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## The Bulletin of the International Linear Algebra Society

Serving the International Linear Algebra Community Edited by S. J. Leon and R. C. Thompson

Issue 6

JANUARY 1991



Newly elected ILAS officers Daniel Hershkowitz (left) and R. C. Thompson (right)

## ILAS NEWS

## **RESULTS OF 1990 ILAS ELECTIONS**

## Report by S. J. Leon

Robert C. Thompson has been elected Vice-President of ILAS and Daniel Hershkowitz has been elected Secretary of ILAS. Each will serve for a two year term beginning January 1, 1991. Both individuals have long and outstanding records of contributions to the field of linear algebra and to the international linear algebra community.

Daniel Hershkowitz received the degrees of B.S., M.S. and Ph.D. from the Technion -Israel Institute of Technology. Since 1985 he has been a faculty member of the Department of Mathematics at the Technion. He has also held visiting positions at the University of Wisconsin - Madison.

Danny has won the Landau Research Prize in Mathematics (1982); the Technion's Award for Excellence in Teaching (1990); and the New England Academic Award for Excellence in Research (1990), granted to the best researchers at the Technion. Danny is the author or co-author of more than 50 mathematical papers. Since 1988, Danny has been an associate editor of *Linear Algebra and its Applications*. He was also a special editor of the issues of LAA devoted to the Fourth and to the Sixth Haifa Matrix Theory Conferences, as well as to the Inaugural Meeting of ILAS.

Danny has been a member of the organizing committee of the 3rd, the 4th, the 5th, the 6th (co-chairman) and the 7th (co-chairman) Haifa Matrix Theory Conferences, of the Inaugural Meeting of ILAS, Provo, Utah (1989), and of the ILAS Meeting at Lisbon, Portugal (1992).

Danny has been the secretary and member of the executive board and of the board of directors of ILAS since 1987. He is also the manager of ILAS-NET - the electronic newsletter of ILAS, and of the electronic newsletter of the Israel Mathematical Union.

Robert C Thompson received his Ph.D. in 1960 at Cal Tech under Olga Taussky Todd, after having earned an MA at the University of British Columbia under Marvin Marcus. From 1960 to 1964 he was a faculty member at the University of British Columbia, and since 1964 he has been a faculty member at the University of California, Santa Barbara.

In collaboration with Marvin Marcus he founded *Linear and Multilinear Algebra* in 1972, and he has been a major participant in its editorial supervision ever since. Bob also contributed to the founding of the International Linear Algebra Society.

Bob's research has been heavily occupied with spectral inequalities (of which he claims there are enough to occupy more than one person's lifetime), for matrices over a field or a ring. When questioned about his goals for the future Bob replied: "My highest objective at this point in my career is to see some (all?) of my unproved conjectures resolved, but then almost every mathematician has similar hopes".

Richard A. Brualdi, Chair of the 1990 Nominating Committee reports that there were a total of 71 ballots cast in the 1990 ILAS elections. Of these two were left blank. The count for the remaining 69 ballots was as follows:

Vice-President

Robert C. Thompson	69 votes
Write-in	0 votes

Secretary

Daniel Hershkowitz69 votesWrite-in0 votes

## NOMINATIONS

The Nominations Committee consisting of Richard A. Brualdi (Chairman), Shmuel Friedland, Tom Laffey, Dias Da Silva and H. K. Au-Young reported on June 11, 1990 at the 6th Haifa Matrix Theory Conference that the nominees for the positions of President, Treasurer, and the two Board of Director's Positions which start in 1992 are Hans Schneider, Jim Weaver, T. Ando, and Dave Carlson, respectively. Additional nominations can be made by any three members of ILAS and these nominations should be sent to:

> Professor Richard A. Brualdi Mathematics Department University of Wisconsin - Madison Madison, WI 53706

The deadline for additional nominations is March 31, 1991.

## INSTITUTIONAL MEMBERSHIP

The ILAS has recently initiated an institutional membership. The annual fee for institutional membership is \$150. We are pleased to announce that Elsevier Science Publishing Company is our first institutional member. We encourage individual ILAS members to ask their institutions to join. For more information about institutional membership contact: James Weaver, Dept. of Mathematics and Statistics, University of West Florida, 11000 University Parkway, Pensacola, Florida 32514-5751 email: jweaver@uwf.bitnet.

## LOGO CONTEST

ILAS needs a logo for use on letterhead and T-shirts, at conferences, and with other promotional activity. We invite readers with artistic skills to submit designs, and those without to submit ideas. A winning design (or idea) will be selected, after consultation with the members, and the contributor submitting it will be given a year's free membership in ILAS, and possibly other (not yet specified) rewards. Designs/ideas may be sent to R. C. Thompson (Math, University of California, Santa Barbara, CA 93106, USA, or thompson@henri.ucsb.edu). Your participation is invited!

## SEVENTH ISSUE OF *IMAGE* PLANNED FOR JULY 1991

IMAGE is edited by S. J. Leon and R. C. Thompson. The Production Editor is Ann Cox. News items for the seventh issue should be sent to:

> Steven J. Leon Dept. of Mathematics Southeastern Massachusetts University North Dartmouth, MA 02747 E-mail: SLEON@SEMASSU.BITNET

All news of interest to the Linear Algebra community is welcome including: news of conferences, journals and books, upcoming events, and activities of members. E-mail appears to be the fastest and most efficient way to submit news items.

Future issues of  $\mathcal{IMAGE}$  will contain feature articles on linear algebra activities in other countries. These articles should be no more than three pages in length. We will also feature more book reviews. Those interested in reviewing books for  $\mathcal{IMAGE}$  should contact S. J. Leon. If you're a member of ILAS then  $\mathcal{IMAGE}$  is your publication. It needs your support. Please keep us informed about the linear algebra activities in your country.

## ILAS-NET

The International Linear Algebra Society also maintains an electronic news service *ILAS*-*NET* edited by Danny Hershkowitz. If you want to submit news items or to have your name added to the *ILAS*-*NET* distribution list, send a message to Danny at:

## MAR23AA@TECHNION.BITNET

## NEWS FROM CHINA

## Report by J. C. Chen

J. G. Sun is now visiting the Department of Computer Science, University of Maryland, U. S. A. with G. W. Stewart as his host. He will stay there until the end of February, 1991. He will then pay a four month visit to Bielefeld University at the invitation of L. Eisner.

L. Eisner has paid a three week visit to Beijing. He gave four lectures to the following institutes: the Numerical Analysis Centre (two lectures), the Beijing University, and the Chinghua University.

## NOMINATIONS FOR SIAG-LA LINEAR ALGEBRA PRIZE

## Report by Michael T. Heath

Nominations are hereby solicited for the 1991 SIAM/LA Linear Algebra Prize. The SIAM/LA Linear Algebra Prize is sponsored by the SIAM Activity Group on Linear Algebra and awarded every three years to the author(s) of the best paper in applicable linear algebra published in English in a peer-reviewed journal during the preceding three calendar years. For the 1991 Prize, nominated papers must bear a journal publication date of 1988, 1989, or 1990. The 1991 Prize will be presented in a Prize Ceremony to take place at the Fourth SIAM Conference on Applied Linear Algebra, which will be held in Minneapolis, Minnesota, on September 11-14, 1991. Nominated papers should contain significant research contributions to the field of linear algebra that have direct or potential applications. Nominated papers will be judged by a Prize Committee appointed by the SIAM President and consisting of the following persons: Michael T. Heath, Chair (Oak Ridge), Chandler Davis (Toronto), Stanley C. Eisenstat (Yale), Alan J. Hoffman (IBM), Henry Wolkowicz (Waterloo).

The prize will consist of a plaque and certificate; there will be no cash award. At least one of the awardees will be expected to attend the Prize Ceremony and present the winning paper. The winner(s) will also be announced in the SIAM News and the SIAG/LA Newsletter. All nominations must be received by January 31, 1991 to be considered for the award. Nominations should give a full bibliographic citation for the paper and a brief statement outlining the justification for the nomination in terms of its importance and impact. Written or e-mail nominations of outstanding papers can be submitted to any member of the Prize Committee but for brevity only the Committee Chairman's address is given: Dr. Michael T. Heath, Oak Ridge National Laboratory, P.O. Box 2009, Bldg. 9207A, Oak Ridge, TN 37831-8083, (For FedEx or UPS use "Bear Creek Road" instead of P.O. Box) phone: 615-574-3130 (voice), 615-574-0680 (fax), email: mth@msr.epm.ornl.gov

## IMACS INTERNATIONAL SYMPOSIUM ON ITERATIVE METHODS IN LINEAR ALGEBRA

April 2-4, 1991, Brussels, Belgium

## Report by R. Beauwens

The purpose of the symposium is to provide a forum for the presentation and the discussion of recent advances in the analysis and implementation of iterative methods for solving large linear systems of equations and for determining eigenvalues, eigenvectors or singular values of large matrices. TOPICS:

Matrix analysis: methods for nonsymmetric, singular and overdetermined systems, convergence acceleration, preconditioning, sparse eigenvalue problems

Boundary value problems: multigrid methods, domain decomposition, spectral methods

Implementation techniques: on vector processors, on multiprocessors, on massively parallel systems

Software developments: for sparse linear systems, for sparse eigenproblems

Mathematical applications: partial differential equations, systems theory, least squares problems

## **INVITED LECTURES:**

O. Axelsson, On multilevel iteration methods for problems in elasticity theory

F. Chatelin, The Arnoldi Chebyshev iterative method for the stability of evolution equations

D. Kincaid, Second degree iterative methods

A. van der Sluis, The convergence behaviour of Conjugate Gradients in various situations

H. van der Vorst, Conjugate gradient type methods for non-symmetric systems

E.L. Wachspress, Consistent sparse factorisations

Yu. Yeremin, To be confirmed.

## SPECIAL SESSIONS

Coupled inner-outer iteration methods (O. Axelsson);

Numerical methods for the analysis of Markov models (G. Latouche)

Spectral Methods (M. Delville and E. Mund)

Complex Variable methods for solving non-positive definite linear systems (M. Eiermann and W. Niethammer)

Parallel iterative methods (D. Kincaid and C. Wu)

Iterative solution of unsymmetric systems (H. van der Vorst)

The Lyapunov equation (E. Wachspress)

## CONTRIBUTED LECTURES:

More than 70 papers have been submitted, covering a large number of subjects within the scope of the conference. No more than three parallel sessions will be scheduled at the same time. All papers published in the proceedings will be refereed.

## CALENDAR:

Monday, 1st April: Advance registration and informal get together in one of the hotels listed below.

Tuesday, 2nd April: 9.00 am. Registration. 10.00 am opening of the conference.

Wednesday, 3rd April: Reception in the Gothic Brussels town hall. Admission free for participants. Conference Dinner, BF 2000,- per person.

Thursday, 4th April: 17.00 p.m. Closure

CONFERENCE HALL: Aula of the VUB (Vrije Universiteit Brussel), Pleinlaan 2, B-1050 Brussel.

The conference is sponsored by NFWO-NFRS (Belgian National Science Foundation) IBM, Honeywell and IMACS. Co-chairpersons for the conference are Robert Beauwens, Université Libre de Bruxelles, and Pieter de Groen, Vrije Universiteit Brussel. For more information contact: R. Beauwens, IMACS International Symposium on Iterative Methods in Linear Algebra, Université Libre de Bruxelles, CP 165, Av. F.D. Roosevelt 50, B-1050 Brussels, Belgium, fax. +31-2-6503564, phone +31-2-6502085, email beauwens@bbrnsf11.bitnet, or fax. +31-2-6413495, phone +31-2-6413307, email pieter@tena2.vub.ac.be (Note change of phone number of the ULB: 650xxxx instead of 642xxxx).

## SECOND NIU CONFERENCE ON LINEAR ALGEBRA, NUMERICAL LIN-EAR ALGEBRA AND APPLICATIONS

## Report by Biswa Datta

The Second NIU Conference on Linear Algebra, Numerical Linear Algebra and Applications will be held at Northern Illinois University, DeKalb, Illinois, May 3 - 5, 1991. The purpose of the conference is to bring together researchers in linear algebra, numerical linear algebra and various application areas such as control and systems theory and signal processing, for an effective exchange of ideas and discussion of recent developments and future directions of research.

The conference has been sponsored by International Linear Algebra Society and Northern Illinois University's Department of Mathematical Sciences, the Graduate school and College of Liberal Arts and Sciences.

All areas of theoretical, numerical and applied linear algebra will be addressed by the conference. The journal *Linear Algebra and Applications* will publish a special issue on the conference with Professors Biswa Datta and Robert Plemmons as special editors. Papers should be submitted to one of the two special editors by July 31, 1991. They will be refereed in the normal way.

Besides invited lectures, there will be several sessions of contributed presentations. Inquires about the conference and the titles and abstracts for contributed presentations should be addressed to: Biswa Nath Datta, Department of Mathematical Sciences, Northern Illinois University, DeKalb, IL 60115, Tel: (815) 753-6759, E-Mail: dattab@math.niu.edu or bdatta@na-net.stanford.edu, Fax: (815) 753-1824. Deadline for receiving contributed abstracts is February 15, 1991.

## CONFERENCE ON STRUCTURED MATRIX THEORY

### Report by Carolyn Eschenbach

Georgia State University (Atlanta) will host an NSF/CBMS sponsored regional conference on structured matrix theory from August 19 to August 23, 1991. A supplementary activity may be planned for August 24. The principle speaker will be Charles Johnson of the College of William and Mary, and a small number of additional invited speakers will enrich the discussion. Beginning at an elementary level, a goal will be to describe several of the many open problems in the field. Support of up to \$500 is available for approximately 30 participants, and discount rates will be available at local hotels. For further information, contact: Prof. Carolyn Eschenbach, Department of Mathematics and Computer Science, Georgia State University, Atlanta, GA 30303-3083, Phone: (404) 651-2253

# MINISYMPOSIUM ON TEACHING LINEAR ALGEBRA WITH SOFTWARE TOOLS

## Report by David R. Hill

A minisymposium, "Teaching Linear Algebra with Software Tools" is being organized for the SIAM Conference on Applied Linear Algebra, September 11-14, 1991 in Minneapolis, Minnesota. Of particular interest are classroom tested approaches for teaching elementary or advanced topics in linear algebra which involve computer demonstrations or experiments. The software used should be available commerically.

For consideration for participation in the minisymposium send a short description of the technique or project including the name of the software employed to: Dr. David R. Hill, Mathematics Department, Temple University, Philadelphia, Pa. 19122 USA, Email: V5250E@TEMPLEVM.BITNET, Phone: 215-787-1654. (No support funds are anticipated for minisymposia participants.)

## MINISYMPOSIUM ON TEACHING ISSUES IN LINEAR ALGEBRA

### Report by David Carlson

A minisymposium "Teaching Issues in Linear Algebra" is being organized for the SIAM Conference on Applied Linear Algebra September 11-14, 1991 in Minneapolis. The session will include a report with recommendations from the 1990 Workshop on the Undergraduate Linear Algebra Curriculum, and discussion from the floor. In addition, there will be several presentations on curricular and pedigogical issues in linear algebra teaching. (This session is intended to complement the minisymposium "Teaching Linear Algebra with Software Tools", also being organized for the meeting.) For more information contact: David Carlson, Mathematical Sciences Department, San Diego State University, San Diego, CA 92182-0314, Email: carlson@math.sdsu.edu

## CALENDAR OF COMING CONFERENCES

January 16-19, 1991, AMS Annual Meeting, San Francisco, CA

April 2-4, 1991, IMACS International Symposium on Iterative Methods in Linear Algebra, Brussels Free Universities, Belgium

Information: R. Beauwens, IMACS International Symposium, Université Libre de Bruxelles, C.P.165. 50, Av. F.D. Roosevelt, 1050 Brussels, Belgium; (beauwens@bbrnsfl1.bitnet) (See article in this issue of  $\mathcal{IMAGE}$ )

April 21-27, 1991, Numerical Linear Algebra, Oberwolfach, W. Germany Focus: The iterative Focus: The iterative solution of nonsymmetric linear systems

May 3-5, 1991, Linear Algebra, Numerical Linear Algebra and Applications, Northern Illinois University, Sponsored by ILAS Information: See article in this issue of IMAGE

July 8-12, 1991, International Conference on Industrial and Applied Mathematics, Washington, D.C.

Information: ICIAM 91 Conference Manager, c/o SIAM, 3600 University City Science Center, Philadelphia, PA 19104-2688 (e-mail: iciam@wharton.upenn.edu)

Summer 1991, International Conference on Linear Algebra and Applications, Fudan University, Shanghai, China

Information: B. Datta, Dept of Math., Northern Illinois Univ., DeKalb, IL 60115, (dattab@math.niu.edu)

August 19-23, 1991, Conference on Structured Matrix Theory, Georgia State University, Atlanta, Georgia

Information: Prof. Carolyn Eschenbach, Department of Mathematics and Computer Science, Georgia State University, Atlanta, GA 30303-3083 (See article in this issue of  $\mathcal{IMAGE}$ )

1991-92 Applied Linear Algebra Year, IMA, University of Minnesota Emphasis: Fall Quarter: Discrete Matrix Analysis, Winter Quarter: Matrix computations,

Spring Quarter: Signal Processing, Systems and Control Information: R.A. Brualdi, Dept. of Math., Univ. of Wisconsin, Madison, WI 53706, e-mail: brualdi@vanvleck.math.wisc.edu (See article in *IMAGE* #5)

September 14-19, 1991, SIAM Conference on Applied Linear Algebra, Minneapolis, Minnesota

Information: R.A. Brualdi, Dept. of Math., Univ. of Wisconsin, Madison, WI 53706, e-mail: brualdi@vanvleck.math.wisc.edu (See article in  $\mathcal{IMAGE} \#5$ )

Summer 1992, ILAS Conference, Lisbon University, Portugal Information: See future issues of  $\mathcal{IMAGE}$ 

March 1993, ILAS Conference, University of West Florida, Pensacola, Florida Information: See future issues of  $\mathcal{IMAGE}$ 

June 1993, 12th Householder Symposium on Numerical Linear Algebra, Lake Arrowhead, California

Information: Gene Golub, Computer Science Dept., Stanford University or Tony Chan, Mathematics Department, UCLA

August 1993, ILAS Conference, University of Essex, Colchester, England Information: See future issues of  $\mathcal{IMAGE}$ 

December 13-17, 1993 International Cornelius Lanczos Centenary Conference, North Carolina State University, Raleigh, North Carolina

Information: Robert J. Plemmons, North Carolina State University, Raleigh, North Carolina 27695-8205

Summer 1994, ILAS Conference, Erasmus University, Rotterdam Information: See future issues of IMAGE

## REPORTS ON CONFERENCES ATTENDED

## AN OVERVIEW OF THE ELEVENTH HOUSEHOLDER SYMPOSIUM

## Report by John Depillis

The author would like to express his thanks to Randy Bramley for the use of his notes and to Gene Golub and Bob Plemmons for their observations.

On June 18-22, 1990, the Eleventh Householder Symposium on Numerical Algebra took place at the Nya Hotel Tylosand, located on the west coast of Sweden near the town of Halmstad. There were about one hundred and fifty persons in attendance. There were attendees from various countries including, for the first time, a large contingent from the

#### Soviet Union and Eastern Europe.

#### First Impressions:

On Sunday, the 17th, some participants arrived in order to register and settle in early. Friends old and new made contact. Groups were seen in search of local restaurants to share some time and their first meal in Halmstad. Recovery time was required by some victims of price-shock.

In certain respects, the casual visitor might conclude that the charming Nya Tylosand was not so much a hotel as it was an intelligence test. This impression was due, in part, to the numbering system of the rooms (for which no algorithm seems to exist) and to the helpful signs HISS and RUM (elevators and room.)

#### The Formal Talks:

There were so many interesting lectures (often in conflict) that it is impossible to give more than a fleeting impression of the meeting. The rich and stimulating meeting showed the growing use of numerical linear algebra in a widening range of applications. Also, it was of interest to see so many young persons involved in the subject, evidencing a stronger interest than ever.

The Conference opened on Monday, 18 June, with welcoming remarks from Ake Bjorck. Gene Golub extended his greetings and also noted that among the original organizers of the Householder Conferences only Dave Young and Gene himself have been present at them all. Velvel Kahan was also in attendance at the very first meeting at Gatlinburg.

The opening talk by Jim Demmel described some of his work on LAPACK, a matrix library being designed for accuracy and portability, qualities which are not easy to realize on CRAYs! (See "The Informal Talks" section for a CRAY test you can do at home.) Using component-wise relative error, (as opposed to the more standard relative norm bounds), Jim was able to achieve tighter error bounds in the solution of linear systems, generalized *SVD*, the symmetric eigenvalue problem, etc.

The morning continued with Velvel Kahan speaking on symmetric rank-1 perturbed diagonal's system, along with some observations on CRAY's arithmetic weaknesses and failings.

K. Veselic gave more details of the accuracy of one-sided Jacobi as applied to L'L = A: this was in contrast to use of the QR algorithm. The error bounds were element-wise as described by Demmel, and were convincing enough to make Jacobi the method of choice for the LAPACK project.

Nick Higham talked about fast matrix multiplication, describing recent developments using Strassen's algorithm. In the *usual* matrix multiplication, we have an  $n^2$  error term. In Strassen's method, the error exponent p for  $n^p$  ranges from 2-3.85 and the numerical error can be 10-100 times greater than that for standard multiplication. It was noted that IBM and CRAY use Strassen's method in their libraries. R. Grimes pointed out that Strassen's method requires more memory and so can not be implemented in the BLAS-3's as a default. Kahan noted that BLAS-3's perform well with scaling, but Strassen's method does not.

Mario Arioli gave examples where a QR factorization used to solve nonsingular systems gives much larger errors (up to 15 orders of magnitude) than LU. His explanation was an error analysis that accounts for the sparsity pattern of each  $Q_i$  (again c.f. Demmel's talk). Normally QR perturbs all of the upper triangle part of A, not just the nonzero parts. He also showed that QR cannot capture Skeel's error bounds for LU, but yields the classical condition number. Stewart pointed out that this was not a feature of QR, but rather of the implementation of QR — that is, each example that Mario gave could have had a small relative error simply by permuting the rows of the given matrix.

Two talks dealt primarily with condition number estimation. Chris Bischof discussed combining his incremental condition number (ICE) estimator with restricted column pivoting to obtain a rank revealing QR factorization that could run well on high-performance machines. Then Bob Plemmons introduced ACE and ALE, fast adaptive condition num-

ber estimators for signal processing applications. This application requires maintaining the Cholesky factor of a matrix which is being updated/downdated by one row on every time step. The method also applies to any low rank update of a matrix and so might be used for quasi-Newton methods (which have a rank one or rank two update at each step).

New approaches for the iterative solution of nonsymmetric systems were presented in three interesting plenary talks. First, Freund proposed that use of his quasi-minimal residuals (QMR) algorithm can be extended beyond the complex symmetric case. Unfortunately QMR can still fail in the same cases as when incurable breakdowns occur in the Lanczos algorithm.

Secondly, Van der Vorst presented the stabilized CGS scheme, and suggested that it might be combined with QMR. The basic idea is that in bi-conjugate gradients, a polynomial  $P_i$  is created such that  $P_i(A)$  reduces  $r_0$  to  $r_i$ , and  $P_i(A^T)$  reduces  $r'_0$  to  $r'_i$ . CGSuses  $(r_i, r'_j) = (P_j(A)P_i(A)r_0, r'_0)$  to get a recursion for  $r_i$  without needing  $r_i$ . However, the polynomial  $P_i$  is effectively squared, so when  $P_i$  has problems with conditioning, its square suffers even worse effects. Van der Vorst also noted that  $P_i(A)r_0$  is orthogonal to  $Q(i-1)(A^T)r'_0$  for any polynomial Q of degree less than i. He recommends using  $Q_i(A) = (I - \alpha_i A)(I - \alpha_1 A)(I - \alpha_0 A)$ , with the parameters  $\alpha_i$  chosen to minimize the norm of  $r_i$ . The resulting CGSTAB algorithm has a smooth convergence of residual norms, has better performance than GMRES(k) or CGS, and has never broken down on device simulation problems.

Thirdly, Lothar Reichel presented a hybrid method using Richardson's method and GMRES(k). He proposed using GMRES(k) to find the parameters for a Richardson iteration, with the parameters ordered using Leja points. His approach for finding the parameters seems to differ from the one used by Saylor, Smolarski (the pronunciation of which may be left to the reader's discretion), Saad and Elman because instead of using the underlying Arnoldi iteration, he directly uses the GMRES residual polynomial. He proposed that the new method has better properties because the GMRES residual polynomial captures the  $\epsilon$ -pseudo spectrum (defined by Trefethen) while the Arnoldi approach does not.

O. Widlund showed results from SESAM, a large finite element code for elasticity problems. He proposed eliminating interior nodes, that is, explicitly forming the Schur complement. He then tested three block preconditioners, based on using a coarse grid, the edge space of left-over unknowns, and the vertex space of left- over unknowns, respectively. The last choice provided the best preconditioner by far. Kahan asked about nonlinear problems, where structural failure usually begins in the local elements (which are eliminated by Widlund's scheme) and then work their way up to larger structures. Widlund had no answer for that, having tested only linear problems. Roger Grimes said that for 3D problems this approach was too expensive, since what is left over consists of planes, not lines. Tony Chan bounced around in his chair at this comment, but was not able to answer it until the next break. I (R. Bramley) did not hear his response, but apparently Tony feels that it is a practical approach even for 3D problems, and has written something up on it.

Yeremin also proposed explicitly forming the Schur complement for elasticity problems in spite of the additional storage required and the large number of operations required. He suggested using an incomplete BSSOR-CG scheme as preconditioner-solver pair, unlike his previous work which used a complete BSSOR preconditioner. The incomplete BSSOR is based on using an incomplete Cholesky factorization of the diagonal blocks of the matrix, rather than the complete factorization.

In the following talk, Kolotilina discussed using direct approximations to the inverse of the matrix as preconditioners, and presented a way of obtaining a symmetric approximation when A is symmetric and positive definite. When applied to elasticity problems, the preconditioned system has a larger condition number than the unpreconditioned system! However, significant improvement over BSSOR-CG and IBSSOR-CG is achieved when the Schur complement is used instead.

It is impractical to give a full report on all of the excellent talks at the conference. We only mention Bunse-Gertner's talk on computing the eigendecomposition of unitary matrices,

which showed that by applying the QR algorithm to the Schur parameter form of a unitary matrix one can take advantage of many more zeros that occur for free during the bulgechasing sequence.

Van Huffel gave an excellent overview and introduction to total least squares, providing motivation, basic analysis, and guidelines of when total least squares should and should not be used (the alternative is regular least squares). Per-Ake Wedin gave an overview of perturbational analysis of linear and nonlinear least squares problems, and advocated using iterative refinement for such problems. His analysis showed that essentially the dependence on the square of the condition number can be removed using this approach.

Of course, much of the action at the Householder Conference took place in special sessions, not at the plenary sessions. One especially notable special session dealt with row projection methods. A. Dax of the Hydrological Service in Israel discussed applying Kaczmarz methods for solving  $l_{\infty}$ ,  $l_1$ , and linear programming problems by a regularization approach. M. Neumann refined his analysis of the convergence of chaotic iterations, and Mario Arioli presented further results for Cimmino's method applied to sparse nonsingular systems.

## The Householder Prize Lecture:

The Householder Prize, based on the quality of the PhD thesis in numerical analysis/algebra, was awarded jointly to both Alan Edelman (PhD, MIT: Nick Trefethen supervisor) and to Maria Beth Ong (PhD, Univ of Washington: Loyce Adams supervisor.)

At the Thursday night banquet, Pete Stewart formally announced the names of the winners, noting the exceptionally high quality of the submissions which rendered the committee's choice pleasantly difficult.

On Friday, 22 June, Alan Edelman presented his results on Eigenvalues and Condition Numbers of Random Matrices. It was generally agreed that Alan's results were beautiful and his presentation was delivered with clarity and style.

Sad to say, Mary Beth Ong, the co-winner, was not allowed to leave Seattle to present her results in Sweden due to some sort of visa problem with the US Immigration Service. It was rumored that the INS thought her Green's function should also have a green card (what else?) but in all fairness, this report is totally unsubstantiated.

#### Informal Talks:

Besides the formally scheduled talks during the day, evening sessions were spontaneously organized and very well attended.

One of the informal talks was given by Velvel Kahan immediately after the Thursday banquet. This talk actually served as the post-banquet entertainment. Velvel's lively and provocative discourse provided more detail about CRAY's arithmetic. The audience was invited to confirm an odd anomaly found in CRAY's arithmetic, viz., that the CRAY computation of both (62.0 \* 63.0)/62.0 and (63.0 \* 63.0)/63.0, return values, neither of which is an integer.

Hans Schneider made some remarks in support of ILAS, the International Linear Algebra Society. Speaking to professionals whose very business it is to understand the notions of *less* than and greater than, Hans noted that the annual dues for this organization amounted to less than the cost of two Swedish beers.

#### Wednesday Afternoon Excursion:

The afternoon of Wednesday 20 June was set aside for an excursion to a wild-life refuge on an island off the Coast. Many cheerfully piled into the Skandia buses to the harbor where a roofless ferry awaited us. Only after we reached the island, did the rains begin. Just a drizzle. Nothing that could result in any diminution of The Experience. However, those of us who failed to bring either an umbrella or raincoat were left in a state of soggy contrition after our return trip on the roofless ferry. At least the bus was covered!

## Miscellaneous:

To those interested (and there were many), Cleve Moler gave demonstrations of a preliminary version of a forthcoming proposed addition to MATLAB, the handling and graphing of sparse matrices.

The 22nd of June marks the year's longest day in Sweden. (This event is increasingly being noted in other countries.) Folk dancing around special poles took place to mark this happy phenomenon (Midsummer's Day.). But this time is apparently a time to stay at home and celebrate as the ghost-town emptiness of the streets would indicate.

This meant that I was to leave Halmstad at a train station that had no passengers, no station master, and for a while there, I was convinced that there would be no train, either. But the train finally did appear, like a soundless Flying Dutchman with only one or two passengers (strangers, like me, to the Swedish ways.) In a word, a remarkably good meeting for which the organizers are to be congratulated. Special thanks are due to Ake Bjorck for all his attention and consideration!

### Next meeting:

Gene Golub and Tony Chan will be organizing the next Householder (Gatlinburg) Conference which will take place at the University of California's Lake Arrowhead Conference Center in southern California in June 1993.

## SECOND SIAM CONFERENCE ON LINEAR ALGEBRA IN SIGNALS, SYS-TEMS AND CONTROL

#### Report by Biswa N. Datta

The SIAM Conference on Linear Algebra in Signals, Systems and Control, held Nov. 5 – Nov. 8, 1990 in San Francisco, was attended by 311 people. The conference was the second in the series. The organizing committee for the conference consisted of David Carlson, co-chair, Biswa Nath Datta, co-chair, George Cybenko, Robert Plemmons and Eduardo Sontag. The conference was sponsored by the SIAM Activity Group of Linear Algebra and co-sponsored by the SIAM activity group on Control and Systems Theory.

The focus of the conference, like the first one, was highly *interdisciplinary*; blending theoretical, computational and numerical linear algebra with engineering areas such as control and systems theory and signal processing. The purpose of the conference was to bring together academic mathematicians and computer scientists with government and industrial researchers and practicing engineers to have an effective exchange of ideas and, to foster effective communications between these various groups.

This continuing effort to encourage effective scientific communications between scientific and engineering communities which share common interests, but which, until recently, have had little interactions, started with the 1984 AMS summer research conference on linear algebra and its role in systems theory. The effort was greatly enhanced at the SIAM Conference on Linear Algebra in Signals, Systems and Control held August, 1986 in Boston. Both conferences were chaired by Biswa Nath Datta of Northern Illinois University.

All indications are that the main objective of the conference was achieved: the conference brought mathematicians and engineers closer than ever before. As might be expected given the broad interdisciplinary nature of the conference, there were many principal themes addressed by the speakers. These included: linear and nonlinear problems in mathematical control and systems theory; robust and  $H_{\infty}$  control, stochastic and adaptive control, algebraic and geometric methods of control, large-scale systems, large-scale and parallel matrix computations and their applications in control, numerical methods in control and signal processing, etc.

Some of the highlights of the conference were:

The Conference was truly international in nature; there were attendees from Canada, China, Hong Kong, Taiwan, Japan, Australia, India, Germany, Spain, Portugal, Belgium, England, Italy, France, Sweden, the Netherlands, USSR, Algeria, Israel, Brazil, etc. These attendees actively participated at the conference by organizing minisymposia, giving talks, and chairing sessions, etc.

For the first time, there were participants from engineering and other nonmathematical scientific communities who normally do not attend SIAM conferences.

Because of the obvious importance and its impact on present research, scientific computing and its applications to systems and control theory and signal processing were heavily stressed in the conference program. Besides several invited presentations, there were numerous activities in these areas both in minisymposia and contributed sessions. Indeed, scheduling nonconflicting sessions involving scientific computing and computational methods was impossible.

The conference was preceded by a Short Course on Large-Scale and Parallel Matrix Computations in Control, Systems and Signal Processing organized by Biswa Nath Datta of Northern Illinois University.

The short course was an attempt to help fulfill the urgent need of research in the area of large-scale and parallel computations in CSS as pointed out in the recent panel report on *Future Directions in Control Theory*. Control theory is lagging behind with respect to other areas of applied sciences and engineering in this respect. The short course was also attended by several visitors from overseas. In addition to the organizer Biswa Datta, talks were given by Drs. Ahmed Sameh, K. Gallivan, Iain Duff, Beresford Parlett, and K. S. Baheti in the short-course. These talks, according to the evaluations of the attendees, were highly successful.

Conference - Publications: There will be no formal proceedings from the conference. However, Biswa Datta, as a member of the editorial board and on behalf of the managing editor Gene H. Golub and associate managing editor Robert Plemmons of SIAM J. Matrix Anal. Applications (SIMAX) urged speakers to submit papers based on their talks to this journal. Recall that SIMAX was founded immediately after the SIAM Conference on LASSC in Boston and some selected papers from the latter were published in some earlier issues of the journal. An editorial-board luncheon meeting of SIMAX was held during the conference.

SUMMARY: Judging from the response received from the participants and attendees, both the conference and the short course were a tremendous success. It is expected that there will be similar activities in the future at regular intervals.

## FIFTH SOUTHERN CALIFORNIA LINEAR ALGEBRA CONFERENCE

## Report by R. C. Thompson

The fifth annual Southern California Linear Algebra Conference was held at the University of California at Santa Barbara on Saturday, November 3, 1990. Speakers included P. R. Halmos, C. R. Johnson, L. Rodman, H. Schneider, J. Drew, T. Shalom, D. Carlson, M. Bakonyi, W. So, and M. Grady. Attendance was about forty.

This conference is held yearly at a southern California location, usually in November. The site for the November, 1991 meeting is not yet decided. Anyone wishing to be put on the mailing list for the next meeting should send a note to R. C. Thompson, at e-mail to thompson@henri.ucsb.edu, or postal mail to Math, UCSB, Santa Barbara, CA 93106, USA.

## INTERNATIONAL SUMMER SCHOOL ON LINEAR ALGEBRA AND AP-PLICATIONS

## Report by G. N. de Oliveira and J. C. Chen

The International Summer School on Linear Algebra and Applications was held on 3-12 September, 1990, in the University of East Asia, Macau, with G. N. de Oliveira as organizer and J. C. Chen as coordinator in the People's Republic of China. The Summer School consisted of several series of lectures and seminars on current research topics. The main speakers were J. C. Chen, G. N. de Oliveira, J. A. Dias da Silva, and Bit-Shun Tam. There were about twenty two participants from mainland China, Taiwan, Portugal, Hong Kong and Macau.

## JOURNAL NEWS

## LINEAR ALGEBRA AND ITS APPLICATIONS (LAA)

### **Special Issues**

Title: Special Editors: Full Announcement: Submission Deadline: Interior Point Methods for Linear Programming D. Gay, M. Kojima, R. Tapia LAA Vol. 110, November 1988 August 1989

Title: Special Editors: Full Announcement: Submission Deadline:

Title: Special Editors:

Full Announcement: Submission Deadline:

Title: Special Editors: Full Announcement: Submission Deadline:

Title: Special Editors: Full Announcement: Submission Deadline:

Title:

Special Editors: Full Announcement: Submission deadline: Matrix Canonical Forms R. A. Horn, R. J. Laffey, R. L. Merris LAA Vol. 113, February 1989 November 1989

Iterations in Linear Algebra and in Applications Owe Axelsson, John de Pillis, Michael Neumann, Wilhelm Niethammer, Robert J. Plemmons LAA Vol. 116, April 1989 March 1990

Algebraic Linear Algebra R. M. Guralnick, W. H. Gustafson, L. S. Levy LAA Vol. 119, July 1989 August 1990

Proceedings of Auburn 1990 Conference Frank Uhlig, David Carlson See *IMAGE* #3 September 30, 1990

Proceedings of the First Conference of the International Linear Algebra Society
W. Barrett, D. Hershkowitz, and D. Robinson
See article in *IMAGE* #4
January 31, 1990

Title:	Proceedings of the Sixth Haifa Conference on Matrix Theory	
Special Editors:	A. Berman, M. Goldberg, D. Hershkowitz	
Submission deadline:	October 1, 1990	
Title:	Proceedings of the International Workshop on Linear Models,	
	Experimental Designs, and Related Matrix Theory	
Special Editors:	J. K. Baksalary and G. Styan	
Submission Deadline:	October 31, 1990	

## LINEAR AND MULTILINEAR ALGEBRA (LAMA)

The special issue containing papers recognizing Henryk Minc upon his retirement is under preparation. Contributions are still invited, and should be submitted to R. C. Thompson, Math., UCSB, Santa Barbara CA 93106, USA.

Linear and Multilinear Algebra publishes at the rate of eight (sometimes more) issues per year. Submissions are invited, including research level problems. There always is a shortage of good contributions for the research problem section, so if you have an unsolved problem that you would be willing to make public, please submit it.

Articles in press include one by Paul Halmos entitled *Bad Products of Good Matrices*. This is the first in a series of expository articles by distinguished contributors to appear over the next two years.

## NEWS ON BOOKS

## **RECENT PUBLICATIONS**

J. A. Ball, I. Gohberg, L. Rodman, Interpolation of Rational Matrix Functions, Birkhauser Verlag, OT 45, 1990

## Description provided by Israel Gohberg

This volume develops the theory of interpolation for rational matrix functions in a selfcontained and systematic way, and includes applications to modern systems and control theory. The realization approach which comes from system theory serves as a tool to reduce interpolation problems to problems about constant finite matrices, and helps to obtain explicit expressions for the solutions. The book's last part is a self-contained introduction to applications in systems theory. Its themes are sensitivity minimization, model reduction and robust stabilization.

Roger A. Horn, Charles R. Johnson, Topics in Matrix Analysis, Cambridge University Press, 1991

### Description provided by Roger Horn

Building on the foundations of its predecessor volume, *Matrix Analysis*, this book treats in detail several topics with important applications which are of special mathematical interest in matrix theory, but were not included in the previous text. These topics include the field of values, stable matrices and inertia, singular value inequalities, matrix equations and Kronecker products, Hadamard products, and matrices and functions. The authors assume a background in elementary linear algebra and knowledge of rudimentary analytical concepts. This should be welcomed by graduate students and researchers in a variety of mathematical fields and as an advanced text and modern reference book.