

D-optimum designs in multi-factor models with heteroscedastic errors

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Abstract

This paper considers the construction of D-optimum designs for Kronecker product and additive regression models when the errors are heteroscedastic. Sufficient conditions are given so that D-optimum designs for the multi-factor models can be built from D-optimum designs for their sub-models with a single factor. A robustness study is included to investigate how design efficiencies change when the efficiency functions are misspecified.

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1. Introduction

Let $f(x)^T = (f_1(x), \dots, f_m(x))$ denote m linearly independent regression functions defined on some compact subset \mathcal{X} of \mathbb{R}^k and let $\theta^T = (\theta_1, \dots, \theta_m)$ denote a vector of parameters. We consider the usual linear regression model

$$Y = f(x)^T \theta + \varepsilon \quad x \in \mathcal{X}, \quad (1)$$

in which for each x in \mathcal{X} , a random response variable with mean $\sum_{j=1}^m f_j(x)\theta_j$ and variance $\sigma^2/\lambda(x)$ can be observed. The different observations are assumed to be uncorrelated. The efficiency function, $\lambda(x)$, is a positive real-valued continuous function defined on \mathcal{X} . A design ξ will be regarded as a probability measure on \mathcal{X} , and the

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Optimum Designs For Multi Factor Models

P.H. Franses, A.L. Montgomery



Optimum Designs For Multi Factor Models:

Optimum Designs for Multi-Factor Models Rainer Schwabe, 2012-12-06 In real applications most experimental situations are influenced by a large number of different factors In these settings the design of an experiment leads to challenging optimization problems even if the underlying relationship can be described by a linear model Based on recent research this book introduces the theory of optimum designs for complex models and develops general methods of reduction to marginal problems for large classes of models with relevant interaction structures □□□ □□□□□ , MODA 7 - Advances in Model-Oriented Design and Analysis Alessandro Di Bucchianico, Henning Läuter, Henry P. Wynn, 2012-12-06 The volume contains the proceedings of the 7th Workshop on Model Oriented Design and Analysis which has had the purpose of bringing together leading researchers in Eastern and Western Europe for an in depth discussion of the optimal design of experiments The papers are representative of the latest developments concerning non linear models computational algorithms and important applications especially to medical statistics *Econometric Models in Marketing* P.H. Franses, A.L. Montgomery, 2002-02-28 Contains twelve papers discussing the interface between Marketing and Econometrics The papers in this work are representative of the types of problems and methods that are used within the field of marketing *mODa 11 - Advances in Model-Oriented Design and Analysis* Joachim Kunert, Christine H. Müller, Anthony C. Atkinson, 2016-06-06 This volume contains pioneering contributions to both the theory and practice of optimal experimental design Topics include the optimality of designs in linear and nonlinear models as well as designs for correlated observations and for sequential experimentation There is an emphasis on applications to medicine in particular to the design of clinical trials Scientists from Europe the US Asia Australia and Africa contributed to this volume of papers from the 11th Workshop on Model Oriented Design and Analysis *MODA 6 - Advances in Model-Oriented Design and Analysis* Anthony C. Atkinson, Peter Hackl, Werner G. Müller, 2012-12-06 This book includes many of the papers presented at the 6th International workshop on Model Oriented Data Analysis held in June 2001 This series began in March 1987 with a meeting on the Wartburg near Eisenach at that time in the GDR The next four meetings were in 1990 St Kyrik monastery Bulgaria 1992 Petrodvorets St Petersburg Russia 1995 Spetses Greece and 1998 Marseilles France Initially the main purpose of these workshops was to bring together leading scientists from Eastern and Western Europe for the exchange of ideas in theoretical and applied statistics with special emphasis on experimental design Now that the separation between East and West is much less rigid this exchange has in principle become much easier However it is still important to provide opportunities for this interaction MODA meetings are celebrated for their friendly atmosphere Indeed discussions between young and senior scientists at these meetings have resulted in several fruitful long term collaborations This intellectually stimulating atmosphere is achieved by limiting the number of participants to around eighty by the choice of a location in which communal living is encouraged and of course through the careful scientific direction provided by the Programme Committee It is a tradition of these meetings to provide

low cost accommodation low fees and financial support for the travel of young and Eastern participants This is only possible through the help of sponsors and outside financial support was again important for the success of the meeting

Design of Experiments in Nonlinear Models Luc Pronzato, Andrej Pázman, 2013-04-10 Design of Experiments in Nonlinear Models Asymptotic Normality Optimality Criteria and Small Sample Properties provides a comprehensive coverage of the various aspects of experimental design for nonlinear models The book contains original contributions to the theory of optimal experiments that will interest students and researchers in the field Practitioners motivated by applications will find valuable tools to help them designing their experiments The first three chapters expose the connections between the asymptotic properties of estimators in parametric models and experimental design with more emphasis than usual on some particular aspects like the estimation of a nonlinear function of the model parameters models with heteroscedastic errors etc Classical optimality criteria based on those asymptotic properties are then presented thoroughly in a special chapter Three chapters are dedicated to specific issues raised by nonlinear models The construction of design criteria derived from non asymptotic considerations small sample situation is detailed The connection between design and identifiability estimability issues is investigated Several approaches are presented to face the problem caused by the dependence of an optimal design on the value of the parameters to be estimated A survey of algorithmic methods for the construction of optimal designs is provided

Stochastic Models, Statistics and Their Applications Ansgar Steland, Ewaryst Rafajłowicz, Krzysztof Szajowski, 2015-02-04 This volume presents the latest advances and trends in stochastic models and related statistical procedures Selected peer reviewed contributions focus on statistical inference quality control change point analysis and detection empirical processes time series analysis survival analysis and reliability statistics for stochastic processes big data in technology and the sciences statistical genetics experiment design and stochastic models in engineering Stochastic models and related statistical procedures play an important part in furthering our understanding of the challenging problems currently arising in areas of application such as the natural sciences information technology engineering image analysis genetics energy and finance to name but a few This collection arises from the 12th Workshop on Stochastic Models Statistics and Their Applications Wroclaw Poland

Applied Optimal Designs Martijn P.F. Berger, Weng-Kee Wong, 2005-03-11 There is an increasing need to rein in the cost of scientific study without sacrificing accuracy in statistical inference Optimal design is the judicious allocation of resources to achieve the objectives of studies using minimal cost via careful statistical planning Researchers and practitioners in various fields of applied science are now beginning to recognize the advantages and potential of optimal experimental design Applied Optimal Designs is the first book to catalogue the application of optimal design to real problems documenting its widespread use across disciplines as diverse as drug development education and ground water modelling Includes contributions covering Bayesian design for measuring cerebral blood flow Optimal designs for biological models Computer adaptive testing Ground water modelling Epidemiological studies and pharmacological

models Applied Optimal Designs bridges the gap between theory and practice drawing together a selection of incisive articles from reputed collaborators Broad in scope and inter disciplinary in appeal this book highlights the variety of opportunities available through the use of optimal design The wide range of applications presented here should appeal to statisticians working with optimal designs and to practitioners new to the theory and concepts involved *Multidimensional Statistical Analysis and Theory of Random Matrices* A. K. Gupta,V. L. Girko,2019-01-14 No detailed description available for Multidimensional Statistical Analysis and Theory of Random Matrices Optimal Design for Nonlinear Response Models Valerii V. Fedorov,Sergei L. Leonov,2013-07-15 Optimal Design for Nonlinear Response Models discusses the theory and applications of model based experimental design with a strong emphasis on biopharmaceutical studies The book draws on the authors many years of experience in academia and the pharmaceutical industry While the focus is on nonlinear models the book begins with an explanation of the key ideas using linear models as examples Applying the linearization in the parameter space it then covers nonlinear models and locally optimal designs as well as minimax optimal on average and Bayesian designs The authors also discuss adaptive designs focusing on procedures with non informative stopping The common goals of experimental design such as reducing costs supporting efficient decision making and gaining maximum information under various constraints are often the same across diverse applied areas Ethical and regulatory aspects play a much more prominent role in biological medical and pharmaceutical research The authors address all of these issues through many examples in the book **Functional Approach to Optimal Experimental Design** Viatcheslav B. Melas,2006-04-20 The present book is devoted to studying optimal experimental designs for a wide class of linear and nonlinear regression models This class includes polynomial trigonometrical rational and exponential models as well as many particular models used in ecology and microbiology As the criteria of optimality the well known D E and c criteria are implemented The main idea of the book is to study the dependence of optimal signs on values of unknown parameters and on the bounds of the design interval Such a study can be performed on the base of the Implicit Function Theorem the classical result of functional analysis The idea was first introduced in the author's paper Melas 1978 for nonlinear in parameters exponential models Recently it was developed for other models in a number of works Melas 1995 2000 2001 2004 2005 Dette Melas 2002 2003 Dette Melas Pepelyshev 2002 2003 2004b and Dette Melas Biederman 2002 The purpose of the present book is to bring together the results obtained and to develop further underlying concepts and tools The approach mentioned above will be called the functional approach Its brief description can be found in the Introduction The book contains eight chapters The first chapter introduces basic concepts and results of optimal design theory initiated mainly by J Kiefer **New Developments and Applications in Experimental Design** Nancy Flournoy,1998 **Handbook of Design and Analysis of Experiments** Angela Dean,Max Morris,John Stufken,Derek Bingham,2015-06-26 This carefully edited collection synthesizes the state of the art in the theory and applications of designed experiments and their analyses It

provides a detailed overview of the tools required for the optimal design of experiments and their analyses The handbook covers many recent advances in the field including designs for nonlinear models and algorithms applicable to a wide variety of design problems It also explores the extensive use of experimental designs in marketing the pharmaceutical industry engineering and other areas

Topics in Optimal Design Erkki P. Liski, Nripes K. Mandal, Kirti R. Shah, Bikas K.

Sinha, 2012-12-06 In the early nineties at the initiative of Sinha and financial support of Shah and Liski from their respective Research Project Funds the authors inspired by their similar research interests started collaborative research at various institutions mostly in pairs and triplets It took more time and efforts on the part of Mandal to visit the others at regular intervals and keep track of their common as well as diverse research areas and merge his own From this collaborative work the concept of this monograph took a preliminary shape only last year and serious efforts were started to combine diverse avenues into one Admittedly it took more time than expected to converge to a common platform regarding the contents and broad coverage of the topics to be included We were mostly guided by our own common research interests spanning over the last ten years That covered optimal designs in both discrete and continuous settings Availability of huge published literature in various statistical journals on the broad theme of optimal designs has made our task quite interesting and stimulating We hope our readers will be as excited and delighted to read the monograph as we have been in our efforts to write it

Monte Carlo and Quasi-Monte Carlo Methods 2000 Kai-Tai Fang, Fred J. Hickernell, Harald Niederreiter, 2011-06-28 This book represents the refereed proceedings of the Fourth International Conference on Monte Carlo and Quasi Monte Carlo Methods in Scientific Computing which was held at Hong Kong Baptist University in 2000 An important feature are invited surveys of the state of the art in key areas such as multidimensional numerical integration low discrepancy point sets random number generation and applications of Monte Carlo and quasi Monte Carlo methods These proceedings include also carefully selected contributed papers on all aspects of Monte Carlo and quasi Monte Carlo methods The reader will be informed about current research in this very active field

MODA 5 - Advances in Model-Oriented Data Analysis and Experimental Design

Anthony C. Atkinson, Luc Pronzato, Henry P. Wynn, 2012-12-06 This volume contains the majority of the papers presented at the 5th International Workshop on Model Oriented Data Analysis held in June 1998 This series started in March 1987 with a meeting on the Wartburg Eisenach Germany The next three meetings were in 1990 St Kyrík monastery Bulgaria 1992 Petrodvorets St Petersburg Russia and 1995 Spetses Greece The main purpose of these workshops was to bring together leading scientists from Eastern and Western Europe for the exchange of ideas in theoretical and applied statistics with special emphasis on experimental design Now that the separation between East and West has become less rigid this dialogue has in principle become much easier However providing opportunities for this dialogue is as vital as ever MODA meetings are known for their friendly atmosphere leading to fruitful discussions and collaboration especially between young and senior scientists Indeed many long term collaborations were initiated during these events This intellectually stimulating

atmosphere is achieved by limiting the number of participants to around eighty by the choice of location so that participants can live as a community and of course through the careful selection of scientific direction made by the Programme Committee

Model-Oriented Design of Experiments Valerii V. Fedorov, Peter Hackl, 1997-06-20 Here the authors explain the basic ideas so as to generate interest in modern problems of experimental design The topics discussed include designs for inference based on nonlinear models designs for models with random parameters and stochastic processes designs for model discrimination and incorrectly specified contaminated models as well as examples of designs in functional spaces Since the authors avoid technical details the book assumes only a moderate background in calculus matrix algebra and statistics However at many places hints are given as to how readers may enhance and adopt the basic ideas for advanced problems or applications This allows the book to be used for courses at different levels as well as serving as a useful reference for graduate students and researchers in statistics and engineering

Interpolation and Extrapolation Optimal Designs V1 Giorgio Celant, Michel Broniatowski, 2016-03-31 This book is the first of a series which focuses on the interpolation and extrapolation of optimal designs an area with significant applications in engineering physics chemistry and most experimental fields In this volume the authors emphasize the importance of problems associated with the construction of design After a brief introduction on how the theory of optimal designs meets the theory of the uniform approximation of functions the authors introduce the basic elements to design planning and link the statistical theory of optimal design and the theory of the uniform approximation of functions The appendices provide the reader with material to accompany the proofs discussed throughout the book

The Optimal Design of Blocked and Split-Plot Experiments Peter Goos, 2012-12-06 This book provides a comprehensive treatment of the design of blocked and split plot experiments The optimal design approach advocated in the book will help applied statisticians from industry medicine agriculture chemistry and many other fields of study in setting up tailor made experiments The book also contains a theoretical background a thorough review of the recent work in the area of blocked and split plot experiments and a number of interesting theoretical results

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Table of Contents Optimum Designs For Multi Factor Models

1. Understanding the eBook Optimum Designs For Multi Factor Models
 - The Rise of Digital Reading Optimum Designs For Multi Factor Models
 - Advantages of eBooks Over Traditional Books
2. Identifying Optimum Designs For Multi Factor Models
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Optimum Designs For Multi Factor Models
 - User-Friendly Interface
4. Exploring eBook Recommendations from Optimum Designs For Multi Factor Models
 - Personalized Recommendations
 - Optimum Designs For Multi Factor Models User Reviews and Ratings
 - Optimum Designs For Multi Factor Models and Bestseller Lists
5. Accessing Optimum Designs For Multi Factor Models Free and Paid eBooks

- Optimum Designs For Multi Factor Models Public Domain eBooks
- Optimum Designs For Multi Factor Models eBook Subscription Services
- Optimum Designs For Multi Factor Models Budget-Friendly Options
- 6. Navigating Optimum Designs For Multi Factor Models eBook Formats
 - ePub, PDF, MOBI, and More
 - Optimum Designs For Multi Factor Models Compatibility with Devices
 - Optimum Designs For Multi Factor Models Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Optimum Designs For Multi Factor Models
 - Highlighting and Note-Taking Optimum Designs For Multi Factor Models
 - Interactive Elements Optimum Designs For Multi Factor Models
- 8. Staying Engaged with Optimum Designs For Multi Factor Models
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Optimum Designs For Multi Factor Models
- 9. Balancing eBooks and Physical Books Optimum Designs For Multi Factor Models
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Optimum Designs For Multi Factor Models
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Optimum Designs For Multi Factor Models
 - Setting Reading Goals Optimum Designs For Multi Factor Models
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Optimum Designs For Multi Factor Models
 - Fact-Checking eBook Content of Optimum Designs For Multi Factor Models
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development

- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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