

Yipeng Huang

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Academic Appointments

Rutgers University

Assistant Professor

September 2020–present

Princeton University

Postdoctoral Research Associate

Advisor: Dr. Margaret Martonosi

June 2018–August 2020

Education

Columbia University

Ph.D., computer science

2018

Dissertation: Hybrid Analog-Digital Co-Processing for Scientific Computation

Advisor: Dr. Simha Sethumadhavan

M.Phil., computer science

2015

M.S., computer science

2013

B.S. *magna cum laude*, computer engineering, minor in economics

2011

Honors and Awards

- IEEE Micro Top Picks from the Computer Architecture Conferences honorable mention: 2017, 2022
- Rising Stars in Computer Architecture Workshop 2019 participant (one of seven)
- Heidelberg Laureate Forum 2017 participant
- IEEE Micro Top Picks from the 2016 Computer Architecture Conferences (one of 12)
- DARPA Small Business Technology Transfer Phase I grant (for investigating analog computing applications)
- Columbia University Computer Engineering Award of Excellence (annual departmental award)
- Columbia University George Vincent Wendell Memorial Medal nominee (annual school award)

Publications

Conference Publications

Noisy Variational Quantum Algorithm Simulation via Knowledge Compilation for Repeated Inference

Yipeng Huang, Steven Holtzen, Todd Millstein, Guy Van den Broeck, and Margaret Martonosi

ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS), Detroit, MI, 2021

Acceptance rate = 75/398 \approx 18.8%

IEEE Micro Top Picks from the 2021 Computer Architecture Conferences honorable mention

Statistical Assertions for Validating Patterns and Finding Bugs in Quantum Programs

Yipeng Huang and Margaret Martonosi

ACM/IEEE International Symposium on Computer Architecture (ISCA), Phoenix, AZ, 2019

Acceptance rate = 62/365 \approx 17.0%

Hybrid Analog-Digital Solution of Nonlinear Partial Differential Equations

Yipeng Huang, Ning Guo, Mingoo Seok, Yannis Tsividis, Kyle Mandli, and Simha Sethumadhavan
IEEE/ACM International Symposium on Microarchitecture (MICRO), Cambridge, MA, 2017
Acceptance rate = 61/327 \approx 18.7%
IEEE Micro Top Picks from the 2017 Computer Architecture Conferences honorable mention

Evaluation of an Analog Accelerator for Linear Algebra

Yipeng Huang, Ning Guo, Mingoo Seok, Yannis Tsividis, and Simha Sethumadhavan
ACM/IEEE International Symposium on Computer Architecture (ISCA), Seoul, South Korea, 2016
Acceptance rate = 57/291 \approx 19.6%
IEEE Micro Top Picks from the 2016 Computer Architecture Conferences

RoboBench: Towards Sustainable Robotics System Benchmarking

Jonathan Weisz, Yipeng Huang, Florian Lier, Simha Sethumadhavan, and Peter K. Allen
IEEE International Conference on Robotics and Automation (ICRA), Stockholm, Sweden, 2016

Continuous-Time Hybrid Computation with Programmable Nonlinearities

Ning Guo, Yipeng Huang, Tao Mai, Sharvil Patil, Chi Cao, Mingoo Seok, Simha Sethumadhavan, and Yannis Tsividis
European Solid-State Circuits Conference (ESSCIRC), Graz, Austria, 2015
Invited for submission to the IEEE Journal of Solid-State Circuits

Journal Publications

Architectures / Systems: Dynamical Systems: Differential Equation Solving

Yipeng Huang
International Roadmap for Devices and Systems (IRDS), chapter on Beyond CMOS and Emerging Research Materials. 2022.

Analog Computing in a Modern Context: A Linear Algebra Accelerator Case Study

Yipeng Huang, Ning Guo, Mingoo Seok, Yannis Tsividis, and Simha Sethumadhavan
IEEE Micro, Top Picks Special Issue, vol. 37, no. 3, pp. 30-38, 2017

Energy-Efficient Hybrid Analog/Digital Approximate Computation in Continuous Time

Ning Guo, Yipeng Huang, Tao Mai, Sharvil Patil, Chi Cao, Mingoo Seok, Simha Sethumadhavan, and Yannis Tsividis
IEEE Journal of Solid-State Circuits (JSSC), vol. 51, no. 7, pp. 1514-1524, July 2016

Trustworthy Hardware from Untrusted Components

Simha Sethumadhavan, Adam Waksman, Matthew Suozzo, Yipeng Huang, and Julianna Eum
Communications of the ACM, vol. 58, no. 9, pp. 60-71, August 2015

Workshop Papers

Logic Formulas as Program Abstractions for Quantum Circuits

Yipeng Huang, Steven Holtzen, Todd Millstein, Guy Van den Broeck, and Margaret Martonosi
First International Workshop on Quantum Computing Software at The International Conference for High Performance Computing, Networking, Storage, and Analysis (SC), 2020

QDB: From Quantum Algorithms Towards Correct Quantum Programs

Yipeng Huang and Margaret Martonosi
2018 PLATEAU Workshop at ACM conference on Systems, Programming, Languages and Applications: Software for Humanity (SPLASH), Boston, MA, 2018

Dissertation

Hybrid Analog-Digital Co-Processing for Scientific Computation

Committee: Simha Sethumadhavan, Yannis Tsividis, Margaret Martonosi, Martha Kim, and Kyle Mandli

Nominated by Columbia University Computer Science Department for the ACM Doctoral Dissertation Award

Selected Presentations

Invited Talks

Extensions of multivalued and analog computing into the quantum realm

Peking University Institute for Artificial Intelligence and School of Integrated Circuits, Virtual, June 2022

Host: Zhong Sun

Graphical models and logical abstractions for quantum systems

Princeton ACM / IEEE Computer Society Chapter, Virtual, November 2021

Host: Brian Berenbach

Graphical models and logical abstractions for quantum systems

UC Berkeley Challenge Institute for Quantum Information, Virtual, November 2021

Host: John Kubiatoiwicz

Graphical models and logical abstractions for quantum systems

UC Santa Cruz Baskin School of Engineering Hardware Systems Collective, Virtual, October 2021

Host: Tyler Sorensen

Logical Abstractions for Noisy Variational Quantum Algorithm Simulation

IBM Quantum Hub at NC State Quantum Lunch Series, Virtual, April 2021

Host: Huiyang Zhou

Emerging Architectures for Humanity's Grand Challenges

Georgia Tech Rising Stars in Computer Architecture (RISC-A) Workshop, Atlanta, GA, October 2019

Hosts: Alex Daglis and Tushar Krishna

Probabilistic Inference and Statistical Tests for Correct Quantum Programs

Sandia National Laboratories Assessing Performance of Quantum Computers workshop, Estes Park, CO, September 2019

Host: Robin Blume-Kohout

Knowledge Compilation-Based Exact Inference for Quantum Simulation

ISCA/FCRC Quantum Resource Estimation workshop, Phoenix, AZ, June 2019

Hosts: Alexandru Paler, Simon Devitt, and Daniel Herr

Approximate Computing Across the (Quantum) Stack

PLDI/FCRC Workshop on Approximate Computing Across the Stack, Phoenix, AZ, June 2019

Host: Ulya Karpuzcu

A Case Study in Analog Co-Processing for Solving Stochastic Differential Equations

IEEE International Conference on Digital Signal Processing, Shanghai, China, November 2018

Hosts: Arjuna Madanayake, Zhiping Lin, and Sankar Basu

Hybrid Analog-Digital Co-Processor for Scientific Computation

DARPA Accelerated Computation for Efficient Scientific Simulation (ACCESS) principal investigators' meeting

Arlington, VA, December 2016

Host: Vincent Tang

Selected Posters

Hybrid Analog-Digital Accelerator for Differential and Algebraic Equations

IEEE International Conference on Rebooting Computing, Tysons Corner, VA, November 2017

Hybrid Analog-Digital Solution of Nonlinear Partial Differential Equations

Heidelberg Laureate Forum, Heidelberg, Germany, September 2017

Grants

Hybrid Analog-Digital Co-Processor for Scientific Computation

I was the principal investigator for this Small Business Technology Transfer grant,

in response to DARPA's Accelerated Computation for Efficient Scientific Simulation (ACCESS) program.

The research was conducted at a startup I founded, Allegory Labs, LLC, with Columbia University as a subcontractor.

Grant amount: \$100,000; DoD DARPA contract number D16PC00089

Research Artifacts & Impact

Columbia University Prototype Analog Accelerators

I was a part of a team that taped-out two iterations of analog accelerators for solving differential and algebraic equations.

I led the effort in building the chips' digital interfaces, validating the chips' functionality, and programming the chips.

The prototypes have been used at MIT, Ulm University, Sendyne Corporation, and Allegory Labs, LLC for further research.

Press Mentions

| Headline | Publication | Date |
|---|---------------------------|---------------|
| Quantum computing made easier through new debugging tools | Science Times | July 4, 2019 |
| Researchers make steps toward debugging tools for quantum computers | phys.org | June 21, 2019 |
| Not your father's analog computer | IEEE Spectrum | Dec. 1, 2017 |
| Maths on a boat: Yipeng Huang and analog computing | maths.org Plus magazine | Oct. 10, 2017 |
| Back to analog computing: Columbia researchers merge analog and digital computing on a single chip | Columbia CS press release | Nov. 22, 2016 |

Teaching Experience

| Role | Course | Primary instructor | Term |
|--------------------|--|------------------------|---|
| Instructor | Rutgers University 16:198:672 & 16:198:583 & 16:198:443 Quantum Computing: Programs and Systems (graduate course in quantum applications and realizations) | - | Fall 2020, Fall 2021, Fall 2022 |
| Instructor | Rutgers University 01:198:211 Computer Architecture (undergraduate course in C, architecture, and digital logic) | - | Spring 2021, Spring 2022, Spring 2023 |
| Teaching assistant | Columbia University EECS 4340 Computer Hardware Design (graduate course in RTL design, validation, synthesis) | Simha Sethumadhavan | Fall 2012, Fall 2014 |
| Teaching assistant | Columbia University CSEE 3827 Fundamentals of Computer Systems (undergraduate course in logic and architecture) | Dan Rubenstein | Fall 2010 |
| Teaching assistant | Columbia University COMS 1007 Object Oriented Design in Java | Bert Huang | Spring 2010 |
| Mentor | Computer Science independent study mentor for Jackson Lee and Mukund Ramakrishnan <i>Lee received the Barry Goldwater Scholarship in 2023</i> | - | 2022 - 2023 |
| Mentor | Computer Science Honors Capstone Program mentor for Arpan Gupta, Cyrus Majd, and Alex Miralles-Cordal <i>Gupta's work won the Henry Rutgers Scholar Award</i> | - | 2022 - 2023 |
| Mentor | Aresty Research Assistant Program mentor for Arpan Gupta, Michael Schleppey, Aayushi Kasera, and Ian Martin <i>Gupta and Schleppey's work won the first place at the ACM Student Research Competition undergraduate division at PACT 2022</i> | - | 2021 - 2023 |
| Mentor | Undergraduate thesis advisor for Soham Palande <i>His work won the 2022 Chancellor-Provost's Research Excellence Award</i> | - | 2021 - 2022 |
| Mentor | Quantum Undergraduate Research at IBM and Princeton (QURIP) mentor for Emma Dasgupta and Lia Yeh <i>Their work won the bronze medal at the ACM Student Research Competition undergraduate division at MICRO 2019</i> | Margaret Martonosi | Summer 2019 |
| Mentor | Undergraduate thesis mentor for Lois Dzebissov | Margaret Martonosi | Fall 2018 |
| Mentor | Undergraduate research project mentor for Lusa Zhan | Simha Sethumadhavan | Fall 2016 |
| Mentor | Masters research project mentor for Mingrui Liu | Simha Sethumadhavan | Spring 2015 |
| Mentor | Masters research project mentor for Kenneth Harvey | Simha Sethumadhavan | Spring 2015 |

Academic Service

| Role | Venue | Years |
|------------------------|--|------------------|
| PC | ACM/IEEE International Symposium on Computer Architecture (ISCA) | 2023 |
| PC | IEEE International Symposium on High Performance Computer Architecture (HPCA) | 2021, 2022, 2023 |
| PC | IEEE/ACM International Symposium on Microarchitecture (MICRO) | 2020, 2021, 2022 |
| PC | IEEE International Conference on Quantum Computing and Engineering | 2021, 2022 |
| PC | International Workshop on Quantum Software Engineering | 2022 |
| PC | Brookhaven National Laboratory New York Scientific Data Summit | 2020 |
| PC | Programming Languages and Quantum Computing workshop at POPL/PLDI | 2020, 2021 |
| ERC | ACM/IEEE International Symposium on Computer Architecture (ISCA) | 2019, 2020, 2022 |
| ERC | ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS) | 2019, 2020, 2021 |
| ERC | IEEE/ACM International Symposium on Microarchitecture (MICRO) | 2019 |
| Reviewer | ACM Transactions on Quantum Computing (TQC) | 2020 |
| Reviewer | IEEE International Conference on Rebooting Computing (ICRC) | 2020 |
| Reviewer | IEEE Transactions on Circuits and Systems-I | 2018, 2019, 2020 |
| Reviewer | IEEE Computer Architecture Letters | 2019 |
| Reviewer | IEEE International Symposium on High Performance Computer Architecture (HPCA) | 2015, 2019 |
| Reviewer | IEEE Micro Magazine | 2017, 2018, 2021 |
| Reviewer | Columbia University Computer Science M.S. program admissions | 2014 |
| Registration chair | ACM/SIGARCH International Conference on Supercomputing (ICS) | 2021 |
| Session chair | ACM/IEEE International Symposium on Computer Architecture (ISCA) | 2023 |
| Session chair | IEEE International Symposium on High Performance Computer Architecture (HPCA) | 2021 |
| Session chair | IEEE/ACM International Symposium on Microarchitecture (MICRO) | 2020 |
| Dissertation committee | Mohammadreza Soltaniyeh, Rutgers University | Jul. 12, 2022 |
| Examiner | Qualifier exam, Edgar Granados, Rutgers University | May 12, 2023 |
| Examiner | Qualifier exam, Yuwei Jin, Rutgers University | May 9, 2023 |
| Examiner | Qualifier exam, Vihan Shah, Rutgers University | Nov. 11, 2022 |
| Examiner | Qualifier exam, Anastasios Stathopoulos, Rutgers University | April 23, 2021 |
| Examiner | Qualifier exam, Shuchang Liu, Rutgers University | Nov. 24, 2020 |

Science Education Outreach, Leadership, and Professional Memberships

| Organization | Role | Years |
|--|--------------------------------|---------------------------|
| Computer and Information Science and Engineering (CISE) Graduate Fellowships (CSGrad4US) | Reviewer | 2022 |
| Undergrad Architecture Mentoring (uArch) Workshop | Panelist | 2022 |
| Summer Science Program (high school astrophysics summer program) | Admissions committee | 2019, 2020, 2021, 2022 |
| New York Hall of Science STEM Night: Exploring the Tech Workforce | Panelist | October 2019 |
| UC Santa Barbara School for Scientific Thought (high school quantum computing weekend program) | Short course instructor | October 2019 |
| FIRST Robotics Competition (high school annual robotics competition) | Team mentor | Spring 2014 |
| Western Aerospace Scholars at the Seattle Museum of Flight (high school aerospace summer program) | Summer residency mentor | 2012, 2013 |
| Columbia Daily Spectator | Staff director & design editor | 2007–2010 |
| ACM SIGARCH, SIGMICRO | Member | 2012–present |

Professional Experience

| | |
|---|------------------------------------|
| Sendyne Research Intern | New York, NY Summer 2017 |
| • Developed novel stochastic application-specific integrated circuit for financial modeling applications | |
| Allegory Labs, LLC Founder & Principal Investigator | New York, NY Nov. 2015–May 2017 |
| • Founded IP-backed startup via \$100K Small Business Technology Transfer federal government contract | |
| • Collaborated with university subcontractor to research new class of analog continuous-time numerical methods | |
| • Identified and assessed commercial potential in modern scientific computation applications | |
| • Communicated with DARPA in-person and in response to request for information, phase I, and phase II proposals | |
| Boeing Information Technology Career Foundation Program Participant | Seattle, WA June 2011–July 2012 |
| • Built MPI interface to parallelize computational fluid dynamics and engineering geometry applications | |
| ZS Associates Business Information Specialist Intern | New York, NY Summer 2010 |
| Hutchison Port Holdings Information Technology Intern | Hong Kong Summer 2009 |

Technical Tools & Languages

Quantum: IBM Qiskit, Google Cirq, Microsoft ProjectQ, Scaffold

Hardware: SystemC, SystemVerilog, Synopsys, Cadence, Altera EDA tools for ASIC/FPGA

Software: Nvidia CUDA Thrust, Open MPI, Robot Operating System, C/C++, Java, Python, MATLAB, Docker