Randall J. LeVeque

Numerical Methods
for Conservation Laws

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Numerical Methods For Conservation Laws:

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highlights what is specific to and beneficial in the Lagrangian approach and its numerical methods The two first chapters present a selection of well known features of conservation laws and prepare readers for the subsequent chapters which are dedicated to the analysis and discretization of Lagrangian systems The text is at the frontier of applied mathematics and scientific computing and appeals to students and researchers interested in Lagrangian based computational fluid dynamics It also serves as an introduction to the recent corner based Lagrangian finite volume techniques *Property-preserving Numerical Schemes For Conservation Laws* Dmitri Kuzmin,Hennes Hajduk,2023-08-28 High order numerical methods for hyperbolic conservation laws do not guarantee the validity of constraints that physically meaningful approximations are supposed to satisfy The finite volume and finite element schemes summarized in this book use limiting techniques to enforce discrete maximum principles and entropy inequalities Spurious oscillations are prevented using artificial viscosity operators and or essentially nonoscillatory reconstructions An introduction to classical nonlinear stabilization approaches is given in the simple context of one dimensional finite volume discretizations Subsequent chapters of Part I are focused on recent extensions to continuous and discontinuous Galerkin methods Many of the algorithms presented in these chapters were developed by the authors and their collaborators Part II gives a deeper insight into the mathematical theory of property preserving numerical schemes It begins with a review of the convergence theory for finite volume methods and ends with analysis of algebraic flux correction schemes for finite elements In addition to providing ready to use algorithms this text explains the design principles behind such algorithms and shows how to put theory into practice Although the book is based on lecture notes written for an advanced graduate level course it is also aimed at senior researchers who develop and analyze numerical methods for hyperbolic problems *Some Results on Numerical Methods for Hyperbolic Conservation Laws* Huanan Yang,1989 A Study of Numerical Methods for Hyperbolic Conservation Laws with Stiff Source Terms Randall J. LeVeque,1988 Numerical Methods for One-dimensional Hyperbolic Conservation Laws Adriaan Cornelis Berkenbosch,Enrique Francisco Kaasschieter,Johannes Hendrikus Maria Thije Boonkkamp,1992 An Introduction to Recent Developments in Theory and Numerics for Conservation Laws Dietmar Kröner,Mario Ohlberger,Christian Rohde,2012-12-06 The book concerns theoretical and numerical aspects of systems of conservation laws which can be considered as a mathematical model for the flows of inviscid compressible fluids Five leading specialists in this area give an overview of the recent results which include kinetic methods non classical shock waves viscosity and relaxation methods a posteriori error estimates numerical schemes of higher order on unstructured grids in 3 D preconditioning and symmetrization of the Euler and Navier Stokes equations This book will prove to be very useful for scientists working in mathematics computational fluid mechanics aerodynamics and astrophysics as well as for graduate students who want to learn about new developments in this area *Uncertainty Quantification and Numerical Methods for Conservation Laws* Mass Per Pettersson,2013 Conservation laws with uncertain initial and boundary conditions are approximated using a

generalized polynomial chaos expansion approach where the solution is represented as a generalized Fourier series of stochastic basis functions e g orthogonal polynomials or wavelets The stochastic Galerkin method is used to project the governing partial differential equation onto the stochastic basis functions to obtain an extended deterministic system The stochastic Galerkin and collocation methods are used to solve an advection diffusion equation with uncertain viscosity We investigate well posedness monotonicity and stability for the stochastic Galerkin system High order summation by parts operators and weak imposition of boundary conditions are used to prove stability We investigate the impact of the total spatial operator on the convergence to steady state Next we apply the stochastic Galerkin method to Burgers equation with uncertain boundary conditions An analysis of the truncated polynomial chaos system presents a qualitative description of the development of the solution over time An analytical solution is derived and the true polynomial chaos coefficients are shown to be smooth while the corresponding coefficients of the truncated stochastic Galerkin formulation are shown to be discontinuous We discuss the problematic implications of the lack of known boundary data and possible ways of imposing stable and accurate boundary conditions We present a new fully intrusive method for the Euler equations subject to uncertainty based on a Roe variable transformation The Roe formulation saves computational cost compared to the formulation based on expansion of conservative variables Moreover it is more robust and can handle cases of supersonic flow for which the conservative variable formulation fails to produce a bounded solution A multiwavelet basis that can handle discontinuities in a robust way is used Finally we investigate a two phase flow problem Based on regularity analysis of the generalized polynomial chaos coefficients we present a hybrid method where solution regions of varying smoothness are coupled weakly through interfaces In this way we couple smooth solutions solved with high order finite difference methods with non smooth solutions solved for with shock capturing methods **A Study of Numerical Methods for Hyperbolic Conservation Laws with Stiff Source Terms** National Aeronautics and Space Administration (NASA),2018-06-28 The proper modeling of nonequilibrium gas dynamics is required in certain regimes of hypersonic flow For inviscid flow this gives a system of conservation laws coupled with source terms representing the chemistry Often a wide range of time scales is present in the problem leading to numerical difficulties as in stiff systems of ordinary differential equations Stability can be achieved by using implicit methods but other numerical difficulties are observed The behavior of typical numerical methods on a simple advection equation with a parameter dependent source term was studied Two approaches to incorporate the source term were utilized MacCormack type predictor corrector methods with flux limiters and splitting methods in which the fluid dynamics and chemistry are handled in separate steps Various comparisons over a wide range of parameter values were made In the stiff case where the solution contains discontinuities incorrect numerical propagation speeds are observed with all of the methods considered This phenomenon is studied and explained Leveque R J and Yee H C Ames Research Center **Compact Higher-order Numerical Methods for Hyperbolic Conservation Laws** Robert Byron Lowrie,1996

Godunov Methods E.F. Toro,2012-12-06 This edited review book on Godunov methods contains 97 articles all of which were presented at the international conference on Godunov Methods Theory and Applications held at Oxford in October 1999 to commemo rate the 70th birthday of the Russian mathematician Sergei K Godunov The meeting enjoyed the participation of 140 scientists from 20 countries one of the participants commented everyone is here meaning that virtu ally everybody who had made a significant contribution to the general area of numerical methods for hyperbolic conservation laws along the lines first proposed by Godunov in the fifties was present at the meeting Sadly there were important absentees who due to personal circumstance could not at tend this very exciting gathering The central theme o the meeting and of this book was numerical methods for hyperbolic conservation laws fol lowing Godunov s key ideas contained in his celebrated paper of 1959 But Godunov s contributions to science are not restricted to Godunov s method

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