



*Platinum Jubilee Series*

Statistical Science and  
Interdisciplinary Research – Vol. 14

# Statistical Paradigms

## Recent Advances and Reconciliations

Editors

**Ashis SenGupta**  
**Tapas Samanta**  
**Ayanendranath Basu**

*Series Editor: Sankar K. Pal*



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# **Statistical Paradigms**

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## *Description:*

In conjunction with the Platinum Jubilee celebrations of the Indian Statistical Institute, a series of books will be produced to cover various topics, such as Statistics and Mathematics, Computer Science, Machine Intelligence, Econometrics, other Physical Sciences, and Social and Natural Sciences. This series of edited volumes in the mentioned disciplines culminate mostly out of significant events — conferences, workshops and lectures — held at the ten branches and centers of ISI to commemorate the long history of the institute.

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## Foreword

The Indian Statistical Institute (ISI) was established on 17th December, 1931 by a great visionary Prof. Prasanta Chandra Mahalanobis to promote research in the theory and applications of statistics as a new scientific discipline in India. In 1959, Pandit Jawaharlal Nehru, the then Prime Minister of India introduced the ISI Act in the parliament and designated it as an Institution of National Importance because of its remarkable achievements in statistical work as well as its contribution to economic planning.

Today, the Institute occupies a prestigious position in the academic firmament. It has been a haven for bright and talented academics working in a number of disciplines. Its research faculty has done India proud in the arenas of Statistics, Mathematics, Economics, Computer Science, among others. Over more than eighty years, it has grown into a massive banyan tree, like the institute emblem. The Institute now serves the nation as a unified and monolithic organization from different places, namely Kolkata, the Headquarters, Delhi, Bangalore, Chennai, and Tezpur, four centers, a network of five SQC-OR Units located at Mumbai, Pune, Baroda, Hyderabad and Coimbatore, and a branch (field station) at Giridih.

The platinum jubilee celebrations of ISI had been launched by Honorable Prime Minister Prof. Manmohan Singh on December 24, 2006, and the Govt. of India has declared 29th June as the “Statistics Day” to commemorate the birthday of Prof. Mahalanobis nationally.

Prof. Mahalanobis, was a great believer in interdisciplinary research, because he thought that this will promote the development of not only Statistics, but also the other natural and social sciences. To promote interdisciplinary research, major strides were made in the areas of computer science, statistical quality control, economics, biological and social sciences, physical and earth sciences.

The Institute’s motto of ‘unity in diversity’ has been the guiding principle of all its activities since its inception. It highlights the unifying role of statistics in relation to various scientific activities.

In tune with this hallowed tradition, a comprehensive academic programme, involving Nobel Laureates, Fellows of the Royal Society, Abel prize winners and other dignitaries, has been implemented throughout the Platinum Jubilee year, highlighting the emerging areas of ongoing frontline research in its various scientific divisions, centers, and outlying units. It includes international and national-level seminars, symposia, conferences and workshops, as well as series of special lectures. As an outcome of these events, the Institute is bringing out a series of comprehensive volumes in different subjects under the title *Statistical Science and Interdisciplinary Research*, published by the World Scientific Press, Singapore.

The present volume titled *Statistical Paradigms: Recent Advances and Reconciliations* is the fourteenth one in the series. The volume consists of fourteen chapters, written by eminent scientists from different parts of the world. These chapters provide a current perspective of research and development, both from theoretical and application points of views, in different classical and emerging statistical paradigms, namely, parametric, non-parametric and semi-parametric, frequentist and Bayesian. Application areas considered include: Bioinformatics, Factorial Experiments and Linear Models, Hotspot Geoinformatics and Reliability. I believe the state-of-the art studies presented in this book reflecting advances in both theory and application of statistical science will be very useful to students, researchers as well as practitioners.

Thanks to the contributors for their excellent research contributions and to the volume editors Profs. Ashis SenGupta, Tapas Samanta and Ayanendranath Basu for their sincere effort in bringing out the volume nicely. Initial design of the cover by Mr. Indranil Dutta is acknowledged. Sincere efforts by Prof. Dilip Saha and Dr. Barun Mukhopadhyay for editorial assistance are appreciated. Thanks are also due to World Scientific for their initiative in publishing the series and being a part of the Platinum Jubilee endeavor of the Institute.

January 2013  
Kolkata



Sankar K. Pal  
Series Editor and  
Former Director

## Preface

The year 2006 marked the Platinum Jubilee of Indian Statistical Institute (ISI). ISI has a seminal role in promoting statistics in general worldwide. The International Conference on Statistical Paradigms: Recent Advances and Reconciliations (ICSPRAR-2008) was held during Jan 1–4, 2008, at ISI, Kolkata. This volume is number 14 in the series derived from the events celebrating the Platinum Jubilee of ISI, which is being published by World Scientific. It presents a collection of 14 papers in the said spirit, which emanated from the Conference and were peer-reviewed and edited. The papers are broadly arranged in four groups: Review, Parametric, Semi-parametric, and Nonparametric and Probability consisting of 2, 5, 4 and 3 entries, respectively. The chapters reflect advances in both theory and applications of several classical and emerging Statistical Paradigms — parametric, nonparametric and semi-parametric, frequentist and Bayesian — encompassing both theoretical advances and emerging applications in a variety of scientific disciplines. For advances in theory, the topics include: Bayesian Inference, Directional Data Analysis, Distribution Theory, Econometrics and Multiple Testing Procedures. The areas in emerging applications include: Bioinformatics, Factorial Experiments and Linear Models, Hotspot Geoinformatics and Reliability.

We acknowledge with thanks the support received from Ministry of Statistics and Program Implementation, Department of Science and Technology and Reserve Bank of India — all these being organizations of Government of India. We are also thankful to the Indian Statistical Institute for partial financial support. It is a pleasure to thank Prof. Sankar K. Pal, Ex-Director, ISI, for his support and encouragements prior to and during the conference and to Prof. Bimal K. Roy, Director, ISI for continuation of support thereafter. We are indeed grateful to the Referees for their cooperation and scholarly reports on the papers they have reviewed. The list of Referees includes: Drs. Sudipto Banerjee, Gopal Basak, Subir Bhandari, Sourabh Bhattacharya, Arijit Chakrabarti, Subhashis Ghosal, D.V. Gokhale, Sungsu



Kim, Arnab K. Laha, B. Purkait and Nityananda Sarkar. We also thank Prof. Pradipta Bandyopadhyay, Dr. Abhijit Mandal, Mr. Biswajit Basak, Mr. Imon Choudhury, Mr. Bhaskar Dutta, Ms. Debolina Ghatak. Ms. Debarati Ghosh, Mr. Taranga Mukherjee, Ms. Jitadeepa Nayak, Ms. Moumita Roy and Mr. Indranil Dutta for their help with the processing of the text. Last but not the least, we are deeply thankful to all the authors for contributing scholarly papers which have greatly enriched this volume.

We hope that this volume will serve as a useful and timely resource monograph to the researchers and practitioners of advances in the areas of Statistical Theory and Methods emanating from the rich spectrum of traditional and emerging statistical paradigms.

30 December 2013  
Kolkata

Ashis SenGupta  
Tapas Samanta  
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