Pranav Rajbhandari

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Education

Carnegie Mellon University   *Pittsburgh, USA*
PhD in Machine Learning   08/2025 - Present

Carnegie Mellon University   *Pittsburgh, USA*
Bachelor of Science, Double Major   08/2020 - 05/2024
   Artificial Intelligence;
   Mathematical Sciences (Discrete Mathematics and Logic);
GPA: 4.0/4.0; University Honors

<div align="center">Relevant Coursework</div>

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 visual attention beehind bee-inspired UAV navigation   *Canberra, Australia*
Bioengineering Group, University of New South Wales - PI: Sridhar Ravi   02/2025 - 08/2025
- 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

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

AlephZero: Extending AlphaZero to Infinite Boards   *Pittsburgh, USA*
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 - 08/2025
- 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

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

Learning NEAT Emergent Behavior in Robot Swarms
Distributed Autonomous Systems Group, U.S. Naval Research Laboratory - PI: Donald Sofge

Washington, D.C., USA
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
Distributed Autonomous Systems Group, U.S. Naval Research Laboratory - PI: Swaroop Darbha

Washington, D.C., USA
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

Utilizing Sim-to-Real Methods for Training a Robot Arm
Reliable Autonomous Systems Laboratory, Carnegie Mellon University - PI: Reid Simmons

Pittsburgh, USA
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

Comparing Transfer Learning Methods for Continuous Reinforcement Learning
Adaptive Systems Section, U.S. Naval Research Laboratory - PI: Laura Hiatt

Washington, D.C., USA
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
Reliable Autonomous Systems Laboratory, Carnegie Mellon University - PI: Reid Simmons

Pittsburgh, USA
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] Florian Frick and **Pranav Rajbhandari**. Geodesic complexity of the octahedron, and an algorithm for cut loci on convex polyhedra, 2025. (Preprint, submitted to Journal of Applied and Computational Topology).

[2] **Pranav Rajbhandari**, Abhi Veda, Matthew Garratt, Mandyam Srinivasan, and Sridhar Ravi. Understanding visual attention beehind bee-inspired UAV navigation, 2025. (Preprint, poster accepted to 2025 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2025)).

[3] **Pranav Rajbhandari**, Prithviraj Dasgupta, and Donald Sofge. Transformer Guided Coevolution: Improved Team Formation in Multiagent Adversarial Games. In *Proc. of the 24th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2025)*, pages 2720–2722. IFAAMAS, 2025.

[4] **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.

[5] **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.

[6] 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.

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

Researcher
Mountain View, USA

Ames Research Center, National Aeronautics and Space Administration
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, USA

Carnegie Mellon University
08/2021 - 12/2022

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, USA

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, USA

Chronic Viral Diseases Branch Immunology Lab, Centers for Disease Control and Prevention
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**	*Naval Surface Warfare Center Dahlgren Division*
	• Was awarded $50,000 cash prize at three-day competition hosted by the US Navy	
	• Designed algorithm to protect ships from enemy missiles	

Extracurricular Activities

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

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

Carnegie Mellon University PRISM Club
Pittsburgh, USA
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; AirSim (Unreal Engine); Gazebo; CoppeliaSim; MuJoCo; LaTeX;
Other Languages	English (Native); Nepali (Native); Latin;