Institute for Computational Mathematics
Annual Report
July 1, 1997 - June 30, 1998

prepared by

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INTRODUCTION

The mission of ICM has not changed; it is to encourage and facilitate interdisciplinary research involving advanced scientific computing. In support of this mission, ICM acts as a locus for interactions among researchers from the Department, Kent State University, industry and other universities, both in the United States and internationally. Although ICM is a unit within the Department of Mathematics and Computer Science, its associated membership includes faculty from several disciplines within the University. ICM provides its associate and visiting members with excellent computing facilities and a stimulating supporting environment for cooperative scientific efforts in computational mathematics. Richard Varga and Paul Wang are research directors of ICM.

Current strengths in ICM include numerical analysis and approximation theory, and symbolic mathematical computation. ICM edits and publishes the Electronic Transactions on Numerical Analysis (ETNA), maintains the Symbolic Computation Information Center web site (SymbolicNet), offers intensive training courses for local industry, develops interdisciplinary research proposals, facilitates visiting researchers, and publishes ICM Technical Reports.

The interdisciplinary nature of ICM and its accomplishments contributed significantly in the favorable OBR (Ohio Board of Regents) review of Kent's Ph.D. program in Computer Science. The Kent central administration has also decided to support the establishment of an "Interdisciplinary Seminar Series" to involve the whole campus and local industry for developing new interactions and collaborations among different disciplines in the creative use of modern computing technologies. The Seminar Series will be anchored in our Department, and ICM will be a primary force in executing the Seminar Series. We expect to invite our first lecturer in this Seminar Series, for the Spring Semester of 1999.

ICM activities for the current reporting period are summarized herein under eight major headings: Research Activities, ICM Visitors, Publications, ETNA, SymbolicNet, ICM Web Site, ICM Technical Reports and Goals.

SECTION 1: Research Activities

Research Directors:

Professor Richard S. Varga continues his research in the areas of complex approximation theory, numerical linear algebra, and complex analysis, including the Riemann Hypothesis.

During this reporting period, Professor Varga gave lectures at University of Dresden (Aug. 25, 1997), the Bergakademie Freiberg (Aug. 28, 1997), the Hungarian Mathematical Institute in Budapest (Oct. 9, 1997), and the University of Cyprus (Oct. 12, 1997), on the new use of potential theory in complex approximation theory. He also gave a series of five invited lectures at the King Fahd University in Dhahran, Saudi Arabia (Dec. 9-19, 1997), and talks at conferences in Nashville (Jan. 4, 1998) and Madison, Wisconsin (June 4, 1998).

During this reporting period, Professor Varga continues his extensive editorial work, which involves serving as co-editor-in-chief of Numerische Mathematik and ETNA and as editor for eight other journals, including French, Chinese, and Bulgarian journals.

Professor Varga has been involved in cooperative mathematical research efforts with Professor A. J. Carpenter (Indianapolis, IN), Professor Xiezhang Li (Statesboro, GA), Professor Michael Eiermann (Dresden, Germany), and Drs. Andras Kroó and Jozsef Szabados (Budapest, Hungary). In addition, Professor Varga has worked with Professor John Todd (Caltech), and Professors Alan Krautstengl and Igor Pritsker (Case Western Reserve University).

Dr. Varga received partial external grant support in this period from NSF and also from NATO.

A complete list of Professor Varga's research publications for the reporting period is contained in Section III of this report.

Professor Paul Wang's main activities in this period fall in two broad areas:

- Parallel and Distributed Symbolic Computation
- Research and Curriculum Development for *Web Publishing*

The activities will be summarized separately.

For *Parallel and Distributed Symbolic Computation* the major activities focus on

1. Parallel Algorithms and Implementations for the Grobner Bases Algorithm and the Characteristic Sets Method—The Characteristic Sets Method and Grobner Bases Algorithm are two advanced mathematical computations that have a variety of applications in commutative algebra and algebraic geometry. The work reported in this Ph.D. dissertation involves the design and implementation of new and improved parallel algorithms for these computations. Tools and interfaces have been built and used to implement and evaluate these two algorithms on message-passing parallel computers. The implementations were conducted on a cluster of workstations and on a Massively Parallel Processor, the CRAY T3E. The research conducted is the first product of the research collaboration between ICM/Kent and MMRC-Beijing. It is the corner stone of the US-China collaboration grant by the NSF. Six conference papers and

a Ph.D. dissertation have resulted from the research including an award-winning paper appearing in the proceedings of the IEEE 1997 National Aerospace and Electronics Conference (NAECON'97).

2. Internet Accessible Mathematical Computation (IAMC)—The main objective of IAMC is to make mathematical-oriented services easily accessible on the Internet: via TCP/IP, through the Web, and by email.

   The research requires expertise from both mathematics and computer science. With IAMC, mathematical and scientific computing services will be simple to establish and as easily available as a Web page. The potential impact of IAMC is great for

   - Research in mathematics, science, and engineering
   - Mathematical education and distance learning
   - Establishing remote scientific databases
   - Making parallel/super computing more accessible
   - Computing via NetPC for high school or occasional users
   - Providing infrastructure for *Problem Solving Environments*

   There are many other applications. IAMC investigates these major research issues:

   (a) A *Mathematical Computation Protocol* for connecting IAMC clients and servers
   (b) Standards for the syntax and semantics of mathematical notations and representations
   (c) File format and efficient transmission of mathematical data/formula
   (d) Design and implementation of ready-to-use IAMC client and server
   (e) End-user interface and compute engine interface issues
   (f) Models for different IAMC services
   (g) Interoperability of IAMC components

   The initial planning for the IAMC research has taken place during this period. Dr. Wang has developed a research proposal in collaboration with Prof. Dieter Schmidt (Electrical and Computer Engineering, Cincinnati), Prof. Simon Gray (Mathematics and Computer Science, Ashland), and Prof. Norbert Kajler (Ecole des Mines de Paris, France) and submitted it to the NSF/KDI program in May 1998. Initial investigations for IAMC have also begun.

   Research and curriculum development for *Web Publishing* involves integrating the design and technology aspects of Web publishing in upper undergraduate and beginning graduate level courses. The effort receives support and cooperation from the College of Arts and Sciences, the College of Fine and Professional Arts, and industry. The curriculum development is conducted by Paul Wang and Professor Sanda Katila from Visual Communication Design with help from instructional design expert, Professor Frank Suzi, and industrial consultants.

   The curriculum will combine maturing World-wide Web technologies with emerging design principles for creating effective, functional, and attractive Websites.

The Web is the newest medium of mass-communication and human expression in the Nation and the world. The combination and synergy of computing technology with visual design is intrinsically important. The curriculum also addresses a critical need for training personnel with balanced skills in the programming, functional, and artistic design aspects of Web sites.

The project will develop a two-semester sequence of courses, *Introduction to Web Publishing* and *Advanced Web Publishing*, with these major features:

- Combination, integration, and interplay of computer science and visual communication design
- Team work on design and implementation
- Critical analysis of requirements, and evaluation of Web site created
- Developing students' abilities to apply both programming techniques and design principles to achieve Web site goals
- Project-based, hands-on learning

Paul Wang continues to nurture and develop industrial connections, student internships with local industry, intensive training courses, and consulting arrangements.

A list of Professor Wang's research publications for the reporting period are included in Section III of this report.

Numerical Analysis and Approximation Theory:

Researchers in these areas include Professors Alfred Cavaretta, Paul Farrell, E. Charles Gartland, Lothar Reichel, Arden Ruttan, Meera Sitharam and Richard Varga. The work of Professors Farrell, Sitharam and Varga is described elsewhere in this report.

Professor Alfred Cavaretta's primary mathematical interests are spline functions, numerical analysis, numerical quadrature, differential inequalities, approximation theory, classical analysis and optimization. He is a specialist on subdivision techniques for the computer generation of curves and surfaces, a subject on which he has coauthored a research monograph. Professor Cavaretta continues his collaboration with A. Sharma, Univ. of Alberta, and C. R. Selveraj, Penn. State University, on such subjects as optimal recovery and overconvergence phenomena. He also works on multi-variate subdivision with A. Melkman (of Ben Gurion University, Israel).

Professor Chuck Gartland continued his research program of investigation of numerical solutions of problems in liquid crystals. His current research projects include investigation of liquid crystal tensor models, stripe phase instabilities in liquid crystals, liquid crystal display optics, nonlinear optics of liquid crystals and automatic code generations and problem-solving environments for liquid crystals. Two doctoral students continue their dissertation research under Dr. Gartland's direction. Dr. Gartland and one of his doctoral students were supported by NSF ALCOM funding. During this reporting period, Professor Gartland delivered three invited lectures on his research activities and has been awarded a new three-year individual NSF grant.

Professor Lothar Reichel's area of research is numerical linear algebra. He has an NSF grant to develop numerical methods for the solution of large scale ill-posed problems, and is a Co-PI on a grant for developing numerical methods for large-scale bifurcation problems. He is currently directing one Ph.D. dissertation and one Master's thesis.

Professor Arden Ruttan is the managing editor for Electronic Transactions on Numerical Analysis (ETNA) and a co-principal investigator of the NSF Science and Research Center for Advanced Liquid Crystalline Optical Materials (ALCOM). His current research is on environments for visualization and interactive computational steering on a network of distributed workstations on a fast network. As part of that project, he has obtained (together with Paul Farrell and Mike Lee) an NSF CISE equipment grant for $270,000, an OBR Research Excellence grant (with Paul Farrell) for $100,187, and an NSF New Technologies grant (with Paul Farrell, Mike Lee, and Lothar Reichel) for $395,000.

Additionally, Professor Ruttan has obtained a CISE Research Equipment Grant for $100,187 (with Paul Farrell, Steve Chapin, and Mike Lee); an OBR Action and Investment Fund grant for $67,500 (with Paul Farrell, Steve Chapin, and Mike Lee), and an ALCOM grant, which provided some monies for a graduate assistantship for his PH.D. student, James Baglama, who graduated in December 1997.

Current collaborative researchers are James Baglama, Hong Ong, Yang-Minh Zhu, Daniella Calvetti, Lothar Reichel, and Paul Farrell.

Computer Science:

In this area, the major foci of the ICM associated faculty are parallel and distributed computing and scientific computations. Brief descriptions of the activities of these faculty members are given below.

Professor Johnnie Baker's research activities focus on parallel models of computation and parallel algorithms, computational chemistry, and applications of parallel computing to areas such as computational geometry and air traffic control. He has also published in the areas of Banach spaces and general topology. Dr. Baker is currently directing three doctoral dissertations and is the Department Coordinator for Computer Science.

A major focus of Baker's recent research has been the development of a computational model for data parallel and associative computing, establishing algorithms and software for this model, and comparing this model to other models of parallel computation. The associative model is designed to provide a common platform for the development of data parallel type algorithms and software for SIMD and massively parallel computers in particular and for all computers that can efficiently support the model, in general. Current work is underway to compare this model to other parallel models of computation, including BSP and LogP. Also, an extension to this model has been developed to include predictability so that the running time of algorithms for this model can be predicted on various compute systems that support the model, as is the case with the LogP model. A new research direction is to study how effectively the model can be supported on a wide range

of compute engines, including distributed and net-based computing systems.

A second current research area is developing sequential and parallel algorithms to measure the similarity between different organic molecules and using this information to predict properties of unknown compounds and to engineer compounds with certain desirable properties and structure.

Professor Arvind Bansal's research contribution during 1997-98 has been in the areas of 'The foundations for fault tolerance in distributed agent based languages,' 'Functional genomics of microbial organisms,' and 'The development of high performance distributed environment for the integration of symbolic and numeric computing'. He has also collaborated with researchers in Protein Institute, Russia, on the regulation mechanism of microbial genomes; researchers at Argonne National Laboratory, USA, on the metabolic pathways of microbial genomes; researchers from European Bioinformatics Institute on functional genomics of eukaryotes; and researchers from University of Melbourne and Australian AI Institute on the foundation of fault tolerance in distributed agent based languages. He has also developed and taught a new graduate level course in Computational Biology which attracted students from multiple disciplines such as Physics, Biology, Medicine, Chemistry and Biochemistry, Mathematics, and Computer Science. The course is a state of art course which prepares the students to do research using computational and mathematical techniques in the field of genomics and microbiology. Dr. Bansal was also involved in starting a new Ph.D. program with BMS-CS during 1997-98.

Professor Kenneth Batcher and his students continue research on the automated restructuring of serial code to extract parallelism. A search for faster sorting networks has also been initiated.

Professor Paul Farrell is currently the sole investigator on a NSF Computational Mathematics and International Programs Divisions grant, principal investigator on a joint grant from the NSF CISE New Technologies Program (with co-PIs Mike Lee, Lothar Reichel, and Arden Ruttan), and on a joint equipment grant from the NSF CISE Research Equipment Program (with co-PIs Steve Chapin, Mike Lee, and Arden Ruttan), and a co-principal investigator of the NSF Center for Advanced Liquid Crystalline Optical Materials (ALCOM). He is a member of the IMACS Technical Committee on Partial Differential Equations. His research interests are distributed and parallel computation and algorithms, high speed networking, computational steering and visualization, application of numerical methods to liquid crystal problems, singularly perturbed differential equations, Navier-Stokes equations and semi-conductor devices, automatic code generation for parallel architectures, application of expert systems in numerical computing, and mathematical text processing. During the reporting period he published two research papers, had two others accepted for publication, was an organizer and invited speaker of Workshop'98 on Methods for Singular Perturbation Problems, Losnetz, Bulgaria; an invitee to the Oberwolfach Meeting on Numerical Methods for Singular Perturbation; a speaker at the Copper Mountain Conference on Iterative Methods and attended Networks+Interop. He also had the following grants which are active:

1996, PI, *Uniform Numerical Methods for Singularly Perturbed Equations*, NSF Computational Mathematics and International Programs Divisions, 9/1/96–8/31/99, $66,000.

1996, PI, *A High-Performance Network for Distributed Computation and Visualization*, Ohio Board of Regents Action and Investment Fund, $67,500, with co-PIs Arden Ruttan, Steve Chapin and Mike Lee.

1996, PI, *A High-Performance Network for Distributed Computation and Visualization*, NSF CISE Research Equipment Program for $135,000, with co-PIs Arden Ruttan, Steve Chapin and Mike Lee.

1997, PI, *A Steering and Visualization Environment*, NSF CISE New Technologies Program, 1997–2000, $395,003, with Mike Lee, Lothar Reichel and Arden Ruttan.

Professor Cheng Lu's research interests are data compressions, image processing and document image processing.

Professor Hassan Peyravi's research focuses on interconnection networks for large scale parallel and distributed processing, and on computer communications networks. During this reporting period, he has finished a book chapter in multiple access protocols. His research has been supported by NASA, and he has received a $75,000 and $15,309 equipment grant from the RAGS office.

Professor Jerry Potter's research interests include the continuing development of the associative computing paradigm, the integration of associative SIMD computers with other architectures in a heterogeneous supercomputer environment, the development of techniques for compilation on massively parallel SIMD computers, natural language and artificial intelligence processing on SIMD computers, and the development of techniques for the introduction of parallel programming at the high school level. Professor Potter published six research papers in 1997-1998, and he is currently directing three doctoral students and 4 master's students.

Dr. Potter (with J. Baker and R. Walker) was awarded an OBR CS Initiative grant in the Spring of 1998, and SFRC, AFRL Rome, NY, was completed in the Summer of 1998.

Professor Michael Rothstein directs his research activities toward algorithms and systems for symbolic and algebraic computation, parallel computations, symbolic-numeric interfaces, high-level languages, object-oriented programming, scientific user interfaces, and functional language implementations.

Professor Meera Sitharam's research interests fall under three categories: circuit and algebraic complexity lower and upper bounds, approximation theory, and applied work in geometric modeling and networking.

In complexity theory, her main work (with Soren Riis at BRICS, Aarhus) in the last reporting period is the proof of a fundamental gap theorem and several lower bounds for algebraic proof complexity. Talks on various aspects of this result have already been given at the Complexity lower bounds workshop at the Field's Institute in Feb.'98, at the Workshop in Logic and Computation (Wollic) at Sao Paolo in June '98 and at the Midwest Theory Seminar in Chicago in December 1997. A series of four papers related to this work are planned to appear shortly. One of these

has already appeared in the refereed conference proceedings of the Wollic conference, and will additionally appear in a special issue of the IGPL journal.

Work with her Ph.D. student, Tim Straney, concentrates on learning theory and the algebraic and combinatorial properties of Boolean functions on abelian groups. One paper appeared in the proceedings of the fully refereed Algorithmic learning theory conference in Japan Prof. Norbert Kajler (Ecole des Mines de Paris, France) and submitted in October 1997, and a journal paper is to be submitted shortly.

In the applied area of geometric modelling, she has two papers in the reporting period, written jointly with another of her Ph.D students, Andrew Lomonosov, and Chris Hoffman at Purdue. One of these papers appeared in the fully refereed proceedings of the Constraint Programming Conference in Austria in Nov. '97. The other appeared as an invited article in a book on Geometric constraints edited by Bruderlin and Roller. A journal article will be submitted shortly.

In the applied area of non-cooperative networking, she has two articles accepted to refereed conferences (ICE '98 and SPIE Performance and Control of Network Systems '98), coauthored with Kihong Park and Shaogang Chen at Purdue. These conferences will take place this coming fall. Two journal papers are to be submitted shortly.

She has received continued support for the NSF RIA award (CCR 9409809) and was awarded one research and creativity award at Kent State for '97-98. Furthermore, she has just received a POWRE award from NSF, for 1998-2000.

Meera is involved in a joint project (awarded an NSF-DUE grant starting Summer '98) with D. Juedes, and J. Krone, in cooperation with local industries, to "incorporate research and theory into the undergraduate computer science curriculum via practical case studies." A graduate student, Jim Chalmers, was supported on this grant in Summer '98.

A summary of her activities can be found at http://www.mcs.kent.edu/∼sitharam .

Tetsuji Ueda's research interests are in applied mathematics, in particular the mathematical modeling of physical phenomena, asymptotic methods, and scientific computations. His current projects include the dynamics of liquid-crystalline filament immersed in fluids and the high-speed spinning of polymer fibers. These works involve collaborations with researchers at the Courant Institute at New York University, the Mathematics Department at the University of North Carolina–Chapel Hill, and the Liquid Crystal Institute at Kent State University. One research paper has been accepted for publication, and another has been submitted for review.

Computational Chemistry:

This interdisciplinary research program continues in cooperation with Upjohn Laboratories. **Professor Victor Nicholson**, ICM, and Professors C. Tsai and R. Gregory of the KSU Chemistry

Department are conducting this research in which the emphasis is on the development and application of computer algorithms and software to investigate the relationship between molecular structure and chemical activity. This effort involves applications of topology, graph theory, organic chemistry and biochemistry.

SECTION II: ICM VISITORS

Listed below are the names of ICM visitors during the period from July 1, 1997 through June 30, 1998. These visits have been very beneficial to both ICM and the visitors. The visitors always gain an appreciation of the high level and calibre of the research activity here at Kent State University. All of these visitors received full or partial support from ICM.

1. Vilmar Trevisan, UFRGS-Campus do Vale, Brazil, January 21, 1997 to January 20, 1998.
2. A. Sharma, Univ. of Alberta, Quebec, Canada, July 24-27, 1997.
3. Yanjie Zhao, Japan, August 2-23, 1997.
4. A. Carpenter, Butler University, March 12-15, 1998.
5. O. Ernst, Bergakademie Freiberg, June 22-26, 1998.

SECTION III: PUBLICATIONS

J. Baker

"ASC–An Associative Computing Paradigm," Associative Processing ad Processors, edited by A. Krikelis and C. C. Weems, IEEE Computer Society, 1997, 188–194.

"VLCD String Matching for Associative Computing and Multiple Broadcast Mesh," Proceedings of the IASTED International Conference on Parallel and Distributed Computing and Systems, 1997, 69–74.

"Simulating PRAM with a MSIMD Model (ASC)," Proceedings of of the International Conference on Parallel Processing, 1998, pp. 3–10 (with Darrell Ulm).

Co-editor (with Yi Pan and Selim Akl), "Computing on Bus-Based Architectures of PPL," special issue of Parallel Processing Letters, vol. 8, no. 2, 1998.

A. Bansal

A. K. Bansal, K. Rammohanarao, A. Rao, "A Distributed Storage Scheme for Replicated Beliefs to Facilitate Recovery in Distributed System of Cooperating Agents," Fourth International Workshop on Agent Theory, Architecture, and Languages, July 1997, pp. 71-84.

S. Ryan and A. K. Bansal, "A Scalable Heterogeneous Associative Logic Programming System," Proceedings of the International Conference for Tools with Artificial Intelligence, 1997, pp. 37-44.

A. K. Bansal, K. Rammohanarao, A. Rao, "A Distributed Storage Scheme for Replicated Beliefs to Facilitate Recovery in Distributed System of Cooperating Agents," Lecture Notes in Springer Verlag Series, LNAI 1365, 1998, pp. 77-92.
A. Vitreschak, A. K. Bansal, M. S. Gelfand, "Conserved RNA structures regulate initiation of translation of Escerichia coli and Haemophilus influenzae ribosomal protein operons," Abstract of International School on Theoretical Biophysics, Moscow, June 1998, p. 105.

P. Farrell

"On the Non-existence of ε-Uniform Finite Difference Methods on Uniform Meshes for Semilinear Two-point Boundary Value Problems," with J.J.H. Miller, E. O'Riordan, G.I. Shishkin), Math. Comp., 67 no. 222, April 1998, pp. 603–617.

"On the Convergence of Iterative Methods for Linear Systems arising from Singularly Perturbed Equations," (with G.I. Shishkin), Proc. Copper Mountain Conf. on Iterative Methods, 1998, pp 1–7.

E. C. Gartland

"Finite Element Analysis of the Landau-de Gennes Minimization Problem for Liquid Crystals," with Timothy A. Davis, SIAM J. Numer. Anal., 35 (1998), pp. 336-362.

H. Peyravi

"An Approach Towards Adaptive Routing Using Traffic Intensity Threshold Points," *Proceedings of International Conference on Modeling and Simulation*, pp. 79–84, May 1998, (with Ashish Agarwal).

"Delay and Queue Size Analysis of TDMA with General Traffic," *Technical Report,* 1997, pp. 1–10, *http://mars.mcs.kent.edu/∼peyravi/Tech/*

"Simulation Modeling and Comparison of Multiple Access Protocols," *Technical Report,* 1997, http://mars.mcs.kent.edu/∼peyravi/Tech/

J. Potter

"Associative Computing Environment," Associative Processing and Processors, IEEE Computer Society, Los Alamitos, CA, 1997, pp. 180-187.

"ASC:An Associative-Computing Paradigm," in Associative Processing and Processors, Krikelei and Weems (eds.), IEEE Computer Society, Los Alamitos, 1997, pp. 188-194 (with J. Baker, S. Scott, A. Bansal, C. Leangsuksun and C. Asthagiri).

"Associative Data Structures" in Associative Processing and Processors, Krikelei and Weems (eds.), IEEE Computer Society, Los Alamitos, 1997, pp. 195-201.

"Associative Parallel Common Subexpression Elimination" in Associative Processing and Processors, Krikelei and Weems (eds.), IEEE Computer Society, Los Alamitos, 1997, pp. 202-217 (with C. Asthagiri).

"An Associative Calculus," in the Proceedings of the 11th Annual International Symposium on High Performance Computing Systems, HPCS'97, July 10-12, 1997, Crowne Plaza Hotel, Winnipeg, Manitoba, Canada, pp. 495-504 (with Liszka).

"ACE: An Associative Calculus Data Structure," Journal of Parallel and Distributed Computing, Vol. 51, No.1, May 1998, pp. 63-74.

L. Reichel

"Adaptively preconditioned GMRES algorithms," SIAM J. Sci. Comput., 20 (1998), pp. 243-269, (with J. Baglama, D. Calvetti and G.H. Golub).

"Gram polynomials and the Kummer function," J. Approx. Theory, 94 (1998), pp. 128-143, (with R.W. Barnard, G. Dahlquist, K. Pearce and K.C. Richards).

"Factorizations of Cauchy matrices," J. Comput. Appl. Math., 86 (1997), pp. 103-123, (with D. Calvetti).

"Numerical aspects of some solution methods for large Sylvester-observer equations," in Proceedings of the 36th IEEE Conference on Decision and Control, IEEE, Piscataway, 1997, pp. 4389-4393, (with D. Calvetti).

"Iterative solution methods for large linear discrete ill-posed problems," Applied and Computational Control, Signals and Circuit, 1 (1998), pp. 317-373. (with D. Calvetti and Q. Zhang). A hybrid iterative method for symmetric indefinite linear systems (with D. Calvetti), J. Comput. Appl. Math., 92 (1998), pp. 109-133.

"Computation of a few close eigenvalues of a large matrix with application to liquid crystal modeling," J. Comp. Phys., to appear, (with J. Baglama, D. Calvetti and A. Ruttan).

"Computation of Gauss-Kronrod quadrature rules," Math. Comp., to appear, (with D. Calvetti, G.H. Golub, and W.B. Gragg).

A. Ruttan

"Computation of a few small eigenvalues of a large matrix with applications to liquid crystal modeling," J. Comp. Phys., to appear, (with J. Baglama, D. Calvetti, and L. Reichel).

M. Sitharam

C. Hoffman, A. Lomonosov, M. Sitharam, "Finding dense subgraphs of constraint graphs," Constraint Programming '97, Lecture Notes in Computer Science 1330, G. Smolka, Ed., Springer Verlag, pp. 463–478.

B. Anderson, J. Jackson, M. Sitharam, "Descartes' law of signs revisited," American Mathematical Monthly, May '98, pp. 447–451. Manuscript available at http://131.123.170.58/sitharam/ .

C. Hoffman, A. Lomonosov, M. Sitharam, "Geometric constraint decomposition," in "Geometric Constraint Solving and Applications," Springer Verlag. June 1998. Edited by Beat Brüderlin and Dieter Roller.

Shaogang Chen, Kihong Park, Meera Sitharam, "On the Ordering Properties of GPS Routers for Multi-Class QoS Provision," to appear, SPIE Conference on Performance and Control of Network Systems, 1998.

Kihong Park, Meera Sitharam, Shaogang Chen, "Quality of Service Provision in Noncooperative

Networks: Heterogenous Preferences, Multi-Dimensional QoS Vectors, and Burstiness," to appear, International Conference on Information and Computation Economies, ICE 1998.

K. Park, M. Sitharam, S. Chen, "Quality of service provision in noncooperative network environments," Purdue University TR, Aug. 1997.

M. Sitharam, T. Straney, "Derandomized learning of Boolean functions," Algorithmic Learning Theory 1997, Lecture notes in Artificial Intelligence, subseries of Lecture Notes in Computer Science, 1316, Ming Li and Akira Maruoka Eds., pp. 100–115, Springer-Verlag.

Soren Riis and Meera Sitharam, "Generating hard tautologies using predicate logic and the symmetric group," Workshop on Logic, Language, Information and Computation, Wollic '98.

S. Riis, M. Sitharam, "Nonconstant degree lower bounds imply linear degree lower bounds." Appears in the Electronic Colloquium on Computational Complexity, Oct.'97, Kent State TR, Aug. '97, (see http://www.brics.dk/~smriis or http://sitharam.mcs.kent.edu/~sitharam for the latest revision). Talks given at the Complexity lower bounds workshop at the Fields Institute, Feb. 98, and Midwest Theory Seminar, Dec. 1997.

T. Ueda

"An Isothermal Model for High-Speed Spinning of Liquid Crystalline Polymer Fibers–Coupling of Flow, Orientation, and Crystallization," to appear in the Journal of Non-Newtonian Fluid Mechanics.

R. S. Varga

"Weighted polynomial approximation in the complex plane," Electronic Research Announcements of the AMS, 3(1997), 38-44, jointly with I. E. Pritsker.

"The Szegő curve, zero distribution and weighted approximation," Trans. Amer. Math. Soc., 349(1997), 4085-4105, jointly with I. E. Pritsker. MR 97m:30054.

"Weighted polynomial approximation in the complex plane," Const. Approx., 14(1998), 475–492, jointly with I. E. Pritsker.

P. Wang

"Tools for Parallel/Distributed Mathematical Computation," Proceedings, PASCO '97 (July 20-22) Maui, HI, pp. 188-195.

"Applying Parallel/Distributed Computing to Advanced Algebraic Computations," (with Iyad A. Ajwa), Proceedings of IEEE National Aerospace and Electronics Conference (NAECON '97), pp. 156-164, Dayton, OH, July 14-18, 1997.

"PvmJobs: A Generic Parallel Jobs Library for PVM," (with Hong H. Ong and Iyad A. Ajwa), Proceedings of IEEE National Aerospace and Electronics Conference (NAECON '97), pp. 165-172, Dayton, OH, July 14-18, 1997.

"Design and Implementation of MP, a Protocol for Efficient Exchange of Mathematical Expressions," (with S. Gray and N. Kajler), *Journal of Symbolic Computation*, Vol. 25, No. 2, Academic Press, Feb. 1998, pp 213-238.

SECTION IV: ETNA

Electronic Transactions on Numerical Analysis (ETNA) is an entirely electronic journal which was created by Lothar Reichel, Arden Ruttan and Richard Varga in 1993.

ETNA has just published its sixth volume to date. Volume 6 is the Proceedings of the Eighth Copper Mountain Conference on Multigrid held April 6-11, 1997. Volumes 1-6 were also published on an ETNA CDROM, ISSN 1097-4067. As of now, ETNA has approximately 1000 subscribers and over 20 mirror sites around the world. Countries which have requested ETNA manuscripts include

Argentina	Australia	Austria	Belgium	Brazil
Canada	Chile	Cyprus	Croatia	Czech Rep.
Denmark	Egypt	Finland	France	Germany
Greece	Hong Kong	Hungary	India	Ireland
Israel	Italy	Japan	Korea	Netherlands
Norway	Poland	Portugal	Singapore	Slovakia
South Africa	Soviet Union	Spain	Sweden	Switzerland
Taiwan	Turkey	United Kingdom	United States	

ETNA has been a ground-breaking journal which has set the standard for electronic journals, both with regard to paper quality and to electronic formats. In addition, ETNA is fully reviewed by Mathematical Reviews.

SECTION V: SymbolicNet

`SymbolicNet` is a World Wide Web (WWW) service for information related to symbolic computation. It was established (Fall 1994) by the ICM under the support of a specific NSF grant. The `SymbolicNet` web site is now recognized as the leading information center in the area of Symbolic Computing and is used regularly by researchers world-wide.

ICM is responsible for the continued maintenance and upgrade of `SymbolicNet`. Under the supervision of Dr. Wang, graduate student, WeiDong Liao, performs the day-to-day operations of the site. `SymbolicNet` has put in innovative interactive demonstrations of mathematical computing systems which are now being upgraded to the new HTTP 1.1-level Web server.

As a result of research cooperation with the *Mathematical Mechanization Research Center* (MMRC) of the Chinese Academy of Science in Beijing, the People's Republic of China, a `SymbolicNet` mirror site has been established at MMRC.

`http://SymbolicNet.mmrc.iss.ac.cn:8000/`

The current Web master at MMRC who also maintains the `SymbolicNet` mirror is Dr. Doung-dai Lin. The mirror site not only expands the effectiveness of the site but also reduces long-distance traffic to ICM/Kent.

SECTION VI: ICM Web Site

To increase the visibility of ICM, to make its research results available on the Internet quickly, and for a host of other good reasons, it was decided that a Web site should be created for ICM.

A functional Web site for ICM was created early in 1998 and all ICM reports are put on-line for instant retrieval from the Web site. Research activities, cooperation areas, and faculty, together with other useful information, have been placed on the Web. The URL for the ICM Web site is

`http://monkey.mcs.kent.edu/icm/index.html`

During the Summer of 1998, the services of a Web design student, Mr. H. Em, has been engaged to upgrade the ICM Web site in terms of graphics and visual communication. This has been completed and a copy of the top page is included at the end of this report.

SECTION VII: ICM TECHNICAL REPORTS

As of September 1995, ICM technical reports are available on the World-Wide Web. Address is http://monkey.mcs.kent.edu/icm/tr/index.html .

ICM-199802-0001 Factorization of Chebyshev Polynomials, Mohamed O. Rayes, Vilmar Trevisan and Paul S. Wang.

ICM-199803-0002 IAMC: Internet Accessible Mathematical Computation, Paul S. Wang.

ICM-199805-0003 Experiments with Internet Accessible Mathematical Computation, Wei (David) Wang.

ICM-199805-0004 Rational Approximation with Varying Weights in the Complex Plane, Igor E. Pritsker and Richard S. Varga. PREPRINT.

SECTION VIII: GOALS

Future Plans

A continuing goal for ICM is to raise its level of visibility both internally and externally and increase its level of financial support through some additional internal funding and major external

funding. ICM has proved very useful in securing the recent OBR funding of the CS graduate program at Kent.

ICM will facilitate a broader scope of interactions and research collaborations among departments within Kent, with local industry, nationally, and internationally. Emphasis will be on scientific computing, distributed/parallel computing, and application of new computing technologies in different disciplines.

ICM will also increase and expand its industrial contacts through consulting, custom training courses, the ICM Web site, and other means. The hope is to increase opportunities for student placement, faculty consultation, and industrial research cooperation through ICM. Joyce Fuell, the administrative assistant at ICM, has the responsibility of managing and advancing this activity.

The ICM research directors and associated faculty will continue to seek external funding and to advance the reputation of the Institute. However, in order to sustain its forward motion, ICM needs to restore its operating budget to a higher level.