

# Benjamin C. Lee

Curriculum Vitae

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benjamin.c.lee@duke.edu  
Nationality: United States  
Place of Birth: California

Pratt School of Engineering  
Duke University  
210 Hudson Hall, Box 90291  
Durham, NC 27708

## Interests

**Computer architecture** – processor and memory design, power efficiency, security.  
**Datacenter systems** – server architecture, resource management, simulation methods.  
**Systems modeling** – performance and power analysis, statistical machine learning.  
**Algorithmic economics** – allocation and scheduling, multi-agent markets, game theory.  
**Technology policy** – technology, economics, policy for environmentally sustainable IT.

## Education

### Harvard University

Ph.D., Computer Science, 2008  
S.M., Computer Science, 2006  
Minor, Statistics

### University of California, Berkeley

B.S., Electrical Engineering and Computer Science, 2004  
Minor, Business Administration

## Experience

### Duke University, Durham NC

Associate Professor, Electrical & Computer Engineering, Computer Science, 2015 – present  
Assistant Professor, Electrical & Computer Engineering, Computer Science, 2010 – 2015

### Stanford University, Stanford CA

NSF Computing Innovation Fellow, Electrical Engineering, 2009 – 2010

### Microsoft Research, Redmond WA

Post-doctoral Researcher, Systems and Networking, 2008 – 2009

### Harvard University, Cambridge MA

Graduate Researcher, Engineering and Applied Sciences, 2004 – 2008

### Intel Corporation, Santa Clara CA

Intern Researcher, Microarchitecture Research, 2007

### Lawrence Livermore National Laboratory, Livermore CA

Intern Researcher, Applied Scientific Computing, 2006

### University of California, Berkeley CA

Undergraduate Researcher, Computer Science, 2002 – 2004

### Charles M. Salter Associates, San Francisco CA

Intern Engineer, Transportation and Airport Acoustics, 2000

- Academic Honors**
- 2018 Hall of Fame, Int’l Symp. High-Perf. Computer Architecture (HPCA)**
  - 2018 Duke University, Celebrating Mentors Honoree**
  - 2013 Duke University, Nortel Networks Professorship**
  - 2012 National Science Foundation, CAREER Award**
  - 2011 Google Faculty Research Award**
  - 2009 National Science Foundation, Computing Innovation Fellowship**
  - 2004 Harvard University, Engineering and Applied Sciences Fellowship**
  - 2000 National Merit Scholarship**
- Paper Awards**
- 2018 Research Highlight, Communications of the ACM**  
“The computational sprinting game.”
  - 2018 Best Paper, Int’l Symp. Perf. Analysis Systems & Software (ISPASS)**  
“MAPS: Understanding metadata access patterns in secure memory.”
  - 2018 Best Paper, Int’l Symp. High-Perf. Computer Architecture (HPCA)**  
“Amdahl’s Law in the datacenter era: A market for fair processor allocation.”
  - 2017 Outstanding PhD Dissertation Award, Duke Electrical & Computer Engineering**  
“Microeconomic models for managing shared datacenters.”
  - 2016 Best Paper, Int’l Conf. Architectural Support... (ASPLOS)**  
“The computational sprinting game.”
  - 2016 IEEE Micro Top Picks, Honorable Mention**  
“The computational sprinting game.”
  - 2016 IEEE Micro Top Picks, Honorable Mention**  
“PoisonIvy: Safe speculation for secure memory.”
  - 2014 IEEE Micro Top Picks**  
“REF: Resource elasticity fairness with sharing incentives for multiprocessors.”
  - 2011 Research Highlight, Communications of the ACM**  
“Understanding sources of inefficiency in general-purpose chips.”
  - 2010 Research Highlight, Communications of the ACM**  
“Phase change memory and the quest for scalability.”
  - 2009 IEEE Micro Top Picks**  
“Phase change technology and the future of main memory.”
  - 2008 Best Paper Nominee, Int’l Symp. Microarchitecture (MICRO)**  
“CPR: Composable performance regression for scalable multiprocessor models.”
  - 2008 ACM Doctoral Dissertation Award, Harvard University Nomination**  
“Statistical inference for efficient microarchitectural analysis.”
  - 2008 Invited Participant, 38th St. Gallen Symposium**  
“Corporate social responsibility and the globalization of ‘local values’.”
  - 2007 Invited Participant, 37th St. Gallen Symposium**  
“Flattening the world efficiently: Digital sustainability for the twenty-first century.”

**2006 First Place, Supercomputing (SC) Student Research Competition**

“Statistical inference for efficient microarchitectural and application analysis.”

**2004 Best Paper, Int’l Conf. Parallel Processing (ICPP)**

“Perf. models for evaluation & auto. tuning of symm. sparse matrix-vector multiply.”

**2002 Best Student Paper Finalist, Supercomputing (SC)**

“Perf. opt. & bounds for sparse matrix-vector multiply.”

**Publications**

**Journals, Magazines, Books**

1. Songchun Fan\*, Seyed Majid Zahedi\*, Benjamin C. Lee. “The computational sprinting game,” *Communications of the ACM (CACM), Research Highlight*. Invited, to appear. \*Equal Contributions.
2. Rupert Freeman\*, Seyed Majid Zahedi\*, Vincent Conitzer, Benjamin C. Lee. “Dynamic proportional sharing: A game-theoretic approach.” *Proc. of the ACM on Measurement and Analysis of Computing Systems (SIGMETRICS)*, 2(1):3:1–3:36, June 2018. \*Equal Contributions.
3. Pengfei Zheng and Benjamin C. Lee “Hound: Causal learning for datacenter-scale straggler diagnosis.” *Proc. of the ACM on Measurement and Analysis of Computing Systems (SIGMETRICS)*, 2(1):17:1–17:36, June 2018.
4. Seyed Majid Zahedi, Songchun Fan, Benjamin C. Lee. “Managing heterogeneous datacenters with tokens.” *ACM Transactions on Architecture and Code Optimization (TACO)*, 15(2):18:1–18:23, June 2018.
5. Seyed Majid Zahedi, Songchun Fan, Matthew Faw, Elijah Cole, Benjamin Lee. “Computational sprinting: Architecture dynamics, and strategies.” *ACM Transactions on Computer Systems (TOCS)*, 34(4):12.1-12.26, January 2017.
6. Benjamin C. Lee. “Datacenter design and management: A computer architect’s perspective,” *Synthesis Lectures on Computer Architecture*, 11(1):1-121, February 2016.
7. Seyed Majid Zahedi, Benjamin C. Lee. “Sharing incentives and fair division for multiprocessors,” *IEEE Micro, Top Picks from the Computer Architecture Conferences*, 35(3):92-100, May/June, 2015.
8. Marisabel Guevara, Benjamin Lubin, Benjamin C. Lee. “Market mechanisms for managing datacenters with heterogeneous microarchitectures,” *ACM Transactions on Computer Systems (TOCS)*, 32(1):3.1-3.31, February 2014.
9. Rehan Hameed, Wajahat Qadeer, Megan Wachs, Omid Azizi, Alex Solomatnikov, Benjamin C. Lee, Stephen Richardson, Christos Kozyrakis, Mark Horowitz. “Understanding sources of inefficiency in general-purpose chips,” *Communications of the ACM (CACM), Research Highlight*, 54(10):85-93, October 2011.
10. Vijay Janapa Reddi, Benjamin C. Lee, Trishul Chilimbi, Kushagra Vaid. “Mobile processors for energy-efficient web search,” *ACM Transactions on Computer Systems (TOCS)*, 29(4):9.1-9.39, August 2011.
11. Ofer Shacham, Omid Azizi, Megan Wachs, Wajahat Qadeer, Zain Asgar, Kyle Kelley, Pete Stevenson, Alex Solomatnikov, Amin Firoozshahian, Benjamin C. Lee, Stephen Richard-

son, Mark Horowitz. “Why design must change: Rethinking digital design,” *IEEE Micro*, 30(6):9-24, November/December, 2010.

12. Benjamin C. Lee, David Brooks. “Applied inference: Case studies in microarchitectural design,” *ACM Transactions on Architecture and Code Optimization (TACO)*, 7(2):1-37, October 2010.
13. Benjamin C. Lee, Engin Ipek, Onur Mutlu, Doug Burger. “Phase change memory architecture and the quest for scalability,” *Communications of the ACM (CACM), Research Highlight*, 53(7):99-106, July 2010.
14. Benjamin C. Lee, Ping Zhou, Engin Ipek, Onur Mutlu, Jun Yang, Youtao Zhang, Bo Zhao, Doug Burger. “Phase change technology and the future of main memory,” *IEEE Micro, Top Picks from the Computer Architecture Conferences*, 30(1):131-141, January/February, 2010.
15. Benjamin C. Lee and D. Brooks. “A tutorial in spatial sampling and regression strategies for microarchitectural analysis,” *IEEE Micro, Special Issue on Hot Tutorials*, 27(3):74-93, May/June 2007.

#### Refereed Proceedings

16. Songchun Fan, Theodoros Salonidis, Benjamin Lee. “Swing: Swarm computing for mobile sensing.” *Proc. International Conference on Distributed Computing Systems (ICDCS)*, July 2018.
17. Rupert Freeman\*, Seyed Majid Zahedi\*, Vincent Conitzer, Benjamin C. Lee. “Dynamic proportional sharing: A game-theoretic approach.” *Proc. International Conference on Measurement and Modeling of Computer Systems (SIGMETRICS)*, June 2018. \*Equal Contributions.
18. Pengfei Zheng and Benjamin C. Lee “Hound: Causal learning for datacenter-scale straggler diagnosis.” *Proc. International Conference on Measurement and Modeling of Computer Systems (SIGMETRICS)*, June 2018.
19. Tamara Lehman, Andrew Hilton, Benjamin C. Lee. “MAPS: Understanding metadata access patterns in secure memory.” *Proc. International Symposium on Performance Analysis of Systems and Software (ISPASS)*, April 2018.<sup>1</sup>
20. Seyed Majid Zahedi\*, Qiuyun Llull\*, Benjamin C. Lee. “Amdahl’s Law in the datacenter era: A market for fair processor allocation,” *Proc. International Symposium on High-Performance Computer Architecture (HPCA)*, February 2018.<sup>2</sup> \*Equal Contributions.
21. Qiuyun Llull, Songchun Fan, Seyed Majid Zahedi, Benjamin C. Lee. “Cooper: Task collocation with cooperative games,” *Proc. International Symposium on High-Performance Computer Architecture (HPCA)*, February 2017.
22. Songchun Fan, Qiuyun Llull, Benjamin C. Lee. “Predicting sensory data and extending battery life for wearable devices,” *Proc. Workshop on Mobile Computing Systems and Applications (HotMobile)*, February 2017.

<sup>1</sup> Best Paper Award.

<sup>2</sup> Best Paper Award.

23. Tamara Silbergleit Lehman, Andrew D. Hilton, Benjamin C. Lee. "PoisonIvy: Safe speculation for secure memory," *Proc. International Symposium on Microarchitecture (MICRO)*, October 2016.<sup>3</sup>
24. Songchun Fan, Theodoros Salonidis, Benjamin C. Lee. "A framework for collaborative sensing and processing of mobile data streams: Demo," *Proc. International Conference on Mobile Computing and Networking (MobiCom)*, October 2016.
25. Ziqiang Huang, Andrew D. Hilton, Benjamin C. Lee. "Decoupling loads for nano-instruction set computers," *Proc. International Symposium on Computer Architecture (ISCA)*, June 2016.
26. Songchun Fan\*, Seyed Majid Zahedi\*, Benjamin C. Lee. "The computational sprinting game," *Proc. International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS)*, April 2016.<sup>4</sup> \*Equal Contributions.
27. Songchun Fan, Benjamin C. Lee. "Evaluating asymmetric multiprocessing for mobile applications," *Proc. International Symposium on Performance Analysis of Systems and Software (ISPASS)*, April 2016.
28. Benjamin C. Lee. "Applied statistical inference for system design and management," *Proc. International Conference on Computer Design (ICCD)*, October 2015.
29. Qiuyun Wang, Benjamin C. Lee. "Modeling communication costs in blade servers," *Proc. Workshop on Power-Aware Computing and Systems (HotPower)*, October 2015.
30. Seyed Majid Zahedi, Benjamin C. Lee. "REF: Resource elasticity fairness with sharing incentives for multiprocessors," *Proc. International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS)*, March 2014.<sup>5</sup>
31. Marisabel Guevara, Benjamin Lubin, Benjamin C. Lee. "Strategies for anticipating risk in heterogeneous system design," *Proc. International Symposium on High-Performance Computer Architecture (HPCA)*, February 2014.
32. Emily Bragg, Marisabel Guevara, Benjamin C. Lee. "Understanding query complexity and its implications for energy-efficient web search," *Proc. International Symposium on Low Power Electronics and Design (ISLPED)*, September 2013.
33. Sam Xi, Marisabel Guevara, Jared Nelson, Patrick Pensabene, Benjamin C. Lee. "Understanding the critical path in power state transition latencies," *Proc. International Symposium on Low Power Electronics and Design (ISLPED)*, September 2013.
34. Marisabel Guevara, Benjamin Lubin, Benjamin C. Lee. "Navigating heterogeneous processors with market mechanisms," *Proc. International Symposium on High-Performance Computer Architecture (HPCA)*, February 2013.
35. Tae Jun Ham, Bharath K. Chelepalli, Neng Xue, Benjamin C. Lee. "Disintegrated control for power-efficient and heterogeneous memory systems," *Proc. International Symposium on High-Performance Computer Architecture (HPCA)*, February 2013.

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<sup>3</sup> Top Picks (Honorable Mention) from Computer Architecture Conferences, IEEE Micro.

<sup>4</sup> ASPLOS Best Paper; Top Picks (Honorable Mention) from Computer Architecture Conferences, IEEE Micro; Research Highlight, Communications ACM.

<sup>5</sup> Top Picks from Computer Architecture Conferences, IEEE Micro.

36. Krishna T. Malladi, Ian Shaeffer, Liji Gopalakrishnan, David Lo, Benjamin C. Lee, Mark Horowitz. “Rethinking DRAM power modes for energy proportionality,” *Proc. International Symposium on Microarchitecture (MICRO)*, December 2012.
37. Weidan Wu, Benjamin C. Lee. “Inferred models for dynamic and sparse hardware-software spaces,” *Proc. International Symposium on Microarchitecture (MICRO)*, December 2012.
38. Krishna T. Malladi, Karthika Periyathambi, Frank A. Nothaft, Benjamin C. Lee, Christos Kozyrakis, Mark Horowitz. “Towards energy-proportional datacenter memory with mobile DRAMs,” *Proc. International Symposium on Computer Architecture (ISCA)*, June 2012.
39. Omid Azizi, Aqeel Mahesri, Benjamin C. Lee, Sanjay J. Patel, Mark Horowitz. “Energy performance tradeoffs in processor architecture and circuit design: A marginal cost analysis,” *Proc. International Symposium on Computer Architecture (ISCA)*, June 2010.
40. Rehan Hameed, Wajahat Qadeer, Megan Wachs, Omid Azizi, Alex Solomatnikov, Benjamin C. Lee, Stephen Richardson, Christos Kozyrakis, Mark Horowitz. “Understanding sources of inefficiency in general-purpose chips,” *Proc. International Symposium on Computer Architecture (ISCA)*, June 2010.
41. Vijay Janapa Reddi, Benjamin C. Lee, Trishul Chilimbi, Kushagra Vaid. “Web search using mobile cores: Quantifying and mitigating the price of efficiency,” *Proc. International Symposium on Computer Architecture (ISCA)*, June 2010.<sup>6</sup>
42. Jeremy Condit, Edmund B. Nightingale, Christopher Frost, Engin Ipek, Benjamin Lee, Doug Burger, Derrick Coetsee. “Better I/O through byte-addressable, persistent memory,” *Proc. Symposium on Operating Systems Principles (SOSP)*, October 2009.
43. Xiaoyao Liang, Benjamin C. Lee, Gu-Yeon Wei, David Brooks. “Design and test strategies for microarchitectural post-fabrication tuning,” *Proc. International Conference on Computer Design (ICCD)*, October 2009.<sup>7</sup>
44. Kristen Lovin, Benjamin C. Lee, Xiaoyao Liang, David Brooks, Gu-Yeon Wei. “Empirical performance models for 3T1D memories,” *Proc. International Conference on Computer Design (ICCD)*, October 2009.<sup>8</sup>
45. Benjamin C. Lee, Engin Ipek, Onur Mutlu, Doug Burger. “Architecting phase change memory as a scalable DRAM alternative,” *Proc. International Symposium on Computer Architecture (ISCA)*, June 2009.<sup>9</sup>
46. Benjamin C. Lee, Jamison Collins, Hong Wang, David Brooks. “CPR: Composable performance regression for scalable multiprocessor models,” *Proc. International Symposium on Microarchitecture (MICRO)*, November 2008.<sup>10</sup>
47. Benjamin C. Lee. “Corporate social responsibility and the globalization of ‘local values,’” *St. Gallen Symposium: Global Capitalism – Local Values*, May 2008.
48. Benjamin C. Lee, David Brooks. “Efficiency trends and limits from comprehensive microarchitectural adaptivity,” *Proc. International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS)*, March 2008.

<sup>6</sup> Also Microsoft Technical Report MSR-TR-2009-105, August 2009.

<sup>7</sup> Also Harvard University Computer Science Technical Report TR-06-08, December 2008.

<sup>8</sup> Also Harvard University Computer Science Technical Report TR-03-08, October 2008.

<sup>9</sup> Top Picks from Computer Architecture Conferences, IEEE Micro; Research Highlight, Communications ACM.

<sup>10</sup> Best Paper Nomination.

49. Benjamin C. Lee, David Brooks. “Roughness of microarchitectural design topologies and its implications for optimization,” *Proc. International Symposium on High Performance Computer Architecture (HPCA)*, February 2008.
50. Benjamin C. Lee. “Flattening the world efficiently: Digital sustainability for the twenty-first century,” *St. Gallen Symposium: The Power of Natural Resources*, May 2007.
51. Benjamin C. Lee, David Brooks, Bronis de Supinski, Martin Schulz, Karan Singh, Sally McKee. “Methods of inference and learning for performance modeling of parallel applications,” *Proc. Symposium on Principles and Practice of Parallel Programming (PPoPP)*, March 2007.
52. Benjamin C. Lee, David Brooks. “Illustrative design space studies with microarchitectural regression models,” *Proc. International Symposium on High-Performance Computer Architecture (HPCA)*, February 2007.
53. Benjamin C. Lee, David Brooks. “Accurate and efficient regression modeling for microarchitectural performance and power prediction,” *Proc. International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS)*, October 2006.
54. Benjamin C. Lee, David Brooks. “Statistically rigorous regression modeling for the microprocessor design space,” *Proc. Workshop on Modeling, Benchmarking, and Simulation (MoBS) in conjunction with ISCA-33*, June 2006.
55. Yingmin Li, Benjamin C. Lee, David Brooks, Zhigang Hu, Kevin Skadron. “Impact of thermal constraints on multi-core architectures,” *Proc. Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronics Systems (ITHERM)*, May 2006.
56. Yingmin Li, Benjamin C. Lee, David Brooks, Zhigang Hu, Kevin Skadron. “CMP design space exploration subject to physical constraints,” *Proc. International Symposium on High-Performance Computer Architecture (HPCA)*, February 2006.
57. Benjamin C. Lee, David Brooks. “Effects of pipeline complexity on SMT/CMP power-performance efficiency,” *Proc. Workshop on Complexity Effective Design (WCED) in conjunction with ISCA-32*, June 2005.
58. Benjamin C. Lee, Richard Vuduc, James Demmel, Katherine Yelick. “Performance models for evaluation and automatic tuning of symmetric sparse matrix-vector multiply,” *Proc. International Conference on Parallel Processing (ICPP)*, August 2004.<sup>11</sup>
59. Richard Vuduc, James Demmel, Katherine Yelick, Shoaib Kamil, Rajesh Nishtala, Benjamin C. Lee. “Performance optimizations and bounds for sparse matrix-vector multiply,” *Proc. International Conference for High Performance Computing, Networking, Storage and Analysis (SC)*, November 2002.<sup>12</sup>

### Dissertations

60. Seyed Majid Zahedi. “Managing shared resources in the data center era: Computer architecture meets game theory,” *Ph.D. Dissertation, Duke University*, 2018.

<sup>11</sup> Best Paper; Also UC Berkeley Technical Report UCB/CSD-03-1297, November 2003.

<sup>12</sup> Best Student Paper Finalist.

61. Qiuyun Llull. "Microeconomic models for managing shared datacenters," *Ph.D. Dissertation, Duke University*, 2017.<sup>13</sup>
62. Songchun Fan. "Towards energy-efficient mobile sensing: Architectures and frameworks for heterogeneous sensing and computing," *Ph.D. Dissertation, Duke University*, 2016.
63. Marisabel Guevara. "Coordinating the design and management of heterogeneous datacenter resources," *Ph.D. Dissertation, Duke University*, 2014.
64. Krishna Malladi. "Energy proportional memory systems," *Ph.D. Dissertation, Stanford University*, August 2013.
65. Benjamin C. Lee. "Statistical inference for efficient microarchitectural analysis," *Ph.D. Dissertation, Harvard University*, May 2008.<sup>14</sup>

## Talks

- 2017.** California Institute of Technology; Princeton University; Carnegie Mellon University; Massachusetts Institute of Technology; Qualcomm Research Raleigh
- 2016.** ARM Research Austin; ARM Research Summit Cambridge; Microsoft Research Redmond; Texas Instruments Dallas
- 2015.** Samsung Memory Solutions Lab Milpitas; Tsinghua University; Chinese Academy of Sciences Beijing; North Carolina State University; University of California Berkeley
- 2014.** Texas A&M University; University of Illinois Urbana-Champaign; University of Massachusetts Amherst Georgia Institute of Technology; Google Mountain View; Intel Santa Clara; Microsoft Research Redmond; University of Michigan Ann Arbor; University of Wisconsin Madison; IBM T.J. Watson Research Center; Academia Sinica Taipei; National Taiwan University Taipei; Oak Ridge National Laboratory
- 2013.** University of Wisconsin Madison; VMware Palo Alto; Qualcomm Research Raleigh; Ghent University; Chinese Academy of Sciences Beijing; AMD Research Beijing; Peking University Beijing; Hong Kong University of Science & Technology; Shanghai Jiaotong University
- 2012.** IBM T.J. Watson Research Center; NetApp Research Triangle Park
- 2011.** IBM T.J. Watson Research Center; NetApp Research Triangle Park Duke University; IBM Research Triangle Park; University of North Carolina Chapel Hill; Rambus Sunnyvale; IBM Austin Research Laboratory; Princeton University; North Carolina State University
- 2010.** University of California Berkeley; Intel Santa Clara; Intel Hudson; Harvard University; Google Mountain View; Lawrence Livermore National Laboratory; Stanford Pervasive Parallelism Lab (PPL); University of California Los Angeles; Princeton University; University of Southern California; Duke University
- 2009.** Stanford University; University of Texas Austin; Swiss Federal Institute of Technology (ETH) Zurich; University of Rochester; Rutgers University; Northwestern University; University of Washington Seattle; AMD Research Bellevue
- 2008.** Microsoft Research Redmond IBM T.J. Watson Research Center
- 2007 and earlier.** Intel Santa Clara; Intel Folsom; Lawrence Livermore National Laboratory

<sup>13</sup> Duke University, ECE Outstanding PhD Dissertation Award.

<sup>14</sup> Harvard University Nomination, ACM Doctoral Dissertation Award.



### Conferences and Workshops

1. “Economic mechanisms for managing risk in datacenters,” *Workshop on Energy Secure Systems Architecture in conjunction with ISCA-41*, June 2014.
2. “Inferred models for dynamic and sparse hardware-software spaces,” *45th IEEE/ACM International Symposium on Microarchitecture (MICRO)*, December 2012.
3. “Web search using mobile cores: Quantifying and mitigating the price of efficiency,” *37th ACM International Symposium on Computer Architecture (ISCA)*, June 2010.
4. “Phase change memory: An architecture and systems perspective,” *Workshop on Emerging Memory Technologies (EMT) in conjunction with ISCA-37*, June 2010.
5. “Architecting phase change memory as a scalable DRAM alternative,” *36th ACM International Symposium on Computer Architecture (ISCA)*, June 2009.
6. “Green – Energy efficient software and principled approximation,” *Microsoft Research Techfest*, February 2009.
7. “CPR: Composable performance regression for scalable multiprocessor models,” *41st IEEE International Symposium on Microarchitecture (MICRO)*, November 2008.
8. “Efficiency trends and limits from comprehensive microarchitectural adaptivity,” *13th ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS)*, March 2008.
9. “Roughness of microarchitectural design topologies and its implications for optimization,” *14th IEEE International Symposium on High Performance Computer Architecture (HPCA)*, February 2008.
10. “Methods of inference and learning for performance modeling of parallel applications,” *12th ACM Symposium on Principles and Practice of Parallel Programming (PPoPP)*, March 2007.
11. “Statistical inference for efficient microarchitectural analysis,” *Boston Area Architecture Workshop (BARC)*, January 2007.
12. “Illustrative design space studies with microarchitectural regression models,” *13th IEEE International Symposium on High Performance Computer Architecture (HPCA)*, February 2007.
13. “Statistical inference for efficient microarchitectural and application analysis,” *IEEE/ACM International Conference for High Performance Computing, Networking, Storage and Analysis (SC)*, November 2006.<sup>15</sup>
14. “Accurate and efficient regression modeling for microarchitectural performance and power prediction,” *12th ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS)*, October 2006.
15. “Statistically rigorous regression modeling for the microprocessor design space,” *Workshop on Modeling, Benchmarking, and Simulation (MoBS) in conjunction with ISCA-33*, June 2006.

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<sup>15</sup> First Place, ACM Student Research Competition.

16. “Efficient design space exploration for chip multiprocessors,” *Harvard University, Industrial Partnership Annual Meeting*, October 2005.
17. “Effects of pipeline complexity on SMT/CMP power-performance efficiency,” *Workshop on Complexity Effective Design (WCED) in conjunction with ISCA-32*, June 2005.
18. “Performance models for evaluation and automatic tuning of symmetric sparse matrix-vector multiply,” *33rd International Conference on Parallel Processing (ICPP)*, August 2004.
19. “Optimizations and bounds for sparse symmetric matrix-vector multiply,” *SIAM Conference on Parallel Processing for Scientific Computing*, March 2004.
20. “Poster: Automatic performance tuning of sparse matrix kernels,” *SIAM Conference on Computational Science and Engineering*, February 2003.

#### **Technical Panels**

21. NSF Workshop on Exploiting Parallelism and Scalability, Arlington, VA, July 2015.
22. DOE Workshop on Modeling and Simulation of Exascale Systems and Applications, University of Washington, Seattle, WA, August 2012.
23. NSF Workshop on a Community Supported Computer Architecture and Design Evaluation Framework, Arlington, VA, June 2012.
24. “Architecting heterogeneous datacenters with algorithmic economics,” Informational Futures Group Meeting, Duke University, NC March 2012.
25. “Architecting a balance of power,” NSF Workshop on Cross-Layer Power Optimization and Management, University of Southern California, Los Angeles, CA, February 2012.
26. “Mega-servers vs. micro-blades,” *Workshop on Architectural Concerns in Large Data Centers (ACLD) in conjunction with ISCA-37*, June 2010.
27. “Emerging technologies,” *International Symposium on Nanoscale Architectures (NANOARCH) in conjunction with DAC-47*, July 2009.
28. “New memory technology,” *36th ACM International Symposium on Computer Architecture (ISCA)*, June 2009.

#### **Artifacts**

1. Duke ActionBench: ActionBench provides mobile benchmarks for user-phone interaction. APK files can be placed in a mounted Gem5 image and installed within simulation. The repository includes benchmark source code, written in Java and Gem5 simulation scripts. (<http://people.duke.edu/~bcl15/software.html>)
2. Harvard CORE: Comprehensive Optimization via Regression Estimates (CORE) is a collection of example R scripts that construct microarchitectural performance, power regression models with correlation, association, significance analyses. (<http://people.duke.edu/~bcl15/software.html>)
3. Berkeley OSKI: The Optimized Sparse Kernel Interface is a collection of low-level C primitives that provide automatically tuned computational kernels on sparse matrix solves for use in solver libraries and applications. (<http://bebop.cs.berkeley.edu/oski/>)

**Patents**

1. Jeremy Condit, Edmund Nightingale, Benjamin C. Lee, Engin Ipek, Christopher Frost, Doug Burger. "Hardware and operating system support for persistent memory on a memory bus," United States Patent #US8533404. Granted September 2013.
2. Jeremy Condit, Edmund Nightingale, Benjamin C. Lee, Engin Ipek, Christopher Frost, Doug Burger. "Hardware and operating system support for persistent memory on a memory bus," United States Patent #US8219741. Granted July 2012.

**Grants**

1. "IUCRC: Center for Alternative Sustainable and Intelligent Computing," Co-principal Investigator with Yiran Chen (PI) and Hai Li, National Science Foundation, \$750K, 2018-2023.
2. "Dynamic power allocation and efficient system-on-chip scaling," Principal Investigator, Semiconductor Research Corporation, \$210K, 2018-2020.
3. "Coalitional game theory for co-locating software on shared hardware," Principal Investigator with Andrew Hilton (Co-PI), National Science Foundation, \$400K, 2015-2019.
4. "Multi-dimensional scheduling and resource allocation in datacenters," Co-principal Investigator with Kamesh Munagala (PI) and Sungjin Im, National Science Foundation, \$959K, 2014-2019.
5. "Allocating heterogeneous datacenter hardware to strategic agents," Principal Investigator with Vincent Conitzer (Co-PI), National Science Foundation, \$700K, 2013-2019.
6. "Gigapixel cameras for ubiquitous surveying and environmental research," Co-principal Investigator with David Brady (PI) et al., Duke University, \$50K, 2016.
7. "AWS research education grant," Principal Investigator, Amazon Web Services, \$3.5K, 2015-2016.
8. "NSF XPS workshop for exploiting parallelism and scalability," Co-principal Investigator with Wuchun Feng (PI), National Science Foundation, \$85K, 2014-2015.
9. "The center for future architectures research," Co-principal Investigator with Todd Austin (PI) et al., Semiconductor Research Corporation, Defense Advanced Research Projects Agency, \$1M to BCL of \$28M award, 2013-2017.
10. "CAREER: Foundations for heterogeneous datacenter design and deployment," Principal Investigator, National Science Foundation, \$460K, 2012-2016.
11. "Pathfinding for emerging memory technologies," Principal Investigator, Google Faculty Research Award, \$55K, 2011.
12. "Foundations for heterogeneous datacenter design and development," Principal Investigator, Duke University Wannamaker Foundation, \$20K, 2011-2012.
13. "An application-driven approach to energy-efficient data centers," Co-principal Investigator with Christos Kozyrakis (PI) et al., Google Focused Research Award, \$750K, 2009-2012.
14. "The Computing Innovation Fellows Project: Rethinking digital design," Fellow with Mark Horowitz (Mentor), National Science Foundation, \$280K, 2009-2010.

**Research  
Advising**

**Doctoral Students**

1. Ziqiang Huang, Electrical and Computer Engineering, 2014-.
2. Tamara Lehman, Electrical and Computer Engineering, 2013-.
3. Yuhao Li, Computer Science, 2016-.
4. Atefeh Mehrabi, Electrical and Computer Engineering, Duke (with Sorin), 2016-.
5. Bryan Prosser, Computer Science, 2015-.
6. Dan Sun, Electrical and Computer Engineering, Duke, 2018-.
7. Pengfei Zheng, Computer Science, 2014-.
8. Seyed Majid Zahedi, Computer Science, 2012-18.
9. Qiuyun Wang, Electrical and Computer Engineering, 2012-17.
10. Songchun Fan, Computer Science, 2011-16.
11. Marisabel Guevara, Computer Science, 2010-14.
12. Krishna Malladi, Electrical Engineering, Stanford University (with Horowitz), 2009-13.

**Masters Students**

13. Keerthana Jetty, Electrical and Computer Engineering, 2017-.
14. Zhiyu Zhang, Computer Science, 2016-17.
15. Henri Maxime Demoulin, Computer Science, 2014-16.
16. Weidan Wu, Electrical and Computer Engineering, 2010-14.
17. Xin Zhou, Electrical and Computer Engineering, 2013-14.
18. Yifan Zhang, Electrical and Computer Engineering, 2012-14.

**Undergraduate Students**

19. Harry Xie, Computer Science, 2018-.
20. Brian Nieves, Computer Science, 2018-.
21. Calvin Ma, Computer Science, 2018-.
22. Ryan Piersma, Electrical and Computer Engineering, 2018-.
23. Vishnu Gottiparthi, Electrical and Computer Engineering, 2017-.
24. Cecily Chase, Applied Mathematics (Brown), 2018.
25. Aninda Manocha, Electrical and Computer Engineering, 2017-18.
26. Dan Sun, Electrical and Computer Engineering, 2017-18.
27. Hunter Lee, Electrical and Computer Engineering, 2016-17.
28. Matthew Faw, Electrical and Computer Engineering, 2016-17.
29. Brian Zhou, Electrical and Computer Engineering, 2016-17.
30. Randall Johnson, Electrical and Computer Engineering, 2016.
31. Rahul Swaminathan, Electrical and Computer Engineering, 2015.
32. Stephen Hughes, Electrical and Computer Engineering, 2015.
33. Kevin Delgado, Electrical and Computer Engineering, 2015.
34. Michael Liou, Computer Science, 2015.
35. Justin Wang, Computer Science, 2015.
36. Paul Kim, Electrical and Computer Engineering, 2014-15.
37. Justine Kim, Electrical and Computer Engineering, 2014-15.
38. William Chang, Computer Science, 2014.
39. Lance Co Ting Keh, Electrical and Computer Engineering, 2014.
40. Zachary Michaelov, Electrical and Computer Engineering, 2014.

41. Nazia Tabassum, Electrical and Computer Engineering, 2013-14.
42. Sam (Likun) Xi, Electrical and Computer Engineering, 2012-13.
43. John Cuffney, Electrical and Computer Engineering, 2012.
44. Taejun Ham, Electrical and Computer Engineering, 2011-12.
45. Michael Ansel, Electrical and Computer Engineering, 2011.

**External Research Experience for Undergraduates**

46. Abhimanyu Yadav, Computer Science and Engineering, IIT Kanpur, 2016.
47. Stephanie Morris, Electrical and Electronics Engineering, University of Alabama, 2013.
48. Emily Bragg, Computer Engineering, Georgia Institute of Technology, 2012.
49. Casey Mackin, Electrical and Computer Engineering, University of Arizona, 2012.

**Committees**

**Doctoral Students**

Mukesh Agrawal (advisor K. Chakrabarty), Sandeep Agrawal (advisor A. Lebeck), Qing Duan (advisor K. Chakrabarty), Rahul Ghosh (advisor K. Trivedi), Yuzhang Han (advisor S. Babu), Blake Hechtman (advisor D. Sorin), Kai Hu (advisor K. Chakrabarty), Mohamed Ibrahim (advisor K. Chakrabarty), Mayuresh Kunjir (advisor S. Babu), Adam Jacobvitz (advisor D. Sorin), Ilija Jovanov (advisor M. Pajic), Craig LaBoda (advisor C. Dwyer), Vuk Lesi (advisor M. Pajic), Opeoluwa Matthws (advisor D. Sorin), Kesari Mishra (advisor K. Trivedi), Mohammed Mottaghi (advisor C. Dwyer), Sean Murray (advisor D. Sorin), Ralph Nathan (advisor D. Sorin), Kent Nixon (advisor Y. Chen), Brandon Noia (advisor K. Chakrabarty), Jun Pang (advisor C. Dwyer), Wubin Pang (advisor D. Brady), Arjun Rallapalli (advisor C. Dwyer), Animesh Srivastava (advisor L. Cox), Xin Song (advisor A. Lebeck), Zilong Tan (advisor S. Babu), Vamsidhar Thummala (advisor J. Chase), Viresh Thusu (advisor C. Dwyer), Bing Xie (advisor J. Chase), Fangming Ye (advisor K. Chakrabarty), Xiaoyan Yin (advisor K. Trivedi), Meng Zhang (advisor D. Sorin), Tong Zhou (advisor K. Chakrabarty)

**Masters Students**

Timothy Calloway (advisor L. Cox), Yifei Deng (advisor S. Babu), Fei Dong (advisor S. Babu), Heather Duschl (advisor C. Dwyer) Alexandru Dutu (advisor A. Lebeck), Zhiqiu Kong (advisor L. Cox), Jie Li (advisor S. Babu), Arpan Roy (advisor K. Trivedi), Benjamin Stoddard (advisor A. Machanavajjhala), Alfredo Velasco (advisor D. Sorin)

**Teaching**

**Duke University, Durham NC**

Professor, Electrical and Computer Engineering, 2010 – present

- Computer Architecture (ECE/CS 250): S18, F15, S14, S13.
- Advanced Computer Architecture I (ECE/CS 552): F17, F16, F12, F11
- Energy-Efficient Computer Systems (ECE/CS 590): F14, S12, F10
- Datacenter Architecture (ECE/CS 590): S16, F13

**Stanford University, Stanford CA**

Guest Instructor, Electrical Engineering, 2009

- Autumn 2009: Advanced Processor Architecture (EE282a).
- Autumn 2009: Digital Systems (EE108b).

**Harvard University, Cambridge MA**

Teaching Fellow, Engineering and Applied Sciences, 2005 – 2008

- Spring 2008: Guest lecture on power modeling, digital sustainability (CS246).
- Fall 2006: Management of innovation in science, engineering (ES139/239).
- Spring 2006: Advanced architecture, power-aware systems (CS246).

- Fall 2005: Introductory computer architecture (CS146), digital logic design (CS141).

**Tutorial: Datacenter system design and management**

Presenter and Co-Organizer

- 11th HiPEAC International Summer School on Advanced Computer Architecture and Compilation for High-Performance and Embedded Systems (ACACES), July 2015.

**Tutorial: Datacenter simulation methodologies**

Presenter and Co-Organizer

- International Symposium on Computer Architecture (ISCA), June 2015.
- International Symposium on Microarchitecture (MICRO), December 2014.
- With Tamara S. Lehman, Qiuyun Wang, Seyed Majid Zahedi.

**Tutorial: Methods of learning and inference for large design and parameter spaces**

Presenter and Co-Organizer

- International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS), March 2008.
- With David Brooks, Bronis de Supinski, Sally McKee, Karan Singh.

**Tutorial: Inference and learning for large scale microarchitectural analysis**

Presenter and Co-Organizer

- International Symposium on Computer Architecture (ISCA), June 2007.
- With David Brooks, Bronis de Supinski, Sally McKee, Karan Singh.

**Professional  
Service**

**Memberships**

IEEE, Institute of Electrical and Electronics Engineers.  
ACM, Association for Computing Machinery.  
SIAM, Society for Industrial and Applied Mathematics.  
AAAS, American Association for the Advancement of Science.

**Conference General Chair**

XPS 2015, Workshop on Exploiting Parallelism & Scalability.  
ISPASS 2015, Int'l. Symp. Perf. Analysis of Systems & Software.

**Conference Program Chair**

ISPASS 2014, Int'l. Symp. Perf. Analysis of Systems & Software.

**Conference Program Committees**

HPCA 2019, Int'l. Symposium on High-Performance Computer Architecture.  
ISCA 2018, Int'l. Symp. Computer Architecture.  
Top Picks 2018, IEEE Micro Top Picks.  
HPCA 2018, Int'l. Symposium on High-Performance Computer Architecture.  
MICRO 2017, Int'l. Symp. on Microarchitecture.  
ISCA 2017, Int'l. Symp. Computer Architecture.  
Top Picks 2017, IEEE Micro Top Picks.  
ASPLOS 2017, Int'l. Conf. Architectural Support...  
HPCA 2017, Int'l. Symposium on High-Performance Computer Architecture.  
Top Picks 2016, IEEE Micro Top Picks.  
DATE 2016, Design and Test in Europe Conf.  
HotPower 2015, Work. on Power-Aware Computing & Systems.  
MICRO 2015, Int'l. Symp. on Microarchitecture.  
HPCA 2015, Int'l. Symposium on High-Performance Computer Architecture.

DATE 2015, Design and Test in Europe Conf.  
HiPEAC 2015, Int'l. Conf. High-Performance Embedded Architectures and Compilers.  
HotPower 2014, Work. on Power-Aware Computing & Systems.  
IISWC 2014, Int'l. Symp. Workload Characterization.  
SIGMETRICS 2014.  
DATE 2014, Design and Test in Europe Conf.  
HiPEAC 2014, Int'l. Conf. High-Performance Embedded Architectures and Compilers.  
MICRO 2013, Int'l. Symp. on Microarchitecture.  
HotPower 2013, Work. on Power-Aware Computing & Systems.  
IISWC 2013, Int'l. Symp. Workload Characterization.  
WEED 2013 (w/ ISCA), Work. on Energy-Efficient Design.  
WDDD 2013 (w/ ISCA), Work. on Duplicating, Deconstructing and Debunking.  
IGCC 2013, Int'l. Green Computing Conference.  
ISPASS 2013, Int'l. Symp. Perf. Analysis of Systems & Software.  
HiPEAC 2013, Int'l. Conf. High-Performance Embedded Architectures and Compilers.  
ICCD 2012, Int'l. Conference on Computer Design.  
WEED 2012 (w/ ISCA), Work. on Energy-Efficient Design.  
WDDD 2012 (w/ ISCA), Work. on Duplicating, Deconstructing and Debunking.  
IGCC 2012, Int'l. Green Computing Conference.  
ISPASS 2012, Int'l. Symp. Perf. Analysis of Systems & Software.  
IPDPS 2012, Int'l. Parallel & Distributed Processing Symposium.  
HPCA 2012, Int'l. Symposium on High-Performance Computer Architecture.  
ICCD 2011, Int'l. Conference on Computer Design.  
MoBS 2011 (w/ ISCA), Work. on Modeling, Benchmarking, Simulation.  
ICS 2011, Int'l. Conf. Supercomputing.  
ICPE 2011, Int'l. Conf. Performance Engineering.  
MoBS 2010, Work. Modeling, Benchmarking, Simulation.  
ISPASS 2010, Int'l. Symp. Perf. Analysis of Systems & Software.  
MoBS 2009 (w/ ISCA), Work. Modeling, Benchmarking, Simulation.  
ISPASS 2009, Int'l Symp. Perf. Analysis of Systems & Software.

#### **Conference Organizing Committees**

MICRO 2012, Int'l. Symp. on Microarchitecture.  
ISCA 2012, Int'l. Symp. on Computer Architecture.  
ICS 2011, Work. on Emerging Supercomputing Technologies.  
ISPASS 2011, Int'l. Symp. Perf. Analysis of Systems & Software.  
WEMT 2010 (w/ ISCA), Work. Emerging Memory Technologies.  
MICRO 2009, Int'l Symp. Microarchitecture.  
WEMT 2009 (w/ ISCA), Work. Emerging Memory Technologies.  
PACT 2009, Int'l Conf. Parallel Arch. & Compilation Techniques.

#### **External Review Committees**

ASPLOS, Int'l. Conf. Arch. Support for Prog. Lang. & Op. Sys.  
HPCA, Int'l. Symp. High Performance Computer Architecture.  
ISCA, Int'l. Symp. Computer Architecture.  
ISLPED, Int'l. Symp. Low Power Electronics and Design.  
ISPASS, Int'l. Symp. Perf. Analysis of Systems & Software.  
MICRO, Int'l. Symp. on Microarchitecture.

#### **Journal Reviews**

ACM Transactions on Architecture and Code Optimization (TACO).  
ACM Transactions on Embedded Computing Systems (TECS).

ACM Transactions on Design Automation of Electronic Systems (TODAES).  
IEEE Transactions on Computers (TC).  
IEEE Transactions on Computer Aided Design (TCAD).  
IEEE Transactions on Parallel and Distributed Systems (TPDS).  
IEEE Transactions on Signal Processing (TSP).  
IEEE Transactions on Very Large Scale Integration Systems (TVLSI).  
IEEE Computer Architecture Letters (CAL).  
IEEE Micro Magazine (Micro).  
Elsevier Parallel Computing.  
Elsevier Sustainable Computing: Informations and Systems.  
International Journal of High Performance Computer Applications.

**Grant Reviews**

National Science Foundation, Computer & Information Science & Engineering, 2017.  
National Science Foundation, Computer & Information Science & Engineering, 2016.  
Research Foundation Flanders, 2015.  
National Science Foundation, Computer & Information Science & Engineering, 2014.  
Department of Energy, Office of Science, Early Career Research Program, 2014.  
Ministry of Education, Singapore Government, 2013.  
National Science Foundation, Computer & Information Science & Engineering, 2013.  
Department of Energy, Office of Science, Small Business Innovation Research, 2012.  
Department of Energy, Office of Science, Small Business Innovation Research, 2011.  
Research Foundation Flanders, 2011.

**Academic  
Service**

**University Service**

Provost's Academic Programs Committee, 2017-20.  
President's Council on Black Affairs, 2016-19.  
University Judicial Board, 2016-18.  
Faculty Diversity Task Force Implementation Committee, 2015-16.

**Department Service**

Lead, Computer Engineering Curricular Group, 2017-18.  
Chair, Faculty Search Committee, 2017-18.  
Chair, Faculty Tenure Committee, 2015-16.  
Chair, Faculty Search Committee, 2015-16.  
Member, Graduate Diversity Committee, 2014-16.  
Member, Business Manager Search Committee, 2012.  
Member, Faculty Search Committee, 2012.