Discontinuous Galerkin Methods For Solving Elliptic And parabolic Equations: Theory and Implementation (Frontiers in Applied Mathematics)

Béatrice M. Rivière

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Discontinuous Galerkin (DG) methods for solving partial differential equations, developed in the late 1990s, have become popular among computational scientists. This book covers both theory and computation as it focuses on three primal DG methods--the symmetric interior penalty Galerkin, incomplete interior penalty Galerkin, and nonsymmetric interior penalty Galerkin which are variations of interior penalty methods. The author provides the basic tools for analysis and discusses coding issues, including data structure, construction of local matrices, and assembling of the global matrix. Computational examples and applications to important engineering problems are also included.

Discontinuous Galerkin Methods for Solving Elliptic and Parabolic Equations: Theory and Implementation is divided into three parts: Part I focuses on the application of DG methods to second order elliptic problems in one dimension and in higher dimensions. Part II presents the time-dependent parabolic problems without and with convection. Part III contains applications of DG methods to solid mechanics (linear elasticity), fluid dynamics (Stokes and Navier Stokes), and porous media flow (two-phase and miscible displacement).

Appendices contain proofs and MATLAB® code for one-dimensional problems for elliptic equations and routines written in C that correspond to algorithms for the implementation of DG methods in two or three dimensions.

Audience: This book is intended for numerical analysts, computational and applied mathematicians interested in numerical methods for partial differential equations or who study the applications discussed in the book, and engineers who work in fluid dynamics and solid mechanics and want to use DG methods for their numerical results. The book is appropriate for graduate courses in finite element methods, numerical methods for partial differential equations, numerical analysis, and scientific computing. Chapter 1 is suitable for a senior undergraduate class in scientific computing.

Contents: List of Figures; List of Tables; List of Algorithms; Preface; Part I: Elliptic Problems; Chapter 1: One-dimensional problem; Chapter 2: Higher dimensional problem; Part II: Parabolic Problems; Chaper 3: Purely parabolic problems; Chapter 4: Parabolic problems with convection; Part III: Applications; Chapter 5: Linear elasticity; Chapter 6: Stokes flow; Chapter 7: Navier-Stokes flow; Chapter 8: Flow in porous media; Appendix A: Quadrature rules; Appendix B: DG codes; Appendix C: An approximation result; Bibliography; Index.

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