

Pukkila
Puntanen
Editors

PROCEEDINGS

of the

First International Tampere Seminar on Linear Statistical Models and their Applications

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Linear Statistical Models and their Applications



EDITED BY Tarmo Pukkila and Simo Puntanen
DEPARTMENT OF MATHEMATICAL SCIENCES
UNIVERSITY OF TAMPERE, FINLAND

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of the

First International Tampere Seminar on Linear Statistical Models and their Applications

*University of Tampere, Tampere, Finland
August 30th to September 2nd, 1983*

Edited by

Tarmo Pukkila and Simo Puntanen

Published by

Department of Mathematical Sciences/Statistics, University of Tampere
P.O. BOX 607, SF-33101 Tampere, Finland

1985

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University of Tampere
1985

Report No. A 138

ISBN 951-44-1693-7
ISSN 0356-4231

Printed by the University of Tampere Printing Service
Composition by Vammalan Kirjapaino Oy, Vammala

Preface

The First International Tampere Seminar on Linear Statistical Models and their Applications was held at the University of Tampere, Tampere, Finland, during the period August 30—September 2, 1983. The seminar brought together, from at least nine different countries, more than 100 researchers in linear statistical models and related areas.

The main speakers in the seminar were Professor C. Radhakrishna Rao (University of Pittsburgh, U.S.A., and the Indian Statistical Institute, New Delhi, India) and George P. H. Styan (McGill University, Montréal, Canada). There is no doubt that the whole seminar audience greatly enjoyed the excellent lecture series given by these two outstanding statisticians. Professor Rao's topic was »A Unified Approach to Inference from Linear Models» and Professor Styan's was »Schur Complements and Linear Statistical Models». The editors of these *Proceedings* are extremely grateful to Professors Rao and Styan for the effort they put into their fine articles for this volume; we are very proud to publish them.

This was the first time Professor Rao had visited Finland and certainly his visit was a great honour for the whole statistical community of Finland. It is also a great honour to the University of Tampere that Professor Rao, one of the fathers of modern statistics, has consented to accept an Honorary Doctorate in connection with the University's 60th anniversary in May 1985.

Both Professor Rao's and Professor Styan's stimulating personalities and their vital participation in all seminar activities made a great impression on the organizers. The role of Professor Styan in planning the seminar was indeed invaluable. Also our sincere thanks go to him for his very useful advice and cooperation in preparing the *Proceedings* for publication.

The invited talks at the seminar were given by Professors R. W. Farebrother (University of Manchester, U.K.), Johan Fellman (Swedish School of Economics, Helsinki), Hannu Niemi (University of Helsinki) and Bimal Kumar Sinha (University of Pittsburgh, U.S.A.). My special thanks are due to these speakers, as well as to the speakers in the contributed paper sessions, for an excellent series of talks and for their kind cooperation in preparing the papers for publication. I also wish to thank Professors Jerzy K. Baksalary (Academy

of Agriculture, Poznań, Poland), J. A. Melamed (Tbilisi, U.S.S.R.) and Der-Shin Chang (Hsinchu, Taiwan), who, unfortunately, for unavoidable reasons, were not able to participate in the seminar. The last two, however, do have their contributions in the *Proceedings*.

All papers in this volume have been refereed and I therefore wish to thank the anonymous referees for their efforts. The deadline for the first versions of the papers was September 2, 1983. On the front page of each paper is the affiliation of the author as of August 1983 and at the end of the paper the current affiliation and the date when the final version was received.

Financially the seminar was supported by the University of Tampere, the Academy of Finland, the City of Tampere, and various associations and companies whose names are listed on page viii. All deserve our sincerest thanks for their invaluable support. The City of Tampere also very kindly invited all participants to a Civic Reception in the Town Hall.

The seminar was organized by a local committee within the Department of Mathematical Sciences/Statistics, consisting of Paula Hietala, Pentti Huuhtanen, Päivi Laurila, Erkki Liski, Simo Puntanen and myself. Also Raija Leppälä, Olavi Stenman and Pirkko Welin very kindly gave their help in various arrangements. I am deeply grateful to each and every one of my colleagues for this tremendous cooperation.

Jointly with Simo Puntanen, as the editors of these *Proceedings*, I wish to give special thanks to Pirkko Welin for her kind assistance in preparing this volume.

I would also like to thank Professor and Mrs. Eino Haikala for their warm hospitality in connection with the seminar. The organizers of the seminar are also grateful to the University Rector J. K. Visakorpi for his address during the inauguration of the seminar.

Our sincere thanks also go to all of the participants in the seminar, whether reading papers or not, for it was their participation which made the seminar a success. The organizers were also glad to see the active interest shown in the social programme of the seminar. It is my impression that everyone will have warm memories of the Seminar Dinner and Civic Reception — even hot ones of the Sauna Party.

The success of the seminar is due also to Professors Gustav Elfving (University of Helsinki) and Timo Mäkeläinen (University of Helsinki). Both acted as chairmen during several sessions in the seminar. Besides this, Professor Elfving gave an inspiring opening address entitled »Finnish Mathematical Statistics in the Past». I am deeply grateful for their help and for their cooperation in carrying out the seminar.

While preparing this volume for publication, we were deeply saddened that Professor Gustav Elfving passed away on March 25, 1984. He was in-

strumental in the promotion of statistics in Finland as well as of our seminar. As the seminar organizers we were very impressed not only by his active participation in mathematical and statistical discussions but also by his great and warm sociability: he was one of the real old-time gentlemen. It is to Professor Elfving that we dedicate this volume.

Tampere, February 1985

*Tarmo Pukkila
Seminar Director*

THE FINANCIAL SUPPORT
OF THE FOLLOWING INSTITUTIONS
IS GRATEFULLY ACKNOWLEDGED:

***THE ACADEMY OF FINLAND
THE TAMPERE UNIVERSITY FOUNDATION
THE TAMPERE CITY SCIENCE FOUNDATION***

KANSALLIS-OSAKE-PANKKI

FINNAIR OY

***OY INTERNATIONAL BUSINESS MACHINES AB
THE FINNISH STATISTICAL SOCIETY
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY***

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*Dedicated to the memory of
Gustav Elfving*

IN MEMORIAM

Gustav Elfving 1908—1984

While these *Proceedings* were in print we learned that the prominent contributor to the Seminar, Professor Gustav Elfving had died on the 25th of March 1984 at his home in Helsinki.

Erik Gustav Elfving was born in 1908 in Helsinki. He graduated in 1930 in Mathematics and took his doctoral degree in 1934, both at the University of Helsinki. He was appointed Professor of Mathematics at the same university in 1948 and retired in 1975.

Elfving wrote his doctoral thesis under the guidance of Rolf Nevanlinna on the latter's value distribution theory. Elfving's first paper in probability in 1937 marks the beginning of a long and distinguished career in probability and statistics. His writings published for the international professional audience contain papers on Markov chains, point processes, sufficiency and complete classes, design of linear experiments and sample designs, test item selection, order statistics, exact distributions and expansions of distributions, quality control, nonparametric statistics, and Bayesian statistics. Characteristic to them are many original ideas, clear formulation, and elegant presentation stressing central ideas.

Perhaps the single most influential piece of Elfving's writings — and one in a subject very close to this Seminar — is the paper »Optimum allocation in linear regression theory» published in 1952 in the *Annals of Mathematical Statistics*. The problem of optimal design of linear experiments is here brought, for the first time in some generality, before a wide statistical audience. Today an extensive field of study, optimal design of experiments has since undergone profound technical development. Yet, Elfving's work remains part of its foundations. (Compare with Professor Fellman's lecture in this volume.)

During his retirement Elving took the role of a historian of mathematics. His lecture in this volume partly draws on a major work »*The History of Mathematics in Finland 1828—1918*» (Societas Scientiarum Fennica, Helsinki 1981, 195 pp.).

September 1984

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