

Ilse C.F. Ipsen

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Main Research Interests Numerical linear algebra; randomized algorithms; numerical analysis

Employment

Professor, Mathematics, North Carolina State University, 1998-present
Associate Director, SAMSI, 2011-present
Faculty, Institute for Advanced Analytics, 2011-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)

Outside Recognition

Fellow, Society for Industrial and Applied Mathematics
The work on mapping algorithms to systolic devices was judged to be one of the ten best
research projects sponsored by the Department of Defence in 1986.

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

Plenary Talks at National and International Meetings

- 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 "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 Board, SIAM Journal on Mathematics of Data Science, 2018-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, 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

AAAS Electorate Nominating Committee, Section on Mathematics, 2016-present
SIAM Journal Committee, 2013-present
SIAM Vice President at Large, 2016-2017
Chair, ILAS Journal Committee, 2014-2016
Co-chair SIAG/LA Nominating Committee, 2015
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
NSF site visit team (CISE Institutional Infrastructure proposal) 1994

Conference and Workshop Organization

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] D. Frame, R. He, I. C. F. Ipsen, D. Lee, D. Lee, and E. Rrapaj. Eigenvector continuation with subspace learning. *Submitted*, 2017. arXiv:1711.07090.
- [2] P. Drineas and I. C. F. Ipsen. Low-rank approximations do not need a singular value gap. *Submitted*, 2018. arXiv:1801.0067.
- [3] 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.*, under revision.
- [4] 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. Appl.*, accepted.
- [5] 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.
- [6] A. K. Saibaba, A. Alexanderian, and I. C. F. Ipsen. Randomized matrix-free trace and log-determinant estimators. *Numer. Math.*, 137:353–395, 2017.
- [7] 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.
- [8] 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.
- [9] 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.
- [10] I. C. F. Ipsen and T. Wentworth. Sensitivity of leverages scores and coherence for randomized matrix algorithms, 2013. Extended abstract.
- [11] R. Rehman and I. C. F. Ipsen. La Budde’s method for computing characteristic polynomials, 2010. arXiv:1104.3769v1.
- [12] 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.
- [13] 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.
- [14] R. Rehman and I. C. F. Ipsen. Computing characteristic polynomials from eigenvalues. *SIAM J. Matrix Anal. Appl.*, 32:90–114, 2011.
- [15] I. C. F. Ipsen and T. M. Selee. Ergodicity coefficients defined by vector norms. *SIAM J. Matrix Anal. Appl.*, 32(1):153–200, 2011.
- [16] 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.

- [17] 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).
- [18] 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.
- [19] 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.
- [20] R. S. Wills and I. C. F. Ipsen. Ordinal ranking for Google’s PageRank. *SIAM J. Matrix Anal. Appl.*, 30(4):1677–1696, 2009.
- [21] I. C. F. Ipsen and R. Rehman. Perturbation bounds for determinants and characteristic polynomials. *SIAM J. Matrix Anal. Appl.*, 30(2):762–776, 2008.
- [22] 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.
- [23] 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.
- [24] I. C. F. Ipsen and D. J. Lee. Determinant approximations, 2003. arXiv:1105.0437v1.
- [25] 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.
- [26] 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.
- [27] 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.
- [28] I. C. F. Ipsen. Departure from normality and eigenvalue perturbation bounds, 2003.
- [29] I. C. F. Ipsen. Ritz value bounds that exploit quasi-sparsity, 2003.
- [30] D. J. Lee and I. C. F. Ipsen. Zone determinant expansions for nuclear lattice simulations. *Phys. Rev. C*, 68:064003, 2003.
- [31] C. Beattie and I. C. F. Ipsen. Inclusion regions for matrix eigenvalues. *Linear Algebra Appl.*, 358(1-3):281–91, 2003.
- [32] I. C. F. Ipsen. A note on unifying absolute and relative perturbation bounds. *Linear Algebra Appl.*, 358(1-3):239–53, 2003.
- [33] 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.
- [34] I. C. F. Ipsen. A note on preconditioning non-symmetric matrices. *SIAM J. Sci. Comput.*, 23(3):1050–1, 2001.
- [35] I. C. F. Ipsen. Absolute and relative perturbation bounds for invariant subspaces of matrices. *Linear Algebra Appl.*, 309(1-3):45–56, 2000.

- [36] I. C. F. Ipsen. Expressions and bounds for the GMRES residual. *BIT*, 40(3):524–35, 2000.
- [37] 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*.
- [38] 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.
- [39] 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.
- [40] 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.
- [41] S. C. Eisenstat and I. C. F. Ipsen. Relative perturbation results for eigenvalues and eigenvectors of diagonalisable matrices. *BIT*, 38(3):502–9, 1998.
- [42] 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.
- [43] 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.
- [44] 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.
- [45] 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.
- [46] I. C. F. Ipsen and C. D. Meyer. The idea behind Krylov methods. *Amer. Math. Monthly*, 105(10):889–99, 1998.
- [47] 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.
- [48] I. C. F. Ipsen. Computing an eigenvector with inverse iteration. *SIAM Rev.*, 39(2):254–291, 1997.
- [49] 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.
- [50] 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.
- [51] I. C. F. Ipsen. Helmut Wielandt’s contributions to the numerical solution of complex eigenvalue problems. In B. Huppert and H. Schneider, editors, *Helmut Wielandt, Mathematische Werke, Mathematical Works*, volume 2: Linear Algebra and Analysis, pages 453–63. Walter de Gruyter, Berlin, 1996.

- [52] I. C. F. Ipsen. A history of inverse iteration. In B. Huppert and H. Schneider, editors, *Helmut Wielandt, Mathematische Werke, Mathematical Works*, volume 2: Linear Algebra and Analysis, pages 464–72. Walter de Gruyter, Berlin, 1996.
- [53] S. Chandrasekaran and I. C. F. Ipsen. On the sensitivity of solution components in linear systems of equations. *SIAM J. Matrix Anal. Appl.*, 16(1):93–112, 1995.
- [54] S. Chandrasekaran and I. C. F. Ipsen. Analysis of a QR algorithm for computing singular values. *SIAM J. Matrix Anal. Appl.*, 16(2):520–35, 1995.
- [55] S. C. Eisenstat and I. C. F. Ipsen. Relative perturbation techniques for singular value problems. *SIAM J. Numer. Anal.*, 32(6):1972–1988, 1995.
- [56] I. C. F. Ipsen and C. D. Meyer. The angle between complementary subspaces. *Amer. Math. Monthly*, 102(10):904–11, 1995.
- [57] S. Chandrasekaran and I. C. F. Ipsen. On rank-revealing QR factorisations. *SIAM J. Matrix Anal. Appl.*, 15(2):592–622, 1994.
- [58] S. Chandrasekaran and I. C. F. Ipsen. A divide and conquer algorithm for computing singular values. *Z. Angew. Math. Mech.*, 74(6):T 532–4, 1994.
- [59] S. Chandrasekaran and I. C. F. Ipsen. Backward errors for eigenvalue and singular value decompositions. *Numer. Math.*, 68:215–223, 1994.
- [60] S. Chandrasekaran and I. C. F. Ipsen. On the singular value decomposition of triangular matrices. In Jiang Er-xiong, editor, *Numerical Algebra*, pages 85–9. China Science and Technology Press, 1994.
- [61] S. C. Eisenstat and I. C. F. Ipsen. Relative perturbation bounds for eigenspaces and singular vector subspaces. In *Applied Linear Algebra*, pages 62–65. SIAM, Philadelphia, 1994.
- [62] I. C. F. Ipsen and C. D. Meyer. Uniform stability of Markov chains. *SIAM J. Matrix Anal. Appl.*, 15(4):1061–74, 1994.
- [63] E. R. Jessup and I. C. F. Ipsen. Improving the accuracy of inverse iteration. *SIAM J. Sci. Stat. Comput.*, 13(3):550–72, 1992.
- [64] S. Chandrasekaran and I. C. F. Ipsen. Perturbation theory for the solution of systems of linear equations. Research Report 866, Department of Computer Science, Yale University, 1991.
- [65] J.-M. Delosme and I. C. F. Ipsen. From Bareiss’ algorithm to the stable computation of partial correlations. *Journal of Computational and Applied Mathematics*, 27:53–91, 1989. Also in: *Parallel Algorithms for Numerical Linear Algebra (Advances in Parallel Computing, 1)*, H. van der Vorst and P. Van Dooren, eds., North Holland, 1990.
- [66] J.-M. Delosme and I. C. F. Ipsen. Parallel computation of algorithms with uniform dependences. In *Parallel Processing for Scientific Computing*, pages 319–26. SIAM, 1990.
- [67] I. C. F. Ipsen. Some remarks on the generalized Bareiss and Levinson algorithms. In *Numerical Linear Algebra, Digital Signal Processing and Parallel Algorithms*, pages 189–214. Springer Verlag, 1990.

- [68] I. C. F. Ipsen and E. R. Jessup. Solving the symmetric tridiagonal eigenvalue problem on the hypercube. *SIAM J. Sci. Stat. Comput.*, 11(2):203–29, 1990.
- [69] W. D. Gropp and I. C. F. Ipsen. Recursive mesh refinement on hypercubes. *BIT*, 29:186–211, 1989.
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- [71] J.-M. Delosme, I. C. F. Ipsen, and C. C. Paige. The Cholesky factorization, Schur complements, correlation coefficients, angles between vectors, and the QR factorization. Research Report 607, Department of Computer Science, Yale University, 1988.
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- [74] J. L. Barlow and I. C. F. Ipsen. Scaled Givens rotations for the solution of linear least squares problems on systolic arrays. *SIAM J. Sci. Stat. Comp.*, 8:716–33, 1987.
- [75] J.-M. Delosme and I. C. F. Ipsen. Efficient systolic arrays for the solution of Toeplitz systems: An illustration of a methodology for the construction of systolic architectures in VLSI. In *Systolic Arrays*, pages 37–46. Adam Hilger, 1987.
- [76] J.-M. Delosme and I. C. F. Ipsen. Computing partial correlations from the data matrix. Research Report 541, Department of Computer Science, Yale University, 1987.
- [77] P. Hudak, J.-M. Delosme, and I. C. F. Ipsen. ParLance: A para-functional programming environment for parallel and distributed computing. Research Report 524, Department of Computer Science, Yale University, 1987.
- [78] I. C. F. Ipsen and E. R. Jessup. Two methods for solving the symmetric tridiagonal eigenvalue problem on the hypercube. In *Hypercube Multiprocessors 1987*, pages 627–38. SIAM, 1987.
- [79] I. C. F. Ipsen and E. R. Jessup. A comparison of Cuppen’s method and multisection for the solution of tridiagonal eigenvalue problems on the hypercube. In *Advances in Computer Methods for Partial Differential Equations VI*, pages 425–30. IMACS, 1987.
- [80] J.-M. Delosme and I. C. F. Ipsen. Parallel solution of symmetric positive definite systems with hyperbolic rotations. *Linear Algebra Appl.*, 77:75–111, 1986.
- [81] J.-M. Delosme and I. C. F. Ipsen. Systolic array synthesis: Computability and time cones. In *Parallel Algorithms and Architectures*, pages 295–312. North-Holland, 1986.
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