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The Bulletin of the International Linear Algebra Society (formerly the International Matrix Group)

Serving The International Linear Algebra Community

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Free to ILAS members

News

Inaugural Meeting: International Linear Algebra Society (ILAS) August 12-15, 1989 Brigham Young University, Provo, Utah USA Report by H. Schneider and C.R. Johnson

The purpose of this first general meeting of ILAS (formerly IMG) is to provide an opportunity for researchers everywhere with an interest in matrix theory to get together. The term "matrix theory" is broadly interpreted to include those parts of the many subjects that have stimulated research about matrices over the years.

In an effort to maximize the number of participants, the cost is being kept to a minimum. Centrally located Salt Lake City International Airport is nearby and is serviced by most major US carriers. A limited number of on-campus housing slots will be available at a very low cost, along with an inexpensive meal plan of good quality. Nearby motels offer very affordable alternative housing. There will be no registration fee as such, although a nominal and optional donation to the Society and for daily refreshments will be solicited.

Within easy driving distance from Provo lie a large fraction of the many spectacular attractions of the Rocky Mountain West. In addition to Yellowstone, the Grand Canyon, Bryce Canyon and Zion Parks there are a host of lesser known but also enjoyable parks. A tour on either side of the meeting would be rewarding.

A special concentration at the meeting on nonnegative matrices and related topics is to be modestly funded by the US NSA. Additional subsidy is being graciously provided by Brigham Young University and the time, effort and research funds of the organizers. We hope that you can help make this meeting a success with your attendance. Please contact Wayne Barrett by electronic mail or in writing about your interest in attending. We hope you will do this soon, as it will be helpful for planning the program.

A special issue of Linear Algebra and Its Applications will be devoted to this meeting. This issue will contain only papers that meet the publication standards of the journal and that are approved by the normal refereeing procedure. Special editors of this issue are Wayne Barrett, Danny Hershkowitz and Don Robinson.

The organizers are:

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Rocky Mountain Mathematical Consortium 1989
Summer Workshop: "Matrix Theory for Applications"
July 17 -August 4, 1989, University of Wyoming, Laramie, Wyoming
 Report by C.R. Johnson

Each summer the Rocky Mountain Mathematical Consortium sponsors a three week series of lectures aimed at advanced graduate students and junior faculty nationwide. The 30 eighty-minute lectures (two per morning) and afternoon discussions are presented by one or more speakers on a single subject. There are usually 25-40 participants, persons who hope to add the subject to their expertise or develop a research program in the area. This year the Consortium hopes to expand the program to a broader range of faculty, via an NSF program that guides pedagogical innovations.

This summer the subject will be "Matrix Theory for Applications" and the talks will be given by Charles R. Johnson, together with Wayne Barrett, Roger Horn and Douglas Shier, assisted by Michael Lundquist and Peter Nysten. A program of support for interested graduate students is already in place and support for faculty is pending. For further information, contact A. Duane Porter, Dept. of Mathematics, University of Wyoming, Laramie WY 82071 USA. Charles R. Johnson could also be contacted about specific issues related to content (address in previous article).

Any individual seeking to augment or develop a research program in the subject may attend. It should be a worthwhile workshop in an enjoyable part of the US.

Introductory Survey Lectures on Matrix Theory and Applications:
AMS Short Course, January 10-11, 1989, Phoenix, Arizona

The American Mathematical Society is presenting this two day short course in conjunction with its 95th annual meeting. The program is being organized by Charles R. Johnson and emphasizes concepts from matrix analysis that are important in areas of modern applied mathematics. Six 75 minute lectures are to be presented:

Richard A. Brualdi, Univ. of Wisconsin, *Combinatorial Matrix Theory*

C.R. Johnson, College of William and Mary, *Matrix Completion Problems: A Survey*

Persi Diaconis, Harvard Univ., *Eigen Analyses of Matrices with Symmetry*

Properties

Arunava Mukherjea, Univ. of South Florida, *The Role of Nonnegative Idempotent*

Matrices in Certain Problems in Probability

Roger A. Horn, Johns Hopkins Univ., *The Hadamard Product*

I. Gohberg, Tel Aviv Univ., *Interpolation Problems for Rational Matrix Functions*

Ingram Olkin, Stanford Univ., *Interplay Between Matrix Theory and Multivariate*

Statistics

New Name for International Matrix Group:
International Linear Algebra Society (ILAS)

Report by H. Schneider

IMG will soon be incorporated as a society under its new name ILAS (the International Linear Algebra Society). The purposes of the organization remain the same (see the first issue of IMAGE, January 1988).

The Executive Board is: Hans Schneider, President; Danny Hershkowitz, Secretary; R.C. Thompson, Vice Chairman.

The Advisory Committee is: R. A. Brualdi, D. H. Carlson and C. R. Johnson.

The International Committee is:

Belgium	✓ P. Van Dooren	Japan	✓ T. Ando
Canada	✓ P. Lancaster	Malaysia	✓ M.H. Lim
Czechoslovakia	✓ M. Fiedler ✓	Netherlands	✓ H. Bart
Finland	✓ J.K. Merikoski	P.R. China	✓ J.C. Chen
Germany	✓ L. Elsner ✓	P.R. China	✓ J.G. Sun
Great Britain	✓ S. Barnett	Portugal	✓ G.N. de Oliveira ✓
Greece	✓ J. Maroulas	Sweden	✓ A. Bjorck
Hungary	✓ P. Rosza	Spain	✓ V. Hernandez ✓
India	✓ R. Bhatia	US	✓ G. Golub
Ireland	✓ T. Laffey	At Large	✓ B. Datta
Israel	✓ A. Berman		

Feature Article

The Development of Linear Algebra in Portugal

by G.N. de Oliveira, University of Coimbra

I was honoured when I received a letter from Professor R.C. Thompson inviting me to write the story of the development of Linear Algebra in Portugal. Of course I cannot enter into too many details and thus will describe the points that seem more interesting from my point of view.

Due mainly to political reasons many Portugese mathematicians had to leave the University, and even the country, in the thirties and forties. When I was a student between 1957 and 1961 there were, as a consequence, very few active mathematicians and the environment for research was far from ideal. When I graduated I felt very interested in research but did not know how to start. I thought I should go to the library and read as many books as possible. One of my teachers, Professor Luis de Albuquerque, played a decisive role in bringing me to Linear Algebra. He had written a monograph on nonnegative matrices which, at the end, described a problem of Suleimanova (find a necessary and sufficient condition for n numbers to be the eigenvalues of an $n \times n$ stochastic matrix). One day I was talking to Professor Albuquerque and asked him why had he not solved the problem. He said it was very difficult and added "why don't you try it?" I tried and as far as I can remember this was my first research problem in Linear Algebra.

In 1962 I was summoned for military service, which I finished by the end of 1966. During this time I did not forget the problem and in 1969 received my doctorate with a thesis on stochastic and doubly stochastic matrices which included several partial results on Suleimanova's problem.

I am often credited with founding the Portugese school of Linear Algebra. It is true that I made some efforts to get younger people interested in this subject but I feel that the real founder was in fact Professor L. de Albuquerque inasmuch as without him there would have been no school of Linear Algebra in Portugal. When Albuquerque was starting his career, the conditions for research in Mathematics were even worse than when I was a student. Partly because of this situation, Professor Albuquerque started to do research in History, mainly concerned with the Portugese navigators. When I first met him, I was a freshman at Coimbra, and although he was teaching Mathematics, his main research interest was already in History. Nevertheless I still consider that he was my real thesis advisor.

Another Portugese mathematician that influenced me was Professor J.J. Dionísio. He is a few years younger than Albuquerque and had moved to Lisbon a couple of years

before I entered the University. His influence on me was indirect, through my reading his papers, many of which were published in Portuguese and in Portuguese journals. In fact I only met Professor Dionísio for the first time in 1970.

After obtaining my doctorate I felt very isolated and dreamt of building a Linear Algebra school instead of confining myself to my own research work. I viewed this as a contribution to the mathematical activity of the country.

By the end of the sixties I had gathered a group of younger people and we organized regular Seminars (three times per week as I was quite enthusiastic). At the end of 1969 I had to leave Coimbra unwillingly and was only able to return a few years later, after the democratization of the country. Once back in Coimbra I reorganized the Linear Algebra Seminars. As a result the group of people working in this area expanded greatly in the late seventies.

For a time I had some difficulties. There has always been much foreign cultural and scientific influence in Portugal, especially from France. Initially it was not easy to attract research students, since there was a widespread feeling that a doctorate obtained abroad carried more prestige than one gained locally. I think that only when the work of my younger collaborators surpassed mine was this difficulty overcome.

How did the interest in Linear Algebra spread from Coimbra? In 1980 after receiving his doctorate in Coimbra, José Vitória of Coimbra got in touch with Juan Miguel Gracia of the Colegio Universitario de Alava in the Basque Country. This was the starting point of a fruitful cooperation in Linear Algebra between the two Iberian countries. It should be pointed out that the cooperation in Mathematics between Portugal and Spain has not been what it ought to be; before 1972 the mathematicians of the two countries were practically unknown to each other and this situation has only been remedied with the Portuguese-Spanish meetings. In particular in Linear Algebra these meetings gave rise to the Iberian Linear Algebra Conferences, the fourth of which was organized last September in Valencia. Due to the action of Juan Miguel Gracia in the Basque Country and Vicente Hernandez in Valencia the cooperation between Portuguese and Spanish linear algebraists has grown very much in recent years. An outcome of this cooperation is Zaballa's outstanding work. He proved recently a result which contains as a Corollary the Sá-Thompson interlacing inequalities.

Thus I am very hopeful about the future.

I have only described the human story (or perhaps my own story) and have not described mathematical work. I think it would not be easy for me to do that in a critical way. However it goes without saying that words like eigenvalue, inverse problems, invariant polynomials, interlacing, star products, normal matrices, and Schur functions mean much for many of us.

Since I believe in mankind, I believe in human struggles, efforts and activities. The human activities include writing papers but are no means restricted to this.

Ed. Note: What follows are the abstracts of the doctoral theses of Professor de Oliveira's first three mathematical "grandchildren," of whom he is justifiably proud.

Sums of matrices with prescribed invariant factors, by Fernando C. Silva.
Supervisor: J.A. Dias da Silva, University of Lisbon. May 20, 1987.

In this thesis, written in Portuguese, several problems of the following form are studied:

Under what conditions do there exist matrices A and B over a field F (resp., a principal ideal domain R) such that $A+B$ has certain properties?

Among the problems concerned with matrices over F , necessary and sufficient conditions are given so that:

- a) $A+B$ has prescribed eigenvalues;
- b) The number of invariant polynomials of $A+B$ is less than or equal to a previously fixed integer;

c) $A-B$ has prescribed rank, when F is algebraically closed.

Among the problems concerned with matrices over R , necessary and sufficient conditions are given so that:

d) The number of invariant factors of $A+B$ that are divisors (resp., multiples) of $\delta \in R$ is greater than or equal to a fixed integer (except for a few cases);

e) $A+B$ has prescribed rank.

These results are also presented in the following papers:

1. Fernando .C. Silva, On the number of invariant polynomials of the matrix $XAX^{-1} + B$, LAA 79 (1986), 1-21.
2. --, On the invariant factors of the matrix $XAY + B$, LAA 96 (1987), 1-16.
3. --, Spectrally complete pairs of matrices, LAA, to appear.
4. --, The eigenvalues of the sum of matrices with prescribed invariant polynomials, LAMA, to appear.
5. --, The eigenvalues of the sum of matrices with prescribed invariant polynomials II, preprint.
6. --, The rank of the difference of matrices with prescribed similarity classes, preprint.

Chains with partial prescription of their coordinates and matrix imbeddings, J.C. David Vieira.

Supervisor: E. Marquis de Sá, University of Aveiro. November 9, 1987.

Let K be an arbitrary field. The main problem considered in this thesis is the following: Find necessary and sufficient conditions for the existence of square matrices A and B over K such that (i) some of the invariant factors of A and B are given in advance; (ii) A is a principal submatrix of B .

We completely solve this problem when K is algebraically closed.

In the first part of this work, we introduce the concept of a polynomial chain, that is, a sequence of polynomials forming a divisibility chain. Some results are proved for pairs of polynomial chains satisfying additional divisibility conditions (the so-called interlacing relations) and subject to rank and degree constraints.

In the second part of the thesis we use a well-known imbedding theorem of M. de Sá and R.C. Thompson to yield a matricial interpretation of the previously obtained results involving polynomial chains. As particular cases of our main result we obtain three theorems about partial prescription of invariant factors of matrices and submatrices proved by M. de Sá in his Ph.D. thesis (Univ. Coimbra, 1979).

The Singular Values/Invariant Factors Analogy, José Felipe Queiró.

Supervisor: Eduardo Marques de Sá, June 18, 1988.

The subject of this work is the formal analogy which exists between singular values of real or complex matrices and invariant factors of matrices over certain types of rings. Main points are:

In Chapter 1 approximation numbers in an abstract setting are considered. They are defined for elements of semigroups where a "norm" with values in a partially ordered set is given. Some of the features of the singular values/invariant factors analogy (e.g., the interlacing theorem) appear with great simplicity in this context. Several models are studied in which the semigroup is just an additive group of matrices.

In Chapter 2, a study is made of A. Pietsch's axiomatic theory of s -numbers for the case of operators acting between finite-dimensional normed linear spaces.

In Chapter 3 a thorough analysis of the reciprocal of the interlacing theorem, both for s -numbers and invariant factors, is carried out. A partial unification is proposed. It is worth mentioning Section 3.6, where the converse of interlacing (previously seen to be false in general) is proved for s -numbers in a special situation. The proof consists of a somewhat delicate homotopy argument.

In Chapter 4, some further analogies are gathered. Section 4.1 presents an axiomatic characterization of the invariant factor sequence for matrices over elementary divisor domains; this parallels Pietsch's work on s -numbers of operators in Hilbert space. The main results of section 4.4 describe the exact range of the k^{th} invariant factor of a product of two square matrices (over a principal ideal domain) with prescribed invariant factors.

Throughout attention is called to the fact that many results about invariant factors usually presented for matrices over principal ideal domains in fact hold for elementary divisor domains (occasionally without change in the proofs). Krull's "localization" technique then allows most of them to be extended to the even larger class of greatest common divisor domains.

News

Special Year on Applied Linear Algebra at IMA Report by Richard A. Brualdi

The Board of Governors of the Institute for Mathematics and Its Applications (IMA) has approved a program in Applied Linear Algebra for 1991-92. The organizers are R.A. Brualdi, George Cybenko, Alan George, Gene Golub and Paul van Dooren. The plans are to focus the program on three major themes. The general emphases and workshops planned as of this time are:

Fall Quarter: Discrete Matrix Analysis, with emphasis on the mathematical analysis of sparse matrices and combinatorial structure. Workshops on (1) Sparse Matrices and (2) Combinatorial and Qualitative Matrix Analysis.

Winter Quarter: Matrix Computations, with special emphasis on iterative methods for solving systems of linear equations and computing the eigenvalues of sparse, possibly structured matrices. Workshops on (1) Iterative Methods for Dense Problems and (2) Markov Chains, Networking and Queuing.

Spring Quarter: Signal Processing, Systems and Control, with emphasis on the matrix analysis and computations that arise in this area of application. Workshops on (1) Signal Processing Applications of Linear Algebra and (2) Systems and Control Applications of Linear Algebra.

It is expected that there will be considerable fluidity between various parts of the program. Specialized seminars on topics in both core and applied linear algebra will be held throughout the year. There will also be opportunities for minisymposia on other special topics of interest. To a considerable extent the activity at any time during the year will be influenced by the interests of the people in residence (typically 30-35 at nonworkshop periods).

It is expected there will be twelve postdoctoral fellowships awarded for the year. There will be a very limited amount of money for senior people who will spend one or more quarters at the IMA. Preference will be given to persons with sabbatical leaves, fellowships or other stipends. There will also be support for the expenses of those invited to be in residence for one month or less, in particular for workshop participants. For more information, contact R.A. Brualdi, Dept. of Math., Univ. of Wisconsin, Madison, WI 53706 USA (brualdi@vanvleck.math.wisc.edu).

Journal News

Linear Algebra and Its Applications (LAA), Report by H. Schneider and R. Brualdi

The following joined the LAA Editorial Board during 1988: Peter Lancaster, previously Associate Editor, is now Advisory Editor; new Associate Editors are R. Bhatia, D. Hershkowitz, R.A. Horn and L Rodman.

The following five special issues of LAA will appear during 1989:

In honor of Alan Hoffman (Volumes 114-115, March 1989),
 Proceedings of the Valencia Conference on Linear Algebra and Applications,
 Proceedings of the Fourth Haifa Conference on Linear Algebra,
 Linear Systems and Control,
 Linear Algebra and Statistics.

Contributions are invited for future additional special issues. Full announcements about all but the last of the following have already been published on IMG-NET. Details about the last will shortly be circulated on the network.

Title: Linear Algebra in Image Reconstruction from Projections
 Special Editors: Y. Censor, T. Elfving, G.T. Herman
 Full announcement: LAA vol. 99, February 1988
 Submission deadline: January 1989

Title: Matrix Valued Functions
 Special Editors: J.A. Ball, L. Rodman, P. Van Dooren
 Full announcement: LAA vol. 106, August 1988
 Submission deadline: July 1989

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

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

Title: ILAS (IMG) Inaugural Meeting, Provo, Utah, August 1989
 Special Editors: W. Barrett, D. Hershkowitz, D. Robinson
 Full announcement: With conference material
 Submission deadline: November 1989

Title: Iteration Methods in Linear Algebra and in Applications
 Special Editors: O. Axelsson, J. de Pillis, M. Neumann, W. Niethammer,
 R.J. Plemmons
 Full announcement: LAA Vol. 116, April 1989
 Submission deadline: March 1990

Linear and Multilinear Algebra (LAMA), Report by R.C. Thompson

Linear and Multilinear Algebra operates on the flow system, that is, issues are published as manuscripts to fill them are accepted. Currently this comprises eight issues per year. Four issues of about 90 pages each make up one volume, and Volume 25, No. 3 is now filling. Volume 25, No. 2 was dispatched to the (London, England) typesetter December 10, 1988. The most recent published issue is Volume 23, No. 4, and it generally takes about six or seven months between receipt of an issue by the typesetter and its