Shimao Zhang

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Research Interests

My current research interests mainly include Long Video Understanding, LLM Reasoning, and Interpretability. I have worked on mathematical reasoning, generation, and mechanistic interpretability. Currently, I also focus on the efficient and effective long video encoding and understanding.

Education

Nanjing University **2023.09 – 2026.06**
Master in Computer Science and Technology

- Advisor: Prof. Shujian Huang
- GPA: 90.3/100

Nanjing University **2019.09 – 2023.06**
Bachelor in Computer Science and Technology

- Advisor: Prof. Shujian Huang and Prof. Lijun Zhang
- GPA: 86.0/100

Publication

[1] Process-based Self-Rewarding Language Models
Shimao Zhang, Xiao Liu, Xin Zhang, Junxiao Liu, Zheheng Luo, Shujian Huang, Yeyun Gong. *In Findings of the Association for Computational Linguistics: ACL 2025 (ACL'25 Findings).* **[Link]**

[2] Getting More from Less: Large Language Models are Good Spontaneous Multilingual Learners
Shimao Zhang, Changjiang Gao, Wenhao Zhu, Jiajun Chen, Xin Huang, Xue Han, Junlan Feng, Chao Deng, Shujian Huang. *In Proceedings of the 2024 Conference on Empirical Methods in Natural Language Processing (EMNLP'24 Oral).* **[Link]**

[3] Distributed Projection-free Online Learning for Smooth and Convex Losses
Yibo Wang*, Yuanyu Wan*, **Shimao Zhang**, Lijun Zhang. *In Proceedings of the 37th AAAI Conference on Artificial Intelligence (AAAI'23).* **[Link]**

[4] How does Alignment Enhance LLMs' Multilingual Capabilities? A Language Neurons Perspective
Shimao Zhang*, Zhejian Lai*, Xiang Liu*, Shuaijie She, Xiao Liu, Yeyun Gong, Shujian Huang, Jiajun Chen. *Preprint.* **[Link]**

[5] PATS: Process-Level Adaptive Thinking Mode Switching
Yi Wang*, Junxiao Liu*, **Shimao Zhang***, Jiajun Chen, Shujian Huang. *Preprint.* **[Link]**

[6] EDT: Improving Large Language Models' Generation by Entropy-based Dynamic Temperature Sampling
Shimao Zhang, Yu Bao, Shujian Huang. *Preprint.* **[Link]**

Internship Experience

Ant Group *Beijing, CN*
Research Intern, Ant Research **2025.07 – Now**

- Mentor: Dr. Jian Guan
- Investigated the algorithm for vision-language multimodal models, particularly long video understanding tasks. Enhanced the model's ability to efficiently understand and reason about long videos.

Microsoft Research Asia (MSRA) *Beijing, CN*
Research Intern **2024.12 – 2025.06**

- Mentor: Dr. Xiao Liu
- Conducted research on LLM reasoning and pretraining. Enhanced LLMs' mathematical reasoning ability through a novel process-based self-rewarding paradigm. Cleaned multilingual data and conducted research on data mixture for large-scale pretraining.

Research Experience

Large Language Models

- **Advisor:** Prof. Shujian Huang
- **Background:** Large Language Models have demonstrated outstanding performance across various downstream tasks and have been widely applied in multiple scenarios. This has prompted the urgent need for further enhancement and understanding of LLMs.
- **LLMs Reasoning & Generation:** We conduct research on LLM reasoning and generation by optimizing model training and generation strategies. We propose a novel paradigm called process-based self-rewarding language models [1], which effectively enhances LLMs' performance on complex mathematical reasoning tasks through an iterative self-rewarding pipeline. For generation strategies, we propose a dynamic entropy-based temperature sampling algorithm for a better trade-off between diversity and quality [6]. For generative long-thought reasoning, we propose a process-level adaptive thinking mode switching paradigm to dynamically switch the System 1/2 reasoning intensity for different reasoning steps [5].
- **Mechanistic Interpretability of LLMs:** To better understand the LLMs' mechanisms, we conduct a series of interpretability studies, particularly regarding multilingualism in LLMs. We first systematically reveal and analyze the spontaneous multilingual alignment phenomenon of LLMs [2], i.e. the model can achieve significant improvement even on languages unseen in the alignment. Furthermore, we propose a new language neuron identification algorithm [4], which is able to identify language-specific, language-related, and language-agnostic neurons in LLMs. Then we present empirical results and valuable insights that contribute to a deeper understanding of multilingual alignment and the multilingual capabilities of LLMs.

Large Vision-Language Models

- **Advisor:** Prof. Shujian Huang
- **Background:** Large language models have been popular in many downstream language tasks. However, for some real-world tasks, it's necessary to process multimodal vision-and-language information. It's important to extend LLMs to the vision-language models that are able to be applied in diverse multimodal scenarios.
- **Long Video Understanding & Reasoning:** Processing long video remains great challenges due to its high computational costs of handling extended temporal sequences. We design a mixed precision algorithm, which effectively and efficiently encodes video by minimizing information redundancy while maximizing the retention of key information in a large number of frames.

Optimization

- **Advisor:** Prof. Lijun Zhang
- **Background:** Distributed online convex optimization has been a popular research topic due to its powerful capability in distributed online decision making, in which the projection operation could be the computational bottleneck.
- **Distributed Online Learning:** To avoid projections, distributed online projection-free methods have been proposed. However, they cannot utilize the smoothness condition, which has been exploited in the centralized setting to improve the regret. We propose a new distributed online projection-free method with a tighter regret for smooth and convex losses in the distributed setting [3].

Honours and Awards

- Outstanding Graduate Student, Nanjing University, 2024.
- BYD Scholarship, Nanjing University, 2024.
- First-class Academic Scholarship, Nanjing University, 2023, 2024.
- People's Scholarship, Nanjing University, 2021, 2022.
- First Prize, The 34th National High School Mathematics League, Chinese Mathematical Society, 2018.

Skills

- Programming: Python, C/C++, LaTeX, Git.
- Library: Pytorch, Transformers, Deepspeed, vLLM.
- Languages: Chinese, English.
- Interests: Movie, Music, Football, Bodybuilding.