

Zhihong Shao

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RESEARCH INTERESTS

My interests are in natural language processing and deep learning. I am particularly interested in how we can build a robust and scalable AI system that can leverage diverse skills (e.g., tool use and reasoning) to aggregate possibly-heterogeneous information and answer natural language questions precisely regardless of their complexity.

EDUCATION

Tsinghua University, Beijing, China

September 2019 - Present

Ph.D. Student, Computer Science and Technology

Advisor: [Minlie Huang](#)

Beihang University, Beijing, China

September 2015 - July 2019

B.E., Computer Science and Technology

GPA: 3.86/4, Rank: 2/213

RESEARCH HIGHLIGHTS

Tool-Augmented Large Language Models

- Optimize LLM-Tool Interaction and Adapt Tools for LLMs based on the Interaction Data: ITER-RETGEN [1] with generation-augmented retrieval and generation-augmented retrieval adaptation;
- Train LLMs to Integrate Tool Use into Generation: ToRA [9] (ToRA-34B is the first open-source LLM scoring over 50% on the competition-level MATH dataset, close to GPT-4 solving problems with code, with 670+ github stars);
- Inference-Time Optimization: (i) Prompt Optimization: Synthetic Prompting [3] for automatically synthesizing high-quality CoT demonstrations; (ii) Self-Correction based on Feedback from Tools: CRITIC [2] (Basically the first paper to show that current LLMs struggle with intrinsic self-correction and propose tool-aided correction for more stable improvements).

PUBLICATIONS

- [1] [Enhancing Retrieval-Augmented Large Language Models with Iterative Retrieval-Generation Synergy](#)
Zhihong Shao, Yeyun Gong, Yelong Shen, Minlie Huang, Nan Duan, Weizhu Chen
Findings of Empirical Methods in Natural Language Processing (Findings of EMNLP), 2023.
- [2] [CRITIC: Large Language Models Can Self-Correct with Tool-Interactive Critiquing](#)
Zhibin Gou, **Zhihong Shao**, Yeyun Gong, Yelong Shen, Yujia Yang, Nan Duan, Weizhu Chen
Neural Information Processing Systems, Workshop on Agent Learning in Open-Endedness (NeurIPS ALOE Workshop), 2023.
- [3] [Synthetic Prompting: Generating Chain-of-Thought Demonstrations for Large Language Models](#)
Zhihong Shao, Yeyun Gong, Yelong Shen, Minlie Huang, Nan Duan, and Weizhu Chen
International Conference on Machine Learning (ICML), 2023.
- [4] [Chaining Simultaneous Thoughts for Numerical Reasoning](#)
Zhihong Shao, Fei Huang, and Minlie Huang
Findings of Empirical Methods in Natural Language Processing (Findings of EMNLP), 2022.

- [5] [Answering Open-Domain Multi-Answer Questions via a Recall-then-Verify Framework](#)
Zhihong Shao, and Minlie Huang
Annual Meeting of the Association for Computational Linguistics (ACL), 2022.
([Best QA system on the AmbigNQ leaderboard](#))
- [6] [AdvExpander: Generating Natural Language Adversarial Examples by Expanding Text](#)
Zhihong Shao, Zhongqin Wu, and Minlie Huang
IEEE/ACM Transactions on Audio, Speech, and Language Processing (TASLP), vol. 30, pp. 1184-1196, 2022.
- [7] [A Mutual Information Maximization Approach for the Spurious Solution Problem in Weakly Supervised Question Answering](#)
Zhihong Shao, Lifeng Shang, Qun Liu, and Minlie Huang
Annual Meeting of the Association for Computational Linguistics (ACL), 2021.
- [8] [Long and Diverse Text Generation with Planning-based Hierarchical Variational Model](#)
Zhihong Shao, Minlie Huang, Jiangtao Wen, Wenfei Xu, and Xiaoyan Zhu
Empirical Methods in Natural Language Processing (EMNLP), 2019.

PREPRINT

- [9] [ToRA: A Tool-Integrated Reasoning Agent for Mathematical Problem Solving](#)
Zhihong Shao*, Zhibin Gou*, Yeyun Gong, Yelong Shen, Yujiu Yang, Minlie Huang, Nan Duan, Weizhu Chen
Arxiv abs/2309.17452, 2023.
- [10] [CoTK: An Open-Source Toolkit for Fast Development and Fair Evaluation of Text Generation](#)
Fei Huang, Dazhen Wan, **Zhihong Shao**, Pei Ke, Jian Guan, Yilin Niu, Xiaoyan Zhu, and Minlie Huang
Arxiv abs/2002.00583, 2020.

RESEARCH EXPERIENCE

Microsoft Research Asia

Sep 2022 - Nov 2023, Beijing, China

Research Intern (Supervisors: Yeyun Gong, Nan Duan, Yelong Shen, Weizhu Chen)

- [Knowledge-Grounded Generation]: **ITER-RETGEN** [1], which synergizes retrieval and generation iteratively, is a strong method that enables large language models to leverage intrinsic and extrinsic knowledge flexibly;
- [Tool-Augmented Reasoning]: (i) **Synthetic Prompting** [3] elicits better reasoning in large language models with model-synthesized chain-of-thought demonstrations, achieving a new state-of-the-art on numerical reasoning, symbolic reasoning, and algorithmic reasoning tasks; (ii) **ToRA** [9] integrates natural language reasoning with program-based tool use for mathematical reasoning; ToRA-34B is the first open-source model to attain an accuracy over 50% on the competition-level MATH dataset; (iii) **CRITIC** [2] teaches large language models to correct themselves via interactions with tools.

CoAI Lab, Tsinghua University

Sep 2019 - Present, Beijing, China

Ph.D. Student (Supervisor: Minlie Huang)

- [Knowledge-Grounded Generation]: **RECTIFY** [5], a Recall-then-Verify framework that exploits retrieved knowledge comprehensively, tops AmbigNQ;
- [Tool-Augmented Reasoning]: (i) **CANTOR** [4], the first non-autoregressive numerical reasoner, outperforms $174\times$ larger PaLM 62B on grade school math; (ii) **MIMAX** [7], a weakly-supervised training algorithm that is applicable to various neuro-symbolic reasoning models;

- [Robust Natural Language Understanding]: **AdvExpander** [6], a novel insertion based textual adversarial attack, reveals new robustness issues.
- [Text Generation and Evaluation]: (i) **PHVM** [8], a data-to-text generation model; (ii) **CoTK** [10], a toolkit for fair evaluation.

AWARDS	Lenovo Scholarship , Tsinghua University	2023
	1st Prize , Comprehensive Scholarship, Tsinghua University	2022
	2nd Prize , Comprehensive Scholarship, Tsinghua University	2021
	3rd Prize , the National Final of "LAN QIAO CUP" C/C++ Group	2018
	1st Prize , National College Students Mathematics Competition (non-math-major)	2016
	China National Scholarship	2016, 2017, 2018

SERVICES	Reviewer/Program Committee: ACL, EMNLP, NLPCC, ARR
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TEACHING ASSISTANT	Artificial Neural Network	Fall 2019 - 2022
	<i>Instructor:</i> Minlie Huang	
	Object-Oriented Programming	Spring 2020 - 2023
	<i>Instructor:</i> Minlie Huang	
	<i>Also gave guest lectures and made assignments</i>	