Tyler Sorensen – CV

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Research Summary

My research interests are in enabling efficient and reliable applications to be developed and executed on current and near-future systems (e.g. heterogeneous architectures). I am interested in a three step approach: *modeling* the semantics of underspecified areas of the system (e.g. operational/axiomatic semantic modeling), *validating* the semantics (e.g. empirical testing, model checking), and *developing* more efficient and reliable applications using the new understanding of the system (e.g. auto-tuning, domain-specific languages).

Current Position

July 2020 - Present — UC Santa Cruz: Department of Computer Science and Engineering
Assistant Professor

June 2023 - Present — Trail of Bits
Security Researcher

Professional Memberships

July 2019 - Present — Khronos Group
Invited Individual Contributor

Prior Positions

July 2018 - June 2020 — Princeton University: Department of Computer Science
Postdoctoral research associate
Supervisor: Margaret Martonosi

Education

Fall 2014- Fall 2018 — PhD in Computer Science - Imperial College London, UK
Thesis: *Device-wide Barrier Synchronisation on Graphics Processing Units*
Supervisor: Alastair F. Donaldson

Fall 2013 - Spring 2014 — MS in Computer Science - University of Utah, USA
Thesis: *Testing and Exposing Weak GPU Memory Models*
Supervisor: Ganesh Gopalakrishnan

Fall 2010 - Spring 2012 — BS in Computer Science - University of Utah, USA
Thesis: *Towards Shared Memory Consistency Models for GPUs*
Supervisor: Ganesh Gopalakrishnan

Fall 2010 - Spring 2012 — BS in Applied Mathematics - University of Utah, USA

Fall 2008 - Spring 2010 — AA with engineering emphasis - Snow College (community college), USA

Publications

Conference Publications

[1] R. Levine, M. Cho, D. McKee, A. Quinn, T. Sorensen "GPUHarbor: Testing GPU Memory Consistency at Large (Experience Paper)". In: ISSTA 2023. **Distinguished artifact award**. **ISSTA** 2023

[2] Y. Xu, A. Li, T. Sorensen "Redwood: Flexible and Portable Heterogeneous Tree Traversal Workloads". In: ISPASS 2023. **ISPASS** 2023

[3] R. Levine, T. Guo, M. Cho, A. Baker, R. Levien, D. Neto, A. Quinn, T. Sorensen "MC Mutants: Evaluating and Improving Testing for Memory Consistency Specifications". In: ASPLOS 2023. **Distinguished paper award**. **Distinguished artifact award**. **Distinguished paper award**. **ASPLOS** 2023

[4] T. Sorensen, L. F. Salvador, H. Raval, H. Evrard, J. Wickerson, M. Martonosi, A. F. Donaldson "Specifying and Testing GPU Progress Models". In: OOPLSA 2021. **OOPSLA** 2021

[5] D. Iorga, A. F. Donaldson, T. Sorensen, J Ẇickerson "The Semantics of Shared Memory in Intel CPU/FPGA Systems". In: OOPLSA 2021. **OOPSLA** 2021

[6] A. Manocha, T. Sorensen, E. Tureci, O. Mathews, J. L. Aragón, M. Martonosi "GraphAttack: Optimizing Data Supply for Graph Applications on In-Order Multicore Architectures". In: TACO 2021. **TACO** 2021

[7] Jake Kirkham, Tyler Sorensen, Esin Tureci, Margaret Martonosi. "Foundations of Empirical Memory Consistency Testing". In: *Object Oriented Programming Systems Languages and Applications (OOPLSA)*. 2020. **OOPSLA** 2020

[8] Dan Iorga, Tyler Sorensen, John Wickerson, Alastair F. Donaldson. "Slow and Steady: Measuring and Tuning Multicore Interference". In: *Real-Time and Embedded Technology and Applications Symposium (RTSS)*. 2020. **RTSS** 2020

[9] Opeoluwa Matthews, Aninda Manocha, Davide Giri, Marcelo Orenes-Vera, Esin Tureci, Tyler Sorensen, Tae Jun Ham, Juan L. Aragon, Luca P. Carloni, Margaret Martonosi. "MosaicSim: A Lightweight, Modular Simulator for Heterogeneous Systems". In: *Int. Symp. on Performance Analysis of Systems and Software (ISPASS)*. 2020. **Best paper nomination**. **ISPASS** 2020

[10] Tyler Sorensen, Sreepathi Pai, Alastair F. Donaldson. "One Size Doesnt Fit All: Quantifying Performance Portability of Graph Applications on GPUs". In: *Int. Symp. on Workload Characterization (IISWC)*. 2019. **Best paper award**. **IISWC** 2019

[11] Tyler Sorensen, Hugues Evrard, Alastair F. Donaldson. "GPU Schedulers: How Fair is Fair Enough?". In: *Int. Conf. on Concurrency Theory (CONCUR)*. 2018. **CONCUR** 2018

[12] Nathan Chong, Tyler Sorensen, John Wickerson. "The Semantics of Transactions and Weak Memory in x86, Power, ARM, and C++". In: *ACM Conf. on Programming Language Design and Implementation (PLDI)*. 2018. **Artifact evaluated and accepted**. **Industry collaboration (Nathan Chong at ARM)**. **Distinguished paper award**. **PLDI** 2018

[13] Tyler Sorensen, Hugues Evrard, Alastair F. Donaldson. "Cooperative Kernels: GPU Multitasking for Blocking Algorithms". In: *ACM Symp. on The Foundations of Software Engineering*. 2017. **Distinguished paper award**. **FSE** 2017

[14] John Wickerson, Mark Batty, Tyler Sorensen, George A. Constantinides. "Automatically Comparing Memory Consistency Models". In: *ACM Symp. on Principles of Programming Languages (POPL)*. 2017. **Artifact evaluated and accepted. Methodology used by Industry in defining the Vulkan GPU memory consistency model.** — **POPL** 2017

[15] Tyler Sorensen, Alastair F. Donaldson, Mark Batty, Ganesh Gopalakrishnan, Zvonimir Rakamarič. "Portable Inter-workgroup Barrier Synchronisation for GPUs". In: *ACM Conf. on Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA)*. 2016. **Artifact evaluated and accepted.** — **OOPSLA** 2016

[16] Tyler Sorensen, Alastair F. Donaldson. "Exposing Errors Related to Weak Memory in GPU Applications". In: *ACM Conf. on Programming Language Design and Implementation (PLDI)*. 2016. — **PLDI** 2016

[17] Jade Alglave, Mark Batty, Alastair F. Donaldson, Ganesh Gopalakrishnan, Jeroen Ketema, Daniel Poetzl, Tyler Sorensen, John Wickerson. "GPU Concurrency: Weak Behaviours and Programming Assumptions". In: *Int. Conf. on Architectural Support for Programming Languages and Operating Systems (ASPLOS)*. 2015. **HiPEAC Paper Award. Invited for fast-track submission to ACM Transactions on Computer Systems.** — **ASPLOS** 2015

Workshop/Other Publications (Peer reviewed)

[18] Tyler Sorensen, Aninda Manocha, Marcelo Orenes-Vera, Esin Tureci, Juan L. Aragon, Margaret Martonosi. "A Simulator and Compiler Framework for Agile Hardware-Software Co-design Evaluation and Exploration: Invited Talk". In: *Int. Conf. on Computer-Aided Design (ICCAD)*. 2020. — **ICCAD** 2020

[19] Tyler Sorensen, Sreepathi Pai, Alastair F. Donaldson. "Performance Evaluation of OpenCL Standard Support (and Beyond)". In *Int. Workshop on OpenCL (IWOCL)*. 2016. **Best paper award.** — **IWOCL** 2019

[20] Tyler Sorensen, Alastair F. Donaldson. "The Hitchhiker's Guide to Cross-platform OpenCL Application Development". In *Int. Workshop on OpenCL (IWOCL)*. 2016. — **IWOCL** 2016

[21] Jade Alglave, Luc Maranget, Daniel Poetzl, Tyler Sorensen. "I Compute, Therefore I am (Buggy): Methodic Doubt Meets Multiprocessors". In *Tiny Transactions on Computer Science Volume 3 (Tiny ToCS)*. 2015. — **TinyToCS** 2015

[22] Tyler Sorensen, Ganesh Gopalakrishnan, Vinod Grover. "Towards Shared Memory Consistency Models for GPUs". In *Int. Conf. on Supercomputing (ICS)*. 2013. **1st place ACM undergrad student research competition (SRC).** — **ICS** A 2013

Professional Service

Conference and workshops

Year	Venue or Organization	Role
2024	ASPLOS	Program committee vice chair
2024	PLDI	Program committee (PC)
2024	DoD	Reviewer for NDSEG fellowship
2023	IA^3 (at SC)	Program committee (PC)
2023	NSF	Proposal panelist
2023	NSF	Proposal panelist
2022	PACT	Program committee (PC)
2022	IA^3 (at SC)	Program committee (PC)
2022	PLDI	SRC co-chair
2021	MICRO	External program committee (ERC)
2021	PLDI	SRC co-chair
2021	IA^3 (at SC)	Program committee (PC)
2021	ASPLOS	External program committee (ERC)
2020	FORTE	Program committee (PC)
2020	OOPLSA	External program committee (ERC)
2020	MICRO	External program committee (ERC)
2020	ASPLOS	External program committee (ERC)
2020	PLDI	Program committee (PC)
2019	ISCA	External review committee (ERC)
2018	PLDI	External review committee (ERC)
2018	ECOOP	Program committee for doctorial symposium (PC for DS)
2016	ASPLOS	Sub-reviewer
2016	TinyToCS	Program committee (PC)
2016	POPL	Artifact evaluation committee (AEC)
2014	POPP	Sub-reviewer

Journals

Year	Venue	Role
2018	Formal Methods in System Design (FMSD)	Article reviewer
2018	ACM Trans. on Arch. and Code Optimization (TACO)	Article reviewer
2014	ACM Trans. on Prog. Lang. and Systems (TOPLAS)	Sub-reviewer

Invited Talks and Panels

Industry

- Accelerating Graph Applications on Parallel Heterogeneous Architectures
  - Oct., 2020: Princeton ACM / IEEE Computer Society Meeting, Princeton NJ
- Reasoning about Heterogeneous Computing, Starting with GPGPU Programming
  - Sept., 2020: Apple, Cupertino, CA
- Cooperative Kernels: GPU Multitasking for Blocking Algorithms (extended FSE'17 talk)
  - Feb., 2017: ARM Cambridge, UK
- Portable Inter-workgroup Barrier Synchronisation for GPUs (extended OOPSLA'16 talk)
  - May, 2016: AMD Bellevue, WA

Academic

- Heterogeneous Synchronization: Polishing Hammers and Finding New Nails
  - Feb, 2024: Invited talk at University of Utah, UT, USA
  - April, 2023: Invited talk at North Carolina State University, NC, USA
- IAˆ3 Debate: Programming Abstractions VS. High-performance
  - Nov, 2019: IAˆ3 at SC'19, CO, USA
- Reasoning about Heterogeneous Computing
  - April, 2019: Lehigh University, PA, USA
- GPU Concurrency: The Wild West of Programming (PhD Talk):
  - June, 2018: University of Utah, UT, USA
  - Sept., 2018: TU Darmstadt, Germany
  - March, 2018: University of Glasgow, UK
- Exposing Errors Related to Weak Memory in GPU Applications (extended PLDI'16 talk)
  - Nov., 2016: University College London, UK
  - Oct., 2015: University of Kent, UK

Awards, Press and Recognition

Winter 2024	GPU machine learning result written about in WIRED: `https://www.wired.com/story/leftoverlocals-gpu-vulnerability-generative-ai/`
Summer 2023	Distinguished artifact award (ISSTA 2023)
Spring 2023	Distinguished artifact award (ASPLOS 2023)
Spring 2023	Distinguished paper award (ASPLOS 2023)
Fall 2020	Contributions to GPU forward progress models mentioned in blog: `https://raphlinus.github.io/gpu/2020/04/30/prefix-sum.html`
Fall 2020	GPU testing found a bug and led to an official patch in Intel OpenCL compilers

https://github.com/intel/intel-graphics-compiler/commit/1c6b78c8b02d7383a1b12bc2323c9bf56380a72c

Fall 2020 Distinguished paper nomination – Int. Symp. on Perf. Analysis of Systems & Software (ISPASS). 2020

Fall 2019 Distinguished paper award – Int. Workshop on OpenCL (IWOCL) 2019

Fall 2019 Distinguished paper award – Int. Symp. on Workload Characterization (IISWC) 2019

Summer 2018 Distinguished paper award – Programming Language Design and Implementation (PLDI) 2018

Summer 2017 Distinguished paper award – Foundations of Software Engineering (FSE) 2017

Fall 2016 Art of research staff pick award – Imperial College
http://multicore.doc.ic.ac.uk/projects/artofresearch

Fall 2015 GPU testing led to errata entry for textbook: *CUDA by Example*
https://developer.nvidia.com/cuda-example-errata-page

Fall 2015 GPU testing contributions mentioned in LWN article
Axiomatic validation of memory barriers and atomic instructions
https://lwn.net/Articles/608550/

Spring 2014 Outstanding graduating senior award – University of Utah

Spring 2014 List of 40 outstanding alumni under 40 – Snow College

Fall 2013 Top 5 in undergraduate researcher competition – Computing Research Association (CRA)

Summer 2013 1st place ACM undergrad student research competition – Int. Conf. on Supercomputing (ICS)

Fall 2012 1st place team super computing student cluster competition - Super Computing (SC)

Fall 2012 2nd place at local ACM fall programming competition – Brigham Young University (BYU)

Spring 2012 1st place at local ACM spring programming competition – Brigham Young University (BYU)

Spring 2011 Honorable mention in the Microsoft Imagine Cup game design competition

Teaching

Classes

Unless explicitly mentioned, all classes taught are at UCSC

- CSE 211: Advanced Compiler Design, Fall 2020, 2021, 2022, 2023
- CSE 113: Concurrent and Parallel Programming, Spring 2021, Winter, 2022, 2023, 2024
- CSE 110A: Fundamentals of Compiler Design, Spring 2022, 2023, 2024

Student Supervision

Current Students

Name	Starting Year	Program	Topic
Rithik Sharma	2022	PhD	Compiler Techniques for Heterogeneous Systems
Jessica Dagostini (co-advised)	2022	PhD	Graph Applications in HPC
Yanwen Xu	2020	PhD	HW/SW Co-design for Sparse Apps
Reese Levine	2020	PhD	Testing Consistency Models
Devon Mckee	2022	PhD	Synchronization cost on GPUs
Zheyuan Chen	2022	MS	Heterogeneous tree optimizations
Sanya Srivastava	2021	MS	Heterogeneous memory models
Albert Lee	2022	UG	Fuzzing WebGPU compilers for security

Grants

Funding

- **Formally Specifying GPU Scheduling Properties in the WebGPU Programming Specification**
  June. 2022 - June 2023
  Google: $60K
  Main PI
  Current
  We are investigating about how GPU forward progress properties can be formall specified, giving special attention to barriers and warps.

- **Collaborative Research**: **Open Process Models Optimizing Self Regulated Learning in the Classroom**
  Co-PI
  Aug. 2023 - July 2025
  NSF: $850K (total)
  $250K for PI Sorensen
  This project develops tools to aid self-regulated learning exercises (e.g., educational games) as applied in a classroom setting. The emphasis is on parallel programming class material at the university level.

- **CAREER**: **Composable Memory Consistency Models for Heterogeneous Systems**
  Aug. 2023 - July 2028
  NSF: $550K
  Main PI
  Current
  This project proposes a modular and composable framework for specifying heterogeneous memory consistency models. The project covers specification, testing, and application use cases. The educational component of this work utilizes new GPGPU frameworks to provide equitable GPGPU education.

- **Investigating the Potential for Undefined Code as an Attack Vector in WebGPU Platforms**
  June. 2022 - June 2023
  Google: $60K
  Main PI
  Current
  We are investigating if undefined behavior can be used as an attack vector in WebGPU using fuzzed wgsl kernels along with a novel undefined behavior injector.

- **DECADES**: **Deeply-Customized Accelerator-Oriented Data Supply Systems (phase 3)**
  Sept. 2021 - June 2023
  DARPA: $154K

subcontract; main PI is Prof. David Wentzlaff at Princeton University
Current
This project is developing hardware/software co-design features to increase computational efficiency of data science applications, e.g. graph traversals and tree applications.

- **DECADES: Deeply-Customized Accelerator-Oriented Data Supply Systems (phase 2)**
July. 2021 - Oct 2021
DARPA: $26K
subcontract; main PI is Prof. David Wentzlaff at Princeton University
Finished
Characterized several scientific and data intensive application to understand if they would be good candidates to accelerate on the new architecture being developed as part of the DECADES program.

- **WebGPU Memory Model Consistency Testing**
July. 2021 - Oct 2021
Google: $20K
Main PI
Finished
We developed a web application for testing the memory consistency of GPUs executing in the new WebGPU framework. We proposed a set of tests for the official WebGPU conformance test suite.

Internships

Spring 2017 Microsoft Research – *RiSE group*
Mentors: Todd Mytkowicz, Madan Musuvathi, Saeed Maleki
Project: a parallel algorithm for DNNs that preserves sequential semantics

Spring 2016 Microsoft – *Speech decoding product group*
Mentors: Veljko Miljanic, Hosam Khalil, Madan Musuvathi
Project: practical parallel speech decoding for product (Cortana backend)
Impact: several contributions accepted to main production branch

Smr 2014/13 Nvidia – *Compiler group*
Mentor: Vinod Grover
Project: Contributed to internal shared memory consistency model