Willow M. **Ahrens**

Research Assistant · Compilers, Data Structures, Algorithms

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Education

Massachusetts Institute of Technology — *Cambridge, MA*

Ph.D. Computer Science, GPA: 4.9 / 5.0, Advisor: Saman Amarasinghe — *Sep. 2016 - Present*

- Collaborated on intermediate languages, cost models, compiler passes, and algorithms for state-of-the-art research projects.
- Published 6 papers in top-tier conferences and journals, including PLDI and TOMS.
- Presented at 15+ conferences, workshops, and research groups in academia and industry.
- Advised 4 undergraduates and 2 masters students. Proposed projects and provided weekly feedback. One student published in SPAA.
- Developed Finch.jl programming language and compiler for sparse and structured arrays.
- Discoved compiler algorithms to automatically adapt programs to input properties.

University of California, Berkeley — *Berkeley, CA*

BS in EECS, Minor in Math, GPA: 3.8 / 4.0 — *Sep. 2012 - May 2016*

Selected Publications

Looplets: A Language for Structured Coiteration. — *CGO 2023*

W. Ahrens, D. Donenfeld, F. Kjolstad, and S. Amarasinghe. — *Feb. 2023*

- Published in Proceedings of the 21st ACM/IEEE International Symposium on Code Generation and Optimization, in CGO 2023.
- Built the core language and compiler behind Finch tensor tensor compiler. Finch is the first compiler to support convolution over sparse arrays, as well as worst-case optimal joins and variable-width block formats.

Autoscheduling For Sparse Tensor Algebra With An Asymptotic Cost Model. — *PLDI 2022*

W. Ahrens, F. Kjolstad, and S. Amarasinghe. — *Jun. 2022*

- Published in Proceedings of the 43rd ACM SIGPLAN International Conference on Programming Language Design and Implementation.
- Discovered an asymptotic notation for the runtime of sparse tensor programs.
- Built the first asymptotic autoscheduler for sparse tensor compilers.

Algorithms for Efficient Reproducible Floating Point Summation. — *ACM Trans. Math. Softw.*

W. Ahrens, J. Demmel, and H. D. Nguyen. — *Jul. 2020*

- Published in ACM Transactions on Mathematical Software, vol. 46, no. 3, p. 22:1-22:49, Jul. 2020.

Tensor Algebra Compilation with Workspaces. — *CGO 2019*

F. Kjolstad, W. Ahrens, S. Kamil, and S. Amarasinghe. — *2019*

- Published in 2019 IEEE/ACM International Symposium on Code Generation and Optimization (CGO), 2019, pp. 180-192.

A Fill Estimation Algorithm for Sparse Matrices and Tensors in Blocked Formats. — *IPDPS 2018*

W. Ahrens, H. Xu, and N. Schiefer. — *2018*

- Published in 2018 IEEE International Parallel and Distributed Processing Symposium (IPDPS), 2018, pp. 546-556.

Brief Announcement: Sparse Tensor Transpositions. — *SPAA 2020*

S. Mueller, W. Ahrens, S. Chou, F. Kjolstad, and S. Amarasinghe. — *2020*

- Published in Proceedings of the 32nd ACM Symposium on Parallelism in Algorithms and Architectures (SPAA), 2020, pp. 559-561.

Teaching

MIT Course 6.1200 (Mathematics For Computer Science) — *Boston, MA*

Teaching Assistant — *Sep 2022 - Dec 2022*

- Taught 6.1200 (formally 6.042), a proof-based course designed to teach the fundamentals of algorithmic thinking in computer science, with attention given to concepts such as induction, asymptotic analysis, graphs, and probability.
- Led two discussion sections with 30 students each, covering example problems and their solutions.
- With 2 other TAs, staffed the last in-person office hours before homework was due each week, with attendance regularly exceeding 40 students requesting individual attention.

MIT Glass Lab *Cambridge, MA*

Glassblowing Instructor *Feb 2019 – Present*

- Supervised pairs of beginner students one at a time for weekly two-hour sessions.
- Ensured student safety in their first experiences with handling 2400 °F glass in a crowded hot shop.
- Explained critical techniques in glassblowing, including gathering, marvering, blocking, and blowing.

Honors, Awards, & Committees

2023	**Program Committee**, DRAGSTERS (Distributions, Relational Algebra, Graphs, Semi-Rings, Tensors, and All That), PLDI	*Orlando, FL*
2017-2021	**CSGF Fellow**, DOE Computational Science Graduate Fellow	*Washington, D.C.*
2016	**Warren Y. Dere Design Award**, UC Berkeley	*Berkeley, CA*

Presentation

2023	**"Sparse Compilers, Sparse Benchmarks"**, Sparse BLAS Workshop 2023, University of Tennessee	*Knoxville, TN*
2023	**"Exploring the Design Space of Sparsity Through Compilers"**, The Sparse Rooflines Group	*Virtual*
2023	**"Exploring the Design Space of Sparsity Through Compilers"**, RelationalAI Virtual Talk	*Virtual*
2023	**"Finch: A Compiler for Sparse and Structured Data"**, Stanford University	*Stanford, CA*
2023	**"Finch: A Compiler for Sparse and Structured Data"**, Lawrence Berkeley National Lab	*Berkeley, CA*
2023	**"Finch: A Compiler for Sparse and Structured Data"**, University of Washington PLSE Group	*Seattle, WA*
2022	**"An Asymptotic Cost Model for Autoscheduling Sparse Tensor Programs"**, ADA Symposium	*Ann Arbor, Michigan*
2021	**"Contiguous Partitioning: Registers, Caches, and Distributed Memories"**, DOE CSGF Review	*Washington, D.C.*
2021	**"On Optimal Partitioning for Variable Block Row Format"**, MIT CRIBB Seminar	*Cambridge, MA*
2018	**"The Tensor Algebra Compiler (taco)"**, CSAIL Alliances Annual Meeting	*Cambridge, MA*
2018	**"For-Loops 2.0: Index Notation And The Future Of Array Compilers"**, JuliaCon 2018	*London, UK*

Reviewing

2022	**Reviewer**, Parallel Computing	*N/A*
2020	**Reviewer**, IEEE Transactions on Computers	*N/A*
2020	**Reviewer**, IEEE Transactions on Computers	*N/A*
2019	**Reviewer**, IEEE Transactions on Computers	*N/A*
2021	**Reviewer**, IEEE Transactions on Parallel and Distributed Systems	*N/A*
2020	**Reviewer**, IEEE Transactions on Parallel and Distributed Systems	*N/A*
2019	**Reviewer**, IEEE Transactions on Parallel and Distributed Systems	*N/A*

Experience

2022 NSF I-Corps Fall Cohort #2 - South Regional Node Program *Virtual*

Entrepreneurial Lead *Aug. 2022 - Nov. 2022*

- Interviewed 100 potential customers to validate the market for tensor algebra compilers.

Sandia National Laboratory *Albuquerque, NM*

CSGF Practicum Intern, Supervisor: Erik Boman *May 2019 – Aug 2019*

- Discovered algorithms to reorganize sparse matrix nonzeros into dense blocks. Proposed the 1D-VBR sparse matrix format. Julia.

Los Alamos National Laboratory *Los Alamos, NM*

Research Intern, Supervisor: Hai Ah Nam *May 2016 – Aug 2016*

- Parallelized a coupled cluster doubles nuclear quantum physics simulation to run on Wolf cluster. C++/MPI.