

# MINGDA WAN

Research Interest: Machine Learning

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## EDUCATION

Anhui University

Internet+ College

B.Eng. in Intelligent Science and Technology

September 2021 – June 2025

Anhui, China

- **Overall GPA:** 2.28/4.5
- **Selected Coursework:** Deep Learning, Natural Language Processing, Pattern Recognition and Machine Learning, Curriculum Design of Machine Learning, Probability Theory and Mathematical Statistics, Linear Algebra, Applied Statistics, Advanced Mathematics, Discrete Mathematics, Algorithm Analysis and Design, Data Structure, Computer Organization and Architecture, Programming and Algorithm Comprehensive Practice.

## PUBLICATIONS

\* denotes equal contribution or alphabetical order.

### Accepted In Conferences:

1. Bo Chen\*, Chengyue Gong\*, Xiaoyu Li\*, Yingyu Liang\*, Zhizhou Sha\*, Zhenmei Shi\*, Zhao Song\*, **Mingda Wan\*** and Xugang Ye. “NRFlow: Towards Noise-Robust Generative Modeling via High-Order Flow Matching” *UAI 2025*. [Camera Ready Paper Preview](#)
2. Zhihang Li\*, Zhizhou Sha\*, Zhao Song\* and **Mingda Wan\***. “Attention Scheme Inspired Softmax Regression” *ICLR 2025 Workshop on Deep Generative Model in Machine Learning: Theory, Principle and Efficacy*. [Camera Ready Paper](#)
3. Zhihang Li\*, Zhizhou Sha\*, Zhao Song\* and **Mingda Wan\***. “An Improved Sample Complexity for Rank-1 Matrix Sensing” *ICLR 2025 Workshop on Deep Generative Model in Machine Learning: Theory, Principle and Efficacy*. [Camera Ready Paper](#)
4. Bo Chen\*, Chengyue Gong\*, Xiaoyu Li\*, Yingyu Liang\*, Zhizhou Sha\*, Zhenmei Shi\*, Zhao Song\* and **Mingda Wan\***. “High-Order Matching for One-Step Shortcut Diffusion Models” *ICLR 2025 Workshop on Deep Generative Model in Machine Learning: Theory, Principle and Efficacy*. [Camera Ready Paper](#)

### Preprints:

1. Yingyu Liang\*, Zhizhou Sha\*, Zhenmei Shi\*, Zhao Song\* and **Mingda Wan\***. “HOFAR: High-Order Augmentation of Flow Autoregressive Transformers” *arXiv preprint arXiv:2503.08032*. [arXiv Link](#)
2. Yang Cao\*, Bo Chen\*, Xiaoyu Li\*, Yingyu Liang\*, Zhizhou Sha\*, Zhenmei Shi\*, Zhao Song\* and **Mingda Wan\***. “Force Matching with Relativistic Constraints: A Physics-Inspired Approach to Stable and Efficient Generative Modeling” *arXiv preprint arXiv:2502.08150*. [arXiv Link](#)
3. Xiaoyu Li\*, Yingyu Liang\*, Zhenmei Shi\*, Zhao Song\* and **Mingda Wan\***. “Theoretical Constraints on the Expressive Power of RoPE-based Tensor Attention Transformers” *arXiv preprint arXiv:2412.18040*. [arXiv Link](#)

## RESEARCH EXPERIENCE

Dynamics and Efficiency Assessment of High-Order Flow Models

Feb 2025 - May 2025

Instructed by [Prof. Zhao Song](#) at UC Berkeley and [Dr. Zhenmei Shi](#) at Voyage AI

- Developed theoretical insights that enable high-order modeling without sacrificing computational efficiency.
- Performed empirical evaluations on the CIFAR-10 dataset to highlight improvement in image generation quality.
- [Under review at NeurIPS 2025](#).

Improving Sampling Precision and Stability in Shortcut Diffusion Models

Oct 2024 - Feb 2025

Instructed by Prof. Zhao Song at UC Berkeley and Dr. Zhenmei Shi at Voyage AI

- Delivered smoother trajectory generation and improved distribution alignment on synthetic datasets.
- Provided theoretical guarantees of the superior approximation precision offered by high-order methods.
- UAI 2025 Poster, ICLR 2025 Workshop DeLTa Poster.

### Exploring Expressiveness of RoPE-based Tensor Attention Transformers

Aug 2024 - Dec 2024

Instructed by Prof. Zhao Song at UC Berkeley and Dr. Zhenmei Shi at Voyage AI

- Proved RoPE-based tensor attention Transformer can be simulated by  $TC^0$  circuit.
- Established hardness results that RoPE-based tensor attention Transformer cannot solve 2 key problems.
- Under review at NeurIPS 2025.

### Large Language Model-Based Information Extraction Project

Sep 2023 - Mar 2024

Instructed by Prof. Zhoujun Li at Beijing University of Aeronautics and Astronautics

- Developed a hybrid data cleansing framework combining regular expressions and rule-based engines to process millions of Chinese financial text records, effectively addressing nested entity recognition.

### OCR Table Structure Recognition Project

July 2023 - Sep 2023

Instructed by Prof. Zhoujun Li at Beijing University of Aeronautics and Astronautics

- Optimized models using quantization and channel pruning techniques, reducing model size to 35% of the original, enabling deployment on embedded business devices.
- Designed an end-to-end table structure recognition model based on a hybrid architecture of CNN and Transformers, achieving accurate detection of complex table lines and cell localization.

### Theoretical Foundations of Attention-Inspired Softmax Regression

Mar 2023 - May 2023

Instructed by Prof. Zhao Song at Adobe Research

- Offering theoretical insights into the training dynamics of attention in neural networks.
- Establishing a regularized softmax regression model with provable convergence guarantees.
- ICLR 2025 Workshop DeLTa Poster.

### Efficient Algorithms and Analysis for Rank-1 Matrix Sensing

Nov 2022 - Mar 2023

Instructed by Prof. Zhao Song at Adobe Research

- Introduced a novel sketching and analysis technique with provable guarantees, enhancing theoretical understanding of low-rank matrix recovery.
- Developed a new algorithm for rank-1 matrix sensing that improves sample complexity from  $\tilde{O}(\epsilon^{-2}dk^2)$  to  $\tilde{O}(\epsilon^{-2}(d+k^2))$  and reduces runtime from  $\tilde{O}(md^2k^2)$  to  $\tilde{O}(md^2k)$ .
- ICLR 2025 Workshop DeLTa Poster.

## SKILLS

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**Language ability:** Mandarin (Native), English (Proficient), Cantonese (Conversational)

**Academic service:** Research Grants Council (Hong Kong), ICCV 2025, KDD 2024

**Tools:** Python, C, C#, C++, JavaScript, Swift, L<sup>A</sup>T<sub>E</sub>X, Bash Script, MATLAB, PyTorch, TensorFlow, JAX, Numpy, sklearn, Pandas, OpenCV, OpenMP, SQL, CUDA