Vidhata Jayaraman

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Education

University of Illinois Urbana-Champaign (UIUC) Anticipated Graduation: May 2026
B.S. in Computer Engineering | B.S. in Mathematics *Current GPA: 3.96/4.0*
Dean's List (Top 20% of Student Body)

Relevant Coursework:

- Math: Real Analysis; Abstract Algebra; Linear Algebra; Probability Theory; Graph Theory; Differential Equations
- Applied Math/CS: Optimization; Quantum Information Theory; Algorithms & Models of Computation; Data Structures and Algorithms; Signal Processing

Skills & Expertise

- Deep Learning Frameworks: PyTorch, TensorFlow
- Natural Language: NLTK, spaCy, LangChain
- Robotics: ROS, OpenCV
- APIs: Flask, Django
- Software Engineering: Python, C/C++, Java
- Web Development: HTML/CSS, Javascript
- DevOps: Git, Docker
- Low-Level: x86 assembly, SystemVerilog
- Research/Math: LaTeX

Research Interests

Machine Learning/Artificial Intelligence, Convex and Non-Convex Optimization, Information Theory, Quantum Information, Natural Language Processing, Computational Linguistics

Research Experience

Research with Professor Lav Varshney at UIUC February 2024 – Present

Past Projects

- *Emergent Capabilities in Transformers*: Experimenting with Modern Hopfield Networks and other Neural Associative Memories to understand emergent capabilities as model size increases and their connection to Transformers
- Equivalence of Modern Hopfield Networks and Transformers has already been proven so showing emergence in Modern Hopfield Networks could help explain emergence in Transformer-based architectures
- *SwitchCIT: Switching for Continual Instruction Tuning of Large Language Models*: Identified clustering in the final layer of an LLM following continual learning and used this to create a switch network which helps avoid catastrophic forgetting

Current Projects

- *No Free Lunch Theorem for Community Detection in Complex Quantum Networks* (Primary researcher): Extending the "No Free Lunch" Theorem from the classical community detection problem to complex quantum networks
- *Information-theoretic lower bound for Knowledge Distillation in LLMs* (Primary researcher): Attempting to find a Shannon-like information-theoretic lower bound for knowledge distillation in LLMs
- *Discovering Analogical Reasoning in LLMs* (Under direction of PhD candidate): Recent work has shown that LLMs may exhibit analogical reasoning capabilities, we seek to show this phenomenon via clustering in the latent space in an LLM

Research with Professor Xu Chen at UIUC March 2023 – February 2024

- Created a Physics Informed Neural Network (PINN) to model the Voltage and Electric field from a charged circle (2D) and sphere (3D) inside of a grounded box
- Utilized a version of the Deep Galerkin Method (DGM) to estimate the differential equation modeling the system
- Implementation was used & modified by Samsung engineers for use in their own research and modeling
- Implemented an operator estimator for an RLC (Resistor, Inductor, Capacitor) circuit to model for any R, L, and C

Publications

1. Wu, X., Hartman, M., **Jayaraman, V. A.**, & Varshney, L. R. (2024). SwitchCIT: Switching for Continual Instruction Tuning of Large Language Models. arXiv preprint arXiv:2407.11780.

2. Bernstein, H. C., Bindel, S. R., McKibben, M. A., & **Jayaraman, V. A.** (2024). Planning Model based on Projection Methodology Bayesian Discrete Extended (PM2-BDE) *Undergoing internal review*

Industry Experience

Johns Hopkins University Applied Physics Laboratory | *Data Science Intern* June 2024 – August 2024

- Created chat-bot with Retrieval Augmented Generation (RAG) for retrieving information in technical documents
- Implemented a Bayesian approach towards reliability growth planning (RGP)
- Created a system of equations to model RGP curves that was solved using advanced optimization techniques
- Manuscript in preparation to be submitted to IEEE

National Institute of Standards and Technology (NIST) | *Research Intern* June 2023 – August 2023

- Created a small GPT-2 model which utilized Cloze Probabilities to identify abnormal sentences in text data
- Demonstrated that analysis of outliers in dimensionally reduced text embeddings can provide similar results
- Further compared different dimensionality reduction methods among themselves to determine the strongest method

Brunswick i-JET Research Lab | *Autonomous Simulation Intern* January 2023 – May 2023

- Utilized Robotic Operating System (ROS) to create maps using Simultaneous Localization and Mapping (SLAM)
- Utilized theories of fluid dynamics and wake physics to build an autonomous "perfect" wake generator
- Used ROS to visualize, manipulate, and analyze visual data of wakes

Projects

RAG Chat-bot for ECE 391 (Computer Systems Engineering) | *Python, LangChain, dash* July 2024 – September 2024

- Created a RAG chat-bot to search through the documents used in ECE 391 projects for easier information retrieval
- Chat-bot cited document title and page number allowing the user to check where the chat-bot retrieved the information
- Implemented cutting-edge RAG techniques such as parent-child text splitting and cross-encoder reranking

Operating System | *C, x86 assembly* March 2024 – May 2024

- Developed kernel for a Linux-based operating system which utilizes interrupt-based device I/O support
- Implemented radix-2 paging, Round-Robin scheduling, and a file system capable of 4MB files
- Created a Linux shell for user command input of basic Linux shell commands

Named Entity Highlighter — Chrome Extension | *Javascript, Python, PyTorch, Django* July 2023 – August 2023

- Trained and implemented a state-of-the-art Named Entity Recognition AI model from scratch
- Developed a Chrome Extension to highlight and provide Wikipedia links to named entities on a web page

Awards and Recognition

- Awarded James Scholar at University of Illinois Urbana-Champaign January 2022 – Present
- Inducted into Eta Kappa Nu (IEEE-HKN), an ECE Honors Society 2023
- Inducted into Tau Beta Pi, the Engineering Honor Society 2023
- Selected for American Invitational Mathematics Examination (AIME) 2022
- Received the Illinois State Seal of Biliteracy in Spanish 2020