NINGYUAN CAO

PERSONAL INFORMATION

work email ncao@nd.edu
personal email ningyuancao@gmail.com
website http://www.ncao-nd.com/
phone (H) +1 (917) 929 3625

RESEARCH INTEREST

- **Analog/mixed-signal/digital circuit** fundamentals of security hardware with scalable resilience to emerging deep learning attack;

- **Architecture-algorithm co-design** for privacy-preserving computation among distributed data / processing resources;

- **ASIC and wireless SoC chip** design for state-of-the-art demonstration of security/privacy-critical real-time CPS (medical-wearable, homeland security, industrial IoT, autonomous vehicle etc..).

ACADEMIC AND INDUSTRY EXPERIENCE

2021-present **Assistant Professor**, University of Notre Dame , South Bend, IN
- Circuit and system fundamentals for secure collaborative intelligence

2020-2021 **Research Associate**, IBM T.J. Watson, Yorktown Heights, NY
- IC design automation for power converter topology synthesis

2020-2021 **Post Doctoral Fellow**, Georgia Institute of Technology, Atlanta, GA
- Cryogenic device / digital circuit modeling

2018 **Architect Intern**, Micron, Folsom, CA
- DRAM workload experiment and analysis

EDUCATION

2015-2020 **Ph.D.**
School of Electrical and Computer Engineering
Georgia Institute of Technology, Atlanta, GA

2013-2015 **M.S.**
Electrical Engineering Department
Columbia University, New York, NY

2009-2013 **B.S.**
School of Electronic Information and Electrical Engineering
Shanghai Jiaotong University, Shanghai, China

ON-GOING RESEARCH

2020-present **Circuit design of *Computational Physically-Unclonable-Function* (C-PUF) with scalable resilience to technology-induced deep-learning attacks**

2021-present **HW-SW co-design of *channel-induced programmable Gaussian noise* for ultra-low-power privacy-preserving differential-privacy communication**

2021-present ***DNN-compatible homomorphic encryption digital circuit* design for IoT intelligence-security co-optimization**

2021-present **Hardware-software co-design of *PUF-enabled reversible de-identification* in private-preserving security applications**

2021-present **Cryogenic Monolithic 3D DRAM Integration with Superconducting Material and Near-memory AI Acceleration**

2020-present **Scalable and Explainable Analog/Mixed-signal Circuit IC Design Automation**

PIOR RESEARCH ACTIVITY

2020-2022 **Model-based Reinforcement Learning with Active Learning for Efficient Electrical Power Converter Design**, Advanced Research Projects Agency–Energy(ARPA-E), Department of Energy

2020-Present **Model-based Reinforcement Learning with Active Learning for Efficient Electrical Power Converter Design**, Advanced Research Projects Agency–Energy(ARPA-E), Department of Energy

2019-2020 **EXPlainable-AI through Efficient hardware-design in EmeRging Technologies**, Semiconductor Research Corporation

2017-2019 **Self-Powered IoT Sensor Node with In-situ Data Analytics and Energy-Aware End-to-end Real-time Optimization**, Semiconductor Research Corporation

2018-2021 **Algorithms for Emerging Hardware**, Center for Brain Inspired Computation (C-BRIC), Semiconductor Research Corporation

2018-2021 **Neural Primitives**, Center for Brain Inspired Computation (C-BRIC), Semiconductor Research Corporation

PATENT

2022 **Graph neural network and active learning framework for electric circuit design**, U.S. Patent (in review)

2022 **Monte Carlo Tree Search-Based Algorithm for Circuit Design Automation**, U.S. Patent

SELECTED PUBLICATIONS

2022 B. Cheng, J. Liu, M. Chang, **Ningyuan Cao** "Privacy-by-Sensing: Mixed-signal Circuit for Deferentially-Private Compressed-Sensing," International Conference on Computer-Aided-Design (ICCAD). (in review).

2022 **Ningyuan Cao**, B. Chatterjee, J. Liu, B. Cheng, M. Gong, M. Chang, S. Sen, A. Raychowdhury "A 65 nm Wireless Image SoC Supporting On-Chip DNN Optimization and Real-Time Computation-Communication Trade-Off via Actor-Critical Neuro-Controller," IEEE Journal of Solid-State Circuits, doi: 10.1109/JSSC.2022.3159473..

2022 S. Fan, S. Zhang, J. Liu **Ningyuan Cao**, J. Li, X. Guo and X. Zhang. "Power Converter Circuit Design Automation using Parallel Monte Carlo Tree Search," in IEEE Transactions on Design Automation of Electronic Systems, 2022 (accepted).

2021 R. Saligram, W. Chakraborty **Ningyuan Cao**, Y. Cao, S. Data and A. Raychwodhury. "Power Performance Analysis of Digital Standard Cells for 28 nm Bulk CMOS at Cryogenic Temperature Using BSIM Models," in IEEE Journal on Exploratory Solid-State Computational Devices and Circuits, volume 7, number 2, pp. 193–200, IEEE, 2021.

2021 S. Fan, **Ningyuan Cao**, X. Guo, S. Zhang, J. Li, and X. Zhang. "From specification to topology: Automatic power converter design via reinforcement learning," in International Conference On Computer Aided Design (**ICCAD**), pp. 1–9, IEEE/ACM, 2021.

2020 **Ningyuan Cao**, Minxiang Gong, Muya Chang, Baibhab Chatterjee, Shreyas Sen and Arijit Raychowdhury. "A 65nm Reconfigurable Image Processing Node Supporting Multiple Neural Networks, a Digitally-Adaptive Transceiver and a Mixed-Signal Actor-Critic Neuro-controller for Real-Time Computation-Communication Trade-off," Symposia on VLSI Technology and Circuits (**VLSI**), 2020

2019 **Ningyuan Cao**, Muya Chang, and Arijit Raychowdhury. A 65-nm 8-to-3-b 1.0-0.36-V 9.1-1.1-TOPS/W Hybrid-Digital-Mixed-Signal Computing Platform for Accelerating

Swarm Robotics," in IEEE Journal of Solid-State Circuits (**JSSC**). doi: 10.1109/JSSC.2019.2935533

2019 **Ningyuan Cao**, Muya Chang, and Arijit Raychowdhury. "14.1 A 65nm 1.1-to-9.1 TOPS/W Hybrid-Digital-Mixed-Signal Computing Platform for Accelerating Model-Based and Model-Free Swarm Robotics." In 2019 IEEE International Solid-State Circuits Conference (**ISSCC**), pp. 222-224. IEEE, 2019

2019 Insik Yoon, **Ningyuan Cao**, Anvesha Amaravati and Arijit Raychowdhury, "A 55nm 50nJ/encode 13nJ/decode Homomorphic Encryption Crypto-Engine for IoT Nodes to Enable Secure Computation on Encrypted Data," 2019 IEEE Custom Integrated Circuits Conference (**CICC**), Austin, TX, USA, 2019, pp. 1-4. doi: 10.1109/CICC.2019.8780277

2018 **Ningyuan Cao**, Justin Ting, Shreyas Sen, and Arijit Raychowdhury. "Smart sensing for hvac control: Collaborative intelligence in optical and infrared cameras." IEEE Transactions on Industrial Electronics (**TIE**) 65, no. 12 (2018): 9785-9794

2017 **Ningyuan Cao**, Saad Bin Nasir, Shreyas Sen, and Arijit Raychowdhury. "Self-optimizing IoT wireless video sensor node with in-situ data analytics and context-driven energy-aware real-time adaptation." IEEE Transactions on Circuits and Systems I (**TCAS-I**): Regular Papers 64, no. 9 (2017): 2470-2480

2017 **Ningyuan Cao**, Saad Bin Nasir, Shreyas Sen, and Arijit Raychowdhury. "In-sensor analytics and energy-aware self-optimization in a wireless sensor node." In 2017 IEEE MTT-S International Microwave Symposium (**IMS**), pp. 200-203. IEEE, 2017

PAPERS IN SUBMISSION

2021 **Ningyuan Cao**, X. Guo, S. Zhang, J. Li, and X. Zhang. "Switch−GNN: Graph−Neural−Networks for Power Converter Topology Design Automation", in Design, Automation & Test in Europe (**DATE**), 2022

2021 **Ningyuan Cao**, Minxiang Gong, Muya Chang, Baibhab Chatterjee, Shreyas Sen and Arijit Raychowdhury. "A 65nm Wireless Image Processing IoT SoC with End-to-end Self-learned Online Optimization, Full DNN Algorithm Reconfigurability and Digitally-Adaptive Transceiver", in IEEE Journal of Solid-State Circuits (**JSSC**), 2021

TEACHING ACTIVITY

2021 Fall **EE67062, Circuits and Systems for Machine Learning**, enrollment 14

2022 Spring **EE20242, Electronic-I**, enrollment 65

PROFESSIONAL SERVICE

2022-Present Reviewer for IEEE Journal of Solid-State Circuits

2022-Present Reviewer for IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems

2022-Present Reviewer for IArtificial Intelligence Circuits and Systems

2020-Present Reviewer for IEEE Access

2019-present Reviewer for IEEE Transaction on Internet of Things Journal

2018-Present Reviewer for IEEE Journal on Emerging and Selected Topics in Circuits and Systems

2017-Present Reviewer for IEEE Transactions on Industrial Electronics (TIE)

2017-Present Reviewer for IEEE Transactions on Circuits and Systems II: Express Briefs (TCAS-II)

2017-Present Reviewer for IEEE Transactions on Circuits and Systems I: Regular Papers (TCAS-I)

AFFILIATION

2020-Present IEEE Member

2015-2020 IEEE Student Member