Siyu(Sylvia) Dai

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Education

M.S., PhD Candidate, Massachusetts Institute of Technology (MIT)   *Sep. 2016 - Present*
Major: *Robotics*   Minor: *Machine Learning*   **Cumulative GPA: 5.0/5.0**
Research Assistant in MIT Computer Science and Artificial Intelligence Laboratory (CSAIL)
Master Thesis: *Probabilistic Motion Planning and Optimization Incorporating Chance Constraints* (Sep. 2018)
Tentative PhD Thesis Title: *Reinforcement Learning for Robotic Manipulation Tasks with Sparse Rewards*
Interests: Robot Manipulation, Reinforcement Learning, Optimization, Motion Planning

B.S. & **BBA, Shanghai Jiao Tong University (SJTU)**   *Sep. 2012 - Jun. 2016*
Major: *Naval Architecture and Ocean Engineering*   —   **Overall Ranking: 1/73**
Overall GPA: 3.89/4.00 (90.6/100)   Major GPA: 3.92/4.00 (91.1/100)
Bachelor Thesis: *Numerical Reconstruction and Mechanism Analysis on Vortex-Induced-Vibration of Steel Catenary Riser Caused by Platform Movement* (Awarded 2016 Excellent Bachelor Thesis (**Top 1%**) of SJTU)
Second Major: *Business Administration*   GPA: 3.74/4.00 (88.4/100)
Bachelor Thesis: *Study of Strategy for Precision Marketing based on the WeChat Platform*

Experience

Research Intern, Mitsubishi Electric Research Laboratories   *May - Aug. 2020*
- Developed a hierarchical motion planning approach that provides real-time motion plans for autonomous valet parking systems with incomplete map information.

Research Intern, General AI Lab, Horizon Robotics   *May - Aug. 2019*
- Proposed an empowerment-driven intrinsic exploration approach that allows reinforcement learning agents to learn manipulation skills with only sparse extrinsic rewards from the environment.

Selected Publications

Siyu Dai, and Yebin Wang. "Long-Horizon Motion Planning for Autonomous Vehicle Parking Incorporating Incomplete Map Information," *2021 International Conference on Robotics and Automation (IRCA)*. Under Review.

Siyu Dai, Wei Xu, Andreas Hofmann, and Brian Williams. "An Empowerment-based Solution to Robotic Manipulation Tasks with Sparse Rewards," *Women in Machine Learning Workshop at NeurIPS 2020.*

Siyu Dai, Andreas Hofmann, and Brian Williams. "Fast-Reactive Probabilistic Motion Planning for High-Dimensional Robots," *The International Journal of Robotics Research (IJRR)*. Under Second Round Review.

Siyu Dai, Shawn Schaffert, Ashkan Jasour, Andreas Hofmann, and Brian Williams. "Chance Constrained Motion Planning for High-Dimensional Robots," *2019 International Conference on Robotics and Automation (IRCA).*

Matthew Orton, **Siyu Dai**, Shawn Schaffert, Andreas Hofmann, and Brian Williams. "Improving Incremental Planning Performance through Overlapping Replanning and Execution, *2019 International Conference on Robotics and Automation (ICRA).*

Siyu Dai, Matthew Orton, Shawn Schaffert, Andreas Hofmann, and Brian Williams. "Improving Trajectory Optimization using a Roadmap Framework," *Proceedings of 2018 International Conference on Intelligent Robots and Systems (IROS).*

Siyu Dai, Yadong Zeng, Feier Chen, 2016. "The Scaling Behavior of Bulk Freight Rate Volatility," *International Journal of Transport Economics.* XLIII(1-2): 85-104

Xiaoxu Ding, **Siyu Dai**, Feier Chen, Yuqi Miao, Kang Tian, Yadong Zeng, Han Xu, Cao Qin. "Long Memory and Scaling Behavior Study of Bulk Freight Rate Volatility with Structural Breaks," *Transportation Letters*, 2017. (published online: http://www.tandfonline.com/doi/full/10.1080/19427867.2016.1270718)

Leijian Song, Shixiao Fu, **Siyu Dai**, Mengmeng Zhang, Yifan Chen. "Distribution of Drag Force Coefficient along a Flexible Riser undergoing VIV in Sheared Flow," *Ocean Engineering*, 2016, 126: 1-11.

Scholarships and Main Awards

CC Tung Fellowship of MIT Mechanical Engineering Department	*Sep. 2016*
National Scholarship of China (**1st** out of 73, for academic and extracurricular excellence)	*Nov. 2015*
Changshi Scholarship (**Top 2** out of 73, for academic and extracurricular excellence)	*Nov. 2014*
City Scholarship of Shanghai (**Top 4** out of 245, for academic and extracurricular excellence)	*Nov. 2013*
Outstanding Graduates of Shanghai City	*May 2016*
Second Prize, National Physics Contest for College Students (Chinese Physics Society)	*Dec. 2014*

Reinforcement Learning for Robotic Manipulation Tasks with Sparse Rewards

Advisor: Brian C. Williams, *Computer Science and Artificial Intelligence Laboratory*, MIT   *Sep. 2019 - Present*
- Goal: To develop a reinforcement learning approach that encourages robots to learn basic manipulation skills through intrinsic exploration, and then transfer the skills to more complex tasks in new environments
- Implemented 3 different intrinsic exploration approaches and evaluated their performance on object-lifting and pick-and place tasks in two different manipulation environments
- Developed an empowerment-based intrinsic motivation that maximizes the conditional mutual information (MI) between actions and states and compared the performance of 3 different MI estimation approaches
- Combined the empowerment-based intrinsic motivation with diversity-driven rewards and enabled the robotic manipulator to learn a diverse set of skills
- Proposed a learning from demonstration framework that combines intrinsic exploration with inverse reinforcement learning to accomplish long-horizon compound tasks

Improving Chance-Constrained Motion Planning using Machine Learning Methods

Advisor: Brian C. Williams, *Computer Science and Artificial Intelligence Laboratory*, MIT   *Feb. - Aug. 2019*
- Goal: To develop an offline learning scheme that can provide faster online reaction time and more accurate collision risk estimation for chance-constrained manipulator motion planning
- Compared the performance of kernel-based regression, random forest and neural networks in terms of improving the accuracy and efficiency of collision risk estimation given a probability distribution of robot states
- Demonstrated a significant improvement on planning speed using neural networks in 1000 randomly sampled simulation test cases

Fast-reactive Risk-aware Robotic Motion Planning and Execution System Design

Advisor: Brian C. Williams, *Computer Science and Artificial Intelligence Laboratory*, MIT *Oct. 2017 - Jan. 2019*
- Goal: To develop a risk-aware robotic motion planning system that accounts for system process noises and observation noises, and can quickly provide safe plans for robots with complicated dynamics but work under uncertainty, for instance underwater vehicles and human support robots
- Improved and tested an implementation of LQR-RRT* algorithm, and explored approaches of building probabilistic roadmaps accounting for complicated system dynamics
- Implemented the Linear Quadratic Gaussian Motion Planning (LQG-MP) algorithm on the 7-DOF Baxter arm
- Developed a quadrature-based collision risk estimation approach and a risk reallocation method to facilitate chance constraints satisfaction for high-dimensional robotic planning tasks
- Conducted 1000 simulation tests and showed significant collision reduction compared to deterministic solutions
- Designed a risk-aware planning and execution system that can iteratively improve plans during execution time by incorporating the Iterative Risk Allocation (IRA) algorithm

Selected Extracurricular Activities

Co-Chair, *Graduate Student Council Academic, Research and Career Committee*, MIT   *May 2019 - May 2020*
- Initiated a subcommittee that works with MIT senior administration to improve advisor-advisee relationship.
- Host academic related events, including panels and workshops on academia and industry job hunting.

President & **Officer**, *Graduate Association of Mechanical Engineers (GAME)*, MIT   *Feb. 2017 - Feb. 2019*
- Arrange GAME meetings with department faculty and express students' concerns
- Host the sixth GAME annual gala, including venue reservation, funding application, publicity, etc.

Chair of Executive Committee, Former Floor Officer, *Ashdown House*, MIT   *Jun. 2017 - May 2019*
- Lead housing-related initiatives in MIT, including changes to housing allocation policies and resident food source problem after the closure of the nearby supermarket
- Initiated a volunteer appreciation system to improve the community engagement in Ashdown
- Won Ashdown House Outstanding Officer Award of the year 2017

Representative of Graduates, *2016 Bachelor Degree Conferring Ceremony*, SJTU   *Jun. 2016*
- Delivered a speech on behalf of 2016 graduates to express gratitude for SJTU and confidence for our new future

Representative, *SJTU Student Congress*   *May 2013 - Jun. 2016*
- Collected students' opinion on academic system and campus life, and presented on the Student Congress

Skills and Interests

Computer Skills: Python, Matlab, TensorFlow, OpenRAVE, ROS, AutoCad, Abaqus, Vba, Sql
Interests: Piano player (16 years), swimmer (16 years, front crawl and breaststroke), amateur yoga instructor (5 years), Chinese Kung fu (Northern style), dancer (5 performances for Dance Club with average audience of 1000+)