The Bulletin of the International Linear Algebra Society

IMAGE

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Editor-in-Chief: Jane M. Day
day@math.sjsu.edu
Department of Mathematics
San Jose State University
San Jose, CA 95192-0103

Editor-in-Chief: Hans Joachim Werner
hjw.de@uni-bonn.de
Department of Statistics
Faculty of Economics, University of Bonn
Adenauerallee 24-42, D-53113 Bonn, Germany

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Now Available

Classical Algebra:
Its Nature, Origins, and Uses

Roger Cooke
University of Vermont, US

Classical Algebra provides a complete and contemporary perspective on classical polynomial algebra through the exploration of how it was developed and how it exists today. With a focus on prominent areas such as the numerical solutions of equations, the systematic study of equations, and Galois theory, this book facilitates a thorough understanding of algebra and illustrates how the concepts of modern algebra originally developed from classical algebraic precursors.

This book successfully ties together the disconnect between classical and modern algebra and provides readers with answers to many fascinating questions that typically go unexamined, including:

- What is algebra about?
- How did it arise?
- What uses does it have?
- How did it develop?
- What problems and issues have occurred in its history?
- How were these problems and issues resolved?

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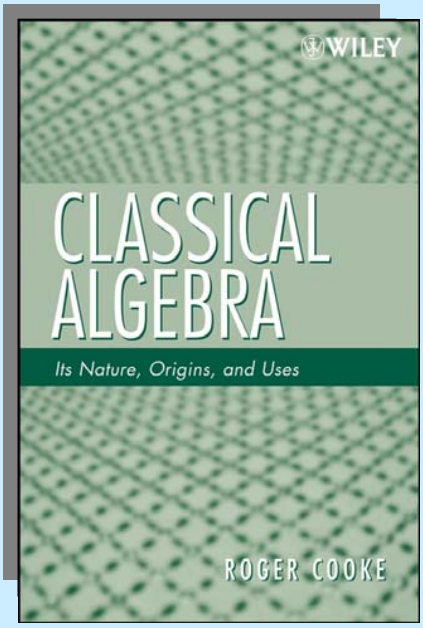

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UPCOMING CONFERENCES AND WORKSHOPS

ILAS08
June 16-20, 2008
Westin Resort and Spa, Cancun, Mexico

Luis Verde-Star, Chair of Organizing Committee

The 15th annual ILAS Conference will be held in Cancun on June 16-20, 2008. We look forward to seeing you there for this very interesting meeting. The plenary speakers will be Albrecht Boettcher, Froilan Dopico, Heike Fassbender, Luca Gemignani, Leslie Hogben, Erxiong Jiang, Daniel Kressner, James Nagy, Juan Manuel Pena, Peter Rosenthal, Naomi Shaked-Monderer, Ilya Spitkovsky, and Paul Van Dooren.

There will be sessions for contributed talks, and eight Mini-symposia:

- Combinatorial Matrix Theory
- Eigenproblems: Theory and computation
- Implementation and application issues in regularizing least squares and total least squares
- Linear Algebra Education
- Linear Algebra in Model Reduction
- Matrix functions and matrix equations
- Max Algebra
- Nonnegative and eventually nonnegative matrices

The ILAS 2008 Hans Schneider Prize in Linear Algebra will be awarded at this conference. This prize is awarded every three years for research, contributions, and achievements at the highest level of Linear Algebra. It may be awarded for an outstanding scientific achievement or for lifetime contributions, and may be awarded to more than one recipient. Previous recipients are:

- 1993 - Miroslav Fiedler, Shmuel Friedland and Israel Gohberg
- 1996 - Mike Boyle, David Handelman and Robert C. Thompson
- 1999 - Ludwig Elsner
- 2002 - Tsuyoshi Ando and Peter Lancaster
- 2005 - Richard A. Brualdi and Richard Varga

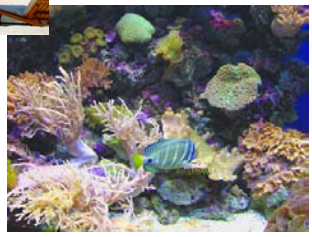
Cancun is located in the Yucatán peninsula, on the coast of the Mexican Caribbean Sea and near the island of Cozumel. There will be one excursion especially for conference participants and guests, to the Mayan archeological site of Tulúm, which is 120 kilometers south of Cancún. Bring your family along, to enjoy the beautiful city, beaches and interesting sights nearby!

For details and a link for hotel reservations, visit the conference website http://star.izt.uam.mx/ILAS08. For information about ILAS and past conferences, visit http://www.ilasic.math.uregina.ca/iic/.

Cancun beach

Dolphins

Parasailing



Coral reef

Mayan temple

Western Canada Linear Algebra Meeting
Winnipeg, Canada, May 30-31, 2008

This 8th WCLAM will be held at the University of Manitoba with three invited speakers: Michael Gekhtman, Univ. of Notre Dame, Olga Holtz, Univ. of California at Berkeley, and David Watkins, Washington State Univ., as well as contributed talks. This is the 8th WCLAM. For details, visit http://www.pims.math.ca/science/2008/08wclam/index.html.

SIAM Annual Meeting
San Diego, CA, July 7-11, 2008

This year there will be much emphasis on life science applications. Also, several sessions for contributed talks will be on numerical linear algebra and two on linear algebra and applications. For details, visit http://www.siam.org/.

9th Workshop on Numerical Ranges and Numerical Radii
Williamsburg, VA
July 19–21, 2008

The purpose of this informal workshop at The College of William and Mary is to stimulate research and foster interaction of researchers interested in the subject. For more details, visit http://www.math.wm.edu/~ckli/wonra08.html. For some background on the subject and previous meetings, visit http://www.math.wm.edu/~ckli/wonra.html.

SIAG/LA-SIMUMAT INTERNATIONAL SUMMER SCHOOL ON NUMERICAL LINEAR ALGEBRA
Castro Urdiales, Spain, July 21-25, 2008

The SIAM Activity Group on Linear Algebra (SIAG/LA) together with SIMUMAT will hold its first Summer School on Numerical Linear Algebra at the International Center of Mathematical Meetings in Castro Urdiales, Spain, from July 21 - 25, 2008. Lecture series will be given on:

- Krylov subspace methods for solving linear systems (Michael Eiermann)
- Matrix methods in data mining (Lars Elden)
- Mechanics and linear algebra (Rich Lehoucq)
- Structured eigenvalue problems: modern theory and computational practice (David Watkins)

SIMUMAT is a new research group in Applied Mathematics, funded by the Regional Government of Madrid. For details, visit http://www.simumat.es/SIAGLA2008/index.php.

International Workshop on Operator Theory & Applications
Williamsburg, VA
July 22-26, 2008

This conference at The College of William and Mary will cover all aspects of theoretical and applied operator theory, and will celebrate the work and career of Israel Gohberg on the occasion of his 80th birthday. There will be a special session on Structured Matrices and Applications, in memory of Israel Koltracht. Hans Schneider will be the ILAS speaker at this meeting.

The organizers are J.A. Ball, V. Bolotnikov, J.W. Helton, L. Rodman, and I.M. Spitkovsky. Online registration is recommended and will be avialable until July 14. Modest support is available for a few graduate students and young researchers who present papers. For a list of plenary speakers and other information, visit: http://www.math.wm.edu/~vladi/

17th International Workshop on Matrices and Statistics
Tomar, Portugal, July 23-26, 2008

The purpose of IWMS08 is to stimulate research in the interface between mathematics and statistics, and to celebrate Professor Theodore Wilbur Anderson's 90th birthday. For details, contact Prof. Francisco Carvalho, fpcarvalho@ipt.pt, +351 249 328 100, Fax: +351 249 328 186 or visit www.ipt.pt/iwms08.

International Conference of Numerical Analysis and Applied Mathematics 2008
September 16-20, 2008
Psalidi, Kos, Greece

This 6th ICNAAM is being held to bring together leading scientists of the international numerical and applied mathematics community, and to honor John Butcher on the occasion of his 75th birthday. The topics will include numerical analysis, computational mathematics and applied mathematics. For details, visit http://www.icnaam.org/ or email Theodore Simos at tsimos@mail.ariadne-t.gr and copy to tsimos.conf@gmail.com.

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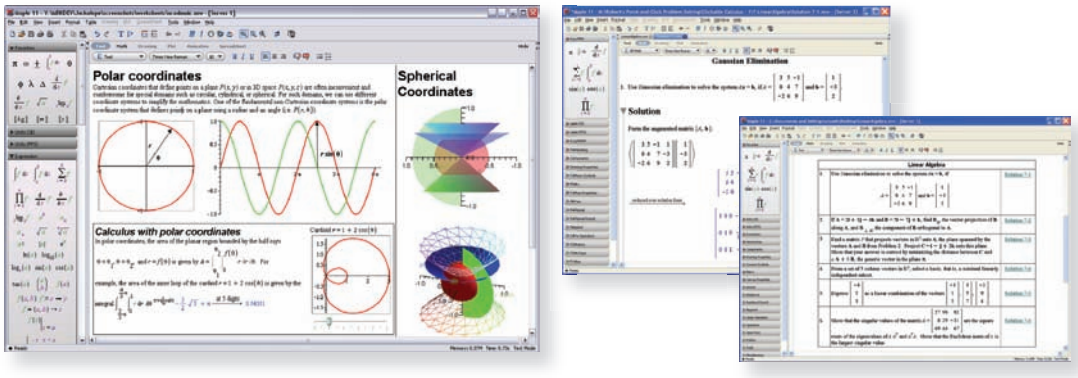

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Robert C. Thompson Matrix Meeting (RCT08)
Goleta, CA, October 18, 2008

This will be a one-day meeting where mathematicians working in linear algebra and related fields can present recent research and have informal discussions. Maribel Bueno will host. Following tradition, there will be no registration fee and a complimentary dinner for all participants and their guests. The conference website is http://www.math.ucsb.edu/~mbueno/RCthompson/rctm08.htm. A biography of Bob Thompson and list of his publications can be found there, as well as a record of previous conferences in this series.

RCT08 will be the 19th of these informal meetings. They were called Southern California Matrix Meetings until 2004, when the participants agreed to rename them to honor Bob Thompson. The tradition grew from a first one organized in Toronto by Steve Pierce, in 1983. The format proved very agreeable. Soon Pierce and Thompson migrated to southern California and began hosting similar events at San Diego State University and UC Santa Barbara. Eventually some of the meetings were held at other locations, most recently at Auburn University in October 2006.

NEWS AND CONFERENCE REPORTS

2008 Hans Schneider Prize in Linear Algebra
Goes to Beresford Parlett and Cleve Moler

By Danny Hershkowitz, ILAS President

It gives me great pleasure to announce, for the ILAS Executive Committee, that Beresford Parlett and Cleve Moler have been chosen to receive the 2008 Hans Schneider Prize in Linear Algebra. This 2008 Prize will be awarded at the ILAS conference in Cancun, Mexico, June 16-20, 2008.

Beresford Parlett

Beresford Parlett will receive the prize for his important and insightful, theoretical and numerical, contributions to numerical linear algebra, especially to the symmetric eigenvalue problem.

Cleve Moler will receive the prize for his creation of MATLAB, a computational and experimental tool in linear algebra, which has had a profound effect on both research in and the teaching of linear algebra.

Cleve Moler

The Hans Schneider Prize is awarded for research, contributions, and achievements at the highest level of Linear Algebra. It may be awarded for an outstanding scientific achievement or for lifetime contribution, and there may be more than one recipient. An invitation is extended to the recipient(s) to attend the award ceremony to receive the Prize and each is invited to present a talk at an ILAS meeting.

Per the ILAS Bylaws, the Prize was awarded as follows. The ILAS Executive Committee appointed a Committee for the Hans Schneider Prize; this Committee made its recommendations to the Executive Committee, which accepted their recommendations. I want to thank the individual members of the Prize Committee, especially the Committee Chair Richard Brualdi, for their difficult work and the thoughtful care they used in accomplishing their task. The committee members were Ravi Bapat, Richard Brualdi (Chair), Leslie Hogben, Hans Schneider and Paul Van Dooren.

Call for Papers: Special Issue of LAA in honor of Shmuel Friedland

Linear Algebra and its Applications is pleased to announce a special issue in honor of Shmuel Friedland on the occasion of his 65th birthday on September 24, 2009, in recognition of his many important and fundamental contributions to linear algebra and other topics in mathematics. The editor-in-chief responsible for this special issue is Hans Schneider.

We solicit papers for the special issue within the entire scope of LAA or other research interests of Professor Friedland. The deadline for submission is November 30, 2008. Papers submitted will be subject to normal refereeing procedures according to the usual standards of LAA. They should be sent, preferably as pdf attachments in email, to one of the following five special editors: Avi Berman, berman@technion.ac.il; Christian Krattenthaler, Christian.Krattenthaler@univie.ac.at; Siegfried M. Rump, rump@tu-harburg.de; Ilya Spitkovsky, ilya@math.wm.edu; and Fuzhen Zhang, zhang@nova.edu.

Functions of Matrices (FM08)
Manchester Institute for Mathematical Sciences
Manchester, England, May 15-16, 2008

Nick Higham

The Manchester Institute for Mathematical Sciences (MIMS) is holding a series of ten New Directions workshops in 2008. FM08, organized by Nick Higham, was the first in the series. The workshop concerned functions mapping $C^{n\times n}$ to $C^{n\times n}$, such as the matrix exponential and the matrix square root.

Interest in the theory and computation of functions of matrices has grown sharply over the last decade, as a result of new applications and improved numerical methods which make new approaches practically viable.The workshop brought together 30 researchers working on both the underlying theory of matrix or operator functions as well as numerical methods for their computation. The year 2008 is a fitting time to hold such a workshop, for it is the 150th anniversary of Cayley's memoir marking the birth of matrix theory (Arthur Cayley, A memoir on the theory of matrices, Philos. Trans. Roy. Soc. London, 148: 17-37, 1858). In that paper, Cayley treated square roots of 2×2 and 3×3 matrices. Also making the workshop timely was the publication just before it of Nick Higham's new book, *Functions of Matrices: Theory and Computation*, SIAM, 2008.

The speakers, in program order, were Rajendra Bhatia, E. Brian Davies,Bruno Iannazzo, Chun-Hua Guo, Michel Crouzeix, Christiane Tretter, Joerg Liesen, Beatrice Meini, Nick Trefethen, Nick Hale, Andreas Frommer, Valeria Simoncini, Marlis Hochbruck, Roger Horn, Krystyna Zietak, and Michael Eiermann. The conference closed with a discussion of open problems.

Information about the speakers, PDF copies of their presentations, references, etc., can be found at http://www.mims.manchester.ac.uk/events/workshops/FM08/programme.php.

A collection of conference photos is stored at http://www.mims.manchester.ac.uk/events/workshops/FM08. The workshop was supported by the Royal Society and the Wolfson Foundation.

FM08 Participants

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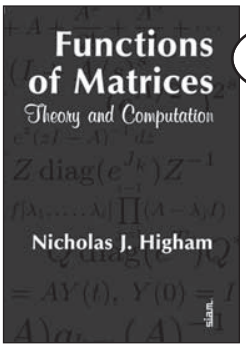


NEW!

Functions of Matrices: *Theory and Computation*
Nicholas J. Higham

"This superb book is timely and is written with great attention paid to detail, particularly in its referencing of the literature. The book has a wonderful blend of theory and code (MATLAB®) so will be useful both to nonexperts and to experts in the field."
— Alan Laub, Professor, University of California, Los Angeles

The only book devoted exclusively to matrix functions, this research monograph gives a thorough treatment of the theory of matrix functions and numerical methods for computing them. The author's elegant presentation focuses on the equivalent definitions of $f(A)$ via the Jordan canonical form, polynomial interpolation, and the Cauchy integral formula, and features an emphasis on results of practical interest and an extensive collection of problems and solutions. It is also useful as a general reference in numerical linear algebra.

Available April 2008 · Approx. xx + 425 pages · Hardcover · ISBN 978-0-898716-46-7
List Price $59.00 · SIAM Member Price $41.30 · **Order Code OT104**

Stability and Stabilization of Time-Delay Systems: *An Eigenvalue-Based Approach*
Wim Michiels and Silviu-Iulian Niculescu
Advances in Design and Control 12

This monograph addresses the problem of stability analysis and the stabilization of dynamical systems subjected to time-delays. It presents a wide and self-contained panorama of analytical methods and computational algorithms using a unified eigenvalue-based approach illustrated by examples and applications.

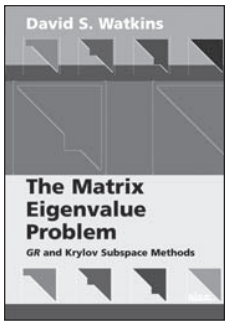
2007 · xxii + 378 pages · Softcover · ISBN 978-0-898716-32-0
List Price $99.00 · SIAM Member Price $69.30 · **Order Code DC12**

Perturbation Bounds for Matrix Eigenvalues
Rajendra Bhatia
Classics in Applied Mathematics 53

This text contains a unified exposition of spectral variation inequalities for matrices. It provides a complete and self-contained collection of bounds for the distance between the eigenvalues of two matrices, which could be arbitrary or restricted to special classes. A good reference for researchers and students, it contains over 60 pages of new material.

2007 · xvi + 191 pages · Softcover · ISBN 978-0-898716-31-3
List Price $49.00 · SIAM Member Price $34.30 · **Order Code CL53**

The Matrix Eigenvalue Problem: *GR and Krylov Subspace Methods*
David S. Watkins



"This is an excellent exposition of the state of the art in eigenvalue computations. It systematically combines the theory and the computational methods for structured and unstructured problems in a unique framework."
— Volker Mehrmann, Technische Universität Berlin.

This book presents the first in-depth, complete, and unified theoretical discussion of the two most important classes of algorithms for solving matrix eigenvalue problems: QR-like algorithms for dense problems and Krylov subspace methods for sparse problems. The author discusses the theory of the generic GR algorithm, including special cases, and the development of Krylov subspace methods.

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An Introduction to Iterative Toeplitz Solvers
Raymond Hon-Fu Chan and Xiao-Qing Jin
Fundamentals of Algorithms 5

This practical book introduces current developments in using iterative methods for solving Toeplitz systems based on the preconditioned conjugate gradient method. The authors focus on the important aspects of iterative Toeplitz solvers and give special attention to the construction of efficient circulant preconditioners. Applications of iterative Toeplitz solvers to practical problems are addressed, enabling readers to use the book's methods and algorithms to solve their own problems.

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The Lanczos and Conjugate Gradient Algorithms: *From Theory to Finite Precision Computations*
Gérard Meurant
Software, Environments, and Tools 19

"No present book comes near this one in the range and depth of treatment of these two extremely important methods—the Lanczos algorithm and the method of conjugate gradients."
— Chris Paige, School of Computer Science, McGill University.

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siam Society for Industrial and Applied Mathematics

2/08

International Workshop on Linear Algebra in Control
Fudan University, Shanghai, China, July 22-24, 2007

Report by Fuzhen Zhang

This conference provided an opportunity for mathematicians in numerical linear algebra and related fields to meet, to present new results and developments of their recent research, and to have informal discussions. About forty people from Australia, Canada, China (Hong Kong and Taiwan), Spain, and United States attended the meeting, and there were twenty presentations.

The workshop was organized by Professor Yimin Wei of Fudan University and generously supported by the National Natural Science Foundation of China, Key Laboratory of Nonlinear Science of Fudan University, and the Education Ministry of China.

Participants in International Workshop on Linear Algebra in Control

Quick Notes

Here are brief references to articles elsewhere that may interest IMAGE readers.

An announcement of N. Higham's new book, *Functions of Matrices: Theory and Computation*, appeared in early April on ILAS-Net and in NA-Digest, and can be found at http://www.netlib.org/na-digest-html/08/v08n14.html#4.

There is an indepth review of Richard Brualdi's recent book, *Combinatorial Matrix Classes*, in SIAM Review 50, 2008, written by Russell Merris, which includes some discussion of the foundation in Herbert Ryser's work.

Matrices, Epidemics, and Olga Taussky Todd, by Barbara Lee Keyfitz appeared in SIAM News, October 2007. Keyfitz, President of AWM, reports here about how the new AWM-EWM-ICIAM Lectureship came to be, about how Pauline Van Den Driessche was selected to give the first lecture in the series, and she discusses that talk.

Several obituaries of John Todd have appeared, including one in the Los Angeles Times (http://www.latimes.com/technology/la-me-todd27jun27,1,3330818.story) and one in SIAM News (http://www.siam.org/about/news-siam.php?id=1129) which has interesting links to the history of scientific computing. An article by Philip Davis about Todd's pioneering work with computers at the National Bureau of Standards in the 1950's appeared in SIAM News in December 2007 (http://sinews.siam.org/old-issues/2007/december-2007/remembering-john-todd/). There is also an in-depth profile of Todd written by Don Albers, which appeared in the College Mathematics Journal, January 2007.

The following link leads to several remembrances of Victor Klee and information about a special issue of the journal Discrete and Computational Geometry that will be dedicated to him: http://www.math.washington.edu/People/klee.php.

An extensive tribute to Gene Golub, written by Michael Heath, appeared in SIAM News January 6, 2008 (http://www.siam.org/news/news.php?id=1289). Symposia dedicated to Golub's memory were held in numerous locations around the world on Feb. 29, 2008, which would have been his 19th birthday, including the University of Illinois, where he earned his Ph.D. (http://www.cse.uiuc.edu/golub/links.html) and at Stanford University, his home for 40 years (http://www.cs.nyu.edu/overton/genearoundtheworld/).

The Stanford event included a session on February 29 where friends, colleagues and students shared memories of Gene, including many stories of his generosity, hospitality, friendship, and his strong influence on all who knew him. The next day's program included a variety of technical talks as well as discussion of the remarkable egalitarian spirit that Gene maintained in Stanford's scientific computation group, how unusually effective this atmosphere has been for encouraging young scientists, and how it might be reproduced elsewhere.

Applied Linear Algebra Conference
Novi Sad, Serbia
In honor of Ivo Marek
April 28-30, 2008

Report by Daniel B. Szyld

This conference, sponsored by ILAS, took place at the University of Novi Sad in Novi Sad, Serbia. More than sixty participants from over fifteen countries gathered to honor Ivo Marek on the occasion of his seventy-fifth birthday, and to celebrate his many contributions to applied linear algebra. Several speakers made references to Ivo's strong background in functional analysis, which permeates his approach to linear algebra problems, in particular to the theory of iterative methods, comparison theorems for them, aggregation-disaggregation methods, and Markov chains.

Three days of an intense schedule began with a lecture by the honored guest, followed by lectures by Richard S. Varga, Hans Schneider, and Owe Axelsson. There were three dozen other speakers and also a poster session.

Participation of young scientists was especially encouraged, and an award was given for the best lecture by a young researcher (meaning either graduate student or Ph.D. received since 2003). The winner was announced at the closing ceremony. The first prize went to Akira Imakura, from Nagoya University. Two honorable mentions were presented to Ivana Pultarova from the Czech Technical University in Prague, and Marko Stošić from the Technical University of Lisbon.

The banquet celebration took place at a restaurant on the banks of the Danube River, and the fare included fish from the Danube itself.

There will be a special issue of Numerical Linear Algebra with Applications dedicated to papers presented at the meeting.

Ljiljana Cvetković of the University of Novi Sad was Chair of the Scientific and Organizing Committees. The wonderful group of local organizers made sure that everyone enjoyed their stay in Serbia. The program and more pictures can be found at http://sites.im.ns.ac.yu/events/2008/ala2008/.

There are plans under way for a similar meeting honoring Hans Schneider, to be held in 2010.

Participants in Novi Sad Applied Linear Algebra Conference

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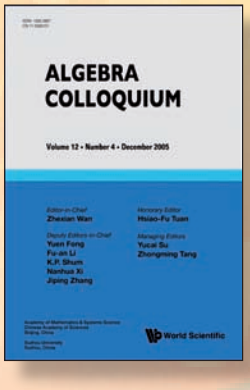

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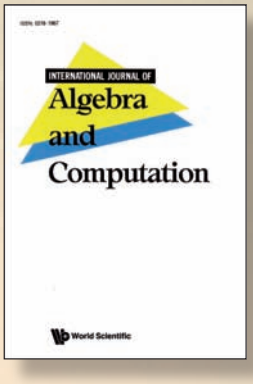

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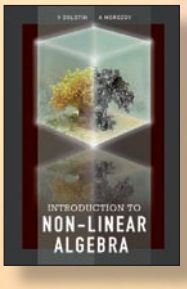
by **V Dolotin** & **A Morozov** *(ITEP, Russia)*



This unique text presents the new domain of consistent non-linear counterparts for all basic objects and tools of linear algebra, and develops an adequate calculus for solving non-linear algebraic and differential equations. It reveals the non-linear algebraic activity as an essentially wider and diverse field with its own original methods, of which the linear one is a special restricted case.

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by **I-Hsiung Lin** *(National Taiwan Normal University, Taiwan)*

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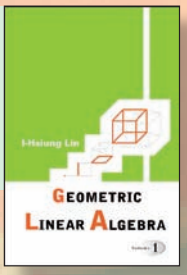

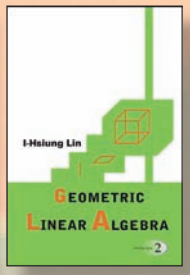

This accessible book for beginners uses intuitive geometric concepts to create abstract algebraic theory with a special emphasis on geometric characterizations. The book applies known results to describe various geometries and their invariants, and presents problems concerned with linear algebra, such as in real and complex analysis, differential equations, differentiable manifolds, differential geometry, Markov chains and transformation groups. The clear and inductive approach makes this book unique among existing books on linear algebra both in presentation and in content.

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ILAS 2007 - 2008 Treasurer's Report

March 1, 2007 through February 29, 2008

Net Account Balances on March 1, 2007			
Vanguard (ST Fed. Bond Fund 3,947.603 Shares)			
(10.60% Each: General Fund, Conference Fund and ILAS/LAA Fund,			
17.40% Taussky Todd Fund, 7.95% Uhlig Fund, 42.85% Schneider Fund)			
		$40,778.74	
Checking account		$50,679.57	
Outstanding checks payable		($ 30.00)	**$91,428.31**
General Fund		$37,481.44	
Conference Fund		$10,954.78	
ILAS/LAA Fund		$ 9,191.23	
Olga Taussky Todd/John Todd Fund		$10,011.26	
Frank Uhlig Education Fund		$ 4,153.52	
Hans Schneider Prize Fund		$19,636.08	**$91,428.31**
Income:			
Dues	6,615.00		
Corporate Dues	1,600.00		
General Fund	4,786.00		
Conference Fund	179.00		
LAA Fund	2,500.00		
LAMA Fund	1,500.00		
Taussky-Todd Fund	369.00		
Uhlig Education Fund	34.00		
Schneider Prize Fund	229.00		
Interest	5,722.41	$23,534.41	
Expenses:			
ILAS Speakers (2)	1,500.00		
ILAS Conference Support	6,000.00		
LAMA Speaker	1,500.00		
Taussky-Todd Prize Speaker	1,200.00		
IMAGE (5 issues)	5,164.35		
Ballot Mailings (2)	769.94		
Dues Mailing	422.97		
Credit Card and Bank Fees	438.51		
License Fees	61.25		
Labor - Conference	197.50		
Supplies, Copying, Postage	141.95		
Errors, currency exchange, other	85.28	$17,426.87	
Net Account Balances on February 29, 2008			
Vanguard (ST Fed. Bond Fund 6639.103 Shares)			
(General Fund 28.55%, Conference Fund 11.11%, ILAS/LAA Fund 12.95%,			
Taussky Todd Fund 13.08%, Uhlig Fund 6.15%, Schneider Fund 28.14%)			
		$71,370.36	
Checking account		$26,255.12	
Cash		$ 100.00	
Outstanding checks payable		($ 2,089.63)	
Pending Deposits		$ 1,900.00	**$97,535.85**
General Fund		$37,483.90	
Conference Fund		$11,755.01	
ILAS/LAA Fund		$12,415.34	
Olga Taussky Todd/John Todd Fund		$ 9,911.64	
Frank Uhlig Education Fund		$ 4,531.40	
Hans Schneider Prize Fund		$21,438.56	**$97,535.85**

Jeffrey L. Stuart, Secretary-Treasurer jeffrey.stuart@plu.edu

Message From Retiring ILAS President

Dear ILAS Members,

Danny Hershkowitz

On February 29, 2008, I shall finish my second term as ILAS President. I shall be then completing 21 years of membership on the ILAS Executive Board, since its establishment in 1987. I first served as ILAS secretary for more than 8 years, then as the Vice-President for 6 years, and finally as the President for 6 years. It has been a big privilege to serve in this important position, especially since my predecessors were Hans Schneider and Richard Brualdi.

During the years ILAS has become a very influential active society. This should be attributed to the willingness and devotion of so many people, such as ILAS officers, conference organizers, committee members, editors, donors and many others. I wish to thank all the people with whom I had the privilege to cooperate to the benefit of our society.

I have no doubt that our next President, Steve Kirkland, will add a lot to the development and promotion of ILAS. I wish him all the best, and I shall be happy to assist whenever asked.

Danny Hershkowitz
February 2008

New Officers Elected

Daniel Hershkowitz, Retiring President, February 2008

Steve Kirkland

Steve Kirkland has been elected to a three year term as ILAS President, starting on March 1, 2008, and Judi McDonald and Andre Ran have been elected to three year terms as members of the ILAS Board, also starting March 1, 2008.

Once Steve becomes ILAS president, his position on the ILAS Board (until 2010) becomes vacant. According to our ByLaws: "The President, with the consent of the Board of Directors, shall have the power to fill any vacancy in any office." I have thus decided, after consulting with Steve Kirkland as well as the whole board, to appoint Wayne Barrett to fill the vacant position, starting on March 1, 2008, ending on February 28, 2010.

On behalf of all ILAS members, thanks to the members of the Nomination Committee (Peter Semrl, Chair, Leslie Hogben, Roger Horn, Hans Schneider and Pauline van den Driessche) for their efforts on behalf of ILAS, and to all of the candidates nominated for their willingness to participate in our elections. Also, thanks to Gregor Dolinar for helping count the ballots.

New Committee Appointments

Steve Kirkland, President

The new members of the ILAS Journals Committee are:
Ravi Bapat <rbb@isid.ac.in>
Jane Day <day@math.sjsu.edu> (for IMAGE)
Ludwig Elsner <elsner@math.uni-bielefeld.de> (for ELA)
Roger Horn <rhorn@math.utah.edu> (Chair)
Daniel Szyld <szyld@temple.edu>
Steve Kirkland (ex-officio)

Danny Hershkowitz and Ludwig Elsner have agreed to serve another three year term as Editors in Chief of the Electronic Journal of Linear Algebra (ELA), the ILAS online research journal. The Education Committee is now comprised of Luz De Alba, Guershon Harel, David Lay, Sang-Gu Lee, and Steve Leon as chair. All ILAS committees and much additional information about ILAS can be found at the ILAS homepage http://www.math.technion.ac.il/iic/.

Call for Announcements for ILAS-Net

ILAS-Net/IIC is the online bulletin board for ILAS, providing current information on linear algebra activities such as international conferences, workshops, and journals. Organizations and individuals are invited to contribute. Announcements should be sent in a text email with no attachments, to owner-ilas-net@math.technion.ac.il. Updates to the IIC webpage should go to the IIC Manager, Sarah Naqvi, at ilasic@math.uregina.ca. The primary website for IIC is http://www.ilasic.math.uregina.ca/iic/index1.html. Mirror sites are located at http://www.math.technion.ac.il/iic/index1.html and htpp://wftp.tu-chemnitz.de/pub/iic/index1.html.

Call for News for *IMAGE*

IMAGE editors welcome information on linear algebra and related topics, including:

- Reports about and announcements of workshops, conferences, honors and awards.
- Feature articles on topics of interest to the linear algebra community - historical essays, emerging applications, research topics, degree programs, education activities, etc.
- Brief references to articles appearing elsewhere which are of interest.
- Announcements of new books and resources.
- Transitions - new positions, deaths
- Letters to the editor.
- New problems and solutions of old problems.

Send material for the Fall 2008 issue as follows:

Problems and solutions to Hans Joachim Werner by September 1, 2008: hjw.de@uni-bonn.de. It is helpful to him to receive these as early as possible. All other news to Jane Day by October 1, 2008: day@math.sjsu.edu.

Searchable online files of all issues of IMAGE are now available on the website, http://www.math.technion.ac.il/iic/.

In Memoriam

We regret to report the loss of two members of the matrix theory community in recent months.

Ralph Byers died on December 15, 2007, at age 52. He was a Professor at the University of Kansas, well known for work in numerical linear algebra. Byers and co-authors Karen Braman and Roy Mathias received the 2003 SIAM Activity Group on Linear Algebra Prize at the SIAM Conference on Applied Linear Algebra in 2003, for their paper "The Multishift QR Algorithm. Part II: Aggressive Early Deflation." Remembrances of Byers and his work have appeared by Volcker Mehrmann (http://www.siam.org/news/news.php?id=1292) and at http://www.news.ku.edu/2007/december/19/byers.shtml.

Israel Koltracht died on February 17, 2008, at age 59. He was a Professor at the University of Connecticut. Remembrances of him can be found at http://advance.uconn.edu/2008/080225/08022505.htm, and also in ILAS-NET message 1649, March 17, 2008, by Miki Neumann and Vadim Olshevsky. There will be a special session dedicated to Koltracht at IWOTA in July 2008 (http://www.math.wm.edu/~vladi/IWOTA/IWOTA2008.htm).

ARTICLES AND RESOURCES

How ILAS Began

James R. Weaver, University of West Florida

In May 1987, a Combinatorial Matrix Analysis Conference was held in Victoria, Canada. Among those in attendance were Hans Schneider, Robert C. (Bob) Thompson, Daniel Hershkowitz, Richard A. Brualdi, David H. Carlson and Charles R. Johnson. Due to the desire to promote linear algebra it was decided to try to form an independent organization which would have the promotion of linear algebra as one of its main goals. It was clear to many linear algebraists that the mathematical community at large did not really appreciate or recognize the pervasive role which linear algebra played in the mathematical world. At one of the meetings of this conference a straw vote was taken to see what kind of interest there was in the creation of a new linear algebra organization. The vote was about 60% for and 40% against the creation of such a new organization. How this new organization would be formed was not a given and how the proper recognition of linear algebra would be accomplished was not yet clear, but the desire and passion of some of the people was so intense that they decided to form what would soon be called the International Matrix Group (IMG). [10] Bob Thompson played a persuasive role by his enthusiasm for creating such a new organization, encouraging Hans Schneider to be its first chairman and offering to edit a newsletter.

It was agreed that the general goal of IMG was to encourage activity in linear algebra. The following statement appears in the first issue of The Bulletin of the International Matrix Group: "A more specific aim is to support groups and individuals active in organizing meetings or publications in all aspects of linear algebra. We have no intention of supplanting or competing with existing organizations, our entire purpose is international coordination, to assist the development of linear algebra. We may add new activities where and when desirable. We welcome activities in all applications of linear algebra and we desire a proper share for theoretical matrix analysis and abstract linear algebra." [10]

Daniel Hershkowitz soon began an electronic mail service called IMG-NET (which later became ILAS-NET). [10] This news service was to provide information on international conferences in linear algebra, other linear algebra activities, linear algebra journals, and of course IMG activities. Daniel sent the first IMG-NET announcement on November 9, 1987.

The first formal structure of IMG was an Executive Committee consisting of Hans Schneider, Chairman; Robert C. Thompson, Editor of IMAGE (previously called the IMG Bulletin); Daniel Hershkowitz, Secretary; and an Advisory Committee consisting of Richard A. Brualdi, David H. Carlson and Charles R. Johnson. [6] Soon the IMG Executive Committee formed an International Advisory Committee which consisted of distinguished linear algebraists from around the world: Belgium - Paul Van Dooren; Canada - Peter Lancaster; Czechoslovakia - Miroslav Fiedler; Germany - Ludwig Elsner; Great Britain - Stephen Barnett; Greece -- John Maroulas; Hong Kong - Yik-Hoi Au-Yeung; Hungary - Pal Rosza; Ireland - Tom Laffey; Israel - Avi Berman; Japan - Tsuyoshi Ando; Netherlands - Harm Bart; Portugal - G. N. de Oliveira; Spain - Vicente Hernandez; United States - Gene Golub; At large - Biswa Datta. [10] The International Committee was discontinued in August of 1995 with the acceptance of revised By-Laws for the International Linear Algebra Society (ILAS). [2]

At the Victoria meeting Bob Thompson volunteered to edit the first newsletter. It was entitled "The Bulletin of the International Matrix Group" and appeared in January 1988. It announced the establishment of IMG, invited new members, included announcements about conferences and journals, and proposed an inaugural conference. He mailed copies to linear algebraists around the world.

About the same time, Hans, Bob and Daniel were exploring the possibility of establishing IMG as a nonprofit organization. The cost of doing this in Wisconsin was prohibitive for an organization with very limited funds. They decided a Treasurer was needed and Hans called James R. Weaver to see if he would serve in that position. James accepted and started working to establish IMG as a corporation not for profit in Florida, where the cost was considerably less. During the third SIAM Applied Linear Algebra Conference in May of 1988 in Madison, Wisconsin, the name "International Matrix Group" was changed to "The International Linear Algebra Society." It was thought that
the new name was more inclusive of people interested in linear algebra and better represented the goals of the organization. [6] After this meeting James was fortunate to find an attorney, Charles C. Sherrill, and a certified public accountant, John R. Shores, who essentially donated their time to help file the appropriate papers at the state and federal level. Due in part to the founding process, ILAS appointed its first officers to be Hans Schneider, President; Robert Thompson, Vice President; Daniel Hershkowitz, Secretary; and James Weaver as Treasurer. [11] A picture of these four can be found on page 2 of the 4th issue of IMAGE (1990). [1]

These officers of ILAS wrote the Articles of Incorporation and the first ILAS By-Laws, along with the applications to the State of Florida and then the Internal Revenue Service of the United States of America to be recognized as a corporation not for profit and designated a 501(c)3 organization. The official date of incorporation of the International Linear Algebra Society, Inc. was March 1, 1989. On that date ILAS was fully recognized by the State of Florida as a Florida Corporation Not For Profit. As of May 17, 1990, the International Linear Algebra Society, Inc. also became a 501(c)3 Organization, thereby exempt from Federal income tax (USA). This meant that donors could deduct contributions to ILAS as provided in section 170 of the IRS code. Dues could also be deducted as a business expense if appropriate, but not as a contribution. The tax exempt status was retroactive since the application was made within l5 months of incorporation. [12]

In August 1989, the inaugural meeting of ILAS was held at Brigham Young University, Provo, Utah USA. The Organizing Committee consisted of Wayne Barrett, Daniel Hershkowitz, Charles Johnson, Hans Schneider and Robert Thompson. It was an excellent conference, with 60 contributed papers. A report in the 4th Issue of IMAGE in January 1990 listed all speakers and said "There were eighty-five participants who came from the countries of Japan, Taiwan, Hong Kong, India, Israel, Finland, Hungary, West Germany, the Netherlands, Belgium, Spain, Portugal, Ireland, Canada, and the United States. Funds provided by Brigham Young University and by the National Security Agency and the National Science Foundation of the United States contributed to the success of the meeting." [1] The speakers included Olga Taussky-Todd and Israel Gohberg.

Many decisions were made at the inaugural meeting. For the Board of Directors, Tsuyoshi Ando and David H. Carlson were appointed to serve in positions that would first stand for election in 1992; Harm Bart and Steven J. Leon were also appointed to positions on the Board of Directors that would first stand for election in 1993. Steven J. Leon was appointed to serve as Co-Editor of IMAGE with Bob Thompson. [8] An Education Committee consisting of David H. Carlson (Chair), Steven J. Leon and Frank Uhlig was appointed. Its goals included fostering, coordinating and helping organize activities that would disseminate information regarding the teaching and encouraging of students to study and do research in linear algebra. It was hoped that such activities would broaden the general knowledge of pure, applied, and computational linear algebra, bring new enthusiasm and ideas into the teaching of the subject, and encourage students and faculty to consider linear algebra as an exciting field in which to work. [3] Frank Uhlig made a generous contribution to support such education activities. Richard A. Brualdi introduced the first Nomination Committee, which consisted of Richard A. Brualdi (Chair), Shmuel Friedland, Tom Laffey, Dias Da Silva and H. K. Au-Yeung. Soon after, this committee nominated Robert C. Thompson for the position of Vice President and Daniel Hershkowitz for the position of Secretary, and they were elected by a mail ballot in January 1990. [8]

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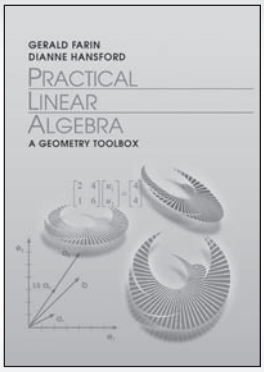
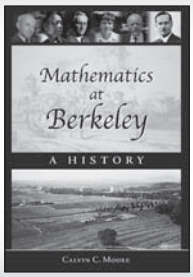


TEXTBOOK

Practical Linear Algebra
A Geometry Toolbox
Gerald Farin, Dianne Hansford $69.00; 978-1-56881-234-2; Hardcover; 394 pp.

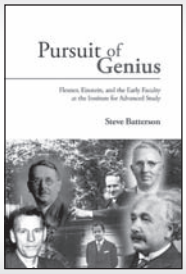
Practical Linear Algebra introduces students in mathematics, science, engineering, and computer science to Linear Algebra from an intuitive and geometric viewpoint, creating a level of understanding that goes far beyond mere matrix manipulations. This book covers all the standard linear algebra material for a first-year course; the authors teach by motivation, illustration, and example rather than by using a theorem/proof style.



Mathematics at Berkeley
A History
Calvin C. Moore $39.00; 978-1-56881-302-8; Hardcover; 394 pp.

"To tell this story a more well-placed person than Calvin Moore could scarcely be found."

—*CMS Notes*, Canadian Mathematical Society



Pursuit of Genius
Flexner, Einstein, and the Early Faculty at the Institute for Advanced Study
Steve Batterson $39.00; 978-1-56881-259-5; Hardcover; 314 pp.

"This is the best book that has yet been written about the Institute. . . . The history of the first nine years is unexpectedly melodramatic, full of quarrels and misunderstandings, power struggles and deceptions.

—Freeman Dyson, *The Institute Letter*

Mathematics and Common Sense
Philip J. Davis $34.95; 978-1-56881-270-0; Hardcover; 250 pp.

"Phil Davis is one of a very small group of mathematicians who are interested and able to step outside the community and take a hard look at what mathematics really 'is'. Its uses, misuses, customs, relations with the so-called 'real' world, psychology and deep nature are all grist for his voracious mill."

—David Mumford, Brown University

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Other major traditions were established in the next year or two. ILAS needed a logo and readers of issue 6 of IMAGE in 1991 were invited to submit designs or ideas for that purpose. A winning design or idea was to be selected after consultation with the members. The winner was John H. Drew of the College of William and Mary. His entry is shown here and for this he was awarded one year's free membership in ILAS. [13]

In 1991 Hans Schneider made a generous gift to establish a prize for outstanding research in linear algebra. Roger Horn and Daniel Hershkowitz accepted appointments to the Guidelines Committee for the Hans Schneider Prize. They developed guidelines and these were soon accepted. The guidelines began with this statement: "The Hans Schneider Prize in Linear Algebra ('the Prize') is awarded by The International Linear Algebra Society for research, contributions and achievements at the highest level of Linear Algebra. The Prize may be awarded for an outstanding scientific achievement or for a lifetime contribution." [4]

In the summer of 1992, ILAS announced the creation of The Olga Taussky/John Todd Lecture. Both Olga and John had been making deep and influential contributions to the development of theoretical and numerical linear algebra for over half a century. This lectureship was created to honor them for their many and varied mathematical achievements and for their efforts to promote linear algebra and matrix theory. The lecture would be given every three or four years, and each lecturer would be a person who had received a Ph.D. within about the previous 15 years. [5]

In March 1993, the Third ILAS Conference was held in Pensacola, Florida. At this meeting it was announced that Miroslav Fiedler, Shmuel Friedland and Israel Gohberg were winners of the first Hans Schneider Prize. Paul Halmos was the banquet speaker. The title of this conference was "Pure and Applied Linear Algebra: the New Generation." The first Olga Taussky/John Todd Lecture was also given at this meeting, by Helene Shapiro.

In 1993 Jeffrey L. Stuart was appointed to be Assistant Treasurer. [9] He served faithfully in that position until he was elected ILAS Treasurer in the year 2000, where he continues to serve. He is but one example of the many people who have served ILAS in many different capacities over the years. Without the efforts of such people ILAS would never have survived to become an organization which has reached around the globe to share the excitement which may be found in the study and research of linear algebra. The first issue of IMAGE in 1989 was mailed to about 100 people. As of May 2008 there are about 390 members of ILAS.

Another major contribution by ILAS to the field of linear algebra was the establishment of The Electronic Journal of Linear Algebra (ELA). The first Editors-in-Chief were Daniel Hershkowitz (who also served as Managing Editor) and Volker Mehrmann. The first Advisory Editors were Chandler Davis, Israel Gohberg, Tom Laffey and Richard Varga. Daniel B. Szyld was appointed Associate Editor, and he also served as Associate Managing Editor. The first two papers published in ELA appeared on June 17, 1996. [2] Through 2007, ELA has published 16 volumes, containing 240 research papers.

To learn more about the development of ILAS, read the short note by Hans Schneider entitled "On Leaving the President's Chair" in the 16th issue of IMAGE in 1996 [7] and articles about ILAS in other issues of IMAGE. All issues of IMAGE can be found at http://www.math.technion.ac.il/iic/IMAGE/. This author thanks Hans Schneider, Richard Brualdi and Daniel Hershkowitz for their help, comments and suggestions on this article.

References

[1] W. Barrett, ILAS Inaugural Conference Held at BYU, *IMAGE* 4:1 (1990).

[2] R. Brualdi and D. Hershkowitz, ILAS President/Vice President Annual Report: June 1996, *IMAGE*, 17:2-3 (1996).

[3] D. Carlson, ILAS Education Committee, *IMAGE* 5:6 (1990).

[4] D. Hershkowitz and R. Horn, Hans Schneider Prize, *IMAGE* 7:6 (1991).

[5] S. Leon, Olga Taussky/John Todd Lecture, *IMAGE* 9:4 (1992).

[6] H. Schneider, New Name for International Matrix Group: International Linear Algebra Society (ILAS), *IMAGE* 2:2 (1989).

[7] H. Schneider, On Leaving the President's Chair, *IMAGE* 16:7 (1996).

[8] H. Schneider and D. Hershkowitz, ILAS Annual Report, *IMAGE* 5:2-3 (1990).

[9] H. Schneider and D.Hershkowitz, ILAS President-Secretary Annual Report, *IMAGE* 11:3 (1993).

[10] R. Thompson, Editorial, *IMAGE* 1:1 (1988).

[11] R. Thompson, Corrected List of ILAS Officers, *IMAGE* 3:4 (1989).

[12] J. Weaver, ILAS is Tax Exempt, *IMAGE* 5:5 (1990).

[13] J. Weaver, Logo Contest Winner, *IMAGE* 9:4 (1992).

Summaries of Two Theses on Student Thinking in Linear Algebra

Hamide Dogan-Dunlap (hdogan@utep.edu)
Fara P. Meza (fara_paty@yahoo.com.mx)
University of Texas at El Paso

Fara P. Meza and Robert Carlos Trejo, graduate students in the Mathematical Sciences Department at the University of Texas at El Paso, studied students' thinking modes in a matrix algebra course, as research for their Masters degrees. This work was directed by Hamide Dogan-Dunlap, and below are short summaries of their theses, in which they reported their findings. Please contact any of the authors for more information.

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Student Thinking Modes Expressed While Determining Linear Independence/Dependence of Sets of Vectors

Robert Carlos Trejo, UTEP Library, Master's Thesis no. 6375, May, 2007.

The research reported here was an attempt to contribute to the ongoing research on the teaching and learning of linear algebra, in particular to document students' conceptions/misconceptions and modes of thinking in linear algebra, following Anna Sierpinska's framework in [1]. Two interactive Mathematica modules were developed, along with two assignments for students to complete using these modules [2]. The questions in the assignments were adopted from [3] and [4]. Responses were gathered from forty-six matrix algebra students, then qualitatively analyzed and categorized according to the emerging themes.

The first assignment was about interpreting the row reduced echelon form of matrices in various ways. The analysis revealed that almost all students used arithmetic modes in their responses. For example, they wrote phrases like the following. "The vector set is LI [Linearly Independent]. The rref reveals that the trivial solution is the only solution…" "The vectors in 'a' [part a of the question] are LI. Using mathematica tool, I found out the only solution to the vector equation Ax=0 is the trivial solution," and "The rref gives a unique solution of x1=0 and x2=0."

The second assignment asked students to interpret geometrical representations, and as a result, to identify linear independence/dependence for sets of vectors. Analysis showed that when a question did not require generalization/abstract thinking, they used mainly graphical modes to answer. They wrote phrases similar to: "Vectors coming out of a plane," "Vectors that lie on the same plane," and "The magnitude of vectors are the same/different." However, when answering abstract questions in this assignment, the most commonly used responses were arithmetic and algebraic.

Here are two examples of questions. Question 1 is considered not requiring generalization/abstract thinking, and Question 2 is considered abstract.

Question 1: Use the Mathematica activity to enter each set of vectors given in a-g into the box next to "Enter a Matrix" button. Write a few paragraphs about linear independence of each of the sets, and compare the sets in light of your findings. If a set is linearly dependent then state a linear combination revealing the linear dependency of the vectors of the set.

a. $W = \left\{ \begin{bmatrix} 1 \\ 2 \\ 0 \end{bmatrix}, \begin{bmatrix} 2 \\ 4 \\ 1 \end{bmatrix}, \begin{bmatrix} -2 \\ -4 \\ -2 \end{bmatrix}, \begin{bmatrix} 0 \\ 3 \\ 3 \end{bmatrix} \right\}$.

b. $L=\{a_1, a_2, a_3\}$ where the vectors a_1, a_2, and a_3 are stored in the activity.

e. N = {a5, a4, a10, a3} where the vectors a5, a4, a10, and a3 are stored in the activity.

Question 2: Based on your experimentation and observations from part 2, conjecture on the **necessary and sufficient conditions for three vectors** in R^3 to be linearly independent vectors. Explain your reasoning [4].

The most common responses to abstract questions referred to definitions and theorems. Many responses used primarily the formal definition of linear independence without providing any reasoning or computation to verify answers. The second most common mode used in responses to abstract questions was geometrical, consisting mainly of arguments that
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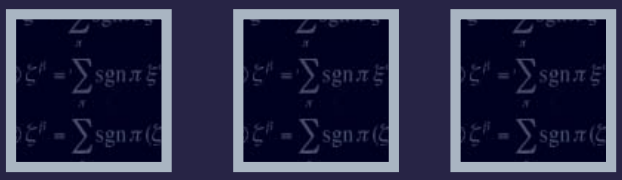

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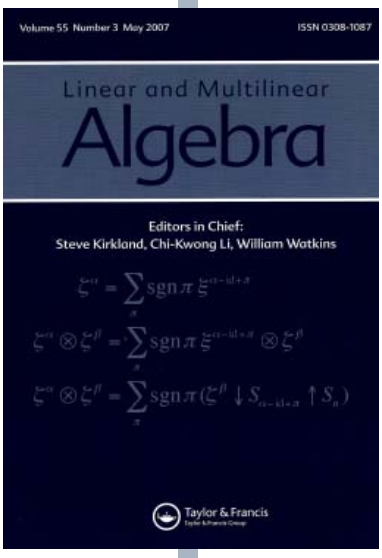

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compared the number of vectors to the dimension of vector spaces.

In the second assignment, considerably more students attempted to make arguments using multiple modes (numerical, algebraic and geometrical) than had done this on the first assignment. This may indicate that the two successive activities, first numerical and then geometrical, may have helped students begin reasoning in multiple modes. We believe this is a desired behavior toward students developing a rich conceptual understanding of linear independence.

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Student Thinking Modes: The Case of Solution Sets and Linear Independence from First Year Linear Algebra

Fara P. Meza, UTEP Library, Master's Thesis no. 6391, May, 2007.

The primary purpose of this research was to document thinking modes described by Sierpinska in [1], about linear independence/dependence. Data were gathered from responses to questions in two separate assignments, which were completed by forty-six students who were enrolled in a matrix algebra class.

Interactive Mathematica modules [2] were used in answering questions on the assignments. The first assignment here and the first module used were different from those Trejo used. This assignment was about graphical representations of consistent and inconsistent systems of equations. The second set of data analyzed here was the same as what Trejo analyzed in his first assignment, about students' solutions obtained using the row reduced echelon form of matrices. However the solutions were analyzed independently and this resulted in some differences in the categories formed.

The first assignment here asked for graphical interpretation of the solution sets of linear and non-linear systems. Students solved both linear and non-linear systems using paper and pencil (or calculators), applying Gauss-Jordan Elimination method for the linear systems. Then they used the first module described above to help determine geometrical descriptions of the solution sets, and finally, they compared their findings from the two approaches.

To categorize students' thinking modes, we implemented an inductive qualitative analysis to search for emerging themes on student responses. In short, we observed that students used both algebraic and graphical means in responding to the questions on the first assignment. For example, by observing that one equation is a scalar multiple of another equation in a system, some students were able to conclude that the solution set had infinitely many points and could be expressed by just one of the equations. Some gave graphical descriptions using lines or planes to make inferences about solution sets. Here is a phrase provided by one student: "These two equations are the same planes therefore all numbers are solutions." Moreover, there were responses with both graphical and algebraic modes used in answering some of the questions in this assignment. One student said "…Do not find any solution because using GJE [Gauss Jordan Elimination] the second equation got simplify to 0. Graphing the system of equation, the planes obtained from the two equations did not intersect, therefore there is no solution."

For the second assignment, we categorized student responses mainly under arithmetic and algebraic (structural) modes, such as "Dependency," "Equations vs. Unknowns," and "Trivial Solution." For example, some students provided responses like "…if x, y, z do not depend on each other," and "The only solution of $x_1v_1+x_2v_2=0$ is the trivial solution $x_1=x_2=0$ so the set $\{v_1, v_2\}$ is linearly independent." We also had a category "Vectors vs. Dimension" for geometrical type responses. The responses of this type were for questions that asked for conjectures on the linear independence of either four or any number of vectors in R^3. For example, one student's response to such a question said: "There have to be less or equal vectors than the dimension, none can be zero vector…"

One notable difference observed among student answers between the two assignments is that many students provided detailed explanation/justification on the first assignment, which asked for an interpretation of graphical representations, whereas they did not provide much detail in their responses on the second assignment, which asked for interpretation of the rref form.

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Henry Agard Wallace and Machine Calculation

Richard William Farebrother

1. Introduction

Henry Agard Wallace (1888–1965) served as U.S. Secretary of Agriculture 1929–1932 and as Vice President 1941–1945. (Indeed, he might have succeeded Franklin Delano Roosevelt as President later in 1945 but for the fact that his colleagues thought him too liberal, so he was replaced by Harry Truman when Roosevelt decided to run for a fourth term.)

About Wallace's life before national politics, Grier [12, p.54] notes that:

> By 1927, he was the editor of *Wallaces' Practical Farmer*, an advocate of numerous political causes, and the manager of ... the Pioneer Hi-Bred Seed Company ... [which] eventually became one of the two major suppliers of hybrid seed [in the U.S.A.]

Such a man does not seem a likely candidate for inclusion in the pages of *IMAGE*. However, he was a practicing statistician who published an influential monograph coauthored by George Waddel Snedecor [21], which has not been properly acknowledged. This pamphlet contained a very useful computational technique which was known to geodesists but not to statisticians at the time, and which apparently Wallace had rediscovered independently.

2. Computational Mathematics

In Ezekiel's [5, p.792] obituary of Wallace we find:

> Wallace's statistical work in his earlier price studies led to his following closely later developments in their use; and after Tolley and I had published simpler methods of computing multiple correlations and regressions in 1923, Wallace, in cooperation with George Snedecor [1881–1974] of Iowa, prepared a correlation manual using these methods, which was published by Iowa State College in 1925 as a handy guide for students and researchers.

Regarding this manual, Grier [12, p.20] says:

> It seems likely that [Harold T.] Davis used the methods of Snedecor and Wallace because their pamphlet was one of the few works on the computations needed for regression models.

In other words, Grier [11, 12] maintains that Harold Thayer Davis (1892–1974) and other leading statisticians learned of the computational procedure proposed by Myrick Hascall Doolittle (1830–1913) from Wallace and Snedecor [21] rather than from Tolley and Ezekiel [20] or Ezekiel [4], as suggested by Farebrother [8, p.156n] and Ezekiel [5, p.792].

Grier [12, p.59n48] makes the same point rather more forcefully:

> It should be noted that Wallace rediscovered a method known to geodesists as Doolittle's method, though it was unknown to statisticians at the time. (Wallace to Snedecor, 20 Dec. 1960 ...)

At first sight, it seems unlikely that Wallace and other practicing statisticians would not have known of a computational procedure that had been in the public domain for 44 years. But Doolittle's paper was published in an unfamiliar journal in 1881, four years too late for inclusion in the extensive list of writings on the Method of Least Squares [14] compiled by Mansfield Merriman (1848–1925) in 1877; see Stigler [17].

Further, according to Grier [12, p.58n42]:

> Wallace did not know Tolley directly but clearly knew of the work of the statisticians at the Bureau of Agriculture. See Wallace to George Snedecor, 31 Dec. 1960.

This statement explicitly rules out any possibility that Wallace might have learnt of Doolittle's procedure indirectly from Howard Tolley, who had been recruited by the U.S. Department of Agriculture in 1922 from the U.S. Coast and Geodetic

Survey where Doolittle had been employed as a computer 1873–1911. See Grier [12, P.52] where Tolley is accidentally misnamed 'Charles.'

Thus, if we can fully credit the recollections of the 72-year-old Wallace (as we cannot those of the 61-year-old Joseph Fourier, see Farebrother [8, p.47], or the 63-year-old Karl Pearson, see Stigler [19, p.343n11]), then it is clear that Wallace's contribution to the 1925 monograph was prepared independently of Doolittle's work.

3. Wallace and the Bernini Code

As a curious aside, Wallace's name came up recently in a very different context. According to Robert Langdon, the hero of Dan Brown's *Angels and Demons* [3, pp.135–137], "it was Wallace who sold the design of the Great Seal to the President [Roosevelt]." This design incorporates the Masonic symbols of the pyramid and the eye within a triangle and is featured on the reverse of the US one dollar banknote.

4. Concluding Remarks

In his discussion of computational procedures for solving the normal equations of the method of least squares, Searle [15, pp.26–27] mentions Doolittle's procedure for the direct decomposition of a square matrix and several variants of it proposed in the 1930s and 1940s, but not the original publication of Gauss [10, §§11–13], the independent discovery by Wallace and Snedecor [21], or the variant of the basic procedure published by Benoît [2] in 1924 on behalf of his deceased colleague André-Louis Cholesky (1875–1918). I propose to excuse Searle [15] for not mentioning Wallace and Snedecor's [21] memoir as it also received no mention in Farebrother [7]; but he should certainly have mentioned the contributions of Gauss and Cholesky. For obituaries of Cholesky, Doolittle, and Wallace see Anonymous [1], Farebrother [6], and Ezekiel [5] respectively. For a life of Davis, see Farebrother [9].

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Richard William Farebrother, R.W.Farebrother@Manchester.ac.uk

11 Castle Road, Bayston Hill, Shrewsbury, England SY3 0NF.

Pulverisers Ancient and Modern

Richard William Farebrother

The following quotation is from [1], p. 279:

"There is a problem of considerable historical interest, for which Bhaskaracharya (born in 1114) offers the first complete solution. This problem is to solve $61x^2 + 1 = y^2$ for minimum x and y. He gives the solution $x = 226,153,980$ and $y = 1,766,319,049$. It is precisely this problem that Fermat proposed to his friend Frénicle de Bessy in 1657. We do not know whether de Bessy took up the challenge; the problem was finally solved by Lagrange about a hundred years later. A comparison between Lagrange's and Bhaskaracharya's methods is quite illuminating. Lagrange's method requires the calculation of twenty-one successive convergents of the continued fraction for the square root of 61, while the Jayadeva–Bhaskaracharya approach (known as 'the Pulveriser') gives the solution in a few easy steps."

I found the above quotation particularly interesting when I discovered it in August 2007, as earlier in the same year I had been concerned with extending Werner's solution of Problem 36-1 [2] to cover the case $d = 61$. Both Hans Joachim Werner of the University of Bonn and John H. Smith of the University of Manchester responded to my enquiry by sending me the above solution within a few days of each other in March 2007.

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Richard William Farebrother, R.W.Farebrother@Manchester.ac.uk

11 Castle Road, Bayston Hill, Shrewsbury, England SY3 0NF.

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