Ilse C.F. Ipsen

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Main Research Interests Numerical linear algebra; randomized algorithms; probabilistic numerical analysis; applications to science, engineering and data science

Employment

Dinstinguished Professor, Mathematics, North Carolina State University, 2023-present
Professor, Mathematics, North Carolina State University, 1998-present
Graduate Faculty, Department of Statistics, 2018-present
Associate Professor, Mathematics, North Carolina State University, 1993-1998
Associate Professor, Computer Science, Yale University, 1988-1993
Assistant Professor, Computer Science, Yale University, 1985-1988
Associate Research Scientist, Computer Science, Yale University, 1983-1985

Consultant, Scientific Research Associates, New Haven, 1987
Research Associate, AERE Harwell, United Kingdom, summer 1986
Visiting Scientist, ICASE, NASA Langley, summer 1984, 1985

Education

Ph.D. Computer Science, 1983, The Pennsylvania State University
Vordiplom Informatik/Mathematik (summa cum laude), 1977, Universität Kaiserslautern, Germany

Ph.D. Students

Elizabeth R. Jessup (1989), Shivkumar Chandrasekaran (1994), Rebecca S. Wills (2007), Teresa M. Selee (2008), Rizwana Rehman (2010), Thomas Wentworth (2014), John Holodnak (2015), Jocelyn T. Chi (2021), Tim W. Reid (2022), Arnel Smith (current)

Outside Recognition

Fellow, American Association for the Advancement of Science
Fellow, Society for Industrial and Applied Mathematics
ICIAM Olga-Taussky Todd Lecture, August 2023
The work on mapping algorithms to systolic devices was judged to be one of the ten best research projects sponsored by the Department of Defense in 1986.

Book *Numerical Matrix Analysis: Linear Systems and Least Squares*, SIAM, 2009

Plenary Talks at National and International Meetings

Olga Taussky-Todd Lecture, International Congress on Industrial and Applied Mathematics (ICIAM), Tokyo, 20-25 August 2023

Workshop on Advances in Numerical Linear Algebra: Celebrating the 60th Birthday of Nick Higham, University of Manchester, UK, 7 July 2022

One-World Mathematics of Information, Data and Signals Seminar, 20 January 2022

Workshop on Advances in Numerical Linear Algebra and High Performance Computing: Celebrating the 70th Birthday of Jack Dongarra, University of Manchester, UK, 8 July 2021

46th Annual Mathematical Sciences Spring Lecture Series at the University of Arkansas, 9 April 2021

E-NLA: Online Seminar series on Numerical Linear Algebra, 20 May 2020
`https://www.youtube.com/watch?v=3ACrpojTJlw`

Workshop on Randomized Numerical Linear Algebra, Statistics, and Optimization, DIMACS, Rutgers University, 16-18 September 2019

Workshop on Advances in Numerical Linear Algebra: Celebrating the Centenary of the Birth of James H. Wilkinson, Manchester, UK, 29-30 May 2019

PIMS Distinguished Lecture, University of Manitoba, Winnipeg, Canada, 14 March 2019

Workshop on Randomized Numerical Linear Algebra and Applications, Simons Institute, UC Berkeley, 24-28 September 2018

Mid-Atlantic Numerical Analysis Day, Temple University, 3 November 2017

5th International Conference on Numerical Linear Algebra and Scientific Computing, Shanghai, 24-30 October 2014

Workshop on Algorithms for Modern Massive Datasets (MMDS), UC Berkeley, 17-20 June 2014

10th International Workshop on Accurate Solution of Eigenvalue Problems (IWASEP X), Dubrovnik, Croatia, 2-5 June 2014

AMS SEAS meeting, Knoxville, TN, 21-23 March 2014

Workshop on Advances in Matrix Functions and Matrix Equations, University of Manchester, UK, 10-12 April 2013

SIAM-SEAS Meeting, University of Tennessee, 23-24 March 2013

9th International Workshop on Accurate Solution of Eigenvalue Problems (IWASEP IX), Napa Valley, 4-7 June 2012

New England Numerical Analysis Day, University of Massachusetts Dartmouth, 16 April 2011

Conference on Numerical Linear Algebra: Perturbation, Performance and Portability, Austin, Texas, 19-20 July 2010

Workshop on Algorithms for Modern Massive Data Sets, Stanford, CA, 15-18 June 2010

Western Canada Linear Algebra Meeting, Banff, Canada, 7-9 May 2010

23rd Biennial Numerical Analysis Conference, University of Glasgow, Scotland, June 2009

Workshop on Large Graphs and Networks: Matrix Algorithms and Applications, University of Manchester, UK, September 2007

VI International Workshop on Accurate Solution of Eigenvalue Problems, Penn State, May 2006

Workshop on Algorithmic and Numerical Aspects of Web Search, Pisa, Italy, 6-7 February 2006

Seventh IMACS International Symposium on Iterative Methods in Scientific Computing, Fields Institute, Toronto, Ontario, Canada, 5-8 May 2005

Householder Symposium XVI, 23-27 May 2005, Silver Springs, PA
12th Meeting of the International Linear Algebra Society (ILAS), Regina, Canada 26-29 June 2005
V International Workshop on Accurate Solution of Eigenvalue Problems, Hagen, Germany, June 2004
BIRS Workshop on Theory and Numerics of Matrix Eigenvalue Problems, Banff, Canada, November 2003
Theoretical and Computational Aspects of Matrix Algorithms, Dagstuhl-Seminar, Germany, October 2003
Matrix Analysis and Applied Linear Algebra, Raleigh, May 2003
Householder Symposium XV, Peebles, Scotland, June 2002
IV International Workshop on Accurate Solution of Eigenvalue Problems, Split, Croatia, June 2002
III International Workshop on Accurate Solution of Eigenvalue Problems, Hagen, Germany, July 2000
International Workshop on Accurate Solution of Eigenvalue Problems, Pennsylvania State University, University Park, July 1998
ODE to linear Algebra and Rational Approximation, conference on the occasion of William B. Gragg's 60th birthday, Naval Postgraduate School, Monterey, CA, November 1996
International Workshop on Eigenvalue Problems, Split, Croatia, July 1996
The XIII Householder Symposium on Numerical Linear Algebra, Pontresina, Switzerland, June 1996
Workshop on Eigenvalues and Beyond, Linear Algebra Year at CERFACS, Toulouse, France, October 1995
Fifth Conference of the International Linear Algebra Society (ILAS), Atlanta, August 1995
The XII Householder Symposium on Numerical Algebra, Lake Arrowhead, June 1993
Workshop on Reliability of Computations, Toulouse, France, March 1993
92 Shanghai International Numerical Algebra and its Applications Conference, Shanghai, China, October 1992
The XI Householder Symposium on Numerical Algebra, Tylosand, Sweden, June 1990
International Symposium on Optimal Algorithms, Varna, Bulgaria, May 1989
NATO Advanced Study Institute on Numerical Linear Algebra, Digital Signal Processing and Parallel Algorithms, Leuven, Belgium, August 1988
Seminar on Mathematical Methods of VLSI Design and Distributed Computing, Oberwolfach, West Germany, November 1987
Gatlinburg X, Fairfield Glade, October 1987
Conference on Vector and Parallel Processing in Computational Science III, Liverpool, United Kingdom, August 1987
Opening ceremony of the Konrad Zuse Centre in Berlin, West Germany, June 1987
Seminar on Large Eigenvalue Problems, IBM Europe Institute, Oberlech, Austria, 1985
Gatlinburg IX, University of Waterloo, Canada, July 1984

Invited Talks at Special Sessions of National and International Meetings

Minisymposium on "Randomized Methods in Large-Scale Inference and Data Problems", SIAM Conference on Data Science, San Diego, 23-30 September 2022
NeurIPS Workshop on "Your model is wrong: robustness and misspecification in probabilistic modeling", 14 December 2021

SAMSI Transition workshop: Numerical Analysis of Data Science, 24 May 2021
Minisymposium on "Accurate and Reliable Computations in Data Science", SIAM Conference on the Mathematics of Data Science, Cincinnati, Ohio, 5-7 May 2020
Minisymposium on "Advances in Analyzing Floating Point Errors in Computational Science", SIAM Conference on Computational Science and Engineering, Spokane, WA, 27 February 2019
Minisymposium on "Some Fundamental Ideas not Appearing in the Standard Curriculum", SIAM Conference on Applied Mathematics Education, Portland, OR, 9-11 July 2018
Minisymposium on "Randomized Methods in Inverse Problems and Uncertainty Quantification", SIAM Conference on Uncertainty Quantification, Garden Grove, CA, 16 April 2018
DOE ASCR Scientific Machine Learning Workshop, Bethesda, MD, 30 January 2018
Minisymposium on "Linear Algebra and Positivity with Applications to Data Science", Meeting of the International Linear Algebra Society (ILAS), Ames, IA, 27 July 2017
Minisymposium on "Inverse Problems Meet Big Data", SIAM Conference on Computational Science and Engineering, Atlanta, GA, 27 February 2017
Invited minitutorial on "Randomization in Numerical Linear Algebra", SIAM Conference on Applied Linear Algebra, Atlanta, GA, 26 October 2015
Minisymposium on "Randomized Algorithms in Numerical Linear Algebra", SIAM Conference on Computational Science and Engineering, Salt Lake City, Utah, 18 March 2015
Minisymposium on "Advances in Krylov and Extended Krylov Subspace Methods", SIAM Annual Meeting, Chicago, IL, 9 July 2014
Minisymposia on "Randomized Matrix Algorithms" and "Structure and Randomization in Matrix Computations", Meeting of the International Linear Algebra Society (ILAS), Providence, RI, 3-7 June 2013
Workshop on "Randomized Numerical Linear Algebra: Theory & Practice", New Brunswick, NJ, 20 October 2012
Minisymposium on "Applications of statistics to numerical linear algebra algorithms", SIAM Conference on Applied Linear Algebra, Valencia, Spain, 18-22 June 2012
Symposium of the IFIP Working Group 2.5 on Numerical Software, Raleigh, 31 August - 1 September 2009
Special session on Numerical Linear Algebra, CEDYA-2005, Madrid, Spain, 19-23 September 2005
Minisymposium on Eigenvector Methods in Information Retrieval, 2005 SIAM Annual Meeting, New Orleans, July 2005
Minisymposium on Markov Chains and PageRank, 2004 SIAM Annual Meeting, Portland, OR, July 2004
Minisymposium on Fast, Accurate Solution of Eigenvalue and Singular Value Problems, Eighth SIAM Conference on Applied Linear Algebra, College of William & Mary, July 2003
Special Session on Linear Algebra and Optimization, Joint Mathematics Meeting, Washington, DC, January 2000
Householder Meeting XIV on Numerical Linear Algebra, Whistler, B.C., Canada, June 1999
Minisymposium on Numerical Linear Algebra, 7th Conference of the International Linear Algebra Society, University of Wisconsin, Madison, June 1998
AMS Southeastern Regional Meeting, Session on Numerical Linear Algebra, Chattanooga,

Tennessee, October 1996
Workshop on Numerical Linear Algebra, 1995 AMS-SIAM Summer Seminar on the Mathematics of Numerical Analysis: Real Number Algorithms, Park City, Utah, August 1995
Third International Congress on Industrial and Applied Mathematics (ICIAM 95), Hamburg, Germany, July 1995
Fifth SIAM Conference on Applied Linear Algebra, Snowbird, Utah, June 1994
Minisymposium on Computational Aspects of Markov Chains, 1994 SIAM Annual Meeting, San Diego, July 1994
SIAM Conference on Linear Algebra in Signals, Systems and Control, Seattle, August 1993
Annual Meeting of the German Society for Applied Mathematics and Mechanics (GAMM), Dresden, Germany, April 1993
40th SIAM Anniversary Meeting, Los Angeles, July 1992
Fourth SIAM Conference on Applied Linear Algebra, Minneapolis, September 1991
NA-Day at Stanford (a part of the 25th anniversary celebration of the Stanford CS Department), 9 November 1990
Second SIAM Conference on Linear Algebra in Signals, Systems and Control, San Francisco, November 1990
First International Conference on Industrial and Applied Mathematics, Paris, France, July 1987
Sixth IMACS Symposium on Computer Methods for Partial Differential Equations, Lehigh University, June 1987
Workshop on Numerical Algorithms for Modern Parallel Computer Architectures, Institute for Mathematics and its Applications, University of Minnesota, November 1986
SIAM Conference on Linear Algebra in Signals, Systems and Control, Boston, August 1986
Workshop on Scientific Applications and Algorithm Design for High Speed Computing, University of Illinois at Urbana-Champaign, April 1986
SPIE Symposium, 549 (Real Time Signal Processing VII), San Diego, 1984

Editorial Work

Founding Editor in Chief, SIAM Book Series on Data Science, 2018-present
Editorial committee, Mathematical Reviews, 2022-present
Editorial board, Acta Numerica, 2016-present
Editorial board, SIAM Review, 2004-present
Editorial Board, SIAM Book Series on Fundamentals of Algorithms, 2014-present
Editorial board, Numerische Mathematik, 2004-present
Editorial board, Numerical Linear Algebra with Applications. 2007-present
Editorial board, Linear Algebra and its Applications, 2023-present
Editorial Board, SIAM Journal on Mathematics of Data Science, 2018
Special editor, Statistics and Computing, 2018
Editorial board, SIAM J. Matrix Anal. Appl., 1997-2014
Editorial board, SIAM J. Sci. Comput. Big Data issue, 2012-2013
Special issue editor, Linear Algebra Appl., 2007, 2012-2013
Section editor, SIAM Review, 2005-2011
Editor-in-charge, SIAM J. Matrix Anal. Appl. special issues, 2006, 2009

Professional Activities

Chair, SIAM Activity Group on Data Science, 2022-present
Nominating Committee of the SIAM Activity Group on Linear Algebra, 2021-present
ILAS Lecturer Selection Committee, 2021 - present
Early Career Prize Committee of the SIAM Activity Group on Linear Algebra, 2020 -
SIAG/LA Nominating Committee: 2021, co-chair (2015)
Selection Committee, SDM/IBM Early Career Data Mining Researcher Award for Excellence in Data Analytics, 2019
Steering Committee and Mentor, NSF CHE-DMS Innovation Lab: Learning the Power of Data in Chemistry, Warrenton, VA, 17-21 December 2018
Steering Committee, NSF DMS Workshop on the Algorithmic, Mathematical, and Statistical Foundations of Data Science, April 2016
AAAS Electorate Nominating Committee, Section on Mathematics, 2016-2018
SIAM Journal Committee, 2013-2018
SAMSI Associate Director, 2011-2018
SIAM Vice President at Large, 2016-2017
Chair, ILAS Journal Committee, 2014-2016
Hans Schneider Prize Committee, 2014
SIAM George Pólya Prize for Mathematical Exposition Committee, 2014
Chair, ILAS Advisory Committee, 2011-2014
AWM-SIAM Sonia Kovalevsky Lecture Selection Committee, 2011-2012
SIAM Fellows Selection Committee, 2012-2013
SIAM Vice President for Programs, 2004-2009
Board of Directors, International Linear Algebra Society (ILAS), 2005-2007
Chair, SIAM Activity Group on Linear Algebra (SIAG/LA), 2004-2006
Program director, SIAM Activity Group on Linear Algebra (SIAG/LA), 1998-2003
SIAG/LA representative to SIAM News, 2001-2006
Reviewer for Mathematical Reviews, 1998-present
NERSC Computational Review Panel, 2002-2005
NSF review panels 1991, 1994, 1995, 2000, 2004-2009, 2011, 2013, 2015, 2020
NSF site visit team (CISE Institutional Infrastructure proposal) 1994

Conference and Workshop Organization

Co-organizer, Computational Mathematics for the 21st Century: 30 years of Acta Numerica, Banach Center, Poland, 26 June-2 July 2022
Organizing Committee, ENLA (Online Seminar Series on Numerical Linear Algebra), 2021-present
Organizing Committee, Seminar Series on Complexity of Matrix Computations, 2021-present
Gene Golub SIAM Summer School Committee, 2019-present
Co-organizer, Dagstuhl Seminar on Probabilistic Numerical Methods – From Theory to Implementation, Schloss Dagstuhl, Germany, October 2021
Co-organizer, Workshop on Numerical Linear Algebra, Foundations of Computational Mathematics (FoCM), Vancouver, Canada, 22-24 June 2020 (cancelled)
Scientific Program Committee, International Congress on Industrial and Applied Mathematics (ICIAM): 2019 Valencia, Spain, and 2007 Zürich, Switzerland

Steering Committee, NSF Workshop on Algorithmic, Mathematical, and Statistical Foundations of Data Science, April 2016

Co-organizer, Gene Golub SIAM Summer School on Randomization in Numerical Linear Algebra, Delphi, Greece, June 2015

Invited sessions at the Joint Statistical Meetings: 2013 Montréal, and 2014 Boston

Organizer, SAMSI Industrial Mathematical & Statistical Modeling Workshop for Graduate Students, 2009-2016

Householder Committee, 2005-2017

Chair, Householder Symposium XIX, Spa, Belgium, 9-13 June 2014

Steering Committee, International Summer School on Numerical Linear Algebra, 2008

Program Committee, Sixth Meeting on the Numerical Solution of Markov Chains, Williamsburg, VA, September 2010

Member, AMS-IMS-SIAM Committee on Summer Research Conferences in the Mathematical Sciences, 2004-2006

Chair, SIAM evaluation committee for ICIAM 2007 travel grants

Organizing Committee, 2007 Meeting of the International Linear Algebra Society (ILAS), Shanghai, China, July 2007

Steering and Program Committees, 150th Markov Chain Anniversary meeting, Charleston, SC, 12-14 June 2006

Organizing Committee, 2005 SIAM Annual Meeting, New Orleans, July 2005

Co-chair, First Joint Meeting of CAIMS & SIAM, 2003 SIAM Annual Meeting, Montréal, Canada, June 2003

Organizing Committee, Eighth SIAM Conference on Applied Linear Algebra, Williamsburg, VA, July 2003

Member, SIAM Coordinating Committee for the Joint Mathematics Meetings, 2001-2002

Co-chair, Seventh SIAM Conference on Applied Linear Algebra 2000, Raleigh, NC, October 2000

Organizing Committee, Sixth SIAM Conference on Applied Linear Algebra, Snowbird, Utah, October 1997

Co-Chair, Workshop on Krylov-Space Methods and Applications, Raleigh, March 1995

Organizing Committee, International Workshop on the Numerical Solution of Markov Chains, Raleigh, January 1995

Chair, Workshop on Systolic Algorithms and Architectures, Hilton Head, SC, December 1986

Research Publications

[1] T. W. Reid, I. C. F. Ipsen, J. Cockayne, and C. J. Oates. Statistical properties of the probabilistic numeric solver BayesCG. *Under revision for Numer. Math.* arXiv:2208.03885.

[2] K. J. Pearce, I. C. F. Ipsen, M. A. Haider, A. K. Saibaba, and R. C. Smith. Robust parameter sensitivity analysis via column subset selection. *Submitted.* arXiv:2205.04203.

[3] E. Hallman, I. C. F. Ipsen, and A. K. Saibaba. Monte Carlo methods for estimating the diagonal of a symmetric matrix. *SIAM J. Matrix Anal.*, to appear. arXiv:2202.02887.

[4] E. Hallman and I. C. F. Ipsen. Precision-aware deterministic and probabilistic error bounds for floating point summation. *Under revision for Numer. Math.* arXiv:2203:15928.

[5] T. W. Reid, I. C. F. Ipsen, J. Cockayne, and C. J. Oates. BayesCG as an uncertainty aware version of CG. *Under revision for SIAM J. Sci. Comput.* arXiv:2008.03225.

[6] P. Hennig, I.C.F. Ipsen, M. Mahsereci, and T. Sullivan. Probabilistic Numerical Methods - From Theory to Implementation (Dagstuhl Seminar 21432). *Dagstuhl Reports*, 11(9):102–119, 2022.

[7] J. T. Chi, I. C. F. Ipsen, T.-H. Hsiao, C.-H. Lin, L.-S. Wang, W.-P. Lee, T.-P. Lu, and J.-Y. Tzeng. SEAGLE: a scalable exact algorithm for large-scale set-based GxE tests in biobank data. *Frontiers in Genetics*, 12:1878, 2021. arXiv:2105.03228.

[8] J. T. Chi and I. C. F. Ipsen. Multiplicative perturbation bounds for multivariate multiple linear regression in Schatten p-norms. *Linear Algebra Appl.*, 624:87–102, 2021. arXiv:2007.06099.

[9] J. T. Chi and I. C. F. Ipsen. A projector-based approach to quantifying total and excess uncertainties for sketched linear regression. *Inf. Inference*, 11(3):1055–1077, 2021. arXiv:1808.05924.

[10] J. Cockayne, I. C. F. Ipsen, C. J. Oates, and T. W. Reid. Probabilistic iterative methods for linear systems. *J. Mach. Learn. Res.*, 22 (232):1–34, 2021. arXiv:2012.12615.

[11] I. C. F. Ipsen and H. Zhou. Probabilistic error analysis for inner products. *SIAM J. Matrix Anal. Appl.*, 41(4):1726–1741, 2020. `arXiv:1906.10465`.

[12] J. Cockayne, C. J. Oates, I. C. F. Ipsen, and M. Girolami. A Bayesian conjugate gradient method (with discussion). *Bayesian Anal.*, 14(3):937–1012, 2019.

[13] S. Bartels, J. Cockayne, I. C. F. Ipsen, and P. Hennig. Probabilistic linear solvers: A unifying view. *Stat. Comput.*, 29(6):1249–1263, 2019.

[14] P. Drineas and I. C. F. Ipsen. Low-rank approximations do not need a singular value gap. *SIAM J. Matrix Anal. Appl.*, 40(1):299–319, 2019.

[15] J. T. Holodnak, I. C. F. Ipsen, and R. C. Smith. A probabilistic subspace bound with application to active subspaces. *SIAM J. Matrix Anal. Appl.*, 39(6):1208–1220, 2018.

[16] P. Drineas, I. C. F. Ipsen, M. Magdon-Ismail, E.-M. Kontopoulo, and M. Magdon-Ismail. Structural convergence results for approximation of dominant subspaces from block Krylov spaces. *SIAM J. Matrix Anal. Apl.*, 39(2):567–586, 2018.

[17] P. Drineas, I. C. F. Ipsen, D. D. Lee, and D. J. Lee. Numerical integrity of scientific machine learning. *DOE ASCR Scientific Machine Learning Workshop*, January 2018.

[18] D. Frame, R. He, I. C. F. Ipsen, D. Lee, D. Lee, and E. Rrapaj. Eigenvector continuation with subspace learning. *Phys. Rev. Lett.*, 121(3):032501, 2018. Featured in Physics: Making Quantum Calculations Behave.

[19] A. K. Saibaba, A. Alexanderian, and I. C. F. Ipsen. Randomized matrix-free trace and log-determinant estimators. *Numer. Math.*, 137:353–395, 2017.

[20] J. T. Holodnak and I. C. F. Ipsen. Randomized approximation of the Gram matrix: Exact computation and probabilistic bounds. *SIAM J. Matrix Anal. Appl.*, 36(1):110–137, 2015.

[21] J. T. Holodnak, I. C. F. Ipsen, and T. Wentworth. Conditioning of leverage scores and computation by QR decomposition. *SIAM J. Matrix Anal. Appl.*, 36(3):1143–1163, 2015.

[22] J. Guinness and I. C. F. Ipsen. Efficient computation of Gaussian likelihoods for stationary Markov random field models. 2015. arXiv:1506.00138.

[23] I. C. F. Ipsen and T. Wentworth. The effect of coherence on sampling from matrices with orthonormal columns, and preconditioned least squares problems. *SIAM J. Matrix Anal. Appl.*, 35(4):1490–1520, 2014.

[24] I. C. F. Ipsen and T. Wentworth. Sensitivity of leverages scores and coherence for randomized matrix algorithms, 2013. Extended abstract.

[25] R. Rehman and I. C. F. Ipsen. La Budde's method for computing characteristic polynomials, 2010. arXiv:1104.3769v1.

[26] C. T. Kelley, I. C. F. Ipsen, and S. R. Pope. Rank-deficient and ill-conditioned nonlinear least squares problems. In *Proc. 2010 East Asian SIAM Conf.* 2010.

[27] S. Eriksson-Bique, M. Solbrig, M. Stefanelli, S. Warkentin, R. Abbey, and I.C.F. Ipsen. Importance sampling for a Monte Carlo matrix multiplication algorithm, with application to information retrieval. *SIAM J. Sci. Comput.*, 33(4):1689–1706, 2011.

[28] R. Rehman and I. C. F. Ipsen. Computing characteristic polynomials from eigenvalues. *SIAM J. Matrix Anal. Appl.*, 32:90–114, 2011.

[29] I. C. F. Ipsen and T. M. Selee. Ergodicity coefficients defined by vector norms. *SIAM J. Matrix Anal. Appl.*, 32(1):153–200, 2011.

[30] I. C. F. Ipsen, C. T. Kelley, and S. R. Pope. Rank-deficient nonlinear least squares problems and subset selection. *SIAM J. Numer. Math.*, 49(3):1244–1266, 2011.

[31] M. E. Broadbent, M. Brown, and K. Penner. Subset selection algorithms: Randomized vs. deterministic. *SIAM Undergraduate Research Online*, 3, May 2010. (Faculty advisors: I.C.F. Ipsen and R. Rehman).

[32] I. C. F. Ipsen. The eigenproblem and invariant subspaces: Perturbation theory. In *G. W. Stewart: Selected Works with Commentaries*, pages 71–93. Birkhäuser, Boston, 2010.

[33] I. C. F. Ipsen and B. Nadler. Refined eigenvalue bounds for eigenvalues of Hermitian and non-Hermitian matrices. *SIAM J. Matrix Anal. Appl.*, 31(1):40–53, 2009.

[34] R. S. Wills and I. C. F. Ipsen. Ordinal ranking for Google's PageRank. *SIAM J. Matrix Anal. Appl.*, 30(4):1677–1696, 2009.

[35] I. C. F. Ipsen and R. Rehman. Perturbation bounds for determinants and characteristic polynomials. *SIAM J. Matrix Anal. Appl.*, 30(2):762–776, 2008.

[36] K. I. Dickson, C. T. Kelley, I. C. F. Ipsen, and I. G. Kevrekidis. Condition estimates for pseudo-arclength continuation. *SIAM J. Numer. Anal.*, 45(1):263–276, 2007.

[37] I. C. F. Ipsen and T. M. Selee. Pagerank computation, with special attention to dangling nodes. *SIAM J. Matrix Anal. Appl.*, 29(4):1281–1296, 2007.

[38] I. C. F. Ipsen and D. J. Lee. Determinant approximations, 2003. arXiv:1105.0437v1.

[39] D. E. Finkel, C. Kuster, M. Lasater, R. Levy, J. P. Reese, and I. C. F. Ipsen. Communicating applied mathematics: Four examples. *SIAM Rev.*, 48(2):359–389, 2006.

[40] I. C. F. Ipsen and S. Kirkland. Convergence analysis of a PageRank updating algorithm by Langville and Meyer. *SIAM J. Matrix Anal. Appl.*, 27(4):952–67, 2006.

[41] I. C. F. Ipsen and R. S. Wills. Mathematical properties and analysis of Google's PageRank. *Bol. Soc. Esp. Mat. Apl.*, 34:191–196, 2006.

[42] I. C. F. Ipsen. Departure from normality and eigenvalue perturbation bounds, 2003.

[43] I. C. F. Ipsen. Ritz value bounds that exploit quasi-sparsity, 2003.

[44] D. J. Lee and I. C. F. Ipsen. Zone determinant expansions for nuclear lattice simulations. *Phys. Rev. C*, 68:064003, 2003.

[45] C. Beattie and I. C. F. Ipsen. Inclusion regions for matrix eigenvalues. *Linear Algebra Appl.*, 358(1-3):281–91, 2003.

[46] I. C. F. Ipsen. A note on unifying absolute and relative perturbation bounds. *Linear Algebra Appl.*, 358(1-3):239–53, 2003.

[47] Y. Genin, I. C. F. Ipsen, R. Stefan, and P. Van Dooren. Stability radius and optimal scaling of discrete-time periodic systems. In *Proc. IFAC PSYCO 2001*, pages 183–6. July 2001.

[48] I. C. F. Ipsen. A note on preconditioning non-symmetric matrices. *SIAM J. Sci. Comput.*, 23(3):1050–1, 2001.

[49] I. C. F. Ipsen. Absolute and relative perturbation bounds for invariant subspaces of matrices. *Linear Algebra Appl.*, 309(1-3):45–56, 2000.

[50] I. C. F. Ipsen. Expressions and bounds for the GMRES residual. *BIT*, 40(3):524–35, 2000.

[51] I. C. F. Ipsen. An overview of relative $\sin\Theta$ theorems for invariant subspaces of complex matrices. *J. Comput. Appl. Math.*, 123(1-2):131–153, 2000. Invited Paper for the special issue *Numerical Analysis 2000: Vol. III – Linear Algebra*.

[52] I. C. F. Ipsen. A note on a certain class of preconditioners for symmetric indefinite linear systems. Technical Report M&CT-TECH-00-005, Mathematics & Computing Technology, Phantom Works Division, The Boeing Company, July 2000.

[53] J. M. Banoczi, N.-C. Chiu, G. E. Cho, and I. C. F. Ipsen. The lack of influence of the right-hand side on the accuracy of linear system solution. *SIAM J. Sci. Comput.*, 20(1):203–27, 1999.

[54] G. E. Cho and I. C. F. Ipsen. If a matrix has a single eigenvalue, how sensitive is this eigenvalue? II. Technical Report CRSC-TR98-8, Center for Research in Scientific Computation, Department of Mathematics, North Carolina State University, 1998.

[55] S. C. Eisenstat and I. C. F. Ipsen. Relative perturbation results for eigenvalues and eigenvectors of diagonalisable matrices. *BIT*, 38(3):502–9, 1998.

[56] S. C. Eisenstat and I. C. F. Ipsen. Three absolute perturbation bounds for matrix eigenvalues imply relative bounds. *SIAM J. Matrix Anal. Appl.*, 20(1):149–58, 1998.

[57] I. C. F. Ipsen. Relative perturbation results for matrix eigenvalues and singular values. In *Acta Numerica 1998*, volume 7, pages 151–201. Cambridge University Press, Cambridge, 1998.

[58] I. C. F. Ipsen. A different approach to bounding the minimal residual norm in Krylov methods. Technical Report CRSC-TR98-19, Center for Research in Scientific Computation, Department of Mathematics, North Carolina State University, 1998.

[59] I. C. F. Ipsen. A note on the field of values of non-normal matrices. Technical Report CRSC-TR98-26, Center for Research in Scientific Computation, Department of Mathematics, North Carolina State University, 1998.

[60] I. C. F. Ipsen and C. D. Meyer. The idea behind Krylov methods. *Amer. Math. Monthly*, 105(10):889–99, 1998.

[61] G. E. Cho and I. C. F. Ipsen. If a matrix has a single eigenvalue, how sensitive is this eigenvalue? Technical Report CRSC-TR97-20, Center for Research in Scientific Computation, Department of Mathematics, North Carolina State University, 1997.

[62] I. C. F. Ipsen. Computing an eigenvector with inverse iteration. *SIAM Rev.*, 39(2):254–291, 1997.

[63] S. L. Campbell, I. C. F. Ipsen, C. T. Kelley, C. D. Meyer, and Z. Q. Xue. Convergence estimates for solution of integral equations with GMRES. *J. Integral Equations Appl.*, 8(1):19–34, 1996.

[64] S. L. Campbell, I. C. F. Ipsen, C. T. Kelley, and C. D. Meyer. GMRES and the minimal polynomial. *BIT*, 36(4):664–675, 1996.

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