The Bulletin of the International Linear Algebra Society

IMAGE

Serving the International Linear Algebra Community
Issue Number 74, pp. 1–28, Spring 2025

Contents continued on page 2.

About *IMAGE*

ISSN 1553-8991. Produced by the International Linear Algebra Society (ILAS). Two issues are published each year, on June 1 and December 1. The editors reserve the right to select and edit material submitted. All issues of *IMAGE* may be viewed online at `http://www.ilasic.org/IMAGE`. *IMAGE* is typeset using LaTeX. Photographs for this issue were obtained from websites referenced in articles, university department websites, conference websites, or from contributors directly, unless indicated otherwise here:

Subscriptions: Contact ILAS Secretary/Treasurer Minerva Catral (`ILASsecretarytreasurer@gmail.com`) to subscribe or send a change of address for *IMAGE*.

Editor-in-Chief: Louis Deaett (`louis.deaett@quinnipiac.edu`).

Managing Editor: Rachel Quinlan (`rachel.quinlan@universityofgalway.ie`).

Contributing Editors: Mohsen Aliabadi (`maliabadisr@ucsd.edu`), Jephian C.-H. Lin (`jephianlin@gmail.com`), Jeffrey Stuart (`jeffrey.stuart@plu.edu`), and Amy Wehe (`awehe@fitchburgstate.edu`).

Advertisers: Contact Amy Wehe (`awehe@fitchburgstate.edu`).

Acknowledgment: Anthony Cronin has completed his term on the *IMAGE* editorial staff; we thank him for his enthusiastic and effective stewardship of the Education section. The ILAS Education Committee will work to coordinate future education articles and nominate a new editor to oversee the Linear Algebra Education section of *IMAGE*.

For more information about ILAS, its journals, conferences, and how to join, visit `http://www.ilasic.org`.

LINEAR ALGEBRA EDUCATION

Linear Algebra Education: An International Perspective – a special issue of *PRIMUS*

Rachel Quinlan, University of Galway, Galway, Ireland, rachel.quinlan@universityofgalway.ie
Sepideh Stewart, University of Oklahoma, Norman, OK, USA, sepidehstewart@ou.edu

ILAS conferences have a history of minisymposia on linear algebra education, featuring engaging talks by mathematicians about their experiences and innovations in teaching. Motivated by these sessions, the ILAS Education Committee (Anthony Cronin, Judi McDonald, Rachel Quinlan, Sepideh Stewart (chair), and David Strong) was keen to find opportunities for speakers to record and share their ideas more widely. We approached the journal *PRIMUS* (Problems, Resources, and Issues in Mathematics Undergraduate Studies) with the idea of a special issue dedicated to the teaching and learning of linear algebra. We are grateful to *PRIMUS*, and in particular to its editor-in-chief, Matthew Boelkins, for their enthusiastic engagement with us on this idea and for the constructive working relationship that ensued.

The target audience of *PRIMUS* consists of education practitioners, and its statement of aims and scope, which calls for articles that "typically present a novel idea, evidence that the idea supports student learning, and indication that the idea is transferable to other faculty, courses, or institutions," closely aligns with those of the education minisymposia at ILAS conferences. The journal, with a focus on pedagogical initiatives in mathematical fields, facilitates collaboration between mathematicians and specialists in the field of education, and supports engagement by mathematicians on practical challenges, opportunities and developments in teaching and learning.

A call for papers for a special issue of *PRIMUS* entitled "Teaching Linear Algebra: An International Perspective" was issued in September 2022, with a submission deadline in the Spring of 2023. The call emphasized "practical usefulness to colleagues around the world" and invited submissions on classroom activities, technology and applications, curriculum, and the teaching of advanced linear algebra. Of the 25 submissions that were received, 13 were published, following a rigorous review process. The result presents a wide variety of mathematical insights, creative uses of technology, modern applications in teaching contexts, and innovations in the communication of mathematical ideas; these are already influencing the thinking of students of linear algebra around the world. Overall, the collection presents a picture of the teaching of linear algebra as a creative and flourishing endeavour that benefits from scholarly interaction between practitioners. We hope to initiate further projects of this nature in the future, and encourage ILAS members to consider how their initiatives and innovations in education might be of interest to the international community.

The following articles appear in the *PRIMUS* special issue.

1. *The art of linear algebra*
   https://doi.org/10.1080/10511970.2024.2321349
   by Gilbert Strang, Kenji Hiranabe and Ashley Fernandes.
   This article uses striking visual methods to explain and highlight key objects and mechanisms of linear algebra, including arithmetic operations and matrix factorizations.
2. *Analogy and generalization as a driving force of learning mathematics – the case of a matrix analog of a zero of a polynomial*
   https://doi.org/10.1080/10511970.2024.2352362
   by Damjan Kobal.
   Starting from the familiar relationship between roots and linear factors of polynomials, this article proposes a matrix analogue and guides the reader through an elementary and self-contained proof of the Cayley-Hamilton theorem, for exploration with students.
3. *A student-centred lesson on eigenvalues and eigenvectors*
   https://doi.org/10.1080/10511970.2023.2300817
   by Judi McDonald, Sepideh Stewart and Guershon Harel.
   This collaboration of mathematicians and researchers in mathematics education discusses the use of the DNR (duality, necessity and repeated reasoning) framework to design and present learning activities, and reports on students' experiences and feedback on these activities.
4. *The power of randomly concrete examples and numerical demonstrations*
   https://doi.org/10.1080/10511970.2024.2423344
   by Yunkai Zhou.
   This paper makes an argument for an integrated approach to the study of concepts and methods of linear algebra and for the necessity of robust and efficient implementation of algorithms. Demonstrations involving Householder reflectors are designed to draw the attention of students to both well-known and more subtle theoretical and numerical features.

5. *Promoting linear algebraic reasoning among students: affordances and challenges*
https://doi.org/10.1080/10511970.2024.2327325
by Guershon Harel.
This paper reveals and discusses a number of major discontinuities that students experience as they transition from high school and later from their experiences with calculus courses to the first course in linear algebra. Pedagogical approaches that address these issues are proposed.

6. *Teaching matrix multiplication with impactful and productive meaning*
https://doi.org/10.1080/10511970.2024.2310246
by Jeffrey S. Meyer.
Through a sequence of lesson plans, this paper outlines an approach to teaching matrix multiplication by helping students to develop mental actions such as "meaning-making, symbolizing, interpreting, and justifying."

7. *An inquiry-oriented approach to determinants*
https://doi.org/10.1080/10511970.2024.2315134
by Matthew Mauntel, Megan Wawro and David Plaxco.
This paper presents a series of four investigative student tasks based on the conceptualization of the determinant of a real matrix as a measure of the "distortion of space" effected by a linear transformation, starting from a concrete interpretation of a 2×2 determinant as a signed area. Examples of student work are provided throughout.

8. *Inquiry-based linear algebra teaching and learning in a flipped classroom framework: a case study*
https://doi.org/10.1080/10511970.2024.2375712
by Helge Fredriksen, Josef Rebenda, Ragnhil Johanne Rensaa and Petter Pettersen.
This case study combines flipped classroom and inquiry-based mathematics education (IBME) and reports on an engaging learning experience for students. Challenges of the approach are also discussed.

9. *A blended teaching sequence for introducing eigentheory in a large university class*
https://doi.org/10.1080/10511970.2024.2369996
by Margherita Piroi and Alessia Cattabriga.
The article presents an innovative teaching experiment on eigentheory. Using technology and online resources, accompanied by tasks designed by the authors, students were given a variety of opportunities to get involved with linear algebra materials.

10. *Learning eigenvalues and eigenvectors with online YouTube resources: a journey in the embodied, proceptual-symbolic and formal worlds of mathematics*
https://doi.org/10.1080/10511970.2024.2327330
by Farzad Radmehr.
This paper reports on the use of a theoretical framework in mathematics education to analyze the content of online linear algebra video resources. The conclusions have implications for teaching and learning.

11. *Problem-solving before instruction: a case study of a matrix theory course*
https://doi.org/10.1080/10511970.2024.2352370
by A. Berman, A. Mahagna, I. Ram and A. Wolf.
This case study focused on a course in which homework problems were assigned (without solutions) at the start of each week, then discussed in detail after the submission date. The success of the pedagogical method was assessed through student feedback and academic performance.

12. *An application approach to teaching linear algebra*
https://doi.org/10.1080/10511970.2024.2361376
by A. Harsy and M. Smith.
This paper presents some examples used in 50-minute lab modules on applications such as computer graphics and sports analytics in a linear algebra course, and discusses the benefits and some practical considerations related to the inclusion of such elements.

13. *Inspiring linear algebra topics using radiography and tomography*
https://doi.org/10.1080/10511970.2025.2456820
by M. A. Snipes, H. A. Moon and T. A. Asaki.
This paper presents a detailed account of a series of five practical activities that model the production of a radiographic image as a linear transformation, and explore the role of linear algebra in interpreting such images.

World Scientific
Connecting Great Minds

WorldSciNet
ebooks • ejournals • databases

SELECTED TITLES IN

ALGEBRA & RELATED TITLES

20% OFF
PROMO CODE
WSWEB2420

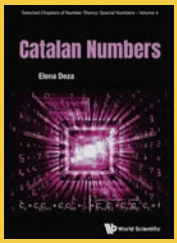
www.worldscientific.com/page/algebra-related

New Releases

Selected Chapters of Number Theory: Special Numbers - Vol 4

Catalan Numbers

by **Elena Deza** (Moscow Pedagogical State University, Russia)



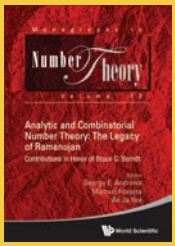
Named after mathematician Eugène Charles Catalan, these numbers appear in various combinatorial problems. With rich history, intriguing properties, and diverse applications, Catalan numbers connect arithmetic, analysis, and combinatorics. This book explores their interesting properties, history, classical and modern applications, relations to other special numbers, and open problems.

290pp | Pub date: Dec 2024
Hardcover 978-981-129-322-1 | **US$98 / £90**
eBook for Individual 978-981-129-324-5 | **US$78 / £70**

Monographs in Number Theory - Vol 12

Analytic and Combinatorial Number Theory: The Legacy of Ramanujan

Contributions in Honor of Bruce C Berndt
edited by **George E Andrews** (The Pennsylvania State University, USA), **Michael Filaseta** (University of South Carolina, USA) & **Ae Ja Yee** (The Pennsylvania State University, USA)

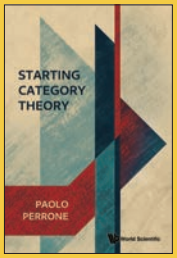


This volume reflects the contributions stemming from the conference Analytic and Combinatorial Number Theory: The Legacy of Ramanujan which took place at the University of Illinois at Urbana-Champaign on June 6 – 9, 2019. The conference included 26 plenary talks, 71 contributed talks, and 170 participants.

704pp | Pub. date: Sep 2024
Hardcover 978-981-127-736-8 | **US$188 / £175**
eBook for Individual 978-981-127-738-2 | **US$150 / 140**

Starting Category Theory

by **Paolo Perrone** (University of Oxford, UK)



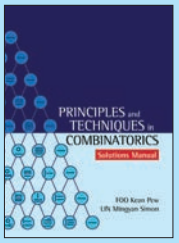
Starting Category Theory serves as an accessible and comprehensive introduction to the fundamental concepts of category theory. Originally crafted as lecture notes for an undergraduate course, it has been developed to be equally well-suited for individuals pursuing self-study. Most crucially, it deliberately caters to those who are new to category theory, not requiring readers to have a background in pure mathematics, but only a basic understanding of linear algebra.

464pp | Pub date: May 2024
Hardcover 978-981-128-600-1 | **US$148 £135**
eBook for Individual 978-981-128-602-5 | **US$118 / 110**

All-Time Bestseller

Principles and Techniques in Combinatorics

Solutions Manual
by **Kean Pew Foo, Mingyan, Simon Lin** (University of Illinois at Urbana-Champaign, USA)

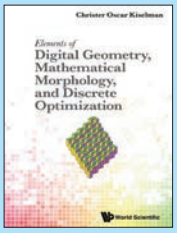


Solutions are written in a relatively self-contained manner, with little undergraduate mathematics assumed. This caters to a wide range of readers, and makes it easy for the reader to understand the thought process behind the solutions to each problem.

440pp | Pub. date: Oct 2018
Softcover 978-981-3238-84-8 | **US$45 / £40**

Elements of Digital Geometry, Mathematical Morphology, and Discrete Optimization

by **Christer Oscar Kiselman** (Uppsala University, Sweden)



"The book offers an attractive option for a course dealing with set theory, general topology. Analysis, and group theory, and their application to digital setting, mathematical morphology and discrete optimization."

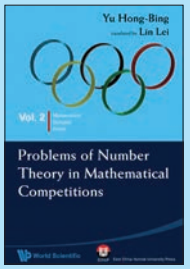
Mathematical Reviews Clippings
American Mathematical Society

488pp | Pub. date: Feb 2022
Hardcover 978-981-124-829-0 | **US$158 / £145**

Mathematical Olympiad Series - Vol 2

Problems of Number Theory in Mathematical Competitions

by **Hong-Bing Yu** (Suzhou University, China)Translated by: Lei Lin (East China Normal University, China)

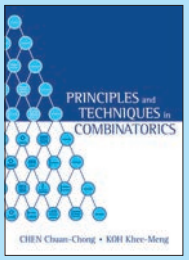


In this book, the author introduces some basic concepts and methods in elementary number theory via problems in mathematical competitions.

116pp | Pub. date: Sep 2009
Softcover 978-981-4271-14-1 | **US$34 / £28**

Principles and Techniques in Combinatorics

by **Chen Chuan-Chong** (NUS, Singapore), Koh Khee-Meng (NUS, Singapore)



"This book should be a must for all mathematicians who are involved in the training of Mathematical Olympiad teams, but it will also be a valuable source of problems for university courses."

Mathematical Reviews

312pp | Pub. date: Jul 1992
Softcover 978-981-02-1139-4 | **US$39 / £32**

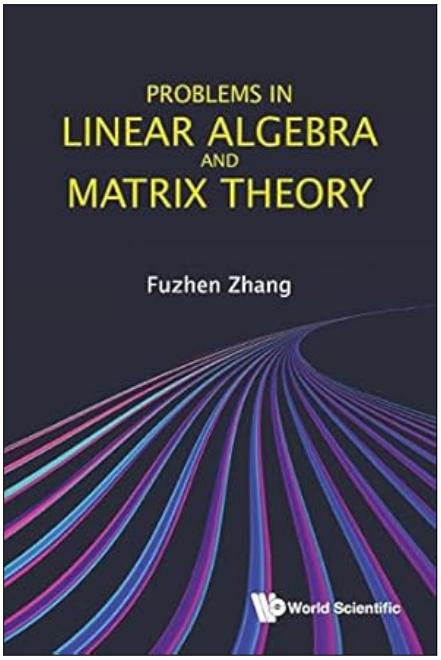
AD EP 10 24 01 RM

For orders and enquiries:
USA | Tel: 1-201-487-9655 | E-mail: wspc_us@wspc.com **UK** | Tel: 44-20-7836-0888 | E-mail: ipsuk.orders@ingramcontent.com **ASIA** | Tel: 65-6466-5775 | E-mail: sales@wspc.com

BOOK REVIEW

Problems in Linear Algebra and Matrix Theory by Fuzhen Zhang

World Scientific, November 2021, ISBN 978-9-8112-3908-3, xiii+476 pages
Reviewed by Mohammad Sal Moslehian, Ferdowsi University of Mashhad, moslehian@um.ac.ir



This is the third edition, an enriched version, of the previously published book "Linear Algebra: Challenging Problems for Students" (Johns Hopkins Studies in the Mathematical Sciences, Johns Hopkins University Press, Baltimore, MD, 2009, xviii+245 pp, ISBN: 978-0-8018-9126-7; 0-8018-9126-4). It supplements the undergraduate textbook "Matrix Theory: Basic Results and Techniques" (Universitext, Springer-Verlag, New York, 1999, xiv+277 pp, ISBN: 0-387-98696-0) by the same author. This new edition includes numerous additional examples and problems derived from the author's lecture notes at various universities.

Frequently used notation and theorems are listed on the first pages of the book, which then includes six chapters: (1) Vector Spaces; (2) Determinants, Inverses, Ranks, and Systems of Linear Equations; (3) Similarity, Eigenvalues, Matrix Decompositions, and Linear Transformations; (4) Special Matrices; (5) Inner Product Spaces; (6) Miscellaneous Problems. Each chapter starts with definitions, facts, and examples that lay the foundations for the chapter. Following this, a collection of various interesting problems is presented and carefully organized within the chapter. Some of these problems are easy, while others are more challenging. The chapters are then followed by hints and answers to the problems, providing powerful problem-solving techniques.

This book brings to mind the style of "A Hilbert Space Problem Book" by Paul Halmos. While Halmos's book is more suitable for graduate students and researchers, the book under review is an excellent resource for undergraduate students. Most problems are presented comprehensively, although a few could benefit from further expansion. For instance, Problem 4.123 includes only the following conditions (a) and (b), but could have naturally been expanded to include four more conditions as follows: Let A and B be $n\times n$ orthogonal projections. Show that the following statements are equivalent: (a) $B\le A$; (b) $AB=B$; (c) $BA=B$; (d) Im $B\subseteq$ Im A; (e) $\|Bx\|\le\|Ax\|$ for all $x\in\mathbb{C}^n$; (f) $A-B$ is an orthogonal projection.

In addition, Problem 5.29 has a generalization that is interesting for those who work on operator algebras. In fact, a matrix with entries in any C^*-algebra $\mathscr{A}$ (not only $\mathbb{C}$, as in the book) is positive semidefinite if and only if it is a sum of matrices of the form $(u_i^*u_j)$ for some $u_1,\dots,u_n\in\mathscr{A}$, where $*$ denotes the involution of $\mathscr{A}$; see Lemma 3.1 of [2].

As a final example, Problem 5.30 characterizes inner products $\langle\cdot,\cdot\rangle$ on $\mathbb{C}^n$ as those that are of the form $\langle x,y\rangle=y^*Ax$ for some positive definite matrix A. Here it is exciting to note that if we replace A with a Hermitian involutive matrix J, that is, one such that $J=J^*$ and $J^2=I$, then we arrive at the notion of an indefinite inner product, and enter the realm of Krein spaces; see [1].

The reviewer has benefited from and enjoyed reading such a well-written and readable problem book.

References.

[1] M. S. Moslehian, T. Sano, and K. Sugawara. The arithmetic-geometric mean inequality of indefinite type. *Arch. Math. (Basel)*, 117(3):347–359, 2021.

[2] M. Takesaki. *Theory of Operator Algebras. I*, volume 124 of *Encyclopaedia of Mathematical Sciences*. Springer-Verlag, Berlin, 2002. Reprint of the first (1979) edition, Operator Algebras and Non-commutative Geometry, 5.

MATHEMATICAL SCIENCES SPONSORSHIP FUND

The Elsevier Mathematical Sciences Sponsorship Fund supports events and activities that benefit individuals and groups within the mathematical sciences community.

We invite researchers and organizations worldwide to submit proposals on topics that reflect this year's theme:

"Mathematics for All: Cultivating Inclusive Excellence"

Submit your proposal before
1 Sept 2025

Grants range from
US$500 to US$4,000

ELSEVIER

To learn more about the eligibility criteria and the application process, please visit
www.elsevier.com/subject/mathematics/mathematical-sciences-sponsorship-fund

OBITUARY NOTICES

Oscar Rojo (1938–2025)

Submitted by Daniel B. Szyld

It with great sadness that we learned of the passing of Oscar Rojo, which occurred on February 7th, 2025, after a battle with an aggressive cancer over the last six months.

It can be said that Professor Rojo, whose career was mostly at the Universidad Catolica del Norte in Antofagasta, was responsible for the establishment and growth of linear algebra research in Chile. His students and colleagues, who continue this tradition, are the embodiment of Rojo's legacy.

Beyond Chile, many of Rojo's papers have had a considerable impact in the profession, especially in areas related to graphs and matrices and their spectra.

We mourn the loss of a good and influential colleague.

ILAS NEWS

ILAS Election Results

Froilán Dopico was reelected to an additional three-year term as ILAS Vice President, starting March 1st, 2025.

Jephian Lin and Enide Andrade were elected to three-year terms as members of the ILAS Board of Directors. They began their terms on March 1st, 2025.

Serkan Güğercin Selected as 2025 SIAM Fellow

The 2025 class of fellows of SIAM, the Society for Industrial and Applied Mathematics, was recently announced. Included among those honored was ILAS member Serkan Güğercin of Virginia Tech. Serkan was recognized for "innovations in the design of algorithms for rational approximation and interpolatory model reduction of large-scale dynamical systems."

For details, and to view the entire class of fellows, visit

`https://www.siam.org/publications/siam-news/articles/siam-announces-2025-class-of-fellows`.

Orly Alter highlighted by SIAM

As part of Mathematics and Statistics Awareness Month – a joint effort of SIAM, the American Mathematical Society, the American Statistical Association, and the Mathematical Association of America – SIAM chose to highlight the work of two of its members online. One of these, Orly Alter of the University of Utah, is also a member of ILAS.

Orly's remarkable career and current work are detailed on the SIAM website at:

`https://www.siam.org/publications/siam-news/articles/`
`siam-celebrates-mathematics-and-statistics-awareness-month-2025/#Alter`

ILAS President/Vice President Annual Report: May 1, 2025

Respectfully submitted by Daniel B. Szyld, ILAS President, szyld@temple.edu
and Froilán M. Dopico, ILAS Vice President, dopico@math.uc3m.es

The past year was another momentous year for ILAS. Highlights include the Hans Schneider Prizes awarded to Dario Bini and Chi-Kwong Li, ILAS participating for a fourth time as a partner in the Joint Mathematics Meetings (JMM), with a record of seven ILAS Special Sessions, increased funding for Ph.D. students and early-career researchers attending ILAS conferences, and the new ranked choice election rules approved by the Board of Directors and now included in the ILAS Bylaws.

1. Board-of-Directors-approved actions since the last report include:

- The Board moved on September 5, 2024 to fund with 1000 Euros one application to the "ILAS Grant Program in support of Mathematicians working in Linear Algebra affected by conflicts."
- The Board moved on February 7, 2025 to change the election rules of ILAS to a ranked choice modality and to replace for this purpose the previous points 4, 5 and 6 in "Article 10. Elections" of the ILAS Bylaws by the new points 4 and 5 that describe the newly adopted ranked choice voting system.
- The Board moved on February 7, 2025 that future Hans Schneider Prizes will consist only of a certificate containing the citation, instead of a plaque, or a medal, and a certificate as in the past. In this way, the three ILAS Prizes (the Hans Schneider Prize, the ILAS Olga Taussky and John Todd Prize and the ILAS Richard A. Brualdi Early Career Prize) will be equal in this respect and will consist only of a certificate containing the citation.
- The Board moved on February 7, 2025 to change the name "ILAS Plenary Speaker" at the Joint Mathematics Meetings (JMM) to "ILAS Invited Address" to adjust to the names used by the organizers of the JMM.
- The Board moved on February 7, 2025 to upgrade the funding of the grants provided by ILAS and by Elsevier, the publisher of *Linear Algebra and its Applications* (*LAA*), to cover partially the expenses of Ph.D. students and early-career researchers participating in ILAS Conferences and to unify the names of these grants. More precisely, the Board moved to fund:
  (a) For the 2025 ILAS Conference: 10 ILAS-*LAA* PhD grants of \$700 each + 5 ILAS-*LAA* Early career grants of \$750 each,
  (b) For the 2026 ILAS Conference: 10 ILAS-*LAA* PhD grants of \$700 each + 5 ILAS-*LAA* Early career grants of \$750 each.

  It was also approved to reassess this initiative after the 2026 ILAS Conference depending on the financial situation of ILAS.

2. Other news:

- The Executive Board awarded on August 6, 2024 Dario Bini and Chi-Kwong Li the 2025 Hans Schneider Prize, accepting the recommendation of the Hans Schneider Prize Committee consisting of Leslie Hogben (chair), Misha Kilmer, Stephen Kirkland, Volker Mehrmann and Daniel Szyld (ILAS President, ex officio). Dario Bini was recognized for his substantial contributions to several areas of computational linear algebra, including matrix multiplication, polynomials and structured matrices, Markov chains, and algebraic Riccati equations. Chi-Kwong Li was recognized for his substantial contributions to several areas of linear algebra, including matrix analysis, operator theory, quantum information theory, and combinatorial matrix theory. Dario Bini and Chi-Kwong Li will deliver the Hans Schneider Prize lectures at the 2025 and 2026 ILAS Conferences, respectively.
- The Executive Board moved on November 21, 2024 to amend the guidelines of the Hans Schneider Prize and the ILAS Olga Taussky and John Todd Prize to define precisely what documentation must be attached to a nomination.
- The Board of Directors approved on October 4, 2024 the request of the organizers of the 9th Linear Algebra Workshop (LAW'25), to be held in Portorož, Slovenia, June 2–6, 2025, for an ILAS Lectureship for the ILAS member Helena Šmigoc.
- The Board of Directors approved on October 4, 2024 the request of the organizers of the 36th International Workshop on Operator Theory and its Applications (IWOTA), to be held at the University of Twente, Enschede, The Netherlands, July 14–18, 2025, for an ILAS Lectureship for the ILAS member Volker Mehrmann.

- The Board of Directors approved on October 4, 2024 the request of the organizers of the XXII Householder Symposium, to be held at Cornell University, Ithaca, NY, USA, June 8–13, 2025, for an ILAS Lectureship. On October 4, 2024, the name of the ILAS Lecturer was not yet known due to the special format of the Householder Symposium. The ILAS Board approved on March 28, 2025 an ILAS Lectureship at the XXII Householder Symposium for the ILAS member Ilse Ipsen.
- The Joint Mathematics Meetings 2025 (JMM 2025, an ILAS partner conference) was held in Seattle, January 8–11, 2025. The ILAS Invited Address was given by the ILAS member Anne Greenbaum with the title "Are Iterative Linear System Solvers Backward Stable?". There were seven ILAS Special Sessions, a record in the time since the agreement between ILAS and JMM was established. These sessions were: (1) Strong Properties of Matrix Classes (organized by Bryan L. Shader and Minerva Catral); (2) Matrix Analysis and Applications (organized by Tin-Yau Tam, Mohsen Aliabadi and Luyining Gan); (3) Innovative and Effective Ways to Teach Linear Algebra (organized by David M. Strong, Sepideh Stewart, Gilbert Strang and Megan Wawro); (4) Randomness in Numerical Linear Algebra (organized by Anne Greenbaum and Heather Denise Wilber); (5) 05C50 Offline (organized by Hermie Monterde and Stephen Kirkland); (6) Preserver Problems (organized by Edward Poon, Chi-Kwong Li, Sushil Singla and Bojan Kuzma); and (7) Inverse Spectral Problems for Nonnegative Matrices (organized by Pietro Paparella).
- The Executive Board accepted on March 21, 2025 the recommendation of the JMM Committee that Dominique Guillot from the University of Delaware (USA) will give the ILAS Invited Address at the 2026 Joint Mathematics Meetings, to be held in Washington, DC, January 4–7, 2026. In addition to this ILAS Lecture, there will be six ILAS Special Sessions scheduled for JMM 2026. The JMM Committee consisted of Orly Alter, Ángeles Carmona Mejía, Mark Embree, Apoorva Khare (chair), and Daniel Szyld (ILAS President, ex officio).
- ILAS funded four applications for the program of childcare grants to participants in the 26th ILAS Conference (Kaohsiung, Taiwan, June 23–27, 2025) with $500 each.

3. **ILAS elections ran November 15 – December 15, 2024, and proceeded via electronic voting.** The following were elected to offices with three-year terms that began on March 1, 2025:

   - Vice President: Froián M. Dopico
   - Board of Directors: Enide Andrade and Jephian C.-H. Lin

   The following continue in the ILAS offices which they currently hold:

   - President: Daniel Szyld (term ends February 28, 2026)
   - Secretary/Treasurer: Minerva Catral (term ends February 28, 2027)
   - Second Vice President (for ILAS conferences): Raf Vandebril (term ends February 28, 2026)
   - Assistant Secretary/Treasurer: Michael Tait (term ends February 28, 2026)
   - Board of Directors: Fernando De Terán (term ends February 28, 2026), Stefan Güttel (term ends February 28, 2027), Chi-Kwong Li (term ends February 28, 2026) and Naomi Shaked-Monderer (term ends February 28, 2027).

   Paola Boito and Lek-Heng Lim completed their terms on the ILAS Board of Directors on February 28, 2025. We thank them for their valuable contributions as Board members; their service to ILAS is most appreciated.

   We also thank the members of the Nominating Committee – Sebastian Cioabă, Melina Freitag, Karl Meerbergen, Alicia Roca, and Hugo Woerderman (chair) – for their efforts on behalf of ILAS, and all of the nominees for their participation in the elections.

4. **New appointments**

   Editor-in-Chief of *ELA* (August 1, 2025 – July 31, 2028)

   Vanni Noferini

   ILAS 2025 Nominating Committee

   Federico Poloni
   Rachel Quinlan
   Bryan Shader (chair)
   Pauline van den Driessche
   Paul Van Dooren

Joint Committee for the 2026 ILAS Olga Taussky and John Todd Prize and for the 2026 ILAS Richard A. Brualdi Early Career Prize

Misha Kilmer
Steve Kirkland (chair)
Lek-Heng Lim
Alison Ramage
Daniel Szyld (ILAS President, ex officio)

5. ILAS endorsed the following conferences of interest to ILAS members that have taken place since the last President/Vice President annual report:

- SIAM Conference on Applied Linear Algebra (LA24), Sorbonne Université, Paris, France, May 13–17, 2024. Daniel Kressner and Laura Grigori were the co-chairs of the organizing committee. The ILAS members Andrii Dmytryshyn and Beatrice Meini were the ILAS plenary speakers at the conference. `https://www.siam.org/conferences/cm/conference/la24`

- ALAMA 2024, the 8th meeting of the Spanish Thematic Network of Linear Algebra, Matrix Analysis, and Applications (ALAMA), Universidad de Oviedo, Gijón campus, Spain, June 12–14, 2024. `https://www.unioviedo.es/alama2024`

- 35th International Workshop on Operator Theory and its Applications (IWOTA 2024), University of Kent, Canterbury, UK, August 12–16, 2024. The ILAS member Mark Embree was the Israel Gohberg ILAS-IWOTA Lecturer, and the ILAS member Melina Freitag was an ILAS supported lecturer. `https://blogs.kent.ac.uk/iwota2024`

- Applied Matrix Positivity II, International Centre for Mathematical Sciences, Edinburgh, UK, November 4–8, 2024. `https://www.icms.org.uk/workshops/2024/applied-matrix-positivity-ii`

6. ILAS endorsed the following conferences of interest to ILAS members that will take place in the following months:

- VII Thematic Conference of the Spanish ALAMA Network of Linear Algebra, Matrix Analysis, and Applications (ALAMA), "A tribute to Nick Higham", International Center of Mathematical Meetings (CIEM) of the Universidad de Cantabria, Castro Urdiales, Spain, May 14–16, 2025. `https://congresosalcala.fgua.es/jornadasalama/?idioma=en`

- 9th Linear Algebra Workshop (LAW'25), Portorož, Slovenia, June 2–6, 2025. The ILAS member Helena Šmigoc will be an ILAS supported lecturer. `http://www.law05.si/law25`

- XXII Householder Symposium, Cornell University, Ithaca, NY, USA, June 8–13, 2025. The ILAS member Ilse Ipsen will be an ILAS supported lecturer. `https://householder-symposium.github.io`

- 36th International Workshop on Operator Theory and its Applications (IWOTA), University of Twente, Enschede, The Netherlands, July 14–18, 2025. The ILAS member Volker Mehrmann will be an ILAS supported lecturer. `https://www.utwente.nl/en/iwota2025`

- International Conference on Linear Algebra its Applications (ICLAA 2025) CARAMS, MAHE, Manipal, India, December 17–20, 2025. `https://carams.in/events/iclaa2025`

7. The following ILAS conferences are scheduled:

- The 26th ILAS Conference will be held at National Sun Yat-sen University (NSYSU) in Kaohsiung, Taiwan, June 23–27, 2025, with Jephian C.-H. Lin (National Sun Yat-sen University) as Chair of the Organizing Committee. The plenary speakers will be Haim Avron (Tel Aviv University, Israel, SIAG/LA Lecturer), Fan Chung Graham (University of California, San Diego, USA), Fumio Hiai (Tohoku University, Japan), Daniel Kressner (EPFL, Switzerland, *LAA* Lecturer), Ren-Cang Li (University of Texas at Arlington, USA), Karen Meagher (University of Regina, Canada), Polona Oblak (University of Ljubljana, Slovenia), Fernando De Terán (Universidad Carlos III de Madrid, Spain), Karol Życzkowski (Jagiellonian University, Poland), and the 2025 Hans Schneider Prize winner Dario Bini. Thirty-five mini-symposia covering a wide variety of topics related to linear algebra and its applications are scheduled. `https://ilas2025.tw`

- The 27th ILAS Conference will be held at Virginia Tech in Blacksburg, Virginia, USA, May 18–22, 2026, with Mark Embree and Serkan Gugercin (Virginia Tech) as co-Chairs of the Organizing Committee and Agnieszka Miedlar and Eric de Sturler (Virginia Tech) as co-Chairs of the Scientific Committee. `https://ilas2026.math.vt.edu`

8. **The following ILAS partner conference is scheduled:**

   - The Joint Mathematics Meetings 2026 will be held in Washington, DC, January 4–7, 2026. The ILAS member Dominique Guillot from the University of Delaware (USA) will give the ILAS Invited Address and the following six ILAS Special Sessions are scheduled: (1) Matrix Analysis and Applications (organized by Hugo Woerdeman and James E. Pascoe); (2) Algebraic Graph Theory: New Trends (organized by Milica Andelic, Zoran Stanic, Sudipta Mallik, and Renata Del Vecchio); (3) Innovative and Effective Ways to Teach Linear Algebra (organized by Sepideh Stewart, David Strong, Gilbert Strang, and Megan Wawro); (4) Recent Advances in Model Order Reduction and Data-Driven Modeling: Theory and Computations (organized by Steffen W. R. Werner and Ionut Farcas); (5) Matrix Analysis (organized by Tin-Yau Tam, Xiang Xiang Wang, Mohsen Aliabadi, and Dominique Guillot); and (6) Combinatorial Matrix Theory (organized by Minerva Catral and Bryan Shader).

9. **The *Electronic Journal of Linear Algebra* (*ELA*)** is now in its 41st volume. *ELA*'s URL is `https://journals.uwyo.edu/index.php/ela`. Volume 40 was published in 2024 and contains 49 papers. *ELA* received 259 new submissions in 2024. The current acceptance rate is less than 24%. In 2024, 113869 downloads and 98846 abstract views of *ELA* papers occurred.

   The current Editor-in-Chief (EiC), Froilán M. Dopico (Universidad Carlos III de Madrid, Spain), will complete his second consecutive 3-year term of service on July 31, 2025 and in accordance with the ILAS Bylaws will be replaced, by Vanni Noferini (Aalto University, Finland), on August 1, 2025.

   ILAS members are strongly encouraged to submit their work to *ELA*, the flagship research journal of our society.

10. ***IMAGE* is the semi-annual bulletin for ILAS**, available online at `https://ilasic.org/image/`. The Editor-in-Chief is Louis Deaett (Quinnipiac University, USA). In 2024, the website of *IMAGE* received 844 visits.

11. **ILAS-NET is a moderated electronic newsletter for mathematicians worldwide**, with a focus on linear algebra. It is currently managed by Leonardo Robol (Università di Pisa, Italy). An archive of ILAS-NET messages is available at `https://ilasic.org/ilas-net/`. To send a message to ILAS-NET, please send the message (preferably in text format) in an email to `leonardo.robol@unipi.it` indicating that you would like it to be posted on ILAS-NET. If the message is approved, it will be posted soon afterwards. To subscribe to ILAS-NET, please go to `https://www.ilasic.org/ilas-net/`. On April 29, 2025, there were 1294 active subscribers to the ILAS-NET newsletter.

12. **ILAS's website** is located at `https://ilasic.org/` and highlights the main activities of ILAS: the *Electronic Journal of Linear Algebra* (*ELA*), conferences, *IMAGE*, ILAS-NET and other activities. In addition, the website provides general information about ILAS (e.g., ILAS officers, bylaws, special lecturers, ILAS prizes, grant programs) as well as links to pages of interest to the ILAS community. Currently it is managed by Dominique Guillot (University of Delaware, USA). In 2024, the website of ILAS received 17274 pageviews from users from 99 countries. The front page received 8626 of these pageviews, the conference page 2794, and the *IMAGE* page 844.

13. **Number of current ILAS Members.** As of April 14, 2025, the number of ILAS members was 492.

Finally, we want to express our great gratitude to all the officers of ILAS who all show wonderful dedication to the society, as well as to all the individual members of ILAS and our corporate sponsors. Without any of them ILAS would not be what it is today.

Respectfully submitted,

Daniel B. Szyld, ILAS President (`szyld@temple.edu`); and
Froilán M. Dopico, ILAS Vice President (`dopico@math.uc3m.es`).

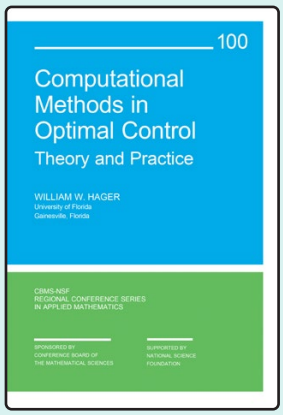
ILAS 2024–2025 Treasurer's Report

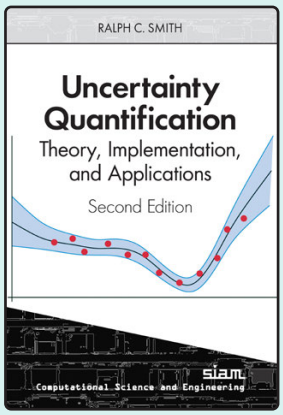
April 1, 2024 – March 31, 2025

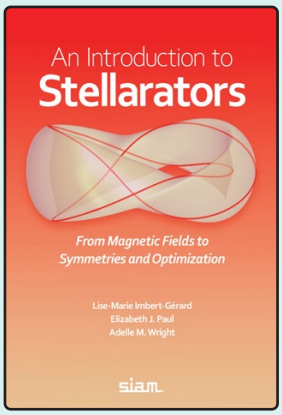
by Minerva Catral, ILAS Secretary/Treasurer

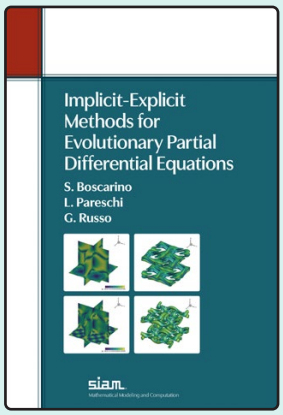
Net Account Balance on March 31, 2024			
Checking Account – First Interstate Bank		$ 20,564.32	
Certificate of Deposit 1		$ 50,000.00	
PayPal		$ 7,942.42	
Vanguard		$ 225,051.60	
Accounts Receivable		$ 100.00	
			$ 303,658.34
General Fund		$ 159,829.53	
Israel Gohberg ILAS-IWOTA Lecture Fund		$ 8,376.08	
Conference Fund		$ 10,494.17	
ILAS Olga Taussky and John Todd Prize Fund		$ 11,049.13	
Hans Schneider Lecture Fund		$ 9,558.62	
Frank Uhlig Education Fund		$ 6,083.03	
Hans Schneider Prize Fund		$ 25,690.90	
ILAS Richard A. Brualdi Early Career Prize Fund		$ 5,294.14	
ELA Fund		$ 1,507.73	
LAMA Fund		$ 65,775.01	
			$ 303,658.34
INCOME:			
Dues	$ 8,300.00		
Israel Gohberg ILAS-IWOTA Lecture Fund Donations	$ 0.00		
General Fund Donations	$ 3,100.00		
Conference Fund Donations	$ 220.00		
ILAS Olga Taussky and John Todd Prize Fund Donations	$ 0.00		
Hans Schneider Lecture Fund Donations	$ 10.00		
Uhlig Education Fund Donations	$ 50.00		
Hans Schneider Prize Fund Donations	$ 0.00		
ELA Fund Donations	$ 60.00		
ILAS Richard A. Brualdi Early Career Prize Fund Donations	$ 40.00		
Corporate Dues Income	$ 2,300.00		
Interest - First Interstate Bank	$ 11.26		
Interest on FIB Certificate of Deposit	$ 2,510.65		
Vanguard Unrealized Capital Gains	$ 15,669.86		
Miscellaneous	$ 180.00		
Total Income		$ 32,451.77	
EXPENSES:			
ILAS Conference Expenses	$ 0.00		
ELA	$ 5,055.30		
IMAGE	$ 0.00		
IWOTA	$ 1,345.91		
JMM Expenses	$ 4,281.35		
PayPal/Credit Card Processing & Bank Fees	$ 364.18		
Non-ILAS Conferences	$ 7,172.02		
Hans Schneider ILAS Lecture	$ 0.00		
Hans Schneider Prize	$ 0.00		
LAMA Lecture	$ 0.00		
ILAS Olga Taussky and John Todd Prize	$ 0.00		
ILAS Richard A. Brualdi Early Career Prize	$ 0.00		
Business License	$ 61.25		
Election Costs	$ 390.40		
Web Hosting, MailChimp & Online Membership Forms	$ 744.88		
Grant for Mathematicians in Conflict	$ 1,073.50		
Total Expenses		$ 20,488.79	
Net Account Balance on March 31, 2025			
Checking Account - First Interstate Bank		$ 24,093.70	
Certificate of Deposit		$ 35,000.00	
PayPal		$ 15,806.16	
Vanguard		$ 240,721.46	
			$ 315,621.32
General Fund		$ 163,338.72	
Israel Gohberg ILAS-IWOTA Lecture Fund		$ 7,357.62	
Conference Fund		$ 11,267.20	
ILAS Olga Taussky and John Todd Prize Fund		$ 11,678.57	
Hans Schneider Lecture Fund		$ 10,223.52	
Frank Uhlig Education Fund		$ 6,451.39	
Hans Schneider Prize Fund		$ 27,164.43	
ILAS Richard A. Brualdi Early Career Prize Fund		$ 5,763.47	
ELA Fund		$ 1,656.87	
LAMA Fund		$ 70,719.53	
			$ 315,621.32

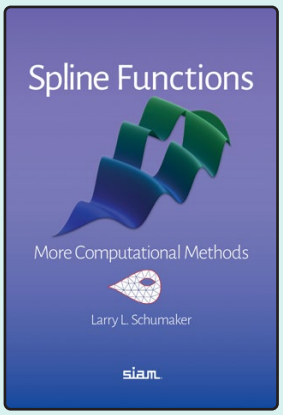
New books from SIAM

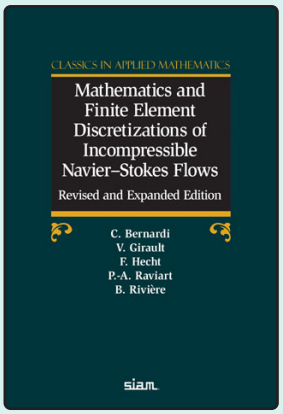


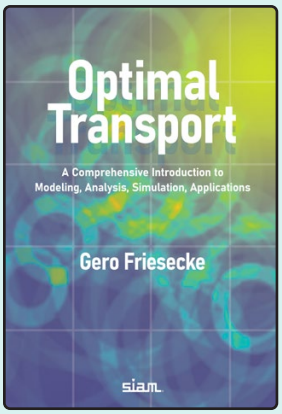


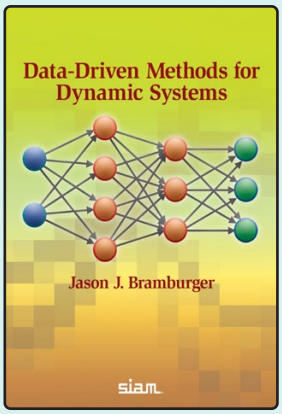


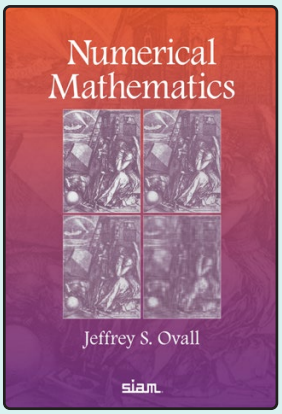


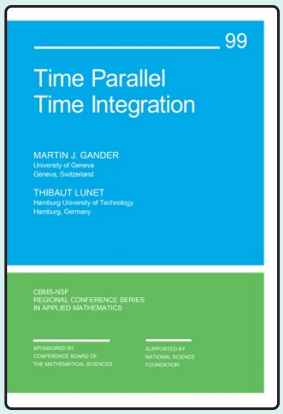












Computational Methods in Optimal Control: Theory and Practice • William W. Hager
2025 • xiv + 160 pages • Softcover • 9781611978254 • List $62.00 • Member $43.40 • CB100

Uncertainty Quantification: Theory, Implementation, and Applications, Second Edition • Ralph C. Smith
2024 • xxiv + 546 pages • Softcover • 9781611977837 • List $89.00 • Member $62.30 • CS30

An Introduction to Stellarators: From Magnetic Fields to Symmetries and Optimization
Lise-Marie Imbert-Gérard, Elizabeth J. Paul, and Adelle M. Wright
2024 • xviii + 290 pages • Softcover • 9781611978223 • List $77.00 • Member $53.90 • OT202

Implicit-Explicit Methods for Evolutionary Partial Differential Equations
Sebastiano Boscarino, Lorenzo Pareschi, and Giovanni Russo
2024 • x + 323 pages • Softcover • 9781611978193 • List $89.00 • Member $62.30 • MM24

Spline Functions: More Computational Methods • Larry L. Schumaker
2024 • xii + 337 pages • Softcover • 9781611978179 • List $89.00 • Member $62.30 • OT200

Mathematics and Finite Element Discretizations of Incompressible Navier—Stokes Flows
Christine Bernardi, Vivette Girault, Frédéric Hecht, Pierre-Arnaud Raviart, and Beatrice Rivière
2024 • xviii + 840 pages • Hardcover • 9781611978117 • List $99.00 • Member $69.30 • CL90

Optimal Transport: A Comprehensive Introduction to Modeling, Analysis, Simulation, Applications • Gero Friesecke
2024 • xii + 333 pages • Softcover • 9781611978254 • List $79.00 • Member $55.30 • CB100

Data-Driven Methods for Dynamic Systems • Jason J. Bramburger
2024 • x + 169 pages • Hardcover • 9781611978155 • List $64.00 • Member $44.80 • OT201

Numerical Mathematics • Jeffrey Ovall
2024 • xxiv + 604 pages • Softcover • 9781611978063 • List $89.00 • Member $62.30 • OT198

Time Parallel Time Integration • Martin J. Gander and Thibaut Lunet
2024 • xii + 260 pages • Softcover • 9781611978018 • List $79.00 • Member $55.30 • CB99

siam Society for Industrial and Applied Mathematics
BOOKSTORE
TO ORDER, visit *bookstore.siam.org*

CONFERENCE REPORTS

ILAS at the Joint Mathematics Meetings
Seattle, USA, January 8–11, 2025

Report by Daniel B. Szyld

ILAS was once again a partner of the Joint Mathematics Meetings (JMM). Anne Greenbaum (University of Washington) gave the ILAS Invited Address, with the title "Are Iterative Linear System Solvers Backward Stable?" The session was very well attended. In addition, we had a total of eight special sessions, for a total of fourteen three-hour slots, with sixty-one talks altogether. It was a little like having a small ILAS Conference within the JMM.

Anne Greenbaum delivers the ILAS Invited Address at the 2025 JMM (far left) and is presented by ILAS President Daniel Szyld with the associated award at the JMM awards ceremony (middle two photos); the Leslie Hogben commemorative t-shirt (far right) worn by participants who gathered to honor Leslie at the ILAS Special Session on Strong Properties of Matrix Classes (see below)

In one of the sessions, there was a surprise celebration honoring Leslie Hogben on the occasion of her retirement from teaching at Iowa State University. There were moving speeches of appreciation, and, of course, the talks were of the usual high quality.

Participants of the ILAS Special Session on Strong Properties of Matrix Classes at the 2025 JMM, which featured a celebration of Leslie Hogben's career and mentorship on the occasion of her retirement from ISU; many participants are seen wearing the commemorative Leslie Hogben t-shirt (see above)

A complete record of ILAS sessions and talks at the JMM can be found at:

`https://jointmathematicsmeetings.org/meetings/national/jmm2025/2314_ilas.html`

Special Session on Applied and Numerical Linear Algebra *at the* 95th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM) Poznań, Poland, April 7–11, 2025

Report by Agnieszka Międlar, Michal Outrata, and Michał Wojtylak

Founded in 1922 by Ludwig Prandtl and Richard von Mises, GAMM is a global network of researchers in applied mathematics, mechanics, and related fields. Each year, over 1,000 participants gather at the GAMM Annual Meeting for a dynamic exchange of ideas. Amid plenary and prize lectures, mini-symposia, as well as networking and general public events, the cutting-edge conference program features dedicated sessions focused on specific areas of specialization which offer younger participants in particular an opportunity to introduce themselves to the scientific community.

In 2025, the 95th meeting of GAMM was held in Poznań, Poland, and the linear algebra community was represented with Special Session S17, on the topic of Applied and Numerical Linear Algebra, organized by:

- Agnieszka Międlar, Virginia Tech, Blacksburg, VA, USA, `amiedlar@vt.edu`,
- Michal Outrata, Charles University, Prague, Czech Republic, `outrata@karlin.mff.cuni.cz`, and
- Michał Wojtylak, Jagiellonian University, Kraków, Poland, `michal.wojtylak@uj.edu.pl`.

Participants of the special session on Applied and Numerical Linear Algebra at GAMM 2025

Featuring sixteen talks, the session showcased a broad range of topics, including recent advances in rational functions, matrix pencils, structure-preserving techniques, partial differential-algebraic equations, mixed-precision computations, tensor methods, matrix equations, Krylov subspace methods, saddle point problems, preconditioners, Newton-Krylov methods for nonlinear eigenvector-dependent eigenvalue problems, and eigenvalue estimates. The topical speakers of the session were:

- Froilán M. Dopico, Universidad Carlos III de Madrid, Spain, with the talk *Structured rational matrices and their linearizations*, and
- André Uschmajew, Augsburg University, Germany, presenting *Accelerating operator Sinkhorn iteration with over-relaxation.*

Research discussions carried on in a vibrant and informal setting during the section's networking dinner on Wednesday, April 9th.

Papers presented during the conference may be published in *PAMM* (*Proceedings in Applied Mathematics and Mechanics*). For more information, please see the conference website:

`https://jahrestagung.gamm.org/annual-meeting-2025/95th-annual-meeting-2`


MathWorks®
A PROUD SPONSOR
OF ILAS
mathworks.com
© The MathWorks, Inc.

UPCOMING CONFERENCES AND WORKSHOPS

The 9th Linear Algebra Workshop (LAW'25)
Portorož, Slovenia, June 2–6, 2025

http://www.law05.si/law25

The LAW'xx meetings are back after a short "pandemic delay," with an opportunity to mark the round anniversary of the founder of these gatherings, Heydar Radjavi. The event is co-organized by (in alphabetical order) the Institute of Mathematics, Physics, and Mechanics (IMFM); the University of Ljubljana; and the University of Primorska.

Confirmed Invited Speakers:

- Jane Breen (Ontario Tech University, Canada)
- Doug Farenick (University of Regina, Canada)
- João Gouveia (University of Coimbra, Portugal)
- Laurent Marcoux (University of Waterloo, Canada)
- Lajos Molnár (University of Szeged and University of Budapest, Hungary)
- Clément de Seguins Pazzis (Université de Versailles Saint-Quentin-en-Yvelines, France)
- Ryotaro Tanaka (Tokyo University of Science, Japan)

ILAS Lecturer at a non-ILAS conference:

- Helena Šmigoc (University College Dublin, Ireland)

Young researcher sections. Short presentations by Ph.D. students or postdocs are welcome, as usual at LAW'xx meetings.

Working groups. Much of math research is done through discussing open problems. We always do that, but not at conferences, at least not officially. At LAW'xx gatherings, we do. Thus, the number of published papers written or at least started at these meetings is greater than the number of meetings itself. Here are the prearranged working groups (in alphabetical order of the first leader).

- Chi-Kwong Li: Preserver problems
- Mitja Mastnak and Heydar Radjavi: Local to global properties of collections of matrices
- Konrad Schmüdgen and Aljaž Zalar: Moment problems, positive polynomials and applications

Geography: As past LAW'xx meetings have visited changing locations in Slovenia, a seaside area was chosen this time, a former Venetian salt-harvesting "colony", where people are still Slovene-Italian bilingual. It includes saltpans at Sečovlje (Sicciole), the touristy place Portorož (Portorose) in the middle, and an ancient salt exporting port-fortress, Piran (Pirano).

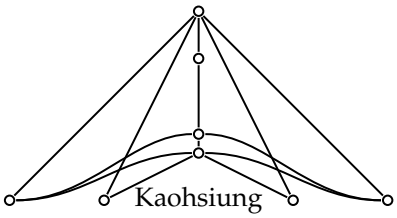
Scientific Committee: Dijana Ilišević (University of Zagreb, Croatia); Chi-Kwong Li (William & Mary, USA) Raphael Loewy (Technion - Israel Institute of Technology, Israel); Mitja Mastnak (Chair, Saint Mary's University, Canada); Martin Mathieu (Queen's University Belfast, United Kingdom); João Filipe Queiró (University of Coimbra, Portugal); and Konrad Schmüdgen (University of Leipzig, Germany).

Organizing Committee: Ljiljana Arambašić (University of Zagreb, Croatia); Bojan Kuzma (Local Organizer, University of Primorska, Slovenia); Matjaž Omladič (Chair, University of Ljubljana, Slovenia); Nik Stopar (University of Ljubljana, Slovenia); and Aljaž Zalar (University of Ljubljana, Slovenia).

Deadlines: Abstracts of contributions and early bird registrations are welcome before January 31st, 2025.

Welcoming Statement: The LAW'25 organizing team is committed to promoting an environment where everyone can be themselves and achieve their full potential regardless of protected characteristic or socio-economic background. LAW'25 will foster an atmosphere where exchange of ideas is highly encouraged and all participants feel included, valued and safe. We believe that in such atmosphere people can be more engaged and achieve more.

The 26th ILAS Conference
Kaohsiung, Taiwan, June 23–27, 2025



$\lambda_2^L = 1.6$

ILAS2025

4364962 · · ·

The 26th Conference of the International Linear Algebra Society will be held in the vibrant city of Kaohsiung, Taiwan, June 23–27, 2025. This prestigious event will bring together leading experts, researchers, and enthusiasts from around the world to share their knowledge and explore the latest advancements in the field of linear algebra.

The conference schedule includes ten plenary lectures, 35 minisymposia and a program of contributed talks.

Local Organizing Committee: Chih-Wei Chen, Tsung-Ming Huang, Hao-Wei Huang, Yueh-Cheng Kuo, Jephian C.-H. Lin, Matthew M. Lin, Ching-Sung Liu, ShengLi Tzeng, Ngai-Ching Wong, Suh-Yuh Yang.

Scientific Committee: Melina Freitag, Tsung-Ming Huang, Sejong Kim, Chi-Kwong Li, Jephian C.-H. Lin, Shahla Nasserasr, Helena Šmigoc, Daniel B. Szyld, Raf Vandebril.

Plenary speakers:

- Haim Avron (Tel Aviv University) **SIAG/LA Lecture**
  Tubal tensor algebra: mathematical foundations and applications
- Dario Bini (Università di Pisa) **Hans Schneider Prize Lecture**
  Matrix structures in queueing and network models: an overview
- Fan Chung Graham (University of California, San Diego)
  Clustering in graphs with high clustering coefficients
- Fumio Hiai (Tohoku University)
  Various inequalities for quasi-arithmetic mean and quasi-geometric type means of matrices
- Daniel Kressner (EPFL) ***LAA* Lecture**
  Adaptive randomized pivoting
- Ren-Cang Li (University of Texas at Arlington)
  Principal joint block diagonalization
- Karen Meagher (University of Regina)
  Using algebra to prove Erdős-Ko-Rado type theorems
- Polona Oblak (University of Ljubljana)
  Extremal eigenvalue multiplicities of matrices of a given pattern
- Fernando De Terán Vergara (Universidad Carlos III de Madrid)
  The canonical form for congruence: some history and applications
- Karol Życzkowski (Jagiellonian University)
  A ramble through mathematics relevant for quantum theory: A personal perspective

Minisymposia:

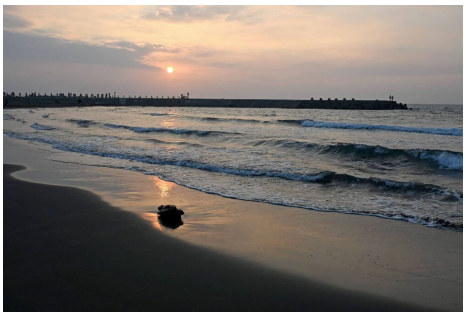
1. *Embracing new opportunities in numerical linear algebra*, Pengwen Chen and Matthrew Lin
2. *Combinatorial matrix theory*, Aida Abiad, Shaun Fallat and Michael Tait
3. *Matrix inequalities with applications*, D. S. Cvetković Ilić, Qing-Wen Wang and Yang Zhang
4. *Linear algebra methods for inverse problems and data assimilation*, Julianne Chung and Arvind K. Saibaba
5. *Advances in matrix equations: Theory, computations, and applications*, Andrii Dmytryshyn and Davide Palitta
6. *Model reduction*, Christopher Beattie and Zlatko Drmać
7. *Linear algebra and quantum information science*, Hao-Wei Huang and Ray-Kuang Lee
8. *Tensor and quantum information science*, Shmuel Friedland and Chi-Kwong Li
9. *Total positivity*, Projesh Nath Choudhury and Apoorva Khare
10. *Matrix means and related topics*, Trung Hoa Dinh, Sejong Kim and Tin-Yau Tam
11. *Structured matrix computations and its applications*, Tsung-Ming Huang, Yueh-Cheng Kuo and Wen-Wei Lin

12. *Preserver problems, I*, Lajos Molnár, Ming-Cheng Tsai and Ngai-Ching Wong
13. *Advances in QR factorizations*, Sivan Toledo
14. *Pencils, polynomial, and rational matrices*, Froilán Dopico, Vanni Noferini and Alicia Roca
15. *Graphs and their eigenvalues: Celebrating the work of Fan Chung Graham*, Mark Kempton
16. *Approximations and errors in Krylov-based solvers*, Xiaobo Liu, Xin Liu and Bastien Vieublé
17. *Graphs and matrices in honor of Leslie Hogben's retirement*, Minerva Catral and Mary Flagg
18. *New methods in numerical multilinear algebra*, Xiaobo Liu, Anna Ma, Elizabeth Newman and Eda Oktay
19. *Explicit and hidden asymptotic structures, GLT Analysis, and applications*, Sven-Erik Ekström and David Meadon
20. *Manifold learning and statistical applications*, Chih-Wei Chen and ShengLi Tzeng
21. *Linear algebra techniques in graph* , Milica Anđelić and Zhibin Du
22. *Linear algebra applications in computational geometry*, Marco Sutti and Mei-Heng Yueh
23. *Advances in Krylov subspace methods and their applications*, Michele Rinelli and Igor Simunec
24. *Nonnegative and related families of matrices*, Geir Dahl, Raphael Loewy and Julio Moro
25. *Enumerative/algebraic combinatorics and matrices*, Yen-Jen Cheng, Sen-Peng Eu and Yuan-Hsun Lo
26. *Utilizing structure to achieve low-complexity algorithms for data science, engineering, and physics*, Sirani M. Perera and Natalia Bebiano
27. *Linear algebra education* Rachel Quinlan and Sepideh Stewart
28. *From matrix theory to Euclidean Jordan algebras, FTvN systems, and beyond*, Juyoung Jeong and David Sossa
29. *Matrix functions and related topics*, Yuki Seo and Takeaki Yamazaki
30. *Bohemian matrices: Theory, applications, and explorations* Eunice Y. S. Chan and Robert M. Corless
31. *Matrix decompositions and applications*, Kennett Dela Rosa, Daryl Granario and Hermie Monterde
32. *Advances in matrix manifold optimization*, Zehua Lai
33. *Norms of matrices, numerical range, applications of functional analysis to matrix theory*, Ryan O'Loughlin, Jani Virtanen and Ilya Spitkovsky
34. *Combinatorics, association schemes, and graphs*, Wei-Hsuan Yu
35. *Preserver Problems, II*, Ngai-Ching Wong and Sushil Singla

For further details, including registration information and program updates, please visit the conference website:

`https://ilas2025.tw`

We look forward to welcoming you to this exciting event in June!



The 36th International Workshop on Operator Theory and its Applications (IWOTA) Enschede, Netherlands, July 14–18, 2025

The IWOTA conference series is the largest and most important annual event in operator theory and its applications, bringing together leading international experts from pure mathematics and application areas to trace the future development of operator theory and related areas such as complex analysis, harmonic analysis, linear algebra, random matrix theory, and mathematical physics, as well as their applications, including control theory, signal processing, and AI.

IWOTA 2025 will take place from (the afternoon of) July 14 to July 18, 2025, at the University of Twente in Enschede, The Netherlands. It will provide a medium for an intense exchange of new results, information and opinions, and for

international collaboration in operator theory and its applications worldwide. It will further set directions for future research through the conference activities and proceedings. A substantial part of the meeting will consist of more than 20 special sessions whose organizers have been selected to ensure a coherent, diverse and attractive agenda of research activity and talks. These special sessions provide opportunities for all participants to present their results and interact with other researchers with similar interests.

Plenary Speakers:

- José Manuel Conde Alonso (Universidad Autònoma de Madrid)
- Hélène Frankowska (Sorbonne University)
- Philipp Grohs (University of Vienna)
- Volker Mehrmann (TU Berlin, ILAS lecture)
- Luz Roncal (Basque Center for Applied Mathematics)
- Roland Speicher (Saarland University)
- Walter van Suijlekom (Radboud University Nijmegen)
- Quanhua Xu (University of Franche-Comté, Harbin Institute of Technology)

The conference will also host a further 12 international semi-plenary talks. The scientific program is complemented by an attractive social program including a historic steam train ride, a festive reception and a conference dinner taking place in the VIP lounge of Twente's professional soccer club, FC Twente.

The IWOTA 2025 organizing committee consists of Emiel Lorist (TU Delft), Felix Schwenninger (University of Twente), and Hans Zwart (University of Twente) in collaboration with the IWOTA executive steering committee members: J. William Helton (University of California, San Diego, USA, chair), Sanne ter Horst (North-West University, South Africa), Igor Klep (University of Ljubljana, Slovenia), Irene Sabadini (Polytecnico di Milano, Italy), Jani Virtanen (University of Helsinki, Finland, and University of Reading, UK), and Hugo J. Woerdeman (Drexel University, Pennsylvania, USA).

Registration for the conference will remain open until June 30th. For further information, including a list of special sessions, please visit `https://www.utwente.nl/en/iwota2025`.

The 4$^{\text{th}}$ Nordic Numerical Linear Algebra Workshop
Uppsala, Sweden, August 19–20, 2025

The 4th Nordic Numerical Linear Algebra workshop will be held at Uppsala University, Sweden, August 19–20, 2025. The workshop is devoted to all aspects of applied and numerical linear algebra, spanning theory, analysis, computation and methods to specific research areas in applications as well as mathematical software.

Invited speakers:

- Michele Benzi (Scuola Normale Superiore, Italy)
- Erna Begović Kovač (University of Zagreb, Croatia)
- Jörn Zimmerling (Uppsala University, Sweden)

Organizers: Roman Iakymchuk (Umeå University, Sweden), Sven-Erik Ekström (Uppsala University, Sweden), Elias Jarlebring (KTH Royal Institute of Technology, Sweden)

The organizers warmly encourage contributions for talks and would greatly appreciate your participation. Attendance is free. Register by June 10, 2025 at `http://nordic-nla.eu/uppsala-meeting-2025`.

The 15$^{\text{th}}$ Workshop on Matrices and Operators (MAO)
Regina, Canada, August 19–21, 2025

The MAO series of international workshops has promoted and instigated research and collaboration among researchers with general interests in matrix theory, operator theory, operator algebra, quantum information theory, and related topics. Participants at all levels are encouraged to present their latest research advances and discoveries and share their experiences and research problems among the participants, while fostering an atmosphere of collaboration and mutual learning. Through dialogue and knowledge exchange, this workshop aims to enhance the collective growth and development of the research community involved in matrix theory, operator theory, operator algebra, quantum information theory, and related fields.

The workshops began in 2007 and ran annually through 2019, after which the series was halted due to COVID-19, until it resumed in 2024. A detailed 20-year history of the MAO workshop series can be found at `https://cklixx.people.wm.edu/mao-history.html`.

The 2025 MAO workshop will be held at the University of Regina in Regina, Saskatchewan, August 19th – 21st.

Information on registration, housing, the conference schedule (when available), and the conference location can be found on the official MAO 2025 conference website, `https://sites.google.com/view/matrices-and-operators-2025/home`.

A designated email contact has been set up and is `mao2025@uregina.ca`. Please use this email for all correspondence associated with MAO 2025.

The organizers of MAO 2025 are Shaun Fallat, Douglas Farenick, Sushil Singla (all of the University of Regina) and Chi-Kwong Li (of the College of William and Mary). The organizers gratefully acknowledge financial support from the Faculty of Science at the University of Regina.

The 3rd Workshop on Low-Rank Models and Applications (LRMA) Mons, Belgium, September 11–12, 2025

The third workshop on Low-Rank Models and Applications (LRMA) will take place on the 11th and 12th of September 2025 at the University of Mons, Belgium. The LRMA workshop will offer a vibrant and intimate venue for interactions between researchers from fields such as numerical analysis, computer science, information theory, mathematics, and signal processing. The scientific program will include invited plenary lectures, as well as regular contributed talks and posters. The plenary speakers are:

- Stanislav Budzinskiy (University of Vienna)
- Luca Calatroni (CNRS, i3S laboratory of Sophia Antipolis)
- Alice Cortinovis (University of Pisa)
- Mariya Ishteva (KU Leuven)
- Paul Magron (LORIA, Centre INRIA de l'Université de Lorraine)
- Margherita Porcelli (University of Florence)
- Bertrand Rivet (Grenoble-INP)
- Lawrence Saul (Flatiron Institute)

The call for papers is available at `https://bit.ly/LRMA25`. The deadline for submitting an abstract is July 4th, 2025. All relevant information can be found at: `https://sites.google.com/view/lrma25`

Workshop on Spectral Graph Theory 2025 (WSGT 2025) Gramado, Brazil, October 28–31, 2025

The Brazilian community in Spectral Graph Theory is very pleased to announce the 2025 Workshop on Spectral Graph Theory, in honor of Vilmar Trevisan for his 65th birthday. The meeting will be held from October 28th to 31st, 2025 at the conference center of the Buona Vitta Gramado, in Gramado, Rio Grande do Sul, Brazil.

The aim of this workshop is to bring together young and experienced researchers in subjects related to spectral graph theory and its applications. The official language of the event is English, and the call for submissions is now open.

For more information, please visit `https://spectralgraphtheory.org/ed2025` or send a message to the organizers at `wspectralgraphtheory@gmail.com`.

International Conference on Linear Algebra and its Applications (ICLAA 2025) Manipal, India, December 17–20, 2025

The International Conference on Linear Algebra and its Applications (ICLAA 2025) will be organized by the Center for Advanced Research in Applied Mathematics & Statistics (CARAMS), Manipal Academy of Higher Education (MAHE), Manipal, India, and held December 17–20, 2025. The Scientific Advisory Committee consists of Ravindra B. Bapat (chair), Manjunatha Prasad Karantha (convener), Steve Kirkland, and Simo Puntanen. The conference is endorsed by ILAS.

This conference is the sixth in its series and is in sequel to the conferences CMTGIM 2012, ICLAA 2014, ICLAA 2017, ICLAA 2020(21), and ICLAA 2023, held in Manipal during January 2012, December 2014, December 2017, December 2021, and December 2023, respectively. The present conference shall provide an avenue for leading mathematicians, statisticians, and applied scientists who are working around the globe in the theme area to get together in physical space, interact with each other, discuss research issues, and introduce new innovations. Besides arranging invited talks from eminent speakers, the organizers invite participants to present their research in the sessions of contributed talks.

The tentative list of speakers includes eminent mathematicians such as Abraham Berman, T. E. S. Raghavan, Shaun M. Fallat, Stephen J. Haslett, Surender Kumar Jain, Stephen J. Kirkland, Andre Leroy, Lina Mallozzi, Augustyn Markiewicz, Simo Puntanen, Dietrich von Rosen, R. Balakrishnan, Apoorva Khare, Samir K. Neogy, T. S. S. R. K. Rao, Sukanta Pati, K. C. Sivakumar, Sivaramakrishnan Sivasubramanian, and Murali K. Srinivasan.

For an up-to-date list of speakers and other details, see the ICLAA 2025 webpage at `https://carams.in/events/iclaa2025`.

All original papers selected for presentation in the conference will be forwarded to the review process in the appropriate conference publications.

Preconference Workshop IWSMGA 2025: The ICLAA 2025 conference will take place following a preconference workshop, the "International Workshop on Special Matrices, Graphs, and Applications" that will be held December 10–16, 2025, and for which the resource persons are Abraham Berman, Stephen J. Kirkland, Simo Puntanen, T. E. S. Raghavan, S. K. Neogy, Sukanta Pati, Sivaramakrishnan Sivasubramanian and other leading personalities in the subject. For more details, visit the IWSMGA 2025 webpage at `https://carams.in/events/iwsmga2025`.

Registration is open for both the conference and the workshop. For timelines, registration fees, and other details, visit `https://carams.in`. You may also write to the organizing secretary, K. Manjunatha Prasad, at `carams.mahe@gmail.com` or `kmprasad63@gmail.com`.

The 27th ILAS Conference: Linear Algebra on the Blue Ridge: Panoramas of Theory and Application
Blacksburg, Virginia, USA, May 18–22, 2026

The 27th Conference of the International Linear Algebra Society will be held in Blacksburg, Virginia from May 18–22, 2026, on the campus of Virginia Tech. The conference's theme, "Linear Algebra on the Blue Ridge: Panoramas of Theory and Application" highlights the geographical setting for the conference in the mountains of southwest Virginia, but also serves as an invitation to researchers from across linear algebra, ranging from core areas through to numerical analysis, applications, and linear algebra education.

Local Organizing Committee: Christopher Beattie, Paul Cazeaux, Eric de Sturler, Mark Embree, Serkan Gugercin, Agnieszka Miedlar, Mirjeta Pasha, Megan Wawro, Steffen Werner.

Scientific Committee: Shreemayee Bora, Geir Dahl, Eric de Sturler, Ioana Dumitriu, Stefan Güttel, Misha Kilmer, Agnieszka Miedlar, André Ran, Helena Šmigoc, David Strong, Daniel Szyld, Raf Vandebril, Heather Wilber.

Further details, such as registration information, lodging details, and program updates, will be available in due course from the conference website `https://ilas2026.math.vt.edu`. For immediate questions, email the local organizing committee at `ilas2026@math.vt.edu`.

We look forward to a vibrant ILAS meeting in May 2026, and hope to see you in Blacksburg!

ONGOING ONLINE SEMINARS

Algebraic Graph Theory Seminar

`https://math.uwaterloo.ca/~agtheory`

Host: University of Waterloo

Schedule: weekly on Mondays

Time: 11:30AM, Waterloo (Ontario, Canada) time

Most recent talk:

Alice, Bob, and colours: an algebraic approach to quantum advantage

Lorenzo Ciardo (University of Oxford, United Kingdom)

Next talk: TBA

Contact: Sabrina Lato (`smlato@uwaterloo.ca`)

Matrix Seminar

`https://docs.google.com/document/d/1MswSd16JqsZE294kYCXujLio4cnAiuYv6QKRc6BxvI0/edit`

Host: University of Nevada, Reno

Schedule: biweekly on Fridays

Time: 4:15PM, Reno (Nevada, USA) time

Most recent talk:

Multplicity of points in the k-numerical range

Nancy Menzelthe (University of Nevada, Reno)

Next talk: TBA

Contact: Pan Shun Lau (`plau@unr.edu`)

05C50 Online

`https://sites.google.com/view/05c50online/home`

Host: University of Manitoba

Schedule: biweekly on Fridays

Time: 10:00AM, Winnipeg (Manitoba, Canada) time

Most recent talk:

Entrywise transforms and positive definite matrices over finite fields

Prateek Vishwakarma (Université Laval, Canada)

Next talk: September 2025

Contact: Hermie Monterde (`monterdh@myumanitoba.ca`)

Matrix Analysis and Linear Algebra Group Seminar

`https://sites.google.com/up.edu.ph/mala/`

Host: University of the Philippines Diliman

Schedule: for this semester: biweekly on Mondays (TBD for next semester)

Time: for this semester: 10:00AM, Philippine Standard Time (TBD for next semester)

Most recent talk:

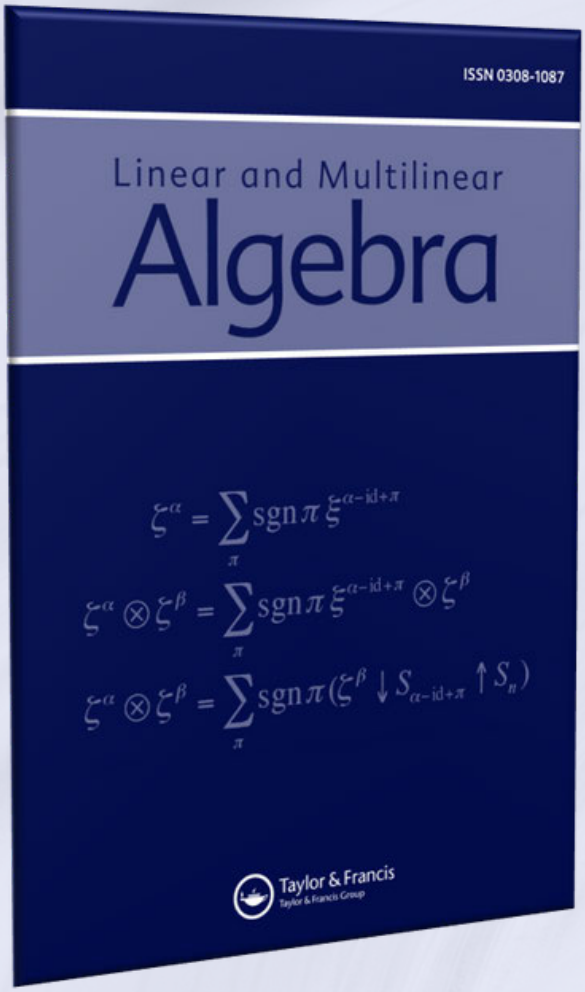
Initially Positive Sign Patterns

Denise Mae Go (De La Salle University, Philippines)

Next talk: TBA

Contact: Kennett Dela Rosa (`prkdelarosa@math.upd.edu.ph`)

LINEAR AND MULTILINEAR ALGEBRA



Linear and Multilinear Algebra publishes high-quality original research papers that advance the study of linear and multilinear algebra, or that include novel applications of linear and multilinear algebra to other branches of mathematics and science.

Linear and Multilinear Algebra also publishes research problems, survey articles and book reviews of interest to researchers in linear and multilinear algebra.

Members of the International Linear Algebra Society can benefit from a special society member rate on individual subscriptions to *Linear and Multilinear Algebra*.

Read, register, and subscribe at:
www.tandfonline.com/glma

Taylor & Francis Group
an **informa** business

Send News for *IMAGE* Issue 75

IMAGE seeks to publish all news of interest to the linear algebra community. Issue 75 of *IMAGE* is due to appear online on December 1, 2025. Send your news for this issue to the appropriate editor by October 15, 2025. Photos are always welcome, as well as suggestions for improving the newsletter. Please send contributions directly to the appropriate editor:

- book reviews to Mohsen Aliabadi (`maliabadisr@ucsd.edu`)
- linear algebra education news and articles to Sepideh Stewart (`sepidehstewart@ou.edu`)
- interviews of senior linear algebraists to the editor-in-chief, Louis Deaett (`louis.deaett@quinnipiac.edu`)
- problems and solutions to Jeffrey Stuart (`jeffrey.stuart@plu.edu`)
- advertisements to Amy Wehe (`awehe@fitchburgstate.edu`)
- announcements and reports of conferences/workshops/etc. to Jephian C.-H. Lin (`jephianlin@gmail.com`)
- other articles and proposals to the editor-in-chief, Louis Deaett (`louis.deaett@quinnipiac.edu`)

Send all other correspondence to the editor-in-chief, Louis Deaett (`louis.deaett@quinnipiac.edu`).

For past issues of *IMAGE*, please visit `https://www.ilasic.org/IMAGE`.

IMAGE PROBLEM CORNER: OLD PROBLEMS WITH SOLUTIONS

We present a counterexample to Problem 73-1. Solutions are invited to Problems 68-2, 68-4, 69-2, 69-3, 70-2, 71-3, 72-1, 72-2, 73-2, and to the two new problems from the present issue 74.

Problem 73-1: Generalised Quadratic Equations of Higher Order
Proposed by Richard William Farebrother, *Bayston Hill, Shrewsbury, England*, `R.W.Farebrother@hotmail.com`

Let n be a positive integer. Suppose that A is a nonzero $n \times n$ complex matrix satisfying

$$A^{r+2} = \alpha A^{r+1} + \beta A^r$$

for some positive integer $r \geq 1$ and some nonzero complex numbers α and β.

Show that, provided A is not nilpotent, A also satisfies the generalised quadratic equation

$$A^2 = \alpha A + \beta P,$$

for some $n \times n$ complex matrix P satisfying $P^2 = P$ and $AP = PA = A$.

Solution 73-1 by Roger A. Horn, *University of Utah, Salt Lake City, Utah, USA*, `rhorn@math.utah.edu`

The claim in the problem is not correct. It suffices to give an example in which, under the stated hypotheses, $\beta^{-1}(A^2 - \alpha A)$ is not a projection. Let $n = 3$, $r = 2$, $\alpha = 3$, $\beta = -2$, and $A = [1] \oplus J_2$, in which J_2 is the 2×2 nilpotent Jordan block. Then $A^k = [1] \oplus 0_2$ for every $k \geq 2$, so that A is not nilpotent and, in particular, $A^2 = A^3 = A^4$, so that

$$\alpha A^{r+1} + \beta A^r = 3A^3 - 2A^2 = A^4 = A^{r+2}.$$

Then

$$P = \frac{1}{\beta}(A^2 - \alpha A) = -\frac{1}{2}(A^2 - 3A) = [1] \oplus \left(\frac{3}{2} J_2\right)$$

commutes with A, but $PA \neq A$ and P is not a projection.

IMAGE PROBLEM CORNER: NEW PROBLEMS

Problems: We offer two new problems in this issue and invite readers to submit solutions for publication in *IMAGE*.
Submissions: Please submit proposed problems and solutions in macro-free LaTeX along with the PDF file by e-mail to *IMAGE* Problem Corner editor Jeff Stuart (`jeffrey.stuart@plu.edu`).

New Problems:

Problem 74-1: Determinant of a Matrix Difference

Proposed by Roger A. Horn, *University of Utah, Salt Lake City, Utah, USA*, `rhorn@math.utah.edu`

Let $n \geq 2$. Let A and B be $n \times n$ complex matrices such that $\det A = \det B$ and $\operatorname{rank}(A+B) = 1$. Show: (a) If $\det A \neq 0$, then $\det(A-B) = 0$ if and only if n is odd. (b) If $\det A = 0$, then $\det(A-B) = 0$.

Problem 74-2: Determinant of a Matrix of Factorials

Proposed by Jeffrey Stuart, *Pacific Lutheran University, Tacoma, Washington, USA*, `jeffrey.stuart@plu.edu`

Let n and p be positive integers. For the $n \times n$ matrix $A = (a_{ij})$ with $a_{ij} = (i+j-1)!$ for $1 \leq i, j \leq n$,

$$\det A = \prod_{k=0}^{n-1} [k!(n-k)!] .$$

For the $n \times n$ matrix $B = (b_{ij})$ with $b_{ij} = (p+i+j-1)!$ for $1 \leq i, j \leq n$,

$$\det B = \prod_{k=0}^{n-1} [k!(p+k)!] .$$

A solution to Problem 73-1 appears on page 27.