Unsupervised Curricula for Visual Meta-Reinforcement Learning

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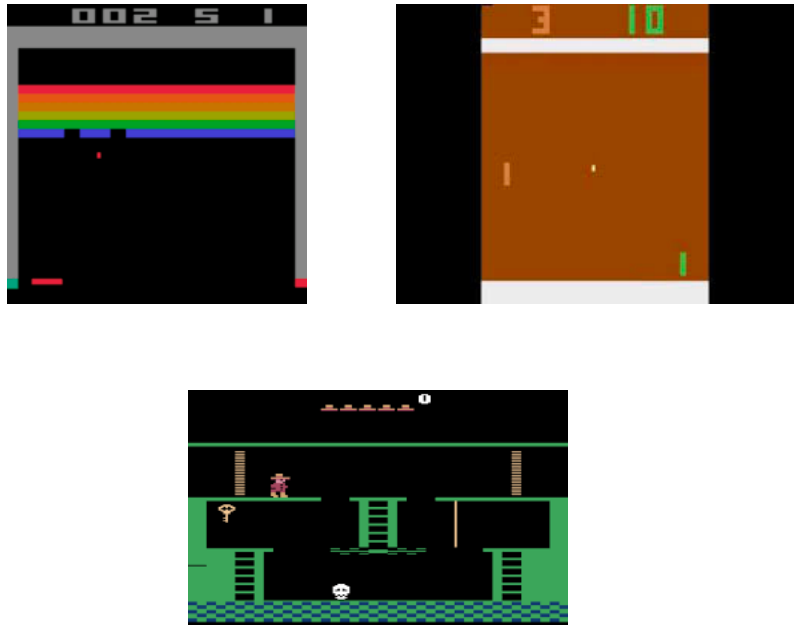
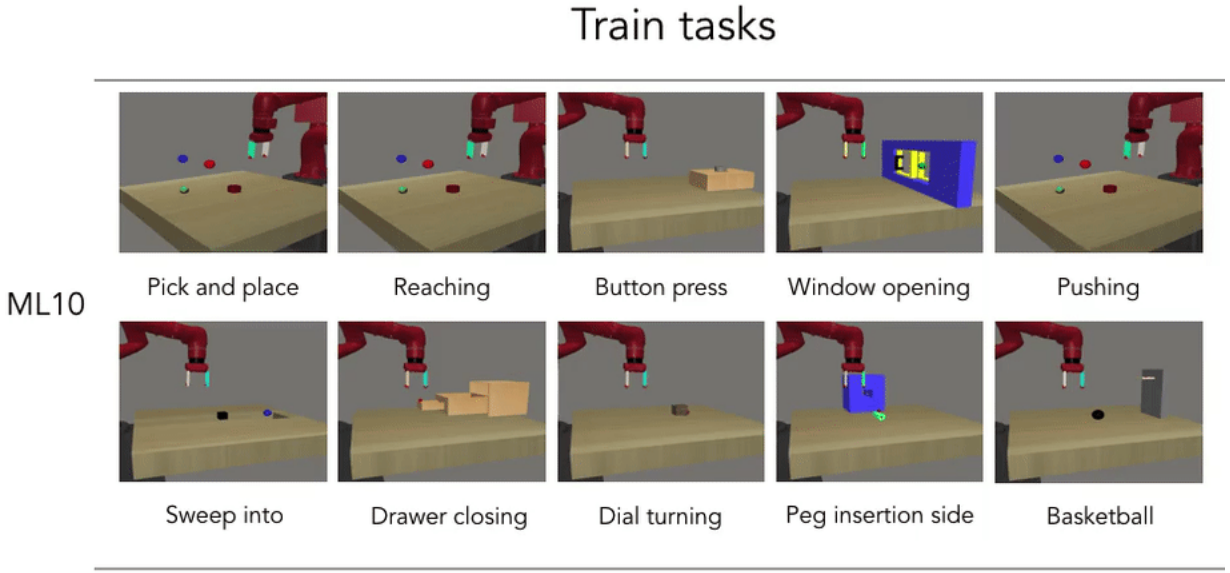
NeurIPS 2019

From Specialist to Generalist





Source: Meta-World
meta-world.github.io

Multi-task Reinforcement Learning

Contextual Policies

$$\pi(a|o, z)$$

Task description is given

e.g. a goal

more general

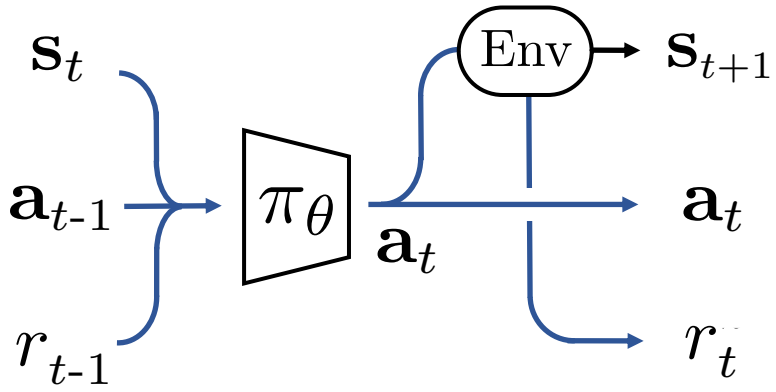
Meta-learning for RL

$$\pi(a|o, \mathcal{D}_{\mathcal{T}})$$

Task inferred from data

collected by policy

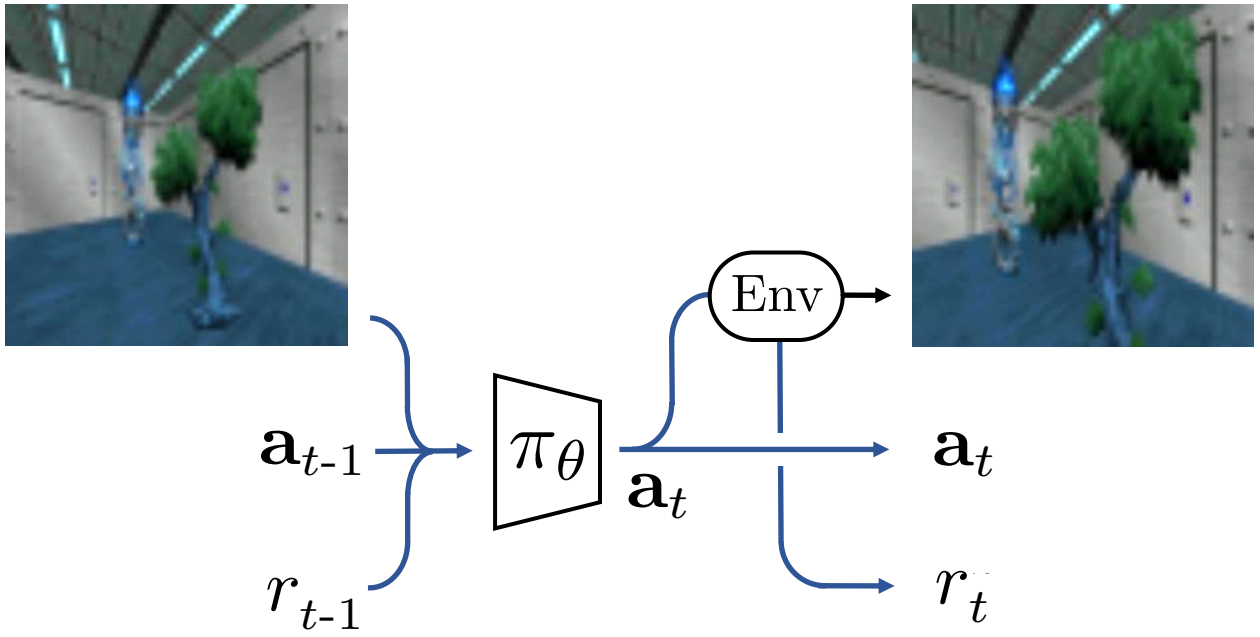
Meta-Reinforcement-Learning



$$\pi(a|o, \mathcal{D}_{\mathcal{T}})$$

Recurrent policy learns to infer task by collecting the right data

Visual Meta-Reinforcement-Learning



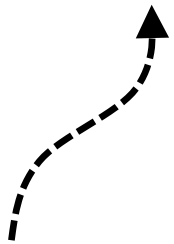
$$\pi(a|o, \mathcal{D}_\mathcal{T})$$

Search for and associate stimulus and reward.

The Task Distribution

$$\arg\max_{\theta} \sum_{i=1}^{n} \mathbb{E}_{\pi_\theta(\mathcal{D}_{\mathcal{M}_i})}[R(\tau)]$$

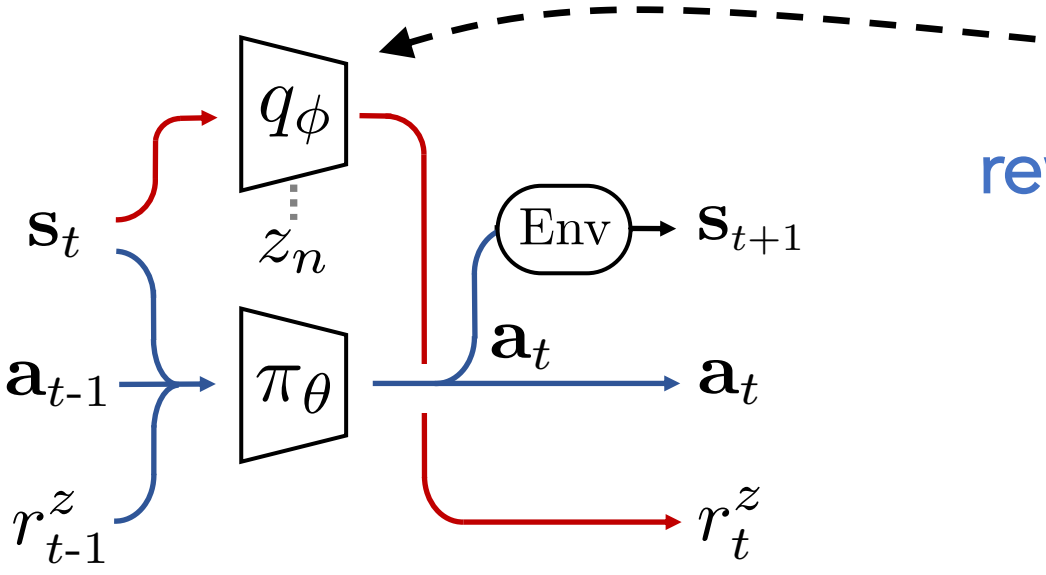
$$\text{where } \mathcal{M}_i \sim p(\mathcal{M})$$



Meta-training tasks give rise to
task inference and execution strategies

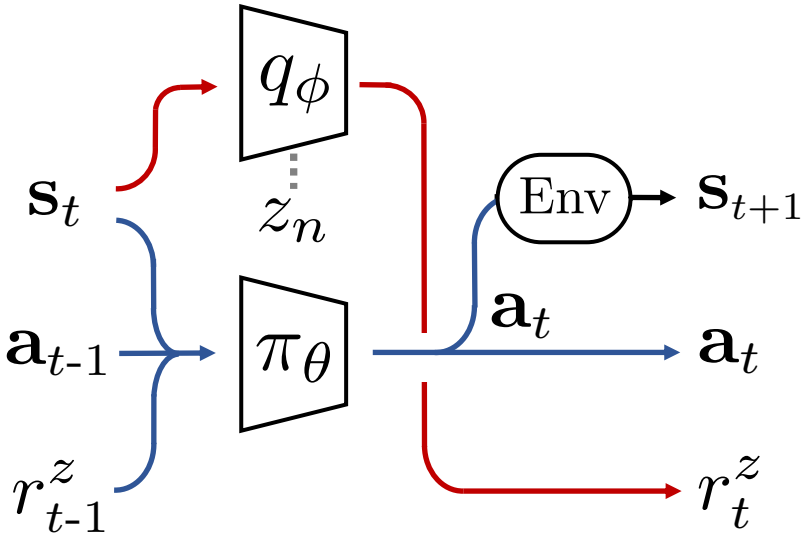
Can we learn useful meta-RL strategies with tasks formed without supervision?

"Meta-Pre-training"

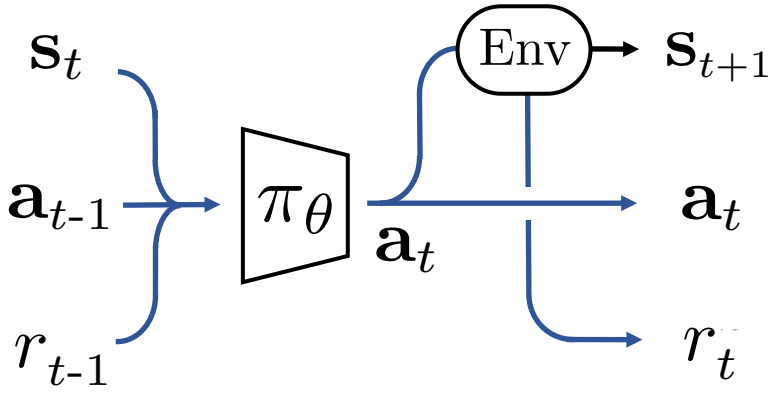


learned model providing
reward functions for meta-learning

"Meta-Pre-training"



Unsupervised Pre-training



Transfer to Test Tasks

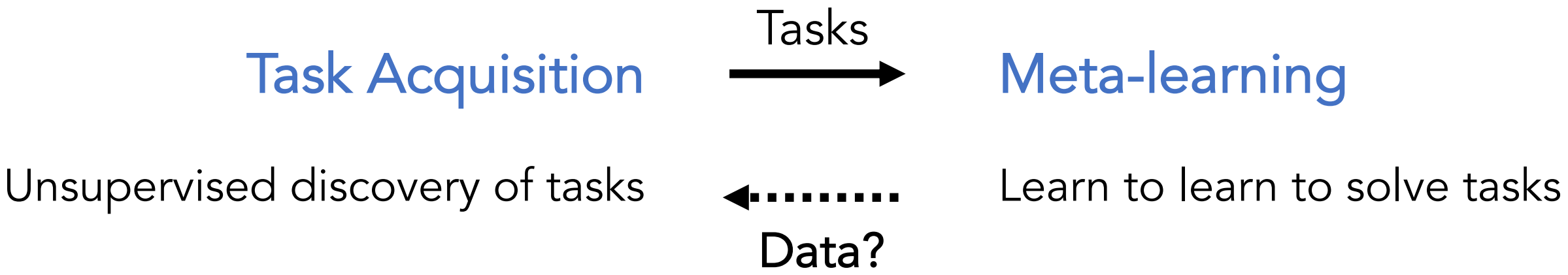
Task Acquisition

Tasks

Meta-learning

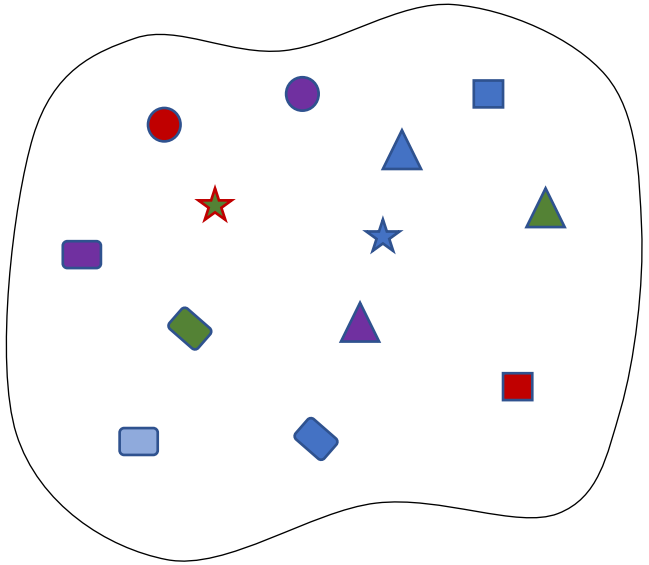
Unsupervised discovery of tasks

Learn to learn to solve tasks

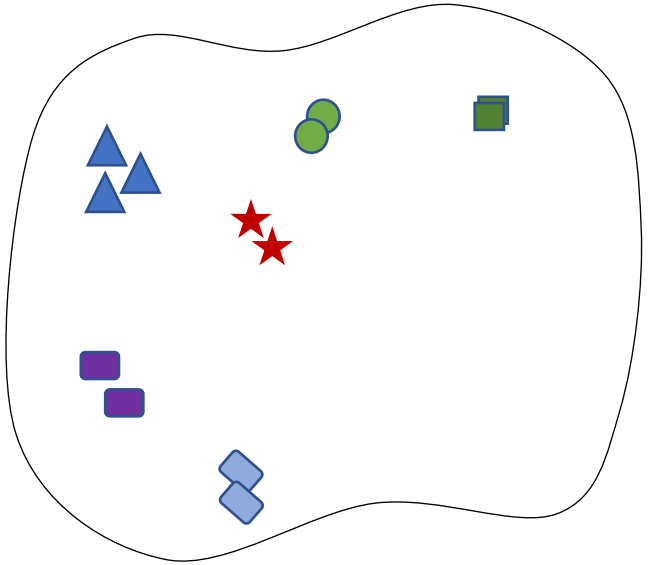


Should co-adapt

Criteria for Task Distribution

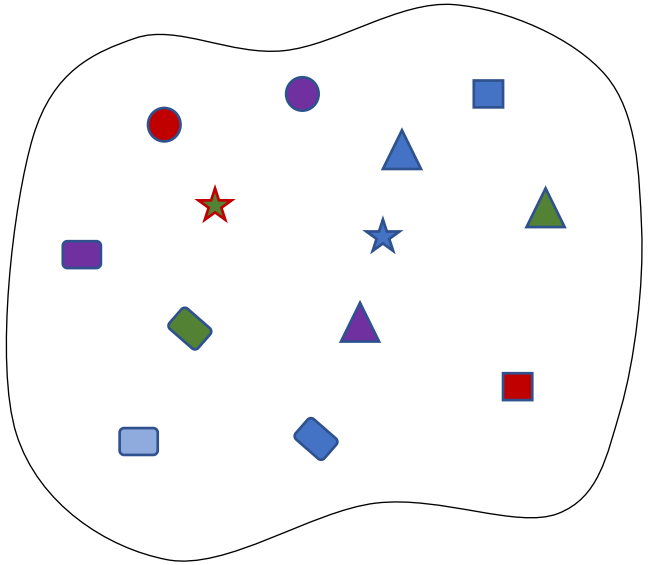


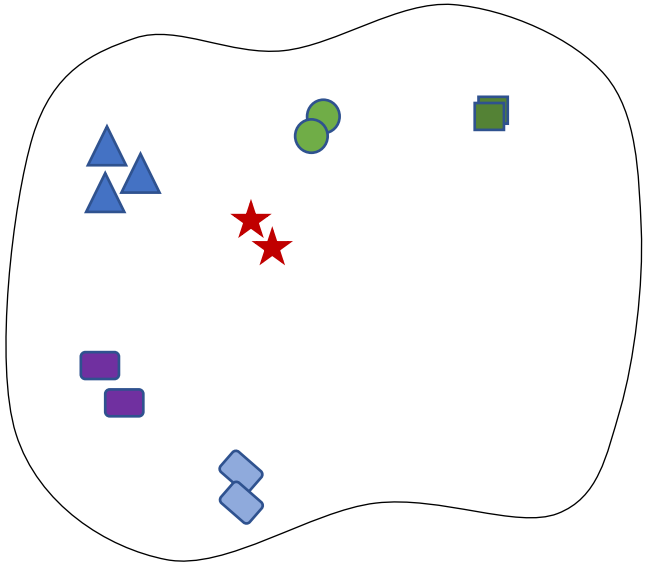
Diversity



Structure

Criteria for Task Distribution





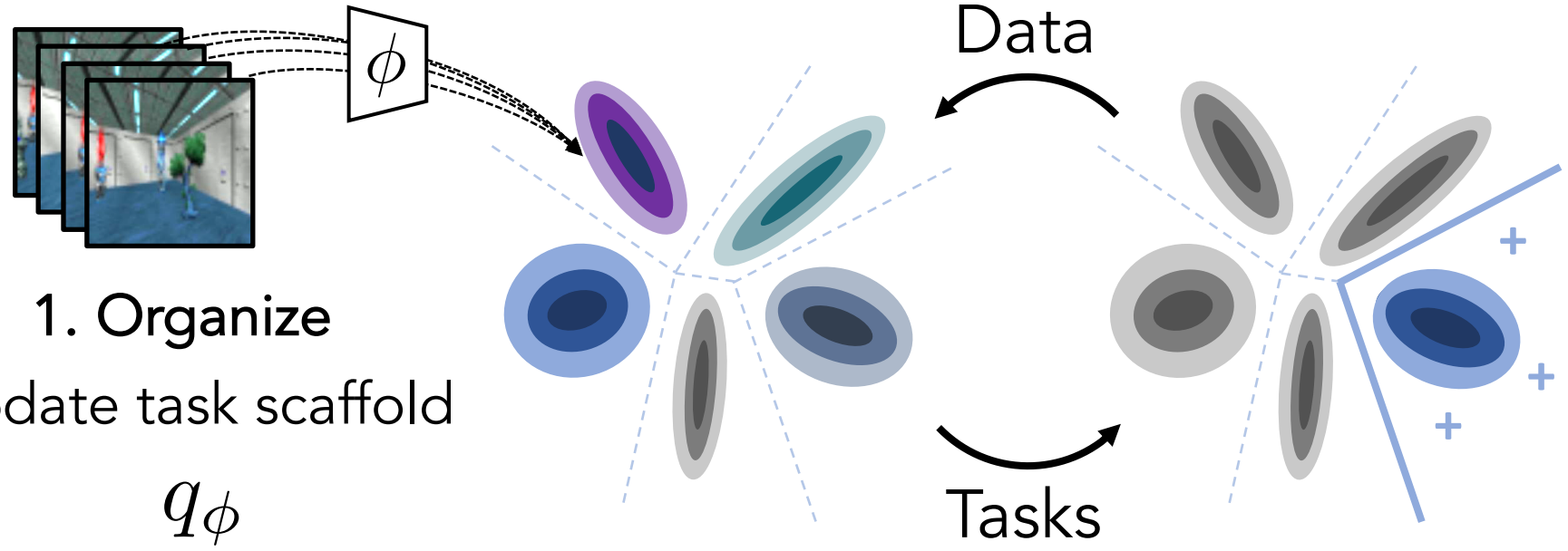
Diversity $H(\boldsymbol{\tau})$ $-H(\boldsymbol{\tau}|\mathbf{z})$ Structure

$$= I(\boldsymbol{\tau}; \mathbf{z})$$

Formulation

$$\max_{\theta,\phi} I(\boldsymbol{\tau}; \mathbf{z})$$

Policy	π_θ	$\boldsymbol{\tau}$	Post-update trajectories
Task scaffold	q_ϕ	$\mathbf{z}$	Task latent variable



1. Organize

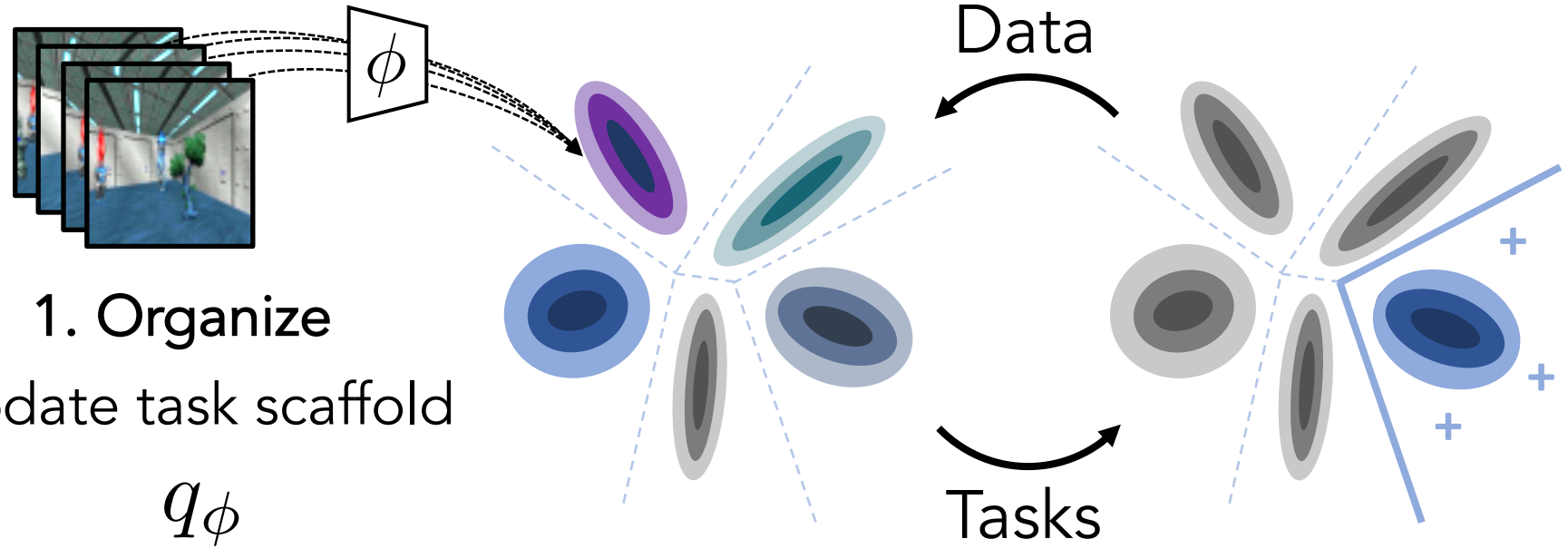
Update task scaffold

q_ϕ

2. Meta-Train

Update policy

π_θ



1. Organize

Update task scaffold

q_ϕ

E-step

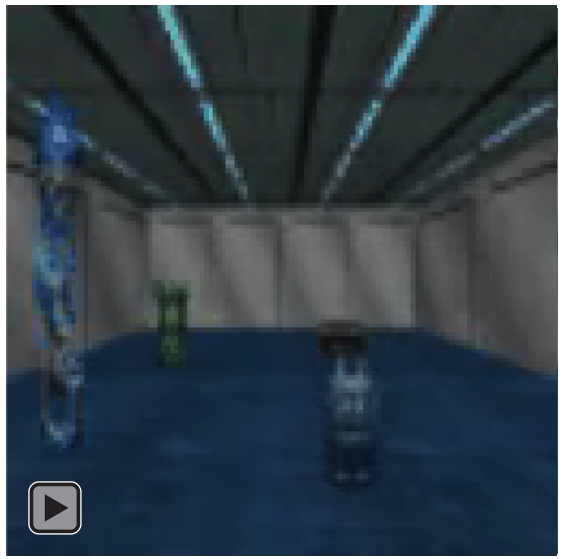
2. Meta-Train

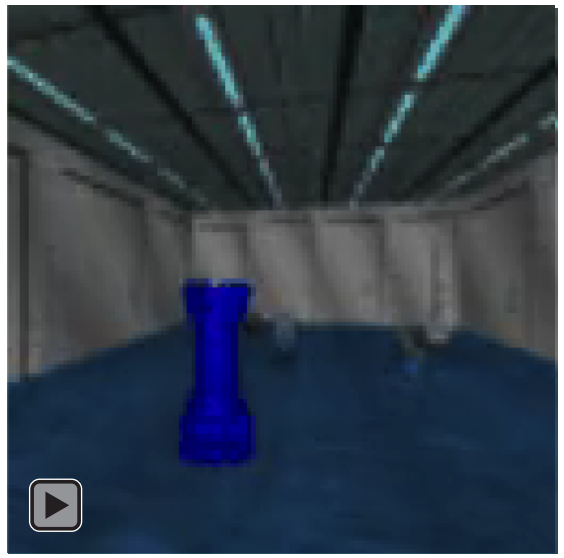
Update policy

π_θ

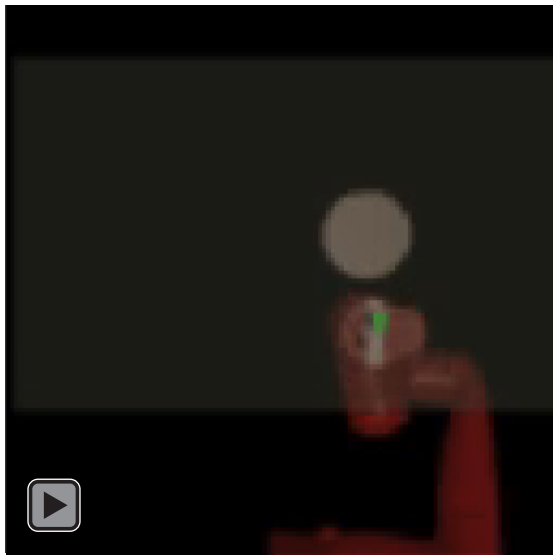
M-step

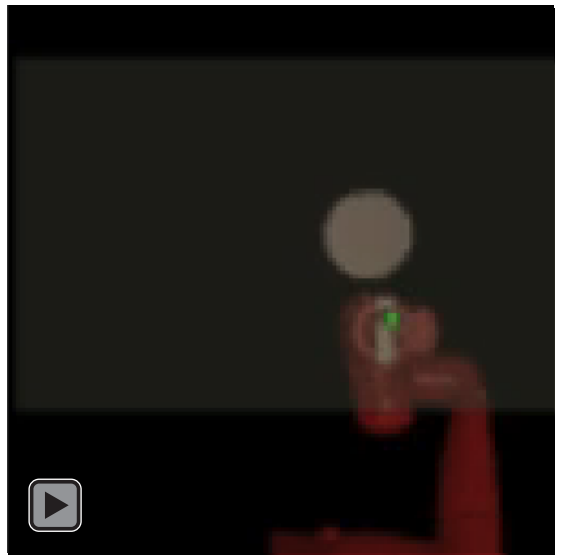
Experimental Setting





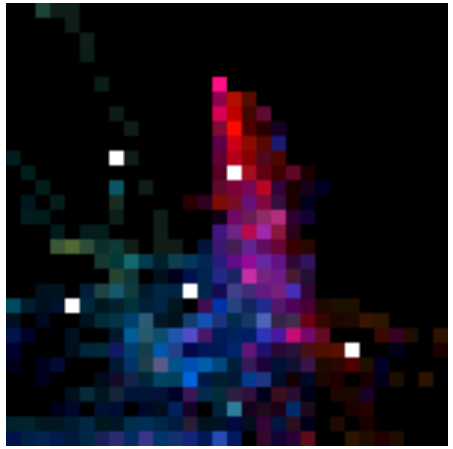
Visual Navigation
in VizDoom

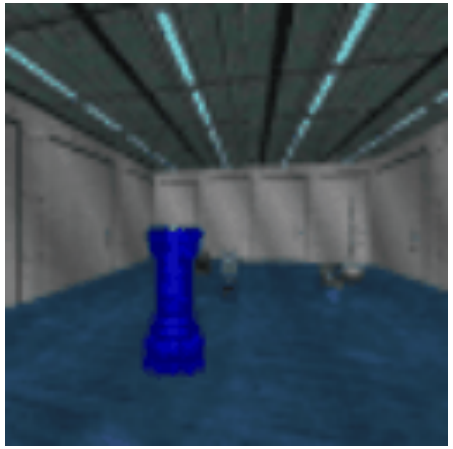
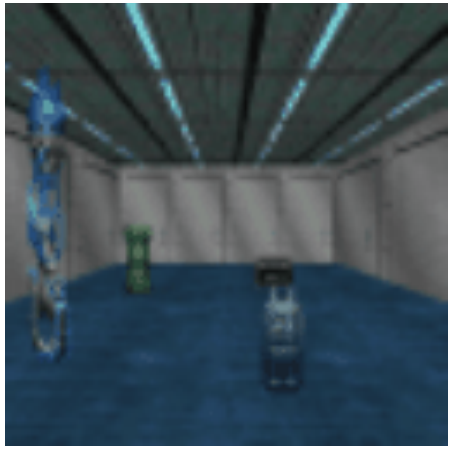
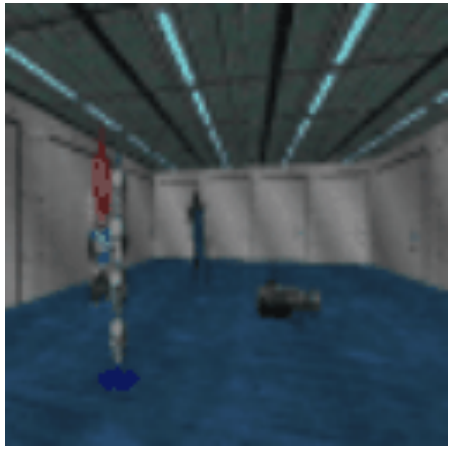


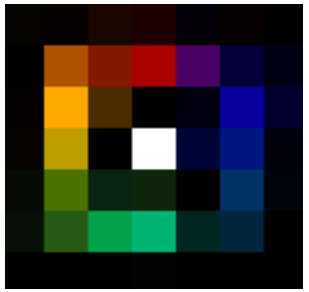


Object Pushing
with Sawyer in MuJoCo

What kind of tasks are discovered?

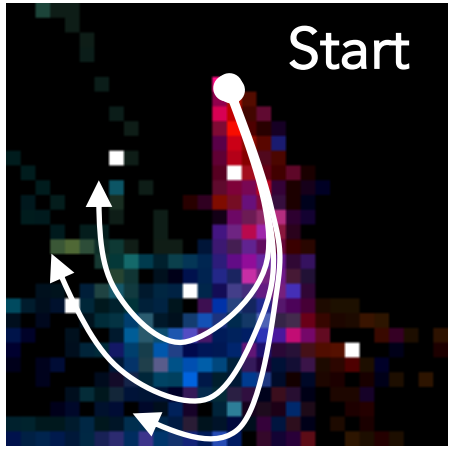


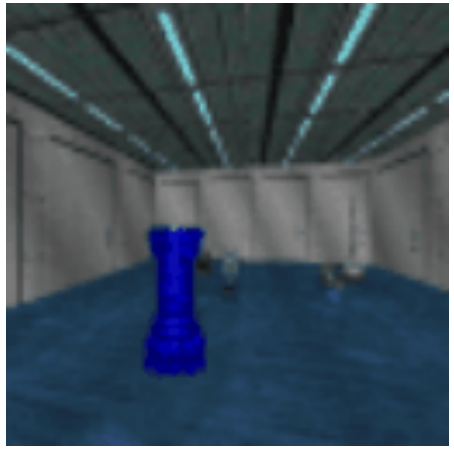




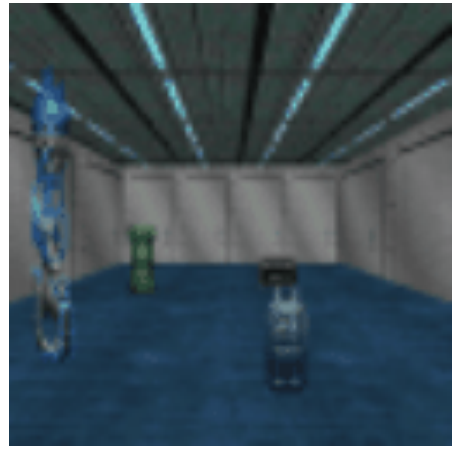


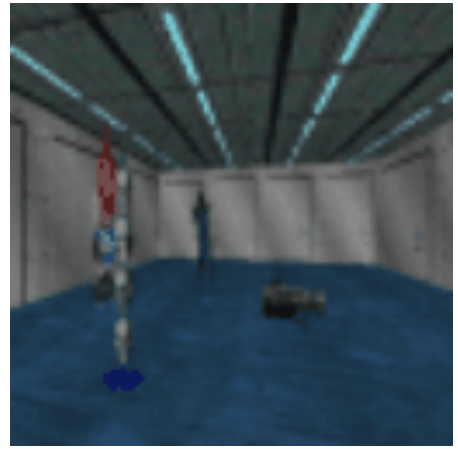
Direction encoded as color

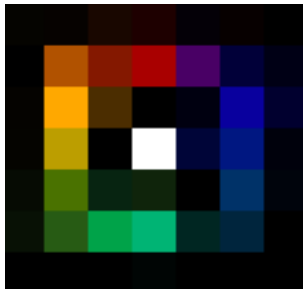
What kind of tasks are discovered?







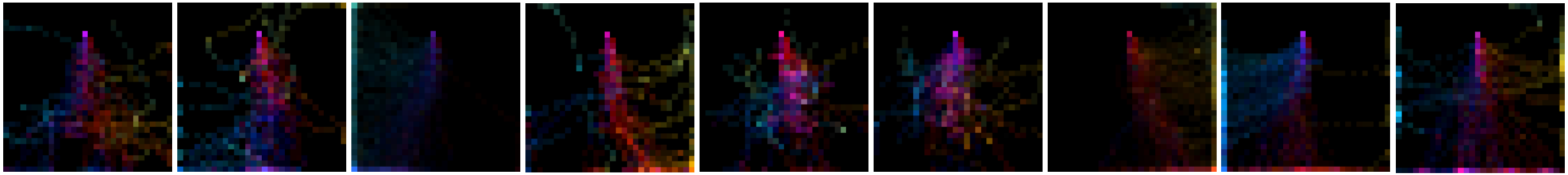




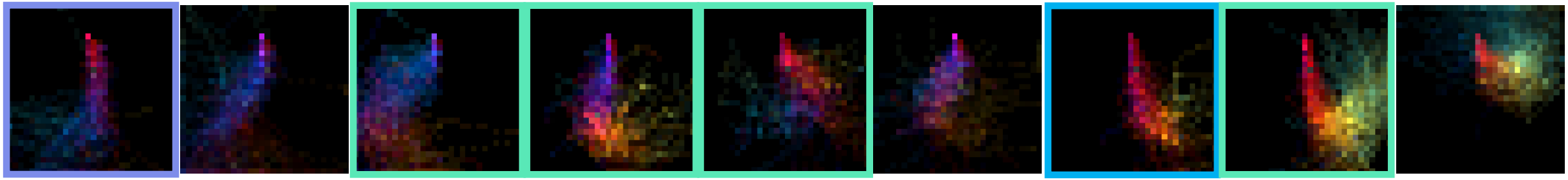
Direction encoded as color

What kind of tasks are discovered?

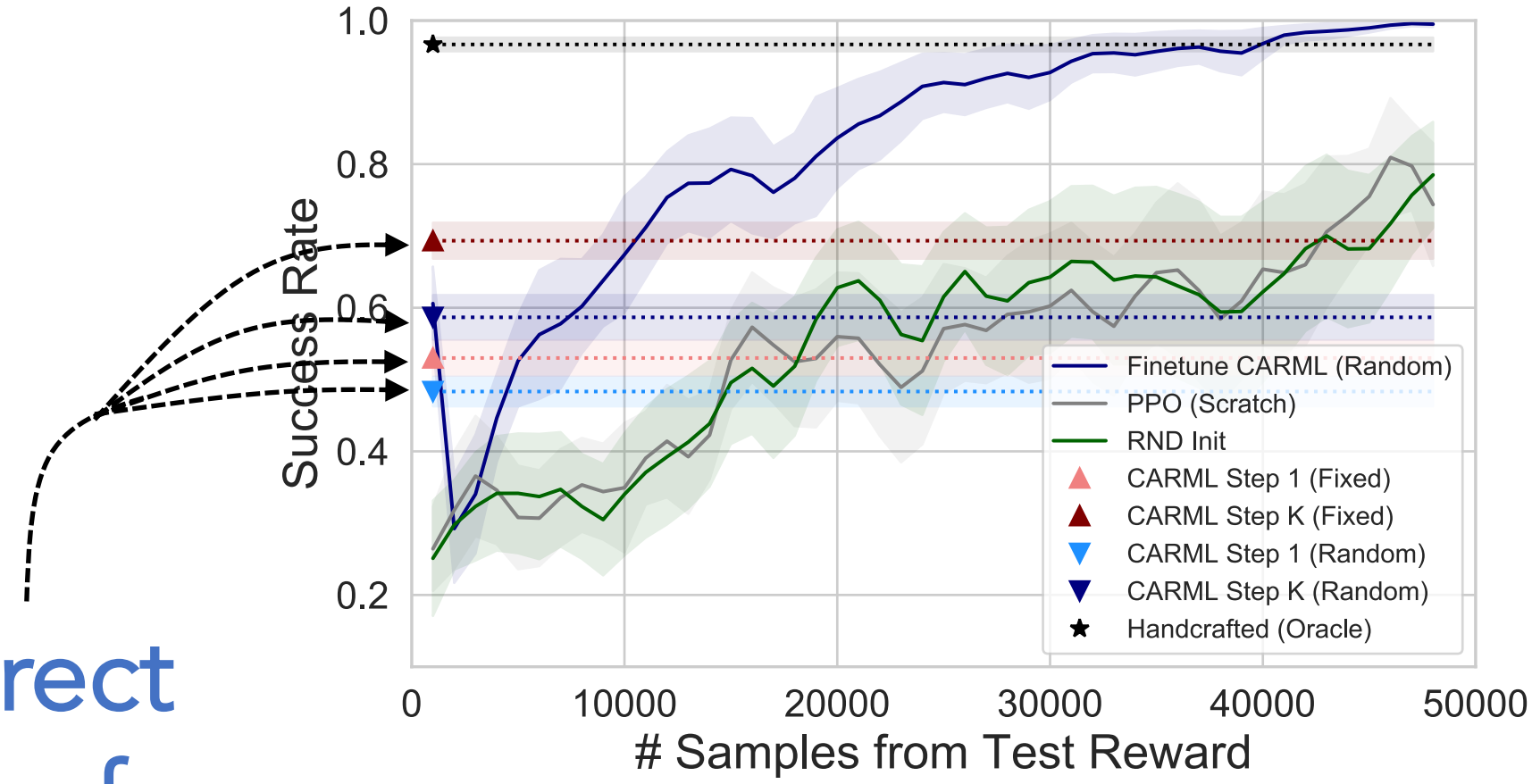
Step 1



Step 5

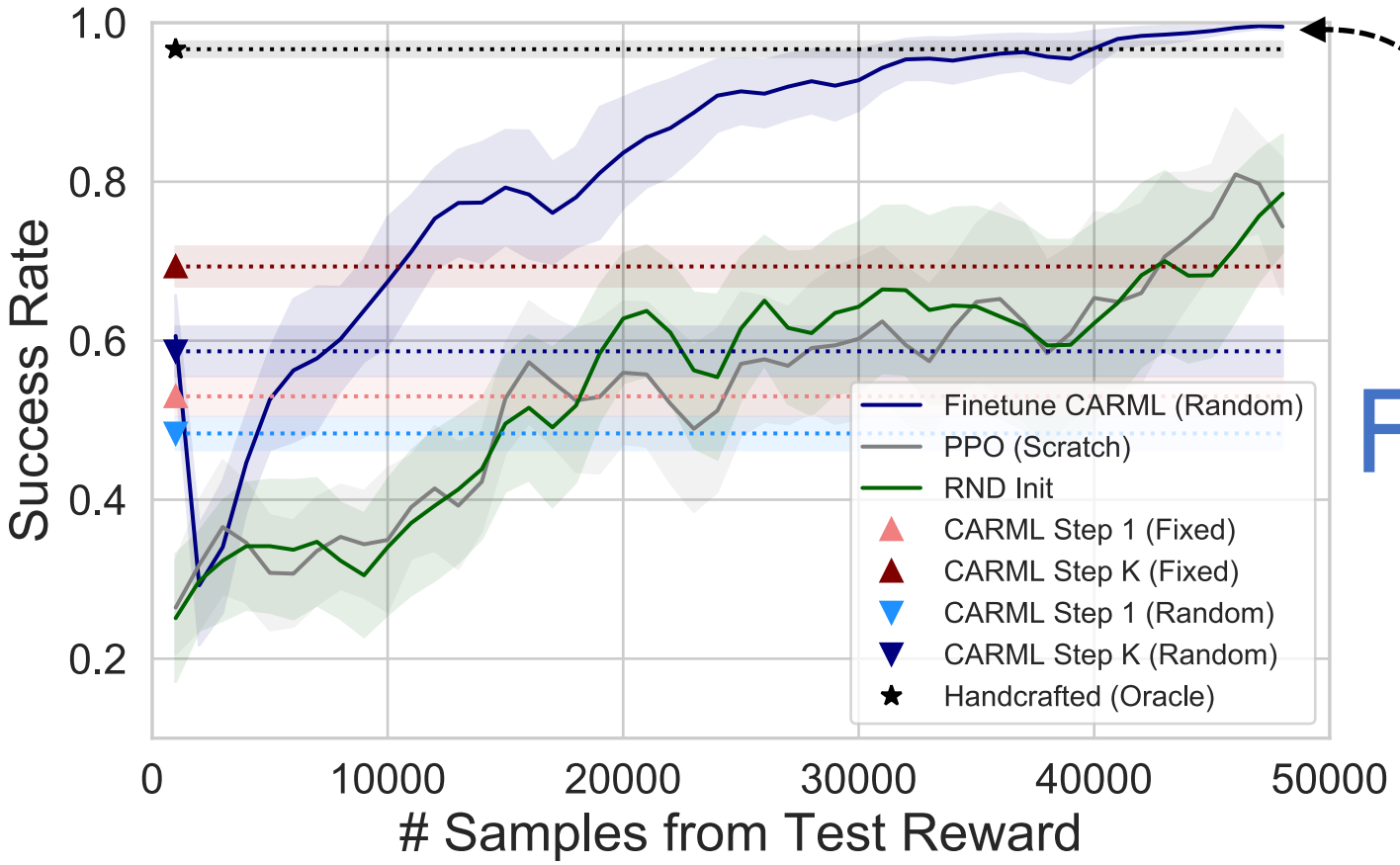


Transfer to Test Tasks – VizDoom



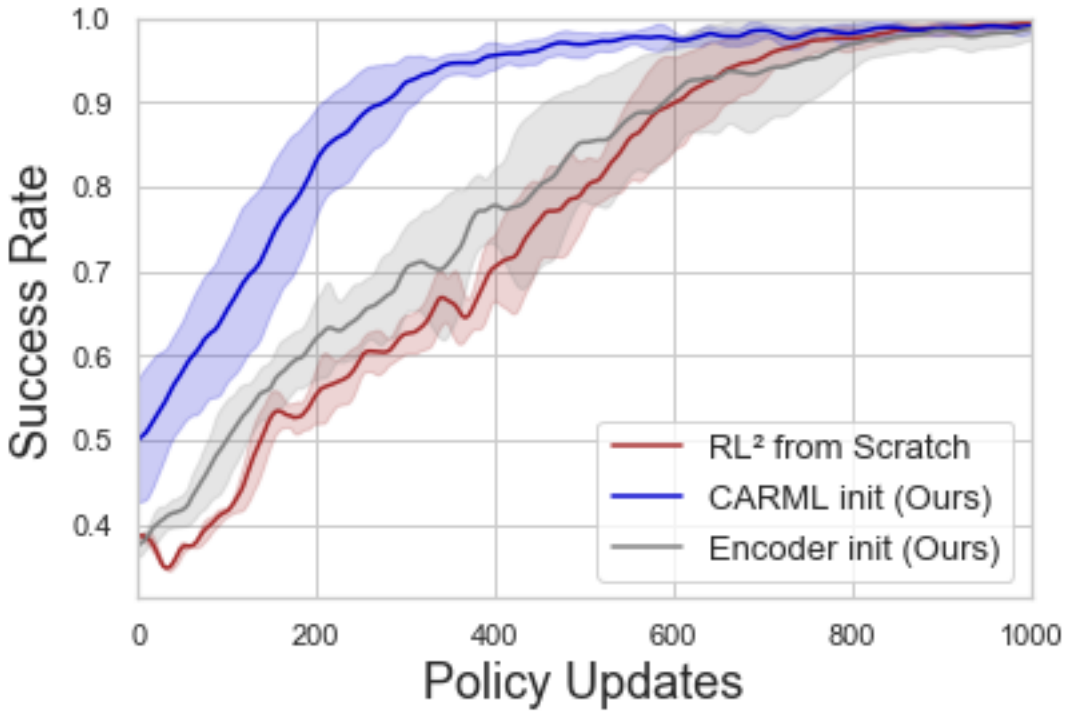
Direct Transfer

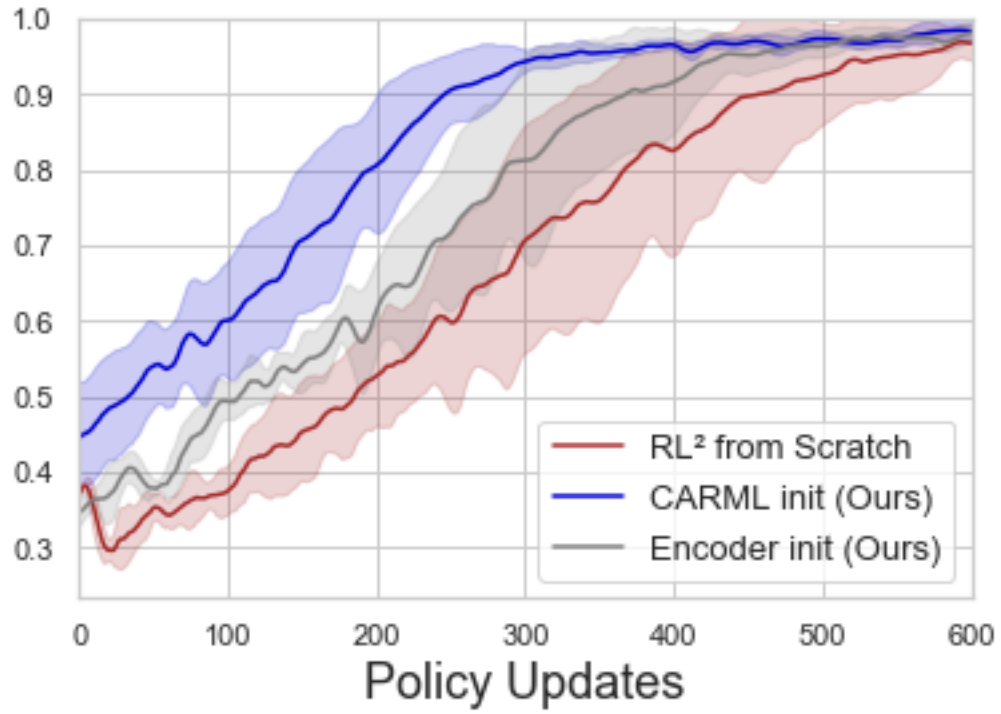
Transfer to Test Tasks – VizDoom



Faster Finetuning

Faster Supervised Meta-RL





Thank You

Kyle Hsu

Ben Eysenbach

Abhishek Gupta

Sergey Levine

Chelsea Finn

Poster #35, East Exhibition Hall B + C

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