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ROWAN ZOE

Mathematics of Uncertainty Modeling in the Analysis of Engineering and Science Problems Springer "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. stablishes 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"-- *Mathematics of Uncertainty Modeling in the Analysis of Engineering and Science Problems* Springer This is one of the only books to describe uncertain volatility models in mathematical finance and their computer implementation for portfolios of vanilla, barrier and American options in equity and FX markets. Uncertain volatility models place subjective constraints on the volatility of the stochastic process of the underlying asset and evaluate option portfolios under worst- and best-case scenarios. This book, which is bundled with software, is aimed at

graduate students, researchers and practitioners who wish to study advanced aspects of volatility risk in portfolios of vanilla and exotic options. The reader is assumed to be familiar with arbitrage pricing theory.

Uncertainty Quantification
Springer Science & Business Media
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

Uncertainty Modeling and Analysis in Engineering and the Sciences Springer Science & Business Media

A valuable guide to understanding the problem of quantifying uncertainty in dose response relations for toxic substances In today's scientific research, there exists the need to address the topic of uncertainty as it pertains to dose response modeling. Uncertainty Modeling in Dose

Response is the first book of its kind to implement and compare different methods for quantifying the uncertainty in the probability of response, as a function of dose. This volume gathers leading researchers in the field to properly address the issue while communicating concepts from diverse viewpoints and incorporating valuable insights. The result is a collection that reveals the properties, strengths, and weaknesses that exist in the various approaches to bench test problems. This book works with four bench test problems that were taken from real bioassay data for hazardous substances currently under study by the United States Environmental Protection Agency (EPA). The use of actual data provides readers with information that is relevant and representative of the current work being done in the field. Leading contributors from the toxicology and risk assessment communities have applied their methods to quantify model uncertainty in dose response for each case by employing various approaches, including Benchmark Dose Software methods, probabilistic inversion with isotonic regression, nonparametric Bayesian modeling, and Bayesian model averaging. Each chapter is reviewed and critiqued from three professional points of view: risk analyst/regulator, statistician/mathematician , and toxicologist/epidemiologis t. In addition, all methodologies are worked

out in detail, allowing readers to replicate these analyses and gain a thorough understanding of the methods. Uncertainty Modeling in Dose Response is an excellent book for courses on risk analysis and biostatistics at the upper-undergraduate and graduate levels. It also serves as a valuable reference for risk assessment, toxicology, biostatistics, and environmental chemistry professionals who wish to expand their knowledge and expertise in statistical dose response modeling problems and approaches. *Uncertainty Modeling in Dose Response* SIAM The expression of uncertainty in measurement poses a challenge since it involves physical, mathematical, and philosophical issues. This problem is intensified by the limitations of the probabilistic approach used by the current standard (the GUM Instrumentation Standard). This text presents an alternative approach. It makes full use of the mathematical theory of evidence to express the uncertainty in measurements. Coverage provides an overview of the current standard, then pinpoints and constructively resolves its limitations. Numerous examples throughout help explain the book's unique approach. An Introduction to Data Analysis and Uncertainty Quantification for Inverse Problems Springer Science & Business Media 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

Uncertainty Springer Science & Business Media
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.

Modeling Uncertainty Springer Nature
This book presents the fundamental notions and

advanced mathematical tools in the stochastic modeling of uncertainties and their quantification for large-scale computational models in sciences and engineering. In particular, it focuses in parametric uncertainties, and non-parametric uncertainties with applications from the structural dynamics and vibroacoustics of complex mechanical systems, from micromechanics and multiscale mechanics of heterogeneous materials. Resulting from a course developed by the author, the book begins with a description of the fundamental mathematical tools of probability and statistics that are directly useful for uncertainty quantification. It proceeds with a well carried out description of some basic and advanced methods for constructing stochastic models of uncertainties, paying particular attention to the problem of calibrating and identifying a stochastic model of uncertainty when experimental data is available. This book is intended to be a graduate-level textbook for students as well as professionals interested in the theory, computation, and applications of risk and prediction in science and engineering fields.

Measurement Uncertainty National Academies Press

"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.

Modeling, Design, and Simulation of Systems with Uncertainties
Springer
To describe the true behavior of most real-world systems with sufficient accuracy, engineers have to overcome difficulties arising from their lack of knowledge about certain parts of a process or from the impossibility of characterizing it with absolute certainty. Depending on the application at hand, uncertainties in modeling and measurements can be represented in different ways. For example, bounded uncertainties can be described by intervals, affine forms or general polynomial enclosures such as Taylor models, whereas stochastic uncertainties can be characterized in the form of a distribution described, for example, by the mean value, the standard deviation and higher-order moments. The goal of this Special Volume on Modeling, Design, and Simulation of Systems with Uncertainties is to cover modern methods for dealing with the challenges presented by imprecise or unavailable information. All contributions tackle the topic from the point of view of control, state and parameter estimation, optimization and simulation. Thematically, this volume can be divided into two parts. In the first we present works highlighting the theoretic background and current research on algorithmic approaches in the field of uncertainty handling,

together with their reliable software implementation. The second part is concerned with real-life application scenarios from various areas including but not limited to mechatronics, robotics, and biomedical engineering.
Modeling Change and Uncertainty Springer Science & Business Media The purpose of this book is to present new mathematical techniques for modeling global issues. These mathematical techniques are used to determine linear equations between a dependent variable and one or more independent variables in cases where standard techniques such as linear regression are not suitable. In this book, we examine cases where the number of data points is small (effects of nuclear warfare), where the experiment is not repeatable (the breakup of the former Soviet Union), and where the data is derived from expert opinion (how conservative is a political party). In all these cases the data is difficult to measure and an assumption of randomness and/or statistical validity is questionable. We apply our methods to real world issues in international relations such as nuclear deterrence, smart power, and cooperative threat reduction. We next apply our methods to issues in comparative politics such as successful democratization, quality of life, economic freedom, political stability, and failed states. Finally, issues involving deaf and hard of hearing children

are explored.

Convex Models of Uncertainty in Applied Mechanics Chapman & Hall

Vital information on machine intelligence and pattern recognition is provided by this publication. In particular, the 31 papers discuss the ways in which uncertainty modelling and analysis are becoming an integral part of system definition and modelling in many fields. Contributions are sourced from an international base of researchers, scientists and engineers working on theoretical developments and diversified applications in engineering systems. The book is divided into two main parts. The first, Uncertainty Models and Measures, includes chapters on theoretical studies and developments carried out on uncertainty (including cognitive uncertainty and how it relates to information and intelligence), information, fuzzy logic, expert systems and neural networks. There are also chapters on modelling uncertainty in the reliability assessment of complex systems, linguistic connectives, the principle of maximum buoyancy, uncertain evidence, inductive learning, convex modelling, new uncertainty measures and information and uncertainty.The larger second part, Applications to Engineering Systems, contains application-oriented studies in fields related to civil, electrical, energy and general engineering systems. The papers cover studies on

general uncertainty types in structural engineering, bridges, transmission structures, structural reliability, structural identification, system life cycle analysis, control, construction activities, decision analysis, signal detection, risk management, product quality, military command and control, data bases, long-term projections and predictions and assessment of insurance indices.The book conveys the excitement, advances and promises that all these fields offer to our expanding information-based technological society. It also hopes to stimulate the interest of other researchers around the world who are facing the challenge of new theoretical studies and innovative technological changes.

Uncertainty Theory CRC Press

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.

Uncertainty Theory Springer

The dynamics of systems have proven to be very powerful tools in understanding the

behavior of different natural phenomena throughout the last two centuries. However, the attributes of natural systems are observed to deviate from their classical states due to the effect of different types of uncertainties. Actually, randomness and impreciseness are the two major sources of uncertainties in natural systems. Randomness is modeled by different stochastic processes and impreciseness could be modeled by fuzzy sets, rough sets, Dempster-Shafer theory, etc. **Dynamics under Uncertainty** Springer Science & Business Media Uncertainty theory is a branch of mathematics based on normality, monotonicity, self-duality, countable subadditivity, and product measure axioms. Uncertainty is any concept that satisfies the axioms of uncertainty theory. Thus uncertainty is neither randomness nor fuzziness. It is also known from some surveys that a lot of phenomena do behave like uncertainty. How do we model uncertainty? How do we use uncertainty theory? In order to answer these questions, this book provides a self-contained, comprehensive and up-to-date presentation of uncertainty theory, including uncertain programming, uncertain risk analysis, uncertain reliability analysis, uncertain process, uncertain calculus, uncertain differential equation, uncertain logic, uncertain entailment, and uncertain inference. Mathematicians, researchers, engineers,

designers, and students in the field of mathematics, information science, operations research, system science, industrial engineering, computer science, artificial intelligence, finance, control, and management science will find this work a stimulating and useful reference.

Solutions Manual for Uncertainty Modeling and Analysis in Engineering and the Sciences Springer Science & Business Media

The field of uncertainty quantification is evolving rapidly because of increasing emphasis on models that require quantified uncertainties for large-scale applications, novel algorithm development, and new computational architectures that facilitate implementation of these algorithms. Uncertainty Quantification: Theory, Implementation, and Applications provides readers with the basic concepts, theory, and algorithms necessary to quantify input and response uncertainties for simulation models arising in a broad range of disciplines. The book begins with a detailed discussion of applications where uncertainty quantification is critical for both scientific understanding and policy. It then covers concepts from probability and statistics, parameter selection techniques, frequentist and Bayesian model calibration, propagation of uncertainties, quantification of model discrepancy, surrogate model construction, and local and global sensitivity

analysis. The author maintains a complementary web page where readers can find data used in the exercises and other supplementary material.

Uncertainty Quantification Elsevier Publishing Company
This book presents a philosophical approach to probability and probabilistic thinking, considering the underpinnings of probabilistic reasoning and modeling, which effectively underlie everything in data science. The ultimate goal is to call into question many standard tenets and lay the philosophical and probabilistic groundwork and infrastructure for statistical modeling. It is the first book devoted to the philosophy of data aimed at working scientists and calls for a new consideration in the practice of probability and statistics to eliminate what has been referred to as the "Cult of Statistical Significance." The book explains the philosophy of these ideas and not the mathematics, though there are a handful of mathematical examples. The topics are logically laid out, starting with basic philosophy as related to probability, statistics, and science, and stepping through the key probabilistic ideas and concepts, and ending with statistical models. Its jargon-free approach asserts that standard methods, such as out-of-the-box regression, cannot help in discovering cause. This new way of looking at uncertainty ties together disparate fields — probability, physics,

biology, the “soft” sciences, computer science — because each aims at discovering cause (of effects). It broadens the understanding beyond frequentist and Bayesian methods to propose a Third Way of modeling.
Uncertainty Modeling with Applications to Multidimensional Civil Engineering Systems
Springer Science & Business Media
When no samples are available to estimate a probability distribution, we have to invite some domain experts to evaluate the belief degree that each event will happen. Perhaps some people think that the belief degree should be modeled by subjective probability or fuzzy set theory. However, it is usually inappropriate because both of them may lead to counterintuitive results in this case. In order to rationally deal with belief degrees, uncertainty theory was founded in 2007 and subsequently studied by many researchers. Nowadays, uncertainty theory has become a branch of axiomatic mathematics for modeling belief degrees. This is an introductory textbook on uncertainty theory, uncertain programming, uncertain statistics, uncertain risk analysis, uncertain reliability analysis, uncertain set, uncertain logic, uncertain inference, uncertain process, uncertain calculus, and uncertain differential equation. This textbook also shows applications of uncertainty theory to scheduling, logistics,

networks, data mining, control, and finance. *Applications of Mathematics of Uncertainty* Elsevier Modelling has permeated virtually all areas of industrial, environmental, economic, bio-medical or civil engineering: yet the use of models for decision-making raises a number of issues to which this book is dedicated: How uncertain is my model ? Is it truly valuable to support decision-making ? What kind of decision can be truly supported and how can I handle residual uncertainty ? How much refined should the mathematical description be, given the true data limitations ? Could the uncertainty be reduced through more data, increased modeling investment or computational budget ? Should it be reduced now or later ? How robust is the analysis or the computational methods involved ? Should / could those methods be more robust ? Does it make sense to handle uncertainty, risk, lack of knowledge, variability or errors altogether ? How reasonable is the choice of probabilistic modeling for rare events ? How rare are the events to be considered ? How far does it make sense to handle extreme events and elaborate confidence figures ? Can I take advantage of expert / phenomenological knowledge to tighten the probabilistic figures ? Are there connex domains that could provide models or inspiration for my problem ? Written by a leader at the crossroads

of industry, academia and engineering, and based on decades of multi-disciplinary field experience, Modelling Under Risk and Uncertainty gives a self-consistent introduction to the methods involved by any type of modeling development acknowledging the inevitable uncertainty and associated risks. It goes beyond the “black-box” view that some analysts, modelers, risk experts or statisticians develop on the underlying phenomenology of the environmental or industrial processes, without valuing enough their physical properties and inner modelling potential nor challenging the practical plausibility of mathematical hypotheses; conversely it is also to attract environmental or engineering modellers to better handle model confidence issues through finer statistical and risk analysis material taking advantage of advanced scientific computing, to face new regulations departing from deterministic design or support robust decision-making. Modelling Under Risk and Uncertainty: Addresses a concern of growing interest for large industries, environmentalists or analysts: robust modeling for decision-making in complex systems. Gives new insights into the peculiar mathematical and computational challenges generated by recent industrial safety or environmental control analysis for rare events. Implements decision theory choices differentiating or

aggregating the dimensions of risk/aleatory and epistemic uncertainty through a consistent multi-disciplinary set of statistical estimation, physical modelling, robust computation and risk analysis. Provides an original review of the advanced inverse probabilistic approaches for model identification, calibration or data assimilation, key to digest fast-growing multi-physical data acquisition. Illustrated with one favourite pedagogical example crossing natural risk, engineering and economics, developed throughout the book to facilitate the reading and understanding. Supports Master/PhD-level course as well as advanced tutorials for professional training Analysts and researchers in numerical modeling, applied statistics, scientific computing, reliability, advanced engineering, natural risk or environmental science will benefit from this book. *Mathematics of Uncertainty* Springer Science & Business Media This volume is a collection of papers presented at the international conference on Nonlinear Mathematics for Uncertainty and Its Applications (NLMUA2011), held at Beijing University of Technology during the week of September 7--9, 2011. The conference brought together leading researchers and practitioners involved with all aspects of nonlinear mathematics for uncertainty and its applications. Over the last

fifty years there have been many attempts in extending the theory of classical probability and statistical models to the generalized one which can cope with problems of inference and decision making when the model-related information is scarce, vague, ambiguous, or incomplete. Such attempts include the study of nonadditive measures and their integrals, imprecise probabilities and random sets, and their applications in information sciences, economics, finance, insurance, engineering, and social sciences. The book presents topics including nonadditive measures and nonlinear integrals, Choquet, Sugeno and other types of integrals, possibility theory, Dempster-Shafer theory, random sets, fuzzy random sets and related statistics, set-valued and fuzzy stochastic processes, imprecise probability theory and related statistical models, fuzzy mathematics, nonlinear functional analysis, information theory, mathematical finance and risk managements, decision making under various types of uncertainty, and others.

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