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Preface

The "International Workshop on the Technological Aspects of Mathematics: advances in computing and software development for Differential Equations" was held in December 18–20, 2002. The aim of the workshop was to bring together numerical analysts, applied mathematicians and researchers to present, discuss and exchange ideas about the numerical solution of differential problems. This has been useful to collect ideas for updating, according to the current requirements in real-life applications, the Test Set for IVP solvers available at the url: http://pitagora.dm.uniba.it/∼testset/.

To achieve this objective all the members of the steering committee of the test set for IVP solvers, that were able to attend the workshop, have been principal speakers and gave the following lectures:

- Jeff R. Cash (Imperial College, London, England): *Mesh selection in methods for solving Boundary Value Problems*;
- Alfredo Bellen (Università di Trieste): *Adaptive integration of Delay Differential Equations*;
- Wayne Enright (University of Toronto, Canada): *The cost/reliability trade-off in verifying approximate solutions to Differential Equations*;
- Ernst Hairer (Università of Genéve, Switzerland): *Implementation of geometric integrators for ordinary differential equations*;
- Linda Petzold (University of California, Santa Barbara, USA): *Sensitivity analysis and optimal control for large-scale Differential-Algebraic Systems*;
- Gustaf Soderlind (Lund University, Sweden): *Computational stability—a quality aspect of ODE/DAE codes*;
- Fred T. Krogh (Math à la Carte, Tujunga, California): *On Developing Mathematical Software*.

There were 21 contributed of 25-min lectures and 55 participants.

The use of Mathematical models involves a kind of cooperation between different branches of Mathematics and Computer Science. They are devoted not only to the translation of real-life phenomena (in Physics, Chemistry, Engineering and Computer Science too) into mathematical equations but also in the numerical treatment and solution of them (usually they are ordinary or partial differential equations). It is not to be neglected that not only experts in PDEs or ODEs are involved into this process. The use of classical numerical methods for these equations requires the efficient solution of related problems (i.e. the efficient solution of large linear or nonlinear systems, structured systems, eigenvalue problems, and so on). The aim of the First International Workshop on the Technological Aspects of Mathematics was the meeting between all the experts in these different aspects of Applied Mathematics, Mathematical Modeling and Computational Coding. It is important to underline that probably the Mathematical Software is the meeting point between Mathematicians and Mathematics Users, those who need mathematical

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tools to improve the knowledge and the real-life phenomena. In the workshop many aspects of applied Mathematics are met and the papers submitted to the proceedings of the conference are just a picture of this aspect.

Probably the most common problem that applied mathematicians meet often is the solution of ordinary differential equations. It represents also the largest set of papers submitted. In the paper by M. Sofroniou and G. Spaletta and in the talk given by E. Hairer a relative young branch of this topic is considered: the Geometric Integration. It means that when solving an ordinary differential system, one needs not only to have a "good" approximation of the theoretical solution but also to share with it some geometric properties. The work by M. Sofroniou and G. Spaletta describes a wide variety of geometric integrators contructed using composition and splitting techniques. Moreover a new framework for ODEs written in Mathematica and implementing the described methods is presented.

In the work by W.H. Enright the problem of the validation of the numerical results is considered and in particular the effectiveness of a recent suite of tools introduced in the Matlab Problem Solving Environment (PSE) is investigated. The problem of the evaluation of numerical methods for ODEs/DAEs is also considered by G. Söderlind and L. Wang. They outline some basic principles of a test protocol and apply them to DASPK and RADAU5 codes. The second paper by G. Söderlind and L. Wang is devoted to the investigation of the effects of adaptive time-stepping and other algorithmic strategies on the computational stability of ODE codes. Another important aspect of mathematical codes that has been considered just recently is the solution of implicit delay differential equations. N. Guglielmi considers in his paper some open issues concerning this aspect. In particular the error control strategies especially in relation with derivative discontinuities, the integration of problems with unbounded delays and the solution of special structure problems. In the paper by J.H. Verner the class of two-step Runge–Kutta methods (TSRK) is considered. In particular it analyzes the problem to provide correct starting methods (necessary at the first step of the implementation) for low stage-order, showing how they should be selected for methods of order 3 and stage-order 6. However, the procedure can be generalized also to different order methods.

In the paper by J. Cash, F. Mazzia, N. Sumarti and D. Trigiante the important role of conditioning in mesh selection algorithm for the solution of boundary value problems is analyzed, in particular some algorithms for estimating the condition number of boundary value problems are described and how this estimate can be used in the grid refinement algorithm is shown.

A second important group of papers submitted is the one concerning the solution of partial differential equations and in particular the use of finite element techniques. In the paper by F. Santos and M. Lencastre a computational environment, called Plaxus, is presented. Its main goal is to help the project and implementation of simulation software based on finite element method. The idea is to make available a tool which can be used by scientists and engineers without having a deeper knowledge in the mathematical methodologies. Another paper concerning the numerical solution of partial differential equations is the one presented by L. Pavarino and E. Zampieri. In this case the acoustic wave equation is considered. The numerical approximation is obtained using a mixed finite difference-spectral element method: the spatial discretization is based on conforming spectral elements while the Newmark's explicit method is used for the temporal variable. The work by A. Mazzia and M. Putti deals with the numerical solution of the density-dependent flow and transport problem in groundwater on three-dimensional triangulations using a mixed hybrid finite element scheme for the flow equation combined with mixed hybrid finite element-finite volume time-splitting-based technique for the transport equation. This approach seems to be an efficient tool when the process is advection dominated or there are instabilities in the flow field.

The paper by A. Al-Kurdi and D. Kincaid is the only work submitted concerning linear algebra. It analyzes in particular the use of optimal strategy to improve the iterative refinement applied together with *LU* decomposition to solve large sparse linear systems.

The work by J.G. Fijnvandraat, S.H.M.J. Houten, E.J.W. ter Maten and J.M.F. Peters represents an interesting application of numerical methods to the simulation of time analog circuits. In fact applying the modified nodal analysis to the network description of the circuit a system of differential-algebraic equations arises that usually is solved using backward differentiation formulae (BDF). In the paper the use of alternative integration methods is considered (Radau and Rosenbrock–Wanner methods).

The paper by V. Gorbunov and I. Lutoshkin is devoted to the explanation of the numerical parameterization method for optimal control problems. The idea of the method is approximate the control function using a parametric class of functions. The problem becomes a finite-dimensional nonlinear programming, with the optimization part and the differential part separated. Appropriate parameterizations allows one to obtain a nonlinear programming problem of lower dimension than the problems obtained by traditional finite-difference approximations.

The paper by M. Carletti represents another important feature; the stochastic differential equations plays, in fact, an important role in biology, epidemiology and population dynamics since they describe in a more complete way those phenomena. The work by E. Bertolazzi, F. Biral and M. Da Lio takes into account another important aspect of modern mathematics: the use of symbolic tools (i.e. Maple in this case) together with numerical ones. In this paper the symbolic derivation is used in order to derive the boundary value problem–differential algebraic equation (BVP–DAE) originating from the variational form of the optimal control problem (OCP). The constrained problem deriving from a multi-body system is transformed into a non-constrained problem and hence the finite discretization yields a non-linear system solved using damped Newton scheme.

The work by J. Hugger represents the modellization of a financial tool (the Asian option). It examines in particular the problem to find wellposed boundary conditions for the degenerated parabolic differential equation.

In the paper by P. Ghelardoni, G. Gheri and M. Marletta a technique based on the evaluation of the zeros of a polynomial is proposed in order to estimate the spectral errors and set up a correcting procedure in Sturm–Liouville problems.

To conclude, we wish to thank the authors, for the contributions they submitted, and all the anonymous referees for their help in improving submitted papers. The success we believe we have achieved with this workshop would not have been possible without the dedicated work of the colleagues on the organizing committee, Felice Iavernaro and Donato Trigiante. We also acknowledge the financial support of the G.N.C.S. INdAM, the University of Bari and of the Politecnico of Bari. The University of Bari and in particular the Mathematics Department, also provided infrastructure and other assistance. We are also grateful to Prof. Luigi Brugnano, who assisted us in a crucial moment, and to Prof. Luc Wuytack, who gave us the opportunity to publish the proceedings of the workshop.

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