

SHIQI LIU

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Education

Carnegie Mellon University

Doctor of Philosophy - Mechanical Engineering

May 2024 – Present

Pittsburgh, PA

Carnegie Mellon University

Master of Science - Mechanical Engineering | 3.96/4.0

February 2021 – December 2022

Pittsburgh, PA

Beijing University of Technology

Bachelor of Energy and Power Engineering | 3.88/4.0

September 2014 – May 2018

Beijing, China

Research Interests

My research interest focuses on robotics, robot learning, and reinforcement learning. I aim to develop more generalized agents that can better adapt to challenging new environments. More specifically, I propose new methods that combine geometry properties with learning theory to enhance robotics generalizability and robustness.

Publications

(* indicates equal contribution)

1. Jieli Qiu*, Jiacheng Zhu*, **Shiqi Liu**, William Han, Jingqi Zhang, Chaojing Duan, Michael Rosenberg, Emerson Liu, Douglas Weber, Ding Zhao. Automated Cardiovascular Record Retrieval by Multimodal Learning between Electrocardiogram and Clinical Report. *Machine Learning for Health (ML4H)*, 2023.
2. **Shiqi Liu***, Mengdi Xu*, Peide Huang, Yongkang Liu, Kentaro Oguchi, and Ding Zhao. Continual Vision-based Reinforcement Learning with Group Symmetries. *Conference on Robot Learning (CoRL)*, 2023. (oral, 6.6%)
3. Peide Huang, Xilun Zhang*, Ziang Cao*, **Shiqi Liu***, Mengdi Xu, Wenhao Ding, Jonathan Francis, Bingqing Chen, Ding Zhao. What Went Wrong? Closing the Sim-to-Real Gap via Differentiable Causal Discovery. *Conference on Robot Learning (CoRL)*, 2023.
4. Hanjiang Hu, Baoquan Yang, Zhijian Qiao, **Shiqi Liu**, Jiacheng Zhu, Zuxin Liu, Wenhao Ding, Ding Zhao, Hesheng Wang. SeasonDepth: Cross-Season Monocular Depth Prediction Dataset and Benchmark under Multiple Environments, 2023 *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2023.
5. **Shiqi Liu**, Yang Bin, Yaoyu Li, and Birgit Scheppat. Hierarchical mpc control scheme for fuel cell hybrid electric vehicles. *IFAC-PapersOnLine*, 51(31):646–652, 2018
6. **Shiqi Liu**, Yang Bin, Yaoyu Li, and Birgit Scheppat. Decentralized model predictive control for polymer electrolyte membrane fuel cell system. *IFAC-PapersOnLine*, 51(31):659–664, 2018
7. **Shiqi Liu**, Yang Bin, Yaoyu Li, and Birgit Scheppat. Hierarchical model predictive control for the fuel cell hybrid electric vehicles. In 2018 37th Chinese Control Conference (CCC), pages 3599–3605. *IEEE*, 2018

Preprints

1. Mengdi Xu*, Peide Huang*, Wenhao Yu*, **Shiqi Liu**, Xilun Zhang, Yaru Niu, Tingnan Zhang, Fei Xia, Jie Tan, Ding Zhao. Creative Robot Tool Use with Large Language Models. *arXiv preprint arXiv:2310.13065*, 2023

Experience

Research Assistant

CMU Safe AI Lab

February 2023 – August 2023

Pittsburgh, PA

SafeBench: A Benchmark for Evaluating Autonomous Vehicles in Safety-critical Scenarios

- Implemented a simulation platform based on Carla to evaluate the safety of autonomous driving algorithms.
- Developed various driving scenarios to test algorithm performance under safety-critical circumstances.
- Designed various driving maps to test the performance and generality of different algorithms.

Equivariant Continual Reinforcement Learning in Robotic Manipulation

- Extended the previous continual reinforcement learning framework from group invariant actions to group equivariant actions, therefore increased the framework's flexibility and generalizability.
- Tested the proposed RL framework on various robotic manipulation tasks, each containing multiple variants with observations and actions belonging to different groups.
- The results demonstrate that the algorithm exhibits superior generalization capability over the baselines with significantly improved sample efficiency of the model.

Research Assistant

CMU Safe AI Lab

June 2022 – August 2022

Pittsburgh, PA

Continual Reinforcement Learning Framework with Group Symmetries in Traffic Manipulation

- Proposed continual RL framework with group symmetries grows a policy for each group of equivalent tasks instead of a single task, using a PPO-based RL algorithm with an invariant feature extractor and a novel task grouping mechanism based on invariant features.
- Tested the proposed RL framework is in realistic autonomous driving scenarios, where each group is associated with a map configuration.
- Results show that the algorithm assigns tasks to different groups with high accuracy and outperforms baselines in terms of generalization capability by a large margin. Reduced mean failure rate from **94%** to **41%** compared to other baselines.

Cardiac Disease Diagnosis on Imbalanced ECG Data through Optimal Transport Augmentation

- Proposed a method to address data imbalance issue in ECG datasets for improved heart disease detection accuracy and robustness.
- Utilized optimal transport to augment abnormal ECG data from normal ECG beats, achieving balanced data across different categories.
- Constructed a Transformer-based classification model that leverages time and frequency domain features to improve the accuracy of cardiac disease diagnosis.
- Results demonstrated the classification model's ability to make competitive predictions on five ECG categories, while our data augmentation method effectively improves the model's accuracy and robustness, highlighting its effectiveness in addressing data imbalance in ECG datasets.
- Improved diagnostic accuracy from **63.74%** to **74.38%** on rare diseases.

Technical Skills

Languages: Java, Go, C/C++, Python, Scala,
Tools: Git, Maven, PyCharm, VS Code, Eclipse

Frameworks: NumPy, PyTorch, OpenCV

Awards

- Academic Excellence Award, Beijing University of Technology, 2015, 2016, 2017