

# Mrinal Verghese

Graduate Student

Email: [mrinal.verghese@gmail.com](mailto:mrinal.verghese@gmail.com) | Website: <http://mrinal.verghese.org/>

## Research Theme

I'm interested in building data-efficient robot learning methods in real-world environments, often leveraging retrieval-based methods and large pretrained models. For more information on my research work, please see my website at <http://mrinal.verghese.org/>.

## Education

Ph.D. Robotics, Carnegie Mellon University, Pittsburgh Aug 2021-Present  
Advised by Prof. Chris Atkeson

M.S. Robotics, Carnegie Mellon University, Pittsburgh Aug 2020 - Aug 2021  
Advised by Prof. Chris Atkeson

B.S. Mathematics-Computer Science, University of California, San Diego Sep 2016 - June 2020  
Relevant courses include: Sensing and Estimation in Robotics\*, Planning and Learning in Robotics\*, Robot Reinforcement Learning\*, Deep Learning and Neural Networks, Numerical Methods for Physical Modeling.  
(\* denotes graduate-level class)

## Research Experience

Research Scientist Intern, Meta Reality Labs Research Jun 2023 - Nov 2023  
I'm interning with an Embodied AI team at Reality Labs Research working with Ruta Desai on grounding large language models.

Graduate Research Assistant, Atkeson Lab Sep 2020 - Present  
I'm interested in developing methods to allow robots to learn complex long-horizon tasks and generalize quickly. To do this I'm exploring ideas related to memory-based Learning, skill learning, symbolic reasoning, and the role of natural language in robot learning. My most recent work explored learning tasks with constraint structures where actions must be taken in a specific order, a domain that has traditionally been very challenging for Reinforcement Learning algorithms.

Undergraduate Research Assistant, Advanced Robotics and Controls Lab Sep 2016 - Oct 2020

I worked on decomposing configuration space to accelerate proxy collision checking for motion planning. This work has been accepted to *Robotics and Automation Letters* and was presented at the *International Conference on Robotics and Automation* in May 2022. My prior work looked at robust model-free methods for the control of surgical tendon-based continuum manipulators in constrained environments. I presented a first-author paper on an adaptive visual controller based on this work at the *International Symposium on Robotics Research* in October 2019.

Machine Learning Research Intern, Brain Corporation June 2019 - Sep 2019  
I investigated methods for accelerating kinodynamic search-based planning using heuristics learned via Inverse Reinforcement Learning. I was able to reduce the number of nodes expanded during a search by two orders of magnitude in unseen environments.

### Teaching Experience

Co-Instructor, 16-890 Robot Cognition for Manipulation, CMU Spring 2023  
Co-designed and taught a seminar class on robot cognition, focusing on robot task learning. Selected class topics and papers, and led discussions.

Teaching Assistant, 16-745 Optimal Control and Reinforcement Learning, CMU Spring 2023  
TA for graduate-level optimal control class. Held office hours and graded assignments

Teaching Assistant, 16-264 Humanoids, Robotics Institute, CMU Spring 2022  
TA for an undergraduate class on humanoid robotics. Created assignments, held office hours, and graded work.

Teaching Assistant, Code in Place, Stanford Spring 2021  
Volunteer TA for code in place, a Stanford program that offers the first half of CS106A to students around the world. Lead weekly sections.

Instructional Assistant, Deep Learning and Neural Networks, UC San Diego Spring 2020  
Graded assignments and held office hours. Average Rating: 4.6/5

Instructional Assistant, Supervised Machine Learning, UC San Diego Winter 2020  
Taught a weekly discussion section and held office hours. Average Rating: 4.8/5

### Publications

Using Memory-Based Learning to Solve Tasks with State-Action Constraints  
**M Verghese** and C Atkeson  
International Conference on Robotics and Automation 2023

Configuration Space Decomposition for Scalable Proxy Collision Checking in Robot Planning and Control

**M Vergheze**, N Das, Y Zhi, M Yip

Robotics and Automation Letters and International Conference on Robotics and Automation, May 23-27, Philadelphia, PA, 2022

[\[https://arxiv.org/abs/2201.04314\]](https://arxiv.org/abs/2201.04314)

Model-free Visual Control for Continuum Robot Manipulators via Orientation Adaptation

**M Vergheze**, F Richter, A Gunn, P Weissbrod, M Yip

International Symposium on Robotics Research (ISRR), Oct. 6-10, Hanoi, Vietnam, 2019.

[\[https://arxiv.org/abs/1909.00450\]](https://arxiv.org/abs/1909.00450)

Robot Control of Endoscopic Instruments using Flexible Polymer Sheath

A Gunn, **M Vergheze**, W Wong, P Weissbrod, M Yip IEEE/RSJ Int. Conference on Intelligent Robots and Systems. In Workshop: Continuum Robots in Medicine: Design, Integration, and Applications, Vancouver, Canada, Sept. 23, 2017.

### Talks

Configuration Space Decomposition for Scalable Proxy Collision Checking in Robot Planning and Control, International Conference on Robotics and Automation (ICRA), May 22, Philadelphia, United States, 2022.

Model-free Visual Control for Continuum Robot Manipulators via Orientation Adaptation  
Spotlight presentation, International Symposium on Robotics Research (ISRR), Oct. 8, Hanoi, Vietnam, 2019.

Improving Planning in Autonomous Navigation via Learning

Invited talk, ECE 148 - Introduction to Autonomous Vehicles, UC San Diego, March 9, 2021.

### Mentorship

Yiqi Wang (Masters Student CMU ECE)	2023
Vignesh Rajmohan (Masters Student CMU ECE)	2022-2023
Yuemin Mao (Undergraduate Student CMU MechE and CMU Robotics)	2022-2023
Longping Zhang (UIUC Undergraduate Student Mathematics)	2022-2023

### Awards

NSF Graduate Research Fellowship Program Honorable Mention	2022
--	------

## Service

Reviewer, Robotics Institute PhD committee 2022-2023

Reviewing PhD applications for the Robotics Institute at Carnegie Mellon.

Member, Robotics Institute Climate Committee

Monitoring the overall working climate of the CMU robotics institute and working on various initiatives related to DEI and student well-being. Leading sub-committee on student recruiting and admissions.

Reviewer, International Conference on Robotics and Automation

Reviewed submissions to the International Conference on Robotics and Automation

Reviewer, Robotics and Automation Letters

Reviewed submissions to the Robotics and Automation Letters Journal

Reviewer, Robotics Institute Summer Scholars

Reviewed applicants for the Carnegie Mellon Robotics Institute's undergrad summer research program

## Selected Projects

Encoding Legibility in Optimal Control Frameworks

We explored encoding the HRI concept of trajectory legibility as an objective in Optimal Control frameworks. I found a time-independent quadratic stage cost approximation for the time-dependent highly-nonlinear legibility equation to allow legibility to be directly optimized for.

Unsupervised Skill Acquisition

We created a method to parse a set of video demonstrations of a human executing multiple skills, cluster those demonstrations in a latent space, and extract those skills to be executed by a robot. This method can enable a robot to learn new skills from large sets of video demonstrations without supervision.

Safety Verification for Black Box Controllers

Created a framework to verify learned black box controllers for autonomous navigation were operating within safe parameters, and trigger a fallback controller if necessary.

Online Jacobian Correction Estimation

Built a framework to find structured, model-agnostic corrections to the Jacobian matrix to compensate for modeling inaccuracies in robot manipulator control.

## Extending Model-Based Reinforcement Learning to Sparse Reward Environments

We extended the paper “Neural network dynamics for model-based deep reinforcement learning with model-free fine-tuning” by Nagabandi et. al to work in sparse reward environments by implementing a critic network to approximate rewards and hindsight experience replay to improve training. Code available on github at [\[https://github.com/MVerghese/NN-Dynamics-Sparse-Reward\]](https://github.com/MVerghese/NN-Dynamics-Sparse-Reward)