Amirhossein Amini

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Research Summary

Training dynamics and generalization of Transformer models in in-context learning (ICL) and chain-of-thought (CoT) settings. Focus on out-of-domain CoT guarantees via concentration inequalities, and dynamics of value/attention matrices; theory complemented with PyTorch simulations.

Education

Rensselaer Polytechnic Institute (RPI), Troy, NY   Sep 2023 – Present
Ph.D., Electrical & Computer Engineering (GPA: 3.71/4.0)   Advisor: Prof. Meng Wang
Keywords: Transformers, ICL/CoT, generalization theory, optimization, probability.

University of Tehran, Tehran, Iran   2018 – 2021
M.Sc., Mechanical Engineering   Advisor: Prof. Masoud Shariatpanahi

University of Tehran, Tehran, Iran   2014 – 2018
B.Sc., Mechanical Engineering.

Publications & Preprints

- **Amini, A.**, Wang, M. *Training Dynamics of a Two-Head Transformer on In-Context Learning Tasks* (in preparation).

Research Experience

Research Assistant, RPI   Sep 2023 – Present

- Proved two-stage attention concentration for one-layer Transformers under GD; showed $O(\varepsilon)$ in-domain population risk.

- * *Tools:* Python, PyTorch, NumPy, Matplotlib; LaTeX.

Graduate Researcher, Univ. of Tehran (AI Lab)   2021 – 2023

- Built U-Net pipelines for femur X-ray segmentation/landmarking; integrated 3D Slicer labeling and post-processing.

Teaching

Graduate TA, RPI   2023 – 2024

- Engineering Probabilities; Control Systems Engineering. Held 3 hrs/week office hours for two semesters; graded 80+ students.

Selected Projects

- **What do Multi-Head Transformers Learn in ICL?** Theory + experiments.

- **Image Captioning (Flickr8K).** Transformer-based image captioning model; reported BLEU; released code.

- **Machine Translation (Multi30K).** Transformer-based seq2seq model; reported test BLEU.

- **Classification Using CNN(CIFAR10)** CNN-based classifier.Code

Selected Courses

- Machine Learning From Data

- Introduction to Deep Learning

- Introduction to Optimization

- Mathematical Analysis I

- Introduction to AI

- Introduction to Stochastic Signals and Systems

Awards & Honors

- Ranked 82nd at nation-wide university entrance exam (Iran)

- Exempted from the entrance exam to pursue graduate studies in recognition of excellent academic performance

- Academic excellence awards (Iran)

Skills

ML/AI: Training Dynamics Analysis, Deep Learning, Transformers
Tools: Python, PyTorch, NumPy, SciPy, Matplotlib, LaTeX,
Languages: Persian (native), Azerbaijani (native), English (full professional), Turkish (limited working)

References

Available upon request.