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Leifur Leifsson *Editors*

Surrogate-Based Modeling and Optimization

Applications in Engineering

 Springer

Surrogate Based Modeling And Optimization Applications In Engineering

Slawomir Koziel, Adrian Bekasiewicz



Surrogate Based Modeling And Optimization Applications In Engineering:

Surrogate-Based Modeling and Optimization Slawomir Koziel, Leifur Leifsson, 2013-06-06 Contemporary engineering design is heavily based on computer simulations Accurate high fidelity simulations are used not only for design verification but even more importantly to adjust parameters of the system to have it meet given performance requirements Unfortunately accurate simulations are often computationally very expensive with evaluation times as long as hours or even days per design making design automation using conventional methods impractical These and other problems can be alleviated by the development and employment of so called surrogates that reliably represent the expensive simulation based model of the system or device of interest but they are much more reasonable and analytically tractable This volume features surrogate based modeling and optimization techniques and their applications for solving difficult and computationally expensive engineering design problems It begins by presenting the basic concepts and formulations of the surrogate based modeling and optimization paradigm and then discusses relevant modeling techniques optimization algorithms and design procedures as well as state of the art developments The chapters are self contained with basic concepts and formulations along with applications and examples The book will be useful to researchers in engineering and mathematics in particular those who employ computationally heavy simulations in their design work

Surrogate Model-Based Engineering Design and Optimization Ping Jiang, Qi Zhou, Xinyu Shao, 2019-11-01 This book covers some of the most popular methods in design space sampling ensembling surrogate models multi fidelity surrogate model construction surrogate model selection and validation surrogate based robust design optimization and surrogate based evolutionary optimization Surrogate or metamodels are now frequently used in complex engineering product design to replace expensive simulations or physical experiments They are constructed from available input parameter values and the corresponding output performance or quantities of interest QOIs to provide predictions based on the fitted or interpolated mathematical relationships The book highlights a range of methods for ensembling surrogate and multi fidelity models which offer a good balance between surrogate modeling accuracy and building cost A number of real world engineering design problems such as three dimensional aircraft design are also provided to illustrate the ability of surrogates for supporting complex engineering design Lastly illustrative examples are included throughout to help explain the approaches in a more hands on manner

Multi-objective Design Of Antennas Using Surrogate Models Slawomir Koziel, Adrian Bekasiewicz, 2016-11-18 This book addresses computationally efficient multi objective optimization of antenna structures using variable fidelity electromagnetic simulations surrogate modeling techniques and design space reduction methods Based on contemporary research it formulates multi objective design tasks highlights related challenges in the context of antenna design and discusses solution approaches Specific focus is on providing methodologies for handling computationally expensive simulation models of antenna structures in the sense of their multi objective optimization Also given is a summary of recent developments in antenna design optimization using

variable fidelity simulation models Numerous examples of real world antenna design problems are provided along with discussions and recommendations for the readers interested in applying the considered methods in their design work Written with researchers and students in mind topics covered can also be applied across a broad spectrum of aeronautical mechanical electrical biomedical and civil engineering It is of particular interest to those dealing with optimization computationally expensive design tasks and simulation driven design

Applications of Evolutionary Computation Paul Kaufmann, Pedro A. Castillo, 2019-04-10 This book constitutes the refereed proceedings of the 22nd International Conference on Applications of Evolutionary Computation EvoApplications 2019 held in Leipzig Germany in April 2019 co located with the Evo 2019 events EuroGP EvoCOP and EvoMUSART The 44 revised full papers presented were carefully reviewed and selected from 66 submissions They were organized in topical sections named Engineering and Real World Applications Games General Image and Signal Processing Life Sciences Networks and Distributed Systems Neuroevolution and Data Analytics Numerical Optimization Theory Benchmarks and Applications Robotics

Data-Driven Global Optimization Methods and Applications Huachao Dong, Peng Wang, Jinglu Li, 2025-07-15 This book presents recent advances in data driven global optimization methods combining theoretical foundations with real world applications to address complex engineering optimization challenges The book begins with an overview of the state of the art key technologies and standard benchmark problems in the field It then delves into several innovative approaches space reduction based hybrid surrogate model based and multi surrogate model based global optimization followed by surrogate assisted constrained global optimization discrete global optimization and high dimensional global optimization These methods represent a variety of optimization techniques that excel in both optimization capability and efficiency making them ideal choices for complex engineering optimization problems Through benchmark test problems and real world engineering applications the book illustrates the practical implementation of these methods linking established theories with cutting edge research in industrial and engineering optimization Both a professional book and an academic reference this title will provide valuable insights for researchers students engineers and practitioners in a variety of fields including optimization methods and algorithms engineering design and manufacturing and artificial intelligence and machine learning

Advanced Structural Textile Composites Forming Peng Wang, Nahiène Hamila, 2024-08-27 Advanced Structural Textile Composites Forming Characterization Modeling and Simulation comprehensively describes the influence of fiber fabric architectures and properties on composites forming along with their deformability and structural optimization covering the latest advances in the composites forming field Part one reviews textile reinforcement architectures and discusses the forming behaviors of important 2D and 3D fabrics Part two discusses numerical models to conduct simulation analysis of different structural composites forming at mesoscopic and macroscopic scales in particular 3D preforms with through the thickness yarns Part three looks at the latest developments in the relationship between forming and other steps in composite manufacturing such

as resin injection and automated fiber placement AFP and the effects on certain mechanical properties such as structural damage and impact resistance The book will be an essential reference for academic researchers industrial engineers and materials scientists working with the manufacture and design of fiber reinforced composite materials Describes the influence of the fiber fabric architectures and properties on composites forming along with their deformability and structural optimization Provides numerical modeling and simulation of different fiber reinforced composites forming at mesoscopic and macroscopic scales in particular reinforcements with discontinuous fibers and 3D preforms with through the thickness yarns Discusses cutting edge topics such as resin injection and automated fiber placement AFP and the effects of forming results on mechanical properties such as structural damage and impact resistances *Simulation-based Optimization Of Antenna Arrays* Slawomir Koziel, Stanislav Ogurtsov, 2019-02-13 The book addresses surrogate assisted design of antenna arrays in particular how surrogate models both data driven and physics based can be utilized to expedite procedures such as parametric optimization design closure statistical analysis or fault detection Algorithms and design frameworks are illustrated using a large variety of examples including real world printed circuit antenna and antenna array structures This unique compendium contains introductory materials concerning numerical optimization both conventional gradient based and derivative free including metaheuristics and surrogate based as well as a considerable selection of customized procedures developed specifically to handle antenna array problems Recommendations concerning practical aspects of surrogate assisted multi objective antenna optimization are also given The methods presented allow for cost efficient handling of antenna array design problems involving CPU intensive EM models in the context of design optimization and statistical analysis which will benefit both researchers designers and graduate students *Applications of Differential-Algebraic Equations: Examples and Benchmarks* Stephen Campbell, Achim Ilchmann, Volker Mehrmann, Timo Reis, 2019-06-08 This volume encompasses prototypical innovative and emerging examples and benchmarks of Differential Algebraic Equations DAEs and their applications such as electrical networks chemical reactors multibody systems and multiphysics models to name but a few Each article begins with an exposition of modelling explaining whether the model is prototypical and for which applications it is used This is followed by a mathematical analysis and if appropriate a discussion of the numerical aspects including simulation Additionally benchmark examples are included throughout the text Mathematicians engineers and other scientists working in both academia and industry either on differential algebraic equations and systems or on problems where the tools and insight provided by differential algebraic equations could be useful would find this book resourceful *Computational Optimization and Applications in Engineering and Industry* Xin-She Yang, Slawomir Koziel, 2011-06-19 Contemporary design in engineering and industry relies heavily on computer simulation and efficient algorithms to reduce the cost and to maximize the performance and sustainability as well as profits and energy efficiency Solving an optimization problem correctly and efficiently requires not only the right choice of

optimization algorithms and simulation methods but also the proper implementation and insight into the problem of interest. This book consists of ten self-contained detailed case studies of real world optimization problems selected from a wide range of applications and contributed from worldwide experts who are working in these exciting areas. Optimization topics and applications include gas and water supply networks, oil field production optimization, microwave engineering, aerodynamic shape design, environmental emergence modelling, structural engineering, waveform design for radar and communication systems, parameter estimation in laser experiment and measurement engineering, materials and network scheduling. These case studies have been solved using a wide range of optimization techniques including particle swarm optimization, genetic algorithms, artificial bee colony, harmony search, adaptive error control, derivative free pattern search, surrogate based optimization, variable fidelity modelling, as well as various other methods and approaches. This book is a practical guide to help graduates and researchers to carry out optimization for real world applications. More advanced readers will also find it a helpful reference and aide memoire.

Nanoelectronic Coupled Problems Solutions E. Jan W. ter Maten, Hans-Georg Brachtendorf, Roland Pulch, Wim Schoenmaker, Herbert De Gersem, 2019-11-06. Designs in nanoelectronics often lead to challenging simulation problems and include strong feedback couplings. Industry demands provisions for variability in order to guarantee quality and yield. It also requires the incorporation of higher abstraction levels to allow for system simulation in order to shorten the design cycles while at the same time preserving accuracy. The methods developed here promote a methodology for circuit and system level modelling and simulation based on best practice rules which are used to deal with coupled electromagnetic field, circuit heat problems as well as coupled electro-thermal stress problems that emerge in nanoelectronic designs. This book covers:

1. advanced monolithic multi-rate co-simulation techniques which are combined with envelope wavelet approaches to create efficient and robust simulation techniques for strongly coupled systems that exploit the different dynamics of sub-systems within multiphysics problems and which allow designers to predict reliability and ageing.
2. new generalized techniques in Uncertainty Quantification (UQ) for coupled problems to include a variability capability such that robust design and optimization, worst case analysis and yield estimation with tiny failure probabilities are possible including large deviations like 6 sigma.
3. enhanced sparse parametric Model Order Reduction techniques with a posteriori error estimation for coupled problems and for UQ to reduce the complexity of the sub-systems while ensuring that the operational and coupling parameters can still be varied and that the reduced models offer higher abstraction levels that can be efficiently simulated.

All the new algorithms produced were implemented, transferred and tested by the EDA vendor MAGWEL. Validation was conducted on industrial designs provided by end users from the semiconductor industry who shared their feedback, contributed to the measurements and supplied both material data and process data. In closing, a thorough comparison to measurements on real devices was made in order to demonstrate the algorithms' industrial applicability.

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