

Nathan Beckmann

Computer Science Department
School of Computer Science
Carnegie Mellon University

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RESEARCH INTERESTS

My research improves the performance and energy-efficiency of future computing systems. I am interested in hardware-software co-design so that systems dynamically and transparently adapt themselves to running applications. My current focus is the memory bottleneck: processors spend an increasing fraction of their time and energy on accessing data, not processing it. My recent work takes two main approaches to reduce data movement: *software-defined caches* reduce the distance between threads and their data; and *analytical performance modeling* helps to better manage cache space.

Research areas: computer systems; computer architecture; operating systems; performance modeling & analysis.

EDUCATION

Massachusetts Institute of Technology Sep 2015

Ph.D., Electrical Engineering and Computer Science.

Thesis: Design and Analysis of Spatially-Partitioned Shared Caches.

Supervisor: Daniel Sanchez.

Massachusetts Institute of Technology Sep 2010

S.M., Electrical Engineering and Computer Science.

Thesis: Distributed Naming in a Factored Operating System.

Supervisor: Anant Agarwal.

University of California, Los Angeles Mar 2008

B.S. Computer Science. *Summa cum Laude.*

B.S. Mathematics of Computation. *Summa cum Laude.*

AWARDS

Google Faculty Research Award 2017

George M. Sprowls Doctoral Thesis Prize 2015

Best doctoral thesis in computer science at MIT.

William A. Martin Memorial Thesis Award 2010

Best master's thesis in computer science at MIT.

UCLA Bachelor of the Year in Computer Science 2008

UCLA Rose Hills Foundation Science and Engineering Scholarship (2×) 2007 & 2008

PROFESSIONAL EXPERIENCE

Carnegie Mellon University Jan 2017 - Present

ASSISTANT PROFESSOR in the Computer Science Department of the School of Computer Science.

Massachusetts Institute of Technology Sep 2015 - Jan 2017

POSTDOC with Prof. Daniel Sanchez; worked on well-behaved, high-performance memory systems for parallel processors.

Massachusetts Institute of Technology Sep 2012 - Sep 2015

RESEARCH ASSISTANT to Prof. Daniel Sanchez; worked on scheduling data across caches in parallel processors.

Massachusetts Institute of Technology Sep 2008 - Sep 2012

RESEARCH ASSISTANT to Profs. Anant Agarwal, Frans Kaashoek, and Nikolai Zeldovich; worked on distributed operating systems (fos project).

NVidia Summer 2007

SOFTWARE INTERN in the embedded division; worked on OpenGL ES 2.0 and optimizing customer applications.

Symantec Research Labs Summers 2005 & 2006

RESEARCH INTERN at Symantec Research Labs; prototyped an early design of an extrusion detection system.

University of California, Los Angeles Sep 2003 - Mar 2008

UNDERGRADUATE RESEARCHER with Profs. Glenn Reinman and Miodrag Potkonjak; worked on cache organization for physics simulation and statistical analysis of sensor networks.

Refereed Journal Publications

Practical Bounds on Offline Caching with Variable Object Sizes POMACS 2018

Daniel Berger, Nathan Beckmann, Mor Harchol-Balter *Journal of SIGMETRICS conference.* Acceptance rate: 16%

Cache Calculus: Modeling Caches through Differential Equations CAL 2016

Nathan Beckmann, Daniel Sanchez

Refereed Conference & Workshop Publications

- Intelligence Beyond the Edge: Inference on Intermittent Embedded Systems** ASPLOS 2019
Graham Gobieski, Brandon Lucia, *Nathan Beckmann* Acceptance rate: 21%
- Improving the Locality of Graph Processing through Hardware-Accelerated Traversal Scheduling** ... MICRO 2018
Anurag Mukkara, *Nathan Beckmann*, Maleen Abeydeera, Xiaosong Ma, Daniel Sanchez Acceptance rate: 21%
- Intermittent Deep Neural Network Inference** SysML 2018
Graham Gobieski, *Nathan Beckmann*, Brandon Lucia Acceptance rate: 57%
- LHD: Improving Cache Hit Rate by Maximizing Hit Density** NSDI 2018
Nathan Beckmann, Haoxian Chen, Asaf Cidon Acceptance rate: 15%
- Cache-Guided Scheduling: Exploiting Caches to Maximize Locality in Graph Processing** AGP at ISCA 2017
Anurag Mukkara, *Nathan Beckmann*, Daniel Sanchez
- Nexus: A New Approach to Replication in Distributed Shared Caches** PACT 2017
Po-An Tsai, *Nathan Beckmann*, Daniel Sanchez Acceptance rate: 23%
- Jenga: Software-Defined Cache Hierarchies** ISCA 2017
Po-An Tsai, *Nathan Beckmann*, Daniel Sanchez Acceptance rate: 17%
- Maximizing Cache Performance Under Uncertainty** HPCA 2017
Nathan Beckmann, Daniel Sanchez Acceptance rate: 22%
- Whirlpool: Improving Cache Management with Application-Level Data Classification** ASPLOS 2016
Anurag Mukkara, *Nathan Beckmann*, Daniel Sanchez Acceptance rate: 22%
- Modeling Cache Performance Beyond LRU** HPCA 2016
Nathan Beckmann, Daniel Sanchez Acceptance rate: 22%
- Technical report: MIT CSAIL, April 2015.
- Rubik: Fast Analytical Power Management for Latency-Critical Systems** MICRO 2015
Harshad Kasture, Davide Bartolini, *Nathan Beckmann*, Daniel Sanchez Acceptance rate: 22%
- Talus: A Simple Way to Remove Cliffs in Cache Performance** HPCA 2015
Nathan Beckmann, Daniel Sanchez Acceptance rate: 22%
- CDCS: Scaling Non-Uniform Cache Architectures with Computation and Data Co-Scheduling** HPCA 2015
Nathan Beckmann, Po-An Tsai, Daniel Sanchez Acceptance rate: 22%
- Jigsaw: Scalable Software-Defined Caches** PACT 2013
Nathan Beckmann, Daniel Sanchez Acceptance rate: 17%
- The Case for Elastic Operating System Services in fos** DAC 2012
Lamia Youseff, *Nathan Beckmann*, Harshad Kasture, Charles Gruenwald III, David Wentzlaff, Anant Agarwal Acceptance rate: 23%
- An Operating System for Multicore and Clouds: Mechanisms and Implementation** SOCC 2010
David Wentzlaff, Charles Gruenwald III, *Nathan Beckmann*, Kevin Modzelewski, Adam Belay, Lamia Youseff, Jason Miller, Anant Agarwal Acceptance rate: 19%
- Technical report: MIT CSAIL, Feb 2010.
- ATAC: Improving Performance and Programmability with On-Chip Optical Networks** ISCAS 2010
James Psota, Jason Miller, George Kurian, Henry Hoffmann, *Nathan Beckmann*, Jonathan Eastep, Anant Agarwal Acceptance rate: 45%
- A Unified Operating System for Clouds and Manycore: fos** CAOS at HiPEAC 2010
David Wentzlaff, Charles Gruenwald III, *Nathan Beckmann*, Kevin Modzelewski, Adam Belay, Lamia Youseff, Jason Miller, Anant Agarwal
Technical report: MIT CSAIL, November 2009.
- Graphite: A Distributed Parallel Simulator for Multicores** HPCA 2010
Jason Miller, Harshad Kasture, George Kurian, Charles Gruenwald III, *Nathan Beckmann*, Christopher Celio, Jonathan Eastep, Anant Agarwal Acceptance rate: 18%
- Technical report: MIT CSAIL, November 2009.
- Hardware-based Public-key Cryptography with Public Physically Unclonable Functions** IH 2009
Nathan Beckmann, Miodrag Potkonjak
- ## ADDITIONAL TECHNICAL REPORTS
- PIKA: A Network Service for Multikernel Operating Systems.** MIT CSAIL, Jan 2014
Nathan Beckmann, Charles Gruenwald III, Charles Johnson, Harshad Kasture, Fillipo Sironi, Anant Agarwal, Frans Kaashoek, Nikolai Zeldovich
- Efficient Cache Coherence on Manycore Optical Networks** MIT CSAIL, Feb 2010
George Kurian, *Nathan Beckmann*, Jason Miller, James Psota, Anant Agarwal
- Core Count vs Cache Size for Manycore Architectures in the Cloud** MIT CSAIL, Feb 2010
David Wentzlaff, *Nathan Beckmann*, Jason Miller, Anant Agarwal

ATAC: A Manycore Processor with On-Chip Optical Network MIT CSAIL, May 2009
Jason Miller, James Psota, George Kurian, *Nathan Beckmann*, Jonathan Eastep, Jifeng Liu, Mark Beals, Jurgen Michel, Lionel Kimerling, Anant Agarwal

POSTERS

Improving Datacenter Efficiency through Partitioning-Aware Scheduling PACT, Sep 2017
Harshad Kasture, Xu Ji, Nosayba El-Sayed, *Nathan Beckmann*, Xiaosong Ma, Daniel Sanchez

Improving Cache Hit Rate by Maximizing Hit Density Parallel Data Lab (PDL) Visit Day, CMU, May 2017
Haoxian Chen, *Nathan Beckmann*, Asaf Cidon

CDCS: Computation and Data Co-Scheduling Cloud Workshop, MIT, 2014
Po-An Tsai, *Nathan Beckmann*, Daniel Sanchez
Best student poster.

Jigsaw: Software-defined Caches MIT CSAIL Industry Affiliate Program, 2013
Nathan Beckmann, Daniel Sanchez

Scalable Applications on a Factored Operating System ASPLOS 2012
Chris Johnson, Charles Gruenwald III, *Nathan Beckmann*, Harshad Kasture, David Wentzlaff, Larry Stewart, Adam Belay, James Ward, Lamia Youseff, Anant Agarwal

Applications on a Factored Operating System EuroSys 2012
Charles Gruenwald III, *Nathan Beckmann*, Harshad Kasture, Chris Johnson, Barry Kasindorf, Larry Stewart, Anant Agarwal

Distributed Parallel Network Stack for Multicore NSDI 2011
Charles Gruenwald III, *Nathan Beckmann*, David Wentzlaff, Harshad Kasture, James Ward, Anant Agarwal

TALKS

Teaching An Old Cache New Tricks: Learning Better Caching Policies Online Google, 19 Sep 2018

LHD: Improving Cache Hit Rate by Maximizing Hit Density PDL Retreat, Bedford Springs, 24 Oct 2017

Maximizing Cache Performance Under Uncertainty HPCA, Austin, 6 Feb 2017

Whirlpool: Improving Dynamic Cache Management with Static Data Classification . ASPLOS, Atlanta, 4 Apr 2016

Hardware and Software Techniques to Scale the Memory Wall Berkeley, 28 Mar 2016

Hardware and Software Techniques to Scale the Memory Wall NYU, 23 Mar 2016

Hardware and Software Techniques to Scale the Memory Wall CMU, 17 Mar 2016

Modeling Cache Performance Beyond LRU HPCA, Barcelona, 14 Mar 2016

Hardware and Software Techniques to Scale the Memory Wall Toronto, 8 Mar 2016

Hardware and Software Techniques to Scale the Memory Wall Stanford, 2 Mar 2016

Talus: A Simple Way to Remove Cliffs in Cache Performance HPCA, San Francisco, 9 Feb 2015

Jigsaw: Scalable Software-Defined Caches PACT, Edinburgh, 11 Sep 2013

PATENTS

Authentication of financial transactions via wireless link US Patent 9177311, Nov 2015
Miodrag Potkonjak, *Nathan Beckmann*

Autonomous, non-interactive, context-based services for cellular phone US Patent 8744429, June 2014
Miodrag Potkonjak, *Nathan Beckmann*

Differential uncloneable variability-based cryptography US Patent 9020150, Jun 2013
Nathan Beckmann, Miodrag Potkonjak

Method and apparatus for efficient token matching using complex rules US Patent 8160989, April 2012
Scott Schneider, *Nathan Beckmann* (at Symantec Research Labs)

Semantic compression US Patent pending (filed Apr 2010)
Nathan Beckmann, Miodrag Potkonjak

TEACHING

15-740 Computer Architecture INSTRUCTOR, CMU, Fall 2018

15-740 Computer Architecture INSTRUCTOR, CMU, Spring 2018

15-740 Computer Architecture INSTRUCTOR, CMU, Spring 2017

6.823 Computer System Architecture TEACHING ASSISTANT, MIT, Spring 2014

SERVICE

Panel member for NSF in 2018.

Program Committee member for MICRO 2017.

External Program Committee member for ISCA 2017, HPCA 2019, ASPLOS 2019.

Reviewer for ACM Trans. on Architecture and Compiler Optimization (TACO), IEEE/ACM Trans. on Networks (TON), NSDI 2019, Eurosys 2017, HPCA 2016, MICRO 2015, HPCA 2015, MICRO 2014, PACT 2014, and MICRO 2013.

Organizer of ZSim tutorial at MICRO 2015 and Graphite tutorial at ISCA 2011.

Major open-source contributor to both ZSim and Graphite.

STUDENTS

Axel Feldmann (B.S.) Fall 2017 - present
Amolak Nagi (B.S.) Fall 2017 - present
Abhinit Modi (M.S.) Fall 2017 - Spring 2018
Graham Gobieski (Ph.D.) Fall 2017 - present
Brian Schwedock (Ph.D.) Fall 2017 - present
Elliot Lockerman (Ph.D.) Summer 2017 - present
Haoxian Chen (Ph.D.) Fall 2016 - Summer 2017

PERSONAL

Background: Born 1986 in Boulder, CO. Raised in Los Angeles, CA. *Citizenship:* United States of America.

Last updated on November 7, 2018.