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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

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Group Picture from ILAS-NSF ATLAST Workshop in Auburn

ILAS NEWS

ILAS-NSF *ATLAST* LINEAR ALGEBRA WORKSHOPS

Report by S. J. Leon

ATLAST is an ILAS-NSF Project to *A*ugment the *T*eaching of *L*inear *A*lgebra through the use of *S*oftware *T*ools. The initial *ATLAST* proposal was supported by an ILAS Education Seed Grant and the project was funded through an NSF Faculty Enhancement grant. The project got under way this summer. Four workshops were presented in June and a fifth workshop is scheduled for July 23–25 at the University of Maryland. Each workshop has approximately thirty participants and also allows additional participation by faculty members from the host institutions on a space available basis. Five more workshops are scheduled for next summer.

The goal of the workshops is to encourage and facilitate the use of software in linear algebra courses. Workshop participants learn about existing commercial software packages and are trained in the use of the MATLAB software package. The emphasis of the workshops is on how to effectively incorporate software into linear algebra classes and on how to design meaningful computer exercises.

Each participant designs their own computer exercises suitable for assigning to an undergraduate linear algebra class. These exercises should be further developed and class tested during the school year following the workshop. They are then submitted to the project director for inclusion in a database. A selection of these exercises will be published as an *ATLAST* Computer Exercise Book for Linear Algebra.

The four workshops held in June already have produced some impressive results. Participants worked together in small groups and interacted extensively with the workshop presenters and local coordinators. In the three day period of the workshops many stimulating computer exercises were developed. Additional exercises will be developed by the participants in the coming school year. The workshop also included many lively discussions on linear algebra curriculum and reform in the teaching of linear algebra. The interactions among such a diverse group of individuals provided new perspectives on linear algebra education for both the participants and the presenters alike.

The *ATLAST* Project was conceived by the Education Committee of the International Linear Algebra Society (ILAS). Steven J. Leon of the ILAS Education Committee is serving as the *ATLAST* Project Director and the Assistant Director is Richard Faulkenberry. Both are in the Mathematics Department of the University of Massachusetts Dartmouth. Special thanks are due to all who helped in planning the *ATLAST* Project, the workshop presenters, the local coordinators and to all of the participants whose diligence and enthusiasm contributed so much to the success of the workshops.

The workshop presenters and coordinators for the summer 1992 workshops were:

1. West Valley College Workshop
   Presenter: Jane Day
   Local Coordinator: Joe Kenstowicz

2. Auburn University Workshop
   Presenter: Kermit Sigmon
   Local Coordinator: Frank Uhlig

3. University of Wisconsin Workshop
   Presenter: Steven Leon
   Local Coordinators: Rod Smart and Larry Farnsworth

4. University of Wyoming Workshop
   Presenter: Eugene Herman
   Local Coordinator: Benito Chen

5. University of Maryland Workshop
   Presenter: Dave Hill
   Local Coordinator: David Lay

The schedule of workshops for the summer of 1993 will be released this coming fall. For more information about the 1993 workshops contact:

Steven J. Leon
ATLAST Project Director
Department of Mathematics
University of Massachusetts Dartmouth
Dartmouth, MA 02747
Telephone: (508) 999–8320
FAX (508) 999–8901
E-mail: ATLAST@UMASSD.EDU

ILAS PENSACOLA MEETING

Linear Algebra Conference at the University of West Florida

March 17 – 20, 1993

CONFERENCE TITLE: PURE AND APPLIED LINEAR ALGEBRA: THE NEW GENERATION

CONFERENCE LOCATION: The University of West Florida and the Pensacola Hilton in Pensacola, Florida.

SPONSORS: The University of West Florida and The International Linear Algebra Society

PROGRAM: This conference will feature as its principal invited speakers the next generation of linear algebraist, those younger scholars who are now starting to make a decisive impact on linear algebra. A few well-established people are included to give balance to the plenary addresses at the conference. The plenary addresses will be complemented with half hour invited presentations by well established individuals, contributed papers and minisymposia.

PROGRAM COMMITTEE: R. Brualdi, P. Coxson, P. Van Dooren, L. Rodman, H. Schneider, R. Thompson, J. Weaver (chair)

INVITED PLENARY SPEAKERS: R. Bapat (Indian Statistical Institute), J. Cohen (The Rockefeller University), G. Cybenko (University of Illinois), B. de Moor (Katholieke Universiteit Leuven), R. Guralnick (University of Southern Illinois), D. Hershkowitz (Technion-Israel Institute of Technology), C. K. Li (College of William and Mary), R. Mathias (College of William and Mary), V. Mehrmann (Universitat of Bielefeld), D. O'Leary (University of Maryland), Andre Ran (Universitait Amsterdam), Helene Shapiro (Swarthmore College), I. Zaballa (Universidad Del Pois Vasco)

BANQUET SPEAKER/ONE HOUR PANEL DISCUSSION: P. Halmos (Santa Clara University)

CALL FOR CONTRIBUTED PAPERS: Participants are invited to present 10 to 15 minute talks on topics in linear algebra. Send an abstract, camera ready, 7.5 inches wide by 5 inches long with at most 4 lines per inch to the address below by January 20, 1993. It should be noted that a refereed Conference Proceedings will be published in *Linear Algebra and Its Applications*, details will be provided later.

INFORMATION: James R. Weaver, Department of Mathematics and Statistics, 11000 University Parkway, University of West Florida, Pensacola, FL 32514-5751; (904)474-2283, email: JWEAVER@UWF.BITNET.

ILAS MEETING ANNOUNCEMENTS

Twice a year the International Linear Algebra Society (ILAS) sends out dues notices. At that time ILAS can also send an announcement or a call for papers for an ILAS MEETING or an ILAS SPONSORED MEETING. The deadlines for submission of these announcements are June 20 and December 1 of each year. Information should be sent to:

James R. Weaver
Department of Mathematics and Statistics
The University of West Florida
11000 University of West Florida
Pensacola, Florida 32514-5751, USA
E-Mail: JWEAVER@UWF.BITNET

OLGA TAUSSKY/JOHN TODD LECTURE

The International Linear Algebra Society is happy to announce

The Olga Taussky/John Todd Lecture

Olga Taussky and John Todd have had a decisive impact on the development of theoretical and numerical linear algebra for over half a century. This lecture honors them for their many and varied mathematical achievements and for their efforts in promoting linear algebra and matrix theory.

The lecture is to be given once every three to four years at an ILAS meeting designated by the ILAS executive committee. The lecturer will be a person who has received a Ph.D. within about the previous 15 years, and the lecture should cover a broad area of current research and be of a survey or historical area.

The first lecture will be given at the ILAS meeting in Pensacola, Florida (March 1993). The first lecturer will be Prof. Helene Shapiro (Swarthmore College).

LOGO CONTEST WINNER

Report by James Weaver

The winner of the contest for a logo for ILAS is Professor John H. Drew of the College of William and Mary in Williamsburg Virginia. His winning entry is given below and is now the official logo for ILAS. For his winning design Professor Drew was awarded one year's free membership in ILAS.

$$\begin{bmatrix} \mathrm{I} & \mathrm{L} \\ \mathrm{A} & \mathrm{S} \end{bmatrix}$$

NEXT ISSUE OF *IMAGE* PLANNED FOR JANUARY 1993

IMAGE is edited by S. J. Leon and R. C. Thompson. The Production Editor is Ann Cox. News items for the next issue should be sent no later than December 1, 1992 to:

Steven J. Leon
Dept. of Mathematics
University of Massachusetts Dartmouth
North Dartmouth, MA 02747
E-mail: SLEON@UMASSD.EDU
FAX: (508) 999–8901

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 *IMAGE* will contain feature articles on linear algebra activities in other countries. Articles should be no more than four pages in length. If you're a member of ILAS then *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

ILAS INFORMATION CENTER (IIC)

Report by Daniel Hershkowitz

As of May 27, 1992, ILAS INFORMATION CENTER (IIC) operates from the Technion. The new manager of IIC is

Daniel Hershkowitz
Department of Mathematics
Technion - Israel Institute of Technology
Haifa 32000 Israel
(972-4-294182 office; 972-4-324654 FAX)
E-mail: mar23aa@technion.bitnet

The system provides information on ILAS, on international conferences in linear algebra, on other linear algebra activities, on linear algebra journals, and on ILAS-NET notices. We invite organizations and individuals to contribute information to this database. If you have any questions and/or want to contribute information please contact Danny Hershkowitz.

We would like to thank Henry Wolkowicz, the first manager of IIC, for establishing it and for running it for more than two years.

IIC (ILAS INFORMATION CENTER) USER'S GUIDE

How to get files from IIC

There are two ways to get files from IIC:

I. Get the file(s) by e-mail.
Here you have to issue the command "get File-name File-type" to

LISTSERV@TECHNION.BITNET

You can do it in two ways:

1. If you are on BITNET, you can issue the command

   TELL LISTSERV AT TECHNION command_request

   in which case the file will be sent to you in a netdata format.
2. Include the command in the mail body of a message sent to

   LISTSERV@TECHNION.BITNET

   In this case the file(s) will be sent to you in a mail file. The message can include more than one request.

II. **FTP the file(s)** If you have the FTP ability, you can do the following:

1. Enter FTP TECHNION.TECHNION.AC.IL

2. Enter ANONYMOUS for the 'user:' prompt
3. Type your local userid as a PASSWORD
4. Once you get the first panel, type CD MAT to be connected to the Math disk
5. Issue any FTP command (type 'help' for available FTP commands)

Files that can be obtained from IIC

The updated list of files that can be obtained from IIC is included in the file ILAS-NET FILES. If you wish to retrieve a specific ILAS-NET message, you can ask for the file ILAS-NET INDEX, which contains the index of all ILAS-NET messages. Check for the number of the message you want and ask Danny Hershkowitz (MAR23AA@TECHNION.BITNET) to mail it to you.

ILAS ANNUAL REPORT

by Hans Schneider and Danny Hershkowitz

1. The elections of Hans Schneider (President), James Weaver (Treasurer), Tsuyoshi Ando and David Carlson (Board of Directors), were completed this past year. They all started their terms of office on March 1, 1992.

2. The Nominating Committee of ILAS (Y. H. Au-Yeung, R. Brualdi (chair), T. Laffey, J. Dias da Silva and S. Friedland) has completed its selection of nominees for the ILAS elections scheduled for the summer of 1992 with term of office beginning March 1, 1993. The nominees are: Vice-President (one to be elected): Russell Merris (Hayward, USA) and Graciano de Oliveira (Coimbra, Portugal); Secretary: Daniel Hershkowitz (Haifa, Israel); Board of Directors (two to be elected): Harm Bart (Rotterdam, The Netherlands), Rajendra Bhatia (New Delhi, India), Steven Leon (North Dartmouth, USA) and Paul Van Dooren (Champaign-Urbana, USA).

3. Frank Uhlig has replaced Dave Carlson as the chair of the Education Committee. Dave Carlson and Steve Leon stay on as members of the committee.

4. Gene Golub has resigned as representative of ILAS in the U.S.A.. After consulting the Executive Committee of ILAS, Hans Schneider has appointed Paul Van Dooren and Robert E. Hartwig as U.S. ILAS representatives. Both have accepted the appointment.

5. ILAS has announced $\mathcal{ATLAST}$: an NSF-ILAS Project to $\mathcal{A}$ugment the $\mathcal{T}$eaching of $\mathcal{L}$inear $\mathcal{A}$lgebra through the use of $\mathcal{S}$oftware $\mathcal{T}$ools. The project will offer ten 3-day workshops across the U.S.A. through the summers of 1992 and 1993. The project director is Steven J. Leon and the assistant director is Richard Faulkenberry.

6. As of May 27, 1992, ILAS INFORMATION CENTER (IIC) operates from the Technion. The new manager of IIC is Daniel Hershkowitz.

7. In order to improve the operation of ILAS-NET, we have switched to the LISTSERV distribution system.

8. There were two ILAS sponsored meetings since the previous report. These were the 2nd NIU Conference on Linear Algebra, Numerical Linear Algebra, and Applications, held in May 1991, and the 7th Haifa Matrix Conference, held in June 1991.

9. Future ILAS meetings are:

   (a) Lisbon (August 1992) Organizer: Jose Dias Da Silva

   (b) Pensacola (March 1993) Organizer: Jim Weaver

   (c) Rotterdam (August 1994) Organizer: Harm Bart

   (d) Atlanta (August 1995)

10. Future ILAS sponsored meetings will be

   (a) Workshop "Computational Linear Algebra in Algebraic and Related Problems", Essen (July 1992)

   (b) Workshop on Matrix Methods for Statistics, Auckland (December 1992)

ILAS TREASURER'S REPORT March 1, 1991 – Feb. 29, 1992

Report by James R. Weaver

Balance on hand March 1, 1991				
Certificate of Deposit		10,000.00		
Checking		3,788.09		13,788.09
Checking Account Balance on March 1, 1991				3,788.09
March 1991				
Income:				
	Interest	12.88	12.88	
Expenses:				
	Sec. of State	70.00	70.00	(57.12)
April 1991				
Income:				
	Dues	108.00		
	Interest on CD	61.37		
	Interest (First Union)	12.69	182.06	
Expenses:		00.00	00.00	182.06
May 1991				
Income:				
	Dues	72.00		
	Interest on CD	133.70		
	Interest (First Union)	12.76	218.46	
Expenses:				
	F. Uhlig Ed. Seed grant	400.00	400.00	(181.54)
June 1991				
Income:				
	Dues	24.00		
	Interest on CD	67.94		
	Interest (First Union)	11.94	103.88	
Expenses:				
	Postage	25.33	25.33	78.55
July 1991				
Income:				
	Dues	132.00		
	Interest on CD	67.94		

	Contributions			
	H. Schneider Prize	25.00		
	Regular	46.00		
	Interest (First Union)	11.86	280.62	
Expenses:				
	IMAGE #7	540.99		
	(Printing - 232.30)			
	(Mailing - 308.69)			
	Shipping Poste	134.85		
	Postmaster	79.29	755.13	(474.51)
August 1991				
Income:				
	Dues	396.00		
	Interest on CD	67.94		
	Contributions			
	H. Schneider Prize	12.00		
	F. Uhlig Educational	112.00		
	Regular	62.00		
	Interest (First Union)	10.85	660.79	
Expenses:				
	Post Office Expenses	19.71		
	7 Books of Stamps	40.60		
	Shipping Poste	93.05		
	Returned Check	12.00		
	Service Charge (First Union)	5.00	170.36	490.43
September 1991				
Income:				
	Dues			
	Regular	672.00		
	Institutional	150.00		
	Interest on CD	67.95		
	Contributions			
	H. Schneider Prize	57.00		
	F. Uhlig Educational	214.00		
	Regular	89.00		
	Interest (First Union)	11.85	1,261.80	
Expenses:		00.00	00.00	1,261.80
October 1991				
Income:				
	Interest (First Union)	15.85	15.85	
Expenses:		00.00	00.00	15.85
November 1991				
Income:				
	Interest (First Union)	14.01	14.01	
Expenses:		00.00	00.00	14.01
December 1991				
Income:				
	Dues	912.00		
	Contributions			
	H. Schneider Prize	25.00		
	Interest (First Union)	15.40	1,400.85	
Expenses:				
	Shipping Poste	237.45		
	Returned Check	12.00		
	Service Charge	5.00	254.45	1,146.40
January 1992				
Income:				
	Dues	84.00		
	Contribution			

	H. Schneider Prize	25.00		
	Interest (First Union)	12.19	121.19	
Expenses:				
	Mailing $\mathcal{IMAGE}$ to Auburn	13.95		
	$\mathcal{IMAGE}$ #8	692.41	706.36	(585.17)
February 1992				
Income:				
	Dues	540.00		
	Interest on CD	135.89		
	Contributions			
	H. Schneider Prize	13.00		
	F. Uhlig Educational	10.00		
	Regular	41.00		
	Interest (First Union)	11.29	751.18	
Expenses:				
	Shipping Poste	23.35		
	Returned Check	12.00		
	Service Charge	6.00	41.35	709.83
February 29, 1992				6,388.68
Account Balance				
	Checking Account	6,388.68		
	Certificate of Deposit	10,000.00	16,388.68	
General Fund		3,985.79		
Frank Uhlig Educational Fund		1,109.00		
Hans Schneider Prize		11,293.89	16,388.68	

NEWS ITEMS

WORKSHOP ON MATRIX THEORY, University Bielefeld, July 24–25, 1992

Report by Volker Mehrmann

A two day workshop on Matrix Theory will be held at the University of Bielefeld from July 24–25, 1992. The following speakers have agreed to talk so far: Richard Brualdi, Shmuel Friedland, Chunjang He, Gerd Krause, Volker Mehrmann, Reinhard Nabben, Alex Pothen, Hans Schneider (tentatively).

The workshop will be organized in the context of the "SFB Diskrete Strukturen in der Mathematik" at the University of Bielefeld. For information please contact:

Volker Mehrmann
Fakultaet fuer Mathematik
Universitaet Bielefeld
Postfach 8640
D-4800 Bielefeld 1, FRG
email: mehrmann@math1.mathematik.uni-bielefeld.de
tel. 0521-106-4798

WORKSHOP ON GENERALIZED INVERSES – COMPUTATIONAL TECHNIQUES AND APPLICATIONS

Indian Statistical Institute, New Delhi, India, December 11–16, 1992

Report from Rajendra Bhatia

The Workshop is being organised as a satellite to the International Conference on Multivariate Analysis to be held in Delhi during December 17–22, 1992 and is part of the celebrations to mark the birth centenery of Professor P. C. Mahalanobis, the founder of the Indian Statistical Institute. We plan to have invited talks, contributed papers and mini-courses. The possibility of bringing out a Conference Proceedings is being explored.

The Organising Committee for the Workshop consists of S. K. Mitra, G. P. H. Styan, R. E. Hartwig, S. K. Jain, P. Bhimasankaram, R. Bhatia and R. B. Bapat. We welcome contributed talks which will be of 15–20 minutes duration.

The participants will be provided local hospitality including accomodation at the Institute guest house which is conveniently located on campus. We regret that we have no funds to support travel. For participants coming from the U.S. there are programs such as the Fulbright Scholarship and the Indo-U.S. Exchange Program which can be explored. For more information on these programs please contact S. K. Jain (e-mail jains @ ouaccvmb (bitnet)). There may be similar programs in other countries. For a minimum stay of fifteen days in India it is usually possible to get an excursion fare which is much cheaper than the standard fare.

We would like to know about your intention to attend the Workshop by April 15, 1992 and we expect abstracts of talks by September 15, 1992. For additional information please contact us by e-mail at ISID!MITRA%VIKRAM@SHAKTI.ERNET.IN

SESSION ON LINEAR ALGEBRA EDUCATION AT JOINT MEETINGS OF AMS-MAA

San Antonio, Texas, January 13–16, 1993

Report by Steve Leon

The Mathematical Association of America announces a session of contributed papers on linear algebra education. Specifically, this session invites papers on innovations in teaching linear algebra, including:

1. The use of computer algebra systems, supercalculators, or computer software
2. Experiences with materials from the ATLAST summer workshops
3. Experiences with the Core Curriculum recommended by the Linear Algebra Curriculum Study Group
4. "Gems" of exposition in linear algebra
5. Other innovative teaching or curriculum ideas in linear algebra

The session is being organized by Don LaTorre, Clemson University, Steve Leon, University of Massachusetts Dartmouth, and Duane Porter, University of Wyoming. Individuals wishing to submit a paper for this session should send a one page summary to:

Don LaTorre
Department of Mathematical Sciences
Clemson University
Clemson, SC 29634– 1907

The summary must be received by September 10, 1992. If the paper is accepted for presentation, the author will be sent a standardized abstract form which must be returned promptly – no later than September 24. The session will be given in three parts which will take place on Wednesday, Thursday evening, and Friday.

WORKSHOP AND 8TH HAIFA MATRIX CONFERENCE

Report by Danny Hershkowitz

The Mathematics Department at the Technion, together with its Institute for Advanced Studies in Mathematics, will hold a workshop on "Nonnegative Matrices, Applications and Generalizations" at the Technion, on May 31 - June 4, 1993. The workshop will be followed by the Eighth Haifa Matrix Theory Conference, to be held June 7–10, 1993.

The workshop will consist of approximately thirteen invited talks (45 minutes each) and of minisymposia. The organizing committee for the workshop consists of A. Berman, D. Hershkowitz and R. Loewy (chair).

The conference will consist of talks given in plenary sessions (30 minutes or more each talk), and of talks given in parallel sessions (30 minutes or less each talk). The organizing committee for the conference consists of A. Berman, M. Goldberg, D. Hershkowitz, L. Lerer, R. Loewy (chair), and A. Zaks.

The following people have tentatively accepted our invitation to participate in the workshop and/or the conference:

N. Alon (Israel), T. Ando (Japan), H. Bart (Netherlands), R. Bhatia (India), M. Boyle (USA), R. Brualdi (USA), J. Da Silva (Portugal), J. Cohen (USA), P. Diaconis (USA), D. Djokovic (Canada), L. Elsner (Germany), M. Fiedler (Czechoslovakia), K. H. Foerster (Germany), S. Friedland (USA), P. Fuhrmann (Israel), I. Gohberg (Israel), R. Grone (USA), R. Hartwig (USA), R. Horn (USA), C. Johnson (USA), T. Laffey (Ireland), R. Mathias (USA), V. Mehrmann (Germany), M. Neumann (USA), S. Pierce (USA), R. Plemmons (USA), L. Rodman (USA), U. Rothblum (Israel), H. Schneider (USA), B. S. Tam (Taiwan), R. Thompson (USA), R. Varga (USA), I. Zaballa (Spain).

If you are interested in participating in the workshop and presenting a paper in a minisymposium, and/or speaking in the conference, please contact Danny Hershkowitz (e-mail: mar23aa@technion.bitnet). Room on the program for talks is limited, so please respond as soon as possible.

CALENDAR OF COMING CONFERENCES

July 24–25, 1992, Workshop on Matrix Theory, University Bielefeld
Information: See article in this issue of *IMAGE*.

August 3–7, 1992, ILAS Conference, Lisbon University, Portugal
Information: See article in *IMAGE* #7

August 3–14, 1992, NATO Advanced Study Institute: Linear Algebra for Large Scale and Real-Time Applications, Leuven, Belgium
Information: M. Moonen, e-mail: moonen@esat.kuleuven.ac.be

August 10–15, 1992, Workshop on Numerical Ranges and Numerical Radii, College of William and Mary
Information: Dr. Chi-Kwong Li, e-mail: ckli@cma.math.wm.edu

October 17, 1992, Three Decades of Numerical Linear Algebra at Berkeley, a Conference in Honor of the 60th Birthdays of Beresford Parlett and William Kahan
Information: James Bunch, e-mail: jbunch@ucsd.edu

November 7, 1992, Southern California Matrix Meeting, San Diego State University
Information: Steve Pierce, e-mail: pierce@math.sdsu.edu

December 4–5, 1992, International Workshop on Matrix Methods for Statistics, University of Auckland, Auckland, New Zealand
Information: George Styan, e-mail: MT56@MUSICA.MCGILL.CA

December 11–16, 1992, Workshop on Generalized Inverses: Computational Techniques and Application, India Statistical Institute, New Delhi
Information: See article in this issue of *IMAGE*.

January 13–16, 1993, Combined Meeting of the AMS and MAA, San Antonio, Texas

March 17–20, 1993, ILAS Conference, University of West Florida, Pensacola, Florida
Information: See article in this issue of *IMAGE*

Summer 1993, *ATLAST* Workshops on the Use of Software in Teaching Linear Algebra
Information: S. J. Leon, e-mail: ATLAST@UMASSD.EDU

June 1993, Special Month in Linear Algebra, Technion-Israel Institute of Technology, Haifa; Eighth Haifa Matrix Theory Conference, Technion-Israel Institute of Technology, Haifa
Information: A. Berman, e-mail: MAR64AA@TECHNION.BITNET or D. Hershkowitz (MAR23AA@TECHNION.BITNET). See also article in this issue of *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

December 13–17, 1993 International Cornelius Lanczos Centenary Conference, North Carolina State University, Raleigh, North Carolina
Information: R. J. Plemmons, North Carolina State University, Raleigh, NC 27695–8205

August 15–19, 1994, ILAS Conference, Erasmus University, Rotterdam
Information: See future issues of *IMAGE*

August, 1995 ILAS Conference, Atlanta, Georgia, U.S.A.
Information: See future issues of *IMAGE*

REPORTS ON CONFERENCES ATTENDED

A SCIENTIFIC REPORT ON THE MTNS '91

Report by B. N. Datta

General Overview of the Conference

The international symposium of the mathematical theory of networks and systems (MTNS '91) was held in Kobe, Japan, June 17–21, 1991. This was the 9th MTNS meeting and the first to be held in the Far East. The previous meetings were held in USA, Canada, The Netherlands, Sweden, and Israel. MTNS has been organized biannually since 1973. The

MTNS '91 was held at the International Conference Center on the man-made port island in Kobe City. Kobe is the largest port-city in Japan and one of the most popular tourist spots, surrounded by centuries-old historical cities like Kyoto, Osaka, Nara, Nagoya etc.

The local organizing committee was co-chaired by internationally renowned control theorists Professors H. Kimura and S. Kodama, both of Osaka University, Osaka. The committee should be commended on doing a super job. Particularly notable was the fact that the committee was able to enlist the support of most of the leading corporations of Japan, (about 50 altogether). Such a large number of corporate sponsors is a clear indication of the strong industry-university relationship that exists in Japan. I wish that a similar relationship existed in the U.S.A. as well.

The conference was truly international in nature. There were 558 attendees from all over the world. The purpose of the conference was to bring together research engineers, mathematicians and computer scientists to discuss mathematical problems of systems theoretic nature arising in applications of current interest. In order to help promote such interdisciplinary collaborations, I had previously organized two SIAM conferences on Linear Algebra in Signals, Systems and Control, (1986 and 1990) and an AMS Research Conference on "Linear Algebra and its Role in Systems Theory", (1986). These conferences certainly helped advance the goal of interdisciplinary collaboration and it is a pleasure to note that the MTNS '91 was another step forward.

The scientific program of the conference consisted of Plenary Lectures, Special Topic Lectures, Mini Courses, Invited and Contributed Sessions and a Poster Session.

Plenary Lectures

The goal of the plenary lectures was to provide the participants with major research developments in the areas of interest to the conference. All these lectures had some tutorial flavors.

In his opening address, Professor Katsuhisa Furuta, a well-known control theorist from Tokyo Institute of Technology, discussed how intelligent control can be effectively used in Robotics. Intelligent Control is usually defined as the "activities in the intersection of Automatic Control and artificial intelligence", however Professor Furuta coined a new definition. He defined *intelligence* as "the ability to adapt to the environment" and the *intelligent control* as "the control to provide the intelligence to the system." Based on this definition, he proposed a mechanism which appears to be effective for the "sensor based robot control such as compliance control, vision based servo and coordination control of multiple arms".

In another plenary talk on a similar topic entitled "Systems Theory and Intelligence", Dr. M. Vidyasagar, the Director of the Center For Artificial Intelligence and Robotics in Bangalore, India, showed "that there are several areas of intelligence which give rise to interesting and challenging problems in systems theory". By *intelligence* Dr. Vidyasagar referred to "those aspects of (rational) human behavior which computers find difficult to replicate," and, by *systems theory* he referred to a wide variety of topics such as complexity theory, stochastic algorithms, simulated annealing, neural networks etc., besides the traditional areas of control theory. This talk was somewhat unusual in nature because of its coverage of a wide range of interrelated interesting topics and I am sure that everybody in the audience got something out of the talk.

The other plenary lectures were given by professors B. D. O. Anderson of Australian National University; Israel Gohberg of Tel-Aviv University, Israel; and A. Isidori of University of Roma, Italy.

Professor Anderson's plenary talk was on optimizing the discretization of continuous-time controllers. A standard problem in digital control is a problem of replacing a continuous time controller with a discrete-time controller so that, as far as possible, closed-loop properties are preserved. The standard approaches to solve the problem do not make any use of the plant, whereas the closed-loop properties clearly depend on the plant as well as the controller. In this talk, Professor Anderson proposed some novel approaches for solving the problem that make use of the knowledge of the plant. Two aspects of the closed-loop properties, stability

and the closed-loop transfer matrix, were emphasized.

Professor Gohberg's talk was on the interplay between interpolation problems and systems theory. He described some recent developments in interpolation theory and showed how these developments have greatly influenced the modern theoretical systems theory research. The talk, as usual, was very interesting and well presented.

Professor Isidori's talk was on Robust Regulation of Nonlinear Systems. Research in nonlinear systems is still in its infancy. In this very enjoyable and interesting talk, Professor Isidori showed how certain nonlinear systems problems can be solved using linearization techniques, while for others these techniques are not useful.

Special Topics Lectures

The goal of the special topics lectures was to present research advances in certain selected areas of interest to the conference. These lectures were really designed for specialized subgroups of the participants. There were twelve special topics lectures altogether. These were presented by F. M. Callier, Notre-Dame de la Paix, Belgium, Bruce Francis, University of Toronto, Canada, M. Halsler, Ecole Polytechnic of Switzerland, Pramod Khargonekar, University of Michigan, M. Ikeda, Kobe University, Japan, Pradip Pandey, University of California Berkeley, A. Morse, Yale University, K. Murota, Tokyo University, A. Ohsumi, Kyoto Institute of Technology, M. Silva, Spain

Two of the lectures were a bit unusual in the sense that they really did not fit into the main-stream areas addressed by the conference; but I found them extremely interesting.

The first of these was a talk by Professor K. Murota on Combinatorial System Theory. Murota showed how certain basic concepts such as controllability, observability, stabilizability, etc., that arise in the design and analysis of linear control systems in state-space modeling, can be studied eloquently using the techniques of combinatorics. These discussions were strongly inspired by an earlier work of C.T. Lin on structural controllability. The far-reaching goal is to develop a combinatorial analogue of the dynamical systems theory in matroid theoretic framework.

The other talk was given by Professor M. Silva. It described how tools from linear algebra could be used in the analysis and synthesis of Petrinets.

Mini Courses

There were two mini courses: one on "Recent Advances in Neural Network Theory" given by S. Amari of the University of Tokyo and M. I. Jordan of MIT and the other on H^∞ /$H2$ / μ synthesis given by John Doyle of Caltech, K. K. Glover of Cambridge University, U.K. and Andy Packard of UC, Berkeley.

The goal of these courses were to educate the participants in the two above mentioned important research areas. The presentations were tutorial in nature, with particular attention given to motivation, definitions and examples.

Scientific Computing and Control Theory

A. Activities in the MTNS '91

The design and analysis of linear control systems give rise to a variety of interesting computational linear algebra problems. Some of the well-known ones are: controllability and observability problems, stability and inertia problems, feedback stabilization and eigenvalue assignment problems (the so-called Pole Assignment problems), Frequency Response problems and Matrix Equations problems (such as Lyapanov, Sylvester, Riccati). Because of the importance of these problems, they have been very well-studied both in mathematics and control literatures. There exists a voluminous work, both on theory and computation of these problems. Theory is extremely rich; however, one can not say the same thing about computation.

Many of the methods available in present control theory textbooks are not suitable for computer implementations. Most of these methods, in fact, were developed before the computer era and are not based on computationally sound techniques. Fortunately, the situation

is changing very fast. In the last few years, computationally viable methods have been developed for several of the above problems and presently studies are being conducted not only on the development of computationally viable methods but also on other important numerical analysis aspects, such as perturbation analyses of the problems, stability analysis of the algorithms by backward and forward round-off error analyses, etc.

Unfortunately, most of the algorithms are not suitable for large and sparse problems. They are based on transformation of the system matrices to some sort of condensed form such as Hessenberg, triangular, Real-Schur form, etc., and the methods used to achieve these forms such as Gaussian elimination, Householder and Givens methods, the QR iterations, etc., are well- known to give fill-in. On the other hand, there are practical situations such as the design of large space structures [1], [12], control of power systems [7], etc., that give rise to extremely large problems. These problems are both sparse and well-structured. Most of the existing methods, however are not designed to take advantage of the structures exhibited by these problems.

Another aspect of control theory research that needs attention of computational scientists and practicing engineers is parallel computations in control. Currently there is a revolution going on in the area of parallel/vector computations. Any serious research in applied sciences and engineering should pay attention to developments in this field. Unfortunately, control theory is lagging behind with respect to other areas of science and engineering.

For example, in recent years much effort has been devoted to parallelizing sequential algorithms and developing new parallel algorithms in numerical linear algebra (for an account of the recent developments in the area of parallel matrix computations, see the recent excellent survey by Gallivan et al [11]). Parallel software libraries based on these algorithms are being developed on some of the existing parallel machines. It is only natural to take advantage of those parallel linear algebra algorithms and the associated software libraries and software packages suitable for hierarchial computations (such as recent linear algebra package LAPACK) to develop parallel algorithms for linear control problems.

One obvious advantage of using these libraries is a significant reduction in programming effort. Those experienced with parallel programming and computations are well aware of the difficulties of coding and debugging some of the new parallel/vector computers. Admittedly, some of the linear control algorithms (e.g. eigenvalue assignment methods via implicit QR iterations) are very sequential in nature. For these problems novel parallel algorithms (parallel algorithms that will perhaps never be used on sequential machines) need to be developed. In control theory, there are opportunities for the development of both types of algorithms. However, so far, activities in the area in Control Theory of large-scale and parallel computations have been quite limited. Only a handful of papers have appeared. See the references quoted in a recent work of the author [2].

A recent panel report [8] on "Future Directions in Control Theory" has emphasized, among many other things, the need for expanded research in these areas. Indeed, research on computational methods in control theory is still in its infancy. To address the need of research in these areas, the author organized an INVITED special session on Numerical Linear Algebra in Signals, Systems and Control for this conference. Speakers for the session were the author himself, R. Plemmons of Wake Forest University, George Cybenko of Center for Supercomputing Research and Development of University of Illinois at Urbana-Champaign and Daniel Peirce of Boeing Computer Services. The session was chaired by the author himself and co-chaired by Professor Murota of University of Tokyo.

The author in his talk "Parallel Computations in Control Theory" first summarized the "state of the art" research in this area. He then discussed parallel algorithms for eigenvalue assignment and observer matrix equation problems along with implementational details of these algorithms both on shared memory and distributed memory machines and showed some actual results of implementations on CRAY X-MP/4, CRAY Y-MP, ALLIANT FX/8 and transputors. Professor Plemmons gave a talk on parallel algorithms for linear prediction on inverse factorization. The paper was joint work with his student James Nagy.

Daniel Pierce's talk was based on sparse matrix techniques for condition estimation based

on a rank-revealing QR factorization. Attempts are being made by the author and others to incorporate these powerful tools from sparse matrix computations into developing algorithms and analysing robustness properties for feedback stabilization associated with large second order model.

The final talk of the session was delivered by George Cybenko on linear algebra aspects of wavelet transforms.

Another invited session on Parallel Algorithm Design was also organized by L. Thiere of Univ. Saarlandes, Germany. The talks were given by A. Sayed of Stanford University on Fast Algorithms for Generalized Displacement Structures, based on a joint work with Tom Kailalh; by P. Dewilde on the Algebra of Parallel Processor; by L. Thiere on Multidimensional Discrete Event Systems and their Applications to Parallel Program Design, based on a joint work with W. Backes and U. Scwniegelshohn of IBM T. J. Watson Research Center; and by J. Bu on Design of Fixed-Size Systolic Arrays: Control Structure and Data, based on a joint work with Ed T. DePrettere of Delft University Tech. Also, as mentioned earlier, a special lecture on Supercomputer Solution of the Algebraic Riccati Equation was given by Pradip Pandey based on a joint work with Alan Laub of University of California, Santa Barbara.

Finally, let me mention another talk by Professor Brian Anderson on the Finite Word Length (FWL) design of state-space digital systems with weighted sensitivity minimization and spareness consideration, given at an invited special session on Finite Precision and Quantization Effects in Control Design II organized by Professors E. I. Verriest of Georgia Institute of Technology and M. Gevers of Louvain University of Belgium. Professor Anderson's talk centered around the optimal FWL state-space design which aims to identify those realizations that minimize the degradation of the system performance due to the FWL effects.

B. Associated Past and Future Activities

It should be noted in this connection that a one-day short course on Large-Scale and Parallel Computations in control was organized by the author preceeding the second SIAM conference on Linear Algebra in Signals, Systems and Control held in San Francisco, Nov. 1990. Besides the author himself, Ahmed Sameh of University of Illinois, Beresford Parlett of Berkeley, California, Iain Duff of CERFACS, France and R. S. Baheti of NSF gave talks in this short course. In addition to this short course, there were several other sessions on large-scale and parallel matrix computations and their applications to systems and control problems, mostly organized by the author, for the above SIAM conference. Similar sessions to the present one for the MTNS '91 have been organized by the author jointly with Floyd Hanson of University of Illinois, Chicago for the upcoming IEEE conference on Decision and Control to be held in Brighton, England, Dec., 1991; and for the American Control Conference to be held in Chicago, June, 1992.

C. Remarks

As expected, activities in the area of computational methods for control systems design and signal processing were far less than the other areas. I would like to see more special sessions, more contributed talks and even plenary lectures in this area in future MTNS meetings.

Linear Algebra and Control and Systems Theory

Linear Algebra and Control and Systems Theory have long enjoyed a natural synergism; however, the interdisciplinary activities blending these two areas were disappointingly fewer than expected. Fortunately, a significant increase in activities in this area has taken place since the 1984 AMS summer research conference on Linear Algebra and its Role in Systems Theory, chaired by the author. For example, for the current MTNS, there were noticeable activities in this area. There were several invited sessions. One was organized by A.C. Ran of Vrije University, The Netherlands, on Matrix Equations and Applications.

Two sessions on Matrix Completion and extension problems were organized by L. Rod-

man of the College of William and Mary. Several linear algebraists and system theorists such as Leiba Rodman, A. Ran, M. A. Kaashoek, Carlos De-Sonza, etc., gave talks in these sessions. There was an extremely interesting session on Interpolation problems for Matrix Functions and Applications in Systems Theory organized by M. A. Kaashoek of Virje University, The Netherlands. The speakers for this session were A. C. Antoulas, Joe Ball, Leiba Rodman, A. Tannenbaum and M. A. Kaashoek. Professors Kaashoek, Ball, Rodman and Tannenbaum are leading authorities in operator theory and their work heavily involves applications of operator theory to systems theory and H^∞ control. Professor Antoulas is well-known for his work on interpolation and its applications.

H^∞ and Robust Control

One of the central areas of research in control theory is H^∞ control. Suppose that ΔP is an unknown perturbation to a nominal plant P and that the feedback is internally stable for $\Delta P = 0$. A very important question then is how large can $|\Delta P|$ be so that the internal stability is maintained? The question can be answered in terms of the H^∞-norm on a weighted closed-loop transfer function. The goal is to design a feedback controller so that the closed-loop system is internally stable and the H^∞-norm of the closed-loop transfer function matrix is minimized.

Dr. Vidyasagar, in his plenary talk, remarked jokingly "this conference has been hijacked by H^∞ people". I think that there was some truth in the statement. There were more talks in any single category of this area than in any of the other areas addressed by the conference. One of the reasons for this was, of course, love for H^∞ control by Japanese control theorists who were involved in organizing the conference. In fact, I was told by Professor Kimura and his colleagues that H^∞-control techniques are not academic anymore; they are being incorporated in industrial applications such as in the design of large space structures. I am aware of similar activities in Langley NASA Research Center in our country; however, the Japanese seem to be ahead.

Conclusions

All indications are that the conference was a great success; the aim of the conference to bring together mathematicians and control and systems theorists, was somehow achieved. However, I had expected somewhat more participants from industries, especially since the conference had such a large number of corporate sponsorships.

As mentioned before, I strongly believe that the mutual interactions and research collaborations between mathematicians, computer scientists and practicing engineers are important ingredients in timely success of any interdisciplinary projects.

It is a well-known fact that there exists a considerable communication gap between mathematicians and engineers. This is especially true in the area of control and systems theory. Realizing this, as mentioned earlier, I had organized three interdisciplinary conferences in USA in 1984, 1986 and 1990. These interdisciplinary conferences aimed at fostering effective communications between mathematicians, computer scientists, control theorists and practicing engineers. The conferences were viewed to be highly successful (see the reports of the SIAM News letter [8], [9]). It would be nice to see greater participation by practicing engineers at future MTNS meetings. The next MTNS (1993) is scheduled to be held in West Germany and will be organized by Prof. Reinhard Mennicken of Universitat Regensburg. The MTNS '95 will be held in the USA.

Acknowledgement

I am thankful to the office of Naval Research, Asian office in Japan for a grant to attend the MTNS '91 and to visit Japanese Universities. Dr. David Kahaner was the co-ordinating scientist.

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(Editor's Note: In addition to attending MTNS '91, Professor Datta visited two universities in Japan and a number of other Asian Universities. The next issue of IMAGE will include a report by Professor Datta describing these visits.)

JOURNAL NEWS

JOURNAL OF NUMERICAL LINEAR ALGEBRA WITH APPLICATIONS (**JNLAA**)

Special Issue of JNLAA

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Publication:	To appear as Volume 157, November 1992

Title:	Numerical Linear Algebra in Control, Signals and Systems
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LINEAR AND MULTILINEAR ALGEBRA (LAMA)

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Change of Editors

Marvin Marcus and Robert C Thompson announce that they are retiring as editors in chief of Linear and Multilinear Algebra. The new principal editor is

William Watkins
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Marvin and Bob deserve the thanks of the entire linear algebra community for the outstanding work they have done on LAMA. We are confident that Professor Watkins will continue their tradition of excellence.

THE COLLEGE MATHEMATICS JOURNAL

The College Mathematics Journal announces a special issue devoted entirely to linear algebra. The special linear algebra issue will be published in January 1993.

BOOK REVIEWS

LAPACK Users' Guide, by E. Anderson, Z. Bai, C. Bischof, J. Dremmel, J. Dongarra, J. Du Croz, A. Greenbaum, S. Hammarling, A. McKenney, S. Ostrouchov, and D. Sorensen

Review by David H. Wood, University of Delaware

LAPACK is intended to replace LINPACK and EISPACK, setting new standards for floating-point linear algebra software. LAPACK objectives include: (1) much smaller errors, (2) additional problem coverage, and (3) new algorithms using special capabilities of many high-performance computers. Most of the effort and payoff of the LAPACK project is in the exploitation of non-sequential computers. However, *all* users can benefit from the additional routines and reduced errors.

Basically, LAPACK is now a package of Fortran 77 subroutines for solving linear equations, linear least squares problems, and symmetric eigenproblems. Future versions are intended to treat generalized SVD and nonsymmetric generalized eigenproblems. In addition, subroutines will be produced to take advantage of IEEE arithmetic, Fortran 90 and C compilers, and distributed memory multiprocessor machines.

The authors state their hope that LAPACK and its *Users' Guide* exemplify model software development and documentation. The *Guide* is very good documentation indeed. It is nicely structured so that users will generally not have to jump around, but will usually start at the beginning and read only as far as their needs (or interests) carry them. The first four chapters form the heart of the *Guide*: Essentials, Contents of LAPACK, Performance of LAPACK, and Accuracy and Stability. These are followed by chapters entitled Documentation and Software Conventions, Installing LAPACK Routines, and Troubleshooting. Appendices are provided: Index of Driver and Computational Routines, Indices of Auxiliary Routines, Quick Reference Guide to the BLAS, Converting From LINPACK or EISPACK, and LAPACK Working Notes. The preceding forms only *half* of the *Guide*. The last half is devoted to Specifications of Routines (but not the actual codes or their Further Details and Internal Parameters, if any).

The first three chapters of the *Guide* are very clearly written. Abundant evidence in the literature demonstrates that this is hard to do. I suspect that it requires multiple authors. It seems impossible to clarify something of your own that you have already read twenty times while knowing what it is ***supposed*** to mean.

Chapter 2, Contents of LAPACK, describes three types of routines: driver routines, computational routines, and auxiliary routines. The driver routines are a welcome convenience compared to LINPACK and EISPACK. These are intended to solve complete problems: linear equations, linear least squares, eigenproblems, SVDs, or generalized symmetric eigenproblems. These drivers usually come in two versions, simple and expert. An expert routine may rescale, estimate condition numbers, refine solutions, estimate forward and backward error bounds, and so forth. The many computational routines, such as LU factorization, give building blocks that the sophisticated user will want for combining to perform less usual computations. Auxiliary routines, implementing a variety of low-level tasks such as scaling and generating an elementary Householder matrix, are only listed in an appendix with a brief description of their function. However, documentation is included in the code of these routines.

Even supposing that you have all 600,000 or so lines of LAPACK on your machine, you still aren't ready until you have the Basic Linear Algebra Subprograms (BLAS) for your computer. You can always use a Fortran version obtained from `netlib`, and it is probably all you will ever need if you work on a ***sequential*** computer.

Chapter 3, Performance of LAPACK, explains why machine dependent BLAS are needed to make LAPACK efficient and portable on ***non-sequential*** computers. A BLAS package provides operations such as (Level 1) vector operations, $y \leftarrow \alpha x + y$, (Level 2) matrix-vector operations, $y \leftarrow \alpha Ax + \beta y$, and (Level 3) matrix-matrix operations, $C \leftarrow \alpha AB + \beta C$. LAPACK is essentially constructed from calls to the BLAS. Since different computer architectures call for different methods to optimize the BLAS subprograms, it is clear that isolating these operations in a BLAS package is essential for LAPACK to be both efficient and portable. Left unsaid is that a computer manufacturer must provide a BLAS package in order for a machine to be competitive.

In actual fact, LAPACK uses Level 3 matrix-matrix operations as much as possible, even though this occasionally induces algorithmic contortions that sometimes increase the number of arithmetic operations. Memory reference is slow. This motivates doing as much arithmetic as possible on groups of data whenever they are in high-speed memory. In a Level 3 matrix-matrix operation, $O(n^2)$ data are subjected to $O(n^3)$ arithmetic operations, compared to only $O(n^2)$ arithmetic operations on $O(n^2)$ data in a Level 2 matrix-vector operation.

Chapter 4, Accuracy and Stability, discusses error bounds. Almost all of the old LINPACK and EISPACK routines are normwise backward relatively stable in the sense that when they are applied to a matrix A, they produce the exact result for a nearby matrix $A + E$, where the ratio of norms $\|E\|/\|A\|$ is near machine precision. LAPACK provides some routines where a much stronger criterion holds: for such a matrix E, *each element* $e_{i,j}$ is zero if $a_{i,j}$ is zero, otherwise the ratio of elements $|e_{i,j}/a_{i,j}|$ is near machine precision.

LAPACK presently provides this componentwise backward relative stability for linear equation solving, for the bidiagonal SVD, for the symmetric tridiagonal eigenproblem, and (as an option) for least squares problems.

It is well that the authors simplify, even misstate, some error estimates in the interest of clarity. Nevertheless, most of this chapter seems to be less clearly written than the rest of the *Guide*. As I recall, *Mad Magazine* once offered the instructions, "Not for use except in case of non-emergency." A similar construction is used by our authors when they advise, "For other algorithms, the answers (and computed error bounds) are as accurate as though the algorithms were componentwise relatively backward stable, even though they are not."

Only a few years ago, it was thought that almost all issues concerning practical software for floating-point linear algebra computation were settled. Parallel computation created distinctions that were previously meaningless, or it may be more accurate to say, literally unthinkable. These distinctions now reveal beautiful and subtle structure yet to be fully exploited. LAPACK is far from finished. However, it is as finished as it needs to be for many users. They will benefit from the current release of LAPACK and the outstanding documentation the *LAPACK Users' Guide* provides for this important milestone.

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