Programming Paradigms for Scientific Problem Solving Environments

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Summary. Scientific problem solving environments (PSEs) are software platforms that allow a community of scientific users the ability to easily solve computational problems within a specific domain. They are designed to hide the details of general purpose programming by allowing the problem to be expressed, as much as possible, in the scientific language of the discipline. In many areas of science, the nature of computational problems has evolved from simple desktop calculations to complex, multidisciplinary activities that require the monitoring and analysis of remote data streams, database and web search and large ensembles of supercomputer-hosted simulations. In this paper we will look at the class of PSE that have evolved for these "Grid based" systems and we will consider the associated programming models they support. It will be argued that a hybrid of three standard models provides the right programming support to handle the majority of the applications of these PSEs.

1 Introduction

Domain specific problem solving environments have a long history in computing and there are several examples of widely used tools that are also commercial successes. For example Mathematica [1] provides a platform for doing symbolic mathematics and related visualization tasks using a programming language that is designed with mathematical primitives as a basic component of the type system. Another example is Matlab [2], which is widely used in the scientific community to study problems requiring matrix manipulations or other linear algebra operations. In the area of computer graphics PSE like AVS and Explorer [3] pioneered the use of programming by component composition to build visualization pipelines. This same approach is used in SciRun [4] and many of the other systems described below.

In recent years, we have seen a shift in the nature of the problems scientists are trying to solve and this is changing the way we think about the design of PSEs. Specifically, many contemporary computational science applications require the integration of resources that go beyond the desktop. Remote data sources including online instruments and databases and high-end supercomputing platforms are among

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Programming Environments For High Level Scientific Problem Solving

Pat W. Gaffney,Elias N. Houstis

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Programming Environments for High-level Scientific Problem Solving Pat W. Gaffney,Elias N. Houstis,1992 Programming environments as the name suggests are intended to provide a unified extensive range of capabilities for a person wishing to solve a problem using a computer In this particular proceedings volume the problem considered is a high level scientific computation In other words a scientific problem whose solution usually requires sophisticated computing techniques and a large allocation of computing resources **Enabling Technologies for Computational Science** Elias N. Houstis,John R. Rice,Efstratios Gallopoulos,Randall Bramley,2012-12-06 Enabling Technologies for Computational Science assesses future application computing needs identifies research directions in problem solving environments PSEs addresses multi disciplinary environments operating on the Web proposes methodologies and software architectures for building adaptive and human centered PSEs and describes the role of symbolic computing in scientific and engineering PSEs The book also includes an extensive bibliography of over 400 references Enabling Technologies for Computational Science illustrates the extremely broad and interdisciplinary nature of the creation and application of PSEs Authors represent academia government laboratories and industry and come from eight distinct disciplines chemical engineering computer science ecology electrical engineering mathematics mechanical engineering psychology and wood sciences This breadth and diversity extends into the computer science aspects of PSEs These papers deal with topics such as artificial intelligence computer human interaction control data mining graphics language design and implementation networking numerical analysis performance evaluation and symbolic computing Enabling Technologies for Computational Science provides an assessment of the state of the art and a road map to the future in the area of problem solving environments for scientific computing This book is suitable as a reference for scientists from a variety of disciplines interested in using PSEs for their research **Advanced Methodologies and Technologies in Artificial Intelligence, Computer Simulation, and Human-Computer Interaction** Khosrow-Pour, D.B.A., Mehdi,2018-09-28 As modern technologies continue to develop and evolve the ability of users to adapt with new systems becomes a paramount concern Research into new ways for humans to make use of advanced computers and other such technologies through artificial intelligence and computer simulation is necessary to fully realize the potential of tools in the 21st century Advanced Methodologies and Technologies in Artificial Intelligence Computer Simulation and Human Computer Interaction provides emerging research in advanced trends in robotics AI simulation and human computer interaction Readers will learn about the positive applications of artificial intelligence and human computer interaction in various disciples such as business and medicine This book is a valuable resource for IT professionals researchers computer scientists and researchers invested in assistive technologies artificial intelligence robotics and computer simulation **Scientific and Technical Aerospace Reports** ,1992 **Intelligent Computer Mathematics** Serge Autexier,2008-07-16 This book constitutes the joint refereed proceedings of the 9th

International Conference on Artificial Intelligence and Symbolic Computation AISC 2008 the 15th Symposium on the Integration of Symbolic Computation and Mechanized Reasoning Calculemus 2008 and the 7th International Conference on Mathematical Knowledge Management MKM 2008 held in Birmingham UK in July August as CICM 2008 the Conferences on Intelligent Computer Mathematics The 14 revised full papers for AISC 2008 10 revised full papers for Calculemus 2008 and 18 revised full papers for MKM 2008 plus 5 invited talks were carefully reviewed and selected from a total of 81 submissions for a joint presentation in the book The papers cover different aspects of traditional branches in CS such as computer algebra theorem proving and artificial intelligence in general as well as newly emerging ones such as user interfaces knowledge management and theory exploration thus facilitating the development of integrated mechanized mathematical assistants that will be routinely used by mathematicians computer scientists and engineers in their every day business Lectures on Finite Precision Computations Francoise Chaitin-Chatelin,Val□rie Frayss□,1996-01-01 Finite precision computations are at the heart of the daily activities of many engineers and researchers in all branches of applied mathematics Written in an informal style the book combines techniques from engineering and mathematics to describe the rigorous and novel theory of computability in finite precision In the challenging cases of nonlinear problems theoretical analysis is supplemented by software tools to explore the stability on the computer **Supercomputation In Nonlinear And Disordered Systems: Algorithms, Applications And Architectures** Luis Vazquez,Ignacio Martin,Francisco Tirado,1997-10-22 This proceedings volume is devoted to simulation and parallel computing related to nonlinear problems One of its fundamental aims is the study of how the efforts of computer and computational scientists may be combined to develop most modern simulation environments of nonlinear systems Programming Environments for Massively Parallel Distributed Systems Karsten M. Decker,Rene M. Rehmann,2013-04-17 Massively Parallel Systems MPSs with their scalable computation and storage space promises are becoming increasingly important for high performance computing The growing acceptance of MPSs in academia is clearly apparent However in industrial companies their usage remains low The programming of MPSs is still the big obstacle and solving this software problem is sometimes referred to as one of the most challenging tasks of the 1990 s The 1994 working conference on Programming Environments for Massively Parallel Systems was the latest event of the working group WG 10 3 of the International Federation for Information Processing IFIP in this field It succeeded the 1992 conference in Edinburgh on Programming Environments for Parallel Computing The research and development work discussed at the conference addresses the entire spectrum of software problems including virtual machines which are less cumbersome to program more convenient programming models advanced programming languages and especially more sophisticated programming tools but also algorithms and applications Design and Implementation of Symbolic Computation Systems Alfonso Miola,1993-09-02 This volume constitutes the proceedings of the International Symposium on Design and Implementation of Symbolic Computation Systems DISCO 93 held in Gmunden Austria in September 1993 The

growing importance of systems for symbolic computation has greatly influenced the decision of organizing this third conference in the series DISCO 93 focuses mainly on the most innovative methodological and technological aspects of the design and implementation of hardware and software systems for symbolic and algebraic computation automated reasoning geometric modeling and computation and automatic programming The general objective of DISCO 93 is to present an up to date view of the field and to serve as a forum insymbolic computation for the scientific exchange among academic industrial and user communities Besides invited talks by Buchberger Monagan Omodeo and Hong the volume contains 28 contributions carefully selected by a highly competent international program committee from a total of 56 submissions **Encyclopedia of Information Science and Technology, Third Edition** Khosrow-Pour, D.B.A., Mehdi,2014-07-31 This 10 volume compilation of authoritative research based articles contributed by thousands of researchers and experts from all over the world emphasized modern issues and the presentation of potential opportunities prospective solutions and future directions in the field of information science and technology Provided by publisher Proceedings of the Seventh SIAM Conference on Parallel Processing for Scientific Computing David H. Bailey,1995-01-01 Proceedings Parallel Computing Visualization of Scientific Parallel Programs Gerald Tomas,Christoph W. Ueberhuber,1994-02-28 The substantial effort of parallelizing scientific programs is only justified if the resulting codes are efficient Thus all types of performance tuning are important to parallel software development But performance improvements are much more difficult to achieve with parallel programs than with sequential programs One way to overcome this difficulty is to bring in graphical tools This monograph covers recent developments in parallel program visualization techniques and tools and demonstrates the application of specific visualization techniques and software tools to scientific parallel programs The solution of initial value problems of ordinary differential equations and numerical integration are treated in detail as two important examples **Advances in Software Tools for Scientific Computing** Hans Petter Langtangen,Are M. Bruaset,Ewald Quak,2000 This book concerns programming techniques like object oriented programming and generic template programming These modern techniques have proven to increase flexibility modularization code reuse and improve maintenance of large numerical codes The book contains 11 refereed and comprehensive chapters on major subjects in computational science and engineering quality measurement of numerical software high performance numerical computations with C without sacrificing efficiency a balanced discussion of Java in scientific computing object oriented design of direct sparse solvers geometric kernels in geographical information systems and tools for error estimation in finite element methods tools for validating computational results and how to simplify the implementation of highly complex mathematical model for material processing **ICIAM 91** Robert E. O'Malley,1992-01-01 Proceedings Computer Arithmetic Algebra OOP Parallel Language and Compiler Research in Japan Lubomir Bic,Alexandru Nicolau,Mitsuhisa Sato,2012-12-06 Parallel Language and Compiler Research in Japan offers the international community an opportunity to learn in depth about key Japanese research efforts in the particular software

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