

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.
- Discovered 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

GLASSBLOWING INSTRUCTOR

- 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.

Cambridge, MA

Feb 2019 – Present

Honors

2017-2021 **CSGF Fellow**, DOE Computational Science Graduate Fellow

Washington, D.C.

2016 **Warren Y. Dere Design Award**, UC Berkeley

Berkeley, CA

Presentations

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|------|---|---------------------|
| 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 |

Service

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| 2022-2024 | Organizer , Sparse Roofline Benchmark Working Group, a multi-university collaboration to standardize benchmarking of sparse linear algebra | Virtual |
| 2022-2024 | Editor , GraphBLAS BinSparse Binary Sparse File Format Standards Committee | Virtual |
| 2023 | Program Committee , DRAGSTERS (Distributions, Relational Algebra, Graphs, Semi-Rings, Tensors, and All That), PLDI | Orlando, FL |
| 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.