Pranav Rajbhandari

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Education

Carnegie Mellon University *Pittsburgh, PA*

Bachelor of Science, Double Major

Artificial Intelligence;

Mathematical Sciences (Discrete Mathematics and Logic);

GPA: 4.0/4.0; University Honors

Relevant Coursework

Artificial Intelligence		*Mathematics*	
• AI: Representation & Problem Solving	• Convex Optimization	• Algebraic Topology	• Dynamics of Polish Groups
• Deep Reinforcement Learning & Control	• Art & Machine Learning	• General Topology	• Probabilistic Combinatorics
• Advanced Deep Learning	• Autonomous Agents	• Graph Theory	• Extremal Combinatorics
• Natural Language Processing	• Search Engines	• Game Theory	• Modern Regression

Research Projects

Understanding bee visual attention by imitating beehavior *Canberra, Australia*

University of New South Wales - PI: Sridhar Ravi 02/2025 - Present

- Used the attention patterns of trained Reinforcement Learning (RL) agents to infer how a real bee makes movement decisions
- Built a goal-conditioned RL environment in OpenAI Gym to train a UAV to imitate bee behaviors using bee-like input sensors
- Used SHAP values, a tool for explaining model output, to measure visual regions that trained RL agents pay attention to

AlephZero: Extending AlphaZero to Infinite Boards *Pittsburgh, PA*

Independent Research - PI: Pranav Rajbhandari 04/2024 - Present

- Defined and analyzed $\aleph_0$ **board games**, a class of games with potentially unbounded action spaces. Interesting examples include 'Jenga' and '5D Chess with Multiverse Time Travel', as well as classic games like 'Chess' and 'Tic-Tac-Toe'
- Developed AlephZero, an extension of AlphaZero able to learn optimal policies in $\aleph_0$ board games
- Utilized transformer architectures to define policy networks and value networks able to take multi-dimensional sequential input
- Compared approach to standard algorithms such as AlphaZero, Deep Q-Learning, and Monte Carlo Tree Search

Fine Tuning Swimming Locomotion Learned from Mosquito Larvae *Canberra, Australia*

University of New South Wales; U.S. Naval Research Laboratory - PI: Sridhar Ravi; Donald Sofge 01/2024 - Present

- Optimized swimming locomotion copied from mosquito larvae for use on a robotic platform
- Utilized Reinforcement Learning to guide a local search algorithm optimizing swimming locomotion
- Designed an OpenAI Gym environment utilizing a Computational Fluid Dynamics (CFD) model for training
- Sped up the training process by using a pre-trained deep neural network to accurately predict forces on a robotic swimmer
- Compared performance of various architectures, including Deep Neural Networks, Recurrent Neural Networks, and LSTMs

Transformer guided coevolution: Team selection in multiagent adversarial games *Washington, D.C.*

U.S. Naval Research Laboratory - PI: Donald Sofge; Prithviraj Dasgupta 07/2024 - 10/2024

- Developed BERTeam, an algorithm to learn diverse and cooperative team selection for multiagent adversarial team games
- Evaluated algorithm on Pyquaticus, a simulation of robotic Marine Capture-The-Flag
- Used Masked Language Modeling to teach optimal team composition to BERTeam's transformer architecture
- Cotrained BERTeam with Coevolutionary Deep Reinforcement Learning to select teams from a diverse population of agents
- Compared result of training with established algorithms in literature
- Developed and maintained unstable_baselines3, a Python package extending stable_baselines3 to multiagent environments

Geodesic complexity? It's actually quite simplex *Pittsburgh, PA*

Department of Mathematical Sciences, Carnegie Mellon University - PI: Florian Frick 08/2023 - 05/2024

- Explored geodesic complexity, a measure of difficulty for creating an efficient continuous motion plan on a metric space
- Designed a technique utilizing local properties of a space to lower bound its geodesic complexity
- Created and proved correctness of an algorithm calculating cut loci on surfaces of polyhedra, a property related to their geodesic complexity
- Applied these techniques to produce a novel result for the geodesic complexity of the octahedron
- Proved existing geodesic complexity bounds in a new way, displaying the utility of our general method

Utilizing Sim-to-Real Methods for Training a Robot Arm *Pittsburgh, PA*

Reliable Autonomous Systems Laboratory, Carnegie Mellon University - PI: Reid Simmons 01/2023 - 05/2024

- Led a team of four to design and maintain an OpenAI Gym environment for a Kinova Jaco Gen3 6DOF robot arm
- Simulated a model of the robot arm compatible with the control scheme of the physical arm using the Gazebo simulator
- Utilized ROS to handle communication between the robot arm and Python scripts
- Trained a 'real life filter' with the CycleGAN algorithm to make photo-realistic simulation images used for training
- Implemented a training pipeline for a robotic manipulation task, trained in simulation and refined on the real arm

Learning NEAT Emergent Behavior in Robot Swarms *Washington, D.C.*

U.S. Naval Research Laboratory - PI: Donald Sofge 05/2023 - 08/2023

- Developed an algorithm for training local policies to produce emergent behaviors in a robot swarm
- Designed a training pipeline applying the NeuroEvolution of Augmenting Topologies (NEAT) algorithm to robot swarm control
- Tested the algorithm's performance on a variety of tasks and simulated robotic swarms using the CoppeliaSim simulator
- Utilized ROS to handle communication between Python scripts and robotic swarms (both real and simulated)

UAV Routing for Enhancing the Performance of a Classifier-in-the-loop *Washington, D.C.*

U.S. Naval Research Laboratory - PI: Swaroop Darbha 05/2023 - 08/2023

- Collaborated on an interdisciplinary research project optimizing the information gained from targets by robot swarms
- Designed a heuristic algorithm for planning robot paths inspired by approximate solutions to the Traveling Salesman Problem
- Utilized Mathematica software, as well as methods from 'Convex Optimization' to optimize solutions for large test cases
- Tested our algorithm on both generated and real-life problem instances using Julia and the Gurobi optimizer

Comparing Transfer Learning Methods for Continuous Reinforcement Learning *Washington, D.C.*

U.S. Naval Research Laboratory - PI: Laura Hiatt 05/2022 - 08/2022

- Planned and executed a research project evaluating various transfer learning methods on robot arm manipulation tasks
- Designed an OpenAI Gym environment for a robotic manipulation task using the MuJoCo simulator
- Compared the performance of known transfer learning methods in transferring knowledge between Deep Neural Networks
- Utilized ROS to handle communication between the robot arm and Python scripts

Creating a Strategic Agent to Play Jenga *Pittsburgh, PA*

Reliable Autonomous Systems Laboratory, Carnegie Mellon University - PI: Reid Simmons 02/2021 - 05/2022

- Planned and executed a research project evaluating the performance of various adversarial AI algorithms playing Jenga
- Implemented algorithms such as Monte Carlo Tree Search, Deep Q-Networks, and Inverse Reinforcement Learning
- Created a statistical model to estimate the stability of a Jenga tower for use in Model Based Reinforcement Learning
- Trained the model through repeatedly sampling stabilities of towers with the PyBullet physics engine

Publications

[1] **Pranav Rajbhandari**, Prithviraj Dasgupta, and Donald Sofge. Transformer Guided Coevolution: Improved Team Formation in Multiagent Adversarial Games: Extended Abstract. In *Proc. of the 24th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2025), Detroit, Michigan, USA, May 19 – 23, 2025*. IFAAMAS, 2025.

[2] **Pranav Rajbhandari** and Donald Sofge. Learning NEAT Emergent Behaviors in Robot Swarms. In *2024 IEEE International Conference on Robotics and Biomimetics (ROBIO)*, pages 414–419, 2024.

[3] **Pranav Rajbhandari**, Karthick Dhileep, Sridhar Ravi, and Donald Sofge. Fine Tuning Swimming Locomotion Learned from Mosquito Larvae. In *2024 IEEE International Conference on Robotics and Biomimetics (ROBIO)*, pages 2082–2085, 2024.

[4] Deepak Prakash Kumar, **Pranav Rajbhandari**, Loy McGuire, Swaroop Darbha, and Donald Sofge. UAV Routing for Enhancing the Performance of a Classifier-in-the-loop. *Journal of Intelligent & Robotic Systems*, 110(134), 2024.

[5] **Pranav Rajbhandari** and Florian Frick. Geodesic complexity? It's actually quite simplex. 2025. (In preparation).

[6] **Pranav Rajbhandari**. AlephZero: Extending AlphaZero to Infinite Boards. 2025. (In preparation).

Presentations

[1] **Pranav Rajbhandari** and Donald Sofge. Learning Emergent Behavior in Robot Swarms with NEAT. Naval Applications of Machine Learning, March 2024.

[2] **Pranav Rajbhandari**, Sophia Zalewski, and Reid Simmons. Sim-to-real Transfer Reinforcement Learning. Carnegie Mellon University Meeting of the Minds, May 2023.

[3] **Pranav Rajbhandari** and Reid Simmons. Creating Agents to Learn Jenga. Carnegie Mellon University Meeting of the Minds, May 2022. https://symposium.foragerone.com/meeting-of-the-minds-2022/presentations/45991.

Experience

Contract Researcher — *Mountain View, CA*

National Aeronautics and Space Administration - Ames Research Center — 01/2023 - 05/2023

- Created an AI system to automate calling airport TMI events, especially Ground Stops and Ground Delay Programs
- Explored Imitation Reinforcement Learning methods to compete against the baseline of training a classifier model
- Processed historical data and created models to approximate decision processes using Python and R

Teaching Assistant — *Pittsburgh, PA*

Carnegie Mellon University — 08/2021 - 12/2022

- Teaching assistant for 'AI: Representation and Problem Solving' (3 semesters), 'Concepts of Mathematics' (1 semester), and 'Probability Theory for Computer Scientists' (1 semester)
- Collaborated in a team of up to 10 Teaching Assistants to manage classes of up to 100 students
- Planned and led class-wide review sessions, as well as recitations of about 20 students
- Held office hours to help students understand course material in a one-on-one setting
- Created, tested, and graded programming assignments and written homework

Research Assistant — *Pittsburgh, PA*

Carnegie Mellon University — 05/2021 - 08/2021

- Collaborated with a team of three researchers to develop and maintain an R package for Natural Language Processing
- Utilized Rust's BERT Natural Language Processing to tokenize and classify strings in R

Programmer — *Atlanta, GA*

Centers for Disease Control and Prevention - Chronic Viral Diseases Branch Immunology Lab — 12/2020 - 01/2021

- Designed a Constraint Satisfaction Problem instance to automate generating laboratory experiment setup procedures
- Utilized Python and R to automate post-experiment data processing
- Refined and deployed these programs across the laboratory after prototyping and incorporating feedback from lab members

Awards and Honors

05/2024	**Dean's List, High Honors (8 semesters)**	*Carnegie Mellon University*
05/2024	**Senior Leadership Recognition Award**	*Carnegie Mellon University*
05/2024	**Dr. William Brown Academic Achievement Award**	*Carnegie Mellon University*
05/2024	**Tartan Leaders of Tomorrow**	*Carnegie Mellon University*
03/2023	**Winner of AI/ML Innovation Challenge** • Was awarded $50,000 cash prize at three-day competition hosted by the US Navy • Designed algorithm to protect ships from enemy missiles	*Naval Surface Warfare Center Dahlgren Division*

Extracurricular Activities

Carnegie Mellon University Super Informal Topology Discussion Group — *Pittsburgh, PA*
Presenter, Member — 08/2023 - 05/2024

Carnegie Mellon University Track & Field — *Pittsburgh, PA*
Sprint Team Captain — 08/2020 - 05/2024

Carnegie Mellon University PRISM Club — *Pittsburgh, PA*
Volunteer, Member — 08/2020 - 05/2024

Technical Skills

Languages	Python; Julia; Mathematica; R; Java; C++; Ocatave; SML; Golang; Matlab;
Software & Tools	Pytorch; TensorFlow; OpenAI Gym; Stable Baselines; Git; ROS; Gazebo; CoppeliaSim; MuJoCo; LaTeX;
Other Languages	English (Native); Nepali (Native); Latin;