MINGZE WANG

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SHORT BIO

I am a third-year Ph.D candidate in Computational Mathematics, Peking University. I am very fortunate to be advised by Prof. Weinan E. Prior to that, I received my B.S. degree in Pure and Applied Mathematics (ranking 1/111 for the first three years during my undergraduate study) from Zhejiang University in 2021. My homepage is https://wmz9.github.io/.

EDUCATION

Peking University Beijing, China
Ph.D Candidate, *Computational Mathematics* *2021.09 - Present*
School of Mathematical Sciences
Advisor: Prof. Weinan E.

Zhejiang University Hangzhou, China
Bachelor of Science, *Pure and Applied Mathematics* *2017.09 - 2021.06*
School of Mathematical Sciences
Academic ranking: 1/111, Comprehensive ranking: 1/111, Major GPA: 4.84/5 (95.5/100).

RESEARCH INTERESTS

I am broadly interested in theory, algorithm and application of machine learning. I am also interested in non-convex and convex optimization. Recently, I am also dedicated to use theory to design algorithms elegantly. Specifically, my recent research topics are

- **Deep learning theory**: theory and theory-inspired algorithm [1][2][3][4][5][6][8][9][10]
  - **Expressivity**: Explore the expressive power of Transformers through the lens of approximation theory [9]; the expressivity of state-space models.
  - **Optimization**: Why can optimization algorithms converge to global minima when training neural networks [2][4]?
  - **Implicit Bias**: Why can optimization algorithms converge to global minima with favorable generalization ability when training neural networks? Flat-minima-bias [3][5][10]; max-margin-bias aspects [4][6].
  - **Generalization**: How to measure the generalization ability of neural networks [1].
  - **Algorithm Design**: For machine learning problems, design new optimization algorithms which can (i) converge faster [10]; (ii) generalize better [6][10].
- **Transformer and Large Language Models**: theory and algorithm. [9][10]
  - **Expressivity**: The expressive power and mechanisms of Transformer [9]; the mechanisms of in-context learning; the expressivity of state-space models.
  - **Algorithm Design:** Design faster optimizers for training LLMs [10]; design more efficient model architectures; design more efficient strategy for data selection.
- **Non-convex and Convex Optimization**: theory and algorithm. [2][4][6][10]
  - **Convex Optimization in ML**. [6]
  - **Non-convex Optimization in ML**. [2][4][10]
  - **Algorithm Design**: Design faster optimizers for training neural networks [10]; accelerate the convergence for the problems with specific structure [6].
- **Computer vision and Natural language processing**: algorithm and application [7].

PUBLICATIONS & PREPRINTS

10. **Mingze Wang**, Haotian He, Jinbo Wang, Zilin Wang, Guanhua Huang, Feiyu Xiong, Zhiyu Li, Weinan E, Lei Wu. **Improving Generalization and Convergence by Enhancing Implicit Regularization.** Under review. *arXiv preprint: 2405.20763, 1-35. 2024.*

9. **Mingze Wang**, Weinan E. **Understanding the Expressive Power and Mechanisms of Transformer for Sequence Modeling.** Under review. *arXiv preprint: 2402.00522, 1-70. 2024.*

8. Liu Ziyin, **Mingze Wang**, Hongchao Li, Lei Wu. **Loss Symmetry and Noise Equilibrium of Stochastic Gradient Descent.** Under review. *arXiv preprint: 2402.07193, 1-26. 2024.*

7. Guanhua Huang, Yuchen Zhang, Zhe Li, Yongjian You, **Mingze Wang**, Zhouwang Yang. **Are AI-Generated Text Detectors Robust to Adversarial Perturbations?** *Annual Meeting of the Association for Computational Linguistics,* (**ACL 2024**), *1-20. 2024.*

6. **Mingze Wang**, Zeping Min, Lei Wu. **Achieving Margin Maximization Exponentially Fast via Progressive Norm Rescaling.** *International Conference on Machine Learning* (**ICML 2024**), *1-38. 2023.*

5. **Mingze Wang**, Lei Wu. **A Theoretical Analysis of Noise Geometry in Stochastic Gradient Descent.** *NeurIPS 2023 Workshop on Mathematics of Modern Machine Learning* (**NeurIPS 2023 Workshop M3L**). *arXiv preprint: 2310.00692, 1-30. 2023.*

4. **Mingze Wang**, Chao Ma. **Understanding Multi-phase Optimization Dynamics and Rich Nonlinear Behaviors of ReLU Networks.** *Conference on Neural Information Processing Systems* (**NeurIPS 2023**, **Spotlight (Top 3.5%)**), *1-94. 2023.*

3. Lei Wu, **Mingze Wang**, Weijie J. Su. **The alignment property of SGD noise and how it helps select flat minima: A stability analysis.** *Conference on Neural Information Processing Systems* (**NeurIPS 2022**), *1-25. 2022.*

2. **Mingze Wang**, Chao Ma. **Early Stage Convergence and Global Convergence of Training Mildly Parameterized Neural Networks.** *Conference on Neural Information Processing Systems* (**NeurIPS 2022**), *1-73. 2022.*

1. **Mingze Wang**, Chao Ma. **Generalization Error Bounds for Deep Neural Networks Trained by SGD.** Under review. *arXiv preprint: 2206.03299, 1-32. 2022.*

SERVICE

Conference: Conference on Neural Information Processing Systems (NeurIPS); International Conference on Learning Representations (ICLR).

Journal: Journal of Machine Learning Research (JMLR); Transactions on Pattern Analysis and Machine Intelligence (TPAMI); Pattern Recognition (PR); Transactions on Machine Learning Research (TMLR); Journal of Machine Learning (JML).

EXPERIENCE

Peking University Beijing, China
Teaching assistant: Deep Learning Theory, taught by Prof. Zhiyuan Li (TTIC) *Summer School 2023.*
Teaching assistant: Calculus (A) *Fall 2021*
Teaching assistant: Calculus (B) *Fall 2022, 2023; Spring 2022, 2023, 2024*

Institute for Advanced Algorithms Research Shanghai, China
Algorithm Intern *2023.12 - now*
Work on designing faster optimizers for pretraining large language models.

Moqi Technology Beijing, China
Algorithm Intern *2021.09 - 2022.06*

SELECTED AWARDS & HONOURS

Principal Scholarship, Peking University. *2024.05*
BICMR Mathematical Award for Graduate Students (110,000 RMB), Peking University. *2023.11*
Schlumberge Scholarship (30,000 RMB) , Peking University. *2022.10*
PKU Academic Innovation Award (top 1%), Peking University. *2022.10*
Outstanding Graduate of Zhejiang Province (top 5%); Outstanding Graduate of ZJU *2021.05*
Chinese National Scholarship (top 1%) *2019.10*
First Class Scholarship of ZJU (top 3%) *2019, 2020.10*
Zhejiang Provincial Government Scholarship *2018.10*
First Prize of Mathematical Contest in Modeling of ZJU (top 1%) *2020.06*
Meritourious Award in The Mathematical Contest in Modeling *2020.02*
National Second Prize of Chinese Undergraduate Mathematical Contest in Modeling (top 2.5%) *2019.10*