ISAAC LIAO

iliao@mit.edu   https://iliao2345.github.io

EDUCATION

Massachusetts Institute of Technology   *Sep 2023 - Present*
Master of Engineering, Electrical Engineering and Computer Science

Massachusetts Institute of Technology   GPA: 5.0/5.0   *Sep 2019 - Jun 2023*
Bachelor of Science, Double major in Computer Science and Physics
Classes (*Graduate): Bayesian Modeling and Inference*, Statistical Learning Theory*, Information Theory*, Quantum Physics I-III, Computer Vision, Statistical Mechanics I, Experimental Physics I.

RESEARCH PUBLICATIONS

Isaac Liao, Rumen Dangovski, Jakob Nicolaus Foerster, and Marin Soljačić. Learning to optimize quasi-newton methods. *Transactions on Machine Learning Research*, 2023a. ISSN 2835-8856. URL https://openreview.net/forum?id=Ns2X7Azudy

Isaac Liao, Ziming Liu, and Max Tegmark. Generating interpretable networks using hypernetworks, 2023b. URL https://arxiv.org/abs/2312.03051

EXPERIENCES

Teaching Assistant - MIT 8.01 Classical Mechanics I   *Sep 2023 - Present*
- Worked on a large language model used for generate physics problems to teach ∼700 students.

Researcher - Tegmark AI Safety Group   *Sep 2023 - Present*
- Wrote algorithms that prove recurrent neural networks to have equivalent behavior to state machines.
- Advances our understanding of provable machine learning systems, which are critical to AI safety.

Research Consulting - Beneficial AI Foundation   *Jul 2023 - Aug 2023*
- Built a hypernetwork for simplifying neural network weights to enhance mechanistic interpretability.
- Reverse-engineered 4 algorithms learned by neural networks, to improve AI safety.

Researcher - Soljacic Group   *Jun 2020 - Jun 2023*
- Invented a machine learning optimizer using learning to optimize (L2O) with quasi-Newton methods.
- Wrote theorems to prove the optimizer's convergence and flexibility to adapt to various loss landscapes.
- The optimizer outperformed Adam by 4.9x in loss, with the same number of steps, in some settings.

PROJECTS

Graduate Bayesian Modeling and Inference   *Feb 2023 - May 2023*
- Invented a Bayesian version of the alternating least squares algorithm for large matrix completion.
- Made ≥2% RMSE improvement on the Netflix Prize Dataset for user-product recommendation systems.

Graduate Statistical Learning Theory   *Sep 2022 - Dec 2022*
- Wrote theorems showing the parameter efficiency of randomized sparse neural network architectures.
- Performed experiments to verify the parameter-efficiency of sparse architectures over traditional ones.
- This result shows it is possible to save computer memory by compressing large machine learning models.

Quantum Physics III   *Feb 2022 - May 2022*
- Derived the joint eigenvalue distribution of random Hermitian matrices and the Wigner semicircle law.
- Applications to emission spectra of quantum dots, a promising new technology in quantum optics.

Computer Vision   *Feb 2021 - May 2021*
- Reinvented the variational autoencoder and designed a neural network for lossless image compression.
- Compressed the Kodak image dataset by 18% over raw bitmap encoding.

AWARDS AND HONORS

MIT Battlecode Competition: Champion, solo. $8000 prize.   *Jan 2022*
MIT Battlecode Competition: 7th place, solo. $1000 prize.   *Jan 2021*
MIT Battlecode Competition: Champion of Newbie division, solo. $500 prize.   *Jan 2020*
International Physics Olympiad: *Silver Medal*   *July 2019*
International Physics Olympiad: *Honorable Mention*   *July 2018*