Zezheng Song

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Research

Machine learning, deep learning, reinforcement learning, high performance computing, randomized linear algebra, representation learning.

Education

2019-2024 **Ph.D. of Sciences**; University of Maryland, College Park
Major: Applied Mathematics and Scientific Computation (GPA: 3.80/4.00)
Advisor: Kunpeng Zhang

2015-2019 **Bachelor of Sciences**; University of Texas at Austin
Major: Mathematical Sciences

Selected Honors & Awards

2022 **National Science Foundation (NSF) Mathematical Sciences Graduate Internship program**, awarded to 50 Ph.D. students in the United States

2019-2021 **Dean's Fellowship, Department of Mathematics, University of Maryland, College Park**

2018 **Moncrief Undergraduate Summer Fellowship, Oden Institute for Computational Engineering and Sciences**, awarded to 10 students at UT Austin, US$ 6,000

Coursework Highlights

Machine Learning: Numerical Methods for Machine Learning, Advanced Numerical Optimization, Deep Learning.

Mathematics/Scientific Computing: Advanced Scientific Computing (I & II), Numerical Linear Algebra, Random Processes in Control, Parallel Computing, Applied Stochastic Processes, Complex Analysis.

Research Experience

09.2022-Present **A Reinforcement Learning Approach to Solve Committor Functions using Finite Expression Method (FEX)** (College Park, MD)
Mentor: Haizhao Yang

- Applied Finite Expression Method (FEX) (A deep reinforcement learning method that seeks an approximate solution to the partial differential equations in the space of functions with finitely many analytic expressions) to solve for the committor functions in the potential well, for the transition process between a pair of coecentric spheres, and in the rugged-Muller potential problems in PyTorch.
- The analytic solution obtained by FEX provides deep insights into the structure of the committor functions, and resulting relative error by FEX achieves machine accuracy and is significantly better than the current state-of-the-art neural network approach.

06.2022-08.2022 **Research Intern**; Lawrence Berkeley National Laboratory (Berkeley, CA)
Mentor: Xiaoye Sherry Li

- Applied randomized sketching methods, such as subsampled randomized Fourier transform (SRFT), and leverage score sampling, to accelerate kernel-based machine learning algorithms.
- Proposed an improved index selection method of the CUR matrix decomposition algorithm based on the fast approximation of the leverage scores of the data matrix, which achieved superior performance compared to the state-of-the-art algorithm on various datasets.

09.2021-Now **Identifying Peer Firms by Deep Multimodal Learning** (College Park, MD)
Advisor: Kunpeng Zhang

- Created a network structure with textual and visual information from social media platforms, applied deep learning techniques to learn firms' representations, and successfully identified meaningful and accurate peer firms given a focal firm.
- Our method dominates the state-of-the-art peer firm classification schemes in explaining cross-sectional variations in base firms' monthly stock returns.

05.2021-12.2021 **Matrix Completion for Recommender Systems** (College Park, MD)
Advisor: Kunpeng Zhang

- Derived a mathematical bound for the accuracy of a two-stage sampling and SVD-based matrix completion algorithm, and implemented the algorithm in Matlab, which achieved comparable accuracy to the state-of-the-art matrix completion algorithms.

09.2020-05.2021 **Advanced Scientific Computing I-II Project** Parameter Estimation in Magnetic Resonance Relaxometry Model (College Park, MD)
Mentor: Richard G. Spencer

- Implemented and compared state-of-the-art numerical optimization algorithms in Matlab, such as grid search, gradient descent, and the Levenberg-Marquardt method to learn the parameters in the bi-exponential magnetic resonance relaxometry model.
- Reduced the mean squared error of estimators in the bi-exponential magnetic resonance relaxometry model below the theoretical lower bound by 53.82% by introducing regularization into the model loss function.

Technical Skills

Programming: Python, Matlab, R

Framework & Libraries: NumPy, PyTorch, Pandas, Scikit-learn, Matplotlib, seaborn

Tools & Database: AWS, Google Cloud, Jupyter, Git, Latex