ZHENGQI, GAO

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EDUCATION

Massachusetts Institute of Technology Cambridge, USA

Ph.D. in Electrical Engineering and Computer Science Sep 2021 – May 2026 (Expected)

- GPA: 5.00/5.00 (Rank: N/A); supervised by Prof. Duane S. Boning
- Research interests: design automation for electronic-photonic integrated circuits, and machine learning

Fudan University Shanghai, China

M.S. in Microelectronics and Solid State Electronics Sep 2018 – Jun 2021

- GPA: 3.82/4.00 (Rank: N/A); worked with Prof. Jun Tao and Prof. Xin Li (Duke Univ.)
- Research interests: electronic design automation (EDA), Bayesian methods, and machine learning

B.E. in Microelectronic Science and Engineering Sep 2014 – Jun 2018

- GPA: 3.84/4.00 (Rank: 4/71); selected to Elite Engineering Program (top 5%)
- Relevant coursework: Mathematical Analysis, Probability, Mathematical Statistics and Stochastic Process, Signal and System, Data Structure and Algorithm Design, Design of Analog Integrated Circuits

SELECTED PUBLICATIONS

Machine Learning

1. K. Zha*, **Z. Gao***, M. Shen, Z.-W. Hong, D. S. Boning, and D. Katabi, "RL Tango: Reinforcing Generator and Verifier Together for Language Reasoning," *Conference on Neural Information Processing Systems* (*NeurIPS*), 2025. [PDF][Code] (*Equal Contribution)
2. H. Ye, **Z. Gao**, M. Ma, Q. Wang, Y. Fu, M.-Y. Chung, Y. Lin, Z. Liu, J. Zhang, D. Zhuo, and Y. Chen "Training-free Online KV-cache Communication for Efficient LLM-based Multi-agent System," *Conference on Neural Information Processing Systems* (*NeurIPS*), 2025.
3. **Z. Gao**, K. Zha, T. Zhang, Z. Xue, and D. S. Boning, "REG: Rectified Gradient Guidance for Conditional Diffusion Models," *International Conference on Machine Learning* (*ICML*), 2025. [PDF][Code]
4. S. Zheng*, **Z. Gao***, F.-K. Sun, D. S. Boning, B. Yu, and M. Wong, "Improving Neural ODE Training with Temporal Adaptive Batch Normalization," *Conference on Neural Information Processing Systems* (*NeurIPS*), 2024. [PDF][Code] (*Equal Contribution)
5. H. Lin, C. Liu, C. Xu, **Z. Gao**, Y. Fu, and Y. Yao, "On the Theory of Cross-Modality Distillation with Contrastive Learning," *International Conference on Learning Representations BGPT workshop*, 2024. [PDF]
6. C.-Y. Lai, F.-K. Sun, **Z. Gao**, J. Lang, and D. S. Boning, "Nominality Score Conditioned Time Series Anomaly Detection by Point/Sequential Reconstruction," *Conference on Neural Information Processing Systems* (*NeurIPS*), 2023. [PDF][Code]
7. Z. Xue*, **Z. Gao***, S. Ren*, and H. Zhao, "The Modality Focusing Hypothesis: Towards Understanding Crossmodal Knowledge Distillation," *International Conference on Learning Representations* (*ICLR*), 2023. [PDF] [Code] (*Equal Contribution, ICLR Spotlight)
8. **Z. Gao**, F. Sun, M. Yang, S. Ren, Z. Xiong, M. Engeler, A. Burazer, L. Wildling, L. Daniel, and D. S. Boning "Learning from Multiple Annotator Noisy Labels via Sample-wise Label Fusion," *European Conference on Computer Vision* (*ECCV*), 2022. [PDF] [Code]
9. J. Gu, **Z. Gao**, C. Feng, H. Zhu, R. T. Chen, D. S. Boning, and D. Z. Pan, "NeurOLight: A Physics-Agnostic Neural Operator Enabling Parametric Photonic Device Simulation," *Conference on Neural Information Processing Systems* (*NeurIPS*), 2022. [PDF] [Code]
10. S. Ren, H. Wang, **Z. Gao**, S. He, A. Yuille, Y. Zhou, and C. Xie, "A Simple Data Mixing Prior for Improving Self-Supervised Learning," *IEEE/CVF Conference on Computer Vision and Pattern Recognition* (*CVPR*), 2022. [PDF] [Code]
11. S. Ren, **Z. Gao**, T. Hua, Z. Xue, Y. Tian, S. He, and H. Zhao, "Co-Advise: Cross Inductive Bias Distillation,"

IEEE/CVF Conference on Computer Vision and Pattern Recognition (*CVPR*), 2022. [PDF] [Code]

12. Z. Xue, S. Ren, **Z. Gao**, and H. Zhao, "Multimodal Knowledge Expansion," *IEEE International Conference on Computer Vision (ICCV)*, 2021. [PDF] [Code]

Design Automation for Electronic-Photonic Integrated Circuits

1. P. Ma, Z. Yin, Q. Jing, **Z. Gao**, N. Gangi, B. Zhang, T.-W. Huang, Z. Huang, D. S. Boning, Y. Yao, and J. Gu, "SP^{2}RINT: Spatially-Decoupled Physics-Inspired Progressive Inverse Optimization for Scalable, PDE-Constrained Meta-Optical Neural Network Training," *Arxiv Preprint*, 2025. [PDF]
2. **Z. Gao**, J. Gu, L. Daniel, R. Rohrer, and D. S. Boning, "SPIPE: Differentiable SPICE-Level Co-Simulation Program for Integrated Photonics and Electronics," *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems* (*IEEE TCAD*), 2025. [PDF]
3. P. Ma, **Z. Gao**, M. Zhang, H. Yang, M. Ren, R. Huang, D. S. Boning, and J. Gu, "MAPS: Multi-Fidelity AI-Augmented Photonic Simulation and Inverse Design Infrastructure," *Design, Automation & Test in Europe Conference* (*DATE*), 2025. [PDF]
4. P. Ma, **Z. Gao**, A. Begovic, M. Zhang, H. Yang, M. Ren, R. Huang, D. S. Boning, and J. Gu, "BOSON^{-1}: Understanding and Enabling Physically-Robust Photonic Inverse Design with Adaptive Variation-Aware Subspace Optimization," *Design, Automation & Test in Europe Conference* (*DATE*), 2025. [PDF]
5. P. Ma, H. Yang, **Z. Gao**, J. Gu, and D. S. Boning, "PIC^{2}O-Sim: A Physics-Inspired Causality-Aware Dynamic Convolutional Neural Operator for Ultra-Fast Photonic Device Time-Domain Simulation," *APL Photonics*, 2025. [PDF]
6. **Z. Gao**, Z. Zhang, Z. He, J. Gu, D. Z. Pan, and D. S. Boning, "Selecting Robust Silicon Photonic Designs after Bayesian Optimization without Extra Simulations," *Optica Express* (*OE*), 2024. [PDF] (Editor's Pick)
7. **Z. Gao**, F. Sun, R. Rohrer, and D. S. Boning, "KirchhoffNet: A Scalable Ultra Fast Analog Neural Network," *IEEE/ACM International Conference on Computer-Aided Design* (*ICCAD*), 2024 [PDF][Code] (ML and System Rising Star 2024)
8. **Z. Gao**, X. Chen, Z. Zhang, U. Chakraborty, W. Bogaerts, and D. S. Boning, "Gradient-Based Power Efficient Functional Synthesis for Programmable Photonic Circuits," *IEEE Journal of Lightwave Technology* (*IEEE JLT*), 2024. [PDF]
9. **Z. Gao**, D. Zhang, L. Daniel, and D. S. Boning, "NOFIS: Normalizing Flow for Rare Circuit Failure Analysis," *Design Automation Conference* (*DAC*), 2024. [PDF][Code] (*MIT MARC* 2024 Best Pitch Award)
10. **Z. Gao**, X. Chen, Z. Zhang, C. Y. Lai, U Chakraborty, W. Bogaerts, and D. S. Boning, "Provable Routing Analysis of Programmable Photonics," *IEEE Journal of Lightwave Technology* (*IEEE JLT*), 2024. [PDF]
11. **Z. Gao**, Z. Zhang, and D. S. Boning, "Few-Shot Bayesian Performance Modeling for Silicon Photonic Devices Under Process Variation," *IEEE Journal of Lightwave Technology* (*IEEE JLT*), 2023. [PDF]
12. J. Li*, D. Ahsanullah*, **Z. Gao***, and R. Rohrer, "Circuit Theory of Time Domain Adjoint Sensitivity," *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems* (*IEEE TCAD*), 2023. [PDF] (*Equal Contribution)
13. Z. Zhang, M. Notaros, **Z. Gao**, U. Chakraborty, J. Notaros, and D. S. Boning, "Impact of Process Variations on Splitter-Tree-based Integrated Optical Phased Arrays," *Opica Express* (*OE*), 2023. [PDF]
14. **Z. Gao**, X. Chen, Z. Zhang, U. Chakraborty, W. Bogaerts, and D. S. Boning, "Automatic Synthesis of Light Processing Functions for Programmable Photonics: Theory and Realization," *Photonics Research*, 2023. [PDF] [Code] (Editor's Pick)
15. C. Li, C. An, **Z. Gao**, F. Yang, Y. Su, and X. Zeng, "Unleashing the Power of Graph Spectral Sparsification for Power Grid Analysis via Incomplete Cholesky Factorization," *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems* (*IEEE TCAD*), 2023. [PDF]
16. **Z. Gao**, X. Chen, Z. Zhang, U. Chakraborty, W. Bogaerts, and D. S. Boning "Automatic Synthesis of Light Processing Functions for Programmable Photonics," *IEEE Photonics Conference (IEEE IPC)*, 2022. [PDF]
17. **Z. Gao**, Z. Zhang, and D. S. Boning, "Automatic Synthesis of Broadband Silicon Photonic Devices via Bayesian Optimization," *IEEE Journal of Lightwave Technology* (*IEEE JLT*), 2022. [PDF][Code]
18. **Z. Gao**, Z. Zhang, and D. S. Boning, "Automatic Design of a Broadband Directional Coupler via Bayesian

Optimization," *Conference on Lasers and Electro-Optics* (*CLEO*), 2022. [PDF]

19. Z. Liang, H. Wang, J. Cheng, Y. Ding, H. Ren, **Z. Gao**, Z. Hu, D. S. Boning, X. Qian, S. Han, W. Jiang, and Y. Shi, "Variational Quantum Pulse Learning," *IEEE International Conference on Quantum Computing and Engineering* (*IEEE QCE*), 2022. [PDF]
20. **Z. Gao** and R. Rohrer, "Efficient Non-Monte-Carlo Yield Estimation," *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems* (*IEEE TCAD*), 2021. [PDF]
21. **Z. Gao**, J. Tao, Y. Su, D. Zhou, X. Zeng, and X. Li, "Fast Statistical Analysis of Rare Failure Events with Truncated Normal Distribution in High-Dimensional Variation Space," *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems* (*IEEE TCAD*), 2021. [PDF]
22. **Z. Gao**, Z. Chen, J. Tao, Y. Sun, D. Zhou, and X. Zeng, "Bayesian Inference on Introduced General Region: An Efficient Parametric Yield Estimation Method for Integrated Circuits," *ACM/IEEE Asia and South Pacific Design Automation Conference* (*ASPDAC*), 2021. [PDF]
23. **Z. Gao**, J. Tao, D. Zhou, X. Zeng, and X. Li, "Efficient Rare Failure Analysis over Multiple Corners via Correlated Bayesian Inference," *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems* (*IEEE TCAD*), 2020. [PDF] [Code]
24. **Z. Gao**, J. Tao, D. Zhou, and X. Zeng, "Efficient Parametric Yield Estimation over Multiple Process Corners via Bayesian Inference Based on Bernoulli Distribution," *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems* (*IEEE TCAD*), 2020. [PDF] [Code]
25. Y. Li, X. Zeng, **Z. Gao**, L. Lin, J. Tao, J. Han, X. Cheng, M. Tahoori, and X. Zeng, "Exploring A Bayesian Optimization Framework Compatible with Digital Standard Flow for Soft-Error-Tolerant Circuit," *IEEE/ACM Design Automation Conference* (*DAC*), 2020. [PDF]
26. **Z. Gao**, J. Tao, F. Yang, Y. Su, D. Zhou, and X. Zeng, "Efficient Performance Trade-Off Modeling for Analog Circuit Based on Bayesian Neural Network," *IEEE/ACM International Conference on Computer Aided Design* (*ICCAD*), 2019. [PDF]

PROFESSIONAL EXPERIENCE

Massachusetts Institute of Technology — Cambridge, USA
Research Assistant --- Supervisor: Prof. Duane S. Boning — Sep 2021 – May 2026 (expected)

- Created SPIPE, the first differentiable simulator for electronic–photonic integrated circuits.
- Developed automatic synthesis for programmable photonic circuits, highlighted by Photonic Research 2023.
- Applied Bayesian optimization and neural operators to optimize and model silicon photonic devices under fabrication variations, highlighted by Optica Express 2024.
- Co-designed and prototyped KirchhoffNet, a hardware accelerator for ODE-based generative models, demonstrating sub-nanosecond latency and high energy efficiency, awarded MLSys rising star 2024.

Apple Inc. — Sunnyvale, USA
AR/VR Hardware Engineering Intern --- Manager: Dr. Sheng Zhang — May 2025 – Aug 2025

- Co-designed hardware and an autoencoder to mitigate VisionPro display artifacts.
- Compressed the model by 15× and reduced runtime to 10% of the original without performance loss, enabling efficient on-device execution; deployed in the next-generation VisionPro.
- Developed an LLM-based automated test case generation pipeline for display algorithms, reducing manual inspection effort by 10× and improving bug detection efficiency.

Nvidia Corporation — Austin, USA
Research Intern --- Manager: Dr. Mark H. Ren — Jun 2023 – Sep 2023

- Developed deep neural network model for semiconductor lithography.
- Produced a large-scale image translation model (> 1B) based on Pixel2Pixel and model compression technique.
- Achieved <0.02% MSE error on Nvidia proprietary chip layout dataset containing over 3M images.

Shanghai Qizhi AI Institute — Shanghai, China
Research Intern --- Mentor: Prof. Hang Zhao (Tsinghua Univ.) — Mar 2021 – Jun 2021

- Exploited multimodal learning and knowledge distillation.
- Developed the modality focusing hypothesis (MFH), spotlighted at ICLR'23.

Southern Methodist University — Remotely
Research Assistant --- Supervisor: Prof. Ron Rohrer — May 2020 – Sep 2021

- Proposed a novel circuit theory to re-explain the time-domain adjoint method.
- Analyzed parametric yield based on the adjoint method, achieving >10× efficiency over MC approach.

Baidu Inc. Shanghai, China
Quality Assurance (QA) Engineering Intern Jun 2017 – Sep 2017
- Measured the robustness of programs and took charge of the FEEDS project.

Fudan University (State Key Laboratory of ASIC & System) Shanghai, China
Research Assistant --- Supervisor: Prof. Jun Tao and Prof. Xin Li (Duke Univ.) Sep 2016 – Jul 2021
- Improved post-silicon yield estimation with domain adaptation technique.
- Estimated multi-corner failure rate and yield with Bayesian inference.
- Performed multi-objective optimization of analog circuits based on a Bayesian neural network.
- Optimized a time variant analog filter by hierarchical clustering (bachelor thesis).
- Developed an SRAM failure-rate estimation tool in collaboration with Prof. Xuan Zhang (WUSTL). [see here]

TEACHING EXPERIENCE

Massachusetts Institute of Technology Cambridge, USA
Teaching Assistant --- Head Instructor: Prof. Shen Shen Feb 2025 – May 2025
- Performed TA duties for 6.3900 Introduction to Machine Learning (~400 students).
- Led the Transformer module and contributed extensively to the course lecture notes on Github, ranking as the second-largest contributor as of August 2025.

Fudan University Shanghai, China
Teaching Assistant --- Instructor: Prof. Jun Xu Sep 2019 – Jan 2020
- Performed TA duties for Design of Analog Integrated Circuits.

Duke Kunshan University Kunshan, China
Teaching Assistant --- Instructor: Prof. Dennis Quan (Duke Univ.) Jan 2020 – Mar 2020
- Performed TA duties for Introduction to Programming & Data Structure at DKU.

MENTORING EXPERIENCE

- Ziang Chen, Fudan University B.E., now Ph.D. student at Fudan University Sep 2019 – Jun 2021
- Nanlin Guo, Fudan University B.E., now Ph.D. student at Fudan University Sep 2019 – Jun 2021
- Jiahe Shi, Fudan University B.E., now Ph.D. student at MIT EECS Sep 2019 – Jun 2021
- Su Zheng, CUHK Ph.D. student Sep 2023 – Present
- Michael Vogit, MIT B.S. student Mar 2024 – Aug 2024
- Mohit Dighamber, MIT B.S., now at Google Sep 2024 – Present
- Ferre Vanden Kerchove, Visiting Ph.D. student from IMEC Dec 2024 – Present
- Ziqin Li, University of Connecticut Ph.D. student Mar 2025 – Present
- Hancheng Ye, Duke University Mar 2025 – Present

SELECTED AWARDS AND HONORS

- 1st place, ACM/IEEE DAC Phd Forum 2025
- Editor's highlight, Optica Express 2024
- ML and Systems Rising Star, MLCommons 2024
- Best Pitch Award, MIT Microsystem Annual Research Conference 2024
- Oral (Spotlight) paper, International Conference on Learning Representations (top 5%) 2023
- Editor's highlight, Optica Photonics Research 2023
- 2nd place, CVPR'23 Ego4d TTM challenge 2023
- DAC young fellowship 2023
- Outstanding Graduates of Shanghai (top 5%) 2021
- Biren Scholarship (3 awardees nationwide) 2020
- The Integrated Circuits Scholarship, Chinese Institute of Electronics (44 awardees nationwide) 2020
- National Scholarship, Fudan University (top 1%) 2020
- Rising Star of Academic, Fudan University (awarded to 11 graduate students majoring in Sci. & Engi.) 2020
- Pacemaker to Merit Student, Fudan University (awarded to 15 graduate students) 2019
- First Prize Scholarship, Fudan University (top 5%) 2019
- National Gold Award, China "Internet+" College Student Innovation & Entrepreneur Competition(top 5%) 2018

- National 2nd Prize, China Post-Graduate Mathematical Contest in Modeling (top 15%) 2018
- Outstanding Undergraduates of Shanghai (top 5%) 2018
- Meritorious Winner, American Mathematical Contest in Modeling (top 13%) 2017
- Top 11%, 2017 IEEE Xtreme Global Programming Competition (out of 3,350 teams worldwide) 2017
- First Prize Scholarship, Fudan University (top 5%) 2015, 2016, 2017
- National 2nd prize, China Mathematical Contest in Modeling (top 15%) 2016

REPRESENTATIVE INDEPENDENT PROJECTS

PRML Solution Manual (GitHub ~1k Stars) Shanghai, China
An Original Solution Manual for Pattern Recognition and Machine Learning (PRML) Sep 2017 – Present
- Solved nearly all exercises in *PRML*; used as references by instructors and students globally. [see here]

Auto-Grading System Kunshan, China
An Auto-Grading System Developed at DKU Jan 2020 – Mar 2020
- Led a small TA group to develop an auto-grading system based on the source code of Submitty.

"Dr. Stanley's House" (Puzzle Video Game) Written in Haskell Shanghai, China
Final Project for Introduction to Functional Programming: From C/C++ to Haskell Sep 2018 – Jan 2019
- Implemented the game with a complete plot via Haskell. [see here]
- Organized the program structure, sorted the logic, and set the schedule as the team leader.
- Exploited Haskell libraries (e.g., SDL2, SDL2-ttf, and SDL2-mixer) to add music and animation.

ADDITIONAL INFORMATION

Professional Services
- Reviewers: IEEE TCAD, ACM TODAES, ICCV, CVPR, NeurIPS, ICML, etc.,
- Organizers:
  - Optical/Photonics Computing System Seminar Series (2023 – present), with Jiaqi Gu
  - DAC 2023 tutorial on optical computing, with Jiaqi Gu, Ulf Schilchtmann, Cunxi Yu
  - DAC 2025 workshop on AI and circuit, with Zhou Jin, Mark Ren, Yiran Chen, Ron Rohrer
  - MIT MIMO Symposium Student Research Forum (2022), with Fan-keng Sun and others
- Selected invited talks:
  - Conference presentation: ICCAD'19 & 24, ECCV'22, DAC'23, ICLR'23, ICML'25, etc.,
  - 'Programmable Photonic Synthesis', at DAC 2023 tutorial on optical computing
  - 'Bayesian Optimization for Photonic Devices,' with Ansys Lumerical, 2022 (host: Jens Niegemann)
  - 'Bayes Elegance in Semiconductor Manufacturing', in Lam Research webinar, 2023 (host: Joe Lu)
  - 'KirchhoffNet', at Duke Mini-Workshop on ML for Analog Circuit Design, 2025 (host: Yiran Chen)

Miscellaneous
- Programming languages & software: C/C++, MATLAB, Python, HSPICE, SPECTRE, Lumerical, Verilog, etc.,
- Languages: Mandarin Chinese (native), English (proficient)
- Volunteer teaching in a rural area of Henan Province, China (Jun – Jul 2015)
- Graduate housing officer, Ashdown House, MIT (Mar 2022 – Sep 2024)

REFERENCES

Duane S. Boning, Ph.D., IEEE Fellow (Advisor)
Clarence J. LeBel Professor in EECS, MIT
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Ron Roher, Ph.D., IEEE Life Fellow, NAE Member
Professor Emeritus of ECE, CMU
Associate Director CHESS, UT Dallas
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Professor of EECS, MIT
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David Z. Pan, Ph.D., ACM, IEEE, and SPIE Fellow
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