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Research Interests

Parallel and distributed computing, numerical scientific components, compiler technology, automatic differentiation, performance modeling, interactive supercomputing.

Education

University of Illinois at Urbana-Champaign, Urbana, IL
Sept. 1995–Nov, 1999: Ph.D. in Computer Science, Jan. 2000
Thesis Title: An Environment for Interactive Parallel Numerical Computing
Doctoral Advisor: Dr. Michael Heath

Wake Forest University, Winston-Salem, NC, Aug. 1993–May 1995.
B.S. in Computer Science, May 1995, 3.95/4.0 GPA, Summa Cum Laude.

University of Illinois at Urbana-Champaign, Urbana, IL
Jan. 1993–May 1993: Research Experience for Undergraduates, 5.0/5.0 GPA.

Southwest State University, Marshall, MN, Sep. 1991–Jan. 1993, 4.0/4.0 GPA.

Employment

Assistant Computer Scientist, Argonne National Laboratory, October 2001–present. Design and development of numerical components and related infrastructure; compiler-based tools for automatic differentiation; performance modeling and prediction; methods and software for nanophotonics simulation.

Postdoctoral Research Staff, Argonne National Laboratory, November 1999–October 2001. Development of tools for automatic differentiation and AD integration into numerical software.

Teaching Assistant, University of Illinois at Urbana-Champaign, January–May, 1999. Teaching discussion sections in an introductory computer science course, exam and homework preparation and grading.

Wallace Givens Research Associate, Argonne National Laboratory, Summer 1998. Development of a differentiated version of PETSc using automatic differentiation tools and high-level algorithmic templates.

Graduate Research Assistant to Dr. Michael Heath, National Center for Supercomputing Applications, University of Illinois, June 1996–January 1999, August–November 1999. Design and implementation of a Matlab-based high-performance parallel computing environment.

Consultant/Senior Programmer, Liberty Data Systems, Kernersville, NC, summer 1995. Network application development and consulting.

Consultant/Programmer, self-employed, Apr. 1994–May 1995. Business application development and consulting.

Computer Center Consultant, Wake Forest University, Aug. 1994–May 1995. Applications support for university software.

Software Developer, AMP, Inc., Winston-Salem, NC, summer 1994. MS Windows business application development.

Consultant/Programmer, Information Technology Professionals, Winston-Salem, NC, Aug. 1993–May 1994. Business application development, mainly relational databases.

Undergraduate research assistant to Dr. Michael Heath, National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign, Jan. 1993–May 1993. Developed and implemented a generalized parallel matrix multiplication algorithm using 2D data partitioning.

Honors/Scholarships

Fellowship recipient at the Second MIT CFD Conference, June 2003

SURGE Graduate Fellowship, University of Illinois at Urbana-Champaign, Sep. 1995–present.

Carswell Distinguished Scholarship, Wake Forest University, Sep. 1994–May 1995.

Presidential Scholarship, Southwest State University, Sep. 1991–Dec. 1993.

Member of the National Honor Society since Jan., 1991; Phi Beta Kappa since Apr., 1995.

Professional Activities

Member: ACM (1998), IEEE Computer Society (1999), SIAM (1998), Phi Beta Kappa (1994), National Honor Society (1991)

Member of the Common Component Architecture Forum since 1999.

Member of the MCS Library Committee since 2003.

Co-PI in “Performance Engineering Research Center” (DOE, funded 2001) and “Computational Nanophotonics: Modeling Optical Interactions and Transport in Tailored Nanosystem Architectures” (DOE, funded 2003).

Reviewer, IPDPS’2001, AD Workshop at ICCSA’03, SAC’03, HICSS (2003, 2004), DOE Early Career Grants (2003, 2004), IEEE Proceedings (2004), AD’2004, International Journal of Computers and Applications (2005).

Tutorial presenter: CCA (2002–present), Performance Modeling (SIGMETRICS’04).

Organizer of a minisymposium on Performance Evaluation Challenges and Adaptive Numerical Approaches in Scientific Software at the SIAM Computational Science and Engineering Conference, 2005.

Organizer of a minisymposium on High Performance Components at the Eleventh SIAM Conference on Parallel Processing for Scientific Computing (PP04) conference.

Organizing committee member for AD’2004, co-editor of the post-conference collection.

Organizing committee member for Workshop on Domain-Specific Languages for Optimization, Argonne National Laboratory, August 18-20, 2004.

Served on the organizing committee for the High Performance Computing Workshop at the Computer Science Department, University of Illinois at Urbana-Champaign, 1999.

Publications

Journal Articles

D. E. Bernholdt, B. A. Allan, R. Armstrong, F. Bertrand, K. Chiu, T. L. Dahlgren, K. Damevski, W. R. Elwasif, T. G. W. Epperly, M. Govindaraju, D. S. Katz, J. A. Kohl, M. Krishnan, G. Kumfert, J. W. Larson, S. Lefantzi, M. J. Lewis, A. D. Malony, L. C. McInnes, J. Nieplocha, B. Norris, S. G. Parker, J. Ray, S. Shende, T. L. Windus, S. Zhou. "A Component Architecture for High-Performance Scientific Computing," *Intl. J. High-Perf. Computing Appl.*, 2004, to appear in ACTS Collection special issue.

S. Bhomick, P. Raghavan, L. McInnes, and B. Norris, "Faster PDE-based Simulations Using Robust Composite Linear Solvers," Argonne National Laboratory preprint ANL/MCS-P993-0902, to appear in *Future Generation Computer Systems*, 2003.

C. H. Bischof, P. D. Hovland, and B. Norris. "Implementation of Automatic Differentiation Tools," in *Proceedings of PEPM'02*. Revised version to appear in a special issue of Higher-Order and Symbolic Computation, Elsevier.

P. Hovland, B. Norris, and B. Smith, "Making Automatic Differentiation Truly Automatic: Coupling PETSc with ADIC," to appear in a special issue of *Future Generation Computer Systems*, Elsevier, 2005. Argonne National Laboratory preprint ANL/MCS-P922-0102.

B. Norris, S. Benson, L. Freitag, P. Hovland, L. McInnes, M. Singer, and B. Smith. "Parallel Components for PDEs and Optimization: Some Issues and Experiences," *Parallel Computing* 28 (12) (2002) 1811-1831.

A. Radenski, A. Vann, and B. Norris, "Parallel Probabilistic Computations on a Cluster of Workstations," in *Parallel Computing: Fundamentals, Applications, and New Directions*, Elsevier, New York, 1998.

Book Chapters

L. C. McInnes, B. A. Allan, R. Armstrong, S. J. Benson, D. E. Bernholdt, T. L. Dahlgren, L. F. Diachin, M. Krishnan, J. A. Kohl, J. W. Larson, S. Lefantzi, J. Nieplocha, B. Norris, S. G. Parker, J. Ray, and S. Zhou, "Parallel PDE-Based Simulations Using the Common Component Architecture", Eds., Are Magnus Bruaset, Petter Bjorstad, and Aslak Tveito, to appear in *Numerical Solution of Partial Differential Equations on Parallel Computers, Lecture Notes in Computational Science and Engineering*, Springer-Verlag, 2005.

Publications in Refereed Conference Proceedings

P. Raghavan, M. J. Irwin, L. C. McInnes, and B. Norris, "Adaptive Software for Scientific Computing: Co-Managing Quality-Performance-Power Tradeoffs," in *Proceedings of the IEEE International Parallel & Distributed Processing Symposium 2005 (CDROM)*, IEEE Computer Society Press, 2005.

L. McInnes B. Norris. "Software Architecture Approaches for Adaptive Scientific Computing," to appear in *Proceedings of PARA'04 Workshop on State-of-the-art in Scientific Computing*, Lyngby, Denmark, June 20-23, 2004.

S. Bhowmick, L. McInnes, B. Norris, and P. Raghavan. "Robust Algorithms and Software for Parallel PDE-Based Simulations," High Performance Computing Symposium, Arlington, Virginia, to appear in *Proceedings of the Advanced Simulation Technologies Conference, ASTC'04*, April 18 - 22, 2004.

B. Norris, J. Ray, R. Armstrong, L. C. McInnes, D. E. Bernholdt, W. R. Elwasif, A. D. Malony, and S. Shende. "Computational Quality of Service for Scientific Components," in *Proceedings of the International Symposium on Component-Based Software Engineering (CBSE7), Edinburgh, Scotland, May 24-25, 2004*, Lecture Notes in Computer Science 3054, Editors I. Crnkovic, J. A. Stafford, H. W. Schmidt, and K. Wallnau, Springer, 2004.

S. Bhowmick, L. McInnes, B. Norris, and P. Raghavan. "Robust Algorithms and Software for Parallel PDE-Based Simulations", in *Proceedings of the High Performance Computing Symposium, Arlington, VA, April 18-22, 2004*. Published at scs.proceedingscentral.com.

J. Walter Larson, Boyana Norris, Everest T. Ong, David E. Bernholdt, John B. Drake, Wael R. Elwasif, Michael

W. Ham, Craig E. Rasmussen, Gary Kumfert, Daniel S. Katz, Shujia Zhou, Cecelia DeLuca, and Nancy S. Collins, "Components, the Common Component Architecture, and the Climate/Weather/Ocean Community", in *Proceedings of the 84th American Meteorological Society Annual Meeting*, Seattle, Washington, 11–15 January, 2004.

S. Bhowmick, L. McInnes, B. Norris, and P. Raghavan. "The Role of Multi-Method Linear Solvers in PDE-Based Simulations," in *Proceedings of the 2003 International Conference on Computational Science and its Applications, ICCSA 2003*, Montreal, Canada May 18 - May 21, 2003. Lecture notes in Computer Science 2677, Editors V. Kumar, M. L. Gavrilova C. J. K. Tan, and P. L'Ecuyer, pp. 828–839, 2003. Argonne National Laboratory preprint ANL/MCS-P1027-0203.

P. Hovland, K. Keahey, L.C. McInnes, B. Norris, L.F. Diachin, and P. Raghavan, "A Quality-of-Service Architecture for High-Performance Numerical Components," in *Proceedings of the Workshop on QoS in Component-Based Software Engineering*, Toulouse, France, June 20, 2003.

L. McInnes, B. Norris, S. Bhowmick, and P. Raghavan, "Adaptive Sparse Linear Solvers for Implicit CFD Using Newton-Krylov Algorithms," in *Proceedings of the Second MIT Conference on Computational Fluid and Solid Mechanics*, Massachusetts Institute of Technology, Boston, USA, June 17-20, 2003. Argonne National Laboratory preprint ANL/MCS-P998-0902, 2003.

P. D. Hovland, U. Naumann, and B. Norris, "An XML-Based Platform for Semantic Transformation of Numerical Programs," in *Proceedings of Software Engineering and Applications*, November 4-6, 2002 Cambridge, MA, ACTA Press, Anaheim, CA, pp. 530–538. Argonne National Laboratory preprint ANL/MCS-P950-0402.

J. Abate, S. Benson, L. Grignon, P. Hovland, L. McInnes, and B. Norris, "Integrating Automatic Differentiation with Object-Oriented Toolkits for High-Performance Scientific Computing," in George Corliss, Christèle Faure, Andreas Griewank, Laurent Hascoët, and Uwe Naumann, editors, *Automatic Differentiation of Algorithms: From Simulation to Optimization*. Springer, New York, 2002.

E. Dolan, P. Hovland, J. Moré, B. Norris, and B. Smith, "Remote Access to Mathematical Software," *Internet Accessible Mathematical Computation Workshop 2001 at ISSAC'2001*, University of Western Ontario, Canada, 22 July, 2001.

B. Norris and P. Hovland, "A Distributed Application Server for Automatic Differentiation," Technical Report ANL/MCS-P856-1100, Mathematics and Computer Science Division, Argonne National Laboratory, 2000. Also in *Proceedings of IPDPS2001 (CDROM)*.

A. Radenski, B. Norris, and W. Chenn, "A Generic All-Pairs Cluster Computing Pipeline and Its Applications," in *Parallel Computing: Fundamentals & Applications*, Proceedings of the International Conference ParCo99, TU Delft, The Netherlands, Imperial College Press, 2000, pp. 367-374.

A. Radenski, A. Vann, and B. Norris, "Development and Utilization of Parallel Generic Algorithms for Scientific Cluster Computations," in *Object Oriented Methods for Interoperable Scientific and Engineering Computing: Proceedings of the 1998 SIAM Workshop*, SIAM, Philadelphia, 1999.

P. Hovland, B. Norris, L. Roh, and B. Smith, "Developing a Derivative-Enhanced Object-Oriented Toolkit for Scientific Computations," in *Object Oriented Methods for Interoperable Scientific and Engineering Computing: Proceedings of the 1998 SIAM Workshop*, SIAM, Philadelphia, 1999.

A. Radenski, A. Vann, B. Norris, "Development and Utilization of Generic Algorithms for Scientific Computations," *ECOOP 98, Workshop on Parallel Object Oriented Scientific Computing*, Brussels, Belgium, July 20-24, 1998. 2-page summary in *Object Oriented Technology*, Volume 1543 of *Lecture Notes in Computer Science*, Springer, New York, 1998, pp. 464-465.

A. Radenski, A. Vann, and B. Norris, "Parallel Probabilistic Computations on a Cluster of Workstations," in *Proceedings of the International Conference on Parallel Computing*, Bonn, Germany, September 16–19, 1997.

Other publications

PS. Bhowmick, D. Kaushik, L. McInnes, B. Norris and P. Raghavan, "Parallel Adaptive Solvers in Compressible PETSc-FUN3D Simulations," extended abstract in the *Proceedings of the 17th International Conference on Parallel Computational Fluid Dynamics*, University of Maryland, College Park, MD, May 24–27.

L. McInnes, B. Norris, I. Veljkovic, "Computational Quality of Service in Parallel CFD," extended abstract in the *Proceedings of the 17th International Conference on Parallel Computational Fluid Dynamics*, University of Maryland, College Park, MD, May 24–27.

. D. Hovland and B. Norris, "Users' Guide to ADIC 1.1," Technical Memorandum ANL/MCS-TM-225, July 2002.

J. Abate, P. D. Hovland, B. Norris, and L. Roh, "A Component-Based Software Architecture for Semantic Transformation of Scientific Software," Technical Report ANL/MCS-P930-0202, 2001.

Selected Software Development

- ADIC, source transformation automatic differentiation of ANSI C and C++ programs, including the definition and implementation of XAIF, an XML-based intermediate representation for mathematical computations.
- ADIC and ADIFOR Web-based and command line remote application servers.
- CCA scientific components; CCA middleware infrastructure and automated build system support; CCA-compliant linear algebra and optimization components (this multi-institution collaborative project was named as one of the "Top 10 DOE Science Achievements in 2002").
- Multimethod parallel linear solvers: combine or adaptively apply existing iterative algorithms to produce multi-method heuristics resulting in improved robustness and performance.
- Static performance modeling tools: estimate the number of floating-point operations and memory accesses through source code analysis (C and C++) and provide upper bounds on the performance of an application.
- Structured AMR in FDTD methods for nanophotonics simulations; visualization of parallel AMR results.

Invited Talks and Colloquia

- "Enabling Technologies for Computational Science: Automatic Differentiation, Component Software, and Performance", EECE Colloquium, Marquette University, March 15, 2005.
- "Issues and Approaches in Scientific Component Software Development", Colloquium, Penn State University Computer Science and Engineering, March 18, 2004.
- "High-Performance Scientific Components", First Friday Forum, Argonne National Laboratory, June, 2003.
- Panel member at the Women in Science Careers Conference, Argonne National Laboratory, March, 2003.

References

References are available upon request.