



# Annual Report

2012 - 2013



# Indian Statistical Institute

**PRESIDENT OF THE INSTITUTE, CHAIRMAN AND OTHER MEMBERS OF  
THE COUNCIL AS ON MARCH 31, 2013**

**President:** Dr. C. Rangarajan

Chairman, Economic Advisory Council to the Prime Minister

1. Chairman: Shri A.K. Antony, Hon'ble Defence Minister, Government of India.
2. Director: Prof. Bimal K. Roy.

**Representatives of Government of India**

3. Shri P.K. Pujari, Additional Secretary and Financial Advisor, Government of India, Ministry of Statistics and Programme Implementation, New Delhi.
4. Shri Vijay Kumar, Director General & CEO, NSSO, Ministry of Statistics & P.I., New Delhi.
5. Shri Rajiv Kumar, Joint Secretary, Department of Expenditure, Ministry of Finance, New Delhi.
6. Dr. Sibaji Raha, Director, Bose Institute, Kolkata.
7. Shri Deepak K. Mohanty, Executive Director, Reserve Bank of India, Mumbai.
8. Mrs. Amita Sharma, Additional Secretary, Government of India, Ministry of Human Resource Development, New Delhi.

**Representative of ICSSR**

9. Prof. Sukhadeo Thorat, Chairman, Indian Council of Social Science Research, New Delhi.

**Representatives of INSA**

10. Prof. Ajit Iqbal Singh, FNA, INSA Senior Scientist, Indian Statistical Institute, New Delhi.
11. Prof. R.L. Karandikar, FNA, Director, Chennai Mathematical Institute, Tamil Nadu.
12. Prof. Alok Bhattacharya, FNA, School of Life Science, Jawaharlal Nehru University, New Delhi.
13. Prof. N.K. Gupta, FNA, Department of Applied Mechanics, Indian Institute of Technology, New Delhi.

**Representative of the Planning Commission**

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

**Representative of the University Grants Commission**

15. Prof. Debasis Kundu, Department of Statistics, Indian Institute of Technology, Kanpur.

**Scientists co-opted by the Council**

16. Prof. R. Balasubramanian, Director, Institute of Mathematical Sciences, Chennai.
17. Prof. N. Balakrishnan, Associate Director, Indian Institute of Science, Bangalore.

**Elected representatives of the Institute members not employed in the Institute**

18. Prof. D. Dutta Majumder, FNA, Emeritus Professor, Indian Statistical Institute, Kolkata.
19. Shri Ajay Kumar Ghosh, Kolkata.
20. Prof. Siddani Bhaskara Rao, C.R. Rao Advanced Institute of Mathematics, Statistics and Computer Sciences, Hyderabad.

**Elected representatives of the employees of the Institute**

21. Shri Rajat Kanti Chatterjee, Representative of the Scientific Workers.
22. Shri Gouri Sankar Acharya, Representative of the Non-Scientific Workers.

**Officers of the Institute**

23. Prof. T.S.S.R.K. Rao, Professor-in-Charge, Theoretical Statistics and Mathematics Division.
24. Prof. Mausumi Bose, Professor-in-Charge, Applied Statistics Division.
25. Prof. Prabal Roy Chaudhuri, Professor-in-Charge, Social Sciences Division.
26. Prof. Saswati Bandyopadhyay, Professor-in-Charge, Physics and Earth Sciences Division.
27. Prof. Subrata Kr. Roy, Professor-in-Charge, Biological Sciences Division.
28. Prof. C.A. Murthy, Professor-in-Charge, Computer and Communication Sciences Division.
29. Dr. Ashis Kr. Chakraborty, Head, SQC & OR Division.
30. Prof. Satya P. Das, Head, Delhi Centre.
31. Prof. N.S.N. Sastry, Head, Bangalore Centre.
32. Prof. S. Ponnusamy, Head, Chennai Centre.
33. Prof. Pradipta Bandyopadhyay, Dean of Studies.

**Non-Member Secretary**

Shri S.K. Iyer, Chief Executive (Administration & Finance).

# INDIAN STATISTICAL INSTITUTE

## Annual Report April 2012 – March 2013



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

**INDIAN STATISTICAL INSTITUTE  
EIGHTY FIRST ANNUAL REPORT  
April 2012 – March 2013**

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## Director's Report

It is my proud privilege to present the Annual Report of the Institute for the year 2012-2013 which happens to be the third one after I assumed the charge of the Director of the Institute.

Like on every occasion the Institute is proud to announce the names of faculty, who, through their talent, innovation and perseverance have held the banner of ISI even higher. They will be a source of inspiration for others to emulate. A partial list of such recipients along with the honours and awards received is as follows. Dr. Debashish Goswami and Dr. Siva Athreya received the Shanti Swarup Bhatnagar award in Mathematical Sciences for the year 2012. Dr. Arunava Sen has been awarded the prestigious INFOSYS Prize – 2012 for Social Sciences. Dr. Arup Pal has been elected a Fellow of the Indian Academy of Sciences. Dr. Tanvi Jain has been selected as an Associate of the Indian Academy of Science in 2010 till December 2015. Dr. Atanu Biswas has received IBM Shared University Research Award 2012. Dr. Bhabani P. Sinha has received the IETE-Ram Lal Wadha Award in 2012. Dr. Ansuman Banerjee has been awarded the NASI-Young Scientist Platinum Jubilee Award. Dr. Sanghamitra Bandyopadhyay has been conferred the INAE Silver Jubilee Young Engineers Award, 2012 and National Women Bioscientist Award (Young category), Department of Biotechnology, 2012. Dr. Swagatam Das has received Young Engineer Award, 2012 from INAE.

The proposal for setting up of a new centre of the Indian Statistical Institute (ISI) at Bhubaneswar is fast taking shape by way of merger of the Institute of Mathematics and Applications (IMA), Bhubaneswar with ISI. With the approval of the governing Council of the Institute, Ministry of Statistics & Programme Implementation, Government of India and Government of Odisha, the Memorandum of Agreement (MOA) will be signed in this regard.

The proposal for setting up of the R.C. Bose Centre for Cryptology and Security as a Permanent Autonomous Centre of the Institute has been accepted by the Ministry of Statistics & Programme Implementation, Government of India. The Gupta Nivas campus of the Institute in Kolkata has been chosen as the site for the said centre and necessary actions are being taken in this regard.

The Sampling and Official Statistics Unit (SOSU) has been set up at ISI, Kolkata responding to the long-standing demands of the Government of India and the unit has been functioning in a significant manner. The need for the unit was specified by the Hon'ble Prime Minister Dr. Manmohan Singh in his speech on the occasion of platinum jubilee celebration of ISI on 24<sup>th</sup> December, 2006.

2013 is being observed as the International Year of Statistics the world over. Along with UNESCO, leading Universities/Institutions across the globe, the Institute is observing the occasion through a series of programmes like lectures of Professor Barry C. Arnold, Professor S.R.S. Varadhan, Professor Jayanta Kumar Ghosh and Professor Daniel Scharfstein, held at the Institute a few days ago. We are also contemplating deliberations from Professor Parsi Diaconis, Stanford University as part of the celebration.

The Institute feels proud to confer Honorary D.Sc. degree to Professor K.R. Parthasarathy for Mathematics, Professor Jayanta Kumar Ghosh for Statistics and Professor Pranab Bardhan for Economics as a mark of recognition to their academic excellence and achievements in their respective fields.

The Institute organised a 2-day workshop on the "Economic Growth in West Bengal". Professor James Alexander Mirrlees, Nobel Laureate, Emeritus Professor, University of Cambridge; Professor Pranab Bardhan, University of California, Berkeley (Retd.) and Professor Maitreesh Ghatak, London School of Economics and IGC were the keynote speakers at the workshop.

With a view to academic collaboration and exchanges, development of research etc., several Memorandum of Understandings (MoUs) have been signed between the Institute and TIFR, De Beers

## Director's Report

India Pvt. Ltd., DST Indo German Max-Planck Centre, IISCO, IGC, FICO, Tech Mahindra, Bangladesh Institute of Development Studies, Ecole Polytechnique Masstro, The Warwick University, Institute of Financial Management Research, MCX Stock Exchange Ltd., The Institute of Asia-Pacific Studies, Waseda University.

Another MoU has been signed between the Institute and TCS with an aim to open up employment avenues for the youths of Northeastern states. Keeping this in mind, the Tejpur Centre of the Institute will offer a one-year P.G. diploma course to students incorporating subjects primarily covering statistics and statistical methodologies. Those obtaining a pre-specified threshold in the said course will be recruited by TCS.

As far as construction part is concerned, the Platinum Jubilee ISEC Building in Kolkata is almost complete and the boundary wall of the permanent North-East Centre of the Institute at Tezpur, Assam has been completed. Construction of the boundary wall in Giridih Branch of the Institute in Jharkhand will also start soon.

I am grateful to Dr. C. Rangarajan, President of the Institute and Shri A.K. Antony, Chairman of ISI Council and Hon'ble Defence Minister, Government of India for their kind cooperation, help and guidance. They have been pillars of strength to the Institute. I am also grateful to all the Council members, Dr. T.C.A. Anant, Secretary, Ministry of Statistics and Programme Implementation, Government of India and all other officers of the Administrative Ministry for their kind cooperation and advice. I am also thankful to all the office bearers and all the workers of the Institute for their cooperation in their respective domains of activities.

March, 31, 2013

Bimal K. Roy





# INDIAN STATISTICAL INSTITUTE

HQ: 203, B. T. Road, Kolkata – 700108.

Branch  
Giridih

## Centres

Delhi, Bangalore,  
Chennai and Tezpur

## Outlying SQC & OR Units

Mumbai, Pune, Vadodara,  
Hyderabad and Coimbatore

A premier and internationally acclaimed research, teaching and training institute, founded in 1932 and recognized as an institute of national importance by an act of Parliament in 1959.

The Institute has a 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, as also recipients of prestigious awards like S.S. Bhatnagar Prize, Homi Bhaba Award etc.



Founder :  
Professor  
P. C. Mahalanobis



President :  
Dr.  
C. Rangarajan



Chairman :  
Shri  
A.K. Antony



Director :  
Professor  
Bimal K. Roy

Degree courses offered in B.Stat.(Hons.), B.Math.(Hons.), M.Stat., M.Math., MS in Quantitative Economics, MS in Library and Information Science, M.Tech. in Computer Science, M.Tech. in Quality, Reliability and Operations Research

Post Graduate Diploma offered in Statistical Methods with Applications

Junior/Senior Research Fellowships offered in several areas of natural and social sciences

Ph.D. degrees offered 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





Felicitation of Prof. Sankar K Pal, recipient of Padmashree and Prof. Arunava Sen, recipient of Infosys Award (Social Science) by Prof. C R Rao at ISI on 22 February 2013



Sir James A Mirrless, Nobel Laureate speaking at the Second Workshop on Economic Growth in West Bengal organized by SOSU on 7 January 2013



Third International Conference on Emerging Applications of Information Technology organized by ECSU on 30 September 2012



Professor Michael J. Hopkins with Professor Bimal Kumar Roy in the workshop organized by Theoretical Statistics and Mathematics Unit on 20 May 2012



Felicitations of Siva Athreya (Left) and Debasish Goswami (Right), recipients of S.S. Bhatnagar Award on 18 October 2012



Professor Douglas Oard, University of Maryland, USA delivering lecture in the Forum for Information Retrieval Evaluation (FIRE 2012) organized by CVPR Unit on 17 December 2012



Felicitation of Prof. C R Rao at ISI on 22 February 2013



Prof. Ayanendranath Basu speaking at Hindi Workshop organized by ISI on 14 September 2012



1st 'Training Programme on Adobe Photoshop : A Basic Course' organized by Reprography and Photography Unit, Library during 15-22 January 2013



S S Badhawan, Joint Secretary, Ministry of Statistics and Programme Implementation, at ISI Kolkata on 18 March 2013



International Conference on Quality, Reliability & Operations Research organized by SQC&OR, Mumbai on 7 March 2013



International Conference on Trends in Knowledge and Information Dynamics organized by ISI Bangalore Centre during 10-13 July 2012



Hindi Workshop organized by ISI Kolkata on 25 March 2013



ISI visit by Afgan Delegation Team on 29 November 2012. Team members with Professor Amita Majumder (Right) at Director's office



119th Birthday celebration of Prof. Prasanta Chandra Mahalanobis at ISI Tezpur Centre on 29 June 2012



Inauguration of the plaque of Rani Mahalanobis at Medical Welfare Unit, ISI, Kolkata by Professor Bimal Kumar Roy, Director on 8 May 2012



Workshop on Data Mining and its Industrial Applications organized by SQC-OR Unit at ISI during 20-22 February 2013



National Conference on Reprographic Rights and Copyright Act: Challenges and Management organized by Reprography and Photography Unit, Library during 7-8 March 2013. On the dias (L to R) Justice Chittatosh Mookerjee, Professor Swapan Chakravorty, Professor Dilip Kumar Sinha with the convener of the conference



Felicitation of Swami Purnatmananda of Ramakrishna Mission at ISI by Professor Bimal Kumar Roy on 19 September 2012



Football match of ISI students on 2 August 2012



Blood Donation Camp organized by ISI club on 1 October 2012



Drama competition organized by the ISI club on 7 May 2012



Integration 2013 organized by ISI Students on 12 January 2013



3rd ISI Rock Climbing Training Programme at Titabani, Purulia, W.B. on 15 December 2012

## 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 17<sup>th</sup> 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 28<sup>th</sup> 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 91 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

## Brief History

developing (a) the 1<sup>st</sup> mechanical hand computing machine, (b) the 1<sup>st</sup> Analog computer, (c) the 1<sup>st</sup> Punched Card storing machine and (d) the 1<sup>st</sup> 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 and Genichi Taguchi. In recent times, the visit of Amartya K. Sen, Robert Aumann, Lotfi A. Zadeh 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 28<sup>th</sup> 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 26<sup>th</sup> 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 26<sup>th</sup> 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 23<sup>rd</sup> 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. A new unit, called the Sampling and Official Statistics Unit (SOSU), has been



created at the Headquarters in Kolkata on 1<sup>st</sup> March, 2012 to cater to the growing demand for research and training in sampling and official statistics.

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 Prabab 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.

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. 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 80 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-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	-	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 (9 Nos.)** : Indo-German Max Planck Center for Computer Science;  
Tata Consultancy Service Ltd.;  
The University of Warwick, UK;  
London School of Economics;  
FICO, San Jose, USA;  
Mex Stock-Exchange Ltd., USA;  
Biomedical Devices of Kansas, LLC, USA;  
IISCO, Steel Plant;  
Institute of Asia Pacific Studies, Wasada University, Japan
  
- **Number of books published** : 39
  
- **Number of papers published** : 691
  
- **Number of Conferences, Workshops and Seminars held (Total – 412)** : 16 (Conference)  
132 (Workshop)  
264 (Seminar)
  
- **Observance of the International Year of Statistics**
  - **First Lecture : Date** : 02 January, 2013  
**Speaker** : Prof. Barry C. Arnold, Dept. of Statistics, University of California
  - **Second Lecture: Date** : 04 January, 2013  
**Speaker** : Prof. S.R.S. Varadhan, Courant Institute of Mathematical Sciences,
  - **Third Lecture : Date** : 27 February, 2013  
**Speaker** : Prof. J.K. Ghosh, Dept. of Statistics, Purdue University & ISI
  
- **Regional Mathematical Olympiad (RMO), 2012**
  - **Date** : 02 December, 2012
  - **Participants** : 1353 (West Bengal), 2000 (Karnataka)
  - **Successful Students** : 35 (West Bengal), 36 (Karnataka)
  
- **Indian National Mathematical Olympiad (INMO), 2013**
  - **Date** : 03 February, 2013
  - **Participants** : 42 (West Bengal)
  
- **International Statistical Education Centre (ISEC)**
  - **Founded** : 1950
  - **Commencement date of 66<sup>th</sup> Term (2012-13)** : 03 August, 2012
  - **Number of Trainees** : 08
  - **Countries participated** : Gambia, Georgia, Sri Lanka & Uzbekistan

## 1. TEACHING AND TRAINING

A brief account of teaching and training activities of the Teaching and Training Division during the academic session 2012-2013 is given below.

### Degree, Associateship and Training Courses

During the academic session **2012-2013**, a total of **13382** 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 Library and Information Science, M. Tech. in Computer Science, M. Tech. in Quality, Reliability and Operations Research, Post-Graduate Diploma in Statistical Methods with Applications, **Research Fellowships** in Statistics, Mathematics, Quantitative Economics, Computer Science, Quality, Reliability and Operations Research, Biological Anthropology, Physics and Applied Mathematics, Agriculture & Ecology, Sociology, Geology, Human Genetics, Library and Information Science, Psychology and Linguistics. Admission tests were conducted at **25** different centres all over the country. A total of **9547** candidates finally appeared for admission tests, of which a total of **714** candidates qualified in the written tests and were called for interviews. Based on the performance in the written tests, interview and the academic records, **282** candidates were offered admission to various courses during the academic session under review.

The annual examinations for all the regular courses during 2011-2012 academic session were held during May 2012. The 2012-13 academic session commenced from **July, 2012**.

The number of candidates admitted to the different degree programmes and in Junior Research Fellowship during 2012-2013 and the number of students who passed the annual examinations in 2012, are given in **Table 1**.

Till **31<sup>st</sup> March, 2013**, **122** trainees of Engineering and Technology courses from various Universities/Institutions (A. K. Choudhury School of Information Technology, Academy of Technology – Hooghly, Assam University- Silchar, B. P. Poddar Institute of Management and Technology, Banaras Hindu University, Barrackpore Rastraguru Surendranath College, Bengal College of Engineering & Technology, Bethune College, Calcutta Institute of Engineering and Management, Camellia Institute of Technology, Central University of Rajasthan, DOEACC Society- Kolkata Centre, Doon University- Dehradun, Dr. B. C. Roy Engineering College – Durgapore, DST – New Delhi, Government College of Engineering & Textile Technology - Serampore, Govt. MVM College- Bhopal, Heritage Institute of Technology, Indian Institute of Technology – Kharagpur, Indian Institute of Technology - Mumbai, Indian Institute of Technology - Roorkee, Indian Institute of Technology (BHU), Indira Gandhi National Open University- Delhi, Institute of Mathematics and Applications- Bhubaneswar, Jadavpur University, JIS College of Engineering, Kalyani Government Engineering College, KIIT University, Manipal Institute of Technology, MCKV Institute of Engineering, Meghnad Saha Institute of Technology, Narula Institute of Technology, National Institute of Technology- Rourkela, New Delhi Institute of Management- New Delhi, Oriental Institute of Science and Technology, Presidency University – Kolkata, Rajiv Gandhi Institute of Information Technology and Biotechnology – Pune, RNS Institute of Technology, School of Environment and Natural Resources– Doon University, Dehradun, Sikkim-Manipal Institute of Technology, St. Xavier's College, Supreme Knowledge Foundation Group of Institutions, Swami Vivekananda College of Professional Studies - Bhopal, Techno India College of Technology, Techno India, University of Calcutta, University of Delhi, University of Kalyani, University of North Bengal, University of Notre Dame, University of Rajasthan, Utkal University- Bhubaneswar, Visva-Bharati- Santiniketan, VIT University) 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, BIRU, CSSC, CVPRU, ECSU, ERU, GSU, MIU, PAMU, PRU and SQC & OR under the guidance of different faculty members of the Institute.

### Convocation

The 47<sup>th</sup> Convocation of the Indian Statistical Institute was held on 9<sup>th</sup> January, 2013, at 4.30 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. Bimal K. Roy, Director, ISI, and Chairman's Address by Shri A.K. Antony, Hon'ble Defence Minister, Govt. of India & Chairman of ISI Council. The degrees were awarded to students by Dr. C. Rangarajan, President, ISI. The medals to the recipients were awarded by Sir James A. Mirrlees. This was followed by a Convocation Address by the Chief Guest, Sir James A. Mirrlees, Nobel Laureate, Emerites Professor, University of Cambridge, UK. 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.

**Prasanta Chandra Mahalanobis Gold Medal** for the most outstanding performance in **M. Stat. (Statistics)** students (2010-2012) was given to:

Monika Bhattacharjee

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

**B. Stat. (Hons.):** Soumendu Sundar Mukherjee

**M. Stat.:** Abhik Ghosh

ISI Alumni Association **Rashi Ray Memorial Medals** for outstanding performance in **M. Tech. (CS)** (2010-2012) was given to:

Rudrasis Chakraborty

ISI Alumni Association **P.C. Panesar Gold Medal** for outstanding performance in **M. Math.** (2010-2012) was given to:

Alok Kumar Bakshi

**D. Basu Memorial Award** for outstanding performance in **B. Stat. (Hons.)** (2009-2012) was given to:

Soumendu Sundar Mukherjee

**Nikhilesh Bhattacharya Memorial Gold Medal** for the best student in **B. Stat. (Hons.)** (2009-2012) was given to:

Monika Bhattacharjee

**Usri Gangopadhyay Memorial Medal** for the best female student in **B. Stat. (Hons.)** (2009-2012) was given to:

Pragya Sur

**Mukul Chaudhuri Memorial Prize** for the highest scoring female student in **B. Stat. (Hons.)** second year batch (2010-2011) was given to:

Pragya Sur

**S.H. Aravind Gold Medal** for outstanding performance in **B. Math. (Hons.)** (2009-2012) was given to:

Subhadip Chowdhury

Table 1

Number of students passed during 2012 and  
number of existing students/fellows during 2012-2013.

Sl. No.	Courses	Number of Students		
		Passed in the Annual Exam. in 2012	During the year 2012-13	
01.	<b>B.Stat. (Hons.)</b>	1 <sup>st</sup> year	25	20
		2 <sup>nd</sup> year	30	25
		3 <sup>rd</sup> year	31****	30
02.	<b>B.Math. (Hons.)</b>	1 <sup>st</sup> year	22	19
		2 <sup>nd</sup> year	24	22
		3 <sup>rd</sup> year	10	26****
03.	<b>M.Math.</b>	1 <sup>st</sup> year	01	08
		2 <sup>nd</sup> year	05	01
04.	<b>M.Stat.</b>	1 <sup>st</sup> year	74*=(41+21+12)	52***=(31+21)
		2 <sup>nd</sup> year	16****	74***=(66+8)
05.	<b>M.Stat. (Applications)</b>	1 <sup>st</sup> year	03	07
		2 <sup>nd</sup> year	-	03
06.	<b>M.S. (QE)</b>	1 <sup>st</sup> year	24***=(12+12)	34***=(13+12)
		2 <sup>nd</sup> year	33***=(12**+21)	24***=(12**+12)
07.	<b>M.Tech. (CS)</b>	1 <sup>st</sup> year	23	19***
		2 <sup>nd</sup> year	07	23
08.	<b>M.Tech. (QROR)</b>	1 <sup>st</sup> year	09	16
		2 <sup>nd</sup> year	11	09
09.	<b>M.S. (Library &amp; Information Science)</b>	1 <sup>st</sup> year	05	05
		2 <sup>nd</sup> year	05	05
10.	<b>Post-Graduate Diploma in Statistical Methods with Applications (DST)</b>	1 <sup>st</sup> year	04	09
11.	<b>Junior &amp; Senior Research fellows &amp; Research Associates</b>		13	172
<b>Grand Total</b>			<b>375</b>	<b>603</b>

\* Total number, including Kolkata, Delhi and Chennai.

\*\* A student repeating a year.

\*\*\* Total number, including Kolkata and Delhi.

\*\*\*\*Two students repeating a year.

Table 2

D.Sc. degree (Honoris Causa) awarded by the Institute in the  
47<sup>th</sup> Convocation held on 9<sup>th</sup> January, 2013

Sl. No.	Name of the Awardee	Subject
1.	<b>Prof. K.R. Parthasarathy</b>	Mathematics and Probability Theory
2.	<b>Prof. Jayanta Kr. Ghosh</b>	Statistical Sciences
3.	<b>Prof. Pranab Bardhan</b>	Economics

Table 3

Ph.D. Degree awarded by the Institute in the 47<sup>th</sup> Convocation held on 9<sup>th</sup> January, 2013

Sl. No	Name of the Fellow	Title of the Thesis	Subject	University /Institute	Name of the Supervisor(s)
1.	Buddhadeb Sau, M. Tech. (CS) (Indian Statistical Institute)	Localization of Wireless Sensor Networks.	Computer Science	ISI	Prof. Krishnendu Mukhopadhyay, ACMU, ISI, Kolkata
2.	Debasri Saha, M. Tech. (CS) (University of Calcutta)	On Trusted Sharing of Intellectual Property of VLSI Design.	Computer Science	ISI	Prof. Susmita Sur-Kolay, ACMU, ISI, Kolkata
3.	Ishita De Ghosh, M. Tech. (CS) (Indian Statistical Institute)	Enhancing Effective Depth-of-field by Multi-focus Image Fusion Using Morphological technique.	Computer Science	ISI	Prof. Bhabatosh Chanda, ECSU, ISI, Kolkata
4.	Sukomal Pal, M. Tech. (CS) (Indian Statistical Institute)	Sub-document level Information Retrieval: Retrieval and Evaluation.	Computer Science	ISI	Dr. Mandar Mitra, CVPRU, ISI, Kolkata
5.	Snehasis Mukherjee, M.C.A. (Vidyasagar University)	A Novel Approach for Recognizing Human Actions at a Distance.	Computer Science	ISI	Prof. Dipti Prasad Mukherjee, ECSU, ISI, Kolkata
6.	Subhra Sankar Dhar, M. Sc. (Statistics) (University of Calcutta)	A Study of Some Statistical Procedures based on Median and other Quantiles.	Statistics	ISI	Prof. Probal Chaudhuri, SMU, ISI, Kolkata
7.	Sabyasachi Mukhopadhyay, M. Stat. (Indian Statistical Institute)	New Approaches to Inferential and Computational Aspects in a Flexible Bayesian Mixture Framework.	Statistics	ISI	Dr. Sourabh Bhattacharya, BIRU, ISI, Kolkata
8.	Neena Gupta, M. Math. (Indian Statistical Institute)	Some Results on Laurent Polynomial Fibrations and Quasi A* Algebras.	Mathematics	ISI	Prof. Amartya Dutta, SMU, ISI, Kolkata

9.	Mithun Mukherjee, M. Stat. (Indian Statistical Institute)	Inclusion Systems and Amalgamated Product of Product Systems of Hilbert Spaces.	Mathematics	ISI	Prof. B. V. Rajarama Bhat, SMU, ISI, Bangalore
10.	Sattwik Santra, M. S. (Q.E.) (Indian Statistical Institute)	Theorizing Wage Inequality in the Light of Globalization and Trade.	Quantitative Economics	ISI	Dr. Brati Sankar Chakraborty, ERU, ISI, Kolkata
11.	Mridu Prabal Goswami, M. Phil. (Economics) (University of Delhi)	Essays on Voting and Auction Theory.	Quantitative Economics	ISI	Prof. Arunava Sen, Eco. and PU, ISI, Delhi
12.	Ashokankur Datta, M. A. (Economics) (University of Delhi)	Essays in the Economics of Environmental Policy.	Quantitative Economics	ISI	Prof. E. Somanathan, Eco. and PU, ISI, Delhi
13.	Conan Mukherjee, M. Sc. (Economics) (Indira Gandhi Institute of Development Research)	Essays on Group Deviation.	Quantitative Economics	ISI	Prof. Manipushpak Mitra, ERU, ISI, Kolkata

Table 4

**Research Fellows of ISI who have been awarded Ph.D. degree by Academic Bodies other than ISI during 2012- 13 for work done in the ISI**

Sl. No	Name of the Fellow	Title of the Thesis	University	Name of the Supervisor
1.	Anirban Sengupta	Specification & Validation of Security Policies for Enterprise Information Systems.	Jadavpur University	Prof. Aditya Bagchi, ECSU, ISI
2.	Sujata Kar	Bio-social Study of Two Communities of Cachar District, Assam: Health Status and Maintenance.	University of Calcutta	Dr. Subrata Kumar Roy, BAU, ISI
3.	Shailendra Kumar Singh	A Study On Some Thin Film Coating Flow Problems.	University of Calcutta	Prof. B.S. Dandapat, PAMU, ISI
4.	Damayanti Das Ghosh	Influence of Some Host Immunogenetic And Viral Factors On The Pathogenesis Of HPV 16/18 Related Cervical Cancer.	University of Calcutta	Prof. Sharmila Sengupta, HGU, ISI
5.	Fouzia Alsabah Shaikh	Influence of Social Support & Life Meaningfulness on Perceived Self Control over Addiction: An Exploratory Study on Substance Abusers.	University of Calcutta	Prof. Anjali Ghosh, PRU, ISI



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6.	Dinabandhu Bhandari	On Convergence and Stopping Criteria of Genetic Algorithms with Elitist Model.	Jadavpur University	Prof. Sankar K. Pal, Soft Comp. Centre, ISI
7.	Samba Siva Rao Pasupuleti	Study on Fertility Patterns of Indian Women Cohorts Through Growth Curves and Regression Models.	University of Calcutta	Dr. Prasanta Pathak, PSU, ISI and Prof. Asis Chattopadhyay, CU
8.	Pallavi Chavan	A Study of Rural Credit in Maharashtra: The Resurvey of a Village from Western Maharashtra.	University of Calcutta	Prof. Madhura Swaminathan, SRU, ISI
9.	Tanushyam Chattopadhyay	Some Studies on Value Added Services for Connected TV.	Jadavpur University	Dr. Utpal Garain, CVPRU, ISI

**Number of candidates awarded degrees/ associatiships in the 47<sup>th</sup> Convocation of the Institute held on 9<sup>th</sup> January, 2013**

	<b>Degree / Associateship</b>	<b>Number of candidates</b>
1.	<b>Doctor of Science (D. Sc.)</b>	<b>03</b>
2.	<b>Doctor of Philosophy (Ph. D.)</b>	<b>13</b>
3.	<b>Master of Technology (M. Tech.) in Computer Science</b>	<b>07</b>
4.	<b>Master of Technology (M. Tech.) in Quality, Reliability and Operations Research</b>	<b>11</b>
5.	<b>Master of Statistics (M. Stat.)</b>	<b>16</b>
6.	<b>Master of Mathematics (M. Math.)</b>	<b>05</b>
7.	<b>Master of Science (M.S.) in Quantitative Economics</b>	<b>33</b>
8.	<b>Master of Science (M.S.) in Library and Information Science</b>	<b>05</b>
9.	<b>Bachelor of Statistics (Honours) [B. Stat. (Hons.)]</b>	<b>31</b>
10.	<b>Bachelor of Mathematics (Honours) [B. Math. (Hons.)]</b>	<b>10</b>
11.	<b>Post-Graduate Diploma in Statistical Methods with Applications</b>	<b>04</b>
<b>Total</b>		<b>138</b>

**International Statistical Education Centre (ISEC)  
Annual Report 2012-2013**

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, the Board of Directors of ISEC has had only two chairmen. Prof. P.C. Mahalanobis was the Chairman since the inception of the Centre in 1950 until his death in 1972. Since then, Professor C.R. Rao has been 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, South and 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 course on different topics of varying duration are also organized.

The commencement date of the 66th Term ISEC Regular Course (2012-2013) was August 3, 2012. There were 8 trainees from 4 different countries, namely (1) Gambia, (2) Georgia, (3) Sri Lanka and (4) Uzbekistan. All these trainees were supported by fellowships of the Indian Technical and Economic Cooperation (ITEC)/ Special Commonwealth Assistance for Africa Programme (SCAAP) of Government of India. The trainees were awarded Statistical Training Diploma in the ISEC Convocation. There are three more trainees from the National Statistical Office of Cambodia who are undergoing a special three-month training on Sampling Methodology from March 11, 2013. The training is sponsored by the Swiss International Development Agency (SIDA).

The trainees are provided with computer facilities and Internet connections in the ISEC PC room and in the ISEC hostel. They have access to the books at the ISI library. Teachers at the headquarter of the Indian Statistical Institute and statistical officers of the Government of India are participating in teaching the Regular Course during this year. Till now, nearly 1540 trainees from about 70 countries have received the Statistical Training Diploma.

The new building with modern amenities for ISEC at the 202 B.T. Road campus of the Institute is ready for inauguration in 2013. Professor Bimal Kumar Roy, Director, ISI, has taken special interest in enhancing the international image of the ISEC courses. The Centre had exhibited its achievement in a stall at the OECD World Forum, organized at Hotel Ashoka in New Delhi during October 16-19, 2012.

## 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***

Statistics on Non-Euclidean Manifolds such as Sphere, Projective Spaces and Shape Spaces, Nonparametric Bayes Theory, Asymptotic Statistics, Bootstrapping Techniques.

Abhishek Bhattacharya

A joint work with Professor Arup Bose and Dr. Koushik Saha on finite-diagonal large dimensional matrices was completed. A paper 'Convergence of a class of random and non-random symmetric matrices' was prepared where spectral properties of finite diagonal matrices have been studied, using the method of joint convergence of random matrices. Also a nice interplay between limiting spectral distributions of full-diagonal large dimensional random matrices and finite-diagonal large dimensional non-random matrices has been investigated.

Sreela Gangopadhyay

$L^p$  convergence of the scaled color counts in a general balanced urn model.

Krishanu Maulik and Gourab Ray

Tail behavior of annuities was studied. Regular variation of the annuities was obtained from that of the returns, when the returns and discounting factors jointly follow Sarmanov distribution. A converse result was also obtained where the regular variation of the returns was obtained from that of the annuities under appropriate moment conditions.

Krishanu Maulik and Moumanti Podder

The rates of counts of each colour of balls in a urn model were obtained, when the replacement matrix is not necessarily balanced. It is an ongoing work.

Amites Dasgupta and Krishanu Maulik

Random walk in random environment is studied where Cramer-type conditions fail. It is an ongoing work.

Krishanu Maulik, Zbigniew Palmowski and Parthanil Roy

Rates of convergence in Central Limit Theorem (CLT), Law of iterated logarithms (LIL) and Characterization theorems. Growth curve model, Applications of Statistics to Industrial quality control, Physics, Sociology, Agriculture, Education and other natural sciences.

Ratan Dasgupta

Adaptive Markov Chain Monte Carlo (AMCMC) is a class of MCMC algorithms where the proposal distribution changes at every iteration of the chain. The parameters of the proposal distributions are chosen adaptively over the previous iteration of the chain. However verifying ergodic properties of the adaptive chain is not always so straightforward. A diffusion approximation procedure has been used to a suitably defined AMCMC and to a standard MCMC to obtain Langevin type SDEs. Then target distribution has been recovered from these SDEs for a specific case and compared rate of convergence etc between AMCMC and MCMC.

Gopal K. Basak and Arunangshu Biswas

Work done on some properties of random walks perturbed at ex- tremata, which are generalizations of the walks considered e.g. in Davis (1999, PTRF). This process can be also viewed as a version of excited random walk, studied recently by many authors. A few properties have been obtained related to the range of the process with infinite memory. We also prove the strong law, CLT, and the criterion for the recurrence of the perturbed walk with finite memory.

Gopal K. Basak and Stas Volkov

We constructed a model of capital inflow in a two country framework. A capital-scarce country, typically a developing country with a high return on capital borrows from a capital-rich country, typically a developed country to finance domestic investment. In the process both the countries gain, raising the world welfare. This borrowing leads to appreciation of exchange rate in the developing country. When the external loan is repaid there is depreciation of exchange rate leading to costlier repayment. This is further accentuated when a bad state hits the country. This explanation of financial crisis is different from the usual theoretical explanations based on information theory, while our explanation is drawn from trade theory where worsening of terms of trade in the next period wipes out the gains of cheaper external borrowing, which is supported by several historical episodes in the empirical literature. If the exchange rate depreciation of the next period reduces the welfare of the capital importing country, even then there might be a gain in the total world welfare. However, in a situation of financial crisis, gains of international borrowing turn into total world welfare loss. We study the potential regimes of foreign exchange crisis under different parametric configurations of the model through the exchange rate dynamics.

Gopal K. Basak, Pranab Kumar Das and Sugato Marjit

The Euler class group of a Noetherian ring was invented to develop an "(algebraic) obstruction theory". Given a projective module over a ring whose rank is equal to the dimension of the ring, the Euler class of the projective module is an element of this group, vanishing of which is both necessary and sufficient to ensure that the module splits off a free summand of rank one. It is natural to study

## Research Activities

functorial properties of the Euler class groups. Given a ring  $R$  and a subintegral extension  $S$  of  $R$ , it has been established that the Euler class group is invariant under a subintegral base change, i.e., the two Euler class groups in question are isomorphic. This is the main theorem of the first paper below. In the second paper we extend the theory of the Euler class groups to polynomial extension  $R[X]$  of a ring  $R$  in the most general set up than the existing theory in the literature. The third paper investigates, under what condition, an element of the Euler class group of a polynomial ring over an affine algebra is the Euler class of a projective module.

Mrinal Kanti Das and Md. Ali Zinna

On invariance of the Euler class groups under a subintegral base change, preprint.

Mrinal Kanti Das and Md. Ali Zinna

The Euler class group of a polynomial algebra with coefficients in a line bundle, preprint.

Mrinal Kanti Das and S.M. Bhatwadekar

### **Projective generation of curves III, preprint**

#### **Chaotic Dynamical System**

It was established that the behaviour of the heat semigroup acting on the Lebesgue spaces of the hyperbolic and more generally on Riemannian symmetric spaces of noncompact type as well as on some non-symmetric harmonic manifolds are drastically different from their Euclidean nature. The sharp range of Lebesgue spaces where its dynamics is "chaotic" is determined. Currently we are trying to extend these results for other discrete semigroups generated by the multiplier operators for those spaces.

#### **Completeness of grid translates**

In these works we explore the idea that a "nice" function  $f$  which achieves an absolute maximum (or minimum) at a single point of an appropriate homogeneous manifold can be used to construct a dense set in the any Lebesgue space, by taking a rather small set of translations and powers of the function  $f$ . The problem resembles the construction of wavelets from a mother wavelet which uses translations and dilations, available in the Euclidean space. We substitute dilations by powers of the function which enables us to extend the theorem to groups and homogeneous manifolds where there are no natural dilations.

Rudra P. Sarkar and Swagato K. Ray

#### **Noncommutative geometry and quantum groups**

We have computed quantum isometry groups of group  $C^*$  algebras with natural word length spectral triple for a large class of finitely generated groups

Debashish Goswami and Arnab Das

We have extended our earlier results for computing quantum isometry groups of Rieffel-deformed spectral triples to a more general class of cocycle-twisted examples.

Debashish Goswami and Soumalya Joardar

We show that an affine threefold in  $A^4$  over a field  $k$  defined by an equation of the form  $x^m y = f(z,t)$ , where  $m > 1$ , is non-trivial if the polynomial  $f(z,t)$  is not a coordinate of  $k[z,t]$ . In particular, when  $k$  is of positive characteristic and  $f(z,t)$  a non-trivial line, then the threefold  $x^m y = f(z,t)$  is non-trivial although, by a result of Asanuma, its coordinate ring is a stably polynomial ring over  $k$ . Moreover, if either  $n$  is not equal to  $m$ , or if  $g(z, t)$  is another non-trivial line which is inequivalent to  $f(z, t)$ , then the two rings defined by  $x^m y = f(z, t)$  and  $x^n y = g(z,t)$  are non-isomorphic. Thus, for the affine three space in positive characteristic, we have a large family of non-isomorphic counter-examples to the Zariski's Cancellation Conjecture, a problem which had remained open for a long time.

Neena Gupta

We study simplicial action of groups on one vertex Kan complexes. We show that every semi-direct product of the fundamental group of an one vertex Kan complex with a finite group can be simplicially realized. We also calculate the homology of the fixed point set of a finite p-group action on a one vertex aspherical Kan complex.

Goutam Mukherjee, Swagata Sarkar and Debasis Sen

Information economics, Moral hazard problems and incentives, Spectral inference, Spectral properties of large dimensional random matrices.

Arup Bose

### **Stat-Math Unit, Delhi**

#### **Pólya – Eggenberger – Friedman Urn Models: A New Approach**

In this work we consider the classical and other generalization including infinite color generalization of the Pólya – Eggenberger - Friedman Urn Models and show that in the balanced case the configuration of the urn after  $n$  steps can be obtained by sampling the underlying Markov chain at random time points which depends on  $n$ . We show that most of the existing results on finite and infinite color urn models can be derived using this representation. Moreover we establish new results particularly for the infinite color case.

Debleena Thacker and Antar Bandyopadhyay

#### **On the De-Preferential Attachment Model**

In this work we introduce a new growing random graph process, which is exactly opposite of the well known “*preferential attachment model*”, and call “*de-preferential attachment model*”. In this model a new vertex appears with some number of “half-edges” which it joins sequentially (by updating the degrees) to the existing vertices with probability inversely proportional to the existing degrees. We study the asymptotic properties of a fixed vertex degree as well as the empirical distribution of the degree sequence and show that the behavior is drastically different than what happens in the preferential attachment case. In particular we show that the growth of the degree of a fixed vertex is of the order square-root of  $\log n$  while the limiting degree distribution is light tail.

Subhabrata Sen and Antar Bandyopadhyay

#### **Adjacency matrix and product distance matrix of a graph**

The work centered around the study of various matrices associated with graphs. A block graph is a graph in which each block is a complete graph. The distance matrix and the adjacency matrix of a block graph were investigated. A formula for the determinant of the adjacency matrix of a block graph was proved. Explicit conditions were obtained for the adjacency matrix of a block graph to be nonsingular over the field of integers modulo 2, and a formula for the inverse was obtained in that case. It is known that the nullity of the line graph of a tree is at most one. This result was extended with a different proof, to graphs with an odd number of spanning trees. A product distance was introduced and the corresponding product distance matrix of a tree was studied.

Souvik Roy, S. Sivasubramanian and R.B. Bapat

The ongoing research on geometry of the manifold of positive definite matrices was continued. Positive linear maps on matrix algebras were studied and many new inequalities for them were established.

Rajendra Bhatia

Research on the relationships between Markov processes and martingale problems was continued.

Abhay G. Bhatt

## Research Activities

A work on studying the limiting spectral distributions of large dimensional real symmetric random matrices with entries from a linear process whose input distribution has finite variance, was recently concluded. The long term plan is to carry on the research to the case where the variance of the input sequence is infinite. Furthermore, behavior of the largest eigenvalue of such random matrices is another interesting topic that will be investigated in near future.

Arijit Chakrabarty

Studying the convergence rates of Adaptive Lasso estimators to the limiting Oracle distribution and development of relevant Edgeworth expansions. Also it was shown that the residual bootstrap provides far better convergence rates, even achieving second order accuracy in the case of a studentized pivot, even when the dimension of the regression model  $p$  is much larger than the sample size  $n$ . These are completely new results and shed light on the higher order accuracy of Adaptive Lasso estimators.

Soumendra N. Lahiri and Arindam Chatterjee

Other major activities include studying the asymptotics of the residual empirical distribution function for the Adaptive Lasso estimator in fixed  $p$  and increasing  $p$  situations. We were able to show that the residual empirical distribution function has a functional oracle property that can be exploited to construct uniform confidence bands for the underlying error d.f.

Soumendra N. Lahiri, Professor Shuva Gupta and Arindam Chatterjee

Worked on bounds for reliability function of coherent systems consisting of  $n$  iid IFRA components. Bounds for complete reliability functions and expected life times of monotone systems in terms of the reliability and expected life time of similar systems with exponential components were obtained. Worked on tests based on quantile functions and quantile density functions. Worked on a deconvolution problem in competing risks using Fourier transforms.

Isha Dewan

### **Multiplicity of summands in the random partitions of an integer**

In this paper, we prove a conjecture of Yakubovich regarding slices of Young diagrams of two-dimensional integer partitions. We prove that there is a critical value  $j$  of multiplicity so that the probability that a summand of multiplicity greater than  $j$  occurs in a randomly chosen integer partition of  $n$  asymptotically converges to zero as  $n$  goes to infinity. As a Corollary, we also strengthen the result of Erdos and Lehner (1941) regarding the relation between the number of integer partitions and compositions of a large integer  $n$ .

G. Ganesan

### **Derivatives of Tensor Powers and their Norms**

The norm of the  $m$ th derivative of the map that takes an operator to its  $k$ th antisymmetric tensor power was evaluated. In particular it was shown that

$$\|D^m \wedge^k A\| = m! P_{k-m}(s_1(A), \dots, s_k(A)),$$

where  $P_{k-m}(s_1(A), \dots, s_k(A))$  denotes the  $k$ -mth elementary symmetric polynomial in the top  $k$  singular values of  $A$ . For this purpose a multilinear version of a theorem by Russo and Dye was proved. More precisely it was proved that a positive  $m$ -linear map between  $C$ -algebras attains its norm at the  $m$ -tuple  $(I, I, \dots, I)$ . The expressions for derivatives of the maps that take an operator to its  $k$ th tensor power and  $k$ th symmetric tensor power were obtained. The norms of these derivatives were also evaluated. The expressions for derivatives of the map taking a matrix to its permanent were also obtained.

Rajendra Bhatia, Priyanka Grover and Tanvi Jain

Worked on irreducibility of polynomials, exponential diophantine equations, abc conjecture and Grimm's conjecture. Extended results of Schur, Filaseta and others on irreducibility of generalized Hermite-Laguerre polynomials and gave new ideas connecting prime factors of arithmetic

progressions with irreducibility of polynomials. Made new contributions on an exponential diophantine equation involving products of terms of an arithmetic progression along with Filaseta and Saradha, which has been applied extensively by Filaseta and collaborators on the Inverse Galois problem. Along with Ram Murty, gave a new insight on Grimm's conjecture, connecting smooth numbers with Grimm's function, thereby obtaining best bounds gaps between consecutive primes under Grimm's conjecture, gave applications of an explicit version of abc conjecture to solve a number of conjectures.

Shanta Laishram and T.N. Shorey

Worked on a two-dimensional sinusoidal model in heavy tailed error. Studied asymptotic properties of least squares estimators. Work was done on asymptotic properties of least squares estimators of parameters of random amplitude chirp signal in noise. Work on developing asymptotic results of least squares estimators of unknown parameters present in a burst type signal in stationary noise is in progress. Furthermore, analyzing chirp signal model using sinusoids and developing efficient algorithm for fundamental frequency model are being investigated.

Swagata Nandi

### Quantum information theory

It has been shown that quantum error correcting codes can be obtained from imprimitivity systems. This exhibits the intimate link between the mathematical foundations of quantum mechanics as outlined by G.W. Mackey and the ideas of information transmission through quantum channel.

### Gaussian distributions in $R^n$

Given any fixed finite number of  $(n-1)$ -dimensional subspaces of  $R^n$  there exists probability densities in  $R^n$  whose marginals in these  $(n-1)$ -dimensional subspaces are Gaussian densities.

B.G. Manjunath

Extending the Basu-Khatri theory of Borel automorphisms of  $R^n$  preserving normality we have studied Borel automorphisms which preserve the normality of certain chosen finite sets of normal (Gaussian) probability measures in  $R^n$ .

### Symmetries of Gaussian states in $L^2(R^n)$

A unitary operator  $U$  on  $L^2(R^n)$  is called a Gaussian symmetry if  $UpU^{-1}$  is a Gaussian state whenever  $p$  is a Gaussian state. Such Gaussian symmetries constitute a group. A complete characterization of this group has been obtained.

### Discrete time stationary and ergodic nongaussian processes with $k$ -dimensional Gaussian marginals

For any integer  $k \geq 1$  we have constructed an example of a discrete time nongaussian stationary and ergodic process with all  $k$ -dimensional marginal distributions being Gaussian.

K.R. Parthasarathy

Regularity of a Fractal Interpolation Function (FIF) was studied using wavelet transform. Fourier transform of a FIF was also derived to facilitate the approach of wavelet transform of a FIF via Fourier transform. (Arxiv.1206.4129). The effect of insertion of a new point on Coalescence Hidden-variable Fractal Interpolation Function was studied.

Anurag Srijanani Prasad

Discrete time stationary and ergodic nongaussian processes with  $k$ -dimensional Gaussian marginals Random threshold graphs, random directed trees and the Brownian web has been continued.

Rahul Roy



## Research Activities

### Probability Theory

Worked on a super critical oriented percolation model and proved that under suitable scaling, the right most infinite paths converge to the Brownian web and also the work was done on the Bak Sneppen model in Statistical Physics where we showed that under a suitable modification the self - organised criticality can be rigorously exhibited.

Anish Sarkar

Work done addressed problems related to the study of restriction maps using optical mapping data; in particular, the use of alignments to infer copy number variation using hidden Markov models (HMMs). Ongoing and future work will try to extend the application of HMMs to studying copy number variation using next-generation sequencing data. Several statistical visualization methods were implemented and refined using the *R* environment for statistics and graphics. Work on developing additional tools for statistical graphics is in progress. A particular goal is to implement more efficient low-level tools than are currently available, and use them to implement high-level visualization systems that include support for interactive and dynamic graphics.

Deepayan Sarkar

Fan representations of certain shift and multiply unitary bases and nice error bases have been determined and utilised for finding out if they are equivalent or not.

Sibasish Ghosh

Involutions and trivolutions in algebras related to second duals of group algebras were further studied (ArXiv.math 1211.7368).

Ajit Iqbal Singh, M. Filali and M. Sangani Monfared

The Kneser-Tits Conjecture for Algebraic groups of type  $F_4$  having only cyclic splitting fields were settled along with the  $R$ -equivalence problem for such groups of type  $E_6$ . This is being studied in the general case.

Genus numbers of compact Lie groups and reductive algebraic groups were computed.

Anirban Bose

Some Reality properties for groups of type  $F_4$  and  $D_4$  have been proved and are being studied, this is in progress.

Anirban Bose

Embeddings of semisimple groups of type  $A_2$  in a given twisted form of  $F_4$  are being studied via mod-2 Galois cohomological invariants of such groups. We are studying Albert algebras whose all isotopes are isomorphic.

Neha Hooda and Maneesh Thakur

### ***Stat-Math Unit, Bangalore***

Completely characterized the class of operators with symmetrized bidisc as a spectral set. In this set up, a Beurling-Lax-Halmos type theorem was obtained. A unique and explicit dilation for this class of operator tuple was provided. These results concerning the Beurling-Lax-Halmos theorem and the functional model answers a pair of open questions of J. Agler and N. J. Young. The similarity problem for Hilbert modules in the Cowen-Douglas class associated with the complex geometric object, the hermitian anti-holomorphic vector bundles was considered. In this consideration, a complete classification results on similarity and quasi-affinity for a large class of Hilbert modules was obtained. A vector-valued version of Beurling's Theorem (the Lax-Halmos Theorem) for the polydisc was obtained. As an application of the main result, the necessary and sufficient conditions for the

completion of problem in the bounded holomorphic function on the polydis were obtained. Several variables analog of the Jordan blocks of the Hardy space were developed. In this consideration, a complete characterization of the doubly commuting quotient modules of the Hardy module over the polydisc were obtained. The issues of essential doubly commutativity and rigidity of submodules of the Hardy module were analyzed and proved that the complex dimension  $n = 2$  is important in the study of essentially doubly commuting submodules of the Hardy module. A notion of characteristic function for  $n$  tuples of commuting contractions on Hilbert spaces and obtain an analytic model for doubly commuting  $C_0$ -contractions were introduced.

Jaydeb Sarkar

Solutions of stochastic difference equation or equivalently convolution equation were studied and a new class of solutions called fundamental solutions was introduced. For certain noise processes, necessary and sufficient conditions were given for existence (fundamental) solutions.

C.R.E. Raja

Work continued in the area of geometry of Banach spaces. An analogue of a long standing open problem due to J. Lindenstrauss was formulated, in terms of Ideals, and a partial solution was obtained.

T.S.S.R.K. Rao

Skorokhod reflection mapping is very useful in the study of queueing and insurance models. Hypotheses under which the initial conditions for the Skorokhod reflection mapping on an orthant become asymptotically irrelevant were investigated. Besides a characterization of this property, a natural tractable sufficient condition in terms of the given data was obtained. A particular implication is that under additional stochastic assumptions, asymptotic irrelevance of the initial conditions does not require an existence of a stationary distribution; nor does it require a Markovian structure. Apparently this question was open for more than ten years.

Offer Kella and S. Ramasubramanian

### **Bures distance for completely positive maps**

D. Bures had defined a metric on the set of normal states on a von Neumann algebra using GNS representations of states. This notion has been extended to completely positive maps between  $C^*$ -algebras by D. Kretschmann, D. Schlingemann and R. F. Werner. A Hilbert  $C^*$ -module version of this theory has been developed. It is shown that one does get a metric when the completely positive maps under consideration map to von Neumann algebra. Further, several examples and counter examples have been obtained and a rigidity theorem for representations of completely positive maps has been proved.

K. Sumesh and B.V. Rajarama Bhat

### **On the polynomial convexity of the union of three totally-real planes in $C^2$**

A triple of totally-real planes with some mild assumption can be parametrized, via a  $C$ -linear transformation, by a pair  $2 \times 2$  matrices with real entries. A sufficient condition was found which is also an open condition in the space of pairs of  $2 \times 2$  matrices, for the compact subsets of the union of the members of that triples to be polynomially convex. The work is published online in Int. Math. Res. Notes As an advanced access article.

### **On polynomial convexity of compact subset of totally-real sub manifolds of $C^n$**

A necessary and sufficient condition for a given compact subset of a totally-real sub-manifold of  $C^n$  was found. The article is recently completed.

## Research Activities

### **On the polynomial convexity of the union of three maximal totally-real subspaces in $\mathbf{C}^n$**

This is an ongoing project. Again a triple of maximal totally-real subspaces with a mild transversality condition can be parametrized by pair of  $n \times n$  matrices with real entries. A sufficient condition for polynomial convexity of the union of such triples was found. The aim was to find an open condition on the space of pairs of  $n \times n$  matrices for polynomial convexity of compact subsets of the union of triples.

### **Local polynomial convexity of compact subsets of certain classes of graphs with isolated CR-singularities**

This is also an ongoing project. A class of graphs of homogeneous cubics that can be pulled back to union of three totally-real planes in  $\mathbf{C}^2$ , under a proper holomorphic map was considered. The aim was to characterize in terms of the coefficients when a compact subset of the graph is polynomially convex.

### **Some operator theory**

Two projects are going on simultaneously in this area jointly with Jaydeb Sarkar. One is on Nevanlinna-Pick type interpolation in certain classes of domains in  $\mathbf{C}^n$ ,  $n > 2$ . A sufficient condition using the techniques from interpolation in  $D$  was found. The other topic in this is  $r_n$ -contractions. A  $r_n$ -contraction is an  $n$ -tuple of commuting operators on Hilber space for which symmetrized polydisc is a spectral set. The aim at the beginning was to describe dilations for  $r_n$  contraction. This involves finding different characterizations for a point in  $\mathbf{C}^n$  to lie in symmetrized polydisc. This part of the work was completed.

### **Probabilistic boundary behavior of pluriharmonic functions for certain classes of bounded domains in $\mathbf{C}^n$**

This is a joint work with Siva Athreya. The domains that are strictly pseudo-convex or satisfy the rolling ball condition was considered. For these classes of domains set of boundary points where the non-tangetial boundary value exists and the set of boundary points where the probabilistic boundary value exists are equal almost everywhere was found.

Sushil Gorai

## ***Stat-Math Unit, Chennai***

### **Fractional Calculus and applications to Time series**

Worked on a fractional generalization of the Poisson processes and introduced a generalized Laplacian model associated with it. We also discussed some properties of this new model and its relevance to time series. Distribution of gliding sums, regression behaviours and sample path properties are studied. Also we introduced a more generalization of already obtained process. Furthermore, we studied the functional inequalities associated with the generalized pathway transform and obtained its applications in Astrophysics.

Nicy S.

### **Special Functions and Geometric Function Theory**

We investigate the properties of harmonic  $\nu$ -Bloch mappings by determining coefficient estimates and Landau's theorem for harmonic  $\nu$ -Bloch mappings. The results are generalizations of earlier known results. An improved version of Landau's theorem for bounded harmonic mappings are established and Marden constant for harmonic mappings are also obtained.

Sh. Chen, S. Ponnusamy, M. Vuorinen and X. Wang

We investigate univalence and starlikeness of suitably normalized form of the generalized Bessel functions of the first kind. The method uses ideas from Differential subordination and the classical Schwarz lemma.

Árpád Baricz and S. Ponnusamy

We discuss some properties on hyperbolic-harmonic mappings in the unit ball of  $n$ -dimensional Euclidean space  $\mathbf{C}^n$ . First, we investigate the relationship between the weighted Lipschitz functions and the hyperbolic-harmonic Bloch spaces. Then we establish the Schwarz-Pick type theorem for hyperbolic-harmonic mappings and apply it to prove the existence of Landau-Bloch constant for mappings in  $\alpha$ -Bloch spaces.

Sh. Chen, S. Ponnusamy and X. Wang

We investigate some properties of planar harmonic mappings and then discuss the relationship between area integral means and harmonic Hardy spaces or harmonic weighted Bergman spaces. Also, coefficient estimates of mappings in weighted Bergman spaces are obtained.

Sh. Chen, S. Ponnusamy and X. Wang

Unlike the conformal case, convolution of two univalent harmonic convex mappings in the unit disk is not necessarily even univalent there. We establish that convolution of the extremal function for the harmonic convex family with that of certain slanted half-plane harmonic mappings are still convex in a particular direction. The results in this direction enhance interest among harmonic mappings and, in particular, solves a recent open problem of Dorff, et. al. in a more general setting.

L. Liu and S. Ponnusamy

Exact (largest) radius of univalence of sections of analytic univalent functions remains an open problem, although the corresponding results for sections of various geometric subclasses of it have been obtained by several authors. However, no attempt has been made to derive harmonic analog of these results. We solve this problem for sections of certain class of univalent harmonic function defined on the unit disk.

L. Liu and S. Ponnusamy

We prove sharp coefficient bounds for the moduli of the Taylor coefficients certain family of univalent starlike functions defined on the unit disk. In addition, we determine the sharp bound for the Fekete-Szegő functional and present a convolution characterization for functions in this family and as a consequence we obtain a number of sufficient coefficient conditions for an analytic functions to be in this family. Finally, we discuss geometrically connected information such as the close-to-convexity and starlikeness of partial sums of functions in this family.

M. Obradović, S. Ponnusamy and K.-J. Wirths

We determine conditions on the analytic polynomials  $p$  and  $q$  such that the family of univalent sense-preserving biharmonic polynomials of the form  $P = |Z|^2(p + \bar{q})$  is dense in the family of univalent sense-preserving biharmonic mappings  $F$  defined on the unit disk of the form  $F = |Z|^2G$ . Next, we consider the univalence of harmonic function  $G$  whenever  $F = |Z|^2G$  is univalent in the unit disk. Finally, we give a partial answer to the problem raised by Muhanna about the radius of univalence of a family of sense-preserving biharmonic mappings with the form  $F = |Z|^2G + H$ , where  $G$  is univalent in the unit disk.

J. Qiao and S. Ponnusamy

## Applied Statistics Division

The Applied Statistics Division came into being in September 1996 in place of the Applied Statistics, Surveys and Computing Division. The Computer Science Unit was renamed as the Applied Statistics Unit and the Biometry Unit was transferred to the Biological Sciences Division. Till 2005-2006, the

## Research Activities

Applied Statistics Division consisted solely of the Applied Statistics Unit. During the years 2006-2007, 2011-2012 and 2012-2013, three new units viz. Bayesian and Interdisciplinary Research Unit, Sampling and Official Statistics Unit and Applied and Official Statistics Unit were created within this Division, the last being part of the Tezpur Centre of the Institute. However, the Sampling and Official Statistics Unit moved to Social Sciences Division in 2012-2013 and Applied Statistic Unit, Chennai came into being during the same year. 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 winter/summer schools, workshops and Probationers' Training for Indian Statistical Service Trainees. The members of the faculty conduct research in various areas of statistics, mathematics and computer science, with special emphasis on applications. Some members collaborate with other units of ISI on joint projects and also with scientists from other Universities/Institutes. Currently, there are collaborative on-going projects with the Theoretical Statistics and Mathematics Division, Computer and Communication Sciences Division and the Biological Sciences Division.

#### **Sample Surveys**

(i) Empirical Bayes methods, (ii) protection of privacy in quantitative data on sensitive issues and (iii) innovative modifications of classical techniques of data gathering ---, all related to Randomized Response Techniques, allowing repeated trials till a specified outcome occurs, are the topics of current activities. The relevant findings are incorporated in the forthcoming research monograph by Arijit Chaudhuri & Professor Christofides of University of Cyprus University

Arijit Chaudhuri

An advantageous randomized response model used to estimate the sensitive quantitative population mean based on the simple random sampling with replacement scheme for selecting the respondents, which has the estimator and variance estimator free from the known parameters of the scrambling variable is taken into consideration. Irrespective of how a sample of respondents is chosen, allowing a direct or a randomized response without revealing the option explored has been found to improve estimation procedure by the usual model. In the context of missing data, we consider the problem of estimating the population mean under unequal probability sampling scheme taking into account the doubtful random nonresponse. Our proposed estimators are compared with the usual estimators of population mean in presence of random nonresponse through numerical simulations.

Kajal Dihidar

NSSO is conducting a pilot study of Periodic Labour Force Survey with mixed panel data. The problem of estimation of unemployment rate was considered with two-quarter panel data in a volatile labour market. It was observed that the regression estimator has more variance with increased volatility. Sample size needed to achieve a fixed rse has also been worked out.

Shibdas Bandyopadhyay

#### **Reliability and Survival Analysis**

##### **Reliability**

A discrete time software reliability growth model for the analysis of software testing data with periodic debugging schedule is being considered. Some extensions of Jelinski-Moranda model incorporating nested error structure are being considered. A semiparametric method has been developed to analyse software reliability data with multi-type defects with application to modern bug database. Also, in describing reliability growth through a sequence of parametric models for successive failure time

distribution, a conservative confidence bound for the parameter of interest has been developed with minimum coverage probability. A method is being developed to evaluate reliability of a system under dynamic stress strength scenario.

Some new testing procedures for the goodness of fit of nonparametric classes of life distributions have been proposed and analysed. These are expected to complement the existing spectrum of methods of testing for exponentiality against various types of ageing.

### **Survival Analysis**

The problem of estimating the distribution of quality adjusted lifetime nonparametrically under the simple illness-death model with dependent sojourn time distributions is being considered. An improved calibration procedure for graphical comparison of two life distributions was proposed. The problem of estimating regression parameters and baseline cause specific hazards in competing risks framework with general missing pattern has been investigated.

Utilization of recall data poses new challenges in the analysis of age at menarche of adolescent and young adult women. Recall is often imperfect, and the associated censoring is informative. A new formulation of the problem has been developed, thus permitting parametric and nonparametric estimation of the menarchial age distribution.

New parametric models and tests for Accelerated Life Testing problems using parametric models have been studied based on conditional specifications. Change-point problems with multivariate non-normal observations on cancer patients were studied.

Anup Dewanji, Bimal Kr. Roy, Debasis SenGupta and Ashis SenGupta

### **Design of Experiments, Combinatorial Methods and their Applications**

#### **Crossover designs under non-traditional models are studied**

A new broad-spectrum construction method is proposed for efficient key predistribution schemes for distributed sensor networks based on combinations of duals of block designs. Explicit expressions are obtained for various metrics and properties of these schemes are studied.

#### **Various types of response-adaptive designs were investigated**

The problem of optimal allocation of units, with given prognostic variates or covariates, between two treatments has been studied. This work is being generalized for more than two treatments.

Optimal compound designs in the context of dose-response studies of phase II clinical trials are under study. Some problems related to model selection and parameter estimation for a class of competing models are under study.

Mausumi Bose, Anup Dewanji and Atanu Biswas

### **Signal Processing**

A minimum separation between successive samples is a practical constraint that often comes in the way of sampling of a continuous time stationary stochastic process for the purpose of spectrum estimation. It is known from a recent study that additive random sampling subject to the said constraint can be alias-free for bandlimited spectra with any specified support, but known estimation approaches do not work. A new spectrum estimator for this purpose has been proposed and it has been shown that it can accurately and precisely estimate any power spectral density limited to an arbitrarily large but known support.

Debasis Sengupta

## Research Activities

### **Operating Systems and Queues**

Queuing models used for firm real time systems sometimes have to incorporate constraints that complicate analysis. A case in point for jobs with stochastic deadline is Exact Admission Control, which permits entry of an incoming job only if it can be completed, along with jobs already in queue. An exact theoretical analysis has been carried out in respect of an M/M/1 system, with arbitrary distribution of relative deadline till the end of service, operated under the first come first served scheduling policy with exact admission control. The new analysis leads to an explicit expression for the loss ratio, and quantification of the benefit from Exact Admission Control. In addition, a method for approximately specifying the loss ratio of the earliest-deadline-first scheduling policy along with exit control through the early discarding technique has been developed.

Debasis Sengupta

### **Multivariate analysis**

Tests for multivariate Scatter or Overall Variability are constructed in a nonparametric framework.

Ashis SenGupta

### **Statistical Inference**

Intersection-Union tests and their relations to  $P^3$  tests in mixture models have been studied. Bayesian methods for Growth curve analysis and for Change-point problems enhanced.

Ashis SenGupta

### **Categorical Data Analysis**

A detailed study in the context of a general model for longitudinal categorical data are going on.

Atanu Biswas

### **Time series of discrete data**

Time series for discrete data are studied. A study to compare several stationery processes for categorical data with finite numbers of categories are done. Time series of zero-inflated count data are also under study.

Atanu Biswas

### **Directional Data Analysis**

Constructions of and inference for axial distributions, asymmetric circular distributions and multivariate directional distributions have been given. Models and inference for directional inverse regression analysis have been enhanced. Bayesian analysis of Growth curves for possibly multivariate data have been enhanced. Generalized wrapped stable distributions, symmetric and asymmetric, have been derived and related inference procedures have been developed.

Some test procedures for circular data are carried out in the context of cataract surgery data. Also modeling and analysis of multivariate circular data in the context of some galaxy data are under study.

Ashis SenGupta and Atanu Biswas

### **Cryptology**

Research on several areas on cryptology has been carried out by faculty members and research scholars of ASU. Included among these are theoretical aspects of hash functions, study of weak keys for RSA, correlation and biases in RC4, Boolean functions, key pre-distribution in sensor networks, broadcast encryption and modes of operations of a block cipher. The faculty members also actively participated in the program committees and organizations of several international conferences.

Bimal K. Roy, Palash Sarkar, Subhamoy Maitra, Kishan C. Gupta and Mridul Nandi

### Clinical Trials

Response-adaptive designs are carried out in clinical trials to allocate a larger number of patients to the better treatment. This will result in ethical gain. Some works related to several response-adaptive designs in different set up were carried out. In particular, a study to obtain optimal target allocation is going on. Inference on treatment difference in clinical trials is studied in the presence of surrogate responses when not all the true responses are available. We improve upon the existing results in the case of binary treatment responses. Distribution of log odds ratio and comparison of several standard estimation procedures in this context are studied for such surrogate-augmented data. It is observed that the efficient use of surrogate data improves the inference. Asymptotic closeness of Mantel-Haenszel estimator and profile log-likelihood estimator are under study. The problem of investigating Adverse Drug Reaction (ADR) associated with a specific drug from the post-market spontaneous response database is being studied. Some work has been done assuming binary exposure to drugs and the similar analysis with continuous exposure is under way.

Atanu Biswas and Anup Dewanji

### Mathematical Genomics

In Home of Mathematical Genomics (<http://www.isical.ac.in/~hmg/>) we work on several things like Olfactory Receptors (OR), Micro RNA (miRNA), Proteomics etc. for several species like human, chimpanzee and mouse. We try to develop a proper quantitative understanding of these biological families and the genomic evolution through the species. Applying tools like Fractal geometry, Mathematical morphology, Hurst Exponent, Chaos Game Representation, L-system etc. we try to predict whether a given random sequence is a valid OR/miRNA or not. Every work is done computationally.

Along with mathematical genomics, several mathematical researches are done by the team. Integral Value Transformation (IVT) is a discrete transformation from  $N_0^k$  to  $N_0$ . It was developed by our team. Some mathematical development of this newly formed paradigm is done here. Depending on the converging property of IVT, an analogous problem of Collatz Conjecture was formulated and proved. Also studies of affine discrete dynamical system in the light of Collatz function have been made. A reverse procedure of IVT, for finding the pre image of a number is found for some special IVTs and applied to a network design.

Two different methods are described for determining the classes of the n-variables Boolean functions where only one affine Boolean function belongs to each class. The first method is a recursive procedure that uses the Cartesian product of sets starting from the set of 1-variable Boolean functions and in the second method classification is achieved through a set of invariant bit positions with respect to an affine function. We are also studying the canalizing functions (Biological Relevant Boolean functions) which are uniformly distributed along all the classes. Further, a proper quantitative understanding of protein structure characteristics and the 3D structure comparison by using Mathematical Morphology is under study.

Pabitra Pal Choudhury

### Objective Bayesian Analysis

New measures of divergence between prior and posterior which are maximized by the Jeffreys prior have been presented. Two methods for proving this have been provided, one of which provides an easy to verify sufficient condition on a divergence measure under which it is maximized by the Jeffreys prior. The new divergence measures have been used to measure information in a prior and also to obtain new objective priors outside the class of Bernardo's reference priors.

Tapas Samanta and Arijit Chakrabarti

### Model Selection

Asymptotic properties of Bayesian methods of variable selection in linear regression models based on g-priors have been studied when the model dimension grows with the sample size. It has been shown



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that the methods based on g-priors are consistent in appropriate sense in both the "model false" case, i.e., when the "true" data generating model is not in the model space considered, and in the "model true" case when the "true" model is in the model space. It has also been shown that for squared error prediction loss; these methods perform asymptotically as good as an Oracle in some appropriate sense, where the Oracle refers to a model selection rule which minimizes this loss if the true regression were known.

Tapas Samanta and Arijit Chakrabarti

## Multiple Testing

The problem of model selection in a multiple regression setup through the use of several modifications of the Bayesian Information Criterion are studied. The case where design matrix is orthogonal and the true proportion of non-zero regression coefficients is sparse is considered. Model selection through modifications of BIC can be related to acceptance/rejection of hypotheses in an appropriate multiple testing rule involving the least squares estimate of the regression coefficients. Asymptotic optimality of the resulting decision rules are established. This is joint work with Malgorzata Bogdan, Florian Frommlet and Magdalena Murawska.

Arijit Chakraborti

## Geospatial Health Statistics

Predicted Map of New cases of Tuberculosis in North 24 Parganas District, in West Bengal, was created using Geostatistical method. New smear positive patients initiated on treatment (on the basis of TU –wise RNTCP performance, West Bengal, 2<sup>nd</sup> quarter 2011), was treated as study variable.

Kasturi Basu

## Sociobiology and Cognitive Science

A brief survey of genesis and growth of sociobiology, indicating the emphasis on role of genes on human nature, behavior etc. in sociobiological studies has been made. It has been argued that environment has received relatively less importance in such research. It is being suggested that addressing this critique will require more extensive work, often requiring statistical work to address complex questions.

Sumitra Purkayastha

## ***Bayesian and Interdisciplinary Research Unit***

Scientists of Bayesian and Interdisciplinary Research Unit (BIRU) are involved in different kinds of research, training and development activities. The members of the faculty conduct research in various areas in Applied and Theoretical Statistics. Some members collaborate with scientists of other units of ISI on joint project and also with scientists from other Universities/Institutions. Currently, there are collaborative on-going projects with the Biological Sciences Division and Social Sciences Division.

## Sample Survey

An attempt has been made to derive an exact expression for the mean squared error of a homogeneous linear estimator of the population total based on a varying probability sampling design. An unbiased estimator of the mean squared error has also been found out. This technique has been applied to derive an exact expression for the mean squared error of the ratio estimator and the regression estimator both based on SRSWOR for which no exact expression is available in the literature. This technique has also been applied to derive an exact expression for the mean square error of the generalized regression (GREG) estimator for the population domain total in case of small area estimation in survey sampling.

Arun K. Adhikary

### **Convex Inequalities and Measures of Inequalities**

The concepts of convex inequalities and majorization in connection with social and economic inequality have been studied. Different utility functions leading to different inequality measures have been re-considered both in univariate and multivariate cases. Statistical interpretations have been given and many examples have been constructed.

S.K. Bhandari

### **Structural pattern of some statistical designs**

The nonisotopic structures of Frequency squares of small order with 2 symbols have been identified and a study has been undertaken on the size of critical sets for a single frequency square. It has been observed that using a stronger definition of orthogonality, called equiorthogonality, the size of a critical set to retrieve the combinatorial structure uniquely for a pair of equiorthogonal squares is often reduced significantly compared to the size of the union of the individual critical sets. The structural patterns for a pair of squares having isomorphic corresponding rows and orthogonal corresponding *columns* have also been identified. Bounds on the size of the combined critical sets for such a pair of squares of order 8 with 2 symbols have been proposed and critical sets attaining these bounds for different patterns have been determined. The critical set for a special pair of equiorthogonal Frequency squares having corresponding rows and columns both orthogonal has also been obtained.

Rita SahaRay and Ilene Morgan

### **Study on covariates in Cross over designs**

A study on the optimal choice of covariates in cross over designs has been undertaken.

Rita SahaRay and Ganesh Dutta

### **Partially replicated two level factorial designs**

A study on partially replicated two levels Fractional Factorial (FF) design as an alternative to unreplicated FF has been undertaken. Such designs provide a non-model dependent estimate for pure error, which allows for simpler and more standard methods to identify significant effects through the use of F and t tests for lack of fit and individual contrasts. Focus has been given on the choice of partial replication based on the D-optimality criterion and Estimation Capacity for two factor interactions, in the absence of any prior knowledge of active two factor interactions.

Rita SahaRay

### **Effect of female feticide on the future age distribution of the women in India**

Gender bias is a world-wide serious problem. Especially, in countries like West Asia, North Africa, parts of South Asia, China and India, this gender bias problem is extremely very high. A serious problem in the Indian society system, namely the female feticide has been studied with the details of sex of the birth sequence, re- conception rates as a function of the sex of the previous births. Finally the impact of increasing feticide rate on the number of missing women, downfall in the sex ratios and the future age distribution of the women of reproductive age groups have been analyzed.

Shankar Dihidar

### **Analysis of Olfactory Receptor Genomic Clusters at the Functional Level using Boolean Function/Cellular Automata and Pattern Recognition Techniques**

For solving the problem of olfactory receptor gene sequence classification, the utility of sequence motifs was explored. Sequence motifs are repeating patterns that are generally used to represent genetic areas that control specific biological processes. Thus a sequence motif is a set of proteins, or nucleotides that are conserved in nature, that is, appear regularly in functionally related genes. The public-domain MEME suite of softwares was used to identify motifs in OR sequences. Based on the

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presence/absence of motifs in a given sequence, a binary vector was generated. Training sets of various sizes were drawn from the repertoire of ORs and used to implement binary Support Vector Machine (SVM) classifiers based on 442 motifs in nucleotide sequences. Encouraging results (e.g., 77% accuracy with a 50% training set) were obtained.

Amita Pal, Pabitra Pal Choudhury and Arunava Goswami

## Robust Estimation for Independent Non-Homogeneous Observations

In real life we often have to deal with situations where the sampled observations are independent and share common parameters in their distribution but are not identically distributed. While the methods based on maximum likelihood provide canonical approaches for doing statistical inference in such contexts, it carries with it its usual baggage of lack of robustness to small deviations from the assumed conditions. The present work has developed a general estimation method for handling such situations based on a minimum distance approach which exploits the robustness properties of the density power divergence measure (Basu et al. 1998, *Biometrika*). The asymptotic properties of the method have been established, and it has been demonstrated that the method has immediate applications to several areas including linear regression.

Ayanendranath Basu

## A Common Framework for Robust Minimum Distance Inference

The power divergence (PD) and the density power divergence (DPD) families have proved to be useful tools in the area of robust inference. The families have striking similarities, but also have fundamental differences; yet both families are extremely useful in their own ways. In this work, a comprehensive description of the two families has been provided which ties in their role in statistical theory and practice. At the end, the families have been observed to be a part of a superfamily which contains both of these families as special cases. In the process, the limitation of the influence function as an effective descriptor of the robustness of the estimator has also been demonstrated.

Ayanendranath Basu

## Robust Bayesian Inference Based on Divergences

In this work the application of the density power divergence family to the case of robust Bayesian analysis has been looked at. Some similar applications have been tried in the past in the context of power divergence families. The present analysis shows that the developed approach leads to significant improvements in numerical terms over the existing methods while keeping the other properties competitive.

Ayanendranath Basu

## Minimum Distance Inference Based on the Inlier Modified Renyi Divergence

Inlier modified versions of the Renyi Divergence have been considered and their use in robust minimum distance inference has been explored. The inlier modified versions of the divergences provide stable inference under contaminated data and model misspecifications, but lead to much more accurate inference in small samples when the model is correct. A different direction of modification, on the other hand, appears to provide better overall power for goodness of fit tests based on the Renyi divergence.

Ayanendranath Basu

## Some Alternative Approaches to Robust Minimum Distance Inference

Different variations of weighted likelihood estimation procedures have been proposed over the last three decades. Many of them have the issue of robustness as the primary motivating factor. Here focus has been on such weighted likelihood estimation schemes which combine the robustness property with full asymptotic efficiency. The weights have been based on the comparison of the population distribution function and the empirical distribution function based on the sample. At the

model the weights of the weighted likelihood function all would converge to one, so that asymptotically the estimating equation would behave like the likelihood equation. All these estimators have the same influence functions as that of the maximum likelihood estimator at the model. However the outlier downweighting properties of these estimators have been shown to be significantly better and the influence function would fail in this case to provide a useful summary of the robustness of these estimators.

Ayanendranath Basu

### **Adaptive Nonparametric Discriminant Analysis**

A nonparametric technique generalizing Fisher's Discriminant Analysis has been proposed for a range of elliptically symmetric distributions. An extensive simulation study has been undertaken to illustrate the potential of the method. Using a variety of real life data sets it has been shown that this generalized Fisher's Discriminant analysis is very competitive with other nonparametric methods. The method has been made completely adaptive using cross-validation technique. Further the idea of bagging (bootstrap aggregation) has been incorporated to enhance the performance of the resulting classifier.

Smarajit Bose, Rita SahaRay and Amita Pal

### **Statistical Issues in Content Based Retrieval**

In the context of Content-based Image retrieval, algorithms have been developed by combining conventional and segmentation based approaches for significant improvements in retrieval performance. Coupled with relevance feedback, the resultant algorithms achieved excellent retrieval accuracy in several benchmark datasets. Different combination methods have been implemented and their performances have been compared in benchmark datasets. In addition, new algorithms have been proposed using Bayes classification procedure which appear to perform much better compared to the existing methods.

Smarajit Bose and Amita Pal

### **Mixture of COM-Poisson Distribution**

A theory has been developed for fitting mixtures of Conway-Maxwell-Poisson distribution for count data. The EM algorithm was used for successful implementation of the theory. This algorithm is effective in the case of bimodality in the count data which shows evidence of under or over dispersion. Performance of this method has been found to be much superior compared to mixture of ordinary Poisson distributions. This method has been tested on a variety of simulated and real datasets. This iterative method has been made completely automatic by incorporating an algorithm for selection of the initial starting values.

Smarajit Bose and Galit Shmueli

### **Convergence Properties of TMCMC**

Dutta and Bhattacharya (2012) developed a novel MCMC methodology that uses simple deterministic transformations of some arbitrary, one-dimensional random variable to update high-dimensional random variables in a single block. The proposed methodology, referred to as Transformation-based Markov chain Monte Carlo (TMCMC), has been shown to have superior mixing properties compared to standard MCMC methods and to be computationally much less expensive. In this work, we formally investigate the geometric ergodicity properties of additive and multiplicative TMCMC.

Kushal Dey and Sourabh Bhattacharya

### **Trans-dimensional MCMC Algorithms Based on Deterministic Transformations with Application in Spatial Statistics**

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TMCMC introduced by Dutta and Bhattacharya (2011) is extended to Trans-dimensional TMCMC (TTMCMC), where the number of random variables to be updated is a random variable. Application of TTMCMC to a novel nonstationary, nonparametric, nonseparable spatio-temporal model yielded very encouraging results.

Moumita Das and Sourabh Bhattacharya

### **Bayesian MISE Based Convergence Rates of Mixture Models Based on the Polya Urn Model**

#### **Asymptotic Comparisons and Choice of Prior Parameters**

The posterior rate of convergence of the Dirichlet process-based mixture models proposed by Escobar and West (1994) and Bhattacharya (2008) are calculated in terms of MISE (Mean Integrated Squared Error) and it is shown that the latter converges much faster. Guided by the asymptotic results, it is also shown how to select the “maximum” number of components,  $M$ , and the parameter of the strength of the base measure,  $\alpha$ , of the model of Bhattacharya (2008). The prior MISE convergence rate of the model of Bhattacharya (2008) is also calculated with respect to  $M$  and  $\alpha$  under suitable assumptions on the base measure and the resultant choices of  $M$  and  $\alpha$  are compared with those associated with the posterior convergence rate. Apart from these, the corresponding asymptotic theory of the “large  $p$ , small  $n$ ” paradigm is developed, and it is shown that again the Bhattacharya model beats the Escobar-West model. A more flexible, modified version of Bhattacharya (2008) is also considered and it is shown to have the same asymptotic properties of Bhattacharya (2008).

Sabyasachi Mukhopadhyay and Sourabh Bhattacharya

#### **Perfect simulation in clustering of categorical time series with unknown number of clusters**

A methodology for clustering in categorical time series with unknown number of clusters is proposed and the perfect sampling theory of mixtures of unknown number of components, developed by these authors, is extended for exact Bayesian inference in this case

Sabyasachi Mukhopadhyay and Sourabh Bhattacharya

#### **An Improved Bayesian Semiparametric Model for Palaeoclimate Reconstruction**

A novel Bayesian model is proposed for modelling palaeoclimate data consisting of species counts and associated climate variables. It is shown that the proposed model satisfies the model adequacy test developed by Bhattacharya (2012) for both the data consisting of chironomid and pollen assemblages—problems whose solutions eluded the second author for more than a decade. For computational purposes the novel TMCMC methodology developed by Dutta and Bhattacharya, is used, which yielded excellent mixing properties for reliable exploration of the very high-dimensional posteriors.

Sabyasachi Mukhopadhyay and Sourabh Bhattacharya

#### **Disease Dynamics: Neglected Tropical and highly contagious**

Focus has been made in building Mathematical models that understand the spread of some of recent epidemics and also neglected tropical diseases in the world. These models have been further analysed for interesting properties and controlling measures using bifurcation theory. Attempts have been made to understand the impact of the government programs and assist in implementing various policies.

Arni S.R. Srinivasa Rao

#### **Multiple Decrement functions**

Theoretical derivations have been undertaken which have potential to explain the cause if various pension schemes causes of mortality in actuarial science. Taylor’s multivariate expansions, Chebyshev

polynomials and converging properties have been utilized for obtaining formulae for multiple decrement functions.

Arni S.R. Srinivasa Rao

### **Complex Dynamics in Real world**

In this work, the features of simply-connected regions in complex analysis have been exploited and blended with holomorphic dynamics to explain some of the epidemic evolving behavior. Few interesting examples have been studied where theory of Markov Chains can be linked to complex dynamics.

Arni S.R. Srinivasa Rao

### **Laws of Large Numbers**

Extensions of the Kolmogorov SLLN (IID case) for various dependent random variables and for possibly non-identical ones have been obtained. The problem of large deviation of statistics has been studied in the context of the Bahadur efficiency.

T.K.Chandra

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

### **Stochastic modeling of deterioration process and estimation of failure distribution**

S.M. Bendre

### **Vermicomposting of different waste materials**

Pradip Bhattacharyya and Pabitra Banik

### **Optimization of withered leaf moisture during the manufacture of black tea based upon theaflavins fractions. Polyphenolic compounds and antioxidant activity of CTC black tea of North-East India**

Pradip Bhattacharyya, Lakshmi Bhuyan and Santanu Sabhapandit

### **Utilization of tea industry coal ash as useful material for agriculture**

Pradip Bhattacharyya and SatyaSundar Bhattacharya

### **Approaches to increase potassium use efficiency for sustainable tea (*camellia sinensis*l.) production**

Increasing fertilizer use efficiency through integrating nanofertilizers with available organic manure and its use for sustainable tea (*camellia sinensis* l.) production

Pradip Bhattacharyya and Tanmoy Karak

### **Meta-microbe relationship in century old municipal solid waste amended soil**

Pradip Bhattacharyya and Subhasish Tripathy

### **Optimum designs for estimation of regression parameters in a balanced treatment incomplete block design set-up**

Ganesh Dutta and Premadhis Das

Research Activities

**Glycerol based tough hyperbranched epoxy: Synthesis, statistical optimization and property evaluation**

Ganesh Dutta, Shaswat Barua and Niranjan Karak

**Hazard remediation and recycling of tea industry and paper mill bottom ash through vermiconversion**

Ganesh Dutta, Linee Goswami, Arbind Kumar Patel, Pradip Bhattacharyya,  
Nirmali Gogoi and SatyaSundar Bhattacharyya

**Some Further Aspects of Assessment of Agreement involving Bivariate Normal Responses**

Ganesh Dutta and Bikas K. Sinha

**Innovative modelling and multi-objective optimization based on Response Surface Methodology-Weighted Principal Components-Desirability function approach: A study using rapeseed press-cake (an under-utilized agricultural waste)**

Ganesh Dutta and Manashi Das Purkayastha

**Multi-response based optimal recovery process conditions for light-coloured protein from rapeseed press-cake: A simple, potent, biomass valorization approach**

Optimized production of light-coloured vegetable protein from an industrial waste (rapeseed press-cake): Numerical modeling using innovative and novel "RSM-PCA-desirability function" trio.

Ganesh Dutta, Manashi Das Purkayastha and CharuLata Mahanta

**Involved in investigations on point free rings of continuous functions**

Partha P. Ghosh, Sudip Kumar Acharyya and Goutam Bhunia

Cachar Fold belt which is a part of the foreland fold belt within greater Assam-Arakan basin in the vicinity of the Indo-Myanmar Orogenic Belt with a high hydrocarbon potential has a sediment cover of more than 10 km consisting of Disang (Eocene), Barail (Oligocene), Surma (Miocene), Tipam (Miocene), Dupitila (Pliocene) and Dihing (Pleistocene) groups followed by Alluvium of Pleistocene and Recent age. The area comprises of a series of N-S to NNE-SSW trending tightly folded doubly plunging anticlines separated by broad synclines. Field investigation reveals that the Tipams and the older sediments are more intensely deformed with steep dips as compared to the younger formations. Most of the folds are asymmetric in nature with some anticlines such as Rengte, Chargola, etc. have their axial planes inclined towards east while some of them such as Longai, Ramphan etc. have their axial plane inclined towards west with longitudinal reverse faults affecting the steeper limbs. The sedimentological analysis of the exposed sections is being carried out with field documentation such as preparation of lithologs is done for a few sections and laboratory analysis of the samples collected is under progress.

Anwarul Alam Laskar

**Developing the Quasi maximum likelihood estimator of the parameters of the proposed Vector autoregressive (VAR) models with stochastic parameters and establishing some probabilistic properties such as stationarity, ergodicity etc.**

Neelabh Rohan and G.K. Basak

**Devising a new approach to select the order of GARCH models in financial time series analysis using the Focused Information Criterion**

Neelabh Rohan and T.V. Ramnathan

**Local polynomial estimation procedure for time varying vector autoregressive models**

Neelabh Rohan and T.V. Ramnathan

***Applied Statistics Unit, Chennai***

**A quintile based test for independence of failure time and cause of failure**

Using U-statistic theory, we develop non-parametric tests for testing geometric against different ageing classes.

Anisha P.

**Entropy-based model for non-linear time series**

We developed a new method based on entropy to model non-linear time series data. A non-parametric conditional quantile estimator and prediction interval for time series is obtained. A generalized Stein's identity is obtained and discussed its applications.

Sudheesh K.K.

**Estimation of Integrated Volatility in diffusions driven by Fractional Brownian Motion**

Diffusion processes driven by Fractional Brownian motion (FBM) have often been considered in modeling stock price dynamics in order to capture the long range dependence of stock price observed in reality. Cheridito (2003) has shown that the solution of the diffusion equation will lead to an arbitrage-free model if the integral is done in fractional Wick Ito Skorohod (FWIS) sense. Option prices for such models are obtained by Necula (2002) under constant drift and volatility. We obtain option prices under time varying volatility model. The expression depends on integrated volatility and the Hurst parameter in a complicated manner. Properties of estimators of integrated volatility and of Hurst parameter have been studied separately before. We obtain estimates of option prices and their asymptotic distributions.

R. Sen and A. Lahiri

**Contagion in Multivariate Financial Time Series based on Conditional Recurrence Times**

This paper provides a new idea of Residual and Recurrence Times (RRT) method of high or low values for multivariate time series to detect contagion. In presence of financial contagion, the distributions of residual and recurrence times are not the same, and, we examine the equality of two distributions using the permutation test. In comparison to other methods in multivariate extreme value theory, our proposed method does not need the IID assumption and can handle the situation where the extremes for different components do not occur at the same time. The theoretical results are derived under multivariate GARCH models. We apply the proposed method to real data on weekly stock indices from seventeen markets.

Z. Tan, R Sen and K. Chaudhuri

**Modeling volatility and jumps of Indian Stock market using high-frequency data**

Recent advancements in technology have led to wide availability of high-frequency financial data. In this study, we analyze the returns at five minutes interval from NSE for 2010 using the index NIFTY and the stocks State Bank of India and Infosys. A non-parametric approach is taken to detect jump



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arrival times and estimate the jump sizes. The analysis shows that index jumps relate very closely with the general market news and announcements while individual stock jumps are associated with company specific news. The paper shows that volatility of the market is best captured by asymmetric GARCH models.

R. Sen, R. Deora and P. Mehrotra

## Computer and Communication Sciences Division

### *Advanced Computing and Microelectronics Unit*

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, system-on-a-chip, low-power architectures, 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 2011-2012, the faculty members of the unit were engaged in the following research projects:

- Physical Design for 3D ICs
- Reconfiguration Problems
- Partitioning and covering problem of polygon in 2D
- Power and Bandwidth Management in Wireless Networks
- Low Memory Algorithms
- Universal Mobile Telecommunication Systems (UMTS) network planning
- Computer-aided Design and Testing of Digital Microfluidic Nano-Biochips
- Developing two labs (i) Nano-CAD (ii) Cluster Computing
- Energy-efficient Routing in Mobile Ad-hoc Networks (MANET)
- Automated Debugging for evolving programs
- Multi-valued logic for Quantum Computers

### **Power and Bandwidth Management in Wireless Networks**

In the area of cognitive radio networks (CRN), we have proposed a novel scheme for multi-path routing in a CRN for multimedia communication, based on an extension of the idea of Sample Division Multiplexing (SDM) (developed earlier by us) as given for single-hop communication, even when a contiguous band of required width is not available for some or one of the hops in the route. Each data packet of the multimedia signal is split into several sub-packets each of which needs much smaller bandwidth than the original packet, and these sub-packets are sent through all these routes to be eventually received by the destination node with the desired QoS. We have also proposed a secure communication system in CRN by sending these sub-packets through multiple node-disjoint paths so that an attacker will not be able to have the complete information about the multimedia signal by attacking only one intermediate node of the network. Accordingly, the security of the multimedia signal communication in cognitive radio networks can also be enhanced. In the area of energy-efficient communication, we have proposed a source coding technique based on Modified Redundant radix Based Number System (MRBNS) along with appropriate modulation/demodulation schemes. Performance evaluation for the proposed scheme through simulation has also been made. Also, we have proposed a polynomial-time approximation algorithm for channel allocation in cellular mobile networks which, for all the well-known benchmark instances allocates the demanded channels always with a bandwidth of 1.06 times the optimum value, while requiring very small execution time (of the order of a few milliseconds).

Bhabani P. Sinha

### Algorithmic and Architectural Design Issues of Microfluidic Nano-Biochips for Bioassay Execution (MICROBE)

Execution of a bioassay often requires a mixture of several samples/reagents in a certain proportion. In a digital microfluidic biochip (DMB) platform, because of the constraints of having discrete fluid droplets of integral volume units, mixture preparation turns out to be a complex one. There are several optimizations issues to be addressed in algorithmic microfluidics: mixing time, reactant usage, waste production, throughput, and energy spent. In this research project we have focused on (i) efficient mixing algorithm design, (ii) architectural design of chip layout, and (iii) reliability and fault-tolerance issues. We have studied the problem of minimizing costly reactant usage in biochemical mixing protocols and that of reducing energy demand needed for droplet navigation. The relevant physical layout design problems for dilution engines are also investigated. Further, we have developed, for the first time, an on-line error detection methodology in DMB's and demonstrated its application to several real-life bioassays.

Bhargab B. Bhattacharya

### Distributed Computation in Pervasive Computing Environment

The availability of various types of tiny mobile handheld devices with their ability to support untethered wireless networking is one of the most significant enablers of pervasive computation and communication worldwide. Our focus is on developing algorithms for distributed computations and optimizing their performance by taking into account both *computing* requirements and *communication* constraints of the underlying networks in such environments. For detection of an event like fire or earthquake by wireless sensor networks (WSN), we propose a simple distributed algorithm for in-node area estimation of the event region and its localization using less computation and message overhead compared to the earlier algorithms. Also, given a random uniform distribution of  $n$  sensor nodes over a virtual grid, a self-organized distributed algorithm is developed to find the maximum number of connected partitions to cover the area with  $O(d)$  processing in each node, where  $d$  is the maximum degree of a node. In case of node failure, a fast distributed recovery algorithm is developed to rearrange the partitions locally.

Nabanita Das

### Physical Design of Three-dimensional ICs

Three-dimensional integrated circuits (3D IC) with two or more layers of active electronic components promise lower interconnection complexity and delay. After our success with fast methods for (i) reducing the number of TSVs by multiplexing among scan latches and functional blocks, and (ii) simulated annealing based floorplanning considering thermal profiling, a new global routing method has been designed. Monotone staircase routing region definition by top-down hierarchical balanced bipartition is obtained in  $O(nk \log n)$  time, where  $n$  and  $k$  denote respectively the number of blocks and nets in a given floorplan. Then global routes through these regions are found in  $O(n^2 kt)$  time, where  $t$  denotes the maximum number of terminals in a net. Experimental results on the MCNC/GSRC floorplanning benchmark circuits yielded 100% routability for each of the nets, without any over-congestion through the monotone staircase channels. The wire length for each of the  $t$ -terminal ( $t \geq 2$ ) nets is comparable to the Steiner length of that net in almost all cases.

Susmita Sur-Kolay

### Logic Synthesis for Quantum Computers

Quantum computing is an emerging paradigm of computing with provably super-polynomial speed-up in crucial hard problems such as in cryptography. While experimental physicists have been working on the implementation aspect, computer scientists have been proposing very efficient algorithms for this model of computing. However, mapping these algorithms onto the appropriate hardware in a cost-

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effective, reliable and fault-tolerant manner is yet to be tackled efficiently. In addition to designing methods for binary logic, those for multi-valued logic which has the advantages of less hardware cost, have also been achieved. Synthesis techniques have been devised to realize a number of quantum algorithms such as Shor's factoring, Grover's search in the ternary and quaternary logic domain with lower quantum gate cost.

Susmita Sur-Kolay

### Partitioning and Covering Problem of Polygon in 2D

The one-round discrete competitive facility location problem, with respect to a  $n$  point user set  $U$ , consists of two players Player 1 (P1) and Player 2 (P2). At first, P1 chooses a set  $F_1$  of  $m$  facilities following which P2 chooses another set  $F_2$  of  $m$  facilities, disjoint from  $F_1$ , where  $m = O(1)$  is a positive constant. The payoff of a player  $i$  is defined as the cardinality of the set of points in  $U$  which are closer to a point in  $F_i$  than to every point in  $F_j$ , for  $i = j$ . The objective of both the players in the game is to maximize their respective payoffs. We address the case where the points in  $U$  are located along a line. We show that if the sorted order of the points in  $U$  along the line is known, then the optimal strategy of P2, given any placement of facilities by P1, can be computed in  $O(n)$  time. We then prove that for  $m \geq 2$  the optimal strategy of P1 in the one-round discrete competitive facility location problem game, with the users on a line, can be computed in  $O(n^{m^2/\lambda m})$  time, where  $0 < \lambda m < 1$ , is a constant depending only on  $m$ .

Sandip Das

### Reconfiguration Problems

We are given a graph  $G = (V, E)$  where each vertex is marked as either empty (E), or occupied by a red or blue chip (R/B). Each colored chip can move to an adjacent empty vertex. An R-receptor (B-receptor) is located adjacent to some particular vertex of the graph. Once a red (blue) chip reaches that particular vertex, it can be removed from the graph, thus making that particular vertex empty. Thus the number of empty vertices in the graph increases as colored chips is brought to their respective receptors. The goal is to empty the graph by taking all the colored chips to their respective receptors with minimum number of moves. It is already known that any 2-connected graph  $G = (V, E)$  can always be emptied if there be at least one empty vertex initially. We have got the following results: (i) the feasibility and optimality questions for the problem are in P, and NP respectively, (ii) if  $G = (V, E)$  be a graph with  $k$  cut-vertices, then  $G$  can always be emptied if there be at least  $k+1$  empty vertices initially, and (iii) given a graph, let  $k$  be the length of a shortest path  $p$  between R-receptor and B-receptor. The graph can always be emptied if there are initially at least  $k+1$  empty vertices in the graph.

Arijit Bishnu and Arijit Ghosh

### Universal Mobile Telecommunication Systems (UMTS) Network Planning

This project focuses on developing optimization models and techniques for UMTS network planning. First we have quantified the benefits obtainable with soft handoff in terms of coverage improvement, as opposed to merely stating them on qualitative reasoning. Then we have introduced a new approach called *virtual test point* to improve tractability for the UMTS network planning problem. This concerns changing the resolution of the problem scenario by reducing the number of test points that required to be evaluated. We have established a linear programming formulation of the planning problem and also have developed an efficient heuristic to solve the problem for large instances. Through simulation, we have examined in detail the change in quality of solution that this method induces. The results show that only a marginal reduction in quality of network evaluation is observed, while computational tractability is improved significantly.

Sasthi C. Ghosh

### Low Memory Algorithms

#### Space-efficient prune-and-search

We proposed a general scheme for prune-and-search technique and show how to implement it in space-efficient manner considering both the in-place and read-only model. Our techniques can be applied to a large number of problems which accept prune-and-search. For examples, we considered the problems of computing (i) the minimum enclosing circle (MEC) of a set of points in  $R^2$ , (ii) the convex hull of a set of points in  $R^2$  when these points are sorted with respect to their x-coordinates, and (iii) linear programming problems with two and three variables. The time and extra-space complexities of the proposed algorithms for all these problems are  $O(n \text{ polylog}(n))$  and  $O(\text{polylog}(n))$  respectively.

### **Largest clique problem in geometric intersection graphs**

We also considered fast inplace algorithms for computing the largest cliques in the intersection graphs of axis-parallel rectangles and disks in 2D. It uses  $O(n^3)$  time in-place computation of maximum matching in a bipartite graph, which is of independent interest.

Minati De and Subhas C. Nandy

### **Formal methods in design bug localization**

We have a couple of interesting results in the past year as part of our ongoing project. On one hand, we have come up with a new notion of bug localization using a combination of dynamic program slicing and weakest preconditions. On the other hand, we have designed a complete paradigm for ranking unit-level counterexamples using assertion mining. Our ranking is based on invariant assertions mined from simulation traces of the entire design inside which our module-under-test is instantiated. The proposed method has been shown to be accurate and scalable by orders of magnitude in comparison to existing ones. The results have been published in top tier conferences / journals successfully.

Ansuman Banerjee

## ***Computer Vision and Pattern Recognition Unit***

### **Online Handwriting Recognition**

This study dealt with recognition of online handwritten Bangla word samples. Each word sample was segmented into several sub-strokes. We identified 114 sub-stroke classes for Bangla. Each stroke sample is represented as a sequence of the feature vectors (theta, length) where theta is a directional feature while length is linear. For these bivariate features we define a mixture of their bivariate distributions. We devised an expectation maximization based approach to estimating the whole set parameters of the mixture model. On the basis of this mixture model, a hidden Markov model (HMM) based classifier was then developed for classification of an unknown sub-stroke sample into one of the 114 sub-stroke classes where each component in the mixture model corresponds to one state in the HMM. This constitutes the first phase of the recognition method of online handwritten Bangla word samples.

S.K. Parui, U. Bhattacharya, S. Baral, S. Bhattacharya and A. Chakraborty

### **Video Document Recognition**

Recognition in video is a challenging task because low resolution and complex background of video cause disconnections, loss of information, loss of shapes of the characters etc. We introduced a novel Ring Radius Transform (RRT) and the concept of medial pixels on characters with broken contours in the edge domain for reconstruction. For each pixel, the RRT assigns a value which is the distance to the nearest edge pixel. The medial pixels are those which have the maximum radius values in their neighborhood. We demonstrate the application of these concepts in the problem of character reconstruction to improve the character recognition rate in video images. With ring radius transform

## Research Activities

and medial pixels, our approach exploits the symmetry information between the inner and outer contours of a broken character to reconstruct the gaps. Experimental results and comparison with two existing methods show that the proposed method outperforms the existing methods in terms of measures such as relative error and character recognition rate.

P. Shivakumara, Trung Quy Phan, Souvik Bhowmick, Chew Lim Tan and Umapada Pal

## Graphical Document Processing

Symbol spotting in graphical documents is a challenging area and we proposed a symbol spotting technique in graphical documents. Graphs are used to represent the documents and a (sub) graph matching technique is used to detect the symbols on them. We propose a graph serialization to reduce the usual computational complexity of graph matching. Serialization of graphs is done by computing acyclic graph paths between each pair of connected nodes. Graph paths are one dimensional structure of graphs which are less expensive in terms of computation. At the same time they enable robust localization even in the presence of noise and distortion. Indexing in large graph databases involves a computational burden too. A graph factorization approach is proposed to tackle with this problem. We performed detailed experiments with various datasets of line drawings and compare our method with a state-of-the-art work.

Anjan Dutta, Josep Lladós and Umapada Pal

## Signature segmentation from Document

Automatic signature segmentation from a printed document is a challenging task due to the nature of handwriting of the signatory, overlapping/touching of signature strokes with printed text, graphics, noise, etc. We propose an approach towards the problem of signature segmentation. The method detects the signature blocks and then segments them from the document image using word level classification. Gradient based features are used for word-block feature extraction and Support Vector Machine (SVM) classifier is used for classification purposes. To detect the overlapping/touching printed strokes in the hypothetical zones of signature blocks, the corner points of contours are found by Douglas Peucker polygonal approximation algorithm and skeleton junction points are used. Finally, the touching strokes of signature are separated from text characters using the contour smoothness information near skeleton junction points. The experiment is performed in "tobacco" dataset and we obtained promising results.

Ranju Mandal, Partha Roy and Umapada Pal

## Handwritten Offline Dataset Development

In document image analysis especially in handwritten document recognition, standard databases play significant roles for evaluating performances of algorithms and comparing results obtained by different groups of researchers. We developed an unconstrained handwritten dataset containing documents of Persian, Bangla, Oriya and Kannada (PBOK) is introduced. The PBOK contains 707 text-pages written in four different languages (Persian, Bangla, Oriya and Kannada) by 436 individuals. Total number of text-lines, words/subwords and characters are 12 565, 104 541 and 423 980, respectively. In most documents of PBOK dataset contain either an overlapping or a touching text-lines. The average number of text-lines in text-pages of the PBOK dataset is 18. Two types of ground truths, based on pixels information and content information, are generated for the dataset. Because of such ground truths, the PBOK dataset can be utilized in many areas of document image processing for instance text-line segmentation, word segmentation and word recognition.

Alaei Alireza, Umapada Pal and P. Nagabhushan

## Font Recognition

Font can be used as a notion of similarity amongst multiple documents written in same script. We could automatically retrieve document images with specific font from a huge digital document repository. So Optical Font Recognition could be a useful pre-processing step in an automated

questioned document analysis system for sorting documents with similar fonts. We proposed a scheme to identify 10 different fonts for an Indic script (Bangla). Curvature-based features are extracted from segmented characters and are fed to a Support Vector Machine (SVM) for classification. The classifier determines the font type for each segmented character obtained from a document. Later, font identification for that document is executed on the basis of majority voting amongst 10 different fonts for all characters. Using a Multiple Kernel SVM classifier we obtained 98.5% accuracy from 400 (40 documents for each font type) test documents.

Sukalpa Chanda, Umapada Pal and Katrin Franke

### **Date field extraction from Document**

Automatic extraction of date patterns from handwritten document involves difficult challenges due to writing styles of different individuals, touching characters and confusion among identification of alphabets and digits. We proposed a framework for retrieval of date patterns from handwritten documents. The method first classifies word components of each text line into month and non-month class using word level feature. Next, non-month words are segmented into individual components and classified into one of alphabet, digit or punctuation. Using this information of word and character level components, the date patterns are searched first using voting approach and then we detect the candidate lines for numeric and semi-numeric date using regular expression. Gradient based features and Support Vector Machine (SVM) are used in our work for classification. To our knowledge this is the first work in this area.

Ranju Mandal, Partha Pratim Roy and Umapada Pal

### **Data Compression**

With the advancement of multimedia technology, transmission of data especially images, occurs on a very large scale. Reduction of the volume of data as well as storage becomes essential, bringing in the requirement of compression. JPEG2000 is commonly used for the purpose and being lossy in nature, causes degradation in image quality. Further degradation is by caused channel noise. Proper assessment of the image quality and evaluation of the amount and nature of degradation is important for different applications like Quality of Service, proper restoration of the image etc. The original image may not be available at the receiving end and hence reduced reference approaches form the only solution. In order to ascertain the cause of degradation, one must be able to distinguish between compression and noise. None of the reported reduced or no-reference methods have this capability. A reduced-reference technique, possessing this important feature has been proposed and its performance verified through extensive simulations. The technique is based on the Discrete Wavelet Transform and image behaviour in the multiresolution scenario.

Sarbani Palit

### **Information Retrieval (IR)**

A study of how query expansion techniques may be combined to improve retrieval effectiveness has been completed. Query expansion has also been successfully applied to IR from microblog sites (such as Twitter). A diagnostic tool that attempts to provide some explanation of why certain query expansion techniques work well is being developed. The application of Genetic Algorithms to fusing ranked lists of results is being explored. A novel TF-IDF term-weighting scheme has been developed that employs two different within document term frequency normalizations to capture two different aspects of term saliency. One component of the term frequency is effective for short queries, while the other performs better on long queries. The resulting weight is then measured by taking a weighted combination of these components, and the combination weight is determined on the basis of the length of the corresponding query. Experiments conducted on a large number of TREC collections demonstrate that the proposed scheme almost always outperforms five state of the art retrieval models with remarkable significance and consistency. The experimental results also show that the proposed model achieves significantly better precision than the existing models.

A. Bandyopadhyay, K. Ghosh, M. Mitra, S. Mukherjee, J.H. Paik, D. Pal, S. Pramanik, D. Roy and S.K. Parui

## Research Activities

### **Automatic Reading of Texts in Camera Captured Images**

A novel set of features has been proposed for detection of texts in images of natural scenes using a multi-layer perceptron (MLP) classifier. An estimate of the uniformity in stroke thickness is one of our features and we obtain the same using only a subset of the distance transform values of the concerned region. Estimation of the uniformity in stroke thickness on the basis of sparse sampling of the distance transform values is a novel approach. Another feature is the distance between the foreground and background colors computed in a perceptually uniform and illumination-invariant color space. Remaining features include two ratios of anti-parallel edge gradient orientations, a regularity measure between the skeletal representation and Canny edgemap of the object, average edge gradient magnitude, variation in the foreground gray levels. Simulation results of the proposed approach on the ICDAR 2003 database and another database of scene images consisting of texts of Indian scripts obtained by us are encouraging.

U. Bhattacharya and S. K. Parui

### **Cross Language Information Retrieval from Indic Script OCR'd Text**

This research concerns with retrieval of OCR'd text where queries are given in English and documents are in Bengali OCR'd text. A statistical transliteration module has been developed for transliterating out-of-vocabulary words. RISOT (retrieval of Indic script OCR'd text) activities are still on and this year OCR'd Devanagari data has been added in FIRE 2012 (Forum for Information Retrieval Evaluation).

Arjun Das, Doug Oard, David Doermann, Tamaltaru Pal, Arabinda Shee,  
J.H. Paik, U. Garain.

### **Machine Authentication of Security Documents**

This research is aimed at developing techniques for quick and easy authentication of security paper documents. Image processing and pattern recognition principles form the basis of this authentication technique. The goal is two-fold: (i) to check security features in a document in question in order to establish its authenticity, and at the same time (ii) analysis of security features to grade them according to their vulnerability against counterfeiting effort in order to help the designers for preparing of such security documents in future. Some research has been done for authenticating Indian banknotes. The role of fluorescent pulp for detecting fake banknotes has also been investigated.

Biswajit Halder, Ankush Roy, Rajkumar Darbar, David Doermann and U. Garain

### **Natural language processing and applications**

Computational linguistics of Bengali is studied. This year tools like morphological analyzer, text chunker and dependency parser have been developed. Pronominal anaphora resolution in Bangla has been studied in details. In a separate attempt, text-to-diagram conversion problem is targeted by integrating artificial intelligence and NLP tools. Under this research, machine is able to draw the diagram described in a piece of text (e.g. geometric/physics problems). This research has been extended for the Blind people so that they can perceive the diagrams on a Braille print out. NLP techniques have been used for biological data mining especially in the domain of cancer genetics

Apurbalal Senapati, Arjun Das, Anirban Mukherjee, Arindam Biswas, Suchismita  
Biswas, Debojyoti Sinha and U. Garain

### **OCR research**

As part of OCR research, recognition of handwritten mathematical expressions is now studied. The CROHME (competition on recognition of handwritten mathematical expressions) initiatives are still on and the third CROHME is organized along with ICDAR (Int. Conf. on Document Analysis and Recognition). CROHME dataset is now endorsed by Technical Committee 11 (TC-11) of IAPR (Int.

Assoc. for Pattern Recognition). A novel method for automatic algorithm selection has been proposed for document image binarization.

Tanushyam Chattopadhyay, Harold Mouchère, Christian Viard-Gaudin, Richard Zanibbi, Dae Hwan Kim, Jin H. Kim and U. Garain.

### **Sentiment Analysis - Development of a Prototype System for Telecom Industry**

Sentiment analysis in the most general sense refers to the classification of a piece of text into any of the three classes - positive, negative or neutral - according to its polarity. The text may be an entire document, a paragraph, a sentence, a phrase or even a single word. But the textual data obtained from such sources are extremely noisy. They are characterized by numerous spelling and grammatical errors as well as by the heavy usage of acronyms, abbreviations, shortened words and slang. We have developed a taxonomy and sample database of 8000 comments collected from various social networks on services provided by Telecom Service providers. These data have been annotated on a 5-point scale of the sentiment expressed by the user. We studied a Keygram based approach and also a Cosine Distance based approach for automatic determination of the degree of polarity expressed in a comment. We developed a web-based user interface (<http://www.isical.ac.in:8080/SentimentAnalyzer/>) for the sentiment analyzer developed by us.

U. Bhattacharya and S.K. Parui

### ***Documentation, Research and Training Centre (DRTC), Bangalore***

The main areas of research in which the DRTC Faculty 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 tolerable levels of precision. Research on the following issues is being carried out:

- How to reshape and sharpen traditional knowledge organization tools such as classification schemes and thesauri to meet the changing requirements of information representation and retrieval?
- Development of Faceted Ontologies based Colon Classification Principles

Devika P. Madalli

#### **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 under taken. 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. 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.
- Co-host working group on "Agricultural Data Interoperability" at RDA meet, Gothenburg, Sweden.

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



## Research Activities

### **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. Presently work on Urdu 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 had 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>. As of May, 2010 more than 3000 downloads have taken place. The updated version has been provided at the same site.

A.R.D. Prasad

### **Institutional repositories**

In the 1990's a movement was started to enhance public access to scholarly journal articles through the pre-print servers. In these servers, authors would deposit their pre-prints. 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 those literatures which were not peer reviewed. However, the last decade witnessed the rapid evolution of these into increasingly important media for dissemination of research results in certain fields, broadly known as "Open Access to Information". In this context attempts were made to:

Comparative study of open source tools for digital repositories

- 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.
- Study the adequacy of existing standards in this regard especially for scholarly material in Indian languages and scripts.
- Design an end user interface for browsing, navigating through and searching the Institutional Repository.

A.R.D. Prasad and M. Krishnamurthy

## ***Electronics and Communication Sciences Unit***

### **Bioinformatics**

With a view to find useful building blocks (short structural motifs) for reconstruction of 3-D structure of proteins, we have proposed a modified neural gas learning algorithm that we call Structural Neural Gas (SNG) algorithm. The SNG is applied on a benchmark protein data set and its performance is compared with a well known algorithm from the literature (two stage clustering algorithm (TSCA)). The SNG algorithm is found to generate better building blocks compared to TSCA. We have demonstrated the superiority of SNG over TSCA both in terms local-fit and global-fit errors using fragments of length five, six, and seven. We also use a graphical means for comparison of the performance of the two algorithms.

N.R. Pal

### **Computational Intelligence**

The Ordered Weighted Averaging (OWA) operators are an extensively used class of aggregation operators. The weight vector associated with an OWA can determine the attitudinal character of the aggregation. One of these characterizing measures is called orness measure. We have defined orness measure in an axiomatic framework and proposed an alternate definition of orness based on these axioms. The proposed measure is more restricted than the Yager's orness measure. We further obtain the maximum Shannon's entropy of OWA operator corresponding to a fixed value of orness. We have raised a basic question: should we really cluster any given object data in the kernel space? The answer is no! We have argued and demonstrated that such nonlinear transformation may impose structures that are non-existent in the original data space and the clusters found could be useless. We have justified our position also using numerical examples and visual displays.

N.R. Pal

### **Controlled Access to Documents over a Digital Library Ontology under Multiple Inheritance**

In a Digital Library, related documents are usually identified by a common concept and accessed by a common index. Any concept may have one or more ancestors and/or descendants. As a result, the underlying structure representing such ontology should be a directed acyclic graph (DAG). However, the research efforts for controlled access to digital library ontology or for semantic web, in general, consider the underlying structure as a tree. Project so far has developed the relevant algorithms and implementation strategies for controlled access to documents over a Digital Library (DL) Ontology considering the underlying structure as a DAG. A graph based formalism has been proposed and some successful implementation efforts have also been taken.

A. Bagchi

### **Design of Online Atmospheric Pattern Detection System**

The fabrication work of different electronic circuit modules and other hardware for the system has been completed. Implementation of the system for online SODAR structure classification work is in progress. Design and testing for off-line classification of atmospheric pattern using Antarctic data successfully done and all algorithm /developed software tested that are in operation. The paper "Atmospheric Pattern Classification Using Neural Network" is published in the journal - Neural, Parallel, and Scientific Computations.

N.C. Deb

### **Evolutionary Computing and Swarm Intelligence**

Efficient variants of the Differential Evolution and Particle Swarm Optimization algorithms 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 of the devised optimization algorithms have also been applied to solve some challenging antenna array optimization problems.

S. Das

### **Human Action Recognition**

For the human action recognition from video, we have adopted the approach of space-time interest point detection and describing the interest points (STIP) in terms of local features. Here we have extended 2D facet model to 3D to detect STIP and employed wavelet transform and temporal derivatives of various orders to describe the action in video. The method is tested on public domain bench mark datasets as well as on dance data collected processed by us.

B. Chanda

## Research Activities

### **Image Processing and Analysis**

Producing high resolution image from low resolution ones using super resolution (SR) technique is an important task to overcome hardware limitations. We have developed novel algorithms for both multi-frame SR and single frame image reconstruction. In the former case we have adopted Bregman iteration methods based on morphological regularization, while in the latter case exemplar based approach using topic model is adopted. This single-frame exemplar based approach exploits sparse coding approach with variable size dictionaries.

B. Chanda

### **Monitoring of Air Quality**

Suspended Particulate Matters (SPM) data collection using High Volume Sampler (HVS) at ISI, Giridih are in progress. During last two year (October 2011 to March 2013) a total of 107 samples were collected on pre-heated (450°C) filter papers (20×25 cm<sup>2</sup>) for 8 hour [on day and night basis (10:00h to 18:00h and 20:00h to 04:00h) and averaged]. These collected samples were stored under dry condition at -20°C till analysis. Water soluble ionic components (WSIC) of PM<sub>10</sub> was being analysed using Ion Chromatograph and Organic Carbon (OC) as well as Elemental Carbon EC analysis has been carried out by OC/EC carbon analyser at the National Physical Laboratory (NPL), New Delhi. For the said period data related to health (respiratory problem and death case) were also collected from the local government hospital. Meanwhile we have analysed OC, EC and WSIC data at NPL, New Delhi and developed neural network model for estimation of OC and EC.

N.C. Deb

### **Recognition of Facial Expressions**

Facial expression is one of the most important means of communication for human beings. Emotional state of mind is also often expressed on face. We have initiated a research on automatically determining different emotional expressions depicted in a face image. At this stage given the video of human face image, we are identifying six emotional expressions like happiness, sadness, anger, surprise, disgust and fear visible in that image. At the same time, given an emotion-neutral face image, our attempt is to impose any one of the above six expressions in order to artificially synthesize a specific emotion on the face. In both cases, our methods are comparable to the states-of-the-art in this field.

D.P. Mukherjee

### **Video Retrieval**

Video summarization is an essential step for video indexing/retrieval. We have developed an automatic method for shot level summarization of a video in terms of storyboard consisting of key-frames. A novel algorithm is proposed to extract key frames from the shots and to represent the video by a given number of key frames. The said size constrained video storyboards are generated using statistical Run test and Spanning tree. The method produces well accepted results. Video copy detection is another application of such methodologies. Our proposed method for the purpose yield good results.

B. Chanda

## ***Machine Intelligence Unit***

### **Image Processing & Analysis**

An efficient quantization index modulation (QIM)-based data hiding scheme using dual-tree complex wavelet transform (DTCWT) for the application of image error concealment has been developed. The main goal is achieved by embedding important information (image digest) as watermark signal that is extracted from the original image itself and is used to introduce sufficient redundancy in the

transmitted image. At the decoder side, the extracted image digest is used to correct the damaged regions. DTCWT offers three-fold advantages viz. (1) high embedding capacity due to inherent redundancy that leads to the better reconstruction of high volume missing data, (2) better imperceptibility after data embedding since it most closely captures human visual system (HVS) characteristics than conventional DWT and (3) better watermark decoding reliability. Simulation results show the superiority of the proposed technique over existing methods.

M.K. Kundu

### **Content Based Image Retrieval**

Content Based Image Retrieval (CBIR) system is an emerging research area in effective digital data management and retrieval paradigm. A novel CBIR system based on a new Multiscale Geometric Analysis (MGA)-tool, called Ripplet Transform Type-I (RT) has been developed. To improve the retrieval result and to reduce the computational complexity, the new scheme utilizes a Neural Network (NN) based classifier for image pre classification, Manhattan distance measure for similarity matching and fuzzy entropy based feature evaluation technique for effective relevance feedback mechanism (RFM). Extensive experiments were carried out to evaluate the effectiveness of the developed technique and also a 2 X 5 fold cross validation followed by a statistical analysis is used to show its rigidity from the stand point of theoretical support. The experimental results suggest that the CBIR system based on RT performs better than many existing schemes based on other transforms.

M.K. Kundu

### **Bioinformatics**

#### **Gene Selection**

A novel feature selection algorithm, governed by biological knowledge, has been developed for handling gene expression data. CLARANS algorithm has been applied for attribute clustering and dimensionality reduction based on gene ontology (GO) study. The use of GO analysis helps in the automated selection of biologically meaningful partitions. The algorithm was implemented on high-dimensional Yeast cell-cycle, Human Multiple Tissues, and Leukemia microarray data. In the second pass, clustering on the reduced gene space validates preservation of the inherent behavior of the original high-dimensional expression profiles. While the reduced gene set forms a biologically meaningful gene space, it simultaneously leads to a decrease in computational burden. External validation of the reduced subspace, using various well-known classifiers, established the effectiveness of the developed methodology.

S. Mitra

#### **Gene Regulatory Network**

A simple and novel curve fitting approach has been developed for generating simple gene regulatory subnetworks from time series gene expression data. Initial biclustering reduced the search space in the high-dimensional microarray data. The least-squares error between fitting of gene pairs was minimized to extract a set of gene-gene interactions, involving transcriptional regulation of genes. The higher error values were eliminated to retain only the strong interacting gene pairs in the resultant gene regulatory subnetwork. Next the algorithm was extended to a generalized framework to enhance its capability. The methodology takes care of the higher-order dependencies involving multiple genes co-regulating a single gene, while eliminating the need for user-defined parameters. It has been applied to the time-series Yeast data, and the experimental results biologically validated using standard databases and literature.

S. Mitra

For designing lead molecules for RecA protein of Mycobacterium tuberculosis, a multiobjective optimization (MOO) approach has been proposed. The technique is found to generate ligands some of which are similar to known inhibitors, while others are novel molecules. A multiobjective clustering

## Research Activities

technique integrated with SVM classifier for gene expression data has been developed. In rank aggregation, a new technique based on weighted Markov chain has been proposed, and applied on the results provided by multiple miRNA target prediction methods. In order to predict HIV-1-human protein-protein interactions (PPIs), a biclustering based association rule mining approach has been adopted. In miRNA analysis, multiple data sources are integrated to evolve the transcription start sites of the miRNAs. A new algorithm for differential co-expression analysis of miRNAs applied on patients with Alzheimer's reveals an important role of white matter in disease progression.

S. Bandyopadhyay

## Function Prediction of Unclassified Genes

Predicting the functions of genes is one of the major challenges in biological investigation. A single data source often lacks the degree of accuracy needed for gene function prediction. This can be improved by integrating different data sources in an efficient manner. We propose a weighted power biological score (WPBS), for combining different biological data sources and predicting the function of some of the unclassified yeast *Saccharomyces cerevisiae* genes. The relative power and weight coefficients of different data sources in WPBS are estimated systematically by utilizing functional annotations of classified genes, available from *Saccharomyces* Genome Database. Genes are then clustered by applying k-medoids algorithm on WPBS, and novel functional predictions of 334 unclassified genes are made. These predictions may provide new directions in biological research. The WPBS is available online at <http://www.isical.ac.in/~shubhra/WPBS/WPBS.html> for predicting functions of unclassified genes.

S.S. Ray

## RNA Structure Prediction

A common problem for researchers working with RNA is to choose a suitable technique to determine the three-dimensional structure of the molecule given just the nucleic acid sequence. In this regard, the application and importance of soft computing techniques like artificial neural networks (ANN), genetic algorithms (GAs) and simulated annealing (SA) to analyze and interpret RNA sequence data for predicting RNA secondary structure have been investigated. The learning ability of ANN and searching potential of GAs and SA have been found to be mainly utilized in the process.

S.S. Ray

## Designing Web Server for Functional Classification of RNA

One of the important goals of most biological investigations is to classify and organize the experimental findings so that they are readily useful for deriving generalized rules. 2095 RNA structures in Protein Data Bank (PDB), having RNA chain longer than nine nucleotides and solved by X-ray crystallography or NMR spectroscopy, are programmatically classified into nine functional classes and a web server is developed in this regard. The classification can also determine (i) a non-redundant set of RNA structures and (ii) a set of structures of identical sequence and function, which can highlight structural polymorphism, ligand-induced conformational alterations etc. The web server is available online at <http://www.saha.ac.in/biop/www/HD-NAS.html>.

S.S. Ray

A gene clustering algorithm has been reported to group genes from microarray data. It directly incorporates the information of sample categories in the grouping process for finding groups of co-regulated genes with strong association to the sample categories, yielding a supervised gene clustering algorithm. The average expression of the genes from each cluster acts as its representative. Some significant representatives are taken to form the reduced feature set to build the classifiers for cancer classification. The mutual information has been used to compute both gene-gene redundancy and gene-class relevance. The performance of the new method, along with a comparison with existing

methods, has been studied on several cancer microarray data sets using the predictive accuracy of naive bayes classifier, K-nearest neighbor rule, and support vector machine.

P. Maji

### **Pattern Recognition**

A new algorithm was designed for handling fuzziness while mining large data. A novel cost function weighted by fuzzy membership, was developed in the framework of CLARANS. A new scalable approximation to the maximum number of neighbors, explored at each node, was developed; thus reducing the computational time for large data while eliminating the need for user-defined (heuristic) parameters in the existing equation. The goodness of the generated clusters was evaluated in terms of Xie–Beni validity index. Results demonstrate the superiority of the algorithm, over both synthetic and real data sets, in terms of goodness of clustering. It is interesting to note that this algorithm always converges to the globally best values at the optimal number of partitions. Moreover compared to existing fuzzy algorithms, FCLARANS searches a small number of neighbors, and is able to handle the uncertainty due to overlapping nature of the various partitions.

S. Mitra

Based on the connectivity of the data points within and between clusters, some new cluster validity indices that incorporate the concept of relative neighborhood graph (RNG) have been developed. In multiobjective clustering optimizing multiple validity indices, selecting the appropriate set of indices is an important problem, with the results varying a lot with different sets of objectives. To overcome this limitation, an interactive approach has been proposed. The algorithm starts with a large set of objective functions. Thereafter, periodic interactions with the user helps the system to adjust the weights assigned to the objectives, so that with time, the number of objectives gradually decreases. The concept of multiple seeds within a cluster, integrated with new definitions of symmetry based distance and validity indices has provided a technique that can detect clusters of any shape, size, convexity, overlap and density, making it a very general purpose approach.

S. Bandyopadhyay

In this work, a new rough-fuzzy clustering algorithm, termed as robust rough-fuzzy c-means, has been reported. Each cluster in the new clustering algorithm is represented by a set of three parameters, namely, cluster prototype, a possibilistic fuzzy lower approximation, and a probabilistic fuzzy boundary. The possibilistic lower approximation helps in discovering clusters of various shapes. The cluster prototype depends on the weighting average of the possibilistic lower approximation and probabilistic boundary. The algorithm is robust in the sense that it can find overlapping and vaguely defined clusters with arbitrary shapes in noisy environment. An efficient method has been reported, based on Pearson's correlation coefficient, to select initial prototypes of different clusters. The effectiveness of the algorithm, along with a comparison with other clustering algorithms, has been demonstrated on several data sets using some cluster validity indices.

P. Maji

### **Computational Systems Biology**

#### **Modeling host-pathogen interactions**

Many complex mechanisms in immunological studies cannot be measured by experiments, but can be analyzed by mathematical simulations. Using theoretical modeling techniques, general principles of host–pathogen system interactions can be explored and clinical treatment schedules can be optimized to lower the microbial toxin burden and side effects in the host system. A computational modeling technique was used that aimed to explain the host–pathogen interactions, and suggested how the host system tried to survive from the pathogen attack. The toxin expression regulatory pathway in *Clostridium difficile*, apoptosis and mitogen-activated protein kinase pathways in an infected host

## Research Activities

(*Homo sapiens*) were integrated. It was hypothesized that lower toxin level in a pathogen implied higher chance of host survival.

R.K. De

### **Modeling feedback inhibition on enzymatic activity in metabolic pathways**

Metabolic pathways efficiently produce maximal amount of biomass while maintaining a steady-state behavior. The steady-state activity of such biochemical pathways necessarily incorporates feedback inhibition of the enzymes. This observation motivated us to incorporate feedback inhibition for modeling the optimal activity of metabolic pathways using flux balance analysis (FBA). The effectiveness of the methodology was demonstrated on a synthetic pathway with and without feedback inhibition. Similarly, for the first time, the Central Carbon Metabolic (CCM) pathways of *Saccharomyces cerevisiae* and *Homo sapiens* were modeled and compared based on the above understanding. It was hypothesized that an optimal pathway would opt for higher flux rate reactions. In light of these observations, it can be concluded that an optimal pathway should have lower enzyme concentration and higher flux rates.

R.K. De

### **Petri-net based modeling of an integrated biochemical pathways**

Biochemical networks comprise many diverse intracellular signaling, metabolic and gene regulatory pathways which are highly integrated and whose responses are elicited by extracellular actions. A method was developed for modeling an integrated pathway using an event-driven modeling tool, i.e., Petri nets (PNs). The integrated set of signaling, regulatory and metabolic reactions involved in *Saccharomyces cerevisiae*'s HOG pathway was collected from the literature. The kinetic parameter values were used for transition firings. The dynamics of the system was simulated and the concentrations of major biological species over time were observed. The phenotypic characteristics of the integrated system were investigated under two conditions, viz., under the absence and presence of osmotic pressure. The results were validated favorably with the existing experimental results.

R.K. De

### **Computational method for automated reconstruction of metabolic pathways**

Modeling and analyzing the architecture of metabolic networks using various computational strategies can be successfully used for studying their internal metabolic dynamics as well as predicting missing links in diseased networks. A recent algorithm, developed by us, was implemented, based on structural grammars, for automated metabolic pathway reconstruction and modeling of metabolic pathways involved in Type 1 *Diabetes mellitus* (T1D) in *Homo sapiens*. It was emphasized to study the metabolic pairs responsible for the functioning of GAD1 and GAD2 genes. The algorithm was also used for automated reconstruction of the pathways in glutamate metabolism,  $\beta$ -alanine metabolism, taurine & hypotaurine metabolism and butanoate metabolism. The missing and multiple link prediction were also done by the algorithm as well as nodal point analysis, for all the four metabolic pathways with 90.4-100% accuracy.

R.K. De

### **Face Recognition**

A new method of synthetic face image generation has been developed using the set estimation principles of Statistics. It generates new face images on the basis of images of the same person. Additionally, it sometimes generates images on the basis images of two different persons. The procedures for generation of new face images in the said two cases have been ratified using PSNR. Extensive experimental results have also been generated following the principles of face generation. It has also been observed that the new face images improve the classification accuracy.

C.A. Murthy

A face recognition algorithm using Radon transform, Coiflet and Daubechies wavelet transform based features was developed. Classification was conducted in the LDA space using k-NN classifier based on L1 norm measure and Mahalanobis distance measure. Comparison showed better results with respect to Curvelet based PCA and DWT based existing method.

S. Biswas

### **Biomedical Image Fusion**

A new multimodal Medical Image Fusion (MIF) scheme based on Non-subsampled Contourlet Transform (NSCT) and Pulse-Coupled Neural Network (PCNN) has been developed. The new MIF scheme exploits the advantages of both the NSCT and PCNN to obtain better fusion results. The source medical images are first decomposed by NSCT. The low-frequency sub-bands (LFSs) are fused using the 'max selection' rule. For fusing the high-frequency sub-bands (HFSs) a PCNN model is utilized. Modified Spatial Frequency (MSF) in NSCT domain is input to motivate the PCNN, and coefficients in NSCT domain with large firing times are selected as coefficients of the fused image. Finally, inverse NSCT (INSCT) is applied to get the fused image. Subjective as well as objective analysis of the results and comparisons with state-of-the-art MIF techniques show the effectiveness of the newly developed scheme in fusing multimodal medical image.

M. K. Kundu

### **Data security Management of Biomedical images**

Medical Data Management (MDM) domain consists of various issues of medical information like authentication, security, privacy, retrieval and storage etc. Medical Image Watermarking (MIW) techniques have recently emerged as a key tool for MDM. A new a blind MIW scheme based on Contourlet Transform (CNT), which is robust against high JPEG and JPEG2000 compression is developed. This is also capable of implementing range of MDM issues like, medical information security, content authentication, safe archiving and controlled access retrieval. It also provides a way for effective data communication along with automated medical personnel teaching. Extensive experiments were carried out and the performance of the proposed scheme is evaluated through both subjective and quantitative measures. The experimental results confirm the effectiveness and better efficiency of the newly developed technique in the MDM paradigm.

M. K. Kundu

### **Video Processing**

A novel region matching-based motion estimation technique is developed to detect moving objects with accurate boundaries from videos captured by moving camera. Here, a fuzzy edge incorporated Markov random field (MRF) model is considered for spatial segmentation. The algorithm is able to identify even the blurred boundaries of objects in a scene. Expectation Maximization algorithm is used to estimate the MRF model parameters. To reduce the complexity of searching, a new scheme is proposed to get a rough idea of maximum possible shift of objects from one frame to another by finding the amount of shift in positions of the centroid. A chi-square test-based local histogram matching procedure is used for detecting moving objects from scenes with low illumination environment. This technique is successfully applied for detecting moving objects from video sequences captured in both real-life and controlled environments.

A.Ghosh

### **Clutter Rejection in SAR Images**

A clutter rejection scheme for SAR imagery based on Two-Stage 2D principal component analysis (PCA) followed by a Bipolar Eigenspace Separation Transformation (BEST) and a Multi Layer Perceptron (MLP) have been proposed. For this, four different algorithms were analyzed. They were



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based on PCA both in one dimension (conventional PCA) and in two dimension with three different forms (2DPCA, Alternative 2DPCA and Two-Stage 2DPCA), followed by BEST and MLP in each case. Feature extraction in different cases was carried out using respective PCA scheme. Each algorithm used the BEST to further reduction of dimensionality. Classification between target chips and clutter chips was made through an MLP classifier. Comparison of all the 2DPCA algorithms with an existing technique reveals the fact that Two-Stage 2DPCA based algorithm had been the best (both in performance and time) between all algorithms.

A.Ghosh

## Machine Vision and Perception

Some psychophysical experiments have been performed in order to present some demonstrations concerning the width of Mach bands and henceforth hypothesize certain relations. It has been shown that it is the variation in width of Mach bands in relation to luminance gradients which is responsible for Mach bands being strong for luminance ramps and weak or vanishing for luminance steps. The results of the experiments using some of these demonstrations have been presented in support of the claim

K. Ghosh

## Information Retrieval

A theme matching scheme for SMS based FAQ retrieval is formulated. An SMS text usually consists of certain noisy terms due to the limitation of characters allowed in an SMS and typographical errors; thereby making the task of retrieving the relevant queries from FAQ corresponding to the SMS query a very challenging task. We observe that noun terms (along with verb and adjective-adverb terms) are found to represent the theme of a text, especially short texts. Therefore, the parts of speech of the FAQ queries are initially determined with the help of a POS tagger. Depending on the POS tag, terms of a FAQ query are considered to carry different significant values. Similarities of the terms of the SMS query are measured sequentially with the noun, verb, adjective-adverb and other tagged terms of a FAQ query. Four different string similarity measures are considered in our matching procedure. The method is implemented in monolingual English task in FIRE 2012 SMS-based FAQ Retrieval and the performance is found to be quite satisfactory (MRR is 0.963754 which is the best among all the participants of the task).

D.P. Mandal

## ***Systems Science and Informatics Unit***

Broad areas of research carried out by the faculty members at Systems Science and Informatics Unit (SSIU) fall under the category 'Computing in Science and Engineering'. SSIU deals with multidisciplinary research. Nature, Society, and Science consists of numerous phenomena and processes, the behaviors of which traverse various phases ranging from very *simple* to highly *strange*. Current faculty members of SSIU are dealing with some of such phenomena and processes from certain (but different) domains—such as terrestrial systems, urban and environmental systems, brain function, sociological systems etc—via computationally rigorous approaches and also via informatics. Efficient way of understanding the dynamical behavior of many complex systems of nature, society and science is possible through data acquired at multiple spatial and temporal scales. Earlier, several toy models were developed via classical mathematics to explain several possible phases in dynamical behaviors of complex systems. With the advent of computers with powerful graphics facilities, about three decades ago the interplay between numeric (generated via classical equations explaining the behaviors of dynamical systems) and graphics are shown. That progress provided initial impetus to visualize the systems' spatial and/or temporal behaviors that exhibit simple to complex patterns on graphical screens. Since last two decades, we have been seeing significant breakthroughs in data acquisition procedures with precision. Retrieving relevant information from such precisely acquired spatial-temporal data of varied types about a specific complex system is a basic prerequisite to understand the spatial-temporal behavior of a system. The varied but coherent phases involve in

developing cogent domain-specific models include information retrieval from the source data, information analysis, information reasoning, and simulation and modeling. These essential components that faculty members deal with at SSIU are basic ingredients of informatics, the science and engineering of information. They are pursuing vigorous research programs in Spatial Informatics, Computational Neuroscience, and Computational Intelligence. These areas of research are presently being carried out in two broad research groups: Spatial Informatics Research Group, and Computational Neuroscience Research Group.

### **Mathematical Morphology in Quantitative Spatial Reasoning**

In quantitative spatial reasoning, spatial relationships such as adjacency, betweenness, directional, distances, shape-size and centrality are important aspects. Many studies available have dealt with such spatial relationships through qualitative reasoning. We deal with quantitative approaches in handling the spatial reasoning tasks via applications of mathematical morphological transformations. This study addresses on how mathematical morphology could be employed in addressing the following aspects of relevance to spatial reasoning studies: (i) directional spatial relationship, (ii) between space, (iii) adjacency and touch relationship, (iv) distance-based relationships, (v) relationships based on shape-size complexity measures, and (vi) centrality relationship.

B.S. Daya Sagar, S. Ashok Vardhan and N. Rajesh

### **Mathematical Morphology in Spatial Extrapolations**

From various sources of data acquired by remote sensing, field surveys, demographic surveys, historical records, thematic layers depicting variable specific information will be prepared—by computer-assisted mapping or by digitizing manually mapped information. Integration of spatiotemporal information available as snapshots of the ever-changing phenomena at discrete intervals is an important challenge posed to the GIS community. This study deals with development of morphology-based algorithm for spatial extrapolations.

B.S. Daya Sagar and Shankar Bharathi

### **Cartograms via Mathematical Morphology**

Visualization of geographic variables as spatial objects of size proportional to variable strength is possible via generating cartograms. We developed a methodology based on mathematical morphology to generate contiguous cartograms. This methodology relies on weighted skeletonization by zone of influence (WSKIZ). This WSKIZ determines the points of contact of multiple frontlines propagating, from centroids of various planar sets (states), at the travelling rates depending upon the variable's strength. The contiguous cartogram generated via this morphology-based algorithm preserves the global shape, and local shapes, and yields minimal area-errors. We generated a cartogram for a population variable to demonstrate the proposed approach. Further, the population cartograms for the USA generated via four other approaches<sup>7,8,12,17</sup> are compared with the morphology-based cartogram in terms of errors with respect to area, local shape, and global shape. This approach for generating cartograms preserves the global shape at the expense of compromising with area-errors. It is inferred from the comparative error analysis that the proposed morphology-based approach could be further extended by exploring the applicability of additional characteristics of  $B$ , which controls the dilation propagation speed and direction of dilation while performing WSKIZ, to minimize the local shape errors, and area-errors.

B.S. Daya Sagar

### **Automatic Detection of Orientation of Mapped Units via Directional Granulometries**

Automatic detection of orientation of mapped units via directional granulometries is addressed in this letter. A flat symmetric structuring element ( $B$ ) of size  $3 \times 3$  with nine elements, which is a disk in eight-connectivity grid, is decomposed into four one-dimensional directional structuring elements ( $B_s$ ).

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Multiscale opening transformations are performed on each mapped unit with respect to these four directional structuring elements to eventually compute direction-specific morphologic entropy values. Based on these values, the orientations of mapped units are classified into four classes that include those units with orientations of (i) South East-North West ( $B^1$ ), (ii) North-South ( $B^2$ ), (iii) South West-North East ( $B^3$ ), and (iv) East-West ( $B^4$ ). We demonstrated this approach on five model objects, and nine major river basins extracted from DEM of Indian peninsular. This approach yields quantitative results, based on which the mapped units could be automatically classified into four different orientations.

B.S. Daya Sagar, S. Ashok Vardhan, N. Rajesh and H.M. Rajashekara

### **A Geometric Analysis of Time Domain Signals: From Mathematics to Medicine**

A novel geometric analysis of time domain signals is being carried out to extract important information from multichannel data. In this approach a rigorous mathematical definition of a signal has been proposed, which is broad based enough to encompass almost all signals in real life. The second order differentiable (difference) structure of signals has been analyzed (Conjecture: For an analog signal defined on a compact interval, the second order derivative may not exist only at a finite number of points). The notion of power in the classical mechanics (completely different from the notion of amplitude based power of the signals) has been extended to time domain signals leading to a novel multichannel information retrieval algorithm. This has been applied on epileptic depth EEG data to gain some novel insights.

Kaushik Majumdar

### **Novel Spike-Train Distance Measure**

An efficient spike-train distance measure has been implemented on a large number of simulated neuronal spike trains with added white noise of SNR up to 0.5 (50%). Multiple statistical features from the spike trains have been extracted. With those features a metric on the space of spike trains has been defined. With the help of this metric the new algorithm is working with greater accuracy than the one of the most reliable algorithms known (van Rossum, Neural Computation, 13: 751 - 763, 2001). However it runs slower.

Kaushik Majumdar and Shubhunshu Shekar

### **Class-Dependent Rough-Fuzzy Granular Space, Dispersion Index and Classification**

In this research work, a new rough-fuzzy model for pattern classification based on granular computing is described. In this model, we propose the formulation of class-dependent granules in fuzzy environment. Fuzzy membership functions are used to represent the feature-wise belonging to different classes, thereby producing fuzzy granulation of the feature space. The fuzzy granules thus generated possess better class discriminatory information that is useful in pattern classification with overlapping classes. Neighborhood rough sets are used in the selection of a subset of granulated features that explore the local/contextual information from neighbor granules. The model thus explores mutually the advantages of class-dependent fuzzy granulation and neighborhood rough set. The superiority of the proposed model to other similar methods is established with seven completely labeled data sets and two partially labeled real remote sensing images collected from satellites.

S.K. Pal (MIU), Saroj K. Meher and S. Dutta

### **Granular Computing Models in the Classification of Web Content Data**

In this work, two problems of web content mining, such as scene-region classification (applicable to image annotation), and image based spam detection are addressed. To solve these problems, we describe two granular computing (i.e., with rough-fuzzy and rough-wavelet granular spaces) based pattern classification models. These models can be used to design intelligent agents which may provide an improved solution to web mining. Neighborhood rough sets are used in the selection of a subset of these granulated features of models. Both the models explore mutually the advantages of

fuzzy/wavelet granulation and neighborhood rough sets. The superiority of these models to other similar methods is established with various performance measures.

Saroj K. Meher, S.K. Pal (MIU) and S. Dutta

### **Semisupervised Learning Based Pattern Classification Methods**

Pattern recognition is performed with three basic learning methodologies, such as supervised, unsupervised and semisupervised. Supervised learning is the task of inferring a function from a labeled data consisting of a set of examples. A supervised learning algorithm analyzes the training data and produces an inferred function, which is called a “classifier” (if the o/p is discrete) or a regression function (if o/p is continuous). Unsupervised learning refers to the problem of trying to find hidden structure in unlabeled data. Semisupervised learning is a combination of supervised and unsupervised notions and in recent past, it has gained its momentum in the decision-making process. Supervised learning algorithms require enough labeled training data to learn reasonably accurate classifiers. Unsupervised learning methods are employed to discover structure in unlabeled data. Semi-supervised learning allows taking advantage of the strengths of both. The goal of semi-supervised learning is to understand how combining labeled and unlabeled data may change the learning behavior, and design algorithms that take advantage of such a combination. Many machine-learning algorithms have been designed, which revealed that using unlabeled data in combination with a small amount of labeled data could produce considerable improvement in learning accuracy. The acquisition of labeled data for a learning problem often requires a skilled human agent (e.g. to translate a medical observation) or a physical experiment (e.g. determining the 3D structure of a protein or determining whether there is oil at a particular location). In many practical learning domains, there is a large supply of unlabeled data but limited labeled data, which can be expensive to generate, e.g., text processing, video-indexing, bioinformatics. In such situations, semi-supervised learning can be of great practical value. Semi-supervised learning is also of theoretical interest in machine learning and as a model for human learning because it works with both labeled and unlabeled data sets. The present study aims at developing efficient pattern classification models using semisupervised learning methods.

Saroj K. Meher

### **Derivation of Spatially Significant Set via Spatial Analysis and Reasoning**

All the initially set objectives of this project were met with. The ability to recognize strategically important set(s) within a cluster has interesting applications in geographical information science (GISci). This project focuses on (i) the problem of identifying spatial entities (e.g. continents, countries, states, cities, sets, water bodies, zones of influence, etc) that are ‘strategic’ in the sense that they are the most central or important based on their spatial relationships to other entities, (ii) defining geometric-based criteria based on mathematical morphological operators to derive individual zones that may serve as indicators of their strategic importance to other zones that are part of a collection of zones, and (ii) modelling spatial entities based on boundary, distance and contextuality relationships along with other spatial properties that depend upon the properties of size, shape, adjacency between the sets.

B.S. Daya Sagar and N. Rajesh

### **Human Depth EEG Processing for Epilepsy and Cognition**

Under the ISI funded project depth EEG data of 21 epileptic patients and 5 Schizophrenic + 5 normal controls' scalp EEG data are being analyzed. Seizure offset is being studied in order to understand why do all seizures terminate on their own. A novel hypothesis that seizure changes extracellular pH from  $\sim 7.35$  to  $\sim 6.8$ , which enhances activity of inhibitory neurons and suppresses the activity of excitatory neurons leading to greater focal ECoG channel synchronization towards the end of a seizure, rather than in the midway of its progression has been put forward (paper likely to be accepted in *J. Clin. EEG. Neurosci.*) The Schizophrenia data are being analyzed for auditory hallucination by the newly invented video synchronization method.

Kaushik Majumdar and Pradeep

### **Granular Neural Networks for Pattern Classification**

In general, the GNN is capable of processing granular data (such as numerical and linguistic data), extracting granular information, fusing granular data sets, compressing a granular data base, and predicting new data. In granular data, the granules can be a class of numbers, a cluster of images, a set of concepts, a group of objects, a category of data, etc. These granules are input and output of GNN, just like any natural data are input and output of biological neural networks in the human brain. Therefore, granular-data based GNN is more useful and effective to process natural information of granules than conventional numerical-data-based neural networks. In the following section various aspects of GNN are described with different designs architectures. The present project focuses mainly in the different structural representation of GNNs, that will solve the problems of decision making processes, similar to NN, but with fair knowledge of the network structures and functionalities instead of a black-box realization, as in case of ANN. We have started our approaches in conquering the process of granular computing in various fields and then developing NN in this framework. Recently we have proposed a multiple classifiers system based on GNN, which is applied for the land cover classification of remote sensing images. In future, we aim at developing more efficient systems of GNN for pattern classification tasks.

Saroj K. Meher and D. Arun Kumar

### **Computation in the Brain: Neuron, Synapse, Astrocyte Interactions in Small Networks**

The recent controversy regarding whether astrocytes modulate synaptic plasticity (Nature, 463: 232 - 236, 2010 and Science, 327: 1250 - 1254, 2010) has been addressed by mathematical modeling and computer simulation. It has been showed both long and short forms of plasticity are modulated by astrocytes. The former one was experimentally confirmed by Araque's group in Cajal Institute in Madrid. A close touch was maintained throughout the duration of the work.

Kaushik Majumdar, Shivendra Tiwari, Subhra Rani Patra and P. Ramesh

## ***Computer Science Unit, Chennai***

### **Hidden Protocols: modifying our expectations in an evolving world**

We study how agents perceive protocols that are not commonly known, and propose a logic to reason about knowledge in such scenarios. In particular, we introduce epistemic expectation models and a Propositional Dynamic Logic - style epistemic logic for reasoning about knowledge via matching agents' expectations to their observations. It is shown how epistemic expectation models can be obtained from epistemic protocols. Furthermore, a characterization is presented of the effective equivalence of epistemic protocols. We introduce a new logic that incorporates updates of protocols and that can model reasoning about knowledge and observations. Finally, the framework is extended to incorporate fact changing actions.

H. van Ditmarsch, S. Ghosh, R. Verbrugge and Y. Wang

### **Strategic reasoning: Building cognitive models from logical formulas**

This work attempts to bridge the gap between logical and cognitive treatments of strategic reasoning in games. There have been extensive formal debates about the merits of the principle of backward induction among game theorists and logicians. Experimental economists and psychologists have shown that human subjects, perhaps due to their bounded resources, do not always follow the backward induction strategy, leading to unexpected outcomes. Recently, based on an eye-tracking study, it has turned out that even human subjects who produce the outwardly correct 'backward induction answer' use a different internal reasoning strategy to achieve it. We present a formal language to represent different strategies on a finer-grained level than was possible before. The language and its semantics help to precisely distinguish different cognitive reasoning strategies, that

can then be tested on the basis of computational cognitive models and experiments with human subjects. The syntactic framework of the formal system provides a generic way of constructing computational cognitive models of the participants of a Marble Drop game.

S. Ghosh, B. Meijering and R. Verbrugge

### **Boolean Secrecy Games**

Inspired by the work on Boolean games, we consider turn-based games where each of the players controls a set of atomic variables and each player wants to achieve some individual goal in such a way that the other players remain unaware of the goal until it is actually achieved. We present definitions of winning such games with hidden goals for different non-cooperative settings, and discuss in which types of situations players have winning or equilibrium strategies. We also provide some complexity bounds on deciding whether a player has a winning strategy.

N. Bulling, S. Ghosh and R. Verbrugge

### **Logic, Probability and Strength of Beliefs**

Inspired by a similar use in provability logic, strength of belief formulas are introduced in the existing logical framework for discussing beliefs to express that the strength of belief in a proposition is greater than (or equal to) that in another proposition. A major role is played in our investigations by the relationship between the standard plausibility ordering of the worlds and the strength of belief ordering, which is a set ordering. We advocate to take the set ordering to be the primary ordering, and to define the plausibility ordering in terms of it, and we work on the properties needed to make such a transformation. We also relate to orderings of formulas whose interpretations are probabilistic in nature and attempt to build up a precise connection.

S. Ghosh and D. de Jongh

### **Cryptology**

Some results on Resultants and their application to cryptanalysis of truncated linear feedback shift register over  $Z_m$ .

Ayineedi Venkateswarlu

### **Paillier-based publicly verifiable (non-interactive) secret sharing**

Mahavir P. Jhanwar, Ayineedi Venkateswarlu and Reihaneh Safavi-Naini

### **Challenging the increased resistance of regular hash functions against birthday attacks**

At Eurocrypt 2004, Bellare and Kohno presented the concept of a regular hash function. For a hash function to be regular, every hash value must have the same number of preimages in the domain. The findings of their paper remained unchallenged for over six years, and made their way into several research papers and textbooks. In their paper, Bellare and Kohno claim that regular hash functions are more resistant against the birthday attack than random hash functions. We counter their arguments, by showing that the success probability of the birthday attack against a regular hash function can be made arbitrarily close to that of a random hash function (for the same number of trials). Our analysis uses the fact that the choices of the attacker can be limited to any subset of the domain. Furthermore, we prove that it is not possible to construct a hash function that is regular for only a small fraction of subsets of the domain. In order to avoid these problems, we propose to model hash functions as random functions. Compared to regular functions, we argue that the statistics of random functions are more similar to hash functions used in practice, regardless of how the attacker chooses the domain points.

Nicky Mouha, Gautham Sekar and Bart Preneel

## Research Activities

### **Practical (Second) Preimage Attacks on TCS\_SHA-3**

TCS\_SHA-3 is a family of four cryptographic hash functions that are covered by an US patent (US 2009/0262925). The digest sizes are 224, 256, 384 and 512 bits. The hash functions use bijective functions in place of the standard compression functions. In this work, we describe first and second preimage attacks on the full hash functions. The second preimage attack requires negligible time and the first preimage attack requires  $O(2^{36})$  time. In addition to these attacks, we also present a negligible-time second preimage attack on a strengthened variant of the TCS\_SHA-3. All the attacks have negligible memory requirements.

Gautham Sekar and Soumyadeep Bhattacharya

### **The Stream Cipher Core of the 3GPP Encryption Standard 128-EEA3: Timing Attacks and Countermeasures**

The core of the 3rd Generation Partnership Project (3GPP) encryption standard 128-EEA3 is a stream cipher called ZUC. It was designed by the Chinese Academy of Sciences and proposed for inclusion in the cellular wireless standards called “Long Term Evolution” or “4G”. The LFSR-based cipher uses a 128-bit key. In this work, we first show timing attacks on ZUC that can recover, with about 71.43% success rate, (i) one bit of the secret key immediately, and (ii) information involving 6 other key bits. The time, memory and data requirements of the attacks are negligible. While we see potential improvements to the attacks, we also suggest countermeasures.

Gautham Sekar

### **Position-dependent cryptography and quantum computing with recipients and senders having simple quantum dynamics**

As opposed to the usual static quantum position-dependent cryptography, a formulation of position-dependent quantum cryptography was made in which the recipient and/or the sender have simple quantum dynamics. We are continuing investigations on the effect of such dynamics on the cryptographic results. We envisage that the next step will be introduction of realistic dynamics on the quantum states involved.

Gautham Sekar and Prabuddha Chakraborty

### **Graph Theory and Algorithms**

We have characterized the class of claw-free  $b$ -perfect graphs in terms of certain forbidden induced subgraphs by completely describing their structure.

T. Karthick and F. Maffray

The Maximum Weight Independent Set (MWIS) problem on graphs with vertex weights asks for a set of pairwise nonadjacent vertices of maximum total weight. The complexity of the MWIS problem for hole-free graphs is unknown. We first proved that the MWIS problem for (hole, dart, gem)-free graphs can be solved in  $O(n^3)$ -time. By using this result, we have proved that the MWIS problem for (hole, dart)-free graphs can be solved in  $O(n^4)$ -time. Though the MWIS problem for (hole, dart, gem)-free graphs is used as a subroutine, we also gave the best known time bound for the solvability of MWIS problem in (hole, dart, gem)-free graphs.

T. Karthick, M. Basavaraju, and L.S. Chandran

## **Physics and Earth Sciences Division**

### ***Geological Studies Unit***

**Tectonics of metabasalt-metagranite association in a Proterozoic schist belt (southern NSB) – petrological and geochemical approach**

Field work was undertaken to identify and map granitic stocks, veins, dykes and felsic tuffs, and nature of their relationship with the host rocks in the four domains of the southern Nellore schist belt (NSB). On the basis of geochemical analysis of metabasalt samples collected from these domains, it has been shown that Kanigiri ophiolitic melange (KOM) are dominantly alkaline belonging to high K-series while those from other domains are subalkaline. The Kandra ophiolite samples are calc-alkalic while the Vinjamuru domain samples are calcic; metabasalts are shown to belong to the tholeiitic field irrespective of the domain. Except the Rapur samples (Udaigiri domain), analyzed samples show an enriched HREE and flat LREE patterns, in chondrite normalized plots. The highest  $\Sigma$ REE abundances are in the KOM samples, in the range 60-385 ppm.

Dilip Saha, A. Sain, P. Mahato and P. Chowdhury

### **Nellore schist belt and Proterozoic tectonics of the southeast margin of India**

Four geochemically distinct tectonostratigraphic domains with deformed and metamorphosed volcanosedimentary successions with evidences of multiple crustal convergences have been identified within the Nellore schist belt. Subduction related ocean closure, and accretion of back-arc material as dismembered ophiolites on to the eastern margin of the Dharwar craton have been documented from the c. 1.9 Ga old Kandra ophiolite complex and the c. 1.33 Ga Kanigiri ophiolitic melange. The Vinjamuru domain with amphibolite-grade metabasalts, hornblende metagabbros, and staurolite-kynaites bearing pelitic schists retain remnants of possible Neoproterozoic greenstones, more common in the interior of Eastern Dharwar craton. However, structures of this domain with late Neoproterozoic pegmatites, have been interpreted in terms of a left lateral tectonic transpression in the contact zone with Eastern Ghats granulites in the Ongole domain.

Dilip Saha, P. Nandi and A. Sain

### **The thermal evolution of Peninsular India: past behaviour and future potential**

Preliminary U-Pb zircon data from charnockite sample collected from the Ongole domain provide mean age of 1643 Ma for cores, and 1638 Ma for metamorphic rims of zircons. This suggests an earlier, almost coeval charnockite emplacement and UHT metamorphism. The new data complement the notion that thermal history of the Ongole domain is different from the northern Eastern Ghats belt where the main UHT metamorphism is dated around 1100 Ma. An integrated analysis of stratigraphy, depositional processes, depositional systems, and provenance of the Cuddapah basin was taken up. Four unconformity bound sequences, deposited under syn-rift to post-rift cycles were identified. Each cycle starts with the deposition of conglomerates and feldspathic sandstones representing syn-rift immature clastic deposits which passes up to highly mature quartz arenite-carbonate succession pointing to post-rift, passive subsidence stage deposition.

Dilip Saha, S. Bhattacharya, S. Patranabis-Deb and D Chatterjee

### **Evolution of carbonate platform through time: examples from PG valley, Chattisgarh and Cuddapah basins**

The Vempalle Formation of the Cuddapah basin developed as a shallow water carbonate platform, pointing towards a balance in sediment input and subsidence of the basin. The distribution, nature and extent of microbial deposits in the platform have been investigated and mapped with emphasis on the occurrence, external morphologies, internal fabrics, of the microbial communities. The platform succession was classified into two major facies associations, representing shallow water mixed carbonate-siliciclastic stage, and a transgressive stage depositing sand-free grey limestone with extensive development of stromatolite. Tepee structure, desiccation cracks filled with lime mud or sand, molar-tooth structure and rhombic halite casts are common in the lower Vempalle Formation. Near absence of coarse siliciclastics and predominance of shale and carbonate in the upper part of the Vempalle succession speak for a passive margin setting. The open oceanic connection is attested by multiple cycles of transgression and regression.

Sarbani Patranabis-Deb, Dilip Saha, T. Mazumder and S. Khan



**Community structure and ecology of the Mesozoic non-marine tetrapods of the Gondwana basins of Peninsular India**

Community structure of the Mesozoic terrestrial vertebrates of the Gondwana basins of Peninsular India and their ecology are the major themes of our on going research project. An account of the diversity of those vertebrates has been prepared and will be published soon. The stratigraphy of the Triassic Denwa Formation of the Sapura Gondwana Basin has been revised. Three distinct members having two different faunal assemblages have been identified. A century old problem on the stratigraphic disposition of the Upper Gondwana succession of the Rewa basin has been resolved on the basis thorough geological mapping. The proposed Upper Gondwana stratigraphy of the Rewa basin comprises a continuous and thick package of Triassic sediments unconformably overlain by the Jurassic Parsora Formation. The Triassic succession consists of a basal Pali Formation followed by a newly designated Karki Formation and the overlying mud-dominant Tiki Formation. On the basis of stratigraphic correlation and fossil content, a Lower-Middle Triassic age has been assigned for the Pali and Karki formations, while the Tiki Formation is Upper Triassic (Carnian) in age. Lithological characteristics, sand body geometry and sand: mud ratios suggest that within a fluvial setting there were considerable changes in environments of deposition through time, especially during Triassic to Jurassic transition. Detailed taphonomic studies of the Denwa vertebrates, especially amphibians, have been carried out. During the later part of 'Denwa Time', that is Middle Triassic, intermittent periods of aridity possibly led towards the 'fish scale beds' and amphibian rich beds that are very prominent in the field. Apart from the field based work, morphometric study of the Late Triassic metoposaurid amphibians has been carried out with special reference to the Indian population.

D.P. Sengupta, S. Bandyopadhyay, S. Sengupta, P. Roy and U. Bachher

**Study of gastropod diversity from the Indian fossil record (Mesozoic-Cenozoic) with special emphasis on phylogenetic systematics, evolutionary trends and palaeoecological interactions**

Intense predatory gastropod drilling (about 30%) on an astertid bivalve from the Oxfordian (Upper Jurassic) Dhosa Oolite Member of Kutch, western India already have been reported by us. The possible drillers in absence of true naticids could not been ascertained. Recently, the unambiguous fossils of naticid gastropods from the same stratigraphic level have been recorded. Coeval turritelline prey species bear characteristic beveled naticid drill holes. Now the predator has been found to co-occur with the drilled prey. Besides, another higher incidence of naticid drilling ( $\approx 25\%$ ) on a Late Cretaceous turritelline lineage have been recently documented which, attained the Cenozoic value. This is the biggest sample size (more than 27,000 specimens) for a lineage-level study which, have been collected from the latest Cretaceous sections in Rajahmundry, India. All these records of high drilling frequency refuted the early claim of low-intensity drilling frequency during the Jurassic to Late Cretaceous.

S.S. Das

**Floodplain facies: A study of litho-facies and geochemistry of the fines-dominated fluvial deposits of the Gondwana successions**

Existing fluvial models, constructed from the observations made on perennial rivers, propose that in a fluvial deposit in-channel coarse-grained units would dominate in volume and thickness over the extra-channel fine-grained units. However, the fluvial Late Triassic Maleri Formation, Pranhita-Godavari Valley Gondwana succession, is overwhelmingly mudstone dominated. The extra-basinal sandstone units constitute only about 25% of the total succession. The dominance of mudrocks apparently suggests a low-energy depositional environment with sluggish streams and numerous ponds/lakes. However, in-depth sedimentologic observations, now, reveal that that these mudstones did not settle in standing water bodies but were deposited by high energy fluvial flows carrying sand-grade mud-aggregates. This mode of deposition indicates that the Maleri rivers could be similar to modern dry-land ephemeral streams. The sedimentology of this formation is presently documented in details for proper characterization of this system. The provenance and geomorphic settings that sustained this

fluvial style are also investigated through the study of the palaeosols and the geochemistry of the sediments.

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

### **A study of Neogene and Quaternary successions of eastern Himalayan foreland basin**

Both Neogene and Quaternary sediments of the eastern Himalayan foreland is focussed in this study. The sedimentology and detrital thermochronology of the Siwalik sediments along Kameng River section (Bhalukpong, Arunachal) has been studied and adds data to the uplift history of Himalaya over last 13 million years. Neodymium and Hafnium isotopic studies along with magneto-stratigraphy of the section reveal, Higher Himalayan terrains fed the foreland drainage system during 13-7 Ma and 3-0 Ma time, while the major drainage that fed the foreland deposits during 7-3 million years ago came from the Tibetan terrain possibly via a paleo-drainage system comparable to Yurlung-Brahamaputra system. In the Quaternary foreland deposits systematic sampling for isotopic analysis and cosmogenic radionuclide dating has been done by our French collaborators during a joint field work. Examination of small alluvial fans in the foreland shows that they probably accumulated broadly during intensified summer monsoon of 34,000 years and were plausibly deeply incised during last glacial maximum during 24,000 to 18,000 years ago. Our optically stimulated dating constrains the last seismogenic movement that affected these sediments in between 11,000-6,000 years.

T. Chakraborty, S. Taral and S. Mallick

### **Ganga River Basin Environment Management Plan**

For the first time the geomorphic features of a large river system such as Ganga River, over its entire stretch from Gomukh to Farakka has been mapped with an aim to assess the geomorphic state of the river, evaluate its minimum flow requirements and suggest major planning endeavours to the Govt. After completion of the geomorphic features of the modern river (based on 2010 post-monsoon data) initiative is now on mapping the geomorphology of the River Ganga in several historical time slices (ranging from 1954 to 2009) based on available satellite images or toposheets and integrating the features in a GIS platform. Initial historical data reveal a dynamic behaviour of the river where it has shifted more than 15 km across the floodplain and has continuously changed the position and type of its bars (the chars). The work is being carried out with a team of environmental scientists and biologist from IIT Kanpur to properly evaluate the species diversity and river fragmentation due to anthropogenic intervention in the river. A new image analysis technique is being attempted in collaboration with the scientists of MIU.

T. Chakraborty, P. Ghosh, S.N. Sarkar and S. Sinha

### **Depositional models and sedimentation history of Proterozoic sedimentary basins of Peninsular India**

Preliminary findings are as follows:

- Basement comprises granite-greenstone terrain with gneisses, Closepet-type granites, pegmatites, banded ironstones, jaspilites, metavolcanics and quartz veins.
- Kaladgi Group displays variable attitude of strata, dipping away from granite-greenstone contact, with fold synclines and anticlines, and strike-parallel faults with stratigraphic repetitions (oblique slip?). The Kaladgi rocks also show low grade metamorphism. Possible two cycles of conglomerate, arenite (coastal margin, with tidal influence), argillite and dolomite.
- Badami and Bhima Group of Rocks are generally flat lying, unconformably overlying granite-greenstone terrain and Kaladgi formations suggesting hiatus in sedimentation with deposition following deformation and erosion of Kaladgi succession. Basal formation of the Badami Group is the Kendur Conglomerate. One cycle of conglomerate, arenite (coastal margin, with tidal influence), argillite and dolomite present in both the successions.

Sarbani Patranabis-Deb

## Research Activities

### **Physicochemical studies on organized assemblies (microemulsions/reverse micelles) of mixed surfactants**

The interfacial composition, thermodynamic properties and structural parameters of mixed surfactant (cationic/on-ionic or anionic/on-ionic or on-ionic/on-ionic) w/o microemulsion systems stabilized in both hydrocarbon and polar lipophilic oils have been studied under different physicochemical conditions [viz. Varied molar ratio of water to surfactant ( $\omega$ ) at a fixed mole fraction of on-ionic surfactant ( $X_{\text{nonionic}}$ ) at 303K and also varied mole fraction of on-ionic surfactant ( $X_{\text{nonionic}}$ ) at different experimental temperatures] by the dilution method. Further, these systems have been characterized by different experimental techniques, e.g., conductivity, viscosity, dynamic light scattering (DLS), Fourier transform infrared spectroscopy (FTIR) measurements in absence and presence of electrolytes. Such studies aim to improve the basic understanding of the formation of w/o microemulsion, composition of mixed interfacial film, complete analysis of thermodynamic of the transfer process of cosurfactant from bulk oil to the interface, transport property, microstructure and states of water organization inside the pool of these systems. Solubilization of water or aqueous NaCl in mixed reverse micellar systems comprising anionic surfactant and on-ionic surfactant(s) at different compositions ( $X_{\text{nonionic}}$ ) [at fixed total surfactant concentration] in polar lipophilic oils of different chemical structures and physical properties and hydrocarbon oils have been studied at 303K. Conductance on-ionic of these systems in absence and presence of additives (electrolyte, bile salts, hydrotrope, and modified acetyl amino acids) has also been investigated either varying water content ( $\omega$ ) at 303K (volume-induced percolation) or varying temperature at fixed composition (temperature-induced percolation). An attempt has been made to give an insight to the mechanism of on-ioniction phenomena, standard free energy change of dissolution of water, percolation in conductance, thermodynamics of droplet clustering and microstructures of these systems by dynamic light scattering (DLS) measurements, wherein the chemical structures of both on-ionic surfactants and polar lipophilic oils played significant role. Both of these studies have been undertaken for synthesis of nanomaterials, enzyme catalysis, drug delivery, organic reactions etc. using these self organized microheterogeneous systems.

B.K. Paul and Kaushik Kundu

### ***Physics and Applied Mathematics Unit***

#### **Physics**

##### **Astro Optics**

The construction of an analytic framework for the study of interstellar dust extinction spectra ( $1000 \text{ \AA}^0 - 22,500 \text{ \AA}^0$ ) has been just completed. This whole program has been worked out under the ISRO project for the duration 2010-2013, in collaboration with Prof. R. Gupta of I.U.C.A.A. and Prof. S.K. Sharma of S.N.B.N.C.B.S. Also Mr. P. Ranadive JRF (for this project) is involved in the work. We now prepare ourselves to develop the necessary computational modalities and algorithms for study of interstellar dust extinction spectra in the most general way which has been our prime goal during the last three years.

A.K. Roy

##### **Bayesian Approach to Data Analysis in Astronomy**

The relation between distance and redshift for quasars has been estimated using Bayesian methodology. This clearly indicates the inadequacy of linearity of Hubble relation at high redshifts. It sheds new light on the debates related to cosmological vs non-cosmological origin of redshift.

S. Roy, Sourabh Bhattacharya (BIRU) and Sabyasachi Bhattacharya (BIRU)

##### **Cosmology**

Models for explaining the expansion history of the universe have been proposed, which take into account early universe (inflation) as well as present universe (dark energy) from different perspectives, namely, scalar field models, modified gravity models, higher dimensional models etc. These models

have further been subjected to observational verification via data analysis using publicly available codes like CAMB, COSMOMC etc. Further, novel techniques for extracting crucial information from latest observations like WMAP, PLANCK, ACT, SPT etc. have been proposed and directly confronted with the latest data available.

Supratik Pal

### **Quantum Control Theory and Quantum Tomography (Reconstruction of Quantum States)**

Stable operation is the fundamental prerequisite for proper functioning of any technological system. The formulation of the quantum mechanical control system under these circumstances is seemed to be great challenge for control theory. The wide perspectives of quantum mechanics are utilized in developing a new Emerging Field-Quantum Control System - a marriage of quantum physics and classical control theory, with applications to various branches of modern control theory. Quantum control theory is an emerging field with application to Modern Technology of Quantum Computer and Quantum Information Processing. In recent years, much attention has been focused in designing and developing quantum control systems in Hilbert space. The problems of generating and controlling quantum bits(qubits) are important in developing high speed quantum computer and communication system. Our present concern is the derivation of optimal control of the quantum mechanical system in some more explicit form and a generalization of the abstract approach in solving the weighted energy problem of the system. Some new models were studied to generate nonclassical state, which have P-representations that do not satisfy the requirement of non-negative definiteness valid for classical states. The studies developed earlier in interacting Fock space were continued. It was found that a two-level atom-interacting field system acquires a space parameter dependent Berry phase, which can be applied to implement the fault-tolerant quantum gate. Quantum state tomography is the process of reconstructing the quantum state for a source of quantum systems by measurement on the systems coming from the source. Some progress in this direction is in the offing.

P.K. Das

### **Mesoscopic Physics and Nanoelectronics**

At the end of the twentieth century, a clear tendency to-towards nanostructured system appears in physical material science. This includes semiconductor structures and magnetic materials, but also intrinsically nanostructured systems like bio-materials and macromolecules. These smaller and smaller structures approach the so-called mesoscopic and nanoscopic regimes in which quantum effects become relevant for the behavior of the materials. In our works, we investigate in detail the electronic transport properties in several mesoscopic systems such as an organic molecule, a cluster of molecules, a single mesoscopic ring, an array of mesoscopic rings, nanotubes, graphene sheets and others. We believe that successful conclusion of these works will constitute an important advance in several fundamental aspects of molecular electronics, and also provide useful tools for planning future molecular based electronics devices.

S.K. Maiti

### **Quantum Information Theory**

It has been shown that quantum optimal violation of Bell's inequality can be reproduced by quantum uncertainty principle along with steering effect. This result has been shown to be reproduced by using Bohr's complementarity principle. This was further generalized to general no-signaling probabilistic theory where it was shown that impossibility of joint measurement is necessarily related to the optimal violation of Bell's inequality.

G. Kar

Quantum discord has emerged as an interesting measure of post entanglement quantum correlations. Among its many variants, the geometric discord is especially useful since it facilitates analytic computations. The geometric discord, along with another measure, namely, measurement-induced non-locality, has been evaluated for most of the well-known bound entangled states. Also it has been

## Research Activities

shown that entanglement (as quantified by squared negativity) is not a lower bound for geometric discord, hereby negating a well-known conjecture.

P. Parashar

## Quantum Mechanics

Dirac equation in (2+1) dimensions in the presence of a magnetic field and a minimal length and possible applications of this system to graphene has been studied. Generalized Dirac oscillator problem has been examined in the context of pseudo Hermitian interaction. The relation between this model and the generalized Jaynes-Cummings as well as the Anti Jaynes-Cummings model has been obtained.

P. Roy

Infinite families of exactly solvable Hermitian as well as non-Hermitian potentials possessing recently discovered Jacobi type  $X_m$  exceptional orthogonal polynomials as bound state solutions, have been found. These infinite families of potentials are extensions of the corresponding conventional potentials by the addition of some rational terms characterized by the presence of classical Jacobi polynomials. The non-Hermitian potentials thus obtained are shown to be quasi-Hermitian in nature ensuring the reality of the associated energy spectra.

B. Roy

Non-Commutative space times compatible with Generalized Uncertainty Principle have been used to formulate new generalized relativistic particle models where both free particle as well as particles interacting with external gauge fields has been considered. In the context of General Theory of Relativity, it has been shown that compatibility with Generalized Uncertainty Principle can lead to Equivalence Principle violation. Further work is in progress in this direction.

S. Ghosh

## Quantum Field Theory

Applications of Quantum Field Theory techniques are being studied in the context of photon pair production where (positive and negative) non-linear Kerr effect can be studied, in a time-dependent refractive index perturbation, induced by a laser pulse. Interesting and novel features may follow if the above formalism is applied in metamaterial – conventional material junction.

B. Basu, S. Ghosh and S.K. Maiti

## Quantum Tunneling for Dissipative System

Quantum tunneling has been studied for dissipative systems. The zeno time has been calculated for such kind of dissipative systems. Its connection with weak measurement theory has been studied.

S. Roy and Samyadeb Bhattacharya

## Theoretical Condensed Matter Physics

In recent times, there is a growing interest in the study of spin current, flow of *spins*, from various perspectives. The spin dependent force and spin current in an accelerated system in the presence of electromagnetic field has been studied. The low energy limit of the Dirac equation has been considered to study the spin current which appears due to the combined action of the external electric field, the crystal field and the induced electric field due to acceleration via the total effective spin-orbit interaction. The renormalization of inertial effects on the spin dependent transport of conduction electrons in a semiconductor have been studied by taking into account the interband mixing on the basis of perturbation theory. The enhancement of the spin current resulting from the renormalized spin orbit coupling effective in our model in cubic and non cubic crystal has been predicted. Additionally, attention has been paid to clarify the importance of gauge fields in the spin transport of the inertial

system. The characteristic feature of the momentum space Berry curvature has been analyzed for time dependent and time independent acceleration.

B. Basu

## **FLUID MECHANICS & APPLIED MATHEMATICS**

### **Synchronization and chaos control in time-delayed system**

The major research interest includes analytical and numerical studies of chaos control and different kind of synchronization in time-delayed systems. Studies of projective synchronization between two continuous time delayed neural systems with time varying delay has been investigated. A sufficient condition for synchronization for coupled systems with modulated delay was presented analytically with the help of Kravoskii-Lyapunov approach. The effects of adaptive scaling factors were also studied in details. The important mechanism of chaos control in time delay systems using threshold control mechanism was done using numerical simulation and experimental observation in electronic circuit. Adding a noisy environment was another realistic approach to investigate dynamical systems' behavior. The effect of white and color noise in complete synchronization in time-delayed systems has been done in details.

D. Ghosh

### **Integral Equation sets**

Solutions of second kind integral equations using Daubechies wavelets, numerical solution of integral equations using quadratic Legendre multi-wavelets homotopy method of solving Abel integral equation was carried out. PDE-constrained optimization via genetic algorithm was also studied.

B.N. Mandal

### **Water Waves**

Cauchy-Poisson problem for a sloping beach, for a two-layer fluid with an inertial surface; waves generated by initial disturbances at the bed of a sloping beach; wave scattering by two thin vertical barriers, wave scattering by a thin vertical elastic barrier, by a semi-infinite clock in the presence of bottom undulations, construction of three-dimensional wave-free potentials were carried out.

B.N. Mandal

## **INTERDISCIPLINARY RESEARCH**

### **Flume Laboratory (FL)**

The obstacle on a sediment bed in the way of unidirectional flow developed a scour mark on the bed. Experimental study had been carried out at the Flume Mechanics Laboratory of ISI to elucidate the turbulence statistics of flow over and within the crescent scour hole induced at the upstream of a static horizontal short cylinder placed transverse to the flow. The Micro-acoustic Doppler Velocimeter (ADV) was used to measure the velocity with fluctuations in an open channel flow at different locations from upstream to downstream across the nearly equilibrium scour mark. This study is significantly important in the context of basic problem to understand the mean velocity, shear stresses, turbulent kinetic energy flux and dynamics of coherent structures across the nearly equilibrium scour marks generated by obstacles, which induce strong turbulent eddies in their neighborhood of the objects. Moreover, this is important to interpret the turbulence and flow structures across the crescentic scour marks available at the ancient sedimentary deposits in the light of modern analog. This observation can be further utilized in turbulence modeling for studying the effects of turbulent events in sediment transport occurring due to the scour hole generated by cylinders or piers. In the context of Analogue Gravity some important theoretical predictions can be experimentally tested in physical fluid system. It is possible, as shown by other researchers, that analogue of Hawking Radiation can be observed in the

## Research Activities

Flume Laboratory. Attempts are being made to conduct similar studies, which require a modification of the structure of the present Flume.

S. Ghosh

## Information Processing in the Brain

The recent experimental observations clearly indicate the super-additive nature of information from multisensory sources. It helps us to consider Fisher measure of information as the more appropriate measure of information instead of Shannon information measure in brain. The cellular basis of cognition, decision-making and computability of brain are under investigation jointly with Prof. Rodolfo Llinas of USA and Prof. Daniel Bennequin of France.

S. Roy

## System and Control Theory

Theory to design non-interacting controller for descriptor variable system has been developed earlier. Algorithm for numerical solution of the problem has been developed. Work is done on the behaviour of kinetic energy spectrum in a stratified homogeneous turbulent shear flow. Matrix second-order systems arise frequently in classical mechanics, robotics, and aerodynamics and in many other places. Work to design observer for matrix second-order system has been done.

S. Gangopadhyay

## Advanced Monte Carlo simulations of interacting quantum fermions in a random environment with different symmetries

Research was carried out and published that concerns the effect of randomness on the localization properties of interacting quantum fermions. Using large-scale and heavily parallelized quantum Monte Carlo simulations it was demonstrated that high-energy (bare) symmetries of the Hamiltonian operator play a very important role in deciding the localization vs. delocalization properties (insulating vs. metallic) of an assembly of quantum particles with fermionic statistics at low-energy (renormalized scales), when the Coulomb repulsion is turned on. A new model, that of spin-resolved disorder, was developed in this regard which has now been experimentally realized in optical lattices of cold atoms over last year.

K. Makuch, J. Skolimowski, Prabuddha Chakraborty (ISI, Chennai), K. Byczuk and D. Vollhardt

## Superconductor-insulator transition in d=2 spatial dimensions

A new mechanism for the superconductor – insulator transition (SIT) in two spatial dimensions was demonstrated using Bogoliubov-de Gennes calculations with disorder. It was demonstrated that the well-accepted mechanism for SIT i.e., that of granular superconductivity is not the only way a SIT can take place in d=2, and the mechanism depends on disorder symmetries. Detailed investigation of the mechanism involved is underway.

Sanjeev Kumar and Prabuddha Chakraborty (ISI, Chennai)

## Strong coupling expansion of interacting electrons in the presence of spin-orbit coupling

A strong coupling expansion of interacting electrons in the presence of spin-coupling coupling was formulated with an eye to the application on the newly discovered topological insulator materials. This is a continuing project.

Krishnendu Sengupta and Prabuddha Chakraborty (ISI, Chennai)

### **Position-dependent cryptography and quantum computing with recipients and senders having simple quantum dynamics**

As opposed to the usual static quantum position-dependent cryptography, a formulation of position-dependent quantum cryptography was made in which the recipient and/or the sender have simple quantum dynamics. We are continuing investigations on the effect of such dynamics on the cryptographic results. We envisage that the next step will be introduction of realistic dynamics on the quantum states involved.

Gautham Sekar (CSU, Chennai) and Prabuddha Chakraborty (ISI, Chennai)

## **Biological Sciences Division**

### ***Agricultural and Ecological Research Unit***

#### **Evaluation of different sources and levels of Phosphorus on field crops in eastern India**

It is known that water-soluble P (WSP) can be converted to water insoluble P after reaction with soil minerals, which can result in a decrease of P availability. Several terminologies, such as P sorption, adsorption, retention, fixation, precipitation, and immobilization, have been used to describe this process. The forms of reaction products depend on P sources and soil minerals. The most common phosphate fertilizers are single superphosphate (0–16–0) and diammonium phosphate (18–46–0). All of these materials are highly water soluble. The ammonium phosphates also are excellent nitrogen sources. Experiments have been conducted to fulfill the following objectives:

1. To evaluate the effect of different levels of water and/or citrate soluble phosphorus on crop productivity and soil health.
2. Effect of different sources of phosphorus and Nitrogen alone and in combination on crop productivity and soil health.
3. To evaluate the residual effect of different sources of nutrients

Two field experiments were conducted in 2012-13 at Agricultural experimental farm, Giridih to identify the effect of sources and levels of Phosphoric fertilizers on rice and baby corn crops. The data is under process.

#### **Management strategies for rice cultivation in the eastern plateau: Field experimental and crop modeling approaches**

In another interdisciplinary study, biophysical and socio-economic parameters are considered to formulate a suitable rice management strategy at micro-level. The potential of climate as an important resource in agricultural has not been used or even realized by the scientific community even though it has sometimes been observed that farmers have their own perceptions. As a result, several crops are grown traditionally without considering the suitability of the climate leading to poor yield and thus much of the production potential of this vast resource is left unutilized. Here we will try to develop suitable rice options like varieties, sowing windows, input level etc. at micro level (for upland, medium land and lowland) on the basis of our model. Based on initial rainfall or its weighted counterpart along with other significant covariates we have to identify the toposequence specific crop varieties so that the yield is maximized. Note that proper attention has to be given on farmers' perception as categorical response at the time of model construction.

#### **Development of information on Agricultural and Horticultural production using RS and GIS technology in some district of West Bengal**



## Research Activities

Marketing is the major problem in Agriculture. Attempt has been made to identify the problem and prospect of different Hats and Markets (rural) using survey methodology. Four districts namely Coochbehar, Murshidabad, Purulia and 24 Parganas of West Bengal have been selected for the study. Here we are trying to integrate the spatial data (road network, 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.

Well-organised market that plays a key role to maintain or to accelerate the growth rate of agricultural sector is an immediate necessity. The accessibility of the local markets to the farmer is also an important criterion that will facilitate the marketing of the agricultural and horticultural produces even where storage facilities are not available.

The local haats of West Bengal face a grave crisis of all weather motorable roads. The roads accessing the haats are mostly unmetalled. In most cases the nearest metalled road is sometimes 1 km to even 10 km far from the haat. As a result the accessibility to this haat using the unmetalled roads is tough. Only a small number of villages are joined by railways and pucca roads to haats. Moreover these roads suffer from immense drainage issues during the monsoons often rendering them useless by vehicles. Hence the transport means too are inadequate due to such impediments and these in cumulative manner affect the business of the haat. Basic facilities like drinking water, toilets and electricity are lacking in this market. There is an absence of proper and scientific warehousing facilities in the villages. The unscientific methods of storing lead to considerable wastage. As and when the prices of agricultural produces are controlled by the middlemen, in most cases, the farmers are forced to either sell at a very low rate or often even leave behind their produces on not getting a good rate, as carrying them back would not be economically feasible for them.

On successful completion of the project the digital database will be useful at the national/state/district level as also to the local planners on one hand and to the users at the individual level on the other to take meaningful decisions to extend other related works. The same digital information system may be developed for the whole of West Bengal and it can be a baseline data for e-marketing or geo-marketing.

P. Banik, S. Bhattacharya, I. Mukhopadhyay and J. Chattopadhyay

## **Site Specific Nutrient Management (SSNM) System for submerged rice in the eastern plateau region of India**

The projected food grain demand has been estimated to about 300 Mt by the year 2025. This target of food grain production could be reached only through yield enhancement by proper crop, soil and nutrient management as there is no opportunity to increase the area under cultivation. Many researchers reported that though food grain production doubled during the period 1969-2011 (from 98Mt to a record of 212 Mt in 2001-02) fertilizer requirement to meet this up was increased by about 12 times (from 1.95 Mt to 23 Mt in the year 2007-08). Hence it has presently become essential to be much more judicious about fertilizer use. Taking into account the existence of large variability in the soil nutrient supplying capacity and crop response to these even within a field, the approach of applying a fixed rate of fertilizer over a large area for a particular crop is now discouraged. Rather it is now recommended that fertilizer recommendations should be 'need based' depending on the soil nutrient supplying capacity for a particular crop at a particular location. This gave rise to the concept of Site Specific Nutrient Management (SSNM) System approach for rice, developed in Asia in the mid 1990s. This approach aims to supply nutrient at optimal rate and time to enhance rice yield and the efficiency of nutrient use by rice. With this background the present study is being carried out to increase rice productivity in the submerged acid lateritic soil of the eastern plateau through site-specific nutrient management. Recommendation for field specific fertilizer rate will be made for submerged rice after taking into account the indigenous soil nutrient supplies, plant nutrient demand and interaction among nitrogen, phosphorus and potassium and also maintaining proper balance of nutrient in the soil even after crop removal.

P.K. Ghosal

### **Allelopathy in an Aquatic and neighbouring Ecosystem and the role of allelochemicals in community structure**

Allelopathy plays an important role in microalgae assemblages, community structure and the dynamics of the populations within the aquatic ecosystems. The objectives of our present project is detection, identification and characterization of allelopathically active compounds causing species invasiveness in aquatic and neighbouring ecosystem in relevance to contour the community structure. In aquatic ecosystem, allelopathic activities have been studied in *Vallisneria spiralis*, *Lemna minor*, *Enhydra fluctuans* etc. Three different types of allelochemicals have been isolated and purified from the root exudates of *Vallisneria spiralis* which have been subjected to MS, IR, <sup>1</sup>HNMR and <sup>13</sup>CNMR analyses for molecular characterization of the compounds. Root exudates of *Vallisneria spiralis* inhibited the growth of *Lemna minor* by 27-33%. In neighbouring ecosystem, studies are being carried out on *Eclipta alba*, *Cyper rotundus*, *Piperomia pellucida* etc. The aquatic and neighbouring plants of various growth forms differ greatly among themselves in their responses and adaptations to allelopathy.

S. Mandal Biswas and N. Chakraborty

### **A study on yield performance for different annual crops for the production of bio-fuel**

A pilot project was initiated (A study on yield performance Sweet sorghum [*Sorghum bicolor* (L.) Moench] at Sub-Divisional Agricultural Research Farm (SARF) Govt. of West Bengal, located at Basirhat, North 24-Pgs and SARF located at Bolpur, Birbhum. For sweet sorghum variety Madhura were used. Seeds were given by NARI (Nimbkar Agricultural Research Institute) Maharashtra. In rainy season sweet sorghum was sown in the month of July at both the places with different fertilizer doses. N:P:K doses were Nitroge (N) 4 levels (30, 60, 90 and 120 Kg/ha), P (Phosphorous) single level of 60 Kg/ha and K (Potassium) 3 levels (40, 80 and 120 Kg/ha) were applied with RBD (Randomised Block Design) with three replication. Data were collected every 20 days interval starting from 30 Days after Sowing (DAS). 1st(30 DAS) 2nd(50 DAS) 3rd(70 DAS) 4th(90 DAS) and 5th (130 DAS). Different yield data of sweet sorghum shows that the performance of variety Madhura was quite encouraging at each period in general and at harvest in particular. The highest dose of N4P1K3 gives the highest yield green biomass yield of 72.47 t/ha, grain yield of 1.45 t/ha at 130 DAS. To make sweet sorghum a sustainable and profitable crop, there is a need for standardization of agronomic practices, apart from breeding high-yielding cultivars, which can contribute to increased yields resulting in higher returns to farmers.

S. Barik, S. Chanda, D. Ray (CSSC), G.M. Basak (BIRU) and P. Bhattacharya

## **ECOLOGY**

### **Detection, mapping and phenoplasticity of *Alternanthera philoxeroides*: an invasive weed**

The potential of *Alternanthera philoxeroides*, alligator weed to adapt to diverse conditions present in pond ecosystems was studied through a correlative investigation of its natural growth pattern and peroxidase level. Eleven ponds were graded into two subjective categories: "A. philoxeroides Infestation" (High, Medium, Low) and "Level of Pollution" (High and Low), to test for difference in mean peroxidase concentration in *A. philoxeroides* populations. Significant changes in mean peroxidase concentration in *A. philoxeroides* were found in ponds categorized on the basis of level of pollution, indicating the adaptability of this plant to propagate under pollution stress. No significant change in mean peroxidase concentration for plants growing in ponds categorized on the basis of infestation showed that dense, vegetative proliferation caused no stress in *A. philoxeroides*. An efficient method of assaying peroxidase in *A. philoxeroides*, under field conditions, using the best suited leaf group (Tips, Tips + 1st leaf pair", 2nd leaf pair) was also explored. "Tips + 1st leaf pair" proved to be a better sample than mature leaves for estimation of peroxidase concentration in *A. philoxeroides*.

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

### **Antioxidant scavenging and corresponding gene regulation in some mangroves of Sundarbans**

Working with an intra-mural project entitled “Antioxidant scavenging and corresponding gene regulation in some mangroves of Sundarbans”, commenced on April 2011. Generation of Reactive oxygen species (ROS) such as superoxide, hydroxyl and peroxy radicals are inevitable under oxidative stress as does the level of ROS-induced oxidative damage to lipids, proteins, and nucleic acids. Current strategies for improving salt tolerance rely primarily on the production of low-molecular weight solutes e.g. Flavonoids and polyphenols and radical-scavenging enzyme systems in order to defend alteration in the cytosolic osmotic potential. In the previous project, polymorphic characteristics of two antioxidant (PRX and SOD) and two hydrolyzing (ACP and EST) enzymes in relation to substrate salinity were established. Present work will point out towards the up regulation of the corresponding gene in relation to salinity gradient.

S. Das and N. Dasgupta

### **ETHNO-BOTANY**

#### **An investigation on antimicrobial potential of Chebulic myrobalan (fruit of *Terminalia chebula* Retz.) against methicillin-resistant *Staphylococcus aureus***

*Terminalia chebula* is a medicinal plant, called the ‘King of Medicine’ in Tibet and is always listed at the top of the list of ‘Ayurvedic Materia Medica’ because of its extraordinary power of healing. Effects of different solvent extracts of *T. chebula* fruits against methicillin resistant *Staphylococcus aureus* has been studied in our laboratory. It was observed that all the test extracts showed dose-dependent antibacterial activity against the studied bacteria. Acetone extract was found to be most effective over others. Phytochemical analysis revealed that the most active acetone extract contains high concentration of phenolics along with low to moderate concentrations of other phytoconstituents. High content of phenolics in *T. chebula* fruit extract implied that phenolics may be responsible for this antibacterial activity. Kill-kinetics study showed that acetone extract exhibited both dose and time-dependent antibacterial activity against the test isolates. In combination study, acetone extract did not show any synergistic activity with conventional antibiotics tested. These promising findings reinforce the importance of ethnomedical approach with *T. chebula* fruit as a potential source of bioactive compounds and may lead to the development of antimicrobial agents from this plant material for the treatment of infectious diseases caused by methicillin-resistant *Staphylococcus aureus*.

R.R. Chattopadhyay, S.K. Bhattacharyy and A. Bag

### **NANOBIOTECHNOLOGY**

#### **Nanobiotechnology: From basics to application in different sectors of agriculture veterinary sciences and medicine**

Nanoparticles exhibit novel properties from their bulk counterparts. Students (PhD, BStat, MStat) and researchers of ISI have utilized unique properties of matter at the nanoscale and developed novel antivirals, photosynthetic-enhancers, nutrient and micronutrient fertilizers, homologous genetic recombination tools, nanofungicides, nano bacteriocides, drug delivery and imaging agents etc. Details studies on the mechanism of action of the novel nanomaterials and biosafety of the particles in different model systems using novel molecular, statistical and computational tools have been done. A nanoscience SOP protocols handbook for ICAR has been prepared by ISI, which is currently being evaluated by ICAR as national guideline red-book. ISI scientists are currently developing a nanotool based sucrose sensor for utilization in the agriculture, veterinary and human health sector. World Bank, ICAR and DBT has supported the work extensively. ISI intramural grants were used to generate baseline data, which helped to win big grants from external funding agencies.

A. Goswami, N. Debnath, S.Mitra, S. Pradhan, S. Das, S. Roy Chowdhury,  
P. Patra, A. Bhattacharya, P. Chakraborty, A. Basu, T. Datta Majumder,  
S. Akbar, M. Thapa, S. Roy, S. Chandra and I. Roy

## **MATHEMATICAL/STATISTICAL MODELLING**

### **Eco-epidemiological System with Allee effects**

In recent decades, significant researches have been carried out on the Allee effect that corresponds to the positive correlation between population size/density and per capita growth rate (henceforth, pgr) at low density. It generally happens when certain components of individual fitness (e.g. litter size, juvenile survival, adult mortality, etc.) is reduced when population size decreases.

In prey-predator systems; epidemic transmission can strongly affect the prey dynamics, therefore, the prey may suffer from positive density-dependence. For example, the combined impact of disease and the Allee effect are observed in African wild dog *Lycaon pictus* and island fox *Urocyon littoralis*. In case of strong Allee effects, there is a critical population size below which, the prey goes to extinction and eventually the predator dies out. Recently, researchers are showing interest to identify the association between the Allee effect and parasitism in prey-predator systems.

We propose a general prey-predator model with disease in prey and predator subject to the weak Allee effects. We make the following assumptions: (i) infected prey competes for resources but does not contribute to reproduction; and (ii) in comparison to the consumption of the susceptible prey, consumption of infected prey would contribute less or negative to the growth of predator. Based on the assumptions, we provide basic dynamic properties for the full model and corresponding submodels with and without the Allee effects. By comparing the disease free submodel (susceptible prey-predator model) with and without the Allee effects, we conclude that the Allee effects can create or destroy the interior attractors. This enables us to obtain the complete dynamics of the full model and conclude that the model has only one attractor (only susceptible prey survives or susceptible-infected coexist), or two attractors (bi-stability with only susceptible prey and susceptible prey-predator coexist or susceptible prey-infected prey coexists and susceptible prey-predator coexist). This model does not support the coexistence of susceptible-infected-predator, which is caused by the assumption that infected population contributes less or harmful to the growth of predator in comparison to the consumption of susceptible prey.

J. Chattopadhyay, S. Bhattacharya, S.K. Sasmal, A.R. Bhowmick

### **Cooperative Recovery Mechanism: A Safeguard for Minimizing Extinction Risk**

Density dependent population growth curve seems to be concave in most animal populations, and follows the theta-logistic equation. We introduce a cooperation parameter  $\gamma$  in the generalized theta-logistic equation to model non-monotonic trends in per capita growth rate. The stability analysis of the model suggests that it can provide a potential safeguard against extinction risk and can play a significant role in conservation. To explore this phenomenon further, we investigated 715 time series of Global Population Dynamics Database and identified 28 cases, where, per capita growth rate is small at low densities.

We demonstrate that incorporating intra-species cooperation as an allometric trait into the logistic improves description of the population growth. This emphasizes on the interplay of two opposing factors, viz., cooperation and competition. The cooperation parameter may help better explain the extinction risk of a species and equip us with a good species conservation management tool. If the estimated  $\gamma$  exceeds an appropriate critical threshold, it may be a signature of the risk of extinction. The bifurcation diagram with respect to  $\gamma$  can be useful to choose the threshold. This allows us to quantify the presence of cooperation in a species from census data. Identifying such extinction patterns in the species from demographic history may have significant impact on the preservation and management of biological populations.

For describing above growth processes we need a metric for growth rate to identify the true underlying model. The most frequently used metric, "Average Relative Growth Rate" is invariant under the choice

## Research Activities

of underlying growth model. Theoretically, the estimated rate parameter and relative growth rate remain constant for all mutually exclusive and exhaustive time intervals if the underlying law is exponential, but not for other common growth laws (e.g. Logistic, Gompertz, Power, General Logistic). We propose a new growth metric specific to particular growth law and is shown to be capable of identifying the underlying growth model. The metric remains constant over different time intervals if the underlying law is true, while the extent of its variation reflects the departure of the assumed model from the true one. We propose a new estimator of relative growth rate which is more sensitive to the true underlying model than the existing one. The advantage of using this is that it can detect crucial intervals where the growth process is erratic and unusual. It may help the experimental scientists to study more closely the effect of parameters responsible for growth of organism/population under study.

S. Bhattacharya, J. Chattopadhyay, A.R. Bhowmick, B. Saha and J. Pal

## ***Biological Anthropology Unit***

### **Human Genomic Diversity**

a) Genetic affinity of Tibeto-Burman populations and their genetic relationship with Austro-Asiatic, Dravidian tribes of India and with other East-Asian populations has been investigated. b) Social Stratification versus Genetic diversity among religious groups in India. Similar to the caste populations, other religious groups also show social stratification akin to caste hierarchy. The genetic validation with respect to set of autosomal and X and Y chromosomal markers among these populations.

### **Genetic Epidemiology of malaria in Northeastern regional populations**

Northeastern populations show variation in the prevalence of malaria in different parts. Some regional populations also show more frequent recurrence whereas some others show resistance to malarial infection. In view of the wide genetic diversity among these populations (E.g., HbE frequency varies from 5% to high of 50-60% in some of these populations), the variable prevalence of the disease could be due to some of the candidate genes, e.g., Hb, PKLR, TNF etc. that show variable expression among these populations. These are being investigated in northeastern populations.

### **Selection at mtDNA protein coding genes**

a) The protein coding genes of the mtDNA is expected to have been under intensive evolutionary influence as a result of out of Africa migration and lineage specific demographic expansion in different parts of the globe since around 60 thousand years ago. The signature of the type of selection that has been operating in different populations in case of the protein coding genes have been investigated by bioinformatic tools. The results suggest differential operation of selective forces for the protein coding genes that vary across the haplogroup distribution of Indian populations. b) mtDNA data base on disease and its prevalence among populations.

### **Bioinformatics: MicroRNA**

Patterns and distribution of miRNA in human genome. Since the time the role of miRNA in gene expression and its implications in some of the diseases, there has been interest to understand the nature and distribution and pattern of these miRNAs. Investigations on the location, length, its relation to the target genes, types or classification based on their structure and function indicates that the location of the miRNA is appear to be not related its length or sequence similarity.

T.S. Vasulu

### **Weight related behaviours among urban adolescent girls: an exploratory study**

It is not known how common eating disorders are among adolescent girls of Indian subcontinent. Rising trend of being thin are found to raise their concerns over body image and eating practices.

Unconventional eating habits may affect their health. Data on socio demographic characteristics, perception of body image, eating attitude test (using EAT questionnaire), mental health measures like Beck's Depression Scale, Rosenberg Self Esteem Scale and nutritional knowledge were collected from a total of 1850 adolescent girls aged 14-19 years from 15 schools of twin cities of Kolkata and Howrah. Most of girls of all age groups perceived themselves as overweight and fat and expressed their dissatisfaction regarding fat shape. Results of Eating Attitude Test (EAT 26) showed that 41% of girls were engaged in disordered eating behaviours. Girls (78.5%) mostly had poor nutritional knowledge. They (68.7%) consumed high caloric foods more than starchy foods, vegetables and fruits. Some of them (37.9%) often were remained on skipping meals and starvation diet. Mental health scales revealed that 40% of girls were in severe depression along with lower self esteem.

S. Mukhopadhyay

### **Health of the Stone Quarry Workers of Birbhum district, West Bengal**

Stone quarrying and crushing is potentially a hazardous job, nature of the job, working condition and the environment has severe health impact on the quarry workers. The quarry workers are continuously exposed to stone dusts and noise generated during different modes of operation. Besides, the prevalence of sexually transmitted disease is high among the quarry workers. In general, the quarry workers suffer from respiratory, cardiac, hearing and vision impairment etc. The aim of the project is to (1) see the health status of the stone quarry workers and (2) to investigate the health hazards linked with the stone quarry work. In the present study, four groups of stone quarry workers have been selected – (1) Working in the quarries and residing within the quarry area (2) Not working in the quarries but residing within the quarry area (3) Working in the quarries but residing far away from quarries and (4) Working and residing far away from the quarries. Data have been collected on demography including fertility and mortality, socio-economic pursuits and morbidity from 1381 individuals covered 272 households belonging to first three groups of worker as mentioned above.

Subrata K. Roy

## ***Human Genetics Unit***

### **Genomic and Epidemiological 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.

#### **Genomic Studies on oral cancer**

(a) Genomewide expression profiling of 762 miRNAs in 18 pairs of gingivobuccal cancer-adjacent control tissues (ACT) yielded 531 miRNA's successful assays. Expressions data of these miRNAs were analyzed by stringent statistical procedure with the criterion of more than 4 fold deregulation of expression compare to adjacent control. After analysis, expression of seven miRNAs was found to be significantly altered in cancer tissues. Out of these 7 miRNAs, four miRNAs viz. miR-1293, miR-31, miR-31\* and miR-7 are the ones up-regulated in cancer tissues. Remaining three tumor suppressive miRNAs, including miR-206, miR-204 and miR-133a, were significantly down-regulated in the cancer tissues. For the first ever time we are reporting involvement of miR-204 (downregulated) and miR-1293 (upregulated) in oral cancer. Pathway analysis and "Go Term" enrichment analysis was performed to predict the relevant pathways collectively targeted by these 7 significantly deregulated miRNAs. Several biological pathways that are well characterized in cancer are significantly targeted by these seven miRNAs. These pathways include MAPK pathways, PI3-AKT pathways etc. These results indicate that deregulated miRNAs coordinately regulate several oncogenic pathways in Oral Cancer. Cluster analysis has revealed existence of two clusters of samples in this set of 18 samples. Application of similar statistical test had shown expression deregulation of 30 miRNAs in a cluster of 13 samples. These 30 miRNAs includes all 7 miRs which were identified by analysis of all samples

## Research Activities

without clustering. In the remaining set of 5 samples, expression of one miRNA was observed to be significantly deregulated. So, this miRNA which is involved in these 5 tumor samples for carcinogenesis may target different node/s in different cancer pathways. Thus, these 5 tumor samples are different from remaining 13 samples in terms of involvement of miRNAs in cancer pathways.

B. Roy

## **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, genotype-environment interactions and human evolution.

### **Statistical Methods for Analysis of Complex Traits**

The focus of these studies is to critically analyze existing statistical methodologies and to develop new methodologies for human genetics, especially for gene-mapping, genotype-environment interactions and human evolution. Some novel statistical methods have been developed for association analyses of complex genetic traits. These include:

- (a) A Binomial regression model for simultaneous association mapping of multivariate phenotypes, possibly comprising both quantitative and binary traits.
- (b) Exploring different weighting schemes of combining SNPs associated with a phenotype to estimate the risk or variation in the phenotype explained by the SNPs.
- (c) A novel association method for quantitative traits based on a trio design using transmission information from both parents.
- (d) A simulation-based comparison of population-based association methods and family-based transmission disequilibrium tests for quantitative traits
- (e) A clustering approach for mapping rare variants.
- (f) Kernel based association method based on genotype similarity and phenotype similarity for quantitative trait.
- (g) A multi-locus approach to combine common variants and rare variants to test for genetic association study.
- (h) Modify multifactor dimensionality reduction method to find gene-gene interaction on innate immune genes in controlling Plasmodium falciparum blood infection level.
- (i) Asymptotic distributions of KBAT and QT-KBAT statistics under certain regularity condition.

Association analyses were performed on real data pertaining to:

- (a) GWAS on Type 2 diabetes and correlated quantitative phenotypes.
- (b) Sex-specific genetic factors controlling on major psychoses
- (c) Quantitative precursors of coronary artery disease, such as homocysteine levels and Vitamin B12 levels.
- (d) Blood pressure levels in a longitudinal framework provided in Genetic Analysis Workshop 18.

S. Ghosh and I. Mukhopadhyay

## **Social Sciences Division**

### ***Economic Research Unit***

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:

Measurements of human well being; Poverty and time; Multidimensional poverty, Poverty through calorie intake; inequality; stochastic dominance; Inequality in educational opportunity; Gender inequality; Empowerment of Women; Regional disparity; Temporal trend in anaemia; Health statistics; Child labours; Temporal comparisons of prices, expenditures and growth; Rural-urban food price differentials; Foreign direct investment; Globalization and automatic stabilizers; Pitfalls of monetary policies in India; Privatization, under-pricing and welfare; Efficient access pricing; Pareto efficiency in exchange economies; Bipartite graphs and Shapley value; Subgroup additivity, egalitarian equivalence, reordering in queuing problem; Econophysics of income and wealth distribution; New-Keynesian multiplier without labour/leisure choice; Tariffs, technology licensing and consumer welfare; Preferences, pricing and inequality; Asymmetry in mean and variance; Volatility, Stability, Friedman-Ball hypothesis for inflation, Prediction in autoregressive process; Forecasting, Estimation of Multicollinearity under different loss functions.

With the objective to cater to the need of the government for policy-making for socio-economic development, the focus now is to continue and upgrade research on the following themes: Measurements of Poverty including multidimensional poverty, Poverty Eradication Programmes in India, Growth and Nutritional Status of Children, Gender Bias, Empowerment of Women, Problems of Child Workers and related topics.

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

**Analysis of Top Incomes**

Arup Bose (SMU), Satya R. Chakravarty and Conchita D'Ambrosio

**Financial Inclusion**

Satya R. Chakravarty and Rupayan Pal

**Material Deprivation**

Walter Bossert, Lidia Ceriani, Satya R. Chakravarty and Conchita D' Ambrosio

**Poverty Reduction Failure**

Satya R. Chakravarty and Conchita D'Ambrosio

**Vulnerability and Multi-dimensional Well-being**

Satya R. Chakravarty and Nachiketa Chattopadhyay (SOSU)

**Understanding FDI in Retail: What Can Economic Principles Teach US?**

The recent debate on the acceptability of FDI in the retail sector in India has been mostly political. It is therefore necessary to look into the pros and cons of FDI in retail from a purely economic point of view. After considering the economic arguments for and against multi brand retail we identify the safeguards that should be undertaken before allowing giant multinationals to function in the country.

Abhirup Sarkar

**The Economic Consequences of Opening up FDI in the Retail Sector for Less Developed Country like India**

Abhirup Sarkar

**On Educational Expenditure of Different Groups**

It is found that controlling for a number of factors like income, distance to school etc. the scheduled castes are spending significantly less than the general classes.



**On the Political Economy of a Less Developed Country**

Abhirup Sarkar

**On Panchayat Election and Economic Performance in West Bengal**

Abhirup Sarkar and Chiranjib Neogi

**New-Keynesian Multiplier without Labour/ Leisure Choice**

A Bond financed multiplier process is proposed in a New-Keynesian framework without labour/ leisure choice. The expansion comes through increased profit opportunity inviting entry of new firms and with love for variety in utility function this raises the real wage. The labour market is modelled in Shapiro-Stiglitz fashion. Rise in real wage thus relaxes the 'no Shirking condition', increasing employment and thus output.

Brati Sankar Chakrabarti

**Can Mother's Education and Family Welfare Reduce Under-nutrition of Pre-school Children in India?**

This study examines the growth and nutritional status of 0-59 month old children in India and also tries to delineate the responsible socio-economic factors behind nutrition. The study is based on the third National Family Health Survey (NFHS-3). Analysis of possible regional and socio-economic factors thought to influence child nutrition outcomes does not reveal any substantive causal relations except for the mother's educational status and household welfare.

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

**Anthropological Demography and its Historical Development in India**

Anthropology and Demography both share a common research object, namely human population. Anthropological Demography usually aspires for obtaining information on population level for demographic research. In the reproduction-demography domain the effect of altitude on fertility in the Himalayan region is greater than in other high altitude regions of the world, particularly Andes, Ethiopia, and Tien Shan Pamir, while the mortality pattern is greater in Andean region than in the Himalayan region. The advent of molecular biology has opened a new era to the anthropologists to study the Indian population at molecular level. From a study on genetic selection and haemoglobin heterozygotes it is postulated that heterozygotes will eventually suffer from a selective disadvantage in a place like Kolkata, where malaria was eradicated long back. Recent years have witnessed the increasing shift in research areas of the Anthropologists from traditional evolutionary problems to more on genomic demography.

Dipak Kumar Adak, Manoranjan Pal and Premananda Bharati (BAU)

**Temporal Trend of Anaemia among Reproductive-Aged Women in India Asia-Pacific Journal of Public Health**

The main objective of the study is to determine the temporal trend of anaemia among reproductive-aged women of age 15-49 years. Anaemia 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 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 anaemia have increased over time except in the case of Buddhists, Parsees, Jains, and the STs. Illiteracy and low standard of living may be the main causes of anaemia among women in India. It is also necessary to take appropriate steps to curb anaemia in women in their early adulthood.

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

### **Variation in Height and BMI of Adult Indians**

The objective of this study was to assess the effect of socioeconomic variables on the heights and weights of different groups of people, formed according to different levels of heights and weights, and to see whether there are sex differences in the variations in heights and weights. Data for adults aged 15–49 years were taken from the India National Family Health Survey-3 and descriptive studies and multiple linear regression analyses carried out. A clear positive association was found for height and BMI with economic level (except for overweight females in the case of BMI). In the case of BMI, it is age that seems to be the most influential factor. Surprisingly, the observed changes in height and BMI are not as expected for short and tall or underweight and overweight people; these sometimes behave in the opposite directions to that of normal height and weight people. The basic assumption of multivariate normality is not valid due to changing relations at different height and BMI levels.

Suparna Som (SRU), Stanley Ulijaszek, Manoranjan Pal, Susmita Bharati (SRU) and Premanand Bharati (BAU)

### **A Historical Perspective of Poverty Eradication Programmes in India**

This study critically reviews the effectiveness of programmes like the National Rural Employment Programme (NREP), Rural Landless Employment Guarantee Programmes (RLEGP), Jawahar Rozgar Yojana (JRY), Jawahar Gram Samridhi Yojana (JGSY), Integrated Rural Development Programme (IRDP), Swarnjayanti Gram Swarozgar Yojana (SGSY), Employment Assurance Scheme (EAS) and National Rural Employment Guarantee Scheme (NREGS). The studies so far made on these programmes show that the rural infrastructures have been improved substantially, but these programmes failed to improve the poverty situation. The main reason is that the most of the programmes have transient effect on the eradication of poverty. Either these programmes should be continued indefinitely or should be replaced by programmes which have sustained effect on the amelioration of poverty situation in India.

Manoranjan Pal, Bhola Nath Ghosh (SRU) and Premananda Bharati (BAU)

### **Empowerment of Women in India: A Brief Review on Actions Taken and Goals Achieved**

The Goal 3 of Millennium Development Goals (MDGs) is to promote gender equality and empower women. To ensure the rights and social life of women, government has formed the National Commission for Women in 1990 and provided reservation of seats in local bodies of *Panchayats* by the 73<sup>rd</sup> and 74<sup>th</sup> amendments (1992-3) to the Constitution of India. In recent years there were many agenda of women's consciousness-raising and empowerment. The Ninth Five-year plan (1997-2002) identified the empowerment of women as a key strategy for development. A parliamentary committee on empowerment of women was established in 1997, and the Prime Minister's Office had directed a review be made of the impact of gender mainstreaming in ministries and departments. In spite of all these efforts, the progress is not very satisfactory. This study reviews some important methodological points about the measurement of empowerment and some studies which were made on women's empowerment. It also discusses the role of Government towards promoting the empowerment of women and the historical facts revealing the situation of women over the past few decades.

Bhola Nath Ghosh (SRU), Premananda Bharati (BAU) and Manoranjan Pal

### **Extent and dimensions of gender bias in India**

This paper discusses different dimensions of gender bias, elaborates how one can measure these dimensions and actions taken by Government of India in order to reduce gender bias. In doing so, the concept of gender discrimination is also brought into the picture. To reduce gender differences among children the consensus is that mothers should be literate, made aware of necessity of health care and sanitation facilities to children and the parents should be made capable so that they can afford these facilities.

Premananda Bharati (BAU), Manoranjan Pal and Bhola Nath Ghosh (SRU)

### **Tariffs, Technology Licensing and Consumer's Welfare**

In a control of duopoly with one foreign firm and one domestic firm we show that a tariff on foreign products can be an effective instrument to influence the licensing strategy of the foreign firm. Under free trade technology transfer occurs with a royalty contract, but a suitably designed tariff rate can induce the foreign firm transfer its superior technology to the domestic firm under the fee contract where consumers' welfare is maximized and social welfare is larger. Such a policy appears to be catchy from the viewpoint of a political party in power.

Tarun Kabiraj

### **On the Choice of Target Firm in International Acquisition**

This paper discusses the choice of an MNC's entry strategy between greenfield investment and acquiring a host firm when there are multiple and heterogeneous targets under acquisition. We focus on the *process of selection* of the target firm. We construct three games. In a sequential offer game whom to offer first is endogenized. In the bidding game the potential targets simultaneously bid for merger and the highest bidder wins the race. And under repeated offer game there is always the possibility of a new offer by the MNC if the earlier offer is rejected. In the analysis the externality effect of merger under Cournot competition is internalised. Our results show that acquiring the low-productive firm is optimal under acquisition. This clearly contrasts with the results of the other papers discussed in the literature. When the multinational firm chooses to set up a subsidiary, it does so because the reservation payoff of the inefficient firm is not favourable for acquisition as compared to the low level of fixed set up cost. The divergence of technological efficiency also plays a crucial role in the choice between greenfield investment and acquisition. In our paper, foreign firm entry, either in the form of merger or in the form of subsidiary, is always welfare enhancing for the host country.

Tarun Kabiraj and Uday Bhanu Sinha

### **Temporal Comparisons of Prices, Expenditure and Growth in India: A State-wise Analysis**

This study compares alternative preference consistent methods for calculating price indices. It does so in the context of India paying special attention to the heterogeneity in preferences and price movements among the constituent states. The use of demand systems based methods allows the incorporation of price induced substitution effects between items. The present study allows such substitution effects to vary across states. It examines the ranks of the Indian states in terms of real expenditure and its growth under alternative temporal price scenario during the period 1999-2000 to 2009-2010. It also compares the growth rates both between the nominal and temporal price deflated figures and also between the price deflated growth rates under alternative forms of temporal and preference consistent price indices. The results have methodological and empirical implications that extend much beyond India.

Amita Majumder, Ranjan Ray and Kompal Sinha

### **Preferences, Prices and Inequalities**

This study examines the distributive consequences of inflation in India via the change in relative prices that affects household groups differently owing to differences in their preferences, demographic and economic circumstances. Using the recently proposed 'Exact Affine Stone Index' (EASI) demand system of Lewbel and Pendakur (2008), it focuses on spatial (state wise) price differences and provides evidence on differences in prices of individual items that translate into large differences in state wise spatial price indices. It also records large spatial differences in the temporal movement in the price indices. The price indices are "exact" and this approach allows the incorporation of price induced substitution effects between items. The price information is used to provide evidence on (i) the redistributive effects of inflation by comparing the nominal and real expenditure inequalities by state and in each time-period and (ii) the movement in expenditure inequality both between states and over time.

Manisha Chakrabarty, Amita Majumder and Ranjan Ray

**Measuring Human Well-being**

National Governments, International agencies, Non-government Organizations require reliable concepts and measures of well-being in order to monitor human progress as well as to design effective development strategies for a nation or a group or a society. In consequence, considerable effort has been made to measure well-being at the international, national as well as individual level. Many different notions of well-being have emerged in the literature. In general, 'well-being' is a concept or abstraction that refers to the state of a person's life. It reflects the various activities or achievements that constitute a good form of life. In recent decades there has been widespread agreement that well-being is a multidimensional concept that embraces many aspects of human life. The present study is another such approach. It takes into account economic, social as well as environmental aspects of well-being and formulates a composite index. The value of this index estimated for different countries at a point of time and for a country over a period of time enables one to measure the relative position of well-being for a number of countries at a point of time and changing position of a country over a period of time.

Krishna Mazumdar

**Inter-country Variations in Achieving the Millennium Development Goals**

Since the adoption of The Millennium Development Goals (MDGs), considerable attention has been paid by different researchers and research organizations to study whether these goals would be achieved by the countries within the stipulated date. Broadly, it has been observed that as a whole the developing world is "off track" with respect to the most targets. It has also been observed that the countries differ a lot towards meeting the targets - there are significant inter-regional as well as intra-regional variations in achieving the targets - some regions/countries have progressed well enough in some indicators and lagging in respect of some other indicators. In this context, it is worthy to explore the determining factors behind variations in achieving the targets. The study divides the developing world into six broad regions: (i) Sub-Saharan Africa, (ii) Middle East and North Africa, (iii) East Asia and Pacific, (iv) South Asia, (v) Latin America and Caribbean and (vi) Eastern Europe and CIS.

Krishna Mazumdar

**Life Expectancy at Birth: Proposed Measure for Human Well-being**

Human well being is the center of all human activities. Associated with this is the issue of measurement of human well being. This study measures human well being in terms of achievement in life expectancy at birth. The reason behind is that, people expected to be most happy with added years of life - each and every people in each and every society in all time all over the world aspires for longer life. In fact, increase in life expectancy is an important manifestation of improvement in human well being. Moreover, life expectancy is associated with many other indicators representing human well-being. Therefore, it is worthy to obtain what are the major factors those determine the life expectancy of the people of a country. In this context, the study formulates a simultaneous equations model. Data for 2010 are used to estimate the model. Ultimately, relevant policies for improvement in life expectancies have been suggested.

Krishna Mazumdar

**Life Expectancy at Birth Half Century: Changes, Causes and Consequences**

Every one in every society in all time all over the world aspires for longer life. In fact, increase in life expectancy is an important manifestation of improvement in human well being. Over the last fifty-sixty years life expectancy at birth has increased beyond expectation in most of the countries. This is a major achievement of mankind in the last century. The study attempts to find absolute and relative changes in life expectancy over the last half century (1960 to 2010) for the countries, for which time-series data is available. In this respect regional variations have been taken into account. It has been observed that there exist stark differences among countries in the level and rate of achievements in life

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expectancy. Also it has been found that there are inter-regional variations. This study further tries to find the causes behind the levels and rates of achievements of different countries as well as different regions. Increased life expectancy has some good and bad consequences.

Krishna Mazumdar

### **Privatization, under pricing and welfare in the presence of foreign competition**

A differentiated oligopoly market is considered where a domestic public firm competes with foreign firm(s). Under fairly general demand and constant marginal costs, it is shown that partial privatization of the public firm improves welfare by cutting down public sector losses. Surprisingly, even at the optimal level of privatization the public firm's price lies strictly below marginal cost and it makes losses. In the long run, with free entry of foreign firms, partial privatization improves welfare through an additional channel: more foreign varieties. However, in the long run, under optimal privatization, below-cost pricing does not occur and the public firm earns positive profits.

Manipushpak Mitra, Arghya Ghosh and Bibhas Saha

### **Strategy-proofness and Pareto-efficiency in quasi-linear exchange economies**

A long-standing question on the structure of strategy proof and Pareto-efficient social choice functions (SCFs) in classical exchange economies (Hurwicz (1972)) is revisited in this paper. Using techniques developed by Myerson in the context of auction design, it is shown that in a specific quasi-linear domain, every efficient and strategy-proof SCF satisfying non-bossiness and a mild continuity property, is dictatorial. The result holds for an arbitrary number of agents but the two-person version does not require either the non-bossiness or continuity assumptions. It also follows that the dictatorship conclusion holds on any superset of this domain. A result using the minimum consumption guarantee result (in the spirit of Serizawa and Weymark (2003)) is also provided.

Manipushpak Mitra, Mridu Prabal Goswami and Arunava Sen (EPU, Delhi)

### **Efficient access pricing and endogenous market structure**

How regulatory mechanisms influence the nature of competition in a network industry is investigated. In the downstream segment of the market, the seller of a differentiated retail product competes with an incumbent firm. The incumbent firm is also the owner of the essential input. The regulator cannot observe the costs of the entrant, and to maximize social welfare designs the retail prices and the access charge that the entrant pays to the incumbent. The optimal access charge is a uniform price that respects the criteria of transparency and non-discrimination that are imposed by the competition and regulation directives in most of the countries. New formulas for retail and access prices adhering to the Ramsey rule are derived. Since the competing firm takes the decision to enter following the choice of the regulatory regime, the nature of the retail market competition is endogenous. It can either be served by both the firms, or can have the incumbent as the monopoly supplier of the retail good.

Manipushpak Mitra, Kaniska Dam and Axel Gautier

### **On that old rivalry: Bertrand versus Cournot**

The classic comparison between Bertrand and Cournot outcomes in a symmetric differentiated oligopoly where each firm maximizes a weighted average of its own profit and welfare is considered in the study. For general utility functions, the standard Bertrand-Cournot rankings are reversed for all variables---prices, quantities, profits, consumer surplus, and welfare---provided the weight on profit is strictly less than a threshold value. Surprisingly, it is found that the threshold can be arbitrarily close to unity for two widely used utility specifications, quadratic and CES. The threshold weight increases as the degree of substitutability declines. In addition, for CES, the threshold (i) increases as the number of firms increases and (ii) irrespective of the degree of substitutability, tends to unity as the number of firms approaches infinity.

Manipushpak Mitra and Arghya Ghosh

### **Egalitarian equivalence and strategyproofness in the queueing problem**

The implication of egalitarian equivalence (Pazner and Schmeidler (1978)), queue efficiency and strategyproofness in the context of queueing problems is investigated. The complete class of mechanisms satisfying the three requirements is characterized. Though there is no mechanism in this class satisfying budget balance, feasible mechanisms exist. It is also shown that it is impossible to find a mechanism satisfying queue efficiency, egalitarian equivalence and a stronger notion of strategyproofness called weak group strategyproofness. In addition, it is shown that generically there is no mechanism satisfying two normative notions, egalitarian equivalence and no-envy, together.

Manipushpak Mitra, Youngsub Chun and Suresh Mutuswami

### **Bidding rings: a bargaining approach**

The problem of coalition formation in single as well as multiple indivisible goods second price auction with unit demand is analyzed in a bargaining game set up under the assumption of complete information where valuation of the participants is commonly known amongst themselves while the auctioneer is unaware of these valuations. In the single goods case, the necessary and sufficient conditions for formation of any bidding ring when players are sufficiently patient are identified. In the multiple goods case, the sufficient conditions for formation of an interesting class of coalition structures are also specified. In the multiple goods case where exactly one winner colludes with all the losers and, depending on the protocol, the remaining winners either stay alone or collude in pairs.

Manipushpak Mitra, Kalyan Chatterjee and Conan Mukherjee

### **Bipartite graphs and the Shapley Value**

A cooperative game-theoretic structure to analyze bipartite graphs is provided where there is a set of employers and a set of workers. Links can form between an employer and a worker and there is no link either between employers or between workers. As in Myerson (1977), a cooperation structure is represented by a set of bilateral links. However, unlike Myerson (1977) bilateral links can only be formed between some employers and some workers. In this scenario the Shapley Value is characterized.

Manipushpak Mitra, Dipjyoti Majumdar and Souvik Roy

### **Subgroup-additivity in the queueing problem**

The notion of 'subgroup additivity' is defined and is used as the main axiom to investigate its implications for the queueing problem. The axiom of subgroup additivity requires that a rule assigns the same expected 'relative' utility to each agent whether an agent's expected relative utility is calculated from the problem involving all agents or from its sub-problems with a smaller number of agents. Five important rules in the queueing problem are characterized, they are: the minimal transfer rule, the maximal transfer rule, the symmetrically balanced VCG rule, the pivotal rule and the reward based pivotal rule. Given some basic axioms and subgroup additivity, the characterization results can be obtained by additionally imposing either strategic axioms (like weaker versions of strategyproofness) or equity axioms (adjusted versions of egalitarian equivalence). Each strategic axiom can be replaced by an appropriate equity axiom for the characterization of all five rules.

Manipushpak Mitra and Youngsub Chun

### **Reordering an existing queue**

The queueing problem with an existing initial order is analyzed. It is shown that individual rationality, strategyproofness, outcome efficiency, and budget balance are incompatible. Given this impossibility, three different directions are ventured by dropping budget balance, outcome efficiency and strategyproofness, one at a time. By dropping budget balance the class of mechanisms that satisfy individual rationality, strategyproofness and outcome efficiency are characterized. It is shown that there

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is no mechanism in this class that satisfies feasibility. By replacing outcome efficiency with non-triviality it is shown that *fixed price trading mechanisms* are the only mechanisms satisfying individual rationality, strategyproofness and budget balance when there are two agents. When there are more than two agents, outcome efficiency is replaced with appropriate bounds on the level of admissible inefficiency and the existence of *median price exchange mechanism* is established. By weakening strategyproofness to *one-sided* strategyproofness, the buyers' mechanism and the sellers' mechanism are characterized.

Manipushpak Mitra, Youngsub Chun and Suresh Mutuswami

### **Asymmetry in Both Mean and Variance of Returns: A Multiple –Country Study**

Asymmetry in conditional variance of returns on stock prices/indices, often called the 'leverage effect', is well recognized although the same for conditional mean has got attention of empirical researchers relatively recently. Mean reverting behaviour of returns suggests that asymmetry in conditional mean is only likely. Financial theories have also advocated two hypotheses in support of this. These are: *the time varying rational expectations* and *stock market overreaction hypotheses*. Two models are proposed capturing both these asymmetries -TAR-EGARCH-AM and STAR-EGARCH-AM- in the framework of 'risk-return in mean' relationship. Returns data from a group of developed and important emerging economies are used to study these asymmetric effects.

Nityananda Sarkar

### **Asymmetric Mean Reversion and Volatility with Cross- Country Volatility Dependence in Returns in Bivariate EGARCH-in-Mean Framework**

Transmission of price and volatility spillovers across stock markets of different groups/blocks of countries is quite common in these days of informational efficiency. Obviously, the asymmetric nature of mean reversion and nonlinear dynamics in volatility are important considerations in studying these cross- country spillover effects. In this study, the volatility-return relationships of cross-market and own-market have been explicitly captured by the GARCH-in-Mean model. The news impact has been considered in the framework of multivariate GARCH model. The empirical findings are encouraging in terms of cross-country spillover effects.

Nityananda Sarkar

### **Stability of the Hybrid New Keynesian Phillips Curve: A Study with Inflation Data from BRICS Countries**

One of the central issues in macroeconomics is the relationship between inflation and unemployment / output gap, called the 'Phillips curve'. However, a modified version of the original 'Phillips curve', called the 'hybrid new Keynesian Phillips curve' (HNKPC), is now used extensively to study inflation dynamics. In such studies, one important econometric issue which has hitherto not been looked into in great detail is that of stability of the relationship. This relationship is studied for BRICS group of countries from consideration of structural stability and the results are found to be mixed in nature.

Nityananda Sarkar

### **Does Friedman-Ball Hypothesis for Inflation Hold? A New Approach Incorporating Asymmetry in the First Two Moments of Inflation**

The role of inflation uncertainty in modelling inflation has been studied extensively and the findings are mixed. In this context, Friedman and Ball, and Cukierman and Meltzer, among others, have argued on the nature of causation link from inflation uncertainty and inflation and *vice versa*. This work looks at this link after introducing asymmetric reactions of news on the conditional mean and conditional variance of inflation. The proposed model based on these two considerations, is applied to the time series data on inflation of a group of G7 and Euro Zone countries.

Nityananda Sarkar

### **Estimation and Prediction in an Autoregressive Process of order 2 in the Presence of Missing Observations**

A time series may quite often have missing observations. Using an autoregressive model for such data requires that missing values be first imputed to prevent the disruption in the sequence. This problem is considered for an AR (2) process with multiple missing observations. An appropriate method of imputation is first suggested. The asymptotic properties of the estimator of the model parameters and the estimated predictor based on the imputed series are then studied. A simulation exercise is also carried out to find the usefulness of the imputed method.

Nityananda Sarkar

### **Forecasting House Price in the United States: A Time Series Study of Different Models with Multiple Structural Breaks**

Despite the significant impact of the housing sector on the real sector of the economy, relatively few studies have conducted house price forecasting exercises using alternative modeling approaches. The main objective of this paper is to forecast house prices in the United States for a very recent time period that encompasses the ongoing slump in the housing market. Our empirical findings clearly show that four structural breaks in the series have occurred during this period, and the estimated break points are February 2001, October 2003, April 2006 and August 2008 with the last break coinciding with the time when the housing market effectively collapsed. Forecasting exercises were also obtained using six alternative models – ARMA, ARMA-EGARCH, Random Acceleration (RA), regime switching SETAR and STAR as well as a non-stationary model with structural break(s) in trend. Based on our findings, we recommend that time series models with due consideration to structural breaks in the non-stationary series be used for the purpose of both forecasting and policy decisions in the housing market of the U.S.A. in the aftermath of the crisis.

Nityananda Sarkar

### **Performances of Some Competing Estimators for Multicollinearity under Different Loss Functions**

In presence of multicollinearity, the ordinary least squares estimator no longer remains efficient. To tackle such a situation, alternative estimators like the PCR, ORR and the  $r$ -( $k-d$ ) class of estimators have been proposed. Comparisons across such estimators are made based on different loss functions. This study has proposed a new estimator and then compared its performance with some of the existing ones using different loss functions. Conditions for superiority of one over some others have been obtained, and then some tests have been proposed to test whether the conditions hold or not in a given sample. Empirical exercises, wherever applicable, have also been carried out. The work has been extended to the situation where some parametric restrictions are assumed to hold.

Nityananda Sarkar

### **Promises, Credulity and Integrity**

The research experimentally examines, using dictator and ultimatum games, whether non-binding communication is cheap talk or content, and what beliefs are attached to such communication by receivers, in a framework with competitive communication.

Priyadarshi Banerjee

### **An Analysis of Price Interventions in an Era of Reform Reversal**

The research theoretically analyses price interventions in oligopolistic contexts where firms set prices. The study shows that if firms bear sunk costs, there is inefficiency in equilibrium, and price interventions can induce Pareto superior outcomes.

Priyadarshi Banerjee



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### **Institutional Improvement with Incomplete Contracting**

The research experimentally examines whether inefficiencies induced by incomplete contracting can be mitigated by an improvement in contracting institutions.

Priyadarshi Banerjee

### **Globalization, Crisis and Automatic Destabilizers**

The countries the world over have converged on a set of common policies, namely, stringent restrictions on the size of the fiscal deficit, relaxation of controls over international capital flows, loosening of restrictions on external borrowing by domestic firms and monetary policy of interest rate cuts in the face of declining output. This paper argues that these policies may act as automatic destabilizers and magnify manifold the effects of adverse exogenous shocks such as sudden collapse of asset price bubbles, sudden large scale decline in exports, sudden capital flight etc., and thereby plunge the economy into deep depression and crisis.

Chandana Ghosh

### **Pitfalls of Monetary Policy in Countries like India**

Economically weak countries like India, which are subject to acute transfer problem and tremendous import dependence, have loosened restrictions on foreign investments and external borrowing by domestic firms that derive their income principally from domestic sources. Under these conditions, this paper argues, the conventional monetary policy of rate cuts to tackle recession may reinforce recession instead of reversing it.

Chandana Ghosh

### **Child Labour and Child Work: Pattern, Deprivation and Determinants**

Both child labour and child work still constitute serious problems in the developing countries like India. The current literature concentrates excessively on the child labour problem and the dormant issue of child work has been rather under-attended so far, while both of them might have been creating a wide gap between the achievements and capabilities of these children. The prime objective of this exercise is to assess the deprived childhood of Indian working children by formulating an index of deprivation for each working child depending upon his/her age, intensity of work, loss in attainment of education and health hazards. The socio-economic-cultural variables responsible for the extent of deprivation have also been explored.

Saswati Das

### **Incidence of Child Labour and Child Schooling in India: Pattern and Determinants**

This study aims to carry out a supply-side analysis towards examining the incidence and pattern of child labour and child schooling to test out regional and gender disparities, if any, in terms of these incidences. The pattern of child employment confirms the malfunctioning of lawful steps to save child labourers from mischief of occupational vulnerability. It also reveals significant discrepancy in incidence of child labour both across region and gender, but for schooling choice no considerable regional gap is substantiated.

Saswati Das

### **Women Empowerment and Domestic violence on working women**

Target date to fulfill the Millennium Development Goals (MDG) is 2015. At the verge of this target date it is important to locate the achievement level of the goals and the gap if any, so that appropriate drive can help to fulfil the goals. Third MDG goals aim to promote gender equality and empower women. For empowerment study, an India level measurement of it is provided with its regulating factors. Also this study suggests some of the remedies to overcome the negative effect of some determining

factors. The second study is extremely important because despite earnest efforts of Government and NGOs, now-a-days domestic violence on women has enhanced enormously in the Indian society particularly on the working women. In this study, estimation of the level of violence on working women, confirms the incidence anew only. Study exhibits that patriarchy and conservative social rules are strong enough to outweigh the economic effect. So instead of securing women, their employment invites more violence on them relative to unemployed one. These two studies are based on the unit level data extracted from NFHS 3.

Chaiti Sharma Biswas

### ***Economic Analysis Unit, Bangalore***

The Economic Analysis Unit (EAU) is engaged in research in quantitative methods in economics, agrarian studies and development economics. Topics of current research include developing economy-wide models using VAR and VEC methodologies and simulations; and analysis of the importance of institutions for economic growth and globalization. An important area of research is assessing the quality of official statistics on the rural economy including data on land holdings, and incomes. A special study on gender gaps in official statistics is being undertaken. Studies of rural credit, the condition of labour households in rural India and discrimination against Dalit households in rural markets is also underway.

### ***Linguistic Research Unit***

During the period (from April 2012 to March 2013) the *Linguistic Research Unit* of the Institute has been continuing with its programs of research in the area 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 initiated. Earlier work has demonstrated a connection between this inquiry and the linguistics of lexicophrasal difficulty. Effort is made for intensive research in conceptualization kernel studies. 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, 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 Electronic Lexicon will be the first work of its kind for Bengali, 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 Bengali.

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

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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 Bengali.

Probal Dasgupta

## Sociolinguistics

The unit has taken up studies in linguistic (lexical and syntactic) difficulties in cognition of language in different discourse frames. 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 the important target of study has been the place of English in the sociolinguistic fabric of India.

Probal Dasgupta

## Corpus Based English Language Teaching (C-BELT) System

We have started working towards a general method called Corpus-Based English Language Teaching (C-BELT). It has been observed that the idea of teaching English language to the learners without reference to English Language Corpora (ELC) has become a non-reliable proposition, because data and information obtained from modern ELC provide authenticity and reliability towards the process of teaching English as a second language. We have proposed here to access and utilize the ELC directly in classroom situation with additional help of some corpus processing tools and techniques such as concordance, bilingual lexical databases, etc. for teaching English to the Indian learners. We have also proposed to encourage the Indian learners to extract relevant linguistic data, examples, and information from the ELC to increase their knowledge in the language as well as to enhance their communication skill in English in various interactional environments. Furthermore, we have envisaged the ELC as a highly authentic secondary resource the data and linguistic information of which may be directly utilized for the purpose of developing ELT text books, bilingual dictionaries, dictionary of idioms, phrases and proverbs, and primary and advanced grammar books for the Indian learners. We have planned to generate a lexical database of basic and graded vocabulary of English from the ELC to be used in the development of a C-BELT system for the Indian learners.

Niladri Sekhar Dash

## Domain-Specific Parallel Corpora of Hindi and Bengali

We have developed a Hind-Bengali parallel translation corpus keeping Hindi as the source language and Bengali as the target language. The first phase of the project (ILCI-I) has generated 50,000 parallel sentences in Bengali covering two major domains of information sharing: health and tourism. Each sentence has an average length of sixteen (16) or more words. The most vital feature of this bilingual parallel sentence database is that parallelism between the two languages (Hindi <> Bengali) is preserved both at semantic and syntactic levels – making the corpus an indispensable resource for cross-lingual information retrieval, bilingual lexical database generation, translational equivalent extraction, core grammar development, machine translation, and cross-cultural research. The second phase (ILCI-II) has started in April 2012 and it has included additional two domains: Agriculture and Entertainment. An important output of this work is generation of a bilingual parallel lexical database that may lead to compilation of digital bilingual and multilingual dictionaries for Hind and Bengali. The corpus is now available from the TDIL Data Centre, Govt. of India.

Niladri Sekhar Dash

### **POS Tagging of Bengali Words in the Bengali Corpus**

We have developed a POS tagset for the Bengali text called the “BIS Tagset” (*Bureau of Indian Standard*) as a benchmark standard to be used in POS tagging of Bengali text of all types. We have used this POS tagset to develop a POS tagged corpus of 50,000 Bengali sentences relating to health and tourism domains. An important bi-product of this work is generation of POS tagged digital lexical database for Bengali which may be used to compile digital Bengali dictionaries and thesauruses. The database can also be used information retrieval, grammar development, machine learning, language teaching, word sense disambiguation, and other works of applied and computational linguistics.

Niladri Sekhar Dash

### **Digital WordNet for Bengali**

We have developed a WordNet for Bengali that can stand parallel to other WordNets developed for some other Indian languages, e.g., Hindi, Sanskrit, Marathi, Konkani, Urdu, Oriya, Gujarati, Kashmiri, Tamil, Telugu, and Malayalam, etc. We have adopted an intricate interfaces of lexical structures made of synsets (i.e., set of synonyms) where semantic relations, 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 this act of Wordnet creation, the central focus is not on the words but on the concepts word(s) are capable to denote. 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 Bengali synsets with the synsets of other geographically, genealogically and typologically related Indian languages and with English. So far we have completed more than 36,000 synsets and are on the process of creating more than 1000 Language Specific Synset (LSS) that will represent the uniqueness of Bengali life, living, language, people, and culture in the WordNet

Niladri Sekhar Dash

### **SHELL System for Teaching English to Bengali Learners**

Think of a situation when English is being reintroduced in Bengali 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. That means there is no academic support of any kind that is available 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, at their own ways through direct utilization and assistance of their mother tongue. Since no one is there to help them in learning English, they will help themselves in this process of learning. Therefore, we call this method as Self Help English Language Learning (SHELL) method. This new method is adopted in an experimental basis for developing text books and learning materials for the new generation of Bengali 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.

Niladri Sekhar Dash

### **Field Linguistic Survey at Balasore, Odisha**

As a part of the Indradanush WordNet a team of seven linguists and one technician under the supervision of a faculty of LRU conducted a short survey in some parts of the district of Balasore of Odisha from 24<sup>th</sup> to 28<sup>th</sup> December 2012 for linguistic field survey and data collection for cross-lingual

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verification and validation of culture specific synsets of the two languages. The team conducted an extensive on-spot field survey with more than 35 local informants in four villages of Panchalingeswar and neighbouring areas for collecting language and cultural-related data of the *Baleswari Dialect* to investigate the nature of impact of the Bengali language and culture on the dialect. The process of data collection involved collection of conceptually equivalent lexical items from the native Baleswari dialect speakers through direct audio and video recording. A major part of the survey included the process of digitization of lexicon, sentences, and free discourse texts through on-site direct interviews with native informants. This survey served as a part of the process of digitization and documentation of the minority and endangered languages of the country – an important part of the research activities of the Unit.

Niladri Sekhar Dash

### **Bengali Pronunciation Dictionary in Electronic and Printed Form**

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

Niladri Sekhar Dash

### ***Economics and Planning Unit, Delhi***

The Economics and Planning Unit faculty has diverse research interests in both economic theory and policy. These cover game theory theory, macroeconomic theory, economic development theory, industrial organization, environmental economics as well as empirical analysis of schooling and social programs.

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

Area of Research by the members of the unit:

#### **Social Identity and Inequality: The Impact of China's Hukou System**

Afridi Farzana, Sherry Xin Li and Yufei Ren

#### **Women Political Leaders, Corruption and Learning: Evidence from a Large Public Program in India**

Afridi Farzana, Vegard Iversen and M.R. Sharan

**Labour Force Participation and Child Education in India: The Effect of the National Rural Employment Guarantee Scheme**

Afridi Farzana, Abhiroop Mukhopadhyay and Soham Sahoo

**The Role of Design in School Subsidy Programs: Evidence from Mid-day Meals in India**

Afridi Farzana, Bidisha Barooah and Rohini Somanathan

**Learning Effects of Supplementary School Feeding Programs**

Afridi Farzana, Bidisha Barooah and Rohini Somanathan

**Political Economy of Implementation of Public Programs in India**

Afridi Farzana, Anirban Kar

**Female Labour Supply and the National Rural Employment Guarantee Act**

Afridi Farzana, Taryn Dinkelman and Abhiroop Mukhopadhyay

**Bargaining theory, micro-finance, land acquisition, mergers, and terrorism**

Prabal Roy Chowdhury

**Micro-finance and bargaining theory**

Prabal Roy Chowdhury

**Growth of the service sector, especially the business-service sector**

Satya P. Das

**Indian business cycle, Indian economic growth, and continued work on growth models with endogenous investment specific technological change**

Chetan Ghate

**Mechanism design**

The objective is to understand and characterize the set of possible mechanisms in settings where the private information of agents is multidimensional and transfers are allowed.

Debasis Mishra

**Issues in development economics, with special emphasis on the evaluation of the National Rural Employment Guarantee Scheme**

Abhiroop Mukhopadhyay

**The Macroeconomic Implications of Education: Moving Beyond Labour Productivity; Education Financing Policy: Income Contingent Loans and Educational Poverty Traps; Inequality, Neighbourhoods and Welfare of the Poor; Regional Inequality, Location Choice and Quality Ladder**

Tridip Ray

**Characterization of incentive compatible random social choice functions on various domains**

Arunava Sen

**Impact of the Forest Rights Act on land titles allotted to tribal and other forest dwellers and deforestation; Impact of climate change on the poor in India; Theory of groundwater markets**

E. Somanathan

### ***Population Studies Unit***

#### **Correlates of Diarrhea among children aged 0-4 years in Indian states**

The objective of this study is to examine the causes and determinants of diarrhea among children aged 0-4 years in the Indian states using National Family Health Survey (NFHS 3, 2005-06) data, a sample survey conducted by International Institute for Population Sciences, Mumbai, India. Attempt is made to explore the causes of diarrhea by some socio-economic and demographic characteristics. The study emphasizes regional variation of causes and determinants of diarrhea among children aged 0-4 years.

Subhash Barman

#### **Health Inequality of Child Mortality in Different States of India**

The study determines the state wise child mortality within various socio-economic groups of women and for this cross sectional data has been utilized for the analysis. The parameters of the study are estimated by the extended beta binomial distribution using Newton Raphson method for iteration. Trend analysis of health status of children have been done using NFHS-1,2 and 3 data for different states in India.

Swati Sadhu

#### **Status of Diarrhoea of children for different background characteristics in India**

Diarrhoea is a major cause of illness and death among infant and young children. Using NFHS data of different rounds various background demographic and socio-economic causes of diarrhea among the infants and children are determined.

Swati Sadhu

#### **Impact of spacing between age at marriage and first birth and also between two births on maternal and child healthcare in India**

The spacing between age at marriage and first birth is important to reduce the population growth in a country. Again the spacing between any two births is also important for the good health of mother and child. Using regression analysis effects of different parameters are determined using different demographic and maternal health variables.

Swati Sadhu

#### **District Level Divergence in India in Post-reform Period: Relationship between Infrastructure, Vulnerable Class and Purchasing Power**

The study attempts to test district level performance in social development index from 1990-91 to 2004-05. With the help of chi-square test and other parametric statistics relationship between Infrastructure, vulnerable class and purchasing power are determined.

Swagata Gupta

#### **Poverty, Disparity and Development in Indian Districts: Findings from a Perception Survey**

The main objective of the study is to evaluate the performance of rural areas of the states. To review the performance of rural areas, the study attempts to find out both qualitative and quantitative indicators of development apart from the available official statistics of the country.

Swagata Gupta

#### **A New Relative Measure of Poverty, Inequality and Vulnerability across Indian Districts: Comparison between 61st Round (2004-05) and 66th Round (2009-10)**

In a situation where there is no defined official poverty line of India, an attempt is made here to judge district level transition in terms of 1st quartile, 2nd quartile and top 10 per cent population of India and other indicators from NSSO consumer expenditure survey between 2004-05 and 2009-10.

Swagata Gupta

### **Estimation of components of under-five mortality and of their trends in India using SRS data**

The differences in child survival among geographical regions are of particular importance because of their differences in mortality pattern and magnitude. The variability in child survival among geographical regions is very important factor for state level planning. It is therefore important to identify the conditions underlying these mortality patterns with a view to promote the implementation of effective policies to eliminate them. The present investigation is aimed at understanding the levels and trends of under-five mortality components over time during the period 1976-2010 in the context of India and its major states. Using Sample Registration System (SRS) data, estimates are derived by fitting a regression line to the relationship between infant or under-five mortality rates and their reference dates using Spline Regression. It has been observed that though infant mortality (IMR) rate has declined in India, the gap between IMR and neonatal mortality (NMR) becomes narrowed. The post-neonatal mortality (PNMR) has declined more than NMR, increasing the relative importance of early NMR.

Partha De

### **Multivariate relationship between different characteristics variables and determinants of under-five mortality components**

The impacts of demographic, economic and cultural factors on the components of under-five mortality are examined separately for three rounds of NFHS data. Using the birth history data for ever married woman aged 15 to 49, the effect (i.e., relative risk) of different categories with respect to reference category for each of the maternal and socio-economic variables, neonatal, post-neonatal and child mortality for different states and regions are obtained by fitting Cox proportional hazards model. It has been observed that, during neonatal period, biological factors and maternal factors strongly affect the mortality. But, after the neonatal period, post neonatal and child mortality are attributed mainly to childhood diseases and others, which are governed by the social development and programmatic factors. So, the primary causes of childhood mortality change as children grow older, starting with factors related mostly to biological conditions and ending with factors related mostly to their environment.

Partha De

### **Projection of infant and under-five mortality and achievement of Millennium Development Goal in Indian States**

India is a signatory of the Millennium Declaration of the UN Millennium Summit of 2000 and thereby committed to the achievement of Millennium Development Goals (MDGs) by the year 2015. The Millennium Development Goal 4 (MDG4) calls for a two-thirds reduction in child mortality between the years 1990 and 2015. A time series analysis for forecasting is carried out by applying Autoregressive Integrated Moving Averages (ARIMA) model to the infant and under-five mortality rates. It appears that without further intervention, India would not be able to achieve the target of an U5MR and IMR less than 42 and 28 respectively by 2015. Achieving the target value of MDG4 will require further acceleration in the reduction of IMR and U5MR, particularly in the highest burden or heartland states like, Madhya Pradesh, Assam, Orissa, Uttar Pradesh, Rajasthan and Bihar. Thus, government and other national and international organizations need to do more to stimulate the effort in reducing child mortality which calls for adjustments in planning and more funding immediately.

Partha De



### ***Psychological Research Unit***

#### **Cognitive Processing through PASS model and its role in determining Academic Performance of School Students of North- Eastern India**

The objective of the project is to find out the role of planning, attention, simultaneous and successive processes of Cognitive functioning in determining academic performance of primary school students. The study will also try to find out the effectiveness of the reading enhancement training programme and thereby its effect on academic performance of low achievers. Scales for measuring PASS processes and training programme have been decided. Data collection from different North- Eastern states is going on.

Anjali Ghosh and Manjusha Adak

#### **Understanding Competition through Associative Group Analysis Technique**

Competition is an important concept in today's world. It was found to be a dynamic, vibrant concept as studied through Associative Group Analysis technique among male and female college students. Both positive and negative emotions appear to be important categories of competition. Findings also indicate that these students appear to be motivated, want to win something, achieve goal and progress, and thus to feel happy and cheerful.

Anjali Ghosh

#### **Differential validity of Computer Programming abilities**

Differential validity indicates differential pattern of predictor-criterion relation across sub-populations. A test battery measuring computer programming related reasoning abilities was administered to 994 students of different communities by religion and caste. It is noted that the items of the test battery are reliable and valid. One-way ANOVA shows significant mean differences in reasoning abilities by caste, religion, medium of instruction, age, grade and gender.

D. Dutta Roy and Sumona Datta

#### **Personality Profile, Stress and Job Satisfaction of Indian Sea Farer**

The study aims at empirical investigation of personality profile of sea-farers with emphasis on stress, team work, job satisfaction and related aspects and their roles in shipping. The study also proposes to assess job satisfaction level of the Indian sea fares and their effects. The results revealed that when stress was measured, significant difference was not found between extrovert and introvert type of personality for all the sea fearers. Job satisfaction and stress were negatively correlated. On the other hand, job satisfaction and work related factors were positively correlated and the value was significant at 5% level.

Rumki Gupta and Jayeta Dhara

#### **Role of career stages, Self-efficacy and School Environment on Job Satisfaction of School Teachers**

The aim of the research work was to explore the role of career stages, self-efficacy, and school environment on job satisfaction of school teachers selected from different Government aided schools of Kolkata. The aim of the study was also to see the effect of different demographic variables (e.g. age, gender, school, duration of teaching experience) on job satisfaction of school teachers. Results showed that five career stages share positive relationship with job satisfaction. Self-efficacy and school environment also have strong positive relationship with job satisfaction. Total school environment score and self-efficacy were found to be primary predictors of job satisfaction. The four career stages namely, career entry, stabilization, stock taking and conservatism were also found to be strong predictors of job satisfaction. It implies that school teachers believing about their

own capability, perceiving good school environment and their commitment to teaching profession can build satisfaction, love and respect towards their profession. Among the demographic factors permanent teachers, teachers who teach in Urdu medium schools and girls' schools teach both secondary and higher secondary classes and get high salary are tend to be more satisfied with their jobs. Job satisfaction is relatively higher among the female teachers than the male teachers. This research delineates a detail description of job satisfaction covering many factors related to job of school teachers. The behavior of supervisors, relation with colleagues and students, working culture, pay structure, promotion and security policies of government schools help to understand the teaching world in Kolkata. This research also yields a picture of internal conditions of different government schools from different zones in Kolkata.

Rituparna Basak and Anjali Ghosh

### **Latent trait modeling of cognitive self-efficacy**

Psychometric properties of the questionnaire were tested on 100 patients with schizophrenia. A Principal Component Analysis under Latent trait modeling yielded three components of CSE, namely, Memory efficacy, regulatory behavior and coping efficacy. The components will be related to social functioning and severity in next study.

Shivani Santosh and D. Dutta Roy

### **Teachers' Belief for Innovative Teaching & its relation with Personality and Innovative Work Behaviour**

The purpose of this study is to assess teacher's belief for bringing innovation in teaching and its relationship with personality and innovative work behaviour. Data were collected from secondary school teachers. They completed 3 questionnaires containing the following tools: (a) Belief-Assessment Scale for Innovative teaching, (b) Neo Five Factor Personality Inventory and (c) Innovative Work Behaviour Scale. Results revealed that teachers' belief for innovation was significantly positively related to Extraversion, Openness to Experience and Conscientiousness traits of personality.

Anurupa Kundu and D. Dutta Roy

### **Inter-item Correspondence of categorized data**

A test of similarities was administered to 167 students of grades 8 to 10. Multiple Correspondence Analysis reveals confirmatory validation of test items.

Sravanti Adhikari and D. Dutta Roy

### **Attitude towards Disabled children**

A questionnaire with 20 bipolar adjectives was administered to 1472 teachers of different schools in Kolkata. Principal Component analysis with varimax rotation suggests that disabled children are perceived as careless, doubtful, insincere and rigid. On the other hand, able-bodied children are perceived as systematic, confident, sincere and responsive.

Madhumita Banerjee, Bikashayan, Sumona Datta and D. Dutta Roy

### **Attitude towards gardening: A problem of conservation psychology**

The study examined attitude towards gardening among the urban people across different demographic groups. It is noted that male population has more involvement in gardening. The middle age groups have better seed and plant management ability where as elderly person (above 36 years) have clear concept of urban gardening and also have good involvement of gardening activity.

Anwesa Ghosh, Subarna Bhattacharyya and D. Dutta Roy

### ***Sampling and Official Statistics Unit***

#### **Study on Contractual Relation and Market Structure**

The study consists of a survey of a random sub-set of *phorias* (middlemen) and larger traders who operate in 72 villages of West Medinipur and Hugli districts and their corresponding potato markets. The goal is to understand the nature of contractual relations between farmers and *phorias* on the one hand, and between *phorias* and wholesale traders that they sell to on the other hand. The surveys will enable us to obtain systematic information on market structure, trader costs and profits, entry barriers, contractual relations across successive layers of the supply chain, and the nature of competition at each layer. Eventually the hope is that we will obtain a richer understanding of the organization of these bottom-most layers of the supply chain, that will both explain magnitudes of observed margins and pass-through of external price shocks to farmer earnings, as well as enable us to predict the effect of various policies intended to enhance efficiency of the supply network and pass-through to farmers.

Sandip Mitra, Dilip Mookherjee, Sujata Visaria, Pushkar Maitra, and Alberto Motta

#### **Study on Corporate Social Responsibility**

In the context of public sector enterprises Corporate Social Responsibility (CSR) has been viewed as a way of conducting business, which enables the creation and distribution of wealth for the betterment of its stakeholders, through the implementation and integration of ethical systems and sustainable management practices. CSR is the process by which managers of an organization think about and evolve their relationships with stakeholders for the common good, and demonstrate their commitment in this regard by adoption of appropriate business processes and strategies. The responsibility of a corporate regarding society is thus embedded in the concept of CSR. The research questions are aimed at exploring the links between the corporate and the society and examine how the process of targeting done in order to ensure long term sustainable development.

Sandip Mitra

#### **Study on Medium and Small enterprises**

The unorganized sector accounts for a significant proportion of value added, output and particularly non-farm employment in India. Employment in the organized sector has not expanded over the past two decades, despite high rates of growth. It is therefore important to study small and medium sized non-farm enterprises to understand the determinants of their growth (e.g., how they are affected by various regulations, trade liberalization, infrastructure provision, corruption), their linkages to the organized sector in terms of access to credit, infrastructure and marketing of products, and how their growth has affected wages and employment of unskilled workers

Sandip Mitra

#### **Poverty and Aspiration**

Recent empirical work have shown that enhancing the opportunity sets of individuals and the availability of payoff relevant information on their own may have limited impact. Could other constraints, such as those internal to an individual/community caught in a poverty trap, have a role to play? The literature in economics has traditionally focused less on such internal constraints that have been subjects of longstanding research in other social sciences. For instance, issues such as self-confidence, locus of control etc. are important concepts whose role in influencing life outcomes has been widely researched in the psychology literature. Only in recent years are these concepts beginning to be acknowledged in economics – in the sub-discipline of behavioral economics. Yet, the role these factors play in influencing individual outcomes, or the manner in which individuals may be trained to develop them, so as to enhance their life outcomes, has hitherto never been studied in economics. We propose a research agenda that seeks to examine how internal and social constraints may result in exclusion and perpetuate disadvantage. In particular, we seek to investigate whether a

program that aims to raise aspirations of a marginalized group in society can have a positive impact on aspirations and self-perception (as measured by self-efficacy and locus of control) and, in turn, on actions (e.g. savings behaviour) to improve their well-being.

Sandip Mitra, Sayantan Ghosal, Anandi Mani and Sanchari Roy

### **Land Acquisition**

Disputes over compensation of rural communities that are displaced for the purpose of industrialization have become widespread in India as well as various countries in Asia and sub-Saharan Africa (FAO (2009)). While the events of Singur in West Bengal are well-known from media reports, there is substantial disagreement regarding the underlying causes. Some argue that the livelihoods of large numbers of poor cultivators and agricultural workers were imperilled by the land acquisition; the government did not pay adequate compensation for the lands acquired; under-compensation and adverse economic impact explains (and thus justifies) the refusal of many landowners to accept offered compensation. The opposite point of view is that the refusal to accept compensations by some landowners and the uprisings in the local community were politically motivated rather than justified by adverse economic impact or under-compensation. Current study attempts to understand what actually happened. The study was funded by International Growth Centre.

Maitreesh Ghatak, Dilip Mookherjee, Sandip Mitra and Anusha Nath

### **Why The Left Front Lost West Bengal: Poor Governance or Enhanced Accountability Standards?**

This study relies on two waves of a panel household survey for rural West Bengal corresponding to 2004 and 2011 to examine factors underlying the loss of the Left Front coalition in the 2011 state legislature elections for the first time since 1977. We find this cannot be accounted by a decline in clientelistic distribution of private (recurring) benefits by Left-dominated local governments. The effectiveness of such clientelistic practices declined in terms of generating votes for the Left, but this accounts for a negligible fraction of the observed decline in the Left's vote share. Neither is it likely to be explained by increased media exposure. Hence the reversal of the Left's political fortunes did not result from enhanced accountability mechanisms. Instead anti-Left votes in 2011 mainly reflected dissatisfaction with local leaders with regard to government health and education services.

Pranab Bardhan, Dilip Mookherjee, Sandip Mitra and Anusha Nath

### **Revenue Loss out of Tax Disputes**

It is often observed that a section of the tax payers resort to legal process raising various disputes to avoid paying taxes in the current period. This step often causes huge losses to the government. The purpose is to estimate such a loss. Study is being conducted to look at the cases where disputes were resolved through out of court settlements. Attempts would be made to develop a theoretical model to explain the empirical results.

Sugata Marjit and Sandip Mitra

### **Bayesian and classical methods for estimating total number of rural earners in unorganized non-agricultural industries**

The problem of estimating the totals of some variables in a survey population can be improved using efficient model-based estimators of small area totals. Chaudhuri, Bose and Ghosh (2005) examined the relative accuracy in simultaneous estimation of total numbers of rural earners separately by several different principal unorganized non-agricultural industries in a given district in India. As village wise earning members vary appreciably, the methods of borrowing strength in estimation by the synthetic version of generalized regression method and the Empirical Bayes procedure were used in Chaudhuri et al. (2005). Towards the above problem, presently as a competitor, the method of Hierarchical Bayes technique is being investigated.

Kajal Dihidar

### **Enhancing a randomized response model to estimate population means to sensitive questions**

The population means of variables such as expenditure on alcohol, abortion and amount of dowry are estimated on modifying Gjestvang and Singh's (2009) randomized response model. Instead of simple random sampling with replacement scheme, the respondents are allowed to be chosen by any varying probability sampling scheme, which in particular, also includes simple random sampling with replacement scheme. Whatever the sampling design, the modified estimators perform better than the usual estimator.

Kajal Dihidar and Joydeep Chaudhuri

### **Randomized response: On getting the improved estimator of a sensitive quantitative population mean emphasizing on the multiple responses obtained from the distinct units occurred in a sample**

We consider a randomized response model used to estimate the sensitive quantitative population which has an advantage that the estimator and variance estimator are free from the known parameters of the scrambling variable under simple random sampling with replacement (SRSWR) scheme for selecting the respondents. Emphasizing on the distinct units from SRSWR as well as from simple inverse sampling improved estimation of mean is studied. An attempt is also being made to improve the estimates of the mean using this model, if we knew the underlying distribution of the sensitive variable.

Kajal Dihidar

### **Estimating population mean considering doubtful random non-response under unequal probability sampling scheme**

In the context of missing data, we consider the problem of estimating the population mean under unequal probability sampling scheme. An attempt is being made to derive the unbiased estimators and the variance estimators for population mean of a variable of interest taking into account the doubtful random non-response and to compare the new estimators with the existing estimators through numerical simulations.

Kajal Dihidar

### **Randomized response model generating the trial numbers to get first match to estimate the sensitive population proportion**

In the context of estimating the sensitive population proportion in a community, the randomized response model generating the trial numbers to obtain first match are being examined in comparison to the usual estimators of several existing models under various sampling schemes including the general unequal probability sampling.

Kajal Dihidar and Arijit Chaudhuri

### **Developing a possible Operational Risk Measure for Banking Activities: an application of Bayesian Probabilistic Network – as part of BASEL mandated operational risk management**

Basel accord on capital adequacy norms for financial and banking sector has included operational risk as a specific risk for which separate capital has to be provided. One of the requirements for designing a risk management model that would adequately explain the operational risk faced by the bank, and consequently provide capital to face the risk, is collection of loss data. The major problem with any model of operational risk is that these data are inadequate. Without a credible loss history database, most of the advanced risk analysis and measurement techniques can not be implemented. Bayesian Belief Networks or BBNs provide an elegant solution to this problem. They combine both qualitative and quantitative information for arriving at loss estimates. BBNs are causal networks and are particularly useful for analyzing causes that contribute to operational risks. As with scenario Analysis, one can calibrate one or more causal risk factors in the network and analyze its impact on the loss

estimate, under causal Analysis, new evidence of operational losses is used to calculate updated probabilities (also referred to as posterior probabilities) of all the causal factors. The Bayesian process of statistical estimation is one of continuously revising and refining our subjective beliefs about the state of the world as more data become available. As part of this continuing research, a preliminary framework as mentioned above has been developed and a pilot application made.

Amitava Sarkar

### **Reviewing Empirical Evidence on some “Stylized Facts” in Financial Markets with High Frequency Data**

High frequency financial time series are characterized by some unique regularity, known as the stylized facts. Some of the major stylized facts are: *conditional volatility; volatility persistence or long memory; fat tails; volatility clustering; and nonlinearity and chaos*. Financial time series are, mostly, non-linear in nature and are often characterized by chaotic dynamics. The ongoing research reviews some major theoretical and empirical works discussing the above stylized facts, focusing mainly on volatility, long memory and chaos and extends investigation to high-frequency time series data, especially in foreign exchange and stock markets.

Amitava Sarkar

### **Improved exponential estimator for estimating the population mean in the presence of non-response**

This report defines improvement for estimating the population mean of the study variable using auxiliary information and known values of certain population parameter(s), when there is non-response on study as well as on auxiliary variables. Under simple random sampling without replacement (SRSWOR) scheme, mean square error (MSE) of all proposed estimators are obtained and compared with each other. Numerical illustration is also given.

Sunil Kumar

### **Variance estimation in presence of random non response**

The goal of this report is to study the properties of some proposed estimators for estimating the population variance in presence of random non response. The results are obtained under the assumption that the number of sampling units on which information could not be obtained due to random non response, follows some distribution; for instance, see Singh and Joader (1998), Singh, Joader and Tracy (2000), Singh (2003), Singh, Chandra and Singh (2003), etc.

Sunil Kumar

### **Estimation of the Ratio, Product and Mean using Multi Auxiliary Variables in the Presence of Non Response**

This report addresses the problem of estimating the population ratio, product and mean using multi auxiliary information in presence of non-response. Some classes of estimators have been proposed with their properties. Asymptotic optimum estimator(s) in the class(s) have been investigated along with their mean squared error formulae. Further the optimum value (depending upon population parameters) when replaced from sample values gives the estimators having the mean squared errors of the asymptotic optimum estimators. An empirical study is carried out in the support of the present study. Both theoretical and empirical findings are encouraging and in favour of the present study.

Sunil Kumar

### **Some improved estimators of population mean in finite population sample surveys**

In this report, some improved estimators are proposed for estimating the population mean  $\bar{Y}$  of the study variable  $y$  using auxiliary variable  $x$  in simple random sampling. Explicit expression for the

## Research Activities

bias and MSE of the proposed family are derived to the first order of approximation. Comparisons of the proposed estimators with other estimators are also carried out. Finally, these theoretical findings are illustrated by a numerical example with original data.

Sunil Kumar

### **Use of some known values of population parameters for estimating the finite population mean for random non response in survey sampling**

In the present report a family of estimators for estimating population mean by using known values of some population parameters viz. standard deviation ( $S_x$ ), coefficient of variation ( $C_x$ ), kurtosis ( $\beta_2(x)$ ), correlation coefficient ( $\rho$ ) of the population is studied under an assumption that the number of sampling units on which information cannot be obtained due to random non response follows some distribution. The properties of suggested estimators are studied and their comparison is also studied.

Sunil Kumar

### **Latent class analysis for extreme response bias in consumer confidence data**

Latent class analysis is a statistical tool for evaluating the error in categorical data when two or more repeated measurements of the same survey variable are available. The purpose of this paper is to study the properties of survey based on the consumer confidence, with application for the individual level data from the consumer confidence survey, conducted by RBI, round 9. It is hypothesized that the respondents' answers are affected by extreme (negative) response bias, assuming extreme response bias from some households as a way to complain about their 'bad' position and general situation. With latent class analysis, a group of households that exhibits very negative attitudes in the areas covered by the questionnaire is identified. We identify a model with optimum performance and hence categorize the objective as well as subjective micro and macro factors covered in this survey as good classifiers or otherwise. The results indicate that the respondents are more comfortable with objective micro factors rather than macro or subjective factors.

Sunil Kumar

## ***Sociological Research Unit***

### **Data Gap in Gender Statistics: Women in Mining Industry**

Data on number of miners in India is collected by Annual Survey of Industries and Director General of Mines Safety among others 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. The purpose is to evaluate anomalies in the official data; gender gap in official statistics; and wages in India.

Molly Chattopadhyay

### **Utilization of developmental inputs and social networks**

It has been undoubtedly established that improper utilization of the productive forces especially labour forces creates a wide spread unemployment problem. As a result, incidence of poverty in India is not reduced satisfactorily; especially the rate of reduction in poverty is less in case of the people belonging to SCs, STs, and OBCs of rural India (National Human Development Report, 2001). In this context, the state Jharkhand (newly formed in 2001) can be mentioned. Though it is one of the rich mineral resource states in the country, it is the poorest state. On the basis of URP method, Jharkhand has 40.30% population below poverty line and 46.30% BPL population in rural Jharkhand (Rao, 2007). It has also been found that many of the male members of the villages of Jharkhand have migrated to various industrial sectors outside the state (such as Surat, Meerut, Kolkata, Rajasthan, Punjab etc.) for

maintaining as well as to improve their livelihood (Choudhuri et al., 2006). It can be mentioned that the district of Giridih in Jharkhand is in the lowest rung of developmental indicators as it suffers from high economic deterioration, low literacy level, high infant mortality and lowest health indicators (Choudhuri et al., 2006). So, it is revealed that in Jharkhand, situation is not at all satisfactory i.e., development of the target is marginally achieved. With this backdrop, the main focus of our study is to identify the different socio-economic, socio-cultural and socio-political factors to utilization of different given developmental inputs by SCs, STs, and OBCs in rural area of the Giridih district of Jharkhand.

Tirthankar Ghosh

## **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 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, Bangalore***

#### **Designing and developing a methodology for controlling critical sub-processes in software development life cycle**

As part of designing and developing a methodology for controlling critical sub-processes in software development life cycle to achieve software quality and reliability goals, a study on existing methods was carried out. A model was developed to arrive at an optimum test stopping criterion based on software reliability modelling and Taguchi methods, and tested at different information technology companies around Bangalore. A model for estimating defect density of embedded system software using Bayesian belief networks is developed and tested at different information technology companies around Bangalore. So far, two papers got published during this period.

Boby John

#### **Six Sigma Initiatives**

The present research work deals with the identification of critical success factors both in manufacturing and service sectors, which are important for a successful Six Sigma project. It also aimed at evolving a methodology to measure the effectiveness of the project.

Sanjit Ray

#### **Model for Business Process Improvement through Statistical Techniques**

Literature survey on the available methodology on process improvement was carried out to understand the nature of applications and models already available in business process improvement.

E. V. Gijo



### ***SQC and OR Unit, Chennai***

#### **Multiple Response Optimization**

A manufactured product is often evaluated by several performance measures called quality characteristics, each of which is described by a response variable. The values of these response variables are affected by one or more process parameters, i.e. input variables. Often the required process conditions for two or more response variables are contradictory. Therefore, it is generally difficult to find out an operating level of the input variables that can result in values close to the ideal or target values for all the response variables. The goal of multi-response optimization is, therefore, to find the settings of the input variables that achieve an optimal compromise of the response variables. It becomes more difficult when one or more of the response variables are categorical. We are trying to find a methodology for optimization of multiple responses where one or more response variables are categorical in nature.

Surajit Pal

### ***SQC and OR Unit, Coimbatore***

#### **Increasing the yield in the manufacturing of elastic adhesive bandage at coating stage**

About 1.2 million pieces of adhesive bandage were produced in a month. Over 40,000 pieces were rejected and scrapped which are not biodegradable, and thereby causing environmental risk. The scope of reducing rejection from 3% to below 0.5% was studied, saving about Rs. 14 lakhs annually and minimizing environmental impact. SQC methodologies for identifying size wise rejections and standardizing “**width of crepe fabric**” were followed by adequate training on ironing in order to remove wrinkles. Introduction of “**Kanban**” system of communication of incoming fabrics at coating stage, developing standards at peptitaton stage (the process responsible for the formation of stable dispersion of colloidal particles) in dispersion medium and developing a specification at the grinding stage for peptiser (Catalyst for easy grinding) were developed. Among 89 contributing factors (including batch variation among 56 batches), 27 factors were found significant and the corrective and preventive measures were initiated. As a result the probability of zero defects improved from 90.6% to 98.44% consistently every month.

A. Rajagopal

#### **Tehno-economic viability of investment in replacement of old spindles**

Capacity of spinning mills is measured by spindle capacity. One of the well known branded mills had to replace 67% of the capacity extending up to 42576 spindles which would cost an investment of about Rs. 213 lakhs. The need of replacement schedule, technical feasibility and economic viability were assessed. The loss of production caused due to low Speeds, Wastages, (due to higher breakages), Utilization (due to frequent breakdown) and the deterioration of yarn quality in respect of strength (CSP), imperfections and U% were statistically examined for significance for each frame in order to decide the replacement programme. The frames were grouped into two categories of around 10 years life and around 20 years life. Since annual maintenance of preventive care had been taken continuously, it may happen that the life of the spindle may not adversely affect the performance, productivity and quality of yarn. The statistical analysis revealed that while the life of spindles had significant impact on spindle speeds it did not affect adversely the quality of yarn (evaluated using correlation and regression tools). Therefore a prudent investment policy which affected productivity alone was identified. This helped the unit to decide to replace only 8640 spindles instead of entire old spindles of 10 years numbering 42576 spindles. This reduced the total investment from Rs.213 lakhs to 43 lakhs. The replacement cost and future returns by present worth calculation were arrived at considering the increased productivity of 68 grams from 64 grams per spindle of 8 hrs working. The result increased annual contribution by Rs.28 lakhs, registering an annual net profit around Rs. 2 lakhs for 20 machines of 8640 spindles after the provision of interest. The additional cash generated was

estimated at Rs.22 lakhs over a working life of 14 years paving the way of simple return on investment by 2 years. Such statistical based investment strategies contributed for prudent investment.

A. Rajagopal

### **Increasing the first time pass in foundry castings of high valued will mind components**

The leading corporate group supplied to international brands “**wind mill hub**” from their foundry division. About 2/3 of production pieces were reworked or rejected. This not only affected the sales turnover but additional grinding time on rework was done causing delay in dispatch, re-inspection by customer affecting the entire supply chain. The weight of the hub was about 2 tons for each piece. It was noticed that the additional grinding was carried out on surface from 5 mm up to 16 mm in some cases which had to be brought down below 3 mm. The process involved core preparation, mould preparation, mould core setting, mould closing, mould clamping, metal preparation, pouring, cast cooling and shaping out before dispatch. The chance for at least one defect was 46% predominantly attributed to “**sand inclusion**” among different locations. Top profile recorded higher grinding level as compared to bottom profile. The chemical components were analyzed such as C, Mn, Cr, Ni, Al, for 28 components. The data structure was found to have inter-dependence. Therefore Principle Component Analysis was carried out in order to identify components contributing to higher variations. The additional grinding level was further analyzed based on the predictor variables. An experimental design was conducted in order to choose the optimum levels of the control factors involving 7 factors out of 32 possible factors. The conduct and analysis of the experiments confirmed the optimum level and eliminated the additional operation almost totally.

A. Rajagopal

### **Health Sector**

#### **Reducing the delay in discharge of patients in discharge summary preparation of a multi speciality hospital at Coimbatore**

In recent years there has been a great orientation of the Quality consultants towards the development of more practical approaches in Health Care Management. National Accreditation Board for Hospitals & Healthcare Providers (NABH) is a constituent board of Quality Council of India, set up to establish and operate accreditation program for healthcare organizations. The last six months patient satisfaction survey conducted by the patient care department, in order to understand the “**Patient perceptions**”, revealed that they were particularly dissatisfied by the extensive time required for the preparation of discharge formalities. On an average, patients accepted a one hour for discharge, towards post consultant instructions. However, the reality was that the discharge process typically took as high as five hours. Discharge summaries are intended to transfer important clinical information from inpatient to outpatient settings and between hospital admissions (Rao, 2005). The inefficiency of the discharge process, combined with the dissatisfaction of patients in this process, could adversely affect the reputation and branding of the hospital. The boundaries of the patient discharge process are stretched across the hospital, navigating multiple functions in the hospital. The complexity of the process served as a good opportunity for the adoption of a Six Sigma project. Improvement at the turnaround time of this process would attract high visibility, apart from improving patient satisfaction. The total summary preparation time for the patient discharge summary was decomposed into sub-processes; and corrective actions in reducing discharge summary preparation time were applied through sub-processes. The results were encouraging. The effectiveness of the implementation of sub-process solutions awaiting delay were identified through the statistical distribution patterns of discharge time. The probability of completing the discharge summary by redefining the survival probabilities completing the discharge summary was predicted. This revealed that the discharge summary preparation time of 50% of the patients would be completed before 70 minutes against the previous figure of 117 minutes. This enhanced the capacity of the hospital for admitting additional patients by 20%. The hospital increased its profitability by approximately 18% of their turnover per annum, simultaneously satisfying the patients in quickly responding to discharge formalities.

A. Rajagopal

### **Awareness of breast feeding and effectiveness of multimedia programme**

This study was conducted in association with a reader of a nursing college. Lack of awareness of breastfeeding results in infant mortality, risk of diseases in mother and child, recurrent infections in the newborn, obstetric complications in mother and maternal obesity. Hence there is a need for such studies in the awareness of breastfeeding. It was observed that initiating breastfeeding within the first half an hour of birth and promoting colostrum feeding can save more than 2.5 lakhs babies in India. This would reduce 22% of deaths among newborns. UNICEF (2007) reported that India has close to 25 million children born every year. 1.4 million children die just within 1 year; one million children die due to malnutrition and other preventable diseases. Poor care, inappropriate infant feeding practices, delaying and restricting breast feeds and giving other products before six months, increases the risk of infection, allergy, long term diseases and death. The need for exclusive breast feeding up to six months was brought through awareness initiatives both by questionnaires and Multimedia programme. According to WHO at least 1 million deaths per year from diarrhea and infections are absolutely preventable through breast feeding. Breast fed babies have seven times less chance of an allergy. It was promoted that the breast feeding enhances health benefits for the mothers, prevent pre-lacteal feed, encourage timely complementary feeding with appropriate foods and continue breastfeeding for two years and beyond. That breast feeding increases levels of oxytocin, less post partum bleeding more rapid uterine involution were statistically supported. It was observed that lactating mother easily return to pre-pregnancy weight, delayed resumption of ovulation, increased child spacing, improved bone remineralization post partum. It reduced risks of breast cancer, pre menopausal endometrial cancer and ovarian cancer. The questionnaire was prepared before and after the multimedia programme among 30 mothers, on how to feed, what to feed, first milk (colostrums) being wasted, separations of infant soon after birth, delay in getting the infant to the breast causing reduction in milk production, increased level of anxiety to the mother. Provision of unwanted formula feed, bottle feed, rigid following schedule rather than neonate's demand early weaning and cessation of breastfeeding. 20 questions were prepared. 20 out of 30 mothers were found to be ignorant, answering all the questions wrong. The multimedia programme enabled the awareness of breastfeeding which reduced the unawareness from 66% to 5%. It was emphasized that nursing institutes in India having OBG department have singular role in controlling newborn mortality and morbidity and prevent complications to mother. There is a need to make country wide promotion of the same by all nursing institutions using statistical based information system and effectiveness on awareness of breast feeding.

A. Rajagopal

### **Software Sector**

#### **Maintaining the availability of associates at expected levels in MNC Software Company at Coimbatore**

This software company has an offshore branch in Coimbatore for its support projects. Five teams of 20 members are attending this account from 8 AM to 4 PM of 8 hours (or 480 minutes) with the accepted level of variation for each member. It was observed from past data that an associate is available from as low as '0' mins (non available in a day) to as high as 700 mins during the period from 6-Feb-2012 to 4-Mar-2012. This delayed the planning of availability of associate on the job and caused delay in resolution of tickets to the client. Slowly the employee took advantage of not adhering to any schedule on the duration of the work. Thus an uncertainty prevailed. This study was aimed at ensuring the availability of associates irrespective of their personal pre-occupation. Thus the problem was to reduce the standard deviation of working minutes from 96 to 50 minutes. The study enabled to reduce the non-availability of associates working below 480 minutes from the existing level of 28% to below 20%. The presence of every associate in their respective work floor was being captured by the automated access card system. For a single day, the time difference between the first entry and last exit of an individual was calculated as the total work hours of an individual. This information was collected from OLAP. The data were collected in respect of distance, age, educational qualification, and marital status and were statistically analyzed day wise. The result revealed that age and educational

qualification have no influence. But the associates can be grouped such that unmarried living in Coimbatore and far distance are allotted Friday / weekend so that the nonconformity could be reduced.

A. Rajagopal

### **Infrastructure Sector (Steel Plant assignment)**

#### **Predicting sensitive variables in material handling for job work in the handling of slag and skull at steel melting shop**

The handling of hot slags and skull in steel mills are special processes – which require special skills – involving earth moving equipment and people to work in hot temperatures. Mostly this process was outsourced. The outsourced team in the supply chain of services, earned profit margin ranging from +9% to –14% (Loss). This margin varied according to production and quantity of waste handled. The recent months registered a loss of –5.5% which needed to be turned in to a profit of +6% identifying sensitive cost variables. The resources involved were deployment of capital equipment such as tippers, excavator, taurus, backhow for the material handling and the setting up of in-house maintenance shop. The process involved cleaning, segregating, loading, removing spillage of slags and skull from different furnaces. The logistics had to be planned such that vehicles time, people time and resources like fuel, lube, tires and spares were not wasted. While some costs were sensitive to the quantity of production, some are insensitive. It was vital to identify sensitive cost among varieties of operational, administration, repairs, hiring and operational cost. The need for statistical analysis adopting regression methods were used in order to identify sensitive cost to material handling. The outsourced personnel however received a fixed rate of Rs. 184/per M.ton. The analysis enabled the service provider to fix minimum quantity from 14800 M. ton to 16300 M. ton per month. This helped both manufacturer and service provider. Sensitivity of fuel cost was noticed and, therefore, it was decided to increase by Rs. 11/M. ton. Reduction in expenditure on spares and tyres was achieved. Thus the supplier’s partnership was established, turning around the margin from -5.5% +3% consistently.

A. Rajagopal

### **Education Sector**

#### **School level**

##### **Parental feedback towards “Kaizen”**

The school designed a questionnaire in order to improve in the areas of

- a] Infrastructure related to class rooms, play ground, wash rooms, library and laboratories,
- b] School environment – related to cleanliness, communication, discipline, values and principles,
- c] Academics – related to efficiency of the teachers, teaching methodology, assignment and home work, student – teacher relationship, and
- d] Sports-co- Curricular – related to motivation, opportunity, coaching, recognition.

Both ordinal and dichotomous choices were given among parents of class VII and VIII students. The questions were analyzed using the conditional Bayes concept. The four areas attributed for improvement were identified as communication, washroom, teaching methodology, and coaching for co-curricular activities. This helped the management to redefine the processes. The response at the end of the academic year proved to yield an efficacious result – providing pleasing environment for introducing lean concept of learning.

#### **College level**

Quality of education when number of graduates increased was studied. Marks focus to market success was studied in understanding subjects for better placement opportunities. The employable

## Research Activities

capabilities and the pattern of arrears were statistically examined. This paper was submitted for PhD thesis by one of the faculty members of Engineering College affiliated to Anna University.

A. Rajagopal

### ***SQC and OR Unit, Delhi***

Mathematical Programming, Linear Complementarity Problem and its generalizations, Generalized Principal Pivot Transforms and its application in Game 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 Chakraborty

### ***SQC and OR Unit, Hyderabad***

Linear Complementarity Problem, Decision Support Systems, Six Sigma, DOE, SPC, Text Data Mining, Generalized Gaussian Distributions (GGD)

G.S.R. Murthy, A.L.N. Murthy, G.M. Rao, S.M. Subhani and P. Bhimasankaram

### ***SQC and OR Unit, Kolkata***

#### **Optimization and Reliability Modelling**

The following research problems have been undertaken under this project: Properties of a newly introduced matrix class; Weak Generalized Positive Sub-Definite (WGPSBD) matrices; Models for optimization of passengers' pick-up route by Radio Taxi in Metro cities; Optimization models to design minibus services to serve metro rail stations; Optimization models in air pollution management; Inference under hybrid censoring scheme; Inference and optimum censoring scheme for different lifetime distributions under progressive type-I interval censoring scheme; Determination of optimum censoring schemes using cost function approach; Proportional reversed hazard geometric extreme distribution.

Abhijit Gupta, Amitava Bandyopadhyay, Anup Dewanji (ASU), Anup Majumdar, Arup K. Das, Biswabrata Pradhan, Debasis Sengupta (ASU), Dipak K. Manna, Samir K. Neogy (SQC & OR Unit, Delhi)

#### **Assessing Defect Proneness of Use Cases**

Estimating defects of a large software product is a complex problem. The usual models require data that are often not available. Standard models often do not take the requirement complexity into consideration. In this work attempts were made to look at use cases as the functional requirement and characterize the same on the basis of their size and complexity. Subsequently, models were developed to estimate the number of defects in the use cases. The complexity assessment was made from the perspective of testing – a completely new perspective - and hence the issue of data availability was taken care of to a great extent. The developed methodology is being tested on real life applications and is being updated accordingly.

Amitava Bandyopadhyay

### **Framework Development to Control Accounts Receivable in Software Service Industries**

Software service industries work in the B2B space and the entire sale is made on credit. Accounts Receivable (AR) at any point of time often exceeds 25% of the assets of the firms. Standard measures like DSO and Aging Schedule exist to control the AR but these measures have well known weaknesses. Alternative measures have been suggested at a micro level but these are difficult to use particularly for software service companies having very large number of customers. In this work a framework for controlling AR has been proposed. The framework attempts to look at the problem of controlling AR from strategic, managerial and operational perspectives and is unique as no such framework exists for controlling AR. The framework is currently being evolved.

Amitava Bandyopadhyay

### **Identification of Important Capabilities for Growth of Indian IT Service Industry**

The growth of Indian IT service industry was intriguing and many attempts were made to understand the underlying capabilities. Capabilities like offshore delivery and availability of cheap manpower were well known. Other capabilities like project management, team dynamics and domain capability were studied. In this work, capabilities that may impact the performance of outsourced projects – particularly performance with respect to sales were identified. Value articulation capability was identified as the major capability impacting sales performance. The methods for developing this capability have been identified and measures for the same are currently being developed.

Amitava Bandyopadhyay

### **Identification of Skill Components for Java and .NET Programming and Development of Skill Index for the same**

Coding skill is one of the most important factors contributing to the success of software development projects. Although there are methods to measure technical coding skill, there is no way to roll up the skill data at a project level. Also various areas like domain knowledge, knowledge of tools and engineering and behavioural skills are often not assessed though these are extremely important from the perspective of project management. The coding and associated skills have been divided into 5 major categories and indicator variables have been identified for all. Experiments have been planned and conducted to collect this data. Attempts are now being made to confirm the theorized dimensions, develop a skill index at a project level and establish relationship between the skill index and project performance.

Amitava Bandyopadhyay

### **Work Done Under PPAC Data Quality Project**

PPAC, Ministry of Petroleum obtains oil and gas data from many different sources. PPAC compiles these data and provide information to the government regarding the usage of petroleum products. Ensuring quality of data from the perspectives of accuracy, consistency, timeliness and completeness is an important requirement. In this project a flexible reporting and data quality checking system has been developed. Using the concepts of stationarity and balance specific checks for accuracy and consistency were developed. The developed system is unique as international data quality systems do not provide methodologies for ensuring accuracy. Software was developed to implement the system on a routine basis.

Amitava Bandyopadhyay, Ranjan Sett and Anup Majumdar

### **Study on Some Implementation Issues of TQM in Higher Education and Other Service Sectors and Gap Analysis by Lean Management**

The scope of this work primarily centers on evaluation of degree engineering colleges in West Bengal by adopting six sigma metrics. The weak areas have been identified, benchmarking has been done and corrective measures have been suggested to attain the benchmark. In addition, a few financial

## Research Activities

institutions have been evaluated with regard to TQM implementation that helped to build up appropriate model to provide faster and better service to the customer.

Arup Ranjan Mukhopadhyay

### **Impact of Noise Quality due to Highway and Related Infrastructure Development: A Case Study of Construction of Second Vivekananda Bridge and Its New Approach Road**

Empirical data based studies have been carried out on honking and its influence on noise pollution and assessment of noise environment during construction of the Second Vivekananda Bridge and its new approach roads. The studies have dealt with extensively the measures of noise pollution in terms of equivalent sound energy level (Leq) as well as the noisiest situation that has been termed as  $L_{10}$ .

Arup Ranjan Mukhopadhyay

### **Study on Some Challenging Issues in Implementing Lean Six Sigma**

This work is primarily concerned with improvement of service quality by appropriately identifying and reducing non-value adding activities, waste, work-in-progress inventory level etc. to build up appropriate process modeling and measures in Lean Six Sigma.

Arup Ranjan Mukhopadhyay

### **Estimating join points and modeling for multiple change point problem for single series data**

Change point models arise in many life time data analysis, as it is often reasonable to assume that early failures occur at one rate and later on after some threshold times at different paces. The conventional single change point problem comes up when there are observation of a sequence of random variables  $X_1, X_2, \dots, X_n$  such that  $X_1, X_2, \dots, X_\eta$  ( $\eta \leq n$ ) follows a common distribution  $F$  and  $X_{\eta+1}, X_{\eta+2}, \dots, X_n$  have distribution  $G$  with  $F \neq G$ . The index  $\eta$ , called the change point, is usually unknown and has to be estimated from the data. Modeling this type of lifetime data is called 'change point modeling'.

We propose a general class of change point hazard model for survival data considering  $\eta (\geq 1)$  change points present in the data. We assume a curve to be composed of phases that are complex functions of time. We use Bayesian approach and provide inference conditional upon the observed data. The parameters of the proposed Bayesian model are estimated using Markov Chain Monte Carlo method.

Ashis Kumar Chakraborty

### **Modeling Structural Breaks in Panel Data**

Panel data is a multi-dimensional data collected at multiple time points on a number of subjects. Introduction of a common intervention for all the subjects may give rise to single or multiple change points sometimes called structural breaks, in each row of panel data. Several works have been reported on change point analysis of panel data.

We assume that the break points in the panel data occur at different time points for each of the subjects and common break points are a special case of the more realistic model. We assume here that the change points of different subjects follow a common distribution allowing heterogeneity in the timings of structural changes, and the problem of heterogeneous means *i.e.*, the magnitude of break depends on the series and the amount of change may not be same for all the series. A model for US data on quarterly personal income in million dollars of 50 states from 1948 to 2012 during Great Moderation by taking into account the above assumptions has been proposed. The initial phase of all the subjects following Pareto distribution with subsequent parameter change after intervention and the joint distribution of the change points as mixed normal distribution were assumed. This allowed heterogeneity in the structural change timings *i.e.*, response times across the subjects while retaining the commonality of the structural breaks occurrence due to the same reason. A Bayesian approach

has been proposed and a conditional inference upon the observed data has been provided. Markov Chain Monte Carlo technique was used to estimate the model parameters.

Ashis Kumar Chakraborty.

### **Process capability Control Chart for $C_{PU}$ and $C_{PL}$ Using Subgroup Information**

Most of the process capability indices (PCI) available in literature are formulated in terms of the parameters of the concerned quality characteristics. However, since the actual values of these parameters are often unknown, their estimated values are used to evaluate the estimated capability of a process. One such estimation procedure may be to use the estimates of these parameters obtained from the corresponding control charts used to check the stability of the said process. We have used this approach to redefine plug-in (natural) estimators of the two most famous PCI's for unilateral specification limits viz.,  $C_{PU}$  and  $C_{PL}$ . We have formulated the corresponding unbiased estimators and uniformly minimum variance unbiased estimators (UMVUE), wherever possible, and their distributions as well. We have also designed the process capability control charts of  $C_{PU}$  and  $C_{PL}$  based on these UMVUEs. For constructing these control charts, we have used the estimators of the parameters of the quality characteristics as obtained from the corresponding  $\bar{X}$  - S and  $\bar{X}$  - R charts. Process capability control charts can be used to check the consistency of capability of a process and also to keep a constant vigil on the process. It has been observed that our proposed process capability control charts are more efficient to detect changes in process capability than those already available in literature.

Ashis Kumar Chakraborty

### **Super-structure of Multivariate Process Capability Indices for Asymmetric Specification Region**

In manufacturing industries, often it is seen that the specification region corresponding to a particular quality characteristic is not symmetric about the mid-point of the two sided specification. A unified super-structure  $C_p^*(u, v)$  of process capability indices (PCI) for univariate case was specially designed for processes with asymmetric specification region. However, since in most of the practical situations, a process consists of a number of inter-related quality characteristics, we have developed a multivariate analogue of  $C_p^*(u, v)$  which is called  $C_M(u, v)$ . We have studied some properties of  $C_M(u, v)$  including its optimality on target, threshold value and relationship with proportion of non-conformance. A comparative study is also made of its properties to that of  $C_p(u, v)$ , the super-structure of PCI's for univariate processes with symmetric specification limits.

Ashis Kumar Chakraborty

### **Bayes Estimation of Quality Adjusted Lifetime Distribution**

This work considers Bayes estimation of quality adjusted lifetime (QAL) distribution in illness-death models. In particular two three-state illness-death models have been considered. In the proposed approach the theoretical distribution of the QAL has been first derived under suitable parametric modeling of sojourn time distribution. The model parameters and QAL distribution are then estimated by Bayesian method.

Biswabrata Pradhan and Anup Dewanji (ASU)

### **Developing a Measure of Multivariate Process Capability Index Using Multivariate g-and-h Distribution**

Process capability of a process is defined as inherent variability of a process which is running under chance cause of variation only. Process capability index is measuring the ability of a process to meet the product specification limit. The multivariate process capability indices, which are used for evaluation of processes with correlated quality characteristics are considered as new emerging research area. In this work, an approach has been provided on estimating multivariate process capability indices assuming multivariate g and h distribution that shows their performance using simulated and practical data set.

Nandini Das and Prem Saurav Dwivedi



### **Robust Control Charts for Controlling Location Parameter**

Control charts are very effective tools used for detecting whether there is any assignable cause of variation. They are usually developed under the assumption of independent and normally distributed data, an assumption rarely true in practice, and implemented with estimated control limits. But in general, we essentially want to control the process mean value and the process standard deviation, independently of the data distribution. In order to monitor these parameters, it thus seems sensible to advance with control charts based on robust statistics, because these statistics are expected to be more resistant to moderate changes in the underlying process distribution. In this work, some alternatives control charts have been proposed for controlling location parameters based on some robust estimators to show the performance of the proposed control charts and compare them with some existing robust control chart.

Nandini Das and Lalit Sachan

### **Estimating Process Capability Indices Using Univariate g-and-h Distribution**

Process capability of a process is defined as inherent variability of a process which is running under chance cause of variation only. Process capability index is measuring the ability of a process to meet the product specification limit. Generally process capability is measured by  $6\sigma$  assuming that the product characteristic follows Normal distribution. In many practical situations the product characteristics do not follow normal distribution. In this work, an approach is provided for estimating process capability assuming generalized g and h distributions proposed by Tukey.

Nandini Das

### **Optimum Censoring Scheme and Reliability Acceptance Sampling Plan under Hybrid Censoring**

This work considers determination of optimum hybrid censoring scheme using cost function approach. The proposed cost model is scale invariant for some specific life distributions. The optimum values of the decision parameters have been obtained under different lifetime distributions. The proposed method has been extended to other censoring scheme like progressive censoring scheme. This work also considers the determination of reliability acceptance sampling plan (RASP).

Ritwik Bhattacharya, Biswabrata Pradhan and Anup Dewanji (ASU)

### **Inference for the component and system lifetime distribution of a k-unit parallel system based on system data**

The inference for the component and system lifetime distribution of a  $k$ -unit parallel system with independent components based on system data is considered in this work. The components are assumed to have identical Weibull distribution. The maximum likelihood estimates of the unknown parameters based on system data is obtained. The Fisher information matrix has been derived. The  $\beta$ -expectation tolerance interval and  $\beta$ -content  $\gamma$ -level tolerance interval for the life distribution of the system is proposed. Performance of the estimators and tolerance intervals is investigated via simulation study. A simulated data set is analyzed for illustration.

Biswabrata Pradhan, Soumya Roy and M.Z. Anis

### **A family of tests for exponentiality against IFR alternatives**

The problem of testing exponentiality against IFR alternatives has been investigated. A measure of deviation from exponentiality is developed and a family of test statistics is constructed on the basis of this measure. It has been proved that the test statistic is an  $L$ -statistic. The asymptotic as well as the exact distributions of the test statistics are obtained and the test statistics are proved to be consistent. The Pitman efficiency has also been studied.

M.Z. Anis

### **Tests for exponentiality against NBUE alternatives: a Monte Carlo comparison**

The problem of testing exponentiality (which essentially implies no aging) against positive aging which is captured by the fairly large class of New Better than Used in Expectation (NBUE) distributions has been investigated. These tests of exponentiality against NBUE alternatives are discussed and compared. The empirical size of the tests is obtained by simulation. Power comparisons for different popular alternatives are done using Monte Carlo simulation. These comparisons are made both for small and large sample sizes. Suggestions have been made regarding the choices of the test when a particular alternative is suspected.

M.Z. Anis and Kinjal Basu

### **On some properties of the IDMRL class of life distribution**

Some properties of the Increasing then Decreasing Mean Residual Life (IDMRL) class of life distributions, which have not been addressed in the literature thus far have been investigated. Specifically it has been show that the IDMRL classes of life distributions are closed under weak convergence. The second result concerns preservation under the Poisson shock model. Some closure properties of IDMRL distributions have also been investigated.

M.Z. Anis

### ***SQC and OR Unit, Mumbai***

#### **Analysis of Project Management Process**

The objective of the study was to investigate the project delays happening in execution of real estate projects. Three sites were chosen for the study representing three geographic regions and variability in the type of structures. The findings of the study have been discussed with the management and an integrated project planning, scheduling, monitoring and review system is planned for future projects.

Ashok Sarkar

### **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.

#### ***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 4 floors (56000sq.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.

## Research Activities

- 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:

### 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 1205 books out of which 1041 were purchased from ISI budget and 98 from NBHM grant, while 73 books were received on complimentary basis. Added 01 book to the project collection. The Library also accessioned more than 1000 bound volumes of journals and subscribed to 540 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 8000 loose issues of journals. It classified and catalogued 1000 new books and filed 3562 computer printed catalogue cards. It also processed 120 titles on government reports/data-books etc. more than 200 government reports has been added. Beside this, the library has added a collection of 140 books, mainly in English, Bengali and Hindi on literature, humanities, travel, health and recreation in its Statistical Workers' Circulating Library totaling its collection to around 40000. 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 approximately 600 ebooks, 15 CDs & floppies containing books and CDs 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.

### 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 325 persons and 970 readers were given special permission to use the library for a short period. Currently the total number of library member rose to 2548. Total number of members including staff, students and research scholars of the Institute rose to 960 in its workers' circulating library.

## 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.

**Lending/Document Delivery Service:** During this period 103463 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 2500 pages of reprint requests and 1403 pages in soft copy from different full text database /journals. It provided email-based reminder services like 7-day advance alert, long overdue notice and check-in information. 18000 books from the workers' circulating library were issued for lending and reference during this period.

**Inter-library loan:** 50 Books and journals were borrowed from other libraries, while 129 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 8000 pages were photocopied from the journals.

**Electronic Document Delivery Service:** Full-text articles and/or bibliographical data were provided through email from online resources. Besides electronic document delivery, 5000 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: JSYOR (Life science). The online access is available through campus-wide network.

**Reprographic & Photographic Service:** During the year, it provided around 409270 pages of photocopies, 662 graphic designs, 7901 scanned items, 3500+ pages of color and b/w pages of print outs, 18300 pages of color photocopies, and 966 spiral bindings. 853 pages were laminated.

**Documentation Service:** A searchable bibliographic database has been prepared on scientific contributions made by the ISI scientists on all subject fields since 1934. The entries are currently being subjected to editing.

**General Enquiry Assistance & Consultation Service:** Assistance extended to 200 external visitors including participants of the Winter School, NBHM Nurture Programme and Summer Research School and visiting students of different institutions.

Research Activities

### **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 1000 physical volumes of journals. Lamination and de-acidification of 8 rare books of 2000 pages were completed, fumigated 120 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 100 Ph.D theses.

### **Digitization**

40 books were digitized. 17650 frames of microfilm/fiche were digitized. These will be made available on the Web after the completion of the work.

## ***Library, Delhi***

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 an automated library with an extensive collection of books, journals, CDs, reports, govt. publications and other documents in print and electronic formats. Some of the main activities of the library during the period under review were as under:

### **Collection Development**

**Books:** The collection size of books etc is 32500 and there are 16538 bond volumes of journals.

**Journals:** During the period under review 273 titles of journals, both foreign as well as Indian have been renewed. 23 journals on gratis and 10 journals in exchange are being received in the library from various sources. Over 820 journals are accessible online due to consortia based subscription initiated by Delhi Centre Library.

**Online Resources:** EconLit, "SIAM Academic Membership", "Current Index to Statistics", have been renewed.

**Consortia Based Subscription:** During the period under review, following Consortia based online subscription have been renewed:

- ScienceDirect (Consortia of three ISIs) Kolkata, Delhi and Bangalore with full text Elsevier Science group journals from year 1995.
- SpringerLink (Consortia of three ISIs) for Springer Group journals from year 1997.
- J-STOR (Consortia of three ISIs) for 184 full texts back volumes from Volume 1 onwards.
- Oxford University Press Online Journals (Consortia of three ISIs) for 54 full text journals from year 1996.
- MathSciNet (AMS) (Consortia of 22 institutions including three ISIs: Kolkata, Delhi and Bangalore) containing Bibliographic data and reviews from year 1940.

### **Exchange Program**

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" (book series).

### **Services**

**Circulation Services:** During the period April 1st 2012 to March 31, 2013, more than 100 members, availed the lending facilities as permanent members of the library, whereas around 250 members availed reference facilities of the library. More than 4000 publications have been circulated among the members.

**Reprographic Services:** During the period April 1, 2012 to March 30, 2013, more than 15000 pages have been Xeroxed and made available to users of the library and outsiders. Xerox facilities were also provided to 150+ research scholars of neighboring Institutes under NBHM programme.

**Electronic Document Delivery Service:** In addition to Xerox facilities, many full texts articles (PDF files) were provided through email from online journals/databases under NBHM programme.

**Current Awareness Service:** The following lists were brought out regularly from the library:

(i) Monthly list of current periodicals (Online) (ii) New additions (books) Online  
Brought out "Current Contents of Journals", by photocopying the contents page of each journal received at ISI, Delhi Centre library, during a specified period and distributed to 33 departments of Statistics and Mathematics of universities and institutions in the Northern region under NBHM programme.

### **Library WEBOPAC (BOOKS)**

The users have been given access to the complete Catalogue of the holdings through CATALOGUE-OPAC. A Web search engine has been provided in the library Home page.

### **LIBSYS- OPAC:**

LibSys-y was installed during this period. The internal user can use LIBSYS OPAC for the access of Catalogue by Author, Title and Publisher, which is only available in the campus LAN.

### **Journals Access from Outside ISI Delhi Campus**

Link has been provided to access the full text of journals from outside ISI Delhi. Outside user can access full text by using Username and Password, available with Library Staff.

### **Library Internship**

Two Library Trainees with were appointed for a period of ten months to undergo training in the practical aspects.

## ***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. Bangalore Centre Library has initiated applications were in users are made more interactive. The Library has developed a very distinguished collection in different knowledge domains namely Mathematics, Statistics, Economics, Quality Control and Operation Research, and Library and Information Science. Neural networks, Spatial Data Analysis and Communication Networks are some of the latest additions. Various services are designed to meet the Information needs of the Faculty members, Students, Research Scholars and Visiting Scientists.

## Research Activities

Walk-in users from other Research Institutes and Universities are also permitted to use the reading facility of the Library.

In order to cater to the requirements of the Users, the Bangalore Centre Library has extended its working hours from 5.45 PM to 7.45 PM on Week Days and on Saturdays from 9.30 AM to 5.30 PM, with effect from 01/12/2011.

The following activities were undertaken/and is being undertaken by the Library to achieve the aim during the period April 2012 – March 2013.

### **Collection Development:**

In order to meet the Collection development needs, books were displayed on approval basis at regular intervals in the Library for procurement, from various publishers. A BOOK EXHIBITION was held at ISIBC Library.

The Library purchased more than 400 books during this period of report. The Library subscribed to 317 journals, 13 journals were subscribed from NBHM grants. Additionally Library has subscribed to "IEL ONLINE" which gives access to journals and technical reports published by IEEE. The Library has 39 E-Books from World Scientific Publishing.

### **Technical Processing:**

Total number of books classified and catalogued during this period is 500.

### **Membership:**

More than 100 registered users enjoyed the Library facilities and the services. Also these facilities were extended to around 800 walk-in users during this period.

## **Library Services**

### **Current Content Service:**

Content pages of around 650 loose issues (Subscribed Journals) have been scanned to provide this service at ISIBC.

### **Circulation Service:**

Around 5,000 books and 200 bound volumes of journals were circulated during this period, 800 loose issues of journals were issued to overnight to users.

### **Inter-Library Loan Service:**

ISI Bangalore Centre Library has been identified as one of the best libraries in the select fields of study. As a result and also 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 50 documents in pdf format were downloaded and supplied to the registered users from e-versions of the journals.

### **Reprographic Service:**

During this period more than 70000 Xerox 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>. As a result of these services the library users have access to 450 Full-text Online journals. During January 2013, access was given to Econolit with two other databases

LISTA and Greenfile. Most of them are made accessible on account of ISI Consortia. The Library also provides access to various A&I services such as LISA, LISTA, MathScinet, Current Index to Statistics. A virtual Library in Mathematics has been designed for the benefit of the users. Additionally, Library has enumerated lists of Open Access journals in Mathematics & Statistics (120 titles); Library & Information Science (69 titles); Economics (89 titles); SQC (25 titles) and SSIU (14 titles). Further, ISIBC Library has finished processing the order for subscribing Lecture Notes in Mathematics (LNM) series of books with backfiles, which will be accessible from 1st April 2012. They are all made accessible through the Library Portal.

### ***Library, Tezpur***

It started functioning in mid 2011. During this period, it has added 600 books, 13 journals, 4 newspapers and 2 magazines. It has more than 400 circulations. Automation of library has been initiated. It has online access to more than 2000 e-journals. Total allocation was Rs 41.00 lakhs

#### **Collection Development:**

In order to meet the Collection development needs, books were displayed on approval basis at regular intervals in the Library for procurement, from various publishers. The Library purchased certain books during this period of report.

#### **Membership:**

The library caters mainly to the needs of students, scholars and faculty members of the Institute. Total number of members is 12.

#### **Library Services**

##### **Circulation Service:**

Around 150 books and other materials were circulated during this period.

##### **Inter-Library Loan Service:**

Received number of books from Central Library, Kolkata on inter library loan Kolkata to meet the immediate needs of the students and faculty members.

##### **Web Based Library Services:**

It has remote online access to more than e-journal 2000 e-journals. They are all accessible at <http://www.isical.ac.in/~library/ajournals.html>. Most of them were made accessible on account of ISI Consortia.

### ***Library, Chennai***

With the start of a full-fledged academic programme in 2011, Indian Statistical Institute Chennai Centre (ISIC) also started building up an academic library extending the already existing library of the SQC & OR unit at ISIC. The library, which aims to be a leading library in the fields of statistics, mathematics, computer science, quality control and operation research, started functioning in 2011. The library caters mainly to the needs of students, scholars and faculty members of the Institute.

#### **Collection Development:**

In order to meet the needs, books from various publishers were sometimes displayed on approval basis in the Library for procurement. A book exhibition was held in December, 2012. The Library also purchased more than 500 books during this period of report based on the request of the faculty. The library also got subscriptions of 16 journals during this time.



Research Activities

**Technical Processing:**

Total number of books classified and catalogued during this period is more than 700.

**Membership:**

The library caters mainly to the needs of students, scholars and faculty members of the Institute. Total number of members is 25.

**Library Services**

**Circulation Service:**

Around 300 books and other materials were circulated during this period.

**Inter-Library Loan Service:**

This service was not availed during the period of the report.

**Web Based Library Services:**

We are in process of becoming a part of the ISI Consortium, which will enable us in accessing over 2000 e-journals.

***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 website of museum & archives has undergone a new look and a new customized software has been developed for data storage and retrieval system of digitized PDF files. Ten nos.of audio spools has been restored through CD conversion and 3,500 no. of archival documents has been digitized. Under the conservation programme 4,500 archival documents has been treated. Computerized fire alarm and display security system like surveillance camera has been installed in the museum galleries.

The work for the proposed new gallery on Rabindranath Tagore and Prasanta Chandra has been initiated in this financial year.

Besides the general visitors, eminent persons and scientists and students from schools, colleges and universities were among the visitors of the museum. Scholars and researchers from different field consulted our archival collection for reference.

***Center for Soft Computing Research: A National Facility***

**Moving Object Segmentation & Tracking**

Change detection is an important low-level image processing operation that identifies changes in the state of a scene/object by observing it at different times. The number of applications that use a change detection stage is very large and includes automatic video surveillance, automatic traffic monitoring, remote sensing, and medical diagnosis, to mention a few. Most digital images and video sequences

today are both stored and transmitted in compressed form. This widespread compressed status of visual information in current multimedia systems promotes a large interest in the design and implementation of image and video processing algorithms that operate directly in a compressed video. In our work, a new method is presented for background subtraction in bitstreams encoded in H.264. Based on the motivation derived from the facts as outlined above, we contribute towards substantial savings in terms of computational and memory requirements, with performance comparable to those of the current state-of-the-art. Contributions are also made in which the proposed method is shown to work in real-time consistently under *variable* as well as *constant* bitrate encoding options.

B. Dey and M.K. Kundu

### **Using Rough Sets**

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. We have performed the task without having any prior knowledge; the object has been estimated here rather estimating the background. In this approach, we have used the feature reduction concept of rough set theory. Till now, the problem has been solved for single object and still camera. More complicated cases will be considered in future. A spatio-temporal approach for tracking with non-uniform granules, and rough entropy based spatial segmentation and beta-distribution based temporal segmentation is formulated. Merits of unequal granules vis-à-vis granules of same size are established. A new concept of forming 3-dimensional granules is introduced for object-background separation. This is useful for RGB-D feature space where depth information is available. Several indices for quantifying the performance of tracking are defined. These features are adequately demonstrated over different video images.

D. Chakraborty and S.K. Pal

### **Granulation and Natural Computing**

#### **Granular Computing, Granular Neural Networks for Pattern Recognition and Mining**

Granular computing is a very convenient approach for handling incomplete and uncertain information involved in data and plays essential role in human cognition. Granules can be described by performing operations, viz. similarity, proximity, equality, etc., among the data points.

We focus on developing granules using the concept of fuzzy sets, fuzzy rough sets and neural networks. The granules are incorporated into neural networks in order to generate granular neural networks rather than using conventional neural networks for pattern recognition and mining. These networks are efficient in solving the uncertainty and incomplete information involved in the data while they are using for handling pattern recognition tasks, viz., classification, clustering, feature selection etc. Recently, new fuzzy rough granular neural networks for supervised and unsupervised classification have been introduced, based on multilayer perceptron using gradient-descent method and self-organizing map. Future work includes gene selection, classification and clustering based on the proposed granular neural networks.

A. Ganivada and S.K. Pal

#### **Fuzzy Rough Granular Self Organizing Map**

A fuzzy rough granular self-organizing map (FRGSOM) is developed for clustering patterns having overlapping regions. Each feature of a pattern is transformed into a 3-dimensional granular space with centers and scaling factors corresponding to the linguistic terms low, medium or high. The three dimensional linguistic vectors are then used to develop granulation structures. These structures are presented in a decision table, which is used to determine the dependency factors of the conditional attributes using the concept of fuzzy rough sets. A new "fuzzy rough entropy measure", based on the resulting clusters and using the concept of fuzzy rough sets is also developed. Effectiveness of the

## Research Activities

FRGSOM and the utility of “fuzzy rough entropy” in evaluating cluster quality are demonstrated on different real life datasets, including microarrays.

A. Ganivada, S.S. Ray and S.K. Pal

### Remote Sensing Image Analysis

#### **Hyper Spectral Image Processing**

Hyperspectral sensors acquire a set of images from hundreds of narrow and contiguous bands of electromagnetic spectrum from visible to infrared regions. Hyperspectral imagery can be viewed as an image cube where the first two dimensions indicate the size of the image and the third one specifies the band number of the imagery. The computational complexity and curse of dimensionality are two major difficulties for classification of hyperspectral imagery due to the presence of large number of bands. In such a scenario, dimensionality reduction is an important task of hyperspectral image processing. Band selection and band extraction are two main approaches for dimensionality reduction. Depending of availability of label patterns, band selection and band extraction can be categorized as supervised and unsupervised ones. An attempt has been made to develop two band selection techniques, one follows supervised method and the other is unsupervised one. A supervised band selection technique use self-adaptive differential evolution (SADE) for searching band subset and fuzzy k-NN to calculate the classification accuracy which is used as evaluation criterion. Unsupervised band selection techniques combine clustering and ranking techniques in a single frame- work which uses DBSCAN algorithm for clustering operation and measures information divergence for ranking operation.

A. Datta and A. Ghosh

#### **Change Detection in Remotely Sensed Images**

A change detection technique using semi-supervised Hopfield-Type Neural Network (HTNN) has been developed. The purpose of the work is to show the usefulness of semi-supervision over existing unsupervised/fully supervised methods when we have only a few labeled samples. Here, training of HTNN is performed iteratively using a few labeled patterns along with a number of unlabeled patterns. A method has been suggested to propagate the label information using a kind of K-nearest neighbor approach. To check the effectiveness of the proposed method, experiments are carried out on multi-temporal remotely sensed images. Results are compared with other state of the art techniques and found to be significantly better.

A. Ghosh

#### **Supervised and unsupervised landuse map generation from remotely sensed images using ant based systems**

The landuse or land-cover map depicts the physical coverage of the Earth’s terrestrial surface according to its use. Landuse map generation from remotely sensed images is one of the challenging tasks of remote sensing technology. Motivated from group forming behavior of real ants, we have proposed two novel ant based (one supervised and one unsupervised) algorithms to automatically generate landuse map from multispectral remotely sensed images. Here supervised landuse map generation is treated as a classification task which requires some labeled patterns/pixels beforehand, whereas the unsupervised landuse map generation is treated as a clustering based image segmentation problem in the multispectral space. Investigations are carried out on four remotely sensed image data. Experimental results of the proposed algorithms are compared with corresponding popular state of the art techniques using various evaluation measures.

A. Haldar and A. Ghosh

#### **Optimization technique based on nature inspiring method and its application in real life problems**

We propose a new optimization technique for solving complex unconstrained optimization problems. In this method, the existing pattern search method has been modified and hybridized with the artificial

bee colony algorithm to improve the performance of the existing artificial bee colony algorithm. Moreover, the convergence proof of the algorithm has been studied analytically.

A mathematical model of a passenger car has been established taking into account the nonlinearity of the suspension and the tire. The suspension parameters and the tire stiffness parameters are determined using genetic algorithm.

S.D. Jabeen

## **Network Mining**

### **Analysis of Structural and Statistical Properties of a Large Network**

Degree distribution of nodes, especially a power law degree distribution, has been regarded as one of the most significant structural characteristics of social and information networks. In real world connectivity of network nodes generally follow a Power-law distribution. However, it is observed that for many large scale real world networks, the power law does not fit properly or in other words a single distribution is inadequate for the whole degree-frequency table of the real world networks. Therefore our aim is to break the whole degree-frequency table into several segments and try to fit appropriate distribution over each part. We have proposed a model to fit truncated geometric distribution on three distinct and non-overlapping segments of the degree frequency table. Extensive experimentation on 21 real world networks revealed that the proposed model is found to fit better than the power-law.

S. Chattopadhyay, C.A. Murthy and S.K. Pal

### **Influence Maximization in Large Scale Directed Social Networks**

Large scale on-line social networks became popular in recent years. Twitter, Facebook, Orkut, LinkedIn are a few examples. These social networks have millions of users. People around the globe are connected with the purpose of common interests. These applications are becoming a huge marketing platform of products and services, specially spreading the information to a large number of people in a short amount of time. However, the most important question arises "How to select the influential individual quickly, to target for marketing?" On-line social networks are dynamic in nature with large amount of user base. The most challenging part of the work is to deal with the large scale data and network dynamics. Solution needs to be flexible and efficient. The present work proposes a new centrality measure, called diffusion degree, for Independent Cascade Model, and it is then used to find the top k influential individuals in large scale directed social networks using Diffusion Degree Heuristic (DiDH). Further more, the existing centrality measures assume the propagation probability to be uniform throughout the network. That is, each node influences its neighbours with the same probability. But, in social relations, the trust of each tie may not be the same. The proposed centrality measure takes care of this accordingly and works flawlessly for such non uniform propagation probabilities. Besides these, mathematical upper bound of a node's influence is defined based on the network structure. Accordingly, a new centrality score of nodes, called Maximum Influence Degree (MID), is defined. Though it is computationally heavy to determine MID, yet it provides a good estimation to the upper bound of the influence over the entire network. Focus of the ongoing work is to provide deprecation based greedy strategy, which takes a list as an input and tries to find out the least beneficial nodes and remove them for further consideration. Through this approach, we show mathematically that the solution found through DiDH can be rectified for better results.

S. Kundu, C.A. Murthy and S.K. Pal

### **Dimensionality Reduction for Data Mining Applications**

The problem of finding window length for kernel density estimation has been studying. The window length is taken to be a function of the length of the Minimum Spanning Tree (MST) of the given observations where the edge weight is taken to be the Euclidean distance between the nodes. When the observations are in  $R^2$ , the function is taken to be  $\sqrt{\frac{l_N}{N}}$ , where N is the number of observations and

## Research Activities

$l_N$  is the length of MST. It has been shown that  $l_N \rightarrow \infty$  in probability and  $\frac{l_N}{N} \rightarrow 0$  in probability. It has also been shown that the above mentioned window length based density estimation is asymptotically unbiased and consistent to the exact value of the density at every continuity point. This proof will be extended to higher dimension with finer modifications on the window length. This procedure provides an automatic way of determining the window length for kernel density estimation. It has many uses in several applications including feature selection.

Sreevani and C.A. Murthy

## Bio-informatics

### Function Prediction of Unclassified Genes

Predicting the functions of un-annotated genes is one of the major challenges of biological investigation. A single data source can be used for such task but it often lacks the degree of accuracy needed for accurate gene function prediction. This can be improved by integrating different data sources in an efficient manner. In this study, we propose a weighted power scoring framework, called weighted power biological score (WPBS), for combining different biological data sources and predicting the function of some of the unclassified yeast *Saccharomyces Cerevisiae* genes. The relative power and weight coefficients of different data sources, in the WPBS, are estimated systematically by utilizing functional annotations of classified genes, available from *Saccharomyces* Genome Database. Genes are then clustered by applying k-medoids algorithm on WPBS, and novel functional predictions of 334 unclassified genes are made using a P-value cutoff  $1 \times 10^{-5}$ . These predictions may provide new directions in biological research. The WPBS is available online at <http://www.isical.ac.in/~shubhra/WPBS/WPBS.html>, where one can download WPBS, related files, and a MATLAB code to predict functions of unclassified genes.

S.S. Ray and S.K. Pal

### RNA and micro RNA Analysis

A common problem for researchers working with RNA is to choose a suitable technique to determine the three-dimensional structure of the molecule given just the nucleic acid sequence. In this regard, the application and importance of soft computing techniques like artificial neural networks (ANN), genetic algorithms (GAs) and simulated annealing (SA) to analyze and interpret RNA sequence data for predicting RNA secondary structure have been investigated. The learning ability of ANN and searching potential of GAs and SA have been found to be mainly utilized in the process. MicroRNA is a small RNA molecule (22 nucleotides) that functions in the regulation of gene expression and plays a major role in cancer. Three methods are developed to predict cancer from breast, colon, and melanoma cancer miRNA expressions. The first two methods determine whether a miRNA is indicating normal or cancer condition, and the third one determines how many miRNAs are supporting the cancer sample/patient. While, Method 1 acts as two class classifier and based on normalized average expression value, Method 2 also does the same and based on the normalized average intraclass distance. Method 3 checks whether a miRNA belongs to the cancer class or not, provides the percentage of supporting miRNAs for a cancer patient, and is based on weighted normalized average intraclass distance. The values of the weights are determined using exhaustive search by maximizing the accuracy in training samples. The proposed methods are found to be superior to the kNN and SVM classifiers for the above mentioned data sets.

J.K. Pal, S.S. Ray and S.K. Pal

### Computing With Words

Visualizing CWW as a supplement to natural language processing, our study on the Z-number methodology highlighted its capability of semantic-summarization and speaker-subjectivity-summarization of a statement; algorithms underlying the realization of CWW and Z-number based CWW have been proposed. This study further led to the design of a methodology based on Shannon's and Bayes' theorems that: a) granulates a text sample into cohesive units; b) extracts key sentences in

a text sample with reference to the exposure (familiarity) of a machine to a particular context and commonsense reasoning perspectives; and c) results in faster text processing. The results of all these investigations have been envisioned as major components of a cognitive model of text comprehension and Machine Intelligence Quotient (MIQ) measurement; work towards the fruition of these visualizations is currently in progress.

R.Banerjee and S.K. Pal

### **Cognitive Vision**

We have proposed a physiologically inspired adaptive algorithm for noise removal in an image, while preserving significant amount of edge details. The algorithm is motivated by the classical lateral inhibition based receptive field in the visual system as well as the holistic approach of the well-known bilateral filter. We propose an adaptive Difference of Gaussian (DoG) filter with varying window size depending upon edge strengths in the image. Our algorithm has advantages over similar other techniques like simple Gaussian filter, DoG filter and is comparable to the bilateral filter in terms of edge enhancement. Furthermore, time complexity of our algorithm is much less than the bilateral filter.

K. Ghosh

## **Computer and Statistical Services Centre**

Throughout the year CSSC managed the central computing facilities of ISI, Kolkata. It served approximately 700 users. Software packages available at the centre are – Arc GIS and MatLab. The centers at Bangalore and Tezpur were also given access to Matlab software.

The Centre managed campus-wide network and Internet facilities at ISI, Kolkata and Tezpur and also managed (a) secure wifi network of ISI, Kolkata and Tezpur and (b) Video Conference facility of all the centres of ISI. IP telephone infrastructure at ISI, Kolkata and Tezpur was installed by CSSC and IP telephones were provided to all the centres. The Centre provided Internet facilities and e-mail services to all the users of ISI, Kolkata and Tezpur.

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) workshops for training ISI officials on using of computers.
- (ii) courses for North-eastern states of India.

### 3. PROJECTS

#### Internally Funded Projects

##### *Ongoing Projects*

Sl. no.	Name of the project	Principal Investigator(s)	Unit(s) involved
<b>Applied Statistics Division</b>			
1.	Understanding of Genes and Genomes through Fractals and Mathematical Morphology	Pabitra Pal Choudhury	ASU
2.	Some Application of the Density Power Diverge In Statistical Inference	Ayanendranath Basu	BIRU
3.	Strategic Network Formation and Evolution	Sourabh Bhattacharya	BIRU
4.	Neogene Sedimentation and Tectonics of Cachar Fold Belt, Northeast India	Anwarul Alam Laskar, Dilip Saha & Parag Phukon	ISINE, Tezpur, & GSU
<b>Computer and Communication Sciences Division</b>			
1.	Physical Design for 3D IC's	Susmita Sur-Kolay	ACMU
2.	Reconfiguration Problems	Subhas C. Nandy	ACMU
3.	Partitioning and Covering Problem of Polygon in 2D	Sandip Das	ACMU
4.	Power and Bandwidth Management in Wireless Networks	Bhabani P. Sinha	ACMU
5.	Low Memory Algorithms	Arijit Bishnu	ACMU
6.	Universal Mobile Telecommunication Systems (UMTS) network planning	Sasthi C. Ghosh	ACMU
7.	Distributed Computation in pervasive Computing Environment (DCPC)	Nabanita Das	ACMU
8.	Extending the scope of formal Verification with Assertion Mining from Simulation Traces (ASMT)	Ansuman Banerjee	ACMU
9.	Algorithmic and Architectural Design Issues of Microfluidic Nano-Biochips for Bioassay Execution (MICROBE)	B.B. Bhattacharya	ACMU
10.	Script Identification from Handwritten Documents	U. Pal	CVPR
11.	Analysis of Tagore's handwriting	B.B. Chaudhuri	CVPR
12.	Automatic real word error detection and correction	B.B. Chaudhuri	CVPR
13.	Online Bangla Cursive Handwriting Recognition	U. Bhattacharya	CVPR
15.	Detection of Man and Calcification in Digital Mammogram	D.P. Mukherjee	ECSU
16.	Design and Development of a Multimodal Biometric System	B. Chanda	ECSU

17.	Controlled Access to Documents over a Digital Library Ontology under Multiple Inheritance	A. Bagchi	ECSU
18.	Content based Video Indexing & Retrieval using Visual & Temporal Features	B. Chanda	ECSU
19.	Design & Implementation of Online Atmospheric Pattern Detection & Global change monitoring System.	S. Pal & N.C. Deb	ECSU
20.	Automated Surveillance Systems using Hidden Markov Model	K.S. Ray	ECSU
21.	DNA computing based on splicing operation	K.S. Ray	ECSU
22.	Development of gene selection algorithms from microarray data: fuzzy-rough and neighborhood rough set based approaches.	P. Maji	MIU
23.	Incorporation of knowledge for analyzing biological data	S. Mitra	MIU
24.	Use of computational intelligence approach for image and video content based retrieval and data security.	M.K. Kundu	MIU
25.	Development of Computational Methods for Analyzing Biochemical Pathways as Integrated Systems	R.K. De	MIU
26.	Face recognition in color images II	C.A. Murthy	MIU
27.	Moving Object Detection and Tracking from Complex Video Sequences	A. Ghosh	MIU
28.	Fuzzy Opinion Mining in Social Networking	D.P. Mandal	MIU
29.	A computational approach for human gene function prediction and network analysis	S.S. Ray	MIU
30.	Network Analysis of Biomolecules for Disease Therapeutics	S. Bandyopadhyay	MIU
31.	Human depth EEG processing for epilepsy and cognition	Kausik K. Majumdar	SSIU
32.	Pattern classification with granular neural networks	Saroj K. Meher	SSIU
<b>Physics and Earth Sciences Division</b>			
1.	Tectonics of metagranite-metabasalt association in the southern part of the Nellore schist belt – petrological and geochemical approach	D. Saha	GSU
2.	Evolution of carbonate platform through time: examples from PG valley, Chattisgarh and Cuddapah basins	S. Patranabis-Deb	GSU
3.	Community Structure and ecology of the Mesozoic non-marine tetrapods of the Gondwana basins of peninsular India	D.P. Sengupta	GSU
4.	Study of gastropod diversity from the Indian fossil record (Mesozoic-Caenozoic) with special emphasis on phylogenetic systematic, evolutionary trends and palaeoecological interactions	S.S. Das	GSU
5.	A Study of Neogene and Quaternary successions of eastern Himalayan foreland basins	T. Chakraborty	GSU



## Projects

6.	Precision Cosmology using combined dataset of CMB Lansing and SN1a	Supratik Pal	PAMU
7.	Simulation of hawking effect in effect in analogue (fluid) gravity model	Subir Ghosh	PAMU
<b>Biological Sciences Division</b>			
1.	Management strategies for rice cultivation in the eastern plateau: Field experimental and crop modelling approaches	P. Banik	AERU
2.	Allelopathy in an Aquatic and neighbouring Ecosystem and the role of allelochemicals in community structure	S. Mandal Biswas	AERU
3.	Site Specific Nutrient Management (SSNM) System for submerged rice in the eastern plateau region of India	P. K. Ghosal	AERU
4.	A study on yield performance for different annual crops for the production of bio-fuel	S. Barik	AERU
5.	Detection, mapping and phenoplasticity of <i>Alternanthera philoxeroides</i> : an invasive weed	A. Dewanji	AERU
6.	Antioxidant scavenging and corresponding gene regulation in some mangroves of Sundarbans	S. Das	AERU
7.	Nanobiotechnology: From basics to application in different sectors of agriculture veterinary sciences and medicine	A. Goswami	AERU
8.	Cooperative Recovery Mechanism: A Safeguard for Minimizing Extinction Risk	S. Bhattacharya	AERU
9.	Field testing, biosafety assays and agronomic evaluation of nanocides and nanofertilizers	A. Goswami	AERU
10.	Health of the stone quarry workers of Birbhum district, West Bengal	S.K. Roy	BAU
11.	Weight related behaviours among adolescent girls: An exploratory study	S. Mukhopadhyay	BAU
12.	Population based Versus Family-based Genetic Association Studies	S. Ghosh	HGU
13.	Significance of mitochondrial DNA (mtDNA) mutations in the Progression of normal epithelium cell to leukoplakia and cancer in oral cavity	Bidyut Roy	HGU
14.	Multi Locus association and related issues	I. Mukhopadhyay	HGU
<b>Social Sciences Division</b>			
1.	Evaluation of Data on Land Holdings in Rural India	V.K. Ramachandran	EAU
2.	Interlexical study of Asamiya in a substantivist framework	Probal Dasgupta	LRU
3.	Bengali Pronunciation Dictionary in Electronic and Printed Form	Niladri Sekhar Dash	LRU

4.	Women's Labour Force Participation in India. Women and Work in Rural India	Farzana Afridi, Abhiroop Mukhopadhyay & Taryn Dinkelman (Dartmouth College)	EPU
5.	Group Identity and Gift Exchange	Farzana Afridi & Sherry Xin Li (University of Texas, Dallas)	EPU
6.	Does Gender Impact Public Accountability and the Quality of Poverty Alleviation Programmes? Evidence from Andhra Pradesh, India.	Farzana Afridi & Vegard Iversen	EPU
7.	The Macroeconomic Implications of Education: Moving Beyond Labour Productivity	Tridip Ray & Mausumi Das (Delhi School of Economics)	EPU
8.	An Empirical Examination of Consumption Externalities	Abhiroop Mukhopadhyay & Monishankar Bishnu	EPU
9.	Status and Bargaining: An Experimental Investigation	Bharat Ramaswami & Subrato Banerjee	EPU
10.	Competition Dynamics and Sustainability of Micro Finance Institutions	Prabal Roy Chowdhury & Indrani Roy Chowdhury (Jamia Millia Islamia)	EPU
11.	Empirical Testing of Multi-Object iterative Auctions	Debasis Mishra	EPU
12.	Non – Farm Employment and Rural Wages	Kanika Mahajan & Bharat Ramaswami	EPU
13.	Information and Efficiency in Agricultural Markets	Bharat Ramaswami & Ken Kubo	EPU
14.	Long Run Consequences of the Mahatma Gandhi National Rural Employment Guarantee Scheme	Abhiroop Mukhopadhyay	EPU
15.	Cognitive processing through PASS model and its role in determining academic performance of school students in North – Eastern India	Anjali Ghosh	Psychology Research Unit
16.	Differential Validity of Computer Programming Abilities	D. Dutta Roy	Psychology Research Unit
17.	Strategic Network Formation and Evolution	Diganta Mukherjee	SOSU
18.	Data Gap in Gender Statistics: Women in Mining Industry	Molly Chattopadhyay	SRU
19.	Utilization of developmental inputs by SCs, STs, OBCs and their social networks: Experiences in Jharkhand	Tirthankar Ghosh	SRU
<b>Statistical Quality Control and Operations Research Division</b>			
1.	Study to identify key parameters leading to failure of BPO/outsourcing deals	Boby John & Amitava Bandopadhyay	SQC & OR Unit, Bangalore & Kolkata

## Projects

2.	Optimization and Reliability Modeling	Biswabrata Pradhan	SQC & OR Unit, Kolkata, Delhi & ASU
<b>Library, Documentation and Information Sciences Division</b>			
1.	Indexing, Digital Imaging and Online hosting of Photo images in ISI Repository	Nibedita Ganguly	Library, Kolkata
2.	Digital Repository of Contribution of ISI Scientist-Phase II (1988 - onwards)	Ashis Kumar Pal	Library, Kolkata
3.	Digital processing/redeployment of official statistics collections	Bhomra Chatterji	Library, Kolkata
4.	Arrangement and description of archival collection of P.C. Mahalanobis Memorial Museum & Archives'	Krishna Bhattacharyya	Library, Kolkata

## Completed Projects

Sl. No.	Name of the project	Principal Investigator(s)	Unit(s) involved
<b>Theoretical Statistics and Mathematics Division</b>			
1.	Workshop on Extreme and Rare events	Krishanu Maulik	Stat-Math, Division
2.	Workshop on Lie Groupoids and Lie Algebroids	Mahuya Datta	Stat-Math Unit, Kolkata
3.	Indian School and Conference on Logic and its application	S.M. Srivastava	Stat-Math Unit, Kolkata
4.	Lectures on Probability and Stochastic Processes VII	Antar Bandyopadhyay, Siva Athreya & Krishanu Maulik	Stat-Math Unit, Division
5.	Young Visitors Program at ISI, Delhi	Antar Bandyopadhyay & Deepayan Sarkar	Stat-Math Unit, Delhi
<b>Applied Statistics Division</b>			
1.	Some Design Issues in Survival Analysis	Anup Dewanji	ASU
2.	Understanding Genomics and Organ Specific Fractals Landscapes in Transplantable Organs	Pabitra Pal Choudhury	ASU
3.	Design & Analysis of Cryptographic Scheme	Palash Sarkar	ASU
4.	Analysis of Olfactory Receptor Genomic Clusters at the Functional level using Boolean Function/Cellular Automata and Patteren Recognition Techniques	Amita Pal	BIRU
5.	Bayesian Inference in Spatial Point Process	Sourabh Bhattacharya	BIRU
<b>Computer and Communication Sciences Division</b>			
1.	Power and BandwithManagement in Wireless Networks (PoBaMa)	B.P. Sinha	ACMU
2.	Low Memory Algorithms (LowMem)	Arijit Bishnu	ACMU
3.	UMTS Network Planning	Sasthi C. Ghosh	ACMU

Projects

4.	Pronominal Anaphora Resolution in Bangla	U. Garain	CVPR
5.	An Integrated Approach to Rational Drug Design	S. Bandyopadhyay	MIU
6.	Development of pattern recognition and machine learning tools for solving certain problems in systems biology –II	R.K. De	MIU
7.	Derivation of spatially significant set via spatial analysis and reasoning	B.S. Daya Sagar	SSIU
<b>Physics and Earth Sciences Division</b>			
1.	Floodplain facies: A study of litho-facies and geochemistry of the fines-dominated fluvial deposits of the Gondwana successions	P. Ghosh	GSU
2.	Physicochemical Studies on Organized Assemblies (Microemulsions/Reverse Micelles) of Mixed Surfactants	B.K. Paul	GSU
<b>Social Sciences Division</b>			
1.	Substantivist lexicological study of Bangla	Probal Dasgupta	LRU
2.	Linguistic Field Survey at Giridih, Jharkhand	Niladri Sekhar Dash	LRU
3.	Development and Structure of Education Loan Markets in Less Developed Countries	Tridip Ray	EPU
4.	Workshop on Techniques of Analysis of Demographic and Health Statistics and Application of Computer Softwares	Prasanta Pathak, Subhas Burman and Partha De	PSU
5.	Personality profile, stress and job satisfaction of Indian sea farers	Rumki Gupta	Psychology Research Unit
<b>Statistical Quality Control and Operations Research Division</b>			
1.	Study on environmental impact of textile dyeing companies on consumption of water and compliance to pollution control norms	A. Rajagopal	SQC & OR Unit, Coimbatore
2.	Establishing a system for measurement of efficiency of hydro power project – feasibility study only	A. Rajagopal	SQC & OR Unit, Coimbatore

## Externally Funded Projects

### Ongoing Projects

Sl. no.	Name of the project	Principal Investigator(s)	Unit(s) involved	Funded by
<b>Theoretical Statistics and Mathematics Division</b>				
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

## Projects

3.	Harmonic Analysis on Riemannian Symmetric spaces Damek-Ricci spaces Homogenous Tress	Rudra P. Sarkar	Stat-Math Unit, Kolkata	NBHM
4.	Risk Analysis, Ruin and Extremes (RARE)	Krishanu Maulik & Parthanil Roy	Stat-Math Unit, Kolkata	Marie Curie Research Staff Exchange Fellowship from the 7 <sup>th</sup> European Community Framework Programme
5.	Safety Monitoring capability of the Indian air-space	Antar Bandyopadhyay	Stat-Math Unit, Delhi	Airports Authority of India, Ministry of Civil Aviation
6.	Workshop on Airspace Safety Monitoring	Antar Bandyopadhyay	Stat-Math Unit, Delhi	Airports Authority of India, Ministry of Civil Aviation
7.	Indo-Mexico Project on Diophantine Equation with Product of Integers in Arithmetic Progressions	Shanta Laishram	Stat-Math Unit, Delhi	Department of Science and Technology (DST) and the National Council for Science & Technology (CONACYT) of United Mexican States
<b>Applied Statistics Division</b>				
1.	Design and Development of Database and Analytical Tools for Microarray Data on <i>Leishmania donovani</i> Parasite	Ashis SenGupta	ASU	Ministry of Science & Technology, Government of India
<b>Computer and Communication Sciences Division</b>				
1.	New Techniques of Fast Image Compression Based on Human Vision Systems and Geometric Data Structures.	B.B. Bhattacharya & M.K. Kundu	ACMU & MIU	Intel Corporation, USA
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.	Parallel H.264 Codec Implementation	S. Sur-Kolay, B.B. Bhattacharya & A. Banerjee	ACMU	Texas Instruments, India
5.	Distributed Algorithms for Geometric problems for Robot swarms	Krishnendu Mukhopadhyaya	ACMU	DST
6.	Multilingual Word Spotting for Degraded Documents	U. Pal	CVPR	Indo French Centre for the Promotion of Advanced Research (IFCPAR)

Projects

7.	Development of Online Handwriting Recognition System for Indian Languages – Phase II	S. K. Parui	CVPR	DIT, Govt. of India
8.	Cross-Lingual Information Access System (CLIA) – Phase II	M. Mitra	CVPR	DIT, Govt. of India
9.	Development of Robust Document Analysis & Recognition System for Printed Indian Script Phase-II	B. B. Chaudhuri	CVPR	DIT, Govt. of India
10.	Sentiment Analysis & Development of a Prototype System for Telecom Industry	S. K. Parui	CVPR	Tech Mahindra
11.	Development of a Dependency Parser for Bengali	U. Garain	CVPR	Society for Natural Language Technology Research (SNLTR)
12.	agINFRA	A.R.D. Prasad & Devika P. Madalli	DRTC	European Union Commission
13.	ITPAR	A.R.D. Prasad & Devika P. Madalli	DRTC	DST/ University of Trento, Italy
14.	Digital Image Reconstruction of Indian Cultural Heritage with Focus on Hampi Ruins	B. Chanda	ECSU	DST
15.	Rough-Fuzzy Computing and Multiresolution Image Analysis for Segmentation of Brain Tumor from Magnetic Resonance Images.	P. Maji	MIU	Indian National Science Academy
16.	RADIOMICS	S. Mitra	MIU	Maastricht University
17.	Processing and Analysis of Aircraft Images with Machine Learning Techniques for Locating Objects of Interest.	A. Ghosh	MIU	U. S. Army
18.	Computational Methods for Micro RNA Target Detection and its Role in Cancer Development	S. Bandyopadhyay	MIU	DST
19.	Computation in the brain: neuron, synapse, astrocyte interactions in small networks	Kausik K. Majumdar	SSIU	DST
<b>Physics and Earth Sciences Division</b>				
1.	Ganga River Basin Management Plan	T. Chakraborty, P. Ghosh & S.N. Sarkar	GSU	Ministry of Environment and Forests, Govt. of India
2.	Depositional models and sedimentation history of Proterozoic sedimentary basins of Peninsular India.	S.Patranabis-Deb	GSU	De Beers Group
3.	Nellore schist belt and Proterozoic tectonics of the southeast margin of India	D. Saha	GSU	DST
4.	The thermal evolution of Peninsular Indian : past behaviour and future potential	S. Bhattacharya & D. Saha	GSU	DST, AISRF

## Projects

5.	Particle-fluid interactions at turbulent boundary layer flow over smooth/rough surface using Image processing technique	S. Ghosh	PAMU	Council of Scientific and Industrial Research (CSIR)
6.	Water wave scattering and associated mathematical techniques	B.N. Mandal	PAMU	National Academy of Sciences India (NASI)
<b>Biological Sciences Division</b>				
1.	Development of information on Agricultural and Horticultural production using RS and GIS technology in some district of West Bengal	P. Banik	AERU	DST, GoWB
2.	Effect of Different sources of Water soluble Phosphetic Fertilizers in Eastern plateau area	P. Banik	AERU	Rashtriya Chemicals And Fertilizers Ltd.(Gol)
3.	An investigation on antimicrobial potential of chebulic myrobalan (fruit of Terminalia chebula Retz.) against methicillin resistant Staphylococcus aureus	R.R. Chattopadhyay	AERU	DST, GoWB
4.	Designing and Studying Mode of action and biosafety of nanopesticides	A. Goswami	AERU	ICAR, Gol & World Bank
5.	Health status and health behaviour of Santals: Comparison between urban and rural groups	S.K. Roy	BAU	ICMR
6.	Physical Growth, Body Composition and Nutritional Status of the Bengali School aged Children, Adolescents and Young adults of Calcutta: Effects of Socioeconomic Factors on Secular trends	P. Dasgupta	BAU	The Neys van Hoogstraten Foundation, The Netherland
7.	Studies on expression and analysis of miRNA genes in oral cavity cancer and precancer: Significance in marker development and pathogenesis	B. Roy	HGU	DBT, Gol
8.	Genome Wide Association Study of Chronic Pancreatitis	S. Ghosh	HGU	DBT, Gol
<b>Social Sciences Division</b>				
1.	Impact of Economic Reforms on Tribal Poverty	Kunal Chattopadhyay	ERU	NABARD
2.	Socio-Economic Conditions of Five Minority Communities in the District of Murshidabad, West Bengal	Pulakesh Maiti	ERU	Government of West Bengal
3.	The Diagnostic Survey of Closed Industrial under Micro & Small Scale Enterprises, West Bengal	Pulakesh Maiti	ERU	Government of West Bengal

Projects

4.	Linkages between Disperse Urbanization and Rural Industrialization A case Study from West Bengal	Subhendu Chakraborty	ERU	South Asia Network of Economic Research Institutes (SENEI)
5.	Evaluation Study on Boarder Area (BADP) Cluster – B	Buddhadeb Ghosh	ERU	Planning Commission, Government of India
6.	Evaluation Study on Boarder Area (BADP) Cluster – C	Buddhadeb Ghosh	ERU	Planning Commission, Government of India
7.	Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)	Buddhadeb Ghosh	ERU	Planning Commission, Government of India
8.	Gaps in gender statistics	Madhura Swaminathan	EAU	National Statistical Commission
9.	Indian Language Corpora Initiative-Bengali-2 (ILCI-2)	Niladri Sekhar Dash	LRU	DIT, Govt. of India
10.	Inradhanush WordNet Development for Bengali Language	Probal Dasgupta & Niladri Sekhar Dash	LRU	DIT, Govt. of India
11.	Impact of the Forest Rights Act	E. Somanathan	EPU	IGC
12.	Political Competition and Corruption in India	Farzana Afridi Anirban Kar	EPU	No poor Project (EU Grant)
13.	Study of Corporate Social Responsibility under IISCO	Sandip Mitra	SOSU	IISCO, SAIL
14.	Dream Building	Sandip Mitra	SOSU	Warwick (ESRC Grant)
<b>Statistical Quality Control and Operations Research Division</b>				
1.	Six Sigma Training & Implementation	U.H. Acharya	SQC & OR Unit, Bangalore	TVS Motor Company
2.	Quality Control-Basics Training	U.H. Acharya & Somnath Ray	SQC & OR Unit, Bangalore	NADP Nagpur
3.	Six Sigma Training & Implementation	K.K. Chowdhury	SQC & OR Unit, Bangalore & Pune	Bharat Electronics
4.	Review and guidance on statistical methodologies & tools	Boby John	SQC & OR Unit, Bangalore	Accenture
5.	Facilitation and guidance for statistical modelling	Boby John	SQC & OR Unit, Bangalore	Infosys
6.	Facilitation and guidance for statistical modelling	Boby John	SQC & OR Unit, Bangalore	Hewlett Packard
7.	Process Improvement Training and Implementation	P.K. Perumallu	SQC & OR Unit, Bangalore	Centum Rakon



Projects

8.	Six Sigma Training & Implementation	P.K. Perumallu	SQC & OR Unit, Bangalore	HAL Engine Division
9.	Six Sigma Training & Implementation	Sanjit Ray	SQC & OR Unit, Bangalore	Madura Clothing, Aditya Birla Nuovo Ltd.
10.	Training on SQC	P.K. Perumallu	SQC & OR Unit, Bangalore	AVTEC
11.	Six Sigma Training and Project Consultancy	A. Rajagopal	SQC & OR Unit, Coimbatore	KG Hospital
12.	Environmental Aspects and Impacts with Measurements on Zero Liquid Discharge, PH and TDS	A. Rajagopal	SQC & OR Unit, Coimbatore	TCTP
13.	Six Sigma Training and Project Guidance	A. Rajagopal	SQC & OR Unit, Coimbatore	Six Sigma in Weekend
14.	Break Down Analysis of New machinery and Improvement with Compliance to ISO 9001 Standard.	A. Rajagopal	SQC & OR Unit, Coimbatore	Shiva Textiles
15.	DOE approach to foundry Industry	A. Rajagopal	SQC & OR Unit, Coimbatore	L & T
16.	To test the improved quality of the Candidate Oil with respect to Reference Oil at Power Plant.	Rina Chakravorty	SQC & OR Unit, Delhi	Indian Oil Co. Limited
17.	Quality & Process Improvement	G. Murlai Rao	SQC & OR Unit, Hyderabad	Quislex Legal Services Pvt. Ltd.
18.	Design and development of Risk Based Sampling Model	G. Murali Rao & A.L.N. Murthy	SQC & OR Unit, Hyderabad	State Bank of India
19.	Quality Management	G.S.R. Murthy & A.L.N. Murthy	SQC & OR Unit, Hyderabad	Birla Tyres, Laksar
20.	Healthcare Data Quality Assessment	Prasun Das	SQC & OR Unit, Kolkata & Bangalore	NRHM, Dept. of H&FW, Govt. of W.B.
21.	Six Sigma Black Belt Training & Projects	Arup Ranjan Mukhopadhyay	SQC & OR Unit, Kolkata	ITC, Munger
22.	Six Sigma Black Belt Training & Projects	Arup Ranjan Mukhopadhyay	SQC & OR Unit, Kolkata	Price Waterhouse Coopers, Kolkata
23.	Developing Intelligent System for Steel Defects Characterization	Prasun Das	SQC & OR Unit, Kolkata	Tata Steel Limited
24.	ISO 9001:2008 QMS and ISO 14001:2004 EMS	Ranjan Sett	SQC & OR Unit, Kolkata	DIC India Limited.
25.	Training on Sig Sigma	S. Rath	SQC & OR Unit, Pune	ARAI, FID, Chakan
26.	Six Sigma Initiatives	S. Rath	SQC & OR Unit, Pune	Technova Imaging Systems Ltd.
27.	Six Sigma Support	S. Rath	SQC & OR Unit, Pune	Marico Ltd.

Projects

28.	Six Sigma Programme	S. Rath	SQC & OR Unit, Pune	AIM
29.	QFD/DFMEA Programme	S. Rath	SQC & OR Unit, Pune	Elcon, Anand
<b>Center for Soft Computing Research</b>				
1.	Statistical, Structural and Soft Computing based Techniques for Pattern Recognition: Theory, Algorithms and Applications to Bioinformatics	S.K. Pal	Center for Soft Computing Research	Indo-Brazil collaborative project, DST, New Delhi

**Completed Projects**

Sl. no.	Name of the project	Principal Investigator(s)	Unit(s) involved	Funded by
<b>Theoretical Statistics and Mathematics Division</b>				
1.	Algebraic codes associated with rank 2 residues of spherical buildings	N.S.N. Sastry	Stat-Math Unit, Bangalore	DST
<b>Applied Statistics Division</b>				
1.	International Passenger Survey in India 2008-2010	Ashis SenGupta	ASU	Ministry of Tourism, Govt. of India
2.	Language and Brain Organization in Normative Multilingualism	Sumitra Purkayastha	ASU	DST, Government of India
<b>Computer and Communication Sciences Division</b>				
1.	Development of Efficient many Objective Optimization Technique with Parallel Computation and Objective Reduction	S. Bandyopadhyay	MIU	DST
2.	Distributed Knowledge Discovery in Ad-hoc and Sensor Networks for Event Monitoring	S. Bandyopadhyay	MIU	DST
3.	Advanced Techniques for Remote Sensing Image Processing Phase II	A. Ghosh	MIU	DST
<b>Physics and Earth Sciences Division</b>				
1.	Sedimentation history of Palaeoproterozoic Dhalbhum and Dalma Formations, eastern India in the Kokpara-Tata section and its implications	R. Mazumder	GSU	DST
2.	Influence of bedforms on turbulent characteristics and its implications to sedimentology : an experimental study	B.S. Mazumder	PAMU	DST

Projects

<b>Biological Sciences Division</b>				
1.	Polymorphism in CYP1A1, CYP2E1 and NAT drug metabolizing genes and risk of tobacco related oral cavity precancer and cancer in India	B. Roy	HGU	DST, Govt. of India
2.	Diabetes mellitus- New drug discovery R & D, molecular mechanisms and genetic & epidemiological factors	S. Ghosh	HGU	CSIR, Govt. of India
<b>Social Sciences Division</b>				
1.	Climate Policy Outreach	E. Somanathan	EPU	CMCC, Italy
2.	Income Contingent Loans: Policy Implications for Financing Higher Education	Tridip Ray & Mausumi Das (Delhi School of Economics)	EPU	Ministry of Finance (Department of Economic Affairs) Govt. of India
3.	Information provision and the quality of education in Rural India	Farzana Afridi, Bidisha Barooha & Rohini Somanathan	EPU	IGC
4.	Recruitment of Accounts Assistants in KMDA	Anjali Ghosh	Psychology Research Unit	KMDA
<b>Statistical Quality Control and Operations Research Division</b>				
1.	Six Sigma Green Belt Program	Boby John & K.K. Chowdhury	SQC & OR Unit, Bangalore	Visionet Technologies
2.	Training on Basic Statistical Techniques for Analytics	Boby John	SQC & OR Unit, Bangalore	Apollo Munich, New Delhi
3.	Training on Business Analytics	Boby John	SQC & OR Unit, Bangalore	Adobe Systems
4.	Two day Training Programme on Statistical Tools & Techniques	A.R. Chowdhury	SQC & OR Unit, Bangalore	ABB Global Industries & Services Ltd.
5.	Training on Statistical Techniques	Somnath Ray & E.V. Gijo	SQC & OR Unit, Bangalore	Biocon Ltd.
6.	Training on SQC Concepts	Surajit Pal	SQC & OR Unit, Chennai	Ramco Industries Limited
7.	Training on SQC & Sampling Techniques	D. Sampangi Raman	SQC & OR Unit, Chennai	Rites Limited
8.	Training on Six Sigma Green Belt Certification	Surajit Pal	SQC & OR Unit, Chennai	Ninestars Information Technology
9.	ITC Vendor Development Program	D. Sampangi Raman	SQC & OR Unit, Chennai	Kanchanjunga Paper Products Pvt. Ltd.
10.	ITC Vendor Development Program	D. Sampangi Raman	SQC & OR Unit, Chennai	Future Educare Pvt. Ltd

Projects

11.	ITC Vendor Development Program	D. Sampangi Raman	SQC & OR Unit, Chennai	Staples Paper Convertors Pvt Ltd
12.	Training on Statistical Techniques	Surajit Pal	SQC & OR Unit, Chennai	ABCO Advisory Services
13.	Training on Statistical Techniques	A.K. Biswas	SQC & OR Unit, Chennai	Hewlett Packard
14.	Prediction of cotton price in recessive market Surveillance Audit towards ISO 9001 system	A. Rajagopal	SQC & OR Unit, Coimbatore	Bannari Amman Spinning Mills Ltd., Dindigul
15.	Six Sigma exposure to foreign delegates of 15 analysis involving 58 delegates	A. Rajagopal	SQC & OR Unit, Coimbatore	Fluid Research Control Institute, Palakad
16.	Batching plant performance JINDAL – Mettur steel plant Evaluation in infrastructure project	A. Rajagopal	SQC & OR Unit, Coimbatore	SRC Projects, Palladam
17.	In Plant Training Programme on Six Sigma Green Belt and Black belt including Project Consultancy for Software Engineers	A. Rajagopal	SQC & OR Unit, Coimbatore	Cognizant Technology Solutions, Hyderabad with Coordinate from Coimbatore
18.	General Training programme on Six Sigma Green Belt and Black Belt including Project Guidance at Office	A. Rajagopal	SQC & OR Unit, Coimbatore	Participants from various organisation
19.	Reducing foundry rejection using Multivariate Techniques	A. Rajagopal	SQC & OR Unit, Coimbatore	L&T
20.	Focus Improvement Projects	A.L.N. Murthy & G.S.R. Murthy	SQC & OR Unit, Hyderabad	ITC Ltd. – PSPD, Bhadrachalam
21.	Statistical Quality Control & MSA	G. Murali Rao & A.L.N. Murthy	SQC & OR Unit, Hyderabad	Satyam-Venture Engineering Services Pvt. Ltd.
22.	Design and Analysis of Experiments	A.L.N. Murthy & G. Murali Rao	SQC & OR Unit, Hyderabad	Coromandel International Ltd.
23.	Data Quality System	Anup Majumdar	SQC & OR Unit, Kolkata	Petroleum Analysis Cell, Ministry of Petroleum, Govt. of India.
24.	Statistical Training and Quality Improvement Projects	Prasun Das	SQC & OR Unit, Kolkata	Tata Steel, Jamshedpur
25.	Quality assurances of raw material (iron ore, coal), long products, flat products and bought out items (ferro-alloys)	Prasun Das	SQC & OR Unit, Kolkata	Tata Steel
26.	Statistical Training Module	Anup Majumdar	SQC & OR Unit, Kolkata	Tea Board

## Projects

27.	Six Sigma Implementation	A. Sarkar	SQC & OR Unit, Mumbai	Larsen & Toubro Ltd
28.	Six Sigma Implementation	A. Sarkar	SQC & OR Unit, Mumbai	L&T Corporate
29.	Six Sigma Implementation	A. Sarkar	SQC & OR Unit, Mumbai	Wind World India Ltd.
30.	Six Sigma Green Belt Training	A. Sarkar	SQC & OR Unit, Mumbai	HGS Ltd
31.	Training on Six Sigma Tools	A. Sarkar	SQC & OR Unit, Mumbai	PIC Petrochemicals Ltd
32.	Training on Statistical Techniques	A. Sarkar	SQC & OR Unit, Mumbai	TATA SED limited
33.	Six Sigma Implementation	A. Sarkar	SQC & OR Unit, Mumbai	JSW Power
34.	Six Sigma Green Belt Training	A. Sarkar	SQC & OR Unit, Mumbai	XIMB, Bhubaneswar
35.	Process Improvement Studies	A. Sarkar	SQC & OR Unit, Mumbai	Mahindra Life Space

## North East Projects

### *Ongoing Projects*

Sl. no.	Name of the project	Principal Investigator(s)	Unit(s) involved
<b>Biological Sciences Division</b>			
1.	Genetic epidemiology of Malaria and prevalence of Hb E in northeast regions of the country	T.S. Vasulu	BAU

## 4. SYMPOSIA, CONFERENCES, WORKSHOPS, LECTURES AND SEMINARS ORGANISED

### *Symposia and Conferences*

International Workshop and Conference on “*Groups and Geometries*”: Stat-Math, Bangalore, December 10-21, 2012.

International Conference to honour Prof. Rajendra Bhatia on “*Matrices and Operators*”: Stat-Math, Bangalore, December 27-30, 2012.

International Workshop and Conference on “*Recent Advances in Operator Theory and Operator Algebras*”: Stat-Math, Bangalore, December 31, 2012-January 11, 2013.

Seminar on “*Applied Statistics*”: BIRU, Kolkata, March 22, 2013.

International Conference on “*Statistics, Science, and Society: New Challenges and Opportunities*”: ASU, Chennai in collaboration with International Indian Statistical Association, January 02-05, 2013.

Symposium on “*International Year of Statistics*”: ASU, Chennai, March 23-24, 2013.

4<sup>th</sup> Workshop of the Forum on “*Information Retrieval Evaluation (FIRE 2012)*”: CVPR Unit, Kolkata, December 17-19, 2012.

International Conference on “*Trends in Knowledge and Information Dynamics*”: DRTC, Bangalore, July 10-13, 2012.

National Conference on “*LIS Education and Research: Contemplating Persistent and Debatable Issues*”: DRTC, Bangalore Centre in collaboration with Indian Association of Teachers of Library and Information Science (IATLIS), March 20-23, 2013.

3rd International Conference on “*Emerging Applications of Information Technology (EAIT), 2012*”: ECSU, Kolkata, in collaboration with the Computer Society of India Kolkata Chapter, November 29–December 01, 2012.

International Conference on “*India Biodiversity Meet - 2013*”: AERU, Kolkata, March 14-16, 2013.

Seminar on “*Current Trends in Research on Biological Anthropology in West Bengal*”: BAU, Kolkata, March 21-22, 2013.

Symposium on “*Genetic Analyses of Complex Traits*”: HGU, Kolkata, September 15, 2012.

International Conference on “*Recent Advances in Mathematical Statistics and Its Applications in Applied Sciences*”: ERU, Kolkata in collaboration with Department of Statistics, Gauhati University, held at Gauhati University, Assam, December 31, 2012–January 02, 2013.

8<sup>th</sup> Annual Conference on “*Economic Growth and Development*”: EPU, Delhi, December 17-19, 2012.

International Dialogue Forum on “*Low Carbon Development and Poverty Reduction*”: EPU, Delhi, February 21-22, 2013.

Conference on “*Annual Six Sigma Conference along with Case Study Presentation Contest*”: SQC & OR Unit, Bangalore, held at Hotel Atria, Bangalore, February 14-15, 2013.

## Conferences and Seminars

Conference on “*International Symposium on Applied Optimization and Game-Theoretic Models*” (under Quality and Reliability Modeling Project): SQC & OR Unit, Delhi, January 09-11, 2013.

International Conference on “*Game Theory and Management Applications*”: SQC & OR Unit, Hyderabad, in collaboration with Institute of Public Enterprise, Hyderabad, ISI, Chennai C.R. Rao AIMSCS, Hyderabad and Centre for Economics & Finance, U.K., December 16-17, 2012.

International Conference on “*Game theory and Operations Research Applications*”: SQC & OR Unit, Hyderabad, in collaboration with Institute of Public Enterprise, Hyderabad, ISI, Chennai C.R. Rao AIMSCS, Hyderabad and Centre for Economics & Finance, U.K., 21-22 December, 2012.

International Conference on “*Quality, Reliability and Operations Research*”: SQC & OR Unit, Mumbai, January 07-09 2013.

National Conference on “*Reprographics rights and copyrights acts*”: Library, Documentation & Information Division, Kolkata, 07-08 March 2013.

## **Workshops and Training Programmes**

Workshop on “*Heavy-tailed Distributions and Extreme Value Theory*”: Stat-Math Unit, Kolkata, in collaboration with European Community Framework Programme RARE, January 14-17, 2013.

Workshop on “*Set Theory and Logic*”: Stat-Math Unit, Kolkata, held at Kerala School of Mathematics, February 18 - March 01, 2013.

Workshop on “*Cryptography*”: Stat-Math Unit, Delhi, January 28-30, 2013.

Training Programme on “*Statistical Aspects of AMA Modelling*”: ASU, Kolkata, December 10-14, 2012.

Winter School on “*Statistical Data Analysis*”: ASU, Kolkata, January 21-25, 2013.

Training Programme on “*Cryptography*” (under North-East Training Programme): ASU, Kolkata, July 29-30, 2012.

Training Programme on “*Categorical Data Analysis & Survival Analysis*” (under North-East Training Programme): ASU, Kolkata, held at Cotton College, Guwahati, February 7-9, 2013.

Training Programme on “*Data Analysis using SPSS*” (under North-East Training Programme): ASU, Kolkata, held at B.N. College, Assam Agriculture University, Guwahati, March 11-15, 2013.

Training Programme on “*Demographic Surveys in Rural India: State of the Art*” (under North-East Training Programme): BIRU, Kolkata, held at Arya Vidyapeeth College, Guwahati, Assam, June 16-18, 2012.

Summer School on “*Mathematical Modeling of Patterns and Diffusion Processes in Biology*”: BIRU, Kolkata, June 18-22, 2012.

Workshop on “*Statistical Computing and its Applications*” (under North-East Training Programme): BIRU, Kolkata, held at North Eastern Hill University, Shillong, November 29-December 01, 2012.

Research Workshop on “*Strategic Network Formation and Evaluation*”: BIRU, Kolkata, March 7-8, 2013.

## Conferences and Seminars

Workshop on “*Statistical Pattern Recognition and Data Mining*” (under North-East Training Programme): BIRU, ISI, Kolkata in collaboration with Gauhati University, held at Gauhati University, Assam, March 13-15, 2013.

Workshop on “*Emerging Areas in Applied Statistics*”: BIRU, ISI, Kolkata, March 19-21, 2013.

Workshop on “*Undergraduate Algebra, Analysis and its Applications for North East*” (for North East students only): Applied and Official Statistics Unit, North-East Centre, Tezpur in collaboration with Department of Mathematical Sciences, Tezpur University, March 28-April 03, 2013.

Training Programme on “*Statistics (Orientation Programme)*”: ASU, Chennai, held at BCM College, Kottayam, March 09-12, 2013.

6<sup>th</sup> Workshop on “*Nanocomputing and Biochips*”: ACMU, Kolkata, December 21-22, 2012.

WALCOM Pre-Workshop School on “*Graph and Geometric Algorithms*”: ACMU, Kolkata, February 11-13, 2013.

Spring School on “*Algorithms: Theory, Application and Implementation*” (under North-East Programme): ACMU, Kolkata, in collaboration with Manipur University held at Manipur University, February 20-22, 2013.

Winter School on “*Soft Computing and Applications*”: MIU, Kolkata in collaboration with Mizoram University (MZU), held at Mizoram University, Aizawl, November 05-09, 2012.

Training Programme on “*Indian Neuroinformatics and Computational Neuroscience*”: SSIU, Bangalore, June 04–12, 2012.

Training Programme on “*Spatial Statistical Tools in Data Processing and Analysis*”: SSIU, Bangalore, November 26–30, 2012.

Workshop on “*Mathematical Morphology and Pattern Recognition: Theory and Applications*”: SSIU, Bangalore, March 26-28, 2013.

National Workshop on “*Graph Colorings (NWGC-2013)*”: CSU, Chennai, January 25-27, 2013.

Training Programme on “*Vertebrate Paleontology and Evolution*”: GSU, Kolkata in collaboration with Research and Training Institute, Eastern Region, GSI held at Geological Survey of India (GSI), Salt Lake, Kolkata and Indian Statistical Institute, Kolkata, April 09, 2012.

Training Programme on “*Vertebrate Evolution through Geologic time*” (for students of IISER Kolkata): GSU, Kolkata, April 18, 2012.

National Workshop on “*Modeling in Biological Systems*”: PAMU, Kolkata, held at Aizwal University, August 21-25, 2012.

National Workshop on “*Decision Making, Quantum Probability and Modeling in Cognitive Science*”: PAMU, Kolkata, held at Tezpur University, March 21-22, 2013.

Workshop on “*Evaluating Official Statistics on Land and Livestock Holdings*”: EAU, Bangalore, January 03-04, 2013.

Training Program on “*Macro and Microeconomics*” (for 33<sup>rd</sup> Batch of ISS Probationers): EPU, Delhi, April 16–May 04, 2012.



## Conferences and Seminars

Workshop on “*Techniques of Analysis of Demographic and Health Statistics and Application of Computer Software*”: PSU, Kolkata, October 10-12, 2012.

Workshop on “*Cognitive Processing through Pass model with special reference to PREP*”: Psychology Research Unit, Kolkata, held at Agartala, January 30, 2013.

Workshop on “*Questionnaire Design for Social Science Research*”: SOSU, Kolkata, July 23–27, 2012.

Workshop on “*Evolving forms of Agricultural Financing*”: SOSU, Kolkata, in collaboration with Monash University, August 03, 2012.

Workshop on “*West Bengal Growth*”: SOSU, Kolkata, January 07-08, 2013.

Training Programme on “*Sample Survey Methodology and Estimation Process*” (for ISS Probationers): SOSU, Kolkata, January 21–February 01, 2013.

Refresher Course on “*Poverty Analysis and Mapping*” (for ISS in-Service Officers): SOSU, Kolkata, March 18-22, 2013.

Certification Program on “*Six Sigma Green Belt (GB-11)*”: SQC & OR Unit, Bangalore, April 21-22 & 27-29, 2012.

Certification Program on “*Six Sigma Black Belt (BB-13)*”: SQC & OR Unit, Bangalore, April 28-June 2012 (Weekend Program: Saturdays & Sundays).

Certification Program on “*Six Sigma Green Belt (GB-12)*”: SQC & OR Unit, Bangalore, June 11-15, 2012.

Certification Program on “*Six Sigma Master Black Belt (MBB-19)*”: SQC & OR Unit, Bangalore, June 18-July 01, 2012.

Certification Program on “*Six Sigma Black Belt (BB-14)*”: SQC & OR Unit, Bangalore, July 09-15 (Phase I) & September 03-11 (Phase II), 2012.

Certification Program on “*Six Sigma Green Belt (GB-13)*”: SQC & OR Unit, Bangalore, August 09-11 & 17-19, 2012.

Training Program on “*Statistical Techniques for Data Mining & Business Analytics (DMBA-09)*” SQC & OR Unit, Bangalore, August 29-31, 2012.

Certification Program on “*Six Sigma Green Belt (GB-14)*”: SQC & OR Unit, Bangalore, October 07-09 & 12-14, 2012.

Training Program on “*Statistical Techniques for Data Mining & Business Analytics (DMBA-10)*” SQC & OR Unit, Bangalore, November 05-07, 2012.

Certification Program on “*Six Sigma Black Belt (BB-15)*”: SQC & OR Unit, Bangalore, November 19-25, 2012 (Phase I) & January 17-25, 2013 (Phase II).

Certification Program on “*Six Sigma Green Belt (GB-15)*”: SQC & OR Unit, Bangalore, December 01-04 & 08-09, 2012.

Training Program on “*Statistical Techniques for Quantitative Project Management (QPM-05)*” SQC & OR Unit, Bangalore, December 05-07, 2012.

## Conferences and Seminars

Certification Program on “*Six Sigma Green Belt* (for North-East Region)”: SQC & OR Unit, Bangalore, held at Tezpur University, Tezpur, Assam, January 21–24, 2013.

Certification Program on “*Six Sigma Master Black Belt (MBB-20)*”: SQC & OR Unit, Bangalore, January 27–February 10, 2013.

Certification Program on “*Six Sigma Green Belt (GB-16)*”: SQC & OR Unit, Bangalore, February 23-25 & March 01-03, 2013.

Training Program on “*Statistical Process Control* (for North-East Region)”: SQC & OR Unit, Bangalore, held at Agartala, Tripura, March 21 & 22, 2013.

Certification Program on “*Six Sigma Green Belt* (for the students of Basaveshwara Engineering College Bagalkot)”: SQC & OR Unit, Bangalore, March 17-21, 2013.

Training Program on “*Six Sigma Green Belt*”: SQC & OR Unit, Chennai, June 12-16, 2012.

Training Program on “*Six Sigma Black Belt*”: SQC & OR Unit, Chennai, June 23-28, 2012.

Training Program on “*Six Sigma Green Belt*”: SQC & OR Unit, Chennai, September, 10-14, 2012.

Training Program on “*Six Sigma Black Belt*”: SQC & OR Unit, Chennai, December 08–March 31, (Week End Full Time).

Workshop on “*Achieving Breakthrough Quality - Edition II*”: SQC & OR Unit, Coimbatore, in collaboration with the Hindu and India Chamber of Commerce and Industry, June 29, 2012.

Workshop on “*Prove and Improve Nursing Research Methods Using Statistical Methodologies*”: SQC & OR Unit, Coimbatore, November 23, 2012.

Training Programme on “*Statistical process control Measurement System Analysis*”: SQC & OR Unit, Coimbatore, held at FCRI, Palakad, September 24 & December 04, 2012.

Training Programme on “*Nursing Research in Hospital using Medical Informatics*”: SQC & OR Unit, Coimbatore held at KG, Hospital Coimbatore, November 23, 2012.

Training Programme on “*Lean Implementation and Environmental Studies*”: SQC & OR Unit, Coimbatore, held at Bannari Amman Spinning Mills Ltd, Dindigul, October 04-13, 2012.

Training Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Delhi, April 18–20, 2012.

Training Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Delhi, July 11–13, 2012.

Training Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Delhi, September 26–28, 2012.

Training Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Delhi, November 07–09, 2012.

Training Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Delhi, January 16–18, 2013.

Training Programme on “*Six Sigma Black Belt* (1<sup>st</sup> Module)”: SQC & OR Unit, Delhi, August 07–09, 2012.

Training Programme on “*Six Sigma Black Belt* (2<sup>nd</sup> Module)”: SQC & OR Unit, Delhi, September 11–14, 2012.

## Conferences and Seminars

Training Programme on “*Six Sigma Black Belt (3<sup>rd</sup> Module)*”: SQC & OR Unit, Delhi, October 09–12, & November 21–23, 2012.

Training Programme on “*Six Sigma Master Black Belt (1<sup>st</sup> Module)*”: SQC & OR Unit, Delhi, January 21–25, 2013.

Training Programme on “*Six Sigma Master Black Belt (2<sup>nd</sup> Module)*”: SQC & OR Unit, Delhi, February 18–23, 2013.

Workshop on “*Environmental Data Analysis, Compilation, Interpretation, Presentation and Reporting*”: SQC & OR Unit, Delhi (funded by CPCB, Ministry of Environment and Forests, Govt. of India), January 28-01 February, 2013.

Training Program on “*Lean Six Sigma Green Belt*”: SQC & OR Unit, Hyderabad, August-September, 2012.

Training Program on “*Six Sigma Green Belt*”: SQC & OR Unit, Hyderabad, December 17–21, 2012.

Training Program on “*Six Sigma Black Belt*”: SQC & OR Unit, Hyderabad, November 05-10 & December 10-15, 2012.

International Workshop on “*Game Theory and Operations Research Applications*” SQC & OR Unit, Hyderabad, December 19, 2012.

Training Program on “*Six Sigma Master Black Belt*”: SQC & OR Unit, Hyderabad, March 04-08 and 18-22, 2013.

Workshop on “*Design and Analysis of Experiments for Laboratory Scientists/ Research Scientists/ Research Fellows of Government Funded Research Laboratories in India*”: SQC & OR Unit, Kolkata, November 19-23, 2012.

Workshop on “*Applications in Industry and Service Sectors inter alia with Business and Social Science*”: SQC & OR Unit, Kolkata, held at Guru Charan College, Silchar, Assam, March 18-19, 2013.

Workshop on “*Practices using computer software*”: SQC & OR Unit, Kolkata, held at Janata College, Silchar, Assam, December 17-20, 2012.

Workshop on “*Modeling and Optimization*”: SQC & OR Unit, Kolkata, held at Debraj Roy College, Golaghat, Assam, September 25-29, 2012.

Workshop on “*Experiencing Data Mining using Statistica*”: SQC & OR Unit, Kolkata, March 25-26, 2013.

Workshop on “*Data Mining and its Industrial Applications*”: SQC & OR Unit, Kolkata, February 21-23, 2013.

Training Programme on “*Six Sigma Black Belt (Phase 1 for L&T Corporate)*”: SQC & OR Unit, Mumbai, held at Lonavla, April 02-05, 2012.

Training Programme on “*Inferential Statistics with Minitab (for Larsen & Toubro Ltd.)*”: SQC & OR Unit, Mumbai, held at Mumbai, April 09-10, 2012.

Training Programme on “*Six Sigma Green Belt (Part – 1 for TATA SED)*”: SQC & OR Unit, Mumbai, held at Bangalore, April 17-18, 2012.

## Conferences and Seminars

Training Programme on “*Design of Experiment* (for Aditya Birla Insulator)”: SQC & OR Unit, Mumbai, held at Vadodara, May 10-11, 2012.

Training Programme on “*Six Sigma Green Belt* (1<sup>st</sup> Module) [for Wind World (India)]”: SQC & OR Unit, Mumbai, held at Vapi, May 11-12, 2012.

Training Programme on “*Six Sigma Green belt*”: SQC & OR Unit, Mumbai, May 14-18, 2012.

Training program on “*Six Sigma Black Belt* (for HDFC Bank)”: SQC & OR Unit, Mumbai, held at HDFC Bank, May 20-25 and June 25-29, 2012.

Training Programme on “*Six Sigma Yellow Belt* [for Wind World (India)]”: SQC & OR Unit, Mumbai, held at Vapi, May 29-30, 2012.

Training Programme on “*Six Sigma Black Belt* (Phase 2) (for L & T Corporate)”: SQC & OR, Mumbai, held at Lonavla, June 11-14, 2012.

Training Program on “*Six Sigma Black Belt* (for HDFC Bank)”: SQC & OR Unit, Mumbai, held at HDFC Bank, May 20-25 and June 25-29, 2012.

Training Programme on “*Six Sigma Green Belt* (for JSW Energy)”: SQC & OR Unit, Mumbai, held at Ratnagiri, July 04-06, 2012 and February 04-06 2013.

Training Programme on “*Six Sigma Green belt* (Module 1) (for L&T EBG)”: SQC & OR Unit, Mumbai, July 16-18, 2012.

Training Programme on “*Six Sigma Black Belt*”: SQC & OR Unit, Mumbai, July-September, 2012.

Training Programmed on “*Six Sigma Green Belt* (for L&T EBG)”: SQC & OR Unit, Mumbai, August 16-18, 2012.

Training Programme on “*Six Sigma Green Belt* (for JSW Energy Limited)”: SQC & OR Unit, Mumbai held at JSW Energy Limited, Vijaynagar, August 23-25 and December 04-06, 2012.

Training Programme on “*Six Sigma Green Belt* (for HGS Limited)”: SQC & OR Unit, Mumbai, held at HGS Ltd., Mumbai, September 03-05, and October 02-04, 2012.

Training Programme on “*Six Sigma Tools* (for PIC Petrochemicals)”: SQC & OR Unit, Mumbai held at Dubai, UAE, October 27-31, 2012 and January 19-24, 2013.

Training Programme on “*Six Sigma Master Black Belt*”: SQC & OR Unit, Mumbai, November-December, 2012.

Training Programme on “*Six Sigma Green Belt*”: SQC & OR Unit, Mumbai, January 01-05, 2013.

Training Programme on “*Statistical Techniques for Quantitative Project Management*”: SQC & OR Unit, Mumbai, January 10-11, 2013.

Training Programme on “*Statistical Process Control (SPC)* (for L&T MHI)”: SQC & OR Unit, Mumbai, held at Larsen & Toubro Ltd., Hazira, January 15-11, 2013.

Training Programme on “*Statistical Process Control (SPC)* (for JSPL)”: SQC & OR Unit, Mumbai, held at JSPL, Raigarh, January 28-30, 2013.

Training Programme on “*Six Sigma Green Belt* (for XIMB TQM Students)”: SQC & OR Unit, Mumbai, held at Xavier Institute of Management, Bhubaneswar, February 09-10, 2013.

## Conferences and Seminars

Training Programme on “Six Sigma Green Belt (Part – 1)”: SQC & OR Unit, Mumbai, held at L&T Mysore, February 22-24, 2013.

Visual Presentation on “*A tribute to Professor P.C. Mahalanobis on 119<sup>th</sup> Birth Anniversary*”: Library, Documentation & Information Division, Kolkata, June 29, 2012.

Exhibition on “*Higgs-Boson*”: Library, Documentation and Information Science Division, September 28-October 12, 2012.

Training programme on “*Adobe Photoshop: a basic course*”: Library, Documentation & Information Division, Kolkata, January 15-22, 2013.

National Seminar-cum-Workshop on “*Building network database in northeast region of India*”: Library, Documentation & Information Division, Kolkata, February 18-22, 2013.

3<sup>rd</sup> Workshop on “*Digital Pictorial Photography*”: Library, Documentation & Information Division, Kolkata, March 04-05, 2013.

Exhibition and Contest on “*Photography*”: Library, Documentation & Information Division, Kolkata, March 04-08, 2013.

Workshop on “*Social Network Analysis (SNAW12)*”: Center For Soft Computing Research Center, Kolkata, June 27-28, 2012.

Demonstration on “*Income Tax E-filing - How to Submit I.T. Return on-line (for ISI Employees - 2 Batches)*”: CSSC, Kolkata, June 18-19, 2012.

Training Program on “*Basic Computer System (for ISI Employees)*”: CSSC, Kolkata, July 02-13, 2012.

Training Program on “*SPSS*”: CSSC, Kolkata, held at Statistics Department, Guwahati University, July 23-27, 2012.

Training Program on “*Advanced MS-Word & Excel 2007 (for ISI Employees)*”: CSSC, Kolkata, September 10–21, 2012.

Training Program on “*SPSS*”: CSSC, Kolkata, held at Statistics Department, Guwahati University, September 25-29, 2012.

Training Program on “*Linux OS, Open Office & LaTeX (for ISI Employees)*”: CSSC, Kolkata, November 01–12, 2012.

Training Program on “*Linux OS, Open Office & LaTeX (for ISI Employees)*”: CSSC, Kolkata, held at Delhi, December 06-14, 2012.

Training Program on “*Word & Excel (for ISI Employees)*”: CSSC, Kolkata, held at Delhi, December 06-14, 2012.

Training Program on “*Word & Excel (for ISI Employees)*”: CSSC, Kolkata, held at Bangalore, December 31, 2012-January 04, 2013.

Training Program on “*Basic Computer and LaTeX (for ISI Employees)*”: CSSC, Kolkata, held at Bangalore, December 30, 2012–January 04, 2013.

## Conferences and Seminars

Training Program on “*Linux OS, Open Office & LaTeX* (for ISI Employees)”: CSSC, Kolkata, held at Bangalore, January 09-16, 2013.

Training Program on “*Basic Computer and LaTeX* (for ISI Employees)”: CSSC, Kolkata, held at Bangalore, March 04-08, 2013.

Training Program on “*Web site Development & Hosting* (for ISI Employees)”: CSSC, Kolkata, February 04–14, 2013.

Demonstration on “*Income Tax E-filing - How to Submit I.T. Return on-line* (for ISI Employees)”: CSSC, Kolkata, March 28, 2013.

## **Lectures and Seminars**

### **Theoretical Statistics and Mathematics Division**

#### **Stat-Math Unit, Kolkata**

Artamonov, V.A., Moscow University, Russia (21.01.2013): Polynomially complete algebras.

Banerjee, Arindam, University of Kansas, U.S.A. (16.07.2012): Some Questions about Castelnuovo-Mumford Regularity of Edge Ideals.

Banerjee, Arindam, University of Kansas, U.S.A. (23.07.2012): Bounds on Castelnuovo-Mumford Regularity.

Banerjee, Arindam, University of Kansas, U.S.A. (01.08.2012): Primary Decomposition: A New Uniqueness.

Banerjee, Moulinath, University of Michigan, U.S.A. (03.01.2013): M-estimation under multistage sampling.

Basak, Tathagata, Iowa State University, U.S.A. (11.06.2012): Finite projective planes, Lattices and the Monster.

Basak, Arindam, Stanford University, U.S.A. (22.08.2012): Limiting spectral Distribution of Sum of Unitary Matrices.

Dutta, Santanu, Tezpur University (11.01.2013): Uniform and  $L_1$  convergence of kernel density estimators using random bandwidths.

Fei, Shao-Ming, Capital Normal University, Beijing and MPL, Leipzig, Germany (15.01.2013): Theory of Quantum Entanglement and its Applications in Quantum Information and Computation.

Gupta, Neena, Tata Institute of Fundamental Research (02.11.2012): A Counterexample to the Cancellation Problem for Affine Spaces.

Hazra, Rajat Subhra, University of Zurich, Switzerland (24.01.2013): Limiting spectral distribution of Wigner matrices with dependent entries.

Hillier, Robin, Dipartimento di Matematica, Università di Roma ‘Tor Vergata’, via della Ricerca Scientifica 1, Italy (03.12.2012 & 04.12.2012): Operator algebras and conformal quantum field theory.

## Conferences and Seminars

Krishnapur, Manjunath, Indian Institute of Science, Bangalore (27.04.2012): Nodal length of random eigenfunctions of the Laplacian of the 2-d torus.

Kuroda, Shigeru, Metropolitan University, U.K. (18.02.2013): Generalizations of the tame automorphisms of a polynomial ring over a domain of positive characteristic.

Lahiri, S.N., North Carolina State University, U.S.A. (07.03.2013): A Frequency Domain Empirical Likelihood Method for Irregularly Spaced Spatial Data.

Limaye, B.V., Indian Institute of Technology, Bombay (04.10.2012): Reduction of some infinite-rank problems to matrix problems.

Mukherjee, Ritwik, Institute of Mathematical Sciences, Chennai (30.07.2012): Counting curves via topology.

Mukherjee, Sumit, Stanford University, U.S.A. (07.01.2013): Persistence probabilities for Gaussian polynomials.

Mazumder, Rahul, Department of Statistics, Stanford University, U.S.A. (04.04.2012): Convex Regularization Algorithms for learning Large Incomplete Matrices.

Munshi, Ritabrata, Tata Institute of Fundamental Research, Mumbai (03.05.2012): the Landau-Siegel zero problem.

Pal, Koushik, University of Maryland, U.S.A. (28.05.2012): Transseries Fields.

Ramana, D. Surya, Harish-Chandra Research Institute, Allahabad (26.11.2012): Chromatic Representation as sums of primes.

Ray, Gourab, University of British Columbia, Canada (10.08.2012): Random planar maps and half planar triangulations.

Roy, Sutanu, Mathematisches Institut, University of Gottingen, Germany (21.03.2013): On braided multiplicative unitaries.

Sankaran, P., Institute of Mathematical Sciences, Chennai (23.11.2012): Borel-de Siebenthal discrete series representations.

Sen, Bodhisattva, University of Cambridge, U.K. (06.08.2012): Estimation in a Two-component Mixture Model.

Sen, Debasis, University of Haifa, Israel (25.09.2012): Rectifying Homotopy group action.

Sunder, V.S., Institute of Mathematical Sciences, Chennai (10.05.2012): Hilbert von Neumann modules.

Thangavelu, S., Indian Institute of Science, Bangalore (09.07.2012): On the unreasonable effectiveness of Gutzmer's formula.

### ***Stat-Math Unit, Delhi***

Adhikari, S.D., Harish-Chandra Research Institute, Allahabad (06.02.2013): A classical zero-sum theorem and some generalizations.

## Conferences and Seminars

- Artamonov, V.A., Moscow State University (04.01.2013): Polynomially complete algebras.
- Athreya, K.B., Iowa State University, USA (19.02.2013): Coalescence in rapidly growing Galton Watson trees.
- Athreya, K.B., Iowa State University, USA (20.02.2013): MCMC for improper targets.
- Baruah, Nayandeep Deka, Tezpur University, Assam (17.10.2012): Ramanujan's theta functions and modular equations with applications to partitions.
- Bhatia, Rajendra, Indian Statistical Institute, Delhi (29.08.2012): Loewner matrices.
- Bhattacharyya, Siddhartha, Tata Institute of Fundamental Research, Mumbai (02.05.2012): Entropy and complexity of dynamical systems-I.
- Bhattacharyya, Siddhartha, Tata Institute of Fundamental Research, Mumbai (03.05.2012): Entropy and complexity of dynamical systems – II.
- Bose, Debashish, Institute of Mathematical Sciences, Chennai (12.09.2012): Structure of spectral pairs in 1-dimension.
- Chaubey, Y.P., Concordia University, Montreal, Canada (16.01.2013): On nonparameteric estimators of the density of a non-negative function of observations.
- Das, Suchismita, Indian Institute of Science Education and Research, Kolkata (31.10.2012): On some (dynamic) proportional and additive models.
- Dutta, Kunal, Institute of Mathematical Sciences, Chennai, Delhi (20.03.2013): New lower bounds for the independence number of sparse graphs and hypergraphs.
- Ghosal, Subhashis, North Carolina State University, USA (04.10.2012): Improving converge rates for estimating location and size of maximum of a nonparameteric regression function using a two-stage sampling process.
- Iyer, Uma N., Bronx Community College, New York (25.07.2012): Quantum differential operators.
- Lahiri, Ananya, Chennai Mathematical Institute, Chennai (27.11.2012): Integrated volatility estimation for a finance model with fractional Brownian motion.
- Lahiri, Ananya, Chennai Mathematical Institute, Chennai (29.11.2012): Efficient algorithm for estimating the parameters of chirp signal.
- Mubayi, Dhruv, University of Illinois at Chicago (13.12.2012): Quasirandom hypergraphs.
- Patra, Kamal, National Institute of Science Education and Research, Bhubanewar, (12.03.2013): Center, centroid and characteristics set of a tree.
- Patra, Kamal, National Institute of Science Education and Research, Bhubanewar, (13.03.2013): Laplacian spectral radius of graphs.
- Rajkumar, Krishnan, Institute of Mathematical Sciences, Chennai (23.01.2013): Irrationality of zeta values-Apéry and Ramanujan.
- Singh, Anuraj, Graphic Era Universitat, Dehradun (03.10.2012): Order, chaos, control and synchronization in nonlinear ecological systems.



## Conferences and Seminars

Tijdeman, Rob, Leiden University, Netherlands (13.02.2013): An introduction to discrete tomography.

Varma, Manik, Microsoft Research and IIT, Delhi (09.01.2013): On computational advertising and big data: A machine learning approach to recommending advertiser bid phrases from web page.

Waldschmidt, Michel, Universite Pierre et Marie Curie, France (10.10.2012): Diophantine approximation and diophantine equations: old and new.

Wilson, Richard, Caltech (California Institute of Technology), USA (14.12.2012): A zero Ramsey-type problem for hypergraphs and diagonal (Smith) forms of certain incidence matrices.

### ***Stat-Math Unit, Bangalore***

Athreya, Krishna B., Iowa State University, USA (27.06.2012 and 03.08.2012): Lectures on Markov Chains and An introduction to the raga structure of Indian Classical music.

Amos, Nevo, Technion-Israel Institute of Technology (13.01.2013): Diophantine approximation, arithmetic groups and ergodic theory.

Bruen, Aiden A., Carleton University, Canada (14.11.2012): Perspective Sets, Blocking Sets and Linear Groups.

Cardinali, Ilaria, University of Siena, Italy (15.11.2012): On embeddings of orthogonal grassmannians.

Fakhruddin, Najmuddin, Tata Institute of Fundamental Research, Mumbai (21.08.2012): The dynamics of generic endomorphisms of n-dimensional Projective space.

Hazrat, R., University of Western Sydney, Australia (15.01.2013 and 17.01.2013): Leavitt path algebras.

Ji, Un Cig, Chungbuk National University, South Korea (26.12.2012): Quantum White Noise Derivatives and Associated Differential Equations.

Kashyap, Navin, Indian Institute of Science, Bangalore (23.04.2012): Probability Distributions over the Integers with Some Useful Independence Properties.

Khandwawala, Mustafa, Indian Institute of Science, Bangalore (19.11.2012): Belief propagation for optimal edge-cover in the random complete graph.

Kondo, Satoshi, Kavli Institute for the Physics and Mathematics of the Universe (IPMU), University of Tokyo (21.02.2013): On the rational  $K_2$  of a curve of  $GL(2)$  type over function fields.

Krishnapur, Manjunath, Indian Institute of Science, Bangalore (23.04.2012): Nodal length of random eigenfunctions of the Laplacian on the 2-d torus.

Krishnan, T., Mu-Sigma Business Solutions, Bangalore (15.03.2013): Data Analysis: Is it Beyond Statistics.

Kumar, Mohan N., Washington University in St Louis, USA (21.05.2012): Families of rational curves on Hypersurfaces.

Lindsay, Martin J., Lancaster University, UK (19.07.2012): Quantum stochastic Lie-Trotter product formulae.

Munshi, Ritabrata, Tata Institute of Fundamental Research, Mumbai (28.02.2013): Recent progress in theory of L-functions.

Nair, Arvind, Tata Institute of Fundamental Research, Mumbai (16.08.2012): Weightless cohomology of algebraic varieties.

Obata, Nobuaki, Tohoku University, Japan (26.12.2012): Quantum probability and spectral analysis of growing graphs.

Pandit, Pranav, University of Vienna (08.02.2013): Derived Geometry and Topological String Theory.

Pal, Sarbeswar, Chennai Mathematical Institute, Chennai (26.12.2012): Rational curves in the moduli of stable bundles.

Pisolkar, Supriya., Tata Institute of Fundamental Research, Mumbai (31.01.2013): Commensurability and representation equivalent arithmetic lattices.

Prakasa Rao, B.L.S., Ramanujan Chair Professor, C.R. RAO Advanced Institute of Mathematics, Statistics & Computer Science (15.03.2013): Statistical Inference for Fractional Diffusion Processes.

Purkait, Soma, University of Warwick, United Kingdom (02.04.2012): On Shimura Decomposition and Tunnell-like Formulae.

Raghuram, A., Indian Institute of Science Education and Research, Pune (13.11.2012): Motives and L-functions.

Sahasrabudhe, Neeraja, University of Padova, Italy (28.03.2013): Covariance Realization Problem for Spin Systems.

Sen, Sagnik, Universite de Bordeaux, France (17.07.2012): Largest Planar Ocliques.

Shirke, D.T., Shivaji University, Kolhapur (19.06.2012): Classification Procedures Based on Data Depth.

Skeide, Michael, Universita degli Studi del Molise, Italy (11.09.2012): Boolean Probability Spaces - and How Far We Get With Them.

Srinivas, V., Tata Institute of Fundamental Research, Mumbai (11.05.2012): Algebraic versus topological entropy for surfaces over finite fields.

Sritharan, S.S., Center for Decision, Risk, Controls & Signals Intelligence (DRCSI), USA (02.08.2012): Large Deviation Theory of Stochastic Navier-Stokes Equations.

Srivastava, Nikhil, Microsoft Research (24.09.2012): Covariance Estimation for Distributions with  $2 + \epsilon$  Moments.

Thangavelu, S., Indian Institute of Science, Bangalore (12.03.2013): Wigner semi-circle law and Heisenberg group.

Vadlamani, Sreekar, TIFR-CAM, Bangalore (04.10.2012): Random fields and their geometry: an infinite dimensional kinematic fundamental formula.

Venugopal, V., Indian Institute Science, Bangalore (24.05.2012): Depth-Duration Characteristics of Global Tropical Rainfall.

## Conferences and Seminars

Venugopalan, Sushmita., Tata Institute of Fundamental Research, Mumbai (14.02.2013 – 15.02.2013): Vortex Equations and Hitchin-Kobayashi correspondence & Vector Bundles and Connections.

Winter, Anita, Universitat-Duisburg, Essen (24.09.2012): Tree valued spatial  $\lambda$  - Cannings dynamics.

Yogeshwaran, D., Technion - Israel Institute of Technology, Haifa (07.03.2013): Simplex counts of random complexes.

### ***Stat-Math Unit, Chennai***

Anisha, P., Visiting Scientist (03.05.2012 to 05.05.2012): A quintile based test for independence of failure time and cause of failure.

### **Applied Statistics Division**

#### ***Applied Statistics Unit, Kolkata***

Agrawal, M., Indian Institute of Technology, Kanpur (24.12.2012): Two Black Box Derandomizations of Restricted Depth Four circuits.

Bhattacharyya, R., Ecole Normale Supérieure de Lyon (05.03.2013): Provable-security Against Related-key attacks.

Dasgupta, T., Harvard University (11.01.2013): Causal inference from  $2^k$  Factorial Designs using the Potential Outcomes Model.

Hassan, Sk. Sarif, Institute of Mathematics & Application, Bhubaneswar (24.01.2013): Integral Value Transformations (IVTs) and discrete Dynamical Systems.

Kim, Kyung M., Department of Biostatistics, University of Wisconsin-Madison, USA, (01.01.2013): Drug Safety and Vioxx Controversy.

Kumar, N., Department of Epidemiology and Public Health, University of Miami (10.12.2012): Two-stage Optimal Spatial Sampling and Enumeration-listing for Surveys.

Maitra, A., Vision and Care, Kolkata (03.04.2012): Paediatric respiratory problems in India and the need for community based research.

Mallick, H., University of Alabama at Birmingham (22.01.2013): some Recent Developments on Bayesian Regularization Methods.

Maji, H., University of California, Los Angeles, USA (21.12.2012): Limitations on the Power of One-way functions.

Narayanan, R., Cornell University, Ithaca, USA (16.10.2012): Shrinkage Estimation for Lasso and Improved Loss Estimation for Lasso.

Pal Choudhury, P., Johns Hopkins University (15.01.2013): On analysis of Studies with Missing Venography Data.

Ray Chaudhuri, Dwijendra K., Ohio State University Columbus, Ohio (04.01.2013): Designs whose Blocks are Multisets.

Ramanathan, T.V., Department of Statistics and Centre for Advanced Studies, University of Pune (06.12.2012): Order Selection in Time Series Models: A New Approach.

Rohan, N., Department of Statistics and Centre for Advanced (27.11.2012): Time varying GARCH model and related statistical inference Studies, University of Pune.

Sahoo, S., Institute of Mathematics and Applications, Bhubaneswar (07.03.2013): Connection of Cellular Automata and Other Domains.

Sankaran, P.G., Cochin University of Science and Technology (17.04.2012): Modeling statistical data using quantile functions.

Scharfstein, D., Johns Hopkins Bloomberg School of Public Health (11.03.2013): On the Analysis of Tuberculosis Studies with Intermittent Missing Sputum Data.

Shrivastava, A., University of Massachusetts (19.11.2012): Building a sustainable India.

Sundaram, R., Northeastern University, USA (18.06.2012): Secure and scalable match: overcoming the universal circuit bottleneck using group programs.

### ***Bayesian Interdisciplinary Research Unit***

Banerjee, Tathagata, Indian Institute of Management, Ahmedabad (22.03.2013): In search of a confidence interval for binomial proportion.

Chakraborty, Anirban, Ecole Centrale Paris, France (18.01.2013): Time-series analysis by Econophysicists.

Chakraborty, Goutam, Iwate Prefectural University, Japan (03.01.2013): Perception delay and its estimation by analyzing EEG Signal.

Chaudhuri, Anindya, Barclays Bank (28.06.12): Business intelligence-application of statistical techniques in banking.

Das, Kiranmoy, Temple University (19.07.12): Matrix stick-breaking process for simultaneous covariance estimation.

Mathur, Ashwini, Novartis Healthcare private Limited, Hyderabad (22.03.2013): Some recent applications of statistical sciences for clinical research.

Mukherjee, Bhramar, University of Michigan (20.12.2012): Shrinkage methods utilizing auxiliary information to Improve High Dimensional Prediction Models.

Nandram, Balgobin, Worcester Polytechnic Institute (16.01.2013): A two-fold Bayesian model for analysis of a small area finite population proportion.

Parsad, Rajender, Indian agricultural Statistics Research Institute, New Delhi (22.03.2013): Applications of designs for factorial experiments in NARS.

Raha, Soumyendu, Indian Institute of Science, Bangalore (26.02.2013): An Algorithm for physically consistent simulation of biochemical reactions.

## Conferences and Seminars

Ray, Surajit, University of Glasgow, U.K. (10.12.2012): Reconstruction Trajectories of Correlated functional data.

Ray, Surajit, University of Glasgow, U.K. (13.12.2012): How many modes can a Gaussian Mixture have?

Upadhyay, S.K., Banaras Hindu University, Varanasi (22.03.2013): A simple model based on competing risk.

## **Computer and Communication Sciences Division**

### ***Advanced Computing and Microelectronics Unit***

Basu, Arindam, Nanyang Technological University (NTU), Singapore (04.01.2013): Neuro-inspired Analog Circuits.

Dhar, Amit Kumar, École Normale Supérieure (ENS), Paris, France (16.08.2012): Taming Past LTL and Flat Counter System.

Drechsler, Rolf, Deutsche Forschungszentrum für Künstliche Intelligenz (DFKI) Bremen University, Germany (05.07.2012): Is  $P = NP$  in the Cloud - Are We Designing the Right Verification Algorithms?

Fransis, Mathew, Laboratoire d'Informatique, de Robotique et de Microélectronique de Montpellier (LIRMM), France (06.09.2012): The Maximum Clique Problem in Multiple Interval Graphs.

Ghosh, Swaroop, University of South Florida, USA, (02.01.2013): Breaking the barrier for low-power and energy-efficiency: An Adaptive and Self-Healing Approach.

Kajihara, Seiji, Kyushu Institute of Technology, Japan (11.01.2013): Design and Test Technology for Enhanced VLSI System Dependability.

Majumdar, Debapriyo, IBM India Research Lab. Bangalore (17.09.2012): Efficient Top-k and Skyline Query Processing.

Pal, Arindam, Dept. of Computer Science & Engineering, Indian Institute of Technology Delhi (02.11.2012): Approximation Algorithms for Un-splittable Flow and Interval Coloring Problems.

Paul, Subhabrata, Department of Mathematics, Indian Institute of Technology Delhi (12.03.2013): Liar Domination In Graphs.

Sau, Budhhadeb, Department of Mathematics, Jadavpur University, Calcutta (12.10.2012): Localization of Wireless Sensor Networks.

Sinha Mahapatra, Priya Ranjan, Kalyani University, (07.09.2012): Studies on Variations of Enclosing Problem using Rectangular Objects.

Santoro, Nicola, Carleton University, Canada (18.02.2013): Dangerous Graphs (Time varying Graphs).

Shukla, Sandeep K, Virginia Polytechnic Institute and State University, USA (2011.2012): Studying the Interdependence between two Critical Infrastructures: Power Systems & Communications in the Smart Grid.

***Computer Vision and Pattern Recognition Unit***

Rothacker, Leonard, TU Dortmund University, Dortmund, Germany (22.03.2013): Segmentation free Word spotting using Shift Descriptor.

Plamondon, Réjean, École Polytechnique de Montréal, Montreal (08.11.2012): Neuromuscular studies of handwriting generation and representation.

Plamondon, Réjean, École Polytechnique de Montréal, Montreal (23.11.2012): Emergence of Four Physical Interactions.

***Documentation Research and Training Centre***

Pattuelli, Cristina, Pratt Institute, School of Information & Library Science, USA (16.07.2012-17.07.2012): Linked Data for Digital Achieves: The Linked Jazz Project and Modeling Individuals: Knowledge Representation of People Entities.

Oh., Dong-Geun, Dept. of Library and Information Science, Kei-Myung University, Daegn, South Korea (02.07.2012): Development and Maintaining Korean Decimal Classification: From its Classification Committee Chair's View.

Yang, Kinduk, Dept. of Library and Information Science, Kei-Myung, University, Daegn, South Korea (02.07.2012): Future of Libraries: Library search optimization.

Koganurmah, Tata Institute of Social Science, Mumbai (05.09.2012): Library as a super information system.

Seaman, Scott, Vernon R. Alden Library, Ohio University, Athens, OH 45701, USA (18.03.2013): Changing Roles & Changing Skills and is an overview of expectations North American academic libraries have for newly graduated librarians to fill entry-level positions.

Arunachalam, Subbiah, M.S Swaminathan Research Foundation, Chennai (06.03.2013): Introduction to Scholarly communication and open access.

M.P., Satija, Gurunanak Dev University, Amritsar (18.12.2012): Changing role of libraries from clay-table libraries to virtual libraries.

M.P., Satija, Gurunanak Dev University, Amritsar (20.12.2012): Classification as foundation of study of librarianship.

M.P., Satija, Gurunanak Dev University, Amritsar (21.12.2012): Modes of growth of knowledge & formation of subjects.

M.P., Satija, Gurunanak Dev University, Amritsar (25.12.2012): Information overloaded and its prevention.

M.P., Satija, Gurunanak Dev University, Amritsar (27.12.2012): Role of Ranganathan in development of academic libraries.

Sreekumar, Library, Indian Institute of Management, Calicut (28.2.2013): E2.0: Enterprises Knowledge Management.

## Conferences and Seminars

### ***Electronics and Communication Sciences Unit***

Dutta, Kaushik, School of Computing, National university of Singapore, Singapore (04.07.2012): Fast, Scalable and Context-Sensitive Detection of Trending Topics in Microblog Post Streams.

Gandhi, Tapan Kumar, Massachusetts Institute of Technology (MIT), Cambridge, USA (06.08.2012): A Window in Brain Plasticity.

Gupta, Amarnath, San Diego Super Computer Center (SDSC), University of California, San Diego (17.08.2012): On Labeling Photos with Events.

Saha, Baidyanath, Wake Forest School of Medicine, USA (24.01.2013): Efficient Image Segmentation Using Enhanced AdaBoost Algorithm.

Mitra, Abhijit, CIT, Ranchi, India (06.03.2013): System Modelling through Statistical Signal Processing: Perspectives and Possibilities.

Dutta, H.N., (15.03.2013): Role of Statistics and Pattern Recognition in Earthquake Precursor Detection.

### ***Machine Intelligence Unit***

Chakraborty, Basabi, Software and Information Science Department, Iwate Prefectural University, Japan (28.12.2012): Pattern Discovery from Social Media.

Kargupta, Hillol, Computer Science & Electrical Engineering Department, University of Maryland, Baltimore County, USA (31.12.2012): Next Generation of Machine-to-Machine Environments and Distributed Data Mining.

Ramachandran, S., Institute of Genomics and Integrative Biology, New Delhi, India (11.01.2013): Identification of virulence factors in pathogenic organisms: Learning Experiences.

Roland, Eils, Bioquant University of Heidelberg, Germany, Head, Theoretical Bioinformatics Group, German Cancer Research Center, Heidelberg, Germany (30.11.2012): Computational Challenges in Next Gen Sequencing Data.

Sen Bhattacharya, B., School of Engineering, University of Lincoln Brayford Pool, Lincoln LN6 7TS, United Kingdom (2.8.2012): Neural Mass Computational Models to Mimic Electroencephalogram in Neurological Disorders.

Sinha, S. Indian Institute of Science Education and Research, Mohali, India (28.12.2012 & 03.01.2013): (i) Modelling Biochemical Pathways, (ii) Analysis of Genomic Signatures for classification of HIV-1 Genomes.

### ***Systems Science and Informatics Unit***

Babu Rao, C., Indira Gandhi Centre for Atomic Research, Kalpakkam (27.11.2012 & 29.11.2012): Practical quantitative microscopy – Part 1 and 2.

Bhalla, Upinder, National Center for Biological Sciences (NCBS), Bangalore (04.06.2012): Neuroinformatics in the new era of brain research.

## Conferences and Seminars

Gandhi, Tapan Kumar, Massachusetts Institute of Technology (MIT), Cambridge, MA, USA (03.08.2012): A window into brain plasticity.

(Jack) Schuenemeyer, John, H., Statistical Consulting Corporation, Colorado, USA (26.11.2012): Analogs, expert judgment, dependency, and aggregation.

(Jack) Schuenemeyer, John, H., Statistical Consulting Corporation, Colorado, USA (27.11.2012): Modeling gas hydrate resources – a statistician's perspective.

Mandal, Pravat, Manesar, Gurgaon, Haryana, National Brain Research Centre (08.06.2012): Biomarkers for brain neurochemicals using noninvasive imaging.

Martin-Boerner, Wolfgang, University of Illinois-Chicago, USA (30.11.2012): Implementation of FULL-POLSAR in agriculture, forestry and aquaculture.

Nair, Sumitra, Indian Institute of Space Science and Technology, Trivendrum (28.11.2012 & 29.11.2012): Introduction to machine learning algorithms – Part 1 and 2.

Pinnamaneni, Bhanu Prasad, Matix Vision, Germany (26.11.2012): The industrial applications; Smart cameras, Parking management, Traffic analysis.

Radhakrishnan, N., Technology Information, Forecasting and Assessment Council - Centres of Relevance & Excellence, (TIFAC-CORE), Rajalakshmi Engineering College, Chennai (27.11.2012): Computer vision application in industries.

Rama Rao, N., Indian Institute of Space Science and Technology, Trivendrum (27.11.2012 & 29.11.2012): Machine learning approaches for hyperspectral image classification.

Ray, Supratim, Center for Neuroscience, Indian Institute of Science, Bangalore (07.06.2012): Local field potential (LFP).

Saini, Jitender, National Institute of Mental Health and NeuroSciences (NIMHANS), Bangalore (09.06.2012): Clinical aspects of fMRI.

Yalavarthy, Phaneendra, Supercomputer Education and Research Centre (SERC), Indian Institute of Science, Bangalore (11.06.2012): Medical image reconstruction and processing.

Venkatesan, Ramesh, GE Healthcare, New Delhi (05.06.2012): fMRI: from physics to physiology.

### ***Computer Science Unit, Chennai***

Sekar, Gautham, Arenberg Doctoral School of Science, Engineering & Technology, Belgium (15.01.2013): Stream Cipher and Statistical Timing Analysis.

## **Physics and Earth Sciences Division**

### ***Geological Studies Unit***

Abrahami, R., ISTERre, Universite Joseph Fourier, Grenoble, France (01.03.2013): Provenance of the Tista megafan deposits from geochemical and petrographic constraints.



## Conferences and Seminars

Huyghe, P., ISTERre, Universite Joseph Fourier, Grenoble, France (01.03.2013): Tectonics, exhumation and drainage evolution of the Eastern Himalaya since 13 Ma from detrital geochemistry and thermochronology, Kameng River section, Arunachal.

Najman, Y., Lancaster University, UK (10.12.2012): Missing record of Himalayan erosion? : Study of the detrital record of Bangladesh and Burma.

Slowakiewicz, M., University of Bristol, UK (04.02.2013): Lipid biomarkers from the upper Permian microbialites.

Van Der Beek, P., ISTERre, Universite Joseph Fourier, Grenoble, France (01.03.2013): Tectonic control on topographic and exhumational segmentation of the Himalaya.

### ***Physics and Applied Mathematics Unit***

Bose, Debanjan, Vrije Universiteit Brussel, Belgium (25.02.2013): Study of astrophysical sources in very high energy regime using ground based gamma-ray and neutrino telescopes.

Chakrabarti, Sayan, Instituto Superior Tecnico, Lisbon, Portugal (21.05.2012): Floating orbits around rotating black holes and imprints of massive scalars.

Datta, K. Kanan, Department of Astronomy and Oscar Klein Center, Stockholm University, Sweden (15.11.2012): Probing the universe's first light: statistical detection of reionization 21 cm signal.

Das, K. Tapas, Harish Chandra Research Institute, Allahabad, (23.11.2012): Black holes in your bathtub.

Dhar, Deepak, Tata Institute of Fundamental Research, Mumbai, (30.11.2012): Statistical physics of glasses.

Ghosh, Sibasish, Department of Physics, Institute of Mathematical Sciences, Chennai (15.05.2012): Zero discordance of initial system-environment correlation versus complete positivity of the dynamical map of the system.

Ghosh, Satyajit, University of Leeds, U. K. (07.06.12): Energy efficiency in architectural designs in the Indus valley civilization: lessons learnt for new designing.

Rahaman, Ramij, Department of Physics, Institute of Mathematical Sciences, Chennai (09.05.2012): Local cloning of multipartite entangled states.

Sen, Anjan Ananda, Center for Theoretical Physics, Jamia Millia Islamia, New Delhi (10.01.2013): Dark energy model building and observational signatures.

Sarkar, Sahotra, University of Texas at Austin, USA (04.01.2013): Information in Biology?

## **Biological Sciences Division**

### ***Human Genetics Unit***

Chakraborty, Sounak, University of Missouri, Columbia, U.S.A. (12.11.2012 & 16.11.2012): Survival Prediction with Simultaneous Shrinkage and Grouping Priors.

## Conferences and Seminars

Chakraborty, Ranajit, University of Texas, USA (26.12.2012): Current issues on Computational Genetics.

Gupta, Mayetri, University of Glasgow, U.K. (13.12.2012): Bayesian block clustering for multi-trait genome wide association studies.

Gupta, Mayetri, University of Glasgow, U.K. (14.12.2012): Statistical Methods for prediction of nucleosome positioning in genomic DNA.

Mukhopadhyay, Nandita, University of Pittsburg, U.S.A. (07.12.2012): Gene Exploration Research at the Center for craniofacial Dental & Oral diseases.

Sikdar, Nilabja, Department of Cancer Epidemiology and Genetics, National Cancer Institute, NIH, SA (02.11.2012): Mutation at ATAD5 gene, human ortholog of yeast Elg1, might cause genomic stability and tumorigenesis.

## **Social Sciences Division**

### ***Economic Research Unit***

Bandyopadhyay, Taradas, University of California, Riverside, U.S.A. (01.02.2013): Rational Choice Procedures.

Basu, Somdutta, Pennsylvania State University, U.S.A. (19.07. 2012): Reputation for Two Audiences: Rating Agencies, Auditors and Issuer-pays Markets.

Basu, Somdutta, Pennsylvania State University, U.S.A. (03.01.2013): Does It Take a Village? Informal Insurance and Group Size under Individual Liability Loans.

Bhattacharya, Biswanath, Asian Development Bank (24.08.2012): ASEAN, the PRC, and India: The Great Transformation.

Bhattacharya, Biswanath, Asian Development Bank (24.01.2013): Determinants of Bond Market Development in Asia.

Bhattacharya, S. Prasad, Deakin University, Australia (10.01.2013): Land Reform Initiatives and Implementation in a World Country Panel.

Chakrabarti, Saumya, Visva-Bharati University, Santiniketan, Birbhum (30.01.2013): Unorganised Manufacturing in India: Structural Transformation / Exclusion / Marginalisation.

Chakravarty, Sujoy, Centre for Economic Studies and Planning, Jawaharlal Nehru University, New Delhi (14.06.2012): Keeping One's World: A Laboratory Study of Promises and Integrity.

Chowdhury, Modak, Subhasish, University of East Anglia, U.K. (20.12.2012): The Max-Min Group Contest with Applications to Turf Wars.

Dam, Kanishka, Centro de Investigation y Docencia Economicas, Mexico (02.01.2013): Incentives and Competition in Microfinance.

Das, Kaustav, Pennsylvania State University, U.S.A. (03.08.2012): Competition, Duplication and Learning in R & D.

## Conferences and Seminars

De, Kumar, Utpal, Department of Economics, North-Eastern Hill University, Shilong (07.02.2013): Integration of States through Globalisation and Development across the Continents.

Dutta, Arijita, University of Calcutta, Kolkata (07.06.2012): Hospital Efficiency: Measurement and Determinants.

Mallick, Indrajit, Centre for Studies in Social Sciences, Kolkata (26.07.2012): Optimal Bankruptcy Procedure under Asymmetric Information.

Mohapatra, Prasad, Debi, Department of Economics, Cornell University, U.S.A. (09.01.2013): Heterogeneous Beliefs and Wealth Dynamics in a Binary Hidden Markov Model.

Mutuswami, Suresh, University of Leicester, U.K. (27.04.2012): Bargaining in an ambiguous environment.

Sinha, Bhanu, Uday, Department of Economics, Delhi School of Economic, New Delhi (22.06.2012): International Cartels with Spheres of Influence

Veettil, Chellattan, Prakashan, Institute of Economic Growth, New Delhi (27.08.2012): Application of Choice Modeling in Policy Analysis Complementary Institutions and Nutrition Labelling.

## ***Economic Research Unit***

Jihe, Kaneko, Kobe University, Japan (11.03.2013): Price policy and production cost of rice in Japan, 1945 to 1995.

Kumar, Sunil M., Doctoral student at University of East Anglia, U.K. (25.02.2013): Does access to formal agricultural credit depend on caste?

Majeed, Javed, King's College, London, U.K. (03.01.2013): What's in a (Proper) Name? : Particulars, Individuals, and Authorship in the Linguistic Survey of India (1894-1928).

Rahman, Arshad, Doctoral student at University of California, Irvine (01.02.2013): Quantile Regressions using Metaheuristic Algorithms.

## ***Linguistics Research Unit***

Ghosh, Rajat, Director of Studies, English Language, Majan University College, Ruwi, Oman (07.07.2012): English Language Teaching.

Selvraj, Arulmozi, Dravidian University, Kuppam, India (03.05.2012 & 04.05.2012): Dravidian WordNet.

## ***Economics and Planning Unit***

Bhalotra, Sonia, University of Bristol, U.K. (20.04.2012): Religion, Political Identity and Public Goods in India.

Chakraborty, Indranil, National University of Singapore, Singapore (07.05.2012): Communication and Authority with a Partially Informed Expert.

## Conferences and Seminars

Chakrabarti, Subir K., Indiana University-Purdue University Indianapolis (IUPUI), U.S.A. (13.07.2012): Long run optimal contracts under adverse selection of limited commitment.

Dam, Kaniska, CIDE, Mexico City, Mexico (18.01.2013): Incentives and Competition in Micro-finance.

Duflo, Esther, Massachusetts Institute of Technology (MIT), U.S.A. (01.03.2013): Can Institutions be Reformed from Within? Evidence from a Randomized Experiment with the Rajasthan Police.

Farmer, Amy, University of Arkansas, U.S.A. (02.11.2012): Competitive Markets when Customers Anticipate Stock Outs.

Goel, Deepti, Delhi School of Economics, New Delhi (15.02.2013): The effect of metro rail on air pollution in Delhi.

Haimanko Ori, Ben Gurion University, Beersheba, Israel (05.10.2012): Approximate Robustness of Equilibrium of Incomplete Information.

Iversen, Vegard, Jindal School of Public Policy, U.S.A. and University of Manchester, U.K. (19.10.2012): On the colonial origins of agricultural development in India: a re-examination of Banerjee and Iyer, 'History, institutions and economic performance'.

Jain, Tarun, Indian School of Business, Hyderabad (03.08.2012): Letting the Briber Go Free: An Experiment on Mitigating Harassment Bribes.

Joshi, Shareen, Georgetown University, U.S.A. (31.07.2012): Collective Action and Community Development; Evidence from Women's Self-Help groups in Rural India.

Kumar, Sunil M., University of East Anglia, U.K. (01.02.2013): Does access to agricultural credit depend on caste?

Laxminarayan, Ramanan, Princeton University, U.S.A. (24.08.2012): Public finance of tuberculosis treatment in India: an extended cost-effectiveness analysis.

Lehrer, Ehud, Tel Aviv University, Israel (06.11.2012): Competitive Economy as a ranking device over networks.

Leoni, Patrick, Euromed Management, France (26.11.2012): Can Patent Duration Hinder Medical Innovation for Neglected Diseases?

Mishra, Prachi, International Monetary Fund (22.03.2013): Protection for Free? The political Economy of U.S. Tariff Suspensions.

Nitzan, Shmuel, Bar Ilan University, Israel (26.02.2013): Discrimination in Contests.

Pattnayak, Sanja, National University of Singapore, Singapore (21.05.2012): Testing for Bubbles in the Indian Housing Market: An ARDL Bonds Testing Approach.

Roy, Sanchari, Warwick University, U.K. (08.08.2012): Motivating Knowledge Agents Financial Incentives versus Social Proximity.

Sane, Renuka, Indira Gandhi Institute of Development Research, Mumbai (12.10.2012): How does Micro-Credit Matter: Evidence from a Large Scale Natural Experiment.

Sarangi, Sudipto, Louisiana State University, U.S.A. (14.12.2012): Reducing Choice Overload without Reducing Choices.

## Conferences and Seminars

Sudarshan, Anant, Harvard University, U.S.A. (08.03.2013): Money for Nothing: Using peer comparisons and Financial Incentives to Reduce Electricity Demand in Urban Indian Households.

Sivadasan, Jagadeesh, University of Michigan, U.S.A. (05.06.2012): Gains from Off shoring: Evidence from New US Microdata.

Wiszniewska-Matyszkiewicz, Agnieszka, Institute of Applied Mathematics and Mechanics, University of Warsaw, Poland (14.01.2013): A new Concept of equilibrium in games with distorted information.

### ***Population Studies Unit***

Islam, M. Nazrul, Department of Statistics, Shahjalal University of Science and Technology, Sylhet, Bangladesh (08.10.2012): Measuring Aging as a Function of Population Momentum - An Application with Bangladesh Population.

Taj Uddin, M., Department of Statistics, Shahjalal University of Science and Technology, Sylhet, Bangladesh (09.10.2012): A New Index for Measuring Aging Inequality: An Application to Asian Countries.

### ***Sampling and Official Statistics Unit***

Marjit, Sugata, Centre for Studies in Social Sciences, Kolkata (12.02.2013): Conflicting Measures of Poverty and Inadequate Saving by the Poor: the Role of Status Driven Utility Function.

### ***Sociological Research Unit***

Mallick, Rajlakshmi, NSHM Business School, Kolkata (27.06.2012): Measuring Quality of Life in the Sundarbans Region.

Mohanti, B.B., Department of Sociology, Pondicherry University (27.07.2012): Farmer Suicides: Durkheim in India.

Rahman, Taimur, Lahore University of Management Sciences, Pakistan (17.12.2012): Class Structure of Pakistan.

## **Statistical Quality Control and Operations Research Division**

### ***SQC & OR Unit, Bangalore***

Murthy, K.G., University of Michigan, U.S.A. (04.09.2012): The Branch and Bound Approach: A personal account.

### ***SQC & OR Unit, Coimbatore***

Srinivasan, Raj, University of Saskatchewan, Canada (23.11.2012): Stochastic modeling of recovery time.

**SQC & OR Unit, Kolkata**

Dasgupta, T., Harvard University, U.S.A. (17.01.2013): A D-optimal design for estimation of parameters of an exponential-linear growth curve of nanostructures.

Syamsundar, A., Visakhapatnam Steel Plant (26.02.2013): Modelling of repairable systems using point processes.

**Center for Soft Computing Research: A National Facility**

Bhattacharyya, K., Indian Association for the Cultivation of Science, Kolkata, India (26.12.2012): Heroes of Indian Science.

Biswas, G., Indian Institute of Technology, Kanpur & Council of Scientific and Industrial Research-Central Mechanical Engineering Research Institute (CSIR-CMERI), Durgapur, India (14.09.2012): Simulation of Multi-Fluid System: Understanding Drop Impact.

Chakrabarti, B., Saha Institute of Nuclear Physics, Kolkata, India (28.02.2013): Econophysics of Income & Wealth Distribution in Societies.

Mondal, P., Jadavpur University, Kolkata, India (19.11.2012): Automatic Extraction on Complex Predicates in Bengali.

## 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.

Beginning 2010, Springer has entered into a co-publication agreement with the Institute and has exclusive rights for the international distribution of the journal. 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 online.

The following issues have been published during April 2012 to March 2013:

February 2012	: Volume 74 Part I, Series A [Electronic Edition, Print Editions]
May 2012	: Volume 74 Part I, Series B [Electronic Edition, Print Editions]
August 2012	: Volume 74 Part II, Series A [Electronic Edition, Print Editions]
November 2012	: Volume 74 Part II, Series B [Electronic Edition, Print Editions]

The following issues are currently under process for publication:

February 2013	: Volume 75 Part I, Series A
May 2013	: Volume 75 Part I, Series B

The present Editorial Board of *Sankhyā* is as follows:

Editor-in-Chief	: B.L.S. Prakasa Rao
Editors: Series A	: Alok Goswami, Sourav Chatterjee, Hemant Ishwaran, Subhashis Ghosal
Editors: Series B	: Atanu Biswas, Nilanjan Chatterjee, Hemant Ishwaran, Lijian Yang
Technical Editor	: Shmindra Kumar Ghosh, Pinakpani Pal
Technical Support	: Urmichhanda Bhattacharya
Editorial Office Support	: Prasanta Kumar Sen, Ranjit Mandal, Kajal De

## 6. SCIENTIFIC PAPERS AND PUBLICATIONS

### Books Published

#### Theoretical Statistics and Mathematics Division

##### *Stat-Math Unit, Kolkata*

Bhattacharya, Abhishek and Bhattacharya, Rabi: *Nonparametric Inference on Manifolds with Applications to Shape Spaces*, Institute of Mathematical Statistics Monographs 2, Statistical Theory and Methods, Cambridge University Press Book, 2012.

Dasgupta, R. (ed.): *Advances in Growth Curve Models: Topics from the Indian Statistical Institute*, Proceedings in Mathematics & Statistics 46, Springer, 2013.

Srivastava, S.M.: *A Course on Mathematical Logic*, Second Edition, Springer, New York, 2013.

##### *Stat-Math Unit, Delhi*

Bhatia, R., Bhatt. A. and Parthasarathy, K.R. (eds.): *Collected Works of S.R.S. Varadhan*, Volume-1 to 4, Hindustan Book Agency, Delhi and Springer, New York, 2013.

Bhatia, Rajendra, Rajan C. S. and Singh, Ajit Iqbal (eds.): *Connected at Infinity II – on the work of Indian Mathematicians*, Hindustan Book Agency, 2013.

Kundu, Debasis and Nandi, Swagata: *Statistical Signal Processing*, Frequency Estimation Series, SpringerBriefs in Statistics, 2012.

Nielsen, F. and Bhatia, R. (eds.): *Matrix Information Geometry*, Springer, Berlin, 2013.

Parthasarathy, K.R.: *Coding Theorems of Classical and Quantum Information Theory* (Revised Edition), Hindustan Book Agency, 2013.

#### Applied Statistics Division

##### *Applied Statistics Unit, Kolkata*

Chaudhuri, A.: *Developing Small Domain Statistics: Modelling in Survey Sampling*, Lambert Academic Publishing GmbH & Co., KG Saarbrucken, Germany, pages 112+3, 2012.

##### *Bayesian and Interdisciplinary Research Unit*

Chandra, T.K.: *Laws of Large Numbers*, Narosa Publishing House Pvt. Ltd, New Delhi, pages 230, ISBN: 978-81-7319-922-6, 2012.

Chandra, T.K.: *The Borel- Cantelli Lemma*, Springer Brief, Springer, New York, pages 106, ISBN: 978-81-3220-676-7, 2012.



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Majumder, Amita (ERU), Pal, Manoranjan (ERU), Ghosh, Buddhadeb (ERU), Basu, Ayanendranath, Bharati, Premananda (BAU), Pal Chowdhury, Pabitra (ASU), Neogy, S.K.(SQC & OR Unit, Delhi), Bapat, Ravindra, B. (Stat-Math Unit, Delhi) (eds.): *Statistics and Development Issues*, Mittal Publications, New Delhi, pages 278, ISBN: 81- 8324-418-1, 2012.

### ***Applied Statistics Unit, Chennai***

Sen, R. and Xu. Q.: *Covolatility*, Lambert Academic Publishing, Saarbrücken, Germany, 2013.

## **Computer and Communication Sciences Division**

### ***Computer Vision and Pattern Recognition Unit***

Chaudhuri, B.B.: *Bhasha Prajuktir Kayekti* (Some articles on language technology- in Bengali), Ananda Publishers, Kolkata, 2012

Chattopadhyay, Tanushyam, Garain, Utpal and Nasipuri, Mita: *Value Added Services for Connected TV*, Lambert Academic Publishing, Germany, 2012.

### ***Documentation Research and Training Centre***

Neelameghan, A. and Raghavan, K.S.(eds.): *Categories, Contexts and Relations in Knowledge Organization*, Advances in Knowledge Organization, Vol. 13, Ergon Verlag, Wurzburg, Germany, pages 396, ISBN: 978-3-89913-902-0, 2012.

### ***Electronics and Communication Sciences Unit***

Panigrahi, Bijaya K., Das, Swagatam, Suganthan, Ponnuthurai Nagarathnam and Nanda, Pradipta Kumar (eds.): *Proceedings of Third International Conference on Swarm, Evolutionary, and Memetic Computing - SEMCCO 2012*, Springer, Lecture Notes in Computer Science 7677, Bhubaneswar, ISBN: 978-3-642-35379-6, 2012.

### ***Machine Intelligence Unit***

Yao, J., Yang, Y., Slowinski, R., Greco, S., Li, H., Mitra, S. and Polkowski, L. (eds.): *Rough Sets and Current Trends in Computing (RSCTC 2012)*, Lecture Notes in Computer Science, 7413, Springer, Verlag, Berlin, 2012.

### ***Systems Science and Informatics Unit***

Najman, L., Barrera, J., Sagar, B.S.D., Maragos, P., and Schonfeld, D. (eds.): *Filtering and segmentation with mathematical morphology* (Special Issue), IEEE Journal on Selected Topics of Signal Processing, Vol. 6, No.-7, pages 737-886, 2012.

Sagar, B.S.D.: *Mathematical Morphology in Geomorphology and GISci*, Chapman & Hall Press (Taylor & Francis Group), Boca Raton, pages 546, ISBN-13: 978-1-439-87200-0, 2013.

## Physics and Earth Sciences Division

### *Physics and Applied Mathematics Unit*

Pal, S., Basu, B. (eds.): *Proceeding of International Conference on Modern Perspectives of Cosmology and Gravitation*, Journal of Physics, Conference Series, Institute of Physics Publication, UK, Vol. 405, 2012.

## Biological Sciences Division

### *Biological Anthropology Unit*

Adak, D.K., Gautam, R.K., Nanda, J. and Bharati, P.: *People, Health and Nutrition*, Mittal Publications, New Delhi, pages 117, 2012.

Bharati, S., Golam Hossain, M. and Bharati, P.: *The Variability of Human Head Form in India*, Lambert Academic Publishing, Saarbrucken, Germany, pages 163, 2012.

Majumder, A., Pal, M., Ghosh, B., Basu, A., Bharati, P., Chowdhury, P.P., Neogy, S.K. and Bapat, R.B. (eds.): *Statistics and Development Issues*, Mittal Publication, New Delhi, pages 278, 2012.

Bansal, I.J.S., Chahal, S.M.S. and Mukhopadhyay, B. (eds.): *Studies on Biological Anthropology*, Biocultural Dimensions, INCAA, Jhargram, pages

## Social Sciences Division

### *Economic Research Unit*

Chakrabarti, Bikas K., Chakraborti, Anirban, Chakravarty, Satya R. and Chatterjee, Arnab, (eds.): *Econophysics of Income and Wealth Distributions*, Cambridge University Press, pages 214, ISBN 978-1-107-01344-5, 2013.

Majumder, Amita, Pal, Manoranjan, Ghosh, Buddhadeb, Basu, Ayanendranath (BIRU), Bharati, Premananda (BAU), Pal Chowdhury, Pabitra (ASU), Neogy, S.K. (SQC & OR, Delhi) and Bapat, Ravindra B. (Stat-Math Unit, Delhi) (eds.): *Statistics and Development Issues*, Mittal Publication, ISBN: 81-8324-418-1, 2012.

### *Economic Analysis Unit*

Narayana, N.S.S.: *Social Value System in India: Looking back to go ahead*, Development Foundation, Bangalore, 2012.

### *Linguistic Research Unit*

Dasgupta, Probal, Camacho, Jorge and Ertl, István: *Beletra Almanako 14*, Mondial, New York, 2012.

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Dasgupta, Probal: *Bhaashaar Bindubishargo*, Gangchil, Kolkata, 2012.

Dash, Niladri Sekhar: *Applied Linguistics*, Heritage Publishers, New Delhi, pages 210, ISBN: 978-81-7026-304-3, 2013.

### ***Economics and Planning Unit***

Ghate, Chetan: *The Oxford Handbook of the Indian Economy*, Oxford University Press, New York, 2012.

### ***Population Studies Unit***

Pandey, Arvind, Bhattacharya, B.N., Sahu, D., De, Partha, Gulati, B.K., Shukla, A.K., Mitra, R.G., Mohan, Pavitra: *Infant and Child Mortality in India: Levels, Trends and Determinants*, National Institute of Medical Statistics (NIMS), Indian Council of Medical Research (ICMR), and UNICEF India Country Office, New Delhi, India, Online Version: <http://www.unicef.org/india/Report.pdf>, 2012.

### ***Sampling and Official Statistics Unit***

Sarkar, Amitava: *Functional Instability or Paradigm Shift? A Characteristic Study of Indian Stock Market in the First Decade of the New Millennium*, Springer, 2012.

### ***Sociological Research Unit***

Bharati, S., Golam Hossain, M. and Bharati, P. (BAU): *Variability of Human Head Form in India*, Lambert Academic Publishing, Saarbrucken, Germany, pages 168, 2012.

## **Library, Documentation and Information Sciences Division**

### ***Library, Kolkata***

Das, Binod Behari and Basak, Nanda Dulal: *Tathy*, Internet Avang Granthagarikata, Second Edition, Kolkata, Progressive Publishers, pages 447, 2012.

### ***Center for Soft Computing Research: A National Facility***

Mitra, M., Chakraborty, M.K. and Sarukkai, S. (eds.): *Studies in Logic: a Dialogue between the east and the west* (Homage to Bimal Krishna Maital), Munshiram Manoharlal Publishers, New Delhi, 2012.

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### Theoretical Statistics and Mathematics Division

#### *Stat-Math Unit, Kolkata*

Basak, G.K., Das P.K. and Marjit, S.: Foreign capital inflow, exchange rate dynamics and potential financial crisis, *Current Science*, **103(6)**, 2012.

Basak, G.K. and Biswas, Arunangshu: Process convergence of self-normalized sums of i.i.d. random variables coming from domain of attraction of stable distributions, *Proceedings of Indian Academy of Sciences (Mathematical Sciences)*, **125(1)**, 85-100, 2013.

Basu, Riddhipratim, Bose, Arup, Ganguly, Shirshendu and Hazra, Rajat Subhra: Joint convergence of several copies of different patterned random matrices, *Electronic Journal of Probability*, **17(82)**, 1-33, 2012.

Basu, Riddhipratim, Bose, Arup, Ganguly, Shirshendu and Hazra, Rajat Subhra: Spectral properties of random triangular matrices, *Random Matrix Theory and Applications*, **1(3)**, 1250003-1250024, Online Version: DOI: 10.1142/S2010326312500037, 2012.

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Bhattacharya, Abhishek and Dunson, David: Strong consistency of nonparametric Bayes density estimation on compact metric spaces with applications to specific manifolds, *Annals of the Institute of Statistical Mathematics*, **64(4)**, 687-714, 2012.

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Bose, Arup and Gupta, Barnali: Optimal training, employee preferences and moral hazard, *Journal of Economic Theory and Social Development*, **1(1)**, 1-24, 2012.

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Bose, Arup, Pal, Debashis and Sappington, David: Extreme screening policies, *European Economic Review*, **56**, 1607-1620, Online Version: DOI: 10.1016/j.euroecorev.2012.09.001, 2012.

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Bose, Arup, Hazra, Rajat Subhra and Saha, Koushik: Extremum of Circulant type matrices: a survey, *Journal of Indian Statistical Association* (Golden Jubilee Issue), **50(1-2)**, 21-49, 2012.

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- Bapat, R.B., Kalita, D. and Pati, S.: On weighted directed graphs, *Linear Algebra and Its Applications*, **436**, 99-111, 2012.
- Bapat, R.B. and Sivasubramanian, S.: The product distance matrix of a tree and a bivariate zeta function of a graph, *Electronic Journal of Linear Algebra*, **23**, 275-286 2012.
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Thakur, Maneesh: Automorphisms of Albert algebras and a Conjecture of Tits and Weiss, *Transactions of the American Mathematical Society*, **365(6)**, 3041-3068, 2013.

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Banerjee, Priyodorshi, Mitra, Manipushpak and Mukherjee, Conan: Kolkata Paise Restaurant Problem and the Cyclically Fair Norm, *Econophysics of Systemic Risk and Network Dynamics*, Frederic Abergel, Bikas Chakrabarti, Anirban Chakraborti and Asim Ghosh (eds.), Springer, Amsterdam, 173-200, 2013.

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Das, S.: Human Well-Being in India, in *Encyclopedia of Quality of Life and Well-Being Research*, A.C. Michalos (ed.), Springer, Online Version: DOI: 10.1007/978-94-007-0753-5, 2013.

Das, S. and D. Mukherjee: Labouring Boys in Urban India, in *Encyclopedia of Quality of Life and Well-Being Research*, A.C. Michalos (ed.), Springer, Online Version: DOI: 10.1007/978-94-007-0753-5, 2013.

Pal, Manoranjan and Mehta, Rajib: Regional Disparities in the Characteristics of Own Account Non-Agricultural Enterprises, *Statistics and Development Issues*, A. Majumder, M. Pal, B. Ghosh, A. Basu, P. Bharati, P. Pal Chowdhury, S.K. Neogy and R.B. Bapat (eds.), Mittal Publications, New Delhi, India, 153-170, 2012.



## Publications

### ***Economic Analysis Unit, Bangalore***

Guha, P.: Implications of EU Enlargement for India-EU Labour Mobility: Competition, Challenges and Opportunities, *CARIM-India Research Report 2012/13*, Robert Schuman Centre for Advanced Studies, San Domenico di Fiesole (FI): European University Institute, Florence, Italy, 1-19, 2012.

### ***Linguistic Research Unit***

Dasgupta, Probal: Antaaparolo, Truyen Kieu, *La Rakonto pri Kjeu*, Le Can Phan (Translator), Thé Giói, Hanoi, 7-9, 2012.

Dasgupta, Probal: Rephrasing the question of complex predicates in Bangla: a biaxial approach, *Annual Review of South Asian Languages and Linguistics 2012*, Rajendra Singh, Shishir Bhattacharja (eds.), Mouton De Gruyter, Berlin/ New York, 3– 44, 2012.

Dasgupta, Probal: Ditiyo shangshkoroner bhumikaa, Badal Sircar, *Bishshobhaashaa Esperanto*, Federacio Esperanto de Barato, Hyderabad, iii-vi, 2012.

Dasgupta, Probal: Antaaparolo al la dua eldono de la lernolibro de Badal Sircar, *Bishshobhaashaa Esperanto*, Federacio Esperanto de Barato, Hyderabad, vi-viii, 2012.

Dasgupta, Probal: Home and the civilian space in Tagore's Book of Consecration, *Tagore: At Home and in the World*, Sanjukta Dasgupta and Chinmoy Guha (eds.), Thousand Oaks and Sage, New Delhi and London, 185–205, 2013.

Dasgupta, Probal: La rugho kaj la verdo: fi-trajto-inertaj sanskritidaj substantivoj en kunreprezenta analizo / Shamaantor protikriti-bisleshoner cokhe Bhaarotiyo Aarjo bhaashaar phaai-nishkriyo bisheshsho, *Littera Scripta Manent: Serta in Honorem Helmar Frank*, Věra Barandovská-Frank (ed.), Akademia Libroservo, Paderborn, Prague, 182-192, 2013.

Dasgupta, Probal: (tr.) Oxford, 1993 [From the Esperanto original by Jorge Camacho Córdón], *Star in a Night Sky: An Anthology of Esperanto Literature*, Paul Gubbins (ed.), Francis Boutle, London, 260-261, 2012.

Dasgupta, Probal: Ramchandra Gandhi: The Gachibowli period, *Ramchandra Gandhi: The Man and His Philosophy*, A. Raghuramaraju (ed.), Routledge, New Delhi/ London/ New York, 238-249, 2013.

Dasgupta, Probal: Kathaabaartaa, *Dialogo*, Cluj-Napoca and Júlia Sigmond (ed.), Exit, Romania, 18-19, 2012.

Dasgupta, Probal: (tr.) Kvar poemoj [From the Bangla originals by Rabindranath Tagore: Aami tomaae jato; Shedin dujone dulechinu; Jodi tor daak shune keu; Gagone garoje megh], *Beletra Almanako 16*, Jorge Camacho et al. (eds.), 13-16, 2013.

Dasgupta, Probal: Deriving the dialectic, *Vaagartha: A Festschrift for Prof. Padmakar R. Dadegaonkar*, Shivarama Padikkal and Tariq Khan (eds.), Centre for Applied Linguistics and Translation Studies, University of Hyderabad, Hyderabad, 3-21, 2012.

Dasgupta, Probal: Look across: The paradigmatic axis and Bangla causatives, *Argument Structure*, Eric Reuland, Tanmoy Bhattacharya and Giorgos Spathas (eds.), John Benjamins, Amsterdam, 213-237, 2012.

### **Psychology Research Unit**

Dutta Roy, D.: Reading Motivation in Primary School Girls: A Problem of Cognitive Mapping, *Globalization and Gender*, Susmita Sarkar and Manjari Srivastava (eds.), Rawat Publications, New Delhi, 236-247, 2012.

Gupta, Rumki: Gender Disparity in Madhyamik Examination Result, *Gender Issues and Empowerment of Women*, Manoranjan Pal, Prasanta Pathak, Premananda Bharati, Bholanath Ghosh and Amita Majumder (eds.), Nova Science Publishers Inc., New York, 246-256, 2012.

Gupta, Rumki: Evaluation of Content and Performance in Mathematics at the Secondary Level School Students, *Redefining Education Expanding Horizons*, Mintu Sinha (ed.), Alfa Publications, New Delhi, 283-291, 2013.

### **Sampling and Official Statistics Unit**

Bakshi, Sanjeev and Pathak, Prasanta: An Analysis of the State of Empowerment of Females vis-à-vis Males at Old Ages in India, *Gender Issues and Empowerment of Women*, Manoranjan Pal, Prasanta Pathak, Premananda Bharati, Bholanath Ghosh and Amita Majumder (eds.), Nova Science Publishers Inc., New York, USA, 83-108, 2012.

Bardhan, Pranab, Mookherjee, Dilip, Sarkar, Abhirup (ERU) and Mitra, Sandip: Local Democracy and Clientelism: Implications for Political Stability in Rural West Bengal, *Decentralisation and Local Governments*, T.R Raghunandan (ed.), Orient Black Swan Publication, 131-142, 2012.

### **Sociological Research Unit**

Bharati, Susmita: Dual burden of malnutrition among Indian women: A comparative analysis between NFHS-3 and NFHS-2, *Human Malnutrition: Twin Burdens of Undernutrition and Overnutrition*, Kaushik Bose (ed.), Nova Science Publishers Inc., Hauppauge, New York., 165-176, 2013.

Ghosh, Bholanath: Gender Budgeting, Resource Control & Empowerment of Women: A Study in Meghalaya, *Gender Budgeting: State Towards Justice (Conceptual and empirical issues)*, Abdul Motin (ed.), Dasgupta & Company Publication House, Kolkata, 27-37, 2012.

## **Statistical Quality Control and Operations Research Division**

### **SQC & OR Unit, Kolkata**

Das, A.K., and Sen, J.: Modeling the Stock Price for an Indian IT Company Using Time Series Analysis, *Mathematical Sciences, International Research Journal*, Ratnakar D.B. (ed.), IMRF Publication, **1(3)**, 1039-1044, ISBN-978-93-81583-57-9, 2012.

## Publications

### ***Center for Soft Computing Research: A National Facility***

Dutta, M., Basu, S. and Chakraborty, M.K.: Many- Valued Logics and Graded Consequence: A Comparative Appraisal, *Logic and its Applications*, K. Lodaya (eds.), Springer, 197-209, 2013.

Pal, S.K. and Banerjee, R.: The Z-number enigma: A study through an experiment, *Soft Computing: State of the Art Theory and Novel Applications*, R. Yager and M. Reformat (eds.), Springer, 71-88, 2013.

Skowron, A., Chakraborty, M.K., Grzymala-Buse, J., Marek, V. Pal, S.K., Peters, J.F., Rozenberg, D., Slezak, D., Slowinski, R., Tsumoto, S., Wakuliez-Deja, G., Wang and Ziarko, W.: Professor Zdzislaw Pawlak (1926-2006): Founder of the Polish School of Artificial Intelligence, *Rough Sets and Intelligent Systems*, A. Skowron and Z. Suraj (eds.), Springer-Verlag, Heidelberg, Berlin, 1-56, 2013.

## 7. VISITING SCIENTISTS, HONOURS AND AWARDS

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*

Banerjee, Arindam, University of Kankas, June 08- August 08, 2012.

Biswas, Indranil, Tata Institute of Fundamental Research, Mumbai, December 21-26, 2012.

Basak, Tathagata, Iowa State University, Ames, USA, May 23-July 14, 2012.

Chattopadhyay, Pratyusha, Mainzerstrass, Saarbrucken, Germany, September 10, 2012-March 31, 2013.

Dutta, Santanu, Tezpur University, July 16-22, 2012.

Fei, Shao-Ming, Capital Normal University, Beijing, China, January 08-16, 2013.

Hazra, Rajat Subhra, University of Zurich, January 01-February 01, 2013.

Hillier, Robin, Dipartimento di Matematica, Universita di Roma 'Tor Vergata', Italy, November 15, 2012-March 15, 2013.

Gondhali, Shilpa Suresh, Tata Institute of Fundamental Research, Mumbai, September 01, 2012-March 31, 2013.

Kar, Aditi, Oxford University, UK, February 07-March 31, 2013.

Mondal, Ashis, Mathematics Research Unit, University of Luxembourg, April-September, 2012

Munshi, Ritabrata, Tata Institute of Fundamental Research, Mumbai, April 02-May 31, 2012.

Palmowski, Zbigniew, University of Wroclaw, Poland, January 14-26, 2013.

Pal, Koushik, University of Maryland College Park, May 22-June 01, 2012.

Saeb, Ali, Department of Studies in Statistics, University of Mysore, August 16, 2012-February 28, 2013.

Saraswat, Vishal, C.R. Rao Advanced Institute of Mathematics, Statistics and Computer Science, January 14-18, 2013.

Sen, Bodhisottva, University of Cambridge, UK, July 25-August 20, 2012.

Sengupta, Jyotirmoy, Tata Institute of Fundamental Research, Mumbai, December 07-23, 2012.

Visiting Scientists, Honours and Awards

Sofi, M.A., Kashmir University, Srinagar, November 11-January 06, 2013.

***Stat-Math Unit, Delhi***

Adhikari, Bibhas, Indian Institute of Technology, Rajasthan, July 10-21, 2012.

Adhikari, S.D., Harish-Chandra Research Institute, Allahabad, February 5-8, 2013.

Athreya, K.B., Iowa State University, USA, February 18-27, 2013.

Bhattacharyya, Siddhartha, School of Mathematics, Tata Institute of Fundamental Research, Mumbai, April 30-May 4, 2012.

Bhattacharyya, Amitava, School of Mathematics, Tata Institute of Fundamental Research, Mumbai, May 18-28, 2012.

Bhowmik, Arpan, Indian Agricultural Statistics Research Institute, New Delhi, January 01-March 31, 2013.

Bose, Debashish, Institute of Mathematical Sciences, Chennai, since August 07, 2012.

Chakrabarty, Parthasarathi, Institute of Mathematical Sciences, Chennai, September 13-17, 2012.

Chatterjee, Kashinath, Visva-Bharati University, Santiniketan, March 05-12, 2013.

Chaubey, Y.P., Department of Mathematics and Statistics, Concordia University, Canada, January 14-25, 2013.

Chorwadawala, Anisa, Indian Institute of Science and Educational Research, Pune, February 14-16, 2013.

Das, Suchismita, Indian Institute of Science and Educational Research, Kolkata, October 28-November 03, 2012.

Das, Suchismita, Indian Institute of Science and Educational Research, Kolkata, since January 01, 2013.

Deshpande, J.V., Department of Mathematics, Indian Institute of Technology, Mumbai, June 30-July 06, 2012.

Dutta, Kunal, Institute of Mathematical Sciences, Chennai, since January 01, 2013.

Goyal, Anju, Panjab University, Chandigarh, July 20–September 03, 2012.

Grabchak, Michael, Department of Mathematics and Statistics, University of North Carolina, USA, June 10-27, 2012.

Iyer, Uma N., Department of Mathematics and Computer Science, Bronx Community College, USA, July 20-25, 2012.

Jain, Kanchan, Panjab University, October 12-16, 2012.

Karandikar, R.L., Chennai Mathematical Institute, Siruseri, November 29-December 09, 2012.

## Visiting Scientists, Honours and Awards

Khaledi, Baha-Eldin, Razi University, Iran, March 10-April 07, 2013.

Kochar, Subhash, Department of Mathematics and Statistics, Portland State University, USA, December 03, 2012-January 04, 2013.

Kumar, Ravinder, Department of Mathematics and Statistics, Himachal Pradesh University, Shimla, January 01-31, 2013.

Lahiri, Ananya, Chennai Mathematical Institute, Siruseri, Kellambakkam, November 25–December 01, 2012.

Mishra, Amit Kumar, Department of Statistics, Central University of Bihar, Patna, June 04-16, 2012.

Patra, Kamal L., National Institute of Science Education and Research, Bhubanewar, March 10-16, 2013.

Prasad, Srijanani Anurag, National Board for Higher Mathematics, since September 01, 2012.

Ruggeri, Fabrizio, Istituto di Matematica Applicata e Tecnologie Informatiche, Italy, January 11-15, 2013.

Sano, Takashi, Yamagata University, Japan, December 20-26, 2012.

Shanmugasundaram, Sundar, Tuticorin, Chennai, April 01-September 30, 2012.

Sharma, Rajesh, Department of Mathematics and Statistics, Himachal Pradesh University, Shimla, September 23-30, 2012.

Sharma, Rajesh, Department of Mathematics and Statistics, Himachal Pradesh University, Shimla, January 01-31, 2013.

Singh, Anuraj, Graphic Era University, Dehradun, September 29–October 06, 2012.

Sivasubramanian, Krishnan, Department of Mathematics, Indian Institute of Technology, Mumbai, May 31–June 07, 2012 and December 12-16, 2012.

Sofi, M.A., Department of Mathematics, Kashmir University, Jammu and Kashmir, October 1-23, 2012.

Tijdeman Rob, Leiden University, Netherlands, February 01-16, 2013.

Waldschmidt, Michel, University of Paris, France, October 09-13, 2012.

Willems, Harrie, January 14-16, 2013.

### ***Stat-Math Unit, Bangalore***

Appal Raju, Venkat I., National Board for Higher Mathematics, since April 30, 2012 for one year.

Athreya, K.B., Iowa State University, USA, June 15–August 08, 2012 and January 07–February 06, 2013.

Bruen, Aiden, University of Calgary, Canada, October 31–November 16, 2012.

## Visiting Scientists, Honours and Awards

- Cardinali, Ilaria, University of Siena, Italy, October 19–December 21, 2012.
- Chattopadhyay, Arup, JNCASR, Bangalore, February 01–June 30, 2013.
- Das, Bata Krishna, University of Lancaster, UK, since November 17, 2012.
- Dutta, Sudipta, Indian Institute of Technology, Kanpur, June 24–29, 2012.
- Hazrat, R., University of Western Sydney, Australia, January 14–18, 2013.
- Kondo, Satoshi, University of Tokyo, Japan, February 15–March 03, 2013.
- Kulkarni, Manisha, Department of Science & Technology Project, April 01–May 02, 2012.
- Kumar, Krishna, Indian Institute of Technology, Chennai, September 10, 2012–February 07, 2013.
- Kumar, Mohan N., Washington University, St. Louis, USA, May 16–26, 2012.
- Muralidharan, Amrita, University of Exeter, UK, April 01–July 31, 2012.
- Pal, Sarbeswar, Chennai Mathematical Institute, Chennai, December 23–30, 2012.
- Pal, Sourav, Indian Institute of Science, Bangalore, April 02–October 16, 2012.
- Pandit, Suhas, Abdus Salam International Centre for Theoretical Physics, Italy, January 14–18, 2013.
- Paul, Tanmoy, National Board for Higher Mathematics, April 01, 2012–October 31, 2012.
- Pisolkar, Surpiya, Tata Institute of Fundamental Research, Mumbai, January 20–February 01, 2013.
- Purkait, Soma, University of Warwick, UK, April 01-03, 2012.
- Ram, Samrith, Indian Institute of Technology, Kanpur, July 01, 2012–February 11, 2013.
- Sahasrabudhe, Neeraja, University of Padova, Italy, March 25–29, 2013.
- Sahoo, Binod Kumar, National Institute of Science Education and Research, Bhubaneswar, June 02–30, 2012.
- Sainudiin, Raazesh, University of Canterbury, New Zealand, November 01–23, 2012.
- Sebastian, Ronnie, Humboldt Universitat zu Berlin, since December 14, 2012.
- Sethuraman, Bharath, California State University, Northridge, April 01– June 30, 2012.
- Shirke, D.T., Shivaji University, Kolhapur, May 09–July 04, 2012.
- Skeide, Michael, Universita degli Studi del Molise, Italy, June 23–September 22, 2012.
- Subbiah, L.N. Government College, Ponneri, Tamil Nadu, December 24–31, 2012.
- Tanner, Stephen Bruce, Eastern Oregon University, USA, November 01, 2012–March 31, 2013.
- Thakur, Ajay Singh, Institute of Mathematical Sciences, Chennai, April 01–September 8, 2012.

Thakur, Ajay Singh, Tata Institute of Fundamental Research Mumbai, October 28–November 11, 2012, February 08–22, 2013 and March 18–25, 2013.

Tripathi, Amit, National Board for Higher Mathematics, since December 01, 2012 for one year.

Tsukazari, Kiminori, University of Warwick, UK, April 01–03, 2012.

Winter, Anita, Universitat Duisburg-Essen, Germany, September 22–October 07, 2012.

### ***Stat-Math Unit, Chennai***

Patankar, Vijay M., since July 2011.

Baoulina, Ioulia, since October 10, 2011.

Sebastian, Nicy, since December 10, 2012.

### **Applied Statistics Division**

#### ***Applied Statistics Unit, Kolkata***

Narayanan, Rajendran, Cornell University, New York, USA, August 02, 2012–March 31, 2013.

Sungsu Kim, Duk-your height, Sindang-dong, Dalseo-gu, Daegu, South Korea, September 12, 2012–January 14, 2013.

#### ***Bayesian and Interdisciplinary Research Unit***

Chakraborti, Anirban, Laboratoire De Mathematiques Appliquees aux Systemes, Ecole Centrale, Paris, France, January 01-08, 2013.

Chakraborty, Goutam, Iwate Prefectural University, Japan, December 17, 2012-January 04, 2013.

Raha, Soumyendu, Indian Institute of Science, Bangalore, India, February 25-March 01, 2013.

Ray, Surajit, University of Glasgow, United Kingdom, December 05-22, 2012.

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

Bhattacharjee, Sushant K., Rajshahi University, Bangladesh, November 21, 2012-March 31, 2013.

#### ***Applied Statistics Unit, Chennai***

Anisha, P., July 16, 2012-March 31, 2013.



Visiting Scientists, Honours and Awards

## **Computer and Communication Sciences Division**

### ***Advanced Computing and Microelectronics Unit***

Binay, Bhattacharya K., School of Computer Science, Simon Fraser University, Canada, September 01, 2012-March 31, 2013.

Chakrabarti, Partha P., Department Computer Science and Engineering, Indian Institute of Technology, Kharagpur, since January 07, 2013.

Ghosh, Arijit, Institut National de Recherche en Informatique et en Automatique (INRIA), France, April 01, 2012-March 31, 2013.

Ghosh, Subir K., School of Technology & Computer science, Tata Institute of Fundamental Research, Mumbai, November 05-December 04, 2012.

Gupta, Bidyut, Department Computer Science and Engineering, Southern Illinois University, USA, November-December, 2012.

Ho, Tsung-Yi, Department of Computer Science and Information Engineering, Institute of Medical Informatics, National Cheng Kung University, Taiwan, December 18, 2012-January 01, 2013.

Kajihara, Seiji, Kyushu Institute of Technology, Iizuka, Japan, January 04-13, 2013.

Pal, Shyamosree, Department of Computer Science & Engineering, Indian Institute of Technology, Kharagpur, January 01-March 31, 2013.

Pal, Subhabrata, Department of Mathematics Indian Institute of Technology, Delhi, since March 2013 to continue.

Shukla, Sandeep Electronics and Communication Engineering, Virginia Tech., USA, November 01-30, 2012.

### ***Computer Vision and Pattern Recognition Unit***

Ballester, Miguel Ángel Ferrer, Universidad de Las Palmas de Gran Canaria, Spain, August 17-24, 2012.

Leonard, Rothacker, TU Dortmund University, Dortmund, Germany, March 03-31, 2013.

Plamondon, Réjean, École Polytechnique de Montréal, Montreal, October 30--November 22, 2012.

Ragot, Nicolas, Université François Rabelais Tours, Tours, France, February 22-March 07, 2013.

Ramel, Jean Yves, Université François Rabelais Tours, Tours, France, February 18-March 03, 2013.

### ***Documentation, Research and Training Centre***

Arunachalam, Subbiah, M.S Swaminathan Research Foundation, Chennai, March 06, 2013.

Chandra, Suresh, Department of Statistics, University of Madras, Bangalore, July 01-31, 2012.

Mahesh, Kavi, Department of Computer Science, People's Education Society College, Bangalore, May 17-June 22, 2012.

Muralidharanm, L., Innovation Management, Bangalore, March 01-31, 2013.

Oh., Dong-Geun, Department of Library and Information Science & School of Library and Information Science, Kei-Myung University, Daegn, South Korea, July 01-03, 2012.

Pattuelli, Cristina, Pratt Institute, School of Information & Library Science, USA, July 09-August 04, 2012.

Satija, M.P., Gurunanak Dev University, Amritsar, December 15-31, 2013.

Seaman, Scott, Vernon R. Alden Library, Ohio University, Athens, USA, March 14-18, 2013.

Sinha, Koushik, HP Labs India, Bangalore, February 01-March 31, 2013.

Sonwane, Shashank S., Department of Library and Information Science, Dr. Babasheb Ambedkar Marathwada University, Aurangabad, November 01-15, 2012

Sreekumar, Indian Institute of Management, Calicut, February 28, 1013.

### ***Electronics and Communication Sciences Unit***

Agarwal, Swapna, Depart of Computer Science, Visva-bharati University, Santiniketan, April 01–September 30, 2012.

Chakraborty, Rudrasis, Visiting Scientist, December 15, 2012-March 31, 2013.

Chen, Chen Yang, Institute of Bio-medical Informatics, National Yang–Ming University, Taipei, Taiwan, February 23–August 31, 2012.

Chen, Chen-Yang, Institute of Bio-medical Informatics, National Yang–Ming University, Taipei, Taiwan, February 16–March 16, 2013.

Chen, Yi-Cheng, Institute of Bio-medical Informatics, National Yang–Ming University, Taipei, Taiwan, July 01–August 31, 2012.

Chung, I-Fang, Institute of Biomedical Informatics, National Yang-Ming University, Taipei, Taiwan February 16–March 02, 2013.

Dutta, H.N., National Physical Laboratory, New Delhi, March 12-16, 2013.

Huang, Sheng-Yao, Institute of Bio-medical Informatics, National Yang–Ming University, Taipei, Taiwan, July 01–August 31, 2012.

Huang, Sheng-Yao, Institute of Bio-medical Informatics, National Yang–Ming University, Taipei, Taiwan, February 16–March 16, 2013.

Lopez, Miguel A. Medina, Centre de investigacion y de Estudios Avanzados del IPN, Mexico, September–October, 2012.

Mitra, Abhijit, Cambridge Institute of Technology, Tatisilwai, Ranchi, January 10–March 31, 2013.

## Visiting Scientists, Honours and Awards

Mukherjee, Debasis, Indian Institute of Science, October 01, 2012–March 31, 2013.

Nag, Kaustav, National Institute of Technology, Durgapur, August 06, 2012- February 05, 2013.

Su, Chun-Hung, Institute of Bio-medical Informatics, National Yang–Ming University, Taipei, Taiwan, July 01–August 31, 2012.

Tang, Wei-Chun, Institute of Bio-medical Informatics, National Yang – Ming University, Taipei, Taiwan, February 16–March 16, 2013.

Tsai, Yu-Shuen, Institute of Bio-medical Informatics, National Yang–Ming University, Taipei, Taiwan, July 01–August 31, 2012.

Tsai, Wei-Hsiang, Institute of Bio-medical Informatics, National Yang–Ming University, Taipei, Taiwan, February 16–March 16, 2013.

### ***Machine Intelligence Unit***

Chakraborty, Basabi, Iwate Prefectural University, Japan, December 17, 2012-January 11, 2013.

Ramachandran, Srinivasan, Institute of Genomics and Integrative Biology, New Delhi, January 10-12, 2013.

Sinha, Somdatta, Indian Institute of Science Education and Research, Mohali, December 26, 2012-January 03, 2013.

### ***Systems Science and Informatics Unit***

Bhalla, Upinder, National Center for Biological Sciences, Bangalore, India, June 04-12, 2012.

Gandhi, Tapan Kumar, Massachusetts Institute of Technology, Cambridge, MA, USA, August 03, 2012.

Herrmann, Christoph, University of Oldenburg, Germany, June 4-12, 2012.

Mandal, Pravat, National Brain Research Center, Manesar, Gurgaon, Haryana, India, June 04-12, 2012.

Martin-Boerner, Wolfgang, University of Illinois-Chicago, USA, November 29-December 03, 2012.

Nair, Sumitra, Indian Institute of Space Science and Technology, Trivendrum, India, November 26-30, 2012.

Pinnamaneni, Bhanu Prasad, Matrix Vision, Germany, November 26-30, 2012.

Ray, Supratim, Center for Neuro Science, Indian Institute of Science, Bangalore, India, June 04-12, 2012.

Rao, C. Babu, Indira Gandhi Centre for Atomic Research, Kalpakkam, India, November 26-30, 2012.

Radhakrishnan, N., Technology Information, Forecasting and Assessment Council-Centres Of

## Visiting Scientists, Honours and Awards

Relevance & Excellence, Rajalakshmi Engineering College, Chennai, India, November 26-30, 2012.

Rao, N. Rama, Indian Institute of Space Science and Technology, Trivendrum, India, November 26-30, 2012.

Saini, Jitender, National Institute of Mental Health and Neuro Sciences, Bangalore, India, June 4-12, 2012.

Schuenemeyer, John H. (Jack), Statistical Consulting Corporation, USA, November 23-30, 2012.

Yalavarthy, Phaneendra, SERC, Indian Institute of Science, Bangalore, India, June 04-12, 2012.

Venkatesan, Ramesh, GE Health Care, Bangalore, India, June 04-12, 2012.

### ***Computer Science Unit***

Karthick, T., Visiting Scientist, since June 03, 2011.

Sekar, Gautham, Visiting Scientist, since May 02, 2012.

## **Physics and Earth Sciences Division**

### ***Geological Studies Unit***

Abrahami, R., ISTerre, Universite Joseph Fourier, Grenoble, France, February 17-March 07, 2013.

Huyghe, P., ISTerre, Universite Joseph Fourier, Grenoble, France, February 25-March 02, 2013.

Najman, Y., Lancaster University, UK, December 09-10, 2012.

Slowakiewicz, M., University of Bristol, UK, February 02-15, 2013.

Van Der Beek, P., ISTerre, Universite Joseph Fourier, Grenoble, France, February 17-March 07, 2013.

### ***Physics and Applied Mathematics Unit***

Ghosh, Sibasish, Institute of Mathematical Sciences, Chennai, May 20–28, 2012 and February 24–March 08, 2013.

Rahaman, Ramij, Institute of Mathematical Sciences, Chennai, April 19–May 11, 2012.

Samanta, Arghya, Fluids, Automatique et Systems Thermiques, Universitaire d'orsay, France, July–August, 2012.

## **Biological Sciences Division**

### ***Biological and Anthropology Unit***

Bagga, Amrita, Department of Anthropology, University of Pune, February 26-28, 2013.

Visiting Scientists, Honours and Awards

Ghose, Sudipta, Department of Anthropology, North Eastern Hill University, Shillong, February 04-08, 2013.

### ***Human Genetics Unit***

Chakraborty, Sounak, Department of Statistics, University of Missouri-Columbia, USA, November 12-16, 2012.

Gupta, Mayetri, School of Mathematics and Statistics, University of Glasgow, UK, December 13-14, 2012.

## **Social Sciences Division**

### ***Economic Research Unit***

Chakrabarti, Bikas K., Centre for Applied Mathematics and Computational Science, Saha Institute of Nuclear Physics, Kolkata, since August, 2012.

Chatterjee, Kalyan, Department of Economics, The Pennsylvania State University, University Park, USA, July 12–August 06, 2012 and March 11-15, 2013.

Kamiike, Atsuko, Shimotakaoka, Miki-cho, Kita-gun, Kagawa, Japan, June 01–October 07, 2012.

Mallick, Girijasankar, School of Economics and Finance, University of Western Sydney, Locked Bag 1797, Penrith South DC, NSW, Australia, November 01–December 31, 2012.

Maiti, Pradip, Visiting Scientist, Kolkata, July 01-December 31, 2012 & January 01–June 30, 2013.

Mukherjee, Conan, Visiting Scientist, June 01, 2012–February 28, 2013.

Mutuswami, Suresh, Department of Economics, University of Leicester, University Road, Leicester, UK, April 23-27, 2012.

Sinha, Uday Bhanu, Department of Economics, Delhi School of Economics, University of Delhi, New Delhi, May 20–June 30, 2012.

Sen, Debapriya, Department of Economics, Ryerson University, Toronto, Canada, November 01, 2012- August 31, 2013.

Sengupta, Sarbajit, Department of Economics, Visva Bharati University, Santiniketan, since January 01, 2013.

### ***Economic Analysis Unit***

Jihe, Kaneko, Department of Agricultural Engineering and Socio-Economics, Graduate School of Agricultural Science, Kobe University, Japan, March 07-14, 2013.

***Linguistic Research Unit***

Ghosh, Rajat, Director of Studies, English Language, Majan University College, Ruwi, The Sultanate of Oman, July 16–20, 2012.

Selvraj, Arulmozi, Dravidian University, Kuppam, India, May 03–06, 2012.

***Economics and Planning Unit***

Auriel, Gilardone, University of Gaen, August 11-16, 2012.

Bhattacharya, Anindya, University of York, UK, August 06-10, 2012.

Bose, Amitava, Indian Institute of Management, Kolkata, May 17-18, 2012.

Chakrabarti, Rajesh, Indian School of Business, July 23-November 30, 2012.

Chakraborty, Indranil, National University of Singapore, May 06-09, 2012.

Chakraborty, Shankha, University of Oregon, December 20-25, 2012.

Chakravarty, Shoibal, Princeton University, October 04-10, 2012.

Chakravorty, Ujjayant, Tufts University, July 09-13, 2012.

Chetry, Moon, Centre for Artificial Intelligence and Robotics, DRDO, Bangalore, July 15-August 31, 2012.

Deb, Rahul, University of Toronto, July 23-August 24, 2012.

Dmitrov, Dinko, Saarland University, Germany, August 01-16, 2012 and February 19-March 08, 2013.

Farmer, Amy, University of Arkansas, October 27-November 02, 2012.

Kjelsrud, Anders, University of Oslo, August 23-September 11, 2012.

Kjelsrud, Anders, University of Oslo, September 22-October 18, 2012.

Leoni, Peter, Euromed Management, November 25-28, 2012.

Lychogin, Central European University, Budapest, April 19-21, 2012.

Majumdar, Dipjyoti, Condordia University, September 24-October 07, 2012, since November 01, 2012.

Mallik, Rajlakshmi, NSHM Business School, December 20, 2012-January 20, 2013 and February 20-March 31, 2013.

Maniquet, F, Core, Universite Catholique de Louvain, August 25, 2012.

Mathur, Raj, founder member of the Indian Linux Users Group, July 23-November 30, 2012.

Murty, Sushama, University of Exeter, July 09-29, 2012.

Muto, Nozomu, Universidad Autonoma De Barcelona, Spain, August 09-16, 2012.

#### Visiting Scientists, Honours and Awards

Nitzen, Shmuel, Bar Ilan University, February 24-28, 2013.

Pattnayak, S., National University of Singapore, May 19-21, 2012.

Postl, Peter, University of Birmingham, UK, August 30-September 10, 2012.

Roy, Sanchari, University of Warwick, UK, July 17-August 24, 2012.

Sarkar, Nityanand, Kolkata, July 05-11, 2012.

Singh, Gurbachan, January 01-April 30, 2013.

Sinha Roy, Debdatta, Indian Institute of Science Education and Research, Mohali, May 15-July 20, 2012.

Sivadasan, M. Jagadeesh, Trivandram, June 04-05, 2012.

Tarafdar, Suchismita, July 20-November 30, 2012.

Wadhwa, Willima, July 23-November 30, 2012.

Wright, Stephen, Birkbeck College, University of London, December 08-15, 2012.

#### ***Population Studies Unit***

Islam, M. Nazrul, Department of Statistics, Shahjalal University of Science and Technology, Sylhet, Bangladesh, October 08-09, 2012.

Taj Uddin, M., Department of Statistics, Shahjalal University of Science and Technology, Sylhet, Bangladesh, October 08-09, 2012.

#### ***Psychology Research Unit***

Chatterjee, Susmita, Globsyn Business School, Kolkata, December 07, 21, 28, 2012; January 07, 11, 18, 2013 and March 15, 25, 26, 2013.

Chakrabarty, S.N., Galgotias Business School, Noida, March 25, 2013.

Thakur, G.P., Indian School Psychology Association, Chennai, January 07, 2013.

#### ***Sampling and Official Statistics Unit***

Hussain, Zakir, Population Research Centre, University of Delhi, since October 26, 2012.

Kumar, Sunil, University of Jammu, since September 01, 2012.

Marjit, Sugata, Center for Studies in Social Sciences, Kolkata, since November 01, 2012.

Sarkar, Amitava, West Bengal University of Technology, Kolkata, since July 16, 2012.

***Sociological Research Unit***

Mallick , Rajlakshmi, NSHM Business School, Kolkata, May 01, 2012–June 30, 2012.

Mohanti, B.B., Department of Sociology, Pondichery University, September 30-October 17, 2012.

Rahman, Taimur, Lahore University of Management Sciences, Pakistan, November 01-30, 2012.

**Statistical Quality Control and Operations Research Division**

***SQC & OR Unit, Delhi***

Raghavan, T.E.S. University of Illinois at Chicago, USA, January 07-12, 2013.

Wiszniewska-Matyszkiew, Agnieszka, Institute of Applied Mathematics and Mechanics, University of Warsaw, Poland, January 08-15, 2013.

Bourque, Matthew. Department of Mathematics, Statistics and Computer Science, USA, December 28, 2012-January 01, 2013.

***SQC & OR Unit, Hyderabad***

Katta G. Murthy, University of Michigan, Ann Arbor., USA, July 24-September 14, 2012.

**HONOURS AND AWARDS**

**Theoretical Statistics and Mathematics Division**

***Stat-Math Unit, Kolkata***

Goswami, Debashish

Awarded: Shanti Swarup Bhatnagar Award (Mathematical Sciences), Indian Council of Agricultural Research, 2012.

Bhattacharya, Abhishek

Awarded: Microsoft Young Faculty Award (MSR), Microsoft Research Lab., India, 2012.

Roy, Parthanil

Elected: Associate of Indian Academy of Sciences, 2012–2015.

Awarded: Microsoft Young Faculty Award, Microsoft Research Lab., India, 2012.

***Stat-Math Unit, Delhi***

Jain, Tanvi

Selected: Associate, Indian Academy of Sciences, 2010-15.



Visiting Scientists, Honours and Awards

***Stat-Math Unit, Bangalore***

Athreya, Siva

Awarded: Shanti Swarup Bhatnagar Award (Mathematical Sciences), 2012.

***Stat-Math Unit, Bangalore***

Kumar, Abhinav

Awarded: India Innovation Fund Award, Massachusetts Institute of Technology, 2013.

Patankar, Vijay M.

Awarded: India Innovation Fund Award, Massachusetts Institute of Technology, 2013.

**Applied Statistics Division**

***Applied Statistics Unit, Kolkata***

Biswas, A.

Awarded: IBM Shared University Research Award, 2012.

**Computer and Communication Sciences Division**

***Advanced Computing and Microelectronics Unit***

Sinha, B.P.

Awarded: Ram Lal Wadha Gold Medal, Institution of Electronics and Telecommunications Engineers, India.

Banerjee A.

Awarded: Young Scientist Award, National Academy of Sciences, India, 2012.

***Computer Vision and Pattern Recognition Unit***

Mitra, M.

Awarded: Best Journal Paper, American Society for Information Science and Technology, 2012.

***Documentation, Research and Training Centre***

Krishnamurthy, M.

Awarded: Bharath Seksa Award, Global Society for Health & Education Growth, New Delhi, 2013 and ILA CD Sharma Award (Best Paper on Visibility of Institutional Repositories), 2013.

***Electronics and Communication Sciences Unit***

Pal, Nikhil Ranjan

Elected: Vice President (Publications), IEEE Computational Intelligence Society, USA.

Das, Swagatam

Awarded: Young Engineer Award, INAE 2012,

Selected: Senior Member, IEEE, 2012;

Member (Evolutionary Computation Technical Committee), IEEE Computational Intelligence Society, 2012–2013 and

Member (Intelligent Systems Applications Technical Committee), IEEE Computational Intelligence Society, 2012-2013.

***Machine Intelligence Unit***

Babdyopadhyay, S.

Awarded: Silver Jubilee Young Engineers Award, Indian National Academy of Engineering, 2012 and National Women Bioscientist Award (Young), Department of Biotechnology, Govt. of India, 2012.

Kundu M.K.

Selected: Distinguished Professor, Indian National Academy of Engineering.

***Systems Science and Informatics Unit***

Sagar, B.S.D.

Selected: Member, MHRD (Govt. of India) Committee on Normalization of Class-XII Board Marks and Founding Chairman, IEEE Bangalore Section Chapter, Geoscience and Remote Sensing Society.

***Social Sciences Division***

***Economic Research Unit***

Pal, Manoranjan

Selected: Biographical Record, Who's Who in the World 2013 (Pearl Anniversary Edition), Marquis Who's Who.

***Linguistics Research Unit***

Dasgupta, Probal

Awarded: Archana Chaudhuri Smriti Puroskar, Bangiya Sahitya Parishad, 2012.

***Economics and Planning Unit***

Afridi, Farzana

Awarded: NO POOR Research Grant, European Union (Delhi School of Economics).

Sen, Arunava

Awarded: Infosys Prize (Social Sciences), Infosys Science Foundation, 2012.

Visiting Scientists, Honours and Awards

## **Statistical Quality Control and Operations Research Division**

### ***SQC & OR Unit, Bangalore***

Acharya, U.H.

Nominated: Member, Rajiv Gandhi National Quality Award Assessments, Southern Region, 2012.

Ray, Somnath

Nominated: Member, Sub-Committee, Library Survey, Raja Rammohan Roy Library Foundation (through Gates Foundation of India).

### ***SQC & OR Unit, Coimbatore***

Rajagopal, A.

Selected: Best Faculty (US Scales of Assessment), Cognizant Technology.

### ***SQC & OR Unit, Coimbatore***

Anis, M.Z.

Awarded: Mary G. and Joseph Natrella Scholarship, American Statistical Association (Quality and Productivity Section), 2012.

## **Center for Soft Computing research: A National Facility**

Pal, S.K.

Awarded: Padma Shri, Govt. of India, 2013.

Chakraborty, M.K.

Selected: Council Member (Invited), Indian Council for Philosophical Research, New Delhi, 2012.

## 8. EDITORIAL AND OTHER SCIENTIFIC ASSIGNMENTS

### EDITORIAL ASSIGNMENTS

#### Theoretical Statistics and Mathematics Division

##### **Stat-Math Unit, Kolkata**

Bose, Arup (Associate Editor): *Statistical Methodology*; *Indian Journal of Pure and Applied Mathematics*; *Statistics and Probability Letters*.

Chaudhuri, P. (Editor): *International Statistical Review*; *International Statistical Review*; STAT; (Associate Editor): *Advances in Statistical Analysis*.

##### **Stat-Math Unit, Delhi**

Bandyopadhyay, Antar (Associate Editor): *Journal of Statistical Planning and Inference*, 2012-2014.

Bhatt, Abhay Gopal (Co-Editor): *Sankhya*.

Dewan, Isha (Associate Editor): *Computational Statistics and Data Analysis*; *Journal of Indian Statistical Association*.

##### **Stat-Math Unit, Bangalore**

Bhat, B.V. Rajarama (Chief Editor): *Proceedings of the Indian Academy of Sciences, Mathematics*; (Member, Council of Editors): *Resonance*, *Journal of Science Education*.

Ramasubramanian, S. (Co-editor): *Sankhya*, Series A, Volume 74, Indian Statistical Institute, 2012.

Sarkar, Jaydeb (Referee): *Journal of Ramanujan Math Society*; *Journal of Math. Anal. Appl.*; *Conference Proc.*, *Field Institute*; (Reviewer): *AMS Reviewer*, *Math. Zblt*.

##### **Stat-Math Unit, Chennai**

Ponnusamy, S. (Editor-In-Chief): *Mathematics News Letter*, *Ramanujam Mathematical Society*; (Managing Editor): *The Journal of Analysis*; (Associate Editor): *Bulletin of Malaysian Mathematical Society*.

#### Applied Statistics Division

##### **Applied Statistics Unit**

Biswas, A. (Editor): *Sankhya*, Series B, 2012-13; (Associate Editor): *Statistics & Probability Letters*, Since July, 2011; *Sequential Analysis*, Since June, 2003, *Marcel Dekker*, *Taylor and Francis*, Since 2005; *Communications in Statistics, Theory and Methods*, Since January, 2007; *Communications in*

## Editorial and other Assignments

*Statistics, Simulation and Computation*, Since January, 2007 and *Sri Lankan Journal of Applied Statistics*.

Dewanji, Anup (Associate Editor): *Calcutta Statistical Association Bulletin*, Since 2006; *Journal of Statistical Planning and Inference*, Since 2012.

SenGupta, Ashis (Editor-in-Chief): *Environmental and Ecological Statistics*, Springer, USA, 2012-2013; (Editor): *Scientiae Mathematicae Japonicae*, Japan, 2012-2013; (Associate Editor): *Statistics and its Applications*, USA, 2012-2013; *Journal of Indian Statistical Association*, India, 2012-2013; (Reviewer): *Mathematical Reviews*, USA, 2012-2013.

### **Bayesian Interdisciplinary Research Unit**

Adhikary, Arun, K. (Associate Editor): *The Calcutta Statistical Association Bulletin*, Calcutta Statistical Association, 2012.

## **Computer and Communication Sciences Division**

### **Advanced Computing and Microelectronics Unit**

Bhattacharya, B.B. (Editor): *Journal of Electronic Testing: Theory and Applications*, Springer.

### **Computer Vision and Pattern Recognition Unit**

Bhattacharya, Ujjwal (Guest Editor): *Pattern Recognition Letter on Frontiers in Handwriting Processing*, Special Issue.

Garain, Utpal (Associate Editor): *International Journal on Document Analysis and Recognition (IJ DAR)*, Springer, Since 2011.

Pal, Umapada (Associate Editor): *Association for Computing Machinery (ACM) Transactions on Asian Language Information Processing*, ACM; *Electronic Journal on Computer Vision and Image Analysis*, CVC Press.

### **Electronics and Communication Sciences Unit**

Das, Swagatam (Co Editor-in-Chief): *Swarm and Evolutionary Computing*, Elsevier; (Associate Editor): *IEEE Transactions on Systems, Man, and Cybernetics: Systems*; *Information Sciences*, Elsevier; *Neurocomputing*, Elsevier.

Mukherjee, Dipti Prasad: *ISRN Machine Vision Open Access Journal*, Since 2010.

Pal, Nikhil R. (Associate Editor): *IEEE Transactions on Fuzzy Systems*, IEEE, USA; *IEEE Transactions Systems, Man and Cybernetics- B*, IEEE, USA; (Associate Editor): *International Journal of Approximate Reasoning*, Elsevier, Netherlands; *Fuzzy Information and Engineering: An International Journal*, Springer; (Member, Editorial Advisory Board): *International Journal of Neural Systems*, World Scientific.

### **Machine Intelligence Unit**

Bandyopadhyay, S. (Associate Editor): *IEEE Transactions on Systems, Man and Cybernetics, Systems*, 2013.

Ghosh, A. (Associate Editor): *IET-Computer Vision*.

Mitra, S. (Associate Editor): *IEEE/ACM Trans. On Computational Biology and Bioinformatics (IEEE TCBB)*, 2010-13; *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery (WIRE DMKD)*, 2008-2013; *Information Sciences*, 2013; *Neurocomputing*, 2005-2013; *Journal of Computational Intelligence in Bioinformatics (JCIB)*, 2005-2013.

### **Systems Science and Informatics Unit**

Sagar, B.S.D. (Editor): *Discrete Dynamics in Nature and Society: Multidisciplinary Review and Research Journal*, Hindawi Publishers, USA; (Guest Editor): *IEEE Journal on Special Topics in Signal Processing*, 2012.

Meher, S.K. (Guest Editor): *Applied Soft Computing*, 2012.

## **Physics and Earth Sciences Division**

### **Geological Studies Unit**

Chakraborty, T. (Guest Editor): *Geomorphology*, Special Issue, Elsevier, 2012.

Mazumder, R. (Editor): *Palaeoproterozoic of India*, Special Publications, The Geological Society of London, 2012.

Saha, D. (Editor): *Palaeoproterozoic of India*, Special Publications, The Geological Society of London, 2012.

Saha, D. (Editor): *Palaeoproterozoic of India*, Special Publications, The Geological Society of London, 2012; *Indian Journal of Geology*, Geological Mining and Metallurgical Society of India, Kolkata, 2012.

### **Physics and Applied Mathematics Unit**

Mandal, B.N. (Editor-in-Chief): *OPSEARCH*, Journal of the Operational Research Society of India, Springer.

## **Biological Sciences Division**

### **Biological and Anthropology Unit**

Mukhopadhyay, B. (Associate Editor): *Journal of Indian Anthropological Society*, Indian Anthropological Society, 2012.

Editorial and other Assignments

Roy, S.K. (Associate Editor): *The Anthropologist*, International Journal of Contemporary and Applied Studies of Man, Kamla Raj Enterprise.

## **Social Sciences Division**

### ***Economics Research Unit***

Chakravarty, S.R. (Associate Editor): *Social Choice and Welfare*, Springer-Verlag, 2012; (Co-editor): *Economics E-Journal*, Kiel Institute of the World Economy, Germany, 2012; (Member, Advisory Board): *Economic Studies in Inequality* (Book Series), Springer-Verlag.

### ***Economics Analysis Unit***

Ramachandran, V.K. (Editor): *Review of Agrarian Studies*.

### ***Linguistic Research Unit***

Dasgupta, Probal (Editor): *Language Problems and Language Planning*, Amsterdam, Benjamins, 2012,

Dash, Niladri Sekhar (Editor-in-Chief): *Journal of Advanced Linguistic Studies*, 2012.

### ***Economics and Planning Unit***

Das, Satya P. (Editor): *Indian Growth and Development Review*, 2012.

Roy Chowdhury, Prabal (Associate Editor): *Indian Growth and Development Review*, 2012.

Somanathan, E. (Associate Editor): *Environment and Development Economics*, 2012.

### ***Psychology Research Unit***

Dutta Roy, D. (Editor-in-Chief): *Psyber News*, Prasad Psycho Corporation, 2012.

### ***Sampling and Official Statistics Unit***

Pathak, Prasanta (Assistant Editor): *Indian Journal of Regional Science*, Since 2004.

### **Sociological Research Unit**

Ghosh, Bholanath (Associate Editor): *South Asian Anthropologist*, Serials Publications, New Delhi, 2012-2013; *News Letter on Dalit and Backward Classes*, All India Sociological Society, New Delhi, 2012-2013.

Jana, Rabindranath (Statistical Editor): *Indian Journal of Dermatology*, Medknow Publications, 2012-2013.

### **Statistical Quality Control and Operations Research Division**

#### **SQC & OR Unit, Coimbatore**

Rajagopal, A. (Editor): *Achieving Breakthrough Quality*, Edition – 2.

### **Library, Documentation and Information Science Division**

#### **Library, Kolkata**

Pal, Jiban K. (Member, Board of Editors): *Databib World Repository* (A project under partnership between Purdue University and Penn State University, USA), since October 2012; *International Journal of Library Science* (IJLS), ISSN: 0975-7546, CESER Publications, since March 2012; *International Journal of Library Administration* (IJLA), ISSN: 2231-1300, Research India Publications, since September 2012; *International Journal of Library Automation, Networking and Consortia* (IJLANC), Research India Publications, since September 2012; (Honorary Associate Editor): *International Journal of Digital Library Services* (IJODLS), ISSN: 2250-1142, Academic Journals, Since September 2011; *IASLIC Newsletter*, ISSN: 0018-845X, IASLIC, Since April 2011.

### **Centre for Soft Computing Research: A National Facility**

Chakraborty, M.K. (Guest Editor): *Rough and Fuzzy Methods in Data Mining*, International Journal of Hybrid Intelligent Systems (Special Issue), Vol.-8, IOS Press, since 2011; *Transactions on Rough Sets*, Vol.-XIV, Springer, since 2011.

Ghosh, A. (Associate Editor): *IET-Computer Vision*.

Pal S.K. (Associate Editor): *Pattern Recognition Letters*; *International Journal of Pattern Recognition & Artificial Intelligence*; *Applied Intelligence*; *Information Sciences*; *Fuzzy Sets and Systems*; *Fundamenta Informaticae*; (Editor-in-Chief): *International Journal of Signal Processing*; *Image Processing and Pattern Recognition*; (Book Series Editor): *Frontiers in Artificial Intelligence and Applications*, IOS Press, Holland and Statistical Science and Interdisciplinary Research, World Scientific; *Frontiers in Artificial Intelligence (FAIA)*, IOS Press, Amsterdam and Statistical Science and Interdisciplinary Research, World Scientific, Singapore; (Member, Advisory Editorial Board): *IEEE Transactions on Fuzzy Systems*; *International Journal of Approximate Reasoning*; *International Journal of Computational Science & Engineering*; (Advisor): *International Journal of Image and Graphics*; (Guest Editor): *IEEE Transactions on Systems, Man and Cybernetics-A*; *Applied Soft Computing*; *Fundamenta Informaticae*; *Intelligent Decision Technologies*, IOS Press.



## SCIENTIFIC ASSIGNMENTS/ACADEMIC VISITS ABROAD

### Theoretical Statistics and Mathematics Division

#### *Stat-Math Unit, Kolkata*

Bose, Arup:

(1) Department of Statistics, Michigan State University, USA, May 27-30, 2012; (2) Department of Economics and Department of Mathematics, University of Cincinnati, USA, May 15-June 08, 2012; (3) IMS-APRM Conference, Tsukuba, Japan, July 02-04, 2012; (4) University of Minnesota, USA, August 25–September 02, 2012; (5) Department of Mathematical Sciences, Indiana University, Purdue University, Indianapolis, USA, September 03–05, 2012; (6) Department of Mathematics, Lehigh University, USA, September 06–12, 2012 and (7) Department of Mathematics, University of Cincinnati, September 25-October 03, 2012.

Dasgupta Ratan:

Rajshahi University, Bangladesh, December 22-24, 2012.

Ganguly Satadal:

EPFL, Lausanne, Switzerland, September 01-30, 2012.

Goswami, Debashis:

Institute de Matematica Pura e Aplicada (IMPA), Rio de Janeiro, Brazil, August 13-17, 2012.

#### *Stat-Math Unit, Delhi*

Bandyopadhyay, Antar:

(1) Convention Center, Istanbul, July 09-14, 2012; (2) Asia Pacific Office of the International Civil Aviation, Bangkok, Thailand, August 27-31, 2012.

Bapat, R.B.:

(1) Conference in Graph Theory and Combnations. Kashan, Iran, June 25-July 07, 2012; (2) Conference in ICTP, Trieste, Italy, Septembe 10-14, 2012; (3) Conference in Technion, Haifa, Israel, Novembe 12-15, 2012.

Bhatia, Rajendra:

1) Mathematics Department of Kyungpook National University and Chungbuk National University, June 04-29, 2012; (2) Institute of Mathematics of the Polish Academy of Sciences, Bedlewo, Poland, July 16-24, 2012; (3) Tianjin Institute of Industrial Biotechnology Chinese Academy of Sciences, Tianjin, China, September 17-21, 2012; (4) University of Wisconsin, USA, October 08-15, 2012; (5) Technion-Israel Institute of Technology, Haifa, Israel, November 12-20, 2012.

Bhatt, Abhay G.:

Department of Statistics and Probability, Michigan State University, East Lansing, Michigan, USA, April 01, 2012-May 15, 2012.

Chakrabarty, Arijit:

Second Institute of Mathematical Statistics Asia Pacific Rim Meeting, Tsukuba, Japan, July 02-04, 2012.

Chatterjee, Arindam:

(1) 2<sup>nd</sup> IMS APRM, Tsukuba, Japan, July 02-04, 2012; (2) Department of Statistics, North Carolina

State University and Department of Statistics, Texas A&M University, August 31-September 28, 2012; (3) Statistical and Applied Mathematical Sciences Institute (SAMSI), North Carolina, USA, September 09-22, 2012.

Dewan, Isha:

Meetings of ISO/TC'69 `Application of Statistical Methods, Tokyo, Japan, June 18-22, 2012.

Dey, Aloke:

IMS-Asia Pacific RIM Meeting, Tsukuba, Japan, July 01-04, 2012.

Laishram, Shanta:

(1) University of Marseilles, France, May 14-30, 2012; (2) School on Combinatorics, Automata and Number Theory - CIRM Marseille, France, May 21-25, 2012; (3) University Jussieu, Paris, May 31-June 02, 2012; (4) Leiden University, Netherlands, June 02-15, 2012; (5) Canadian Number Theory Meeting (CNTA XII), Let bridge, Canada, June 17-22, 2012; (6) University of British Columbia, Canada, June 23-30, 2012.

Roy, Rahul:

(1) Department of Probability and Statistics, Center for Research in Mathematics (CIMAT), Guanajuato, Mexico, May 10-25, 2012; (2) Third Indo-Brazilian Mathematics Symposium 2012 and Interacting Particle Systems Conferences, Florence, Italy, August 13-31, 2012.

### ***Stat-Math Unit, Bangalore***

Athreya, Siva:

(1) Alexander Drewitz, ETH, Zurich, Switzerland, July 07-15, 2012; (2) Rongfeng, Sun National University of Singapore, Singapore, November 22-29, 2012.

Bhat, B V Rajarama,

(1) Centre International de Rencontres Mathématiques, Marseille, France, October 01-05, 2012; (2) Operator Spaces and Quantum Information, Lyon, France, October 08-09, 2012; (3) 4<sup>th</sup> International Workshop on Quantum Probability and Its Applications, Ferrazzano, Campobasso, Italy, October 11-14, 2012.

Gorai, Sushil:

Winter School in Complex Analysis and Complex Geometry, KAWA 4, Toulouse and Albi, January 21-26, 2013.

Raja, C R E:

(1) Prof. H. Glockner of University of Paderborn, Paderborn, Germany, May 13-20, 2012; (2) Workshop on Periodic Orbits in Dynamical Systems, ESI, Vienna, Austria, May 21-25, 2012.

Ramasubramanian, S.:

The University of Hong Kong Hong Kong, June 27--30, 2012.

Rao, TSSRK:

Department of Mathematics, Southern Illinois University, Edwardsville, USA, September 02, 2011-May 05, 2012.

Editorial and other Assignments

## **Applied Statistics Division**

### ***Applied Statistics Unit, Kolkata***

Bose, Mausumi:

(1) Stanford University, USA, May, 2012; (2) The Australasian Applied Statistics Conference, Queenstown, New Zealand, December, 2012; (3) ISM-ISI-ISSAS Joint Conference 2013, Academia Sinica, Taipei, Taiwan, January, 2013.

Dewanji, Anup:

(1) Stanford University, USA, May, 2012; (2) The Australasian Applied Statistics Conference, Queenstown, New Zealand, December, 2012; (3) ISM-ISI-ISSAS Joint Conference 2013, Academia Sinica, Taipei, Taiwan, January, 2013.

Palchoudhury, Pabitra:

(1) NCSU Bioinformatics Research Centre, April 03, 2012; (2) Uncertainty Quantification 2012, April 01-05, 2012.

SenGupta, Ashis:

(1) Institute of Statistical Mathematics, Tokyo, Japan, 2012; (2) Michigan State University, May-July, 2012; (3) San Diego, USA, July 28-August 02, 2012; (4) 1<sup>st</sup> ISM International Statistical Conference, Johor Bahru, September 04-06, 2012; (5) Department of Mathematical Sciences, University of Malaya, Kuala Lumpur, Malaysia, September, 6-14, 2012; (6) SAMSI, North Carolina, USA, February 2013; (7) Department of Statistics, University of California-Riverside, USA, March, 07-16, 2013.

### ***Bayesian Interdisciplinary Research Unit***

Basu, Ayanendranath:

(1) University of Vermont, Arlington, USA, August 04-12, 2012; (2) ISM-ISI-ISSAS Joint Conference 2013, Academia Sinica, Taipei, Taiwan, January 31-February 01, 2013.

Bose, Smarajit:

(1) The International Conference on Information and Knowledge Engineering – (IKE 2012), Las Vegas, USA, July 16-19, 2012; (2) ISM-ISI-ISSAS Joint Conference 2013, Academia Sinica, Taipei, Taiwan, January 31-February 01, 2013.

Pal, Amita:

(1) International Conference on Soft Computing, Intelligent System and Information Technology (3<sup>rd</sup> ICSIT 2012), Bali, Indonesia, May 24-25, 2012; (2) Computer Vision and Pattern Recognition (ICCV 2012), Las Vegas, USA, July 16-19, 2012; (3) University of Maryland, College Park, MD, USA, July 23-27, 2012; (4) Bangladesh University of Science and Technology, Dhaka, Bangladesh, November 07, 2012; (5) ISM-ISI-ISSAS Joint Conference 2013, Academia Sinica, Taipei, Taiwan, January 31-February 01, 2013.

Rao, Arni S.R. Srinivasa:

Imperial College, London, U.K. and Royal Vet College, London, U.K., August 27-September 21, 2012.

Saharay, Rita:

(1) Missouri University of Science and Technology, Rolla, MO, USA, June 01- June 26, 2012; (2) ISM-ISI-ISSAS Joint Conference 2013, Academia Sinica, Taipei, Taiwan, January 31-February 01, 2013.

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

Ghosh, Partha Pratim:  
University of KwaZulu Natal, June, 2012.

***Applied Statistics Unit, Chennai***

Sen, R.:  
University of California, Davis, Department of Statistics, USA, June 04-12, 2012.

**Computer and Communication Sciences Division**

***Advanced Computing and Microelectronics Unit***

Banerjee A.:  
East China Normal University, August 23–31, 2012.

Das, N.:  
(1) IEEE Globecom 2012 Workshop, CA, USA, December 03-05, 2012; (2) San Jose State University, CA, December 06-14, 2012; (3) California State University, East Bay, CA, December 11, 2012.

Das, S.:  
(1) Thailand-Japan Joint Conference, Computational Geometry and Graphs, Bangkok, Thailand, December 05-11, 2012.

Mukhopadhyaya, K.:  
Eidgenössische Technische Hochschule (ETH) Zürich, Switzerland, September 01-30, 2012.

Sinha, B.P.:  
(1) 10<sup>th</sup> International Conference on Wired/Wireless Internet Communication, Island of Santorini, Greece, June 6-8, 2012; (2) 10<sup>th</sup> International Conference on Wired/Wireless Internet Communication, Island of Santorini, Greece, June 6-8, 2012; (3) UMICH, RWTH, Aachen University, June 11, 2012; (4) 8<sup>th</sup> Annual IEEE International Conference on Automation Science and Engineering, Seoul, Republic of Korea, August 20-24, 2012; (5) 21<sup>st</sup> Asian Test Symposium, Niigata, Japan, November 19-22, 2012; (6) International Symposium on Dependable VLSI System, Tokyo, Japan, December 01, 2012; (7) Tsinghua University, Beijing, China, November 01-December 15, 2012; (8) ECE Department, Duke University, USA, March 01-May 31, 2013.

Sur-Kolay, S.:  
(1) Princeton University, USA, August-October, 2012; (2) DeVry University, USA, September 25, 2012; (3) IBM Yorktown Heights, USA, September 27, 2012; (4) New Jersey Institute of Technology on October 04, 2012; (5) Rice University, Houston USA, October 08, 2012; (6) University of Texas, Austin, USA, October 09-10, 2012; (7) IBM Austin Research Laboratories, October 11, 2012; (8) Synopsys Inc., Mountain View, California, USA, October 16, 2012; (9) Intel Corp., Santa Clara, California, USA, October 17-18, 2012.

***Computer Vision and Pattern Recognition Unit***

Bhattacharya, Ujjwal:  
(1) *International Conference on Frontiers in Handwriting Recognition (ICFHR-2012)*, Bari, Italy, September 18-20, 2012; (2) Technische Universitaet Braunschweig, Germany, September, 2012.

## Editorial and other Assignments

Chaudhuri, B.B.:

(1) University of Dortmund, Germany, September 12, 2012; (2) Deutsches Forschungszentrum für Gesundheit und Umwelt, Munich, Germany, September 13-16, 2012; (3) *13<sup>th</sup> International Conference on Frontiers in Handwriting Recognition (ICFHR)*, Italy, September 18-20, 2012; (4) *21<sup>st</sup> International Conference for Pattern Recognition (ICPR)*, Japan, November 11-15, 2012.

Garain, Utpal:

(1) *5<sup>th</sup> International Workshop on Computational Forensics (IWCF)*, Japan, November 11, 2012, (2) *21<sup>st</sup> International Conference on Pattern Recognition (ICPR)*, Japan, November 12-15, 2012.

Pal, Umapada:

(1) ETS (Ecole de technologie Superieure), University of Quebec, Montreal, Canada, July 16-20, 2012; (2) Concordia University Montreal, Canada July 20, 2012; (3) Département Informatique, Université François Rabelais Tours, France, August 27-September 21, 2012; (4) *13<sup>th</sup> International Conference on Frontiers in Handwriting Recognition (ICFHR)*, Bari, Italy, September 18-20, 2012; (5) Graduate School of Engineering, Mie University, Japan, October 29-November 22, 2012; (6) *21<sup>st</sup> International Association for Pattern Recognition (IAPR)*, Japan, November 11-15, 2012.

Parui, Swapan K.:

*International Conference on Pattern Recognition (ICPR)*, Tsukuba, Japan, November 10-15, 2012.

## **Documentation, Research and Training Centre, Bangalore**

Krishnamurthy, M.:

University of Edinburgh, Edinburgh, UK, July 09-13, 2012.

Madalli, Devika P.:

(1) University of Trento. Italy, March 26-April 06, 2012; (2) Middlesex University, London, April 02-13, 2012; (3) UNESCO Information for All Programme, Moscow, Russia and Moscow State Tech University, Moscow, Russia June 24-28, 2012; (4) University of New South Wales, Sydney, Australia, October 18-30, 2012; (5) Agricultural data Interoperability first plenary meeting, Research Data Alliance, Gothenburg, Sweden, March 18-20, 2013; (6) Content & Users Meeting, agINFRA Project, Athens, Greece, March 25-30, 2013.

Prasad, A.R.D.:

(1) Rome April 09-13, 2012; (2) Content & Users Meeting, agINFRA Project, Athens, Greece, March 25-30, 2013.

## **Electronics and Communication Sciences Unit**

Das, Swagatam:

(1) *International Conference on Artificial Intelligence and Soft Computing (ISAISC)*, Zakopane, Poland, 29 April-May 03, 2012; (2) National University of Singapore, Singapore, July 04, 2012.

Mukherjee, Dipti Prasad:

Department of Radiology, Graduate School of Medicine, Osaka University, Japan, October 09-November 23, 2012.

Pal, Nikhil Ranjan:

(1) National Chiao-Tung University, Taiwan, August 06-October 19, 2012; (2) IEEE Computational Intelligence Society, National University, Singapore, October 12, 2012; (3) Executive Committee

Meeting, *IEEE Computational Intelligence Society*, San Francisco, USA, December 07-09, 2012; (4) *First Joint German-Indian Workshop on Big Data in Engineering and Science*, INSA, INAE, Acetech and Leopoldina, Germany, March 14-15, 2013.

### ***Machine Intelligence Unit***

Bandyopadhyay, S.:

(1) Max Planck Institute for Informatik, Saarbrücken, Germany, April-June, 2012; (2) University of Evora, Portugal, May 29, 2012; (3) Department of Bioinformatics, University of Goettingen, Germany, June 18, 2012.

Biswas, S.:

University of Constanzt, Germany, September 18-23, 2012

De, R.K.:

(1) *13<sup>th</sup> International Conference on Bioinformatics and Computation Biology (BIOCOMP'12)*, Las Vegas, USA, July 16-19, 2012.

Ghosh, A.:

Hong Kong Poly Technical University, Hong Kong, October 30-November 03, 2012.

Kundu, Malay K.:

(1) University of Westminster, London, UK, July 03-04, 2012; (2) *21<sup>st</sup> International Conference on Pattern Recognition 2012*, Tsukuba, Japan, November 11-15, 2012; (3) Applied Science University, Amman, Jordan, March 27-28, 2013.

Mitra, S.:

(1) Clayton School of Information Technology, Monash University, Melbourne, Australia, June 4, 2012; (2) IEEE World Congress on Computational Intelligence (WCCI 2012), Brisbane, Australia, June 10-14, 2012.

Maji, P.:

*6th IEEE International Conference on Bioinformatics and Biomedicine (BIBM2012)*, Philadelphia, PA, USA, October 04-07, 2012.

Murthy, C.A.:

*8th International Conference on Advanced Data Mining and Applications*, Nanjing, China, December 15-18, 2012.

### ***Systems Science and Informatics Unit, Bangalore***

Kausik, K. Majumdar:

University of Oldenburg, Germany, July 16-30, 2012.

### ***Computer Science Unit, Chennai***

Ghosh, S.:

(1) University of Groningen, Netherlands, May 11–July 10, 2012; (2) Universitat Politècnica de Valencia, Spain, June 03-09, 2012.

Gangopadhyay, Sugata:

Natural Sciences and Information Technologies, University of Primorska, Slovenia, May 12-23, 2012.

Editorial and other Assignments

## **Physics and Earth Sciences Division**

### ***Geological Studies Unit***

Chakraborty, T.:

(1) 29<sup>th</sup> Meeting of International Association of Sedimentologists, Schladming, Austria, September 10-13, 2012; (2) Institute des Sciences de la Terre, University of Grenoble, France during September 16-22, 2012.

Das, S.S.:

(1) Annual Meeting of Geological Society of America, Charlotte, North Carolina, USA, November 04-07, 2012; (2) Smithsonian Institution, Washington D.C., USA, November 09-17, 2012.

Majumder, Rajat:

University of New South Wales, Australia, April 2012- March, 2013.

Patranabis-Deb, S.:

International Association for Gondwana Research Annual Convention and 9<sup>th</sup> International Symposium on Gondwana to Asia. Adelaide, Australia, November 18-21, 2012.

Saha, Dilip:

27<sup>th</sup> Himalaya-Karakoram-Tibet (HKT) Workshop in Kathmandu, Nepal, November 29-December 08, 2012.

### ***Physics and Applied Mathematics Unit***

Basu, Banasri:

International Conference, Prague, Czech Republic, June 18-22, 2012.

Das, P.K.:

(1) National Institute of Mathematical Science, Daejeon, Korea, July 22–29, 2012; (2) International Workshop, Bedlewo and Wroclaw University, Poland, September 16–30, 2012; (3) International Workshop, Aichi Prefectural University, Nagoya, Japan, January 06–10, 2013.

Ghosh, Subir:

(1) Australian National University of Canberra, Australia, June 03-July 08, 2012; (2) Federal University of Juiz de Fora, Minas Gerais, Brazil, September 30–October 30, 2012.

Maiti, Santanu K.:

Tel Aviv University and Weizmann Institute of Science, Israel, January 02–20, 2013.

Roy, P.:

(1) International Workshop, University of Athens, Greece, June 09–17, 2012; (2) INFN Sezione di Perugia, Italy, September 17–October 18, 2012; (3) Osaka Prefecture University, Japan, January 07–February 04, 2013 and (4) University of Sao Paulo, Brazil, March 07 – 29, 2013.

Roy, S.:

(1) VARNA, Bulgaria, July 02–07, 2012; (2) Konkoly Observatory, Budapest, Hungary July 10–16, 2012; (3) Marine Biological Lab, Woods Hole, MA, USA, August 07–17, 2012.

Roy, Barnana:

International Conference, Prague, Czech Republic, June 18–22, 2012.

## **Biological Sciences Division**

### ***Biological Anthropology Unit***

Bharati, Premananda:

(1) Training Programme on Health Statistics, Bangladesh, April 15-25, 2012; (2) Conference on Social Work Development, Sweden, July 07-13, 2012.

### ***Human Genetics Unit***

Ghosh, Saurabh:

(1) EMGM, Germany, April, 2012; (2) IBC, Japan, August, 2012; (3) GAW, USA, October, 2012 and (4) University of Michigan in USA, October, 2012.

## **Social Sciences Division**

### ***Economic Research Unit***

Chakravarty, Satya Ranjan:

(1) The Centre for Operations Research and Econometrics, Catholic University of Louvain, Belgium, May, 28-June 01, 2012; (2) University of International Business and Economics (UIBE), Beijing, China, October 16-November 02, 2012.

Das, Samarjit:

Department of Mathematical Sciences, School of Science, Indian University-Purdue University, USA, August 16, 2012-May 20, 2013.

Maiti, Pulakesh:

Department of Economics, Rajshahi University, Bangladesh, December 20-26, 2012.

Mitra, Manipushpak:

13<sup>th</sup> International Meeting of the Association for Public Economic Theory (APET), Academic Sinica in Taipei, Taiwan.

Kabiraj, Tarun:

Seoul National University, Korea and Department of Economics of Hanyang University inERICA, South Korea, October 11-19, 2012.

Pal, Manoranjan:

(1) Department of Statistics, Rajshahi University, Bangladesh, April 15-25, 2012; (2) International Conference on Social Work Development 2012: Action and Impact, Stockholm, Sweden, July 07-13, 2012.

Sarkar, Abhirup:

(1) London School of Economics, September, 2012; (2) Ithaca, New York, USA, University of Nottingham, the University of York, and University of Manchester, UK, September 24-October 18, 2012; (3) 8<sup>th</sup> Kolkata to Kunming (K2K) Forum, Yunnan, China, November 19-22, 2012.

### ***Economics Analysis Unit***

Guha, Puja:

National University of Singapore, September 27-28, 2012.



## Editorial and other Assignments

Swaminathan, Madhura:

(1) Attended 32<sup>nd</sup> General Conference of the International Association for Research on Income and Wealth, Boston, USA, August 5-11, 2012; (2) Fudan University, School of Economics, February 28-June 30, 2013.

### ***Linguistic Research Unit***

Dasgupta, Probal:

(1) World Esperanto Association Board Meeting, Rotterdam, Netherlands, April 29-May 01, 2012; (2) 97th World Esperanto Congress July 28-August 04, 2012, Hanoi, Vietnam and (3) World Esperanto Association Board Meeting, March 22-24, 2013. Rotterdam, Netherlands.

Dash, Niladri Sekhar:

(1) GLOSSA: Language Research Center, School of Social and Human Sciences, Universidad del Turabo, Gurabo, Puerto Rico; (2) Lutfi Kirdar, Istanbul Exhibition and Congress Centre, Istanbul, Turkey, May 21-27, 2012.

### ***Economics and Planning Unit***

Afridi, Farzana:

(1) Asian Development Bank, Manila, July, 2012; (2) International Growth Centre, London School of Economics, September 24-28, 2012.

Ghate, Chetan:

(1) 12th Journées d'économie publique Louis-André Gerard-Varet. Marseilles, France, June 2012, (2) Harvard Project for Asian and International Relations Asia Conference (HPAIR), Taipei, Taiwan, August 2012 and (3) Korean Institute of Economic Policy (KIEP) Seoul, Korea, September, 2012.

Mishra, Debasis:

National University of Singapore, July, 2012.

Mukhopadhyay, Abhiroop:

(1) London School of Economics and Political Science and Michelsen Institute, Bergen, Norway June 04-July 06, 2012; (2) University of Manchester, UK October 04-05, 2012; (3) Northeast Universities Development Consortium Conference, Dartmouth College, Hanover, New Hampshire and University of Connecticut, USA, October 24-November 05, 2012.

Ramaswami, Bharat:

(1) University of British Columbia, Vancouver, September, 2012; (2) International Growth week 2012 conference, London School of Economics, London UK, September 17-27, 2012; (3) Green College, University of British Columbia, Vancouver, September, 2012; (4) Asian Development Bank, Manila, Philippines, November 01-30, 2012; (5) TUFTS, University in Boston, USA, January 24-29, 2013.

Roy Chowdhury, Prabal:

Centro De Investigacion Docencia Economicas(CIDE), Mexico, November 14-23, 2012.

Somanathan. E:

(1) Sandee Research and Training Workshops, Colombo, Sri Lanka and Kathmandu, Nepal, June 19-28, 2012; (2) Princeton University, USA, September 22, 2012; (3) Tufts University, USA September 19-21, 2012 and September 23-24, 2012; (4) IPCC Lead Authors Meeting Vigo, Spain, November 05-09, 2012.

Sen, Arunava:

(1) University of Warwick, England and University of Birmingham, England, May 14-June 04, 2012; (2) Department of Economics, University of Malaga and University of Pablo de Olavide (Seville), January 24-February 05, 2013; (3) Hitotsubashi University, Japan, March 18-22, 2013,

### ***Psychology Research Unit***

Dutta Roy, D.:

(1) Operation Research Society, Kathmandu, Nepal, November 27-December 01, 2012; (2) International Conference of Psychology, Lahore, Pakistan, December 19, 2012; (3) Engineering and Technology, Oslon Social Sciences, Bangkok, Thailand, January 25-27, 2013.

### ***Sampling and Official Statistics Unit***

Mitra, Sandip:

(1) Warwick University, December, 2012; (2) Boston University and Cleveland State University, March, 2013.

### ***Sociological Research Unit***

Chattopadhyay, Molly:

International Sociological Association, Buenos Aires, Argentina, August 01–04, 2012.

Ghosh, Bholanath:

2<sup>nd</sup> joint World Congress in Social Work and Social Development: Action and Impact, Stockholm, Sweden, July 08-12, 2012.

Chakroborty, Sonali:

International Sociological Association, Buenos Aires, Argentina, August 01–04, 2012.

## **Statistical Quality Control and Operations Research Division**

### ***SQC & OR Unit, Delhi***

Neogy, S.K.:

21<sup>st</sup> International Symposium on Mathematical Programming (ISMP), Berlin, Germany, August 19-24, 2012.

### ***SQC & OR Unit, Hyderabad***

Murali Rao, G.:

ACCESS Health International and Institute of Healthcare Improvement, Massachusetts, Cambridge, USA, February 04-05, 2013.

### ***SQC & OR Unit, Kolkata***

Anis, M.Z.:

(1) 29<sup>th</sup> Quality & Productivity Research Conference, California State University, Long Beach, California, June 04-07, 2012; (2) 19<sup>th</sup> Spring Research Conference, Harvard University, June 13-15, 2012.

## Editorial and other Assignments

Das, A.K.:

International Symposium on Mathematical Programming (ISMP2012), Berlin, Germany, August 19-24, 2012.

Das, Prasun:

6<sup>th</sup> Annual International Conference on Mathematics, Statistics and Education, Athens, Greece, June 11-14, 2012.

Majumdar, Anup:

2<sup>nd</sup> Annual International Conference on Operations Research and Statistics (ORS 2012), Bali, Indonesia, May 7-8, 2012.

Pradhan, Biswabrata:

33rd Annual Conference of the International Society for Clinical Biostatistics (ISCB33), Bergen, Norway, August 19-23, 2012.

### ***SQC & OR Unit, Mumbai***

Sarkar, Ashok:

Delivered Lecture, Root Cause Analysis in the context of Lean Six Sigma, 18<sup>th</sup> Asia Specific Quality Conference, Colombo, Sri Lanka, October, 14-17, 2012.

### ***Center for Soft Computing research: A National Facility***

Chakraborty, M.K.:

(1) Istanbul University, Turkey, April 09-10, 2012; (2) American University of Beirut, Beirut, Lebanon, June 26-30, 2012; (3) Southwest Jiaotong University, Chengdu, China, August 17-20, 2012; (4) The International Conference and the Second East Asian School of Logic, Language and Computation (EASLLC2012), Southwest University, Chongqing, China, August 25-31, 2012; (5) Chendu University of Technology, China, September 01-04, 2012; (6) Sun Yat-Sen University, Guangzhou, China, November 09-12.

Ghosh, A.:

Hong Kong Polytechnic University, Hong Kong, 2012.

Pal S.K.:

(1) Intelligent System and Information Technology (ICSIT), Bali, May 24-25, 2012; (2) King Abdullah University of Science & Technology, Saudi Arabia, June 08-12, 2012; (3) *4th International Conference on Advanced Communication and Networking (ACN 2012)*, Jeju Island, August 30-31, 2012; (4) *4th International Conference on Advanced Communication and Networking (ACN 2012)*, Jeju Island, Korea, August 30-31, 2012; (5) TWAS, Tianjin, China, September 17-21, 2012; (6) University of Pennsylvania, Radiology Department, Philadelphia, USA and the University of IOWA, ECE and Radiology Dept., Iowa, USA October 02-12, 2012; (7) Bangladesh University of Engineering and Technology, Dhaka and Rajshahi University of Engg & Technology, Rajshahi, and BRAC University, Dhaka Bangladesh, November 05-08, 2012; (8) *International Conference on Active Media Technology 2012 (AMT-12)*, World Intelligence Congress, Macau, China, December 03-07, 2012,.

**SCIENTIFIC ASSIGNMENTS/ ACADEMIC VISITS IN INDIA**

**Theoretical Statistics and Mathematics Division**

***Stat-Math Unit, Kolkata***

Basak, Gopal K.:

Delivered lecture, International Conference on Recent Advances in Mathematical Statistics and its Applications in Applied Sciences, Department of Statistics, Gauhati University, December 31, 2012-January 03, 2013.

Bhattacharya, Abhishek:

(1) Speaker, Symposium on The Legacy of Srinivasa Ramanujam, Durgapur Viswagandha Science Society, December 22, 2012; (2) Delivered lecture, ISBA Regional Meeting and International Workshop/Conference on Bayesian Theory and Applications (IWCBT), Benaras Hindu University, January 06-10, 2013.

Bose, Arup:

(1) Invited Speaker, Conference on Topics in Probability, Institute of Mathematical Sciences and Statistical and Mathematical Sciences Institute, December 18-20, 2012; (2) Special talk, STATQUEST-III, Calcutta University, March 05, 2013.

Dasgupta, Ratan:

(1) Participated and delivered lecture, International Conference on Statistics and Informatics in Agricultural Research Institute, New Delhi, December 18-20, 2012

Dutta, Amartya, Kumar:

(1) Delivered lecture and Moderator, Ramkrishna Mission Institute of Culture (RMIC), April, June and December, 2012; (2) Visited School of Mathematics, Tata Institute of Fundamental Research, Mumbai, September 07-October 10, 2012; (3) Delivered lecture and attended ATM Workshop and Conference on Indian Mathematics, IIT, Bombay, February 06-16, 2013; (4) Restructure of the Mathematics syllabus, St. Xavier's College, 2012-2013; (5) Delivered lecture, Workshop on Promoting History of Science in India, Gandhinagar, March 16-17, 2013.

Ganguly Satadal:

Visited, TIFR, Mumbai, November 01-30, 2012.

Maulik Krishanu:

Invited Speaker, Workshop on Topics in Probability, Virtual Institute of Mathematical and Statistical Sciences, Chennai, December 18-20, 2012.

***Stat-Math Unit, Delhi***

Bandyopadhyay, Antar:

Invited talk, Conference on Limit Theorems in Probability, Indian Institute of Science, Bangalore Mathematics Initiative, January 09-11, 2013.

Bapat, R.B.:

Delivered Lecture, V.V. Narlikar Memorial, Indian National Science Academy, 2012.

Bhatia, Rajendra:

(1) Chairman, National Committee for International Mathematical Union; (2) Adjunct Professor and Member Research Advisory Board, IISER, Mohali; (3) Honorary Professor, University of Delhi; (4)

## Editorial and other Assignments

Visitor's Nominee on Committees, IIT Bombay and Panjab University, Chandigarh. (5) Visited, Microsoft Research Labs and Infosys, Mysore, July 2012; (6) Visited, Indian Institute of Science, Bangalore, December 27-30, 2012.

Dey, Alope:

(1) Delivered a lecture, Distinguished Lecture Series during the International Conference on Statistics and Informatics in Agricultural Research held in New Delhi, December 18-20, 2012; (2) Delivered Invited talk, 8<sup>th</sup> Calcutta Triennial Symposium held in Kolkata, December 27-30, 2012.

Chakrabarty, Arijit:

Participated, Conference on Limit Theorems in Probability, Indian Institute of Science, Bangalore, January 09-11, 2013.

Dewan, Isha:

(1) Visited, IIT Mumbai, May, 2012; (2) Delivered lecture, Workshop on Reliability and Survival Analysis, IIT Kanpur, December 03-05, 2012; (3) Delivered lecture, IISA conference at Chennai, January 02-05 2013.

Jain, Tanvi:

Attended, Conference honor of Prof. Rajendra Bhatia, IISc Bangalore, December, 2012.

Laishram, Shanta:

(1) Attended, Mini MTTTS, Manipur University, Imphal, August 27-September 01, 2012; (2) Attended Seminar, IISER Mohali, October 16, 2012; (3) Attended, Conference in Number Theory, Jadavpur University, Kolkata, December 12-14, 2012; (4) Attended, Winter School on Galois Theory, Tezpur University, December 12-15, 2012; (5) Attended, International conference on *The Legacy of Srinivasa Ramanujan*, University of Delhi, December 17-22, 2012; (6) Visited, Harish-Chandra Research Institute, Allahabad, January 29-February 02, 2013; (7) Visited, IIT Mumbai, February 24-March 02, 2013.

Prasad, Srijanani Anurag:

(1) Attended, *Science Academies Workshop on Ergodic Theory and Dynamical Systems*, Jawaharlal Nehru University, New Delhi, October 01, 2012; (2) Attended *Science Academies Lecture Workshop - Mathematics and its Applications*, Jamia Millia Islamia, New Delhi, October 18, 2012; (3) Attended, *27th Annual Conference of the Ramanujan Mathematical Society (RMS)*, New Delhi, October 20-23, 2012; (4) Attended, *Conference Matrices and Operators: Conference in Honour of Sixtieth Birthday of Rajendra Bhatia*, Indian Institute of Science, Bangalore, December 27-30, 2012.

Singh, Ajit Iqbal:

(1) Visited, Institute of Mathematical Sciences, Chennai, August 12-17, 2012 and February 16-25, 2013; (2) Visited, Manipur University, Imphal and Mizoram University, Aizawal, November 08-17, 2012.

Thakur, Maneesh:

(1) Visited, School of Mathematics, Tata Institute of Fundamental Research, Mumbai, April 16-30, 2012; (2) Visited, IISER-Mohali, March 11-13, 2013.

## **Stat-Math Unit, Bangalore**

Athreya, Siva:

(1) Attended, Conference on Topics in Probability, Chennai Mathematical Institute (CMI), Institute of Mathematical Sciences (IMSC) & Statistical and Mathematical Sciences Institute (SAMSI); (2) Delivered lecture, Convergence of Nearest Neighbor Markov chains on discrete trees towards

Brownian Motion on real-trees, December 18-20, 2012; (3) Programme Committee Member, Probability Year, National Mathematics Initiative, 2012.

Bhat, B V Rajarama:

(1) Delivered lecture, International Conference on Operator Algebras in Non-equilibrium Statistical Mechanics, Goa, India, December 17-21, 2012; (2) Attended, Matrices and Operators : Conference in honour of sixtieth birthday of Professor Rajendra Bhatia, IISc, Bangalore, December 27-30, 2012.

Ramasubramanian, S.:

(1) Participated, International Conference on Mathematical Modelling, CIT, Coimbatore and Delivered lecture, Coimbatore Institute of Technology, Coimbatore, July 10-13, 2012; (2) International Conference on Limit Theorems in Probability, IISc, Bangalore and Delivered lecture, Department of Mathematics, Indian Institute of Science, Bangalore, January 9-11, 2013; (3) National Conference on Recent Advances in Statistics with Applications in Finance and Actuarial Science and Delivered lecture, Central University of Rajasthan, Kishangarh, February 21-24, 2013.

Rao, T.S.S.R.K.:

(1) Visited, Department of Mathematics, IIT Madras, May, 2012; (2) Department of Mathematics, IIT Kanpur, November, 2012; (3) Department of Mathematics, Pondicherry University, January, 2013.

### ***Stat-Math Unit, Chennai***

Baoulina, Ioulia N.:

(1) Delivered lecture, Thematic Summer Program on Finite Fields held at the Institute of Mathematical Sciences, Chennai, May 14-June 01, 2012; (2) Delivered lecture, On the Ax-Katz theorem, Harish-Chandra Research Institute, Allahabad, December 21, 2012; (3) Attended, IMSc Golden Jubilee Conference, The Institute of Mathematical Sciences, Chennai, January 02-04, 2013.

Ponnusamy, S.:

(1) Delivered lecture, NIT Srinagar, Kashmir, November 11, 2012; (2) Attended, seminar on function analysis, Scott Christian College (NBHM) at Nagercoil, January 31–February 02, 2013; (3) Chief Guest, Jammu Mathematical Society Meeting and Delivered lecture, Jammu University, February 26-27, 2013; (4) Gave a lecture, Amrita Vishwa Vidyapeetham, Coimbatore, March 06, 2013; (5) Resource person, Workshop and Conference on complex Analysis & related topics, ATM School supported by NBHM, Jaipur, March 16-19, 2013.

Sebastian, Nicy:

Attended, Workshop, Topics in Probability, Chennai Mathematical Institute (CMI), Chennai, December 18–20, 2012.

### **Applied Statistics Division**

#### ***Applied Statistics Unit***

Chaudhuri, Arijit:

1) Presented paper, 9<sup>th</sup> Triennial Conference, Calcutta Statistical Association, Kolkata, December 28, 2012; 2) International Indian Statistical Association (IISA), Chennai, January 02-05, 2013.

SenGupta, Ashis:

(1) Member, Program Advisory Committee of Mathematical Sciences, DST, Govt. of India, since 2012; (2) President, Mathematical Sciences Section, Indian Science Congress Association, 2012-2013; (3) Attended, National Workshop on Mathematical Modelling and Analysis of Financial Data, Pune

## Editorial and other Assignments

University, September, 24-29, 2012; (4) Invited Lecture, Workshop on Reliability, Survival Analysis and Industrial Statistics, Pune University, November 09-10, 2012; (5) Lecture, Workshop on Tourism Satellite Account, Ministry of Tourism, Govt of India, New Delhi, November 19-20, 2012; (6) Delivered Lecture, International Conference of Forum for Interdisciplinary Mathematics, Panjab University, Chandigarh, December 15-17, 2012; (7) Delivered Lecture, International Conference, Frontiers of Statistics and Its Applications, Pondicherry University, December 21-23, 2012; (8) Delivered Lecture, 12<sup>th</sup> International Symposia on Statistics, Aligarh Muslim University, December, 21-23, 2012; (10) Chief Guest, Conference on Statistics, Patna University, December 22-24, 2012; (11) Delivered Lecture, Eighth International Triennial Calcutta Symposium on Probability and Statistics, Calcutta University, December 27-30, 2012; (12) Invited, Session of the International Conference of International Indian Statistical Association, Chennai, January 02-05, 2013.

### ***Bayesian Interdisciplinary Research Unit***

Adhikary, Arun, K.:

Attended, Eighth Triennial International Calcutta Symposium on Probability and Statistics, University of Calcutta, Kolkata, December 27-30, 2012.

Basu, Ayanendranath:

Attended IISA 2013 Conference, Chennai, January 02-05, 2013.

Saharay, Rita:

International Conference on Statistics and Informatics in Agricultural Research, Indian Agricultural Statistics and Research Institute, New Delhi, December 17-19, 2012.

### ***Applied Statistics Unit, Chennai***

Sen, R.:

(1) Taught, Semester course on Risk Management, Applied Mathematics, Chennai Mathematical Institute, January-April, 2012; (2) Visited, Applied Mathematical Finance, Indian Institute of Quantitative Finance, June-August, 2012; (3) Delivered lecture, Statistical Methods, Madras School of Economics, September-December, 2012.

## **Computer and Communication Sciences Division**

### ***Advanced Computing and Microelectronics Unit***

Bhattacharya, B.B.:

(1) Honorary Research Professor, Bengal Engineering and Science University, Shipur, Howrah; (2) Member, PhD Committee, Department of Computer Science & Engineering, University of Calcutta; (3) Advisory Chair, 16<sup>th</sup> International Symposium on Design and Test (VDAT), July 01-04, 2012; (4) General Chair, IEEE International Symposium on Electronic Design, Kolkata, December 19-21, 2012; (5) Organizing Committee Co-Chair, 4<sup>th</sup> IEEE International Workshop on Reliability Aware System Design and Test (RASDAT), Pune, January 09-13, 2013; (6) Program Committee, VDAT 2012, ISED 2012, IWCA 2012; (7) Delivered Tutorial, 5<sup>th</sup> International Conference on Computers and Devices for Communication (CODEC), Kolkata, December 16-19, 2012.

Das, N.:

(1) Member, Board of Governors of NIT, Durgapur, 2012-2013; (2) PC Member, ICETACS 2013, NCC

2013; (3) Member, PhD Committee, Department of Information & Technology, Bengal Engineering and Science University, Shibpur, Howrah, 2012-13; (4) Member, PhD Committee, School of Mobile Computing, Jadavpur University, 2012-13.

Sinha, B.P.:

(1) Keynote Speaker, National Seminar on Computers and Communications, B.C. Roy Engineering College, Durgapur, December 06, 2012; (2) Invited talk, IEEE Advanced Networks and Telecommunication Systems Conference, Bangalore, December 16-19, 2012; (3) Panel Co-chair and Member of TPC, IEEE Advanced Networks and Telecommunication Systems Conference 2013; (4) Member, Senate, NIT, Meghalaya, 2012.

Sur-Kolay, S.:

(1) *Technical Program Committee, International Conference on Computer-Aided Design (ICCAD), 2012, VLSI Design and Test Symposium (VDATE), 2012, International Conference on Electronic Design (ISED), 2012, International Conference on VLSI Design, 2013;* (2) Chair, IEEE Women in Engineering Affinity Group, Kolkata Section; (3) Delivered Tutorial, ISED 2012.

### **Computer Vision and Pattern Recognition Unit**

Chaudhuri, B.B.:

(1) Delivered lecture, University of Manipur and IIT Guwahati, August 21-24, 2012; (2) Keynote Speech, National Conference on Computing & Communication Systems, Durgapur, November 21-22, 2012; (3) Attended, *Document Analysis and Recognition workshop, IIT Mumbai*, December 16, 2012; (4) Attended, *8<sup>th</sup> Indian Conference on Vision, Graphics and Image Processing*, IIT Mumbai, December 16-19, 2012; (5) Invited Lecture, Workshop on Current Trends in Linguistic, Calcutta University, January 15, 2013; (6) Keynote Speech, National Conference on Indian Language Computing, University of Kochi, January 19-20, 2013; (7) Invited talk, *International Conference on Pattern Recognition Applications and Techniques*, Chennai, March 01-02, 2013.

Bhattacharya, Ujjwal:

(1) Participated, ICVGIP 2012 and Document Analysis and Recognition Workshop held at the Indian Institute of Technology, Mumbai, December 16-19, 2012; (2) Delivered lectures, Application of Machine Learning in Document Analysis, Delivered talk, North-East Workshop, Guwahati University, Assam, Guwahati, March 07-11, 2013.

Garain, Utpal:

(1) Delivered talk, North-East Workshop, Guwahati University, Assam, March 09, 2013; (2) Delivered talk (Refresher Course), Burdwan University, March 19, 2013.

Pal, Umapada:

(1) Attended, Document Analysis and Recognition Workshop, IIT Mumbai, December 16, 2012; (2) Attended, *8<sup>th</sup> Indian Conference on Vision, Graphics and Image Processing*, December 16-19, 2012. (3) Delivered talk, Delivered talk, North-East Workshop, Guwahati University, Assam, March 08, 2013; (4) Delivered talk (Refresher Course), Burdwan University, March 11, 2013.

### **Documentation, Research and Training Centre**

Raghavan, K.S.:

(1) ISKO Conference Meeting, University of Mysore, Mysore, July 09, 2012; (2) Invited External Expert, Screening Committee Meeting, Tumkur University, September 25, 2012; (3) Invited Resource Person, Rajiv Gandhi University of Health Science, Karnataka, Bangalore, September 27, 2012; (4) Attended Board of Selection Committee Meeting, Tumkur University, Tumkur, October 10, 2012; (5) Invited, Workshop on National Information Centre for Indian Language, Mysore, December 03-14,



## Editorial and other Assignments

2012; (6) Keynote Address, National Conference on Integrated Library Management System, Tumkur University, Tumkur December 13, 2012; (7) Invited lecture, UGC Academic Staff College, University of Mysore, Mysore, January 11-12, 2013.

Madalli, Devika P.:

(1) Invited, Workshop faculty for MDP on Publishing 2.0: Business Strategies for the 21<sup>st</sup> Century, IIM, Kozhikode, May 21-23, 2012; (2) Joint Scientific Committee Meeting, India-Trento Programme for Advance Research (ITPAR), October 05, 2012; (3) Ph.D Committee Meeting, Dept. of Library and Information Science, University of Calcutta, Kolkata, December 06, 2012; (4) Invited Speaker, ICAL-2013, New Delhi, February 12-15, 2013.

Krishnamurthy, M.:

(1) Invited lecture, Department of Library and Information Science, University of Madras, Chennai, June 29, 2012; (2) Selection Committee Meeting, Rajiv Gandhi University of Health Science, Karnataka, Bangalore, July 20, 2012; (3) Attended International ISKO Conference, University of Mysore, Mysore, August 06-08, 2012; (4) Expert Committee Meeting, Kuvempu University, Shankaraghatta, September 12, 2012; (5) Invited Resource Person, Rajiv Gandhi University of Health Science, Karnataka, Bangalore, September 27, 2012; (6) Attended, SAARC Conference, New Delhi December 01-03, 2012; (7) Chief Guest, Inauguration of Automated Circulation System & Launching of Library Website, Acharya Institute of Technology, Bangalore, January 02, 2013; (8) Participated, ICKMODE-2013, January 17, 2013; (9) Invited Lecture, University of Madras, Chennai, February 20, 2013; (10) Attended, ILA Conference, Karnataka University, Dharwad, February 25-27, 2013.

Prasad, A.R.D.:

(1) National Mission for Libraries Meeting, New Delhi May 17-18, 2012, September 07 & 14, 2012, January 10 & 28, 2013; (2) Invited lecture, Jawaharlal Nehru University, Delhi July 25-26, 2012; (3) National Mission for Library Meeting, New Delhi, September 07, 2012 (4) Joint Scientific Committee Meeting, India-Trento Programme for Advance Research (ITPAR), October 05, 2012; (5) Invited Speaker, National Knowledge Network (NKN) Annual Workshop and the CHAIN Workshop, IIT-Bombay, Mumbai, October 31-November 02, 2012; (6) Delivered special lecture and Chair Session, NAACLIN 2012, Baroda, November 20-22, 2012; (7) Meeting of the Working Group on National Virtual Library, Networking and ICT Application in Libraries, New Delhi, January 09, 2013; (8) Invited lecture, Academic Staff College, Pune University, Pune, December 06-07, 2012; (7) Resource Persons, UGC Academic Staff College, University of Hyderabad 05-07, January 2013; (8) Delivered Lecture, University of Hyderabad, Hyderabad January 08, 2013; (9) Invited Speaker, ICAL-2013, New Delhi, February 12-15, 2013.

## ***Electronics and Communication Sciences Unit***

Bagchi, Aditya:

(1) Invited Lecture, Discovery of Association Rules and Sequential Patterns, Workshop at Indian Association for Productivity, Quality and Reliability (IAPQR), Kolkata, June 22, 2012; (2) Invited Lecture, Data Security, Access Control issues, Workshop on Network Security, National Institute of Technology, Patna, October 18-19, 2012; (3) Invited Lecture, Association Rule Mining, An Expository Presentation, Amal Roy Memorial Lecture, Computer Day 2012, Computer Society of India, Kolkata Chapter, December 15, 2012; (4) Invited Lecture, National Workshop on Psycho-Informatics, Kolkata, March 11-12, 2013; (5) Invited Lecture, Database Security, Access Control Issues, Academic Staff College, Burdwan University, Burdwan, March 15, 2013.

Chanda, Bhabatosh:

(1) Delivered Lecture, National Seminar National Seminar on Computer Vision and Image Processing (NaSCoVIP), Rajkot, September 21-22, 2012; (2) Delivered Lecture, half-day seminar on Remote Sensing and Image Processing, Govt. College of Engineering and Ceramic Technology, 9

Novemebrrer 09, 2012; (3) Delivered Lecture, TEQIP Sponsored Programme, Bengal Engineering & Science University, Shibpur, November 26, 2012; (4) Delivered Lecture, National Conference on Recent Trends in Mathematical and Computational Sciences, IASST, Guwahati, November 28-30, 2012; (5) Delivered Lecture, Third International Conference of Emerging Applications of Information Technology (EAIT 2012), Kolkata, 28 November 28-December 01, 2012; (6) Delivered Lecture, International Workshop on Computer Vision and Machine Learning, Sri Sathya Sai Institute of Higher Learning, Puttaparthi, December 21-22, 2012; (7) Delivered Key-Note Lecture, International Conference on Recent Trends in Computer and Computational Sciences, PES-BSC, Bangalore, January 11-13, 2013; (8) Delivered Tutorial Lecture, International Conference on RECOMP'13, PESSE, Bangalore, January 11-13, 2013; (9) Session Chair, NC-RTMCS, IASST, Guwahati, November 28—30, 2012; (10) Session Chair, EAIT'12, Kolkata, 28 November 28-December 01, 2012.

Das, Swagatam:

(1) Co General Chair, Fourth International Conference on Swarm, Evolutionary and Memetic Computing (SEMCCO) 2013, SRM University, Chennai; (2) Invited Lecture, "Frontiers of swarm and evolutionary computing" at Nirma University, Ahmadabad, Gujarat on March 20, 2013; (3) Invited Lecture, Department of Electronics and Communication Engineering, Anil Neerukonda Institute of Technology And Sciences(ANITS), Vizag, on February 27, 2013.

Mukherjee, Dipti Prasad:

(1) Delivered Invited Talk, Image Processing Applications using Computational Intelligence Techniques, RCCIIT, Kolkata, March 19, 2013; (2) Delivered Invited Talk, Barrackpore Rastraguru Surendranath College, Kolkata, March 05, 2013; (3) Delivered Invited Talk, International Conference CODIS-2012, Jadavpur University, December 29, 2012; (4) Delivered Invited Talk, IEEE GOLD Invited Talk, Jadavpur University, Kolkata, August 27, 2012; (5) Delivered Invited Talk, TEQIP Workshop, RCCIIT, Kolkata, July 25, 2012; (6) Regional Vice President, Computer Society of India, 2012; (7) Organizing Chair, Third international Conference on Emerging Applications of Information Technology (EAIT 2012), November 29-December 01, 2012; (8) Organizing Chair, 47<sup>th</sup> Annual National Convention of the Computer Society of India (CSI-2012), December 01-02, 2012; (9) Publication Chair, 8<sup>th</sup> Indian Conference on Vision, Graphics and Image Processing (ICVGIP12), IIT Bombay, December 15-17, 2012; (10) Member, Executive Committee, Science City, Kolkata, 2012-13; (11) Member, PhD Research Board of Studies, West Bengal State University, Barasat; (12) Session Chair, 8<sup>th</sup> Indian Conference on Vision, Graphics and Image Processing (ICVGIP12), IIT Bombay, December 15-17, 2012.

Pal, Nikhil Ranjan:

(1) Plenary Lecture, International Conference on Frontiers of Intelligent Computing: Theory and Applications (FICTA 2012), Bhubaneswar, December 22–23, 2012; (2) Plenary Lecture, Satish Kumar Commemorative Lecture, International School on Quantum and Nano Computing Systems and Applications (QANSAS 2012), Dayalbag, November 29–December 02, 2012.

### ***Machine Intelligence Unit***

Bandyopadhyay, S.:

(1) Member, Board of Governors, NIT Warangal; (2) Invited lectures at Institute for Development and Research in Banking Technology (IDRBT), Hyderabad, August 06, 2012; (3) National Institute of Biomedical Genomics (NIBMG), Kalyani, October 17, 2012; (4) Annual Convention, Indian National Academy of Engineering (INAE), CBRI, IIT Roorkee, December 06-07, 2012.

Biswas S.:

(1) Invited Lecture, Science Academies Refresher Course, GRD College of Science, Coimbatore, January 24, 2012.

## Editorial and other Assignments

De, R.K.:

(1) Acted, External Examiner, Indian School of Mines, Dhanbad, May 17, 2012; (2) Acted, External Examiner, Department of Information Technology, University of Calcutta, June 19, 2012; (3) Delivered Talk, North-East Workshop on Modeling Biological Systems - II, Mizoram University, Aizwal, August 21-25, 2012; (4) Acted External Examiner, Tezpur University, Tezpur, September 21, 2012; (5) Attended, International Conference on Systems Biology, University of Calcutta, Kolkata, January 21-22, 2013; (6) Delivered, North-East Workshop on Statistical Pattern Recognition and Data Mining, Gauhati University, Guwahati, March 13-15, 2013.

Ghosh A.:

(1) Institute of Mathematics and Applications, December 05-07, 2012; (2) Key-note Speech, National Conference on Fuzzy Soft Computing Mathematical Analysis, Pondichery University, October 03-05, 2012; (3) Faculty Interview, IIIT, Bhubaneswar, June 16-18, 2012; (4) PhD Viva-voce, Indian Institute of Technology, Kharagpur and National Institute of Technology, Rourkela, May 25-26, 2012; (5) Keynote Speech, 15<sup>th</sup> National Conference of Society of Statistics Computer and Applications, February 23-24, 2013.

Kundu, M.K.:

(1) Member, Technical Program Committee, 8th Indian Conference on Vision, Graphics and Image Processing 2012 (ICVGIP 2012), Mumbai, December 16-19, 2012; (2) Member, National Advisory Committee and Technical Session Chair, 5th International Conference on Computers and Devices for Communication (CODEC 2012), Kolkata, December 16-18, 2012; (3) Invited Lectures, Digital Watermarking: A Tool for Digital Right & Integrity Management of Multimedia Data, CDAC, Kolkata, March 23, 2013; (4) Invited Lectures, CDAC Kolkata, January 08, 2013; (5) Invited Lectures, IEEE Seminar, Intelligence In Information Systems, Imaging and Security, St. Thomas College of Engineering & Technology Kolkata, August 03-04, 2012; (6) Invited Lectures, TEQIP Seminar, RCC Institute of Information Technology, Kolkata, July 24-26, 2012.

Maji, P.:

(1) External Expert, M. Tech Thesis Viva, Department of Information Technology, Bengal Engineering and Science University, Shibpur, May 09, 2012; (2) External Expert, MCA Viva, Heritage Institute of Technology, May 17, 2012; (3) External Expert, PhD Committee, Department of Information Technology, Bengal Engineering and Science University, Shibpur, August 07, 2012; (4) Invited Lecture, Workshop on Applications of Soft Computing, Heritage Institute of Technology, August 23, 2012; (5) Attended, INSA Young Scientist Conclave, Indian National Science Academy, New Delhi, November 20-21, 2012; (6) External Examiner, Department of Physics, Viswa-bharati, Shantiniketan, December 10, 2012; (7) Invited Lecture, Workshop on Nonuniform Cellular Automata: Theory and Applications, Bengal Engineering and Science University, Shibpur, March 25, 2013.

Mitra, S.:

Invited Lecture, International Conference on Artificial Intelligence and Soft Computing on Hybridization with rough sets, IIT Varanasi, December 08, 2012.

## ***Systems Science and Informatics Unit***

Sagar, B.S.D.:

(1) Member of Doctoral Committee, University of Hyderabad, Hyderabad, 2012; (2) Member of Doctoral Committee, Indian Institute of Space Science and Technology, Trivandrum, 2012; (3) Member of Doctoral Committee, Andhra University, Waltair, 2013; (4) Invited Lecture, Mathematical Morphology: Theory and Applications, TEQIP-II (Faculty Development Program) on Biostatistics-Statistical Analysis through Software Tools organized by BMS College of Engineering, Bangalore, February 15, 2013; (5) Invited lecture, Mathematical Morphology in Terrestrial Surface Characterization, Institution of Engineers, Bangalore, March 07, 2013; (6) Invited Lecture, Directional

Dilation Distances and Directional Granulometries for Quantitative Spatial Reasoning, School of Computer Science and Information Systems, University of Hyderabad, March 08, 2013.

Majumdar, Kausik K.:

Invited Lecture, Video Synchronization in Schizophrenia, INCF Workshop, IIT Madras and IMSc, Chennai, November 05-07, 2012.

Meher, Saroj K.:

(1) Member of Doctoral Committees, Sambalpur University, Sambalpur, 2012; (2) Member of Doctoral Committee, Fakirmohan University, Balasore, 2012; (3) Invited Lecture, Department of Chemical Engineering, GMR Institute of Technology, Rajam, Srikakulam, August, 2012.

### ***Computer Science Unit, Chennai***

Ghosh, S.:

(1) Delivered Lecture, Department of Mathematics, Visva-Bharati, March, 2013; (2) Delivered Lecture, Department of Mathematics, Tripura University, January, 2013; (3) Delivered Lecture, Calcutta Logic Circle Annual Meet, September, 2012; (4) Delivered Lecture, IMSc, Chennai, April, 2012; (5)

Venkateswarlu, A.:

(1) Delivered Lecture, International Workshop on Recent Advances in Lattice Reduction Algorithms and their Applications, CR Rao AMIMSCS, Hyderabad, April 10-12, 2012.

Sekar, Gautham:

(1) Delivered Lecture, National Workshop on Cryptology 2012, August 08, 2012; (2) Delivered Lecture, CEP Programme of the Scientific Analysis Group, DRDO, Delhi, September 24, 2012.

Gangopadhyay, Sugata:

Delivered Lecture, Boolean Functions at SAG, DRDO, Delhi September 24-28, 2012.

## **Physics and Earth Sciences Division**

### ***Geological Studies Unit***

Ghosh, Parthasarathi:

Participated, Goals of Solid Earth Geosciences in India in the next decade, IIT Kharagpur, September 06-07, 2012.

### ***Physics and Applied Mathematics Unit***

Chakraborty, Prabuddha:

(1) Invited Seminar, Indian Association for the Cultivation of Science, Kolkata, May, 2012; (2) IISER Mohali, Department of Physics, November, 2012; (3) Invited Seminar, Graphene, Majorana fermions and quantum Computations, IISc. Bangalore, December, 2012.

Kar, Guruprasad:

Academic Collaboration work, Institute of Mathematical Sciences, Chennai, October 30–November 09, 2012.

## Editorial and other Assignments

Pal, Supratik:

1) Delivered Lectures, Astroparticle Physics, Saha Institute of Nuclear Physics, Kolkata, September 03-22, 2012; 2) Delivered Lectures, Winter School in Gravitation and Cosmology, Assam University, Silchar, March 04-11, 2013.

Roy, A. K.

Academic Collaboration work, Inter-University Centre for Astrophysics (IUCAA), Pune, January 11–25, 2013.

Roy, S.:

1) Invited talk, National Workshop on Modeling in Biological Systems, Aizwal University, August 21-25, 2012; (2) Invited talk, International Conference on Quantum Biology, Indian Institute of Technology Jodhpur, January 17-21, 2013; (3) Invited talk, National Conference on the Application of Physics, Mathematics in Consciousness and Cognitive Science, NIAS, Bangalore March 11-12, 2013; (4) Invited talk, National Workshop on Quantum Ontology, Decision Making and Modeling in Cognitive Science, Tezpur University, March 21-22, 2013.

## **Biological Sciences Division**

### ***Biological Anthropology Unit***

Bharati, P.:

Invited talk, Cotton College, Gauhati, December 31, 2012-January 02, 2013.

Mukhopadhyay, B.:

(1) Attended, International Symposia on Aging, North Eastern Hill University, Shillong. December, 2012; (2) Attended, Indian Anthropological Congress, Kannor University, Kerala, February 14-16, 2013.

## **Social Sciences Division**

### ***Economic Research Unit***

Banerjee, Priyadarshi:

Invited talk, Economic Theory and Policy Conference on Promises, Credulity and Integrity, Jawaharlal Nehru University, New, Delhi, March 21-23, 2013.

Chakravarty, Satya Ranjan:

Invited talk, Six international conferences on Economic Theory and Policy, National Institute of Public Finance and Policy, New Delhi and Kagawa University, Japan, March 21–23, 2013.

Majumder, Amita:

(1) Member, Working Group on Terms of Trade between the Agricultural and Non-agricultural Sectors, Govt. of India, Ministry of Agriculture, Dept. of Agriculture and Cooperation, Directorate of Economics and Statistics (IAC Division), 2012; (2) Presented paper, Asian Meeting of the Econometric Society, Delhi, December, 2012.

Kabiraj, Tarun:

(1) Presented paper, Indian Econometric Society Conference 2013, Patna University, January, 09-11, 2013; (2) Presented paper, Conference, Centre for Advanced Studies, Dept. of Econ., Jadavpur

University, March 21-22, 2013; (3) Invited Key Note Address, Indo-Myanmar border trade: Volume and composition, Manipur University, March 25-26, 2013; (4) Acted as Jury, Paper Presentation, Confluence 2012, St Xavier's College, Kolkata, September 18-20, 2012.

Pal, Manoranjan:

Invited talk, Recent Advances in Mathematical Statistics and Its Applications in Applied Sciences, Department of Statistics, Gauhati University, December 31, 2012-January 02, 2013.

Sarkar, Abhirup:

Presented a paper, the Indian Econometric Society Conference 2013, National Institute of Public Finance and Policy, Jawaharlal Nehru University, New, Delhi, March, 2013.

Sarkar, Nityananda:

Invited talk, Recent Advances in Mathematical Statistics and Its Applications in Applied Sciences, Gauhati University, Assam, December 31, 2012-January 02, 2013.

### ***Economic Analysis Unit***

Guha, Puja:

(1) Attended, 14th Annual International Conference, Money and Finance, IGDR, Mumbai, April 08, 2012; (2) Lectures, VAR-VEC Models for the Indian Statistical Services (ISS) Probationary Officers, ISEC, August 2012; (3) Attended, Macroeconomic Stabilization Policy in an Era of Low Growth, IIFT, New Delhi, December 18, 2012; (4) Attended, National Conference, Emerging Issues in International Trade: Theory and Empirics, Centre for Advanced Studies, Department of Economics, Jadavpur University, March 22, 2013; (5) Advisor, Statistical Strengthening Programme for Karnataka Statistical Systems Development Agency (KSSDA), Deloitte Touche Tohmatsu India Pvt. Ltd.; (6) Taught course, Institute of Social and Economic Change (ISEC), Bangalore, February-March 2013; (7) Lecture on Statistical Interventions in Social Science Research, M.S. Ramaiah Institute of Technology, Bangalore, March, 2013.

Narayana, N.S.S.:

(1) Invited lectures, VAR-VEC Models for the Indian Statistical Services (ISS) Probationary Officers, ISEC, August, 2012; (2) Indian Institute of Management, Tiruchirapally, Economic Reforms and Fiscal & Monetary Policies, February, 2013.

Ramachandran, V.K.:

(1) Invited lecture, AKG Centre, Thiruvananthapuram, July 19, 2013; (2) Invited lecture, Tata Institute of Social Sciences, Mumbai, September, 2012; (3) Invited lecture, International Conference on Longitudinal Village Studies, London School of Economics and Jawaharlal Nehru University, New Delhi, November 09-11, 2012; (4) Invited lecture, Conference at EMS Academy, Thiruvananthapuram, December 12, 2012; (5) Invited lecture, Terres des Hommes, Pune, February 03, 2013; (6) Invited lecture, Agricultural Labour Workshop, Thrissur, March 15, 2013.

Swaminathan, Madhura:

Invited lecture, International Village Studies Conference, London School of Economics and Jawaharlal Nehru University, New Delhi, November 09-11, 2012.

### ***Linguistic Research Unit***

Dash, Niladri Sekhar:

(1) Attended, UNL (Universal Networking Language) Workshop (Indian Chapter), Dept. of Computer Science and Engineering, Indian Institute of Technology, Mumbai, June 11-16, 2012; (2) Delivered lectures, Dept. of Konkani, Goa University, Panjim, Goa, July 16, 2012; (3) External Examiner, 5-

## Editorial and other Assignments

Years integrate MA course, Sanskrit of Ramakrishna Mission Vivekananda University, Belur Math, Howrah, July 30, 2012; (4) Reviewer, 34<sup>th</sup> All Indian Conference of Linguists (34-AICL) North Eastern Hill University (NEHU), Shillong, November 01-03, 2012; (5) Delivered talk, National Conference on Recent Trends in Mathematical Computational Sciences, Institute of Advanced Study in Science and Technology (IASST), Guwahati, Assam, November 28-30, 2012; (6) Expert, Linguistic Training Program at North Eastern Hill University, Shillong, December 14-24, 2012; (7) Attended, PI/Co-PI meeting, Indradhanush WordNet, Dept. of Computer Science and Engineering, Indian Institute of Technology, Mumbai, December 15-16, 2012; (8) Chief Investigator, Develop a digital archive of the dialect, Balasore, Odisha, December 24-28, 2012; (9) Participated, workshop-cum-training programme of the Indian Languages Corpora Initiative (Phase II), Centre for Sanskrit Studies, Jawaharlal Nehru University, New Delhi, January 11-12, 2013.

## ***Economics and Planning Unit***

Afridi, Farzana:

(1) Visited, International Growth Centre, July, 2012; (2) Visited, IIM Bangalore, Centre for Public Policy, September, 2012; (3) Visited, Indian School of Business, September, 2012; (4) Attended, IZA World Bank Conference (Delhi), November, 2012; (5) Attended, World Bank Seminar (Delhi), November, 2012; (6) Attended, Journal of Economics Theory workshop on governance and political economy (Mysore), December, 2012.

Ghate, Chetan:

(1) Member, Reserve Bank of India, Technical Advisory Council (TAC) for Monetary Policy; (2) Speaker, Competition and Competiveness in Indian Industry, Women's Christian College and CSSS, Kolkata, April, 2012; (3) 4th ICRIER G20 Conference, New Delhi, India, October, 2012; (4) Asian Meetings of the Econometric Society, Delhi School of Economics, New Delhi, December 2012; (5) Attended, Fiscal Compulsions and Monetary Policy, CSSS Kolkata, February 2013; (6) Indian Institute of Management, Bangalore, March, 2013.

Mukhopadhyay, Abhiroop:

Visited, Indira Gandhi Institute of Development Research, Mumbai, 2012.

Ramaswami, Bharat:

Invited, Indira Gandhi Institute of Development Research Silver Jubilee International Conference, December, 2012.

Ray, Tridip:

Visited, Indian School of Business, Hyderabad, 09 January, 2013.

Roy Chowdhury, Prabal:

(1) Presented paper, CSSS, Kolkata, November, 2012; (2) Visited, Delhi School of Economics, December, 2012; (3) Attended, University of Hyderabad, February 25, 2013 and (4) Jawaharlal Nehru University, February, 2013.

Somanathan, E.:

(1) Visited, Azim Premji University, Bangalore, July 14, 2012; (2) Speaker, Digital Deliberations Workshop, Bangalore, July 16, 2012.

## ***Psychology Research Unit***

Bhattacharya, H:

Attended, 100<sup>th</sup> Indian Science Congress, Anxiety and Eating attitude among Higher Secondary School students, Kolkata, January 03-07, 2013.

Dutta Roy, D.:

(1) Invited Lecture, Psychographic Profile Analysis for Market segmentation, Amrita University, Coimbatore, May 21-25 and June 03-09, 2012; (2) Research methodology, NMIMS, Mumbai, October 26-28, November 09-11, 2012; (3) Invited Lecture, Psycho-informatics in Market Research, Amrita University, Bangalore, November 08, 2012.

Gupta, Rumki:

(1) Participated and presented paper, Redefining Education: Expanding Horizons, Bombay Teachers' Training College, January 10-12, 2013; (2) Participated and presented paper, National Conference on Mental Health and Well-being: Issues, Challenges and Strategies for the Future at the Discipline of Psychology, School of Social Sciences, Indira Gandhi National Open University, New Delhi, February 07-08, 2013.

### ***Sampling and Official Statistics Unit***

Mitra, Sandip:

Attended, ICSSR Workshop, Shillong, March 04-13, 2013.

Mukherjee, Diganta:

(1) Consultant, IMRB International, 2012; (2) Technical Advisor, Index Committee of MCX-SX, 2013.

Pathak, Prasanta:

(1) Attended as an expert, Roadmap for Bridging Gaps in Health and Hospital Management Research, Training and Education in Eastern India, Kolkata, May 05, 2012; (2) Attended, Technical Expert Group on TB Burden Estimation in India, LRS Institute, Sri Aurobindo Marg, New Delhi, April 23-November 20, 2012; (3) Acted as Chairman, Jadavpur University, Kolkata, March, 2013.

### ***Sociological Research Unit***

Ghosh, Bholanath:

Attended, 38<sup>th</sup> All India Sociological Conference, Department of Sociology, University College of Social Sciences & Humanities, Mohan Lal Sukhadia University, Udaipur, Rajasthan, December 27-29, 2012.

Ghosh, Tirthankar:

Delivered invited lectures, Introduction to Research Methodology in Social Science and Field Methodology Approach Empirical Data Collection, M S University, Tamil Nadu, February 26-28, 2013.

Jana, Rabindranath:

Delivered invited lectures, Introduction to Social Network Analysis and SNA Approach to Empirical Data, M S University, Tamil Nadu, February 26-28, 2013.

## **Statistical Quality Control and Operations Research Division**

### ***SQC & OR Unit, Bangalore***

John, Bobby:

(1) Invited Lecture, Statistical Process Control using Minitab Software at Staff Development Program, Siddaganga Institute of Technology, Tumkur, Karnataka, June 30, 2012; (2) Invited Lecture, Six Sigma Methodology and Taguchi Methods, JSS Academy of Technical Education, Bangalore, July, 2012; (3) Invited Lecture, Rapid Miner: an open source software for data mining at Faculty Development Program, R V College of Engineering, Bangalore, October 13, 2012; (4) Invited Lecture, Problem



## Editorial and other Assignments

Solving using Design of Experiments, LBS Institute of Technology, Thiruvananthapuram, Kerala, November 21, 2012; (5) Delivered Lecture, Advanced Data Analysis using Statistical Software's, Faculty Development Program, BMS College of Engineering, Bangalore, February 28-March 01, 2013; (5) Delivered Lecture, Data Mining using Rapid Miner", at one day hands-on training on Rapid Miner – a data mining tool, PSG College of Technology, Coimbatore, March 16, 2013.

Islam, I.:

Delivered Lectures, Statistical Process Control and Practical Case Studies on Design of Experiments, JSS Academy of Technical Education, Bangalore, July, 2012.

Gijo, E.V.:

Delivered Lectures, National Workshop on Recent Developments in Statistics with Special Emphasis on Computational Statistics, University of Kerala, Trivandrum, March 06, 2013

### ***SQC & OR Unit, Chennai***

Raman, D. Sampangi:

(1) External Examiner, Safety Analysis of Natural Circulation based Decay Heat Removal Systems, Safety Research Institute, University of Madras, Division of Indian Atomic Energy Regulatory Board (Govt. of India), Indira Gandhi Centre for Atomic Research Campus, Kalpakkam, 2012; (2) Member of Doctoral Committee, Centre for Research, Anna University, Chennai, 2012; (3) Guest Lecture, Quality Management, Veltech University, Avadi, Chennai, 2012; (4) Guest Lecture, Quality Management, Sri Ramachandra University, Porur, Chennai, 2012; (5) Guest Lecture, Quality Management, Anna University, Guindy, Chennai, 2012.

Ravindran, G.:

(1) Invited Talk, Matching Algorithms: A Survey, International Workshop on Game Theory and Operations Research, IPE, Hyderabad, December 19, 2012; (2) Invited Talk, Game on Unit Square – the Square Root Game and the Beta Distribution, International Workshop on Game Theory and Operations Research, IPE, Hyderabad, December 21-22, 2012.

### ***SQC & OR Unit, Coimbatore***

Rajagopal A.:

(1) Taught: Statistics in Textile Technology, Acharya Nagarjuna University, Guntur, February–March 2013; (2) Board Member, Statistics in Textiles Course, Nagarjuna University, Guntur, 2012; (3) Reviewer of Syllabus for Board of Studies, Statistics, PSG College of Arts and Science, 2012; (4) Member of Board of Studies, Studies and Humanities-Mathematics, Avinashilingam Institute for Home Science and Higher Education for women, 2012.

### ***SQC & OR Unit, Hyderabad***

Murthy, G.S.R.:

(1) Invited Lecture, Advanced Workshop and Tutorial on Operations Research (AWTOR), IIM, Indore, August 2012; (2) Invited Talk, International Workshop on Game Theory and Operations Research Applications, Hyderabad, December 19, 2012.

Murthy, A.L.N.:

Invited Talk, International Workshop on Game Theory and Operations Research Applications, Hyderabad, December 19, 2012.

Murali Rao, G.:

Invited Talk, BHEL, R & D, November 01, 2013; (2) Presented paper, International Conference on Quality, Reliability and Operations Research, Mumbai, January 07-09, 2013.

Subhani, S.M.:

Delivered Guest Lectures, Defence Metallurgical Research Laboratory, Hyderabad, on 22 November 22, 2012; (2) Delivered Lectures, Statistical Process Control, Centre for Electronics Test Engineering, Hyderabad, July 19-21, 2012.

### ***SQC & OR Unit, Kolkata***

Das, A.K.:

Invited talk, Statistics for Environmental Data Analysis, Workshop on Environmental Data Analysis and Interpretation, CPCB, Ministry of Environment and Forests, Government of India, Delhi, January 28-February 01, 2013.

Das, P.:

(1) Invited talk, Multi-response Experiments and Optimization, Workshop on Design and Analysis of Experiments, Kolkata, November 19-23, 2012; (2) Invited talk, Multi-objective Optimization in the Advanced Workshop & Tutorial on Operations Research (AWTOR – 2012), IIM, Indore, August 22-25, 2012.

Pradhan, B.:

(1) Invited talk, Inference and optimum censoring scheme under progressive censoring, Workshop on Reliability Theory and Survival Analysis, Department of Mathematics and Statistics, Indian Institute of Technology, Kanpur, December 03-05, 2012; (2) Invited talk, Estimation of unknown population size based on general order statistic model by Bayesian approach. Eighth International Triennial Calcutta Symposium on Probability and Statistics, University of Calcutta, December 27-30, 2012; (3) Invited talk, Estimation of quality adjusted lifetime distribution in progressive illness-death models. International Indian Statistical Association Conference: Statistics, Science and Society: New Challenges and Opportunities, Chennai, January 02-05, 2013.

### ***SQC & OR Unit, Mumbai***

Sikder, Sagar:

Invited lecture, Vendor selection using process capability, Indian Railway Electrical Engineering Institute, Nasik, December, 2012.

## **Library, Documentation and Information Science Division**

### ***Library, Kolkata***

Pal, Jiban K.:

(1) Attended, Workshop on Data Curation in the University: Libraries, Research and Learning, Jawaharlal Nehru University, New Delhi, March 25, 2013; (2) Invited Resource Person, Interactive Radio Counseling of MLIS course at GyanVani FM Radio Station (105.4 MHz), IGNOU, Kolkata, September 8, 2012; (3) Pursuer, Academic Counsellors' Training Online, Staff Training and Research Institute of Distance Education (STRIDE), IGNOU, New Delhi, December 12, 2012-March 11, 2013.

## Editorial and other Assignments

Ganguly, Nibedita:

(1) Acted Supervisor, Master's Thesis, Integrated Rural Development and Management, Ramakrishna Mission Vivekananda University, 2013; (2) Delivered Lecture, Integrated Rural Development and Management, Ramakrishna Mission Vivekananda University, February 11, 2013; (3) Taught, M. Phil-DLIS, University of Calcutta, November, 2012; (4) Conducted, National Conference on Reprographic Rights and Copyright Act: Challenges and Management, Kolkata, March 07-08, 2013; (5) Editorial Committee Member, Proceedings of the National Conference "A Discourse on Reprographic Rights and Copyrights: Contemporary Facets", March, 2013.

### ***Center for Soft Computing Research: A National Facility***

Chakraborty, M.K.:

(1) Organizer, 4th Indian School on Logic and its Applications (ISLA 2012), Manipal University, Manipal, Karnataka, January 09-20, 2013; (2) Invited Lecture, International Conference on Rough Sets, Fuzzy Sets and Soft Computing, ICRFSC12, Tripura University, Tripura, January 17-19, 2013; (3) Invited Lecture, School on Logic, Indian Council for Philosophical Research (ICPR), Lucknow, March 11-22, 2013.

Ghosh, A.:

(1) Ph. D Viva-voce, Indian Institute of Technology, Kharagpur, May 25-26, 2012; (2) M. Tech Viva-voce, National Institute of Technology, Rourkela, May 25-26, 2012; (3) Faculty Interview, IIIT, Bhubaneswar, June 16-18, 2012; (4) Key-note Speech, National Conference on Fuzzy Soft Computing Mathematical Analysis, Pondichery University, October 03-05, 2012; (4) Institute of Mathematics and Applications, Banasthali University, Jaipur, December 05-07, 2012; (5) Keynote Speech, 15th National Conference of Society of Statistics Computer and Applications on Advanced Development and Applications in Statistical Sciences, February 23-24, 2013.

Ghosh, K.:

(1) Invited Lecture, Seminar on Optics and Photonics: Trends and Prospects, Department of Applied Optics and Photonics, University of Calcutta, December 02, 2012; (2) Invited Lecture, Faculty upgradation program on Digital Signal Processing, Speech Processing and Image Processing, CDAC, Kolkata December 31, 2012-January 11, 2013.

Pal, S.K.:

(1) Plenary Lecture, 12th International Conference on International Systems Design and Applications, 2012 (ISDA), Kochi, Kerala, November 26-29, 2012; (2) Keynote Talk, 7th International Conference on Bio-Inspired Computing: Theories and Application 2012 (BIC-TA 2012), IIIT Gwalior, December 14-17, 2012; (3) Keynote Lecture, 5th International Conference on Computers and Devices for Communication (CODEC 2012), Kolkata, December 18, 2012; (4) Keynote Lecture, International Conference on Rough Sets, Fuzzy Sets and Soft Computing, ICRFSC12, Tripura University, Tripura, January 17-19, 2013; (5) 5th Srinivasa Ramanujan Memorial Lecture, Netaji Subhash Open University, Bangla Academy Sabhaghar, Kolkata, March 07, 2013; (6) Keynote Lecture, Workshop on Mathematics for Nonlinear Systems, Visva Bharati, Santiniketan, West Bengal, March 17-18, 2013.

## **9. REGIONAL MATHEMATICAL OLYMPIAD 2012 AND INDIAN NATIONAL MATHEMATICAL OLYMPIAD 2013**

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.

Every year the Kolkata and Bangalore centres of Indian Statistical Institute organize the Regional Mathematical Olympiad (RMO) at West Bengal and Karnataka, respectively. This is followed subsequently by Indian National Mathematical Olympiad (INMO) whose participants are those who have cleared the RMO test and are primarily from West Bengal and Karnataka, respectively. There are two Regional Co-ordinators from the Kolkata centre of Indian Statistical Institute and one from the Bangalore centre.

On December 02, 2012, RMO-2012 in West Bengal and Karnataka were held in 14 and 23 different centres in these two states. The numbers of participants in these two states were 1353 and approximately 2000. The numbers of successful candidates from these two states were 35 and 36, respectively. INMO-2013 was held on February 03, 2013. The number of participants in INMO-2013 in West Bengal was 42.

In the period between RMO-2012 and INMO-2013, week-long week long training camps were organized at both ISI Kolkata and ISI Bangalore for the students who had cleared RMO-2013 and a few more, to make them familiar with advanced problem solving techniques before they appear for INMO. Several distinguished speakers were invited for this purpose. The numbers of participants in West Bengal and Karnataka were approximately 40 and 56.

## PART II. ADMINISTRATION AND OFFICE BEARERS

### 10. GENERAL ADMINISTRATION

#### Administrative Services Division

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:

SI. No.	Name of the Unit	SI. 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.	Publication and Printing Unit
10.	Director's Office	26.	Rajbhasha / Hindi 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 Cell	32.	SC / ST / OBC Cell

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.

#### Office bearers of the Institute Administration during the year:

<i>Director</i>	:	Bimal K. Roy
<i>Professors-in-Charge of Scientific Divisions</i>	:	T.S.S.R.K. Rao (Theoretical Statistics & Mathematics) Mausumi Bose (Applied Statistics)

Probal Roy Chowdhury (Social Sciences)

Saswati Bandyopadhyay (Physics &amp; Earth Sciences)

Subrata Kr. Roy (Biological Sciences)

C.A. Murthy (Computer &amp; Communication Sciences)

*Head, SQC & OR* : Ashis Kr. Chakraborty*Head, Delhi Centre* : Satya P. Das*Head, Bangalore Centre* : N.S.N. Sastry*Head, Chennai Centre* : P.S.S.N.V.P. Rao (Acting) upto 31.08.2012  
D. Sampangi Raman (Officiating) from 01.09.2012 to 09.10.2012.  
Prof. S. Ponnusamy w.e.f. 10.10.2012*Dean of Studies* : Pradipta Bandyopadhyay*Chief Executive (A & F)* : S.K. Iyer**List of workers who joined/retired/voluntarily retired/resigned/terminated/died during the year****Appointments**

## Scientific / Technical Workers

Sl. No.	Name		Sl. No.	Name
1.	Tanvi Jain		8.	Santanu Kumar Maiti
2.	Pradip Bhattacharyya		9.	Manish Kumar
3.	Dibakar Ghosh		10.	S. Ponnusamy
4.	Anupam Pal		11.	Nachiketa Chattopadhyay
5.	Swagatam Das		12.	Raghunath Chatterjee
6.	Indraneel Dasgupta		13.	Somnath Das
7.	Arijit Chakraborty			

## Non-Scientific Workers

Sl. No.	Name		Sl. No.	Name
1.	Indrani Karmakar		5.	Deb Kumar Das
2.	Parama Gogoi		6.	Viju Gulabrao Chavan
3.	Imran Ahmed		7.	Jayanta Kumar Mishra
4.	Pallipurath Sreejith		8.	Rabindra Nath Raul

**Retirement/Voluntary Retirement:**

## Scientific &amp; Technical Workers

Sl. No.	Name		Sl. No.	Name
1.	Pranati Datta		9.	N.K. Khatri
2.	Ajoy Kr. Das		10.	Aloka Sarkar
3.	Kazi Kabir Hossain		11.	Pradip Kumar Maulik
4.	Monoranjan Ghosh		12.	Kunal Chattopadhyay
5.	Jayasree Dattagupta		13.	Manabendu Chattopadhyay
6.	P.S.S.N.P.V. Rao		14.	K.S. Raghavan
7.	Badal Kumar Dey		15.	Anup Majumder
8.	Shibdas Bandyopadhyay			

Administration

Non-Scientific Workers

Sl. No.	Name	Sl. No.	Name
1.	Seema Ghatak	21.	Nemai Ch. Jana
2.	Mira Datta	22.	Susil Karmakar
3.	Mana Oraon	23.	Ajoy Kr. Hore
4.	Amar Nath Mullick	24.	Ashok Singh
5.	Pranab Banerjee	25.	Umeshwar Thakur
6.	Shew Charan	26.	Atasi Biswas Chaudhuri
7.	Lakshman Ch. Das	27.	Sanat Kr. Joarder
8.	Koma Beharani	28.	Debabrata Sen
9.	Jogeshwar Prasad	29.	Biswanath Hazam
10.	Radhey Shyam	30.	Sourendra Munshi
11.	Bishnu Prasad Yadav	31.	Sk. Abul Hossain
12.	Lakshmi Chand	32.	Panchananda Das
13.	Diptendu Bikash Das	33.	Kamal Kr. Saha
14.	Nemai Chakraborty	34.	Suresh Ch. Mondal
15.	Gouranga Bose	35.	Kajal Lodh
16.	Ganesh Mahato	36.	Dolsingar Mourya
17.	Mangal Prasad Oraon	37.	Shiva Brata Chaudhuri
18.	Joseph Devadass	38.	Shib Sankar Mallick
19.	Sisir Kr. Dey	39.	Subhas Malakar
20.	Niranjan Rout		

**Resignation/Termination**

Scientific Worker

Sl. No.	Name
1.	B.M. Meera
2.	Mithun Raj M.
3.	Sugata Gangopadhyay

Non-Scientific Worker

Sl. No.	Name
1.	Suchintya Kr. Gupta

**Death**

Scientific/Technical Worker

Sl. No.	Name
1.	Jethu Bhuiya
2.	Sankar Mahato
3.	Joydeb Gupta
4.	Lundu Orawo

**Number of workers in the Institute as on 31<sup>st</sup> March 2013 (A.N)**

Number of workers in the Institute as on 31 March 2013:

(i)	Scientific and Technical Workers	-	444
(ii)	Non-Scientific Workers	-	<u>606</u>
	Total	:	<u>1050</u>

**Breakup of manpower by Gender, Social category and Disability group as on 31<sup>st</sup> March 2013 (A.N.)**

Total Strength		Physically Handicapped (PH)	Scheduled Caste (SC)	Scheduled Tribe (ST)	Other Backward Class (OBC)
Male	888	06	107	29	65
Female	162	Nil	15	01	02
Total	1050	06	122	30	67

**Applications received and action taken by the Institute under RTI Act, 2005**

Name of the Appellate Authority: Professor Bimal K. Roy, Director of the Institute.

Name of Central Public Information Officer: Shri S.K. Iyer, Chief Executive (Admn. &amp; Finance) of the Institute.

A total number of 76 (seventy six) applications were received by the Central Public Information Officer of the Institute during 2012-13, out of which 3 (three) applications were rejected. Central Public Information Officer provided information against remaining 73 (seventy three) applications within the stipulated date. The summary statement in this regard for the year 2012-13 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
76	73	3	Nil	5	4	NIL	NIL	1432	174	NIL



Administration

## **Budget and Finance**

For the year 2012-2013, Section 8(1) Committee recommended Rs.15552.00 lakhs (Government Grant Rs.15230.00 lakhs and ISI internal receipt Rs.322.00 lakhs) under Non-Plan (BE) and Rs.14284.73 lakhs under Plan (BE). The Government approved a sum of Rs.11000.00 lakhs and of Rs.4200.00 lakhs for Non-Plan and Plan expenditure respectively. At the revised estimate stage, the Institute sought for a grant of Rs.15326.75 lakhs and Rs.5160.90 lakhs under Non-Plan and Plan respectively which also recommended by the Section 8(1) Committee. The Government sanctioned a grant of Rs.12897.57 lakhs (including the unutilized amount of Rs.1181.57 lakhs during the financial year 2011-2012) under Non-Plan and the Plan RE allocation was fixed at Rs.4200.00 lakhs (including the unutilized amount of Rs.61.36 lakhs during the financial year 2011-2012). The expenditure during report was well within the budget allocation sanctioned by the Government. The Audited Annual Accounts of the Institute for the year 2012-2013 have been furnished in Part IV of this report.

## **Major Construction / Renovation works taken up by the Institute during 2012-2013**

### ***Kolkata***

*Interior Finishing Works of the 7<sup>th</sup> floor Platinum Jubilee Academic Building at ISI.*

The work of interior finishing and LAN works of the vacant 7<sup>th</sup> floor is under progress.

### *Construction of JBS Haldane Bhavan*

The Institute took up the construction of the ISEC Building (JBS Haldane Bhavan) at the 202 campus for providing ISEC students with all facilities under one roof. The building has been designed to have space for all facilities like Classrooms, Seminar room, Library, Accommodation for students and visiting faculties, Gymnasium, Dining hall, etc. The structural work of the building has been completed and the finishing works like fire-fighting and fire-alarm system, lift installation, air-conditioning and LAN have also been completed. The interior works including furniture and electrical works is nearing completion. A separate electrical sub-station for the building has also been commissioned. The order for the area development of the 202 campus in the vicinity of the newly constructed building will be placed shortly.

An amount of Rs.281.00 lakhs has been paid to the agencies and consultant regarding the subject work.

### *Major Renovation/construction works*

The Institute took up the renovation/construction of boundary walls, staff quarters, internal roads, security pathway, various units, parking space, hostel rooms, water-supply lines, etc. during 2012-2013.

The tendering of the renovation of the 3<sup>rd</sup> floor of the P. N. Haksar Bhavan has been completed.

An amount of Rs.171.00 lakhs has been paid to the agencies for the above works.

### ***Delhi***

#### *Land and Construction*

During the financial year 2012-2013, three Works Advisory Committee meetings took place on October 30, 2012, December 21, 2012 and 23 March, 2013.

A write up on major civil and electrical works during the period April 01, 2012 to March 31, 2013. Following major civil and electrical activities were carried out during 2012-2013

*Electrical*

- i) Rewiring work in residential flats.
- ii) Repair and upgradation of street lights.

*Civil*

- i) Special repair to residential flats
- ii). Water proofing of ISI buildings
- iii) Repair and renovation of faculty block and guest house etc.
- iv) Development of hostel ground and badminton and volleyball court in the children's park

**Bangalore**

During the year 2012-13 the following construction/ renovation works were taken up by the Bangalore Centre.

*Construction work of Research Scholar Hostel building*

The construction work of Research Scholar Hostel building in ISI Bangalore Centre is nearing completion. The estimate of this project was Rs.4,20,20,165/- (Rupees Four crore twenty lakhs twenty thousand one hundred sixty five only). It is a project with a built up area of 1687.95 square metre. Present plan comprises of three blocks with lift facility. The work is expected to be completed shortly.

*Guest House – Construction and up-gradation*

The work relating to construction and up gradation of the Guest House has been duly approved by the WAC. The estimated amount of Rs.20 lakhs and plan, drawing etc have been approved. Preliminary paper works are going on and construction work is expected to start shortly.

*Renovation of students Mess & Kitchen*

Administration undertaken the work of repairing / modernizing the Dining Hall, Store Room, Workers Rest Rooms etc. and providing kitchenette for the use of students. The proposal was placed before the WAC. Since the estimated cost of the work was Rs.25 lakhs, it was also felt necessary to appoint a consultant. WAC suggested to complete the job before the academic term 1<sup>st</sup> of 2013.

*Repair/ renovation of toilets*

The work relating to repairing of the toilets in the 2<sup>nd</sup> and 3<sup>rd</sup> floors of the main building was undertaken by the administration. However, it was felt necessary to take up the work with certain changes in the specification. On this issue WAC also commented for renovation the toilets incorporating the recommendations and further recommended that the earlier allocation of Rs.4.2 lakhs be revised to Rs.15 lakhs to renovate the toilets on all the three floors. The renovation work of the 2<sup>nd</sup> floor toilets is in progress.

*Other proposed work*

a) *Construction of toilet-cum-cloak rooms*

Administration decided to construct toilet-cum-cloak room (2 nos.) near both the security gates, for the use of security personnel and the visitors of the Institute. WAC agreed to the proposal. The estimated cost of the work is Rs.10 lakhs.

b) *Construction of canopy over the main building and other miscellaneous work*

## Administration

Administration contemplates to construct canopy over the main building to develop space for classrooms and other academic discussions to meet the increasing demand of space of the Centre. Rain harvesting will also be included in the project. A total amount of Rs.30 lakhs has been estimated for the purpose. The work is expected to be taken up in the next financial year.

The football and cricket ground is ready for use and the gardening and landscaping work of the centre is expected to be completed shortly.

## Tezpur

Major Construction / renovation works taken up by the Institute during 2012-2013.

On realization of the requested premium and capitalized land revenue, Government of Assam issued Jabanbandi of the land measuring about 25 acres at Punioni, Tezpur in favour of ISI for the permanent campus of the North-East Centre of the Institute. The construction of the boundary wall is completed and the Phase I construction of permanent campus is expected to start soon.

## Society Type Activities

### Membership: April 2012 – March 2013

- 1) During the period 29 persons became Ordinary Members of the Institute.
- 2) 20 Ordinary Members became Life Members of the Institute.

The membership position as on 31 March, 2013 is as follows:

Ordinary Members	-	538
Life Members	-	960
Institutional Members	-	03
Total	-	<u>1501</u>

*Finance Committee Meetings:* The Finance Committee met twice on 16<sup>th</sup> October, 2012. Besides the decisions taken on various financial matters, the Finance Committee recommended RE 2012-13 and BE 2013-14 (both Plan and Non-Plan) in its meeting held on 16<sup>th</sup> October, 2012. The Annual Report including Audited Statement of Accounts for the year 2011-2012 was considered and recommended in the meeting of the Finance Committee held on 16<sup>th</sup> October, 2012

*Council Meetings:* During the period under report (2012-13), the Council met seven times on 20<sup>th</sup> May, 2012, 28<sup>th</sup> July, 2012, 2<sup>nd</sup> and 28<sup>th</sup> September, 2012, 20<sup>th</sup> October, 2012, 9<sup>th</sup> January, 2013 and 30<sup>th</sup> March, 2013, 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 for 2012-13 and BE for 2013-14) were considered in the meetings of the Council held on 20<sup>th</sup> October, 2012 as recommended by the Finance Committee in its meeting held on 16<sup>th</sup> October, 2012. The Annual Report including the Audited Statement of Accounts for the year 2011-2012 was considered and approved by the Council in its meeting held on 20<sup>th</sup> October, 2012.

A list containing the names 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 are given in the Back Cover page and in Chapter 12 respectively.

*Annual General Meetings:* During the period under report (2012-13), the General Body of the Institute met on 23<sup>rd</sup> November, 2012. The Annual Report of the Institute for the year 2011-2012 and Audited Statement of Accounts for the year 2011-2012 together with the Auditor's comments and replies of the Administration thereto were adopted in the meeting of the General Body held on 23<sup>rd</sup> November, 2012.

## 11. LIST OF MEMBERS OF THE ACADEMIC COUNCIL AND OTHER COMMITTEES OF THE INSTITUTE AS ON 31 MARCH 2012

### ***Academic Council***

Bimal K. Roy, Director (Chairman)

Pradipta Bandyopadhyay, Dean of Studies (Convener)

### *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, Pl. Muthuramalingam, 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, Jishnu Gupta Biswas, Amites Dasgupta.

### *Applied Statistics Division*

Sushama M. Bendre, Bimal Kr. Roy, Debasis Sengupta, Anup Dewanji, Mausumi Bose, Palash Sarkar, Ashis SenGupta, Debapriya Sengupta, Tapas Samanta, Atanu Biswas, Subhamoy Maitra, Pabitra Pal Choudhury, Ayanendranath Basu, Tapas Kumar Chandra, Subir Kumar Bhandari, Smarajit Bose, Rita Saha Ray, Arun Kumar Adhikary, Amita Pal, Kishan Chand Gupta.

### *Social Sciences Division*

N.S.S. Narayana, V.K. Ramachandran, Madhura Swaminathan, Satya Ranjan Chakravarty, Amita Majumder, Abhirup Sarkar, Nityananda Sarkar, Manash Ranjan Gupta, Tarun Kabiraj, Monoranjan Pal, Krishna Majumder, Manipushpak Mitra, Indraneel Dasgupta, Anjali Ghosh, Arunava Sen, Bharat Ramaswami, Satya P. Das, E. Somanathan, Prabal Roy Chowdhury, Prasanta Pathak, Tridip Roy, Ptobal Dasgupta.

### *Biological Sciences Division*

Joydev Chattopadhyay, Anjana Dewanji, Arunava Goswami, Ranjan Gupta, Premananda Bharati, Barun Mukhopadhyay, Subrata Kr. Roy, Bibha Karmakar, Parasmani Dasgupta, P.P. Majumder, Bidyut Roy, Saurabh Ghosh, Sharmila Sengupta.

### *Physics and Earth Sciences Division*

Dilip Saha, Chandan Chakraborty, Dhurjati Prasad Sengupta, Soumendra Nath Sarkar, Bidyut Kr. Pal, Saswati Bandyopadhyay, Sisir Roy, Pinaki Roy, Subir Ghosh, Barnana Roy, P.K. Das, Banasri Basu, Guruprasad Kar, Parthasarathi Ghosh, Preeti Parashar.

### *Computer and Communication Sciences Division*

Bhabani Prasad Sinha, Bhargab Bikram Bhattacharya, Subhas Chandra Nandy, Nabanita Das, Susmita Sur-Kolay, Krishnendu Mukhopadhyay, Sandip Das, Bidyut Baran Chowdhuri, Swapan Kr. Parui, Umapada Pal, A.R.D. Prasad, Bhabatosh Chanda, Nikhil Ranjan Pal, Kumar Sankar Roy, Dipti Prasad Mukherjee, Srimanta Pal, Aditya Bagchi, Sankar Kumar Pal, C.A. Murthy, Malay Kr. Kundu, Sushmita Mitra, Ashish Ghosh, Sanghamitra Bandyopadhyay, Rajat Kumar De, Sambhu Nath Biswas, Pradipta Maji, Mandar Mitra.

Administration

*Statistical Quality Control and Operations Research Division*

Kalyan Kumar Chowdhury, P.K. Perumallu, Ashim Roy Chowdhury, U. Haridas Acharya, Surajit Pal, A. Rajagopal, Samir Kr. Neogy, B. Mohan Reddy, G.S.R. Murthy, A.L.N. Murthy, Amitava Bandyopadhyay, Dipak Kr. Manna, Arup Kumar Das, Ranjan Sett, Arup Ranjan Mukhopadhyay, Abhijit Gupta, Prasun Das, Ashis Kr. Chakraborty, Nandini Das, Sugata Adhikari, Somnath Ray.

*Library, Documentation and Information Sciences Division*

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## Acknowledgements

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Prof. Bimal K Roy, Director speaking at 121st Birth Anniversary Celebration of Dr. B. R. Ambedkar organized by ISI SC/ST/BC Employees' Coordination Council on 15 January 2013



Professor C R Rao delivering lecture in International Year of Statistics-2013 at ISI Chennai Centre on 23 March 2012



Celebrating International Year of Statistics-2013 at ISI Chennai Centre on 23 March 2012



Prof. Jean Bernard Lasserre, Institute of Mathematics, Toulouse, France delivering welcome address on International Symposium on Applied Optimization and Game-Theoretic Models at ISI Delhi on 09 January 2013



Indian Statistical Probationer's Training Programme organized by SOSU, ISI Kolkata on 01 February 2013



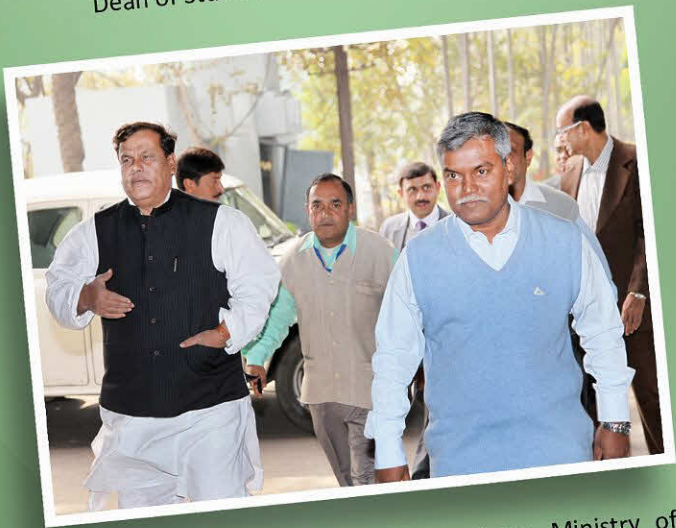
Infosys Awardee Prof. Arunava Sen lecturing in a class at ISI Delhi



Sir James A. Mirrlees, Nobel Laureate at the 47th Annual Convocation of ISI on 9 January 2013. On the dias (front row R to L) Sir James A. Mirrlees (Nobel Laureate), Dr. C. Rangarajan, President of ISI, Professor Bimal Kumar Roy, Director, Professor P. Bandyopadhyay, Dean of Studies



Dr. C. Rangarajan, President of ISI, speaking at 119th Birth Anniversary of Prof. Prasanta Chandra Mahalanobis



Hon'ble Minister of State Srikant Jena, Ministry of Planning and Programme Implementation visiting ISI, Kolkata on 28 January 2013



Professor A. Rajagopal, Head, SQC speaking at the one day workshop on Application of Statistical Techniques for Textile/Apparel Industry in Coimbatore



3rd Workshop on Digital Pictorial Photography and a Photographic Exhibition organized by Reprography and Photography Unit at ISI during 04-08 March 2013



Prof. Satya R Chakravarty delivering the Inaugural address at the Workshop organized by SOSU ISI Kolkata on 18 March 2013