# Michael Wilkins

HPC/AI Researcher

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## EDUCATION

**Ph.D. Computer Engineering** 2023
Northwestern University

**M.S. Computer Engineering** 2021
Northwestern University

**B.S. Computer Engineering** 2019
Rose-Hulman Institute of Technology

## SKILLS

- **Software/Scripting Languages:** C, C++, Python, Standard/Parallel ML, C#, LabVIEW, Java, SQL, Bash
- **Parallel Programming/Communication:** MPI, Libfabric, NCCL, CUDA, PyTorch, Parallel ML
- **Simulators/Tools:** Sniper, gem5, ZSim, Xilinx Vivado, Xilinx ISE, Quartus II
- **Hardware Description Languages:** Chisel, VHDL, Verilog, SPICE

## LEADERSHIP

- **Research Supervisor** (2021-Present)
  Guided 13 students through novel research projects at Nortwestern and ANL
- **Pi Kappa Alpha Fraternity Iota Delta Chapter** (2017-2019)
  Managed a budget of over $400,000 across two school years
- **Rose-Hulman Bowling Club** (2016-2019)
  Restructured the club's leadership and daily operation; increased membership by 300%
- **Mooseheart Tutoring Program** (2014-2016)
  Began program to tutor orphaned students at Mooseheart Child City; after 3 years of growth, had 45 students and 24 tutors meeting twice a week

## HONORS & AWARDS

- **Argonne Laboratory Directed Research and Development (LDRD) Project** (2024-2027)
  $1m funding over 3 years to pursue independent research
- **Argonne National Laboratory Research Subcontract** (2020-2023)
  Full funding for my Ph.D. from ANL
- **Cabell Fellowship** (2019-2020)
  Awarded to the top 10 1st year Ph.D. students across all engineering majors
- **Department Choice Award** (2019)
  Awarded to the best senior research project
- **Embedded Systems Design Competition Champion** (2018)
- **Freshman ECE Design Competition Champion** (2016)
- **Dean's List** (All Semesters (2016-2019))
- **Class of 1940 Endowed Scholarship** (2016-2019)
- **National AP Scholar** (2016)
- **Illinois State Scholar** (2016)
- **36 ACT Certificate** (2015)

## Experiences

**Maria Goeppert Mayer Fellow** Oct 2024 - Present
*Argonne National Laboratory*
- Directed an independent research program on autotuning and collective communication, supported by a 3-year, $1M award from Argonne
- Translated my MPI autotuning research into production, achieving speedups up to 35x for collective operations on Argonne's exascale system, Aurora
- Contributed major enhancements to MPICH, the leading open-source MPI implementation, with a focus on optimizing collective communication for high-performance computing environments

**Software Engineer** Jan-Sep 2024
*Cornelis Networks*
- Spearheaded major performance optimizations for the OPX libfabric provider, achieving 5× bandwidth improvements for GPU communications and other critical improvements
- Led the architecture and development of the reference libfabric provider for the Ultra Ethernet Consortium, achieving a key milestone in the standard's development
- Created OPX developer tools, including a profiler and autotuner, boosting team velocity

**AI Research Intern** Summer 2023
*Meta*
- Designed and implemented an application-aware communication (NCCL) autotuner for large-scale AI workloads
- Developed an AI application emulation tool that mimics production models by overlapping communication and genericized compute kernels

**Research Aide/Visiting Student** 2020 - 2023
*Argonne National Laboratory*
- Founded the MPI collective algorithm/machine learning project, initially under the supervision of Dr. Min Si and Dr. Pavan Balaji, later Dr. Yanfei Guo and Dr. Rajeev Thakur
- Earned perpetual external funding from ANL for the remainder of my Ph.D

**Undergraduate Internships**
*Power Solutions International (2016), Flexware Innovation (2017), National Instruments (2018)*

## Sample Research Projects

**ML Autotuning for MPI** (Ongoing)
- Invented many optimizations to make ML-based MPI autotuning feasible on large-scale systems
- Developed the world's first exascale-capable MPI collective algorithm autotuner and achieved up to 20% speedups for production applications
- Exploring new "holistic" tuning methodologies to encompass performance-critical parameters across the software stack, targeting large scale AI workloads

**Algorithms for Collective Communication** (Ongoing)
- Created new generalized MPI collective algorithms that expose a tunable radix and outperform the previous best algorithms by up to 4.5x
- Exploring new generalized algorithms for GPU-specific collective communication (e.g., NCCL) and new abstractions (e.g., circulant graphs)

## Publications

**On Transparent Optimizations for Communication in Highly Parallel Systems**
*Michael Wilkins* • Ph.D. Thesis

**Generalized Collective Algorithms for the Exascale Era**
*Michael Wilkins, Hanming Wang, Peizhi Liu, Bangyen Pham, Yanfei Guo, Rajeev Thakur, Nikos Hardavellas, and Peter Dinda* • CLUSTER'23

**Evaluating Functional Memory-Managed Parallel Languages for HPC using the NAS Parallel Benchmarks**
*Michael Wilkins, Garrett Weil, Luke Arnold, Nikos Hardavellas, Peter Dinda* • HIPS'23 Workshop

**WARDen: Specializing Cache Coherence for High-Level Parallel Languages**
*Michael Wilkins, Sam Westrick, Vijay Kandiah, Alex Bernat, Brian Suchy, Enrico Armenio Deiana, Simone Campanoni, Umut Acar, Peter Dinda, Nikos Hardavellas* • CGO'23

**Program State Element Characterization**
*Enrico Deiana, Brian Suchy, Michael Wilkins, Brian Homerding, Tommy McMichen, Katarzyna Dunajewski, Nikos Hardavellas, Peter Dinda, Simone Campanoni* • CGO'23

**ACCLAiM: Advancing the Practicality of MPI Collective Communication Autotuning Using Machine Learning**
*Michael Wilkins, Yanfei Guo, Rajeev Thakur, Peter Dinda, Nikos Hardavellas* • CLUSTER'22

**A FACT-Based Approach: Making Machine Learning Collective Autotuning Feasible on Exascale Systems**
*Michael Wilkins, Yanfei Guo, Rajeev Thakur, Nikos Hardavellas, Peter Dinda, Min Si* • ExaMPI'21 Workshop