Foundations Of Optimum Experimental Design

"Optimal Observation for Cyber-physical Systems" addresses the challenge, fundamental to the design of wireless sensor networks (WSNs), presented by the obligatory trade-off between precise estimates and system constraints. A unified theoretical framework, based on the well-established theory of optimal experimental design and providing consistent solutions to problems hitherto requiring a variety of approaches, is put forward to solve a large class of optimal observation problems. The Fisher information matrix plays a key role in this framework and makes it feasible to provide analytical solutions to some complex and important questions which could not be answered in the past. Readers with an applied background in WSN implementation will find all the understanding of the key theory of optimal experimental design they need within this book. The use of multiple examples to illustrate the theoretical parts of the book brings the subject into sharper focus than would an abstract theoretical disquisition.

Randomised Response-Adaptive Designs in Clinical Trials presents methods for the randomised allocation of treatments to patients in sequential clinical trials. Emphasizing the practical application of clinical trial designs, the book is designed for medical and applied statisticians, clinicians, and statisticians in training. After introducing clinical trials in drug development, the authors assess a simple adaptive design for binary responses without covariates. They discuss randomisation and covariate balance in normally distributed responses and cover many important response-adaptive designs for binary responses. The book then develops response-adaptive designs for continuous and longitudinal responses, optimum designs with covariates, and response-adaptive designs with covariates. It also covers response-adaptive designs that are derived by optimising an objective function subject to constraints on the variance of estimated parametric functions. The concluding chapter explores future directions in the development of adaptive designs.

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.

Experiments in the field and in the laboratory cannot avoid random error and statistical methods are essential for their

efficient design and analysis. Authored by leading experts in key fields, this text provides many examples of SAS code, results, plots and tables, along with a fully supported website.

Handbook of Design and Analysis of Experiments provides a detailed overview of the tools required for the optimal design of experiments and their analyses. The handbook gives a unified treatment of a wide range of topics, covering the latest developments. This carefully edited collection of 25 chapters in seven sections synthesizes the state of the art in the theory and applications of designed experiments and their analyses. Written by leading researchers in the field, the chapters offer a balanced blend of methodology and applications. The first section presents a historical look at experimental design and the fundamental theory of parameter estimation in linear models. The second section deals with settings such as response surfaces and block designs in which the response is modeled by a linear model, the third section covers designs with multiple factors (both treatment and blocking factors), and the fourth section presents optimal designs for generalized linear models, other nonlinear models, and spatial models. The fifth section addresses issues involved in designing various computer experiments. The sixth section explores "cross-cutting" issues relevant to all experimental designs, including robustness and algorithms. The final section illustrates the application of experimental design in recently developed areas. This comprehensive handbook equips new researchers with a broad understanding of the field's numerous techniques and applications. The book is also a valuable reference for more experienced research statisticians working in engineering and manufacturing, the basic sciences, and any discipline that depends on controlled experimental investigation.

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. Explores mathematical statistics in its entirety—from the fundamentals to modern methods This book introduces readers to point estimation, confidence intervals, and statistical tests. Based on the general theory of linear models, it provides an in-depth overview of the following: analysis of variance (ANOVA) for models with fixed, random, and mixed effects; regression analysis is also first presented for linear models with fixed, random, and mixed effects before being expanded to nonlinear models; statistical multi-decision problems like statistical selection procedures (Bechhofer and Gupta) and sequential tests; and design of experiments from a mathematical-statistical point of view. Most analysis methods have

been supplemented by formulae for minimal sample sizes. The chapters also contain exercises with hints for solutions. Translated from the successful German text, Mathematical Statistics requires knowledge of probability theory (combinatorics, probability distributions, functions and sequences of random variables), which is typically taught in the earlier semesters of scientific and mathematical study courses. It teaches readers all about statistical analysis and covers the design of experiments. The book also describes optimal allocation in the chapters on regression analysis. Additionally, it features a chapter devoted solely to experimental designs. Classroom-tested with exercises included Practice-oriented (taken from day-to-day statistical work of the authors) Includes further studies including design of experiments and sample sizing Presents and uses IBM SPSS Statistics 24 for practical calculations of data Mathematical Statistics is a recommended text for advanced students and practitioners of math, probability, and statistics.

Robust statistics and the design of experiments are two of the fastest growing fields in contemporary statistics. Up to now, there has been very little overlap between these fields. This is the first book to link these two areas by studying the influence of the design on the efficiency and robustness of robust estimators and tests. The classical approaches of experimental design and robust statistics are introduced before the areas are linked, and the author shows that robust statistical procedures profit by an appropriate choice of the design and that efficient designs for a robust statistical analysis are more applicable.

This is a volume consisting of selected papers that were presented at the 3rd St. Petersburg Workshop on Simulation held at St. Petersburg, Russia, during June 28-July 3, 1998. The Workshop is a regular international event devoted to mathematical problems of simulation and applied statistics organized by the Department of Stochastic Simulation at St. Petersburg State University in cooperation with INFORMS College on Simulation (USA). Its main purpose is to exchange ideas between researchers from Russia and from the West as well as from other coun tries throughout the World. The 1st Workshop was held during May 24-28, 1994, and the 2nd workshop was held during June 18-21, 1996. The selected proceedings of the 2nd Workshop was published as a special issue of the Journal of Statistical Planning and Inference. Russian mathematical tradition has been formed by such genius as Tchebysh eff, Markov and Kolmogorov whose ideas have formed the basis for contempo rary probabilistic models. However, for many decades now, Russian scholars have been isolated from their colleagues in the West and as a result their mathe matical contributions have not been widely known. One of the primary reasons for these workshops is to bring the contributions of Russian scholars into lime light and we sincerely hope that this volume helps in this specific purpose.

The book celebrates the centenary of Biometrika, one of the world's leading academic journals in statistical theory and methodology by collating two sets of papers from the journal. One set consists of seven articles that review the journal's contribution to statistical science; the other set contains ten seminal papers from the journals first hundred years. The book opens with an introduction by the editors Professor D.M. Titterington and Sir David Cox.

This proceedings volume highlights a selection of papers presented at the Sixth International Conference on High Performance Scientific Computing, which took place in Hanoi, Vietnam on March 16-20, 2015. The conference was jointly organized by the Heidelberg Institute of Theoretical Studies (HITS), the Institute of Mathematics of the Vietnam Academy of Science and Technology (VAST), the Interdisciplinary Center for Scientific Computing (IWR) at Heidelberg University, and the Vietnam Institute for Advanced Study in Mathematics, Ministry of Education The contributions cover a broad, interdisciplinary spectrum of scientific computing and showcase recent advances in theory, methods, and practical applications. Subjects covered numerical simulation, methods for optimization and control, parallel computing, and software development, as well as the applications of scientific computing in physics, mechanics, biomechanics and robotics, material science, hydrology, biotechnology, medicine, transport, scheduling, and industry.

This volume is part of the two-volume proceedings of the 19th International Conf- ence on Artificial Neural Networks (ICANN 2009), which was held in Cyprus during September 14–17, 2009. The ICANN conference is an annual meeting sp- sored by the European Neural Network Society (ENNS), in cooperation with the - ternational Neural Network Society (INNS) and the Japanese Neural Network Society (JNNS). ICANN 2009 was technically sponsored by the IEEE Computational Intel- gence Society. This series of conferences has been held annually since 1991 in various European countries and covers the field of neurocomputing, learning systems and related areas. Artificial neural networks provide an information-processing structure inspired by biological nervous systems. They consist of a large number of highly interconnected processing elements, with the capability of learning by example. The field of artificial neural networks has evolved significantly in the last two decades, with active partici- tion from diverse fields, such as engineering, computer science, mathematics, artificial intelligence, system theory, biology, operations research, and neuroscience. Artificial neural networks have been widely applied for pattern recognition, control, optimization, image processing, classification, signal processing, etc.

The book is concerned with the statistical theory for locating spatial sensors. It bridges the gap between spatial statistics and optimum design theory. After introductions to those two fields the topics of exploratory designs and designs for spatial trend and variogram estimation are treated. Special attention is devoted to describing new methodologies to cope with the problem of correlated observations.

This volume contains the majority of the papers presented at the 5th Inter national 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 Kyrik monastery, Bulgaria), 1992 (Petrodvorets, StPetersburg, Russia) and 1995 (Spetses, Greece). The main purpose of these workshops was to bring together lead ing scientists from 'Eastern' and 'Western' Europe for the exchange of ideas in theoretical and applied statistics, with special emphasis on experimen tal 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 scien tists. 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 care ful selection of scientific direction made by the Programme Committee.

An unappealing characteristic of all real-world systems is the fact that they are vulnerable to faults, malfunctions and, more generally, unexpected modes of - haviour. This explains why there is a continuous need for reliable and universal monitoring systems based on suitable and e?ective fault diagnosis strategies. This is especially true for engineering systems,whose complexity is permanently growing due to the inevitable development of modern industry as well as the information and communication technology revolution. Indeed, the design and operation of engineering systems require an increased attention with respect to availability, reliability, safety and fault tolerance. Thus, it is natural that fault diagnosis plays a fundamental role in modern control theory and practice. This is re?ected in plenty of papers on fault diagnosis in many control-oriented c- ferencesand journals.Indeed, a largeamount of knowledgeon model basedfault diagnosis has been accumulated through scienti?c literature since the beginning of the 1970s. As a result, a wide spectrum of fault diagnosis techniques have been developed. A major category of fault diagnosis techniques is the model based one, where an analytical model of the plant to be monitored is assumed to be available.

Introductory remarks about the experiment and its disign. The regression model and methods of estimation. The ordering of designs and the properties of variaces of estimates. Optimality critaria in the regression model. Iterative computation of optimum desings Design of experiments in particular cases. The functional model and measurements of physical fields.

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.

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"This is an engaging and informative book on the modern practice of experimental design. The authors' writing style is entertaining, the consulting dialogs are extremely enjoyable, and the technical material is presented brilliantly but not overwhelmingly. The book is a joy to read. Everyone who practices or teaches DOE should read this book." - Douglas C.

Montgomery, Regents Professor, Department of Industrial Engineering, Arizona State University "It's been said: 'Design for the experiment, don't experiment for the design.' This book ably demonstrates this notion by showing how tailor-made, optimal designs can be effectively employed to meet a client's actual needs. It should be required reading for anyone interested in using the design of experiments in industrial settings." —Christopher J. Nachtsheim, Frank A Donaldson Chair in Operations Management, Carlson School of Management, University of Minnesota This book demonstrates the utility of the computer-aided optimal design approach using real industrial examples. These examples address questions such as the following: How can I do screening inexpensively if I have dozens of factors to investigate? What can I do if I have day-to-day variability and I can only perform 3 runs a day? How can I do RSM cost effectively if I have categorical factors? How can I design and analyze experiments when there is a factor that can only be changed a few times over the study? How can I include both ingredients in a mixture and processing factors in the same study? How can I design an experiment if there are many factor combinations that are impossible to run? How can I make sure that a time trend due to warming up of equipment does not affect the conclusions from a study? How can I take into account batch information in when designing experiments involving multiple batches? How can I add runs to a botched experiment to resolve ambiguities? While answering these questions the book also shows how to evaluate and compare designs. This allows researchers to make sensible trade-offs between the cost of experimentation and the amount of information they obtain.

The present volume is a collective monograph devoted to applications of the optimal design theory in optimization and statistics. The chapters re?ect the topics discussed at the workshop "W-Optimum Design and Related Statistical Issues" that took place in Juan-les-Pins, France, in May 2005. The title of the workshop was chosen as a light-hearted celebration of the work of Henry Wynn. It was supported by the Laboratoire I3S (CNRS/Universit ? e de Nice, Sophia Antipolis), to which Henry is a frequent visitor. The topics covered partly re?ect the wide spectrum of Henry's research - terests. Algorithms for constructing optimal designs are discussed in Chap. 1, where Henry's contribution to the ?eld is acknowledged. Steepest-ascent - gorithms used to construct optimal designs are very much related to general gradientalgorithmsforconvexoptimization. Inthelasttenyears,asigni?cant part of Henry's research was devoted to the study of the asymptotic prop- ties of such algorithms. This topic is covered by Chaps. 2 and 3. The work by Alessandra Giovagnoli concentrates on the use of majorization and stoch- tic ordering, and Chap. 4 is a hopeful renewal of their collaboration. One of Henry's major recent interests is what is now called algebraic statistics, the application of computational commutative algebra to statistics, and he was partly responsible for introducing the experimental design sub-area, reviewed in Chap. 5. One other sub-area is the application to Bayesian networks and Chap. 6 covers this, with Chap. 7 being strongly related.

Residualplots 74 Normaland half-normal plots 77 2. 3. 10. TRANSFORMATIONS OF VARIABLES 80 2. 3. 11. WEIGHTED LEAST SQUARES 82 2. 4. Bibliography 84 Appendix A. 2. 1. Basic equation ofthe analysis ofvariance 84 Appendix A. 2. 2. Derivation of the simplified formulae (2. 1 0) and (2. 11) 85 Appendix A. 2. 3. Basic properties ofleast squares estimates 86 Appendix A. 2. 4. Sums ofsquares for tests for lack offit 88 Appendix A. 2. 5. Properties ofthe residuals 90 3. DESIGN OF REGRESSION

A bibliography on stochastic orderings. Was there a real need for it? In a time of reference databases as the MathSci or the Science Citation Index or the Social Science Citation Index the answer seems to be negative. The reason we think that this bibliog raphy might be of some use stems from the frustration that we, as workers in the field, have often experienced by finding similar results being discovered and proved over and over in different journals of different disciplines with different levels of mathematical so phistication and accuracy and most of the times without cross references. Of course it would be very unfair to blame an economist, say, for not knowing a result in mathematical physics, or vice versa, especially when the problems and the languages are so far apart that it is often difficult to recognize the analogies even after further scrutiny. We hope that collecting the references on this topic, regardless of the area of application, will be of some help, at least to pinpoint the problem. We use the term stochastic ordering in a broad sense to denote any ordering relation on a space of probability measures. Questions that can be related to the idea of stochastic orderings are as old as probability itself. Think for instance of the problem of comparing two gambles in order to decide which one is more favorable.

Proceedings of the European Control Conference 1993, Groningen, Netherlands, June 28 – July 1, 1993

Sensor networks have recently come into prominence because they hold the potential to revolutionize a wide spectrum of both civilian and military applications. An ingenious characteristic of sensor networks is the distributed nature of data acquisition. Therefore they seem to be ideally prepared for the task of monitoring processes with spatio-temporal dynamics which constitute one of most general and important classes of systems in modelling of the real-world phenomena. It is clear that careful deployment and activation of sensor nodes are critical for collecting the most valuable information from the observed environment. Optimal Sensor Network Scheduling in Identification of Distributed Parameter Systems discusses the characteristic features of the sensor scheduling problem, analyzes classical and recent approaches, and proposes a wide range of original solutions, especially dedicated for networks with mobile and scanning nodes. Both researchers and practitioners will find the case studies, the proposed algorithms, and the numerical examples to be invaluable.

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.

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. Practitionners 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.

This book contains Volume 6 of the Journal of Graph Algorithms and Applications (JGAA). JGAA is a peer-reviewed scientific journal devoted to the publication of high-quality research papers on the analysis, design, implementation, and applications of graph algorithms. Areas of interest include computational biology, computational geometry, computer graphics, computer-aided design, computer and interconnection networks, constraint systems, databases, graph drawing, graph embedding and layout, knowledge representation, multimedia, software engineering, telecommunications networks, user interfaces and visualization, and VLSI circuit design.Graph Algorithms and Applications 3 presents contributions from prominent authors and includes selected papers from the Symposium on Graph Drawing (1999 and 2000). All papers in the book have extensive diagrams and offer a unique treatment of graph algorithms focusing on the important applications.

This judicious selection of articles combines mathematical and numerical methods to apply parameter estimation and optimum experimental design in a range of contexts. These include fields as diverse as biology, medicine, chemistry, environmental physics, image processing and computer vision. The material chosen was presented at a multidisciplinary workshop on parameter estimation held in 2009 in Heidelberg. The contributions show how indispensable efficient methods of applied mathematics and computer-based modeling can be to enhancing the quality of interdisciplinary

research. The use of scientific computing to model, simulate, and optimize complex processes has become a standard methodology in many scientific fields, as well as in industry. Demonstrating that the use of state-of-the-art optimization techniques in a number of research areas has much potential for improvement, this book provides advanced numerical methods and the very latest results for the applications under consideration.

The series is aimed specifically at publishing peer reviewed reviews and contributions presented at workshops and conferences. Each volume is associated with a particular conference, symposium or workshop. These events cover various topics within pure and applied mathematics and provide up-to-date coverage of new developments, methods and applications.

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.

This COMPSTAT 2002 book contains the Keynote, Invited, and Full Contributed papers presented in Berlin, August 2002. A companion volume including Short Communications and Posters is published on CD. The COMPSTAT 2002 is the 15th conference in a serie of biannual conferences with the objective to present the latest developments in Computational Statistics and is taking place from August 24th to August 28th, 2002. Previous COMPSTATs were in Vienna (1974), Berlin (1976), Leiden (1978), Edinburgh (1980), Toulouse (1982), Pra~ue (1984), Rome (1986), Copenhagen (1988), Dubrovnik (1990), Neuchatel (1992), Vienna (1994), Barcelona (1996), Bris tol (1998) and Utrecht (2000). COMPSTAT 2002 is organised by CASE, Center of Applied Statistics and Eco nomics at Humboldt-Universitat zu Berlin in cooperation with F'reie Universitat Berlin and University of Potsdam. The topics of COMPSTAT include methodological applications, innovative soft ware and mathematical developments, especially in the following fields: statistical risk management, multivariate and robust analysis, Markov Chain Monte Carlo Methods, statistics of E-commerce, new strategies in teaching (Multimedia, In ternet), computerbased sampling/questionnaires, analysis of large databases (with emphasis on computing in memory), graphical tools for data analysis, classification and clustering, new statistical software and historical development of software.

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.

Probability and Statistics theme is a component of Encyclopedia of Mathematical Sciences in the global Encyclopedia of Life Support Systems (EOLSS), which is an integrated compendium of twenty one Encyclopedias. The Theme with contributions from distinguished experts in the field, discusses Probability and Statistics. Probability is a standard mathematical concept to describe stochastic uncertainty. Probability and Statistics can be considered as the two sides of a coin. They consist of methods for modeling uncertainty and measuring real phenomena. Today many important political, health, and economic decisions are based on statistics. This theme is structured in five main topics: Probability and Statistics; Probability Theory; Stochastic Processes and Random Fields; Probabilistic Models and Methods; Foundations of Statistics, which are then expanded into multiple subtopics, each as a chapter. These three volumes are aimed at the following five major target audiences: University and College students Educators, Professional practitioners, Research personnel and Policy analysts, managers, and decision makers and NGOs.

Optimal Design of Experiments offers a rare blend of linear algebra, convex analysis, and statistics. The optimal design for statistical experiments is first formulated as a concave matrix optimization problem. Using tools from convex analysis, the problem is solved generally for a wide class of optimality criteria such as D-, A-, or E-optimality. The book then offers a complementary approach that calls for the study of the symmetry properties of the design problem, exploiting such notions as matrix majorization and the Kiefer matrix ordering. The results are illustrated with optimal designs for polynomial fit models, Bayes designs, balanced incomplete block designs, exchangeable designs on the cube, rotatable designs on the sphere, and many other examples.

This book constitutes the thoroughly refereed post-proceedings of the 4th International Conference on Parallel Processing and Applied Mathematics, PPAM 2002, held in Naleczow, Poland, in September 2001. The 101 papers presented were carefully reviewed and improved during two rounds of reviewing and revision. The book offers topical sections on distributed and grid architectures, scheduling and load balancing, performance analysis and prediction, parallel non-numerical algorithms, parallel programming, tools and environments, parallel numerical algorithms, applications, and evolutionary computing and neural networks.

Statisticians and experimentalists will find the latest trends in optimal experimental design research. Some papers are pioneering contributions, leading to new open research problems. It is a colection of peer reviewed papers.

This book covers a wide range of topics in both discrete and continuous optimal designs. The topics discussed include designs for regression models, covariates models, models with trend effects, and models with competition effects. The prerequisites are a basic course in the design and analysis of experiments and some familiarity with the concepts of optimality criteria.

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