ZHENGQI, GAO

Tel: +1-(617)7630963 | Email: zhengqi@mit.edu
Homepage: https://zhengqigao.github.io/
Address: Room 39-328, 60 Vassar Street, Cambridge, MA 02139, USA

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," *Arxiv Preprint*, 2025. [PDF][Code] (*Equal Contribution)

2. **Z. Gao**, K. Zha, T. Zhang, Z. Xue, D. S. Boning, "REG: Rectified Gradient Guidance for Conditional Diffusion Models," *International Conference on Machine Learning* (*ICML*), 2025. [PDF][Code]

3. S. Zheng*, **Z. Gao***, F.-K. Sun, D. S. Boning, B. Yu, M. Wong, "Improving Neural ODE Training with Temporal Adaptive Batch Normalization," *Conference on Neural Information Processing Systems* (*Neurips*), 2024. [PDF][Code] (*equal contribution)

4. H. Lin, C. Liu, C. Xu, **Z. Gao**, Yanwei Fu, Yuan Yao, "On the Theory of Cross-Modality Distillation with Contrastive Learning," *International Conference on Learning Representations BGPT workshop*, 2024. [PDF]

5. 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]

6. 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)

7. **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]

8. 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]

9. 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]

10. 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]

11. 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, 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 co-simulator for electronic–photonic systems.
- 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
- Designed an Autoencoder to compensate for display artifacts due to pupil movement
- 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 PROJECTS

PRML Solution Manual (GitHub 980+ 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 peruse the source code of Submitty
- Developed a fully automatic grading system based on 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)

Computer and Language Skills
- Programming languages & Software: C/C++, MATLAB, Python, HSPICE, SPECTRE, Lumerical, Verilog, etc.,
- Languages: Mandarin Chinese (native), English (proficient)

Other Activities
- 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
MIT Vice Provost
boning@mtl.mit.edu

Luca Daniel, Ph.D., IEEE Fellow
Professor of EECS, MIT
dluca@mit.edu

Yiran Chen, Ph.D., AAAS, ACM, IEEE, and NAI Fellow
John Cocke Distinguished Professor
Department of ECE, Duke University
yiran.chen@duke.edu

Wim Bogaerts, Ph.D., IEEE and OPTICA Fellow
Professor, Ghent University – IMEC
wim.bogaerts@ugent.be

Ron Roher, Ph.D., IEEE Life Fellow, NAE Member
Professor Emeritus of ECE, CMU
Associate Director CHESS, UT Dallas
rr1j@andrew.cmu.edu

Dirk Englund, Ph.D., IEEE and OPTICA Fellow
Professor of EECS, MIT
englund@mit.edu

David Z. Pan, Ph.D., ACM, IEEE, and SPIE Fellow
Silicon Laboratories Endowed Chair Professor
Department of ECE, UT Austin
dpan@ece.utexas.edu