2015): Wishful Thinking, Manipulation, and the Wisdom of Crowds: Evidence from a Political Betting Market.

Spears, Dean, RICE Institute, USA (16.10.2015): Policy implications of population ethics in a world of climate change.

Subramanian, Arvind, Chief Economic Adviser, Ministry of Finance (22.05.2015): Revisiting Convergence and the Middle Income Trap.

Economic Analysis Unit, Bangalore

Asha, Kuzhiparambil, NIAS Bangalore (18.09.2015): Secondary Circuit of Globalisation: Case of Odisha Labour for Garment Production in Kerala, India.

Bajar, Sumedha, NILERD, Delhi (19.10.2015): The Impact of infrastructure Provisioning on Inequality: Evidence from India.

Bhargava, Alok, Univeristy of Maryland School of Public Policy (04.01.2016): Diest Quality, child health and food policies in developing countries.

Banerjee, Debosree, Institute of Economic Growth, Delhi (21.05.2015): Running for Leadership: Evidence from an artegactual field experiment in matrilineal and patriarchic societies in India.

Basu, Sujata, JNU, Delhi (27.07.2015): Intergenerational Mobility, Human Capital Composition and Distance to Technological Frontier.

Dhar, Niladri S, TISS, Tuljhapur (14.10.2015): On Data base on Labour in India.

Murari, Kamal & Jayaraman, T., Tata Institute of Social Sciences, Mumbai (10.04.2015): Analysis of Fertiliser use from district level date for Andhra Pradesh.

Pais, Jesim, Institute for Studies in Industrial Development, New Delhi (01.03.2015): Industrial Labour and rural-urban linkages: A study from Ludhiana.

Periaswami, P., Bharathiyar University, Coimbatore (02.11.2015): On Economic Value of Health Impact: A case study of Sago Industrial Pollution in Salem District, Tamil Nadu.

Sadashivappa, Prakash, (20.11.2015): Adoption and Impacts of Transgenic Bt. Cotton Technology in India- A Panel Data Approach.

Shindo, Junko, Japan (10.04.2015): Village-level nitrogen cycle in India: A Study based on primary data.

Thomas, Jayan Jose, IIT, Delhi (03.11.2015): Data sources on Industry in India.

Center for Soft Computing Research: A National Facility, Kolkata

Chakraborty, Suman, IIT Kharagpur, Kharagpur, West Bengal (29.02.2016): Future of Engineering: Engineering in 2050.

Das, Saurabh, Center for Soft Computing Research, ISI, Kolkata (15.07.2015): Radio remote sensing of precipitation and satellite communication.

Raychaudhuri, Barun, Presidency University, Kolkata (06.01.2016): Hyperspectral remote sensing and applications.

Stolkin, Rustam, University of Birmingham, U.K. (12.11.2015): Overview of vision and robotics research at University of Birmingham, UK.

5. SANKHYĀ

The internationally renowned journal *Sankhyā*, an official publication of the Indian Statistical Institute, was founded by Professor P.C. Mahalanobis in 1932 and began publication under his editorship. It is devoted to original research articles in Probability, Mathematical Statistics and Applied Statistics. Reviews and discussion articles on current research activity in the above areas are also published. A rigorous peer review process is followed for acceptance of articles submitted for publication in *Sankhyā*. Many seminal articles in Probability, Theoretical Statistics and Applied Statistics have appeared in *Sankhyā*. The journal is published in two separate series – Series A and Series B. Series A with two issues per year, one in February and the other in August, covers Probability and Theoretical Statistics, while Series B with two issues per year, one in May and the other in November, covers Applied and Interdisciplinary Statistics. The present Editorial Board (January 2016-2018) of *Sankhyā* is as follows:

Editor-in-Chief	: Dipak K. Dey, University of Connecticut, USA.
Series A Editors	: Krishna Athreya, Iowa State University, Ames, USA : Gopal K. Basak, Indian Statistical Institute, Kolkata, India : Alok Goswami, Indian Statistical Institute, Kolkata, India : Francisco Louzada, University of Sao Paulo, Sao Paulo, Brazil
Series B Editor	: Sudipto Banerjee, University of California, Los Angeles, USA : Bertrand Clarke, University of Nebraska, Lincoln, USA : Bani Mallick, Texas A & M University, College Station, USA : Sumitra Purkayastha, Indian Statistical Institute, Kolkata, India
Technical Editors	: Biswaranjan Behera, Indian Statistical Institute, Kolkata, India : Kiranmoy Das, Indian Statistical Institute, Kolkata, India
Technical Support	: Urmichhanda Bhattacharya, Indian Statistical Institute, Kolkata, India
Editorial Office Support	: Kajal De, Indian Statistical Institute, Kolkata, India : Elango Vinothini, Springer Journals Editorial Office, India

The Editorial Board in 2015 and earlier (2012- December 2015) of *Sankhyā* had been as follows:

Editor-in-Chief	: B.L.S. Prakasa Rao, C.R. Rao Advanced Institute of Mathematics, Statistics and Computer Science, Hyderabad, India
Series A Editors	: Alok Goswami, Indian Statistical Institute, Kolkata, India : Sourav Chatterjee, New York University, USA : Hemant Ishwaran, University of Miami, USA : Subhashis Ghosal, North Carolina State University, USA
Series B Editor	: Atanu Biswas, Indian Statistical Institute, Kolkata, India : Nilanjan Chatterjee, National Cancer Institute, USA : Hemant Ishwaran, University of Miami, USA : Lijian Yang, Michigan State University, USA
Technical Support	: Urmichhanda Bhattacharya, Indian Statistical Institute, Kolkata, India

Editorial Office Support : Kajal De, Indian Statistical Institute, Kolkata, India
 : Elango Vinothini, Springer Journals Editorial Office, India

Beginning 2010, Springer has entered into a co-publication agreement with the Institute and has taken over exclusive rights for the international distribution of the journal, in both prints and electronic editions. The editorial system is now completely electronic, that is, the entire process starting from submission of articles to editorial processing ending in final editorial decision for articles is now done on line. The free access to the electronic editions of *Sankhyā* is now expected to be available for all scientific workers of the Institute through Springer.

Since the time Springer took over, the international subscription sale volume has multiplied manifolds. The figures below on sale volume (in Indian Rupees) for the current year (2015-2016):

Series	Print Edition	Online Subscription	Other	Total	Royalty Received by ISI (After TDS)
A+B		26,41,906.94		26,41,906.94	
A	4,48,979.60	1,31,996.76	7,01,894.71	12,82,871.07	
B	4,48,983.12	1,29,271.53	6,84,913.73	12,63,168.38	
					19,82,603.00

The following issues have been published during April 2015 to March 2016:

May, 2015 : Volume 77, Part I, Series B [Both Electronic and Print Editions]
 August, 2015 : Volume 77, Part II, Series A [Both Electronic and Print Editions]
 November, 2015 : Volume 77, Part II, Series B [Both Electronic and Print Editions]
 February, 2016 : Volume 78, Part I, Series A [Both Electronic and Print Editions]

6. SCIENTIFIC PAPERS AND PUBLICATIONS

(Some Publications may have multiple entries due to collaboration across units)

Books Published

Theoretical Statistics and Mathematics Division

Stat Math Unit, New Delhi

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Statistical Quality Control and Operations Research Division

SQC&OR Unit, Hyderabad

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5. Dash, Niladri Sekhar and Aman, Atul: Generation of a Dialect Corpus in Khortha used in Jharkhand India: Some Empirical Observations and Theoretical Postulations, *Proceedings of the 31st South Asian Languages Analysis Roundtable (SALA-31)*, Dept. of Linguistics and English Language, Lancaster University, UK, 23-27, 2015.
6. Dash, Niladri Sekhar, Shukla, Devika and Pathak, Sayantani: Bangla Web Corpus: Crawling in the Web and Fishing with the Net, *Proceedings of the 43rd All India Conference of Dravidian Linguists (43-AICDL)*, Annamalai University, Annamalainagar, Tamil Nadu, India, 2015.
7. Dash, Niladri Sekhar, Selvaraj, Arulmozi and Hussain, Mazhar: Generating Translation Corpora in Indic Languages: Cultivating Bilingual Texts for Cross-Lingual Fertilization, *Proceedings of the 12th International Conference on Natural Language Processing (ICON-2015)*, Indian Institute of Information Technology and Management-Kerala (IIITM-K), Trivandrum, India, 231-240, 2015.
8. Pal, Alok Ranjan, Saha, Diganta, Naskar, Sudip and Dash, Niladri Sekhar: Word Sense Disambiguation in Bengali: A Lemmatized System Increases Accuracy of the Result, *Proceedings of the IEEE 2nd International Conference on Recent Trends in Information Systems (ReTIS-15)*, Dept. of Computer Science and Engineering, Jadavpur University, Kolkata, 342-346, 2015,

9. Pal, Alok, Dash, Niladri Sekhar and Saha, Diganta: An Innovative Lemmatization Technique for Bangla Nouns by Using Longest Suffix Stripping Methodology, *Proceedings of the International Conference on Computing and Network Communications (CoCoNet'15)*, IIITM-Ka, Trivandrum, Kerala, India, 681-684, 2015.
10. Vandana, Dash, Niladri Sekhar and Chakraborty, Jayshree: A Corpus Based Analysis of Hindi Newspaper Headlines Representing Specific Socio-cultural Practices, *Proceedings of the 31st South Asian Languages Analysis Roundtable (SALA-31)*, Dept. of Linguistics and English Language, Lancaster University, UK, 66-68, 2015.
11. Vandana, Dash, Niladri Sekhar and Chakraborty, Jayshree: Identifying Sources of Ambiguity in Hindi Newspaper Headlines, *Proceedings of the 43rd All India Conference of Dravidian Linguists (43-AICDL)*, Annamalai University, Annamalainagar, Tamil Nadu, India, 2015.

Psychology Research Unit, Kolkata

1. Ghosh, A.: Correlates of Academic Achievement in a Group of Primary School Students, *Proceedings of the 2nd International Conference on Social Sciences*, 2, 110-116, Online Version: DOI: 10.17501/ icos 2015-1112, 2015.

Economic Analysis Unit, Bangalore

1. Chattopadhyay, Molly: Women Workers in Coffee industry of India, *Proceedings of 2nd International Conference on Social Sciences*, Colombo (ICOSS), The International Institute of Knowledge Management, Sri Lanka, 5-14. ISSN: 2357-268, Online Version: DOI: 10.17501/ icos 2015-1103, 2015.
2. Chattopadhyay, Molly: Women in the Indian Mining Sector, *Annual conference by Indian Society of Labour Economics (5^{7th} ISLE)*, 230-232, Online Version: DOI: [http://www.isleijle.org/ theme-3-abstract-final-rev2.pdf](http://www.isleijle.org/theme-3-abstract-final-rev2.pdf), 2015.
3. Rajasekhara, H.M., Sanda, Ashok Vardhan and Daya Sagar, B.S.: Computations of Bi-variable spatial relationships between the political divisions of Karnataka, India via Mahalanobis Distance, *International Geoscience and Remote Sensing Symposium 2015 (IGARSS 2015)*, IEEE, Milan, Italy, 4518-4521, Online Version: DOI: 10.1109/IGARSS.2015.7326832, 2015.

Statistical Quality Control and Operations Research Division

SQC & OR Unit, Kolkata

1. Das, A.K., Deepmala and Jana, R.: On Some Generalized Convex Functions under Differentiability, *International Conference on Mathematical Sciences and Statistics (ICMSS2016)*, AIP Publication, 2016.

SQC & OR Unit, Coimbatore

1. Rajagopal, A. and Prasanth, M. Krishna: Statistical tool for identification of design variables and developing specification for design optimization from image processing and neural network for achieving functional performance of turbine housing, *Proceedings of 2015, International*

Publications

Conference on Soft Computing Techniques and Implementations (ICSCTI), Manav Rachna International University, Faridabad, IEEE, 78-82, ISBN: 978-1-4673-6790-5, Online Version: DOI: 10.1109/ ICSCTI .2015.7489608, 2015.

Library, Documentation and Information Sciences Division

Library, Kolkata

1. Paul, Pritam and Raychaudhury, Arup: Serial management through Koha. Towards implementing Koha among Libraries in Indian Subcontinent-Proceedings of IndKoha2016, *International Conference on Koha*, BLA, 55-64, 2016.

Center for Soft Computing Research: A National Facility, Kolkata

1. Ghosh, K., Mallick, A., Roy, S. and Bakshi, A.: Limitations of the ODOG filter in special cases of brightness perception illusions, *38th European Conference on Visual Perception (ECVP 2015)*, University of Liverpool, Publisher: Pion, *Perception*, **44(SI)**, ECVP Abstract Supplement, 252, 2015.
2. Paul, A., Mukherjee Paul, A. and Ghosh, K.: Communication converging towards adaptive intelligence: a survey, *Proceedings of 2nd International Conference on Computational Intelligence and Networks (CINE 2016)*, IEEE, KIIT University, Bhubaneswar, India, 3-12, 2015.

Papers Published in Books

Theoretical Statistics and Mathematics Division

Stat-Math Unit, Kolkata

1. Chakraborty, A. and Chaudhuri, P.: Paired sample tests in infinite dimensional spaces, *Modern Nonparametric, Robust and Multivariate Methods: Festschrift in Honour of Hannu Oja**, K. Nordhausen and S. Taskinen (eds.), Springer, Switzerland, 351–369, 2015.
2. Dutta, Amartya K.: The Decimal System in India Book: Encyclopaedia of the History of Science, Technology, and Medicine, *Non-Western Cultures*, H. Selin (ed.), Springer, 2015.

Stat-Math Unit, Bangalore

1. Padmawar, V.R.: On an indirect response model, *Handbook of Statistics 34, Data Gathering, Analysis and Protection of Privacy through Randomized Response Techniques: Qualitative and Quantitative Human Traits*, 1st Edition, Arijit Chaudhuri, Tasos C. Christofides and C.R. Rao (eds.), Elsevier, **29**, 497-513, 2016.
2. Sarkar, Jaydeb: An Introduction to Hilbert Module Approach to Multivariable Operator Theory (Survey article), *Handbook of Operator Theory*, D. Alpay (ed.), Springer, 969-1033, 2015.

3. Sarkar, Jaydeb: Applications of Hilbert Module Approach to Multivariable Operator Theory (Survey article), *Handbook of Operator Theory*, D. Alpay (ed.), Springer, 1035-1091, 2015.

Applied Statistics Division

Applied Statistics Unit, Chennai

- 1) Bose, M. and Dey, A.: Crossover Designs, *Handbook of Design and Analysis of experiments*, A. M. Dean *et al.* (eds.), Chapman & Hall/CRC Press, London, 159-195, 2015.
- 2) Bose, M.: Measures of respondent privacy in randomized response surveys, *Handbook of Statistics* 34, A. Chaudhuri *et al.* (eds.), Elsevier, Amsterdam, 341-351, 2015.

Computer and Communications Sciences Division

Advanced Computing and Microelectronics Unit, Kolkata

1. Barneva, R.P., Bhattacharya, B.B. and Brimkov V.E.: Combinatorial Image Analysis, *LNCS, 9448*, V. E. Brimkov (ed.), Springer, 2015.

Computer Vision and Pattern Recognition Unit, Kolkata

1. Das, Abhijit, Kunwar, R., Pal, Umapada, Ferrer, Miguel A. and Blumenstein, Michael: An Online Learning-Based Adaptive Biometric System, *Adaptive Biometric Systems*, Ajita Rattani, Fabio Roli and Eric Granger (eds.), Springer, 73-96, 2015.

Cryptology and Security Research Unit, Kolkata

1. Bakshi, A. and Ghosh, K.: Perceiving and Modelling Brightness Contradictions through the Study of Brightness Illusions, *New Directions in Paraconsistent Logic*, Jean-Yves *et al.* (ed.), Springer Proceedings in Mathematics and Statistics, **152**, 2015, ISBN 978-81-322-2717-5.
2. Banerjee, R. and Pal, S. K.: On Z-numbers and the machine-mind for natural language comprehension, *Fifty Years of Fuzzy Logic and its Applications*, D.E. Tamir, D. Rishe and A. Kandel (eds.), Springer, vol. 326, 415-457, 2015.

Biological Sciences Division

Agricultural and Ecological Research Unit, Kolkata

1. Chatterjee, S. and Dewanji, A.: Interaction between two commonly co-occurring invasive species in Kolkata, *Recent Trends in Environment and Ecology*, T. Rudra and A. Guha (eds.), Syed Murad Sparrow Publishers, 561-568, 2015, ISBN 978-81-8910-97-7.

Publications

Biological Anthropology Unit, Kolkata

1. Bharati, S.(SRU), Pal, M.(ERU) and Bharati.P.: Declining patterns of average height of adult Indians Between 20 and 49 Years: State Wise Trends and Influence of socioeconomic factors, *Growth Curve and Structural Equation Modeling*, R. Dasgupta (ed.), Springer Proceedings in Mathematics & Statistics, Springer International Publishing, 51-170, 2015.
2. Bharati, S.(SRU), Pal, M. (ERU) and Bharati, P.: Social dimensions related to under nutrition among adult men, *Health, Nutrition and Physical Growth in Developing Nations*, Bharati P, Singh, S.P., Kaur, J. and Adak, D.K. (eds.), Mittal Publication,21-31, 2015.
3. Bharati, P., Pal, M. (ERU), and Bharati, S. (SRU): Determinants of nutrition-deficient anaemia among adult Indian men, *Health, Nutrition and Physical Growth in Developing Nations*, P. Bharati, S.P. Singh, J. Kaur and D.K. Adak (eds.), Mittal Publication, 33-42. 2015.
4. Roy, P., Som, S.(SRU), Pal, M. (ERU) and Bharati.P.: Intra and Inter-State variation of height and weight in north-eastern states of India, *Explorations in Anthropology of North-East India*, S. Sengupta (ed.), Gyan Publishing House, 179-188, 2015.
5. Shome, S.(SRU), Pal, M.(ERU) and Bharati, P.: Relation among socio-economic status, body mass index and diabetes in India: An overview from national data, *Health, Nutrition and Physical Growth in Developing Nations*, P. Bharati, S.P. Singh, J. Kaur and D.K. Adak (eds.), Mittal Publication, 67-78, 2015.
6. Shome, S.(SRU), Pal, M.(ERU) and Bharati, P.: Levels of undernutrition among the tribes of central India, *Recent Researches on the Tribes of Central India*, B Tripathy and B Mohanty (eds.), AAYU Publication, 2016.

Social Sciences Division

Economic Research Unit, Kolkata

1. Banerjee, P. and Chakraborty, A.: Auctions with Ceilings, Themes in Economic Analysis: Theory, *Policy and Measurement*, S. Guha, R. Kundu and S. Subramanian (eds.), Routledge, London, UK, 189 - 224, 2015.
2. Bardhan, Pranab, Mitra, Sandip (SOSU), Mookherjee, Dilip and Sarkar, Abhirup: Political Participation, Clientelism, and Targeting of Local Government Programs: Results from a Rural Household Survey in West Bengal, India, *Is Decentralization Good for Development? Perspectives from Academics and Policy Makers*, Jean-Paul Faguet and Caroline Poschl (eds.), Oxford University Press, UK, 299-328, 2015.
3. Bharati, Susmita (SRU), Pal, Manoranjan and Bharati, Premananda (BAU): Social dimensions related to under nutrition among adult men, *Health, Nutrition & Physical Growth in Developing Nations*, P. Bharati, S.P. Singh, J. Kaur and D.K. Adak (eds.), Mittal Publication, New Delhi, 21-31, 2015.
4. Bharati, Premananda (BAU), Pal, Manoranjan and Bharati, Susmita (SRU): Determinants of nutrition-deficient anemia among adult Indian men, *Health, Nutrition & Physical Growth in Developing Nations*, P. Bharati, S.P. Singh, J. Kaur and D.K. Adak (eds.), Mittal Publication, New Delhi, 33-42, 2015.

5. Roy, Papiya, Shome, Suparna (SRU), Pal, Manoranjan and Bharati, Premananda (BAU): Intra and Inter-State Variation of Height and Weight in North-Eastern States of India, *Explorations in Anthropology of North East India*, Sarthak Sengupta (ed.), Gyan Publishing House 23, Main Ansari Road, Daryaganj, New Delhi-110002, India, 179-188, 2015.
6. Shome, Suparna (SRU), Pal, Manoranjan and Bharati, Premananda (BAU): Levels of Undernutrition Among the Tribes of Central India, *Recent Researches on the Tribes of Central India*, Byomakesh Tripath and Basanta Kumar Mohanta (eds.), Aayu Publications, New Delhi, 337-344, 2015.
7. Shome, Suparna (SRU), Pal, Manoranjan and Bharati, Premananda (BAU): Relation among socio-economic status, body mass index and diabetes in India: An overview from National data, *Health, Nutrition & Physical Growth in Developing Nations*, P. Bharati, S.P. Singh, J. Kaur and D.K. Adak (eds.), Mittal Publication, New Delhi, 67-78, 2015.

Linguistic Research Unit, Kolkata

1. Dasgupta, Probal: Bhaashaatattwer aar Banglar ubho-dut Pabitrababu, *Bhaashaatattwik Pabitra Sarkar*, Ramaprasad De (ed.), Sanskar, Kolkata, 15-17, 2015.
2. Dasgupta, Probal: (translated) Poemoj el ghemela planedo pri Esperanto kaj pri la lingvaneco, by Srikanth Reddy, *Beletra Almanako 23*, Probal Dasgupta, Istvan Ertl, Jesper Lykke Jacobsen, Suso Moinhos (eds.), Mondial, New York, 62-67, 2015.
3. Dasgupta, Probal: How Sunitikumar Chatterji's legacy has been treated, *Suniti Kumar Chatterji Revisited*, Gangchil and Kolkata Society for Asian Studies, Kolkata, 66-94, 2015.
4. Dasgupta, Probal: Wide wh-scope from a postverbal adjunct in Bangla, *Charting the Landscape of Linguistics: On the Scope of Josef Bayer's Work*, Ellen Brandner, Anna Czypionka, Constantin Freitag, Andreas Trotzke (eds.), Konstanz, 28-30, 2015, <http://ling.uni-konstanz.de/pages/WebschriftBayer>.
5. Dasgupta, Probal: Eschewing defaults in linguistics: three methodological notes, *Rajendra Singh: In Memoriam: Papers from a Special Commemorative Session at the 44 Poznan Linguistic Meeting*, Katarzyna Dziubalska-Kolaczyk, Jaroslaw Weckwerth (eds.), Wydawnictwo Naukowe UAM, Poznan, 7-23, 2015.
6. Dasgupta, Probal: The methodological location of linguistic descriptions, *Sciences and Methods*, Bijoy Mukherjee, Rajkumar Raychoudhury (eds.), The Asiatic Society, Kolkata, 95-120, 2015.
7. Dash, Niladri Sekhar: The history and methodologies of corpus development research in India, Hock, *The Languages and Linguistics of South Asia, 7*, Hans Henrich and Elena Bashir (eds.), Mouton de Gruyter, Berlin, 736-744, 2015.

Psychology Research Unit, Kolkata

1. Adak, M. and Ghosh, A.: Information Processing through Successive learning: An Experience with Primary School Children, *School Psychology: Enhancing Psychological Competencies*, Panch Ramalingam and Indranee Phoocon Borooah (eds.), Puducherry Co-op. Book Society Ltd., Puducherry, India, 219-227, 2015.

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2. Bhattacharya, H.: Self-esteem and Coping strategies: A Gender based comparison among University students, *School Psychology: Enhancing Psychological Competencies*, Panch Ramalingam and Indranee Phoocon Borooh (eds.), Puducherry Co-op. Book Society Ltd., Puducherry, India, 329-338, 2015.
3. Dutta Roy, D.: Professional ethics of School Psychology in India, *School Psychology: Enhancing Psychological Competencies*, Panch Ramalingam and Indranee Phoocon Borooh (eds.), Puducherry Co-op. Book Society Ltd., Puducherry, India, 36-43, 2015.
4. Gupta, R. and Dhara, J.: Self Concept and Academic Achievement in Secondary School Children, *School Psychology: Enhancing Psychological Competencies*, Panch Ramalingam and Indranee Phoocon Borooh (eds.), Puducherry Co-op. Book Society Ltd., Puducherry, India, 197-206, 2015.

Sampling and Official Statistics Unit, Kolkata

1. Bardhan, Pranab, Mitra, Sandip, Mookherjee, Dilip and Sarkar, Abhirup (ERU): Political Participation, Clientelism, and Targeting of Local Government Programs: Results from a Rural Household Survey in West Bengal, India, *Is Decentralization Good for Development? Perspectives from Academics and Policy Makers*, Jean-Paul Faguet and Caroline Poschl (eds.), Oxford University Press, UK, 299-328, 2015.
2. Dihidar, K.: Estimating Sensitive Population Proportion by Generating Randomized Response Following Direct and Inverse Hypergeometric Distribution, *Handbook of Statistics, Vol. 34, Data Gathering, Analysis and Protection of Privacy Through Randomized Response Techniques: Qualitative and Quantitative Human Traits*, Arijit Chaudhuri, Tasos C. Christofides and C.R. Rao (eds.), Elsevier, North Holland, Amsterdam, The Netherlands, 26, 427-441, 2016.

Sociological Research Unit, Kolkata

1. Bharati, S., Pal, M. (ERU) and Bharati, P. (BAU): Declining patterns of average height of adult Indians between 20 and 49 years: State wise trends and influence of socioeconomic factors, *Growth Curve and Structural Equation Modelling*, R. Dasgupta (ed.), Springer International Publishing, Switzerland, 151-170, 2015.
2. Bharati, S., Pal, M. (ERU) and Bharati, P. (BAU): Social dimensions related to under nutrition among adult men, *Health, Nutrition & Physical Growth in Developing Nations*, P. Bharati, S.P. Singh, J. Kaur and D.K. Adak (eds.), Mittal Publication, New Delhi, 21-31, 2015.
3. Bharati, P. (BAU), Pal, M. (ERU) and Bharati, S.: Determinants of nutrition-deficient anaemia among adult Indian men, *Health, Nutrition & Physical Growth in Developing Nations*, P. Bharati, S.P. Singh, J. Kaur and D.K. Adak (eds.), Mittal Publication, New Delhi, 33-42, 2015.
4. Ghosh, B.N. and Das, Sarmistha: Empowerment: Status of Muslim women, *West Bengal in Women Empowerment in India: Challenge Ahead*, Debasis Mazumdar et al. (ed.), Naba Ballygunge Mahavidyalaya, Kolkata, 220-227, ISBN 978-81-923645-7-5, 2015.
5. Roy, Papiya (BAU), Shome, Suparna, Pal, M. (ERU) and Bharati, P. (BAU): Intra and Inter-State Variation of Height and Weight in North-Eastern States of India, *Explorations in anthropology of North East India*, Sarthak Sengupta (ed.), Gyan Publishing House, New Delhi, 179-188, 2015.

6. Shome, S., Pal, M. (ERU) and Bharati, P. (BAU): Levels of undernutrition among the tribes of central India, *Recent researches on the tribes of Central India*, B Tripathy and B Mohanta (eds.), AAYU publication, New Delhi, 337-344, 2016.
7. Shome, S., Pal, M. (ERU) and Bharati, P. (BAU): Relation among socio-economic status, body mass index and diabetes in India: An overview from National data, *Health, Nutrition & Physical Growth in Developing Nations*, P. Bharati, S.P. Singh, J. Kaur and D.K. Adak (eds.) Mittal Publication, New Delhi, 67-78. 2015.

Economics and Planning Unit, Delhi

1. Ramaswami, Bharat and Murugkar, Milind: Incremental Food Policy Reforms; What are the Possibilities? *Development in India: Micro and Macro Perspectives*, S. Mahendra Dev and P. G. Babu (Ed.) Springer, New Delhi, 125-153, 2015.

Library, Documentation and Information Sciences Division

Library, Kolkata

1. Bhattacharyay, Krishna: Scientific heritage and the role of P. C. Mahalanobis Memorial Museum and Archives, Indian Statistical Institute, *SanskritiVichitra: Essence of Art and Archaeology Museums, Museology and Heritage Management* (In Honour of Dr. S.S. Biswas). New Delhi: Kaveri Books, 236-242, 2015.
2. Mandal, Tapan Kumar: Webometric study, *Bibliometric Data and Impact Management in Information Science*, P.K. Jain (ed.), Delhi, Bookwell, 169-184, 2016

Library, Chennai

1. Kalpana, T.M. and Gopalakrishnan, S.: Network, sustainability and Security of Libraries on Smartphones, *Encyclopedia of Information Science and Technology (3rd Edition)*, ID. Mehdi Khosrow-Pour (ed.), Hershey, U.S.A: IGI Global, 765-774, 2015.

7. VISITING SCIENTISTS, HONOURS AND AWARDS

VISITING SCIENTISTS

A number of distinguished scientists from India and abroad participated in the research, training and other scientific activities of the Institute during the year. Some of them came to the Institute on invitation and spent fairly long periods in the Institute to assist in the regular research and teaching programmes, while others came for short periods and gave lectures and seminars. Most of them were available for consultation by the faculty members of the Institute. Names of the visiting scientists are given below.

Theoretical Statistics and Mathematics Division

Stat-Math Unit, Kolkata

Acessandra, Cipriani, Wias Institute, Berlin, Germani, April 04-14, 2015.

Asanuma, Teruo, University of Toyama (Retd.), Japan, February 16-March 15, 2016.

Bagchi, Sayan, Department of Mathematics, IISc. Bangalore, September 05-August 05, 2015.

Baier, Stephan, IISER, Thiruvananthapuram, February 14-20, 2016.

Banerjee, Arindam, University of Virginia, U.S.A., June 01-31, 2015.

Bhattacharya, Soumya, CIRM, FBK, Italy, January 01-February 28, 2016.

Bhattacharya, Soumya, CIRM, Trento, January 01-February 29, 2016.

Bikram, Panchugopal, Department of Mathematics, Ben-Gurion University of the Negev, Israel, April 27-September 30, 2015.

Chakraborty, Sagnik, School of Mathematics, TIFR, Mumbai, September 01, 2015-August 31, 2016.

Choudhuri, Manoj, Centre for Applicable Mathematics, TIFR, Bangalore, May 25, 2015-April 25, 2016.

Das, Presenjit, Indian Institute of Space Science and Technology, Trivandrum, February 27-March 11, 2016.

Das, Soumya, Indian Institute of Science, Bangalore, November 12-19, 2015.

Dey, Arijit, IIT, Madras, December 21, 2015-January 01, 2016.

Ghosh, Anish, TIFR, August 26-20, 2015.

Hofstad, Remco W. van, Eindhoven University of Technology, November 11-04, 2015.

Holowinsky, Roman, Department of Mathematics, The Ohio State University, U.S.A., December 01-08, 2015.

Jha, Somnath, IIT, Kanpur, December 06-12, 2015.

Visiting Scientists, Honours and Awards

Kasilingam, Ramesh, Department of Mathematics, IIT, Bombay, April 01- September 30, 2015.

Koestler, Claus, University College Cork, Ireland, December 13-19, 2015.

Kulkarni, Dheeraj, Department of Mathematics, Ramakrishna Mission Vivekananda University, March 01, 2016-February 28, 2017.

Mj., Mahan, School of Mathematical Sciences, Ramakrishna Mission Vivekananda University, July 13-September 20, 2015.

Mohanty, Parasara, IIT, Kanpur, March 07-08, 2016.

Mondal, Sugata, Max-Planck Institute for Mathematics, Germany, May 05-19, 2015.

Parekh, Sandeepan, Vanderbilt University, December 29, 2015-January 06, 2016.

Rajan, C.S., TIFR, Mumbai, March 20-23, 2016.

Sajadi, Faikhondeh Alasadat, University of Isfahan, March 02-29, 2016.

Sebastian, Palcoux, Institute of Mathematical Sciences, Chennai, July 01-25, 2015.

Singh, Saurabh Kumar, School of Mathematics, TIFR, Mumbai, November 05, 2015-October 05, 2016.

Zinna, Md. Ali, IIT, Bombay, June 15-27, 2015.

Stat-Math Unit, Delhi

Adhikari, S. D., HRI Allahabad, March 28–April 1, 2016.

Banerjee, Arindam, University of Virginia, USA, August 4- 5, 2015.

Bhatnagar, Gaurav, Educomp Solutions Ltd, September 1, 2015 – January 31, 2016.

Bhattacharya, Amitava, Tata Institute of Fundamental Research, Mumbai, August 10-18, 2015.

Brug, Tim Van De, V U University, Amsterdam, February 19-March 7, 2016.

Camia, Federico, VU University Amsterdam & NYU, Abu Dhabi Campus, February 20-28, 2016.

Choudhury Pabitra Pal, Indian Statistical Institute, Kolkata, November 15-22, 2015.

Chakraborty, Parthasarathi, Institute of Mathematical Science, Chennai, June 20-July 20, 2015.

Dalawat, C.S., HRI, Allahabad, February 13-21, 2016.

Das, Soumya, Indian Institute of Science, Bengaluru, March 12-16, 2016.

Deshpande, J.V., CMI, Chennai, March 15-21, 2016.

Ganesan, G., EPFL, Lausanne, Switzerland. April 1-4, 2015.

Gupta, Ankit, ETH Zurich, January 17-20, 2016.

Visiting Scientists, Honours and Awards

Hollander, Frank Den, Universiteit Leiden, Netherland. January 4-8, 2016.

Karimi, Masoud, Islamic Azad University, January 1-29, 2016.

Krishnapur, Manjunath, Indian Institute of Science, Bengaluru, September 28-October 2, 2015.

Kumar, Chaman, University of Delhi, Ramjas College, New Delhi, November 2, 2015-November 1, 2016.

M, Aneesh, Indian Institute of Technology, Kanpur, September 1-November 30, 2015.

Panda, Swarup Kumar, IIT Guwahati, February 8, 2016–February 7, 2017.

Pazuki, Fabien Mehdi, University of Copenhagan, Denmark, October 19-22, 2015.

Philippon, Patrice, Institut de Mathematiques de Jussieu, France, February 2- 12, 2016.

Prasad, K. Manjunatha, Department of Statistics, Manipal University, January 19-30, 2016

Roy, Indrava, Spienza Universita di Roma, Italia, June 1, 2015–April 1, 2016.

S., Anjana, Cochin University of Science and Technology, Cochin, December 1, 2015–November 30, 2016.

Sahoo, Sudhakar, IMA, Bhubaneswar, November 15-22, 2015

Sajadi, Farkhondeh A., Department of Statistics, Isfahan University, Isfahan. March 16-26, 2016

Saraswat, Vishal, CR Rao AIMSCS, Hyderabad, February 12-16, 2016.

Shah, Hemangi, HRI, Allahabad, April 4-8, 2015.

Sharma, Devika, Tata Institute of Fundamental Research, Mumbai, October 1, 2015–March 31, 2016.

Shorey, T. N., Indian Insitute of Technology, Mumbai, August 21-September 6, 2015.

Sivaramkrishnan, S., Indian Institute of Technology Bombay, May 12-21, 2015.

Soni, Pooja, University Business School, Panjab University, Chandigarh, May 25, 2015–June 8, 2015.

Sofi, Mohammad Amin, University of Kashmir, December 22, 2015–January 20, 2016.

Tanner, Steve, Easitute of Mathematical Sciences, Chennai, July 22–November 30, 2015.

Thacker, Debleena, University of Lund, Sweden, July 12-18, 2015.

Vershik, Anatoly, Steklov Institute of Mathematics, St. Petersburg State University, and Oregaon University, USA, July 24–27, 2015 and January 22–25, 2016.

Verma, Manoj, Institute of Mathematical Sciences, Chennai, July 22–November 30, 2015.

Vershik, Anatoly, Steklov Institute of Mathematics and St.Petersburg State University, January 22-25, 2016.

Stat-Math Unit, Bangalore

- Alexander, Belton, Univ. of Lancaster, UK, December 8-22, 2015.
- Anoop, T.V., INSPIRE Faculty Fellow, June 1-August 10, 2015.
- Bajpai, Saumya, IITRAM, Ahmedabad, June 18–August, 2015.
- Banerjee, Kalyan, Visiting Scientist, September 30, 2015-for one year.
- Basak, Biplab, NBHM Post-Doctoral Fellow, September 1, 2015-for one year.
- Basu, Madhushree, NBHM Post-Doctoral Fellow, since July 1, 2014-June 21, 2015.
- Basu, Sudeshna, George Washington University, USA, June 1-13, 2015.
- Chakrabarti, Debraj, Central Michigan University, USA, July 28-August 1, 2015.
- Chakraborty, Prateep, NBHM Post-Doctoral Fellow, November 2, 2015-for one year.
- Chattopadhyay, Arup, NBHM Post-Doctoral Fellow, since July 1, 2013-June 1, 2015.
- Chattopadhyay, Pratyusha, INSPIRE Faculty Fellow, since November 1, 2013-for five years.
- Das, Bata Krishna, NBHM Post-Doctoral Fellow, since August 1, 2014 - July 29, 2015.
- Ganesan, G., Visiting Scientist, January 01, 2016-March 31, 2017.
- Giri, Sumit, IMSc., Chennai, August 12-September 21, 2015.
- Gopalswamy, Arjun, WildCRU, University of Oxford, November 23-December 23, 2015.
- Gorai, Sushil, INSPIRE Faculty Fellow, since April 2, 2012-August 5, 2015.
- Haria, Kalpesh, INSPIRE Faculty Fellow, June 18, 2015-for five years.
- Hollander, Frank Den, Leiden University, Netherlands, January 10-17, 2016.
- Jurczynski, Mateusz, Lancaster University, UK, September 15, 2015–January 2016.
- Kasilingam, Ramesh, INSPIRE Faculty Fellow, September 24, 2015-for five years.
- Keshari, Dinesh Kumar, INSPIRE Faculty Fellow, April 1, 2015-for five years.
- Kumari, Rani, Visiting Scientist, December 01, 2015-March 31, 2016.
- Maddaly, Krishna, IMSc., Chennai, July 10-25, 2015.
- Maji, Amit, NBHM, Post-Doctoral Fellow, July 13–September 30, 2016.
- Mukherjee, Mithun, IISER, Kolkata, July 13-25, 2015.
- Ouknine, Youssef, Cadi Ayyad University, Morocco, July 29-August 10, 2015.
- Rollin, Adrian, National University of Singapore, June 14-19, 2015.

Visiting Scientists, Honours and Awards

Sebastian, Ronnie, IISER Pune, June 4-July 20, 2015.

Sethuraman, Bharath, Californica State University Northridge, USA, July 20-October 04, 2015.

Shah, Riddhi, Jawaharlal Nehru University, Delhi, June 17-25, 2015.

Srinivasan, R., Chennai Mathematical Institute, Chennai, July 6-31, 2015.

Tanner, Steve, Eastern Oregon University, USA, July 7-August 5, 2015.

Thakur, Ajay Singh, INSPIRE Faculty Fellow, since January 31, 2014 - for five years.

Thoppe, Gugan, TIFR, Mumbai, July 13-August 31, 2015.

Tripathi, Amit, NBHM Post-Doctoral Fellow, since December 1, 2012 - August 9, 2015.

Trivedi, Harsh, IIT-Bombay, Mumbai, January 01-March 31, 2016.

Vaish, Vaibhav, INSPIRE Faculty Fellow, since January 4, 2016 - for five years.

Vanchinathan, P., VIT University, Chennai, February 22-26, 2016.

Vershik, A., St. Petersburg Department of Steklov Institute of Mathematics, Russia, January 15-24, 2016.

Stat-Math Unit, Chennai

Ekaterina, Ganenkova, Petrozavodsk State University, Russia, December 1-28, 2015.

Kaliraj, Sairam, NBHM Post-Doctoral Fellow, April 01-November 01, 2015.

Muhanna, Yusuf Abu, American University of Sharjah, United Emirates of Arab, January 23-29, 2016.

Sergey, Graf, Tver State University, Russia, December 1-21, 2015.

Victor, Starkov, Petrozavodsk State University, Russia, December 1-21, 2015.

Applied Statistics Division

Applied Statistics Unit, Kolkata

Das, Sudipta, Indian Institute of Science, Bengaluru, India, July 10–March 31, 2016.

Ghosh, Malay, University of Florida, USA, October 05, 2015–January 08, 2016.

Ghoshal, Subhashis, North Carolina State University, USA, December 14–30, 2015.

Hazra, Nil Kamal, IISER, Mohanpur, India, July 10–March 31, 2016.

Visiting Scientists, Honours and Awards

Karati, Sabyasachi, Indian Institute of Technology, Kharagpur, India, May 05–March 31, 2016.

Nandy, Rajesh Ranjan, University of North Texas Health Science Center, USA, December 1–18, 2015.

Sharma, Amit Kumar, Indian Institute of Technology, Delhi, India, December 01, 2015–March 31, 2016.

Computer and Communication Sciences Division

Advanced Computing and Microelectronics Unit, Kolkata

Chakraborty Goutam, Department of Software & Information Science, Iwate Prefectural University, Takizawa, Japan, December 19, 2015-January 08, 2016.

Dutta, Ayan Dept. Of Compute Science, University of Nebraska Omaha, USA. August 07, 2015-May 20, 2017.

Dutta, Kunal, Max-Planck University, fur Informatic, Saarbrucken, Germany, January 01-07, 2016.

Datta, Kamalika, Department of Computer Science and Engineering, National Institute of Technology, Meghallaya, January 04-11, 2016.

Ghosh, Arijit, Max-Plank-Institute for Informatics in Sarbrucken, Germany, September 14, 2015-February 8, 2016.

Gorain, Barun, Department of Mathematics Indian Institute of Technology, Guwahati, September 01, 2015-March 31, 2016.

Khan, Arindam, Georgia Institute of Technology, USA, September 18, 2015–October 30, 2015.

Mathew, Rogers, IIT Kharagpur, November 13-14, 2015.

Mishra, Prabhat, Department of Computer and Information Science and Engineering (CISE) University of Florida, USA, August 01-15, 2015.

Paul, Subhabrata, Department of Mathematics, Indian Institute of Technology, Delhi, April 1, 2015–March, 2016.

Ray, Rajarshi, Department of Computer Science and Engineering, IIT, Shillong, January 5–9, 2016.

Roy, Chowdhury, Shubhajit School of Computing & Electrical Engineering, IIT, Mandi, Himachal Pradesh, December 11, 2015–January 11, 2016.

Computer Vision and Pattern Recognition Unit, Kolkata

Ballester, Miguel Ángel Ferrer, Instituto Universitario para el Desarrollo Tecnológico e Innovación en Comunicaciones, Universidad de Las Palmas de Gran Canaria, Spain, April 30-August 29, 2015.

Chakraborty, Neloy, PhD (Free University Berlin), November, 2015 – March, 2016.

Visiting Scientists, Honours and Awards

Eskenazi, Sébastien, Campus Numérique et Système d'Informations, l'Université de la Rochelle, France, January 26-April 25, 2016.

Mitra, Abhijit, Department of ECE, Netaji Subhash Engineering College, Techno City, Garia, Kolkata-152, July-September, 2015.

Ogier, Jean-Marc, Vice Président Campus Numérique et Système d'Informations, l'Université de la Rochelle, France, December 19-23, 2015.

Electronics and Communication Sciences Unit, Kolkata

Purkait, Pulak, University of Adelaide, Australia, February 05-March 31, 2016.

Saha, Baidyanath, Centro de Investigacion en Matematicas (CIMAT), Monterrey, Mexico, November 30-December 18, 2015.

Machine Intelligence Unit, Kolkata

Banka, Haider, Department of Computer Science & Engineering, Dhanbad School of Mines, Dhanbad, March 08-31, 2016.

Mandal, Koyal, Department of Computer Science & Engineering, Tezpur University, Napam, February 01- March 31, 2016.

Rahman, Nazreena, Department of Computer Science & Engineering, Tezpur University, Napam, January 04-March 31, 2016.

Ze, Carlos, Universidade de Evora, Portugal, April 01-07, 2015.

Documentation, Research and Training Centre, Bangalore

Amin, Saiful, Library Systems Specialists, Semantic Consulting Services Pvt. Ltd, Bangalore, April-2015- March 31, 2016.

Caterina, Caracciolo, V. Ettore Giovenale, Rome, Italy, March 1-31 2016.

Keizer, Johannes, Strategic Partnership Lead GODAN Secretariat, UNFAO, Rome, Italy, October 7, 2015.

Kim, Eungi, Assistant Professor, Dept. of Library and Information Science, Kei-Myung University, Daegn, South Korea, June 7-8, 2015.

Neupane, Bhanu R., Programme Specialist, Communication and Information Sector (CI), UNESCO, Paris, March 9-19, 2016.

Oh, Dong Geun, Professor and Chairperson, Dept. of Library and Information Science, Kei-Myung University, Daegn South Korea, June 7-8, 2015.

Sangam, S.L., Retd. Professor (Retd.), Karnataka Univrsity, Dharwad, September–December, 2015.

Visiting Scientists, Honours and Awards

Satija, M.P., Professor (Retd.), Dept. of Lib. & Inf. Sc., Guru Nanak Dev University, Amritsar, October 8 – November 8, 2015.

Shashank, Sonwane S, Asst. Professor, DLIS, Dr, Babasaheb Ambedkar Marathwarda University, Aurangabad, September 18-27, 2015.

Waltraut, Ritter, Knowledge Dialogues, Applied Knowledge Society Research Hong Kong and Berlin, Germany, January 14-18, 2016.

Systems Science and Informatics Unit, Bangalore

Basu, Pallab, International Center for Theoretical Sciences (a TIFR facility), Bangalore.

Crawford, Melba M., Purdue University, February 27-29, 2016.

Rosen, Paul A., Jet Propulsion Laboratories (JPL), NASA-Caltech, November 22-23, 2015.

Mormann, Florian, Department of Epileptology, University of Bonn, Germany, February 10–23, 2016.

Cryptology and Security Research Unit, Kolkata

Burton, Benjamin, School of Mathematics and Physics, University of Queensland, Australia, November 5-7, 2015.

Gebremedhin, Alem, Information Network Security Agency, Ethiopia, December 14-18, 2015.

Gurmessa, Hanibal, Information Network Security Agency, Ethiopia, December 14-18, 2015.

Hiroaki Anada, ISIT Labs, Japan, December 15-21, 2015.

Spreer, Jonathan, School of Mathematics and Physics, University of Queensland, Australia, November 5-7, 2015.

Woldemariam, Biniam, Information Network Security Agency, Ethiopia, December 14-18, 2015.

Weldermarium, Daniel, Information Network Security Agency, Ethiopia, December 14-18, 2015.

Physics and Earth Sciences Division

Geological Studies Unit, Kolkata

Ezcurra, M. D., Senior Research Fellow, University of Birmingham, U. K., May 03-21, 2015.

Gierlowski-Kordesch, Elizabeth, Professor, Department of Geological Sciences, Ohio University, USA, January 11-31, 2016.

Marczewski-Newman, Tess, Research Fellow, Lancaster University, U. K. April 24-May 08, 2015.

Visiting Scientists, Honours and Awards

Physics and Applied Mathematics Unit, Kolkata

Bera, M., Post Doctoral Fellow, Department of Physics, Harish-Chandra Research Institute, Allahabad, May 15-30, 2015.

Bhattacharjee, S., Post Doctoral Fellow, Indian Institute of Technology, Gandhinagar, Ahmedabad, June 22–26, 2015.

Choudhury, S., Post Doctoral Fellow, Department of Theoretical Physics, TIFR, Mumbai, May 18–20, 2015.

Ghosh, S., Department of Theoretical Physics, Institute of Mathematical Science, Chennai, May 1-15, 2015.

Moitra, A., School of Advanced Studies, Vellore Institute of Technology, Vellore, Tamil Nadu, January–February, 2016.

Rahaman, R., Department of Mathematics, University of Allahabad, June 17–July 01, 2015.

Rai, A., Faculty of Computing, University of Latvia, 19 Raina Blvd, Riga, Latvia, December 01–31, 2015.

Roychowdhury, D., Post Doctoral Fellow, Centre for High Energy Physics, Indian Institute of Science, Bangalore, May 5–14, 2015.

Sasmal, K. S., Department of Mathematics, Vellore Institute of Technology, Tamil Nadu, December 01, 2015–January 31, 2016.

Biological Sciences Division

Agricultural & Ecological Research Unit, Kolkata

Fuwa, Hiko, Nobu, Waseda University, Japan, September 09–19 and November 11–21, 2015.

Social Sciences Division

Economic Research Unit, Kolkata

Bag, Kanti, Parimal, Department of Economics, National University of Singapore, AS2 Level 6,1 Arts Link, Singapore 117570, December 21, 2015-January 8, 2016.

Banerjee, Sarmila, Department of Economics, Calcutta University, January 1- May 31, 2016.

Bera, Anil K., Department of Economics, University of Illinois, Urbana Champaign, USA, August 7, 2015.

Basu, Deepankar, Department of Economics, University of Massachusetts, Amherst, January 18-February 12, 2016.

Visiting Scientists, Honours and Awards

Bhattacharjee, Arnab, Professor of Economics and Director, Spatial Economics & Econometrics Centre (SEEC), Heriot-Watt University, Edinburgh, United Kingdom, January 5-28, 2016.

Chakraborty, K. Bikas, Centre for Applied Mathematics & Computational Science, Saha Institute of Nuclear Physics, Kolkata, Since August, 2015.

Chatterjee, Kalyan, Department of Economics, The Pennsylvania State University, University Park, PA 16802, USA, June 15-July 19, 2015 and December 28, 2015–January 6, 2016.

Dixit, Avinash, Department of Economics, University Professor of Economics Emeritus, Princeton University, USA, December 14-15, 2015.

Ghosh, Arghya, School of Economics, UNSW Business School, University of New South Wales, Sydney, NSW 2052, Australia, July 7- 21 and October 30-November 10, 2015.

Goswami, Mridu Prabal, Department of Economics, Ben-Gurion University of the Negev, Beer-Sheva, Israel 84105, October 1, 2015–March 31, 2016.

Lahiri, Kajal, Distinguished Professor of Economics, Department of Economics, University of Albany, SUNY, January 11-20, 2016.

Pokhrel, Rohini, Department of Applied Mathematics, Indian School of Mines, Dhanbad, Jharkhand – 826004, July 14-17, 2015.

Roychoudhury, Saurav, School of Management, Capital University, Columbus, OH 43209, U.S.A., November 27, 2015–January 7, 2016.

Sen, Debapriya, Department of Economics, Ryerson University, Canada, December 28, 2015–January 8, 2016.

Suman, Surbhi, Department of Applied Mathematics, Indian School of Mines, Dhanbad, Jharkhand – 826004, July 14-17, 2015.

Linguistic Research Unit, Kolkata

Bhatia, Parteek, Thapar University, Patiala, August 19-21, 2015.

Bhattacharya, Pratibha, Dept. of Linguistics, Delhi University, August 28, 2015.

Bose, Arpita, School of Psychology and Clinical Language Sciences, Reading University, UK, February 11-12, 2016.

Lange, Claudia, Technische Universität Dresden, Germany, February 15-19, 2016.

Nag, Chowdhury, Sreyasi, Max-Planck-Institut für Informatik, Department of Databases and Information Systems, Saarbrücken, Germany, December 30, 2015.

Ray, Arpita, International Institute of Information Technology, Hyderabad, May 6-7, 2015.

Psychology Research Unit, Kolkata

Adhikari, Mitali, Senior Lecturer of Nursing Training College, Calcutta Medical College, February 26, 2016.

Visiting Scientists, Honours and Awards

Bandyopadhyay, Souvik, Assistant Professor, Indian Institute of Public Health, August 17, 2015.

Bhattacharya, Swaha, Professor, Department of Applied Psychology, University of Calcutta, January 21 and February 26, 2016.

Basu, Jayanti, Professor, Department of Applied Psychology, University of Calcutta, March 22, 2016.

Das Gupta, Sadhan, Professor, Department of Applied Psychology, University of Calcutta, February 17, 2016.

Das, Koel, Assistant Professor, Department of Mathematics and Statistics, IISER. August 19, 2015.

Jana, Amlan, Assistant Professor, K.P.C. Medical College, Kolkata, February 16, 2016.

Mondal, Uday Shankar, Assistant Professor, Department of Psychiatry, R. G. Kar Medical College, February 16, 2016.

Mukherjee, Divyagopal, Professor, Department of Psychiatry, R. G. Kar Medical College, August 17, 2015 and February-16, 2016.

Mukhopadhyay, Susmita, Assistant Professor, Vinod Gupta School of Management, IIT, Kharagpur. February 17, 2016.

Pyne, Saumyadipta, Professor, University of Hyderabad, August 17, 2015.

Pandey, G.K., Director- Professor, Department of Epidemiology, August 19, 2015.

Pal, Nilanjana, Assistant Professor, Haldia Medical College, February 16, 2016.

Pandey, Arvind, Director, National Institute of Medical Statistics, ICMR, New Delhi, February 17, 2016.

Poddar, Ashok, Ex- Secretary (Actuarial), Central office, LIC, Mumbai, February 16, 2016.

Pahwa, Khuswant, Actuary, New Delhi, February 16, 2016.

Ray, Anjali, Professor, Department of Applied Psychology, University of Calcutta, March 4, 2016.

Sharma, K., Narendra, Retired Professor, IIT Kanpur, February 17, 2016.

Sampling and Official Statistics Unit, Kolkata

Bhattacharjee, Arnab, Heriot- Watt University Edinburgh EH14 4AS, UK, January 14, 2016.

Borkotokey, Surajit, Department of Mathematics, Dibrugarh, September 18-25, 2015.

Das, Kishore Kumar, Guwahati University, May 5–June 6, 2015.

Mitra, Murari, Department of Mathematics, Indian Institute of Engineering Science and Technology, Shibpur Howrah, April 1, 2015–March 31, 2016.

Pal, Sarmistha, Department of Finance, University of Surrey Guildford GU27XH, UK, July 27, 2015.

Subramanian, S., ICSSR National Fellow Madras Institute of Development Studies, Tamil Nadu, April 2015.

Economics and Planning Unit, Delhi

Abreu, Dilip, Princeton University, United States, July 31, 2015.

Banerjee, Shraman, Southern Methodist University, United States, September 11, 2015.

Basak, Deepal, NYU, United States, February 3, 2016.

Bhattacharjee, Swagata, University of Texas, Austin, United States, January 22, 2016.

Bhattacharyya, Aditi, Sam Houston State University, United States, July 28, 2015.

Bloch, Francis, Universite Paris 1 and Paris School of Economics, France, March 18, 2016.

Bond, Eric, Vanderbilt University, United States, November 13, 2015.

Borah, Abhinash, Shiv Nadar University, Visiting Scientist, since January 01, 2016 for 6 months.

Bradford, Scott, Brigham Young University, United States, July 23, 2015.

Burnett, Johann Caro, Yale University, United States, March 4, 2016.

Chand, Srustidhar Arya Kumar, IIT Delhi, September 22-November 21, 2015.

Chatterjee, Somdeep, University of Houston, United States, February 12, 2016.

Chaturvedi, Rakesh, IIM, Udaipur, August 28, 2015.

Chaudhuri, Arka Roy, University of British Columbia, Canada, Lecturer Cum Post-Doctoral Fellow, Since October 14, 2015 for 3 years.

Chowdhury, Shyamal, University of Sydney, Australia, Visiting Scientist, November 18-January 20, 2016.

Coffey, Diane, RICE Institute, United States, November 20, 2015.

Das, Sabyasachi, Lecturer cum Post-Doctoral Fellow, since July 1, 2015 for 3 years.

De, Sankar, Shiv Nadar University, September 18, 2015.

Deshpande, Ashwini, DSE, October 9, 2015.

Dhillon, Amrita, King's College London, UK, August 21, 2015.

Dimri, Aditi, CORE, Université catholique de Louvain and Paris School of Economics, January 29, 2016.

Dubey, Ram Sewak, Montclair State University, United States, July 24, 2015.

Dutta, Bhaskar, Warwick University, UK, September 2, 2015.

Dutta, Prajit K., Columbia University, United States, January 27, 2016.

Visiting Scientists, Honours and Awards

Goswami, Mridu Prabal, Ben Gurion University, Israel, September 11-20, 2015.

Gupta, Amlan Das, Lecturer cum Post-Doctoral Fellow, since July 1, 2015 for 1 year.

Khwaja, Ahmed, Yale University, United States, August 14, 2015.

Kishor, Kundan, University of Wisconsin – Milwaukee, United States, January 15, 2016.

Krishnaswamy, Karuna, GIZ, Germany, February 5, 2016.

Kumar, Rishabh, The New School, United States, March 23, 2016.

Mallick, Debdulal, Deakin University, Australia, December 17-26, 2015.

Manghnani, Ruchita, UNC, Chapel Hill, United States, March 16, 2016.

Narayanan, Abhinav, University of Georgia, United States, February 29, 2016.

Prakash, Nishith, University of Connecticut, United States, March 9, 2016.

Raimaekers, Eve, Core, Belgium, since July 16-22, 2015.

Sander, Frederico Gil, World Bank, December 4, 2015.

Sane, Renuka, IGIDR, Visiting Assistant Professor, since July 1, 2015 for 2 years.

Serizawa, Shigehiro, Osaka University, Japan, March 10, 2016.

Sethi, Rajiv, Barnard College, Columbia University, United States, June 23, 2015.

Singh, Gurbachan, January 1-April 30, 2016.

Spears, Dean, RICE Institute, October 16, 2015.

Subramanian, Arvind, Chief Economic Adviser, Ministry of Finance, May 22, 2015.

Economic Analysis Unit, Bangalore

Chakrabarti, Anjan, St. Joseph's College, Darjeeling, March 2016.

Dhar, Niladri, Tata Institute of Social Sciences, Tuljhapur, October 13-15, 2015.

Guha, Puja, Ajim Premji University, February 1–May 1, 2016.

Jayaraman, T., Tata Institute of Social Sciences, Mumbai, April 7-14, 2015.

Jose, Thomas Jayan, IIT, New Delhi, November 3, 2015.

Kumar, Shiva, A.K. UNICEF, New Delhi, March 28-20, 2016.

Murari, Kamal, Tata Institute of Social Sciences, Mumbai, April 7-14, 2015.

Visiting Scientists, Honours and Awards

Pais, Jesim, Institute for Studies in Industrial Development, New Delhi, February 29- March 5, 2016.

Periaswami. P., Bharathiyar University, Coimbatore, November 2, 2015.

Sarkar, Sandip, CSSS, Kolkata March 14-25, 2016.

Statistical Quality Control and Operations Research Division

SQC & OR Unit, Delhi

Powers, Brian Reed, University of Illinois, Chicago, USA, January 16-24, 2016.

Raghavan, T.E.S., University of Illinois, Chicago, USA, January 18-23, 2016.

SQC & OR Unit, Bangalore

Prasad, V Rajendra, Optisol, USA, July 13 – 16, 2015.

HONOURS AND AWARDS

Theoretical Statistics and Mathematics Division

Stat-Math Unit, Kolkata

Datta, Mahua

Member: Executive committee of the National Board for Higher Mathematics 2015.

Gupta, Neena

Awarded: Inaugural Professor A. K. Agarwal Award, The Indian Mathematical Society, 2015;
Swarna Jayanti Fellowship, Department of Science and Technology, 2016.

Stat-Math Unit, Delhi

Bhatia, Rajendra

Awarded: Hans Schneider Prize in Linear Algebra, International Linear Algebra Society.

Jain, Tanvi

Awarded: INSA Young Scientist Award awarded, INSA.

Laishram, Shanta

Recipient: INSA Bilateral Exchange Program 2015 (with Hungary).

Stat-Math Unit, Bangalore

Bhat, B V Rajarama

Elected: Fellow, Indian National Science Academy, New Delhi, since January 1, 2016.

Visiting Scientists, Honours and Awards

Rao, T.S.S.R.K.

Awarded: Fullbright Academic and Professional Excellence Award, 2015-16.

Applied Statistics Division

Applied Statistics Unit, Kolkata

SenGupta, A.

Conferred: Distinguished Statistician Award, Indian Society for Probability and Statistics, ISPS Conference, Lucknow, India, 2015.

Computer and Communication Sciences Division

Computer Vision and Pattern Recognition Unit, Kolkata

Chaudhuri, Bidyut Baran

Fellow (Upgraded): IEEE Life Fellow since January, 2016.

Electronics and Communication Sciences Unit, Kolkata

Das, S.

Awarded: Thomson Reuters Research Excellence India Citation Award (Engineering and Computer Science Category), 2015.

Machine Intelligence Unit, Kolkata

Bandyopadhyay, S.

Fellow: Institute of Electrical and Electronics Engineers (IEEE);
Indian National Science Academy (INSA).

Ghosh, A.

Fellow: West Bengal Academy of Science and Technology, Kolkata.

Cryptology and Security Research Unit, Kolkata

Barua, Rana

Selected: Member Advisory Board, Society for Electronic Transactions and Security (SETS), Chennai.

Paul, Goutam

Elected: Senior Member, IEEE (experience and achievements), 2015.

Ruj, Sushmita

Elected: Senior Member, IEEE (experience and achievements), 2015.

Biological Sciences Division

Agricultural and Ecological Research Unit

Mukherjee, A.

Awarded: Endeavour Executive Fellowship, Department of Education and Training,
Government of Australia.

Social Sciences Division

Linguistic Research Unit, Kolkata

Dasgupta, Probal

Elected: President, Akademio de Esperanto.

Psychology Research Unit, Kolkata

Dutta Roy, Debdulal

Awarded: Best Paper, 4th International Conference on recent advances in cognition and health,
Banaras Hindu University, 2016.

Economics and Planning Unit, Delhi

Ghate, Chetan

Awarded: The Mahalanobis Memorial (Gold) Medal 2014, The Indian Econometric Society (TIES)
(for Best Research Economist in India under 45 yrs.), 2015.

Economic Analysis Unit, Bangalore

Rajashekara, H.M.

Elected: Senior Member, IEEE.

Ramachandran, V.K.

Elected: National Fellowship, Indian Council of Social Science Research.

Swaminathan, Madhura

Elected: Chairperson, M.S. Swaminathan Research Foundation, Chennai, August 2012 onwards.

Elected: Member, Committee on Development Policy, United Nations,
Department of Economic and Social Affairs, New York.

Library, Documentation and Information Sciences Division

Library, Kolkata

Basu, Tapas

Awarded: ICS Gold Medal (USA), 58th Dum Dum International Photographic Salon 2015;
International Union of Photographers Silver Medal, Hong Kong, 2016;

Visiting Scientists, Honours and Awards

Elected: Honorary Fellow, ICS (FICS), Image Colleague Society International, USA 2016;
Honorary PESGPC (for outstanding contribution in International Art Photography),
Cyprus, 2016.

Pal, Jiban K.

Awarded: Distinguished Service Award, Distributed Data Curation Center (D2C2),
Institute of Museum and Library Services (IMLS), USA, 2015.

Statistical Quality Control and Operations Research Division

SQC & OR Unit, Bangalore

Gijo, E.V.

Awarded: Outstanding Reviewer Award, Emerald Group Publishing Limited, 2015;
Highly Commended Paper Award, Emerald Group Publishing, UK, 2015.

Center for Soft Computing Research: A National Facility, Kolkata

Ghosh, A.

Fellow: West Bengal Academy of Science and Technology, Kolkata.

Pal, S.K.

Awarded: Professor S.N. Mitra Memorial Award, 2015;
Indian National Academy of Engineering, 2015.

Elected: IEEE Life Fellow, IEEE, 2015.

8. EDITORIAL AND OTHER SCIENTIFIC ASSIGNMENTS

EDITORIAL ASSIGNMENTS

Theoretical Statistics and Mathematics Division

Stat-Math Unit, Kolkata

Bose, Arup (Associate Editor): *Statistical Methodology*, 2016.

Chaudhuri, Probal (Editor): *International Statistical Review and Statistics*, International Statistical Institute.

Roy, Parthanil (Associate Editor): *Sankya Series A*, 2016-2018.

Stat-Math Unit, Delhi

Bandyopadhyay, Antar (Associate Editor): *Journal of Statistical Planning and Inference (JSPI)*, Elsevier.

Bhatia, R. (Senior Editor): *Linear Algebra and Its Applications*, Elsevier, New York; (Managing Editor): *Texts and Readings in Mathematics*, Hindustan Book Agency, New Delhi; (Managing Editor): *Culture and History of Mathematics*, Hindustan Book Agency, New Delhi.

Dewan, Isha (Associate Editor): *Computational Statistics and Data Analysis*; Journal of Indian Statistical Association; (Associate Editor): *CSDA* and *JISA*.

Stat-Math Unit, Bangalore

Athreya, Siva (Associate Editor): *Journal of Ramanujan Mathematical Society*.

Bhat, B. V. Rajarama (Chief Editor): *Proceedings of the Indian Academy of Sciences, Mathematics*.

Ramasubramanian, S. (Associate Editor): *Sankhya, Series A*, 77, 2015.

Sury, B. (Editor): *Mathematical Sciences*, Proceedings of the Indian Academy of Sciences, IAS Bangalore; (Associate Editor): *Indian Journal of Pure & Applied Mathematics*, INSA, Delhi; (Editor): *Mathematics Student*, INSA, Delhi; (Associate Editor): *Resonance*, Indian Academy of Sciences Bangalore; (Editor): *Mathematics Newsletter*, Ramanujan Mathematical Society.

Stat-Math Unit, Chennai

Ponnusamy, S. (Editor-In-Chief): *Mathematics Newsletter published*, Ramanujan Mathematical Society; (Chief Editor): *Journal of Analysis*, Springer; (Associate Editor): *Bulletin of Malaysian Mathematical Sciences Society*, Springer.

Editorial and other Assignments

Applied Statistics Division

Applied Statistics Unit, Kolkata

Biswas, A. (Editor): *Sankhya Series B*, 2012-2015; (Associate Editor): *Statistics & Probability Letters*, Elsevier, since July 2011; (Associate Editor) : *Sequential Analysis*, Taylor and Francis, since June 2003; *Communications in Statistics, Theory and Methods*, Taylor and Francis, since January 2007; *Communications in Statistics, Simulation and Computation*, Taylor and Francis, since January 2007; *Sri Lankan Journal of Applied Statistics*, The Institute of Applied Statistics, Sri Lanka, since January 2013.

Dewanji, A. (Associate Editor): *Journal of Statistical Planning and Inference*, Elsevier; (Special Invited Editor): *Calcutta Statistical Association Bulletin*, Sage Publications.

Sen Gupta, A. (Editor): *Scientiae Mathematicae Japonicae*, International Society for Mathematical Sciences; (Associate Editor): *Statistics and its Applications*, USA; (Associate Editor): *Journal of Indian Statistical Association*, India.

Computer and Communication Sciences Division

Advanced Computing and Microelectronics Unit, Kolkata

Bhattacharya, B.B. (Editor): *Journal of Electronic Testing: Theory and Applications*, Springer.

Sur-Kolay, S. (Associate Editor): *ACM Transactions on Embedded Computing Systems*.

Computer Vision and Pattern Recognition Unit, Kolkata

Garain, Utpal (Associate Editor): *International Journal of Document Analysis and Recognition*, Springer.

Pal, Umapada (Associate Editor): *Pattern Recognition Letters*, Elsevier, since 2014; (Associate Editor): *ACM Transactions on Asian and Low-Resource Language Information Processing (TALLIP)*, ACM since 2012; (Associate Editor): *Electronic Journal on Computer Vision and Image Analysis*, CVC Press, Since 2010; (Associate Editor): *International Journal of Document Analysis and Recognition*, Springer, Since 2015.

Electronics and Communication Sciences Unit, Kolkata

Chanda, Bhabatosh (Editorial Advisory Board Member): *Mathematical Morphology - Theory and Applications*, De Gruyter; (Editor): *IETE Journal of Education*, 2015, Taylor and Francis.

Das, Swagatam (Associate Editor): *IEEE Access*; *Neurocomputing*, Elsevier; *Information Sciences*, Elsevier; (Editor): *Engineering Application of Artificial Intelligence*, Elsevier; (Co Editor-in-Chief), *Swarm and Evolutionary Computing*, Elsevier Journal.

Mukherjee, Dipti Prasad (Associate Editor): *IEEE Transactions on Image Processing*, since 2014; (Associate Editor): *IET Image Processing*, 2016; *Sadhana*, Springer and Indian Academy of Sciences, since 2014.

Pal, Nikhil R. (Associate Editor): *Fuzzy Information and Engineering*, 2015, Elsevier; *IEEE Transactions on Cybernetics*, 2015, IEEE; *IEEE Transactions on Fuzzy Systems*, 2015, IEEE; *International Journal of Approximate Reasoning*, 2015, Elsevier; *Journal of Neuroscience and Neuroengineering*, 2015, American Scientific Publishers;

Machine Intelligence Unit, Kolkata

Bandyopadhyay, S. (Associate Editor): *BioSystems*; *IEEE Transactions on Systems, Man and Cybernetics, Systems*; *Sadhana*, Springer and Indian Academy of Sciences.

De, R.K. (Associate Editor): *Sadhana*.

Ghosh. A. (Associate Editor): *IET-Computer Vision*.

Ghosh, K. (Editor): *Computational Intelligence and Networks (CINE)*, Proceedings of 2016 International Conference, IEEE.

Mitra, S. (Editor): *IEEE/ACM Trans. on Computational Biology and Bioinformatics (IEEE)*; *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*; *Information Sciences*; *Neurocomputing*; *INAE Letters*.

Documentation Research and Training Centre, Bangalore

Dutta, Biswanath (Editor): *Proceeding of International Conference on Big Data and Knowledge Discovery (ICBK-2016)*.

Krishnamurthy. M (Consulting Editor): *Journal of Information Science Theory and Practice*, Korea Institute of Science and Technology Information, Korea.

Systems Science and Informatics Unit, Bangalore

Meher, S.K. (Guest Editors): *Granular Mining and Knowledge Discovery*, Pattern Recognition Letters, since 2015.

Sagar, B.S.D. (Editorial Advisory Board Member): *Computers & Geosciences*, Elsevier Publishers, since 2014; (Associate Editor): *Image Analysis & Stereology*, 2014-2015; (Review Editor): *Frontiers: Environmental Informatics*, since 2014.

Physics and Earth Sciences Division

Geological Studies Unit, Kolkata

Patranabis-Deb, Sarbani (Executive Editor): *Geological Journal*, Wiley-Blackwell Group, UK.

Saha, Dilip (Editor): *Indian Journal of Geology*; (Section Editor): *Current Science*.

Editorial and other Assignments

Physics and Applied Mathematics Unit, Kolkata

Maiti, Santanu K. (Section Editor): *International Journal of Nanobiotechnology*, Journals Pub, since 2015; *International Journal of Nanomaterials and Nanostructures*, Journals Pub, since 2015; *International Journal of Solid State Materials*, Journals Pub., since 2015; *International Journal of Applied Nanotechnology*, Journals Pub., since 2015.

Biological Sciences Division

Agricultural & Ecological Research Unit, Kolkata

Bhattacharya, P. (Associate Editor): *International Journal of Environmental Science and Technology*, Springer.

Social Sciences Division

Economics Research Unit, Kolkata

Chakravarty, Satya R. (Associate Editor): *Social Choice and Welfare*, Springer Verlag, 2015.

Majumder, Amita (Associate Editor): *International Econometric Review*, Econometric Research Association.

Sarkar, Nityananda (Associate Editor): *Indian Growth and Development Review*, Emerald Group Publishing Limited; *International Econometric Review*, Econometric Research Association.

Linguistic Research Unit, Kolkata

Dasgupta, Probal (Editor): *Beletra Almanako*, New York, Mondial.

Dash, Niladri Sekhar (Editor-in-Chief): *Journal of Advanced Linguistic Studies*, since 2011.

Sampling and Official Statistics Unit, Kolkata

Pathak, Prasanta (Assistant Editor): *The Indian Journal of Regional Science*.

Economics and Planning Unit, Delhi

Mishra, Debasis (Associate Editor): *Mathematical Social Sciences*.

Somanathan, E. (Editor): *Environment and Development Economics*, Cambridge University Press.

Somanathan, E. (Editor): *Environment and Development Economics*, Cambridge University Press.

Economics Analysis Unit, Bangalore

Ramachandran, V.K. (Editor): *Review of Agrarian Studies*; (General Editor): *Agrarian Studies Series*, Tulika Books, since 2002.

Centre for Soft Computing Research: A National Facility, Kolkata

Ghosh. A. (Associate Editor): *IET-Computer Vision*.

Pal S.K. (Associate Editor): *Information Sciences*, Elsevier; *Fuzzy Sets and Systems*, Elsevier; *Fundamenta Informaticae*, IOS Press; *International Journal Pattern Recognition and Artificial Intelligence*, World Scientific; *International Journal Computational Intelligence and Applications*, World Scientific; *IET Image Processing*, IEE Press; *LNCS Trans. on Rough Sets*, Springer) (Editor-in-Chief): *International Journal of Signal Processing, Image Processing and Pattern Recognition*, SERSC, Korea; (Executive Advisory Editor): *International Journal of Approximate Reasoning*; *International Journal of Computational Science and Engineering*; *International Journal of Image and Graphics*; (Guest Editor): *Pattern Recognition Letters*; *IET Image Processing*; *Natural Computing*, Springer; (Book Series Editor): *Frontiers in Artificial Intelligence and Applications (FAIA)*, IOS Press, Netherlands; *Statistical Science and Interdisciplinary Research*, World Scientific, Singapore; (Book Editor): *Pattern Recognition and Big Data*, World Scientific Press; *Soft Computing Applications in Sensor Networks*, CRC (Taylor & Francis) Press.

SCIENTIFIC ASSIGNMENTS/ACADEMIC VISITS ABROAD

Theoretical Statistics and Mathematics Division

Stat-Math Unit, Kolkata

Bose, Arup:

(1) Dept. of Economics, University of Cincinnati, April 17-25, 2015; (2) Oberwolfach, Germany, June 07-13, 2015; (3) Dept. of Economics, Miami University, Oxford, Ohio, July 14-22, 2015; (4) Dept of Mathematics, University of Cincinnati, July 21, 2015; (5) Dept. of Statistics, University of Minnesota, July 23-31, 2015; (6) Lehigh University, Bethlehem, Pennsylvania, July 31-August 2, 2015; (7) Dept. of Economics, Univ. of Cincinnati, March 15-28, 2016; (8) Miami University, Oxford, Ohio, March 15, 2016. (9) Dept. of Mathematics, Lehigh Univ., March 28-April 01, 2016.

Chaudhuri, Probal:

(1) National University of Singapore, April 8, 2015; (2) Trinity College, University of Cambridge, December 10-11, 2015.

Goswami, D.:

(1) Dept. of Maths, M.I.T. (USA), April 2015; (2) University of Cork, Dept. of Maths, The Republic of Ireland, August 2015; (3) SISSA, Trieste, Italy, September 2015; (4) TSIMF, Sanya, China, March 2016.

Hazra, Rajat, Subhra:

(1) Weierstrass Institute for Applied Analysis and Stochastics, Berlin, September 2015; (2) University of Zurich, January, 2016.

Editorial and other Assignments

Roy, Parthanil:

(1) University of Michigan, Ann Arbor, USA, June 2015; (2) Cornell University, Ithaca, USA, June 2015; (3) Department of Statistics and Probability, Michigan State University, East Lansing, USA, June 2015; (4) Department of Statistics, Columbia University, New York, USA, June 2015; (5) Karlsruhe Institute of Technology, Karlsruhe, Germany, March 2016.

Stat-Math Unit, Delhi

Bandyopadhyay, Antar:

(1) Institute of Statistical Mathematics (ISM), Tokyo, Japan, April 2015; (2) International Civil Aviation Organization (ICAO), Asia-Pacific Office, Bangkok, Thailand, May 2015; (3) Institute of Statistical Sciences Academia Sinica (ISSAS), Taipei, Taiwan, March 2016; (4) International Centre for Mathematical Sciences (ICMS), Edinburgh, UK, March 2016.

Bapat, R:

(1) Hainan Normal University, Haikou, China, May 25-29, 2015; (2) University of Tokyo, Japan, June 15-26, 2015; (3) Thomas J. Watson Research Center, IBM, USA, October 27-November 5, 2015.

Bhatia, R.:

(1) Shanghai University, China, June 8–July 7, 2015; (2) Vietnam Institute, Hanoi, August 31-September 4, 2015; (3) Austrian Academy of Sciences, Vienna and University of Ljubljana, Slovenia, November 13-20, 2015.

Laishram, Shanta:

(1) University of Salzburg, Austria, April 19-25, 2015; (2) Mathematical Institute, University of Debrecen, Hungary, April 26- May 25, 2015; (3) University of Liege, Belgium, May 25-29, 2015; (4) University of Leiden, Netherlands, May 30-June 5, 2015; (5) Department of Mathematics, Brown University, USA, August 11-15, 2015.

Roy, Rahul:

(1) Steklov Institute, St. Petersburg Russia, July 6-12, 2015; (2) University of Bristol, Bristol, UK, July 18-22, 2015; (3) University of Waterloo, Waterloo, Canada, November 8-20, 2015.

Sarkar, Anish:

(1) Department of Mathematics, VU University, Amsterdam, June 29 - July 3, 2015; (2) Universite De Lille, France, January 25- February 12, 2016.

Thakur, Maneesh:

(1) University of Muenster, Germany, September 2015; (2) Department of Mathematics, University of Muenster, February 28-March 13, 2016.

Stat-Math Unit, Bangalore

Athreya, Siva:

(1) University of Sheffield, Sheffield, United Kingdom, September 4-11, 2015; (2) Industrial Engineering and Management of Technion Institute of Technology, Haifa, Israel, January 21-29, 2016; (3) National University of Singapore, Singapore, February 22-26, 2016.

Bhat, B.V. Rajarama:

(1) University College Cork, Ireland, August 17-28, 2015; (2) Casa Matematica Oxaca (CMO), Mexico, August 23-28, 2015; (3) Vietnam Institute for Advanced Study in Mathematics (VIASM), Hanoi, Vietnam, September 1-4, 2015; (4) North-West University, Potchefstroom, South-Africa,

September 18-22, 2015; (5) North-West University, Potchefstroom, South-Africa, September, 23-26, 2015.

Kumar, Manish:

(1) University of Tel-Aviv, Israel, July 2- 14, 2015.

Rao, T.S.S.R.K:

(1) Department of Mathematical Sciences, University of Memphis, September 2015 - May 2016; (2) Geometry of Banach spaces, Southern Sectional Meeting, American Mathematical Society, October 17-18, 2015.

Sarkar, Jaydeb:

(1) Banff International Research Station (BIRS), Banff, Canada, April 5-10, 2015; (2) University of Lille 1, Lille, France, June 8-12, 2015; (3) Tbilisi, Georgia, July 4-10, 2015; (4) Department of Mathematics, Texas A&M University, USA, July 20 - August 4, 2015.

Yogeshwaran, D.:

(1) Ann Arbor, USA, June 15-19, 2015; (2) Haifa, Israel. June 29 - July 3, 2015; (3) Technion, Haifa, Israel, July 4 - 8, 2015; (4) Mathematisches Forschungsinstitut, Oberwolfach, Germany, November 1 - 14, 2015; (5) Karlsruhe Institute of Technology, Germany for discussion, November 15-18, 2015; (6) Tohoku University, Sendai, Japan, February, 15 -17, 2016.

Stat-Math Unit, Chennai

Ponnusamy, S.:

(1) Kazan (Volga Region), Federal University, Russia, June 27– July 4, 2015; (2) Sapientia, Hungarian University of Transylvania and Babeş-Bolyai University, Romania, August 28– September 11, 2015; (3) Petrozavodsk State University and Tver State University.

Applied Statistics Division

Applied Statistics Unit, Kolkata

Biswas, A.:

(1) Institute of Statistical Mathematics and University of Tokyo, Japan, March 29-April 4, 2015; (2) National Chengchi University and Academia Sinica, Taipei, January 27-February 2, 2016.

Dewanji, A.:

(1) Fred Hutchinson Cancer Research Center, Seattle, USA, June 05- July 17, 2013.

Pal Chowdhury, P.:

(1) Claflin University, Orangeburg, SC-29115, October 8-9, 2015; (2) Department of Statistics, George Washington University, October 12, 2015; (3) University of Louisiana, USA, October 15-16, 2015.

Sarkar, P.:

(1) CINVESTAV, Mexico City, Mexico, October 2015.

Sen Gupta, A.:

(1) Hacettepe University, Turkey, May – August, 2015; (2) Middle East Turkish University, Ankara, Turkey, August 2015; (3) Department of Commerce, US Government, Washington, D.C., USA, February, 16-19, 2016; (4) Hebrew University of Jerusalem, Israel, March-April, 2016.

Editorial and other Assignments

Interdisciplinary Statistical Research Unit, Kolkata

Bose, Smarajit:

(1) Institute of Statistical Mathematics, Japan and Institute of Statistical Sciences, Academia Sinica, Taiwan, Tokyo, April 1-2, 2015; (2) Institute of Statistical Sciences, Academia Sinica, Taiwan, January 29- February 5, 2016; (3) Institute of Statistical Mathematics, Japan and Institute of Statistical Sciences, Academia Sinica, Taiwan, Taipei, February 4-5, 2016.

Pal, Amita:

(1) Institute of Statistical Mathematics, Japan and Institute of Statistical Sciences, Academia Sinica, Taiwan, Tokyo, April 1-2, 2015; (2) University of Pierre and Marie Curie, Paris, June 24-28, 2015; (3) Warsaw, June 30-July 3, 2015.

Saharay, Rita:

(1) Department of Mathematics and Statistics, Missouri University of Science and Technology, Rolla, MO, USA, April – July, 2015; (2) College of Charleston, SC, USA, October 17-25, 2015.

Applied and Official Statistics Unit, North-East Centre, Tezpur

Chungkham, H.S.:

(1) Division of Epidemiology, Stress Research Institute, Stockholm University, Stockholm, Sweden, May 17-22, 2015; (2) University of Manchester, Manchester, U.K, September 10-18, 2015; (3) Division of Epidemiology, Stress Research Institute, Stockholm University, Stockholm, Sweden, March 07-18, 2016.

Computer and Communication Sciences Division

Advanced Computing and Microelectronics Unit, Kolkata

Bhattacharya, B.B.:

(1) Department of Computer Science, National Tsing Hua University, and Department of Electronics Engineering, National Chiao Tung University, Taiwan, December 20-26, 2015.

Banerjee, A.

(1) National Tsing Hua University (NTHU), Taiwan, March 5 - March 13, 2016.

Das, N.:

(1) LCN 2015, October 26-29, 2015; (2) CSE Dept. of University of Central Florida, Orlando, USA, October 30–November 9, 2015.

Nandy, S.C.:

(1) Univ. Of Victoria, Canada, August 5-7, 2015; (2) Queens Univ., Kingston, Canada, August 10-12, 2015; (3) Carleton University, Ottawa, Canada, August 13-September 12, 2015.

Sur-Kolay, S.:

(1) National Taiwan University, Taiwan, May 11- June 4, 2015; (2) Universitat Bremen, Germany, June 15- July 7, 2015; (3) Montpellier, France, July 8-10, 2015; (4) Daejeon, South Korea, October 5-7, 2015.

Computer Vision and Pattern Recognition Unit, Kolkata

Bhattacharya, Ujjwal:

(1) 3rd IAPR Asian Conference on Pattern Recognition (ACPR2015), Kuala Lumpur, Malaysia, November 3-6, 2015.

Chatterjee, Garga:

(1) Asian University of Women, Dhaka, Bangladesh, November 2015.

Garain, U.:

(1) Prouvé Convention Center, Nancy, France, August 23-26, 2015; (2) LITIS Lab, University of Rouen, France, August 27 - September 16, 2015.

Pal, Umapada:

(1) Kefalonian Island, Greece, June 21-26, 2015; (2) l'Université de la Rochelle, France, August 16-September 6, 2015; (3) Prouvé Convention Center, Nancy, France, August 23-26, 2015; (4) 3rd Asian Conference on Association for Pattern Recognition, Kuala Lumpur Malaysia, November 3-6, 2015.

Electronics and Communication Sciences Unit, Kolkata

Das, S.:

(1) Brno, Czech Republic, June 23 - 25, 2015.

Mukherjee, D P.:

(1) Quebec City, Canada, September 27-30, 2015; (2) Quebec City, Canada, September 30, 2015; (3) Department of Digital Arts, University of Guanajuato, Mexico, October 13, 2015; (4) Department of Electronics Engineering, University of Guanajuato, Mexico, October 15, 2015.

Pal, N.R.:

(1) IEEE Computational Intelligence Society, AC Palacio de Santa Paula, Granada, Spain, April 8-13, 2015; (2) Laboratoire d'informatique de l'Université Paris 6 (LIP6), Université Pierre et Marie Curie, Paris, France, May 22, 2015- June 19, 2015; (3) IEEE Computational Intelligence Society, The Marmara Pera Hotel, Istanbul, Turkey, July 30-August 2, 2015; (4) Brain Research Center, National Chiao-Tung University, Taiwan, October 17- November 20, 2015; (5) Canberra, Australia, February 2-5, 2016.

Machine Intelligence Unit, Kolkata

Bandyopadhyay, S.:

(1) ICMS, Edinburgh, Scotland, May 5-8, 2015.

Ghosh, A.:

(1) Yonsei University, South Korea, April 12-20, 2015; (2) Hong Kong Polytechnique University, Hong Kong, October 14-16, 2015; (3) King Mongkut's University of Technology, Thonburi, Bangkok, Thailand, November 22-25, 2015 and March- April, 2015.

Ghosh, K.:

(1) Warsaw University of Technology, Warsaw, Poland, June 30-July 3, 2015.

Maji, P.:

(1) Warsaw University, Warsaw, Poland, June 29, 2015.

Editorial and other Assignments

Mitra, S.:

(1) Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh, May 22, 2015; (2) University of Salerno, Fisciano, Università Mediterranea, Reggio Calabria, DIBRIS, University of Genova & University of Milan, Milano, Italy, June 26-July 12, 2015; (3) Southwest Jiaotong University, Chengdu & Chinese Academy of Sciences, Beijing, China, December 21, 2015- January 04, 2016.

Documentation, Research and Training Centre, Bangalore

Devika P Madalli:

(1) University of Trento, Italy, April 1-19 and July 4-17, 2015; (2) UNFAO, Rome, July 1-3, 2015; (3) University of Waterloo, Canada, August 16-23, 2015; (4) Paris FAO, Rome, Italy, September 21-16, 2015; (5) Dept. of Lib. & Inf. Science, Keimyung University, Korea, October 13-16, 2015; (6) Dept. of Lib. & Inf. Science, Kyungpook National University, Daegu, Korea, October 17-21, 2015; (7) Interest Group on Agricultural data, National Informetrics Centre, Tokyo, Japan, February 28- March 5, 2016.

Krishnamurthy. M:

(1) Dept. of Lib. & Inf. Science, Keimyung University, Korea, February 24-28, 2016.

Prasad A.R.D:

(1) Dept. of Lib. & Inf. Science, Keimyung University, Korea, October 13-16, 2015; (2) Dept. of Lib. & Inf. Science, Kyungpook National University, Daegu, Korea, October 17-21, 2015.

Systems Science and Informatics Unit, Bangalore

Sagar, B.S.D.:

(1) International Symposium on Mathematical Morphology, Reykjavik, Iceland, May 27-29, 2015; (2) Convention Center, Milan, Italy, July 26-31, 2015; (3) International Association for Mathematical Geosciences, Freiberg, Germany, September 5-13, 2015.

Computer Science Unit, Chennai

Chakraborty, Prabuddha:

(1) Institute of Theoretical Physics, Centre for Electronic Correlations and Magnetism (EKM), University of Augsburg, Augsburg, Germany, June 2015.

Ghosh, Sujata.:

(1) Istanbul Congress Center, Istanbul, Turkey, May 4-8, 2015; (2) Carnegie Mellon University, Pittsburgh, USA, June 4-6, 2015; (3) University of California (Davis), USA, June, 2015; (4) National Taiwan University and National Yang Ming University, Taiwan, October 28-31, 2015.

Venkateswarlu, Ayineedi.:

(1) Institut Henri Poincaré (IHP), Paris, France, April 11-15, 2015.

Cryptology and Security Research Unit, Kolkata

Paul, Goutam:

(1) International Centre for Mathematical Sciences (ICMS), Edinburgh, UK, May 25-29, 2015; (2) School of Computer Engineering, Nanyang Technological University, Singapore, September-October 2015; (3) Department of Mathematics, Ruhr University Bochum, Germany, March 2016.

Ruj, Sushmita:

(1) International Centre for Mathematical Sciences (ICMS), Edinburgh, UK, May 25-29, 2015; (2) University of Derby, June 1-5, 2015; (3) ISIT labs, Fukuoka, Japan, August 31-September 4, 2015; (4) San Diego, USA, December 6-10, 2015; (5) Le Régent Congress Centre, Crans-Montana, Switzerland, March 23-25, 2016.

Sen Gupta, Sourav:

(1) International Centre for Mathematical Sciences (ICMS), Edinburgh, UK, May 25-29, 2015.

Physics and Earth Sciences Division

Geological Studies Unit, Kolkata

Chakraborty, Tapan:

(1) Institute of Geosciences, University of Campina, Sao Paulo, Brazil, November 24-December 9, 2015.

Das, Shiladri S.:

(1) Geological Society of America, Baltimore, Maryland, USA, November 5-13, 2015.

Ghosh, Parthasarath:

(1) University of Christchurch, New Zealand, November 30 – December 4, 2015.

Sarbani P. Deb:

(1) Jagiellonian University, Kraków, Poland, June 19 - 28, 2015.

Physics and Applied Mathematics Unit, Kolkata

Ghosh, Dibakar:

(1) Saratov State Technical University, Saratov, Russia, November 1-9, 2015; (2) Nizhny Novgorod State University, Nizhny Novgorod, Russia, November 10-13, 2015.

Ghosh, Subir

(1) National University of La Plata, Argentina, March 10 – May 12, 2015; (2) Institute of Physics and Interdisciplinary Science of Shaanxi University of Technology (SUT), China, March 3 – 30, 2016.

Pal, Supratik:

(1) Cosmo Cruise 2015, Barcelona, Spain, September 01 – 11, 2015.

Sarkar, Sankar:

(1) AMCE 2015, Hong Kong, September 25 – 26, 2015.

Biological Sciences Division

Agricultural and Ecological Research Unit, Kolkata

Mukherjee, Abhisek:

(1) Health & Biosecurity, CSIRO, Brisbane, Australia, September 01 – December 31, 2015.

Editorial and other Assignments

Human Genetics Unit, Kolkata

Ghosh, Saurabh:

(1) (ISI-ISM) ISSAS Joint Meeting, Tokyo, Japan, April 2-4, 2015; (2) European Mathematical Genetics Meeting, Brest, France, April 16-17, 2015; (3) University of Minnesota, Minneapolis and Mount Sinai, New York, September 24-29, 2015.

Indranil Mukhopadhyay:

(1) (ISI-ISM) ISSAS Joint Meeting, Tokyo, Japan, April 2-4, 2015; (2) Workshop on Big Data Challenges from Modern Science through Statistical Modeling, Edinburgh, UK, May 2015.

Social Sciences Division

Economic Research Unit, Kolkata

Chakravarty, Satya Ranjan.:

(1) 2nd UNEP Workshop, Geneva, Switzerland, June 24-26, 2015.

Neogi, Chiranjib:

(1) Technische Universitat Braunschweig, Braunschweig, Germany, August 24-27, 2015.

Roy, Souvik:

(1) Department of Quantitative Economics of Maastricht University, Netherlands, August 31-December 4, 2015.

Sarkar, Abhirup:

(1) The Institute of South Asian Studies of the National University of Singapore, October 27-November 2, 2015.

Sharma Biswas, Chaiti:

(1) ICOSS 2015, Colombo, Sri Lanka, August 11-13, 2015.

Linguistic Research Unit, Kolkata

Dasgupta, Probal:

(1) Universala Kongreso de Esperanto, Lille, France, July 30, 2015; (2) Chateau Gresillon, Bauge, France, August 4, 2015; (3) Jahangirnagar University and Gono Bishwabidyalay, Dhaka, February 22, 2016; (4) Institute of Modern Languages, Dhaka University, Dhaka, February 24, 2016.

Dash, Niladri Sekhar:

(1) UCREL Research Centre, Lancaster University, UK, May 12-18, 2015; (2) Institute of Information and Communication Technology (IICT), Shahjalal University of Science and Technology (SUST), Sylhet, Bangladesh, May 22-24, 2015.

Population Studies Unit, Kolkata

Pasupuleti, S.S.R.:

Population Association of America, 2015 annual meeting, San Diego, CA, April 30-May 2, 2015.

Psychology Research Unit, Kolkata

Ghosh, Anjali:

(1) Universitat de Autònoma de Barcelona, Spain, June 23-26, 2015; (2) University of Madrid, Spain, June 28-30, 2015; (3) University of Lisbon, Portugal, July 1-4, 2015; (4) International Conference on Social Sciences, Colombo, Sri Lanka, August 11-13, 2015.

Gupta, Rumki:

(1) Advances in Computer Science, Electronics and Communication Technologies, Eastin Hotel, Bangkok, Thailand, January 22, 2016.

Sampling and Official Statistics Unit, Kolkata

Kar, Aloke:

(1) Food and Agricultural Organization (FAO) and BPS-Statistics Indonesia, Jakarta, Indonesia, November 9-20, 2015; (2) Nay Pyi Taw, December, 2015; (3) International Labour Organization (ILO), Lebanon and Beirut, February, 2016; (4) Asian Development Bank (ADB), Myanmar. Nay Pyi Taw, March, 2016.

Mitra, Sandip:

BRAC University, Bangladesh, May 23-26, 2015 and August 29 - September 12, 2015.

Sociological Research Unit, Kolkata

Ghosh, Bhola Nath:

(1) Member, Book Reviewer Board, South Asian Journal of Policy and Governance (SJPG), Bi-annual Publication of Central Department of Public Administration, Tribhuvan University, Kathmandu, Nepal, 2015; (2) Bangladesh Academy for Rural Development (BARD), Comilla, Bangladesh, December 18-19, 2015.

Economics and Planning Unit, Delhi

Das, Satya P:

University of Illinois at Urbana Champaign, U.S.A., August 1, 2015 – May 30, 2016.

Ghate, Chetan:

(1) Centre for Economic Growth and Policy (CEGAP) Annual Conference, Durham University Business School, UK, May 16-17, 2015. (2) KOC University, Istanbul, September 17-18, 2015; (3) Asian Development Review Conference Seoul Hilton, Seoul, Korea, November 16-18, 2015;

Kapoor, Mudit:

(1) ECRC/EDRI, Addis Ababa, Ethiopia, February 22-26, 2016.

Mukhopadhyay, Abhiroop:

(1) CMI, Norway, May 28–June 12, 2015; (2) Ninth Annual Population, Reproductive Health and Economic Development Conference, Addis Ababa, Ethiopia, June 24-26, 2015; (3) University of Caen, France, June 28 – July 4, 2015; (4) Montreal and Chr. Michelsen Institute (CMI), Bergen, August 17 - September 3, 2015; (5) UNU-WIDER, Helsinki, Finland, September 16-19, 2015; (6) University of Sussex, Brighton, UK, March 21-24, 2016.

Editorial and other Assignments

Mishra, Debasis:

(1) Centre for Operations Research and Econometrics, Belgium and Maastricht University Graduate School of Business and Economics, Netherlands, April 20-May 1, 2015; (2) Institute of Social and Economic Research, Osaka University, Japan, May 18- June 30, 2015; (3) Bilgi University, Istanbul, Turkey, July 2-3, 2015.

Ramaswami, Bharat:

(1) Technical working group of food and agriculture organisation, United Nations, Rome, Italy, May 7-8, 2015; (2) International Food Policy Research Institute, Beijing, China, May 25-27, 2015; (3) University of British Columbia, Canada, July 6-15, 2015; (4) Food and Agriculture Organization (FAO), Rome, Italy, June 24-26, 2015; (6) ICAE, University of Milan, Milan, Italy, August 10-14, 2015.

Somanathan, E.:

(1) University of Gothenburg, Sweden, May 5-8, 2015; (2) South Asian Network for Development and Environmental Economics (SANDEE), USA, July 1, 2015 - July 31, 2017.

Sen, Arunava:

(1) New York University, USA, August 17-23, 2015; (2) Williams College, U.S.A, September 15, 2015 – July 1, 2016.

Economics Analysis Unit, Bangalore

Chattopadhyay, Molly:

(1) University of Colombo, Sri Lanka, August 10-12, 2015.

Ramachandran, V.K.:

(1) Rosa Luxemburg Stiftung, Berlin, May 29- 30, 2015; (2) Southern Institute of Social Sciences, Ho Chi Minh City, Vietnam, October 21, 2015.

Statistical Quality Control and Operations Research Division

SQC & OR Unit, Kolkata

Anis, M.Z.:

(1) Rider University, Lawrenceville, New Jersey, USA, June 1-3, 2015, (2) University of Florida, Gainesville, Florida, USA, June 4-8, 2015; (2) College of Textiles, North Carolina State University, Raleigh, North Carolina, USA, June 9-12, 2015.

SQC & OR Unit, New Delhi

Neogy, S K:

(1) ISMP, Pittsburgh, USA, July 12-17, 2015.

SQC & OR Unit, Mumbai

Sarkar, Ashok:

(1) Equate Petrochemical, Kuwait, April 25–May 5, 2015.

Center for Soft Computing research: A National Facility, Kolkata

Ghosh, A.:

(1) Yonsei University, South Korea, April 12-20, 2015; (2) Hong Kong Polytechnique University, Hong Kong, October 14-16, 2015; (3) King Mongkut's University of Technology, Thonburi, Bangkok, Thailand, November 22-25, 2015.

Pal, S. K.:

(1) Telecom ParisTech, Paris, France, June 24- July 04, 2015; (2) Warsaw University of Technology, Warsaw, Poland, June 30-July 3, 2015; (3) Szechenyi Istvan University, Gyor, Hungary, November 13-16, 2015; (4) Austrian Academy of Science, Vienna, Austria, November 17-21, 2015; (5) Universitat Paderborn, Germany, November 22-25, 2015, (6) German Workshop on Computational Intelligence, Dortmund, Germany, November 26-27, 2015; (7) Beijing University of Technology, China, December 25-28, 2015; (8) University of Deusto, Bilbao, Spain, February 7-11, 2016.

SCIENTIFIC ASSIGNMENTS/ ACADEMIC VISITS IN INDIA

Theoretical Statistics and Mathematics Division

Stat-Math Unit, Kolkata

Bose, Arup:

(1) Indian Institute of Science Education and Research (IISER), Pune, May 25-30, 2015.

Chaudhuri, Probal:

(1) Gauhati University, November 24-28, 2015; (2) IIT Kharagpur, March 19, 2016.

Datta, Mahuya:

(1) IWM Conference, Delhi University, Delhi, April 2-4, 2015; (2) NEHU, Shillong, June 15- July 4, 2015; (3) IIT Gauhati, February 19-20, 2016.

Dutta, Amartya, K.:

(1) University of Engineering and Management, Kolkata, May 14, 2015; (2) Ramakrishna Mission Institute of Culture, July 28 and 31, 2015; (3) St. Xavier's College, Kolkata, September 21 and BKC College, Kolkata, September 29, 2015; (4) NSS, Jadavpur University, October 6, 2015; (5) Asutosh Mookherje Memorial Institute, Ramakrishna Mission Institute of Culture, December 11, 2015; (6) Interviewer for the selection of school-teachers, Ashrama of the Ramakrishna Mission, 17 February, 2016; (7) RKM Vidyamandira, Belur, March 1, 2016.

Gupta, Neena:

(1) Delhi University, Delhi, April 2-4 2015; (2) TIFR, Bangalore, November 21-30, 2015.

Ray, Swagato, K.:

(1) Mathematics Training and Talent search programme (MTTS), Shiv Nadar University, Organized, NBHM, June 15-27, 2015; (2) Rastraguru Surendranath College, Barrackpore, NBHM, September 18-22, 2015; (3) Advanced Instructional School, Tejpur University, December 15-19, 2015.

Roy, Parthanil:

(1) School of Technology and Computer Science, Tata Institute of Fundamental Research, Mumbai, August 2015; (2) 3rd Indian Statistical Physics Community Meeting, International Centre for Theoretical Sciences, Bangalore, February 2016.

Editorial and other Assignments

Stat-Math Unit, Delhi

Bandyopadhyay, Antar:

(1) IISA Conference on Statistics, Probability and Data Analysis, Pune, December 2015; (2) Indian Institute of Technology (IIT), Bombay, Mumbai, India, January 2016; (3) Jaipur National University, Jaipur, India, March 2016; (4) Institute of Mathematical Sciences (IMSc), Chennai, India, March 2016.

Bhatia, R.:

(1) Advanced Training in Mathematics School, National Centre for Mathematics, Shiv Nadar University, Noida, May 4-30, 2015; (2) Summer Research Program, IISER Mohali, May 18, 2015; (3) Mathematics Society, PGDAV College, Delhi University, September 18, 2015; (4) Punjab University Colloquium, Chandigarh, September 30, 2015; (5) Conference Indian Women and Mathematics, February 19-20, 2016; (6) Himachal Pradesh University, Shimla, March 18-19, 2016; (7) Punjab University, IIT Delhi, IIT Bombay and IISER Bhopal; (8) INSPIRE Faculty Award Committee, INSA and Department of Science and Technology.

Bhatt, Abhay G.:

1) Chennai Mathematical Institute, Chennai, July 13-17, 2015; (2) Indira Gandhi Institute of Development Research, Mumbai, Mathematics and Economics Workshop, October 15-17, 2015; (3) Indian Institute of Science, Bangalore, Indo-UK workshop on Stochastic Partial Differential Equations, December 9 - 19, 2015; (4) National Board for Higher Mathematics, Research Projects Committee; (5) Council of Scientific and Industrial Research, CSIR-UGC NET examination.

Dewan, Isha:

(1) IISER Pune, June 2015; (2) Punjab University Chandigarh Nov 3-5, 2015; (3) IISA Conference, Pune December 20-14, 2015.

Jain, Tanvi:

(1) University Gautam Buddha Nagar U.P., May 4, 2015.

Laishram, Shanta:

(1) KIIT Bhubaneswar, June 8-13, 2015; (2) NISER Bhubaneswar, June 13-20, 2015; (3) UGC – Human Resource Development Centre, University of Hyderabad, September 23, 2015; (4) LNMIIT Jaipur, December 14-15, 2015; (5) IISER, Pune, February 4-5, 2016; (6) HRI, March 4-8, 2016.

Roy, Rahul:

(1) IIT Mumbai, January 28, 2016.

Sarkar, Anish:

(1) Indian Institute of Science, Bangalore, December 9-18, 2015.

Thakur, Maneesh:

(1) Shiv Nadar University, May 2015.

Stat-Math Unit, Bangalore

Bhat, B.V. Rajarama:

(1) Academic Committee of IISER, Trivandrum; (2) Board of Studies of RV College of Engineering, Bangalore; (3) North-East Summer Workshop in Analysis and Probability (NE-SWAP), Agartala, June 27-30, 2015; (4) Sri Venkateswara University, Tirupati, October 29, 2015-November 02, 2015; (5) KIITS University, Bhubaneswar, November 4-8, 2015; (6) IISER Bhopal, December 28-30, 2015; (7) Institute of Mathematical Sciences, Chennai, January 11-24, 2016; (8) Periyar University, Salem, February 11 -12, 2016; (9) Central University of Kerala, Kasaragod, March 3-5, 2016.

Nayak, Suresh:

(1) Chennai Mathematical Institute, September 3 - 8, 2015 and January 29 - February 5, 2016.

Raja, C.R.E.:

(1) Institute of Mathematical Sciences, Chennai, January 11-24, 2016; (2) St. Joseph's College, Tiruchirappalli, March 4, 2016.

Rajeev, B.:

(1) Department of Mathematics, I.I.T Chennai, January 27-29, 2016.

Ramasubramanian, S.:

(1) Department of Statistics, University of Mysore, Mysore, November 2 - 5, 2015.

Sarkar, Jaydeb:

(1) Shiv Nadar University, Delhi, May 2015; (2) North-East Summer Workshop in Analysis and Probability (NE-SWAP), Agartala, June 2015; (3) Aligarh Muslim University, December 2015; (4) Department of Mathematics, Rajiv Gandhi University, Arunachal Pradesh, January 2016; (5) Indian Academy of Sciences, February 2016; (6) Ramanujan Institute for Advanced Study in Mathematics, University of Madras, March 2016, Chennai; (7) IIT Bombay, Mumbai, March 2016; (8) Central University of Kerala, Kasaragod, March 2016.

Sury, B.:

(1) RMS-APU workshop for Mathematics Teachers, June 27, 2015; (2) IISER Mohali, August 1-31, 2015; (3) Panjab University, Chandigarh, August 19, 2015; (4) Thapar University, Punjab, August 28, 2015; (5) IIT Kanpur, October 15, 2015; (6) RMS-APU workshop for Mathematics teachers, December 11, 2015; (7) 81st Annual Conference of the Indian Mathematical Society, Nagpur, December 27-30, 2015; (8) Homi Bhabha Centre for Science Education, TIFR Mumbai, December, 2015; (9) 103rd Indian Science Congress, Mysore, January 1-5, 2016; (10) NISER Bhubaneswar, February 15, 2016; (11) KIIT Bhubaneswar, February 16, 2016; (12) HRI Allahabad, March 4-8, 2016; (13) St. Stephen's College Delhi, March 29, 2016;

Yogeshwaran, D.:

(1) Indo-UK Workshop on SPDE, IISc, Bangalore, December 10-19, 2015; (2) 10th Lecture Series in Probability and Stochastic Processes, IISc, Bangalore, December 13-16, 2015; (3) IIT, Bombay, Mumbai, January 4-8, 2016.

Stat-Math Unit, Chennai

Ponnusamy, S.:

(1) Sri Lakshmi Ammaal Engineering College, Chennai, August 17-20, 2015.

Applied Statistics Division

Applied Statistics Unit, Kolkata

Basu, K.:

(1) Department of Statistics, Manipal University, Manipal, January 11-12 2016.

Biswas, A.:

(1) Indian Institute of Management, Ahmedabad, April 11-12, 2015; (2) GSK, Bangalore, October 16, 2015; (3) University of Lucknow, December 28-30, 2015; (4) Internal Novartis Statistics Conference, Novartis, Hyderabad, March 18, 2016.

Editorial and other Assignments

Dewanji, A.:

(1) Department of Statistics, Panjab University, Chandigarh, November 4 -6, 2015.

Sarkar, P.:

(1) International Conference on Cryptology in India, Indocrypt, December 6-9, 2015.

SenGupta, A.:

(1) Serving on the Program Advisory Committee of Mathematical Sciences, DST, Govt. of India, 2015; (2) IIM-Ahmedabad, April 11-12, 2015; (3) International Conference on Multiple Comparison Procedures, Hyderabad, September 2-5, 2015; (4) International Workshop in Big Data Benchmarking, New Delhi, India, December 14-15, 2015; (5) International Organizing Committee, International Conference of the International Indian Statistical Association, Pune, December 20-24, 2015; (6) Ninth International Triennial Calcutta Symposium, December 28-31, 2015.

Interdisciplinary Statistical Research Unit, Kolkata

Adhikary, A.K.:

(1) University of Burdwan, West Bengal, 2015.

Bose, S.:

(1) IIM, Kolkata, April 22, 2015.

Applied Statistics Unit, Chennai

Sen, R.:

(1) Vellore Institute of Technology, Chennai Campus, September 28, 2015; (2) IGIDR, Mumbai, October 15, 2015; (3) IISA conference, Pune, December 20-24, 2015.

Applied and Official Statistics Unit, Tezpur

Chungkham, H.S.:

(1) Workshop on Biostatistics with applications in SPSS, LGB Regional Institute of Mental Health, Tezpur, December 17-18, 2015; (2) LGB Regional Institute of Mental Health, Tezpur, February 03-29, 2016.

Computer and Communication Sciences Division

Advanced Computing and Microelectronics Unit, Kolkata

Bhattacharya, B.B.:

(1) Adjunct Professor, Department of Computer Science and Engineering, Indian Institute of Technology, Guwahati, June 12-July 11, 2015; (2) Department of Electronics and Communication Engineering, MNIT, Jaipur, November 6-8, 2015; (3) Department of Electrical Engineering, Indian Institute of Technology, Bombay, November 18-13, 2015.

Banerjee, A.:

(1) Research Advisor, Xerox Research Labs India, May- September, 2015.

Das, N.:

(1) Program Chair, IEEE ANTS 2015, Indo-US Bilateral Workshop on Large Scale Complex Network Analysis (LSCNA 2015).

Sur-Kolay, S.:

(1) Invited lecture, CAIR, DRDO, Bangalore, August 12, 2015; (2) General Chari, 29th International Conference on VLSI Design and the 15th International Conference on Embedded Systems, Kolkata, January 4-8, 2016.

Computer Vision and Pattern Recognition Unit, Kolkata

Bhattacharya, Ujjwal:

(1) Rajiv Gandhi University, Doimukh, Arunachal Pradesh, November 19-20, 2015; (2) Cochin University of Science and Technology, Cochin, Kerala, February 26, 2016; (3) Bodioland University, Kokrajhar, Assam, March 19-10, 2016.

Garain, Utpal:

(1) Rajiv Gandhi University, Doimukh, Arunachal Pradesh, November 19, 2015.

Parui, Swapan Kumar:

(1) Rajiv Gandhi University, Doimukh, Arunachal Pradesh, November 19, 2015.

Electronics and Communication Sciences Unit, Kolkata

Chanda, B.:

(1) NIT Kurukshetra, June 6-8, 2015; (2) Session Chair, 17th International Workshop on Combinatorial Image Analysis, Kolkata, November 24-27, 2015; (3) IIIT Allahabad, December 12-13, 2015; (4) IIT Patna, December 17-19, 2015; (5) Jadavpur University, Kolkata, January 8-10, 2016; (6) Invited lecture, 18th Workshop on Computational Information Processing, Khowai, Tripura, February 4-5, 2016; (7) Invited lecture, Science Academies Lecture Workshop on Recent Trends in Machine Learning, Coimbatore, February 9-11, 2016; (8) Invited lecture, First Workshop on Computing: Theory and application, Tezpur, March 14-18, 2016.

Das, S.:

(1) Keynote Lecture, IC3T 2015, Hyderabad, India, July 24 - 26, 2015; (2) Keynote Lecture, 2nd International Conference on Intelligent Computing and Applications (ICICA) 2015, Chennai, December 23-24, 2015; (3) Keynote Lecture, 3rd International Conference on Information System Design and Intelligent Applications (INDIA), Vizag, January 5-7, 2016; (4) University of Kalyani, West Bengal, February 18-19, 2016; (5) Keynote Lecture, SHAASTRARTH - 2016, Raipur, February 24-25, 2016; (6) Dhirubhai Ambani Institute of Information and Communication Technology, Gandhinagar, Gujarat, March 2-8, 2016; (7) Invited Lecture, DocCon 2016, Udaipur, Rajasthan, March 4, 2016; (8) Keynote Lecture, ICDECT 2016, Lavasa, Pune, March 10 - 11, 2016; (9) South Asian University (SAU), New Delhi, 19 March, 2016.

Mohanta, P.P.:

(1) Dasaratha Deb Memorial College (DDMC), Khowai, Tripura, February 04-05, 2016.

Mukherjee, D.P.:

(1) Presented course on Research Methodology, Computer Society of India, Kolkata Chapter August 22, 2015; (2) IIT Patna, December 17-19, 2015; (3) Invited lecture, 18th Workshop on Computational Information Processing, Khowai, Tripura, February 4-5, 2016; (4) Presented seminar on Few Applications of Medical Imaging Research, National Workshop on Medical Image Processing, IASST Guwahati, February 20, 2016.

Editorial and other Assignments

Machine Intelligence Unit, Kolkata

De, R.K.:

(1) Dept. of Computer Science & Engineering, Tezpur University; (2) Dept. of Computer Science & Engineering, Mizoram University; (3) External Expert of Assessment Committee of Research Fellows, Bose Institute.

Ghosh, A.:

(1) Tripura University Agartala, Tripura, January 21-22, 2016;

(2) IISc Bangalore, May, 4, 2015; (3) IIT Bombay Mumbai, June 3, 2015; (4) South Asian University, August 16-17, 2015; (5) Anna University, Chennai November 15-16, 2015; (6) Keynote Talk, IEEE International Conference on Information Technology (ICIT), Bhubaneswar, December 21-23, 2015; (7) Utkal University, Bhubaneswar, February, 14-15, 2016; (8) Tripura University, Agartala, March, 14-15, 2016.

Ghosh. K.:

(1) Dept. of Agricultural Statistics, Assam Agricultural University, Jorhat, Assam, December 4-8, 2015; (2) Department of Computer Science & Engineering, Institute of Engineering & Management, Kolkata, 2016.

Maji, P.:

(1) Department of Computer Science and Engineering, Indian Institute of Technology, Kharagpur, April, 2015; (2) M. Tech thesis, Department of Computer Science and Technology, Indian Institute of Engineering Science and Technology, Shibpur, May 2015; (3) M. Tech thesis, Department of Information Technology, Indian Institute of Engineering Science and Technology, Shibpur, June 2015;

Mitra, S.:

(1) Member, Board of Studies, Dept. of Computer Science & Engineering, Tezpur University; (2) Member, Board of Studies, Dept. of Information Technology, Govt. College of Engineering and Ceramic Technology, Kolkata (autonomous); (3) Examiner Ph.D. thesis, Indian School of Mines, Dhanbad, 2015; (4) Keynote Lecture, Third International Symposium on Women in Computing and Informatics (WCI-2015), Kochi, August 11, 2015; (5) Indian School of Mines, Dhanbad, February 10, 2016; (6) Invited talk, IEEE CIS Winter School on Emerging Trends in Computational Intelligence: Theory and Applications, Ahmedabad, March 3, 2016.

Murthy, C.A.:

(1) Member of Research Council of CSIR-NISTADS (National Institute of Science, Technology and Development Studies); (2) Research advisor to Tata Consultancy services (TCS), Kolkata, October 2015 to March 2016.

Ray, S.S.:

(1) Institute of Engineering and Management, Salt Lake City, Kolkata, India, August 22, 2015.

Documentation, Research and Training Centre, Bangalore

Dutta, Biswanath:

(1) Dept. of Inf. Technology, National Institute of Technology, Durgapur, July 20-24, 2015, December 9-11, 2015 and March 30-31, 2016.

Krishnamurthy. M:

(1) Punjab University, Chandigarh, April, 8-19, 2015; (2) Alagappa University, Karikudi, April 24-25, 2015; (3) K.S School of Engg. and Management, Bangalore, May 5, 2015; (4) Sri Krishna College of

Engg. and Technology, Coimbatore, May 15, 2015; (5) Mangalore University, Mangalagangothri, May 31, 2015; (6) Karnataka State Open University, Mysore, June 8-9, 2015; (7) SRM University, Chennai, June 11-13, 2015; (8) Mangalore University, Mangalagangothri, June 22, 2015; (9) Library & Inf. Centre, PES Colleges of Engineering, Mandya, August, 19, 2015; (10) Indian Audit and Accounts Department, Regional Training Centre, Bangalore, October 14-15, 2015; (11) Sri Devaraj Urs Academy of Higher Education and Research Institute, Kolar, October 28, 2015; (12) Dept. of Lib. & Inf. Science, Mangalore University, Mangalagangothri, November 3-5, 2015; (13) Gulbarga University, Gulbarga, November 24-26, 2015; (14) New Horizon College of Engineering, Bangalore December 4, 2015; (15) MSLIS, Mangalore University, Mangalagangothri, December 29-30, 2015; (16) Bharathiar University, Coimbatore, February 2, 2016; (17) Karnataka State Women's University, Bijapur, February 10, 2016.

Madalli, Devika P:

(1) University of Calcutta, Kolkata, October 29, 2015; (2) ITPAR Scientific Committee Meeting, Jodhpur, December 9-10, 2015; (3) Karnataka Evaluation Committee Member, Evaluation Authority, Bangalore, Karnataka, 2015-16.

Prasad, A.R.D:

(1) Member, National Mission for Library (NML), National Virtual Library of India, Meeting of Technical & Evaluation Committee, New Delhi, April 7, 2015; (2) North-Eastern Hill University, Shillong, June 17, 2015; (3) Sikkim University, Gangtok, Sikkim, June 18-20, 2015; (4) Tripura University, Suryamaninagar, Tripura, June 26, 2015; (5) Jammu University, Jammu, September 14-20, 2015; (6) Central University of Himachal Pradesh, September 21-24, 2015; (7) Research Advisory Committee Meeting, DELNET, New Delhi, October 7, 2015; (8) INSA, New Delhi, November 5-6, 2015; (9) Cochin University of Science and Technology, Cochin, November 20, 2015; (10) All India Shri Shivaji Memorial Society's College of Engineering, Pune, November 23-27, 2015; (11) ITPAR Scientific Committee Meeting, Jodhpur, December 9-10, 2015; (12) Selection Committee, Sikkim University, January 25, 2016; (13) Selection Committee, Tripura University, February 2-3, 2016; (14) Manipal University, Manipal, February 19-20, 2016.

Systems Science and Informatics Unit, Bangalore

Meher, S.K.:

(1) University Visvesvaraya College of Engineering, Bangalore, India, August 19-21, 2015; (2) Granted Patents, (with S.K. Pal), "Rough Wavelet Granular Space and Classification of Multispectral Remote Sensing Image", Indian Application # 1324/KOL/2010, US patent # IN-800853-03-US-NAT, Issued patent (06 Oct. 2015), Korea patent # IN-800853-05-KR-NAT, Issued patent (21 Jan. 2015); (3) M.S. Ramaiah Institute of Technology, Department of Telecommunication Engineering, Bangalore, India, January 7 -9, 2016.

Sagar, B.S.D.:

(1) Indian Institute of Technology-Bombay, 2015; (2) International Institute of Information Technology-Bangalore (IIITB), November 20, 2015; (3) Bharathiar University, 2016; (4) International Institute of Information Technology-Bangalore (IIITB), 2016; (5) Mathematical Morphology and Morphological Interpolations, Gayatri Vidya Parishad, Vizag, March 2, 2016.

Computer Science Unit, Chennai

Ayineedi Venkateswarlu.:

(1) Department of Mathematics, IIT Madras, March 7, 2016.

Karthick, T.:

(1) Pondicherry University, Puducherry, July 15-16, 2015; (2) PG Department of Mathematics, Government Arts College, Melur, Madurai, August 06-08, 2015; (3) Amrita Viswa Vidyapeetam,

Editorial and other Assignments

Coimbatore, December 16-19, 2015; (4) IIT Madras, Chennai, February 8, 2016; (5) University of Kerala, Trivandrum, Kerala, February 18–20, 2016; (6) Faculty Development Programme (FDP) on Algorithm Analysis and Design, NIT Warangal, Telangana, March 4 – 9, 2016.

Mathew C. Francis.:

(1) IIT Madras, July 10-13, 2015; (2) Advisor, M. Tech project, Department of Computer Science and Engineering, Government Engineering College, Idukki; (3) Department of Computer Science and Engineering, Government Engineering College, Idukki, June 29, 2015; (4) Department of Mathematics, IIT Madras, August 12, 2015. (5) Institute of Mathematical Sciences during the semester January–May, 2016;

Sujata Ghosh.:

(1) Theoretical Computer Science, Institute of Mathematical Sciences (IMSc), Chennai, 2015; (2) IMSc Logic Seminar, September, 2015; (3) Calcutta Logic Circle Annual Meet, Kolkata, November, 2015; (4) Association for Logic in India, 2015.

Cryptography and Security Research Unit, Kolkata

Barua, Rana:

(1) University of Kashmir, Srinagar, April 23- May 1, 2015; (2) NIT, Sikkim, October 14-16, 2015; (3) Indian School of Mines, Dhanbad, January 28-29, 2016.

Paul, Goutam:

(1) Department of Computer Science and Engineering, Indian Institute of Technology Roorkee, October 21-28, 2015.

Physics and Earth Sciences Division

Geological Studies Unit, Kolkata

Chakraborty, Tapan:

(1) Geological Survey of India, Aizwal, January 26-28, 2016.

Saha, Dilip:

(1) Wadia Institute of Himalayan Geology, Dehra Dun, October 5-12 2015; (2) Indian Institute of Science, Bangalore November 28-29, 2015; (3) University of Calcutta, 2015-16.

Physics and Applied Mathematics Unit, Kolkata

Ghosh, Dibakar,

(1) National Institute of Technology, Durgapur, February 15 – 17, 2016.

Kar, Guruprasad:

(1) National Institute of Technology, Patna, November 27– December 4, 2015; (2) Institute of Physics, Bhubaneswar, February 11–18, 2016; (3) International Institute of Information Technology, Hyderabad, March 26–30, 2016.

Maiti, Santanu K.:

(1) RCC Institute of Information Technology, Kolkata, July 06-10, 2015; (2) Budge Budge Institute of Technology, Kolkata, October 09-10, 2015; (3) Mahatma Gandhi University, Kottayam, Kerala,

November 13-15, 2015; (4) CSIR-UGC NET Coaching Programme on Condensed Matter Physics and Quantum Mechanics, Tezpur University, Assam, November 23-26, 2015; (5) Department of Physics, Tezpur University, Assam, November 26, 2015; (6) Department of Mathematics, Vivekananda College (Govt. Sponsored), Kolkata, West Bengal, February 26, 2016; (7) Hiralal Mazumdar Memorial College for Women, Dakshineswar, Kolkata-700 035, India, March 02-03, 2016.

Pal, Supratik:

(1) IISER Kolkata, September 19, 2015; (2) Bose Institute, Kolkata, October 06, 2015; (3) Saha Institute of Nuclear Physics, Kolkata, October 12-17, 2015; (4) University of Tezpur, December 01-03, 2015; (5) Workshop on High Energy Physics Phenomenology, IIT Kanpur, December 06-13, 2015; (6) University of Burdwan, March 31, 2016.

Biological Sciences Division

Agricultural and Ecological Research Unit, Kolkata

Mondal Biswas, Suparna:

(1) 25th Asian Pacific Weed Science Society Conference on Weed Science for Sustainable Agriculture, Environment and Biodiversity, Hyderabad, October 13–16, 2015.

Biological Anthropology Unit, Kolkata

Mukhopadhyay, Susmita:

(1) Vidyasagar University, Medinipore, January 23, 2016; (2) Sikkim University, Gangtok, March 17-19, 2016; (3) Women's Studies Center, Vidyasagar University, Medinipore, March 24, 2016.

Human Genetics Unit, Kolkata

Chatterjee, Raghunath:

(1) International Congress on Friedreich's Ataxia and International conference on DNA Structure in Health & Disease, AllMS, Delhi, April 11-13, 2015; (2) One Day Symposium on DNA methylation and cell type identity, CCHuGe, Kolkata, West Bengal, October 02, 2015; (3) Mizoram University, Aizawl, Mizoram, December 02-09, 2015; (4) Department of Genetics, University of Calcutta, February 07, 2016.

Mukhopadhyay, Indranil:

(1) 15th International Symposium on Mathematical and Computational Biology, Rourkee, October 2015.

Social Sciences Division

Economic Research Unit, Kolkata

Chakravarty, Satya Ranjan:

(1) Kohima Science College, Nagaland, November 2-4, 2015; (2) Hindal College, Dhenkanol, Odisha, December 27-28, 2015; (3) Indian Institute of Technology, Guwahati, Assam, January 8-9, 2016.

Kabiraj, Tarun:

(1) Department of Economics, Calcutta University, April 01, 2015; (2) West Bengal State University, December 2015.

Editorial and other Assignments

Pal, Manoranjan:

(1) Conference on International Business and Trade in the School of Management Studies of Techno India University, May 24, 2014.

Sarkar, Nityananda:

(1) Burdwan University, May 20, 2015.; (2) Jadavpur University from June 2- 6, 2015; (3) Gauhati University, Guwahati, Assam, June 29-July 1, 2015; (4) Indian Institute of Technology, Guwahati, Assam, July 8-10, 2015; (5) The WB National University of Juridical Sciences, December 19, 2015.

Sharma Biswas, Chaiti:

(1) NEHU, Shillong, October 8 -10, 2015.

Linguistic Research Unit, Kolkata

Dasgupta, Probal:

(1) University of Hyderabad, Hyderabad, October 14, 2015; (2) Indira Gandhi National Centre for the Arts, Delhi, November 16, 2015; (3) Kolkata University, Kolkata, November 26, 2015; (4) Vidyasagar University, Medinipur, March 30, 2016.

Dash, Niladri Sekhar:

(1) Linguistic Society of India, Pune, India, April, 2015; (2) School of Humanities and Social Sciences, Indian Institute of Technology Patna, India, April 3-4, 2015; (3) Office of the Registrar General-India (ORGI), Language Division, Ministry of Home Affairs, Govt. of India, May 2015; (4) Annamalai University, Annamalainagar, Tamil Nadu, India, June 18-20, 2015; (5) E-PG Pathshala Programme of UGC, Ministry of HRD, Govt. of India, July-December, 2015; (6) Tamil Virtual Academy, Chennai Campus, Chennai, Tamil Nadu, India, August 1-2, 2015; (7) 4th International Conference on Advances in Computing, Communications and Informatics (ICACCI-2015), SCMS, Kochi, Kerala, India, August 10-13, 2015; (8) DietY, Electronic Niketan, 6, CGO Complex, New Delhi, August 21, 2015; (9) Central Institute of Indian Language (CIIL), Mysore, September 8, 2015; (10) Jadavpur University, Kolkata in collaboration with the UGC, and HRDC, JU, August 31-September 19, 2015; (11) Humanities and Social Sciences Department, Vidyasagar University, Medinipur, West, Bengal, September 24, 2015; (12) Department of English and Foreign Languages, Tezpur University, Assam, India, October 1-5; (13) National Translation Mission, Central Institute of Indian Languages, Manasagangothri, Mysore, India, November 3-5, 2015; (14) Indian Institute of Information Technology and Management-Kerala (IIITM-K), Trivandrum, India, December 13-16, 2015; (15) Centre for endangered Languages and Mother Tongue Studies, University of Hyderabad, Telangana, India, January 7-9, 2016; (16) University of Hyderabad, Hyderabad, Telangana, January 07-09, 2016; (17) Department of Linguistics, K.M. Institute of Hindi and Linguistics, Dr. Bhim Rao Ambedkar University, Agra, February 25-27, 2016; (18) School of Languages and Linguistics, Jadavpur University, India, March 17, 2016; (19) Dept. of English, Vidyasagar University, Midnapore, India, March 29, 2016.

Population Studies Unit, Kolkata

De, Partha:

(1) Department of Economics, North Eastern Hill University, Shillong, Meghalaya, October 8-10, 2015.

Psychology Research Unit, Kolkata

Bhattacharya, Himani:

(1) 4th International Conference on Psychology and Allied Sciences, Margao, Goa, January 16-18, 2016.

Dutta Roy, Debdulal:

(1) SCB, Medical College Hospital, Cuttack, Odisha, January 12-17, 2015; (2) Professional Examination Board, Bhopal, April 14, 2015; (3) VGSOM of IIT., Kharagpur, May 11, 2015; (4) Indian Institute of Management, Calcutta, May 21, 2015; (5) Amrita University, Ettimadai, Coimbatore, May 22-29, 2015; (6) BSF Academy, Tekanpur, July 10, 2015; (7) Legal Aid Services - West Bengal, September 27, 2015; (8) Regional Occupational Health Centre (Eastern), Kolkata, October 8, 2015; (9) Departments of Psychology and Applied Psychology, University of Calcutta, October 11, 2015; (10) Department of Musicology, Rabindra Bharati University, Kolkata, November 5-6, 2015; (11) Indian Institute of Psychometry, November 16, 2015; (12) Indian Institute of Forest Management and National Institute of Technical Teachers' Training & Research, Bhopal, December 12, 2015; (13) Conference of the National Academy of Psychology, Allahabad University, Allahabad, February 2-5, 2016.

Ghosh, Anjali:

(1) Department of Applied Psychology, University of Calcutta, September, 2015; (2) Centenary Conference of the Department of Psychology, University of Calcutta, October 9-11, 2015.

Gupta, Rumki:

(1) Centenary Conference of the Department of Psychology, University of Calcutta, Kolkata, October 9-11, 2015; (2) Osmania University, Hyderabad, November 6-7, 2015; (3) Indian Institute of Social Welfare and Business Management (IISWBM), Kolkata, January 29, 2016.

Sampling and Official Statistics Unit, Kolkata

Chattopadhyay, Nachiketa:

(1) Working Group on NSS 73rd Round, NSSO, MoS&PI.

Kar, Alope:

(1) Working Group on NSS 73rd Round and Member, Core Committee, NSSO, MoS&PI; (2) Working Group on NSS 74th Round and Member, Core Committee, NSSO, MoS&PI.

Mitra, Sandip:

(1) IFMR, Chennai, February 6-8, 2016.

Mukherjee, Diganta:

(1) Core group within the Working group for the 72nd round of NSS, NSSO, since 2013; (2) Core group within the Working group for the 74th round of NSS, NSSO, since 2015; (3) Member of Survey Monitoring Committee of SEBI.

Pathak, Prasanta:

(1) Working Group on NSS 71st Round, NSSO, MoS&PI.

Sociological Research Unit, Kolkata

Chakraborty, Sonali:

(1) North East Hill University, October 8-10, 2015.

Ghosh, Bhola Nath:

(1) Heritage Business School, Anandapur, Kolkata, April 2015; (2) Department of Economics, North-Eastern Hill University, Shillong, Meghalaya, October 8-10, 2015; (3) Institute of Integrated Himalayan Studies, Himachal Pradesh University, Summer Hill, Simla-171005, November 4-5, 2015. (4) Kalinga Institute of Social Sciences (KISS), KIIT University Bhubaneswar, Odisha, December 27-29, 2015; (5) Department of Anthropology, Assam University (A Central University) Diphu Campus, Diphu, Karbi

Editorial and other Assignments

Anglong, Assam, January 6-7, 2016; (6) Department of Social Work, Viswa-Bharati and International Consortium for Social Development-Asia Pacific, Santiniketan, January 16-18, 2016; (7) Sambalpur University, Jyoti Vihar, Orissa, March, 2-3, 2016.

Jana, Rabindranath:

(1) Ramakrishna Mission Vivekananda University (RKMVU), Narendrapur, West Bengal, since 2012; (2) Dept. of Anthropology, Assam University, Diphu Assam, January 6-7, 2016.

Shome, Suparna:

(1) North East Hill University, October 8-10, 2015.

Sociological Research Unit, Giridih

Behera, H.C.:

(1) Convention Centre, IGNOU, Maidan Garhi, New Delhi, October 28-29, 2015; (2) Kalinga Institute of Social Sciences, KIIT University, Bhubaneswar, Odisha, December 27-29 2015.

Economics and Planning Unit, Delhi

Ghate, Chetan:

(1) TAC on Monetary policy, RBI, Mumbai, April 1, 2015; (2) TAC on Monetary policy, RBI, Mumbai, September 23, 2015; (3) Discussant, RBI-CAFRAL Conference on Emerging Market Monetary Policy, RBI Mumbai, December 14-15 2015; (4) TAC on Monetary policy, RBI, Mumbai, March 30, 2016.

Ramaswami, Bharat:

(1) Indian School of Business, Hyderabad, June 10-21, 2015; (2) Centre for studies in social sciences (CSSS), Kolkata, August 26, 2015; (3) Ashoka University, New Delhi, since January 1, 2016.

Ray, Tridip:

Indian School of Business, Hyderabad, July 17-18, 2015.

Ray Chowdhury, Prabal:

(1) Jadavpur University, Kolkata, June 30, 2015; (2) University of Hyderabad, Hyderabad, September 4, 2015; (3) Annual Conference on contemporary issues in development economics, Jadavpur University, Kolkata, December 21-24, 2015; (4) IGIDR, Mumbai, February 4-5, 2016.

Somanathan, E.:

(1) IAS Academy, Lal Bahadur Shastri National Academy of Administration (LBSNAA), Mussorie, May 12-14, 2016.

Economic Analysis Unit, Bangalore

Ramachandran, V.K.:

(1) Symposium on Results from Village Surveys in West Bengal, Durgapur, September 11-13, 2015; (2) North Bengal University, Department of Economics, October 8-15, 2015; (3) National Institute of Rural Development, Rajendranagar, Hyderabad, October 16, 2015; (4) AKG Centre, Thiruvananthapuram, January 9-10, 2016; (5) International Seminar on Agriculture and Rural India after Economic Reforms, Chennai, January 29-30, 2016; (6) Tata Institute of Social Sciences, Mumbai, February 29, 2016.

Swaminathan, Madhura:

(1) Board of Governors, Institute of Rural Management Anand, 2013-2015; (2) Board of Studies, School of Development Studies, Tata Institute of Social Sciences Mumbai, 2015 onwards; (3) Round Table Conference on Agrarian Questions and Small Scale Farming, New Delhi, October 5, 2015; (4) International Seminar on Agriculture and Rural India after Economic Reforms, Chennai, January 29-30, 2016.

Statistical Quality Control and Operations Research Division

SQC & OR Unit, Kolkata

Anis, M.Z.:

(1) IIM-Ahmedabad, Gujrat, April, 2015.

Amitava Bandyopadhyay:

(1) Chairman for the Working Group / Expert Committee on "Quality, Documentation and Project Management" of STQC/NeST, 2015.

Das, P.:

(1) IIM-Ahmedabad, Gujrat, April, 2015; (2) DSF, Kolkata, August, 2015; (3) BIT Mesra (Deoghar), September, 2015; (4) Jadavpur Univ., November, 2015; (5) Govt. College of Engg. & Ceramic Technology, Kolkata, February, 2016.

SQC & OR Unit, Bangalore

Boby, John:

(1) Siddaganga Institute of Technology, Tumkur, May 28, 2015; (2) BMS Institute of Technology, Bangalore, June 26, 2015; (3) Siddaganga Institute of Technology, July 17, 2015; (4) MS Ramaiah Institute of Technology, Bangalore, July 30, 2015; (5) NTT, August 11, 2015; (6) Bangalore University, December 05, 2015; (7) Sir M Visvesvaraya Institute of Technology, Bangalore, March 03, 2016.

SQC & OR Unit, Hyderabad

Subhani, S.M.:

(1) Career Guidance giving focus on ISI for training schemes and employment opportunities, Doordarshan, Hyderabad, March 15, 2015.

SQC & OR Unit, Mumbai

Sikder, Sagar:

(1) IIT, Bombay, October 20, 2015.

Center for Soft Computing Research: A National Facility, Kolkata

Das, S.:

(1) Vikram Sarabhai Space Centre- ISRO, Thiruvananthapuram, India, 2016.

Editorial and other Assignments

Ghosh, K.:

(1) University of Calcutta, August 11, 2015; (2) International Conference on Computer Vision and Image Processing (CVIP 2016), Roorkee, February, 2016; (3) KIIT Bhubaneswar, January 11, 2016.

Pal, S.K.:

(1) Internal Screening Committee (Main) meeting for promotion of Scientist F to the next grade, RAC, DRDO, New Delhi, April 04-06, 2015; (2) National Symposium on Innovations in Product Design, PDPM IITDM, Jabalpur, Madhya Pradesh, May 10-13, 2015; (3) NIT Calicut, IISc, Bangalore, May 18-20, 2015; (4) Consultancy Development Centre, New Delhi, May 26, 2015; (5) Satellite Conference Science in Bengal, Dept. of Science & Technology, Govt. of West Bengal, University of North Bengal, Darjeeling, June 03, 2015; (6) Central University of South Bihar at Association of Indian Universities, New Delhi, June 04-05, 2015; (7) RAC, DRDO, New Delhi, June 05-06, 2015; (8) IISc, Bangalore, June 18-20, 2015; (9) 30th BOG Meeting, PDPM IITDM, Jabalpur, Madhya Pradesh, July 31-August 2, 2015; (10) School on Systems and Control, IIT Kanpur, August 06-08, 2015; (11) Short term course on Fundamentals of Soft Computing and its Applications, ISM Dhanbad, Jharkhand, September 11-12, 2015; (12) IISc Bangalore, September 17-19, 2015; (13) INSA, New Delhi, October 02-03, 2015; (14) Innovision-15, NIT Rourkela, Odisha, October 30-31, 2015; (15) IEEE WCI 2015, IIT Kanpur, December 14-15, 2015; (16) IISc, Bangalore, December 17-18, 2015; (17) NIT Patna, December 19-20, 2015; (18) INSA, New Delhi, December 21-22, 2015; (19) PLINTH 2016, LNMIIT, Jaipur, Rajasthan and Central University of Rajasthan, Ajmer, January 21-23, 2016; (20) NIT Durgapur, January 24-25, 2016; (21) Indian School of Mines, Dhanbad, March 03-05, 2016; (22) IISc, Bangalore, March 11, 2016; (23) Indian Institute of Information Technology Design and Manufacturing Jabalpur, March 12-13, 2016; (23) Hindusthan University, Chennai, March 14, 2016; (24) International Conference on Data Mining and Advanced Computing (SAPIENCE), Ernakulam, Kerala, March 16-18, 2016.

9. REGIONAL MATHEMATICAL OLYMPIAD 2015 AND INDIAN NATIONAL MATHEMATICAL OLYMPIAD 2016

Mathematical Olympiad Programme in India and Indian Statistical Institute, Kolkata

The Mathematical Olympiad Programme in India, which leads to participation of Indian students in the International Mathematical Olympiad (IMO) is organized by the Homi Bhabha Centre for Science Education (HBCSE) on behalf of the National Board for Higher Mathematics (NBHM) of the Department of Atomic Energy (DAE), Government of India. Its main purpose is to spot mathematical talent among pre-university students in the country. For the purpose of training and selection of students for the Olympiad contest, 25 regions all over the country have been designated and each assigned a Regional Coordinator. Additionally, three groups (Central Board of Secondary Education (CBSE), Navodaya Vidyalaya Samiti (NVS) and Kendriya Vidyalaya Sangathana (KVS) have a 'Regional Coordinator' each.

The Kolkata centre of Indian Statistical Institute (ISI) organizes the Pre-Regional Mathematical Olympiad (Pre-RMO) and Regional Mathematical Olympiad (RMO) at West Bengal, to be followed subsequently by Indian National Mathematical Olympiad (INMO) whose participants are those who have cleared the RMO test are primarily from West Bengal. Pre-Regional Mathematical Olympiad (Pre-RMO) is organized prior to RMO. The purpose is to select candidates for RMO. Besides these, Kolkata centre of ISI organized Asian Pacific Mathematics Olympiad (APMO) as well in 2016.

The Regional Co-ordinator from the Kolkata centre of ISI is from Applied Statistics Unit, and the Joint Co-ordinator is from Statistics and Mathematics Unit.

Regional Mathematical Olympiad (RMO) 2015: Karnataka Region

The mathematical Olympiad activity in Karnataka has been co-ordinated by the Bangalore Centre of ISI for several years with Prof. B. Sury as the regional co-ordinator for Karnataka. In 2015, the number of Students registered for the Regional Mathematical Olympiad (RMO), Karnataka region was 1848. The exam was held on 6th December, 2015, in 25 centres across the state. With the help of some faculty members at ISI Bangalore, some post-doctoral fellows and research scholars, 1147 answer scripts of RMO were evaluated at ISI Bangalore. Fortyfour students qualified to write the national level test Indian national mathematical Olympiad (INMO). A week long training camp was organized at ISI Bangalore for a total of 58 Students, to make them familiar with advanced problem solving techniques before they appear for the INMO. Several distinguished speakers were invited for this purpose. Participants were provided with food and accommodation at ISI Bangalore. The INMO was held on 17th January, 2016 at the Bangalore centre.

The Madhava mathematics competition for second year undergraduate students is held in various parts of India. This year, ISI Bangalore co-ordinated the activities for the first time and Prof. B. Sury was the co-ordinator. The exam was held on 13th December, 2015 at the Bangalore centre. Nearly 100 college students from Bangalore registered for the exam. Again with the assistance of postdoctoral fellows and research scholars, the scripts were evaluated and sent to the national co-ordinator. Subsequently, since 7 of the 8 winners at the national level were from Bangalore, the prize distribution was held at the Bangalore centre. Lecture by a distinguished mathematician Prof. M.S. Narasimhan was arranged and all students were awarded certificates and mementos.

Mathematical Olympiad

***Pre-Regional Mathematical Olympiad 2015 and Regional Mathematical Olympiad 2015
in West Bengal, Indian National Mathematical Olympiad 2016***

Pre-RMO-2015 was held on November 21 & 22, 2015. The number of candidates who appeared at Pre-RMO-2015 is 855. Based on the performance in Pre-RMO-2015, 217 candidates were selected to appear at RMO-2015. Out of these 217 candidates, 207 appeared at RMO-2015, held on December 6, 2015. Based on the performance in RMO-2015, 30 candidates and 5 more girl candidates, i.e., 35 candidates in all were selected to appear at INMO-2016, held on January 17, 2016. All these 35 candidates and 4 more attended a week-long training camp at ISI, held at ISI, Kolkata during January 4-8, 2016. The purpose of this camp was to train prospective candidates for INMO-2016. The speakers were faculty members of ISI, persons involved in training students for Mathematical Olympiad, and students of ISI who have either cleared INMO in the past or represented India in IMO. Finally, nearly 50 students appeared at INMO-2016. Seven candidates from West Bengal who had written RMO-2015 in West Bengal successfully cleared INMO-2016, and six more received INMO Certificate of Merit.

Participation in International Mathematical Olympiad 2016

Finally, after having gone through a training camp for participation in International Mathematical Olympiad (IMO), two students from West Bengal were selected for the six-member Indian team at IMO-2016, held in Hong Kong, during July 6-16, 2016. Both of them won Bronze medals.

Asian Pacific Mathematics Olympiad 2016

On March 8, 2016, as part of Mathematical Olympiad Programme in India, ISI hosted Asian Pacific Mathematics Olympiad 2016. This is an International Mathematics Competition held every year in a country in the Asia-Pacific rim in the month of March. The participants in ISI were students from West Bengal who have done well in INMO either in 2016 and/or in recent years. The selection was done by HBCSE. One of the participants from West Bengal won Silver medal and one won Bronze medal.

PART III. ADMINISTRATION AND OFFICE BEARERS

10. GENERAL ADMINISTRATION

Administrative Services Division

1. The Administrative Services Division at the Headquarters caters to the various needs of the scientific Workers in all the scientific units of the Institute engaged in various scientific, research and academic activities and provides them with necessary infrastructural facilities in their pursuit of excellence. The centres at Delhi, Bangalore, Chennai and Tezpur, each having a number of science units are, by and large, getting administrative support from the administrative units/sections there. The Administrative Services Division has the following units at the Headquarters in Kolkata:

Sl. No.	Name of the Unit	Sl. No.	Name of the Unit
1.	Accounts Section	17.	Import & Travel Cell
2.	Audio-Visual Unit	18.	Internal Audit Cell
3.	Binding Unit	19.	Legal Cell
4.	Canteen	20.	Medical Expenses Reimbursement Unit
5.	Cash	21.	Medical Welfare Unit
6.	C E (A & F)'s Office	22.	Personnel Unit
7.	Central Office & Despatch Unit	23.	Provident Fund Unit
8.	Central Stores & Tailoring Unit	24.	Public Relations Unit
9.	Council Section	25.	Printing and Publication Unit
10.	Director's Office	26.	Official Language Cell
11.	Electrical Maintenance Unit	27.	Retirement Benefit Cell
12.	Engineering Unit	28.	Sankhya Office
13.	Estate Office	29.	Security Unit
14.	Guest House	30.	Telephone Unit
15.	Hostels	31.	Transport Unit
16.	House Building Advance Cell	32.	SC / ST / OBC Cell

2. Apart from the Units mentioned above, there are some small cells dealing with Budget, and other issues to take care of the specific needs of the Institute. The Administrative Services Division also looks after the running of hostels for students, research scholars and International Statistical Education Centre (ISEC) trainees and also the running of Canteen for the workers and students of the Institute. The other outlying Units are controlled directly by the Headquarters at Kolkata. The Administrative Services Division takes the responsibility for all new constructional activities of the Institute at its Headquarters and also at outlying centres/branches. A brief report on the constructional activity in the current year is narrated in the subsequent paragraphs.

The Administrative activities in the four Centres, namely Delhi, Bangalore, Chennai and North East Centre at Tezpur and in other outlying branches of the Institute and Giridih Office, are more or less similar to the Headquarters but on a much smaller scale.

3. Office bearers of the Institute Administration during the year:

Director : Sanghamitra Bandyopadhyay

Professors-in-Charge of Scientific Divisions : Anish Sarkar (Theoretical Statistics & Mathematics)

Administration

Anup Dewanji (Applied Statistics)

Manoranjan Pal (Social Sciences)

Barnana Roy (Physics & Earth Sciences)

Saurabh Ghosh (Biological Sciences)

Dipti Prasad Mukherjee (Computer & Communication Sciences)

Head, SQC & OR : Amitava Bandyopadhyay

Head, Delhi Centre : Abhay G. Bhatt

Head, Bangalore Centre : T.S.S.R.K. Rao

Head, Chennai Centre : S. Ponnusamy

Chairman, Committee for ISI
North-East Centre, Tezpur : Nityananda Sarkar

Dean of Studies : Pradipta Bandyopadhyay

Chief Executive (A & F) : S. Chakraborty

4. List of workers who joined/ retired/ voluntarily retired/ resigned/ terminated/ died during the year

A. Appointments

(i) Scientific / Technical Workers

Srl. No.	Name
1.	Soumyanetra Munshi
2.	Mudit Kapoor
3.	Ritabrata Munshi
4.	Sasanka Roy
5.	Debrup Chakraborty
6.	Monisankar Bishnu

(ii) Non-Scientific Workers

Srl. No.	Name
1.	Soumyabrata Chakraborty

B. Retirement/Voluntary Retirement:

(i) Scientific & Technical Workers

Srl. No.	Name	Srl. No.	Name
1.	Abha Pal	9.	Pulakesh Maiti
2.	Pl. Muthuramalingam	10.	Snigdha Chakrabarti
3.	Rachna Nayyar	11.	Anjali Ghosh
4.	Nanda Dulal Basak	12.	Bidyut Baran Chaudhuri
5.	Shikha Bhowmik	13.	Dipankar Sen
6.	Sankar Kumar Pal	14.	Chiranjib Neogi
7.	Chandana Hazra	15.	Samanta Paramanik
8.	Sankar Kr. Ghosh	16.	Devender Shaw

(ii) Non-Scientific Workers

Srl. No.	Name	Srl. No.	Name
1.	Nemai Bhaduri	23.	P.K. Lal
2.	Dilip Dutta	24.	Prasanta Kr. Sen
3.	Malay Chatterjee	25.	Fatik Paul
4.	Pranab Kr. Pal	26.	Sanat Datta
5.	Shibnath Sadhukha	27.	Debkumar Shome
6.	Montosh Das	28.	G. Munniswamy
7.	Biswanath Mondal	29.	Dilip Kr. Saha
8.	Tapan Banerjee	30.	Provanjan Roy
9.	Ravan Chorai	31.	Sipra Sinha
10.	Pannalal Hela	32.	Swapna Das
11.	Gundappa	33.	Alok Nath Mullick
12.	Ganeshi Bhuiya	34.	Fakira Nayak
13.	Gita Ghosh	35.	Mihir Dutta
14.	Subramani Kasi Iyer	36.	Arabinda Maity
15.	Debasish Chakraborty	37.	Nirod Baran Dutta

C. Resignation

(i) Scientific Worker

Srl. No.	Name
1.	Arni S.R.S. Rao
2.	Partha Pratim Ghosh

(ii) Non - Scientific Worker

Srl. No.	Name
1.	Dhananjay Kumar Chaubey
2.	Om Prakash

Administration

D. Death

(i) Non - Scientific Worker

Srl. No.	Name
1.	Kartick Rajak
2.	Rajo Debi Bhuiya
3.	Bharat Lal Balmiki

5. Number of workers in the Institute as on 31st March 2016

Number of workers in the Institute as on 31st March 2016:

(i)	Scientific and Technical Workers	-	414
(ii)	Non-Scientific Workers	-	<u>501</u>
	Total	:	<u>915</u>

6. Breakup of manpower by Gender, Social Category and Disability group as on 31st March 2016

Total Strength	Physically Handicapped (PH)	Scheduled Caste (SC)	Scheduled Tribe (ST)	Other Backward Class (OBC)	Minorities	
Male	772	04	97	24	68	20
Female	143	Nil	13	01	04	02
Total	915	04	110	25	72	22

7. Annual Return on Cases of Sexual Harassment

1.	Number of complaints of sexual harassment received in the year	Nil
2.	Number of complaints disposed off during the year 2015-16	Nil
3.	Number of cases pending for more than 90 days	Nil
4.	Number of workshops on awareness programmes against sexual harassment conducted during the year	Nil
5.	Nature of action	NA

8. Applications received and action taken by the Institute under RTI Act, 2005

Name of the Appellate Authority : Prof. Sanghamitra Bandyopadhyay, Director of the Institute.

Name of Central Public Information Officer: Shri A.K. Biswas, Dy. Chief Executive (Admn.) of the Institute.

The summary statement in this regard for the year 2015-16 is appended below: -

No. of Applications received	No. of cases accepted	Decisions where requests were fully or partially rejected		No. of decisions from Appellate Authority	C I C decision			Amount collected (Rs.)		
		Fully rejected	Partially rejected		No. of decisions received	Penalty imposed	Disciplinary action, if any	Fee	Other Charges	Penalty amount
127	127	Nil	Nil	16	5	NIL	NIL	700	2326	NIL

9. Budget and Finance

For the year 2015-2016, Section 8(1) Committee recommended Rs.19145.00 lakhs (Government Grant Rs.18795.00 lakhs and ISI internal receipt Rs.350.00 lakhs) under Non-Plan (BE) and Rs.19440.93 lakhs under Plan (BE). The Government approved a sum of Rs.16417.10 lakhs and of Rs.14000.00 lakhs for Non-Plan and Plan expenditure respectively. At the revised estimate stage, the Institute sought for a grant of Rs.20370.94 lakhs and Rs.14000.00 lakhs under Non-Plan and Plan respectively which was also recommended by the Section 8(1) Committee. The Government sanctioned a grant of Rs.15436.63 lakhs (including the negative balance of Rs.1864.47 lakhs during the financial year 2014-2015) under Non-Plan and the Plan RE allocation was fixed at Rs.5197.46 lakhs (including the amount of Rs.102.54 lakhs expenditure over income during the financial year 2014-2015). The non – plan expenditure was more by Rs. 10.40 lakhs over the fund allotted by the Ministry and that Plan Budget was Rs. 1093.17 Lacs over the fund allotted. The Audited Annual Accounts of the Institute for the year 2015-2016 has been furnished in Part IV of this report.

10. Major Construction / Renovation works taken up by the Institute during 2015-2016

A. Kolkata

(i) R C Bose Centre for Cryptology and Security

The Centre is located at the Gupta Niwas Campus of the Institute. The planning, design, engineering and construction work for the project has been awarded to M/s NBCC on deposit work basis. Construction activities started from May, 2015. Construction of the Cryptology Centre, Hostel Building and Residential Building is in progress.

Administration

(ii) Infrastructure Development at Baranagar Campus of the Institute.

- a) Construction of New Academic Building and New Students' Hostel – Plan of Academic Building is under preparation.
- b) Repair, renovation and restoration work of R.A. Fisher Bhavan & S.N. Bose Bhavan – Building survey completed, project report and cost estimate submitted by B & R for approval.
- c) Augmentation and distribution of electric power – Survey completed, project report and cost estimate under preparation.
- d) Repair, renovation of M. Tech Hostel and Amrapali (Prasanta Chandra Mahalanobis Museum and Archives) – CPWD has been approached to take up the work on deposit work basis.

B. Delhi

A. Land and Construction

No major Civil / Construction / renovation works taken up by the Institute during 2015-2016.

B. Electrical

One SITC of 40 Kwp Solar power system, amounting to Rs. 25,12,600 was installed in faculty building, Delhi Centre in the month of February, 2016.

C. Bangalore

Major construction / renovation works completed / undertaken by the Bangalore Centre during 2015 -2016.

- (i) The Construction of rain water harvesting structures and aquifer measures (Phase I). The work has been undertaken under the supervision of an architect –cum - consultant and is expected to be completed in the financial year 2016-17.
- (ii) The Construction of biogas plant will be started in the financial year 2016-17. The selection of a suitable project consultant is over. Tendering has been completed for the selection of a contractor.
- (iii) The work for addition of first floor to the Gymnasium will start in financial year 2016 – 17. The construction plan has been prepared in consultation with an expert in civil engineering who is also a WAC member. The selection of an electrical consultant has also been made.
- (iv) The height of the boundary wall from the rear gate to the press gate has been increased to provide better security.
- (v) Civil and electrical renovation in the staff quarters on campus was undertaken.

D. Tezpur

No major Construction / renovation works were taken up by the Institute during 2015-2016

11. Society Type Activities

A. Membership: April 2015 – March 2016

- A. During the period 41 persons became Ordinary Members of the Institute.
- B. 10 Ordinary Members became Life Members of the Institute.

The membership position as on 31 March, 2016 is as follows:

Ordinary Members	-	256
Life Members	-	1011
Institutional Members	-	04
Total	-	<u>1271</u>

- B. **Finance Committee Meetings:** The Finance Committee met once on 1st October, 2015. Besides the decisions taken on various financial matters, the Finance Committee recommended RE 2015-16 and BE 2016-17 (both Plan and Non-Plan) in its meeting held on 1st October, 2015. The Annual Report including Audited Statement of Accounts for the year 2014-2015 was considered and recommended in the same meeting of the Finance Committee
- C. **Council Meetings:** During the period under report (2015-16), the Council met four times on 23rd April, 2015, 20th August, 2015, 9th October, 2015 and 23rd January, 2016 to take decisions on various academic and administrative matters of the Institute. The Budget Proposals of the Institute both for Plan and Non-Plan (RE 2015-16 and BE 2016-17) were considered in the meetings of the Council held on 9th October 2015, as recommended by the Finance Committee in its meeting held on 1st October, 2015. The Annual Report including the Audited Statement of Accounts for the year 2014-2015 was considered and approved by the Council in its meeting held on 9th October, 2015.

The details of the President of the Institute, Chairman and members of the Council of the Institute and lists of members of different committees constituted by the Council (2015-16) are given in the Back Cover page and in Chapter 11 respectively.

- D. **Annual General Meetings:** During the period under report (2015-16), the Annual General Meeting was held on 16th November, 2015. The Annual Report of the Institute for the year 2014-2015 and Audited Statement of Accounts for the year 2014-2015 together with the Auditor's comments and replies of the Administration thereto were adopted in the meeting of the General Body held on 16th November, 2015.

11. LIST OF MEMBERS OF THE ACADEMIC COUNCIL AND OTHER COMMITTEES OF THE INSTITUTE AS ON 31 MARCH 2016

1. Academic Council

Sanghamitra Bandyopadhyay, Director (Chairman)

Pradipta Bandyopadhyay, Dean of Studies (Convener)

A. Theoretical Statistics and Mathematics Division

T.S.S.R.K. Rao, B.V. Rajarama Bhat, N.S. Narasimha Sastry, Bhaskar Bagchi, S. Ramasubramanian, K. Ramamurthy, Mohana Delampady, Sunanda Bagchi, B. Rajeev, V. Pati, B. Sury, V.R. Padmawar, Siva Athreya, C. Robinson Edward Raja, S.M. Srivastava, Probal Chaudhuri, Rana Barua, Alok Goswami, Arup Bose, Goutam Mukherjee, Ratan Dasgupta, Gopal Krishna Basak, Pradipta Bandyopadhyay, Amartya Kumar Dutta, Debashish Goswami, Rudra Pada Sarkar, Mahuya Datta, S. Pannusamy, Rajendra Bhatia, Rahul Roy, R.B. Bapat, Abhay Gopal Bhatt, Arup Kumar Pal, Isha (Bagai) Dewan, Anish Sarkar, Swagato Kumar Ray, Ritabrata Munshi, Antar Bandyopadhyay, Jaydeb Sarkar.

B. Applied Statistics Division

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Visit of Parliamentary Standing Committee (Finance), Govt. of India at ISI Kolkata on 7 July 2015



50th ISI Convocation at ISI Kolkata on 15 January 2016



Felicitations of Prof. Sankar K. Pal, former Director, ISI by Prof. S. Bandyopadhyay, Director, in presence of Prof. D. Dutta Majumdar at the Workshop on 40 years of Fuzzy Sets in ISI organized by MIU on 15 September 2015



Dr. Paul A. Rosen, Jet Propulsion Laboratories, NASA, Caltech, delivering IEEE Geoscience and Remote Sensing Society (GRSS) talk at the ISI Bangalore Centre on 23 November 2015



Prof. S. Bandyopadhyay, Director, ISI speaking at Book release occasion in the presence of Shri Mani Shankar Aiyar and Prof. Abhirup Sarkar on 22 January 2016



North East Workshop on Cryptology organized by ASU during 21-27 January 2016



68th ISEC Convocation at ISI Kolkata on 29 May 2015



Prof. Sankar K. Pal speaking at the Annual Workshop on Machine Intelligence and Applications organized by MIU on 30 March 2016



Felicitations of Prof. Dr. W. Th Frank Den Hollander, Leiden University by Prof. S. Bandyopadhyay, Director, ISI on the occasion of PC Mahalanobis Lecture at Stat Math Unit on 18 January 2016