Yingcong Li

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https://yingcong-li.github.io/

EDUCATION

- **University of Michigan, Ann Arbor**
  PhD in Electrical Engineering and Computer Science (Jan. 2024–EST: Apr. 2025)
- **University of California, Riverside**
  PhD in Electrical and Computer Engineering (Jun. 2020–Dec. 2023)
  MS in Electrical and Computer Engineering (Sep. 2019–Jun. 2020)
- **University of Science and Technology of China**
  BS in Electrical Engineering and Information Science (Jun. 2015–Sep. 2019)

RESEARCH INTERESTS

- **Mathematical Foundations of LLMs**
- **Optimization and Statistical Learning Theory**
- **Data and Computation Efficiency in Deep Learning**
- **Self-Evaluating and Evolving AI Systems**
- **Interdisciplinary Machine Learning Applications**

RESEARCH EXPERIENCE

Research at SOTA Lab *Advisor: Samet Oymak* (Jun. 2020–Present)

- **Optimization Theory for Sequence Models.** Conducted research on the optimization of model training, focusing on sequence models like Transformers and State-space Models. Specifically, studied the optimization landscape of linear Transformers [2,3], State-space Models [3], and Gated Linear Attention [1] in the context of in-context learning. Developed a theoretical framework that equates the optimization geometry of self-attention in Transformers to max-margin SVM problems [4,7,8] and Markov models [5].
- **Emergent Abilities of Autoregressive Models.** Investigated both empirical and theoretical performance of autoregressive models, such as Mamba and Transformers. Empirically studied the emergent behavior of Mamba compared to Transformers under task-mixture settings [6]. Analyzed generalization bounds of Transformers in in-context learning and applied insights to dynamical systems [10]. Researched the emergent "chain-of-thought" reasoning in Transformers, supporting its compositional learning capabilities through in-context filtering from both empirical evidence and theoretical exploration [9].
- **Statistical Learning and Model Architectures.** Extensively studied statistical learning with a focus on sample efficiency and model architecture across diverse learning paradigms. Tackled challenges of data dependency in in-context learning [10], and analyzed sample complexity in multitask [11,13] and continual learning [14] scenarios using heterogeneous model architectures.

PUBLICATIONS

Google scholar: https://scholar.google.com/citations?user=9uWgjIUAAAAJ&hl=en&oi=ao

* Equal contribution.

3 NeurIPS (1 spotlight), 2 ICML, 1 AISTATS, 3 AAAI papers

[1]. Yingcong Li, Davoud Ataee Tarzanagh, Ankit Singh Rawat, Maryam Fazel, Samet Oymak. "Gating is Weighting: Understanding Gated Linear Attention through In-context Learning" *in submission*, 2024.

[2]. Xiangyu Chang, Yingcong Li, Muti Kara, Samet Oymak, Amit Roy-Chowdhury. "Provable Benefits of Task-Specific Prompts for In-context Learning" *in submission*, 2024.

[3]. Yingcong Li, M. Ankit Singh Rawat and Samet Oymak. "Fine-grained Analysis of In-context Linear Estimation." *Thirty-eighth Conference on Neural Information Processing Systems* (**NeurIPS**), 2024.

[4]. Yingcong Li*, Yixiao Huang*, M. Emrullah Ildiz, Ankit Singh Rawat and Samet Oymak. "Mechanics of Next Token Prediction with Self-Attention." *Artificial Intelligence and Statistics* (**AISTATS**), 2024.

[5]. M. Emrullah Ildiz, Yixiao Huang, Yingcong Li, Ankit Singh Rawat, and Samet Oymak. "From Self-Attention to Markov Models: Unveiling the Dynamics of Generative Transformers" *The Forty-first International Conference on Machine Learning* (**ICML**), 2024.

[6]. Yingcong Li, Xupeng Wei, Haonan Zhao, and Taigao Ma. "Can Mamba In-Context Learn Task Mixtures?" *In ICML 2024 Workshop on In-Context Learning* (**ICML** Workshop), 2024.

[7]. Tarzanagh, Davoud Ataee*, Yingcong Li*, Christos Thrampoulidis, and Samet Oymak. "Transformers as Support Vector Machines." *In NeurIPS 2023 M3L Workshop* (**NeurIPS** Workshop), 2023.

[8]. Tarzanagh, Davoud Ataee, Yingcong Li, Xuechen Zhang, and Samet Oymak. "Max-Margin Token Selection in Attention Mechanism" *Thirsty-seventh Conference on Neural Information Processing Systems* (**NeurIPS, spotlight, top 3%**), 2023.

[9]. Yingcong Li, Kartik Sreenivasan, Angeliki Giannou, Dimitris Papailiopoulos, and Samet Oymak. "Dissecting Chain-of-Thought: Compositionality through In-Context Filtering and Learning." *Thirty-seventh Conference on Neural Information Processing Systems* (**NeurIPS**), 2023.

[10]. Yingcong Li, M. Emrullah Ildiz, Dimitris Papailiopoulos, Samet Oymak "Transformers as Algorithms: Generalization and Stability in In-Context Learning" *The Fortieth International Conference on Machine Learning* (**ICML**), 2023.

[11]. Yingcong Li, Samet Oymak "Provable Pathways: Learning Multiple Tasks over Multiple Paths" *The Thirty-Seventh AAAI Conference on Artificial Intelligence* (**AAAI**), 2023.

[12]. Yuzhen Qin, Yingcong Li, Fabio Pasqualetti, Maryam Fazel, Samet Oymak "Stochastic Contextual Bandits with Long Horizon Rewards" *The Thirty-Seventh AAAI Conference on Artificial Intelligence* (**AAAI**), 2023.

[13]. Yingcong Li and Samet Oymak, "On the Fairness of Multitask Representation Learning," *IEEE International Conference on Acoustics, Speech and Signal Processing* (**ICASSP**), 2023.

[14]. Yingcong Li, Mingchen Li, M Salman Asif, Samet Oymak "Provable and Efficient Continual Representation Learning" *arXiv preprint*, 2022.

[15]. Xiangyu Chang*, Yingcong Li*, Samet Oymak, Christos Thrampoulidis "Provable Benefits of Overparameterization in Model Compression: From Double Descent to Pruning Neural Networks" *The Thirty-Fifth AAAI Conference on Artificial Intelligence* (**AAAI**), 2021.

TALKS

- **Invited talk at ICML 2024 1st ICL workshop** (Jul. 2024)
  "Exploring Model Expressivity and Optimization Landscape in in-context Learning"
- **Guest lecture at UMich EECS 553: Machine Learning** (Oct. 2023)
  "Understanding In-context Learning and Chain-of-thought"
- **Guest lecture at UCR EE/CS228: Introduction to Deep Learning** (Jun. 2023)
  "Prompt as Parameter-efficient Transfer Learning"
- **Presentation at AAAI 2023** (Feb. 2023)
  "Provable Pathways: Learning Multiple Tasks over Multiple Paths"

PROFESSIONAL ACTIVITIES

- **38th Conference on Neural Information Processing Systems (NeurIPS2024)** *presenter* (Dec. 2024)
- **41st International Conference on Machine Learning (ICML2024)** *invited talk* (Jul. 2024)
- **Midwest Machine Learning Symposium (MMLS 2024)** *presenter* (May. 2024)
- **37th Conference on Neural Information Processing Systems (NeurIPS2023)** *presenter* (Dec. 2023)
- **40th International Conference on Machine Learning (ICML2023)** *presenter* (Jul. 2023)
- **2023 Information Theory and Applications workshop (ITA2023)** *presenter* (Feb. 2023)
- **37th AAAI Conference on Artificial Intelligence (AAAI2023)** *presenter* (Feb. 2023)
- **MURI Workshop** *presenter* (Sep. 2022)
- **39th International Conference on Machine Learning (ICML2022)** *attendance* (Jul. 2022)
- **C Language programming** *teaching assistant* (Sep. 2017–Feb. 2018)

SERVICE

- **Reviewer for** NeurIPS, ICLR, AAAI, AISTATS, ICASSP, TOPML, and SIGKDD

HONORS & AWARDS

- **NeurIPS 2023 Scholar Award** (2023)
- **AAAI-23 Student Scholarship** (2023)
- **UCR Dean's Distinguished Fellowship Award** (2020–2021)
- **USTC Bronze Award of Scholarship for Undergraduates** (2017 & 2016)