Hierarchically Blocked Algorithms and Optimized Kernels for Dense Matrix Computations on Memory-Tiered High-Performance Computing Systems

Publications 2002–2009 within the VR project

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The following list of publications (scientific journal articles, refereed conference proceedings, Theses, and technical reports) is structured by subprojects. Within each subproject, the publications are listed in alphabetical order by authors. Except for a few cases, the authors of a publication are listed alphabetically, which is the tradition we typically follow. Notice that several publications fit more than one subproject and are therefore listed under each of them.

Square and Recursive Blocked Algorithms and Hybrid Data Structures

[1] E. Elmroth, F. Gustavson, I. Jonsson, and B. Kågström. Recursive Blocked Algorithms and Hybrid Data Structures for Dense Matrix Library Software. *SIAM Review*, 46(1):3–45, 2004.

[2] R. Granat, I. Jonsson, and B. Kågström. Recursive Blocked Algorithms for Solving Periodic Triangular Sylvester-Type Matrix Equations. In B. Kågström et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2006*, Lecture Notes in Computer Science, LNCS 4699, pages 531–539. Springer, 2007.

[3] F. Gustavson, L. Karlsson, and B. Kågström. Distributed SBP Cholesky factorization algorithms with near-optimal scheduling. *ACM Trans. on Math. Software*, 36(2):11:1–11:25, March 2009. (Also published as Report UMINF 07.19 and IBM Research Report RC24342).

[4] F. Gustavson, L. Karlsson, and B. Kågström. Three Algorithms for Cholesky Factorization on Distributed Memory Using Packed Storage. In B. Kågström et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2006*, Lecture Notes in Computer Science, LNCS 4699, pages 550–559. Springer, 2007.

[5] I. Jonsson and B. Kågström. Recursive blocked algorithms for solving triangular systems. Part I. One-sided and coupled Sylvester-type matrix equations. *ACM Trans. Math. Software*, 28(4):392–415, 2002.

[6] I. Jonsson and B. Kågström. Recursive blocked algorithms for solving triangular systems. Part II. Two-sided and generalized Sylvester and Lyapunov matrix equations. *ACM Trans. Math. Software*, 28(4):416–435, 2002.

[7] Isak Jonsson. Recursive Blocked Algorithms, Data Structures, and High-Performance Software for Solving Linear Systems and Matrix Equations. *PhD Thesis* UMINF-03.17, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, December, 2003.

[8] B. Kågström. Management of Deep Memory Hierarchies—Recursive Blocked Algorithms and Hybrid Data Structures for Dense Matrix Computations. In J. Dongarra et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2004*, Lecture Notes in Computer Science, LNCS 3732, pages 21–32. Springer, 2006.

[9] Lars Karlsson. *Blocked and Scalable Matrix Computations — Packed Cholesky, In-Place Transposition, and Two-Sided Transformations.* Ph. Licentiate Thesis, Dept. of Computing Science, Umeå University, Sweden, 2009. Report UMINF 09.11, ISBN 978–91–7264–788–6.

[10] Lars Karlsson. Blocked in-place transposition with application to storage format conversion. Technical Report UMINF 09.01, Dept. of Computing Science, Umeå University, Sweden, 2009.

Blocked and Parallel Matrix Equation Solvers

[1] P. Andersson, R. Granat, and B. Kågström. Parallel Algorithms for Triangular Periodic Sylvester-type Matrix Equations. In E. Luque, T. Margalef, and D. Benítez, editors, *Euro-Par 2008 Parallel Processing – 14th International Euro-Par Conference*, volume LNCS 5168 of *Lecture Notes in Computer Science*, pages 780–789. Springer-Verlag, 2008.

[2] R. Granat, I. Jonsson, and B. Kågström. Combining Explicit and Recursive Blocking for Solving Triangular Sylvester-Type Matrix Equations in Distrubuted Memory Platforms. In M. Danelutto, D. Laforenza, and M. Vanneschi, editors, *Euro-Par 2004*, volume 3149, pages 742–750. Lecture Notes in Computer Science, Springer, 2004.

[3] R. Granat, I. Jonsson, and B. Kågström. RECSY and SCASY Library Software: Recursive Blocked and Parallel Algorithms for Sylvester-Type Matrix Equations with Some Applications. In R. Ciegis et al., editor, *Parallel Scientific Computing–Advances and Applications*, volume 27, pages 3–24. Springer Optimization and Its Applications, 2009.

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[8] R. Granat, B. Kågström, and D. Kressner. A parallel Schur method for solving continuous-time algebraic Riccati equations. In *Proc. 2008 IEEE Conference on Computer Aided Control Systems Design (CACSD)*, 2008.

[9] R. Granat, B. Kågström, and P. Poromaa. Parallel ScaLAPACK-style Algorithms for Solving Continuous-Time Sylvester Equations. In H. et al Kosch, editor, *Euro-Par 2003 Parallel Processing*, volume 2790, pages 800–809. Lecture Notes in Computer Science, Springer, 2003.

[10] R. Granat and B. Kågström. Parallel Algorithms and Condition Estimators for Standard and Generalized Triangular Sylvester-Type Matrix Equations. In B. Kågström et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2006*, Lecture Notes in Computer Science, LNCS 4699, pages 127–136. Springer, 2007.

[11] Robert Granat. Algorithms and Library Software for Periodic and Parallel Eigenvalue Reordering and Sylvester-Type Matrix Equations with Condition Estimations. *PhD Thesis* UMINF-07.21, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, November, 2007.

[12] I. Jonsson and B. Kågström. Recursive blocked algorithms for solving triangular systems. Part I. One-sided and coupled Sylvester-type matrix equations. *ACM Trans. Math. Software*, 28(4):392–415, 2002.

[13] I. Jonsson and B. Kågström. Recursive blocked algorithms for solving triangular systems. Part II. Two-sided and generalized Sylvester and Lyapunov matrix equations. *ACM Trans. Math. Software*, 28(4):416–435, 2002.

[14] I. Jonsson and B. Kågström. RECSY - A High Performance Library for Solving Sylvester-Type Matrix Equations. In Kosch H. et al, editor, *Euro-Par 2003 Parallel Processing*, volume 2790 of *Lecture Notes in Computer Science*, pages 810–819. Springer-Verlag, 2003.

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[16] D. Kressner. Block variants of Hammarling's method for solving Lyapunov equations. *ACM Trans. Math. Software*, 34(1):1–15, 2008.

[17] RECSY - High Performance library for Sylvester-type matrix equations. See `http://www8.cs.umu.se/research/parallel/recsy`.

[18] SCASY - ScaLAPACK-style solvers for Sylvester-type matrix equations. See `http://www8.cs.umu.se/research/parallel/scasy`.

Blocked and Parallel Two-Sided Reductions to Condensed Forms

[1] B. Kågström, D. Kressner, E. Quintana-Orti, and G. Quintana-Orti. Blocked Algorithms for the Reduction to Hessenberg-Triangular Form Revisited. *BIT Numerical Mathematics*, 48(1):563–584, 2008.

[2] L. Karlsson and B. Kågström. A Framework for Dynamic Node Scheduling of Two-Sided Blocked Matrix Computations. In *State of the Art in Scientific and Parallel Computing, PARA 2008*, *Lecture Notes in Computer Science* (to appear). Springer, 2009.

[3] Lars Karlsson. *Blocked and Scalable Matrix Computations — Packed Cholesky, In-Place Transposition, and Two-Sided Transformations*. Ph. Licentiate Thesis, Dept. of Computing Science, Umeå University, Sweden, 2009. Report UMINF 09.11, ISBN 978–91–7264–788–6.

Blocked and Parallel Reduction to Schur Forms

[1] R. Granat, B. Kågström, and D. Kressner. A Novel Parallel QR Algorithm for Hybrid Distributed Memory HPC Systems. *SIAM J. Scientific Computing* (submitted), 2009. (Also as Lapack Working Note LAWN 216).

[2] R. Granat, B. Kågström, and D. Kressner. Parallel Eigenvalue Reordering in Real Schur Forms. *Concurrency and Computation: Practice and Experience*, 21(9):1225–1250, September, 2007 (Also as Report UMINF-07.20 and LAPACK Working Note 192).

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[4] B. Kågström and D. Kressner. Multishift Variants of the QZ Algorithm with Aggressive Early Deflation. *SIAM J. Matrix Anal. Appl.*, 29(1):199–227, 2006.

[5] D. Kressner. Block algorithms for reordering standard and generalized Schur forms. *ACM Trans. Math. Software*, 32(4):521–532, 2006.

HPC Software and Tools

[1] B. Adlerborn, B. Kågström, and D. Kressner. Parallel Variants of the Multishift QZ Algorithm with Advanced Deflation Techniques . In B. Kågström et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2006*, Lecture Notes in Computer Science, LNCS 4699, pages 117–126. Springer, 2007.

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[5] P. Johansson and D. Kressner. Semi-automatic generation of web-based computing environments for software libraries. In *Computation Science – ICCS 2002*, number LNCS 2329 in Lecture Notes in Computer Science, pages 827–880. Springer, 2002.

[6] Pedher Johansson. Software Tools for Matrix Canonical Computations and Web-Based Software Library Environments. *PhD Thesis* UMINF-06.30, Department of Computing Science, Umeå University, S-901 87 Umeå, Sweden, November, 2006.

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[8] C. Lacoursière. A parallel block iterative method for interactive contacting rigid multibody simulations on multicore PCs. In *PARA'06*, pages 956–965, 2006.

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[10] SCASY - ScaLAPACK-style solvers for Sylvester-type matrix equations. See `http://www8.cs.umu.se/research/parallel/scasy`.

[11] J. Tångrot, L. Wang, B. Kågström, and U. Sauer. Design, Construction and Use of the FISH Server. In B. Kågström et al., editor, *Applied Parallel Computing: State of the Art in Scientific Computing, PARA 2006*, Lecture Notes in Computer Science, LNCS 4699, pages 647–657. Springer, 2007.