

Measurement uncertainty of power measurement (arbitrary waveforms)

- ▶ Applying the Gaussian error propagation to $P = \frac{1}{T} \cdot \int_T p(t) dt$ is an analytical challenge ⚡
- ▶ Practical implementation of active power calculation on measuring devices is discrete anyway

$$P = \frac{1}{N} \cdot \sum_{k=1}^N u_k \cdot i_k$$

- ▶ Max. Measurement error [4,6]: $\Delta P = \frac{1}{N} \cdot \sum_{k=1}^N |i_k \cdot \Delta u_k| + \frac{1}{N} \cdot \sum_{k=1}^N |u_k \cdot \Delta i_k|$

- ▶ MU [4,6]: $\delta P = \sqrt{\frac{1}{N^2} \cdot \left(\sum_{k=1}^N (i_k \cdot \delta u_k)^2 + \sum_{k=1}^N (u_k \cdot \delta i_k)^2 \right)}$

- ▶ Suitable method for dynamic processes/transients
- ▶ Bandwidth must be considered in addition to the error propagation when estimating the MU

Mathematics Of Uncertainty Mathematics Of Uncertainty

Baoding Liu



Mathematics Of Uncertainty Mathematics Of Uncertainty:

Mathematics of Uncertainty Hans Bandemer, 2009-09-02 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

Nonlinear Mathematics for Uncertainty and its Applications Shoumei Li, Xia Wang, Yoshiaki Okazaki, Jun Kawabe, Toshiaki Murofushi, Li Guan, 2011-07-21 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

Probability Dorian Feldman, Martin Fox, 1991-09-24 *Measurement Uncertainty* Simona Salicone, 2007-06-04 It is widely recognized by the scientific and technical community that measurements are the bridge between the empirical world and that of the abstract concepts and knowledge In fact measurements provide us the quantitative knowledge about things and phenomena It is also widely recognized that the measurement result is capable of providing only incomplete information about the actual value of the measurand that is the quantity being measured Therefore a measurement result comes useful in any practical situation only if a way is defined for estimating how incomplete is this information The more recent development of measurement science has identified in the uncertainty concept the most suitable way to quantify how incomplete is the information provided by a measurement result However the problem of how

to represent a measurement result together with its uncertainty and propagate measurement uncertainty is still an open topic in the field of metrology despite many contributions that have been published in the literature over the years. Many problems are in fact still unsolved starting from the identification of the best mathematical approach for representing incomplete knowledge. Currently measurement uncertainty is treated in a purely probabilistic way because the Theory of Probability has been considered the only available mathematical theory capable of handling incomplete information. However this approach has the main drawback of requiring full compensation of any systematic effect that affects the measurement process. However especially in many practical applications the identification and compensation of all systematic effects is not always possible or cost effective.

Do Dice Play God? Ian Stewart, 2019-06-06. 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 to 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.

Measurement Uncertainty Simona Salicone, 2006-12-06. 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.

The Mathematics of the Uncertain Eduardo Gil, Eva Gil, Juan Gil, María Ángeles Gil, 2018-02-28. This book is a tribute to Professor Pedro Gil who created the Department of Statistics, OR and TM at the University of Oviedo and a former President of the Spanish Society of Statistics and OR SEIO. In more than eighty original contributions, it illustrates the extent to which Mathematics can help manage uncertainty, a factor that is inherent to real life. Today it goes without saying that in order to model experiments and systems and to analyze related outcomes and data, it is necessary to consider formal ideas and develop scientific approaches and techniques for dealing with uncertainty. Mathematics is crucial in this endeavor as this

book demonstrates As Professor Pedro Gil highlighted twenty years ago there are several well known mathematical branches for this purpose including Mathematics of chance Probability and Statistics Mathematics of communication Information Theory and Mathematics of imprecision Fuzzy Sets Theory and others These branches often intertwine since different sources of uncertainty can coexist and they are not exhaustive While most of the papers presented here address the three aforementioned fields some hail from other Mathematical disciplines such as Operations Research others in turn put the spotlight on real world studies and applications The intended audience of this book is mainly statisticians mathematicians and computer scientists but practitioners in these areas will certainly also find the book a very interesting read

The Geometry of Uncertainty Fabio Cuzzolin, 2020-12-17 The principal aim of this book is to introduce to the widest possible audience an original view of belief calculus and uncertainty theory In this geometric approach to uncertainty uncertainty measures can be seen as points of a suitably complex geometric space and manipulated in that space for example combined or conditioned In the chapters in Part I Theories of Uncertainty the author offers an extensive recapitulation of the state of the art in the mathematics of uncertainty This part of the book contains the most comprehensive summary to date of the whole of belief theory with Chap 4 outlining for the first time and in a logical order all the steps of the reasoning chain associated with modelling uncertainty using belief functions in an attempt to provide a self contained manual for the working scientist In addition the book proposes in Chap 5 what is possibly the most detailed compendium available of all theories of uncertainty Part II The Geometry of Uncertainty is the core of this book as it introduces the author's own geometric approach to uncertainty theory starting with the geometry of belief functions Chap 7 studies the geometry of the space of belief functions or belief space both in terms of a simplex and in terms of its recursive bundle structure Chap 8 extends the analysis to Dempster's rule of combination introducing the notion of a conditional subspace and outlining a simple geometric construction for Dempster's sum Chap 9 delves into the combinatorial properties of plausibility and commonality functions as equivalent representations of the evidence carried by a belief function then Chap 10 starts extending the applicability of the geometric approach to other uncertainty measures focusing in particular on possibility measures consonant belief functions and the related notion of a consistent belief function The chapters in Part III Geometric Interplays are concerned with the interplay of uncertainty measures of different kinds and the geometry of their relationship with a particular focus on the approximation problem Part IV Geometric Reasoning examines the application of the geometric approach to the various elements of the reasoning chain illustrated in Chap 4 in particular conditioning and decision making Part V concludes the book by outlining a future complete statistical theory of random sets future extensions of the geometric approach and identifying high impact applications to climate change machine learning and artificial intelligence The book is suitable for researchers in artificial intelligence statistics and applied science engaged with theories of uncertainty The book is supported with the most comprehensive bibliography on belief and uncertainty theory

Understanding Uncertainty Dennis V.

Lindley, 2013-12-16 Praise for the First Edition a reference for everyone who is interested in knowing and handling uncertainty Journal of Applied Statistics The critically acclaimed First Edition of Understanding Uncertainty provided a study of uncertainty addressed to scholars in all fields showing that uncertainty could be measured by probability and that probability obeyed three basic rules that enabled uncertainty to be handled sensibly in everyday life These ideas were extended to embrace the scientific method and to show how decisions containing an uncertain element could be rationally made Featuring new material the Revised Edition remains the go to guide for uncertainty and decision making providing further applications at an accessible level including A critical study of transitivity a basic concept in probability A discussion of how the failure of the financial sector to use the proper approach to uncertainty may have contributed to the recent recession A consideration of betting showing that a bookmaker's odds are not expressions of probability Applications of the book's thesis to statistics A demonstration that some techniques currently popular in statistics like significance tests may be unsound even seriously misleading because they violate the rules of probability Understanding Uncertainty Revised Edition is ideal for students studying probability or statistics and for anyone interested in one of the most fascinating and vibrant fields of study in contemporary science and mathematics

Uncertainty Quantification Ralph C. Smith, 2013-12-02 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

Spectral Methods for Uncertainty Quantification Olivier Le Maître, Omar M Knio, 2010-03-11 This book deals with the application of spectral methods to problems of uncertainty propagation and quantification in model based computations It specifically focuses on computational and algorithmic features of these methods which are most useful in dealing with models based on partial differential equations with special attention to models arising in simulations of fluid flows Implementations are illustrated through applications to elementary problems as well as more elaborate examples selected from the authors' interests in incompressible vortex dominated flows and compressible flows at low Mach numbers Spectral stochastic methods are probabilistic in nature and are consequently rooted in the rich mathematical foundation associated with probability and measure spaces Despite the authors' fascination with this foundation the discussion only alludes to those theoretical aspects

needed to set the stage for subsequent applications The book is authored by practitioners and is primarily intended for researchers or graduate students in computational mathematics physics or uid dynamics The book assumes familiarity with elementary methods for the numerical solution of time dependent partial differential equations prior experience with spectral methods is naturally helpful though not essential Full appreciation of elaborate examples in computational uid dynamics CFD would require familiarity with key and in some cases delicate features of the associated numerical methods Besides these shortcomings our aim is to treat algorithmic and computational aspects of spectral stochastic methods with details sufficient to address and reconstruct all but those highly elaborate examples

Uncertainty Quantification Ralph C. Smith, 2013-12-02

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 Theory Baoding Liu, 2011-11-07

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

Introduction to Uncertainty Quantification T.J. Sullivan, 2015-12-14

This text provides a framework in which the main objectives of the field of uncertainty quantification UQ are defined and an overview of the range of mathematical methods by which they can be achieved Complete with exercises throughout the book will equip readers with both theoretical understanding and practical experience of the key mathematical and algorithmic tools underlying the treatment of uncertainty in modern applied mathematics Students and readers alike are encouraged to apply

the mathematical methods discussed in this book to their own favorite problems to understand their strengths and weaknesses also making the text suitable for a self study

Uncertainty quantification is a topic of increasing practical importance at the intersection of applied mathematics statistics computation and numerous application areas in science and engineering This text is designed as an introduction to UQ for senior undergraduate and graduate students with a mathematical or statistical background and also for researchers from the mathematical sciences or from applications areas who are interested in the field T J Sullivan was Warwick Zeeman Lecturer at the Mathematics Institute of the University of Warwick United Kingdom from 2012 to 2015 Since 2015 he is Junior Professor of Applied Mathematics at the Free University of Berlin Germany with specialism in Uncertainty and Risk Quantification

Measuring Uncertainty within the Theory of Evidence Simona Salicone,Marco Prioli,2018-04-23 This monograph considers the evaluation and expression of measurement uncertainty within the mathematical framework of the Theory of Evidence With a new perspective on the metrology science the text paves the way for innovative applications in a wide range of areas Building on Simona Salicone s Measurement Uncertainty An Approach via the Mathematical Theory of Evidence the material covers further developments of the Random Fuzzy Variable RFV approach to uncertainty and provides a more robust mathematical and metrological background to the combination of measurement results that leads to a more effective RFV combination method While the first part of the book introduces measurement uncertainty the Theory of Evidence and fuzzy sets the following parts bring together these concepts and derive an effective methodology for the evaluation and expression of measurement uncertainty A supplementary downloadable program allows the readers to interact with the proposed approach by generating and combining RFVs through custom measurement functions With numerous examples of applications this book provides a comprehensive treatment of the RFV approach to uncertainty that is suitable for any graduate student or researcher with interests in the measurement field

Uncertainty Theory Baoding Liu,2014-11-03 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

Calculating Uncertainty John Thibault,2013-10-28 This book provides a brief introduction to Probability Management and a tutorial on the theory and practice of SIP math

Economic-Mathematical Methods and Models under Uncertainty

A. G. Aliyev,2013-12-07 In this book on mathematical programming the postulate spacial time certainty of economic process at uncertainty conditions in finite dimensional vector space and the principle piecewise linear homogeneity of economic process at uncertainty conditions in finite dimensional vector space are first suggested A special theory on constructing piecewis *Probability: The Science of Uncertainty* Michael A. Bean,2009 Covers the basic probability of distributions with an emphasis on applications from the areas of investments insurance and engineering This book is suitable as a text for senior undergraduate and beginning graduate students in mathematics statistics actuarial science finance or engineering

Decision Making Under Uncertainty Via Optimization, Modelling, and Analysis Laxminarayan Sahoo,Tapan Senapati,Madhumangal Pal,Ronald R. Yager,2025-03-02 This book focuses on cutting edge developments in optimal decision making incorporating modeling and optimization for determining renewable energy sources supply chain management and environmental planning under uncertainty It addresses mathematical models of cost effective management policies This book presents the best decision making practices for solving real world challenges This book provides access to an invaluable collection of various decision making issues that scholars and industry practitioners use as a reference The readers are able to understand how decision making problems are formulated under uncertainty and how to use right optimization strategies to fix problems

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