# Siyu(Sylvia) Dai

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## Education

**M.S., PhD, Massachusetts Institute of Technology (MIT)** *Sep. 2016 - May 2022*
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)
PhD Thesis: *Learning to Make Decisions in Robotic Manipulation* (Apr. 2022)
Expertise: Robot Manipulation, Reinforcement Learning, Curriculum Learning, 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

**Applied Scientist II, Robotics AI / Amazon Robotics, Amazon.com** *Mar. 2022 - Present*
- Tech lead for a cross-functional team with 10+ members from hardware, controls, motion planning, perception and software. Drove a robotics system from its initial integration to achieving robust performance.
- Designed and deployed multiple computer vision features into robotic manipulation systems in Amazon production warehouse, including estimation of object depth behind translucent barriers, 3D scene understanding and space prediction for storage shelves, dimension and pose estimation for item manipulation, and production-scale instance and semantic segmentation models.

**Applied Scientist Intern, Robotics AI, Amazon.com** *Oct. 2021 - Jan. 2022*
- Proposed a visual prediction approach to estimate the outcome of robot actions based on visual input.

**Research Intern, Honda Research Institute USA** *Jul. - Sep. 2021*
- Developed an intention-aware decision making and motion planning framework for autonomous vehicles in dense traffic with human drivers (manuscript to be submitted to Intelligent Vehicles Symposium (IV) 2022).

**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**, et al. "Depth Estimation Through Translucent Surfaces," *2024 Conference on Robot Learning*, Under Review.

**Siyu Dai**, Andreas Hofmann, and Brian Williams. "Automatic Curricula via Expert Demonstrations," *2021 Conference on Neural Information Processing Systems (NeurIPS) Deep Reinforcement Learning Workshop.*

**Siyu Dai**, Wei Xu, Andreas Hofmann, and Brian Williams. "An Empowerment-based Solution to Robotic Manipulation Tasks with Sparse Rewards," *Proceedings of Robotics, Science and Systems (RSS), 2021.*

**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).*

**Siyu Dai**, Andreas Hofmann, and Brian Williams. "Fast-Reactive Probabilistic Motion Planning for High-Dimensional Robots," *Springer Nature Computer Science, 2021, 2(6), 1-39.*

**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).*

**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).*

## Selected Patents

Yebin Wang, **Siyu Dai**. *Autonomous Parking with Hhybrid Exploration of Parking Space.*, US Patent 11,767,035, 2023

**Siyu Dai**, David F Isele, and Sangjae Bae. *Game Theoretic Decision Making*, US Patent App. 17/707,043

**Siyu Dai**, et al. *Monocular Depth Prediction and Occupancy Correction Systems And Methods for Item stow Processes*, US Patent App. 18/191,358

**Siyu Dai**, Kislay Kumar, Sisir Karumanchi, Rahul Warrier, Syndey Kaplan, Christine Fuller, and Walter Bircher. *Item Dimension and Pose Estimation for Robotic Manipulation Systems*, US Patent App. 18/535,188

Shantanu Thakar, Sisir Karumanchi, **Siyu Dai**, and Lei Fan. *Stability Affordance Generation for Robotic Item Stacking*, US Patent App. 18/519,603

Parker Owan, et al. including **Siyu Dai**. *Visual Perception and Strategies for Placing Inventory into Fabric Pods*, US Patent App. 17/707,579

## Scholarships and Main Awards

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| 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* |

## Selected Research Projects

**Automatic Curricula via Expert Demonstrations (ACED)**
Advisor: Brian C. Williams, *Computer Science and Artificial Intelligence Laboratory*, MIT *Sep. 2020 - Jun. 2021*

- Goal: To develop an imitation learning algorithm that utilizes demonstrations in an efficient manner and allows robotic manipulators to learn common tasks with as few as one demonstration
- Proposed ACED, a reinforcement learning framework that automatically extracts a sequence of curricula from expert demonstrations in order to accelerate the learning process of complicated robotic manipulation tasks
- Integrated ACED with well-known imitation learning algorithms including behavior cloning and generative adversarial imitation learning, and evaluated the combination's performance on common robotic tasks
- Analyzed the influence of number of demonstrations, number of curricula and policy initializations on the performance of ACED in robotic pick-and-place tasks and block stacking tasks

**Reinforcement Learning for Robotic Manipulation Tasks with Sparse Rewards**
Advisor: Brian C. Williams, *Computer Science and Artificial Intelligence Laboratory*, MIT *Sep. 2019 - Sep. 2020*

- 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

**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
- 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