Che-Kai Liu

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Education

Georgia Institute of Technology, Ph.D. *Atlanta, Georgia, USA*

School of Electrical and Computer Engineering *Aug. 2023 - 2028 (expected)*

- Graduate Research Assistant, Advisor: Prof. Arijit Raychowdhury
- Research focus: Neuro-symbolic (NS) computer architecture and circuit tape-out.

Zhejiang University, B.Eng. *Hangzhou, Zhejiang, P.R.China*

College of Information Science and Electronic Engineering. *Sep.2019 - July 2023 (expected)*

- **3 consecutive** Award of Merits for HongKong, Macau, Taiwan, and Overseas Chinese, 2020‡, 2021*, 2022†. Ministry of Education, P.R.China.
- Research sponsorship/scholarship from Fellow of IEEE/ACM Prof. X. Sharon Hu, 2022.
- Research scholarship from the University of Notre Dame, IN, USA 2022.
- **First Place**, ACM Student Research Competition at ACM/IEEE Int'l Conference on Computer-Aided Design (ICCAD), 2022.
- **Best** presentation award at ACM/IEEE ESWEEK EIC workshop, 2022.
- Third-Class Scholarship for Award of Merits, 2022. Top 25%⋆. Issued: Zhejiang University.
- Outstanding student of innovation 2022, academic records 2022, foreign exchange 2022. Top 30% each. Issued: Zhejiang University.

‡: Ranked 3/30 (among all grades, 17'-19', our dept.). ∗: Ranked 2/30 (among all grades, 18'-20', our dept.). †: Ranked 1/100 (among all grades, 19'-21', **ALL** engg. dept.). ⋆: Among 280 students in our dept. **Not** limited to HongKong, Macau, Taiwan, and Overseas Chinese.

Publications & Patents & Selected Projects

- 1. **Che-Kai Liu**, H. Chen, M. Imani, K. Ni, A. Kazemi, A. F. Laguna, M. Niemier, X. S. Hu, L. Zhao, C. Zhuo and X. Yin. COSIME: FeFET based Associative Memory for In-Memory Cosine Similarity Search. *full paper, Int'l Conference on Computer-Aided Design (ICCAD), 2022. (acceptance rate: 22%)*
- 2. H. E. Barkam, S. Yun, P. R. Genssler, Z. Zou, **Che-Kai Liu**, H. Amrouch and M. Imani. HDGIM: Hyperdimensional Genome Sequence Matching on Unreliable Highly-Scaled FeFET. *full paper, accepted to IEEE/ACM Design Automation and Test in Europe (DATE), 2023. (acceptance rate: 25%)*
- 3. **Che-Kai Liu**, H. E. Barkam, Z. Zou, H. Chen, S. Yun, C. Zhuo, X. Yin, H. Najafi and M. Imani. Seamless Integration Sensing with Hyperdimensional Computing. *Submitted to 60th IEEE/ACM Design Automation Conference (DAC), 2023*
- 4. M. Issa*, **Che-Kai Liu***, S. Yun, H. Chen, X. Yin, A. Roohi, S. Angizi and M. Imani. XSensor: In-Sensor Autoencoder Compression for Compact Information Sensing. ***: Co-first author**, *Submitted to 53rd Annual IEEE/IFIP International Conference on Dependable Systems and Networks (DSN), 2023.*
- 5. Z. Xu, C. Li, R. Mao, Z. Yang, **Che-Kai Liu**, M. Imani, C. Zhuo, C. Li and X. Yin. A Reconfigurable Design for In-Memory Nearest Neighbor Search. *Submitted, 2023.*
- 6. M. Li*, **Che-Kai Liu***, K. Ni, X.S. Hu. A systematic approach for the reconfigurable in-memory device. ***: Co-first author**, *In prep., 2023.*
- 7. H. E. Barkam, S. Yun, Z. Zou, C. Yeung, **Che-Kai Liu** and M. Imani. When AI Theory Meets Emerging Technologies: Connecting Hyper-Dimensional Algorithms to Hardware Uncertainty. *In prep. 2023.*
- 8. US Patent/P.R.China Invention Patent, 2022: Compute-in-memory for cosine similarity nearest neighbor search. X. Yin, **Che-Kai Liu**, H. Chen, and C. Zhuo. Pending/No. 202211025181.4
- 9. P.R.China Invention Patent, 2022: Multi-bit in-memory multiplication and XNOR unit. X. Yin, **Che-Kai Liu**, H. Chen, and C. Zhuo. No. 202210390722.7
- 10. P.R.China National Research Program, 2021. **Che-Kai Liu**, and H. Chen. Final defense grade: excellent (Top 20%), granted with 12000 CNY.
- 11. B.Eng. Degree Thesis: **Cross-Layer Optimization for Computing-in-Memory Circuits, Architectures and Applications.** 2023. Advisors: Xunzhao Yin,X. Sharon Hu, Mohsen Imani

Graduate Research Projects

Georgia Institute of Technology *Remote*

Graduate Research Assistant, advisor: Prof. Arijit Raychowdhury *Dec. 2022 - June 2023*

- Hardware acceleration for NS-AI applications.

Undergraduate Research Experiences

University of California, Irvine *Irvine, California, USA*

Visitor, advisor: Prof. Mohsen Imani *Aug. 2022 - Dec. 2022 (8-10 **on campus**)*

- Seamless integration sensing with Hyperdimensional Computing (HDC) (see 3). Efficient in-sensor hardware with autoencoder (see 4). **Contribution:** Conceive project. Design architecture for in-sensor radar/lidar in HDC encoding and inference. Adjusting bit-precision for ADC and investigating application-level behavior. HDC algorithm in Python. Paper write-ups. Autoencoder hardware design's energy/area/latency estimation with C++ DNN-Neurosim. Kernel math write-up. Give a lecture for 11 Ph.D.s regarding compute-in-memory (CiM) in the group meeting.
- **Collaboration:** Content addressable memory for genome sequence matching (see 2). NS HDC (see 7).

University of Notre Dame *Notre Dame, Indiana, USA*

Visitor, advisor: Prof. X. Sharon Hu *Apr. 2022 - Present (6-8 **on campus**)*

- Reconfigurable FeFET CiM for cosine, dot product, Euclidean, and Manhattan distance (see 6). **Contribution:** Conceive project. Investigate equivalent expressions for nearest neighbor search with Sift/Deep/Glove datasets with self-calibrated Python code. GPU benchmark with *Nvidia-smi* tool. Design space exploration for 22nm FeFET programming scheme by using SPICE and transform the problem into optimization in math. Formulate and solve the optimization problem with Matlab.

Zhejiang University *Hangzhou, Zhejiang, P.R.China*

Researcher, advisor: Prof. Xunzhao Yin *Dec. 2020 - May 2022*

- COSIME: Invent cosine similarity based in-memory engine using FeFET. (see 1 and 8). **Contribution:** Conceive project. All SPICE simulations, including all Monte Carlo simulations. Neurosim C++ simulation. All small signal circuit analysis. All paper write-up. All patent write-ups.
- Invent multi-bit in-memory multiplication cell (see 9). **Contribution:** Conceive project. All SPICE simulation. All patent write-ups.
- Collaborate (see 5) and mentor National and Provincial Research Programs in the lab.

Skills & Academic Service & Talks & Interests

Skills SPICE (Cadence Virtuoso), Python (Pytorch), C, Verilog, MATLAB, Assembly (RISC-V)

Review IEEE JETCAS x2 (Invited by editors, Prof. S. Yu and Prof. H. Najafi)

Talks ACM/IEEE 41^{st} ICCAD'22; Student Research Competition@ICCAD'22; ACM/IEEE ESWEEK'22 EIC workshop

Interests Sports (3 basketball champions; Minister of our sports dept.; 90+hr of volunteering). Travel. Discourse.

References

- **Dr. Arijit Raychowdhury**, Steve W. Chaddick School Chair and Professor, Fellow of IEEE.
  - School of Electrical and Computer Engineering, Georgia Institute of Technology.
- **Dr. Mohsen Imani**, Tenure-track Professor.
  - Dept. of Information and Computer Sciences, University of California, Irvine.
- **Dr. Xiaobo Sharon Hu**, Professor, Fellow of IEEE and ACM.
  - Dept. of Computer Science and Engineering, University of Notre Dame.
- **Dr. Xunzhao Yin**, Tenure-track Professor.
  - College of Information Science and Electronic Engineering, Zhejiang University.