Naifeng Zhang

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EDUCATION

Ph.D. Electrical and Computer Engineering, Carnegie Mellon University, 2026
Advisor: Prof. Franz Franchetti

M.S. Electrical and Computer Engineering, Carnegie Mellon University, 2024
Advisor: Prof. Franz Franchetti

B.S. Computer Science, University of Southern California, 2021
Advisor: Prof. Viktor K. Prasanna
Thesis: Lightweight Augmented Neural Network For Performance Prediction and Its Applications
W.V.T. Rusch Undergraduate Engineering Honors Program

B.S. Mathematics, University of Southern California, 2021
Departmental Honors Program

AWARDS

2024 Best Poster Runner-up
PRISM Annual Review, Systems & Software track
Together with S. Fu (Lead Student) and F. Franchetti

2024 First Place, ACM Student Research Competition
The International Conference on Parallel Architectures and Compilation Techniques
Together with S. Fu (Lead Student) and F. Franchetti

2023 Outstanding Short Paper Award
IEEE High Performance Extreme Computing Conference
Together with P. Brinich, A. Ebel, F. Franchetti, and J. Johnson.

2023 Second Place, ACM Student Research Competition
The International Symposium on Code Generation and Optimization
Together with F. Franchetti

2021 Discovery Scholar Distinction
University of Southern California

2018–21 Academic Achievement Award
University of Southern California

FELLOWSHIPS

2021–22 Carnegie Institute of Technology Dean's Fellowship

2019–21 University of Southern California Provost's Research Fellowship

GRANTS

2023-   *High-Performance Code Generation for Homomorphic Encryption on GPUs using SPIRAL*
Tuned and benchmarked SPIRAL-generated number theoretic transform (NTT) implementations for
homomorphic encryption (HE) applications on start-of-the-art GPUs.
N. Zhang (PI), F. Franchetti (Co-PI)
200,000 ACCESS Credits
NSF

RESEARCH EXPERIENCE

2024-   *LLM Cerberus: Guardrails for Generative AI in High-Performance Math Kernels*
Extended SPIRAL with symbolic execution and theorem proving to derive semantics and provide
correctness guarantees for LLM-generated math kernels.
NSF

2023-   *Code Synthesis for the PRISM Architecture*
Extended SPIRAL to target processing-in-memory (PIM) kernels on PRISM architectures.
SRC JUMP 2.0

2022-   *Neocortex: SPIRAL Code Generation for Wafer-Scale Engine*
Extended SPIRAL to target Cerebras second-generation Wafer-Scale Engine (WSE-2).
NSF

2022–23 *Performance Analysis and Optimization of Quantum Library*
Conducted real-world performance analysis and optimizations of IBM's quantum library Qiskit for
Shor's Algorithm.

2021-23 *Trebuchet: NTTX for OpenFHE*
Developed SPIRAL NTTX package to automatically generate high-performance vectorized number
theoretic transform (NTT) code for fully homomorphic encryption (FHE) applications.
DARPA DPRIVE

2020–21 *Compiler Abstractions Supporting High Performance on Extreme-scale Resources (CASPER)*
Developed a compiler-oriented autotuner that automatically profiles a kernel and performs tuning
guided by performance prediction.
DARPA PAPPA

2019   *Dynamic Data-Aware Reconfiguration, INtegration and Generation (DDARING)*
Developed a lightweight augmented neural network for performance prediction.
DARPA SDH

PUBLICATIONS

Conference Proceedings

1. N. Zhang, S. McAleer, T. Sandholm. "Faster Game Solving via Hyperparameter Schedules." *Under review.*

2. S. Rao, A. Prakash, N. Zhang, H. Mankad, F. Franchetti. "LibraryX: A Framework for Cross-Library-Call
Optimization." *Under review.*

3. N. Zhang, F. Franchetti. "Code Generation for Cryptographic Kernels using Multi-word Modular
Arithmetic on GPU." The International Symposium on Code Generation and Optimization (CGO), 2025.
To appear.

4. N. Zhang, A. Ebel, N. Neda, P. Brinich, B. Reynwar, A. G. Schmidt, M. Franusich, J. Johnson, B. Reagen, F. Franchetti. "Generating High-Performance Number Theoretic Transform Implementations for Vector Architectures." IEEE High Performance Extreme Computing Conference (HPEC), 2023.

5. D. Sun, N. Zhang, F. Franchetti. "Optimization and Performance Analysis of Shor's Algorithm in Qiskit." IEEE High Performance Extreme Computing Conference (HPEC), 2023.

6. D. Soni, N. Neda, N. Zhang, B. Reynwar, H. Gamil, B. Heyman, M. N. T. Moopan, A. Al Badawi, Y. Polyakov, K. Canida, M. Pedram, M. Maniatakos, D. B. Cousins, F. Franchetti, M. French, A. Schmidt, B. Reagen. "RPU: The Ring Processing Unit." IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS), 2023.

7. N. Zhang, A. Srivastava, R. Kannan, V. K. Prasanna. "GenMAT: A General-Purpose Machine Learning-Driven Auto-Tunerfor Heterogeneous Platforms." The Workshop on Programming Environments for Heterogeneous Computing (PEHC), in conjunction with the International Conference for High Performance Computing, Networking, Storage, and Analysis (SC), 2021.

8. A. Srivastava*, N. Zhang*, R. Kannan, V. K. Prasanna. "Towards High Performance, Portability, and Productivity: Lightweight Augmented Neural Networks for Performance Prediction." The International Conference on High Performance Computing, Data, and Analytics (HiPC), 2020. *Equal contribution*.

9. C. Imes, A. Colin, N. Zhang, A. Srivastava, V. K. Prasanna, J. P. Walters. "Compiler Abstractions and Runtime for Extreme-scale SAR and CFD Workloads." The Workshop on Extreme Scale Programming Models and Middleware (ESPM2), in conjunction with the International Conference for High Performance Computing, Networking, Storage, and Analysis (SC), 2020.

Other Conference Papers, Technical Reports, Extended Abstracts, and Posters

1. N. Zhang, S. Rao, M. Franusich, F. Franchetti. "Towards Semantics Lifting for Scientific Computing: A Case Study on FFT." The Theory and Practice of Static Analysis Workshop (TPSA), in conjunction with the ACM SIGPLAN Symposium on Principles of Programming Languages (POPL), 2025, Extended abstract with presentation.

2. S. Fu, N. Zhang, F. Franchetti. "Accelerating High-Precision Number Theoretic Transforms using Intel AVX-512." The International Conference on Parallel Architectures and Compilation Techniques (PACT), 2024, Extended abstract with poster and presentation. **First Place, ACM Student Research Competition**. **Best Poster Runner-up** at PRISM Annual Review, Systems & Software track.

3. Y. Eum, N. Zhang, L. Tang, F. Franchetti. "Towards a RISC-V Instruction Set Extension for Multi-word Arithmetic." IEEE High Performance Extreme Computing Conference (HPEC), 2024, Extended abstract with poster.

4. P. Brinich, N. Zhang, A. Ebel, F. Franchetti, J. Johnson. "Twiddle Factor Generation for a Vectorized Number Theoretic Transform." IEEE High Performance Extreme Computing Conference (HPEC), 2023, Extended abstract with poster. **Outstanding Short Paper Award**.

5. H. Mankad, A. Rovinelli, M. Zecevic, P. McCorquodale, F. Franchetti, N. Zhang, S. Rao, R. A. Lebensohn, L. Capolungo "EVPFFTX: A First Look at FFTX Applications in Material Science." IEEE High Performance Extreme Computing Conference (HPEC), 2023, Extended abstract with poster.

6. D. B. Cousins, Y. Polyakov, A. Al Badawi, M. French, A. Schmidt, A. Jacob, B. Reynwar, K. Canida, A. Jaiswal, C. Mathew, H. Gamil, N. Neda, D. Soni, M. Maniatakos, B. Reagen, N. Zhang, F. Franchetti, P. Brinich, J. Johnson, P. Broderick, M. Franusich, B. Zhang, Z. Cheng, M. Pedram. "TREBUCHET: Fully Homomorphic Encryption Accelerator for Deep Computation." The Government Microcircuit Applications and Critical Technology Conference (GOMACTech), 2023, Preprint with presentation.

7. N. Zhang, F. Franchetti. "Generating Number Theoretic Transforms for Multi-Word Integer Data Types." The International Symposium on Code Generation and Optimization (CGO), 2023, Extended abstract with poster and presentation. **Second Place, ACM Student Research Competition**.

8. N. Zhang, H. Gamil, P. Brinich, B. Reynwar, A. Al Badawi, N. Neda, D. Soni, K. Canida, Y. Polyakov, P. Broderick, M. Maniatakos, A. G. Schmidt, M. Franusich, J. Johnson, B. Reagen, D. B. Cousins, F. Franchetti. "Towards Full-Stack Acceleration for Fully Homomorphic Encryption." IEEE High Performance Extreme Computing Conference (HPEC), 2022, Extended abstract with presentation.

9. I. Grosof, N. Zhang, M. Heule. "Towards the shortest DRAT proof of the Pigeonhole Principle." The Pragmatics of SAT Workshop (PoS), in conjunction with the International Conference on Theory and Applications of Satisfiability Testing (SAT), 2022, Preprint with presentation.

TALKS

Seminars

2025   *Code Generation for Cryptographic Kernels using Multi-word Modular Arithmetic.*
The Programming Languages Group at the University of Pennsylvania (PLClub), Feb. 21.
Philadelphia, United States

2025   *Code Generation for Cryptographic Kernels using Multi-word Modular Arithmetic.*
Computer Architecture Lab at Carnegie Mellon (CALCM), Feb. 14.
Pittsburgh, United States

Conference and Workshop Presentations

2025   *Towards Semantics Lifting for Scientific Computing: A Case Study on FFT.*
The Theory and Practice of Static Analysis Workshop (TPSA), in conjunction with the ACM SIGPLAN Symposium on Principles of Programming Languages (POPL), Jan. 21.
Denver, United States

2023   *Generating High-Performance Number Theoretic Transform Implementations for Vector Architectures*
IEEE High Performance Extreme Computing Conference (HPEC), Sep. 29.
Virtual

2023   *Generating Number Theoretic Transforms for Multi-Word Integer Data Types*
The International Symposium on Code Generation and Optimization (CGO), Feb. 28.
Montreal, Canada

2022   *Towards Full-Stack Acceleration for Fully Homomorphic Encryption*
IEEE High Performance Extreme Computing Conference (HPEC), Sep. 23.
Virtual

2021   *GenMAT: A General-Purpose Machine Learning-Driven Auto-Tuner for Heterogeneous Platforms*
The Workshop on Programming Environments for Heterogeneous Computing (PEHC), in conjunction with the International Conference for High Performance Computing, Networking, Storage, and Analysis (SC), Nov. 19.
Virtual

2020   *Towards High Performance, Portability, and Productivity: Lightweight Augmented Neural Networks for Performance Prediction*
The International Conference on High Performance Computing, Data, and Analytics (HiPC), Dec. 16.
Virtual

Tutorials Given

2024   *Open Source SPIRAL 8.5 Tutorial*
IEEE High Performance Extreme Computing Conference (HPEC), Sep. 25. Together with F. Franchetti and M. Franusich.
Virtual

2023   *Open Source SPIRAL 8.5 Tutorial*
IEEE High Performance Extreme Computing Conference (HPEC), Sep. 27. Together with F. Franchetti, M. Franusich, and P. Broderick.
Virtual

TEACHING EXPERIENCE

Carnegie Mellon Univeristy

Teaching Assistant

24 Fall   Mathematical Foundations of Electrical Engineering

23 Spring   Computational Problem Solving for Engineers

University of Southern California

Undergraduate Teaching Assistant

21 Spring   Special Topics - Accelerated Computing Using FPGAs

20 Fall   Parallel and Distributed Computation

20 Spring   Special Topics - Accelerated Computing Using FPGAs
Discrete Methods in Computer Science

19 Fall   Parallel and Distributed Computation
Discrete Methods in Computer Science

MENTORING

Master's

2024-   Yujun Lee

2023   Kofi Poku

2022–23   Dewang Sun

2022   Hongbo Sun

Undergraduate

2025-   Yiwen Jiang

2024-   Misho Alexandrov

2024-   Sophia Fu

2024-   Govind Malasani

2023-   Gordon Xu

2024   Zubin Narayan

2024   Youngjin Eum

2024   Steven Lee

2022–23   Matt Ngaw

2022–23   Jimmy Zhou

SERVICE

Peer Review Assisted

IEEE High Performance Extreme Computing Conference (HPEC), 2022-24

IEEE International Conference on Big Data (BigData), 2020

Service to the University

CMU ECE Faculty Hiring Student Council, 2022-

Outreach

CMU College of Engineering Graduate Student Outreach Committee, 2023-24

Updated February 2025