DONGNING MA

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Department of Electrical and Computer Engineering, Villanova University

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EDUCATION

Villanova University, PA   *January 2019 - Present*
Doctor of Philosophy Student in Computer Engineering
Department of Electrical and Computer Engineering

University of Science and Technology Beijing, China   *September 2014 - June 2018*
Bachelor of Engineering in Automation
School of Advanced Engineering

RESEARCH FOCUS

- Hyperdimensional Computing, Vector Symbolic Architectures, and Neuromorphic computing

- AI-powered Bio-informatics and Smart Health-care

- Electronic Design Automation and Approximate Computing

RESEARCH PROJECTS

Brain Inspired Hyperdimensional Computing

- Novel Application of Hyperdimensional Computing (2021 – Now)

  - Introduce the emerging brain inspired neuromorphic scheme – hyperdimensional computing on various applications including natural language processing and molecular pharmacology.

  - Implementing efficient spam text detection using hyperdimensional computing which achieve comparable accuracy with 30–115X model size compression (ISVLSI'21).

  - Using hyperdimensional computing to encode SMILES representation of molecules and develop ultra-low-cost model for classification tasks on pharmacology that shows comparable results with SOTA GNNs.

- On Energy-efficient, Secure and Robust Hyperdimensional Computing Models (2021 – Now)

  - Exploring error characteristics and propose mitigation methods on energy efficient hyperdimensional computing systems using voltage scaling (ASAP'21).

  - Propose black-box and grey-box fuzz testing schemes to analyze robustness of hyperdimensional computing under adversarial samples (DAC'21, ISVLSI'21).

Approximate Computing and EDA

- Approximate Computation Memoization and Bypass for Data Intensive Applications (2019 – 2021)

  - Propose methodologies leveraging data locality along with error tolerance to enable approximate computing on emerging applications.

  - Implement computation memoization via emerging FeFET CAM to enable up to 60% energy saving on CNNs with minimal accuracy loss (GLVLSI'20).

– Design computation bypass logics on data-intensive applications such as image processing, vision transformers to enhance energy efficiency on multiple platforms such as GPU and FPGA (NANOARCH'19, DSD'20, ISQED'21).

- Machine Learning Based Timing and Error Modelling of (Approximate) Functional Units (2019 – 2020)

  – Design and train machine learning algorithms to model dynamic timing delay and output errors of (approximate) functional units.

  – Successfully predict dynamic timing delays and output errors of functional units under specific input with accuracy higher than 95% (TCAD'20, DAC'20, DSN'20, SELSE'20, TCAD'21).

  – ML models help architects to obtain circuit timing or output information without the need of using complicated EDA toolchains, enabling concise design loop and faster verification and testing.

ACADEMIC RECORDS

Journals

3. <u>Dongning Ma</u>, Xinqiao Zhang, Ke Huang, Yu Jiang, Wanli Chang, Xun Jiao, "DEVoT: Dynamic Delay Modeling of Functional Units under Voltage and Temperature Variations". IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD), 2021.

2. Xun Jiao, <u>Dongning Ma</u>, Wanli Chang, Yu Jiang, "LEVAX: An Input-aware Learning-based Error Model of Voltage-Scaled Functional Units". IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD), 2020.

1. <u>Dongning Ma</u>, Xun Jiao, "WoMA: An Input-Based Learning Model to Predict Dynamic Workload of Embedded Applications". Embedded Systems Letters, 2019.

Conferences

15. <u>Dongning Ma</u>, Rahul Thapa, Xun Jiao, "MoleHD: Drug Discovery using Brain-Inspired Hyperdimensional Computing", in preparation.

14. <u>Dongning Ma</u>, Xue Qin, Xun Jiao, "AxBy-ViT: Reconfigurable Approximate Computation Bypass for Vision Transformers", 23rd International Symposium on Quality Electronic Design (ISQED), Virtual, California, 2022

13. Sizhe Zhang, Ruixuan Wang, <u>Dongning Ma</u>, Jeff Jun Zhang, Xunzhao Yin, Xun Jiao, "Energy-Efficient Brain-Inspired Hyperdimensional Computing Using Voltage Scaling". 2022 Design, Automation and Test in Europe Conference (DATE), Antwerp, Belgium, 2022

12. Rahul Thapa, <u>Dongning Ma</u>, Xun Jiao, "HDXplore: Automated Differential Testing of Brain-Inspired Hyperdimensional Computing". 2021 IEEE Computer Society Annual Symposium on VLSI (ISVLSI), Tampa, FL, 2021.

11. Rahul Thapa, Bikal Lamichhane, <u>Dongning Ma</u>, Xun Jiao, "SpamHD: Efficient Text Spam Detection Using Brain-Inspired Hyperdimensional Computing". 2021 IEEE Computer Society Annual Symposium on VLSI (ISVLSI), Tampa, FL, 2021.

10. <u>Dongning Ma</u>, Jianmin Guo, Yu Jiang, Xun Jiao, "HDTest: Differential Fuzz Testing of Brain-Inspired Hyperdimensional Computing". 58th 2021 ACM/EDAC/IEEE Design Automation Conference (DAC), San Francisco, CA, 2021.

9. <u>Dongning Ma</u>, Rahul Thapa, Xingjian Wang, Cong Hao and Xun Jiao, "Workload-Aware Approximate Computing Configuration". 2021 Design, Automation & Test in Europe Conference & Exhibition (DATE), Grenoble, France, 2021.

8. <u>Dongning Ma</u>, Xun Jiao, "A Machine Learning-based Error Model of Voltage-Scaled Circuits". 50th IEEE/IFIP International Conference on Dependable Systems and Networks (DSN), Valencia, Spain, 2020.

7. <u>Dongning Ma</u>, Xun Jiao, "AxBy: Approximate Computation Bypass for Data-Intensive Applications". 2020 Euromicro Conference on Digital System Design (Euromicro DSD), Portoro, Slovenia, 2020. **(Outstanding Paper Award)**

6. <u>Dongning Ma</u>, Xunzhao Yin, Michael Niemier, X. Sharon Hu, Xun Jiao, "AxR-NN: Approximate Computation Reuse for Energy-Efficient Convolutional Neural Networks". 30th ACM Great Lakes Symposium on VLSI (GLSVLSI), Beijing, China, 2020.

5. Xun Jiao, <u>Dongning Ma</u>, Wanli Chang, Yu Jiang, "TEVoT: Timing Error Modeling of Functional Units under Dynamic Voltage and Temperature Variations". 57th 2019 ACM/EDAC/IEEE Design Automation Conference (DAC), San Francisco, CA, 2020.

4. <u>Dongning Ma</u>, Xun Jiao, "An Input-aware Learning-based Error Model of Voltage-Scaled Functional Units". The 16th IEEE Workshop on Silicon Errors in Logic - System Effects (SELSE), Stanford, CA, 2020. **(Best Paper Award)**

3. <u>Dongning Ma</u>, Siyu Shen, Xun Jiao, "Work-in-Progress: DeVos: A Learning-based Delay Model of Voltage-Scaled Circuits". International Conference on Hardware/Software Codesign and System Synthesis (CODES+ISSS), New York, USA, 2019.

2. <u>Dongning Ma</u>, Xun Jiao, "Detecting and Bypassing Trivial Computations in Convolutional Neural Networks", IEEE/ACM International Symposium on Nanoscale Architectures (NANOARCH), 2019

1. <u>Dongning Ma</u>, Xun Jiao, "Energy Efficient GPU Applications Through Computation Skip". in Proc. IEEE International Conference on Embedded Software and Systems (ICESS), Las Vegas, USA, 2019.

Honors and Grants

- 2021 International Green and Sustainable Computing Conference (IGSC 2021) - Student Support Grant (NSF)

- 2021 ACM/EDAC/IEEE Design Automation Conference (DAC 2021) Young Fellow Program with the **Best 2-Minute Research Video** Award!

- IEEE Computer Society Annual Symposium on VLSI (ISVLSI 2021) - Student Travel Grant (NSF)

- 2020 ACM/EDAC/IEEE Design Automation Conference (DAC 2020) A. Richard Newton Young Student Fellow

- International Green and Sustainable Computing Conference (IGSC 2020) - Student Support Grant

- IEEE VLSI Test Symposium 2020 (VTS'20) - Student Activities Program (NSF)

- 10th International Green and Sustainable Computing Conference (IGSC 2019) - Poster Presentation - Student Travel Grant (NSF)

- Embedded System Week 2019 (ESWEEK'19) ACM SIGBED Student Research Competition - Student Travel Grant (Microsoft)

OTHER SERVICES

Teaching

- Teaching Assistant for EGR 1620 - Engineering Programming and Application (Spring 2022)
- Teaching Assistant for EGR 1200 - Engineering Interdisciplinary Project I (Fall 2021)
- Teaching Assistant for ECE 5450 - Microcontrollers & Applications (Fall 2021)
- Teaching Assistant for EGR 1620 - Engineering Programming and Application (Spring 2021)
- Teaching Assistant for EGR 1200 - Engineering Interdisciplinary Project I (Fall 2020)
- Teaching Assistant for ECE 5450 - Microcontrollers & Applications (Fall 2020)
- Teaching Assistant for ECE 1620 - Engineering Programming and Application (Spring 2020)
- Teaching Assistant for ECE 2045 - Fundamentals of Computer Engineering II Lab (Spring 2020)
- Teaching Assistant for ECE 5400 - Applied Machine Learning (Fall 2019)
- Teaching Assistant for ECE 5450 - Microcontrollers & Applications (Fall 2019)
- Teaching Assistant for ECE 2431 - Embedded Systems I Lab (Spring 2019)

Professional Services

- Reviewer for IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD)

Memberships

- Institute of Electrical and Electronics Engineers (IEEE), Student Member, 2019 - Present
- Association for Computing Machinery (ACM), Student Member, 2019 - Present

Last Update: 1/25/2021