

Nathan Beckmann

Computer Science Department
School of Computer Science
Carnegie Mellon University

Gates-Hillman Center #9021
4902 Forbes Ave
Pittsburg PA 15213

(412) 268-7412
beckmann@cs.cmu.edu
nathanbeckmann.com

RESEARCH INTERESTS

I am interested in improving the energy-efficiency of computer systems. Specifically, my research addresses the data bottleneck: computers spend most of their energy accessing data, not processing it. My research designs new, data-centric systems that dramatically reduce the cost of accessing data. This research spans many topics, including computer systems, computer architecture, programming models, operating systems, storage, and 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 Research Scholar Award 2021
Best Paper at APoCS 2020
NSF CAREER Award 2019
Google Faculty Research Award 2019
Google Faculty Research Award 2017
George M. Spowls 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 Nickolai 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 (*Journal of SIGMETRICS*) POMACS 2018
Daniel Berger, Nathan Beckmann, Mor Harchol-Balter Acceptance rate: 16%

Cache Calculus: Modeling Caches through Differential Equations CAL 2016
Nathan Beckmann, Daniel Sanchez

REFEREED CONFERENCE & WORKSHOP PUBLICATIONS

Brief Announcement: Block-Granularity-Aware Caching	SPAA 2021
<i>Nathan Beckmann, Phillip Gibbons, Charles McGuffey</i>	Acceptance rate: ??%
SNAFU: An Ultra-Low-Power, Energy-Minimal CGRA-Generation Framework and Architecture	ISCA 2021
Graham Gobieski, Oguz Atli, Ken Mai, Brandon Lucia, <i>Nathan Beckmann</i>	Acceptance rate: 19%
The Role of Edge Offload in Hardware-Accelerated Mobile Devices	HotMobile 2021
Mahadev Satyanarayanan, <i>Nathan Beckmann</i> , Grace A. Lewis, Brandon Lucia	Acceptance rate: 36%
The CacheLib Caching Engine: Design and Experiences at Scale	OSDI 2020
Benjamin Berg, Daniel S. Berger, Sara McAllister, Isaac Grosf, Sathya Gunasekar, Jimmy Lu, Michael Uhlar, Jim Carrig, <i>Nathan Beckmann</i> , Mor Harchol-Balter, Gregory R. Ganger	Acceptance rate: 18%
Jumanji: The Case for Dynamic NUCA in the Datacenter	MICRO 2020
Brian Schwedock, <i>Nathan Beckmann</i>	Acceptance rate: 19%
Tvarak: Software-Managed Hardware Offload for DAX NVM Storage Redundancy	ISCA 2020
Rajat Kateja, <i>Nathan Beckmann</i> , Greg Ganger	Acceptance rate: 18%
Livia: Data-Centric Computing Throughout the Memory Hierarchy	ASPLOS 2020
Elliot Lockerman, Axel Feldmann, Mohammad Bakhshalipour, Alex Stanescu, Shashwat Gupta, Daniel Sanchez, <i>Nathan Beckmann</i>	Acceptance rate: 18%
Writeback-Aware Caching	APoCS 2020 (Best Paper)
<i>Nathan Beckmann, Phillip Gibbons, Bernhard Haeupler, Charles McGuffey</i>	Acceptance rate: 60%
MANIC: An Energy-Efficient Architecture for Ultra-Low-Power Embedded Systems	MICRO 2019
Graham Gobieski, Amolak Nagi, Nathan Serafin, Mehmet Meric Isgenc, <i>Nathan Beckmann</i> , Brandon Lucia	Acceptance rate: 23%
PHI: Architectural Support for Synchronization- and Bandwidth-Efficient Commutative Scatter Updates	MICRO 2019
.....	Acceptance rate: 23%
Anurag Mukkara, <i>Nathan Beckmann</i> , Daniel Sanchez	Acceptance rate: 23%
Brief Announcement: Writeback-Aware Caching	SPAA 2019
<i>Nathan Beckmann, Phillip Gibbons, Bernhard Haeupler, Charles McGuffey</i>	Acceptance rate: 40%
Intelligence Beyond the Edge: Inference on Intermittent Embedded Systems	ASPLOS 2019
Graham Gobieski, Brandon Lucia, <i>Nathan Beckmann</i>	Acceptance rate: 21%
Improving the Locality of Graph Processing through Hardware-Accelerated Traversal Scheduling ...	MICRO 2018
Anurag Mukkara, <i>Nathan Beckmann</i> , Maleen Abeydeera, Xiaosong Ma, Daniel Sanchez	Acceptance rate: 21%
Intermittent Deep Neural Network Inference	SysML 2018
Graham Gobieski, <i>Nathan Beckmann</i> , Brandon Lucia	Acceptance rate: 57%
LHD: Improving Cache Hit Rate by Maximizing Hit Density	NSDI 2018
<i>Nathan Beckmann, Haoxian Chen, Asaf Cidon</i>	Acceptance rate: 15%
Cache-Guided Scheduling: Exploiting Caches to Maximize Locality in Graph Processing	AGP at ISCA 2017
Anurag Mukkara, <i>Nathan Beckmann</i> , Daniel Sanchez	
Nexus: A New Approach to Replication in Distributed Shared Caches	PACT 2017
Po-An Tsai, <i>Nathan Beckmann</i> , Daniel Sanchez	Acceptance rate: 23%
Jenga: Software-Defined Cache Hierarchies	ISCA 2017
Po-An Tsai, <i>Nathan Beckmann</i> , Daniel Sanchez	Acceptance rate: 17%
Maximizing Cache Performance Under Uncertainty	HPCA 2017
<i>Nathan Beckmann, Daniel Sanchez</i>	Acceptance rate: 22%
Whirlpool: Improving Cache Management with Application-Level Data Classification	ASPLOS 2016
Anurag Mukkara, <i>Nathan Beckmann</i> , Daniel Sanchez	Acceptance rate: 22%
Modeling Cache Performance Beyond LRU	HPCA 2016
<i>Nathan Beckmann, Daniel Sanchez</i>	Acceptance rate: 22%
Technical report: MIT CSAIL, April 2015.	
Rubik: Fast Analytical Power Management for Latency-Critical Systems	MICRO 2015
Harshad Kasture, Davide Bartolini, <i>Nathan Beckmann</i> , Daniel Sanchez	Acceptance rate: 22%
Talus: A Simple Way to Remove Cliffs in Cache Performance	HPCA 2015
<i>Nathan Beckmann, Daniel Sanchez</i>	Acceptance rate: 22%
CDCS: Scaling Non-Uniform Cache Architectures with Computation and Data Co-Scheduling	HPCA 2015
<i>Nathan Beckmann, Po-An Tsai, Daniel Sanchez</i>	Acceptance rate: 22%
Jigsaw: Scalable Software-Defined Caches	PACT 2013
<i>Nathan Beckmann, Daniel Sanchez</i>	Acceptance rate: 17%
The Case for Elastic Operating System Services in fos	DAC 2012
Lamia Youseff, <i>Nathan Beckmann</i> , 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 .. Information Hiding 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, Nickolai 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

OTHER WRITING

The Case for a Programmable Memory Hierarchy SIGARCH blog, 5 Apr 2021

TALKS

Making Data Access Faster and Cheaper via Ubiquitous Flash Caching Google, 6 Apr 2021

Overview of Caching Research at the Parallel Data Lab Cache@Scale, 4 Mar 2021

Practical Bounds on Offline Caching with Variable Object Sizes PMHO @ PPOPP, 28 Feb 2021

Tvarak: Software-Managed Hardware Offload for DAX NVM Storage Redundancy ISCA, 2 Jun 2020

The Case for a Richer Memory Interface Memory Systems Panel @ ISCA, 2 Jun 2020

Pushing the Limits of Online and Offline Caching U. Rochester, 2 Dec 2019

Teaching An Old Cache New Tricks: Learning Better Caching Policies Online ML for Systems @ ISCA, 23 Jun 2019

Intelligence Beyond the Edge: Inference on Intermittent Embedded Systems Stanford, 1 May 2019

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

15-418 Parallel Computer Architecture and Programming INSTRUCTOR, CMU, Spring 2021

15-740 Computer Architecture INSTRUCTOR, CMU, Fall 2020

15-418 Parallel Computer Architecture and Programming INSTRUCTOR, CMU, Spring 2020

15-740 Computer Architecture INSTRUCTOR, CMU, Fall 2019

15-418 Parallel Computer Architecture and Programming INSTRUCTOR, CMU, Spring 2019

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 and 2019.

Program Committee member for FAST 2022, HPCA 2022, MICRO 2021, ISCA 2021, MICRO 2020, ISCA 2020, MICRO 2019, ISCA 2019, and MICRO 2017.

External Program Committee member for ISPASS 2020, HPCA 2019, ASPLOS 2019, and ISCA 2017.

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

Nathan Serafin (Ph.D.) Fall 2020 - present

Sara McAllister (Ph.D.) Fall 2019 - present

Mohammad Bakhshalipour (Ph.D.) Fall 2019 - Spring 2020

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.