# Parv **Kapoor**

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## Education

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| **Carnegie Mellon University** | *Pittsburgh, PA* |
| Ph.D. in Software Engineering \| Advisors: Dr. Eunsuk Kang and Dr. Sebastian Scherer | *August 2026 (expected)* |
| **Carnegie Mellon University** | *Pittsburgh, PA* |
| Masters in Software Engineering \| GPA: 4.03/4.00 | *May 2025 (expected)* |
| **Manipal Institute of Technology** | *Manipal, India* |
| B.Tech. in Computer Science Engineering \| GPA: 8.59/10 | *August 2020* |

## Skills

**Programming**  Python, C, C++, CUDA programming, JAVA, MATLAB, Alloy, TLA+, MySQL, OpenCL

**Tools and Libraries**  PyTorch, TensorFlow, ROS, Docker, Habitat, Isaac Gym, FSDP

## Ph.D. Research

**AirLab,** *Carnegie Mellon University* — *Pittsburgh, PA*

PI: Sebastian Scherer — *August 2021 - Ongoing*

- Pretrained Learning from Demonstration (LfD) policies on real-world aerial trajectory data, and enhanced constraint satisfaction through on-line Monte Carlo Tree Search refinement achieving a 60 % improvement over traditional LfD techniques
- Developed a vision-based collision avoidance system for autonomous aircraft using control barrier functions, achieving 71 % improvement over baselines. Validated through digital twin simulations in Nvidia Isaac Sim and 70+ hours of in-field testing on Aurelia X6 drones
- Built a full stack deep learning library from scratch, with both CPU (C++) and GPU (CUDA) backends, enabling efficient automatic differentiation and custom RNNs and LLMs. Engineered implicit layers for end-to-end non-linear optimization

**Software Design and Analysis Lab,** *Carnegie Mellon University* — *Pittsburgh, PA*

PI: Eunsuk Kang — *August 2021 - Ongoing*

- Developing tools for Large Language Model alignment via automata constrained decoding for structured output generation
- Developed STLCG++, an attention masking based approach leveraging PyTorch and JAX for efficient sequence analysis, achieving an order of magnitude improvement over RNN-based methods
- Formulated a comprehensive theory and toolset for robustness analysis of safe reinforcement learning policies using stochastic optimisation
- Pioneered an optimization-driven trajectory synthesis framework using requirement decomposition for long horizon Task and Motion Planning. Achieved a 65 % reduction in solving time and a 51 % performance improvement over state-of-the-art planners

## Experience

**Scaled Foundations** — *Seattle, WA*

Student Researcher (Part time) \| PIs: Dr. Jonathan Huang and Dr. Ashish Kapoor — *September 2024 - Ongoing*

- Developed pipelines for distributed synthetic data generation, pretraining and fine tuning of robot foundation models
- Developed aligned robotics foundation models using novel fine tuning paradigms for navigation and instruction following
- Contributing to the development of the AirGen simulation platform for aerial, ground, and manipulator robots

**Scaled Foundations** — *Seattle, WA*

Research Intern \| PIs: Dr. Sai Vemprala and Dr. Ashish Kapoor — *May 2024 - August 24*

- Developed a novel technique for safe trajectory generation extending state-of-the-art autoregressive robotics pretraining architecture, outperforming baselines by 74.3%.
- Built a foundation model field deployment pipeline for diverse robots (Unitree Go2, DJI Robomaster) using domain adaptation.
- Integrated multimodal foundation models into the GRID platform, developed and deployed skills chaining the models.

**Verimag,** *Université Grenoble Alpes* — *Grenoble, France (Remote)*

Research Engineer \| PI: Dr. Thao Dang — *January 2021 - August 2021*

- Developed input stimulus generation theory using timed automata for autonomous system validation
- Evaluated these techniques within the SUMO simulation environment for applications in autonomous vehicles

### Cyber Physical Systems Lab, *University of Southern California*

Research Intern | PI: Dr. Jyotirmoy Vinay Deshmukh

*Los Angeles, U.S.A.*

*January 2020 - January 2021*

- Developed novel model-based reinforcement learning algorithms for safe policy training from signal temporal logic specifications
- Implemented efficient model-free algorithms (TRPO, A3C, PPO) in PyTorch with unique STL-based reward design
- Achieved 82% higher specification satisfaction compared to baseline RL policies
- Engineered in-house simulation environments for algorithm benchmarking employing CARLA, AirSim, and Gazebo

### Visual Computing Group, *Cardiff University*

Research Intern | PI: Dr. David Marshall

*Cardiff, U.K.*

*May 2019 - July 2019*

- Constructed a safe trajectory prediction system for visually impaired individuals using ZED stereo camera
- Implemented and trained a 2-stream CNN in TensorFlow on human walking data for forecasting ego agent camera movement
- Improved CNN accuracy in low-data regimes through neuro-inspired data augmentation

### RapidQube Digital solutions Pvt. Ltd.

Research Intern

*Mumbai, India*

*May 2018 - July 2018*

- Created an accident prediction system leveraging convolutional neural networks and object tracking algorithms (YOLOv3)
- Implemented depth prediction Residual CNNs alongside YOLO v3 in Tensorflow to classify nearby drivers' speed profiles with 300 ms latency

## Preprints and Publications

### STLCG++: A Masking Approach for Differentiable Signal Temporal Logic Specification

**P. Kapoor**, Kazuki Mizuta, Eunsuk Kang, Karen Leung

- Under submission [arxiv]

### Logically Constrained Robotics Transformers for Enhanced Perception Action Planning

**P. Kapoor**, Sai Vemprala, Ashish Kapoor

- **Robotics Science and Systems (RSS): Towards Safe Autonomy** 2024 [arxiv]

### Constrained LTL Specification Learning from Examples

C. Zhang, **P. Kapoor**, I. Dardik, A. Cui, R.M. Goes, D. Garlan, E. Kang

- **IEEE International Conference on Software Engineering (ICSE)** 2025 [arxiv]

### Analyzing Tolerance of Reinforcement Learning Controllers against Deviations in Cyber Physical Systems

C. Zhang*, **P. Kapoor**\*, R.M. Goes, D. Garlan, E. Kang, A. Ganlath, S. Mishra, N. Ammar

- **Formal Methods (FM)** 2024 [arxiv]

### Safe Planning through Incremental Decomposition of Signal Temporal Logic

**P. Kapoor**, R.M. Goes and E. Kang

- **Nasa Formal Methods (NFM)** 2024 [arxiv]

### ViSafe: Vision-enabled Safety for High-speed Detection and Avoidance

**P. Kapoor**, I. Higgins, N. V. Keetha, J. Patrikar I. Cisneros, Z. Ye, Y. He, Y. Hu, S. Scherer

- Under Review

### FoundLoc: Vision-based Onboard Aerial Localization in the Wild

Y. He, I. Cisneros, N. V. Keetha, J. Patrikar, Z. Ye, I. Higgins, Y. Hu, **P. Kapoor**, S. Scherer

- Under Review [arxiv]

### Follow The Rules: Online Signal Temporal Logic Tree Search for Guided Imitation Learning in Stochastic Domains

J. Patrikar, J. Aloor, **P. Kapoor**, S. Scherer and J. Oh

- **IEEE International Conference on Robotics and Automation (ICRA)** 2023 [arxiv]

### Challenges in Close-Proximity Safe and Seamless Operation of Manned and Unmanned Aircraft in Shared Airspace

J. Patrikar, J. Dantas, S. Ghosh, **P. Kapoor** et al

- **IEEE International Conference on Robotics and Automation (ICRA)** 2022 [arxiv]

### Model-based Reinforcement Learning from Signal Temporal Logic Specifications

**P. Kapoor**, A. Balakrishnan, J. V. Deshmukh

- 2020 [arxiv]