

EDUCATION

- **College of Information and Computer Sciences(CICS), University of Massachusetts(UMASS)** Amherst, MA, USA
MS/Phd in Computer Science Aug. 2017 – Present
- **National Institute of Technology** Trichy, Tamil Nadu, India
Bachelor of Technology in Computer Science and Engineering Aug. 2013 – May. 2017

RESEARCH EXPERIENCE

- **Biologically Inspired Neural and Dynamical Systems Laboratory** UMASS Amherst
Research Assistant January 2021-Present
 - **Temporal Memory Models:** Introduced a new class of energy-based biological memory models called the General Sequential Episodic Memory Model (GSEMM), which exhibits a temporal energy surface. The project involved applying non-linear dynamical systems principles, energy-based memory modeling, and Python numerical simulations to design and simulate GSEMM.
 - **Improving RNNs using GSEMM:** Investigate the connection between discrete versions of GSEMM and current recurrent neural architectures. The project involved applying non-linear dynamical systems principles, and tasks and models for typical RNN applications using Pytorch. Currently, we have exploited this connection to form an Episodic Memory Theory of RNN dynamics capable of mechanistic interpretability.

PUBLICATIONS

- **Episodic Memory Theory of Recurrent Neural Networks: Insights into Long-Term Information Storage and Manipulation (2023):** Karuvally, A., DelMastro, P., Siegelmann, H. T. (2023). *Proceedings of the 2nd Annual Workshop on Topology, Algebra, and Geometry in Machine Learning (TAG-ML)* at the 40th International Conference on Machine Learning, Honolulu, Hawaii, USA, 2023.
- **General Sequential Episodic Memory Model (2023):** Karuvally, A., Sejnowski, T., Siegelmann, H.T.. (2023). General Sequential Episodic Memory Model. *Proceedings of the 40th International Conference on Machine Learning*, in *Proceedings of Machine Learning Research* 202:15900-15910 Available from <https://proceedings.mlr.press/v202/karuvally23a.html>.
- **Energy-based General Sequential Episodic Memory Networks at the Adiabatic Limit (2022):** Arjun Karuvally, Hava T. Siegelmann and Terry J. Sejnowski. preprint available at: <https://arxiv.org/abs/2212.05563>
- **Learning proposals for sequential importance samplers using reinforced variational inference (2019):** Ahmed, Zafarali, Arjun Karuvally, Doina Precup and S. Gravel. DeepRLStructPred@ICLR (2019). URL: <https://openreview.net/forum?id=HJgxTf89vV>
- **Cache Miss Rate Predictability via Neural Networks (2018):** Karuvally, Arjun. Rishikesh Jha, Saket Tiwari, J. Eliot B. Moss. In Annual Conference on Neural Information Processing Systems, 2018. ML for Systems Workshop. URL: http://mlforsystems.org/assets/papers/neurips2018/cache_jha_2018.pdf

WORK EXPERIENCE

- **Data Science for Common Good, UMASS** Amherst
Data Science Intern May 2019 - August 2019
 - **Exploratory Analysis:** Worked with UMASS CICS Center for Data Science(CDS) and Springfield Public School(SPS) system on the development of a tool to identify and improve course recommendations to students based on a model of success created from course trajectories of previous students. We used a Bayesian network to model the causal relationship between student course trajectories and their success probability.
- **Google Summer of Code with C3G, Canada**
Research Intern May 2018 - August 2018
 - **Reinforcement Learning:** The problem of inferring unobserved values in a partially observed trajectory from a stochastic process can be considered as a structured prediction problem which is traditionally conducted using heuristic-based Monte Carlo methods. In this project, I studied the application and effectiveness of learning proposals for sequential importance samplers using the concept of reinforced variational inference. Work done was published in ICLR 2019, Deep Reinforcement Learning Meets Structured Prediction workshop. The final product is an open source framework that provides a convenient interface for researchers to create and manage Reinforced Variational Inference experiments.

- **Summer Intern at Flipkart** Bangalore, India
Intern May 2016 - July 2016
 - **Data Science:** Engineered improvements to the efficiency of the company's existing *fraud detection* technology using Decision Trees. Developed a *skill tracker* application for employees in the company. Developed a *chrome plugin* to enable new and existing employees to discover and learn acronyms used in the company.
- **Remote Mentorship Program at IBM** Bangalore, India
In semester project February 2016 - April 2016
 - **Data Science:** Worked on creating a model to automatically assign teams to customer support tickets based on the description of the issue in the ticket using Natural Language Processing techniques. The project was part of the Remote Mentorship Program to create an *EDI Spec Creator* Application led by Mr. Manjit.S.Sodhi, IT Architect, IBM.

TEACHING

- **Instructor:** First Year Seminar - Nature Inspired Design in Computing: Fall 2023
- **Teaching Assistant:** Neural Networks: From Neuroscience to the forefront of AI: Spring 2023; Introduction to Computing: Spring 2023; Web Technology: Spring 2022; Systems: Fall 2021; Mobile Health Sensing and Analytics: Spring 2021; Programming Methodologies: Fall 2020; Machine Learning: Spring 2020; Web Technology Spring, Fall 2019;

RELEVANT COURSES

- **Machine Learning:** Machine Learning, Neural Networks: Modern Intro, Reinforcement Learning, Advanced Natural Language Processing, Computer Vision, Algorithms for Data Science, Neural Networks: Neuroscience to AI, Probabilistic Graphical Models.
- **Systems:** Systems
- **Theory:** Advanced Algorithms
- **Mathematics:** Networks and Spectral Graph Theory, Applied Mathematics and Mathematical Modeling, Differential Equations and Dynamical Systems.

SKILLS

- **Languages:** C, C++, Python, Rust, GoLang
- **Machine Learning Frameworks:** Pytorch, Tensorflow, Scikit-learn

OTHER PROJECTS

- **Distributed Chat Application**
Distributed Systems - Secure and Fault Tolerant Systems
 - **GoChat Application:** Created a chat application in Golang that is totally distributed with a single central discovery server. The messages sent via the application is encrypted using AES wrapped in GCM using 16 byte keys generated from the invite code. A fault detection and recovery mechanism also was built into the application using various techniques like checkpoints and state messages.
- **Memory Management System**
Computer Engineering - Garbage Collection
 - **System Memory Management:** Implemented and researched the effectiveness of an alternative memory management system for linux using Rust language. The memory manager was designed to be thread safe with fine-grained locks instead of a single coarse lock for thread protection. The use of fine grained locks led to almost 20 percent average performance gain in various standard memory management benchmarks.
- **Effectiveness of Gated Attention in Visual Question Answering**
Natural Language Processing, Computer Vision
 - **Visual Question Answering:** Created a Gated Attention based model for the task of Visual Question Answering(image and a question is input and the output will be the answer to the question based on the image provided). The performance and effectiveness of the Gated Attention model was quantified in comparison to existing baseline and state of the art models.
- **Car Warning System using Reinforcement Learning**
Reinforcement Learning
 - **Autonomous Car Warning System:** Created a reinforcement learning based car warning system that adapts to different users. The idea was to model the Fatality Analysis Reporting System(FARS) data and other experimental data of various accidents into a novel reinforcement learning framework with an agent trained to warn the user and mitigate accidents.

- **Leveraging Structural Similarities in Generative Adversarial Networks**

Deep Learning, Generative Models

- **Generative Modeling of Faces:** Created a novel architecture that leverages the structural similarities of generator and discriminator networks and studied the improvement on the performance of GANs.

- **Automatic Planning of trips using social network data**

Data Mining; Social network analysis; Planning

- **Generative Modeling of Faces:** Worked on creating a recommendation system that functions as a planner for tourist destinations. The system uses social network data to create personalized recommendations. *Github Repository:* <https://github.com/arjun23496/auto-tour-planner>

- **Music Recommendation based on user emotion in microblogs**

Data Mining - Social Network Analytics - Sentiment Analysis - Natural Language Processing

- **Recommender System:** Implemented a framework to analyse user emotion in twitter and recommend music based on the emotional context of user. Presented the research paper in *IEEE-EDS Kolkata Chapter Sponsored 5th International Conference on Computing, Communication and Sensor Network* *Github Repository:* <https://github.com/arjun23496/music-recommendation>

- **Genetic algorithm to evolve neural networks to play Checkers**

Genetic Algorithms-Artificial Intelligence-Game Playing

- **Checkers AI:** Implemented a genetic algorithm to evolve neural networks for playing checkers. The moves are computed using min-max algorithm(with alpha-beta pruning for efficiency) using neural network to compute the heuristic cost function of different configurations of the board. A web interface was created for users to test the performance of the artificial intelligence implemented. *Github Repository:* <https://github.com/arjun23496/checkers-sp>