

STEPHEN F. SIEGEL

Curriculum Vitæ

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1 Employment

Associate Professor, Department of Computer and Information Sciences and Department of Mathematical Sciences, University of Delaware, September 2012 to present

Assistant Professor, Department of Computer and Information Sciences and Department of Mathematical Sciences, University of Delaware, September 2006 to August 2012

Senior Research Scientist, Laboratory for Advanced Software Engineering Research, Department of Computer Science, University of Massachusetts Amherst, August 2001 to August 2006

Senior Software Engineer, Laboratory for Advanced Software Engineering Research, Department of Computer Science, University of Massachusetts Amherst, August 1998 to July 2001

Visiting Assistant Professor, Department of Mathematics, University of Massachusetts Amherst, September 1996 to August 1998

Visiting Assistant Professor, Department of Mathematics, Northwestern University, September 1993 to June 1996

2 Education

Ph.D., Mathematics, University of Chicago, August 1993 (*Advisor*: Prof. Jonathan L. Alperin)

M.Sc., Mathematics, Oxford University, June 1989

B.A., Mathematics, University of Chicago, June 1988

3 Grants

Awarded

- Principal Investigator, Subcontract 4000159498, Oak Ridge National Laboratory, *Extend and Improve the CIVL Software Verification Platform*. January 31, 2018 – September 30, 2020. Award amount: \$245,963 (sole PI). Subcontract under Department of Energy award *RAPIDS: A SciDAC Institute for Computer Science and Data*.
- Principal Investigator, Department of Energy Award DE-SC0012566, *Program Verification for Extreme-Scale Applications*, September 1, 2014 – August 31, 2018. Award amount: \$510,000. (Sole PI)
- Principal Investigator, National Science Foundation Award NSF CCF-1319571, *SHF: Small: Contracts for Message-Passing Parallel Programs*, September 1, 2013 – August 31, 2018. Award amount: \$449,999. (Sole PI)

- Principal Investigator, National Science Foundation Award CCF-1346769, *CIVL: A Concurrency Intermediate Verification Language*, August 1, 2013 – July 31, 2016. Award amount: \$300,000 (Includes subcontract to U. Nebraska for co-PI Matthew Dwyer. UD amount: \$182,000.)
- Principal Investigator, National Science Foundation Award CCF-0953210 Supplement 001, *Extension of TASS to Chapel*, June 1, 2011 – March 31, 2016. Award amount: \$99,333. (Sole PI)
- Principal Investigator, National Science Foundation Award CNS-0958512, Computing Research Infrastructure program, *II-New: System Acquisition for the Development of Scalable Parallel Algorithms for Scientific Computing*, May 1, 2010 – April 30, 2013. Co-PIs: Peter B. Monk, Douglas M. Swamy, and Krzysztof Szalewicz. Award amount: \$749,769. *Equipment award used to purchase the UD Chimera cluster.*
- Principal Investigator, National Science Foundation Award CCF-0953210, *CAREER: Ensuring the Accuracy of Scientific Software: A Formal Approach*, April 1, 2010 – June 31, 2016. Award amount: \$411,689 (Sole PI)
- Principal Investigator, National Science Foundation Award CCF-0541035/CCF-0733035, *Finite-State Verification for High Performance Computing*, April 15, 2006 – March 31, 2010. Co-PI: George S. Avrunin, University of Massachusetts. Lead institution: University of Massachusetts, transferred to University of Delaware. Collaborating Institutions: University of Nebraska (PI Matthew Dwyer), University of Chicago (PI Andrew Siegel). Award amount: \$960,000 (total), \$546,000 (lead institution)
- Principal Investigator, University of Delaware Research Foundation Grant, *Verifying the Order of Accuracy of Numerical Software*, June 1, 2009 – May 31, 2011. Award amount: \$35,000. Awarded Research Experience for Undergraduate supplement for summer 2010: \$3,500.
- Targeted Grant for Capstone Experience (with Keith Decker), University of Delaware, summer 2008, \$8,658, to develop capstone experience for CISC 475

4 Publications

Refereed Journal Publications

1. Adam Hammouda, Andrew R. Siegel, and Stephen F. Siegel. Noise-tolerant explicit stencil computations for nonuniform process execution rates. *ACM Transactions on Parallel Computing*, 2(1):7:1–7:33, April 2015.
2. Kyle G. Felker, Andrew R. Siegel, and Stephen F. Siegel. Optimizing memory constrained environments in Monte Carlo nuclear reactor simulations. *International Journal of High Performance Computing Applications*, 27(2):210–216, May 2013.
3. Stephen F. Siegel. Transparent partial order reduction. *Formal Methods in System Design*, 40(1):1–19, February 2012.
4. Ganesh Gopalakrishnan, Robert M. Kirby, Stephen Siegel, Rajeev Thakur, William Gropp, Ewing Lusk, Bronis R. De Supinski, Martin Schulz, and Greg Bronevetsky. Formal analysis of MPI-based parallel programs. *Communications of the ACM*, 54(12):82–91, December 2011.
5. Stephen F. Siegel and Timothy K. Zirkel. TASS: The Toolkit for Accurate Scientific Software. *Mathematics in Computer Science*, 5(4):395–426, 2011.
6. Stephen F. Siegel and Timothy K. Zirkel. FEVS: A Functional Equivalence Verification Suite for high performance scientific computing. *Mathematics in Computer Science*, 5(4):427–435, 2011.
7. Stephen F. Siegel and Andrew R. Siegel. MADRE: The Memory-Aware Data Redistribution Engine. *International Journal of High Performance Computing Applications*, 24(1):93–104, February 2010.

8. Stephen F. Siegel, Anastasia Mironova, George S. Avrunin, and Lori A. Clarke. Combining symbolic execution with model checking to verify parallel numerical programs. *ACM Transactions on Software Engineering and Methodology*, 17(2):Article 10, 1–34, 2008.
9. Stephen F. Siegel. Hochschild cohomology and elementary abelian subgroups. *Trans. Amer. Math. Soc.*, 358(7):2911–2915, July 2006. Appendix to Jonathan Pakianathan and Sarah Witherspoon, Quillen stratification for Hochschild cohomology of blocks.
10. Stephen F. Siegel and George S. Avrunin. Improving the precision of INCA by eliminating solutions with spurious cycles. *IEEE Transactions on Software Engineering*, 28(2):115–128, 2002.
11. Stephen F. Siegel and Sarah J. Witherspoon. The Hochschild cohomology ring of a cyclic block. *Proc. Amer. Math. Soc.*, 128(5):1263–1268, 2000.
12. Stephen F. Siegel. The cohomology of split extensions of elementary abelian 2-groups and Totaro’s example. *J. Pure Appl. Algebra*, 145(2):183–198, 2000.
13. Stephen F. Siegel and Sarah J. Witherspoon. The Hochschild cohomology ring of a group algebra. *Proc. London Math. Soc.*, 79(1):131–157, 1999.
14. Stephen F. Siegel, Vassily Gorbounov, and Peter Symonds. The cohomology of the Morava stabilizer group \mathbb{S}_2 at the prime 3. *Proc. Amer. Math. Soc.*, 126(3):933–941, 1998.
15. Stephen F. Siegel. On the cohomology of split extensions of finite groups. *Trans. Amer. Math. Soc.*, 349(4):1587–1609, 1997.
16. Stephen F. Siegel. The spectral sequence of a split extension and the cohomology of an extraspecial group of order p^3 and exponent p . *J. Pure Appl. Algebra*, 106(2):185–198, 1996.
17. Leonard Evens and Stephen F. Siegel. Generalized Benson-Carlson duality. *J. Algebra*, 179(3):775–792, 1996.
18. Stephen F. Siegel. Projective modules for A_9 in characteristic three. *Communications in Algebra*, 19(11):3099–3117, 1991.

Refereed Conference and Workshop Publications

19. Ziqing Luo and Stephen F. Siegel. Symbolic execution and deductive verification approaches to VerifyThis 2017 challenges. In Tiziana Margaria and Bernhard Steffen, editors, *Leveraging Applications of Formal Methods, Verification and Validation, ISO/FA 2018, Proceedings*, 2018. To appear.
20. Jan Hükelheim, Ziqing Luo, Sri Hari Krishna Narayanan, Stephen Siegel, and Paul D. Hovland. Verifying properties of differentiable programs. In Andreas Podelski, editor, *Static Analysis: 25th International Symposium, SAS 2018, Proceedings*, volume 11002 of *Lecture Notes in Computer Science*. Springer, 2018.
21. Ziqing Luo, Manchun Zheng, and Stephen F. Siegel. Verification of MPI programs using CIVL. In *Proceedings of the 24th European MPI Users’ Group Meeting, EuroMPI ’17*, pages 6:1–6:11, New York, NY, USA, 2017. ACM. Paper acceptance rate: $17/37 = 46\%$.
22. Jan Hükelheim, Ziqing Luo, Fabio Luporini, Navjot Kukreja, Michael Lange, Gerard Gorman, Stephen Siegel, Matthew Dwyer, and Paul Hovland. Towards self-verification in finite difference code generation. In *Proceedings of the First International Workshop on Software Correctness for HPC Applications, Correctness’17*, pages 42–49, New York, NY, USA, 2017. ACM. Acceptance rate: $7/13 = 54\%$.
23. Manchun Zheng, John G. Edenhofner, Ziqing Luo, Mitchell J. Gerrard, Michael S. Rogers, Matthew B. Dwyer, and Stephen F. Siegel. CIVL: Applying a general concurrency verification framework to C/Pthreads programs (competition contribution). In *Tools and Algorithms for the Construction and Analysis of Systems – 22nd International Conference, TACAS 2016, Held as Part of the European Joint Conferences on Theory and Practice of Software, ETAPS 2016, Eindhoven, The Netherlands, April 2–8, 2016. Proceedings*, volume 9636 of *Lecture Notes in Computer Science*, pages 908–911. Springer, 2016.

24. Stephen F. Siegel, Manchun Zheng, Ziqing Luo, Timothy K. Zirkel, Andre V. Marianiello, John G. Edenhofner, Matthew B. Dwyer, and Michael S. Rogers. CIVL: The Concurrency Intermediate Verification Language. In *SC15: Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis*, New York, NY, USA, Nov 2015. ACM. Article no. 61, pages 1–12.
25. Manchun Zheng, Michael S. Rogers, Ziqing Luo, Matthew B. Dwyer, and Stephen F. Siegel. CIVL: Formal verification of parallel programs. In *Proceedings of the 30th ACM/IEEE International Conference on Automated Software Engineering (ASE'15)*, New York, NY, USA, 2015. ACM. Pages 830–835.
26. Adam Hammouda, Andrew Siegel, and Stephen Siegel. Overcoming asynchrony: An analysis of the effects of asynchronous noise on nearest neighbor synchronizations. In Stefano Markidis and Erwin Laure, editors, *Solving Software Challenges for Exascale*, volume 8759 of *Lecture Notes in Computer Science*, pages 100–109. Springer, 2015.
27. Timothy K. Zirkel, Stephen F. Siegel, and Timothy McClory. Automated verification of Chapel programs using model checking and symbolic execution. In Guillaume Brat, Neha Rungta, and Arnaud Venet, editors, *NASA Formal Methods*, volume 7871 of *Lecture Notes in Computer Science*, pages 198–212. Springer Berlin Heidelberg, 2013.
28. Stephen F. Siegel and Timothy K. Zirkel. Loop invariant symbolic execution for parallel programs. In Viktor Kuncak and Andrey Rybalchenko, editors, *Verification, Model Checking, and Abstract Interpretation: 13th International Conference, VMCAI 2012*, volume 7148 of *Lecture Notes in Computer Science*, pages 412–427. Springer, January 2012.
29. Stephen F. Siegel and Timothy K. Zirkel. Automatic formal verification of MPI-based parallel programs. In Calin Cascaval and Pen-Chung Yew, editors, *Proceedings of the 16th ACM SIGPLAN Annual Symposium on Principles and Practices of Parallel Programming (PPoPP '11), short paper and poster*, pages 309–310. ACM, January 2011.
30. Stephen F. Siegel and Timothy K. Zirkel. Collective assertions. In Ranjit Jhala and David Schmidt, editors, *Verification, Model Checking, and Abstract Interpretation: 12th International Conference, VMCAI 2011, Austin, TX, January 23–25, 2011, Proceedings*, volume 6538 of *Lecture Notes in Computer Science*, pages 387–402, 2011.
31. Stephen F. Siegel and Andrew R. Siegel. A memory-efficient data redistribution algorithm. (Video). In Matti Ropo, Jan Westerholm, and Jack Dongarra, editors, *Recent Advances in Parallel Virtual Machine and Message Passing Interface, 16th European PVM/MPI User's Group Meeting, Proceedings*, volume 5759 of *Lecture Notes in Computer Science*, pages 219–229. Springer, 2009.
32. Stephen F. Siegel and Andrew R. Siegel. MADRE: The Memory-Aware Data Redistribution Engine. In Alexey Lastovetsky, Tahar Kechadi, and Jack Dongarra, editors, *Recent Advances in Parallel Virtual Machine and Message Passing Interface, 15th European PVM/MPI User's Group Meeting, Proceedings*, volume 5205 of *Lecture Notes in Computer Science*, pages 218–226. Springer, 2008.
33. Stephen F. Siegel and Louis F. Rossi. Analyzing BlobFlow: A case study using model checking to verify parallel scientific software. In Alexey Lastovetsky, Tahar Kechadi, and Jack Dongarra, editors, *Recent Advances in Parallel Virtual Machine and Message Passing Interface, 15th European PVM/MPI User's Group Meeting, Proceedings*, volume 5205 of *Lecture Notes in Computer Science*, pages 274–282. Springer, 2008.
34. Stephen F. Siegel and George S. Avrunin. Verification of halting properties for MPI programs using nonblocking operations. In Franck Cappello, Thomas Héroult, and Jack Dongarra, editors, *Recent Advances in Parallel Virtual Machine and Message Passing Interface, 14th European PVM/MPI User's Group Meeting, Paris, France, September 30 - October 3, 2007, Proceedings*, volume 4757 of *Lecture Notes in Computer Science*, pages 326–334. Springer, 2007.
35. Stephen F. Siegel. Model checking nonblocking MPI programs. In Byron Cook and Andreas Podelski, editors, *Verification, Model Checking, and Abstract Interpretation: 8th International Conference, VM-*

CAI 2007, Nice, France, January 14–16, 2007, Proceedings, volume 4349 of *Lecture Notes in Computer Science*, pages 44–58, 2007.

36. Stephen F. Siegel, Anastasia Mironova, George S. Avrunin, and Lori A. Clarke. Using model checking with symbolic execution to verify parallel numerical programs. In Lori L. Pollock and Mauro Pezzé, editors, *Proceedings of the ACM SIGSOFT International Symposium on Software Testing and Analysis, ISSTA 2006, Portland, Maine, USA, July 17–20, 2006*, pages 157–168. ACM, 2006.
37. Stephen F. Siegel and George S. Avrunin. Modeling wildcard-free MPI programs for verification. In *Proceedings of the ACM SIGPLAN Symposium on Principles and Practice of Parallel Programming*, pages 95–106, Chicago, IL, June 2005.
38. George S. Avrunin, Stephen F. Siegel, and Andrew R. Siegel. Finite-state verification for high performance computing. In Philip M. Johnson, editor, *Proceedings of the Second International Workshop On Software Engineering For High Performance Computing System Applications, St. Louis, Missouri, USA, May 15, 2005*, pages 68–72, 2005.
39. Stephen F. Siegel. Efficient verification of halting properties for MPI programs with wildcard receives. In Radhia Cousot, editor, *Verification, Model Checking, and Abstract Interpretation: 6th International Conference, VMCAI 2005, Paris, January 17–19, 2005, Proceedings*, volume 3385 of *Lecture Notes in Computer Science*, pages 413–429, 2005.
40. Stephen F. Siegel and George S. Avrunin. Verification of MPI-based software for scientific computation. In Susanne Graf and Laurent Mounier, editors, *Model Checking Software: 11th International SPIN Workshop, Barcelona, Spain, April 1–3, 2004, Proceedings*, volume 2989 of *Lecture Notes in Computer Science*, pages 286–303. Springer-Verlag, 2004.
41. Stephen F. Siegel and George S. Avrunin. Improving the precision of INCA by preventing spurious cycles. In Mary Jean Harrold, editor, *Proceedings of the ACM SIGSOFT 2000 International Symposium on Software Testing and Analysis, Portland, OR, USA, August 21–24, 2000*, pages 191–200. ACM Press, 2000.

Papers & Extended Abstracts for Invited Talks/Tutorials Published in Peer-Reviewed Conference Proceedings

42. Marc Jasper, Maximilian Fecke, Bernhard Steffen, Markus Schordan, Jeroen Meijer, Jaco van de Pol, Falk Howar, and Stephen F. Siegel. The RERS 2017 challenge and workshop (invited paper). In *Proceedings of the 24th ACM SIGSOFT International SPIN Symposium on Model Checking of Software*, SPIN 2017, pages 11–20, New York, NY, USA, 2017. ACM.
43. Stephen F. Siegel and Ganesh Gopalakrishnan. Formal analysis of message passing (Invited Talk). In Ranjit Jhala and David Schmidt, editors, *Verification, Model Checking, and Abstract Interpretation: 12th International Conference, VMCAI 2011, Austin, TX, January 23–25, 2011, Proceedings*, volume 6538 of *Lecture Notes in Computer Science*, pages 2–18, January 2011.
44. Stephen F. Siegel. Formal verification for scientific computing: Trends and progress. In Matti Ropo, Jan Westerholm, and Jack Dongarra, editors, *Recent Advances in Parallel Virtual Machine and Message Passing Interface*, volume 5759 of *Lecture Notes in Computer Science*, page 7. Springer Berlin / Heidelberg, 2009.
45. Stephen F. Siegel. Verifying parallel programs with MPI-Spin. In Franck Cappello, Thomas Héroult, and Jack Dongarra, editors, *Recent Advances in Parallel Virtual Machine and Message Passing Interface, 14th European PVM/MPI User’s Group Meeting, Paris, France, September 30 - October 3, 2007, Proceedings*, volume 4757 of *Lecture Notes in Computer Science*, pages 13–14. Tutorial. Springer, 2007.

Other Published Invited Papers

46. Stephen F. Siegel. CIVL solutions to VerifyThis 2016 challenges. *ACM SIGLOG News*, 4(2):55–75, May 2017.

47. Stephen F. Siegel. Verification of MPI-based computations. In Henri E. Bal, Lubos Brim, and Martin Leucker, editors, *Distributed Verification and Grid Computing*, number 08332 in Dagstuhl Seminar Proceedings, Dagstuhl, Germany, 1–3, 2008. Schloss Dagstuhl - Leibniz-Zentrum für Informatik, Germany.

Refereed Posters

48. Wenhao Wu. A22: Verifying Functional Equivalence Between C and Fortran Programs. (Advisor: Stephen Siegel) ACM Student Research Competition, *Archive, SC17: International Conference for High Performance Computing, Networking, Storage and Analysis*, Nov. 2017. Acceptance rate: $28/59 = 47\%$.
49. Ziqing Luo and Stephen F. Siegel. P83: Contracts for Message-Passing Programs. Research Poster, *Archive, SC17: International Conference for High Performance Computing, Networking, Storage and Analysis*, Nov. 2017. Acceptance rate: $99/169 = 59\%$.

Significant Reports

50. Ganesh Gopalakrishnan, Paul D. Hovland, Costin Iancu, Sriram Krishnamoorthy, Ignacio Laguna, Richard A. Lethin, Koushik Sen, Stephen F. Siegel, and Armando Solar-Lezama. *Report of the HPC Correctness Summit*. Department of Energy, 2017. https://science.energy.gov/~media/ascr/pdf/programdocuments/docs/2017/HPC_Correctness_Report.pdf.
51. Stephen F. Siegel, Andrew R. Siegel, and Cristian Rabiti. UNIC Code: Algorithmic specification of the Method of Long Characteristics. Technical Memo ANL/MCS-TM-301, Mathematics and Computer Science Division, Argonne National Laboratory, June, 2008.
52. Stephen F. Siegel and George S. Avrunin. Modeling MPI programs for verification. Technical Report UM-CS-2004-75, Department of Computer Science, University of Massachusetts Amherst, 2004.
53. Stephen F. Siegel. The INCA Query Language. Technical Report UM-CS-2002-18, Department of Computer Science, University of Massachusetts Amherst, 2002.
54. George S. Avrunin, James C. Corbett, Matthew B. Dwyer, Corina S. Păsăreanu, and Stephen F. Siegel. Comparing finite-state verification techniques for concurrent software. Technical Report UM-CS-1999-69, Department of Computer Science, University of Massachusetts Amherst, 1999.

5 Software Systems Developed

- The Concurrency Intermediate Verification Language (CIVL), <http://vsl.cis.udel.edu/civl>
 - CIVL is a framework encompassing (1) a programming language, CIVL-C, which adds to C a number of concurrency primitives, as well as the ability to define functions in any scope. Together, these features make for a very expressive concurrent language that can faithfully represent programs using various APIs and parallel languages, such as MPI, OpenMP, CUDA, and Chapel. CIVL-C also provides a number of primitives supporting verification. (2) a model checker which uses symbolic execution to verify a number of safety properties of CIVL-C programs. The model checker can also be used to verify that two CIVL-C programs are functionally equivalent. (3) a number of translators from various commonly-used languages and APIs to CIVL-C.
 - approximately 204 complete, non-bot downloads during year beginning Feb. 1, 2017
 - releases during this period
 1. v1.7.4, 10 March 2017
 2. v1.8, 18 April
 3. v1.9, 25 May

4. v1.10, 23 June
 5. v1.11, 7 July
 6. v1.11.1, 8 Aug
 7. v1.12, 15 Dec
- Symbolic Algebra and Reasoning Library (SARL), <http://vsl.cis.udel.edu/sarl>
 - SARL is a library for manipulating and reasoning about symbolic expressions. It supports a wide variety of types, simplifies expressions (including polynomials and rational functions), and uses automated theorem provers in an efficient way to resolve queries. It is intended primarily to support symbolic execution tools.
 - ABC (ANTLR-Based C compiler), <http://vsl.cis.udel.edu/abc>
 - ABC is a front-end for the C11 and CIVL-C dialects of C. ABC is written in Java, and uses the ANTLR parser generator. It can be used to preprocess, parse, analyze, and transform source programs.
 - Functional Equivalence Verification Suite (FEVS), <http://vsl.cis.udel.edu/fevs>
 - FEVS is a suite of 37 programs (all in C, many using MPI) to test the precision of verification tools that target numerical/scientific software. The programs are arranged in 11 groups, each containing one simple version believed to be correct, the *specification*. Each group also contains several implementations which can be considerably more complex, some of which contain known errors.
 - Toolkit for Accurate Scientific Software (TASS), <http://vsl.cis.udel.edu/tass>
 - TASS is a state-of-the-art symbolic execution and model checking platform for numerically-intensive C/MPI programs. Working directly from source code, it can be used to verify or refute a number of safety properties of such programs. It can also show that two programs are functionally equivalent, within specified bounds on the input. TASS is now being used to investigate new specification and verification techniques (such as collective assertions and invariants) in a number of projects in the Verified Software Lab.
 - MPI-SPIN, <http://vsl.cis.udel.edu/mpi-spin>
 - The predecessor to TASS, MPI-Spin is a significant extension to the model checker Spin. It adds support for a large subset of MPI, and was the main platform used for the research reported in many of our publications.
 - Memory Aware Data Redistribution Engine (MADRE), <http://vsl.cis.udel.edu/madre>
 - MADRE is a C/MPI library for re-distributing blocks of data in a memory-constrained distributed environment. This problem arises frequently in many kinds of scientific applications, such as particle-based algorithms. A number of different heuristics and algorithms have been proposed (by ourselves and other researchers) to solve this problem, and MADRE has been used to investigate and compare these.

6 Talks

Invited Talks

- *A Verification Language for High Performance Computing*, Keynote address, Correctness 2017: First International Workshop on Software Correctness for HPC Applications, at SC17, Denver, Colorado, November 12, 2017.

- *Data race detection with CIVL*, Invited talk, RERS Workshop: 7th International Challenge on the Rigorous Examination of Reactive Systems, University of California Santa Barbara, July 12, 2017.
- *Scopes & Processes: a general concurrency model for parallel program analysis and model checking*, Colloquium, School of Computing, University of Utah, September 7, 2012
- *Formal Specification and Verification of MPI Programs Using TASS*, Argonne National Laboratory, Mathematics and Computer Science Division, April 31, 2011
- *Formal Specification and Verification of MPI Programs Using TASS*, Massachusetts Institute of Technology, Computer Science and Artificial Intelligence Laboratory, April 15, 2011
- *Formal Verification for Scientific Computing: Trends and Progress*, EuroPVM/MPI 2009. (Video), September 10, 2009.
- *Towards Verifiable Scientific Computing*, University of Nebraska Lincoln colloquium, July 10, 2008
- *Towards Verifiable Scientific Computing*, University of Utah colloquium, Salt Lake City, UT, November 16, 2007
- *Finite-state verification for scientific computing*, in the series *Computing the future: lectures in computational science, engineering, and mathematics*, Center for Computation and Technology, Louisiana State University, Baton Rouge, LA, April 18, 2005.
- *Recent progress in the finite-state verification of MPI programs*, Argonne National Laboratory, November 18, 2004.
- *Applying finite-state verification to scientific software using MPI*, Smith College, December 3, 2003.
- *Applying finite-state verification to scientific software using MPI*, Argonne National Laboratory, January 13, 2003.

Other selected talks

- *Generalizing Formal Methods from Sequential to Message-Passing Parallel Programs: The Case of Symbolic Execution*, (EC)²: Exploiting Concurrency Efficiently and Correctly, July 14, 2011
- *The Toolkit for Accurate Scientific Software*, the Third International Workshop on Numerical Software Verification, July 15, 2010
- *Using MPI-Spin to model check MPI programs with nonblocking communication*, EuroPVM/MPI, Late and Breaking Results, <http://www.pvmmpi06.org>, Bonn, Germany, September 20, 2006
- *The Hochschild cohomology ring of a finite group*, Algebra Seminar, Northwestern University, June 1997
- *Cohomology is really representation theory*, AMS Special Session on Representation Theory of Finite Groups, Detroit, Michigan, May 1997
- *The Hochschild cohomology ring of a finite group*, Group cohomology seminar, University of Georgia, Athens, May 1997
- *On the cohomology of split extensions of elementary abelian 2-groups*, AMS Special Session on Classifying Spaces and Cohomology of Finite Groups, Columbia, Missouri, November 1996
- *On the cohomology of split extensions of elementary abelian 2-groups*, The Fields Institute, Toronto, April 1996
- *The cohomology of the Burt group*, Algebra seminar, Northwestern University, May 1995

- *The cohomology of the Morava stabilizer group S_2 at the prime 3*, AMS Special Session on Classifying Spaces and Cohomology of Finite Groups, Orlando, Florida, March 1995
- *Generalized Benson-Carlson duality*, AMS Special Session on Cohomology and Representations of Finite Groups, San Francisco, California, January 1995
- *Generalized Benson-Carlson duality*, Canadian Mathematical Society Annual Seminar, Representations of groups: finite, algebraic, Lie, and quantum, Banf, Canada, June 1994
- *Poincaré duality and cohomology of finite groups*, Workshop on Group Representation Theory, Technion, Israel Institute of Technology, Haifa, Israel, June 1994
- *Twisting cochains and group cohomology*, Colloquium, University of Georgia, Fall 1992
- *Twisting cochains and the spectral sequence of a split extension of finite groups*, Algebra seminar, University of Virginia, Fall 1992
- *Characteristic classes and cohomology of groups*, Algebra seminar, Northwestern University, Winter 1992

7 Service

External

- Program Committee, Correctness 2017: First International Workshop on Software Correctness for HPC Applications, 2017
- Program Committee, TACAS 2018: 24th International Conference on Tools and Algorithms for the Construction and Analysis of Systems
- Jury and Program Committee, SV-COMP 2016, 2017: Software Verification Competition, TACAS 2016, 2017
- Associate Editor, *IEEE Transactions on Software Engineering*, 2015–present.
- Proposal review panel, Department of Energy SciDAC program, 2017
- Workshops Chair, CGO 2018: International Symposium on Code Generation and Optimization
- External reviewer, POPL 2017
- Participant, NSF Software Infrastructure for Sustained Innovation (SI2) workshop, Feb. 16–17, 2016
- Program Committee (Technical track, Programming Systems), SC16
- Ad-hoc proposal reviewer, National Science Foundation, 2015
- Proposal evaluation panel member, National Science Foundation, 2006, 2009, 2011, 2014
- Subreviewer, *International Symposium on Software Reliability Engineering*, 2014
- Reviewer, *IEEE Transactions on Reliability*, 2014, 2015
- External Review Committee, Programming Language Design and Implementation (PLDI), 2014
- External Review Committee, Principles and Practices of Parallel Programming (PPoPP), 2014
- Program Committee, NASA Formal Methods, 2013
- Program Committee, NSV-2011
- Program Committee, EuroPVM/MPI 2009, 2010, 2012

- Organizing committee, *Exploiting Concurrency Efficiently and Correctly ((EC)²)*, CAV Workshop, 2008, 2009, 2010, 2011 (chair), 2012. Steering committee, 2012–present
- Panelist, Department of Energy, Advanced Scientific Computing Research Exascale Tools Workshop, Panel on Correctness and Debugging, October 13–14, 2011
- Program Committee (Technical track, Systems), SC10
- Program Committee (Tutorials), SC09
- External reviewer for the following journals and conferences (selected):
 - *Automated Software Engineering* (journal), reviewer, 2012
 - *International Symposium on Software Testing and Analysis* (ISSTA 2011)
 - *Supercomputing* (SC09)
 - *ACM SIGPLAN Symposium on Principles and Practice of Parallel Computing* (PPoPP 2008)
 - *Transactions on Software Engineering*, IEEE, 2008
 - *17th International Conference on Computer Aided Verification* (CAV 2008)
 - *Concurrency and Computation: Practice and Experience*, 2007
 - *Parallel Computing*, 2007
 - *ACM Transactions on Software Engineering and Methodology* (TOSEM), 2007
 - *13th European PVM/MPI Users’ Group Meetings* (EuroPVM/MPI 2006)
 - *Communications in Algebra*, 2006
- Ph.D. committee, external member, Sarvani Vakkalanka, University of Utah (advisor: Ganesh Gopalakrishnan)
- Publicity Chair, International Symposium on Software Testing and Analysis, Boston, Massachusetts, July 11–14, 2004
- Co-chair (with John Maginnis), Special Session on Cohomology of Finite Groups, 1998 Spring Central Sectional Meeting (#932) of the American Mathematical Society, March 27–28, 1998

UD

- CIS Undergraduate Committee Chair
- CIS representative to College of Engineering Educational Activities Committee, January 2016–present
- assisted with the UD booth presence at SC07, SC09, SC15, and SC17 (the International Conference for High Performance Computing, Networking, Storage and Analysis, also known as “Supercomputing”) with funding, posters, students, post-doc, and demos
- SIG-SYS organizer, Fall 2016
- CIS Undergraduate Committee member, 2007–2009, 2015–present
- M.S. Software Engineering Committee chair, 2013–2017
- Dean’s Diversity Committee member, 2015
- ECE/CIS Lab System Administrator Search Committee, 2014
- Dean’s Junior Faculty Advisory Council, 2013–2014
- UD Engineering Outreach Advisory Committee, 2013–2015
- Computing Infrastructure Hiring Committee, 2011–2012

- Graduate Program Committee, 2010–2012
- HPC Programming Team coach, 2010
- Search Committee member, tenure-track position in software engineering, 2009–2010
- CISC 475 assessment team member, 2007, 2008, 2009
- Graduate Recruitment Committee member, 2006–2007
- Master of Science in Software Engineering committee member: helped develop curriculum of new program and prepare documents for university approval
- organized and coached two UD teams which competed in the HPC Programming Contest at SC09. One team tied for first place, the other came in third.
- co-organized the Computer and Information Sciences Distinguished Lecture Series, 2007–2008
- regular co-organizer of SIG-SYS, most recently Spring 2014

8 Teaching and Mentoring

University of Delaware

- Post-doctoral researchers sponsored:
 - Dr. Manchun Zheng, Novemember 2013–2016
- Graduate student advisees and research assistants
 - Yihao Yan; Ph.D. student and RA, Jan. 2016–present. Passed Preliminary Exam, Dec. 2016
 - Wenhao Wu; M.S. Software Engineering student and RA, 2015–present. Passed Preliminary Exam, Aug. 2016.
 - Ziqing Luo; Ph.D. student and RA, Feb. 2014–present; passed PhD Preliminary Exam, 2015; passed proposal defence, October 2017
 - Si Li; Ph.D. student and RA, 2015–2016.
 - Timothy Zirkel: Ph.D. student and RA, 2008–2014. *Formally Verifying the Accuracy of Numerical Approximations in Scientific Software*
 - Timothy McClory: independent study, M.S. student, and RA, 2011–2012
 - Yi Wei: M.S. student and RA, 2007–2010. Earned M.S., 2010
 - Michael Karpeles: RA, 2011
 - Benjamin Perry: RA, 2010
 - Jiaqiang Xu: M.S. student and RA, 2007–2008. Earned M.S., 2009
 - Pujan Kafle: M.S. student and RA, 2006–2008. Earned M.S., 2008
 - Samuel Moelius: RA, 2007–2008
- Ph.D. Dissertation Committees
 - PhD Dissertation Committee for Tristan Vanderbruggen: defended proposal, February 2017; passed dissertation exam, January 2018
 - PhD Dissertation Committee for Chen Huo: defended proposal, Sep. 2016; passed dissertation exam, June 2017
 - PhD Dissertation Committee for E.J. Park, graduated 2014

- PhD Dissertation Committee for Trilce Estrada, graduated 2012
- Preliminary Project Committees
 - Sergio Pino (exam: May, 2017)
- Undergraduate students supervised in research projects
 - Andre Marianiello, NSF REU, *Translation of CUDA to CIVL intermediate form for verification*, 2014
 - Jacob Trieu, NSF REU, *Translation of OpenCL to CIVL intermediate form for verification*, 2014
 - John Edenhofner, NSF REU, *Translation of POSIX Threads programs to CIVL intermediate form for verification*, 2014
 - Benjamin Handanyan, NSF REU, *Graphical User Interface for concurrent trace display*, 2014
 - Steven Noyes, REU, *Graphical User Interface for the CIVL framework*, 2014
 - Alex Stachnik, Independent Study, 2011. Topic: *Construction of compiler-based front-end for TASS*
 - Andrew Chester, Independent Study, 2011. Topic: *Development of new ECE/CIS Account System*
 - Daniel Fix, University of Delaware Research Foundation summer internship, 2010. Topic: *Counterexample trace display for TASS*
 - Robert Deaton, Independent Study, 2009. Topic: *An XML representation for TASS models*
 - John Hankins, Independent Study, 2008. Topic: *A concurrent elevator control system in Java*
 - Brandon Maas, Independent Study, 2008. Topic: *nfoShare (Vgoo) and Bus Bookie Startup Projects*
- Nominated for Excellence in Undergraduate Academic Advising Award, May 2009
- 2018 Spring
 - CISC 449.010/649.010: *Topics in Computer Applications: Rigorous Program Development*
 - CISC 467.013: *VIP: High-Performance Computing*
- 2017 Fall
 - CISC 372.010: *Parallel Computing*
 - CISC 675.010: *Software Engineering: Principles & Practices*
 - CISC 467.013: *VIP: High-Performance Computing*
- 2017 Spring
 - CISC 879.010: *Reproducibility in Software Systems Research*
 - CISC 467.013: *VIP: High-Performance Computing*
- 2016 Fall
 - CISC 108.010: *Introduction to Computer Science 1*
 - CISC 372: *Parallel Computing*
- 2016 Spring
 - CISC 879.010: *Concurrency & Verification*
- 2015 Fall
 - CISC 108: *Introduction to Computer Science 1*

- CISC 414/614: *Formal Methods in Software Engineering*
- 2015 Spring
 - CISC 108: *Introduction to Computer Science 1*
- 2014 Fall
 - CISC 475/675: *Advanced Software Engineering*
 - CISC 414/614: *Formal Methods in Software Engineering*
- 2014 Spring
 - CISC 879.011: *Formal Methods for High Performance Computing*
- 2013 Fall
 - CISC 414/614: *Formal Methods in Software Engineering*
 - CISC 475/675: *Advanced Software Engineering*
- 2012 Spring
 - CISC 475/675: *Advanced Software Engineering*
- 2011 Fall
 - CISC 108: *Introduction to Computer Science 1*
 - CISC 414/614: *Formal Methods in Software Engineering*
- 2011 Spring
 - CISC 475/675: *Advanced Software Engineering*
 - CISC 879.011: *Advanced Topics in Software Verification*
- 2010 Fall
 - CISC 414/614: *Software Verification*
- 2010 Spring
 - CISC 475/675: *Advanced Software Engineering*
 - CISC 372: *Parallel Programming* (co-taught with Martin Swamy)
- 2009 Fall
 - CISC 403/603: *Software Verification*
 - CISC 879.010: *Advanced Parallel Computing* (co-taught with Martin Swamy)
- 2009 Spring
 - CISC 475/675: *Object-Oriented Software Engineering*
 - CISC 372: *Parallel Programming*
- 2008 Fall
 - CISC 879.011: *Abstract Interpretation*, Fall 2008
- 2008 Spring
 - CISC 475: *Object-Oriented Software Engineering*
 - CISC 675: *Object-Oriented Software Engineering* (graduate)

- 2007 Fall
 - CISC403/603: *Program Validation*
- 2007 Spring
 - CISC 475: *Object-Oriented Software Engineering*
- 2006 Fall
 - CISC 879.011: *Finite-State Verification*

University of Utah

- 2013 Spring
 - CS 5965/6965: *Formal Methods for High Performance Computing*

Amherst College

- Instructor, CS31: *Concurrency*, Amherst College, Fall 2003

University of Massachusetts Amherst

- Instructor, Math 411: *Introduction to Abstract Algebra I*, Spring 1997
- Instructor, Math 132: *Calculus II with Graphing Calculator*, Spring 1997, Fall 1997, Spring 1998
- Instructor, Math 190: *Basic Math Skills for the Modern World*, Fall 1996
- Instructor, Math 131: *Calculus I with Graphing Calculator*, Fall 1996

Northwestern University

- Instructor, Math D-78: *Group representation theory*, Spring 1995
- Instructor, Math B15-0: *Multiple integration and vector calculus*, Winter 1994–5
- Instructor, Math E-11: *Group cohomology*, Winter 1993–4
- Instructor, Math B14-1: *Calculus*, Northwestern University, Fall 1993

Other

- Instructor, *Beginner and Intermediate Lindy Hop*, 2001–2004, Northampton Center for the Arts, Northampton, Mass.
- College Fellow (teaching assistant), *Functional analysis*, University of Chicago, Winter 1990
- College Fellow, *Representation theory of finite groups*, University of Chicago, Fall 1989
- Teaching Assistant, *Introduction to Computer Programming III*, University of Chicago, Spring 1988
- Computer Lab Assistant, University of Chicago, 1987–8
- Class tutor, *Calculus*, University of Chicago, 1985–6
- Instructor, *Introduction to Computer Programming*, Miami Microcomputer Training Center, 1982–1984

9 Other Awards and Honors

- VerifyThis 2017 software verification competition, *Best Tool Feature: CIVL: Functional Equivalence*, April 2017
- Yihao Yan, Verified Software Laboratory, Rigorous Examination of Reactive Systems (RERS) Challenge 2017, Gold Medal in category *Parallel LTL* model checking
- National Science Foundation Postdoctoral Fellowship, September 1993 – June 1996
- Sloan Foundation Dissertation Fellowship, October 1992 – August 1993
- Office of Naval Research Graduate Fellowship, University of Chicago, June 1989 – May 1992
- Senior Mathematics Award for M.Sc. dissertation, Oxford University, June 1989
- Fulbright Graduate Fellowship, Oxford University, September 1988 – June 1989
- Paul R. Cohen Mathematics Prize, University of Chicago, June 1988
- National Science Foundation Graduate Fellowship (declined), April 1988
- Admitted to Phi Beta Kappa, University of Chicago, June 1987