

Boyana Norris

Mathematics and Computer Science Division
Argonne National Laboratory
Building 221, Room D236
9700 South Cass Avenue
Argonne, IL 60439

Office: (630) 252-7908

Fax: (630) 252-5986

norris@mcs.anl.gov

<http://www.mcs.anl.gov/~norris>

RESEARCH INTERESTS

Norris conducts research on enabling technologies for high-performance simulations in computational science and engineering, with emphasis on *automation* of the development, deployment, testing, and performance tuning of parallel applications. Specific research areas include (1) source code analysis and transformation, specifically on automatic differentiation, performance analysis, and empirical code tuning; (2) embeddable domain-specific languages for high-performance computing; and (3) quality of service infrastructure for scientific components, for optimizing performance, energy use, and resilience of complex applications.

EDUCATION

Ph.D. in Computer Science, University of Illinois at Urbana-Champaign, Urbana, IL, Jan. 2000.

Thesis Title: “An Environment For Interactive Parallel Numerical Computing”

Thesis Advisor: Professor Michael T. Heath

B.S. in Computer Science, Wake Forest University, Winston-Salem, NC, May 1995.

EMPLOYMENT

Computer Scientist, Argonne National Laboratory, March 2006–present. Design and development of numerical components and related infrastructure; compiler-based tools for automatic differentiation; performance modeling and prediction; power-aware high-performance computing; methods and software for nanophotonics simulation.

Assistant Computer Scientist, Argonne National Laboratory, October 2001–March 2006. High performance scientific component software; automatic differentiation; performance modeling and prediction; computational nanophotonics.

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 Professor 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 general software and hardware consulting.

Computer Center Consultant, Wake Forest University, Aug. 1994–May 1995. Applications support for university software (Windows, MacOS, Unix).

Software Developer, AMP, Inc., Winston-Salem, NC, summer 1994. MS Windows business application development, mainly relational databases for plant operation and administration.

Consultant/Programmer, Information Technology Professionals, Winston-Salem, NC, Aug. 1993–May 1994. Business application development, including relational databases management applications and custom accounting software.

Undergraduate research assistant to Dr. Michael Heath (REU Program), 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 AND AWARDS

- Fellowship recipient at the Second MIT CFD Conference, June 2003.
- Led the design and implementation of the parallel components for partial differential equations and optimization, which were recognized as one of the top 10 DOE Office of Science achievements in 2002 (http://www.sc.doe.gov/sub/accomplishments/top_10.htm).
- Excellent Teaching Assistant Award, University of Illinois at Urbana-Champaign, Spring 1999.
- SURGE Graduate Fellowship, University of Illinois at Urbana-Champaign, Sep. 1995–1999.
- 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., 1994.

EXTERNAL FUNDING

- Co-PI, Department of Energy, *Institute for Sustained Performance, Energy, and Resilience (SUPER)*, Scientific Discovery through Advanced Computing (SciDAC-3), collaborative project led by Robert F. Lucas (USC), \$325K/year (Argonne), 2011 – 2016.
- Co-PI, Department of Energy, Phase II SBIR lead by Gerald Sabin of RNET Technologies on performance tuning of PETSc kernels and data structures, \$240K (Argonne), 2010 – 2012.
- Co-PI, Department of Energy, *Algorithms and Software for Communication Avoidance and Communication Hiding at the Extreme Scale*, collaborative project led by Erich Strohmeier (LBNL), \$349K/year (Argonne), 2009 – 2012.
- Co-PI, Department of Energy, *Performance Engineering Research Institute*, Scientific Discovery through Advanced Computing (SciDAC-2) Institute, collaborative project led by Robert F. Lucas (USC), \$3M/year, 2006 – 2011.
- Co-PI, Department of Energy, *Performance Engineering Research Institute*, Scientific Discovery through Advanced Computing (SciDAC-2) Institute, collaborative project led by Robert F. Lucas (USC), \$3M/year, 2006 – 2011.
- Co-PI, National Science Foundation, *Taxonomy for the Automated Tuning of Matrix Algebra Software*, collaborative project led by E. Jessup (University of Colorado at Boulder), B. Norris (ANL), \$500K total, 2009 – 2011.
- Co-PI, National Science Foundation, *Multicore Optimization of an Astrophysical Simulation Code using Performance Annotations*, P. Ricker (UIUC), B. Norris (ANL), \$75K, 2007 – 2008.
- Co-PI, Department of Energy, *Combinatorial Scientific Computing and Petascale Simulations*, SciDAC-2 Institute headed by Alex Pothen (Old Dominion University), \$1.3M/year, 2006 – 2011.
- Co-PI, National Science Foundation, *Adaptive Software for Extreme-Scale Scientific Computing: Co-Managing Quality-Performance-Power Tradeoffs*, P. Raghavan (Penn. State), M. J. Irwin (Penn. State), L. C. McInnes (ANL), and B. Norris (ANL), \$750K total, October 2004 – October 2007.
- Co-PI, National Science Foundation, *Collaborative Research: CMG: Uncertainty Quantification in Geophysical State Estimation*, P. Hovland (University of Chicago), B. Norris (ANL), C. Wunsch (MIT), approximately \$723K total, 2005 – 2008.
- Co-PI, Department of Energy, *Computational Nanophotonics: Modeling Optical Interactions and Transport in Tailored Nanosystem Architectures*, SciDAC-2 Application Project led by Stephen Gray (ANL), approximately \$1.3M/year, August 2003 – August 2008.

PROFESSIONAL ACTIVITIES

- Member of the Community Surface Dynamics Modeling System (CSDMS) Steering Committee, 2009–present.
- Secretary of SIAM Activity Group on Supercomputing: 2006-08, Vice-chair: 2010-12.

- Member (since): ACM (1998), IEEE (1999), IEEE Computer Society (1999), SIAM (1998), SIAG/SC (2005).
- Member of the Common Component Architecture Forum since 1999.
- Member of the MCS Library Committee, 2003–2005, 2011–present.
- Reviewer, IPDPS'2001, AD Workshop at ICCSA'03, SAC'03, HICSS (2003, 2004), DOE SBIR grants (2006), DOE Early Career Grants (2003, 2004), IEEE Proceedings (2004), AD'2004, International Journal of Computers and Applications (2005).
- Minisymposia organized: *Performance Evaluation Challenges and Adaptive Numerical Approaches in Scientific Software* at the SIAM Computational Science and Engineering Conference, February 13, 2005; *High Performance Components* at the Eleventh SIAM Conference on Parallel Processing for Scientific Computing (PP04).
- Organizing and program committee member for Fourth International Conference on Automatic Differentiation, AD'2004.
- Organizing committee member for the Workshop on Domain-Specific Languages for Optimization, Argonne National Laboratory, August 18-20, 2004.
- Organizing committee member for the High Performance Computing Workshop at the Computer Science Department, University of Illinois at Urbana-Champaign, 1999.

PUBLICATIONS

Books Edited

- [1] H. M. Bücker, G. F. Corliss, P. D. Hovland, U. Naumann, and B. Norris, editors. *Automatic Differentiation: Applications, Theory, and Implementations*, vol. 50. Lecture Notes in Computational Science and Engineering. Springer, New York, NY, 2006, <http://dx.doi.org/10.1007/3-540-28438-9>.

Refereed Journal Articles and Book Chapters

- [2] S. Peckham, E. Hutton, and B. Norris. A component-based approach to integrated modeling in the geosciences: The design of CSDMS. *Computers and Geoscience: Modeling for Environmental Change*, 2011, <http://www.mcs.anl.gov/uploads/cels/papers/P1969.pdf>. To appear. Also available as Argonne Preprint ANL/MCS-P1969-1011.
- [3] C. H. Bischof, P. D. Hovland, and B. Norris. On the implementation of automatic differentiation tools. *Higher-Order and Symbolic Computation* 21:311–331, Sept. 2008, <http://www.springerlink.com/content/165g637737055372>.
- [4] B. A. Allan, B. Norris, W. R. Elwasif, and R. C. Armstrong. Managing scientific software complexity with Bocca and CCA. *Scientific Programming* 16(4):315–327, Dec. 2008.
- [5] E. T. Ong, J. Walter Larson, B. Norris, R. L. Jacob, M. Tobis, and M. Steder. A multilingual programming model for coupled systems. *International Journal for Multiscale Computational Engineering* 6:39–51, 2008, <http://www.begellhouse.com/journals/61fd1b191cf7e96f,0c7854ff2b43051a,12a7011e66e8e4cf.html>.

- [6] B. Norris, L. C. McInnes, S. Bhowmick, and L. Li. Adaptive numerical components for PDE-based simulations. *PAMM: Special Issue: Sixth International Congress on Industrial Applied Mathematics (ICIAM07) and GAMM Annual Meeting, Zurich 2007* 7:1140509–1140510, Dec. 2007, <http://dx.doi.org/10.1002/pamm.200700687>.
- [7] D. H. Bailey, R. Lucas, P. Hovland, B. Norris, K. Yelick, D. Gunter, B. de Supinski, D. Quinlan, P. Worley, J. Vetter, P. Roth, J. Mellor-Crummey, A. Snavely, J. Hollingsworth, D. Reed, R. Fowler, Y. Zhang, M. Hall, J. Chame, J. Dongarra, and S. Moore. Performance engineering: Understanding and improving the performance of large-scale codes. *CTWatch Quarterly* 3(4), Nov 2007.
- [8] B. Norris, S. Bhowmick, D. Kaushik, and L. C. McInnes. Middleware for dynamic adaptation of component applications. *Grid-Based Problem Solving Environments*, pp. 127–153. Springer, IFIP International Federation for Information Processing, 2007.
- [9] B. Norris, A. Hartono, and W. Gropp. Annotations for productivity and performance portability. *Peta-scale Computing: Algorithms and Applications*, pp. 443–462. Chapman & Hall / CRC Press, Taylor and Francis Group, Computational Science, 2007, <http://www.mcs.anl.gov/uploads/cels/papers/P1392.pdf>. Preprint ANL/MCS-P1392-0107.
- [10] P. D. Hovland, B. Norris, M. M. Strout, and J. Utke. Term graphs for computing derivatives in imperative languages. *Electronic Notes on Theoretical Computer Science*, 2007, <http://www.mcs.anl.gov/uploads/cels/papers/P1311.pdf>. Preprint ANL/MCS-P1311-0106.
- [11] Z. Meglicki, S. K. Gray, and B. Norris. Mutligrid FDTD with Chombo. *Computer Physics Communications*, 10 2006, <http://dx.doi.org/10.1016/j.cpc.2006.08.008>.
- [12] 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. *Numerical Solution of Partial Differential Equations on Parallel Computers*, pp. 327–381. Springer, Lecture Notes in Computational Science and Engineering 51, 2006, [http://dx.doi.org/10.1016/S0167-8191\(02\)00191-6](http://dx.doi.org/10.1016/S0167-8191(02)00191-6). Preprint ANL/MCS-P1179-0704.
- [13] 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, and S. Zhou. A component architecture for high-performance scientific computing. *International Journal of High Performance Computing Applications* 20(2):163–202, 2006, <http://dx.doi.org/10.1177/1094342006064488>.
- [14] P. Hovland, B. Norris, and B. Smith. Making automatic differentiation truly automatic: Coupling PETSc with ADIC. *Future Generation Computer Systems* 21(8):1426–1438, 2005, <http://dx.doi.org/10.1016/j.future.2004.11.008>.
- [15] B. Norris and P. Hovland. A distributed application server for automatic differentiation. *INFORMATION* 6(3):305–314, July 2003, <http://www.mcs.anl.gov/uploads/cels/papers/P856.ps.Z>. Preprint ANL/MCS-P856-1100.
- [16] C. Bischof, P. Hovland, and B. Norris. Implementation of automatic differentiation tools. *Proceedings of the 2002 ACM SIGPLAN Workshop on Partial Evaluation and Semantics-Based Program Manipulation (PEPM-02)*, vol. 37, pp. 98–107. ACM Press, ACM SIGPLAN Notices 3, Jan. 14–15 2002. Substantially revised version to appear in a special issue of Higher-Order and Symbolic Computation, Springer.
- [17] S. Bhowmick, P. Raghavan, L. C. McInnes, and B. Norris. Faster PDE-based simulations using robust composite linear solvers. *Future Generation Computer Systems* 20(3):373–387, 2004, <http://dx.doi.org/10.1016/j.future.2003.07.012>.

- [18] B. Norris, S. Balay, S. Benson, L. Freitag, P. Hovland, L. McInnes, and B. Smith. Parallel components for PDEs and optimization: Some issues and experiences. *Parallel Computing* 28(12):1811–1831, 2002, [http://dx.doi.org/10.1016/S0167-8191\(02\)00191-6](http://dx.doi.org/10.1016/S0167-8191(02)00191-6).
- [19] 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. *Automatic Differentiation of Algorithms: From Simulation to Optimization*, chapter 20, pp. 173–178. Springer, 2002. Proceedings of AD2000.
- [20] A. Radenski, A. Vann, and B. Norris. Parallel probabilistic computations on a cluster of workstations. *Parallel Computing: Fundamentals, Applications, and New Directions*. Elsevier, 1998.

Refereed Conference Proceedings

- [21] S. H. K. Narayanan, B. Norris, P. Hovland, D. C. Nguyen, and A. H. Gebremedhin. Sparse jacobian computation using ADIC2 and ColPack. *Procedia Computer Science* 4:2115 – 2123, 2011, <http://www.sciencedirect.com/science/article/pii/S1877050911002894>. Proceedings of the International Conference on Computational Science, ICCS 2011.
- [22] S. H. K. Narayanan, B. Norris, and P. D. Hovland. Generating performance bounds from source code. *Proceedings of the First International Workshop on Parallel Software Tools and Tool Infrastructures (PSTI 2010)*, 9 2010, <http://www.mcs.anl.gov/uploads/cels/papers/P1685.pdf>. Also available as Preprint ANL/MCS-P1685-1009.
- [23] S. H. K. Narayanan, B. Norris, and B. Winnicka. ADIC2: Development of a component source transformation system for differentiating C and C++. *Workshop on Automated Program Generation for Computational Science, May 31, Amsterdam, The Netherlands, 5 2010*, <http://www.mcs.anl.gov/uploads/cels/papers/P1714.pdf>. Also available as Preprint ANL/MCS-P1714-0110.
- [24] V. Bui, B. Norris, and L. C. McInnes. An automated component-based performance experiment environment. *Proceedings of the 2009 Workshop on Component-Based High Performance Computing (CBHPC 2009)*, Nov. 2009, <http://www.mcs.anl.gov/uploads/cels/papers/P1666.pdf>. Also available as Preprint ANL/MCS-P1666-0809.
- [25] L. Li, T. Dahlgren, L. C. McInnes, and B. Norris. Interface contract enforcement for improvement of computational quality of service (CQoS) for scientific components (extended abstract). *Proceedings of the 2009 Workshop on Component-Based High Performance Computing (CBHPC 2009)*, Nov. 2009.
- [26] S. Muszala, J. Amundson, L. C. McInnes, and B. Norris. Two-tiered component design and performance analysis of Synergia2 accelerator simulations. *Proceedings of the 2009 Workshop on Component-Based High Performance Computing (CBHPC 2009)*, Nov. 2009.
- [27] B. de Supinski, S. Alam, D. Bailey, L. Carrington, C. Daley, A. Dubey, T. Gamblin, D. Gunter, P. Hovland, H. Jagode, K. Karavanic, G. Marin, J. Mellor-Crummey, S. Moore, B. Norris, L. Oliker, C. Olschanowsky, P. Roth, M. Schulz, S. Shende, A. Snavely, W. Spear, M. Tikir, J. Vetter, P. Worley, and N. Wright. Modeling the office of science ten year facilities plan: The PERI architecture tiger team. *Journal of Physics: Conference Series (Proceedings of SciDAC 2009)* 180(012039), July 2009.
- [28] A. Hartono, M. M. Baskaran, C. Bastoul, A. Cohen, S. Krishnamoorth, B. Norris, J. Ramanujam, and P. Sadayappan. PrimeTile: A parametric multi-level tiler for imperfect loop nests. *Proceedings of the 23rd International Conference on Supercomputing, June 8-12, 2009, IBM T. J. Watson Research Center, Yorktown Heights, NY, USA, 2009*, <http://www.cse.ohio-state.edu/~hartonoa/papers/ics09-ext.pdf>. Also available as Tech. Report OSU-CISRC-2/09-TR04.
- [29] L. Li, J. P. Kenny, M.-S. Wu, K. Huck, A. Gaenko, M. S. Gordon, C. L. Janssen, L. C. McInnes, H. Mori, H. M. Netzloff, B. Norris, and T. L. Windus. Adaptive application composition in quantum

- chemistry. *Proceedings of The 5th International Conference on the Quality of Software Architectures (QoSA 2009)*, February 2009, <http://www.mcs.anl.gov/uploads/cels/papers/P1575.pdf>. Also available as Preprint ANL/MCS-P1575-0209.
- [30] B. Norris, A. Hartono, E. Jessup, and J. Siek. Generating empirically optimized composed matrix kernels from MATLAB prototypes. *Proceedings of the International Conference on Computational Science 2009*, 2009, <http://www.mcs.anl.gov/uploads/cels/papers/P1581.pdf>. Also available as Preprint ANL/MCS-P1581-0209.
- [31] A. Hartono, B. Norris, and P. Sadayappan. Annotation-based empirical performance tuning using Orio. *Proceedings of the 23rd IEEE International Parallel & Distributed Processing Symposium*, 2009, <http://www.mcs.anl.gov/uploads/cels/papers/P1556.pdf>. Also available as Preprint ANL/MCS-P1556-1008.
- [32] K. A. Huck, O. Hernandez, V. Bui, S. Chandrasekaran, B. Chapman, A. D. Malony, L. C. McInnes, and B. Norris. Capturing performance knowledge for automated analysis. *Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis (SC'08)*, 2008.
- [33] V. Bui, B. Norris, K. Huck, L. C. McInnes, L. Li, O. Hernandez, and B. Chapman. A component infrastructure for performance and power modeling of parallel scientific applications. *Proceedings of Component-Based High Performance Computing Workshop, October 14-17, 2008, Karlsruhe, Germany*. ACM, 2008, <http://www.mcs.anl.gov/uploads/cels/papers/P1538.pdf>. Also available as Preprint ANL/MCS-P1538-0908.
- [34] B. Allan and B. Norris. Automating SIDL-based development for new and legacy software. <http://eprints.cca-forum.org/170/>, October 2008. extended abstract: Component-Based High Performance Computing Workshop, October 14-17, 2008, Karlsruhe, Germany.
- [35] J. F. Amundson, D. Dechow, L. McInnes, B. Norris, P. Spentzouris, and P. Stoltz. Multiscale, multi-physics beam dynamics framework design and applications. *Proceedings of SciDAC 2008*. IOP Publishing, 2008. Journal of Physics: Conference Series 125 (2008) 012001.
- [36] B. Allan and B. Norris. Automating multilanguage development for the high-performance software lifecycle. *Proceedings of PARA08: 9th International Workshop on State-of-the-Art in Scientific and Parallel Computing, May 13-16, 2008*, 2008.
- [37] L. Li, B. Norris, H. Johansson, L. C. McInnes, and J. Ray. Component infrastructure for managing performance data and runtime adaptation of parallel applications. *Proceedings of PARA08: 9th International Workshop on State-of-the-Art in Scientific and Parallel Computing, May 13-16, 2008*, 2008.
- [38] D. R. Dechow, B. Norris, and J. Amundson. The Common Component Architecture for particle accelerator simulations. *Proceedings of HPC-GECO/CompFrame'07, October 21-22, 2007, Montreal, Québec, Canada*. ACM, 2007.
- [39] W. Elwasif, B. Norris, B. Allan, and R. Armstrong. Bocca: A development environment for HPC components. *Proceedings of HPC-GECO/CompFrame'07, October 21-22, 2007, Montreal, Québec, Canada*. ACM, 2007.
- [40] J. W. Larson and B. Norris. Component specification for parallel coupling infrastructure. *Proceedings of the International Conference on Computational Science and its Applications (ICCSA 2007)*, vol. 4707, pp. 56–68. Springer-Verlag, Lecture Notes in Computer Science, Aug 2007.
- [41] E. T. Ong, J. W. Larson, B. Norris, R. L. Jacob, M. Tobis, and M. S. der. Multilingual interfaces for coupling in multiphysics and multiscale systems. *Proceedings of the International Conference on Computational Science, May 27- -30, 2007*, Lecture Notes in Computer Science, 2007.
- [42] S. Akioka, K. Malkowski, P. Raghavan, M. J. Erwin, L. C. McInnes, and B. Norris. Characterizing the performance and energy attributes of scientific simulations. *Computational Science ICCS 2006: 6th*

- International Conference, Reading, UK, May 28-31, 2006, Proceedings, Part I*, vol. 3991, pp. 242–249. Springer Berlin / Heidelberg, Lecture Notes in Computer Science, 2006, http://dx.doi.org/10.1007/11758501_36.
- [43] B. Norris. Software architecture issues in scientific component development. *Applied Parallel Computing: 7th International Conference, PARA 2004, Lyngby, Denmark, June 20-23, 2004. Revised Selected Papers*, vol. 3732, pp. 629–636. Springer Berlin / Heidelberg, Lecture Notes in Computer Science, 2006, http://dx.doi.org/10.1007/11558958_75.
- [44] S. Bhowmick, D. Kaushik, L. McInnes, B. Norris, and P. Raghavan. Parallel adaptive solvers in compressible PETSc-FUN3D simulations. *Proceedings of the 17th International Conference on Parallel Computational Fluid Dynamics, University of Maryland, College Park, MD, May 24–27, 2005*, ftp://info.mcs.anl.gov/pub/tech_reports/reports/P1279.pdf. Preprint ANL/MCS-P1279-0805.
- [45] B. Norris, L. McInnes, and I. Veljkovic. Computational quality of service in parallel CFD. *Proceedings of the 17th International Conference on Parallel Computational Fluid Dynamics, University of Maryland, College Park, MD, May 24–27, 2005*, ftp://info.mcs.anl.gov/pub/tech_reports/reports/P1283.pdf. Preprint ANL/MCS-P1283-0805.
- [46] P. Hovland, B. Norris, M. Strout, S. Bhowmick, and J. Utke. Sensitivity analysis and design optimization through automatic differentiation. *SciDAC 2005*, vol. 16, pp. 466–470. Institute of Physics Publishing, Journal of Physics: Conference Series, 2005, http://www.iop.org/EJ/article/1742-6596/16/1/063/jpconf5_16_063.pdf.
- [47] P. Raghavan, M. J. Irwin, L. C. McInnes, and B. Norris. Adaptive software for scientific computing: Co-managing quality-performance-power tradeoffs. *Proceedings of the IEEE International Parallel & Distributed Processing Symposium 2005 (CDROM)*. IEEE Computer Society Press, 2005, <http://dx.doi.org/10.1109/IPDPS.2005.83>.
- [48] S. Bhowmick, L. McInnes, B. Norris, and P. Raghavan. Robust algorithms and software for parallel PDE-based simulations. *Proceedings of the Advanced Simulation Technologies Conference, ASTC'04, April 18 - 22, 2004*. Society for Modeling and Simulation International (SCS), 2004, <http://scs.proceedingscentral.com>.
- [49] B. Norris, J. Ray, R. C. Armstrong, L. C. McInnes, D. E. Bernholdt, W. R. Elwasif, A. D. Malony, and S. Shende. Computational quality of service for scientific components. *Proceedings of the International Symposium on Component-Based Software Engineering (CBSE7), Edinburgh, Scotland, May 24–25, 2004*, vol. 3054, pp. 264–271. Springer, Lecture Notes in Computer Science, 2004, <http://www.springerlink.com/content/bklr81vrwaxuy2bl>.
- [50] J. W. Larson, B. Norris, E. T. Ong, D. E. Bernholdt, J. B. Drake, W. R. Elwasif, M. W. Ham, C. E. Rasmussen, G. Kurfert, D. S. Katz, S. Zhou, C. DeLuca, and N. S. Collins. Components, the common component architecture, and the climate/weather/ocean community. *84th Annual Meeting of the American Meteorological Society*. AMS, 2004, <http://www.mcs.anl.gov/~norris/pubs/larson-et-al-CCA-CWO-AMS-2004.pdf>.
- [51] S. Bhowmick, L. C. McInnes, B. Norris, and P. Raghavan. The role of multi-method linear solvers in PDE-based simulations. *Computational Science and Its Applications - ICCSA 2003, Part I*, vol. 2667, pp. 828–839. Springer, 2003.
- [52] P. Hovland, K. Keahey, L. C. McInnes, B. Norris, L. F. Diachin, and P. Raghavan. A quality of service approach for high-performance numerical components. *Proceedings of Workshop on QoS in Component-Based Software Engineering, Software Technologies Conference, 20 June 2003*.
- [53] L. McInnes, B. Norris, S. Bhowmick, and P. Raghavan. Adaptive sparse linear solvers for implicit CFD using Newton-Krylov algorithms. *Proceedings of the Second MIT Conference on Computational*

- Fluid and Solid Mechanics, Massachusetts Institute of Technology, Boston, USA, June 17-20, 2003*, pp. 1024–1028. Elsevier, 2003.
- [54] P. D. Hovland, U. Naumann, and B. Norris. An XML-based platform for semantic transformation of numerical programs. *Proceedings of Software Engineering and Applications, November 4-6, 2002 Cambridge, MA*, pp. 530–538. ACTA Press, Nov. 02 2002, ftp://info.mcs.anl.gov/pub/tech_reports/reports/P950.pdf. Argonne National Laboratory preprint ANL/MCS-P950-0402.
- [55] P. D. Hovland, B. Norris, and B. F. Smith. Making automatic differentiation truly automatic: Coupling PETSc with ADIC. *International Conference on Computational Science (2)*, vol. 2330, pp. 1087–1096, Lecture Notes in Computer Science, Jan. 2002.
- [56] E. Dolan, P. Hovland, J. More, B. Norris, and B. Smith. Remote access to mathematical software. *Proceedings of Internet Accessible Mathematical Computation, a Workshop at ISSAC'2001, Dec. 27 2001*, <http://icm.mcs.kent.edu/research/iamc2001.papers/norris.pdf>.
- [57] P. Hovland, S. Lee, L. McInnes, B. Norris, and B. Smith. Challenges and opportunities in using automatic differentiation with object-oriented toolkits for scientific computing. *1st Sandia Workshop on Large-Scale PDE-Constrained Optimization, Santa Fe, NM, April 4 – 6, 2001*, Apr. 2001, <http://www.llnl.gov/tid/lof/documents/pdf/244369.pdf>.
- [58] A. Radenski and B. Norris. Generic cluster-computing algorithms and applications. *Proceedings of the International Conference on Parallel and Distributed Processing Techniques and Applications, PDPTA 2000, June 24-29, 2000, Las Vegas, Nevada, USA*. CSREA Press, 2000.
- [59] A. Radenski, B. Norris, and W. Chenn. A generic all-pairs cluster computing pipeline and its applications. *Parallel Computing: Fundamentals & Applications: Proceedings of the International Conference ParCo99, TU Delft, The Netherlands*, pp. 367–374. Imperial College Press, 2000.
- [60] A. Radenski, A. Vann, and B. Norris. Development and utilization of parallel generic algorithms for scientific computations. *Object Oriented Methods for Interoperable Scientific and Engineering Computing: Proceedings of the 1998 SIAM Workshop*, pp. 97–105. SIAM, Mar. 30 1999.
- [61] P. Hovland, B. Norris, L. Roh, and B. Smith. Developing a derivative-enhanced object-oriented toolkit for scientific computations. *Object Oriented Methods for Interoperable Scientific and Engineering Computing: Proceedings of the 1998 SIAM Workshop*, pp. 129–137. SIAM, Mar. 1999, ftp://info.mcs.anl.gov/pub/tech_reports/reports/P731.ps.Z.
- [62] A. Radenski, A. Vann, and B. Norris. Development and utilization of generic algorithms for scientific computations. *Object Oriented Technology: Proceedings of ECOOP 98, Workshop on Parallel Object Oriented Scientific Computing, Brussels, Belgium, July 20-24, 1998*, vol. 1543, pp. 464–465. Springer, Lecture Notes in Computer Science, 1998.
- [63] A. Radenski, A. Vann, and B. Norris. Parallel probabilistic computations on a cluster of workstations. *Parallel Computing: Fundamentals, Applications and New Directions, Proceedings of the Conference ParCo'97, 19-22 September 1997, Bonn, Germany*, vol. 12, pp. 105–112. Elsevier, North-Holland, Advances in Parallel Computing, Feb. 1998.

Other Publications

- [64] Z. Meglicki, B. Norris, and S. Gray. Computations on arbitrary surfaces in FDTD space. Tech. Rep. ANL/MCS-P1883-0411, Argonne National Laboratory, 2011, <http://www.mcs.anl.gov/uploads/cels/papers/P1883.pdf>.

- [65] G. Belter, E. Jessup, I. Karlin, T. Nelson, B. Norris, and J. Siek. Exploring the optimization space for build to order matrix algebra. Tech. Rep. ANL/MCS-P1890-0511, Argonne National Laboratory, May 2011, <http://www.mcs.anl.gov/uploads/cels/papers/P1890.pdf>.
- [66] P. Balaprakash, S. Wild, and B. Norris. SPAPT: Search problems in automatic performance tuning. Tech. Rep. ANL/MCS-P1872-0411, Argonne National Laboratory, 2011, <http://www.mcs.anl.gov/uploads/cels/papers/P1872.pdf>.
- [67] B. R. D. Supinski, S. Alam, D. H. Bailey, L. Carrington, C. Daley, A. Dubey, T. Gamblin, D. Gunter, P. D. Hovl, H. Jagode, K. Karavanic, G. M. J. Mellor-crummey, B. Norris, L. Oliker, C. Olschanowsky, P. C. Roth, M. Schulz, S. Shende, A. Snavely, W. Spear, M. Tikir, J. Vetter, P. Worley, and N. Wright. Modeling the office of science ten year facilities plan: The PERI Architecture Tiger Team. 2010, <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.157.5866>.
- [68] A. Pothen, A. H. Gebremendhin, F. Dobrian, E. G. Boman, K. D. Devine, B. A. Hendrickson, P. Hovland, B. Norris, J. Utke, U. V. Catalyurek, and M. M. Strout. Combinatorial algorithms for petascale science. *SciDAC Review* (5):26–35, Fall 2007.
- [69] L. C. McInnes, J. Ray, R. Armstrong, T. L. Dahlgren, A. Malony, B. Norris, S. Shende, J. P. Kenny, and J. Steensland. Computational quality of service for scientific CCA applications: Composition, substitution, and reconfiguration. Tech. Rep. ANL/MCS-P1326-0206, Argonne National Laboratory, Feb. 2006, <http://www.mcs.anl.gov/uploads/cels/papers/P1326.pdf>.
- [70] B. Norris and I. Veljkovic. Performance monitoring and analysis components in adaptive PDE-based simulations. Tech. Rep. ANL/MCS-P1221-0105, Argonne National Laboratory, Jan. 2005, <http://www.mcs.anl.gov/uploads/cels/papers/P1221.pdf>.
- [71] B. Norris and P. D. Hovland. Users’ guide to ADIC 1.1. Tech. rep., Argonne National Laboratory, Sept. 17 2002, <http://www.mcs.anl.gov/uploads/cels/papers/TM-225.pdf>.
- [72] B. Norris. *An Environment For Interactive Parallel Numerical Computing*. Ph.D. thesis, University of Illinois at Urbana-Champaign, Jan. 2000, <http://citeseer.ist.psu.edu/408665.html>.

INVITED PRESENTATIONS

- Keynote speaker, Science Careers in Search of Women, April 14, 2011.
- Keynote speaker, “Component-Based Scientific Software Development: Usability Challenges and Tools,” Community Surface Dynamics Modeling System (CSDMS) Annual Meeting, 10/15/2010.
- “Approaches and Tools for Understanding and Improving the Performance of Scientific Applications,” University of Nebraska at Omaha, Oct. 2010.
- “Annotation-Based Empirical Performance Tuning of Scientific Applications,” Math/CS Seminar at Chapman University, Orange, CA, May 3rd, 2010.
- “Making High-Performance Multilingual Component Development Easy,” Computational Science and Engineering Colloquium, The Pennsylvania State University, Jan 11, 2008.
- “Enabling Adaptive Numerical Algorithms through Component-Based Software Engineering,” Aachen University, Germany, July 11, 2007.
- “Computational Quality of Service for Scientific Component Applications,” WoCo9: Grid-based Problem Solving Environments: Implications for Development and Deployment of Numerical Software, July 18, 2006.

- “Performance Annotations on the BlueGene/L,” SIAM PP’06 minisymposium on Application Performance Analysis and Optimization on BlueGene/L, February 22, 2006.
- “Enabling Technologies for Computational Science: Automatic Differentiation, Component Software, and Performance,” EECE Colloquium, Marquette University, March 15, 2005.
- “Software Architecture Approaches for Adaptive Scientific Computing,” PARA’04 minisymposium on Advanced Algorithms and Software for Scientific Computing, June 21, 2004.
- “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.
- “CCA Components for Linear System Solution,” SIAM Annual Meeting, minisymposium on New Approaches for Scalable Sparse Linear System Solution, July 10, 2002, Philadelphia.

TUTORIALS

- Common Component Architecture (CCA) Tutorials: SC’05, HPC2005, SC’04, SIAM PP’04, SC’03, and at some quarterly CCA meetings. Developed hands-on code and reusable build system.
- “Tools and Methods for Performance Modeling and Prediction,” SIGMETRICS’04 Tutorial, New York, June 13, 2004.

OUTREACH ACTIVITIES

- Member of the Women in Science and Technology (WIST) program, which was created at Argonne in 1990 to recruit, retain, and promote women in an effort to diversify and strengthen the Laboratory’s scientific workforce (2008-2010).
- Co-organizer of the Science Careers in Search of Women (SCSW) annual conference for high-school girls (multiple years), and Introduce a Girl to Engineering Day (multiple years).
- Commitment to recruiting minority and women for student research positions and postdoctoral appointments (approximately half of my students and postdocs are female).

SELECTED SOFTWARE

- Orio (<http://tinyurl.com/OrioTool>), a lightweight, extensible framework that supports the definition of embeddable domain languages and empirical performance tuning of C and Fortran applications. Orio employs a source code annotation approach that enables key computations to be expressed at a high level and embedded in existing code as comments, from which Orio then generates many optimized versions, which are then evaluated empirically to select the best versions to use for production runs. Correctness testing is also performed as part of the tuning process.

- 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; high-level user performance annotations for generating highly optimized code with the goal of increasing developer productivity, application performance, and performance portability on high-end architectures (<http://www.mcs.anl.gov/performance>).
- ADIC, source transformation automatic differentiation of ANSI C and C++ programs (<http://www.mcs.anl.gov/adic>). ADIC implements a technique for automatically transforming a computer code implementing an arbitrary mathematical function into another code that computes the function and its derivatives without incurring truncation error and often resulting in better performance than numerical approximation approaches, such as finite differences. Over the past five years, ADIC has been downloaded over 500 times and has been used in numerical optimization, sensitivity analysis, climate modeling, computational fluid dynamics, and other application areas.
- XAIF, an XML-based abstract intermediate representation for mathematical computations (<http://www.mcs.anl.gov/xaif>). The XAIF format enables clear separation between language-specific parser and analysis engines, which are typically very difficult to develop, and differentiation algorithms, which are intrinsically language-independent and can be implemented as graph transformations. XAIF is used in ADIC and the language-independent differentiation modules and Fortran AD tool being developed as part of the multi-institution OpenAD project.
- ADIC Web-based and command line remote application servers (<http://www.mcs.anl.gov/adicserver>) for access to ADIC 1.2 and 2.0 without having to install the tools on a user's machine.
- CCA scientific components; CCA middleware infrastructure and automated build system support (see tutorial source code at <http://www.cca-forum.org/tutorials>); Eclipse-based IDE support for scientific component development (see Usability at <http://cca-forum.org/wiki>); CCA-compliant linear algebra and optimization components. Numerical components have been used in scientific applications, such as molecular geometry optimization and computational fluid dynamics.
- Bocca, a tool for automating the management and build of SIDL-based multilanguage projects, including CCA components (<http://trac.mcs.anl.gov/projects/cca/wiki/bocca>).
- Multimethod parallel linear solvers: combining or adaptively applying existing iterative algorithms to produce multimethod heuristics that result in improved robustness and performance. The prototype implementations are designed to feed into linear solver components and numerical toolkits, such as PETSc.
- Structured block adaptive mesh refinement in finite-difference time-domain methods for nanophotonics simulations, whose goal is to learn how to control light on the nanoscale, for example, to replace electrons as information carriers in optical or opto-electronic devices, or to create novel chemical and biological sensors (<http://www.mcs.anl.gov/Nanophotonics>).