

ANQI LI

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RESEARCH INTERESTS

My research focuses on providing theoretical guarantees for robot learning using control theoretic tools. Specific research topics include safe reinforcement learning, learning stable dynamical systems/policies, learning from human demonstrations, and planning & control with formal guarantees.

EDUCATION

University of Washington

Ph.D. student in Computer Science & Engineering

· Advisors: Prof. Byron Boots, GPA: 3.95/4.00

Sept. 2019 – Present

Seattle, WA

Georgia Institute of Technology

Ph.D. student in Robotics

· Advisors: Prof. Magnus Egerstedt & Prof. Byron Boots, GPA: 4.00/4.00

· Transferred to the University of Washington in Sept. 2019

Aug. 2017 – Aug. 2019

Atlanta, GA

Carnegie Mellon University

Masters in Robotics

· Advisor: Prof. Katia Sycara, GPA: 4.00/4.00

Aug. 2015 – May 2017

Pittsburgh, PA

Zhejiang University

Bachelor of Engineering, Automation Major

· GPA: 3.93/4.00, Rank: 1/132

Sept. 2011 – July 2015

Hangzhou, China

RESEARCH EXPERIENCE

University of Washington

Graduate Research Assistant

Sept. 2019 – Present

Seattle, WA

· *Safe Reinforcement Learning with Structured Policy Classes*

- Introduced a policy class with formal control theoretic guarantees on stability and safety based on the Riemannian Motion Policy (RMP) framework
- Showed that reinforcement learning on the structured policy class is more safe and efficient on a planar point robot navigation task trained via natural policy gradient
- (ongoing) testing the policy class on reaching tasks with a simulated Franka Emika robot

· *Learning Coordinated Riemannian Motion Policies on Multiple Task Spaces*

- Proposed a framework for end-to-end learning of multiple Riemannian Motion Policies (RMPs) on different task spaces from human demonstrations
- Demonstrated the proposed framework on a Rethink Sawyer Robot on multiple placing tasks — the proposed framework outperforms baselines where the policies are learned individually

· *Learning Stable Policies from Demonstrations through Learning Diffeomorphisms*

- Proposed a framework for representing a complex policy as a simple policy on an latent space related to the original space through a diffeomorphism
- Designed a neural network architecture for parameterizing diffeomorphism between spaces and the corresponding loss for learning policies on the latent spaces

NVIDIA Research

Robotics Research Intern

May – Aug. 2019, June – Sept. 2020

Seattle, WA

· *RMP²: Combining Riemannian Motion Policies with Automatic Differentiation Libraries*

- Designed an algorithm that solves the same optimization problem as RMP*flow*, but makes use of the gradient oracles from automatic differentiation libraries, e.g., TensorFlow, Pytorch, etc.
- Achieved a smaller memory footprint than RMP*flow* and a more intuitive user interface

· *Learning Riemannian Motion Policies from Human Demonstrations*

- Introduced a framework to learn stable Riemannian Motion Policies (RMPs) from human demonstrations through learning potential functions and Riemannian metrics
- Demonstrated the effectiveness of the proposed learning framework on door reaching and drawer closing tasks performed by a Franka Emika robot

Georgia Institute of Technology

Graduate Research Assistant

Aug. 2017 – May 2019

Atlanta, GA

· *Multi-objectives Policy Generation for Multi-Robot Systems*

- Designed a collection of Riemannian Motion Policies (RMPs) for common multi-robot tasks and showed that many existing potential-based multi-robot controllers can be realized by RMPs
- Proposed decentralized algorithms to generate control policies for multi-robot systems by combining control policies defined for individual tasks

· *Distributed Second-order Optimization for Multi-agent Systems*

- Designed a distributed truncated Newton's method using consensus protocol as building blocks for a class of multi-agent problems

· *Formally Correct Behavior Composition for Teams of Autonomous Robots*

- Proposed a framework that ensures correct-by-construction behavior composition for teams of autonomous robot using Control Barrier Functions (CBFs)

Microsoft Research

Research Intern, CNTK Group

June 2017 – Aug. 2017

Redmond, WA

· *Video Synthesis from Static Images using Generative Adversarial Networks*

- Proposed a deep learning approach to generate videos from static images using Generative Adversarial Networks (GANs)
- Contributed two tutorials on WGANs, LSGANs and BEGANs for Microsoft Cognitive Toolkit. The tutorial on WGANs and LSGANs are available on the Microsoft CNTK github repository

- *Topology-Based Coordination for Large Teams of Robots*
 - Proposed a decentralized and behavior-based approach for large groups of robots to navigate in unknown environments while preserving connectivity and avoiding collisions
- *State Abstraction for Multi-robot Systems under Uncertainty*
 - Designed distributed asynchronous algorithms to abstract high dimensional state information of multi-robot systems with the state information of a subset of robots under state uncertainty
- *Human Action Prediction with Recurrent Neural Networks*
 - Developed a Recurrent Neural Network (RNN) model with Long Short-Term Memory (LSTM) architecture to predict human actions in Cyber-physical Systems

PUBLICATIONS

Journal Publication

- [J1] P. Pierpaoli, **A. Li**, M. Srinivasan, X. Cai, S. Coogan, and M. Egerstedt, “A Sequential Composition Framework for Coordinating Multi-robot Behaviors.” *IEEE Transactions on Robotics (T-RO)*, 2020

Conference Publications

- [C9] M. A. Rana, **A. Li**, D. Fox, B. Boots, F. Ramos, and N. Ratliff, “Euclideanizing Flows: Diffeomorphic Reductions for Learning Stable Dynamical Systems.” *Conference on Learning for Dynamics and Control (L4DC)*, 2020
- [C8] **A. Li**, and C.-A. Cheng, B. Boots, and M. Egerstedt, “Stable, Concurrent Controller Composition for Multi-Objective Robotic Tasks.” *IEEE Conference on Decision and Control (CDC)*, 2019
- [C7] M. A. Rana*, **A. Li***, H. Ravichandar, M. Mukadam, S. Chernova, D. Fox, B. Boots, and N. Ratliff, “Learning Reactive Motion Policies in Multiple Task Spaces from Human Demonstrations.” (* indicates equal contribution), *Conference on Robot Learning (CoRL)*, 2019
- [C6] **A. Li**, M. Mukadam, M. Egerstedt, and B. Boots, “Multi-Objective Policy Generation for Multi-Robot Systems Using Riemannian Motion Policies.” *International Symposium on Robotics Research (ISRR)*, 2019
- [C5] **A. Li**, and M. Egerstedt, “On the Trade-Off Between Communication and Execution Overhead for Control of Multi-Agent Systems.” *American Control Conference (ACC)*, 2019
- [C4] **A. Li**, L. Wang, P. Pierpaoli, and M. Egerstedt, “Formally Correct Composition of Coordinated Behaviors Using Control Barrier Certificates.” *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2018
- [C3] **A. Li**, W. Luo, S. Nagavalli, and K. Sycara, “Decentralized Coordinated Motion for a Large Team of Robots Preserving Connectivity and Avoiding Collisions.” *IEEE Conference on Robotics and Automation (ICRA)*, 2017
- [C2] **A. Li**, W. Luo, S. Nagavalli, N. Chakraborty, and K. Sycara, “Handling State Uncertainty in Distributed Information Leader Selection for Robotics Swarms.” *IEEE Conference on System, Man and Cybernetics (SMC)*, 2016

- [C1] **A. Li**, M. Lewis, C. Lebiere, K. Sycara, S. S. Khatib, Y. Tang, M. Siedsma, and D. Morrison, “A Computational Model Based on Human Performance for Fluid Management in Critical Care.” *IEEE Symposium Series on Computational Intelligence (SSCI)*, 2016

Workshop Paper

- [W1] **A. Li**^{*}, C.-A. Cheng^{*}, M. A. Rana, N. Ratliff, and B. Boot, “RMP²: a Differentiable Policy Class for Robotic Systems with Control-Theoretic Guarantees.” (* indicates equal contribution), *3rd NeurIPS Workshop on Robot Learning*, 2020

Preprints & Technical Reports

- [TR5] N. Ratliff, K. Van Wyk, M. Xie, **A. Li**, and M. A. Rana, “Optimization Fabrics for Behavioral Design.”, *arXiv preprint arXiv:2010.15676*, 2020
- [TR4] M. Xie, K. Van Wyk, **A. Li**, M. A. Rana, D. Fox, B. Boots, and N. Ratliff, “Geometric Fabrics for the Acceleration-based Design of Robotic Motion.”, *arXiv preprint arXiv:2010.14750*, 2020
- [TR3] N. Ratliff, K. Van Wyk, M. Xie, **A. Li**, and M. A. Rana, “Generalized Nonlinear and Finsler Geometry for Robotics.”, *arXiv preprint arXiv:2010.14745*, 2020
- [TR2] N. Ratliff, K. Van Wyk, M. Xie, **A. Li**, and M. A. Rana, “Optimization Fabrics.”, *arXiv preprint arXiv:2008.02399*, 2020
- [TR1] P. Pierpaoli, H. Ravichandar, N. Waytowich, **A. Li**, D. Asher, and M. Egerstedt, “Inferring and Learning Multi-Robot Policies by Observing an Expert.”, *arXiv preprint arXiv:1909.07887*, 2019

Thesis

- [T1] **A. Li**, “Decentralized Coordinated Motion for Robot Teams Preserving Connectivity and Avoiding Collisions.”, *Master’s Thesis, Carnegie Mellon University*, 2017

HONORS

– NVIDIA Graduate Fellowship (5 worldwide)	2020
– Georgia Robotics Fellowship	2017
– ICRA RAS Travel Grant	2017
– GSA Conference Funding, CMU	2016, 2017
– Siebel Scholar Class of 2017 (72 worldwide)	2016
– Outstanding Graduate (top 5%), ZJU	2015
– Excellent Undergraduate Thesis Award (top 10%), ZJU	2015
– Chu Kochen Scholarship (top 0.2%, highest honor), ZJU	2014
– National Scholarship (top 1%), China	2013
– First-Class Scholarship for Outstanding Students (top 3%), ZJU	2013, 2014
– Excellent Student Awards, ZJU	2012, 2013, 2014

LEADERSHIP AND PROFESSIONAL SERVICE

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- Reader, Paul G. Allen School of Computer Science & Engineering, University of Washington 2020
 - Computer Science & Engineering Ph.D. Admissions

- Pre-Application Review Service (PARS)
 - Provided feedback on 5 prospective students' Ph.D. application packages
 - The PARS program is especially designed to assist members of underrepresented communities and related organizations
- Member of Executive Board, RoboGrads, Georgia Institute of Technology 2018 – 2019
 - President (May – Aug. 2019), Vice-President Academics (May 2018 – May 2019)
 - Initiated faculty-student lunch events in the robotics community
 - Organized student seminars where students present their research to their peers
- Reviewer
 - IEEE Robotics and Automation Letters (RA-L)
 - European Journal of Control (EJC)
 - IEEE International Conference on Robotics and Automation (ICRA)
 - IEEE International Conference on Robot & Human Interactive Communication (RO-MAN)
 - NeurIPS Workshop on Imitation Learning and its Challenges in Robotics

TEACHING EXPERIENCE

University of Washington

Mar. 2020 – June 2020

Graduate Teaching Assistant

Seattle, WA

- CSE-599W: Reinforcement Learning, Spring 2020, Instructor: Prof. Byron Boots

Georgia Institute of Technology

Jan. 2018 – May 2018

Graduate Teaching Assistant

Atlanta, GA

- CS-3630: Introduction to Robotics and Perception, Spring 2018, Instructor: Prof. Sonia Chernova

SKILLS

Programming Languages

Python, MATLAB, C/C++, Java, R

Open Source Libraries

PyTorch, Tensorflow, CNTK, Keras, OpenAI Gym, MuJoCo, ROS