

Curriculum Vitae for R. Clint Whaley

February 26, 2008

Research Interests

Empirical optimization, high performance computing, backend compiler optimization, computer architecture, and parallel computing.

Research Synopsis

I originally worked in distributed memory parallelization, where I contributed to the design and implementation of ScaLAPACK, and its associated packages, PBLAS and BLACS. After graduation, I began research into empirical code optimization, which resulted in the ATLAS (Automatically Tuned Linear Algebra Software) project (<http://math-atlas.sourceforge.net/>). I returned for my Ph.D. in optimizing compilers, which has resulted in iFKO (iterative Floating Point Kernel Optimizer), an empirical and iterative compiler specialized for high performance kernel tuning. I am presently fully funded to do ATLAS research.

Academic Training

- Dec 04** Doctor of Philosophy in Computer Science at the Florida State University. Adviser: David Whalley.
- May 94** Master of Science in Computer Science at the University of Tennessee in Knoxville Tennessee. Adviser: Jack Dongarra.
- May 91** Bachelor of Science (Summa Cum Laude) in Mathematics at Oklahoma State University in Goodwell, Oklahoma.

Professional Employment

- Jul 05 - Present** Assistant Professor, Department of Computer Science, University of Texas at San Antonio.
- Jan 05 - Jun 05** Post-doctoral researcher and adjunct at Florida State University. ATLAS and iFKO research, and taught CS 5930 'Fundamentals of High Performance Optimization'.
- Jan 02 - Dec 04** Graduate Research Assistant, Department of Computer Science, Florida State University. Continued ATLAS work, and extended optimization research to include empirical compilation.
- Jun 99 - Dec 01** Senior Research Associate, Department of Computer Science, University of Tennessee. Continued research on automated empirical optimization of software, and the ATLAS project.

- May 94 - Jun 99** Research Associate, Department of Computer Science, University of Tennessee. Research on automated empirical optimization of software. In particular, founded ATLAS project. Research in parallel computing. In particular, work on ScaLAPACK, PBLAS, and BLACS libraries.
- Aug 91 - May 94** Graduate Research Assistant, Department of Computer Science, University of Tennessee. Work on parallel computing. In particular, work on ScaLAPACK, PBLAS, and BLACS libraries.
- May 91 - Aug 91** Student employee, Physics division, Oak Ridge National Laboratory. Worked on parallelization of nuclear collision models.
- Jan 91 - May 91** Lab Assistant, Department of Computer Information Systems, Oklahoma Panhandle State University. Administration of Novel network, and assisting in student computer labs. Half time appointment.
- Jun 90 - Jan 91** Science and Engineering Research Student (SERS), Physics division, Oak Ridge National Laboratory. Worked on parallelization of nuclear collision models.
- Aug 87 - Jun 90** Lab Assistant, Department of Computer Information Systems and Department of Physics, Oklahoma Panhandle State University. Half time appointment.

Honors and Awards

- 1999 R & D 100 Award for the ATLAS project.
- Best paper in the systems category, SuperComputing 1998 Conference.

Publication List with Links

- <http://www.cs.utsa.edu/~whaley/papers.html>

Doctoral Dissertation

- R. Clint Whaley, “Automated Empirical Optimization of High Performance Floating Point Kernels”, December 2004. Defended November 2, 2004.

Master’s Thesis

- R. Clint Whaley, “Basic Linear Algebra Communication Subprograms: Analysis and Implementation Across Multiple Parallel Architectures”, *UT Technical Report UT-CS-94-234*, University of Tennessee, May 1994.

Refereed journal articles

1. Anthony M. Castaldo, R. Clint Whaley and Anthony T. Chronopoulos, “Reducing Floating Point Error in Dot Product using the Superblock Family of Algorithms”, accepted for publication in *SIAM Journal of Scientific Computing*.
2. R. Clint Whaley and Anthony M. Castaldo, “Achieving accurate and context-sensitive timing for code optimization”, accepted for publication in *Software: Practice & Experience*.
3. R. Clint Whaley and Antoine Petitet, “Minimizing Development and Maintenance Costs in Supporting Persistently Optimized BLAS”, *Software: Practice & Experience*, Volume 35, Number 2, pp 101-121, February, 2005.
4. Jim Demmel, Jack Dongarra, Victor Eijkhout, Erika Fuentes, Antoine Petitet, Rich Vudue and R. Clint Whaley, “Self Adapting Linear Algebra Algorithms and Software”, *Proceedings of the IEEE*, Volume 93, Number 2, pp 293-312, February, 2005.
5. L. Susan Blackford, James Demmel, Jack Dongarra, Iain Duff, Sven Hammarling, Greg Henry, Michael Heroux, Linda Kaufman Andrew Lumsdaine, Antoine Petitet, Roldan Pozo, Karin Remington and R. Clint Whaley, “An Updated Set of Basic Linear Algebra Subprograms (BLAS)”, *ACM Transactions on Mathematical Software*, 28(2):135–151, June 2002.
6. L.S. Blackford, A. Cleary, J. Demmel, J. Dongarra, I. Dhillon, S. Hammarling, A. Petitet, H. Ren, K. Stanley, and R. C. Whaley, “Practical Experience in the Numerical Dangers of Heterogeneous Computing”, *ACM Transaction on Mathematical Software*, Volume 23, Number 2, pp 133-147, June 1997.
7. R. Clint Whaley, Antoine Petitet and Jack J. Dongarra, “Automated Empirical Optimization of Software and the ATLAS Project”, *Parallel Computing*, Volume 27, Numbers 1-2, pp 3-25, 2001, ISSN 0167-8191. Also available as University of Tennessee LAPACK Working Note #147, UT-CS-00-448, 2000.
8. J. Choi, J. Demmel, J. Dongarra, I. Dhillon, 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 Physics Communication*, 97 (1996) 1-15.
9. J. Choi, J. Dongarra, S. Ostrouchov, A. Petitet, D. Walker, and R. C. Whaley, “The Design and Implementation of the ScaLAPACK LU, QR, and Cholesky Factorizations”, *Scientific Programming*, Volume 5, pp 173-184, 1996.
10. J. Choi, J. Dongarra, S. Ostrouchov, A. Petitet, D. Walker and R. C. Whaley “A Proposal for a Set of Parallel Basic Linear Algebra Subprograms”, *Lecture Notes in Computer Science*, Volume 1041, pp 107-114, 1996.

Refereed conference proceedings

1. R. Clint Whaley, “Empirically Tuning LAPACK’s Blocking Factor for Increased Performance”, Accepted for publication in *Computer Aspects of Numerical Algorithms*, Wisla, Poland, October 20-22, 2008.
2. Qing Yi and R. Clint Whaley, “Automated Transformation for Performance-Critical Kernels”, In *ACM SIGPLAN Symposium on Library-Centric Software Design*, Montreal, Canada, October, 2007.
3. R. Clint Whaley and David B. Whalley, “Tuning High Performance Kernels through Empirical Compilation”, In *The 2005 International Conference on Parallel Processing*, June 2005.
4. R. Clint Whaley and Jack Dongarra, “Automatically Tuned Linear Algebra Software”, *Ninth SIAM Conference on Parallel Processing for Scientific Computing*, March 22-24, 1999, CD-ROM Proceedings.
5. R. Clint Whaley and Jack Dongarra, “Automatically Tuned Linear Algebra Software”, *SuperComputing 1998 Conference*, Orlando, FL, November 1998. **Winner, best paper in the systems category.**
6. L. S. Blackford, J. Choi, A. Cleary, E. D’Azevedo, J. Demmel, I. Dhillon, J. Dongarra, S. Hammarling, G. Henry, A. Petitet, K. Stanley, D. Walker, and R. C. Whaley, “ScaLAPACK: A Linear Algebra Library for Message-Passing Computers”, *SIAM Conference on Parallel Processing*, March 1997.
7. S. Hammarling, G. Henry, A. Petitet, K. Stanley, D. Walker, and R. Whaley, “Scalapack: A Linear Algebra Library for Message-Passing Computers”, *Proceedings of 1997 SIAM Conference on Parallel Processing*, May 1997.
8. Jack Dongarra, Robert van de Geijn, and R. Clint Whaley, “Two Dimensional Basic Linear Algebra Communication Subprograms” *Proceedings of the sixth SIAM Conference on Parallel Processing for Scientific Computing*, SIAM Publications, pp 347-352, Philadelphia, 1993.

Books

1. *editors*: J. Blazewicz, K. Ecker, B. Plateau, D. Trystram, Handbook on Parallel and Distributed Processing, Springer-Verlag Berlin Heidelberg, 2000. ISBN: 3-540-6641-6.
2. L.S. Blackford, J. Choi, A. Cleary, E. D’Azevedo, J. Demmel, I. Dhillon, J. Dongarra, S. Hammarling, G. Henry, A. Petitet, K. Stanley, D. Walker, and R. C. Whaley, ScaLAPACK Users’ Guide, SIAM Publications, Philadelphia, 1997. ISBN: 0-89871-400-1.

Paper presentations while at UTSA

1. R. Clint Whaley “ATLAS Version 3.8: Overview and Status”, Invited paper at *the international Workshop on Automatic Performance Tuning (iWAPT07)*, pages 1-11, Tokyo & Kyoto, Japan, September 16-22, 2007.

I was one of two invited speakers (the other was Markus Pushel of CMU) at this workshop. Along with the presentation, I submitted a 10-page paper discussing the ATLAS project and research. I gave ATLAS talks both at the conference, and at Kyoto University.

URL: <http://www.na.cse.nagoya-u.ac.jp/~yamamoto/iWAPT2007.html>

Workshop presentations while at UTSA

1. Presented SP&E timing paper at CScADS workshop (Automatic Tuning for Petascale Systems), Snowbird, Utah, July 8-10, 2008.
URL: <http://cscads.rice.edu/workshops/summer08/autotuning>
2. Presented SP&E timing paper at the autotuning workshop during HPCSW, Denver, Colorado, April 3-4, 2008.
URL: <http://www.hpcsw.org/>
3. Presented at CScADS workshop (Automatic Tuning for Petascale Systems), Snowbird, Utah, July 8-13, 2007. Presented ATLAS research in 30 minute talk, and took part in several key discussions, including giving a presentation on the number and type of transformations required for HPC compilation.
URL: <http://cscads.rice.edu/workshops/july2007/autotune-workshop-07>
4. Presented at NSF CRI'07 workshop, Boston, MA, June 3-6, 2007. Presented overview of work performed under my NSF CRI grant, and participated in various sub-meetings, including research at minority-serving institution BOF.
URL: <http://www.cs.bu.edu/NSF-CRI07/>
5. Presented “Tuning High Performance Kernels through Empirical Compilation” at Las Alamos Computer Science Institute (LACSI) Workshop on Automatic Tuning of Whole Applications, October 12, 2005, Sante Fe, NM.
URL: http://lacs.i.rice.edu/symposium/agenda_2005

Technical notes, etc.

1. R. Clint Whaley, “ATLAS Installation Guide”, *Technical Report CS-TR-2008-002*, University of Texas at San Antonio, January 2008.
2. R. Clint Whaley and Anthony M. Castaldo, “Achieving accurate and context-sensitive timing for code optimization”, *Technical Report CS-TR-2008-001*, University of Texas at San Antonio, January 2008.
3. Qing Yi and R. Clint Whaley, “Automated Transformation for Performance-Critical Kernels” *Technical Report CS-TR-2007-003*, University of Texas at San Antonio, June 2007.
4. Anthony M. Castlado and R. Clint Whaley, “Error Analysis of Various Forms of

- Floating Point Dot Products”, *Technical Report CS-TR-2007-002*, University of Texas at San Antonio, May 2007.
5. R. Clint Whaley, “A Guide to User Contribution to ATLAS”, (URL: http://math-atlas.sourceforge.net/devel/atlas_contrib/).
 6. R. Clint Whaley “A User’s Guide to Extract”, (URL: <http://www.cs.utsa.edu/~whaley/extract/Extract400.ps>)
 7. R. Clint Whaley and Peter Soendergaard “A Collaborative Guide to ATLAS development”, (URL: http://math-atlas.sourceforge.net/devel/atlas_devel/).
 8. R. C. Whaley, A. Petitet, J. Dongarra, “Automated Empirical Optimization of Software and the ATLAS Project”, *UT Technical Report UT-CS-00-448*, University of Tennessee, September 2000.
 9. A. Petitet, H. Casanova, J. Dongarra, Y. Robert and R.C. Whaley “A Numerical Linear Algebra Problem Solving Environment Designer’s Perspective”, *UT Technical Report UT-CS-98-405*, University of Tennessee, October 1998.
 10. L. S. Blackford, J. J. Dongarra, C. A. Papadopoulos and R. C. Whaley, “Installation Guide and Design of the HPF 1.1 interface to ScaLAPACK SLHPF”, *UT Technical Report UT-CS-98-396*, University of Tennessee, August, 1998.
 11. L. S. Blackford and R. C. Whaley, “ScaLAPACK Evaluation and Performance at the DoD MSRCs”, *UT Technical Report UT-CS-98-388*, University of Tennessee, April 1998.
 12. R. Clint Whaley and J. Dongarra, “Automatically Tuned Linear Algebra Software”, *UT Technical Report UT-CS-97-366*, University of Tennessee, December 1997.
 13. R. Clint Whaley, “Outstanding Issues in the MPIBLACS” (URL: http://www.netlib.org/blacs/mpiblacs_issues.ps), November 1997.
 14. R. Clint Whaley, “Some Plebian Extensions to MPI”, (URL: http://www.netlib.org/blacs/mpi_prop.ps), November, 1997.
 15. L. S. Blackford, A. Cleary, J. Demmel, I. Dhillon, J. Dongarra, S. Hammarling, A. Petitet, H. Ren, K. Stanley, and R. C. Whaley, “Practical Experience in the Dangers of Heterogeneous Computing”, *UT Technical Report UT-CS-96-330*, University of Tennessee, July 1996.
 16. J. Choi, J. Dongarra, S. Ostrouchov, A. Petitet, D. Walker, and R. C. Whaley, “A Proposal for a Set of Parallel Basic Linear Algebra Subprograms”, *UT Technical Report UT-CS-95-292*, University of Tennessee, May 1995.
 17. 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” *UT Technical Report UT-CS-95-283*, University of Tennessee, March 1995.
 18. Jack Dongarra and R. Clint Whaley, “BLACS User’s Guide V1.1”, *UT Technical Report UT-CS-95-281*, University of Tennessee, March 1995.
 19. J. Choi, J. Demmel, I. Dhillon, J. Dongarra, S. Ostrouchov, A. Petitet, K. Stanley,

D. Walker and R. C. Whaley “Installation Guide for ScaLAPACK” *UT Technical Report UT-CS-95-280*, University of Tennessee, March 1995.

20. J. Choi, J. J. Dongarra, S. Ostrouchov, A. P. Petitet, D. W. Walker, and R. C. Whaley, “The Design and Implementation of the ScaLAPACK LU, QR, and Cholesky Factorization Routines”, *UT Technical Report UT-CS-94-246*, University of Tennessee, September, 1994.

Funded research grants as sole investigator

1. R. Clint Whaley, REU supplement for CNS-0551504. **Period:** 04/22/08 - 02/28/09. **Total Award:** \$12,000 **Funds usage:** Research support for undergraduate students at UTSA.
2. R. Clint Whaley, SiCortex Research Gift. **Period :** donated April 2006, no expiration. **Total award:** \$10,000. **Funds usage:** any. **Notes:** this was a gift from a private company to help further my ATLAS research, since they use ATLAS in their business.
3. R. Clint Whaley, “Technical Proposal (#H98230-06-R-0914) for ATLAS (Automatically Tuned Linear Algebra Software)”. Department of Defense Maryland Procurement H98230-06-C-0443, **Period:** August 1, 2006 - July 31, 2011 (1 year + 4 option years). **Total award:** \$790,446. **Funds usage:** Faculty support: 2 months summer salary, 33% time during regular semester (each year). Student support (number varies, with up to three students in later years), with modest travel and equipment. **Notes:** This report requires quarterly reports, and I have so far submitted five of them. The first option year has been exercised, and funds are presently being allocated for the second option year. The technical contact for the contract has expressed interest in continuing funding past the present five total years.
4. R. Clint Whaley, “CRI, Community Resource Development: ATLAS Support and Development”, NSF CRI award, CNS-0551504. **Period:** March 01, 2006 - February 28, 2009. **Total award:** \$100,000. **Funds usage:** Mainly student support with some travel and equipment. **Notes:** I have filed two yearly status reports, and asked for and received a 1 year no-cost extension.
5. R. Clint Whaley and David B. Whalley, “Grant for Development and Release of ATLAS Library Tuned for x86-64 Technology”. **Period:** 1 year of support, starting in 2002 or 2003. **Total award:** \$28,000 **Funds usage:** payed my own GRA for a year while finishing PhD. **Notes:** small business grant obtained while at FSU.

Funded research grants as collaborative investigator

1. Qing Yi, Daniel J. Quinlan and R. Clint Whaley, “Programmable Code Optimization and Empirical Tuning For High-end Computing”, NSF award CCF-0833203. **Period:** 09/01/08 - 09/31/10. **Total award:** \$462,000.

Service

1. **The ATLAS Project**

My early research into automated optimization is embodied in the ATLAS package. This open source project is used by scientists and engineers worldwide. ATLAS is used by Matlab, Maple, Octave, and many other high-level packages. ATLAS is also included in many Linux distributions, and is built into Apple's OS X. More details can be found at <http://math-atlas.sourceforge.net/>.

2. **The ScaLAPACK and BLACS projects**

Are still the defacto standards for handling dense linear algebra on distributed memory machines, and are still in widespread use today. More details can be found on its homepage, http://www.netlib.org/scalapack/scalapack_home.html.

3. **Educational/UTSA:** I teach courses in computer architecture and high performance computing at UTSA. I currently serve on two committees, and, along with Daniel Jimenez, I have been responsible for the creation and grading of the last two Computer Architecture PhD qualifier exams.

4. **Reviews**

I usually average roughly four paper reviews a year, with recent reviews done for Software: Practice and Experience, Concurrency: Practice and Experience, and Transactions on Mathematical Software.

Personal data

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