Fifth SIAM Conference on

APPLIED LINEAR ALGEBRA

JUNE 15 - 18, 1994

SNOWBIRD SKI AND SUMMER RESORT
SNOWBIRD, UTAH

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SIAM Activity Group on
Linear Algebra

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Society for
Industrial and
Applied
Mathematics

CONFERENCE THEMES

Applications in Optimization and Operations Research

Applications in Systems and Control

Applications in Signal and Image Processing

Least Squares Problems and Applications in Statistics and Probability

Condition Estimation and Rank-Revealing Factorizations

Eigenvalue Computations

Parallel Algorithms

Sparse Linear Equations

Structured Matrices

Matrix Theory

Combinatorial Matrix Problems and Graph Theory

Geometry and Eigenvalues

Education and Teaching of Linear Algebra

CONFERENCE PROGRAM

CONTENTS

DEADLINE DATES

Hotel Reservation
May 23, 1994

Conference Preregistration
June 1, 1994

ORGANIZING COMMITTEE

Beresford N. Parlett (Chair)
University of California, Berkeley

Harm Bart
Erasmus University, The Netherlands

Richard A. Brualdi
University of Wisconsin, Madison

John R. Gilbert
Xerox Palo Alto Research Center

Sven Hammarling
Numerical Algorithms Group, United Kingdom

John G. Lewis
Boeing Computer Services

Paul Van Dooren
University of Illinois, Urbana

FUNDING AGENCY

SIAM would like to thank both the Department of Energy and the National Science Foundation for their support in conducting this conference.

Message from the Organizing Committee

The format of this conference was designed to reduce the amount of concurrency while simultaneously encouraging dialogue. The heart of the change is the replacement of contributed paper sessions by prospectively organized poster sessions and moderated common interest discussion sessions. Contributors to the meeting are invited to use any of these means for presenting their work. In addition, the number of minisymposia has been limited to provide no more than two ways to hear any particular minisymposium sessions.

The proceedings for the conference is included in the price of registration and will be available at the conference. It will include all papers and poster abstracts received by the March 7, 1994 deadline, for which the conference registration information and fee are received by the separate March 21, 1994 deadline.

There will be nineteen moderated common interest sessions and corresponding poster sessions. Each session will last two hours, beginning with a 30-minute attended poster session. The remaining 90 minutes will be an open discussion of the papers and related research questions. The participants will have had a chance to see the poster and skim the papers in the proceedings, so it will not be necessary for the contributors to give talks on their papers. The discussion will be moderated by a session chair who has seen the papers in advance, has prepared an introductory survey of the papers and is prepared to lead discussion. The moderator will be responsible for ensuring that the session does not consist of the contributors attempting to present their papers in a new 5-minute micro-talk format. Posters for the common interest sessions may be displayed for the entire day, excepting on Thursday, when posters for the first three sessions appear up to 4:00pm, and posters for the second session appear after 4:00 pm.

As a further experiment toward reducing conflict between parallel sessions, the nineteen common interest sessions will be scheduled into five time slots according to the priorities we receive from your registration form. You have the opportunity to state your preferences for sessions. We will try to use discrete optimization techniques to find the best overall schedule for these common interest sessions. So, please avail yourself of the opportunity to tell the organizers how to schedule the sessions.

We have left one time slot for counterpoint sessions, for attendees to organize their own common interest sessions or to discussion from earlier common interest sessions.

Lastly, the conference dates were set to allow the attendees to obtain cheaper fares by staying through Saturday night. This was selected as the preferred schedule in the survey taken of the SIAG/LA membership in 1993. You will have another opportunity to express your support or disagreement with these changes at the conference.

GET-TOGETHERS

SIAM Welcoming Reception
Tuesday, June 14, 1994
6:00 PM - 8:00 PM
Golden Cliff Room
Cash bar and assorted hors d'oeuvres

Meet-and-Greet Hour
Wednesday, June 15, 1994
5:00 PM - 6:00 PM
Golden Cliff Room

Meet-and-Greet Hour
Thursday, June 16, 1994
4:00 PM - 5:00 PM
Golden Cliff Room

Meet-and-Greet Hour
Friday, June 17, 1994
5:00 PM - 6:00 PM
Golden Cliff Room

Business Meeting
SIAM Activity Group on Linear Algebra
Friday, June 17, 1994
4:00 PM - 5:00 PM
Ballroom 1
Open to all interested attendees.

Banquet Dinner and Guest Speaker
William M. Kahan, Department of Computer Science and Electrical Engineering
University of California, Berkeley
"Tales of the Role of Technology in War"
Saturday, June 18, 1994
6:00 PM-9:00 PM
Snowbird Resort, Ballroom
The evening begins with a cash bar from 6:00 PM - 7:00 PM, an opportunity to catch up with colleagues. Dinner will be served at 7:00 PM and will consist of a choice of Chicken Marsala with Linguini or London Broil with Mushroom Sauce. Vegetarian meals will be available for those with special dietary preferences. Wine will be served with dinner followed by dessert. Please be certain to indicate your dinner selection on the registration card. *Cost $26.00*

PROGRAM-AT-A-GLANCE

Tuesday, June 14

6:00 PM-8:00 PM
Registration opens
Cliff Lodge Lobby

6:00 PM-8:00 PM
Welcoming Reception
Golden Cliff Room

IP = Invited Plenary
MS = Minisymposium

Each plenary talk is forty-five minutes long, including time for discussion. Each minisymposium presentation is generally thirty minutes long, including time for discussion. The common-interest sessions will consist of a 1/2-hour poster session, followed by 1-1/2 hours of moderated discussion. These sessions will be scheduled based on interests of attendees (see preregistration form on page 19). The day and time for each common-interest session will be available in late April. Session participants will be informed via e-mail or post.

Wednesday Morning, June 15

7:30
Registration opens
Cliff Lodge Lobby

8:15
Opening Remarks
Beresford N. Parlett

INVITED PRESENTATIONS

8:30 **IP1 Geometry and Eigenvalues**
Persi Diaconis

9:15 **IP2 Parallel Matrix Computations**
Robert S. Schreiber

10:00
Coffee

10:30 AM-12:30 PM
CONCURRENT SESSIONS

MS1 **Algebraic Riccati Equations and Their Applications**
Organizer: Peter Lancaster

MS2 **Iterative Methods for Large Sparse Systems**
Organizer: Roland W. Freund

Wednesday Afternoon, June 15

12:30 - 2:00
Lunch

2:00-5:00
CONCURRENT SESSIONS

MS3 **Teaching Linear Algebra**
Organizer: Gilbert Strang

MS4 **Parallel Multisplittings and Applications of Domain Decomposition**
Organizers: Dianne P. O'Leary, Rosemary Renaut, and Barry F. Smith

5:00-6:00
Meet-and-Greet Hour
Golden Cliff Room

Wednesday Evening, June 15

6:00-7:30
Dinner

7:30-9:30
CONCURRENT SESSIONS
COMMON-INTEREST

Thursday Morning, June 16

8:00
Registration opens
Cliff Lodge Lobby

8:30-10:30
CONCURRENT SESSIONS

MS5 **Eigenvalues, Geometry, and Graph Theory**
Organizer: Alex Pothen

MS6 **Accuracy Issues for Eigenvalue and Singular Value Problems**
Organizers: Jesse L. Barlow and Kresimir Veselic

10:30
Coffee

INVITED PRESENTATIONS

11:00 **IP3 Linear Algebraic Duality for Discrete Optimization**
Leslie E. Trotter

11:45 **IP4 Control Theory and Linear Algebra**
Israel Gohberg

Thursday Afternoon, June 16

12:30 - 2:00
Lunch

2:00-4:00
CONCURRENT SESSIONS
COMMON-INTEREST

4:00-5:00
Meet-and-Greet Hour
Golden Cliff Room

Thursday Evening, June 16

6:00-7:30
Dinner

7:30-9:30
CONCURRENT SESSIONS
COMMON-INTEREST

Friday Morning, June 17

8:00
Registration opens
Cliff Lodge Lobby

INVITED PRESENTATIONS

8:30 **IP5 Nonnegative Matrices: Can the Next Century Top This One?**
Charles R. Johnson

9:15 **IP6 Recent Advances in Iterative Methods for Solving Linear Systems**
Anne Greenbaum

10:00
Coffee

10:30 AM-12:30 PM
Concurrent Sessions

MS7 **Matrix Function Developments**
Ralph Byers

MS8 **Iterative Methods for Image Restoration**
Lothar Reichel

Friday Afternoon, June 17

12:30 - 2:00
Lunch

2:00-4:00
CONCURRENT SESSIONS

MS9 **Numerical Methods for Structured Matrices**
Organizer: Angelika Bunse-Gerstner

MS10 **Nonlinear Algebra in Optimization**
Organizer: Thomas F. Coleman

4:00-5:00
Business Meeting
SIAM Activity Group on Linear Algebra
Ballroom 1

5:00-6:00
Meet-and-Greet Hour
Golden Cliff Room

Friday Evening, June 17

6:00-7:30
Dinner

7:30-9:30
CONCURRENT SESSIONS
COMMON-INTEREST

Saturday Morning, June 18

8:00
Registration opens
Cliff Lodge Lobby

8:30-10:30
CONCURRENT SESSIONS

MS11 **Direct Methods for Large Sparse Systems**
Organizer: Iain S. Duff

MS12 **Topics in Matrix Theory**
Organizer: Richard A. Brualdi

10:30
Coffee

INVITED PRESENTATIONS

11:00 **IP7 Fast Parallel Algorithms for Eigenproblems**
James Demmel

Presentation and Award

11:45 **SIAM Activity Group on Linear Algebra Prize**

Saturday Afternoon, June 18

12:30 - 2:00
Lunch

2:00-4:00
CONCURRENT SESSIONS
COMMON-INTEREST

4:00-6:00
COUNTERPOINT SESSION

Saturday Evening, June 18

6:00-9:00
Banquet Dinner
Guest speaker:
William M. Kahan
"Tales of the Role of Technology in War"
Snowbird Resort Ballroom

COMMON-INTEREST SESSIONS

The common-interest sessions will consist of a 1/2 hour poster session, followed by 1-1/2 hours of moderated discussion. The date and time for any common-interest session is not known at press time. The sessions will be scheduled after we receive most of the registration forms by April 15, 1994. The sessions will be spread out over four days during the conference. Participants and attendees will be notified of the schedule in late April. Listed below are 19 common-interest sessions, and under each session are the provisional titles and authors.

Applications in Optimization and Operations Research

Dynamical Systems in Optimization
Leonid Faybusovich, University of Notre Dame

Knapsacks, Regular Independence Systems and Matroids
Paulo J. Barcia, Universidade Nova de Lisboa, Portugal; and J.D. Cerdeira, Instituto Superior de Agronomia, Portugal

PCG Methods for VLSI Layout Optimization
Paulina Chin and Anthony Vannelli, University of Waterloo, Canada

Minimizing Duality Gap in a Primal-dual Interior Point Algorithm for Linear Programming
Jun Ji, Valdosta State University

Application of Minimax Algebra Models to the Representation of Queueing Systems
Nikolai K. Krivulin, St. Petersburg State University, Russia

An Algorithm for Large-Scale Linearly Constrained Optimization
Walter Murray, Stanford University, and Anders Forsgren, Royal Institute of Technology, Sweden

Tensor-Krylov Methods for Large Sparse Systems of Nonlinear Equations
Bouaricha Ali and Ray Tuminaro, CERFACS, France

Applications in Systems and Control

Large-Scale Control Systems with Indeterminancy
Akhouri S.C. Sinha, Purdue University, Indianapolis

Nonnegative Matrices in Positive Control Theory
Boris G. Zaslavsky, Russian Academy of Sciences, Russia

Realization of Positive Systems
Marchesini Giovanni, University of Padova, Italy

Control RADII
Ralph Byers, University of Kansas

Singular Riccati Equation: A Matrix Pencil Based Approach
Vlad S. Ionescu and Cristian Oara, Polytechnic Institute of Bucharest, Romania

A Posteriori Error Bounds for Computed Solutions to the Algebraic Riccati Equation
Judith D. Gardiner, Ohio State University

New Aspects of Newton's Method for Algebraic Riccati Equations
Peter Benner and Ralph Byers, University of Kansas

Using Eigenstructure Assignment for Modal Decoupling in Aircraft Problems
Darren Mark Littleboy and Nancy Kay Nichols, University of Reading, United Kingdom

Regularization of Time-Varying Descriptor Systems Using Continuous Singular Value Decompositions
Nancy Kay Nichols and Simon Bell, University of Reading, United Kingdom

Partial Periodic Realizations of Discrete-Time Linear Periodic Systems
Elena Sanchez Juan, R. Bru, V. Hernandez, and V. Estruch, Universidad Politecnica de Valencia, Spain

Note on Matrix Pencil for the Numerical Solution of Riccati Equations
Qingshan Qian, University of Kentucky

Recent Progress on Applications of Algebraic Geometry to Linear Control Theory
Xiochang A. Wang, Texas Tech University; M.S. Ravi, East Carolina University; and J. Rosenthal, University of Notre Dame

On Some Practical Criteria of M-Matrices
Li Lei and Jie Hu, Aomori University, Japan; and Tadao Nakamura, Tohoku University, Japan

The Theory of Dimensional Matrices
George W. Hart, Columbia University

Applications in Signal and Image Processing

The Eigenvalue Problem for Infinite Matrices with Application to Special Functions
Yasuhiko Ikebe, A. Sakaguchi, N. Asai, Y. Miyazaki, and D. Cai, University of Tsukuba, Japan; and I. Fujishiro, Ochanomizu Women's College, Japan

Unitary Hessenberg Methods for the Retrieval of Harmonics
Chunyang He, Technical University of Chemnitz-Zwickau, Germany; and A. Bunse-Gerstner, University of Bremen, Germany

Predictor of Linear Output for Fast Pattern Recognition
Mario Mastriani, Universidad de Buenos Aires, Argentina

An Application of Matrix in the Minimization of 2-D Digital Filters
Guoliang Zeng, Arizona State University; and Nghi Trong Phung, Varian Tempe Electronics Center, Tempe, AZ

Linearized Inversion and SVD for Seismic Reflection Data: A Short Review
Sergio Chavez-Perez, Satish Pullammanappallil, John Louie and John Anderson, University of Nevada

Look-ahead and Superfast Toeplitz Solvers
Thomas K. Huckle, Stanford University

Recent Approaches to Video Indexing
James Normile, *Dulce Ponceleon,* Kathy Wang, and Hsi-Jung Wu, Apple Computer, Inc., Cupertino, CA

Efficient Algorithms for Some Specific FTT's on Massively Parallel Computers
Avijit Purkayastha and Jaime Seguel, University of Puerto Rico, Mayaguez

Preconditioned Iterative 3-D Finite-Difference Migration or Modeling on MPP Systems
Guangye Li, Jason C. Kao, and Chao Wu Yang, Cray Research, Inc.

Least Squares Design of Composed Filtering and Interpolation Matrix Operators with Application to Resampling
Grigore I. Braileanu, Gonzaga University

An Application for the Symmetric Functions
Mario Mastriani, Universidad de Buenos Aires, Argentina

An Updating Algorithm for On-Line MIMO System Identification
Michael Stewart, University of Illinois, Urbana

Applications, other

Sparse Matrices in Seismic Tomography
Philip Fourie, University of Stellenbosch, South Africa

Some Band Matrices Arising in Spline Analysis
Riaz A. Usmani, University of Manitoba, Canada

Exact Inversion of a Class of Vandermonde Matrices
Paolo Pugliese and Alfredo Eisinberg, Universita della Calabria, Italy

A Comparison of Matrix Methods for the Floating-Point Computation of Polynomial GCD
Ali Abdul Rahman, Universiti Teknologi Malaysia, Malaysia

Modeling Groundwater Flow on MPPs
Steven F. Ashby, Robert Falgout and Andrew Tompson, Lawrence Livermore National Laboratory; and Thomas Fogwell, International Technology Corporation, Martinez, CA

Numerical Methods for the Nonlinear Eigenvalue Problems in High Performance Materials Design
Alan Edelman, Massachusetts Institute of Technology and Elizabeth Ong, University of California, San Diego

Least Squares Problems and Applications in Statistics and Probability

The Kac Matrix and a Kac Question — Did Kac See the Connection?
Alan Edelman, Massachusetts Institute of Technology and Eric Kostlan, Kapiolani Community College, Honolulu

Solving Constrained and Weighted Linear Least Squares Problems
Marten Erik Gullikkson, Institute of Information Processing, Sweden

Regularization by Truncated Total Least Squares
Per Christian Hansen, Technical University of Denmark, Denmark; Ricardo D. Fierro, California State University, San Marcos; Gene H. Golub, Stanford University; and Dianne P. O'Leary, University of Maryland, College Park

Compact Givens Representation of the Orthogonal Factor in Recursive Least Squares
Serge J. Olszanskyj and Adam W. Bojanczyk, Cornell University

Condition Estimation and Rank-Revealing Factorizations

The Sensitivity of Linear Algebraic Equations
Joab R. Winkler, Brunel University, United Kingdom

Pseudo-skeleton Approximations: Theory and Algorithms
Eugene E. Tyrtyshnikov, Sergei A. Goreinov, and Nickolai L. Zamarashkin, Russia Academy of Sciences, Russia

A Schur Method for Low-rank Matrix Approximation
Alle-Jan van der Veen, Stanford University

Downdating a Generalized ULLV Decomposition
James M. Lebak and Adam Bojanczyk, Cornell University

Eigenvalue and Singular Value Algorithms for Dense Matrices

On the Semiclassical Jacobi Algorithm
Domingo Gimenez, University of Murcia, Spain

Transmission of Shifts in the QR Algorithm
David Watkins, Washington State University

Computation of the Schur Form of Dense, Nonsymmetric Matrices via Ultimate Shifts
Jeffrey B. Haag, Humboldt State University; and David S. Watkins, Washington State University

On Quaternion Jacobi's Method for Skew-Symmetric Matrices
Noah H. Rhee, University of Missouri, Kansas City

Faster and More Accurate Eigenvalue Computation
Roy C. Mathias, College of William and Mary

Linear Algebraic Considerations in Solving Convective-Diffusion Equations by the Method of Lines and Finite Volumes (MOLFV)
Antonio Campo, Idaho State University; Juan Morales, University of Texas, Austin; and P. Lang, Idaho State University

On the QR and Inverse QR Algorithms
Kevin Gates and William Gragg, Institute for Scientific Computing, ETH Zurich, Switzerland

Jacobi-like Matrix Factorizations with CORDIC-based Inexact Diagonalizations
N.D. Hemkumar and Joseph R. Cavallaro, Rice University

New Algorithms for Symmetric Eigenvalue Computation
Victor Y. Pan, Lehman College, City University of New York, Bronx

Convergence of the Quaternion-Jacobi Method
Niloufer Mackey, State University of New York, Buffalo

The Parallel Unsymmetric Eigenvalue Problem and Related Applications
Greg Henry, Intel SSD, Beaverton, OR and Robert van de Geijn, University of Texas, Austin

Block Elementary Orthogonal Matrices (Theory and Computation)
Xioabai Sun and Christian H. Bischof, Argonne National Laboratory

Ordering the Singular Values in the One-sided Jacobi Method
Kermit Sigmon, University of Florida

Null-pole Triples for Nonsquare Rational Matrix Functions
Richard E. Faulkenberry, University of Massachusetts, Dartmouth

Eigenvalue and Singular Value Algorithms for Sparse Matrices

Block Diagonalization of a Symmetric Matrix using Armijo's Stepsize
Purandar Sarmah, University of Florida

Computing the Generalized SVD of Large Sparse or Structured Matrix Pairs
Hongyuan Zha, Pennsylvania State University

On a Variant of Lanczos Method
Nikolay E. Mikhailovsky, Moscow Institute of Physics and Technology, Russia

Improving the Rehability of a Deflated Non-Hermitian Generalized Eigenvalue Problem
Miloud Sadkane and Bernard Philippe, IRISA-INRIA, Rennes, France

Maintaining Orthogonality during the Lanczos Factorization
Richard B. Lehoucq and Danny C. Sorensen, Rice University

Lanczos Algorithm for Nonsymmetric Eigenproblem: An Error Analysis and A Block Version
Zhaojun Bai, University of Kentucky

Does the CG Method of Minimization of the Rayleigh Quotient Provide the Global Minimum in the Krylov Subspace as the Lanczos Method? Asymptotically, Yes!
Andrew V. Knyazev, Courant Institute of Mathematical Sciences, New York University

Invariant Subspace Identification by Newton's Method Applied to the Small Signal Stability Analysis of Power Systems
Adam Semlyen and George Angelidis, University of Toronto, Canada

A Block Lanczos Method for the Sparse SVD with Adaptive Re-Orthogonalization
Michael W. Berry and Robin L. Auerbach, University of Tennessee, Knoxville

Merging Jacobi Matrices from Independent Lanczos Recursions
Michael W. Berry and Sowmini Varadhan, University of Tennessee, Knoxville

The Spectral Lanczos Method Applied to the Time-Independent Schrodinger Equation
Faisal Saied, University of Illinois, Urbana

The Subspace Iteration
Xuzhou Chen and Robert E. Hartwig, North Carolina State University

A Study of the Invariant Subspace Decomposition Algorithm (ISDA) for Banded Symmetric Matrices
Thomas Turnbull and Anna Tsao, Supercomputing Research Center; Christian H. Bischof and Xiaobai Sun, Argonne National Laboratory

Successive Band Reduction and Symmetric Eigenvalue Problems
Xioabai Sun and Christian H. Bischof, Argonne National Laboratory

A Parallel Block Lanczos Algorithm for Large Eigenpair Computations
Gen-Ching Lo and Frank Webster, State University of New York, Stony Brook

Generalized and Quadratic Eigenvalue Problems

On the Symmetric-Definite Generalized Eigenproblem
Shivkumar Chandrasekaran and Ilse Ipsen, North Carolina State University

A Class of Modified Generalized Eigenvalue Problems
Cheryl M.M. Carey, California Institute of Technology

Polynomial Roots from Companion Matrices
Alan Edelman, Massachusetts Institute of Technology and H. Murakami, Hokkaido University, Japan

Parallel Algorithms for Dense Problems

Gauss-Huard's Algorithm for Solving Dense Linear Systems on Hierarchical Memory Computers
Walter Hoffmann, T.J. Dekker, and K. Potma, University of Amsterdam, The Netherlands

A Parallel Eigensolver for Dense Symmetric Matrices
Bruce Hendrickson, Sandia National Laboratories, Albuquerque; Elizabeth Jessup, University of Colorado, Boulder; and Christopher Smith, Sandia National Laboratories, Albuquerque

QR Method for Large Least Squares Problems Involving Kronecker Products
Hany Hashish, Mansoura University, Egypt; *Donald W. Fausett* and Charles T. Fulton, Florida Institute of Technology

A New Parallel Triangular Solver for Distributed-memory Multiprocessors
Dianqin Wang and Eleanor Chu, University of Guelph, Canada

A Massively Parallel Method for Matrix Multiplication Based on Strassen's Method
Yuefan Deng, C.C. Chou and Y. Wang, State University of New York, Stony Brook

Improved Parallel Computations in Linear Algebra
Victor Y. Pan, Lehman College, City University of New York, Bronx

Super Effective Slow-down of Parallel Matrix Computations
Victor Y. Pan, Lehman College, City University of New York, Bronx and F.P. Preparata, Brown University

Modifying Singular Value Decompositions on Connection Machine
Peter A. Yoon and Jesse L. Barlow, Pennsylvania State University

Large Dense Numerical Linear Algebra in 1994: The Parallel Computing Influence
Alan Edelman, Massachusetts Institute of Technology

Platform Independent Parallel Dense Matrix Equation Solution with Application to Electromagnetic Scattering
Tom Cwik, Jet Propulsion Laboratory; Robert A. van de Geijn, University of Texas, Austin; and Jean Patterson, Jet Propulsion Laboratory

Parallel Algorithms for Sparse Problems

A Parallel BSSOR Algorithm for Distributed Memory Machines
Marco D'Apuzzo, University of Naples "Federico II", Italy

A Parallel Solver for the hp-Version of Finite Element Method
Xian Z. Gud and Kent Myers, Engineering Software Research and Development, St Louis, MO

An Improved Algorithm for Parallel Sparse LU Decomposition on a Distributed-Memory Multiprocessor
Rob H. Bisseling, University of Utrecht, The Netherlands; and Jacko Koster, CERFACS, France

A Parallel Algorithm for Identification
Jose Tarcisio Costa Filho, Celso Pascoli Bottura, and Gilmar Barreto, Universidade Estadual de Campanias-Unicamp, Brasil

Data Parallel Sparse LU Factorization
Robert Lucas, John Conroy and Steve Kratzer, Institute for Defense Analysis, Bowie, MD

On the Divide and Conquer Algorithm for Solving Tridiagonal Systems
Bogdan Dumitrescu, Polytechnical University of Bucharest, Romania

An Algorithm Solving Tridiagonal Toeplitz Systems on Parallel Computers
Eric P. Jiang, Cleveland State College

A Communication-Optimal Algorithm for Parallel Sparse Cholesky Factorization
Andrew J. Cleary, Australian National University, Australia

Parallel Out-of-Core Block Tridiagonal Solvers with Application to Accoustics
Robert A. van de Geijn and Ken Klimkowski, University of Texas, Austin

Initial Experience with Parallel Oil Reservoir Computation
Jesper Larsen, Math-Tech, Gentofte, Denmark

Potential and Achievable Parallelism in the Unsymmetric-Pattern, Multifrontal LU Factorization Method for Sparse Matrices
Steven M. Hadfield and Timothy A. Davis, University of Florida

Sparse Direct Methods

The Use of Multiple Fronts in Gaussian Elimination
Jennifer Scott, Rutherford Appleton Laboratory, United Kingdom

Combining Unifrontal and Multifrontal Methods for Unsymmetric-Pattern Sparse Matrices
Timothy A. Davis, University of Florida

Sparse Direct Methods for Vector Computer
Friedrich Grund, Institut for Applied Analysis and Stochastics, Germany

Computing Row and Column Counts for Sparse QR Factorization
Esmond G. Ng, Oak Ridge National Laboratory; John Gilbert, Xerox Palo Alto Research Center; and Barry Peyton, Oak Ridge National Laboratory

A Sparse Solver with Multifrontal Method for General Sparse Linear Systems on the Cray C90
Chao Wu Yang, Cray Research, Inc., Eagan, MN

Some Alternatives to Block Cyclic Reduction
Victor Y. Pan, Lehman College, City University of New York, Bronx and I. Sobze, City University of New York, New York

Iterative or Direct Solvers? -- A Theoretical Characterization via Laplacian Spectrum of a Sparse Matrix
Horst D. Simon, NASA Ames Research Center

Sparse Iterative Methods: Iterative Algorithms and Acceleration Methods

A Stabilized Version of Block BiCG
Valeria Simoncini, University of Bologna, Italy

MPE-Iterative Methods for Solving and Reaction-Diffusion Problems
Reza O. Abbasian, Texas Lutheran College and Texas Institute for Computational Mechanics, and Graham F. Carey, Texas Institute for Computational Mechanics

Nonsymmetric Iterative Methods for an Advection-Diffusion Problem
Kieran Joseph Neylon, M.J. Baines and N.K. Nichols, University of Reading, United Kingdom

Optimal Number of Inner Iterations for Two-Stage Methods
Hwajeong Choi and Daniel Szyld, Temple University

Multiple Right-hand Side Systems and Applications
E. Gallopoulos, University of Illinois, Urbana and Valeria Simoncini, University of Bologna, Italy

Chaotic Inner-Outer Iterative Schemes
Rafael Bru, Universidad Politecnica de Valencia, Spain; V. Migallon and J. Penades, Universidad Alicante, Spain

Solution of Least Squares Problems in Electric Power Networks Using Iterative Methods
Hasan Dag, H. Singh, and F.L. Alvarado, University of Wisconsin, Madison

Sparse Iterative Methods: Preconditioning, Domain Decomposition, Multigrid

Multi-Domain Finite Difference Methods for Scalar Waves
Seongjai Kim, Purdue University, West Lafayette

Parallel Preconditioners Based on Sparse Approximate Inverses
Lily Yu. Kolotilina, Russia Academy of Sciences, Russia

On the Preconditioning Conjugate Gradient Method for the Solution of 9-Point Elliptic Difference Equations
Z. Mazhar, *D.S. Daoud,* and D. Subasi, Eastern Mediterranean University, Turkey

Wavelet Preconditioners
Maria Elizabeth G. Ong, University of California, San Diego; Tony Chan, University of California, Los Angeles; and Tarek Mathew, University of Wyoming

A Comparison of Iterative Methods for the Navier-Stokes Equations
Alison Ramage, University of Strathclyde, Scotland

A Preconditioned Arnoldi Method for Computing the Frequency Response Matrix for a Large and Sparse System
Samar Choudhary, Cray Research Inc.; Biswa N. Datta, Northern Illinois University; and M. Heroux, Cray Research Inc.

Parallel Performance and Scalability of a Preconditioning Strategy for High P Finite Element Discretizations for 2D Incompressible Flows
Edward Barragy, University of Texas, Austin, and Intel Corporation; Graham Carey and Robert van de Geijn, University of Texas, Austin

Analytically and Implementationally Optimal 2-Color SSOR Preconditioning on Vector and Parallel Supercomputers
David L. Harrar II, Australian National University, Australia

Structured Matrices

Some Properties of the Rational Function Matrices of the Form $M = Z + T$
Kai-Sheng Lu, Wuhan University of Water Transportation Engineering, People's Republic of China

Numerical Methods for Discrete Least Squares Approximation by Trigonometric Polynomials
Heike Fassbender, Universitat Bremen, Germany

Rank Revealing URV Factorization for Ill-Conditioned Toeplitz Systems of Equations
James G. Nagy, Southern Methodist University

Structured Matrices in System Identification and Block Separable Nonlinear Least Squares
Linda Kaufman and Margaret Wright, AT&T Bell Laboratories

On the Root Distribution of Polynomials Associated with Certain Structured Matrices
Michael E. Shmoish, Weizmann Institute of Science, Israel

Numerical Aspects of Fast Toeplitz Solvers
Adam W. Bojanczyk, Cornell University and Georg Heinig, Kuwait University, Kuwait

On Solving Symmetric Block Toeplitz Systems Using a Block Schur
Kyle Gallivan, *Srikanth Thirumalai,* and Paul Van Dooren, University of Illinois, Urbana

Transformations of Structured Matrices and Stable Methods of Their Inversion
Georg Heinig, Kuwait University, Kuwait, and Adam Bojanczyk, Cornell University

Matrix Functions and Operator Theory

Fast Krylov Subspace Methods for Computing Functions of Large Sparse Symmetric Matrices
Vladimir L. Druskin, Schlumberger Doll Research and Leonid Knizhnetman, Central Geophysical Expedition, Russia

Operator Equations and Range Inclusion
Mohammad Khadivi, Jackson State University

Indefinite Trigonometric Moment Problems
Tiberiu Constantinescu, University of Texas, Dallas; and Aurelian Gneondea, The Institute of Mathematics, Romania

The Nehari Theorem via a Riccati Equation Technique
Martin Weiss, University of Groningen, The Netherlands

Powers of a Matrix in Exact and Finite Precision Arithmetic
Philip Knight, Strathclyde University, Scotland

Shorts, Parallel Addition and Parallel Subtraction of Matrix Functions
Edward L. Pekarev, Odessa Technological Institute of Food Industry, Ukraine

A Block Matrix Formula for Derivatives of Matrix Functions
Roy C. Mathias, College of William and Mary

Matrix Theory: Canonical Forms, Matrix Functions, Multilinear Algebra, Nonnegative Matrices, Spectral Inequalities

Kronecker Normal Form of Matrix
Tianjun Wang, Michigan State University; and Zhinan Zhang, Xinjiang University, People's Republic of China

Solving Systems of Equations to Generate Generalized Inverses of Various Types
James T. Bruening, Southeast Missouri State University

Simultaneous Diagonalizations and Generalized Inverses
Patrick L. Odell, Baylor University; and T.L. Boullion, University of Southwestern Louisiana

Partial Ordering of Matrices and Generalized Inverses
S.K. Jain, Ohio University

Convexity and Concavity of the Moore-Penrose Inverse
Kenneth O. Nordstrom, University of Helsinki, Finland

Algebraic Structure of the Special Polynomial Ring
Vladislav Shapiro, Northeastern University

Spectral Inequalities for Nonnegative Matrices
Raphael Loewy, Technion-Israel Institute of Technology, Israel

Row Sums
James R. Weaver, University of West Florida

Combinatorial Matrix Problems and Graph Theory

Spectral Nested Dissection (II)
Lie Wang, Pennsylvania State University; and Alex Pothen, University of Waterloo, Canada

On Nonnegative Generalized Eigenvectors of Nonnegative Matrices
Rafael Canto, Universitat Politecnica Valencia, Spain; and Joan Josep Climent, Universitat de Alicante, Spain

Generic Rank of Matrix Powers
Svatopluk Poljak, Charles University, Prague, Czech Republic

Skew-rank Decomposability
Bryan L. Shader, University of Wyoming

Biclique Partitions of Graphs
Elizabeth D. Boyer and Bryan Shader, University of Wyoming

The Group Inverse Associated with an Irreducible Periodic Nonnegative Matrix
Steve J. Kirkland, University of Regina, Canada

Powerful Sign Pattern Matrices
Carolyn A. Eschenbach, Frank Hall and Jason Lee, Georgia State University

A Sign-Cut Version of the Recursive Spectral Graph Bisection Algorithm
Tony F. Chan, University of California, Los Angeles; and W.K. Szeto, The Chinese University of Hong Kong, Hong Kong

Education and Teaching

The Gauss-Jordan Matrix Inversion is not Optimal: A Symbolic Adaptation
Hossein Arsham, University of Baltimore

Encouraging Student Conjectures using Structured Random Matrices and Matlab
Jeff Stuart, University of Southern Mississippi

Using Hypermedia in Linear Algebra Teaching
Jari Multisilta and Pohjolainen Seppo, Tampere University of Technology, Finland

Applications of Linear Algebra in Statistics
Roger B. Godard, Royal Military College, Canada

Statistical Quality Control, Assessment, and Cooperative Learning
Charles B. Pierre, San Jose State University

Other

Pairs of Positive Matrices and 2D Systems Dynamics
Ettore Fornasini and Maria Elena Valcher, University of Padova, Italy

The Ellipsoid Method and Karmarkar's Projective Algorithm
J.N. Singh, Ahmadu Bello University, Nigeria

Beyond Linear Perturbation Theory
Valerie Fraysse, Francoise Chatelin and Vincent Toumazou, CERFACS, France

On the Jacobian Conjecture
Kenechukwu Kenneth-Nwabueze, Mathematical Research Institute, Holland

Structure of Some Linear Preservers on Spaces of Matrices
Ali A. Jafarian, University of New Haven

SIAM CONFERENCES, MEETINGS, SYMPOSIA, TUTORIALS, AND WORKSHOPS

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1994

April 18–20, 1994
Conference on Emerging Issues in Mathematics and Computation from the Materials Sciences
Pittsburgh Vista Hotel, Pittsburgh, PA • *Conducted by The Center for Nonlinear Analysis, Carnegie Mellon University, and SIAM*
Organizer: David Kinderlehrer, Carnegie Mellon University

June 15–18, 1994
Fifth SIAM Conference on Applied Linear Algebra
Snowbird Ski and Summer Resort, Snowbird, Utah • *Sponsored by SIAM Activity Group on Linear Algebra*
Organizer: Beresford N. Parlett, University of California, Berkeley

June 22–25, 1994
Seventh SIAM Conference on Discrete Mathematics
Ramada Classic Hotel, Albuquerque, NM • *Sponsored by SIAM Activity Group on Discrete Mathematics* • *Organizer:* William T. Trotter, Bellcore

July 22-23, 1994
Symposium on Control Problems in Industry
Holiday Inn on the Bay, San Diego, CA • *Conducted with the cooperation of INRIA*
Organizers: Irena Lasiecka, University of Virginia, Blaise Morton, Honeywell Technology Center, and Jacques Henry, INRIA, France

July 24, 1994
SIAM Tutorial on Ensemble Based Simulated Annealing
Sheraton Harbor Island East, San Diego, CA
Organizers: Richard Frost, San Diego Supercomputer Center, and Peter Salamon, San Diego State University

July 25–29, 1994
1994 SIAM Annual Meeting
Sheraton Harbor Island East, San Diego, CA • *Organizer:* Barbara L. Keyfitz, University of Houston

December 12–14, 1994
Symposium on Inverse Problems: Geophysical Applications
Tenaya Lodge at Yosemite , Fish Camp, CA • *Sponsored by GAMM and SIAM* • Abstract deadline: 4/25/94
Organizer: William Rundell, Texas A&M University, College Station

1995

January 22-24, 1995
Sixth ACM/SIAM Symposium on Discrete Algorithms
The Nikko Hotel, San Francisco, CA • *Sponsored by ACM Special Interest Group on Automata and Compatibility Theory and SIAM Activity Group on Discrete Mathematics* • Abstract deadline: 7/5/94

February 8-10, 1995
SIAM Conference on Geosciences
San Antonio, TX • *Sponsored by SIAM Activity Group on Geosciences* • Abstract Deadline: 8/8/94

February 15-17, 1995
Seventh SIAM Conference on Parallel Processing for Scientific Computing
The Nikko Hotel, San Francisco, CA • *Sponsored by SIAM Activity Group on Supercomputing* • Abstract Deadline: 5/16/94
Organizer: Robert S. Schreiber, Research Institute for Advanced Computer Science

If would like more information, please contact: SIAM Conference Coordinator, Dept. CCØ294, 3600 University City Science Center, Philadelphia, PA 19104-2688 • Phone: 215-382-9800 • Fax: 215-386-7999 • E-mail: meetings@siam.org • To receive an electronic version of the call for papers and programs, send requests to: meetings@siam.org

MORNING

7:30/Cliff Lodge Lobby
Registration opens

8:15
Opening Remarks
Beresford N. Parlett, University of California, Berkeley

8:30
IP1/Chair: John G. Lewis, Boeing Computer Services

Geometry and Eigenvalues

During the past five years there has been spectacular progress in getting good bounds on the eigenvalues of large sparse stochastic matrices. This work is critical to the markov chain revival that has occurred in combinatorics, computer science, statistical computing, and statistical mechanics. The eigenvalues are understood through the graph of the associated adjacency matrix. This allows geometric ideas such as diameter, girth, and a variety of discrete curvatures (covering numbers) to be used. Borrowing ideas from differential equations and differential geometry (Poincare, Cheeger, Nash, Log-Sobolev inequalities) one gets a theory that actually gives useful results in applied problems.

Persi Diaconis
Department of Mathematics
Harvard University

9:15
IP2/Chair: Sven Hammarling, Numerical Algorithms Group, United Kingdom

Parallel Matrix Computations

A surprising fact about parallel matrix computation is that efficient parallel implementation of Gaussian elimination has taken well over a decade to achieve. In creating good parallel software for this most basic matrix computation, we have fortunately learned much that generalizes to the rest of numerical linear algebra.

After discussing some of the evolution of ideas about parallel Gaussian elimination, from vector algorithms to systolic arrays to column-wrapped distributed algorithms, I will describe an efficient, distributed-memory algorithm and then indicate what limits its efficiency and what can be done to improve it. I will also describe two promising ideas of the past decade that have turned out to be impractical, for quite interesting reasons.

Highly parallel sparse factorization has seemed to be more a more difficult problem. While a theory of efficient, highly parallel sparse factorization has been known for some time, no practical implementations were available until very recently. I will conclude by describing two such implementations.

Robert S. Schreiber
Research Institute for Advanced Computer Science

10:00
Coffee

10:30 AM-12:30 PM
CONCURRENT SESSIONS

MS1
Algebraic Riccati Equations and Their Applications

The central role played by matrix Riccati equations in the theories of filtering and optimal control have been recognized since the landmark papers of Kalman and Bucy appeared about 35 years ago. Since that time, these equations have appeared in a variety of problem areas including least squares approximation, factorization of matrix functions, game theory, and ordinary differential equations. Although these equations are truly non-linear, they admit detailed analysis by the methods of linear algebra. Work in this direction continues to progress and a deeper understanding of the nature of the solution sets as well as generalizations to broader problem classes is being achieved.

The speakers in this minisymposium will cover ideas and techniques used in the analysis of algebraic Riccati equations, including invariant and deflating subspace methods, the stability of solutions under perturbation of the coefficients, the "condition" of Riccati equations from the point of view of numerical analysis.

Organizer: Peter Lancaster, University of Calgary, Canada

10:30 A Survey of the Methods of Linear Algebra Applied to the Solution of Algebraic Riccati Equations
Peter Lancaster, Organizer

11:00 Algebraic Riccati Equations: Parametric Dependence and Stability of Solutions
Leiba Rodman, College of William and Mary

11:30 Estimating the Condition of Algebraic Riccati Equations
Alan J. Laub and Charles S. Kenney, University of California, Santa Barbara

12:00 Indefinite Stabilizing Solutions of H_∞ Riccati Equations
Gary Hewer, Naval Weapons Center, China Lake, CA

MS2
Iterative Methods for Large Sparse Systems

Many numerical computations involve the solution of large sparse systems of linear equations. For example, such systems arise from finite difference or finite element approximations to partial differential equations, as intermediate steps in computing the solution of nonlinear problems, or as subproblems in large-scale linear and nonlinear programming. A natural way to exploit the sparsity in the solution process is to use iterative techniques. In recent years, there have been a number of new developments, such as robust iterative methods for general non-Hermitian systems and a variety of new efficient preconditioning techniques.

The speakers in this minisymposium will survey some of these recent advances in the area of iterative methods. Topics include singular systems, domain-decomposition-type preconditioners for general systems, QMRPACK—a software package for general software for non-Hermitian systems, and iterative methods for fluid-flow computations.

Organizer: Roland W. Freund, AT&T Bell Laboratories

10:30 Conjugate Gradient-Type Methods for Singular Systems
Roland W. Freund, Organizer

11:00 Parallel Preconditioned Iterative Methods for Distributed Sparse Matrices
Youcef Saad, University of Minnesota, Minneapolis

11:30 QMRPACK and Applications
Roland W. Freund, Organizer; and *Noel M. Nachtigal,* Oak Ridge National Laboratory

12:00 Iterative Methods for the Discrete Stokes and Navier-Stokes Equations
Howard Elman, University of Maryland, College Park

AFTERNOON

12:30-2:00
Lunch

2:00 - 5:00
CONCURRENT SESSIONS

MS3
Teaching Linear Algebra

Many linear algebra courses are moving (and have moved) away from an abstract approach to one that includes applications. The theorem-proof style is replaced by a style that emphasizes the purpose and use of linear algebra. Now there is a further movement to include the computational side of this subject. This leads to new questions and new difficulties that need new ideas — from the speakers and the audience at this minisymposium.

Organizer: Gilbert Strang, Massachusetts Institute of Technology

2:00 Random Matrices and Special Matrices
Gilbert Strang, Organizer

2:30 Linear Algebra Projects Using Mathematica
A.D. Andrews and *T.D. Morley,* Georgia Institute of Technology

3:00 Applications and Computation in Beginning Linear Algebra
Jane M. Day, San Jose State University

3:30 Teaching Linear Algebra in the Presence of Supercalculators
Donald R. LaTorre, Clemson University

4:00 Teaching Numerical Linear Algebra at Illinois
Faisal Saied, University of Illinois, Urbana-Champaign

MS4
Parallel Multisplittings and Applications of Domain Decomposition

This session is intended to demonstrate the flexibility of both domain decompostion techniques and multisplitting methods for the solution of problems from a wide variety of applications. Domain decomposition has progressed from being an academic research subject focusing on model problems to a widely used class of techniques suitable for the numerical solution of many partial differential equations. The speakers will present work on domain decomposition devoted to several important application areas. The placement of domain decomposition techniques in the larger context of a linear algebra framework is intended to demonstrate both their power and availablilty to a

wider community of practitioners.

Multisplitting methods for solving linear equations were introduced in the mid-eighties. The philosophy of these methods, that a large-scale problem can be replaced by a set of subproblems, each solved locally and independently in parallel, has been recently extended to the solution of nonlinear equations and optimisation problems. The speakers will review the standard multisplitting strategy and discuss important recent advances in the choice of splitting and recombination of the subproblem solutions. Efficient new algorithms use multisplittings as preconditioners for GMRES, conjugate gradients, and other iterations.

Organizers: Dianne P. O'Leary, University of Maryland, College Park; Rosemary A. Renaut, Arizona State University; and Barry F. Smith, University of California, Los Angeles

2:00 **Domain Decomposition: An Overview**
Barry F. Smith, Co-organizer

2:20 **Domain Decomposition Preconditioners for Plates and Shells**
Jan Mandel, University of Colorado, Denver

2:40 **Domain Decomposition Methods for Some Nonlinear Elliptic Finite Problems**
Xiao-Chuan Cai and M. Dryja, University of Colorado, Boulder

3:00 **Domain Decomposition with Application to Oil-Reservoir Simulation**
Petter Bjørstad and Terje Kaarstad, Institute for Informatik, Norway

3:30 **Parallel Multisplitting: An Overview**
Rosemary A. Renaut, Co-organizer and Qing He, Arizona State University

3:50 **Comparison Results for Splittings Based on Overlapping Blocks**
Andreas Frommer, Universitat Wuppertal, Germany

4:10 **Two-stage Multisplitting Methods**
Daniel B. Szyld, Temple University

4:30 **Equilibrium Equations and Parallel Iterative Methods**
R. E. White, North Carolina State University

5:00/Golden Cliff Room
Meet-and-Greet Hour

EVENING

6:00
Dinner

7:30 - 9:30
CONCURRENT SESSIONS
COMMON-INTEREST

See pages 4 – 7. The common-interest sessions will be spread out over four days during the conference.)

MORNING

8:00/Cliff Lodge Lobby
Registration opens

8:30 - 9:30
CONCURRENT SESSIONS

MS5
Eigenvalues, Geometry, and Graph Computation

Algebraic and geometric techniques are beginning to play an important role in the solution of hard computational problems on graphs. The solution of three problems on graphs by these techniques will be discussed in this minisymposium. These problems have applications in areas such as sparse matrix computations, the mapping problem in parallel computation, and statistical physics.

The first speakers discuss the problem of ordering the vertices of a graph to minimize its profile (a generalization of the concept of bandwidth), and the problem of partitioning the vertices of a graph into two roughly equal-size subsets such that the number of *cut edges* (edges joining vertices in different subsets) is minimized. Both problems are solved by employing eigenvectors of certain matrices associated with the graphs. The third speaker will describe a geometric approach for the partitioning problem when the graphs are embedded in two or three dimensions (e.g., finite-element meshes). This approach yields provably good solutions, and can be implemented on data-parallel computers. The fourth speaker will discuss the *max-cut problem* (partitioning a graph to maximize the number of cut edges). An approach involving both polyhedral and semi-definite linear programming techniques will be described.

Organizer: Alex Pothen, University of Waterloo, Canada

8:30 **A Spectral Algorithm for Profile Minimization**
J. Alan George, University of Waterloo, Canada and *Alex Pothen,* Organizer

9:00 **Eigenvalue Based Techniques for Graph Partitioning and Related Problems**
Julie Falkner, Massey University, New Zealand; Franz Rendl, Technische Universitat Graz, Austria; and *Henry Wolkowicz,* University of Waterloo, Canada

9:30 **Geometric Partitioning for Finite Element Meshes**
Shang-Hua Teng, Massachusetts Institute of Technology

10:00 **Polyhedral and Semidefinite Relaxations for Max Cut**
Christoph Helmberg, Technische Universitat Graz, Austria; Svatopluk Poljak, Charles University, Czech Republic; and *Franz Rendl,* Technische Universitat Graz, Austria

MS6
Accuracy Issues for Eigenvalue and Singular Value Problems

This minisymposium addresses accuracy issues associated with eigenvalue and singular singular value problems. In applications, the main importance of this is the accurate tracking of subspaces in the solution of signal processing problems and total least squares problems. The current directions of this work are to find the answers to two fundamental questions. What kind of accuracy can be expected for eigenvalue and singular value problems, and which methods can be expected to achieve this accuracy?

Organizers: Kresimir Veselic, Fernuniversität Hagen, Germany and Jesse L. Barlow, Pennsylvania State University

8:30 **Accuracy Issues for Eigenvalue and Singular Value Problems**
Kresimir Veselic, Organizer

9:00 **Computing the Extreme Generalized Singular Value/Vector Pairs of Large Sparse or Structured Matrices.**
Hongyuan Zha, Pennsylvania State University

9:30 **Relative Perturbation Theory for Eigenvalues**
James W. Demmel, University of California, Berkeley; Stanley C. Eisenstat, Yale University; *Ming Gu,* University of California, Berkeley; Ivan Slapnicar, University of Split, Croatia; and Kresimir Veselic, Organizer

10:00 **More Relative Perturbation Results for Singular Value and Eigenvalue Reduction**
Ilse C.F. Ipsen, North Carolina State University, and Stanley C. Eisenstat, Yale University

10:30
Coffee

11:00
IP3/Chair: John R. Gilbert, Xerox Palo Alto Research Center

Linear Algebraic Duality for Discrete Optimization

The geometric duality of points as both generators and constraints lies at the heart of elementary linear algebra: any (nonempty) subspace is generated by a basis, while a basis for its orthogonal complement defines a set of homogeneous linear equality constraints which also determine the subspace. In this presentation the speaker will show how an abstraction of these simple concepts leads to a linear duality model which has as special instances several well-studied duality models in optimization: cone polarity, lattice duality, blocking polyhedra, antiblocking polyhedra. He will then extend the linear model to accommodate a duality relation shared by point sets and families of (possibly) nonlinear constraint functions. This extension provides a duality model for discrete optimization (integer programming).

Leslie E. Trotter
School of Operations Research and Industrial Engineering
Cornell University

FRIDAY, JUNE 17

11:45
IP4/Chair: Harm Bart, Erasmus University, The Netherlands

Control Theory and Linear Algebra

Many important problems of control for finite dimensional, time—invariant, linear, input—output systems are solved with methods of linear algebra. The state space method is often used to reduce problems for systems to problems for matrices. This usually leads to new problems for matrices and new points of view for old problems. For applications, the solution of a problem has to be presented in a form of an algorithm or a formula with the analysis of the numerical aspects.

In this presentation, the statements above will be illustrated on a modeling problem and sensitivity minimization problem. Both problems are connected with interpolation problems with constrains for rational matrix—functions and also with Silvester and Lyapunov equations.

Israel Gohberg
School of Mathematical Sciences
Tel Aviv University, Israel

AFTERNOON

12:30-2:00
Lunch

2:00-4:00
CONCURRENT SESSIONS
COMMON-INTEREST
See pages 4 – 7.

4:00-5:00/Golden Cliff Room
Meet-and-Greet Hour

EVENING

6:00-7:30
Dinner

7:30 - 9:30
CONCURRENT SESSIONS
COMMON-INTEREST
See pages 4 – 7.

MORNING

8:00/Cliff Lodge Lobby
Registration opens

8:30
IP5/Chair: Richard A. Brualdi, University of Wisconsin, Madison

Nonnegative Matrices: Can the Next Century Top This One?

With relatively few antecedents in the prior century, the understanding of entry-wise nonnegative matrices beginning with the groundbreaking work of Perron and Frobenius near the beginning of this century, and continuing to this moment, is closely identified with the twentieth century. It is, perhaps, the single most dominant theme in matrix theory this century; a very high percentage of prominent researchers in matrix theory and allied applications have made contributions to the subject. It has also spawned important directions of research that have taken on a life of their own. The speaker will summarize a few threads of the history, discuss current developments and open questions, and ask whether there is room to have as dramatic a set of developments in the next century.

Charles R. Johnson
Department of Mathematics
College of William & Mary

9:15
IP6/Chair: Paul Van Dooren, University of Illinois, Urbana

Recent Advances in Iterative Methods for Solving Linear Systems

The speaker will present a survey of recent work on iterative methods for both symmetric and nonsymmetric linear systems. Results about the effect of finite precision arithmetic on the conjugate gradient algorithm are described. Attempts at understanding the effects of nonnormality on the convergence rate of the GMRES method are also discussed. Various strategies for combining GMRES with a simpler iteration scheme are analyzed based on results about the behavior of polynomial functions of a nonsymmetric matrix. Shorter recurrences such as the BCG and QMR iterations are compared theoretically.

Anne Greenbaum
Courant Institute of Mathematical Sciences
New York University

10:00
Coffee

10:30 AM-12:30 PM
CONCURRENT SESSIONS

MS7

Matrix Sign Function Developments

The matrix sign function forms the foundation of a group of algorithms for invariant subspaces and related problems. Its applications include solving Lyapunov and Riccati equations and the eigenvalue problems. Traditional algorithms for computing the matrix sign function have limited numerical stability and limited ability to exploit special structures. Recent work has led to an enticing algorithm for advanced architecture computers.

The speakers will survey developments over the last several years, then discuss conditioning and condition estimation, backward numerical stability, and adaptations to parallel computation.

Organizer: Ralph Byers , University of Kansas

10:30 **An Overview of the Matrix Sign Function**
Charles S. Kenney and Alan J. Laub, University of California, Santa Barbara

11:00 **A New Parallel Algorithm for Computing the Singular Value Decomposition**
Nicholas J. Higham, University of Manchester, United Kingdom

11:30 **A Stabilized Matrix Sign Function Algorithm for Solving Algebraic Riccati Equations**
Judy Gardiner, Ohio State University, Columbus

12:00 **Condition Estimation for the Matrix Sign Function via the Schur Decomposition**
Roy Mathias, College of William and Mary

MS8

Iterative Methods for Image Restoration

The central problem of image restoration is the estimation of an original image from an image degraded by noise and blur. Many restoration methods give rise to large linear systems of equations with a structure that can be exploited in the development and analysis of efficient algorithms. The structure depends on the assumptions made on the image and the noise. In particular, the systems can be quite ill-conditioned. The matrices in these systems are typically quite large, orders of 10^6 are common, and many applications require real-time image restoration. Efficient algorithms that lend themselves well to implementation on parallel computers are therefore important. The speaker in this minisymposium will present surveys of problems in Linear Algebra that arise in image restoration, and discuss recent algorithmic developments.

Organizer: Lothar Reichel, Kent State University

10:30 **A Survey of Iterative Methods for Image Restoration**
Robert J. Plemmons, Wake Forest University

11:00 **Multigrid Methods for Image Reconstruction from Projections**
Steve McCormick, University of Colorado, Boulder

11:30 **Regularization of Ill-Posed Problems in Image Restoration**
Dianne P. O'Leary, University of Maryland, College Park

12:00 **ADI Iterative Methods Applied to Image Restoration**
Daniela Calvetti, Stevens Institute of Technology

AFTERNOON

12:30-2:00
Lunch

2:00-4:00
CONCURRENT SESSIONS

MS9
Numerical Methods for Structured Matrices

Matrices in numerical linear algebra problems arising from various fields of applications are often structured. Their entries are related via certain functions such that the matrix depends only on a small number of parameters. Well-known examples are Toeplitz and Hankel matrices, symmetric and unitary matrices and also sparse matrices. Although the problems which have to be solved are rather classical, it is often necessary or desirable to develop new methods or adapt standard methods that exploit the structure of the matrix. Unfortunately sometimes such methods can suffer from loss of accuracy, so one needs to take special care in their development. The fields of signal processing and control theory are rich sources for structured matrix problems. In this minisymposium, the speakers will discuss some classes of structured matrix methods arising from these areas. They will give short surveys on these methods or general principles for their development, present some very recent results and provide suggestions for further research.
Organizer: Angelika Bunse-Gerstner, Universität of Bremen, Germany

2:00 **Condensed Forms for Matrices with Symmetry Structures**
Angelika Bunse-Gerstner, Organizer

2:30 **Numerical Methods for Hamiltonian Eigenvalue Problems. New Thoughts About an Old Problem**
Volker Mehrmann, Technische Universität Chemnitz-Zwickau, Germany

3:00 **Unitary Hessenberg Eigenproblems: Algorithms and Application**
Gregory S. Ammar, Northern Illinois University

3:30 **Structured Total Least Squares Problems in Systems Theory and Control**
Bart De Moor, Katholieke Universiteit Leuven, Belgium

MS10
Linear Algebra in Optimization

Two active branches of research in computational (continuous) optimization are interior methods for constrained optimization (and related problems) and the integration of optimization techniques with large-scale applications. This minisymposium covers some recent work along both of these branches: important computational linear algebra issues are highlighted.

The talks by Coleman, Gill, and Overton concern interior methods for optimization: Coleman addresses some large-scale linear algebra issues; Gill considers the ill-conditioning problems that arise with barrier methods; Overton presents a new interior method for solving the semidefinite programming problem. Finally, Plassmann considers an optimization approach to a large-scale application: determination of the structure of vortices on a high-temperature superconductor. Plassmann focuses on the parallel generation of an adaptive mesh and mesh partitioning - subproblems crucial to the overall efficiency of the optimization approach.

Organizer: Thomas F. Coleman, Cornell University

2:00 **Linearly Constrained Optimization and Projected Preconditioned Conjugate Gradients**
Thomas F. Coleman, Organizer

2:30 **On the Conditioning of Interior Methods for Constrained Optimization**
Anders Forsgren, Royal Institute of Technology, Sweden; *Philip E. Gill* and Joseph R. Shinnerl, University of California, San Diego

3:00 **A New Primal-Dual Interior Point Method for Semidefinite Programming**
Farid Alizadeh, International Computer Science Institute; Jean-Pierre A. Haeberly, Fordham University; and *Michael L. Overton,* Courant Institute of Mathematical Sciences, New York University

3:30 **Parallel Algorithms for Unstructured Mesh Computation**
Lori A. Freitag, Argonne National Laboratory; Mark T. Jones, University of Tennessee, Knoxville; and *Paul E. Plassmann,* Argonne National Laboratory

4:00-5:00/Ballroom 1
Business Meeting
SIAM Activity Group on Linear Algebra

5:00-6:00/Golden Cliff Room
Meet-and-Greet Hour

AFTERNOON

6:00-7:30
Dinner

7:30 - 9:30
CONCURRENT SESSIONS
COMMON-INTEREST
See pages 4 – 7.

SATURDAY, JUNE 18

MORNING

8:00/Cliff Lodge Lobby
Registration Opens

8:30-10:30
CONCURRENT SESSIONS

MS11
Direct Methods for Large Sparse Systems

Sparse matrices are ubiquitous in numerical mathematics. Direct methods, based on Gaussian elimination, are still the method of choice in many applications and can be combined with iterative methods for the powerful solution of extremely large systems. This minisymposium looks at several new developments including implementation on distributed memory computers, new results for ordering sparse matrices, and an in-depth study of available software packages. The minisymposium will be of interest to people working in sparse matrix research and to mathematicians, scientists, and engineers who need to solve large linear or nonlinear problems.

Organizer: Iain S. Duff, Rutherford Appleton Laboratory, United Kingdom, and CERFACS

8:30 **A Review of Direct Methods for Solving Linear Systems**
Iain S. Duff, Organizer

9:00 **A Comparison of Some Direct Methods for Solving Sparse Nonsymmetric Linear Systems**
Esmond Ng, Oak Ridge National Laboratory

9:30 **Efficient Sparse Cholesky Factorization on Distributed-Memory Multiprocessors**
Edward Rothberg, Intel Supercomputer Systems Division

10:00 **Generalized Nested Dissection: Some Recent Progress**
Cleve Ashcraft, Boeing Computer Services, Seattle and Joseph Liu, York University, Canada

MS12
Topics in Matrix Theory

The purpose of this minisymposium is to highlight a few select topics in matrix theory/linear algebra which have played, are playing and will continue to play (in the view of the speaker) an important role in its development. Each of the four distinguished speakers will be asked to describe in 25 minutes or less, the origin/motivation, some key early result, some key recent result, and to make at least one conjecture about its future development.

Organizer: Richard A. Brualdi, University of Wisconsin, Madison

8:30 **Some Important Matrix Classes in the Linear Complemantarity Problem**
Richard W. Cottle, Stanford University

9:00 **Nonsingularity Criteria and Bounds for Eigenvalues**
Alan J. Hoffman, IBM Thomas J. Watson Research Center

9:30 **Nonnegativity, Patterns, and Jordan Forms**
Hans Schneider, University of Wisconsin, Madison

10:00 **Products of Matrix Exponentials**
Robert Thompson, University of California, Santa Barbara

10:30
Coffee

11:00
IP7/Chair: Beresford N. Parlett, University of California, Berkeley
Fast Parallel Algorithms for Eigenproblems

The speaker will present a survey of recent work on fast parallel algorithms for finding eigenvalues and eigenvectors of symmetric and nonsymmetric matrices. In addition to parallelizing known sequential algorithms, researchers have devised new algorithms (or reinvigorated old algorithms) especially suited for parallelism. The speaker will highlight algorithms based on spectral divide and conquer, which use approximate invariant subspaces to divide a matrix into submatrices with desired subsets of the spectrum. This work has recently led to the first practical algorithms for finding eigenvalues of large dense nonsymmetric matrices and matrix pencils. These algorithms are not as reliable as their sequential counterparts, and so far there seems to be no way to avoid trading reliability for parallelism in the nonsymmetric case.

James Demmel
Computer Science Division and Mathematics Department, University of California, Berkeley

11:45
Award and Presentation/Chair: Biswa N. Datta, Northern Illinois University
Award of SIAM Activity Group on Linear Algebra Prize and Presentation of Prize Lecture

AFTERNOON

12:30-2:00
Lunch

2:00-4:00
CONCURRENT SESSIONS
COMMON-INTEREST
See pages 4 – 7.

4:00-6:00
COUNTERPOINT SESSIONS
(Common-interest sessions may reconvene, or unscheduled birds-of-a-feather sessions may take place at this time.)

EVENING

6:00-9:00
Banquet Dinner

Guest Speaker: **William M. Kahan**, Department of Electrical Engineering and Computer Science, University of California, Berkeley

Dr. Kahan will talk on "Tales of the Role of Technology in War." He will be introduced by Beresford N. Parlett, University of California, Berkeley

9:00
Conference adjourns.

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- ❑ Government
- ❑ Industry/Corporation
- ❑ Consulting
- ❑ Nonprofit
- ❑ Other

Type of Work (check two)

	Primary	Secondary
Research	❑	❑
Adm./Mgmt.	❑	❑
Teaching	❑	❑
Consulting	❑	❑
Other	❑	❑

Salutation

- ❑ Dr.
- ❑ Mr.
- ❑ Ms.
- ❑ Prof.
- ❑ Other

Gender: ❑ Male ❑ Female

Education (Highest degree)

Institution / Major / Degree / Year

Primary Professional Interests (Check no more than 3)

- ❑1. Linear algebra and matrix theory.
- ❑2. Real and complex analysis including approximation theory, integral transforms (including Fourier series and wavelets), integral equations, asymptotic methods, and special functions.
- ❑3. Ordinary differential equations including dynamical systems.
- ❑4. Partial differential equations including inverse problems.
- ❑5. Discrete mathematics and graph theory including combinatorics, combinatorial optimization, and networks.
- ❑6. Numerical analysis (theory).
- ❑7. Computational mathematics including scientific computing, parallel computing, and algorithm development.
- ❑8. Computer science including computer architecture, computer hardware, computational complexity, applied logic, database, symbolic computation.
- ❑9. Applied probability including stochastic processes, queueing theory, and signal processing.
- ❑10. Statistics including data analysis and time series analysis.
- ❑11. Control and systems theory including optimal control.
- ❑12. Optimization theory and mathematical programming including discrete and numerical optimization and linear and nonlinear programming.
- ❑13. Communication theory including information theory and coding theory.
- ❑14. Applied geometry including computer-aided design and related robotics.
- ❑15. Image processing including computer graphics, computer vision, related robotics, and tomography.
- ❑16. Classical mechanics of solids including elasticity, structures and vibrations, and constitutive models.
- ❑17. Fluid mechanics including turbulence, aeronautics, and multiphase flow.
- ❑18. Quantum physics, statistical mechanics, and relativity.
- ❑19. Geophysical sciences including reservoir modeling, seismic exploration, and petroleum engineering.
- ❑20. Atmospheric and oceanographic sciences.
- ❑21. Chemical kinetics, combustion theory, thermodynamics, and heat transfer.
- ❑22. Biological sciences including biophysics, biomedical engineering, and biomathematics.
- ❑23. Environmental sciences.
- ❑24. Economics.
- ❑25. Social sciences.
- ❑26. Functional analysis and operator equations, and integral and functional equations.
- ❑27. Management sciences including operations research.
- ❑28. Applied mathematics education (K-12, undergraduate curriculum, graduate study and modeling courses).
- ❑29. Astronomy, planetary sciences, and optics.
- ❑30. Simulation and modeling.
- ❑31. Materials science, polymer physics, and structure of matter.
- ❑32. Electromagnetic theory, semiconductors, and circuit analysis.
- ❑Other_____

SIAM use only

F/M _____
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rebilling_____

1293

Please Complete Reverse

Society Memberships
(Check all that apply)

ACM_____ AIAA_____ AMS_____ APS_____ ASA_____ ASME_____
IEEE_____ IMS_____ MAA_____ ORSA_____ TIMS_____ Other_____

Membership Benefits

Dues cover the period January 1, 1994 through December 31, 1994. Members will receive all issues of *SIAM Review* and *SIAM News*. Members are entitled to purchase one each of no more than four SIAM journals, for their personal use only, at member discount prices. Members can join any of the SIAM Activity Groups at $10 per group. Members are entitled to 20% off list prices on all SIAM books, and receive member discounted registration at SIAM sponsored meetings.

Student members have the same benefits as regular members. Students receive one activity group membership free; additional activity group memberships are $10 each.

Associate members are spouses of current regular members and are entitled to all privileges of regular members except that they do not receive *SIAM Review*. Associate members should indicate the full name of their spouse below.* New associate members must complete a separate application.

Fees and Subscriptions

Compute payment as follows:

Dues (Regular Members): $85.00 _____

Dues (Student Members): $15.00 _____

Dues (Associate Members): $18.00 _____

Dues (Activity Groups): $10.00 per group checked below: _____

Control and Systems Theory _____ Discrete Mathematics _____ Dynamical Systems _____

Geometric Design _____ Geosciences _____ Linear Algebra _____ Optimization _____

Orthogonal Polynomials and Special Functions _____ Supercomputing _____

SIAM Journal on . . .	Member Prices: USA, Canada, Mexico/Elsewhere	
Applied Mathematics (bimonthly)	$54/$59	_____
Computing (bimonthly)	$54/$59	_____
Control and Optimization (bimonthly)	$54/$59	_____
Discrete Mathematics (quarterly)	$44/$47	_____
Mathematical Analysis (bimonthly)	$54/$59	_____
Matrix Analysis and Applications (quarterly)	$44/$47	_____
Numerical Analysis (bimonthly)	$54/$59	_____
Optimization (quarterly)	$44/$47	_____
Scientific Computing (bimonthly)	$54/$59	_____
Theory of Probability and Its Applications (quarterly)	$99/$102	_____
1993-94 Combined Membership List	$9	_____

TOTAL $ _____

Application for Membership

I apply for membership in SIAM:

Signature _____

*Spouse's Name (If applying for Associate Membership) _____

Student Status Certification

CERTIFICATION (student members only)

I hereby certify that the applicant is actively engaged in a degree program and is a full-time student, teaching/research assistant, or fellow:

Name of College or University _____

Department Chair (signature please) _____ Date _____

Please enclose payment with this application and mail to: SIAM, P.O. Box 7260, Philadelphia, PA 19101-7260

MEMBERS OUTSIDE THE USA

For SIAM members residing outside the USA, SIAM will accept payment of membership dues and subscription fees by American Express, MasterCard, and VISA. Because SIAM incurs considerable cost in obtaining payment via credit cards, please use credit cards only when other methods of payment are difficult to arrange.

❑ American Express ❑ MasterCard ❑ VISA

Credit Card # _____ Expiration date_____

For further information, please contact SIAM Customer Services:
Telephone: 215-382-9800 / Toll-free (U.S. only): 800-447-SIAM / Fax: 215-386-7999
E-mail: service@siam.org / Address: 3600 University City Science Center, Philadelphia, PA 19104-2688

BY AIR

Official Carrier for Continental USA and Canada

SIAM has selected **USAir** as the official carrier for this conference. Discounts are available to conference attendees from June 13-20, 1994.

By flying USAir you become eligible for the following discounts:

- 5% off of the Supersaver Fares (21 day advance purchase with a Saturday night stayover).
- 10% off of Standard Coach Fares (7 day advance purchase with no Saturday night stayover).
- 45% off of Full Coach Fare (less than 7 day advance purchase and no Saturday night stayover).

SIAM has selected **Get-A-Way Travel** agency to assist attendees in making travel arrangements. Get-A-Way Travel will make your reservations on USAir or any airline of your choice. To take advantage of the USAir discounts, you must book your reservation through Get-A-Way Travel by calling 1-800-223-3863 or 215-379-6800. Ask for Wendy Sukonick or Glen Geary. Be sure to mention that you are attending the Fifth SIAM Conference on Applied Linear Algebra. Get-A-Way Travel will issue your tickets and mail them to you.

CAR RENTAL

Dollar Rent A Car has been selected as the official car rental agency for this conference. The following rates are available to attendees between June 13-20, 1994. See the talbe at right for rates are available at the airport.

Type of Car	Daily Rate (1-4 days)	Weekly Rate (5-7 days)	Daily Weekend (Thu-Mon 2 day Minimum)
Economy	$24.00	$110.00	$21.00
Compact	$26.00	$120.00	$22.00
Intermediate	$28.00	$140.00	$24.00
Standard	$31.00	$165.00	$28.00
Premium	$36.00	$190.00	$32.00
Luxury	$45.00	$240.00	$42.00
MiniVan	$59.00	$360.00	$59.00

RESERVATIONS

We encourage you to make advance reservation, as on-site availability cannot be guaranteed. Make reservations by calling Get A Way Travel at 215-223-3863 or 215-379-6800; ask for Wendy or Glen. Be sure to mention that you are attending the Fifth SIAM Conference on Applied Linear Algebra, June 15-18, 1994 in Snowbird, Utah, in order to receive the discounted rates.

- Cars must be picked up and returned to the same location.
- You must be at least 25 years of age and have a valid U.S. or International Drivers License.
- You must have one of the following credit cards to rent a car: American Express, MasterCard, or VISA.
- Refueling charges, collision insurance, and taxes are not included in the above rates.

On occasion, the car rental agency may offer special rates that are lower than rates quoted above. As an attendee, you are eligible for the lower of the two rates. In most instances, the conference discount rates are lower than those quoted to the general public.

DRIVING DIRECTIONS

From the Airport: Snowbird is located 29 miles (40 minutes) from Salt Lake City International Airport.

Take Interstate 80 east to Interstate 215 south. Interstate 215 swings east toward the Wasatch Mountains. Exit at 6200 South Street making a right turn at the light. Follow this road up to the hill to Wasatch Blvd. and on toward Little Cottonwood Canyon, following the signs to Snowbird and Alta.

From Downtown Salt Lake City: Snowbird is 25 miles (30 minutes) from downtown Salt Lake City.

Take Interstate 15 south to Interstate 215 east and exit at 6200 South Street. Make a right turn at the light. Follow this road up the hill to Wasatch Blvd. and on toward Little Cottonwood Canyon, following the signs to Snowbird and Alta.

To make a reservation with Canyon Transportation, Inc. Shuttle service see page 16 for a reservation form.

PUBLIC TRANSPORTATION FROM AIRPORT

Canyon Transportation Inc. is a shuttle service that transports passengers between the airport and Snowbird. **YOU MUST MAKE RESERVATIONS IN ADVANCE.** You can do this by either filling out the transportation form found page 16 in this brochure, calling Canyon direct at 1-800-255-1841, or making your transportation reservations with Snowbird's Central Reservations Office when making your lodging reservations. If you are making a reservation by phone, please be sure to include the date of arrival, your last name, the airline you are using, the flight number, time of arrival at the Cliff Lodge at which you are staying in at Snowbird. If you are using the registration card on page 16, mail to: Canyon Transportation, P.O. Box 1762, Sandy, Utah 84091.

Once you arrive at the airport, proceed to the ground transportation desk (Canyon Transportation Inc.) located in the baggage claim area of the airport. If you are arriving daily between the hours of 9:00 AM - 11:00 PM and departing from Snowbird between 6:00 AM - 9:00 PM, the cost of the shuttle services is $15.00 per person each way. If you are arriving or departing before or after the times stated, you can still make a reservation with Canyon, but the rate will be $45.00 per person each way. You do not have to pay in advance when making your reservation. All payments are made at the time you confirm your reservation at the Ground Transportation Desk at the airport. Canyon Transportation accepts American Express, VISA and Mastercard as forms of payment for services. Snowbird is approximately 29 miles (40 minutes) from the airport. Canyon Transportation Inc. hours of operation are as follows:

Salt Lake City Airport to Snowbird
9:00 AM - 11:00 PM daily

Snowbird to Salt Lake City
6:00 AM - 9:00 PM daily

You must confirm your reservation for departure from Snowbird to the airport with Canyon Transportation 24 hours prior to your scheduled departure.

The average one way cost of a cab to or from Snowbird is approximately $55.00.

HOTEL INFORMATION

Snowbird Ski and Summer Resort
Snowbird, UT 84092-6019
Telephone: 801-742-2222 • 800-453-3000 (U.S. only)
Fax 801-742-3300

SIAM is holding a block of rooms at Snowbird on a first come first served basis at the following discounted rates until May 23, 1994:

Cliff Lodge
$79.00 Single or Double

Dormitory rooms
$21.00 per person (4 in a room)

There is a 9.75% occupancy tax that will be added to your room rate.

These rooms are being held for our exclusive use until May 23, 1994. After this date, reservations will depend on availability and the above rates may not be in effect. We urge you to make your reservations as soon as possible. You may do so by telephoning (800) 453-3000, or filling out and returning the attached Hotel Reservation Form found on page 19 of this program. You must mention that you are attending the SIAM Conference on Applied Linear Algebra to receive the discounted room rates. A deposit in the amount of one nights room rate is required to make a reservation.

Dormitory Room: DUE TO THE LIMITED NUMBER OF ROOMS AVAILABLE, YOU MUST BE A STUDENT IN ORDER TO RESERVE THESE ROOMS. Rooms are located in the Cliff Lodge and there are 5 rooms available with 4 people per room. These are non-smoking rooms. There is a private bathroom in each room. Common areas located at end of the halls are equipped with televisions and pool tables. When registering for a room, please be sure to mention your gender. You will be asked to show your student I.D. before checking into rooms. Rooms are available on a first come first served basis.

Cancellations: To obtain a refund of a deposit, reservations must be cancelled before 4:00 PM and at least 48 hours prior to scheduled arrival time.

Arrivals and Departures: To check in at Snowbird you should report to the Cliff Lodge. The technical sessions will be held in the Cliff Lodge. Check-in time is 4:00 PM and check-out time is 11:00 AM.

Facilities: The Cliff Lodge is a full service modern hotel with outdoor swimming pool, hot tubs, and health spa. The lodge is equipped with saunas and at least one all-season swimming pool. The Cliff Spa occupies the 9th and 10th floors of the Cliff Lodge and offers numerous services: massages, aerobics and weight room. Spa facilities are available to guests 18 years of age and older. A children's pool is available on Level B. A wide variety of shops and boutiques are available in the Snowbird Center and the Cliff Lodge. There are five tennis courts at Snowbird. Court time is $8.00 per hour. Hotel guests receive their first hour of court time per day at $4.00. For those who enjoy hiking, maps of the Snowbird area are available at the Activities Center. Guides are available by appointment. Mountain bikes are available for rental. Bring a lunch and pedal along at 8,000 feet. Helmets and water bottles are included with your rental.

Parking: There is complimentary valet parking available at the Cliff Lodge.

Restaurants and Lounges: The Mexican Keyhole serves traditional Mexican entrees and drinks. Elegant dining can be found in the Aerie, a glass enclosed rooftop restaurant with views of the mountains on all sides. There are also a variety of other restaurants and lounges located in the Snowbird Village.

TELEPHONE MESSAGES

The telephone number at the Snowbird Resort and Conference Center is **801-742-2222.** Snowbird will transfer your call to the SIAM registration desk or forward a message to the attendee's room.

CANYON TRANSPORTATION RESERVATIONS

P.O. BOX 1762
Sandy, Utah 84091
Telephone: 1-800-255-1841 (domestic and foreign)
Fax: 1-801-255-1868

I am attending the Fifth SIAM Conference on Linear Algebra at Snowbird Resort and Conference Center and am requesting a reservation for shuttle pick up based on the following information.

Name _____ (First) _____ (Middle) _____ (Last)

Address _____

City _____ State _____ Zip _____

Phone _____ Fax _____

The airline I will be using is: _____ Flight # _____

Arrival Date _____ Arrival Time _____

Departure Date _____ Departure Time _____ Departing Flight # _____

☐ I will be staying at the Cliff Lodge.

☐ I will pay for my reservation at the time that I check in at the Canyon Transportation Desk located in the baggage claim area of the airport. I understand the fare to be $15.00 per person each way during daily scheduled hour of operation and $45.00 per person for pick up anytime before or after the daily schedule.

Detach form and mail to: Canyon Transportation, Reservations, P.O. Box 1762, Sandy, Utah 84091

LAPACK Users' Guide

E. Anderson, Z. Bai, C. Bischof, J. Demmel, J. Dongarra,
J. Du Croz, A. Greenbaum, S. Hammarling,
A. McKenney, S. Ostrouchov, and D. Sorensen

Royalties from the sale of this book are contributed to the SIAM Student Travel Fund.

LAPACK is a transportable library of Fortran 77 subroutines for solving the most common problems in numerical linear algebra. LAPACK supersedes LINPACK and EISPACK, principally by restructuring the software to achieve much greater efficiency on vector processors, high-performance "superscalar" workstations, and shared memory multiprocessors. LAPACK also provides extra functionality, uses some new or improved algorithms, and integrates the two sets of algorithms into a unified package.

LAPACK Users' Guide gives an informal introduction to the design of the algorithms and software, summarizes the contents of the package, and describes conventions used in the software and its documentation.

LAPACK can be used to solve the most common problems in numerical linear algebra:

- systems of linear equations
- linear least squares problems
- eigenvalue problems
- singular value problems
- matrix factorizations
- estimating condition numbers

Additional improvements over LINPACK and EISPACK include:

- faster run time
- better error bounds
- more and better condition numbers

Special features of the guide include:

- Quick reference guide to the BLAS
- How to convert calls to LINPACK or EISPACK to LAPACK
- Quick reference tables for Driver Routines

Copies of selected LAPACK routines are accessible through netlib. You may obtain the complete package from NAG at either of the following addresses:

NAG Inc.
1400 Opus Place, Suite 200
Downers Grove, IL 60515-5702
USA
Tel: +1 708 971 2337
Fax: +1 708 971 2706

NAG Ltd.
Wilkinson House
Jordan Hill Road
Oxford OX2 8DR, England
Tel: +44 865 511245
Fax: +44 865 310139

Contents

LINPACK Users' Guide

Jack J. Dongarra, James R. Bunch, Cleve B. Moler, and G. W. Stewart

The authors of this carefully structured guide are the principal developers of LINPACK, a unique package of Fortran subroutines for analyzing and solving various systems of simultaneous linear algebraic equations and linear least squares problems. This guide supports both the casual user and the specialist.

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viii + 367 pages / Softcover
ISBN 0-89871-172-X
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SIAM Member Price $24.00
Order Code OT08

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xv + 235 pages
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SIAM Member Price $15.60
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Point your Gopher client to: gopher.siam.org

Or send check or money order to:
SIAM, Dept. BJ1994, P.O. Box 7260, Philadelphia, PA 19101-7260

Payments may be made by wire transfer to SIAM's bank:
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ABA Routing # 031000053 / Account Name: Society for Industrial and Applied Mathematics / Account Number: 509-704-5

Shipping and Handling
USA: Add $2.75 for first book and $.50 for each additional book. Canada: Add $4.50 for first book and $1.50 for each additional book.
Outside USA/Canada: Add $4.50 per book. All overseas delivery is by airmail.

REGISTRATION INFORMATION

The registration desk will be located in the Cliff Lodge lobby in front of Ballrooms 1 and 2. The registration desk will be open as listed below:

Tuesday, June 14	6:00 PM - 8:00 PM
Wednesday, June 15	7:30 AM - 4:00 PM
Thursday, June 16	8:00 AM - 4:00 PM
Friday, June 17	8:00 AM - 4:00 PM
Saturday, June 18	8:00 AM - 2:00 PM

CANCELLATION POLICY

Cancellation prior to:

May 31, 1994	Full refund
June 1- 14, 1994	$25.00 Cancellation Fee
After June 14, 1994	No Refund

CREDIT CARDS

SIAM accepts VISA, MasterCard and American Express. Please indicate credit card type, account number and the expiration date on the Preregistration Form.

SIAM CORPORATE MEMBERS

Non-member attendees who are employed by the following institutions are entitled to the SIAM member rate.

Amoco Production Company
AT&T Bell Laboratories
Bellcore
The Boeing Company
Cray Research, Inc.
E.I. du Pont de Nemours & Company
Eastman Kodak Company
Exxon Research and Engineering Company
General Motors Corporation
GTE Laboratories, Inc.
IBM Corporation
ICASE
IDA Center for Communications Research
MacNeal-Schwendler Corporation
Martin Marietta Energy Systems
Mathematical Sciences Research Institute
NEC Research Institute
Supercomputing Research Center, a Division of Institute for Defense Analyses
Texaco, Inc.
United Technologies Corporation
Visual Numerics, Inc.

NON-SIAM MEMBERS

Non-SIAM members are encouraged to join SIAM to obtain the member rate for conference registration and enjoy all the other benefits of SIAM membership. Join SIAM by sending your completed membership application (see page 13) along with your Preregistration Form. Be sure to include both membership dues and preregistration fee in your payment.

REGISTRATION FEES

	SIAG/LA*	Member	Non-Member	Student
Preregistration	$155	$160	$205	$55
Registration	$185	$190	$235	$55

*Member of SIAM Activity Group on Linear Algebra.
The registration fee includes the cost of a proceedings which will be available at the conference.

To register, complete the **Preregistration Form** in the back of this program and return it with your payment to SIAM. You can also register in the following ways:

- Telephone: 215-382-9800; Toll free-800-447-7426 (USA only).
- E-mail: meetings@siam.org
- Fax: 215-386-7999

We urge attendees to preregister and save! **The preregistration deadline is Wednesday, June 1, 1994**. To qualify for the preregistration fee, the Preregistration Form and payment must be received at the SIAM Office by Wednesday, June 1, 1994. Attendees whose Preregistration are received at the SIAM office after that date will be required to pay the $30 difference between the preregistration and the on-site registration fees. The difference will be charged to your credit card or collected from you on-site.

There will be no prorated fees. No refunds will be issued once the conference has started. On-site registration begins on Tuesday, June 14, 1994. If your preregistration payment arrives at the SIAM office after the conference has started, that payment will be returned to you. Your on-site registration payment will be processed.

SPECIAL NOTE

Those participants who have submitted papers for the proceedings **must register by March 21, 1994**. Otherwise their papers will be **excluded** from the proceedings. A copy of the preregistration form was mailed on February 7, 1994 to all those who responded to our first announcement and submitted provisional titles.

COMMON INTEREST SESSIONS:

There will be 19 scheduled common interest sessions, as listed below. These will be scheduled into five time slots over the four days of the meeting, so that you will have the opportunity to attend five different common interest sessions.

[A] Applications in Optimization and Operations Research
[B] Applications in Systems and Control
[C] Applications in Signal and Image Processing
[D] Applications, other
[E] Least Squares Problems and Applications in Statistics and Probability
[F] Condition Estimation and Rank-Revealing Factorizations
[G] Eigenvalue and Singular Value Algorithms for Dense Matrices
[H] Eigenvalue and Singular Value Algorithms for Sparse Matrices
[I] Generalized and Quadratic Eigenvalue Problems
[J] Parallel Algorithms for Dense Problems
[K] Parallel algorithms for Sparse Problems
[L] Sparse Direct Methods
[M] Sparse Iterative Methods: Iterative Algorithms and Acceleration Methods
[N] Sparse Iterative Methods: Preconditioning, Domain Decomposition, Multigrid
[O] Structured Matrices
[P] Matrix Functions and Operator Theory
[Q] Matrix Theory: Canonical Forms, Multilinear Algebra, Nonnegative Matrices, Spectral Inequalities
[R] Combinatorial Matrix Problems and Graph Theory
[S] Education and Teaching

BE SURE TO ASSIGN AND SCHEDULE YOUR PAPER BY FILLING IN THE REPLY BOXES ON THE CONFERENCE PREREGISTRATION FORM FOUND ON THE NEXT PAGE.

COMMON INTEREST SESSIONS: PAPER ASSIGNMENTS

Please assign your paper(s) to the session that you feel fits it best. Note that some sessions overlap, so please choose carefully. Even if there is not a session that seems perfectly suitable for your paper, we ask that you assign your paper to the session with the nearest fit. Any papers whose authors don't assign them will be placed in a rump session of miscellaneous papers, which is likely to be even less suitable!

To indicate your choice of session, enter its letter code in the box marked "Paper Assignment and Primary Common Interest Session" in the reply box on page 19.

COMMON INTEREST SESSIONS: SCHEDULING

We solicit your help in scheduling the common interest sessions to minimize conflicts, whether you submitted a paper or not. The program will permit you to attend five common interest sessions. Please list your "primary common interest session" (which is the session your paper is in, or the session of greatest interest to you if you didn't submit a paper), then list four other "secondary common interest sessions." For your four secondary sessions, please assign an "importance index," reflecting how important it is to you that each of these sessions should not conflict with your primary session or with each other. You can assign a total of 100 points (integers please!) to these four sessions. (If you assign more than 100 points, we do not promise to behave rationally regarding your interests.)

After we receive the proceedings papers, we will schedule the common interest sessions to make as many people as possible happy. This is an experiment; we know we can't avoid conflicts for everyone, but we hope we can do better than usual by taking your preferences into account.

Note that your choice of secondary common interest sessions is only for scheduling the sessions; your paper, if any, will appear in the primary session you choose.

Fifth SIAM Conference on

APPLIED LINEAR ALGEBRA

JUNE 15 - 18, 1994

SNOWBIRD SKI AND SUMMER RESORT

SNOWBIRD, UTAH

HOTEL RESERVATION FORM

Please send me a confirmation.
Discounted rooms are being held for our exclusive use until May 23, 1994. After that date, reservations will depend on availability. Your reservation is not confirmed until you receive a confirmation number by phone or mail. Reservations can be made by calling 1-800-453-3000 (USA only) 1-801-742-2222, Fax: 1-801-742-3300. Identify yourself as an attendee at the SIAM Conference on Applied Linear Algebra. A deposit in the amount of one night's room rate is required in order to confirm your reservation. Deposits can be paid by check or credit card.

Please Print

Name _____

Address _____

City _____ State _____ Zip _____

Phone _____

Please reserve a ❑ Cliff Lodge Room $79.00 ❑ Single ❑ Double
❑ Dormitory Room in Cliff Lodge $21.00 (first come first served basis for students only)
❑ I require handicap facilities

Arrival Date _____ Arrival Time _____ Departure Date _____

I wish to pay by: ❑ AMEX ❑ VISA ❑ MasterCard ❑ Check

Credit Card # _____

Expiration Date _____ Deposit $ _____

Signature _____

Please enclose this form in an envelope and mail to:

Snowbird Central Reservations
Snowbird Resort and Conference Center
Snowbird, Utah 84092-6019

CONFERENCE PREREGISTRATION FORM

For your convenience, you can register in the following ways:

- Telephone: 215-382-9800; Toll free: 800-447-7426 (USA Only)
- E-mail: meetings@siam.org
- Fax: 215-386-7999
- Return this form and payment by mail to: SIAM Conference Department 3600 University City Science Center Philadelphia, PA 19104-2688 U.S.A.

Fifth SIAM Conference on

APPLIED LINEAR ALGEBRA

JUNE 15 - 18, 1994

SNOWBIRD SKI AND SUMMER RESORT

SNOWBIRD, UTAH

Preregistration deadline for those who wish to submit to the proceedings: Monday, March 21, 1994
Preregistration deadline: Wednesday, June 1, 1994

	SIAG/LA*	Member	Non-Member	Student
Preregistration** (before 6/01/94)	$155	$160	$205	$55
Registration** (after 6/01/94)	$185	$190	$235	$55
Banquet Dinner	$ 26	$ 26	$ 26	$26
Amount Paid	$____	$____	$ ___	$ ____

*Member of SIAM Activity Group on Linear Algebra.
**The registration fee includes the cost of a proceedings which will be available at the conference. No refunds will be issued after Tuesday, June 14, 1994.

Entree selection ❑ Chicken ❑ Beef ❑ Vegetarian

REPLY BOXES

Paper Title: _____

_____

_____

Poster Title: _____

_____

_____

Paper Assignment and Primary Common Interest Session: (Refer to selection listed on page 18.)

☐

(Use letter code from list shown on page 18; your paper will appear in this session)

Secondary Common Interest Sessions:

Session Letter Code	Importance (total of 100 points)
☐	☐
☐	☐
☐	☐
☐	☐

Preregistration Form and payment must be received at SIAM by Wednesday, June 1, 1994. Those who submitted papers for the Proceedings **must register by March 21, 1994 to ensure that their papers will appear in the Proceedings.**

Please Print:

Name _____

Organization _____ Department _____

Business Address _____

City _____ State _____ Zip _____

Telephone _____ Fax _____

E-Mail _____

Home Address

City _____ State _____ Zip _____

Please send all SIAM correspondence to the following address: ❑ Home ❑ Business

Please update my SIAM records to reflect the above: ❑ Yes ❑ No

Local Address in Snowbird _____

_____

❑ I am a disabled participant and require appropriate accommodations.

NAME BADGE-I prefer my name and affiliation to read as follows:

Name: (20 characters) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Affiliation: (20 characters) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

I wish to pay by: ❑ AMEX ❑ VISA ❑ Master Card ❑ Check (payable to SIAM)

Credit Card # _____ Expiration Date _____

Signature _____