Mathematics Of Uncertainty Modeling In The Analysis Of Engineering And Science Problems Advance In Computational Intelligence And Robotics Acir

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Coping with Uncertainty Springer
Mathematics of Uncertainty Modeling in the Analysis of Engineering and Science ProblemsIGI Global
Modeling Change and Uncertainty Information Science Reference
The first part of the book defines the concept of uncertainties and the mathematical frameworks that will be used for uncertainty modeling. The application to system reliability assessment illustrates the concept. In the second part, evidential networks as a new tool to model uncertainty in reliability and risk analysis is proposed and described. Then it is applied on SIS performance assessment and in risk analysis of a heat sink. In the third part, Bayesian and evidential networks are used to deal with important measures evaluation in the context of uncertainties.

Uncertainty World Scientific
Advances in computing hardware and algorithms have dramatically improved the ability to simulate complex processes computationally. Today's simulation capabilities offer the prospect of addressing questions that in the past could be addressed only by resource-intensive experimentation, if at all. Assessing the Reliability of Complex Models recognizes the ubiquity of uncertainty in computational estimates of reality and the necessity for its quantification. As computational science and engineering have matured, the process of quantifying or bounding uncertainties in a computational estimate of a physical quality of interest has evolved into a small set of interdependent tasks: verification,

validation, and uncertainty of quantification (VVUQ). In recognition of the increasing importance of computational simulation and the increasing need to assess uncertainties in computational results, the National Research Council was asked to study the mathematical foundations of VVUQ and to recommend steps that will ultimately lead to improved processes. Assessing the Reliability of Complex Models discusses changes in education of professionals and dissemination of information that should enhance the ability of future VVUQ practitioners to improve and properly apply VVUQ methodologies to difficult problems, enhance the ability of VVUQ customers to understand VVUQ results and use them to make informed decisions, and enhance the ability of all VVUQ stakeholders to communicate with each other. This report is an essential resource for all decision and policy makers in the field, students, stakeholders, UQ experts, and VVUQ educators and practitioners.

Uncertainty Modeling for Structural Control Analysis and Synthesis Elsevier

Recognition of the need to introduce the ideas of uncertainty in a wide variety of scientific fields today reflects in part some of the profound changes in science and engineering over the last decades. Nobody questions the ever-present need for a solid foundation in applied mechanics. Neither does anyone question nowadays the fundamental necessity to recognize that uncertainty exists, to learn to evaluate it rationally, and to incorporate it into design. This volume provides a timely and stimulating overview of the analysis of uncertainty in applied mechanics. It is not just one more rendition of the traditional treatment of the subject, nor is it intended to supplement existing structural engineering books. Its aim is to fill a gap in the existing professional literature by concentrating on the non-probabilistic model of uncertainty. It provides an alternative avenue for the analysis of uncertainty when only a limited amount of information is available. The first chapter briefly reviews probabilistic methods and discusses the sensitivity of the probability of failure to uncertain knowledge of the system. Chapter two discusses the mathematical background of convex modelling. In the remainder of the book, convex modelling is applied to various linear and nonlinear problems. Uncertain phenomena are represented throughout the book by convex sets, and this approach is referred to as convex modelling. This book is intended to inspire researchers in their goal towards further growth and development in this field.

Uncertainty Modeling and Analysis in Engineering and the Sciences Springer

Engineers and scientists often need to solve complex problems with incomplete information resources, necessitating a proper treatment of uncertainty and a reliance on expert opinions. Uncertainty Modeling and Analysis in Engineering and the Sciences prepares current and future analysts and practitioners to understand the fundamentals of knowledge a

Nonlinear Mathematics for Uncertainty and its Applications IGI Global

"Mathematics of Uncertainty" provides the basic ideas and foundations of uncertainty, covering the fields of mathematics in which

uncertainty, variability, imprecision and fuzziness of data are of importance. This introductory book describes the basic ideas of the mathematical fields of uncertainty from simple interpolation to wavelets, from error propagation to fuzzy sets and neural networks. The book presents the treatment of problems of interpolation and approximation, as well as observation fuzziness which can essentially influence the preciseness and reliability of statements on functional relationships. The notions of randomness and probability are examined as a model for the variability of observation and measurement results. Besides these basic ideas the book also presents methods of qualitative data analysis such as cluster analysis and classification, and of evaluation of functional relationships such as regression analysis and quantitative fuzzy data analysis.

Mathematics of Uncertainty CRC Press Mathematical modeling is a powerful craft that requires practice. The more practice the better one will become in executing the art. The authors wrote this book to develop the craft of mathematical modeling and to foster a desire for lifelong learning, habits of mind and develop competent and confident problem solvers and decision makers for the 21st century. This book offers a problem-solving approach. The authors introduce a problem to help motivate the learning of a particular mathematical modeling topic. The problem provides the issue or what is needed to solve using an appropriate modeling technique. Then principles are applied to the problem and present the steps in obtaining an appropriate model to solve the problem. Modeling Change and Uncertainty: Covers both linear and nonlinear models of discrete dynamical systems. Introduces statistics and probability modeling. Introduces critical statistical concepts to handle univariate and multivariate data. Establishes a foundation in probability modeling. Uses ordinary differential equations (ODEs) to develop a more robust solution to problems. Uses linear programming and machine learning to support decision making. Introduces the reality of uncertainty and randomness that is all around us. Discusses the use of linear programing to solve common problems in modern industry. Discusses he power and limitations of simulations. Introduces the methods and formulas used in businesses and financial organizations. Introduces valuable techniques using Excel, MAPLE, and R. Mathematical modeling offers a framework for decision makers in all fields. This framework consists of four key components: the formulation process, the solution process, interpretation of the solution in the context of the actual problem, and sensitivity analysis. Modeling Change and Uncertainty will be of interest to mathematics departments offering advanced mathematical modeling courses focused on decision making or discrete mathematical modeling and by undergraduate, graduate students and practitioners looking for an opportunity to develop, practice, and apply the craft of mathematical modeling. Table of Contents 1. Perfect Partners: Combining Models of Change and Uncertainty with Technology 2. Modeling Change: Discrete Dynamical Systems (DDS) and Modeling Systems of DDS 3. Statistical and Probabilistic Models 4. Modeling with Probability 5. Differential Equations 6. Forecasting with Linear Programming and Machine Learning 7. Stochastic Models and Markov Chains 8. Linear Programming 9. Simulation of Queueing Models 10. Modeling of Financial Analysis 11. Reliability Models 12. Machine

Learning and Unconstrained Optimal Process Dr. William P. Fox is currently a visiting professor of Computational Operations Research at the College of William and Mary. He is an emeritus professor in the Department of Defense Analysis at the Naval Postgraduate School and teaches a three-course sequence in mathematical modeling for decision making. He received his Ph.D. in Industrial Engineering from Clemson University. He has taught at the United States Military Academy for twelve years until retiring and at Francis Marion University where he was the chair of mathematics for eight years. He has many publications and scholarly activities including twenty plus books and one hundred and fifty journal articles. Colonel (R) Robert E. Burks, Jr., Ph.D. is an Associate Professor in the Defense Analysis Department of the Naval Postgraduate School (NPS) and the Director of the NPS ' Wargaming Center. He holds a Ph.D. in Operations Research from the Air Force Institute of Technology. He is a retired logistics Army Colonel with more than thirty years of military experience in leadership, advanced analytics, decision modeling, and logistics operations who served as an Army Operations Research analyst at the Naval Postgraduate School, TRADOC Analysis Center, United States Military Academy, and the United States Army Recruiting Command. Other book by William P. Fox and Robert E. Burks: Advanced Mathematical Modeling with Technology, 2021, CRC Press. Other books by William P. Fox from CRC Press: Mathematical Modeling in the Age of the Pandemic, 2021, CRC Press. Advanced Problem Solving Using Maple: Applied Mathematics, Operations Research, Business Analytics, and Decision Analysis (w/William Bauldry), 2020, CRC Press. Mathematical Modeling with Excel (w/Brian Albright), 2020, CRC Press. Nonlinear Optimization: Models and Applications, 2020, CRC Press. Advanced Problem Solving with Maple: A First Course (w/William Bauldry), 2019. CRC Press. Mathematical Modeling for Business Analytics, 2018, CRC Press.

Physics Of Cancer, The: Research Advances SIAM

Machine learning and data mining are inseparably connected with uncertainty. The observable data for learning is usually imprecise, incomplete or noisy. Uncertainty Modeling for Data Mining: A Label Semantics Approach introduces 'label semantics', a fuzzy-logic-based theory for modeling uncertainty. Several new data mining algorithms based on label semantics are proposed and tested on real-world datasets. A prototype interpretation of label semantics and new prototype-based data mining algorithms are also discussed. This book offers a valuable resource for postgraduates, researchers and other professionals in the fields of data mining, fuzzy computing and uncertainty reasoning. Zengchang Qin is an associate professor at the School of Automation Science and Electrical Engineering, Beihang University, China; Yongchuan Tang is an associate professor at the College of Computer Science, Zhejiang University, China.

Uncertain Input Data Problems and the Worst Scenario Method John Wiley & Sons

This book features 29 peer-reviewed papers presented at the 9th International Conference on Soft Methods in Probability and Statistics (SMPS 2018), which was held in conjunction with the 5th International Conference on Belief Functions (BELIEF 2018) in Compi è gne, France on September 17 – 21, 2018. It includes foundational, methodological and applied contributions on topics as varied as imprecise data handling, linguistic summaries, model coherence, imprecise Markov chains, and robust optimisation. These proceedings were produced using EasyChair. Over recent decades, interest in extensions and alternatives to probability and statistics has increased significantly in diverse areas, including decision-making, data mining and machine learning, and optimisation. This interest stems from the need to enrich existing

models, in order to include different facets of uncertainty, like ignorance, vagueness, randomness, conflict or imprecision. Frameworks such as rough sets, fuzzy sets, fuzzy random variables, random sets, belief functions, possibility theory, imprecise probabilities, lower previsions, and desirable gambles all share this goal, but have emerged from different needs. The advances, results and tools presented in this book are important in the ubiquitous and fast-growing fields of data science, machine learning and artificial intelligence. Indeed, an important aspect of some of the learned predictive models is the trust placed in them. Modelling the uncertainty associated with the data and the models carefully and with principled methods is one of the means of increasing this trust, as the model will then be able to distinguish between reliable and less reliable predictions. In addition, extensions such as fuzzy sets can be explicitly designed to provide interpretable predictive models, facilitating user interaction and increasing trust.

Convex Models of Uncertainty in Applied Mechanics Mathematics of Uncertainty Modeling in the Analysis of Engineering and Science Problems Mathematical models are used to simulate complex real-world phenomena in many areas of science and technology. Large complex models typically require inputs whose values are not known with certainty. Uncertainty analysis aims to quantify the overall uncertainty within a model, in order to support problem owners in model-based decision-making. In recent years there has been an explosion of interest in uncertainty analysis. Uncertainty and dependence elicitation, dependence modelling, model inference, efficient sampling, screening and sensitivity analysis, and probabilistic inversion are among the active research areas. This text provides both the mathematical foundations and practical applications in this rapidly expanding area, including: An up-to-date, comprehensive overview of the foundations and applications of uncertainty analysis. All the key topics, including uncertainty elicitation, dependence modelling, sensitivity analysis and probabilistic inversion. Numerous worked examples and applications. Workbook problems, enabling use for teaching. Software support for the examples, using UNICORN - a Windows-based uncertainty modelling package developed by the authors. A website featuring a version of the UNICORN software tailored specifically for the book, as well as computer programs and data sets to support the examples. Uncertainty Analysis with High Dimensional Dependence Modelling offers a comprehensive exploration of a new emerging field. It will prove an invaluable text for researches, practitioners and graduate students in areas ranging from statistics and engineering to reliability and environmetrics.

Uncertainty Quantification MDPI

"This book provides the reader with basic concepts for soft computing and other methods for various means of uncertainty in handling solutions, analysis, and applications"--Provided by publisher.

Uncertainty Quantification and Stochastic Modeling with Matlab Chapman & Hall

Computational modeling allows to reduce, refine and replace animal experimentation as well as to translate findings obtained in these experiments to the human background. However these biomedical problems are inherently complex with a myriad of influencing factors, which strongly complicates the model building and validation process. This book wants to address four main issues related to the building and validation of computational models of biomedical processes: 1. Modeling establishment under uncertainty 2. Model selection and parameter fitting 3. Sensitivity analysis and model adaptation 4. Model predictions under uncertainty In each of the abovementioned areas, the book discusses a number of key-techniques by means of a general theoretical description followed by one or more practical examples. This book is intended for graduate students and researchers active in the field of computational modeling of biomedical processes who seek to acquaint themselves with the different ways in which to study the parameter space of their model as well as its overall behavior.

An Introduction to Data Analysis and Uncertainty Quantification for Inverse Problems Elsevier

Ongoing global changes pose fundamentally new scientific problems requiring new concepts and tools. A key issue concerns a vast variety of practically irreducible uncertainties, which challenge traditional

models and require new concepts and analytical tools. Uncertainty can dominate, as in the climate change debates. Increasing the resolution of models does not always yield sufficient certainty. This book presents much-needed new tools for modeling and management of uncertainty.

The Uncertainty Analysis of Model Results Springer

Uncertainty Quantification (UQ) is a relatively new research area which describes the methods and approaches used to supply quantitative descriptions of the effects of uncertainty, variability and errors in simulation problems and models. It is rapidly becoming a field of increasing importance, with many real-world applications within statistics, mathematics, probability and engineering, but also within the natural sciences. Literature on the topic has up until now been largely based on polynomial chaos, which raises difficulties when considering different types of approximation and does not lead to a unified presentation of the methods. Moreover, this description does not consider either deterministic problems or infinite dimensional ones. This book gives a unified, practical and comprehensive presentation of the main techniques used for the characterization of the effect of uncertainty on numerical models and on their exploitation in numerical problems. In particular, applications to linear and nonlinear systems of equations, differential equations, optimization and reliability are presented. Applications of stochastic methods to deal with deterministic numerical problems are also discussed. Matlab ® illustrates the implementation of these methods and makes the book suitable as a textbook and for self-study. Discusses the main ideas of Stochastic Modeling and Uncertainty Quantification using Functional Analysis Details listings of Matlab ® programs implementing the main methods which complete the methodological presentation by a practical implementation Construct your own implementations from provided worked examples

Modeling Uncertainty Springer

This book deals with the impact of uncertainty in input data on the outputs of mathematical models. Uncertain inputs as scalars, tensors, functions, or domain boundaries are considered. In practical terms, material parameters or constitutive laws, for instance, are uncertain, and quantities as local temperature, local mechanical stress, or local displacement are monitored. The goal of the worst scenario method is to extremize the quantity over the set of uncertain input data. A general mathematical scheme of the worst scenario method, including approximation by finite element methods, is presented, and then applied to various state problems modeled by differential equations or variational inequalities: nonlinear heat flow, Timoshenko beam vibration and buckling, plate buckling, contact problems in elasticity and thermoelasticity with and without friction, and various models of plastic deformation, to list some of the topics. Dozens of examples, figures, and tables are included. Although the book concentrates on the mathematical aspects of the subject, a substantial part is written in an accessible style and is devoted to various facets of uncertainty in modeling and to the state of the art techniques proposed to deal with uncertain input data. A chapter on sensitivity analysis and on functional and convex analysis is included for the reader's convenience. · Rigorous theory is established for the treatment of uncertainty in modeling · Uncertainty is considered in complex models based on partial differential equations or variational inequalities · Applications to nonlinear and linear problems with uncertain data are presented in detail: quasilinear steady heat flow, buckling of beams and plates, vibration of beams, frictional contact of bodies, several models of plastic deformation, and more · Although emphasis is put on theoretical analysis and approximation techniques, numerical examples are also present · Main ideas and approaches used today to handle uncertainties in modeling are described in an accessible form · Fairly self-contained book

Modelling Under Risk and Uncertainty Springer

This book is a practical guide to the uncertainty analysis of computer model applications. Used in many areas, such as engineering, ecology and economics, computer models are subject to various

uncertainties at the level of model formulations, parameter values and input data. Naturally, it would be advantageous to know the combined effect of these uncertainties on the model results as well as whether the state of knowledge should be improved in order to reduce the uncertainty of the results most effectively. The book supports decision-makers, model developers and users in their argumentation for an uncertainty analysis and assists them in the interpretation of the analysis results.

Do Dice Play God? John Wiley & Sons

Modeling Uncertainty in the Earth Sciences highlights the various issues, techniques and practical modeling tools available for modeling the uncertainty of complex Earth systems and the impact that it has on practical situations. The aim of the book is to provide an introductory overview which covers a broad range of tried-and-tested tools. Descriptions of concepts, philosophies, challenges, methodologies and workflows give the reader an understanding of the best way to make decisions under uncertainty for Earth Science problems. The book covers key issues such as: Spatial and time aspect; large complexity and dimensionality; computation power; costs of 'engineering' the Earth; uncertainty in the modeling and decision process. Focusing on reliable and practical methods this book provides an invaluable primer for the complex area of decision making with uncertainty in the Earth Sciences.

National Academies Press

Uncertainty is everywhere. It lurks in every consideration of the future - the weather, the economy, the sex of an unborn child - even quantities we think that we know such as populations or the transit of the planets contain the possibility of error. It's no wonder that, throughout that history, we have attempted to produce rigidly defined areas of uncertainty - we prefer the surprise party to the surprise asteroid. We began our quest to make certain an uncertain world by reading omens in livers, tea leaves, and the stars. However, over the centuries, driven by curiosity, competition, and a desire be better gamblers, pioneering mathematicians and scientists began to reduce wild uncertainties to tame distributions of probability and statistical inferences. But, even as unknown unknowns became known unknowns, our pessimism made us believe that some problems were unsolvable and our intuition misled us. Worse, as we realized how omnipresent and varied uncertainty is, we encountered chaos, quantum mechanics, and the limitations of our predictive power. Bestselling author Professor Ian Stewart explores the history and mathematics of uncertainty. Touching on gambling, probability, statistics, financial and weather forecasts, censuses, medical studies, chaos, quantum physics, and climate, he makes one thing clear: a reasonable probability is the only certainty.

Dynamics under Uncertainty Springer

The application areas of uncertainty are numerous and diverse, including all fields of engineering, computer science, systems control and finance. Determining appropriate ways and methods of dealing with uncertainty has been a constant challenge. The theme for this book is better understanding and the application of uncertainty theories. This book, with invited chapters, deals with the uncertainty phenomena in diverse fields. The book is an outgrowth of the Fourth International Symposium on Uncertainty Modeling and Analysis (ISUMA), which was held at the center of Adult Education, College Park, Maryland, in September 2003. All of the chapters have been carefully edited, following a review process in which the editorial committee scrutinized each chapter. The contents of the book are reported in twenty-three chapters, covering more than . . ... pages. This book is divided into six main sections. Part I (Chapters 1-4) presents the philosophical and theoretical foundation of uncertainty, new computational directions in neural networks, and some theoretical foundation of fuzzy systems. Part I1

(Chapters 5-8) reports on biomedical and chemical engineering applications. The sections looks at noise reduction techniques using hidden Markov models, evaluation of biomedical signals using neural networks, and changes in medical image detection using Markov Random Field and Mean Field theory. One of the chapters reports on optimization in chemical engineering processes.

Uncertainty Analysis with High Dimensional Dependence Modelling Springer Science & Business Media

Inverse problems are found in many applications, such as medical imaging, engineering, astronomy, and geophysics, among others. To solve an inverse problem is to recover an object from noisy, usually indirect observations. Solutions to inverse problems are subject to many potential sources of error introduced by approximate mathematical models, regularization methods, numerical approximations for efficient computations, noisy data, and limitations in the number of observations; thus it is important to include an assessment of the uncertainties as part of the solution. Such assessment is interdisciplinary by nature, as it requires, in addition to knowledge of the particular application, methods from applied mathematics, probability, and statistics. This book bridges applied mathematics and statistics by providing a basic introduction to probability and statistics for uncertainty quantification in the context of inverse problems, as well as an introduction to statistical regularization of inverse problems. The author covers basic statistical inference, introduces the framework of ill-posed inverse problems, and explains statistical questions that arise in their applications. An Introduction to Data Analysis and Uncertainty Quantification for Inverse Problems?includes many examples that explain techniques which are useful to address general problems arising in uncertainty quantification, Bayesian and non-Bayesian statistical methods and discussions of their complementary roles, and analysis of a real data set to illustrate the methodology covered throughout the book.