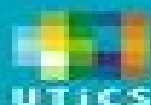


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Principles of Parallel Scientific Computing

A First Guide to Numerical Concepts
and Programming Methods



 Springer

Parallel Scientific Computing

Karin Nielsen-Saines



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Scientific computing has often been called the third approach to scientific discovery emerging as a peer to experimentation and theory. Historically, the synergy between experimentation and theory has been well understood: experiments give insight into possible theories, theories inspire experiments, experiments reinforce or invalidate theories, and so on. As scientific computing has evolved to produce results that meet or exceed the quality of experimental and theoretical results, it has become indispensable. Parallel processing has been an enabling technology in scientific computing for more than 20 years. This book is the first in-depth discussion of parallel computing in 10 years; it reflects the mix of topics that mathematicians, computer scientists, and computational scientists focus on to make parallel processing effective for scientific problems. Presently, the impact of parallel processing on scientific computing varies greatly across disciplines, but it plays a vital role in most problem domains and is absolutely essential in many of them. *Parallel Processing for Scientific Computing* is divided into four parts. The first concerns performance modeling, analysis, and optimization; the second focuses on parallel algorithms and software for an array of problems common to many modeling and simulation applications; the third emphasizes tools and environments that can ease and enhance the process of application development; and the fourth provides a sampling of applications that require parallel computing for scaling to solve larger and realistic models that can advance science and engineering. This edited volume serves as an up-to-date reference for researchers and application developers on the state of the art in scientific computing. It also serves as an excellent overview and introduction, especially for graduate and senior-level undergraduate students interested in computational modeling and simulation and related computer science and applied mathematics aspects.

Contents: List of Figures, List of Tables, Preface, Chapter 1: Frontiers of Scientific Computing: An Overview, Part I: Performance Modeling, Analysis, and Optimization, Chapter 2: Performance Analysis: From Art to Science, Chapter 3: Approaches to Architecture-Aware Parallel Scientific Computation, Chapter 4: Achieving High Performance on the BlueGene/L Supercomputer, Chapter 5: Performance Evaluation and Modeling of Ultra-Scale Systems, Part II: Parallel Algorithms and Enabling Technologies, Chapter 6: Partitioning and Load Balancing, Chapter 7: Combinatorial Parallel and Scientific Computing, Chapter 8: Parallel Adaptive Mesh Refinement, Chapter 9: Parallel Sparse Solvers, Preconditioners, and Their Applications, Chapter 10: A Survey of Parallelization Techniques for Multigrid Solvers, Chapter 11: Fault Tolerance in Large-Scale Scientific Computing, Part III: Tools and Frameworks for Parallel Applications, Chapter 12: Parallel Tools and Environments: A Survey, Chapter 13: Parallel Linear Algebra Software, Chapter 14: High-Performance Component Software Systems, Chapter 15: Integrating Component-Based Scientific Computing Software, Part IV: Applications of Parallel Computing, Chapter 16: Parallel Algorithms for PDE-Constrained Optimization, Chapter 17: Massively Parallel Mixed Integer Programming, Chapter 18: Parallel Methods and Software for Multicomponent Simulations, Chapter 19: Parallel Computational Biology, Chapter 20: Opportunities

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fascinating to undergraduate students Tobias Weinzierl is professor in the Department of Computer Science at Durham University Durham UK He has worked at the Munich Centre for Advanced Computing see the Springer edited book *Advanced Computing* before and holds a PhD and habilitation from the Technical University Munich Parallel Scientific Computing Frédéric Magoules, François-Xavier Roux, Guillaume Houzeaux, 2015-12-15 Scientific computing has become an indispensable tool in numerous fields such as physics mechanics biology finance and industry For example it enables us thanks to efficient algorithms adapted to current computers to simulate without the help of models or experimentations the deflection of beams in bending the sound level in a theater room or a fluid flowing around an aircraft wing This book presents the scientific computing techniques applied to parallel computing for the numerical simulation of large scale problems these problems result from systems modeled by partial differential equations Computing concepts will be tackled via examples Implementation and programming techniques resulting from the finite element method will be presented for direct solvers iterative solvers and domain decomposition methods along with an introduction to MPI and OpenMP *Parallel Scientific Computing and Optimization* Raimondas Ciegis, David Henty, Bo Kågström, Julius Žilinskas, 2010-11-25 Parallel Scientific Computing and Optimization introduces new developments in the construction analysis and implementation of parallel computing algorithms This book presents 23 self contained chapters including survey chapters and surveys written by distinguished researchers in the field of parallel computing Each chapter is devoted to some aspects of the subject parallel algorithms for matrix computations parallel optimization management of parallel programming models and data with the largest focus on parallel scientific computing in industrial applications This volume is intended for scientists and graduate students specializing in computer science and applied mathematics who are engaged in parallel scientific computing

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Applied Parallel Computing Bo Kågström, Erik Elmroth, Jack Dongarra, Jerzy Wasniewski, 2007-10-15 This book constitutes the thoroughly refereed post proceedings of the 8th International Workshop on Applied Parallel Computing PARA 2006 It covers partial differential equations parallel scientific computing algorithms linear algebra simulation environments algorithms and applications for blue gene L scientific computing tools and applications parallel search algorithms peer to peer computing mobility and security algorithms for single chip multiprocessors *Parallel Scientific Computing* Roman Trobec, Gregor Kosec, 2015 This book is concentrated on the synergy between computer science and numerical analysis It is

written to provide a firm understanding of the described approaches to computer scientists engineers or other experts who have to solve real problems The meshless solution approach is described in more detail with a description of the required algorithms and the methods that are needed for the design of an efficient computer program Most of the details are demonstrated on solutions of practical problems from basic to more complicated ones This book will be a useful tool for any reader interested in solving complex problems in real computational domains Parallel Scientific Computing ,1994

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High-Performance Scientific Computing Michael W. Berry,Kyle A. Gallivan,Efstathios Gallopoulos,Ananth Grama,Bernard Philippe,Yousef Saad,Faisal Saied,2012-01-18 This book presents the state of the art in parallel numerical algorithms applications architectures and system software The book examines various solutions for issues of concurrency

scale energy efficiency and programmability which are discussed in the context of a diverse range of applications Features includes contributions from an international selection of world class authorities examines parallel algorithm architecture interaction through issues of computational capacity based codesign and automatic restructuring of programs using compilation techniques reviews emerging applications of numerical methods in information retrieval and data mining discusses the latest issues in dense and sparse matrix computations for modern high performance systems multicores manycores and GPUs and several perspectives on the Spike family of algorithms for solving linear systems presents outstanding challenges and developing technologies and puts these in their historical context **Selected Papers,**

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