Lecture 26 Introduction To Variationalmethods

The methods of functional analysis have helped solve diverse real-world problems in optimization, modeling, analysis, numerical approximation, and computer simulation. Applied Functional Analysis presents functional analysis results surfacing repeatedly in scientific and technological applications and presides over the most current analytical and numerical methods in infinite-dimensional spaces. This reference highlights critical studies in projection theorem, Riesz representation theorem, and properties of operators in Hilbert space and covers special classes of optimization problems. Supported by 2200 display equations, this guide incorporates hundreds of up-to-date citations.

The papers collected in this volume are contributions to the 43rd session of the Seminaire ? de mathematiques ? superieures ? (SMS) on “Morse Theoretic Methods in Nonlinear Analysis and Symplectic Topology.” This session took place at the Universite ? de Montreal ? in July 2004 and was a NATO Advanced Study Institute (ASI). The aim of the ASI was to bring together young researchers from various parts of the world and to present to them some of the most signi cant recent advances in these areas. More than 77 mathematicians from 17 countries followed the 12 series of lectures and participated in the lively exchange of ideas. The lectures covered an ample spectrum of subjects which are re ected in the present volume: Morse theory and related techniques in in nite dim- sional spaces, Floer theory and its recent extensions and generalizations, Morse and Floer theory in relation to string topology, generating functions, structure of the group of Hamiltonian di?eomorphisms and related dynamical problems, applications to robotics and many others. We thank all our main speakers for their stimulating lectures and all p- ticipants for creating a friendly atmosphere during the meeting. We also thank Ms. Diane Belanger ? , our administrative assistant, for her help with the organi- tion and Mr. Andre ? Montpetit, our technical editor, for his help in the preparation of the volume.

This volume presents the latest research results in the thermodynamics and design of thermoelectric devices, providing a solid foundation for thermoelectric element and module design in the technical development process, and a valuable tool for any application development.

At the crossroads between statistics and machine learning, probabilistic graphical models provide a powerful formal framework to model complex data. For instance, Bayesian networks and Markov random fields are two of the most popular probabilistic graphical models. With the rapid advance of high-throughput technologies and their ever decreasing costs, a fast-growing volume of biological data of various types - the so-called "omics" - is in need of accurate andefficient methods for modeling, prior to further downstream analysis. As probabilistic graphical models are able to deal with high-dimensional data, it is foreseeable that such models will have aprominent role to play in advances in genome-wide data analyses. Currently, few people are specialists in the design of cutting-edge methods using probabilistic graphical models for genetics, genomics and postgenomics. This seriously hinders the diffusion of such methods. The prime aim of the book is therefore to bring the concepts underlying these advanced models within reach of scientists who are not specialists of these models, but with no concession on theinformativeness of the book. The target readers include researchers and engineers who have to design novel methods for postgenomics data analysis, as well as graduate students starting a Masters or a PhD. Inaddition to an introductory chapter on probabilistic graphical models, a thorough review chapter focusing on selected domains in genetics and fourteen chapters illustrate the design of such advanced approaches in various domains: gene network inference, inference of causal phenotype networks, association genetics, epigenetics, detection of copy number variations, and prediction of outcomes from high-dimensional genomic data. Notably, most examples also illustrate that probabilistic graphicalmodels are well suited for integrative biology and systems biology, hot topics guaranteed to be of lasting interest.

Arising from the fourth Dagstuhl conference entitled Visualization and Processing of Tensors and Higher Order Descriptors for Multi-Valued Data (2011), this book offers a broad and vivid view of current work in this emerging field. Topics covered range from applications of the analysis of tensor fields to research on their mathematical and analytical properties. Part I, Tensor Data Visualization, surveys techniques for visualization of tensors and tensor fields in engineering, discusses the current state of the art and challenges, and examines tensor invariants and glyph design, including an overview of common glyphs. The second Part, Representation and Processing of Higher-order Descriptors, describes a matrix representation of local phase, outlines mathematical morphological operations techniques, extended for use in vector images, and generalizes erosion to the space of diffusion weighted MRI. Part III, Higher Order Tensors and Riemannian-Finsler Geometry, offers powerful mathematical language to model and analyze large and complex diffusion data such as High Angular Resolution Diffusion Imaging (HARDI) and Diffusion Kurtosis Imaging (DKI). A Part entitled Tensor Signal Processing presents new methods for processing tensor-valued data, including a novel perspective on performing voxel-wise morphometry of diffusion tensor data using kernel-based approach, explores the free-water diffusion model, and reviews proposed approaches for computing fabric tensors, emphasizing trabecular bone research. The last Part, Applications of Tensor Processing, discusses metric and curvature tensors, two of the most studied tensors in geometry processing. Also covered is a technique for diagnostic prediction of first-episode schizophrenia patients based on brain diffusion MRI data. The last chapter presents an interactive system integrating the visual analysis of diffusion MRI tractography with data from electroencephalography.

In the framework of the "Annee non lineaire" (the special nonlinear year) sponsored by the C.N.R.S. (the French National Center for Scien tific Research), a meeting was held in Paris in June 1988. It took place in the Conference Hall of the Ministere de la Recherche and had as an organizing theme the topic of "Variational Problems." Nonlinear analysis has been one of the leading themes in mathemat ical research for the past decade. The use of direct variational methods has been particularly successful in understanding problems arising from physics and geometry. The growth of nonlinear analysis is largely due to the wealth of ap plications from various domains of sciences and industrial applica tions. Most of the papers gathered in this volume have their origin in applications: from mechanics, the study of Hamiltonian systems, from physics, from the recent mathematical theory of liquid crystals, from geometry, relativity, etc. Clearly, no single volume could pretend to cover the whole scope of nonlinear variational problems. We have chosen to concentrate on three main aspects of these problems, organizing them roughly around the following topics: 1. Variational methods in partial differential equations in mathemat ical physics 2. Variational problems in geometry 3. Hamiltonian systems and related topics.

This 2003 book presents min-max methods through a study of the different faces of the celebrated Mountain Pass Theorem (MPT) of Ambrosetti and Rabinowitz. The reader is led from the most accessible results to the forefront of the theory, and at each step in this walk between the hills, the author presents the extensions and variants of the MPT in a complete and unified way. Coverage includes standard topics, but it also covers other topics covered nowhere else in book form: the non-smooth MPT; the geometrically constrained MPT; numerical approaches to the MPT; and even more exotic variants. Each chapter has a section with supplementary comments and bibliographical notes, and there is a rich bibliography and a detailed index to aid the reader. The book is suitable for researchers and graduate students. Nevertheless, the style and the choice of the material make it accessible to all newcomers to the field.

This book takes readers on a tour through modern methods in image analysis and reconstruction based on level set and PDE techniques, the major focus being on morphological and geometric structures in images. The aspects covered include edge-sharpening image reconstruction and denoising, segmentation and shape analysis in images, and image matching. For each, the lecture notes provide insights into the basic analysis of modern variational and PDE-based techniques, as well as computational aspects and applications.

This well-thought-out book covers the fundamentals of nonlinear analysis, with a particular focus on variational methods and their applications. Starting from preliminaries in functional analysis, it expands in several directions such as Banach spaces, fixed point theory, nonsmooth analysis, minimax theory, variational calculus and inequalities, critical point theory, monotone, maximal monotone and pseudomonotone operators, and evolution problems.

This book covers different, current research directions in the context of variational methods for non-linear geometric data. Each chapter is authored by leading experts in the respective discipline and provides an introduction, an overview and a description of the current state of the art. Non-linear geometric data arises in various applications in science and engineering. Examples of nonlinear data spaces are diverse and include, for instance, nonlinear spaces of matrices, spaces of curves, shapes as well as manifolds of probability measures. Applications can be found in biology, medicine, product engineering, geography and computer vision for instance. Variational methods on the other hand have evolved to being amongst the most powerful tools for applied mathematics. They involve techniques from various branches of mathematics such as statistics, modeling, optimization, numerical mathematics and analysis. The vast majority of research on variational methods, however, is focused on data in linear spaces. Variational methods for non-linear data is currently an emerging research topic. As a result, and since such methods involve various branches of mathematics, there is a plethora of different, recent approaches dealing with different aspects of variational methods for nonlinear geometric data. Research results are rather scattered and appear in journals of different mathematical communities. The main purpose of the book is to account for that by providing, for the first time, a comprehensive collection of different research directions and existing approaches in this context. It is organized in a way that leading researchers from the different fields provide an introductory overview of recent research directions in their respective discipline. As such, the book is a unique reference work for both newcomers in the field of variational methods for non-linear geometric data, as well as for established experts that aim at to exploit new research directions or collaborations. Chapter 9 of this book is available open access under a CC BY 4.0 license at link.springer.com.

An Introduction to Variational Autoencoders provides a quick summary for the of a topic that has become an important tool in modern-day deep learning techniques.

This monograph is an introduction to optimal control theory for systems governed by vector ordinary differential equations. It is not intended as a state-of-the-art handbook for researchers. We have tried to keep two types of reader in mind: (1) mathematicians, graduate students, and advanced undergraduates in mathematics who want a concise introduction to a field which contains nontrivial interesting applications of mathematics (for example, weak convergence, convexity, and the theory of ordinary differential equations); (2) economists, applied scientists, and engineers who want to understand some of the mathematical foundations. of optimal control theory. In general, we have emphasized motivation and explanation, avoiding the "definition-axiom-theorem-proof" approach. We make use of a large number of examples, especially one simple canonical example which we carry through the entire book. In proving theorems, we often just prove the simplest case, then state the more general results which can be proved. Many of the more difficult topics are discussed in the "Notes" sections at the end of chapters and several major proofs are in the Appendices. We feel that a solid understanding of basic facts is best attained by at first avoiding excessive generality. We have not tried to give an exhaustive list of references, preferring to refer the reader to existing books or papers with extensive bibliographies. References are given by author's name and the year of publication, e.g., Waltman [1974].

Provides a common setting for various methods of bounding the eigenvalues of a self-adjoint linear operator and emphasizes their relationships.

Variational Inequalities and Frictional Contact Problems contains a carefully selected collection of results on elliptic and evolutionary quasi-variational inequalities including existence, uniqueness, regularity, dual formulations, numerical approximations and error estimates ones. By using a wide range of methods and arguments, the results are presented in a constructive way, with clarity and well justified proofs. This approach makes the subjects accessible to mathematicians and applied mathematicians. Moreover, this part of the book can be used as an excellent background for the investigation of more general classes of variational inequalities. The abstract variational inequalities considered in this book cover the variational formulations of many static and quasi-static contact problems. Based on these abstract results, in the last part of the book, certain static and quasi-static frictional contact problems in elasticity are studied in an almost exhaustive way. The readers will find a systematic and unified exposition on classical, variational and dual formulations, existence, uniqueness and regularity results, finite element approximations and related optimal control problems. This part of the book is an update of the Signorini problem with nonlocal Coulomb friction, a problem little studied and with few results in the literature. Also, in the quasi-static case, a control problem governed by a bilateral contact problem is studied. Despite the theoretical nature of the presented results, the book provides a background for the numerical analysis of contact problems. The materials presented are accessible to both graduate/under graduate students and to researchers in applied mathematics, mechanics, and engineering. The obtained results have numerous applications in mechanics, engineering and geophysics. The book contains a good amount of original results which, in this unified form, cannot be found anywhere else.

This book presents a unified view of image motion analysis under the variational framework. Variational methods, rooted in physics and mechanics, but appearing in many other domains, such as statistics, control, and computer vision, address a problem from an optimization standpoint, i.e., they formulate it as the optimization of an objective function or functional. The methods of image motion analysis described in this book use the calculus of variations to minimize (or maximize) an objective functional which transcribes all of the constraints that characterize the desired motion variables. The book addresses the four core subjects of motion analysis: Motion estimation, detection, tracking, and three-dimensional interpretation. Each topic is covered in a dedicated chapter. The presentation is prefaced by an introductory chapter which discusses the purpose of motion analysis. Further, a chapter is included which gives the basic tools and formulae related to curvature, Euler Lagrange equations, unconstrained descent optimization, and level sets, that the variational image motion processing methods use repeatedly in the book.

Announcements for the following year included in some vols.

This book constitutes the refereed proceedings of the First International Conference on Scale Space Methods and Variational Methods in Computer Vision, SSVM 2007, emanated from the joint edition of the 4th International Workshop on Variational, Geometric and Level Set Methods in Computer Vision, VLSM 2007 and the 6th International Conference on Scale Space and PDE Methods in Computer Vision, Scale-Space 2007, held in Ischia Italy, May/June 2007.

This work, consisting of expository articles as well as research papers, highlights recent developments in nonlinear analysis and differential equations. The material is largely an outgrowth of autumn school courses and seminars held at the University of Lisbon and has been thoroughly refereed. Several topics in ordinary differential equations and partial differential equations are the focus of key articles, including: * periodic solutions of systems with p-Laplacian type operators (J. Mawhin) * bifurcation in variational inequalities (K. Schmitt) * a geometric approach to dynamical systems in the plane via twist theorems (R. Ortega) * asymptotic behavior and periodic solutions for Navier--Stokes equations (E. Feireisl) * mechanics on Riemannian manifolds (W. Oliva) * techniques of lower and upper solutions for ODEs (C. De Coster and P. Habets) A number of related subjects dealing with properties of solutions, e.g., bifurcations, symmetries,

nonlinear oscillations, are treated in other articles. This volume reflects rich and varied fields of research and will be a useful resource for mathematicians and graduate students in the ODE and PDE community.

Computer vision encompasses the construction of integrated vision systems and the application of vision to problems of real-world importance. The process of creating 3D models is still rather difficult, requiring mechanical measurement of the camera positions or manual alignment of partial 3D views of a scene. However using algorithms, it is possible to take a collection of stereo-pair images of a scene and then automatically produce a photo-realistic, geometrically accurate digital 3D model. This book provides a comprehensive introduction to the methods, theories and algorithms of 3D computer vision. Almost every theoretical issue is underpinned with practical implementation or a working algorithm using pseudo-code and complete code written in C++ and MatLab®. There is the additional clarification of an accompanying website with downloadable software, case studies and exercises. Organised in three parts, Cyganek and Siebert give a brief history of vision research, and subsequently: present basic low-level image processing operations for image matching, including a separate chapter on image matching algorithms; explain scale-space vision, as well as space reconstruction and multiview integration; demonstrate a variety of practical applications for 3D surface imaging and analysis; provide concise appendices on topics such as the basics of projective geometry and tensor calculus for image processing, distortion and noise in images plus image warping procedures. An Introduction to 3D Computer Vision Algorithms and Techniques is a valuable reference for practitioners and programmers working in 3D computer vision, image processing and analysis as well as computer visualisation. It would also be of interest to advanced students and researchers in the fields of engineering, computer science, clinical photography, robotics, graphics and mathematics.

Transport Phenomena in Micro- and Nanoscale Functional Materials and Devices offers a pragmatic view on transport phenomena for micro- and nanoscale materials and devices, both as a research tool and as a means to implant new functions in materials. Chapters emphasize transport properties (TP) as a research tool at the micro/nano level and give an experimental view on underlying techniques. The relevance of TP is highlighted through the interplay between a micro/nanocarrier’s characteristics and media characteristics: long/short-range order and disorder excitations, couplings, and in energy conversions. Later sections contain case studies on the role of transport properties in functional nanomaterials. This includes transport in thin films and nanostructures, from nanogranular films, to graphene and 2D semiconductors and spintronics, and from read heads, MRAMs and sensors, to nano-oscillators and energy conversion, from figures of merit, micro-coolers and micro-heaters, to spincaloritronics. Presents a pragmatic description of electrical transport phenomena in micro- and nanoscale materials and devices from an experimental viewpoint Provides an in-depth overview of the experimental techniques available to measure transport phenomena in micro- and nanoscale materials Features case studies to illustrate how each technique works Highlights emerging areas of interest in micro- and nanomaterial transport phenomena, including spintronics

A systematic presentation of energy principles and variationalmethods The increasing use of numerical and computational methods inengineering and applied sciences has shed new light on theimportance of energy principles and variational methods. EnergyPrinciples and Variational Methods in Applied Mechanicsprovides a systematic and practical introduction to the use ofenergy principles, traditional variational methods, and the finiteelement method to the solution of engineering problems involvingbars, beams, torsion, plane elasticity, and plates. Beginning with a review of the basic equations of mechanics andthe concepts of work, energy, and topics from variational calculus,this book presents the virtual work and energy principles, energymethods of solid and structural mechanics, Hamilton'sprinciple for dynamical systems, and classical variational methodsof approximation. A unified approach, more general than that foundin most solid mechanics books, is used to introduce the finiteelement method. Also discussed are applications to beams andplates. Complete with more than 200 illustrations and tables, EnergyPrinciples and Variational Methods in Applied Mechanics, SecondEdition is a valuable book for students of aerospace, civil,mechanical, and applied mechanics; and engineers in design andanalysis groups in the aircraft, automobile, and civil engineeringstructures, as well as shipbuilding industries.

Shape optimization problems are treated from the classical and modern perspectives Targets a broad audience of graduate students in pure and applied mathematics, as well as engineers requiring a solid mathematical basis for the solution of practical problems Requires only a standard knowledge in the calculus of variations, differential equations, and functional analysis Driven by several good examples and illustrations Poses some open questions.

This book presents the mathematical theory of vector variational inequalities and their relations with vector optimization problems. It is the first-ever book to introduce well-posedness and sensitivity analysis for vector equilibrium problems. The first chapter provides basic notations and results from the areas of convex analysis, functional analysis, set-valued analysis and fixed-point theory for set-valued maps, as well as a brief introduction to variational inequalities and equilibrium problems. Chapter 2 presents an overview of analysis over cones, including continuity and convexity of vector-valued functions. The book then shifts its focus to solution concepts and classical methods in vector optimization. It describes the formulation of vector variational inequalities and their applications to vector optimization, followed by separate chapters on linear scalarization, nonsmooth and generalized vector variational inequalities. Lastly, the book introduces readers to vector equilibrium problems and generalized vector equilibrium problems. Written in an illustrative and reader-friendly way, the book offers a valuable resource for all researchers whose work involves optimization and vector optimization.

This book pays tribute to 25 Singaporean South Asians who pioneered and excelled in their respective fields from 1950 to 2015. It is meant to be a 'quick take' on 25 Singaporean South Asian personalities, across a broad spectrum of professions and activities, who believed in the value and virtue of service to the community and gave the best of themselves.They had a sense of mission in their professions, dedicated to what they were doing and fostered a sense of community and nation. Many of them laid foundations that triggered the transformation of the island, including sportspeople whose records have stood the test of time. They were a people of their time whose work many may not know but which we hope will inspire others. This book is timely, for those who want to get a snapshot appreciation of the contributions of Singaporean South Asians.

Recent years have witnessed important developments in those areas of the mathematical sciences where the basic model under study is a dynamical system such as a differential equation or control process. Many of these recent advances were made possible by parallel developments in nonlinear and nonsmooth analysis. The latter subjects, in general terms, encompass differential analysis and optimization theory in the absence of traditional linearity, convexity or smoothness assumptions. In the last three decades it has become increasingly recognized that nonlinear and nonsmooth behavior is naturally present and prevalent in dynamical models, and is therefore significant theoretically. This point of view has guided us in the organizational aspects of this ASI. Our goals were twofold: We intended to achieve "cross fertilization" between mathematicians who were working in a diverse range of problem areas, but who all shared an interest in nonlinear and nonsmooth analysis. More importantly, it was our goal to expose a young international audience (mainly graduate students and recent Ph. D. 's) to these important subjects. In that regard, there were heavy pedagogical demands placed upon the twelve speakers of the ASI,

in meeting the needs of such a gathering. The talks, while exposing current areas of research activity, were required to be as introductory and comprehensive as possible. It is our belief that these goals were achieved, and that these proceedings bear this out. Each of the twelve speakers presented a mini-course of four or five hours duration.

This book addresses key aspects of recent developments in applied mathematical analysis and its use. It also highlights a broad range of applications from science, engineering, technology and social perspectives. Each chapter investigates selected research problems and presents a balanced mix of theory, methods and applications for the chosen topics. Special emphasis is placed on presenting basic developments in applied mathematical analysis, and on highlighting the latest advances in this research area. The book is presented in a self-contained manner as far as possible, and includes sufficient references to allow the interested reader to pursue further research in this still-developing field. The primary audience for this book includes graduate students, researchers and educators; however, it will also be useful for general readers with an interest in recent developments in applied mathematical analysis and applications.

Phase transformations in solids typically lead to surprising mechanical behaviour with far reaching technological applications. The mathematical modeling of these transformations in the late 80s initiated a new field of research in applied mathematics, often referred to as mathematical materials science, with deep connections to the calculus of variations and the theory of partial differential equations. This volume gives a brief introduction to the essential physical background, in particular for shape memory alloys and a special class of polymers (nematic elastomers). Then the underlying mathematical concepts are presented with a strong emphasis on the importance of quasiconvex hulls of sets for experiments, analytical approaches, and numerical simulations.

This book constitutes the thoroughly refereed post-proceedings of the International Workshop on Statistical Network Analysis: Models, Issues, and New Directions held in Pittsburgh, PA, USA in June 2006 as associated event of the 23rd International Conference on Machine Learning, ICML 2006. It covers probabilistic methods for network analysis, paying special attention to model design and computational issues of learning and inference.

This is an exposition of the theory, techniques, and the basic formulation of structural optimization problems. The author considers applications of design optimization criteria involving strength, rigidity, stability and weight. Analytic and numerical techniques are introduced for research in optimal shapes and internal configurations of deformable bodies and structures. Problems of the optimal design of beams, systems of rods, plates and shells, are studied in detail. With regard to applications, this work is oriented towards solutions of real problems, such as reduction of the volume or weight of the material, and improvement of mechanical properties of structures. This book is written for readers specializing in applied mechanics, applied mathematics, and numerical analysis."

The objectives of this monograph are to present some topics from the theory of monotone operators and nonlinear semigroup theory which are directly applicable to the existence and uniqueness theory of initial-boundary-value problems for partial differential equations and to construct such operators as realizations of those problems in appropriate function spaces. A highlight of this presentation is the large number and variety of examples introduced to illustrate the connection between the theory of nonlinear operators and partial differential equations. These include primarily semilinear or quasilinear equations of elliptic or of parabolic type, degenerate cases with change of type, related systems and variational inequalities, and spatial boundary conditions of the usual Dirichlet, Neumann, Robin or dynamic type. The discussions of evolution equations include the usual initial-value problems as well as periodic or more general nonlocal constraints, history-value problems, those which may change type due to a possibly vanishing coefficient of the time derivative, and other implicit evolution equations or systems including hysteresis models. The scalar conservation law and semilinear wave equations are briefly mentioned, and hyperbolic systems arising from vibrations of elastic-plastic rods are developed. The origins of a representative sample of such problems are given in the appendix.

Machine Learning: A Bayesian and Optimization Perspective, 2nd edition, gives a unified perspective on machine learning by covering both pillars of supervised learning, namely regression and classification. The book starts with the basics, including mean square, least squares and maximum likelihood methods, ridge regression, Bayesian decision theory classification, logistic regression, and decision trees. It then progresses to more recent techniques, covering sparse modelling methods, learning in reproducing kernel Hilbert spaces and support vector machines, Bayesian inference with a focus on the EM algorithm and its approximate inference variational versions, Monte Carlo methods, probabilistic graphical models focusing on Bayesian networks, hidden Markov models and particle filtering. Dimensionality reduction and latent variables modelling are also considered in depth. This palette of techniques concludes with an extended chapter on neural networks and deep learning architectures. The book also covers the fundamentals of statistical parameter estimation, Wiener and Kalman filtering, convexity and convex optimization, including a chapter on stochastic approximation and the gradient descent family of algorithms, presenting related online learning techniques as well as concepts and algorithmic versions for distributed optimization. Focusing on the physical reasoning behind the mathematics, without sacrificing rigor, all the various methods and techniques are explained in depth, supported by examples and problems, giving an invaluable resource to the student and researcher for understanding and applying machine learning concepts. Most of the chapters include typical case studies and computer exercises, both in MATLAB and Python. The chapters are written to be as self-contained as possible, making the text suitable for different courses: pattern recognition, statistical/adaptive signal processing, statistical/Bayesian learning, as well as courses on sparse modeling, deep learning, and probabilistic graphical models. New to this edition: Complete re-write of the chapter on Neural Networks and Deep Learning to reflect the latest advances since the 1st edition. The chapter, starting from the basic perceptron and feed-forward neural networks concepts, now presents an in depth treatment of deep networks, including recent optimization algorithms, batch normalization, regularization techniques such as the dropout method, convolutional neural networks, recurrent neural networks, attention mechanisms, adversarial examples and training, capsule networks and generative architectures, such as restricted Boltzman machines (RBMs), variational autoencoders and generative adversarial networks (GANs). Expanded treatment of Bayesian learning to include nonparametric Bayesian methods, with a focus on the Chinese restaurant and the Indian buffet processes. Presents the physical reasoning, mathematical modeling and algorithmic implementation of each method Updates on the latest trends, including sparsity, convex analysis and optimization, online distributed algorithms, learning in RKH spaces, Bayesian inference, graphical and hidden Markov models, particle filtering, deep learning, dictionary learning and latent variables modeling Provides case studies on a variety of topics, including protein folding prediction, optical character recognition, text authorship identification, fMRI data analysis, change point detection, hyperspectral image unmixing, target localization, and more

Energy Principles and Variational Methods in Applied MechanicsJohn Wiley & Sons

Introduces readers to the fundamentals and applications of variational formulations in mechanics Nearly 40 years in the making, this book provides students with the foundation material of mechanics using a variational tapestry. It is centered around the variational structure underlying the Method of Virtual Power (MVP). The variational approach to the modeling of physical systems is the preferred approach to address complex mathematical modeling of both continuum and discrete media. This book provides a unified theoretical framework for the construction of a wide range of multiscale models. Introduction to the Variational Formulation in Mechanics: Fundamentals and Applications enables readers to develop, on top of solid mathematical (variational) bases, and following clear and precise systematic steps, several models of physical systems, including problems involving multiple scales. It covers: Vector and Tensor Algebra; Vector and Tensor Analysis; Mechanics of Continua; Hyperelastic Materials; Materials Exhibiting Creep; Materials Exhibiting Plasticity; Bending of Beams; Torsion of Bars; Plates and Shells; Heat Transfer; Incompressible Fluid Flow; Multiscale Modeling; and more. A self-contained reader-friendly approach to the variational formulation in the mechanics Examines development of advanced variational formulations in different areas within the field of mechanics using rather simple arguments and explanations Illustrates application of the variational modeling to address hot topics such as the multiscale modeling of complex material behavior Presentation of the Method of Virtual Power as a systematic tool to construct mathematical models of physical systems gives readers a fundamental asset towards the architecture of even more complex (or open) problems Introduction to the Variational Formulation in Mechanics: Fundamentals and Applications is a ideal book for advanced courses in engineering and mathematics, and an excellent resource for researchers in engineering, computational modeling, and scientific computing.
Shape optimization deals with problems where the design or control variable is no longer a vector of parameters or functions but the shape of a geometric domain. They include engineering applications to shape and structural optimization, but also original applications to image segmentation, control theory, stabilization of membranes and plates by boundary variations, etc. Free and moving boundary problems arise in an impressingly wide range of new and challenging applications to change of phase. The class of problems which are amenable to this approach can arise from such diverse disciplines as combustion, biological growth, reactive geological flows in porous media, solidification, fluid dynamics, electrochemical machining, etc. The objective and orginality of this NATO-ASI was to bring together theories and examples from shape optimization, free and moving boundary problems, and materials with microstructure which are fundamental to static and dynamic domain and boundary problems.