

**Institute of Mathematical Statistics**  
**LECTURE NOTES—MONOGRAPH SERIES**

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# **Analysis of Censored Data**

Proceedings of the Workshop on Analysis of Censored Data,  
December 28, 1994–January 1, 1995, University of Pune, Pune, India

**H. L. Koul and J. V. Deshpande, Editors**

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Hayward, California**

Institute of Mathematical Statistics

*Lecture Notes-Monograph Series*

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Andrew A. Barbour, Joseph Newton, and David Ruppert (Editor)

The production of the *IMS Lecture Notes-Monograph Series* is managed by the IMS Business Office: Miriam Gasko Donoho, IMS Treasurer, and Barbara J. Lindeman, IMS Business Manager.

Library of Congress Catalog Card Number: 95-81795

International Standard Book Number 0-940600-39-0

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Printed in the United States of America

# ANALYSIS OF CENSORED DATA

*Proceedings of the Workshop on Analysis Of Censored Data,  
December 28, 1994-January 1, 1995, University of Pune, Pune, INDIA*

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## PREFACE

Censored data arises naturally in life testing, reliability, medical studies and clinical trials. Analysis of such data has been a leading concern of statisticians for the last four decades. The recent industrial and economic liberalization in India has led to an enhancement of interaction between industries and universities and thus created a need for a wider understanding of modern statistical methods. To address this need it was felt, at the initiative of the colleagues at the University of Pune, that a workshop about recent advances in the analysis of censored data be organized.

Thus an international *Workshop On Analysis Of Censored Data* was held in Pune, INDIA, on the University of Pune campus from December 28, 1994 to January 1, 1995. The purpose of the workshop was to facilitate quick dissemination of recent advances in the analysis of censored data and to provide an opportunity for researchers from various institutions in India to interact with experts in the field. In all these aspects the workshop was quite successful. The invited participants included Abraham (Canada), Agrawal (India), Anilkumar (India), Aras (India), Arjas (Finland), Bhattacharjee (USA), Crowley (USA), Ghosh (India), Groeneboom (Netherlands), Huang (USA), Karia (India), Kochar (India), Meilijson (Israel), Naik-Nimbalkar (India), Patil (Australia), Praestgaard (USA), Prakasa Rao (India), Rajarshi (India), Sen (USA), Sengupta (India), Singh (India), Singpurwalla (USA), Stute (Germany), Sukhatme (USA), Suresh (India), Swaminathan (India), Tiwari (USA), Vasudaven (Australia), Wellner (USA), Yang (USA) and Zhou (USA).

The workshop began with keynote address by Professor J.K. Ghosh on the need for incorporating prior information in the analysis of the censored data. The papers presented at the workshop ranged from those establishing the need of analyzing censored data, to many theoretical results, development of appropriate methodology to deal with specific type of censoring, and applications of such methodologies to practical problems. There were also comprehensive review talks.

The paper of Ghosh *et. al.* discusses the consistency of posterior distributions in a nonparametric setting while the papers of Deshpande *et. al.* and Singpurwalla *et. al.* discuss some Bayesian inference procedures in lifetime and biological settings. The papers of Groeneboom, Huang and Wellner describe various aspects (computational and mathematical) of nonparametric maximum likelihood based methodology under interval censoring. Crowley *et. al.* and Sengupta give a state of the art survey of the graphical methods for analyzing randomly censored data. Prakasa Rao discusses the Cramer-Rao Inequality and its applications in the presence of random censoring. The paper of Sen raises some interesting questions about the kinds of cen-

soring one should consider in biomechanics. Stute gives a review of recent developments on finite and large sample behavior of Kaplan-Meier integrals. The rest of the papers in this volume deal mostly with random censoring.

Application of methodologies to practical problems were discussed by B. Abraham (Institute of Improvement of Quality and Productivity, Waterloo), P.K. Agrawal (Tata Engineering and Locomotive Company, Pune), and R. Swaminathan (Cancer Research Institute, Madras). Some papers presented in the workshop could not appear in this volume for various reasons. We sincerely thank all participants for their contribution to the workshop and to this proceeding.

The workshop organizers are grateful to Dr. Marjorie Lueck at the International Programs Section of the National Science Foundation for her continued support. The IPS-NSF supported the travel of 6 US participants to the workshop. We are grateful to the University Grants Commission of India for providing a grant through the Special Assistance Program to the Department of Statistics, University of Pune, that supported the travel of Indian participants and the local hospitality of all other participants.

The workshop benefitted from the efforts of several selfless and dedicated colleagues. Uttara Naik-Nimbalkar and Padmanabh Suresh contributed substantially to the academic organization of the workshop. Suresh Paranjape, Head of the Department of Statistics at the University of Pune and his office lent whole hearted administrative support to the workshop. Naik-Nimbalkar, Suresh, and Rajarshi did an excellent job of the local arrangements. Most of the refereeing work was entrusted within the set of speakers in the workshop. Additional referees were as follows. A.P. Basu, T. P.M. Fareed, J.C. Gardiner. A.P. Gore, B.K. Kale, A.V. Kharshikar, R.W. Koenker, Y. Kumazawa, D. Rabinowitz, J. Sethuraman, and Y. Wang. To all of these colleagues we express our sincere thanks. We would also like to express our sincere thanks to David Ruppert for encouraging us to publish this proceeding as a volume in IMS Lecture Notes-Monograph Series.

We are also grateful to Ms. A. V. Sabne, Ms. Cathy Sparks, Mr. S. E. Surve, and Ms. Patricia Vallance for their help in organizing various other aspects of the workshop and this proceeding. Finally, we give our thanks to Dr. Zhiwei Zhu for helping us in *tezing* this proceeding and to the Department of Statistics and Probability at the Michigan State University for making computer facilities and numerous other supplies available for this proceeding.

Hira L. Koul  
Jayant V. Deshpande.

October 2, 1995.



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