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Edited by Felipe Cucker, Ron DeVore, Peter Olver and Endre Suli

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## Preface

The Society for the Foundations of Computational Mathematics supports fundamental research in computational mathematics and its applications, interpreted in the broadest sense. As part of its endeavour to promote research across a wide spectrum of subjects concerned with computation, the Society regularly organises conferences and specialist workshops which bring together leading researchers working in diverse fields that impinge on various aspects of computation. Major conferences of the Society were held in Park City (1995), Rio de Janeiro (1997), Oxford (1999), and Minneapolis (2002).

The next FoCM conference will take place at the University of Santander in Spain in July 2005. More information about FoCM is available from the website <http://www.focm.net>.

The conference in Minneapolis on 5-14 August 2002 was attended by several hundred scientists. Workshops were held in eighteen fields which included: the foundations of the numerical solution of partial differential equations, geometric integration and computational mechanics, learning theory, optimization, special functions, approximation theory, computational algebraic geometry, computational number theory, multiresolution and adaptivity, numerical linear algebra, quantum computing, computational dynamics, geometrical modelling and animation, image and signal processing, stochastic computation, symbolic analysis, complexity and information-based complexity theory. In addition to the workshops, eighteen plenary lectures, concerned with a broad spectrum of topics connected to computational mathematics, were delivered by some of the world's foremost researchers. This volume is a collection of articles, based on the plenary talks presented at FoCM 2002. The topics covered in the lectures — ranging from the applications of computational mathematics in geometry and algebra to optimization theory, from quantum

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complexity to the numerical solution of partial differential equations, from numerical linear algebra to Morse theory — reflect the breadth of research within computational mathematics as well as the richness and fertility of interactions between seemingly unrelated branches of pure and applied mathematics.

We hope that the volume will be of interest to researchers in the field of computational mathematics but also to non-experts who wish to gain insight into the state of the art in this active and significant field.

Like previous FoCM conferences, the Minneapolis gathering proved itself as a unique meeting point of researchers in computational mathematics and of theoreticians in mathematics and in computer sciences. While presenting plenary talks by foremost world authorities and maintaining the highest technical level in the workshops, the emphasis, like in Park City, Rio de Janeiro and Oxford, was on multidisciplinary interaction across subjects and disciplines, in an informal and friendly atmosphere. It is only fair to say that for many of us the opportunity of meeting colleagues from different subject-areas and identifying the wide-ranging, and often surprising, common denominator to our research was a real journey of discovery.

We wish to express our gratitude to the local organisers and administrative staff of our hosts, the Institute of Mathematics and Its Applications and the Department of Mathematics at the University of Minnesota at Minneapolis, for making FoCM 2002 such a success. We also wish to thank the National Science Foundation, the Digital Technology Center in Minneapolis, IBM, the Office of Naval Research, the Number Theory Foundation and the American Institute of Mathematics for their generous sponsorship and support. Above all, however, we wish to express our gratitude to all participants of FoCM 2002 for attending the meeting and making it such an exciting, productive and scientifically stimulating event.