IMACS Workshop on Adaptive Methods for Partial Differential Equations

Summary

This is a request for supplemental support for the IMACS Workshop on Adaptive Methods for Partial Differential Equations to be held at the Fields Institute of Mathematics in Toronto in August, 2002. This workshop is part of a year-long program focusing on numerical computation—the first ever at the Fields Institute. The program recognizes the central importance of numerical analysis in advancing computational science and engineering, and seeks to expand interactions amoung mathematicians, scientists, and engineers. The requested funds will be used to help defray travel expenses of researchers from the U.S., including invited speakers and young researchers at the graduate or post-doctoral level. We are fortunate to have this opportunity to bring young computational scientists to the prestigious Fields Institute and hopeful that the National Science Foundation will participate.

Introduction and Objective

Adaptive methods for partial differential equations (PDEs) are the most effective computational approach for a large class of PDEs that arise in many important applications in science and engineering. This area has grown steadily during the past two decades. This workshop will bring together leading researchers from around the world to address both theoretical and computational aspects of adaptive methods for PDEs and to foster stronger collaboration between mathematicians, engineers and scientists.

Numerical solution of PDEs in a given physical domain is based on some form of discretization, in which the continuum problem formulation is broken down into a discrete number of computational degrees of freedom. Typically, these degrees of freedom represent either nodal values or modal basis coefficients. An increase in the number of degrees of freedom is associated with increased accuracy, that is, a reduction in the difference between the discrete and continuous solutions. Adaptive methods seek to automatically refine the discretization, based on the progressing computation, such that a desired error criterion is met with a minimal number of degrees of freedom. Typically, this requires that the refinement be localized in space in order to capture locally dominant features in the solution. This places special demands on the discretization and the software implementation, especially on parallel computers, where load balance is a primary concern.

The topic of adaptive methods takes on particular relevance at present in light of current interests in the simulation of multiscale phenomena and the rise of initiatives in the development of adaptivity-based software tools aimed at forthcoming Terascale computing platforms. For many problems in areas such as structural mechanics, combustion, micromagnetics (at nanoscales), design optimization, biofluid dynamics, and turbulence, adaptivity offers the potential for orders-of-magnitude reduction in computational cost through a reduction in the number of points required for a given accuracy. The challenge of developing adaptive methods calls for rigorous numerical analysis of challenging nonlinear problems to provide sharp error estimates, the development of high-level software that is flexible and capable of efficient data management on distributed-memory parallel computers consisting of thousands of processors, a correct and complete description of complex geometries in order that the computational boundaries are adequately described upon mesh refinement, flexible variable-order discretizations that can achieve optimal rates of convergence, and the domain-specific expertise of application scientists.

Program Committee

- Paul F. Fischer, Argonne National Laboratory, U.S.A
- Joseph E. Flaherty, Rensselaer Polytechnic Institute, U.S.A.
- Benqi Guo, University of Manitoba, Canada (Co-Chairman)
- Kenneth R. Jackson, University of Toronto, Canada (Co-Chairman)
- Robert D. Russell, Simon Fraser University, Canada

Structure of the Program

The workshop will consist of eight invited and roughly thirty contributed lectures by leading and upcoming researchers in fields that span numerical analysis, computational science, computer science, and engineering. Invited lectures will be 45 minutes each, and contributed talks will be 30 minutes each. The lists of invited speakers and topics proposed for discussion are given below.

Invited Speakers

- Mark Ainsworth, Strathclyde University, Scotland
- Ivo Babuska, University of Texas at Austin, U.S.A.
- Martin Berzins, University of Leeds, U.K.
- Anne Bourlioux, University of Montreal, Canada
- Bernardo Cockburn, University of Minnesota, U.S.A.
- Leszek Demkowicz, University of of Texas at Austin, U.S.A.
- Oleg Vassilyev, University of Missouri, U.S.A.
- Jinchao Xu, Penn State University, U.S.A.

Topics

- A posteriori error estimation
- Adaptive h–p refinement
- Adaptivity with complex geometry
- Implementation of adaptive codes
- Moving mesh techniques and applications
- Adaptive spectral methods
- Nonlinear analysis
- Adaptive modeling
- Applications of adaptive methods

Publicity

The workshop is one of the many activities in the Fields Institute's year-long program in numerical computation. The organizers are contacting colleagues around the world regarding this workshop via email. In addition, the workshop is juxtaposed to two other Institute workshops of relevance to this particular field, namely, "The Short Course on the Numerical Solution of Advection-Diffusion-Reaction Equations" and "The 2002 Workshop on the Solution of Partial Differential Equations on the Sphere." The URL for the workshop is

`www.fields.utoronto.ca/programs/scientific/01-02/numerical/adaptive/index.html#papers`