

## Bibliography

---

- [1] R. Agarwal, F. Gustavson, and M. Zubair. Exploiting functional parallelism of POWER2 to design high performance numerical algorithms. *IBM J. Res. Development*, 38:563–576, 1994.
- [2] L. Ahlfors. *Complex Analysis*. McGraw-Hill, New York, 1966.
- [3] A. Aho, J. Hopcroft, and J. Ullman. *The Design and Analysis of Computer Algorithms*. Addison-Wesley, Reading, MA, 1974.
- [4] G. Alefeld and J. Herzberger. *Introduction to Interval Computations*. Academic Press, New York, 1983.
- [5] P. R. Amestoy and I. S. Duff. Vectorization of a multiprocessor multifrontal code. *International Journal of Supercomputer Applications*, 3:41–59, 1989.
- [6] P. R. Amestoy. Factorization of large unsymmetric sparse matrices based on a multifrontal approach in a multiprocessor environment. Technical Report TH/PA/91/2, CERFACS, Toulouse, France, February 1991. Ph.D. thesis.
- [7] A. Anda and H. Park. Fast plane rotations with dynamic scaling. *SIAM J. Matrix Anal. Appl.*, 15:162–174, 1994.
- [8] A. Anda and H. Park. Self scaling fast rotations for stiff least squares problems. *Linear Algebra Appl.*, 234:137–162, 1996.
- [9] A. Anderson, D. Culler, D. Patterson, and the NOW Team. A case for networks of workstations: NOW. *IEEE Micro*, 15(1), February 1995.
- [10] E. Anderson, Z. Bai, C. Bischof, J. Demmel, J. Dongarra, J. Du Croz, A. Greenbaum, S. Hammarling, A. McKenney, S. Ostrouchov, and D. Sorensen. *LAPACK Users' Guide (2nd edition)*. SIAM, Philadelphia, PA, 1995.
- [11] ANSI/IEEE, New York. *IEEE Standard for Binary Floating Point Arithmetic*, Std 754-1985 edition, 1985.
- [12] ANSI/IEEE, New York. *IEEE Standard for Radix Independent Floating Point Arithmetic*, Std 854-1987 edition, 1987.

- [13] P. Arbenz and G. Golub. On the spectral decomposition of Hermitian matrices modified by row rank perturbations with applications. *SIAM J. Matrix Anal. Appl.*, 9:40–58, 1988.
- [14] M. Arioli, J. Demmel, and I. S. Duff. Solving sparse linear systems with sparse backward error. *SIAM J. Matrix Anal. Appl.*, 10:165–190, 1989.
- [15] O. Axelsson. *Iterative Solution Methods*. Cambridge University Press, Cambridge, UK, 1994.
- [16] Z. Bai. Error analysis of the Lanczos algorithm for the nonsymmetric eigenvalue problem. *Math. Comp.*, 62:209–226, 1994.
- [17] Z. Bai. Progress in the numerical solution of the nonsymmetric eigenvalue problem. *J. Numer. Linear Algebra Appl.*, 2:219–234, 1995.
- [18] Z. Bai, D. Day, and Q. Ye. ABLE: An adaptive block Lanczos method for non-Hermitian eigenvalue problems. Mathematics Dept. Report 95-04, University of Kentucky, May 1995. submitted to *Math. Comp.*
- [19] Z. Bai and G. W. Stewart. SRRIT: A Fortran subroutine to calculate the dominant invariant subspace of a nonsymmetric matrix. Computer Science Dept. Report TR 2908, University of Maryland, April 1992. Available as pub/reports for reports and pub/srrit for programs via anonymous ftp from thales.cs.umd.edu.
- [20] D. H. Bailey. Multiprecision translation and execution of Fortran programs. *ACM Trans. Math. Software*, 19:288–319, 1993.
- [21] D. H. Bailey. A Fortran-90 based multiprecision system. *ACM Trans. Math. Software*, 21:379–387, 1995.
- [22] D. H. Bailey, K. Lee, and H. D. Simon. Using Strassen’s algorithm to accelerate the solution of linear systems. *J. Supercomputing*, 4:97–371, 1991.
- [23] J. Barnes and P. Hut. A hierarchical  $o(n \log n)$  force calculation algorithm. *Nature*, 324:446–449, 1986.
- [24] R. Barrett, M. Berry, T. Chan, J. Demmel, J. Donato, J. Dongarra, V. Eijkhout, V. Pozo, C. Romine, and H. van der Vorst. *Templates for the Solution of Linear Systems: Building Blocks for Iterative Methods*. SIAM, Philadelphia, PA, 1994. also available electronically at <http://www.netlib.org/templates>.
- [25] S. Batterson. Convergence of the shifted QR algorithm on 3 by 3 normal matrices. *Numer. Math.*, 58:341–352, 1990.

- [26] F. L. Bauer. Genauigkeitsfragen bei der Lösung linearer Gleichungssysteme. *Z. Angew. Math. Mech.*, 46:409–421, 1966.
- [27] T. Beelen and P. Van Dooren. An improved algorithm for the computation of Kronecker’s canonical form of a singular pencil. *Linear Algebra Appl.*, 105:9–65, 1988.
- [28] C. Bischof. Incremental condition estimation. *SIAM J. Matrix Anal. Appl.*, 11:312–322, 1990.
- [29] C. Bischof, A. Carle, G. Corliss, A. Griewank, and P. Hovland. ADIFOR: Generating derivative codes from Fortran programs. *Scientific Programming*, 1:11–29, 1992. Software available at <http://www.mcs.anl.gov/adifor/>.
- [30] C. Bischof and G. Quintana-Orti. Computing rank-revealing QR factorizations of dense matrices. Argonne Preprint ANL-MCS-P559-0196, Argonne National Laboratory, Argonne, IL, 1996.
- [31] Å. Björck. *Solution of Equations in  $\mathbb{R}^n$* , volume 1 of *Handbook of Numerical Analysis*, chapter Least Squares Methods. Elsevier/North Holland, Amsterdam, 1987.
- [32] Å. Björck. Least squares methods. Mathematics Department Report, Linköping University, 1991.
- [33] Å. Björck. *Numerical Methods for Least Squares Problems*. SIAM, Philadelphia, PA, 1996.
- [34] J. Blue. A portable FORTRAN program to find the Euclidean norm of a vector. *ACM Trans. Math. Software*, 4:15–23, 1978.
- [35] J. H. Bramble, J. E. Pasciak, and A. H. Schatz. The construction of preconditioners for elliptic problems by substructuring, I. *Math. Comp.*, 47:103–134, 1986.
- [36] J. H. Bramble, J. E. Pasciak, and A. H. Schatz. An iterative method for elliptic problems on regions partitioned into substructures. *Math. Comp.*, 46:361–369, 1986.
- [37] J. H. Bramble, J. E. Pasciak, and A. H. Schatz. The construction of preconditioners for elliptic problems by substructuring, II. *Math. Comp.*, 49:1–16, 1987.
- [38] J. H. Bramble, J. E. Pasciak, and A. H. Schatz. The construction of preconditioners for elliptic problems by substructuring, III. *Math. Comp.*, 51:415–430, 1988.

- [39] J. H. Bramble, J. E. Pasciak, and A. H. Schatz. The construction of preconditioners for elliptic problems by substructuring, IV. *Math. Comp.*, 53:1–24, 1989.
- [40] K. Brenan, S. Campbell, and L. Petzold. *Numerical Solution of Initial-Value Problems in Differential-Algebraic Equations*. North Holland, New York, 1989.
- [41] C. Brezinski, M. Redivo Zaglia, and H. Sadok. Avoiding breakdown and near-breakdown in Lanczos type algorithms. *Numer. Algorithms*, 1:261–284, 1991.
- [42] W. Briggs. *A Multigrid Tutorial*. SIAM, Philadelphia, PA, 1987.
- [43] J. Bunch and L. Kaufman. Some stable methods for calculating inertia and solving symmetric linear systems. *Math. Comp.*, 31:163–179, 1977.
- [44] J. Bunch, P. Nielsen, and D. Sorensen. Rank-one modification of the symmetric eigenproblem. *Numer. Math.*, 31:31–48, 1978.
- [45] B. Buzbee, F. Dorr, J. George, and G. Golub. The direct solution of the discrete Poisson equation on irregular regions. *SIAM J. Numer. Anal.*, 8:722–736, 1971.
- [46] B. Buzbee, G. Golub, and C. Nielsen. On direct methods for solving Poisson’s equation. *SIAM J. Numer. Anal.*, 7:627–656, 1970.
- [47] T. Chan. Rank revealing QR factorizations. *Linear Algebra Appl.*, 88/89:67–82, 1987.
- [48] T. Chan and T. Mathew. Domain decomposition algorithms. In A. Iserles, editor, *Acta Numerica, Volume 3*. Cambridge University Press, Cambridge, UK, 1994.
- [49] S. Chandrasekaran and I. Ipsen. On rank-revealing factorisations. *SIAM J. Matrix Anal. Appl.*, 15:592–622, 1994.
- [50] F. Chatelin. *Eigenvalues of Matrices*. Wiley, Chichester, England, 1993. English translation of the original 1988 French edition.
- [51] F. Chatelin and V. Frayssé. *Lectures on Finite Precision Computations*. SIAM, Philadelphia, PA, 1996.
- [52] J. Choi, J. Demmel, I. Dhillon, J. Dongarra, S. Ostrouchov, A. Petitet, K. Stanley, D. Walker, and R. C. Whaley. ScaLAPACK: A portable linear algebra library for distributed memory computers—Design issues and performance. Computer Science Dept. Technical Report CS-95-283, University of Tennessee, Knoxville, TN, March 1995. (LAPACK Working Note 95.)

- [53] J. Coonen. Underflow and the denormalized numbers. *Computer*, 14:75–87, 1981.
- [54] J. Cullum, W. Kerner, and R. Willoughby. A generalized nonsymmetric Lanczos procedure. *Comput. Phys. Comm.*, 53:19–48, 1989.
- [55] J. Cullum and R. Willoughby. A practical procedure for computing eigenvalues of large sparse nonsymmetric matrices. In J. Cullum and R. Willoughby, editors, *Large Scale Eigenvalue Problems*. North Holland, Amsterdam, 1986. Mathematics Studies Series Vol. 127, Proceedings of the IBM Institute Workshop on Large Scale Eigenvalue Problems, July 8–12, 1985, Oberlech, Austria.
- [56] J. Cullum and R. A. Willoughby. *Lanczos Algorithms for Large Symmetric Eigenvalue Computations*. Birkhäuser, Basel, 1985. Vol. 1, Theory, Vol. 2, Program.
- [57] J. J. M. Cuppen. The singular value decomposition in product form. *SIAM J. Sci. Statist. Comput.*, 4:216–221, 1983.
- [58] J. J. M. Cuppen. A divide and conquer method for the symmetric tridiagonal eigenproblem. *Numer. Math.*, 36:177–195, 1981.
- [59] E. Davidson. The iteration calculation of a few of the lowest eigenvalues and corresponding eigenvectors of large real symmetric matrices. *J. Comp. Phys.*, 17:87–94, 1975.
- [60] P. Davis. *Interpolation and Approximation*. Dover, New York, 1975.
- [61] T. A. Davis and I. S. Duff. An unsymmetric-pattern multifrontal method for sparse LU factorization. Technical Report RAL 93-036, Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire, UK, 1994.
- [62] T. A. Davis and I. S. Duff. A combined unifrontal/multifrontal method for unsymmetric sparse matrices. Technical Report TR-95-020, Computer and Information Sciences Department, University of Florida, 1995.
- [63] D. Day. *Semi-duality in the two-sided Lanczos algorithm*. Ph.D. thesis, University of California, Berkeley, CA, 1993.
- [64] D. Day. How the QR algorithm fails to converge and how to fix it. Technical Report 96-0913J, Sandia National Laboratory, Albuquerque, NM, April 1996.
- [65] A. Deichmoller. *Über die Berechnung verallgemeinerter singulärer Werte mittels Jacobi-ähnlicher Verfahren*. Ph.D. thesis, Fernuniversität-Hagen, Hagen, Germany, 1991.

- [66] P. Deift, J. Demmel, L.-C. Li, and C. Tomei. The bidiagonal singular values decomposition and Hamiltonian mechanics. *SIAM J. Num. Anal.*, 28:1463–1516, 1991. (LAPACK Working Note 11.)
- [67] P. Deift, T. Nanda, and C. Tomei. ODEs and the symmetric eigenvalue problem. *SIAM J. Numer. Anal.*, 20:1–22, 1983.
- [68] J. Demmel. The condition number of equivalence transformations that block diagonalize matrix pencils. *SIAM J. Numer. Anal.*, 20:599–610, 1983.
- [69] J. Demmel. Underflow and the reliability of numerical software. *SIAM J. Sci. Statist. Comput.*, 5:887–919, 1984.
- [70] J. Demmel. On condition numbers and the distance to the nearest ill-posed problem. *Numer. Math.*, 51:251–289, 1987.
- [71] J. Demmel. The componentwise distance to the nearest singular matrix. *SIAM J. Matrix Anal. Appl.*, 13:10–19, 1992.
- [72] J. Demmel, I. Dhillon, and H. Ren. On the correctness of some bisection-like parallel eigenvalue algorithms in floating point arithmetic. *Electronic Trans. Numer. Anal.*, 3:116–140, December 1995. (LAPACK Working Note 70.)
- [73] J. Demmel and W. Gragg. On computing accurate singular values and eigenvalues of acyclic matrices. *Linear Algebra Appl.*, 185:203–218, 1993.
- [74] J. Demmel, M. Gu, S. Eisenstat, I. Slapničar, K. Veselić, and Z. Drmač. Computing the singular value decomposition with high relative accuracy. in progress, 1996.
- [75] J. Demmel, M. Heath, and H. van der Vorst. Parallel numerical linear algebra. In A. Iserles, editor, *Acta Numerica, Volume 2*. Cambridge University Press, Cambridge, UK, 1993.
- [76] J. Demmel and N. J. Higham. Stability of block algorithms with fast Level 3 BLAS. *ACM Trans. Math. Software*, 18:274–291, 1992.
- [77] J. Demmel and B. Kågström. Accurate solutions of ill-posed problems in control theory. *SIAM J. Matrix Anal. Appl.*, 9:126–145, 1988.
- [78] J. Demmel and B. Kågström. The generalized Schur decomposition of an arbitrary pencil  $A - \lambda B$ : Robust software with error bounds and applications. Parts I and II. *ACM Trans. Math. Software*, 19(2), June 1993.
- [79] J. Demmel and W. Kahan. Accurate singular values of bidiagonal matrices. *SIAM J. Sci. Statist. Comput.*, 11:873–912, 1990.

- [80] J. Demmel and X. Li. Faster numerical algorithms via exception handling. *IEEE Trans. Comput.*, 43:983–992, 1994. (LAPACK Working Note 59.)
- [81] J. Demmel and K. Veselić. Jacobi’s method is more accurate than QR. *SIAM J. Matrix Anal. Appl.*, 13:1204–1246, 1992. (LAPACK Working Note 15.)
- [82] P. Dierckx. *Curve and Surface Fitting with Splines*. Oxford University Press, Oxford, UK, 1993.
- [83] J. Dongarra. Performance of various computers using standard linear equations software. Computer Science Dept. Technical Report, University of Tennessee, Knoxville, TN, April 1996. Up-to-date version available at NETLIB/benchmark.
- [84] J. Dongarra, J. Du Croz, I. Duff, and S. Hammarling. Algorithm 679: A set of Level 3 Basic Linear Algebra Subprograms. *ACM Trans. Math. Software*, 16:18–28, 1990.
- [85] J. Dongarra, J. Du Croz, I. Duff, and S. Hammarling. A set of Level 3 Basic Linear Algebra Subprograms. *ACM Trans. Math. Software*, 16:1–17, 1990.
- [86] J. Dongarra, J. Du Croz, S. Hammarling, and R. J. Hanson. Algorithm 656: An extended set of FORTRAN Basic Linear Algebra Subroutines. *ACM Trans. Math. Software*, 14:18–32, 1988.
- [87] J. Dongarra, J. Du Croz, S. Hammarling, and R. J. Hanson. An extended set of FORTRAN Basic Linear Algebra Subroutines. *ACM Trans. Math. Software*, 14:1–17, 1988.
- [88] J. Dongarra and D. Sorensen. A fully parallel algorithm for the symmetric eigenproblem. *SIAM J. Sci. Statist. Comput.*, 8:139–154, 1987.
- [89] C. Douglas. MGNET: Multi-Grid net. <http://NA.CS.Yale.EDU/mgnet/www/mgnet.html>.
- [90] Z. Drmač. *Computing the Singular and the Generalized Singular Values*. Ph.D. thesis, Fernuniversität-Hagen, Hagen, Germany, 1994.
- [91] I. S. Duff, A. M. Erisman, and J. K. Reid. *Direct Methods for Sparse Matrices*. Oxford University Press, London, 1986.
- [92] I. S. Duff. Sparse numerical linear algebra: Direct methods and preconditioning. Technical Report RAL-TR-96-047, Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire, UK, 1996.

- [93] I. S. Duff and J. K. Reid. MA47, a Fortran code for direct solution of indefinite sparse symmetric linear systems. Technical Report RAL-95-001, Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire, 1995.
- [94] I. S. Duff and J. K. Reid. The design of MA48, a code for the direct solution of sparse unsymmetric linear systems of equations. *ACM Trans. Math. Software*, 22:187–226, 1996.
- [95] I. S. Duff and J. K. Reid. The multifrontal solution of indefinite sparse symmetric linear equations. *ACM Trans. Math. Software*, 9:302–325, 1983.
- [96] I. S. Duff and J. A. Scott. The design of a new frontal code for solving sparse unsymmetric systems. *ACM Trans. Math. Software*, 22:30–45, 1996.
- [97] A. Edelman. The complete pivoting conjecture for Gaussian elimination is false. *The Mathematica Journal*, 2:58–61, 1992.
- [98] A. Edelman and H. Murakami. Polynomial roots from companion matrices. *Math. Comp.*, 64:763–776, 1995.
- [99] S. Eisenstat and I. Ipsen. Relative perturbation techniques for singular value problems. *SIAM J. Numer. Anal.*, 32:1972–1988, 1995.
- [100] V. Faber and T. Manteuffel. Necessary and sufficient conditions for the existence of a conjugate gradient method. *SIAM J. Numer. Anal.*, 21:315–339, 1984.
- [101] D. M. Fenwick, D. J. Foley, W. B. Gist, S. R. VanDoren, and D. Wissel. The AlphaServer 8000 series: High-end server platform development. *Digital Technical Journal*, 7:43–65, 1995.
- [102] K. Fernando and B. Parlett. Accurate singular values and differential qd algorithms. *Numer. Math.*, 67:191–229, 1994.
- [103] V. Fernando, B. Parlett, and I. Dhillon. A way to find the most redundant equation in a tridiagonal system. Berkeley Mathematics Dept. Preprint, 1995.
- [104] H. Flaschka. *Dynamical Systems, Theory and Applications*, volume 38 of Lecture Notes in Physics, chapter Discrete and periodic solutions of some aspects of the inverse method. Springer-Verlag, New York, 1975.
- [105] R. Freund, G. Golub, and N. Nachtigal. Iterative solution of linear systems. In A. Iserles, editor, *Acta Numerica* 1992, pages 57–100. Cambridge University Press, Cambridge, UK, 1992.



- [106] R. Freund, M. Gutknecht, and N. Nachtigal. An implementation of the look-ahead Lanczos algorithm for non-Hermitian matrices. *SIAM J. Sci. Comput.*, 14:137–158, 1993.
- [107] X. Sun G. Quintana-Orti, and C. Bischof. A blas-3 version of the QR factorization with column pivoting. Argonne Preprint MCS-P551-1295, Argonne National Laboratory, Argonne, IL, 1995.
- [108] F. Gantmacher. *The Theory of Matrices, vol. II (translation)*. Chelsea, New York, 1959.
- [109] M. Garey and D. Johnson. *Computers and Intractability*. W. H. Freeman, San Francisco, 1979.
- [110] A. George. Nested dissection of a regular finite element mesh. *SIAM J. Numer. Anal.*, 10:345–363, 1973.
- [111] A. George, M. Heath, J. Liu, and E. Ng. Solution of sparse positive definite systems on a shared memory multiprocessor. *Internat. J. Parallel Programming*, 15:309–325, 1986.
- [112] A. George and J. Liu. *Computer Solution of Large Sparse Positive Definite Systems*. Prentice-Hall, Englewood Cliffs, NJ, 1981.
- [113] Alan George and Esmond Ng. Parallel sparse Gaussian elimination with partial pivoting. *Ann. Oper. Res.*, 22:219–240, 1990.
- [114] R. Glowinski, G. Golub, G. Meurant, and J. Periaux, editors. *Domain Decomposition Methods for Partial Differential Equations*, SIAM, Philadelphia, PA, 1988. Proceedings of the First International Symposium on Domain Decomposition Methods for Partial Differential Equations, Paris, France, January 1987.
- [115] S. Goedecker. Remark on algorithms to find roots of polynomials. *SIAM J. Sci. Statist. Comp.*, 15:1059–1063, 1994.
- [116] I. Gohberg, P. Lancaster, and L. Rodman. *Matrix Polynomials*. Academic Press, New York, 1982.
- [117] D. Goldberg. What every computer scientist should know about floating point arithmetic. *ACM Computing Surveys*, 23(1), 1991.
- [118] G. Golub and W. Kahan. Calculating the singular values and pseudo-inverse of a matrix. *SIAM J. Numer. Anal. (Series B)*, 2:205–224, 1965.
- [119] G. Golub and C. Van Loan. *Matrix Computations*. Johns Hopkins University Press, Baltimore, MD, 3rd edition, 1996.

- [120] N. Gould. On growth in Gaussian elimination with complete pivoting. *SIAM J. Mat. Anal. Appl.*, 12:354–361, 1991. see also editor’s note in *SIAM J. Matrix Anal. Appl.*, 12(3), 1991.
- [121] A. Greenbaum and Z. Strakos. Predicting the behavior of finite precision Lanczos and conjugate gradient computations. *SIAM J. Matrix Anal. Appl.*, 13:121–137, 1992.
- [122] L. Greengard and V. Rokhlin. A fast algorithm for particle simulations. *J. Comput. Phys.*, 73:325–348, 1987.
- [123] R. Grimes, J. Lewis, and H. Simon. A shifted block Lanczos algorithm for solving sparse symmetric generalized eigenproblems. *SIAM J. Matrix Anal. Appl.*, 15:228–272, 1994.
- [124] M. Gu. Studies in Numerical Linear Algebra. Ph.D. thesis, 1993.
- [125] M. Gu and S. Eisenstat. A stable algorithm for the rank-1 modification of the symmetric eigenproblem. Computer Science Dept. Report YALEU/DCS/RR-916, Yale University, September 1992.
- [126] M. Gu and S. Eisenstat. An efficient algorithm for computing a rank-revealing QR decomposition. Computer Science Dept. Report YALEU/DCS/RR-967, Yale University, June 1993.
- [127] M. Gu and S. C. Eisenstat. A stable and efficient algorithm for the rank-1 modification of the symmetric eigenproblem. *SIAM J. Matrix Anal. Appl.*, 15:1266–1276, 1994. Yale Technical Report YALEU/DCS/RR-916, September 1992.
- [128] M. Gu and S. C. Eisenstat. A divide-and-conquer algorithm for the bidiagonal SVD. *SIAM J. Matrix Anal. Appl.*, 16:79–92, 1995.
- [129] M. Gu and S. C. Eisenstat. A divide-and-conquer algorithm for the symmetric tridiagonal eigenproblem. *SIAM J. Matrix Anal. Appl.*, 16:172–191, 1995.
- [130] A. Gupta and V. Kumar. Optimally scalable parallel sparse Cholesky factorization. In *Proceedings of the Seventh SIAM Conference on Parallel Processing for Scientific Computing*, pages 442–447. SIAM, Philadelphia, PA, 1995.
- [131] A. Gupta, E. Rothberg, E. Ng, and B. W. Peyton. Parallel sparse Cholesky factorization algorithms for shared-memory multiprocessor systems. In R. Vichnevetsky, D. Knight, and G. Richter, editors, *Advances in Computer Methods for Partial Differential Equations—VII*. IMACS, 1992.

- [132] M. Gutknecht. A completed theory of the unsymmetric Lanczos process and related algorithms, Part I. *SIAM J. Matrix Anal. Appl.*, 13:594–639, 1992.
- [133] M. Gutknecht. A completed theory of the unsymmetric Lanczos process and related algorithms, Part II. *SIAM J. Mat. Anal. Appl.*, 15:15–58, 1994.
- [134] W. Hackbusch. *Iterative Solution of Large Sparse Linear Systems of Equations*. Springer-Verlag, Berlin, 1994.
- [135] L. A. Hageman and D. M. Young. *Applied Iterative Methods*. Academic Press, New York, 1981.
- [136] W. W. Hager. Condition estimators. *SIAM J. Sci. Statist. Comput.*, 5:311–316, 1984.
- [137] P. Halmos. *Finite Dimensional Vector Spaces*. Van Nostrand, New York, 1958.
- [138] E. R. Hansen. *Global Optimization Using Interval Analysis*. Marcel Dekker, New York, 1992.
- [139] P. C. Hansen. The truncated SVD as a method for regularization. *BIT*, 27:534–553, 1987.
- [140] P. C. Hansen. Truncated singular value decomposition solutions to discrete ill-posed problems ill-determined numerical rank. *SIAM J. Sci. Statist. Comp.*, 11:503–518, 1990.
- [141] M. T. Heath and P. Raghavan. Performance of a fully parallel sparse solver. In *Proceedings of the Scalable High-Performance Computing Conference*, pages 334–341, IEEE, Los Alamitos, CA, 1994.
- [142] M. Hénon. Integrals of the Toda lattice. *Phys. Rev. B*, 9:1421–1423, 1974.
- [143] M. R. Hestenes and E. Stiefel. Methods of conjugate gradients for solving linear systems. *J. Res. Natl. Bur. Stand.*, 49:409–436, 1954.
- [144] N. J. Higham. A survey of condition number estimation for triangular matrices. *SIAM Rev.*, 29:575–596, 1987.
- [145] N. J. Higham. FORTRAN codes for estimating the one-norm of a real or complex matrix, with applications to condition estimation. *ACM Trans. Math. Software*, 14:381–396, 1988.
- [146] N. J. Higham. Experience with a matrix norm estimator. *SIAM J. Sci. Statist. Comput.*, 11:804–809, 1990.

- [147] N. J. Higham. *Accuracy and Stability of Numerical Algorithms*. SIAM, Philadelphia, PA, 1996.
- [148] P. Hong and C. T. Pan. The rank revealing QR and SVD. *Math. Comp.*, 58:575–232, 1992.
- [149] X. Hong and H. T. Kung. I/O complexity: The red blue pebble game. In *Proceedings of the 13th Symposium on the Theory of Computing*, pages 326–334. ACM, New York, 1981.
- [150] A. K. Jain. *Fundamentals of Digital Image Processing*. Prentice-Hall, Englewood Cliffs, NJ, 1989.
- [151] E. Jessup and D. Sorensen. A divide and conquer algorithm for computing the singular value decomposition of a matrix. In *Proceedings of the Third SIAM Conference on Parallel Processing for Scientific Computing*, pages 61–66, SIAM, Philadelphia, PA, 1989.
- [152] Z. Jia. *Some Numerical Methods for Large Unsymmetric Eigenproblems*. Ph.D. thesis, Universität Bielefeld, Bielefeld, Germany, 1994.
- [153] W.-D. Webber J. P. Singh, and A. Gupta. Splash: Stanford parallel applications for shared-memory. *Computer Architecture News*, 20:5–44, 1992.
- [154] W. Kahan. Accurate eigenvalues of a symmetric tridiagonal matrix. Computer Science Dept. Technical Report CS41, Stanford University, Stanford, CA, July 1966 (revised June 1968).
- [155] W. Kahan. A survey of error analysis. In *Information Processing 71*, pages 1214–1239, North Holland, Amsterdam, 1972.
- [156] W. Kahan. The baleful effect of computer benchmarks upon applied mathematics, physics and chemistry. <http://HTTP.CS.Berkeley.EDU/~wkahan/ieee754status/baleful.ps>, 1995.
- [157] W. Kahan. Lecture notes on the status of IEEE standard 754 for binary floating point arithmetic. <http://HTTP.CS.Berkeley.EDU/~wkahan/ieee754status/ieee754.ps>, 1995.
- [158] T. Kailath and A. H. Sayed. Displacement structure: Theory and applications. *SIAM Rev.*, 37:297–386, 1995.
- [159] T. Kato. *Perturbation Theory for Linear Operators*. Springer-Verlag, Berlin, 2nd edition, 1980.
- [160] R. B. Kearfott. *Rigorous Global Search: Continuous Problems*. Kluwer, Dordrecht, the Netherlands, 1996. See also <http://interval.usl.edu/euromath.html>.

- [161] W. Kerner. Large-scale complex eigenvalue problems. *J. Comput. Phys.*, 85:1–85, 1989.
- [162] G. Kolata. Geodesy: Dealing with an enormous computer task. *Science*, 200:421–422, 1978.
- [163] S. Krishnan, A. Narkhede, and D. Manocha. BOOLE: A system to compute Boolean combinations of sculptured solids. Computer Science Dept. Technical Report TR95-008, University of North Carolina, Chapel Hill, 1995. <http://www.cs.unc.edu/~geom/geom.html>.
- [164] M. Kruskal. *Dynamical Systems, Theory and Applications*, volume 38 of Lecture Notes in Physics, chapter Nonlinear Wave Equations. Springer-Verlag, New York, 1975.
- [165] K. Kundert. Sparse matrix techniques. In A. Ruehli, editor, *Circuit Analysis, Simulation and Design*. North Holland, Amsterdam, 1986.
- [166] C. Lawson and R. Hanson. *Solving Least Squares Problems*. Prentice-Hall, Englewood Cliffs, NJ, 1974.
- [167] C. Lawson, R. Hanson, D. Kincaid, and F. Krogh. Basic Linear Algebra Subprograms for Fortran usage. *ACM Trans. Math. Software*, 5:308–323, 1979.
- [168] P. Lax. Integrals of nonlinear equations of evolution and solitary waves. *Comm. Pure Appl. Math.*, 21:467–490, 1968.
- [169] R. Lehoucq. *Analysis and Implementation of an Implicitly Restarted Arnoldi Iteration*. Ph.D. thesis, Rice University, Houston, TX, 1995.
- [170] R.-C. Li. Solving secular equations stably and efficiently. Computer Science Dept. Technical Report CS-94-260, University of Tennessee, Knoxville, TN, November 1994. (LAPACK Working Note 89.)
- [171] T.-Y. Li and Z. Zeng. Homotopy-determinant algorithm for solving non-symmetric eigenvalue problems. *Math. Comp.*, 59:483–502, 1992.
- [172] T.-Y. Li and Z. Zeng. Laguerre’s iteration in solving the symmetric tridiagonal eigenproblem—a revisit. Michigan State University Preprint, 1992.
- [173] T.-Y. Li, Z. Zeng, and L. Cong. Solving eigenvalue problems of nonsymmetric matrices with real homotopies. *SIAM J. Numer. Anal.*, 29:229–248, 1992.
- [174] T.-Y. Li, H. Zhang, and X.-H. Sun. Parallel homotopy algorithm for symmetric tridiagonal eigenvalue problem. *SIAM J. Sci. Statist. Comput.*, 12:469–487, 1991.

- [175] X. Li. *Sparse Gaussian Elimination on High Performance Computers*. Ph.D. thesis, Computer Science Division, Department of Electrical Engineering and Computer Science, University of California, Berkeley, September 1996.
- [176] S.-S. Lo, B. Phillippe, and A. Sameh. A multiprocessor algorithm for the symmetric eigenproblem. *SIAM J. Sci. Statist. Comput.*, 8:155–165, 1987.
- [177] K. Löwner. Über monotone matrixfunctionen. *Math. Z.*, 38:177–216, 1934.
- [178] R. Lucas, W. Blank, and J. Tieman. A parallel solution method for large sparse systems of equations. *IEEE Trans. Computer Aided Design, CAD-6*:981–991, 1987.
- [179] D. Manocha and J. Demmel. Algorithms for intersecting parametric and algebraic curves i: simple intersections. *ACM Transactions on Graphics*, 13:73–100, 1994.
- [180] D. Manocha and J. Demmel. Algorithms for intersecting parametric and algebraic curves ii: Higher order intersections. *Computer Vision, Graphics and Image Processing: Graphical Models and Image Processing*, 57:80–100, 1995.
- [181] R. Mathias. Accurate eigensystem computations by Jacobi methods. *SIAM J. Matrix Anal. Appl.*, 16:977–1003, 1996.
- [182] The MathWorks, Inc., Natick, MA. *MATLAB Reference Guide*, 1992.
- [183] S. McCormick, editor. *Multigrid Methods*, volume 3 of SIAM Frontiers in Applied Mathematics. SIAM, Philadelphia, PA, 1987.
- [184] S. McCormick. *Multilevel Adaptive Methods for Partial Differential Equations*, volume 6 of SIAM Frontiers in Applied Mathematics. SIAM, Philadelphia, PA, 1989.
- [185] J. Moser. *Dynamical Systems, Theory and Applications*, volume 38 of Lecture Notes in Physics, chapter Finitely many mass points on the line under the influence of an exponential potential—an integrable system. Springer-Verlag, New York, 1975.
- [186] J. Moser, editor. *Dynamical Systems, Theory and Applications*, volume 38 of Lecture Notes in Physics. Springer-Verlag, New York, 1975.
- [187] A. Netravali and B. Haskell. *Digital Pictures*. Plenum Press, New York, 1988.

- [188] A. Neumaier. *Interval Methods for Systems of Equations*. Cambridge University Press, Cambridge, UK, 1990.
- [189] E. G. Ng and B. W. Peyton. Block sparse Cholesky algorithms on advanced uniprocessor computers. *SIAM J. Sci. Statist. Comp.*, 14:1034–1056, 1993.
- [190] B. Nour-Omid, B. Parlett, and A. Liu. How to maintain semi-orthogonality among Lanczos vectors. CPAM Technical Report 420, University of California, Berkeley, CA, 1988.
- [191] W. Oettli and W. Prager. Compatibility of approximate solution of linear equations with given error bounds for coefficients and right hand sides. *Numer. Math.*, 6:405–409, 1964.
- [192] C. C. Paige and M. A. Saunders. Solution of sparse indefinite systems of linear equations. *SIAM J. Numer. Anal.*, 12:617–629, 1975.
- [193] V. Pan. How can we speed up matrix multiplication. *SIAM Rev.*, 26:393–416, 1984.
- [194] V. Pan and P. Tang. Bounds on singular values revealed by QR factorization. Technical Report MCS-P332-1092, Mathematics and Computer Science Division, Argonne National Laboratory, Argonne, IL, 1992.
- [195] B. Parlett. *The Symmetric Eigenvalue Problem*. Prentice Hall, Englewood Cliffs, NJ, 1980.
- [196] B. Parlett. Misconvergence in the lanczos algorithm. In M. G. Cox and S. Hammarling, editors, *Reliable Numerical Computation*, chapter 1. Clarendon Press, Oxford, UK, 1990.
- [197] B. Parlett. Reduction to tridiagonal form and minimal realizations. *SIAM J. Matrix Anal. Appl.*, 13:567–593, 1992.
- [198] B. Parlett. *Acta Numerica*, chapter The new qd algorithms, pages 459–491. Cambridge University Press, Cambridge, UK, 1995.
- [199] B. Parlett. The construction of orthogonal eigenvectors for tight clusters by use of submatrices. Center for Pure and Applied Mathematics PAM-664, University of California, Berkeley, CA, January 1996. Submitted to *SIAM J. Matrix Anal. Appl.*
- [200] B. N. Parlett, D. R. Taylor, and Z. A. Liu. A look-ahead Lanczos algorithm for unsymmetric matrices. *Math. Comp.*, 44:105–124, 1985.
- [201] B. N. Parlett and I. S. Dhillon. On Fernando’s method to find the most redundant equation in a tridiagonal system. *Linear Algebra Appl.*, 1996. to appear.

- [202] D. Priest. Algorithms for arbitrary precision floating point arithmetic. In P. Kornerup and D. Matula, editors, *Proceedings of the 10th Symposium on Computer Arithmetic*, pages 132–145, Grenoble, France, June 26–28 1991. IEEE Computer Society Press, Los Alamitos, CA.
- [203] A. Quarteroni, editor. *Domain Decomposition Methods*, AMS, Providence, RI, 1993. Proceedings of the Sixth International Symposium on Domain Decomposition Methods, Como, Italy, 1992.
- [204] H. Ren. *On Error Analysis and Implementation of Some Eigenvalue and Singular Value Algorithms*. Ph.D. thesis, University of California at Berkeley, 1996.
- [205] E. Rothberg and R. Schreiber. Improved load distribution in parallel sparse Cholesky factorization. In *Supercomputing*, pages 783–792, November 1994.
- [206] S. Rump. Bounds for the componentwise distance to the nearest singular matrix. *SIAM J. Matrix Anal. Appl.*, 18:83–103, 1997.
- [207] H. Rutishauser. *Lectures on Numerical Mathematics*. Birkhäuser, Basel, 1990.
- [208] J. Rutter. A serial implementation of Cuppen’s divide and conquer algorithm for the symmetric eigenvalue problem. Mathematics Dept. Master’s Thesis, University of California at Berkeley, 1994. Available by anonymous ftp from tr-ftp.cs.berkeley.edu, directory pub/tech-reports/csd/csd-94-799, file all.ps.
- [209] Y. Saad. Krylov subspace methods for solving large unsymmetric linear system. *Math. Comp.*, 37:105–126, 1981.
- [210] Y. Saad. Numerical solution of large nonsymmetric eigenvalue problems. *Comput. Phys. Comm.*, 53:71–90, 1989.
- [211] Y. Saad. *Numerical Methods for Large Eigenvalue Problems*. Manchester University Press, Manchester, UK, 1992.
- [212] Y. Saad. *Iterative Methods for Sparse Linear Systems*. PWS Publishing Co., Boston, 1996.
- [213] Y. Saad and M. H. Schultz. GMRES: A generalized minimal residual algorithm for solving nonsymmetric linear systems. *SIAM J. Sci. Statist. Comput.*, 7:856–869, 1986.
- [214] M. Sadkane. Block-Arnoldi and Davidson methods for unsymmetric large eigenvalue problems. *Numer. Math.*, 64:195–211, 1993.



- [215] M. Sadkane. A block Arnoldi-Chebyshev method for computing the leading eigenpairs of large sparse unsymmetric matrices. *Numer. Math.*, 64:181–193, 1993.
- [216] J. R. Shewchuk. Adaptive Precision Floating-Point Arithmetic and Fast Robust Geometric Predicates. Technical Report CMU-CS-96-140, School of Computer Science, Carnegie Mellon University, Pittsburgh, PA, May 1996. Submitted to *Discrete and Comput. Geom.*
- [217] M. Shub and S. Smale. Complexity of Bezout’s theorem I: Geometric aspects. *J. Amer. Math. Soc.*, 6:459–501, 1993.
- [218] M. Shub and S. Smale. Complexity of Bezout’s theorem II: Volumes and probabilities. In F. Eyssette and A. Galligo, editors, *Progress in Mathematics, Vol. 109—Computational Algebraic Geometry*. Birkhauser, Basel, 1993.
- [219] M. Shub and S. Smale. Complexity of Bezout’s theorem III: Condition number and packing. *J. Complexity*, 9:4–14, 1993.
- [220] M. Shub and S. Smale. Complexity of Bezout’s theorem IV: Probability of success; extensions. Mathematics Department Preprint, University of California, 1993.
- [221] SGI Power Challenge. Technical Report, Silicon Graphics, 1995.
- [222] H. Simon. The Lanczos algorithm with partial reorthogonalization. *Math. Comp.*, 42:115–142, 1984.
- [223] R. D. Skeel. Scaling for numerical stability in Gaussian elimination. *Journal of the ACM*, 26:494–526, 1979.
- [224] R. D. Skeel. Iterative refinement implies numerical stability for Gaussian elimination. *Math. Comp.*, 35:817–832, 1980.
- [225] R. D. Skeel. Effect of equilibration on residual size for partial pivoting. *SIAM J. Numer. Anal.*, 18:449–454, 1981.
- [226] I. Slapničar. *Accurate Symmetric Eigenreduction by a Jacobi Method*. PhD thesis, Fernuniversität-Hagen, Hagen, Germany, 1992.
- [227] G. Sleijpen and H. van der Vorst. A Jacobi-Davidson iteration method for linear eigenvalue problems. Dept. of Mathematics Report 856, University of Utrecht, 1994.
- [228] S. Sleijpen, A. Booten, D. Fokkema, and H. van der Vorst. Jacobi-Davidson type methods for generalized eigenproblems and polynomial eigenproblems, Part I. Dept. of Mathematics Report 923, University of Utrecht, 1995.

- [229] B. Smith. Domain decomposition algorithms for partial differential equations of linear elasticity. Technical Report 517, Department of Computer Science, Courant Institute, September 1990. Ph.D. thesis.
- [230] B. Smith, P. Bjorstad, and W. Gropp. *Domain decomposition: Parallel multilevel methods for elliptic partial differential equations*. Cambridge University Press, Cambridge, UK, 1996. Corresponding PETSc software available at <http://www.mcs.anl.gov/petsc/petsc.html>.
- [231] D. Sorensen. Implicit application of polynomial filters in a k-step Arnoldi method. *SIAM J. Matrix Anal. Appl.*, 13:357–385, 1992.
- [232] D. Sorensen and P. Tang. On the orthogonality of eigenvectors computed by divide-and-conquer techniques. *SIAM J. Numer. Anal.*, 28:1752–1775, 1991.
- [233] G. W. Stewart. *Introduction to Matrix Computations*. Academic Press, New York, 1973.
- [234] G. W. Stewart. Rank degeneracy. *SIAM J. Sci. Statist. Comput.*, 5:403–413, 1984.
- [235] G. W. Stewart and J.-G. Sun. *Matrix Perturbation Theory*. Academic Press, New York, 1990.
- [236] SPARCcenter 2000 architecture and implementation. SUN Microsystems, Inc., November 1993. Technical White Paper.
- [237] W. Symes. The QR algorithm for the finite nonperiodic Toda lattice. *Phys. D*, 4:275–280, 1982.
- [238] G. Szegö. *Orthogonal Polynomials*. AMS, Providence, RI, 1967.
- [239] K.-C. Toh and L. N. Trefethen. Pseudozeros of polynomials and pseudospectra of companion matrices. *Numer. Math.*, 68:403–425, 1994.
- [240] L. Trefethen and R. Schreiber. Average case analysis of Gaussian elimination. *SIAM J. Matrix Anal. Appl.*, 11:335–360, 1990.
- [241] L. N. Trefethen and D. Bau. *Numerical Linear Algebra*. SIAM, Philadelphia, PA, 1997. <http://www.cs.cornell.edu/Info/People/lnt/text.html>.
- [242] A. Van Der Sluis. Condition numbers and equilibration of matrices. *Numer. Math.*, 14:14–23, 1969.
- [243] A. F. van der Stappen, R. H. Bisseling, and J. G. G. van der Vorst. Parallel sparse LU decomposition on a mesh network of transputers. *SIAM J. Matrix Anal. Appl.*, 14:853–879, 1993.

- [244] P. Van Dooren. The computation of Kronecker's canonical form of a singular pencil. *Linear Algebra Appl.*, 27:103–141, 1979.
- [245] P. Van Dooren. The generalized eigenstructure problem in linear system theory. *IEEE Trans. Automat. Control*, AC-26:111–128, 1981.
- [246] C. V. Van Loan. *Computational Frameworks for the Fast Fourier Transform*. SIAM, Philadelphia, 1992.
- [247] R. S. Varga. *Matrix Iterative Analysis*. Prentice-Hall, Englewood Cliffs, NJ, 1962.
- [248] K. Veselić and I. Slapničar. Floating point perturbations of Hermitian matrices. *Linear Algebra Appl.*, 195:81–116, 1993.
- [249] V. Voevodin. The problem of non-self-adjoint generalization of the conjugate gradient method is closed. *Comput. Math. Math. Phys.*, 23:143–144, 1983.
- [250] D. Watkins. *Fundamentals of Matrix Computations*. Wiley, Chichester, UK, 1991.
- [251] The Cray C90 series. <http://www.cray.com/PUBLIC/product-info/C90/>. Cray Research, Inc.
- [252] The Cray J90 series. <http://www.cray.com/PUBLIC/product-info/J90/>. Cray Research, Inc.
- [253] The Cray T3E series. <http://www.cray.com/PUBLIC/product-info/T3E/>. Cray Research, Inc.
- [254] The IBM SP-2. [http://www.rs6000.ibm.com/software/sp\\_products/sp2.html](http://www.rs6000.ibm.com/software/sp_products/sp2.html). IBM.
- [255] The Intel Paragon. <http://www.ssd.intel.com/homepage.html>. Intel.
- [256] P.-Å. Wedin. Perturbation theory for pseudoinverses. *BIT*, 13:217–232, 1973.
- [257] S. Weisberg. *Applied Linear Regression*. Wiley, Chichester, UK, 2nd edition, 1985.
- [258] P. Wesseling. *An Introduction to Multigrid Methods*. Wiley, Chichester, UK, 1992.
- [259] J. H. Wilkinson. *Rounding Errors in Algebraic Processes*. Prentice Hall, Englewood Cliffs, NJ, 1963.
- [260] J. H. Wilkinson. *The Algebraic Eigenvalue Problem*. Oxford University Press, Oxford, UK, 1965.

- [261] S. Winograd and D. Coppersmith. Matrix multiplication via arithmetic progressions. In *Proceedings of the Nineteenth Annual ACM Symposium on the Theory of Computing*, pages 1–6. ACM, New York, 1987.
- [262] M. Wolfe. *High Performance Compilers for Parallel Computing*. Addison-Wesley, Reading, MA, 1996.
- [263] Q. Ye. A convergence analysis for nonsymmetric Lanczos algorithms. *Math. Comp.*, 56:677–691, 1991.
- [264] Q. Ye. A breakdown-free variation of the nonsymmetric Lanczos algorithm. *Math. Comp.*, 62:179–207, 1994.
- [265] D. Young. *Iterative Solution of Large Linear Systems*. Academic Press, New York, 1971.
- [266] H. Yserentant. Old and new convergence proofs for multigrid methods. In A. Iserles, editor, *Acta Numerica 1993*, pages 285–326. Cambridge University Press, Cambridge, UK, 1993.
- [267] Z. Zeng. *Homotopy-Determinant Algorithm for Solving Matrix Eigenvalue Problems and Its Parallelizations*. Ph.D. thesis, Michigan State University, East Lansing, MI, 1991.
- [268] Z. Zlatev, J. Waśniewski, P. C. Hansen, and Tz. Ostromsky. PARAS-PAR: a package for the solution of large linear algebraic equations on parallel computers with shared memory. Technical Report 95-10, Technical University of Denmark, Lyngby, September 1995.
- [269] Z. Zlatev. *Computational Methods for General Sparse Matrices*. Kluwer Academic, Dordrecht, Boston, 1991.