Shortened Curriculum Vitae

Sven Hammarling

QUALIFICATIONS

1968 B.Sc. 1st class, Mathematics for Business, Enfield College of Technology (CNAA)

1990 IMA Fellow

2012 SIAM Fellow

2013 NAG Life Service Award

EXPERIENCE – Career

Positions held

1968 - 1979 Lecturer in Numerical Analysis, Enfield College of Technology. Senior Lecturer from 1971. (In 1973 Enfield became a constituent college of Middlesex Polytechnic. Now Middlesex University.)

1975 - 1976 Sabbatical leave at the National Physical Laboratory.

1979 - 1982 Principal Research Fellow, National Physical Laboratory.

1982 - 2020 Various roles at the Numerical Algorithms Group, Ltd, Oxford (NAG). Algorithms Co-ordinator, Project Development Manager, Numerical Libraries Divisional Manager, Company Secretary, Principal Consultant. Part time from 2007, Honorary Principal Consultant from 2014.

1992 - 2013 Visiting Professor to the Applied Mathematics and Operational Research Group at Cranfield University, Royal Military College of Science (now Defence Academy of the United Kingdom), Shrivenham.

1995 - 1996 Sabbatical leave at the University of Tennessee at Knoxville as a Research Professor.

2002 - date Various part time roles at the School of Mathematics (now Department), University of Manchester. Mainly with the Numerical Linear Algebra Group as a Senior Honorary Research Fellow (2006 - date). nla-group.org

EXPERIENCE – Projects

Co-developer of the Level 2 and 3 Basic Linear Algebra Subprograms (BLAS), and the Batched BLAS.

A Principal Investigator in LAPACK and ScaLAPACK.

Involvement in various EU projects: Supernode II, PINEAPL, NICONET, DECISION and NLAFET.

EXPERIENCE – Personal

1960 First Secretary of the Mount Grace Old Scholars Football Club (1960), now Potters Bar Town Football Club.

1984 - 2006 Vice Chair of Little Tew Parish Meeting (with two short breaks).

1997 - 2007 Member of the Board of Governors, Great Tew Primary School. (Chair 2005 - 2007.)

2000 - 2019 Trustee for Great Tew Primary School. (Chair 2011 - 2019).

BOOKS

[1] S. Hammarling. *Latent Roots and Latent Vectors*. Adam Hilger, Bristol, UK, 1970. Also published by The University of Toronto Press. (http://eprints.ma.man.ac.uk/1021/).

[2] M. G. Cox and S. Hammarling, editors. *Reliable Numerical Computation*. Oxford University Press, Oxford, UK, 1990. Proceedings of the conference, dedicated to James Hardy Wilkinson, on Advances in Reliable Numerical Computation, 8-10 July, 1987 at the National Physical Laboratory.

[3] L. S. Blackford, J. Choi, A. Cleary, E. D'Azevedo, J. Demmel, I. Dhillon, J. J. Dongarra, S. Hammarling, G. Henry, A. Petitet, K. Stanley, D. W. Walker, and R. C. Whaley. *ScaLAPACK Users' Guide*. SIAM, Philadelphia, PA, USA, 1997. Includes a CD containing the software, an HTML version of the Guide and LAPACK Working Notes. An online version is at http://www.netlib.org/scalapack/slug/.

[4] E. Anderson, Z. Bai, C. H. Bischof, S. Blackford, J. Demmel, J. J. Dongarra, J. Du Croz, A. Greenbaum, S. Hammarling, A. McKenney, and D. C. Sorensen. *LAPACK Users' Guide*. SIAM, Philadelphia, PA, USA, 3rd edition, 1999. (http://www.netlib.org/lapack/lug/).

[5] V. A. Barker, S. Blackford, J. J. Dongarra, J. Du Croz, S. Hammarling, M. Marinova, J. Waśniewski, and P. Yalamov. *LAPACK95 Users' Guide*. SIAM, Philadelphia, PA, USA, 2001. (http://www.netlib.org/lapack95/lug95/).

SELECTED PAPERS AND ARTICLES

[1] S. Hammarling. A note on modifications to the Givens plane rotation. *J. Inst. Maths Applics*, 13:215–218, 1974.

[2] S. Hammarling and J. H. Wilkinson. The practical behaviour of linear iterative methods with particular reference to S.O.R. Technical Report NAC 69, National Physical Laboratory, Teddington, Middlesex TW11 0LW, UK, 1976.

[3] S. Hammarling and J. H. Wilkinson. On linear systems arising from finite difference approximations to elliptic differential equations. Technical Report DNACS 34/80, National Physical Laboratory, Teddington, Middlesex TW11 0LW, UK, 1980.

[4] S. Hammarling. A survey of numerical aspects of plane rotations. Report Maths. 1, Middlesex Polytechnic, 1977. (http://eprints.ma.man.ac.uk/1122/).

[5] S. Hammarling. Numerical solution of the stable, non-negative definite Lyapunov equation. *IMA J. of Num. Anal.*, 2:303–323, 1982. (Reprinted as [30]. See also [26]).

[6] Å. Björck and S. Hammarling. A Schur method for the square root of a matrix. *Linear Algebra Appl.*, 52/53:127–140, 1983.

[7] S. Hammarling. How to live without covariance matrices: Numerical stability in multivariate statistical analysis. *NAG Newsletter*, 1:6–31, 1983.

[8] S. Hammarling and M. A. Singer. A canonical form for the algebraic Riccati equation. In P. A. Fuhrmann, editor, *Mathematical Theory of Networks and Systems*. Springer-Verlag, Berlin, Germany, 1984.

[9] S. Hammarling. The singular value decomposition in multivariate statistics. *ACM Signum Newsletter*, 20(3):2–25, July 1985. (http://eprints.ma.man.ac.uk/1121/).

[10] J. Du Croz and S. Hammarling. Eigenvalue problems. In J. L. Mohamed and J. E. Walsh, editors, *Numerical Algorithms*, pages 29–60. Oxford University Press, Oxford, UK, 1986.

[11] J. J. Dongarra, L. Kaufman, and S. Hammarling. Squeezing the most out of eigenvalue solvers on high-performance computers. *Linear Algebra Appl.*, 77:113–136, 1986.

[12] S. Hammarling. The numerical solution of the Kalman filtering problem. In C. I. Byrnes and A. Lindquist, editors, *Computational and Combinatorial Methods in Systems Theory*, pages 23–36. North-Holland, Amsterdam, The Netherlands, 1986.

[13] P. E. Gill, S. Hammarling, W. Murray, M. A. Saunders, and M. H. Wright. User's guide for LSSOL: A Fortran package for constrained linear least-squares and convex quadratic programming. Technical Report SOL 86-1, Systems Optimization Laboratory, Department of Operations Research, Stanford University, Stanford, California 94305, USA, 1986.

[14] S. Hammarling. The numerical solution of the general Gauss-Markov linear model. In T. S. Durrani, J. B. Abbiss, J. E. Hudson, R. N. Madan, J. G. McWhirter, and T. A. Moore, editors, *Mathematics in Signal Processing*, pages 441–456. Oxford University Press, Oxford, UK, 1987.

[15] K. V. Fernando and S. Hammarling. Systolic array computation of the SVD of complex matrices. In J. M. Speiser, editor, *Advanced Algorithms and Architectures for Signal Processing*, pages 54–61. SPIE, Proceedings 696, The Society of Photo-Optical Engineers, Bellingham, WA, USA, 1987.

[16] J. J. Dongarra, J. Du Croz, S. Hammarling, and R. J. Hanson. An extended set of FORTRAN Basic Linear Algebra Subprograms. *ACM Trans. Math. Software*, 14:1–32, 399, 1988. (Algorithm 656. See also [17]).

[17] J. J. Dongarra, J. Du Croz, S. Hammarling, and R. J. Hanson. Corrigenda: "An extended set of FORTRAN Basic Linear Algebra Subprograms". *ACM Trans. Math. Software*, 14:399, 1988. (See also [16]).

[18] K. V. Fernando and S. Hammarling. A product induced singular value decomposition (ΠSVD) for two matrices and balanced realization. In B. N. Datta, C. R. Johnson, M. A. Kaashoek, R. J. Plemmons, and E. D. Sontag, editors, *Linear Algebra in Signals, Systems, and Control*, pages 128–140. SIAM, Philadelphia, PA, USA, 1988.

[19] S. Hammarling. A linear algebra library for high performance computers. In *The Design and Application of Parallel Digital Processors*, page 199. IEE, London, 1988. (IEE International Specialist Seminar, the Gulbenkian Foundation, Lisbon, Portugal, April 11-15. IEE Conference Publication No.298).

[20] J. J. Dongarra, D. C. Sorensen, and S. Hammarling. Block reduction of matrices to condensed forms for eigenvalue computations. *J. Comput. Appl. Math.*, 27:215–227, 1989. (This volume has been collected together in H. A. van der Vorst and P. Van Dooren, editors. *Parallel Algorithms for Numerical Linear Algebra*. North-Holland, Amsterdam, The Netherlands, 1990).

[21] K. V. Fernando and S. Hammarling. Parallel eigenvalue and singular value algorithms for signal processing. In M. Wright, editor, *Aspects of Computation on Asynchronous Parallel Processors*, pages 13–22. North-Holland, Amsterdam, The Netherlands, 1989.

[22] J. J. Dongarra, J. Du Croz, I. S. Duff, and S. Hammarling. A set of Level 3 Basic Linear Algebra Subprograms. *ACM Trans. Math. Software*, 16:1–28, 1990. (Algorithm 679).

[23] J. J. Dongarra and S. Hammarling. Evolution of numerical software for dense linear algebra. In M. G. Cox and S. Hammarling, editors, *Reliable Numerical Computation*, pages 297–327. Oxford University Press, Oxford, UK, 1990.

[24] S. Hammarling. Standards for scientific languages and library modules. In T. Elliman and C. Sanger, editors, *Open Systems for Europe*, pages 161–164. Chapman and Hall, London, UK, 1991.

[25] S. Hammarling. Parallel algorithms for singular value problems. In G. H. Golub and P. Van Dooren, editors, *Numerical Linear Algebra, Digital Signal Processing and Parallel Algorithms*, pages 173–187. NATO ASI Series, F70, Springer-Verlag, Berlin, Germany, 1991.

[26] S. Hammarling. Numerical solution of the discrete-time, convergent, non-negative definite Lyapunov equation. *Systems and Control Letters*, 17:137–139, 1991.

[27] A. van den Boom, A. Brown, F. Dumortier, A. Geurts, S. Hammarling, R. Kool, M. Vanbegin, P. Van Dooren, and S. Van Huffel. SLICOT, a subroutine library in control and systems theory. In H. A. Barker, editor, *Computer Aided Design in Control Systems*, pages 71–76. Pergamon Press, Oxford, UK, 1992. (Proceedings of the IFAC Symposium, Swansea, July 1991).

[28] J. J. Dongarra, S. Hammarling, and J. H. Wilkinson. Numerical considerations in computing invariant subspaces. *SIAM J. Matrix Anal. Appl.*, 13:145–161, 1992.

[29] M. F. Anjos, S. Hammarling, and C. C. Paige. Solving the generalized symmetric eigenvalue problem. Unpublished manuscript, School of Computer Science, McGill University, Montreal, Canada. (http://eprints.maths.manchester.ac.uk/id/eprint/1120), 1992.

[30] S. Hammarling. Numerical solution of the stable non-negative definite Lyapunov equation. In R. V. Patel, A. J. Laub, and P. M. Van Dooren, editors, *Numerical Linear Algebra Techniques for Systems and Control*, pages 500–516. IEEE Press, New York, NY, USA, 1994.

[31] L. S. Blackford, A. Cleary, J. Demmel, I. Dhillon, J. J. Dongarra, S. Hammarling, A. Petitet, H. Ren, K. Stanley, and R. C. Whaley. Practical experience in the numerical dangers of heterogeneous computing. *ACM Trans. Math. Software*, 23:133–147, 1997.

[32] L. S. Blackford, J. Demmel, J. J. Dongarra, I. S. Duff, S. Hammarling, G. Henry, M. Heroux, L. Kaufman, A. Lumsdaine, A. Petitet, R. Pozo, K. Remington, and R. C. Whaley. An updated set of Basic Linear Algebra Subprograms (BLAS). *ACM Trans. Math. Software*, 28:135–151, 2002.

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[34] S. Hammarling, N. J. Higham, and C. Lucas. LAPACK-style codes for pivoted Cholesky and QR updating. In B. Kågström, E. Elmroth, J. J. Dongarra, and J. Waśniewski, editors, *Applied Parallel Computing: State of the Art in Scientific Computing*, pages 137–146. Springer-Verlag, Berlin, Germany, 2007. (Proceedings of the Eighth International Workshop, PARA 2006.).

[35] G. W. Howell, J. Demmel, C. T. Fulton, S. Hammarling, and K. Marmol. Cache efficient bidiagonalization using BLAS 2.5 operators. *ACM Trans. Math. Software*, 34:14.1–14.33, 2008.

[36] S. Hammarling and C. Lucas. Updating the QR factorization and the least squares problem. MIMS EPrint 2008.111, Manchester Institute for Mathematical Sciences, School of Mathematics, University of Manchester, Manchester M13 9PL, UK, 2008. (http://eprints.ma.man.ac.uk/1192/).

[37] S. Hammarling, C. J. Munro, and F. Tisseur. An algorithm for the complete solution of quadratic eigenvalue problems. *ACM Trans. Math. Software*, 39(3):18:1–18:19, 2013. (http://eprints.ma.man.ac.uk/1815/).

[38] S. Hammarling. My time at Enfield. MIMS EPrint 2018.23, Manchester Institute for Mathematical Sciences, School of Mathematics, University of Manchester, Manchester M13 9PL, UK, 2018. This is a lightly edited version, with photographs, of the article [41]. (http://eprints.maths.manchester.ac.uk/2657/1/SvenAtEnfield.pdf, or https://hammarling.com/sven/pubs/SvenAtEnfield.pdf).

[39] S. Hammarling. Sketches of the Moore family. https://hammarling.com/sven/pubs/MooreFamily.pdf, September 2018. An extended version of [40].

[40] S. Hammarling. The Moore family – personal sketches. *Beatrix Potter Society Journal and Newsletter*, 176:15–18, January 2018. An extended version is available as [39].

[41] S. Hammarling. My time at Enfield. In T. Bourner and T. Crilly, editors, *Enfield Voices: The Birth of the People's Universities*, chapter 5, pages 52–61. Self published with CreateSpace Independent Publishing Platform, 2018. Book available from Amazon. (Profit donated to UNICEF.) For a lightly edited version, with photographs, see [38].

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[44] S. Hammarling. James Hardy Wilkinson, 27 September 1919 – 5 October 1986. MIMS EPrint 2019.10, Manchester Institute for Mathematical Sciences, School of Mathematics,

University of Manchester, Manchester M13 9PL, UK, 2019. An article made available for the Workshop on Advances in Numerical Linear Algebra: Celebrating the Centenary of the Birth of James H. Wilkinson, held at the University of Manchester, May 29–30, 2019. (https://nla-group.org/advances-in-numerical-linear-algebra-2019/, http://eprints.maths.manchester.ac.uk/2711/, https://hammarling.com/sven/pubs/JHW.pdf).

[45] A. Abdelfattah, T. Costa, J. Dongarra, M. Gates, A. Haidar, S. Hammarling, N. J. Higham, J. Kurzac, P. Luszczek, S. Tomov, and M. Zounan. A set of Batched Basic Linear Algebra Subprograms and LAPACK routines. *ACM Trans. Math. Software*, 47(3):21:1–21:23, 2021. (https://dl.acm.org/doi/10.1145/3431921).

[46] S. J. Hammarling and N. J. Higham. The influence and contribution of Jack Dongarra to numerical linear algebra. *Computing in Science and Engineering*, 24(4):6–11, 2022. Dedicated to Jack Dongarra on the occasion of him receiving the 2021 ACM Turing Award (https://amturing.acm.org/award_winners/dongarra_3406337.cfm).