

Kai Gao

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EDUCATION

Rutgers, the State University of New Jersey

PhD, Computer Science | Advisor: Dr. Jingjin Yu

Aug. 2019 – Jan. 2025

Piscataway, USA

PhD Thesis: Tabletop Object Rearrangement: Structure, Complexity, And Efficient Combinatorial Search-Based Solutions.

University of Science and Technology of China (USTC)

Bachelor, Mathematics

Aug. 2015 – Jun. 2019

Hefei, China

WORK EXPERIENCE

Applied Scientist II

Industrial Robotics Group & Amazon Robotics

Jan. 2025 – Present

North Reading, USA

1. Led simulation experiments for behavior cloning-based closed-loop control policies in Amazon's manipulation tasks, and contributed to high-impact experiments on foundation model architectures and milestone demos.
2. Owned data processing and result analysis modules of a policy learning infrastructure that reduced experiment completion time from months to 2-3 days, and significantly contributed to training and policy rollout stacks.
3. Set up and maintained a teleoperation system for large-scale dexterous manipulation data collection.

Applied Scientist II Co-op

Amazon Robotics

Feb. 2024 – Sep. 2024

North Reading, USA

1. Led a research project, collaborating with a team of engineers and assigning daily tasks to ensure smooth project execution.
2. Designed and trained a transformer-based visuomotor policy for hardware-agnostic skill learning and multi-skill chaining, leveraging a pre-trained robotics foundation model (generalist policy) as the backbone.
3. Participated in a project of imitation learning based dexterous object grasping, responsible for deciding on the object set and demonstrated skills for subsequent data collection based on the roll-out performance of trained policies.
4. Developed a simulation environment using Nvidia Isaac Sim for multi-step dexterous manipulation tasks, enabling effective demonstration collection and analysis of varying observation types and task descriptions (language prompts or images).

Advanced Robotics Intern

Siemens Corporation

May. 2022 – Sep. 2022

Berkeley, USA

1. Designed and implemented a model-free online algorithm for the bin packing problem with irregularly shaped objects. The method consists of depth-image preprocessing and a gradient-based optimizer for packing pose computation.
2. Built a prototype pick-and-pack system utilizing a UR5 robot and RealSense cameras, seamlessly integrating the proposed packing strategy with Siemens' FlexGrasp.

RESEARCH EXPERIENCE

Robot Arm Manipulation Planning

Research Assistant Advised by Dr. Jingjin Yu

Mar. 2020 – Dec. 2024

Algorithmic Robotics and Control Lab (ARCL), Rutgers University, USA

1. Designed and implemented perception-planning-control pipelines for multiple real-world robotic systems, utilizing UR5 robots in tabletop rearrangement settings and a Baxter Robot for shelf-based object retrieval scenarios.
2. Applied deep learning models for precise object segmentation, grasp pose generation, and prediction of object pose stability.
3. Designed and constructed simulation scenarios for shelf, tabletop, room environments using physics engines such as PyBullet, Isaac Gym, Drake, ROS+Gazebo, and Moveit.
4. Explored dual-arm motion planning through C-space decomposition on MIT Drake and GPU-accelerated motion planning with Nvidia CuRobo.

Language-Guided Semantic Object Rearrangement

Research Assistant Advised by Dr. Jingjin Yu

Mar. 2023 – Sep. 2023

Algorithmic Robotics and Control Lab (ARCL), Rutgers University, USA

1. Explored language-guided manipulation planning strategies in collaboration with Dr. Abdeslam Boularias' team.
2. Developed a Monte-Carlo Tree Search based task planner that uses goal state conditions, interpreted by large language models from human language instructions, as input.

Lab Toolkits Development, and Miscs

Research Assistant Advised by Dr. Jingjin Yu

Jul. 2018 – Dec. 2024

Algorithmic Robotics and Control Lab (ARCL), Rutgers University, USA

1. Developed camera calibration software to precisely evaluate the perception accuracy of RealSense cameras.
2. Created a pose estimation dataset featuring synthesized desktop scenes from diverse camera angles, using Blender.

SELECTED CERTIFICATES & AWARDS

IROS 2023 Finalist of Best RoboCup Paper Award.	IROS, Oct 2023
Gold Award of China Undergrad. Math. Contest in Modeling in Anhui Province (1/65 in USTC)	2017
Reinforcement Learning Specialization.	Coursera, July 2023
Outstanding Graduates (2019)	USTC, Jun. 2019
Outstanding Student Scholarship (2015-2016) (2017-2018)	USTC, 2016, 2018

SKILLS

Programming Languages : Python, C++, Matlab

Tools : Git, ROS, Docker, PyBullet, Gazebo, OpenCV, PyTorch, Gurobi, Drake, Isaac Gym, Unreal Engine, Blender

INVITED TALKS

Fast High-Quality Tabletop Rearrangement in Bounded Workspace.	March 2022
<i>TRIPODS/DATA-INSPIRE Graduate Student Workshop</i>	Virtual
On Minimizing the Number of Running Buffers for Tabletop Rearrangement	May 2021
<i>TRIPODS (Transdisciplinary Research in Principles of Data Science) Seminar</i>	Virtual

PUBLICATIONS

Published First-Author

- **K. Gao**, F Wang, E Aduh, D Randle, and J Shi. "MuST: Multi-Head Skill Transformer for Long-Horizon Dexterous Manipulation with Skill Progress." 2025 IEEE International Conference on Robotics and Automation (ICRA 2025).
- **K. Gao**, Y Ding, S Zhang, and J. Yu. "ORLA*: Mobile Manipulator-Based Object Rearrangement with Lazy A Star." 2025 IEEE International Conference on Robotics and Automation (ICRA 2025).
- **K. Gao**, J. Yu, T. S. Punjabi, and J. Yu. "Effectively Rearranging Heterogeneous Objects on Cluttered Tabletops." 2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2023) (**Finalist of Best RoboCup Paper Award.**).
- Andy Xu*, **K. Gao***, S. W. Feng*, and J. Yu. "Optimal and Stable Multi-Layer Object Rearrangement on a Tabletop." 2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2023).
- **K. Gao**, S. W. Feng, B. Huang, and J Yu. "Minimizing Running Buffers for Tabletop Object Rearrangement: Complexity, Fast Algorithms, and Applications." The International Journal of Robotics Research (IJRR).
- **K. Gao**, and J. Yu. "On the Utility of Buffers in Pick-n-Swap Based Lattice Rearrangement." 2023 IEEE International Conference on Robotics and Automation (ICRA 2023).
- **K. Gao** and J. Yu. "Toward Efficient Task Planning for Dual-Arm Tabletop Object Rearrangement." 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022).
- **K. Gao**, D. Lau, B. Huang, K. E. Bekris and J. Yu. "Fast High-Quality Tabletop Rearrangement in Bounded Workspace." 2022 IEEE International Conference on Robotics and Automation (ICRA 2022).
- **K. Gao** and J. Yu. "Capacitated Vehicle Routing with Target Geometric Constraints." 2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2021).
- **K. Gao**, S. W. Feng, and J Yu. "On Minimizing the Number of Running Buffers for Tabletop Rearrangement." 2021 Robotics: Science and Systems (RSS 2021).
- R. Wang*, **K. Gao***, D. Nakhimovich*, J. Yu, and K. E. Bekris. "Uniform Object Rearrangement: From Complete Monotone Primitives to Efficient Non-Monotone Informed Search." 2021 IEEE International Conference on Robotics and Automation (ICRA 2021).

Published Co-Author

- H. Chang, **K. Gao**, K. Boyalakuntla, A. Lee, B. Huang, H. U. Kumar, J. Yu, and A. Boularias "LGMCTS: Language-Guided Monte-Carlo Tree Search for Executable Semantic Object Rearrangement." Submitted to IROS 2024.
- E. R. Vieira, **K. Gao**, D. Nakhimovich, J. Yu and K. E. Bekris. "Effective and Robust Non-Prehensile Manipulation via Persistent Homology Guided Monte-Carlo Tree Search" the 18th International Symposium on Experimental Robotics (ISER 2023).
- E. R. Vieira, D. Nakhimovich, **K. Gao**, R. Wang, J. Yu and K. E. Bekris. "Persistent Homology for Effective Non-Prehensile Manipulation" 2022 IEEE International Conference on Robotics and Automation (ICRA 2022).
- R. Wang, **K. Gao**, J. Yu and K. E. Bekris. "Lazy Rearrangement Planning in Confined Spaces." the 32nd International Conference on Automated Planning and Scheduling (ICAPS 2022).
- S. W. Feng, **K. Gao**, J. Gong, and J. Yu. "Sensor Placement for Globally Optimal Coverage of 3D-Embedded Surfaces." 2021 IEEE International Conference on Robotics and Automation (ICRA 2021).
- S. W. Feng, S. D. Han, **K. Gao**, and J. Yu. "Efficient Algorithms for Optimal Perimeter Guarding." 2019 Robotics: Science and Systems (RSS 2019).