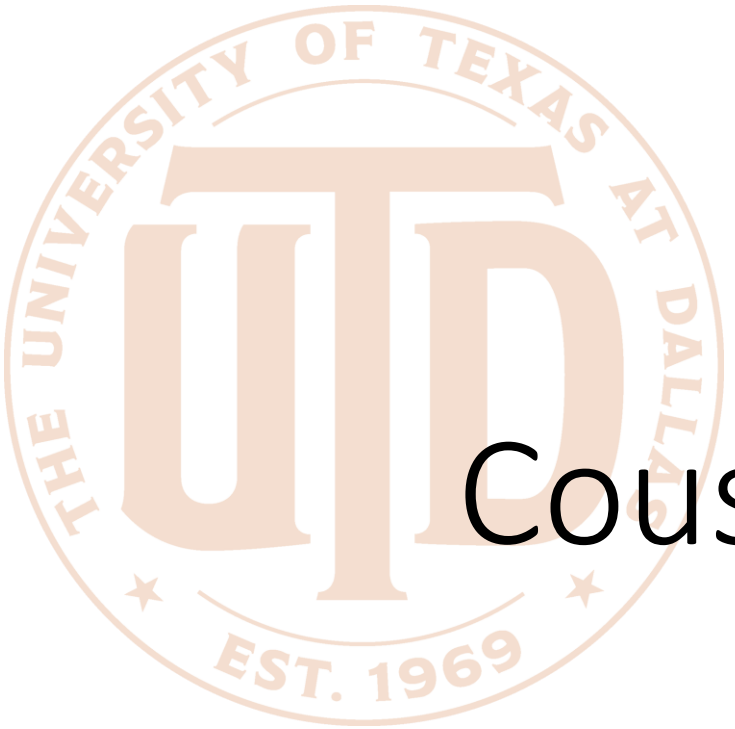



# Couse Project Description

CS 6301 Special Topics: Introduction to Robot Manipulation and Navigation

Professor Yu Xiang

The University of Texas at Dallas

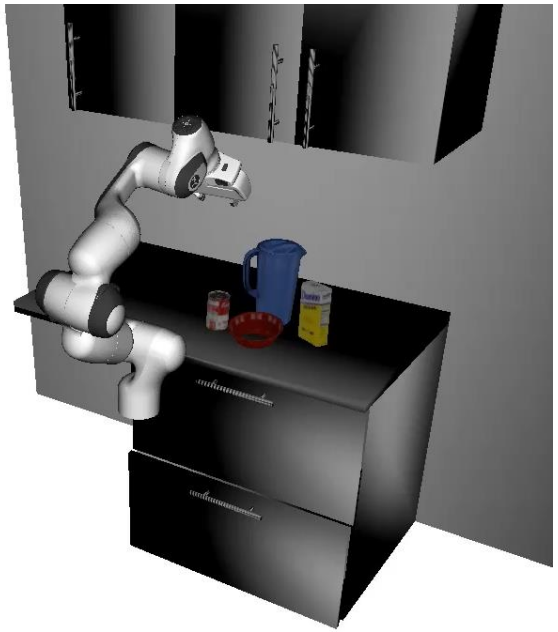
# Course Project

- Team Project (45%)
  - 2 - 4 students for a project
  - Project proposal (5%)
  - Project mid-term report (10%)
  - Project presentation (15%)
  - Project final report (15%)

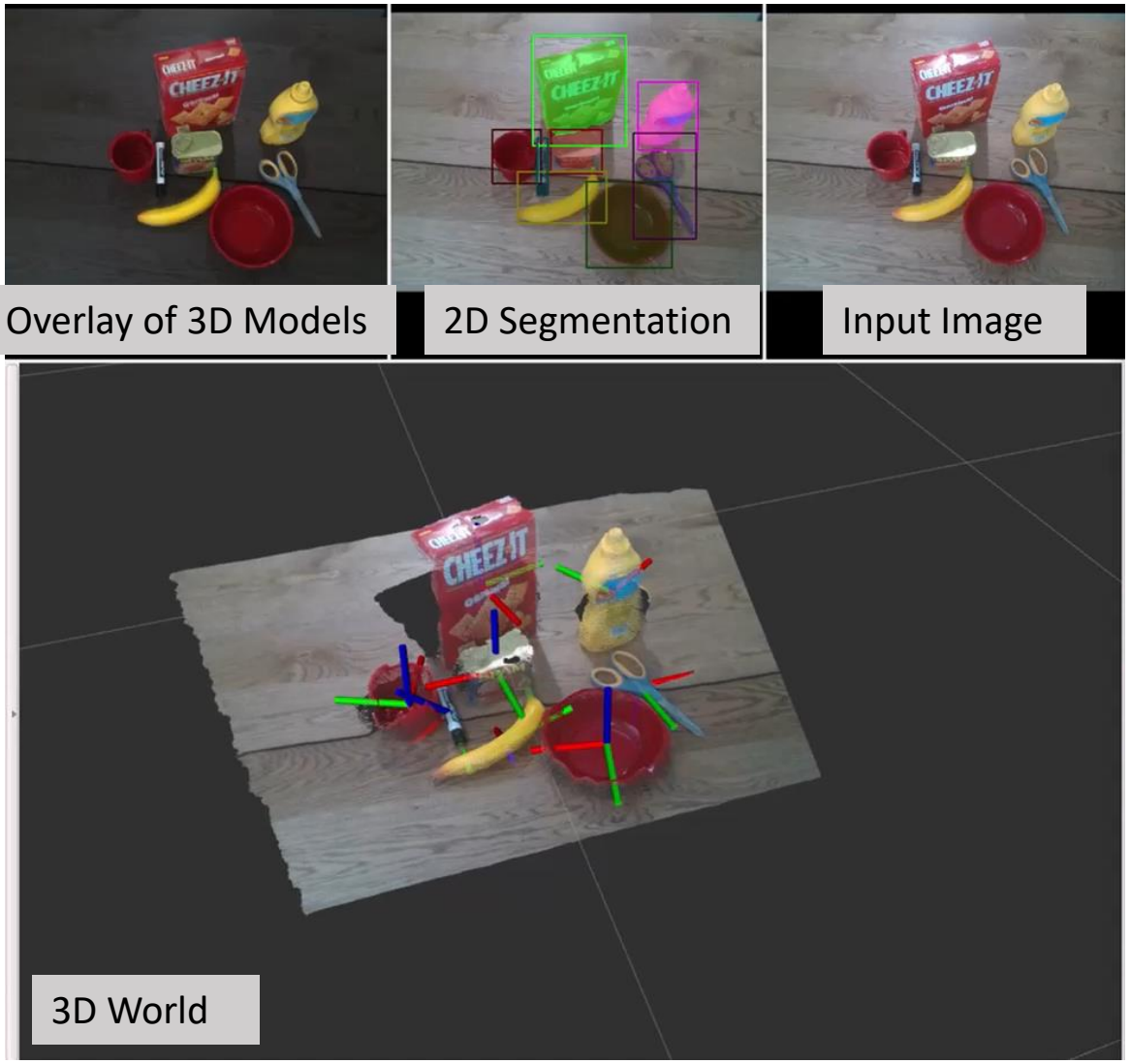
# Course Project Tracks

- Research-oriented
  - Proposal a new idea in robotics that has not been explored before
  - Implement the new idea and conduct experiments to verify it
- Application-oriented
  - Apply an existing algorithm or method to a new problem or a new application
  - E.g., if a method is proposed for domain A, explore applying it to a different domain
- Implementation-oriented
  - Select an existing algorithm or method, implement it and conduct experiments to verify the implementation
  - Cannot just use open-source code and run experiments with it

# Topic: Model-based Grasping



# Topic: 6D Object Pose-based Grasping



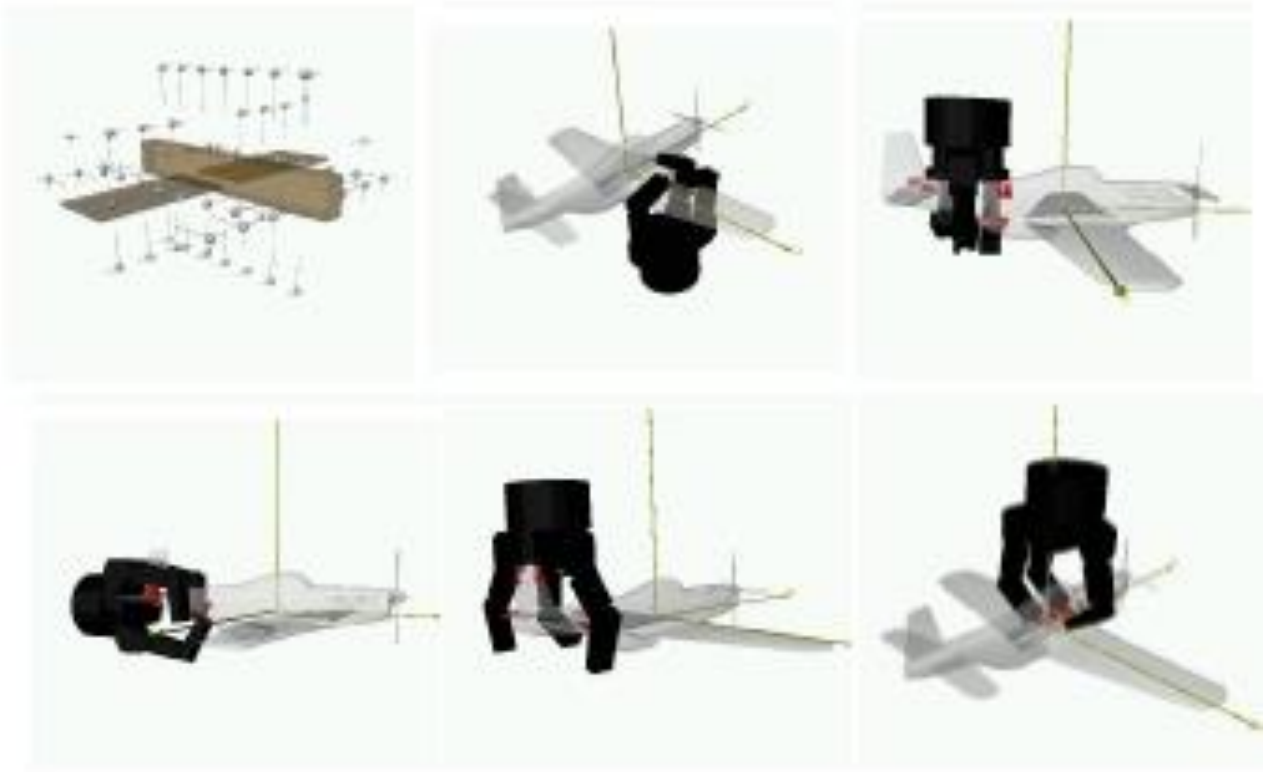


3D models

**Self-supervised 6D Object Pose Estimation for Robot Manipulation. Deng et al., ICRA'20**

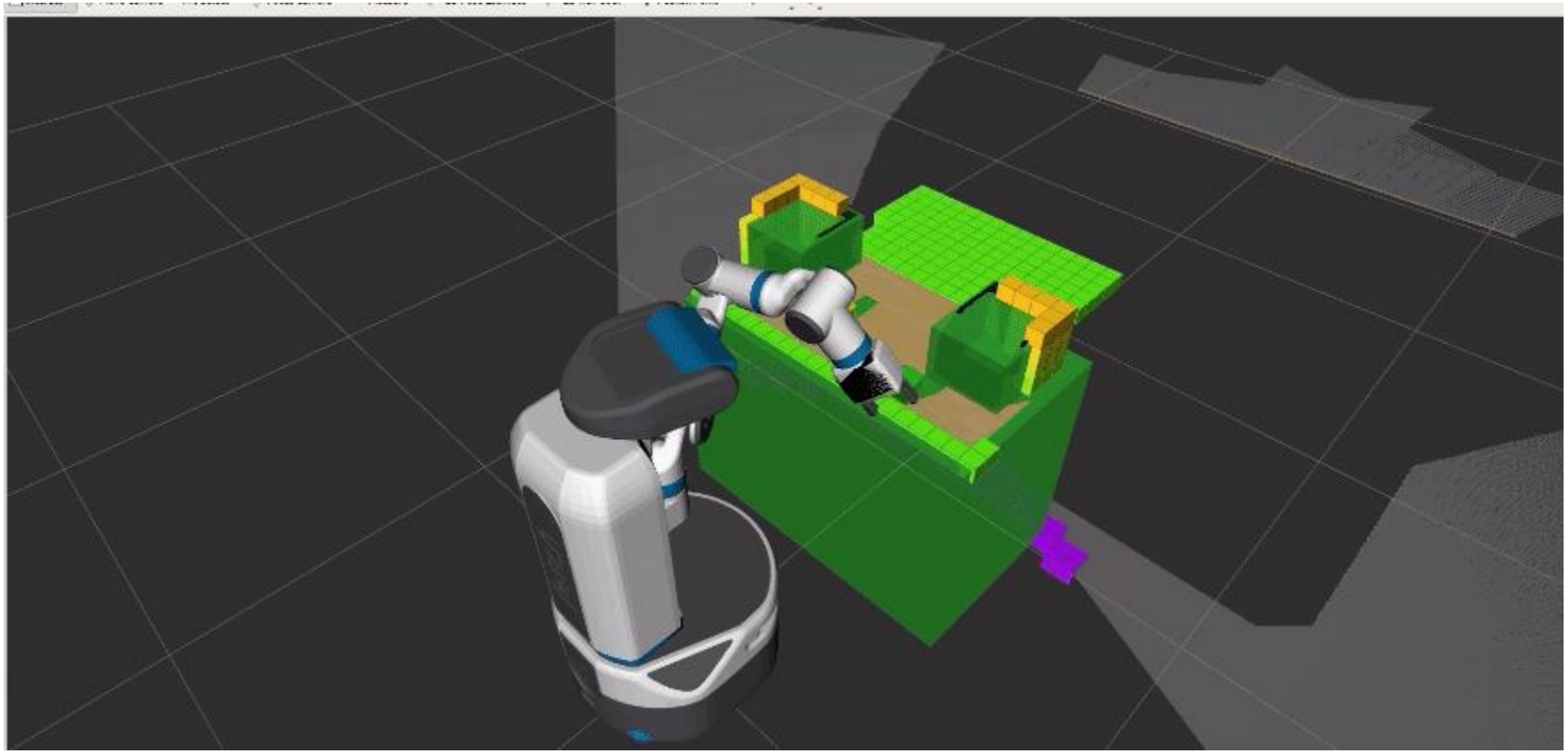
https://arxiv.org/abs/1909.10159

# Topic: Model-based Grasping Planning



Graspit! https://graspit-simulator.github.io/

# Topic: Model-based Motion Planning



https://opensource.fetchrobotics.com/icra-challenge/2019/01/28/tutorial.html

Moveit https://moveit.ros.org/

# Topic: Learning-based Top-Down Grasping

https://ai.googleblog.com/2018/06/scalable-deep-reinforcement-learning.html

**QT-Opt: Scalable Deep Reinforcement Learning for Vision-Based Robotic Manipulation. Kalashnikov, et al., 2018 https://arxiv.org/abs/1806.10293**

# Topic: Learning-based Top-Down Grasping

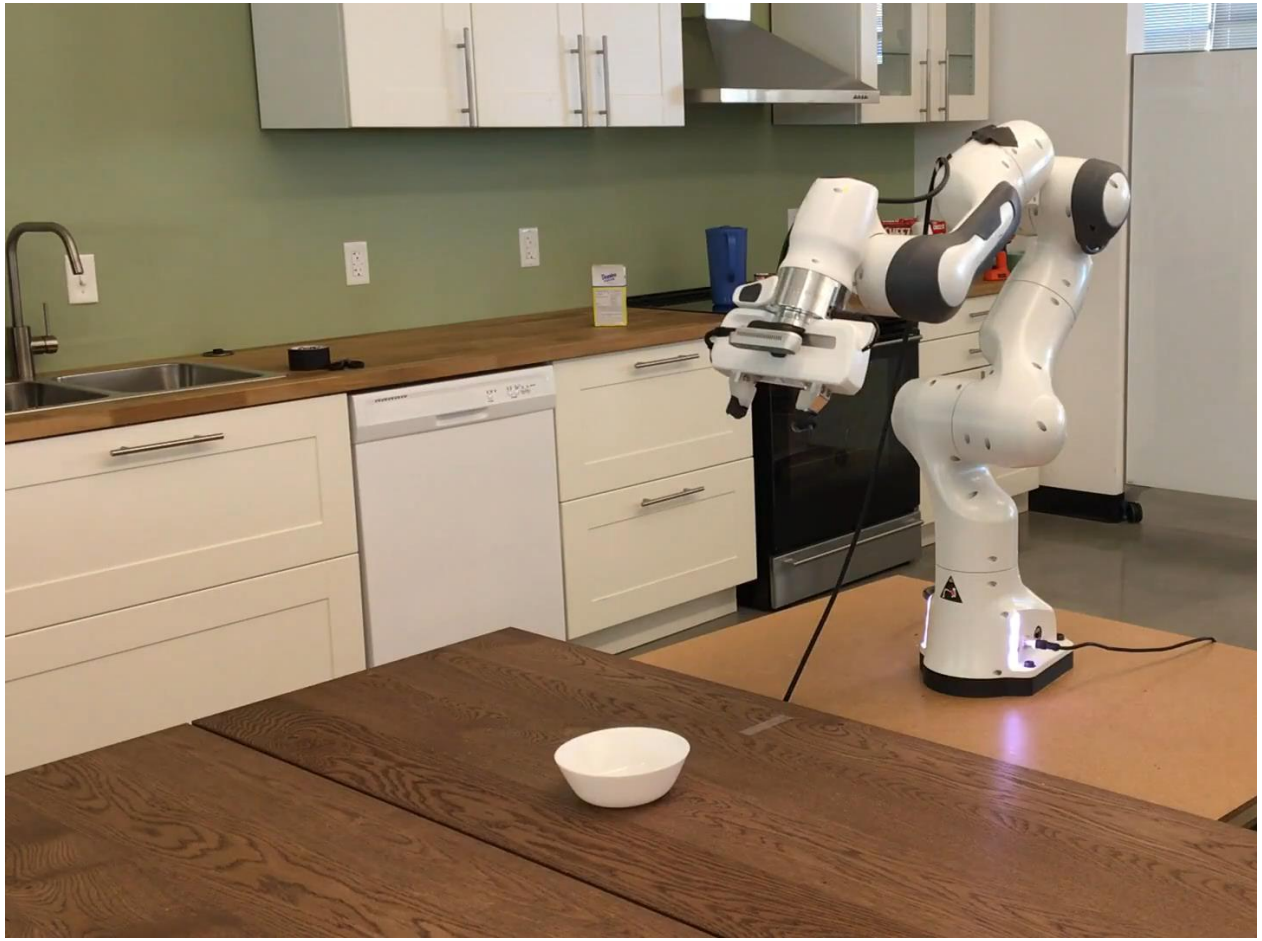

**Sample Efficient Grasp Learning Using Equivariant Models. Zhu et al. RSS, 2022**

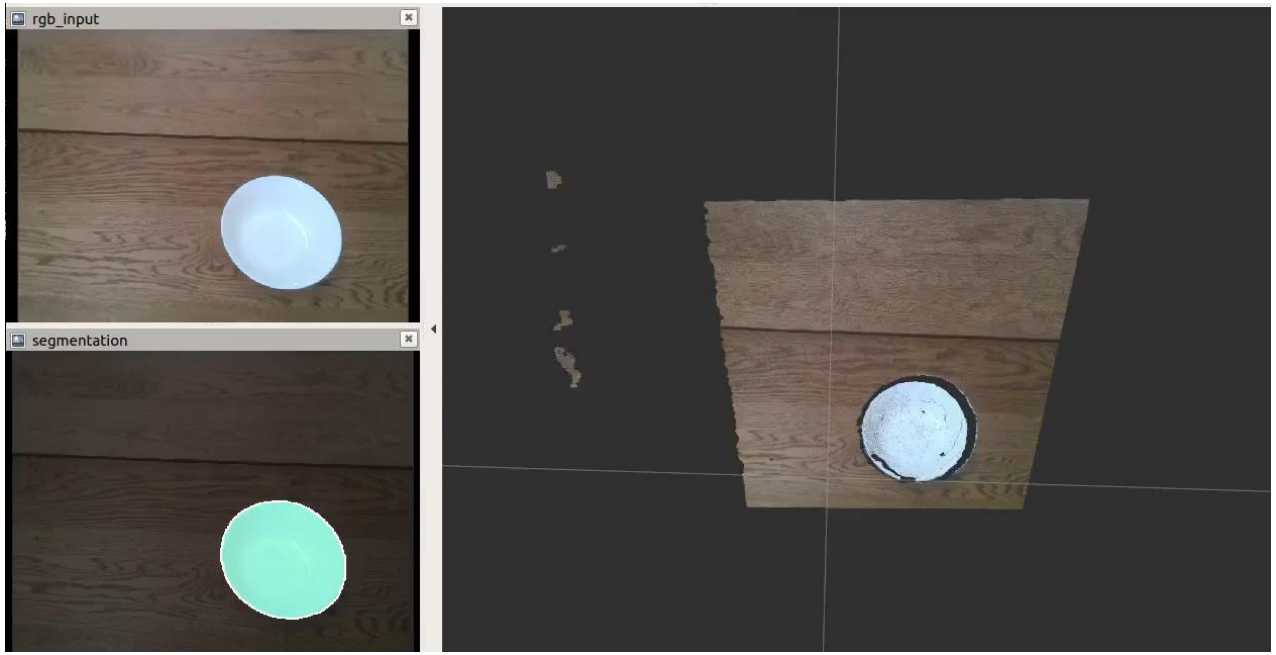
https://zxp-s-works.github.io/equivariant_grasp_site/

# Topic: Learning-based 6D Grasping


**6-DOF GraspNet: Variational Grasp Generation for Object Manipulation. Mousavian et al., ICCV'19**
https://arxiv.org/abs/1905.10520

# Topic: Learning-based 6D Grasping






**Goal-Auxiliary Actor-Critic for 6D Robotic Grasping with Point Clouds. Wang et al., CoRL'21**

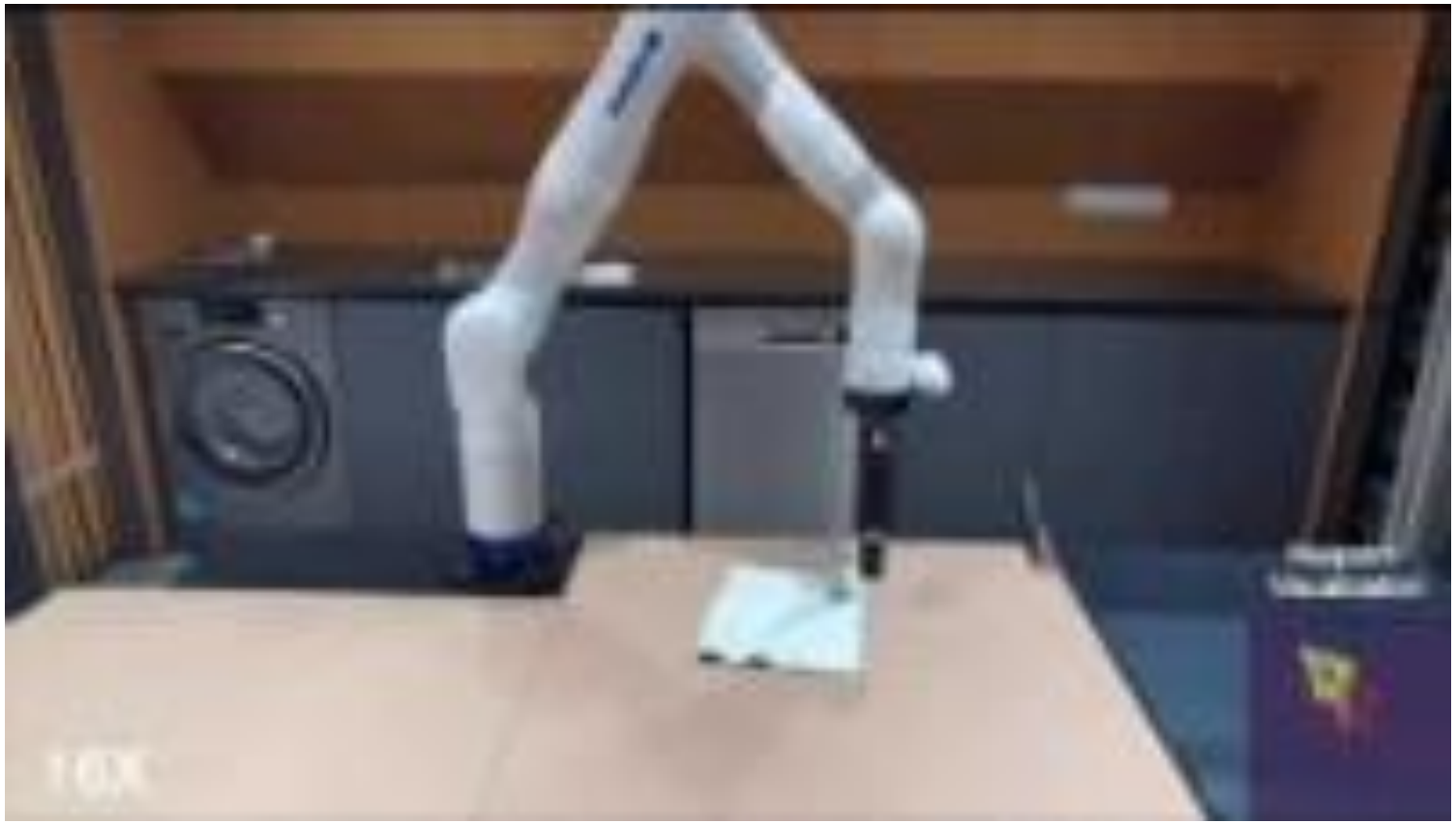
https://sites.google.com/view/gaddpg

# Topic: Articulated Object Manipulation


https://hyperplane-lab.github.io/vat-mart/

VAT-Mart: Learning Visual Action Trajectory Proposals for Manipulating 3D ARTiculated Objects, Wu et al., ICLR'22

# Topic: Deformable Object Manipulation



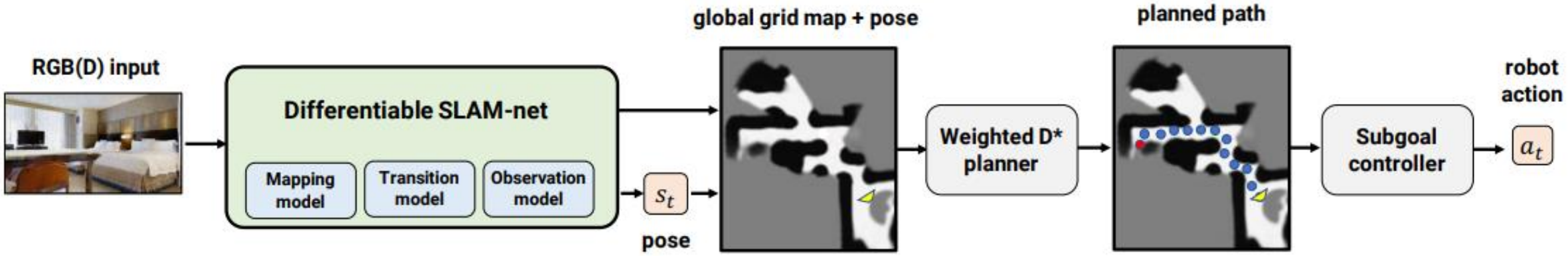
Learning Latent Graph Dynamics for Visual Manipulation of Deformable Objects. Ma et al., ICRA'21.

https://arxiv.org/abs/2104.12149

# Topic: ROS Navigation Stack

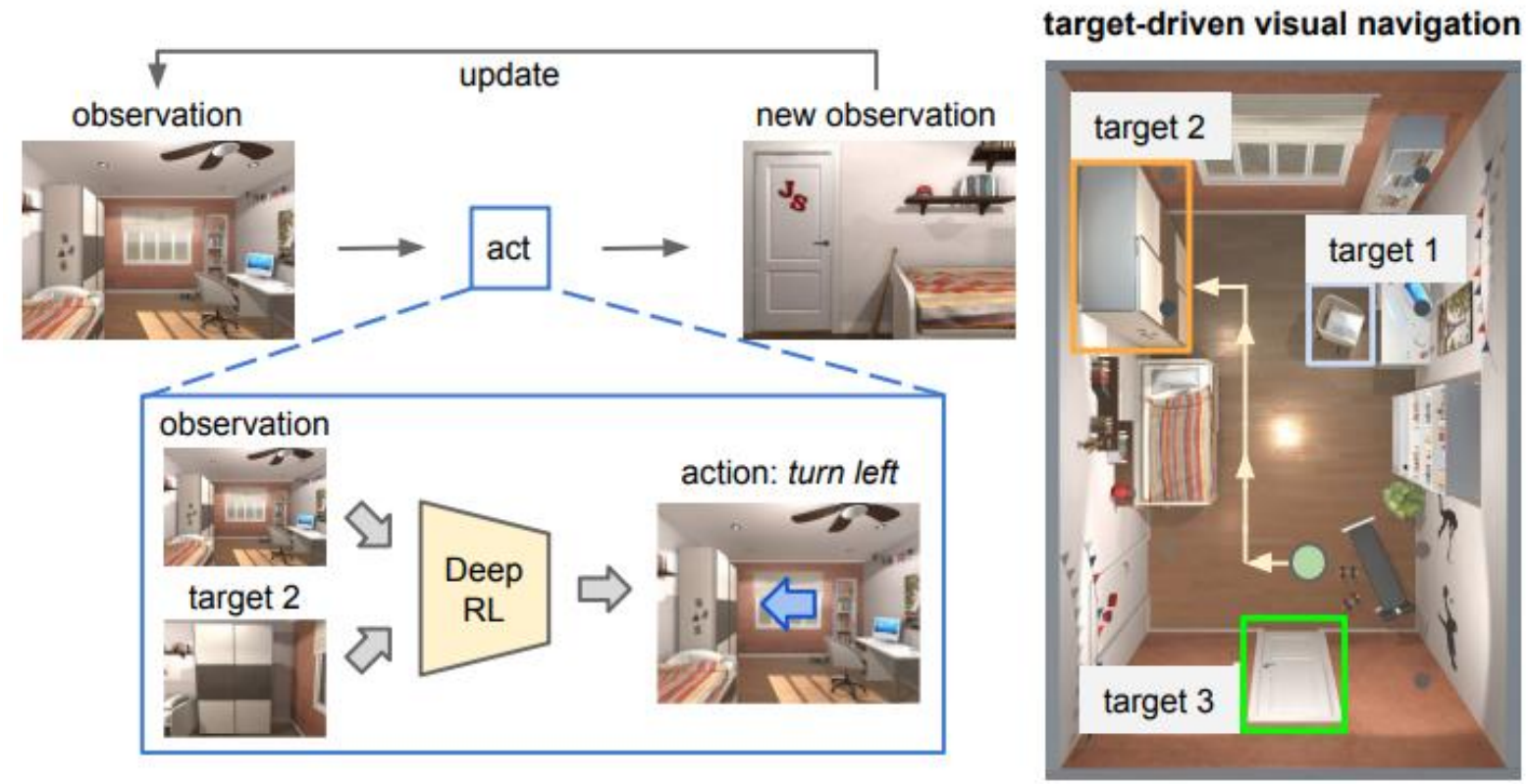
http://wiki.ros.org/navigation

# Topic: Visual Navigation




Differentiable SLAM-net: Learning Particle SLAM for Visual Navigation. Karkus et al., CVPR'21
https://sites.google.com/view/slamnet

# Topic: Target-Driven Visual Navigation




**Target-driven Visual Navigation in Indoor Scenes using Deep Reinforcement Learning. Zhu et al., ICRA'17**

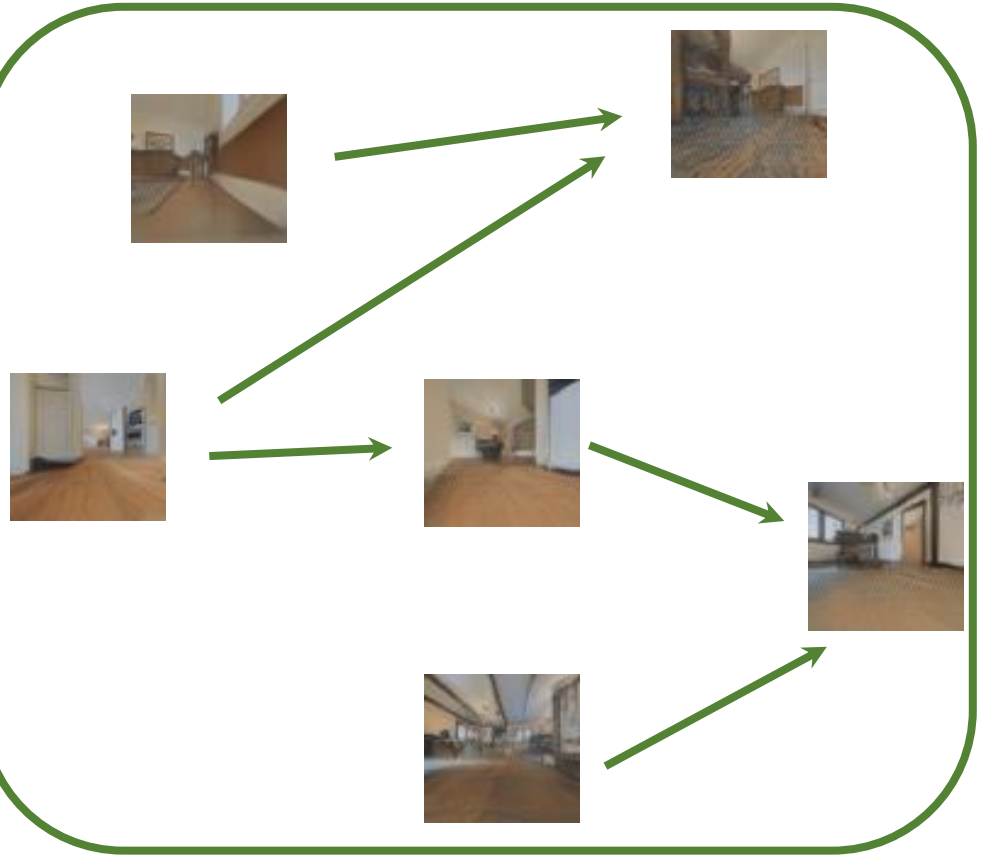
https://arxiv.org/abs/1609.05143

# Topic: Topological Navigation

Dense Trajectories

Reachability Estimator

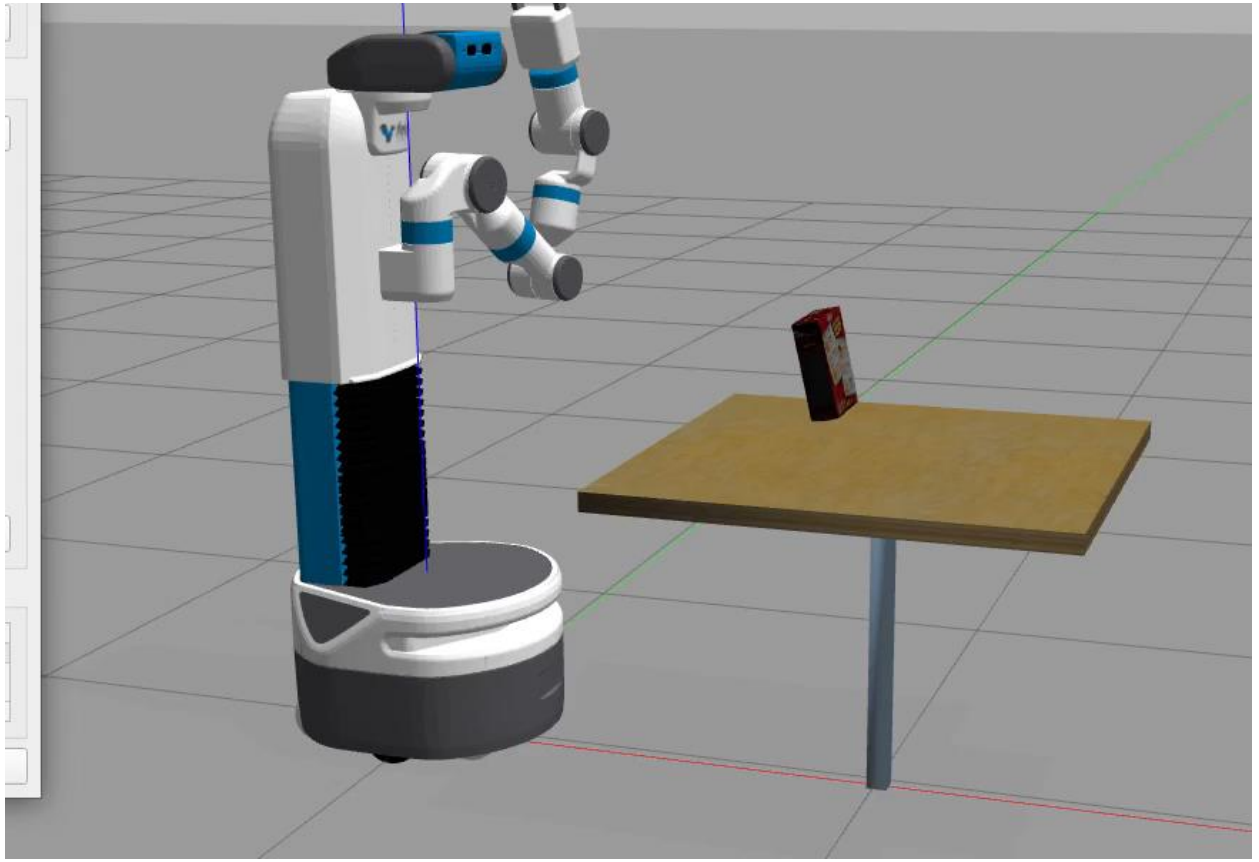
Sparse Topological Map



Scaling Local Control to Large Scale Topological Navigation. Meng et al., ICRA 2020

https://homes.cs.washington.edu/~xiangyun/topological_nav/

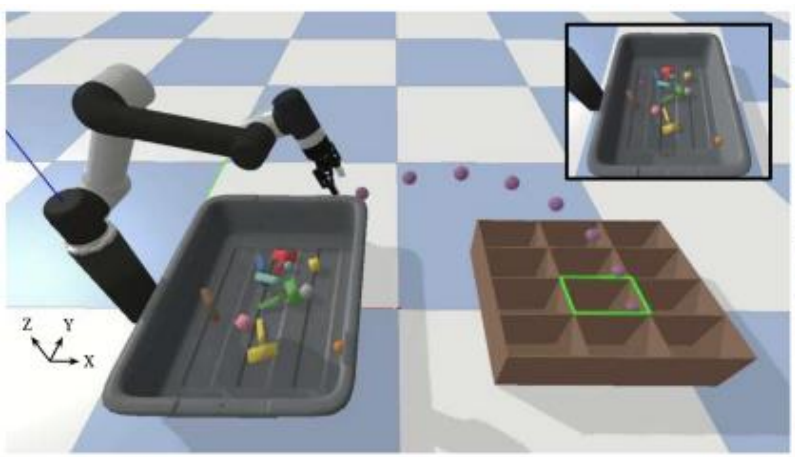
# Simulator: Gazebo

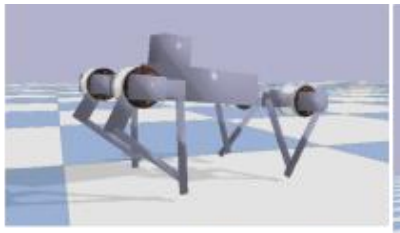


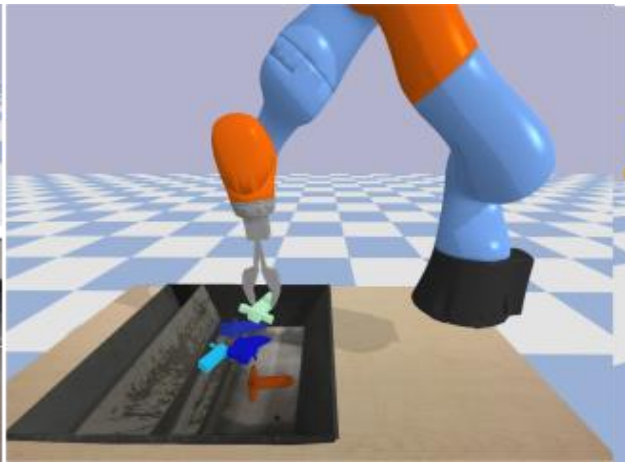
- Integrated with ROS

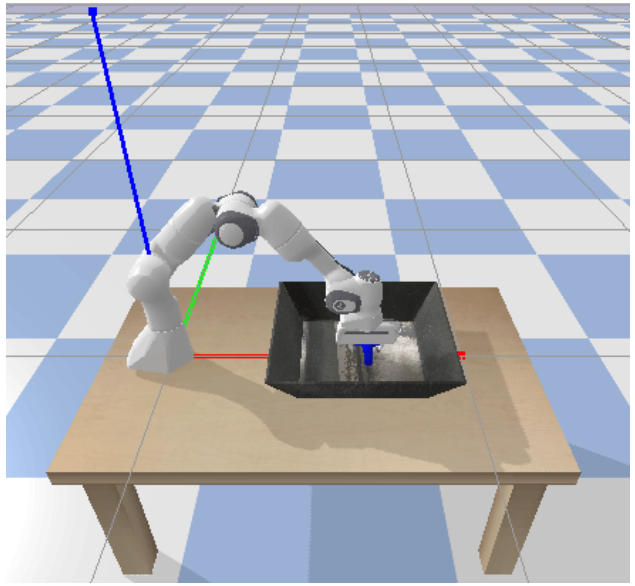
https://gazebosim.org/home

# Simulator: PyBullet



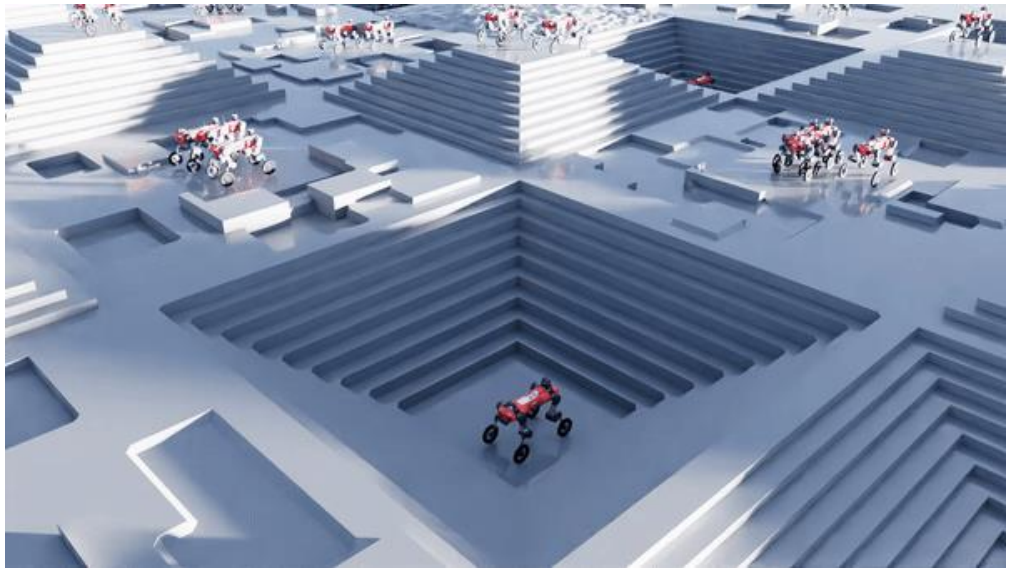


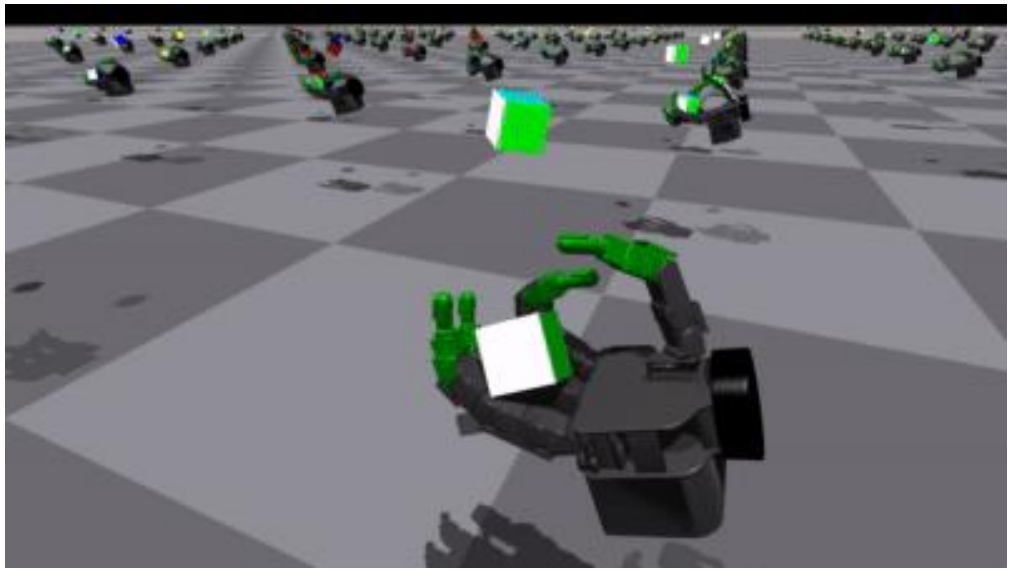


- Python interface

https://pybullet.org/wordpress/

# Simulator: NVIDIA Isaac Gym





- GPU acceleration
- Parallelization of thousands of environments

https://developer.nvidia.com/isaac-gym https://github.com/NVIDIA-Omniverse/IsaacGymEnvs

# Simulation Environment: iGibson

## Fully-Interactive and Photorealistic

**15 scenes annotated from real-world homes**

**Support 12000+ scenes from CubiCasa5K and 3D-Front**

## Physical Interaction with Articulated Objects

More than 500 object models

Sourced from open source datasets and cleaned up

Articulated objects can be operated by agents

https://svl.stanford.edu/igibson/

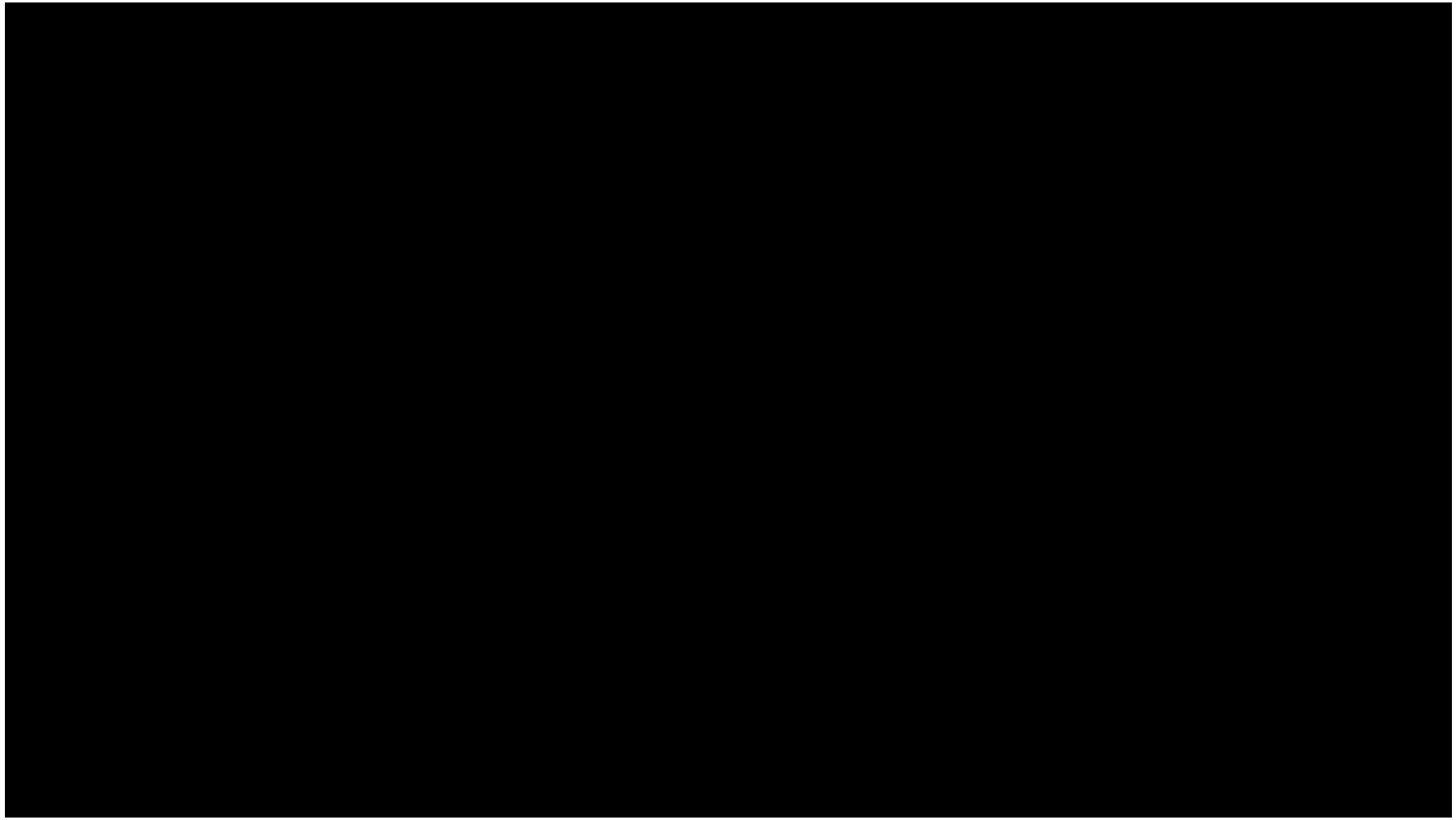
# Simulation Environment: AI2-THOR

iTHOR


RoboTHOR

https://ai2thor.allenai.org/

# Simulation Environment: Habitat

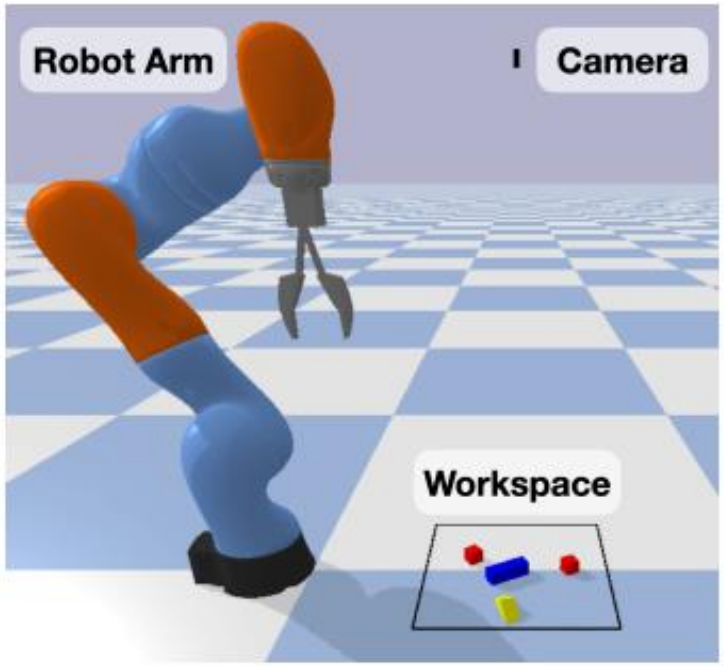


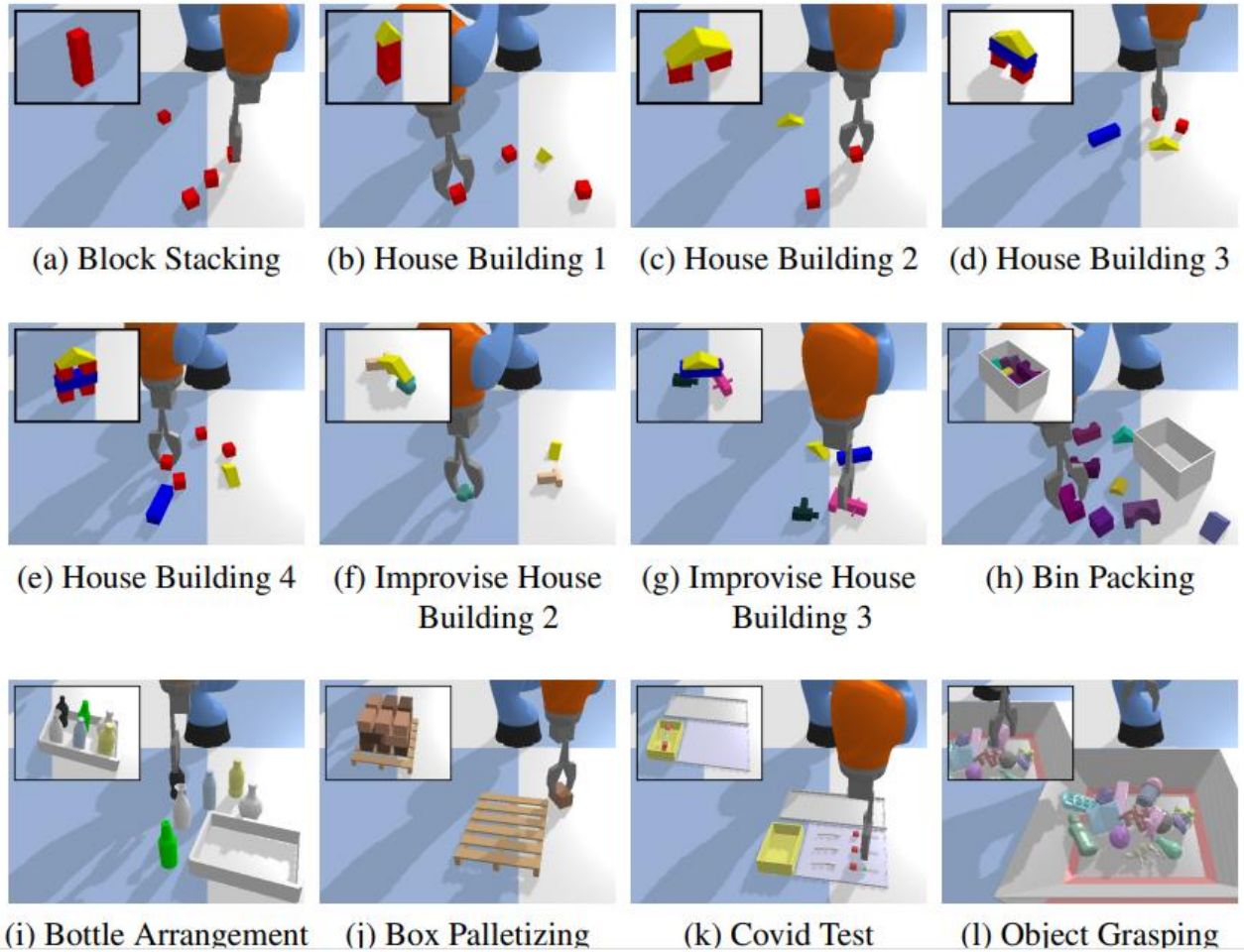
https://aihabitat.org/

# Simulation Environment: SAPIEN

https://sapien.ucsd.edu/

# Simulation Environment: BulletArm




BulletArm: An Open-Source Robotic Manipulation Benchmark and Learning Framework. Wang et al. 2022
https://arxiv.org/abs/2205.14292

# Propose Your Projects

- Which topic to work on?
  - Navigation? Manipulation? Mobile Manipulation?
- What specific problem to work on within the chosen topic?
  - Model-based grasping? Motion planning? RL for navigation? Etc.
- Which simulation environment to use?
  - Gazebo with ROS? iGibson? Isaac Gym? Etc.
- Which track is your project?
  - Research-oriented? Application-oriented? Implementation-oriented?

# Discussion