Armaan A. Abraham

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Education

University of California, Los Angeles (UCLA) *Jun 2023*
B.S., Computer Science, *B.S.*, Biophysics
3.98 GPA, summa cum laude

AI Safety Fundamentals: Alignment (Online course) *Oct 2024 – Present*

Publications

A. A. Abraham, Z. C. Tan, P. Shrestha, E. R. Bozich, and A. S. Meyer, "A multivalent binding model infers antibody Fc species from systems serology," *PLoS Computational Biology*, vol. 20, no. 12, p. e1012663, Dec. 2024, doi: 10.1371/journal.pcbi.1012663.

A. Ramirez, B. T. Orcutt-Jahns, S. Pascoe, **A. A. Abraham**, B. Remigio, N. Thomas, and A. S. Meyer, "Integrative, high-resolution analysis of single cells across experimental conditions with PARAFAC2," *bioRxiv [Preprint]*, Jul. 2024, doi: 10.1101/2024.07.29.605698v1.

Professional Experience

Staff Researcher *Jul 2023 – Present*
Undergraduate Researcher *Sep 2022 – Jun 2023*
Prof. Aaron Meyer's Lab, UCLA

- Invented Unaligned Low-rank Tensor Regression with Attention (ULTRA) (details on my website).
  - Designed to discover interpretable patterns in scRNA-seq that explain an external phenotype, such as patient status.
  - ULTRA outperforms existing approaches in prediction accuracy, and its parameters can be interpreted to discover transcriptional mechanisms related to an arbitrary disease.
  - Advising an undergraduate student who is assisting in analysis and publication.
- Primary technical consultant for Avidicure, an external drug company.
  - Developed and applied a mechanistic binding model to aid in their development of multivalent antibody-cytokine fusions for cancer therapy.
  - Created binding model implementation that was ~4500x faster than lab standard by reimplementing with jax, batching, and switching the root finding to log space.
  - Derived previously unknown relationship between receptor cross-linking and ligand concentration, relying on principles from statistical mechanics and thermodynamics.
  - Created a graphical user interface to facilitate the use of our binding model to design new molecules.

Software Engineer Intern *Jun 2022 – Sep 2022*
Tesla (Vehicle Software)

- Led development of the event data recorder (EDR) file processing pipeline for use by Tesla vehicle owners, regulators, and other Tesla engineers.

    - Had a hard deadline: required completion within 8 weeks for Tesla vehicles to continue being sold in China.
- Created a caching approach for vehicle CAN signals, using Redis and golang, reducing the runtime of a commonly run job by ~100x.

Lead Software Engineer, Cofounder *Mar 2020 – May 2024*
Thriftax (thriftax.com)

- Led development of a tax-filing web application for US nonresidents, assisting in over 5100 tax returns and serving over 1100 customers, primarily international students from UCLA, UC Berkeley, and Stanford.
- Supervised interns, designed and managed the software and infrastructure, designed our product, and conducted sales efforts with universities and Au Pair companies.

Projects

Protein design with RL from ESMFold feedback (details on my website**)** *Apr 2024*

- Independently conceptualized and implemented a protein design approach whereby an RL agent generates a sequence incrementally, with its reward based on how well the structure, predicted by ESMFold, satisfies user-provided design criteria.
- In my first experiment, I trained an agent that, on average, increases ESMFold pLDDT estimates (quantifying structural confidence and stability) by 25% within an edit distance of 4 of an arbitrary length-20 sequence.
    - Implemented transformer and embedding scheme from scratch.
    - Created multi-GPU training routine and trained agent for 12 hours over 8 4090 GPUs.

Deep sparse autoencoders (details on my website**)** *Jan 2025*

- Independently conceptualized, implemented, and trained deep sparse autoencoders on the tiny-stories-3M LLM.
- I found that the addition of hidden (non-sparse) layers improves the sparsity-reconstruction frontier.
- Currently working on measuring the interpretability of deep SAE features.

RL of human-interpretable, multimodal tasks from AI feedback (details on my website**)** *Sep 2024*

- Independently conceptualized an RL approach which uses a multimodal LLM for generating feedback on arbitrary tasks.
- I trained an agent to perform the pendulum swing-up task by presenting a textual prompt and pairs of images of pendulums to a text and image LLM to generate a reward signal.

Discovered new explanation of NN feature direction alignment (details on my website**)** *Oct 2024*

- Independently investigated a tension I saw in the literature between two phenomena of neural network feature superposition.
- Implemented and trained a sparse autoencoder on a 2-layer, 6.3M parameter LLM.
- Discovered explanation for the cosine between the directions of any two features that considers both co-occurrence and downstream output similarity.

Sequential Reptile for graph neural network (GNN) transfer learning *Jun 2022*

- Adapted neural executor of graph algorithms with Sequential Reptile curriculum learning to improve transfer learning between different graph algorithms (e.g., BFS, Bellman-Ford).
- Completed as part of graduate class on GNNs.
- Outperformed benchmark on MSE, predecessor accuracy, and termination accuracy.

Presentations

Microscopists and Modelers (UCLA seminar). Invited oral presentation. 60 minutes. *Oct 2024*
"Unaligned Low-rank Tensor Regression with Attention (ULTRA): Generating mechanistic explanations of external phenotypes from scRNA-seq"

Systems Biology for Infectious Diseases Annual Meeting. Selected poster presentation. *Sep 2024*
120 minutes.
"Multivalent binding model quantifies antibody species from systems serology"

ImmunologyLA. Selected poster presentation. 120 minutes. *May 2024*
"Multivalent binding model quantifies antibody species from systems serology"

Teaching Experience

Undergraduate Tutor *Oct 2021 – Dec 2021*

- Tutored other CS undergraduates on topics ranging from introductory programming to computer architecture to math.
- 2 hours/week, 7 weeks. Completed as part of induction into Upsilon Pi Epsilon (UPE) International Honor Society.

Awards and Honors

Summa cum laude (highest honors) in Samueli School of Engineering. *UCLA.* *2023*
Top 5% GPA for my B.S. in Computer Science.

Summa cum laude (highest honors) in College of Letters and Science. *UCLA.* *2023*
Top 5% GPA for my B.S. in Biophysics.

Inductee. *Upsilon Pi Epsilon (UPE) International Honor Society.* *2021*

Bronze Governor General's Award. *The Governor General of Canada.* *2019*
Awarded to Canadian secondary student with highest GPA in graduating class.

National Book Award. *University of Toronto.* *2019*
National award for Canadian secondary students with outstanding academic performance.

Excellence in Math Award. *Simon Fraser University.* *2018*