

# Zishen Wan

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## RESEARCH INTERESTS

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**Research Areas:** Computer Architecture, VLSI, Autonomous Machine, EDA, Embedded System

**Research Vision:** My research is at the intersection of VLSI, computer architecture, and embedded systems. I build hardware and system for autonomous machines and edge intelligence through cross-stack software-hardware co-design, with the vision to advance their performance, efficiency, resilience, and robustness.

## EDUCATION

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- 2020-2025 **Georgia Institute of Technology, Atlanta, GA, USA**  
(Expected) Ph.D., School of Electrical and Computer Engineering (ECE)
- *Advisor:* Prof. Arijit Raychowdhury
  - *Research Topic:* Efficient and Reliable Hardware and System Design for Edge Intelligence
  - *GPA:* 4.0/4.0
- 2018-2020 **Harvard University, Cambridge, MA, USA**  
M.S., School of Engineering and Applied Science (SEAS)
- *Advisor:* Prof. Vijay Janapa Reddi
  - *Research Topic:* Reliability and Design Automation of Autonomous Machines
  - *GPA:* 3.95/4
- 2014-2018 **Harbin Institute of Technology (HIT), Harbin, China**  
B.E. with High Honors, Department of Electrical Engineering (EE)
- *GPA:* 93.5/100 (Rank: 2/230)

## PERFESSIONAL EXPERIENCE

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- 2020- **Georgia Institute of Technology, Atlanta, GA, USA**  
*Graduate Research Assistant*
- 2018-2020 **Harvard University, Cambridge, MA, USA**  
*Graduate Research Assistant*
- 2018 **Massachusetts Institute of Technology, Cambridge, MA, USA**  
*Graduate Research Assistant*
- 2016-2018 **Harbin Institute of Technology, Harbin, China**  
*Undergraduate Research Assistant*
- 2017 **National Tsing-Hua University, Hsinchu, Taiwan**  
*Visiting Student*
- 2017 **National Chiao-Tung University, Hsinchu, Taiwan**  
*Visiting Student*

## SELECTED AWARDS AND HONORS

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- 2023 **Machine Learning and Systems Rising Star**  
*A cohort of 35 PhD students to develop community, foster research and career growth among the rising generation of researchers at interactions of ML and systems.*
- 2023 **Student Travel Award**, International Symposium on Computer Architecture (**ISCA**)
- 2023 **Student Travel Award**, Conference on Machine Learning and Systems (**MLSys**)
- 2023 **Roger P. Webb Graduate Research Assistant Excellence Award**, Georgia Tech  
*Recognition of Graduate Research Assistant (GRA) who have demonstrated excellent research performance. 2-4 students each year in Georgia Tech School of ECE.*
- 2023 **IEEE Micro Top Picks**, Honorable Mention  
*Recognition of "the most significant research papers in computer architecture based on novelty and potential for long-term impact, published in the top computer architecture conferences of 2022"*
- 2022 **1<sup>st</sup> Place, ACM/SIGBED Student Research Competition**  
*Ranked 1<sup>st</sup> of 30 participants in ACM student research competition at Embedded Systems Week (ESWEEK), will represent SIGBED to compete in ACM Grand Finals.*
- 2022 **3<sup>rd</sup> Place, ACM/SIGDA Student Research Competition** (declined)  
*Ranked 3<sup>rd</sup> of 40 participants in ACM student research competition at International Conference on Computer-Aided Design (ICCAD).*
- 2022 **Qualcomm Fellowship**
- 2022 **Young Fellow**, ACM/IEEE Design Automation Conference (**DAC**)
- 2022 **CRNCH PhD Fellowship**, Center for Novel Computing Hierarchies, Georgia Tech  
*2-4 graduate students each year in Georgia Tech College of Engineering and College of Computing*
- 2021 **Best Research Video Award**, DAC Young Fellow Program  
*25 winners out of ~200 DAC young fellow students*
- 2021 **Young Fellow**, ACM/IEEE Design Automation Conference (**DAC**)
- 2021 **4<sup>th</sup> Place**, ACM Student Research Competition at International Conference on Computer-Aided Design (**ICCAD**)
- 2020 **Best Paper Award** in IEEE Computer Architecture Letter (**CAL**)  
*Paper ranked highest among 42 accepted papers that year*
- 2020 **Best Paper Award** in ACM/IEEE Design Automation Conference (**DAC**)  
*Paper ranked highest among 228 accepted papers out of 984 submissions that year*
- 2020 **Dean's Fellowship**, Purdue University  
*2 winners out of over 1600 worldwide applicants, declined*
- 2018 **Chiang Chen Overseas Graduate Scholarship**  
*10 of all undergraduates and graduates in China, \$50,000/person*
- 2018 **Best Undergraduate Thesis Award**, HIT  
*100 winners out of ~4000 thesis submissions*
- 2018 **First Class of Chunhui Innovation Achievement Award**  
*3 of all undergraduates in HIT, highest student academic honor in HIT*
- 2018 **China Telecom Scholarship**  
*5 of all undergraduates and graduates in HIT*
- 2018 **Outstanding Graduates**, HIT  
*Top 1% of all undergraduates*
- 2017 **Innovation and Entrepreneurship Scholarship**, Ministry of Industry and Information, China
- 2016 **First Prize**, National Undergraduate Mathematical Contest in Modeling, China  
*Team leader, 294 winners out of ~32000 teams, ranked 1st among ~600 HIT teams*
- 2016 **Siemens Academic Scholarship**  
*30 of all undergraduates and graduates in HIT*
- 2016 **Outstanding Student** of Heilongjiang Province, China

- 2015 **Johnson Electric Academic Scholarship**  
*Top 1% of all undergraduates*  
*15 of all undergraduates and graduates in HIT*
- 2015-2017 **First Class Academic Excellence Scholarship, HIT**  
*Top 3% of all undergraduates*

## **PUBLICATIONS**

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(\* Indicates Equal Contributions)

### **Book**

- Synthesis** “Robotic Computing on FPGAs”  
**Lectures on** Shaoshan Liu, Zishen Wan, Bo Yu, Yu Wang  
**Computer** *In Synthesis Lectures on Computer Architecture (Morgan & Claypool Publishers), pp.1-*  
**Architecture** *218, Jun 2021*

### **Research Artifacts**

- ACM SRC** “Intelligence in Robotic Computing: Agile Design Flows for Building Efficient and  
**Grand Final** Resilient Autonomous Machines”  
Zishen Wan, Vijay Janapa Reddi, Arijit Raychowdhury  
*ACM Student Research Competition (SRC), Grand Final, 2023*  
**1<sup>st</sup> Place in ACM/SIGBED Student Research Competition (SRC)**

### **Conference Publications**

- ICCAD 2023** “SEE-MCAM: Scalable Multi-bit FeFET Content Addressable Memories for Energy Efficient Associative Search”  
 Shengxi Shou, Che-Kai Liu, Sanggeon Yun, Zishen Wan, Kai Ni, Mohsen Imani, X. Sharon Hu, Jianyi Yang, Cheng Zhuo, Xunzhao Yin  
*In 42<sup>nd</sup> IEEE/ACM International Conference on Computer-Aided Design (ICCAD), November 2023*  
*Acceptance Rate: 23%*
- DAC 2023** “BERRY: Bit Error Robustness for Energy-Efficient Reinforcement Learning-Based Autonomous Systems”  
Zishen Wan, Nandhini Chandramoorthy, Karthik Swaminathan, Pin-Yu Chen, Vijay Janapa Reddi, Arijit Raychowdhury  
*To appear in ACM/IEEE Design Automation Conference (DAC), July 2023*  
*Acceptance Rate: 23%*
- ISCA 2023** “VPP: The Vulnerability-Proportional Protection Paradigm Towards Reliable Autonomous Machines”  
 (Workshop) Zishen Wan\*, Yiming Gan\*, Bo Yu, Shaoshan Liu, Arijit Raychowdhury, Yuhao Zhu  
*In International Workshop on Domain Specific System Architecture (DOSSA), International Symposium on Computer Architecture (ISCA), June 2023*
- MLSys 2023** “Towards Cognitive AI Systems: A Survey and Perspective on Neuro-Symbolic AI”  
 (Workshop) Zishen Wan, Che-Kai Liu, Hanchen Yang, Chaojian Li, Haoran You, Yonggan Fu, Cheng Wan, Tushar Krishna, Yingyan (Celine) Lin, Arijit Raychowdhury  
*In Workshop on Systems for Next-Gen AI Paradigms, Conference on Machine Learning and Systems (MLSys), June 2023*

- DATE 2023** “MAVFI: An End-to-End Fault Analysis Framework with Anomaly Detection and Recovery for Micro Aerial Vehicles”  
 Yu-Shun Hsiao\*, Zishen Wan\*, Tianyu Jia, Radhika Ghosal, Abdulrahman Mahmoud Arijit Raychowdhury, David Brooks, Gu-Yeon Wei, Vijay Janapa Reddi (\*alphabetical order)  
*To appear in Design, Automation and Test in Europe Conference (DATE), March 2023*  
*Acceptance Rate: 24%*
- DATE 2023** “Real-Time Fully Unsupervised Domain Adaptation for Lane Detection in Autonomous Driving”  
 Kshitij Bhardwaj, Zishen Wan, Arijit Raychowdhury, Ryan Goldhahn  
*To appear in Design, Automation and Test in Europe Conference (DATE), March 2023*  
*Acceptance Rate: 24%*
- ISSCC 2023** “A 73.53TOPS/W 14.74TOPS Heterogeneous RRAM In-Memory and SRAM Near-Memory SoC for Hybrid Frame and Event-Based Target Tracking”  
 Muya Chang\*, Ashwin Lele\*, Samuel Spetalnick, Brian Crafton, Shota Konna, Zishen Wan, Ashwin Bhat, Win-San Khwa, Yu-der Chih, Meng-Fan Chang, Arijit Raychowdhury  
*In IEEE International Solid-State Circuits Conference (ISSCC), February 2023*  
*Acceptance Rate: 33% (205/629)*
- ICCAD 2022** “On Resilience and Robustness of Autonomous Systems”  
Zishen Wan, Karthik Swaminathan, Pin-Yu Chen, Nandhini Chandramoorthy, Arijit Raychowdhury  
*In 41<sup>st</sup> IEEE/ACM International Conference on Computer-Aided Design (ICCAD), November 2022*
- MICRO 2022** “Automatic Domain-Specific SoC Design for Autonomous Unmanned Aerial Vehicles”  
 Srivatsan Krishnan, Zishen Wan, Kshitij Bhardwaj, Paul Whatmough, Aleksandra Faust, Sabrina M. Neuman, Gu-Yeon Wei, David Brooks, Vijay Janapa Reddi  
*In 55<sup>th</sup> IEEE/ACM International Symposium on Microarchitecture (MICRO), October 2022*  
**(Selected as 2023 IEEE Micro Top Picks, Honorable Mention)**  
*Acceptance Rate: 22% (83/369)*
- DAC 2022** “Improving Compute In-Memory ECC Reliability with Successive Correction”  
 Brian Crafton, Zishen Wan, Samuel Spetalnick, Jong-Hyeok Yoon, Wei Wu, Carlos Tokunaga, Vivek De, Arijit Raychowdhury  
*In 59<sup>th</sup> ACM/IEEE Design Automation Conference (DAC), July 2022*  
*Acceptance Rate: 23% (231/987)*
- ICML 2022** (Workshop) “Multi-Task Federated Reinforcement Learning with Adversaries”  
 Aqeel Anwar, Zishen Wan, Arijit Raychowdhury  
*In Adversarial Machine Learning Workshop, International Conference on Machine Learning (ICML), July 2022*
- AICAS 2022** “Robotic Computing on FPGAs: Current Progress, Research Challenges, and Opportunities”  
Zishen Wan, Ashwin Lele, Bo Yu, Shaoshan Liu, Yu Wang, Vijay Janapa Reddi, Cong (Callie) Hao, Arijit Raychowdhury  
*In IEEE International Conference on Artificial Intelligence Circuits and Systems (AICAS), June 2022*

- ISPASS 2022** “Roofline Model for UAVs: A Bottleneck Analysis Tool for Onboard Compute Characterization of Autonomous Unmanned Aerial Vehicles”  
Srivatsan Krishnan, Zishen Wan, Kshitij Bhardwaj, Ninad Jadhav, Aleksandra Faust, Vijay Janapa Reddi  
*In IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS), June 2022*  
*Acceptance Rate: 29% (24/83)*
- NVMW 2022** (Workshop) “RRAM-ECC: Improving Reliability of RRAM-Based Compute In-Memory”  
Zishen Wan\*, Brian Crafton\*, Samuel Spetalnick, Jong-Hyeok Yoon, Arijit Raychowdhury  
*In 13th Annual Non-Volatile Memories Workshop (NVMW), May 2022*
- CICC 2022** “An Energy-Efficient and Runtime-Reconfigurable FPGA-Based Accelerator for Robotic Localization Systems”  
Qiang Liu\*, Zishen Wan\*, Bo Yu\*, Weizhuang Liu, Shaoshan Liu, Arijit Raychowdhury  
*In IEEE Custom Integrated Circuits Conference (CICC), April 2022*  
*Acceptance Rate: 41% (97/235)*
- DATE 2022** “FRL-FI: Transient Fault Analysis for Federated Reinforcement Learning-Based Navigation Systems”  
Zishen Wan, Aqeel Anwar, Abdulrahman Mahmoud, Tianyu Jia, Yu-Shun Hsiao, Vijay Janapa Reddi, Arijit Raychowdhury  
*In Design, Automation and Test in Europe Conference (DATE), March 2022*  
*Acceptance Rate: 25%*
- ASP-DAC 2022** “Circuit and System Technologies for Energy-Efficient Edge Robotics”  
Zishen Wan, Ashwin Lele, Arijit Raychowdhury  
*In Asia and South Pacific Design Automation Conference (ASP-DAC), January 2022*  
*(Invited Paper)*
- DAC 2021** “Analyzing and Improving Fault Tolerance of Learning-Based Navigation System”  
Zishen Wan, Aqeel Anwar, Yu-Shun Hsiao, Tianyu Jia, Vijay Janapa Reddi, Arijit Raychowdhury  
*In 58<sup>th</sup> ACM/IEEE Design Automation Conference (DAC), December 2021*  
*Acceptance Rate: 23%*
- AICAS 2021** “An Energy-Efficient Quad-Camera Visual System for Autonomous Machines on FPGA Platform”  
Zishen Wan\*, Yuyang Zhang\*, Arijit Raychowdhury, Bo Yu, Yanjun Zhang, Shaoshan Liu  
*In IEEE International Conference on Artificial Intelligence Circuits and Systems (AICAS), June 2021*
- AICAS 2021** “iELAS: An ELAS-Based Energy-Efficient Accelerator for Real-Time Stereo Matching on FPGA Platform”  
Tian Gao\*, Zishen Wan\*, Yuyang Zhang, Bo Yu, Yanjun Zhang, Shaoshan Liu, Arijit Raychowdhury  
*In IEEE International Conference on Artificial Intelligence Circuits and Systems (AICAS), June 2021*
- ICLR 2021** (Workshop) “ActorQ: Quantization for Actor-Learner Distributed Reinforcement Learning”  
Max Lam\*, Sharad Chitlangian\*, Srivatsan Krishnan\*, Zishen Wan, Gabriel Barth-Maron, Aleksandra Faust, Vijay Janapa Reddi

*In Hardware-Aware Efficient Training (HEAT) Workshop, International Conference on Learning Representations (ICLR), May 2021*

**DAC 2020** “Algorithm-Hardware Co-Design of Adaptive Floating-Point Encodings for Resilient Deep Learning Inference”  
 Thierry Tambe, En-Yu Yang, Zishen Wan, Yuntian Deng, Vijay Janapa Reddi, Alexander Rush, David Brooks, Gu-Yeon Wei  
*In 57<sup>th</sup> ACM/IEEE Design Automation Conference (DAC), July 2020*  
**(Best Paper Award)**  
*Acceptance Rate: 23% (228/984)*

**MLSys 2020** “Quantized Reinforcement Learning (QuaRL)”  
 (Workshop) Srivatsan Krishnan\*, Sharad Chitlangian\*, Max Lam\*, Zishen Wan, Aleksandra Faust, Vijay Janapa Reddi  
*In Resource-Constrained Machine Learning Workshop, Conference on Machine Learning and System (MLSys), March 2020*

## Journal Publications

**JSSC** “A Heterogeneous RRAM In-Memory and SRAM Near-Memory SoC for Fused Frame and Event-Based Target Identification and Tracking”  
 Ashwin Lele\*, Muya Chang\*, Samuel Spetalnick, Brian Crafton, Shota Konna, Zishen Wan, Ashwin Bhat, Win-San Khwa, Yu-der Chih, Meng-Fan Chang, Arijit Raychowdhury  
*In IEEE Journal of Solid-State Circuits (JSSC), July, 2023*

**TMLR 2022** “QuaRL: Quantization for Fast and Environmentally Sustainable Reinforcement Learning”  
 Srivatsan Krishnan\*, Max Lam\*, Sharad Chitlangian\*, Zishen Wan, Gabriel Barth-Maron, Aleksandra Faust, Vijay Janapa Reddi  
*In Transactions on Machine Learning Research (TMLR), July 2022*

**CAS-M 2021** “A Survey of FPGA-Based Robotic Computing”  
Zishen Wan\*, Bo Yu\*, Thomas Yuang Li, Jie Tang, Yuhao Zhu, Yu Wang, Arijit Raychowdhury, Shaoshan Liu  
*In IEEE Circuits and Systems Magazine (CAS-M), June 2021*

**CAL 2020** “The Sky Is Not the Limit: A Visual Performance Model for Cyber-Physical Co-Design in Autonomous Machines”  
 Srivatsan Krishnan, Zishen Wan, Kshitij Bhardwaj, Paul Whatmough, Aleksandra Faust, Gu-Yeon Wei, David Brooks, Vijay Janapa Reddi  
*In IEEE Computer Architecture Letters (CAL), March 2020*  
**(Best Paper Award)**

**JJAP 2019** “Electrically Tunable Temporal Imaging in a Graphene-Based Waveguide”  
 Peng Xie, Yu Wen, Zishen Wan, Xinyu Wang, Jiarui Liu, Wenqiang Yang, Xiaofeng Li, Yishan Wang  
*In Japanese Journal of Applied Physics, 58(5):050914, April 2019*

## Preprints

**Preprint 2021** “AutoSoC: Automating Algorithm-SoC Co-design for Aerial Robots”  
 Srivatsan Krishnan, Thierry Tambe, Zishen Wan, Vijay Janapa Reddi  
*arXiv preprint arXiv:2109.05683, 2021*

**Preprint 2019** “Adaptivfloat: A Floating-point Based Data Type for Resilient Deep Learning Inference”  
 Thierry Tambe, En-yu Yang, Zishen Wan, Yuntian Deng, Vijay Janapa Reddi, Alexander Rush, David Brooks, Gu-Yeon Wei  
*arXiv preprint arXiv:1909.13271*, 2019

## **SELECTED TALKS**

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- May 2023 “Towards Cognitive AI Systems: A Survey and Perspective on Neuro-Symbolic AI”  
*At CoCoSys (Center for the Co-Design of Cognitive Systems) Annual Summit, DARPA SRC JUMP 2.0, Atlanta, GA, USA*
- May 2023 “Towards Cognitive AI Systems: A Survey and Perspective on Neuro-Symbolic AI”  
*At Georgia Tech 3D Systems Packaging Research Center Spring Meeting, Atlanta, GA, USA*
- May 2023 “Intelligence in Robotic Computing: Exploring Agile Design Flows for Building Efficient and Resilient Autonomous Systems”  
*At Georgia Tech Chips Day, Atlanta, GA, USA*
- Mar 2023 “Intelligence in Robotic Computing: Exploring Agile Design Flows for Building Efficient and Resilient Autonomous Systems”  
*At Georgia Tech Efficient and Intelligent Computing (EIC) Lab, Atlanta, GA, USA*
- Feb 2023 “Intelligence in Robotic Computing: Exploring Agile Design Flows for Building Efficient and Resilient Autonomous Systems”  
*At CRNCH (Center for Research into Novel Computing Hierarchies) Annual Summit, Atlanta, GA, USA*
- Nov 2022 “Intelligence in Robotic Computing: Exploring Agile Design Flows for Building Efficient and Resilient Autonomous Systems”  
*At ACM Student Research Competition (SRC) at ICCAD 2022, San Diego, CA, USA*
- Nov 2022 “Efficient and Resilient Computing for Autonomous Systems”  
*At ACM Student Research Competition (SRC) at ESWEEK 2022, virtual*
- Oct 2022 “Efficient Algorithm-Hardware Co-Design for Robotic Mapping and Localization”  
*At 5<sup>th</sup> IBM AI Compute Symposium, IBM T.J. Watson Research Center, Yorktown Heights, NY, USA*
- Oct 2022 “Efficient Algorithm-Hardware Co-Design for Robotic Mapping and Localization”  
*At CBRIC (Center for Brain-Inspired Computing) Annual Summit, Purdue University, West Lafayette, IN, USA*
- Jun 2022 “Reliability of Autonomous Machines – System Perspective”  
*At COMPSAC Plenary Panel, Torino, Italy (virtual)*
- Mar 2022 “FPGA-Based Robotic Computing: Current Progress, Challenges, and Opportunities”  
*Guest Lecture in Georgia Tech ECE8893 (Parallel Programming for FPGAs), Atlanta, GA, USA*
- Feb 2022 “FPGA-Based Robotic Computing: Current Progress, Challenges, and Opportunities”

*At CRNCH (Center for Research into Novel Computing Hierarchies) Annual Summit, Atlanta, GA, USA*

Nov 2021 “Efficient and Reliable Computing for Autonomous Machines”  
*At ACM Student Research Competition (SRC) at ICCAD 2021, virtual*

Oct 2021 “Enabling Reliable and Safe Autonomous Systems”  
*At CBRIC (Center for Brain-Inspired Computing) Annual Summit, Purdue University, West Lafayette, IN, USA (virtual)*

Aug 2021 “Analyzing and Improving Resilience of Autonomous Systems - From Hardware Faults Perspective”  
*At CBRIC (Center for Brain-Inspired Computing) Industry Talk, virtual*

## **MENTORSHIP**

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Fall 2022 Maanas Purushothapu (BS - Georgia Tech), Nishant Sharma (BS - Georgia Tech)  
*Project: Accelerating Robotic Computing with FPGAs*

Spring 2022 Zhenkun Fan (MS - Georgia Tech)  
*Project: Benchmarking Unsupervised Adaptation on Edge Devices*

Spring 2022 Ying-Hao Wei (MS - Georgia Tech)  
*Project: Reliability Analysis and Improvement of Autonomous Intelligent Systems*

Fall 2021 Katarine Emanuela Klitzke (Undergrad - Georgia Tech)  
*Project: Architectural Analysis and Benchmarking for UAV Navigation Systems*

Summer 2020 Prateek Piniseti (Undergrad - Harvard)  
*Project: Performance Modeling for Cyber-Physical Co-Design in UAV*

## **ACADEMIC SERVICE**

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**ML Commons** ML Commons (MLPerf) Research Working Group  
*Co-found ML Commons Resilience and Robustness Research Working Group, 2022*

**DAC** IEEE/ACM Design Automation Conference (DAC)  
*Reviewer, 2023*

**ESWEEK** IEEE/ACM Embedded Systems Week (ESWEEK)  
*Reviewer, 2023*

**IEEE T-CAD** IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems  
*Reviewer, 2023*

**IEEE TBioCAS** IEEE Transactions on Biomedical Circuits and Systems  
*Reviewer, 2023*

**ISCA** IEEE/ACM International Symposium on Computer Architecture (ISCA)  
*Artifact Evaluation Committee, 2023*

**MICRO** IEEE/ACM International Symposium on Microarchitecture (MICRO)



*Artifact Evaluation Committee, 2023*  
*Artifact Evaluation Committee, 2022*

**ASPLOS** IEEE/ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS)  
*Artifact Evaluation Committee, 2023*  
*Artifact Evaluation Committee, 2022*

**IISWC** IEEE International Symposium on Workload Characterization (IISWC)  
*Artifact Evaluation Committee, 2022*  
*Student Volunteer, 2019*

**NPC** IFIP International Conference on Network and Parallel Computing (NPC)  
*Technical Program Committee, 2022*

**COMPSAC** IEEE Computers, Software & Applications Conference (COMPSAC)  
*Panelist, 2022*

**IEEE Entrep.** IEEE Entrepreneurship of China Region  
*Steering Committee, 2023*

## **SKILLS**

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**Programming** Python, C/C++, Verilog/SystemVerilog, MATLAB

**ML Framework** Pytorch, TensorFlow, Keras, Caffe

**Tool** Virtuoso, Design Compiler, Innovous, Calibre, Vivado, Quartus, OrCAD, MultiSim, Altium Designer, Unreal Engine, AirSim