Object-Oriented Option Framework for Robotics Manipulation in Clutter

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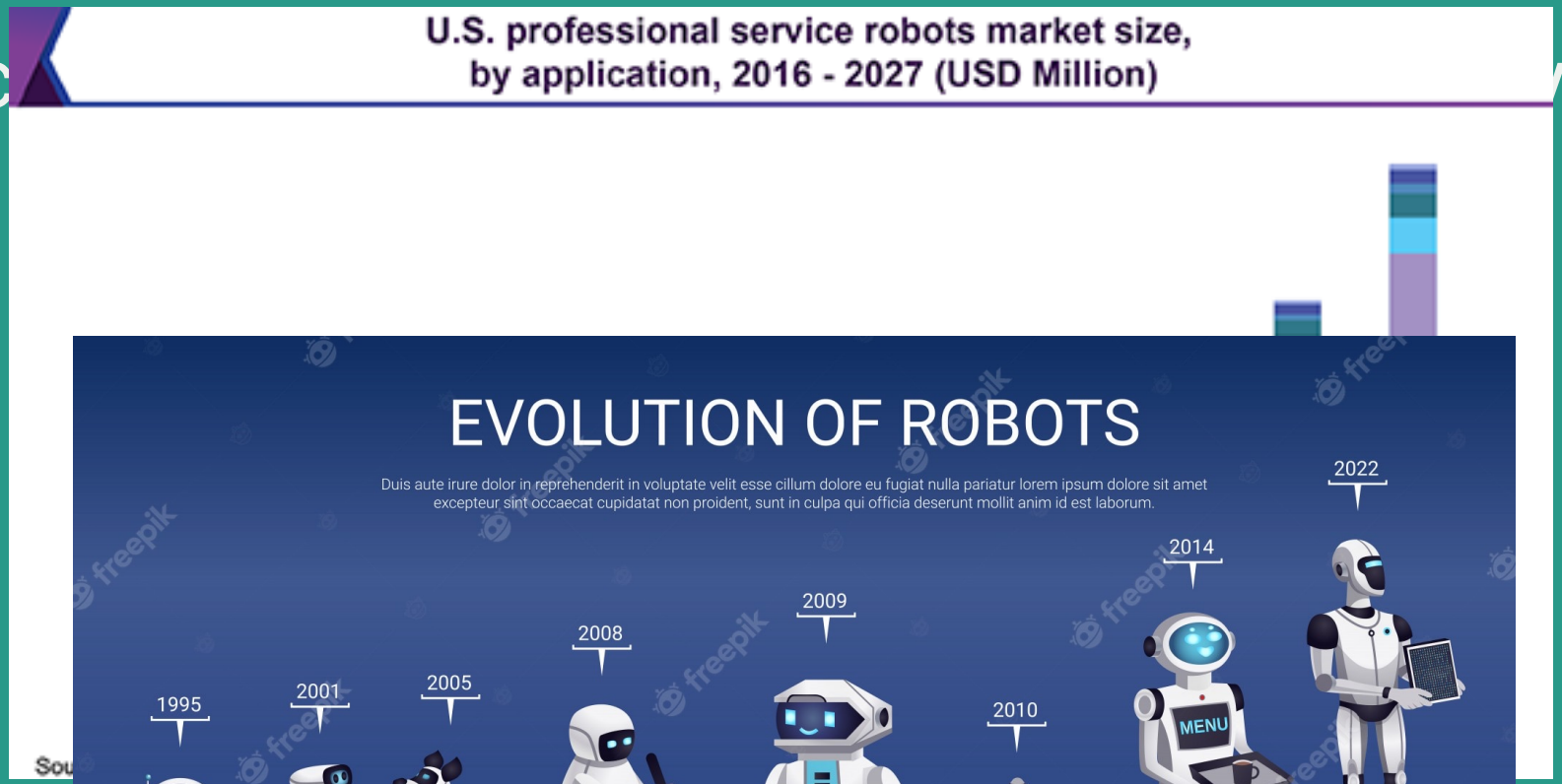
1. Nanjing University 2. CloudMinds Robotics 3. Polixir Technology

Background

- Domestic
popular.



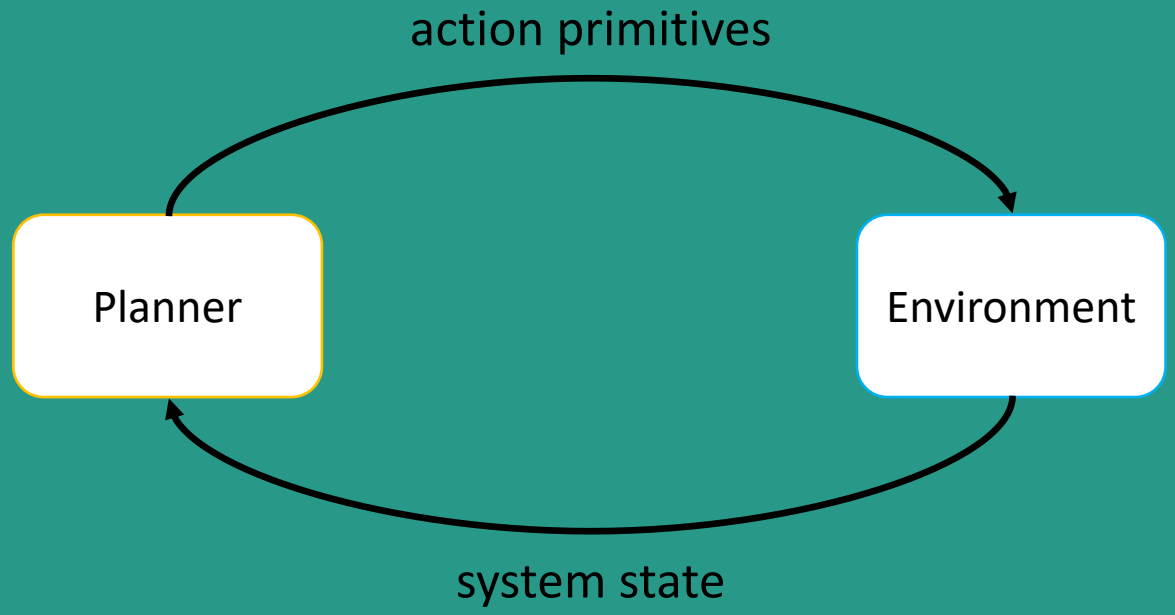
Background

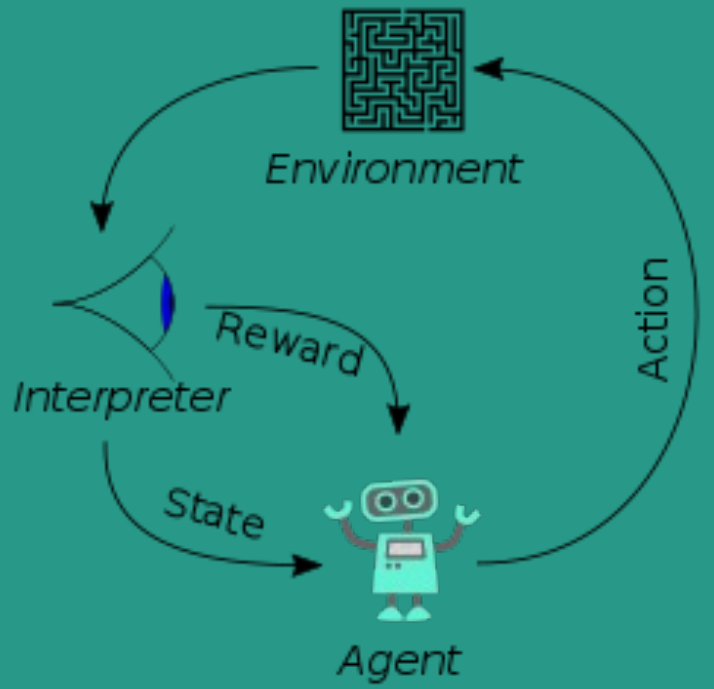
- Examples of Manipulating Objects in Clutter (MoC) problems

Background

- Keys to solve MoC problems:
  - Identify objects
  - Planning
  - Robotics control/manipulation

Related works





Action primitives + planning

reinforcement learning

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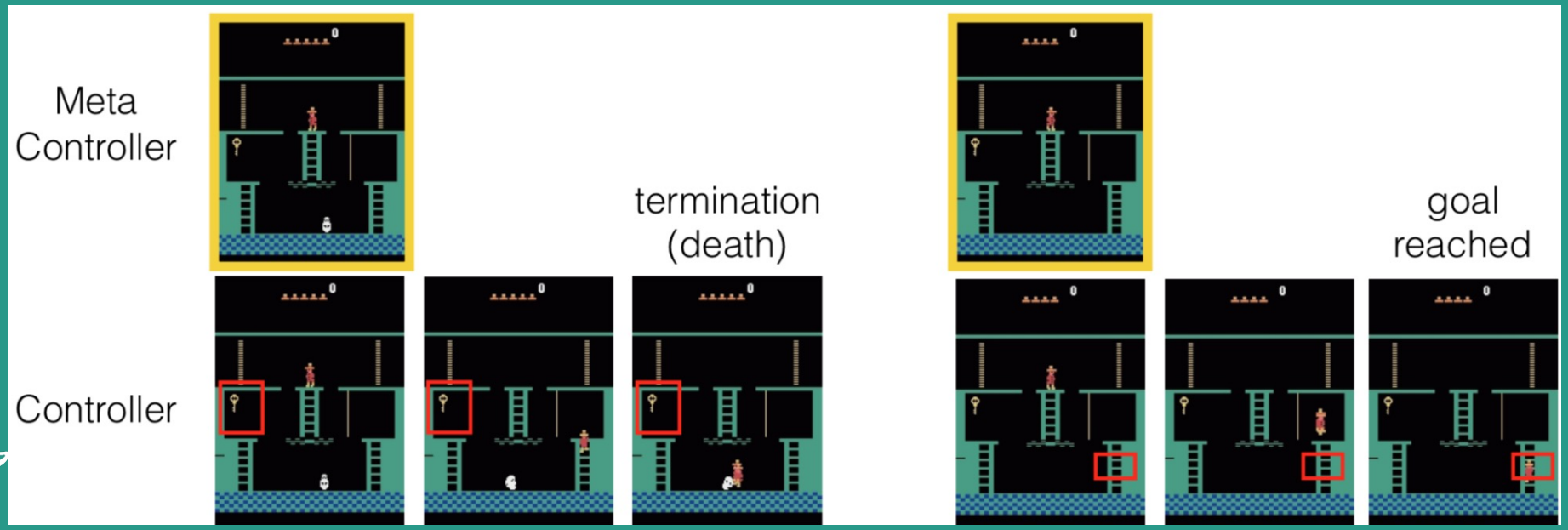
Method

- Option Framework (OF)
  - Option: temporal abstract actions, denoted by $\{I, \pi(a|s), \beta(s,o)\}$



Method

- Option Framework

  - Discover options from scratch based on RL
  - May cause collapsed options and hinder policy learning.

Method

- Object-oriented Option Space
  - Each option in the space represents once object movement.
    1. object to move
    2. target location

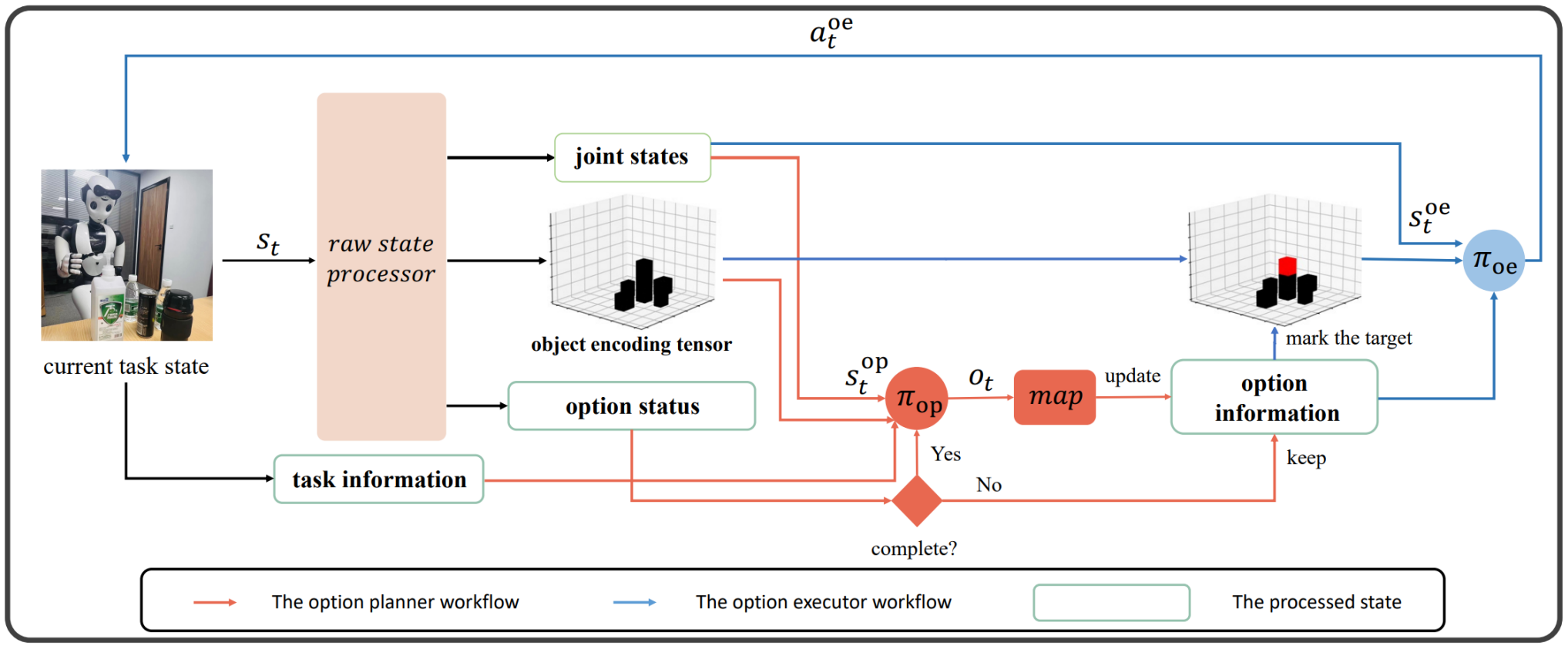
Method

- Object-oriented Option Framework (O3F)
  1. Option planner $\pi_{\text{op}}(o|s)$: a policy that makes decision over option space

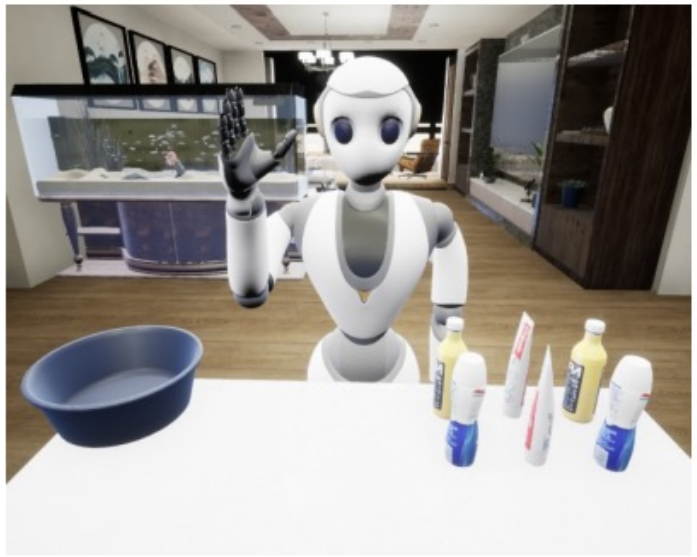
  2. Option executor $\pi_{\text{op}}(o|s)$: a universal intra-policy for all options.

Method

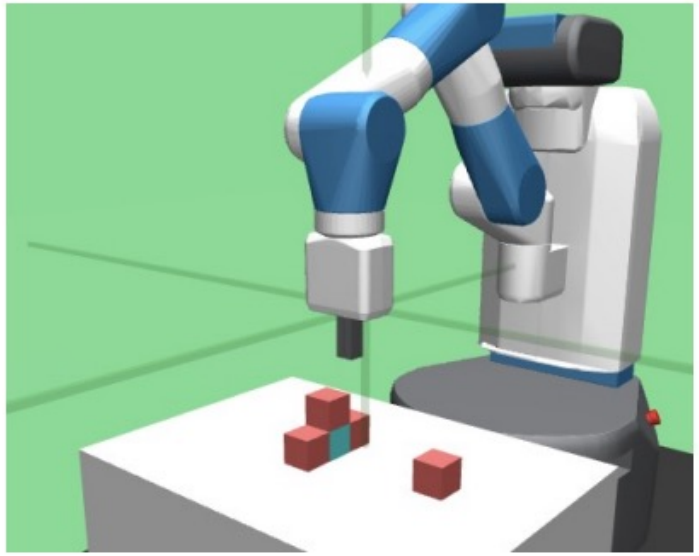
- Object-oriented Option Framework (O3F)



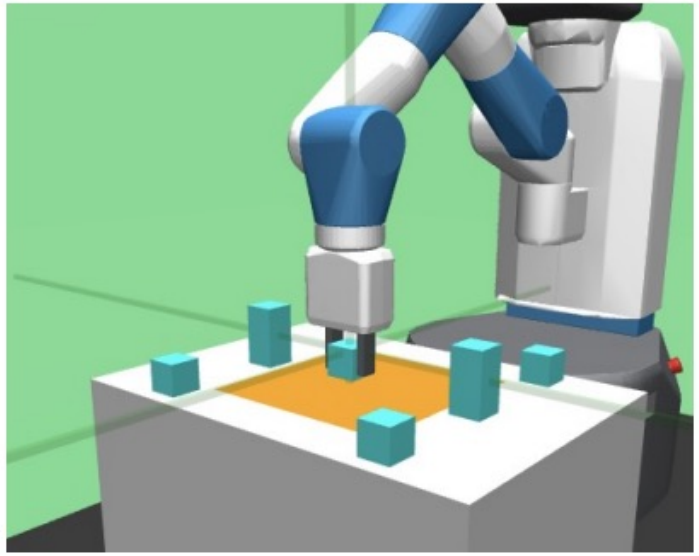
Experiments



(a) Grasp (Ginger XR1)



(b) Grasp



(c) Collect

Results

TABLE I: Success rate (%) of grasping task on the Ginger XR1 Robot.

Method	Scene 1	Scene 2	Scene 3	Average
O3F (Ours)	**88.0**	**95.0**	**91.0**	**91.3**
PPO [36]	2.0	4.0	3.0	3.0

TABLE III: Success rate (%) of O3F and PPO in grasping and collecting tasks with the robot arm.

Method	grasping	collecting
O3F (Ours)	**72.4**	**90.0**
PPO [24]	20.6	3.33

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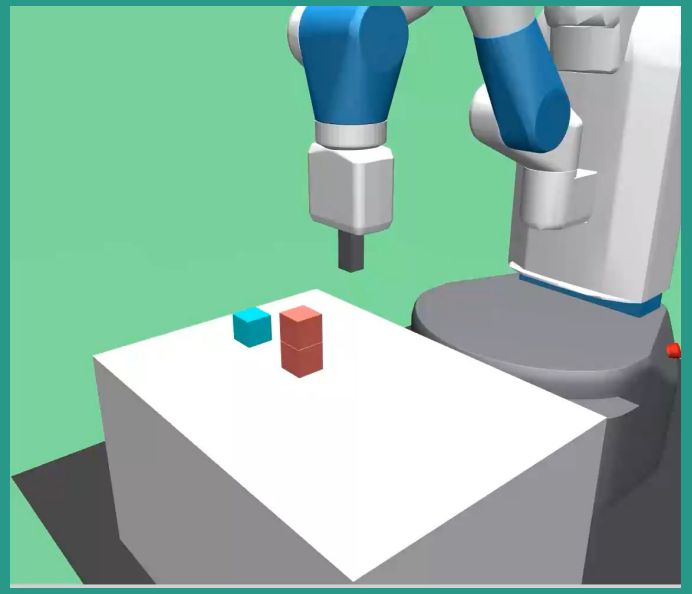
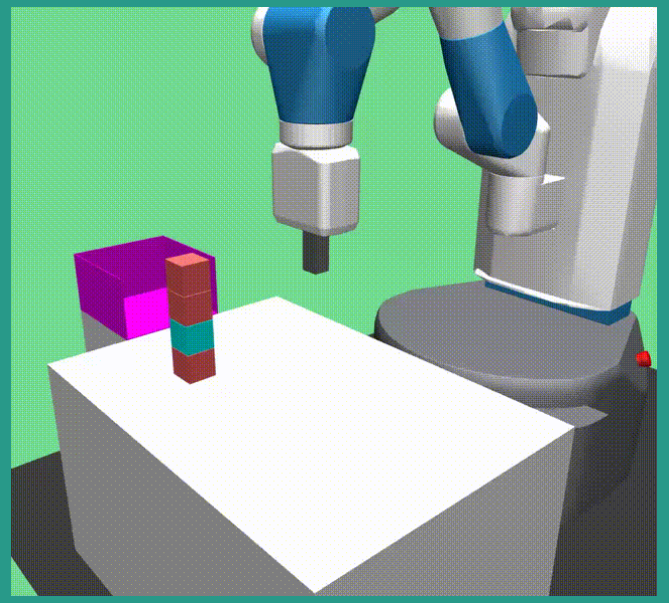
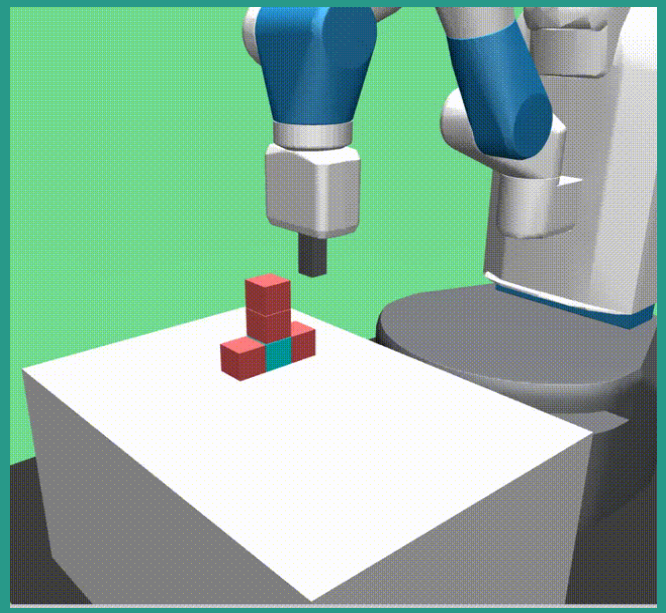
Results



O3F



VPG[1]



PPO [2]

[1] ZENG, A., SONG, S., WELKER, S., LEE, J., RODRIGUEZ, A., AND FUNKHOUSER, T. A. Learning synergies between pushing and grasping with self-supervised deep reinforcement learning. In International Conference on Intelligent Robots and Systems, IROS (2018).
[2] SCHULMAN, J., WOLSKI, F., DHARIWAL, P., RADFORD, A., AND KLIMOV, O. Proximal policy optimization algorithms, 2017.

Thanks for your listening!