Dynamic Programming And Partial Differential Equations Volume 88 Mathematics In Science And Engineering

This is the second edition of the now definitive text on partial differential equations (PDE). It offers a comprehensive survey of modern techniques in the theoretical study of PDE with particular emphasis on nonlinear equations. Its wide scope and clear exposition make it a great text for a graduate course in PDE. For this edition, the author has made numerous changes, including a new chapter on nonlinear wave equations, more than 80 new exercises, several new sections, a significantly expanded bibliography. About the First Edition: I have used this book for both regular PDE and topics courses. It has a wonderful combination of insight and technical detail. … Evans' book is evidence of his mastering of the field and the clarity of presentation. —Luis Caffarelli, University of Texas It is fun to teach from Evans' book. It explains many of the essential ideas and techniques of partial differential equations … Every graduate student in analysis should read it. —David Jerison, MIT I usePartial Differential Equationsto prepare my students for their Topic exam, which is a requirement before starting working on their dissertation. The book provides an excellent account of PDE's … I am very happy with the preparation it provides my students. —Carlos Kenig, University of Chicago Evans' book has already attained the status of a classic. It is a clear choice for students just learning the subject, as well as for experts who wish to broaden their knowledge … An outstanding reference for many aspects of the field. —Rafe Mazzeo, Stanford University
This useful reference provides recent results as well as entirely new material on control problems for partial differential equations.
Extending the well-known connection between classical linear potential theory and probability theory (through the interplay between harmonic functions and martingales) to the nonlinear case of tug-of-war games and their related partial differential equations, this unique book collects several results in this direction and puts them in an elementary perspective in a lucid and self-contained fashion.
Dynamic Programming and Its Application to Optimal Control
International Series in Modern Applied Mathematics and Computer Science
Optimal Control of Hydrosystems
Layered functionals and partial differential equations. XV
Hamiltonian Systems and HJB Equations
Contents: Linear Algebraic EquationsFinding the Square Root of a Positive Definite MatrixLargest and Smallest Characteristic RootsLinear Differential Equations with Constant CoefficientsLinear Differential Equations with Variable CoefficientsOn the Determination of Characteristic Values for a Class of Sturm-Liouville ProblemsNonlinear Differential EquationsAsymptotic BehaviorPartial Differential Equations and Dynamic ProgrammingPartial Differential Equations and Invariant ImbeddingMaximum AltitudeSemigroups in SpaceVariational Problems and Functional EquationsAllocation Processes, Lagrange Multipliers and the Maximum Transform Readership: Applied mathematicians and physicists.
Dynamic Programming and the Calculus of Variations
Dynamic Programming and Partial Differential EquationsAcademic Press
Upper and lower bounds for solutions of nonlinear partial differential equations. XIV
Application of Dynamic Programming to Stochastic Time Optimal Control
Stochastic Controls
Stochastic and Differential Games
Dynamic Programming
Dynamic Programming and Partial Differential Equations
This volume contains the proceedings of a NATO/London Mathematical Society Advanced Study Institute held in Oxford from 25 July - 7 August 1982. The institute concerned the theory and applications of systems of nonlinear partial differential equations, with emphasis on techniques appropriate to systems of more than one equation. Most of the lecturers and participants were analysts specializing in partial differential equations, but also present were a number of numerical analysts, workers in mechanics, and other applied mathematicians. The organizing committee for the institute was J.M. Ball (Heriot-Watt), T.B. Benjamin (Oxford), J. Carr (Heriot-Watt), C.M. Dafermos (Brown), S. Hildebrandt (Bonn) and J.S. pym (Sheffield) . The programme of the institute consisted of a number of courses of expository lectures, together with special sessions on different topics. It is a pleasure to thank all the lecturers for the care they took in the preparation of their talks, and S.S. Antman, A.J. Chorin, J.K. Hale and J.E. Marsden for the organization of their special sessions. The institute was made possible by financial support from NATO, the London Mathematical Society, the u.S. Army Research Office, the u.S. Army European Research Office, and the u.S. National Science Foundation. The lectures were held in the Mathematical Institute of the University of Oxford, and residential accommodation was provided at Hertford College.
A non-linear control process is discussed where the control is bounded as absolute value. A random element (noise) that appears additively as part of the control variable is assumed. The performance criterion of driving the system back to equilibrium from its present perturbed state in minimum "expected" time, due to the presence of the random noise is used. The principle of optimality of dynamic programming to derive a novel partial differential equation in the minimum expected time is applied. Solutions of this equation yield the optimal control policy, which is bang bang. Specifically, far from the origin of the corresponding phase space, the control is set, once only, to drive the system into the linear region near the origin. In the linear region, the control switching sequence corresponding to Bushaw's theorem ensues. (Author).
Functional Equations in the Theory of Dynamic Programming
Optimal Control and Viscosity Solutions of Hamilton-Jacobi-Bellman Equations
Selective Computation
Populations, Reactors, Tides and Waves: Theory and Applications
Control of Partial Differential Equations
We analyze a zero-sum stochastic differential game between two competing players who can choose unbounded controls. The payoffs of the game are defined through backward stochastic differential equations. We prove that each player's priority value satisfies a weak dynamic programming principle and thus solves the associated fully non-linear partial differential equation in the viscosity sense.
This book collects some recent developments in stochastic control theory with applications to financial mathematics. We first address standard stochastic control problems from the viewpoint of the recently developed weak dynamic programming principle. A special emphasis is put on the regularity issues and, in particular, on the behavior of the value function near the boundary. We then provide a quick review of the main tools from viscosity solutions which allow to overcome all regularity problems. We next address the class of stochastic target problems which extends in a nontrivial way the standard stochastic control problems. Here the theory of viscosity solutions plays a crucial role in the derivation of the dynamic programming equation as the infinitesimal counterpart of the corresponding geometric dynamic programming equation. The various developments of this theory have been stimulated by applications in finance and by relevant connections with geometric flows. Namely, the second order extension was motivated by illiquidity modeling, and the controlled loss version was introduced following the problem of quantile hedging. The third part specializes to an overview of Backward stochastic differential equations, and their extensions to the quadratic case.
This memorandum presents an approach to the nonparametric simple problem of the calculus of variations that is in the spirit of dynamic programming. Under the assumptions that the functions that define minimizing curves exhibit a certain regularity in their behavior, differentiability properties of the optimal value function W are determined. Then the fundamental partial differential equation of dynamic programming is obtained, and the necessary conditions of the calculus of variations, with the exception of Jacobi's condition, are deduced as immediate corollaries. (Author).
Nonlinear Partial Differential Equations

Hyperbolic Partial Differential Equations
Dynamic Programming and Partial Differential Equations
Applied Dynamic Programming
The fundu=onal equation technique of dynamic programming is applied to the study of co trol processes governed by equ tions of quite general type. Of particular interest are processes with time lags (differential-difference equations) and processes with distributed parameters (partial differential equations). (Author).
This softcover book is a self-contained account of the theory of viscosity solutions for first-order partial differential equations of Hamilton–Jacobi type and its interplay with Bellman's dynamic programming approach to optimal control and differential games. It will be of interest to scientists involved in the theory of optimal control of deterministic linear and nonlinear systems. The work may be used by graduate students and researchers in control theory both as an introductory textbook and as an up-to-date reference book.
As is well known, Pontryagin's maximum principle and Bellman's dynamic programming are the two principal and most commonly used approaches in solving stochastic optimal control problems. * An interesting phenomenon one can observe from the literature is that these two approaches have been developed separately and independently. Since both methods are used to investigate the same problems, a natural question one will ask is the fol lowing: (Q) What is the relationship betwccn the maximum principlc and dy namic programming in stochastic optimal controls? There did exist some researches (prior to the 1980s) on the relationship between these two. Nevertheless, the results usually werestated in heuristic terms and proved under rather restrictive assumptions, which were not satisfied in most cases. In the statement of a Pontryagin-type maximum principle there is an adjoint equation, which is an ordinary differential equation (ODE) in the (finite-dimensional) deterministic case and a stochastic differential equation (SDE) in the stochastic case. The system consisting of the adjoint equa tion, the original state equation, and the maximum condition is referred to as an (extended) Hamiltonian system. On the other hand, in Bellman's dynamic programming, there is a partial differential equation (PDE), of first order in the (finite-dimensional) deterministic case and of second or der in the stochastic case. This is known as a Hamilton-Jacobi-Bellman (HJB) equation.
Partial Differential Equations from Dynamic Programming Equations
Dynamic Programming in Chemical Engineering and Process Control by Sanford M Roberts
A Weak Dynamic Programming Principle for Zero-Sum Stochastic Differential Games with Unbounded Controls
A Symposium on Methods of Solution
The Dynamic Programming Principles and Applications
Nonlinear Partial Differential Equations: A Symposium on Methods of Solution is a collection of papers presented at the seminar on methods of solution for nonlinear partial differential equations, held at the University of Delaware, Newark, Delaware on December 27-29, 1965. The sessions are divided into four Symposia: Analytic Methods, Approximate Methods, Numerical Methods, and Applications. Separating 19 lectures into chapters, this book starts with a presentation of the methods of similarity analysis, particularly considering the merits, advantages and disadvantages of the methods. The subsequent chapters describe the fundamental ideas behind the methods for the solution of partial differential equation derived from the theory of dynamic programming and from finite systems of ordinary differential equations. These topics are followed by reviews of the principles to the lubrication approximation and compressible boundary-layer flow computation. The discussion then shifts to several applications of nonlinear partial differential equations, including in electrical problems, two-phase flow, hydrodynamics, and heat transfer. The remaining chapters cover other solution methods for partial differential equations, such as the synergetic approach. This book will prove useful to applied mathematicians, physicists, and engineers.
Introduction to mathematical theory of multistage decision processes takes a "functional equation" approach. Topics include existence and uniqueness theorems, optimal inventory equation, bottleneck problems, multistage games, Markovian decision processes, and more. 1957 edition.
In this book, we study theoretical and practical aspects of computing methods for mathematical modelling of nonlinear systems. A number of computing techniques are considered, such as methods of operator approximation with any given accuracy; operator interpolation techniques including a non-Lagrange interpolation; methods of system representation subject to constraints associated with concepts of causality, memory and stationarity; methods of system representation with an accuracy that is the best within a given class of models; methods of covariance matrix estimation; methods for low-rank matrix approximations; hybrid methods based on a combination of iterative procedures and best operator approximation; and methods for information compression and filtering under condition that a filter model should satisfy restrictions associated with causality and different types of memory. As a result, the book represents a blend of new methods in general computational analysis, and specific, but also generic, techniques for study of systems theory ant its particular branches, such as optimal filtering and information compression. - Best operator approximation, - Non-Lagrange interpolation, - Generic Karhunen-Loeve transform - Generalised low-rank matrix approximation - Optimal data compression - Optimal nonlinear filtering
Introduction to Dynamic Programming
Sendai, Japan, July 10–28 and October 2–6, 2017
Optimal Control of Diffusion Processes and Hamilton-Jacobi-Bellman Equations
Nonlinear Partial Differential Equations for Future Applications
A Dynamic Programming Approach to the Nonparametric Problem in the Calculus of Variations
Four techniques for the numerical solution of partial differential equations and eigenvalue problems were investigated. Typical problems considered were elliptic partial differential equations of the form U sub xx + U sub yy = f(x, y), or U sub xx + U sub yy + lambda squared U = O, where appropriate boundary conditions are specified so that the problem is self-adjoint. The four methods are relaxation, Galerkin, Rayleigh-Ritz, and dynamic programming combined with Stodola'a method, for eigenvalue problems. The results indicated that for eigenvalue problems relaxation or dynamic programming modified is to be preferred usually and for partial differential equations Galerkin or dynamic programming is preferred.
Hyperbolic Partial Differential Equations, Volume 1: Population, Reactors, Tides and Waves: Theory and Applications covers three general areas of hyperbolic partial differential equation applications. These areas include problems related to the McKendrick/Von Foerster population equations, other hyperbolic form equations, and the numerical solution. This text is composed of 15 chapters and begins with surveys of age specific population interactions, populations models of diffusion, nonlinear age dependent population growth with harvesting, local and global stability for the nonlinear renewal equation in the Von Foerster model, and nonlinear age-dependent population dynamics. The next chapters deal with various applications of hyperbolic partial differential equations to such areas as age-structured fish populations, density dependent growth in a cell colony, boll-weevil-cotton crop modeling, age dependent predation and cannibalism, parasite populations, growth of microorganisms, and stochastic perturbations in the Von Foerster model. These topics are followed by discussions of bifurcation of time periodic solutions of the McKendrick equation; the periodic solution of nonlinear hyperbolic problems; and semigroup theory as applied to nonlinear age dependent population dynamics. Other chapters explore the stability of biochemical reaction tanks, an ADI model for the Laplace tidal equations, the Carleman equation, the nonequilibrium behavior of solids that transport heat by second sound, and the nonlinear hyperbolic partial differential equations and dynamic programming. The final chapters highlight two explicitly numerical applications: a predictor-convex corrector method and the Galerkin approximation in hyperbolic partial differential equations. This book will prove useful to practicing engineers, population researchers, physicists, and mathematicians.
This comprehensive study of dynamic programming applied to numerical solution of optimization problems. It will interest aerodynamic, control, and industrial engineers, numerical analysts, and computer specialists, applied mathematicians, economists, and operations and systems analysts. Originally published in 1962. The Princeton Legacy Library uses the latest print-on-demand technology to again make available previously out-of-print books from the distinguished backlist of Princeton University Press. These editions preserve the original texts of these important books while presenting them in durable paperback and hardcover editions. The goal of the Princeton Legacy Library is to vastly increase access to the rich scholarly heritage found in the thousands of books published by Princeton University Press since its founding in 1905.
Dynamic Programming Applied to Control Processes Governed by General Functional Equations
A Look at Some Methods of Solving Partial Differential Equations and Eigenvalue Problems
New Methods for Their Treatment and Solution
Dynamic Programming and Linear Partial Differential Equations
Optimal Stochastic Control, Stochastic Target Problems, and Backward SDE
"Combines the hydraulic simulation of physical processes with mathematical programming and differential dynamic programming techniques to ensure the optimization of hydrosystems. Presents the principles and methodologies for systems and optimal control concepts; features differential dynamic programming in developing models and solution algorithms for groundwater, real-time flood and sediment control of river-reservoir systems, and water distribution systems operations, as well as bay and estuary freshwater inflow reservoir oprations; and more."
The purpose of this book is to present some new methods in the treatment of partial differential equations. Some of these methods lead to effective numerical algorithms when combined with the digital computer. Also presented is a useful chapter on Green's functions which generalizes, after an introduction, to new methods of obtaining Green's functions for partial differential operators. Finally some very new material is presented on solving partial differential equations by Adomian's decomposition methodology. This method can yield realistic computable solutions for linear or non linear cases even for strong nonlinearities, and also for deterministic or stochastic cases - again even if strong stochasticity is involved. Some interesting examples are discussed here and are to be followed by a book dealing with frontier applications in physics and engineering. In Chapter I, it is shown that a use of positive operators can lead to monotone convergence for various classes of nonlinear partial differential equations. In Chapter II, the utility of conservation technique is shown. These techniques are suggested by physical principles. In Chapter III, it is shown that dyn~mic programming applied to variational problems leads to interesting classes of nonlinear partial differential equations. In Chapter IV, this is investigated in greater detail. In Chapter V, we show. that the use of a transformation suggested by dynamic programming leads to a new method of successive approximations.
This book may be regarded as consisting of two parts. In Chapters I-IV we pre sent what we regard as essential topics in an introduction to deterministic optimal control theory. This material has been used by the authors for one semester graduate-level courses at Brown University and the University of Kentucky. The simplest problem in calculus of variations is taken as the point of departure, in Chapter I. Chapters II, III, and IV deal with necessary conditions for an opti mum, existence and regularity theorems for optimal controls, and the method of dynamic programming. The beginning reader may find it useful first to learn the main results, corollaries, and examples. These tend to be found in the earlier parts of each chapter. We have deliberately postponed some difficult technical proofs to later parts of these chapters. In the second part of the book we give an introduction to stochastic optimal control for Markov diffusion processes. Our treatment follows the dynamic pro gramming method, and depends on the intimate relationship between second order partial differential equations of parabolic type and stochastic differential equations. This relationship is reviewed in Chapter V, which may be read inde pendently of Chapters I-IV. Chapter VI is based to a considerable extent on the authors' work in stochastic control since 1961. It also includes two other topics important for applications, namely, the solution to the stochastic linear regulator and the separation principle.
By Edward S. Angel and Richard Bellman
Dynamic Programming of Continuous Processes
Dynamic Programming and the Calculus of Variations
Game Theory and Partial Differential Equations
Partial Differential Equations
This volume features selected, original, and peer-reviewed papers on topics from a series of workshops on Nonlinear Partial Differential Equations for Future Applications that were held in 2017 at Tohoku University in Japan. The contributions address an abstract maximal regularity with applications to parabolic equations, stability, and bifurcation for viscous compressible Navier-Stokes equations, new estimates for a compressible Gross-Pitaevskii-Navier-Stokes system, singular limits for the Keller-Segel system in critical spaces, the dynamic programming principle for stochastic optimal control, two kinds of regularity machineries for elliptic obstacle problems, and new insight on topology of nodal sets of high-energy eigenfunctions of the Laplacian. This book aims to exhibit various theories and methods that appear in the study of nonlinear partial differential equations.
The theory of two-person, zero-sum differential games started at the be ginning of the 1960s with the works of R. Isaacs in the United States and L.S. Pontryagin and his school in the former Soviet Union. Isaacs based his work on the Dynamic Programming method. He analyzed many special cases of the partial differential equation now called Hamilton Jacobi-Isaacs-briefiy HJI-trying to solve them explicitly and synthe sizing optimal feedbacks from the solution. He began a study of singular surfaces that was continued mainly by J. Breakwell and P. Bernhard and led to the explicit solution of some low-dimensional but highly nontriv ial games; a recent survey of this theory can be found in the book by J. Lewin entitled Differential Games (Springer, 1994). Since the early stages of the theory, several authors worked on making the notion of value of a differential game precise and providing a rigorous derivation of the HJI equation, which does not have a classical solution in most cases; we mention here the works of W. Fleming, A. Friedman (see his book, Differential Games, Wiley, 1971), P.P. Varaiya, E. Roxin, R.J. Elliott and N.J. Kalton, N.N. Krasovskii, and A.I. Subbotin (see their book Po sitional Differential Games, Nauka, 1974, and Springer, 1988), and L.D. Berkovitz. A major breakthrough was the introduction in the 1980s of two new notions of generalized solution for Hamilton-Jacobi equations, namely, viscosity solutions, by M.G. Crandall and P.-L.
"In this dissertation, novel adaptive/approximate dynamic programming (ADP) based state and output feedback control methods are presented for distributed parameter systems (DPS) which are expressed as uncertain parabolic partial differential equations (PDEs) in one and two dimensional domains. In the first step, the output feedback control design using an early lumping method is introduced after model reduction. Subsequently controllers were developed in four stages; Unlike current approaches in the literature, state and output feedback approaches were designed without utilizing model reduction for uncertain linear, coupled nonlinear and two-dimensional parabolic PDEs, respectively. In all of these techniques, the infinite horizon cost function was considered and controller design was obtained in a forward-in-time and online manner without solving the algebraic Riccati equation (ARE) or using value and policy iterations techniques. Providing the stability analysis in the original infinite dimensional domain was a major challenge. Using Lyapunov criterion, the ultimate boundedness (UB) result was demonstrated for the regulation of closed-loop system using all the techniques developed herein. Moreover, due to distributed and large scale nature of state space, pure state feedback control design for DPS has proven to be practically obsolete. Therefore, output feedback design using limited point sensors in the domain or at boundaries are introduced. In the final two papers, the developed state feedback ADP control method was extended to regulate multi-dimensional and more complicated nonlinear parabolic PDE dynamics"--Abstract, page iv.
Systems of Nonlinear Partial Differential Equations
Theory and Numerical Methods
Deterministic and Stochastic Optimal Control
The Diagonal Decomposition Technique Applied to the Dynamic Programming Solution of Elliptic Partial Differential Equations
Boundary Control of Parabolic PDE Using Adaptive Dynamic Programming
Introduction to Dynamic Programming introduces the reader to dynamic programming and presents the underlying mathematical ideas and results, as well as the application of these ideas to various problem areas. A large number of solved practical problems and computational examples are included to clarify the way dynamic programming is used to solve problems. A consistent notation is applied throughout the text for the expression of quantities such as state variables and decision variables. This monograph consists of 10 chapters and opens with an overview of dynamic programming as a particular approach to optimization, along with the basic components of any mathematical optimization model. The following chapters discuss the application of dynamic programming to variational problems; functional equations and the principle of optimality; reduction of state dimensionality and approximations; and stochastic processes and the calculus of variations. The final chapter looks at several actual applications of dynamic programming to practical problems, such as animal feedlot optimization and optimal scheduling of excess cash investment. This book should be suitable for self-study or for use as a text in a one-semester course on dynamic programming at the senior or first-year, graduate level for students of mathematics, statistics, operations research, economics, business, industrial engineering, or other engineering fields.