YIFEI ZHANG

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Education

University of Wisconsin-Madison Madison, WI

Bachelor of Science, Computer Science *Graduate on May. 2023 (Expected)*

- GPA: 4.0/4.0
- Advisor: Prof. Frederic Sala

Research Interests

I am broadly interested in **machine learning on statistical inference and deep learning on optimization and generalization** from theoretical and algorithmic perspectives. For now, I am working on weakly supervised learning with tensor decomposition and implicit bias of deep learning with efficient training algorithm design.

Publications

[1] [Workshop Paper] Incremental Fourier Neural Operator. Jiawei Zhao, Robert Joseph George, **Yifei Zhang**, Zongyi Li, Anima Anandkumar. 2022. NeurIPS 2022 Workshop AI4Science.

Research Experience

Incremental Learning of Gradient Descent June 2022 - Oct. 2022

Computing + Mathematical Sciences Department, California Institute of Technology

Advisor: Prof. Anima Anandkumar and Dr. Jiawei Zhao

- Successfully generalized low-rank bias of Gradient Descent to practical fully-connected neural network from theoretical work of matrix/tensor factorization ([ICLR '21], [ICML '21] & [[NeurIPS '19]]).
- By applying distance weight matrix, generalized from infinitesimal initialization to any other initializations. Conducted experiments with different initializations and observed incremental learning process.
- Conducted ablation studies to analyze the effects of different hyperparameters on incremental learning process and found the strengthening effect of large depth and small width.
- Applied two ways (expanding along output channels and CP rank decomposition) to handle tensor structure and extended the results to Resnet on CIFAR-10.
- Extended the results to RNN, LSTM, GRU and Transformer on sequence data and found that complicated activation operation would inhibit the low-rank bias. Also, analyzed how large data variance and other regularizations affect the evolution of singular values.
- The work will be submitted to ICML 2023.

Tensor Decomposition on Weakly-Supervised Learning Jan. 2022 - Present

Department of Computer Sciences, University of Wisconsin-Madison

Advisor: Prof. Frederic Sala

- Motivated by [JMLR '14], reformulated the problem of weakly-supervised learning (WSL) into multi-view models and proposed a new approach for WSL. The reformulated model has several desirable properties (e.g., readily accept soft labels, ably merge dependent weak supervision sources).
- Utilized the tensor structure in reformulated model and implemented the algorithm of tensor power method to recover the accuracies of weak supervision sources. Also, stabilized the recovered accuracies by different techniques (e.g., normalization, preprocessing data by other WSL approaches).
- Conducted the experiments on real classification tasks (e.g. income classification, relation classification) within the benchmark WRENCH [NeurIPS '21] and compared the performance with other WSL approaches.
- Will extend the approach to sequence tagging task [NeurIPS '21] with Hidden Markov model. The work targets on NeurIPS 2023 as the first author.

Directed Study

Department of Electrical & Computer Engineering, University of Wisconsin-Madison

Project 1: Gaussian Mixture Model on Speech Command Recognition *Dec. 2021 - Jan. 2022*

Advisor: Prof. Matthew Malloy

- Preprocessed the data by Mel spectrogram and deployed Quadratic Discriminant Analysis on the dataset of speech_commands_v0.02. With regularization for covariance estimation, achieved 68.25% accuracy.
- Based on [arXiv '18], implemented convolutional architecture to do embedding and improved the performance to 84.6% accuracy.

Project 2: Preference Modeling and Crowdsourced Clustering *Sep. 2021 - Dec. 2021*

Advisor: Prof. Ramya Korlakai Vinayak

- According to [NeurIPS '16], implemented generative graph model (e.g., Erdős–Rényi model, stochastic block model) to illustrate the performance of triplewise comparisons better than pairwise comparisons, given a fixed cost of entropy.
- Learned the problem systematic intransitivity in preference modeling and implemented salient feature preference model in [ICML '20]. Checked the model's identifiability and conducted sample complexity analysis.
- Through simulation experiments, illustrated empirical estimation error below theoretical bound, demonstrating the correctness of theoretical analysis. Analyzed the pairwise inconsistencies of training results, validating the model's capability to capture systematic intransitivity.

Professional/Volunteer Experience

Popular Science Channel Feb. 2020 - May 2020

- During the pandeimc, started up one online channel in Bilibili, one video sharing platform in China, to interpret the news of public concern based on mathematical knowledge and computer simulation techniques, aiming to ease the prevalent anxiety.
- Published five videos (7-8 min for each) in total which received dozens of "like"s and praising comments, and two of the videos got more than 1 million views.

Teaching

Peer Mentor, CS 540 Introduction to Artificial Intelligence, Fall 2022

Peer Mentor, CS 540 Introduction to Artificial Intelligence, Spring 2022

– Positive evaluations from students: "Yifei is very responsive and friendly."

Relevant Courses

Graduate CS: Matrix Methods in Machine Learning; Probability Theory and Information Theory in Machine Learning; Learn More Weakly-Supervised Learning

Undergraduate CS: Artificial Intelligence, Numerical Analysis, Algorithm, Digital Electronics, Computer Architecture, Operating System, Programming Language and Compiler

Math: Calculus, Ordinary Differential Equation, Linear Algebra, Probability Theory, Statistical Methods, Mathematical Logic, Set Theory, Combinatorics, Modern Algebra

Technical Skills

Programming: Python, Java, C, C++, MATLAB, LaTeX, JavaScript, HTML/CSS

Data Analysis: NumPy, scikit-learn, Matplotlib, PyTorch, Weights&Biases

Honors and Awards

Dean's List (all semesters), University of Wisconsin–Madison

Undergraduate Scholarship for Summer Study ($1,000) (twice), University of Wisconsin-Madison