Unsupervised Curricula for Visual Meta-Reinforcement Learning

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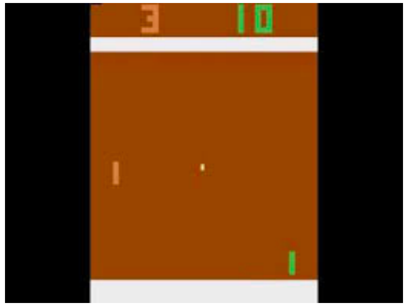
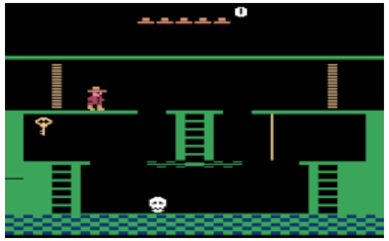
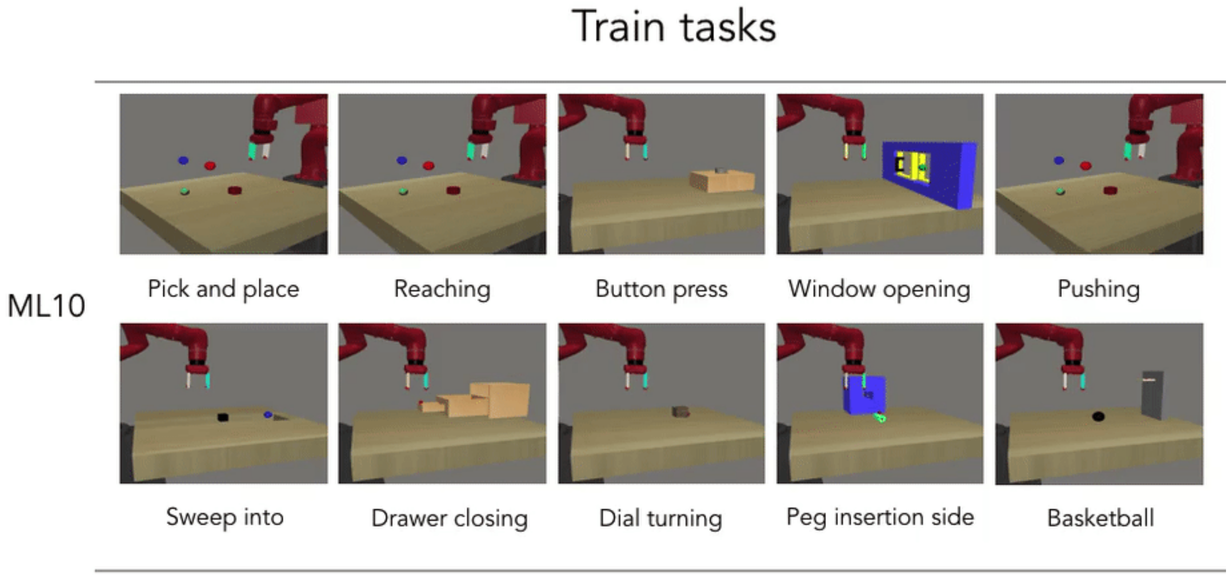
From Specialist to Generalist







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

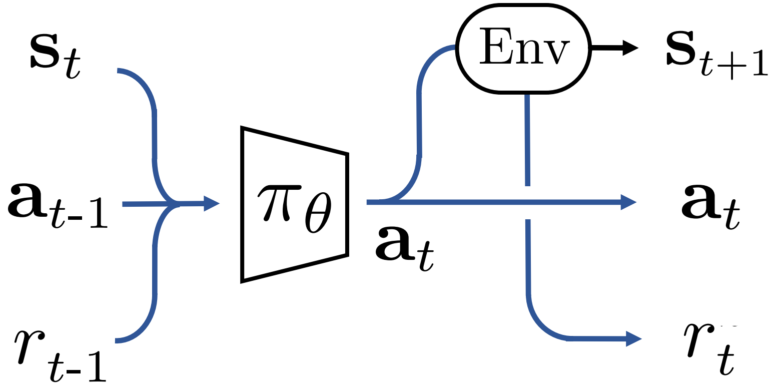
Meta-learning for RL

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

Task inferred from data

collected by policy

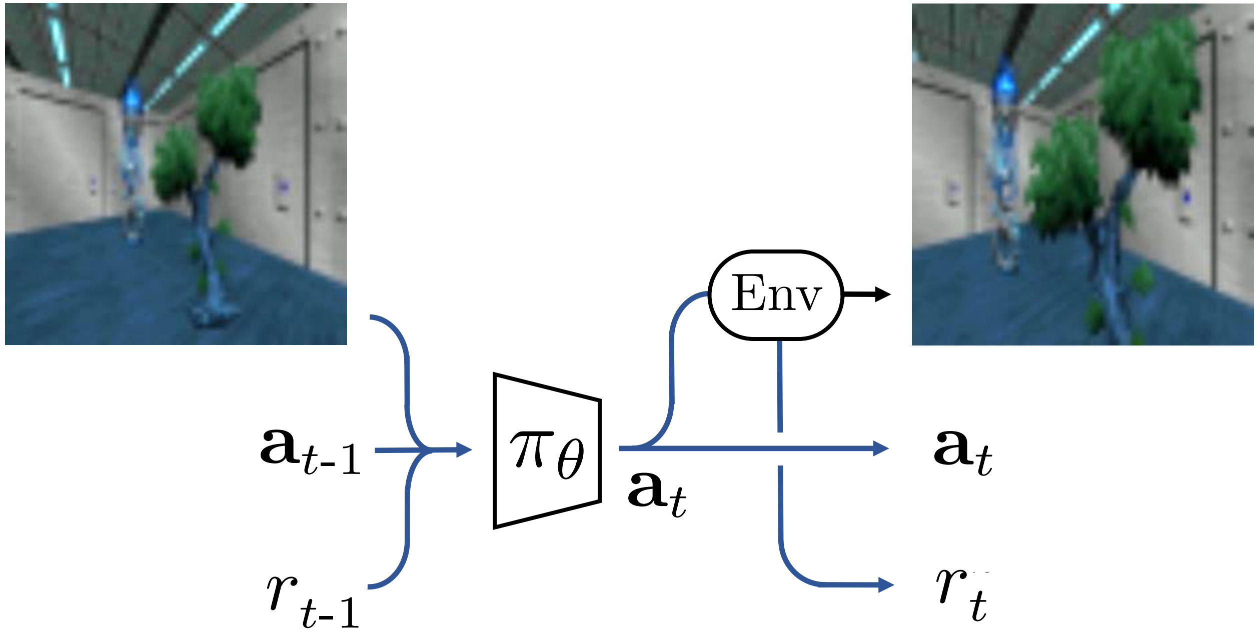
Meta-Reinforcement-Learning



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

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

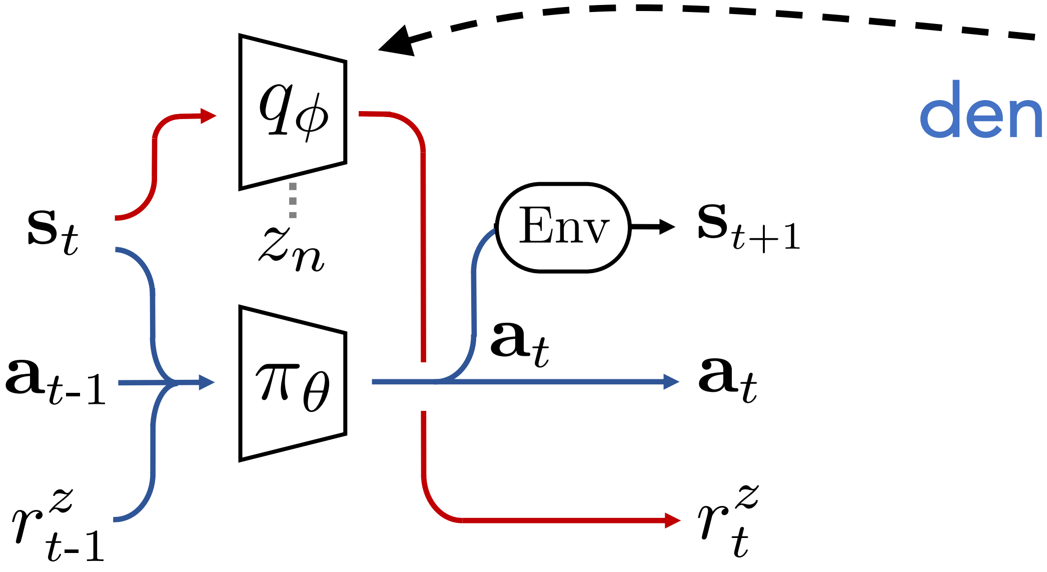
$$\arg\max_{\theta} \sum_{i=1}^{n} \mathbb{E}_{\pi_\theta(\mathcal{D}_{\mathcal{M}_i})}[R(\tau)]$$

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

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

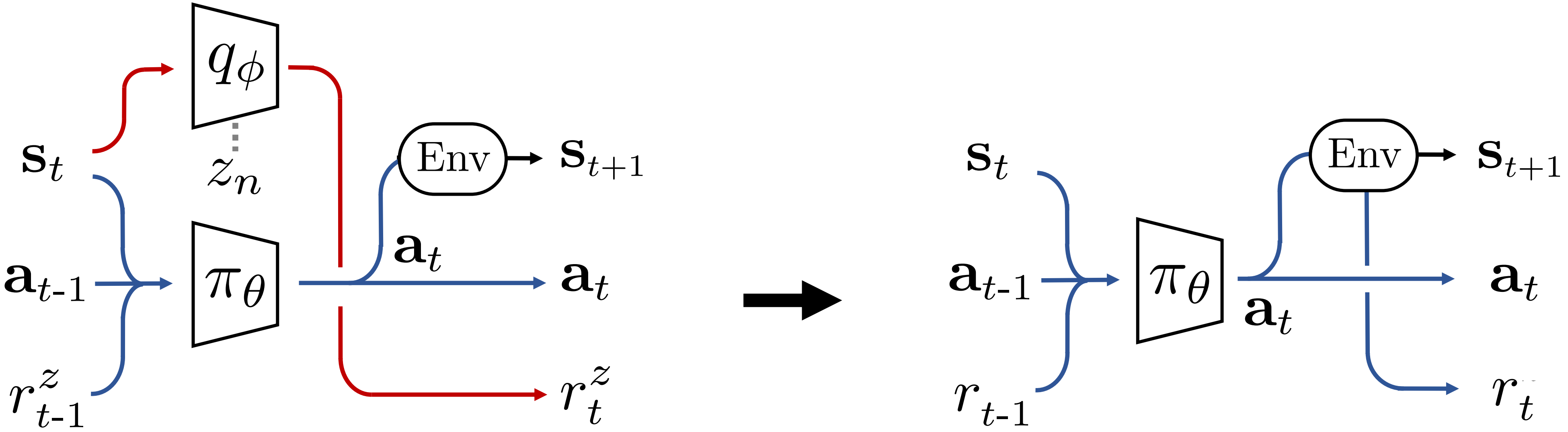
Can we learn useful meta-RL strategies with tasks formed without supervision?

“Meta-Pre-training”



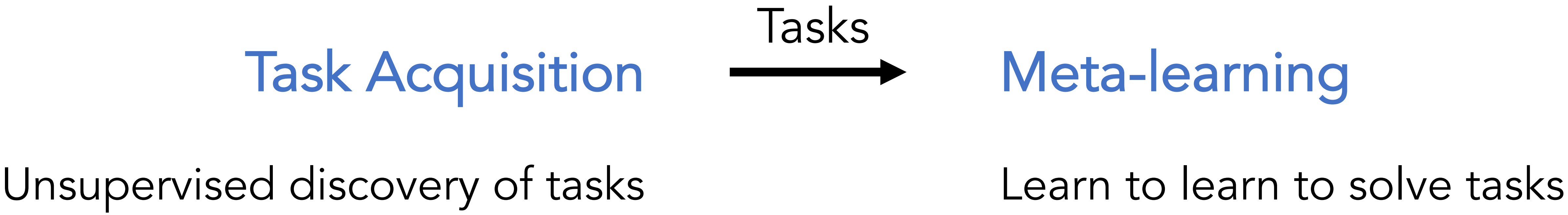
density model of trajectories providing reward functions for meta-RL

"Meta-Pre-training"



Unsupervised Pre-training

Transfer to Test Tasks



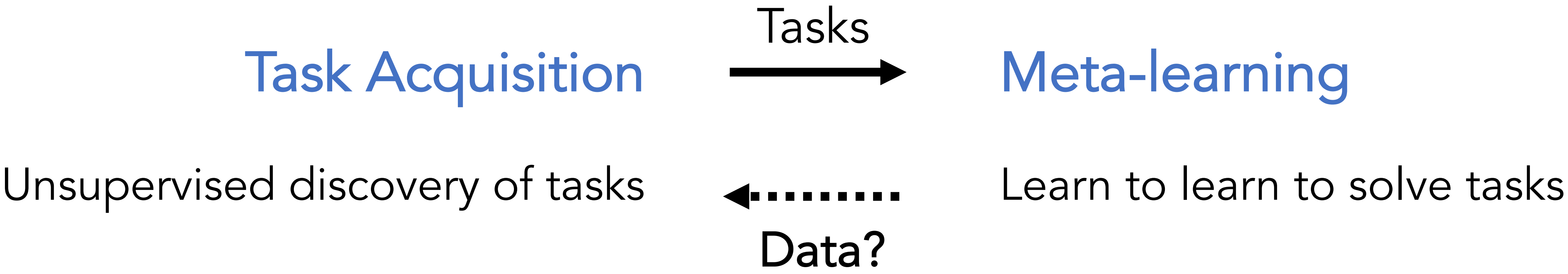
Task Acquisition

Unsupervised discovery of tasks

Tasks

Meta-learning

Learn to learn to solve tasks



Task Acquisition

Tasks

Meta-learning

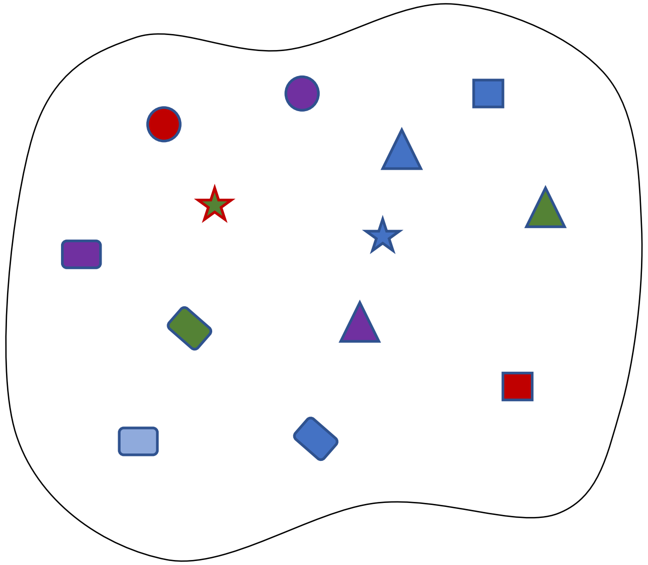
Unsupervised discovery of tasks

Learn to learn to solve tasks

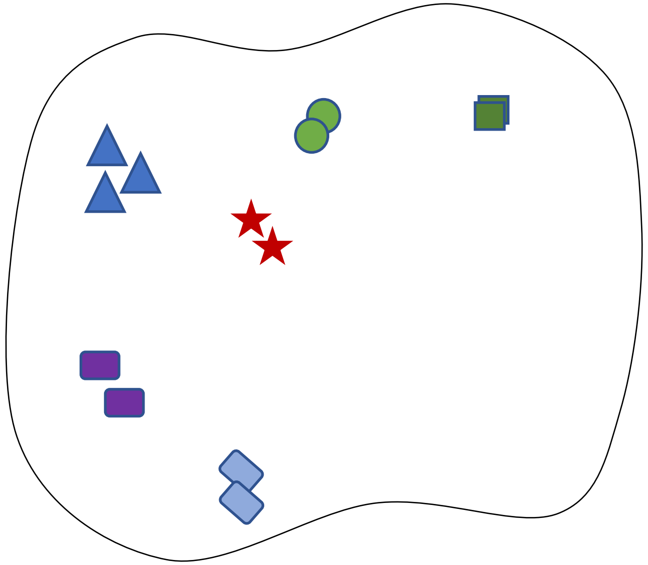
Data?

Should co-adapt

Criteria for Task Distribution

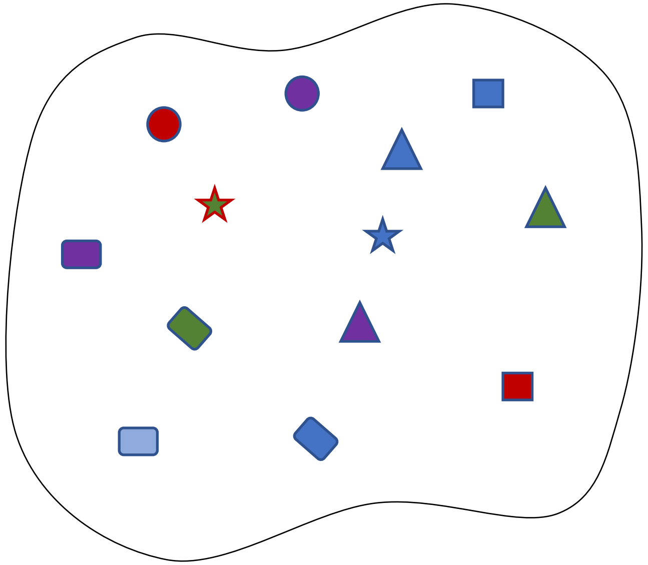


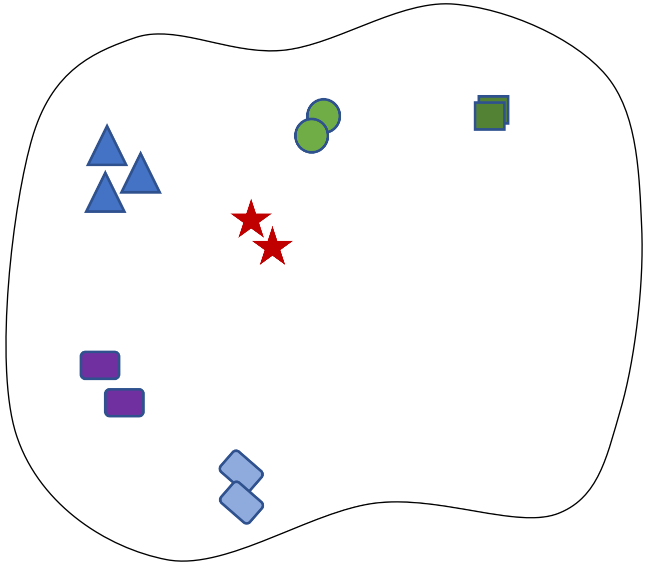
Diversity



Structure

Criteria for Task Distribution





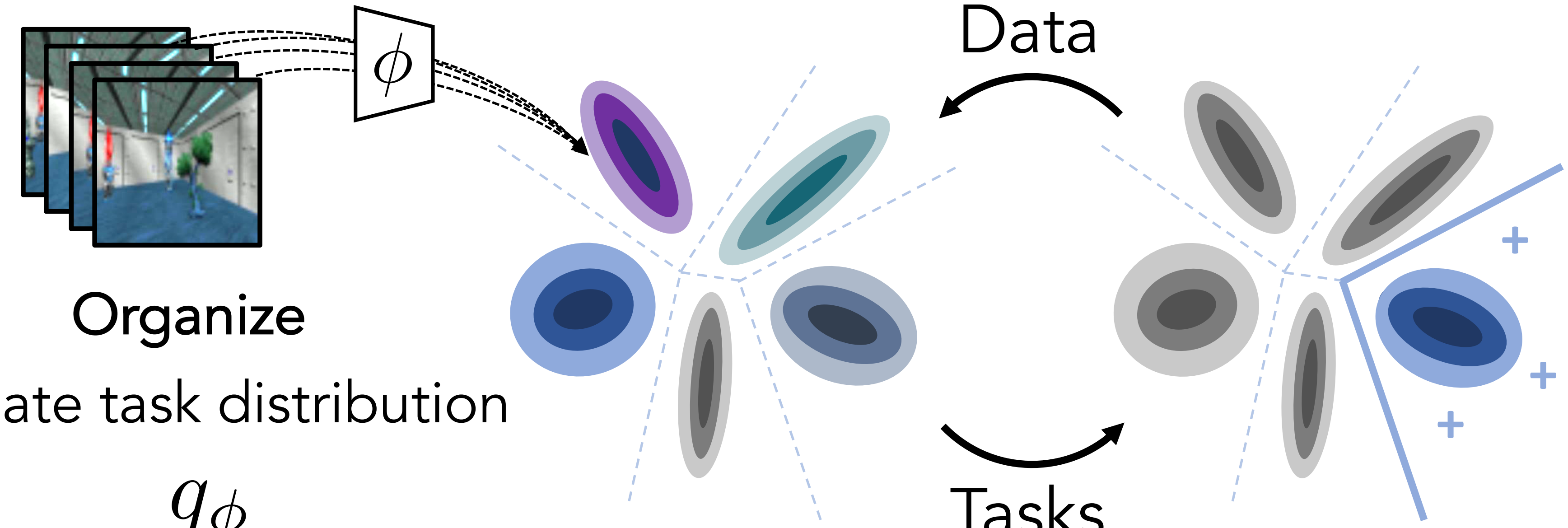
Diversity $H(\boldsymbol{\tau})$ $-H(\boldsymbol{\tau}|\mathbf{z})$ Structure

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

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



Data

Tasks

Organize

Update task distribution

q_ϕ

Meta-Train

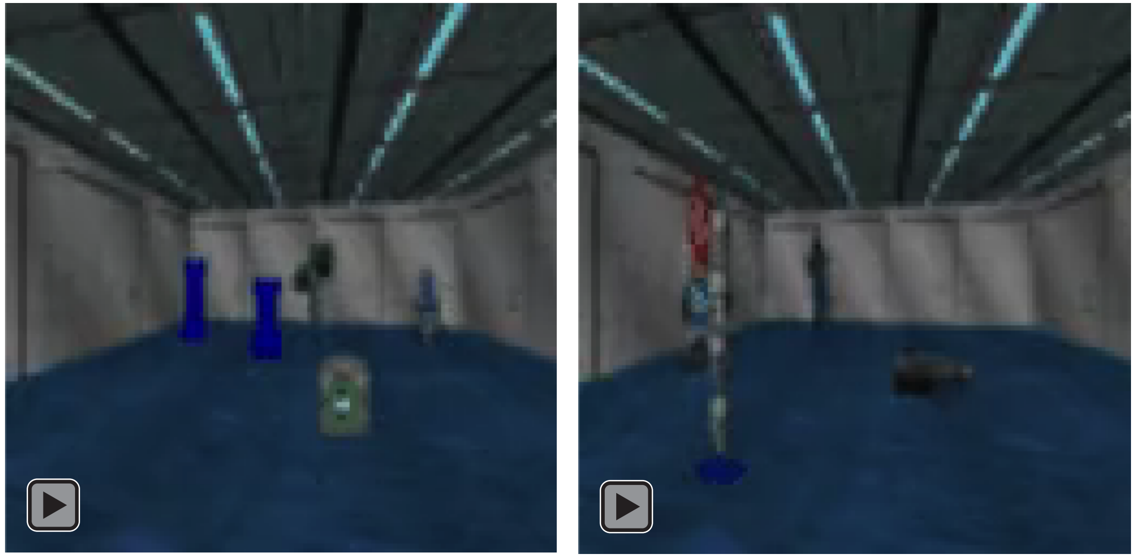
Update policy

π_θ

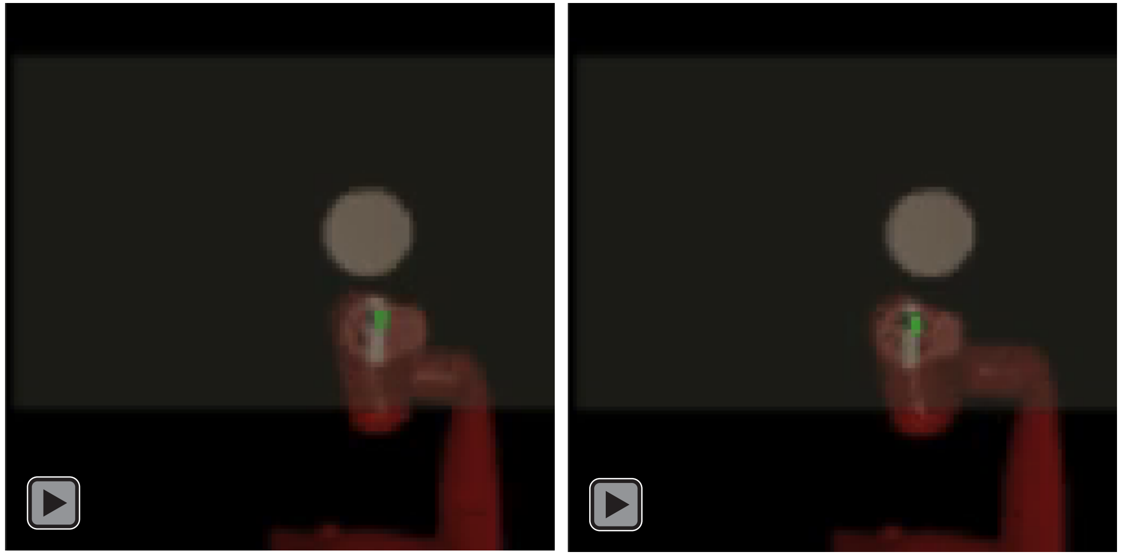
E-step

M-step

Experimental Setting

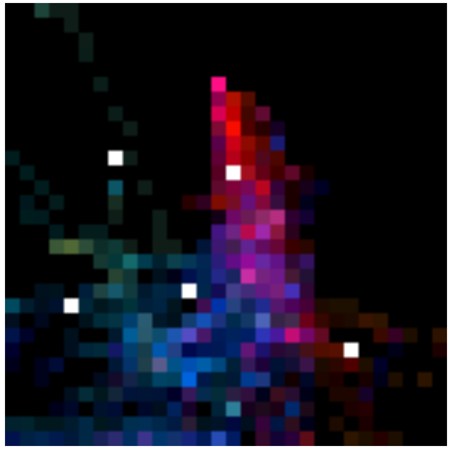


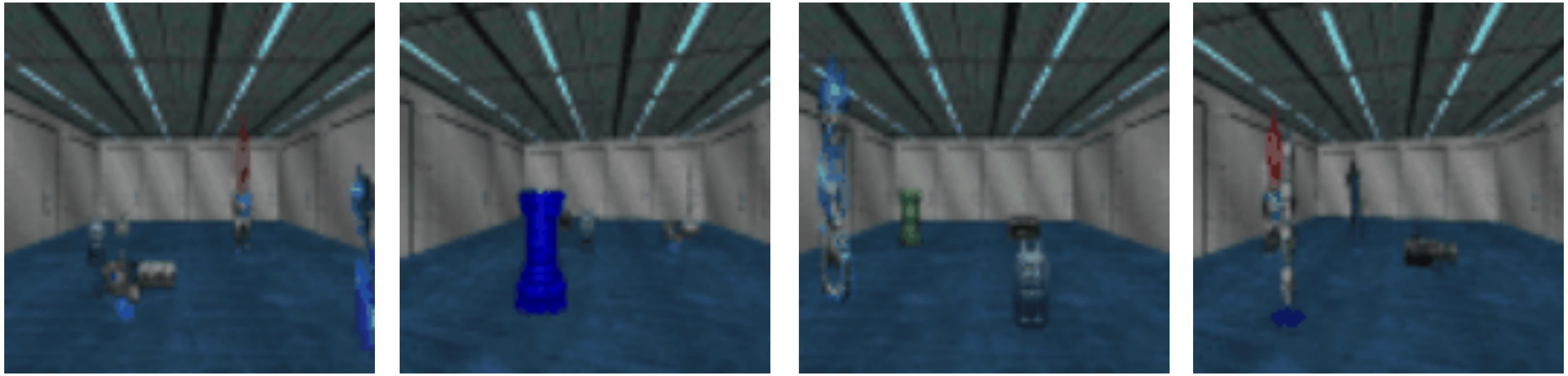
Visual Navigation
in VizDoom

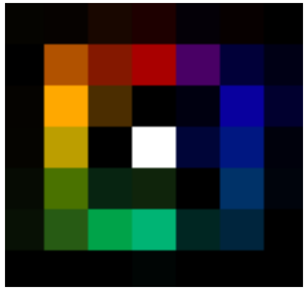


Object Pushing
with Sawyer in MuJoCo

What kind of tasks are discovered?

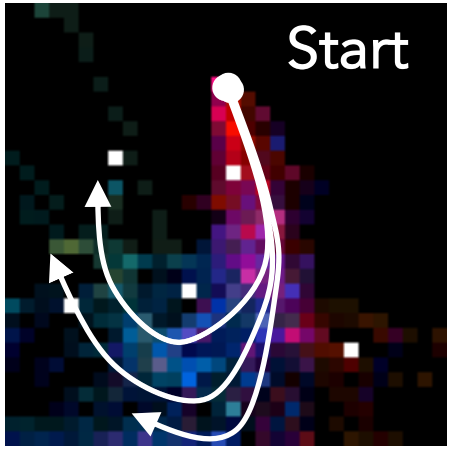


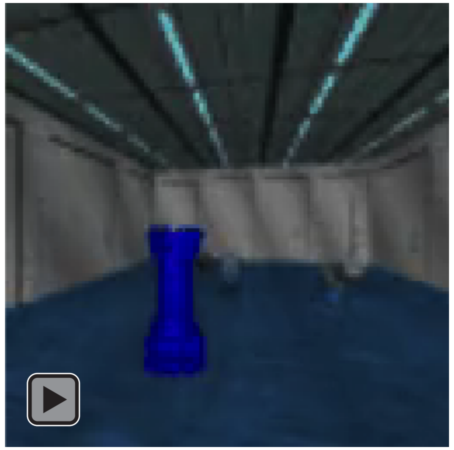


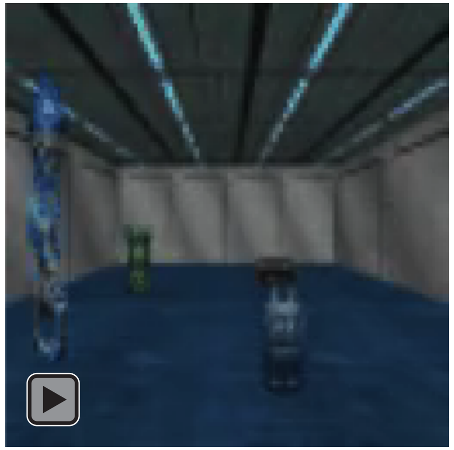


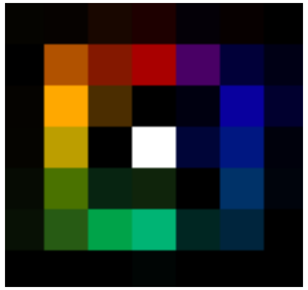
Direction encoded as color

What kind of tasks are discovered?









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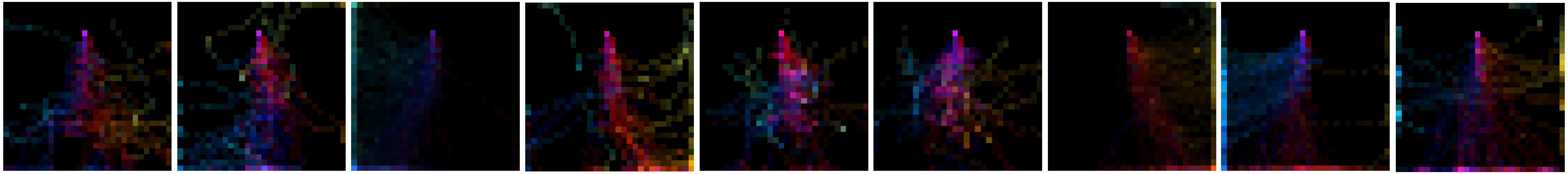
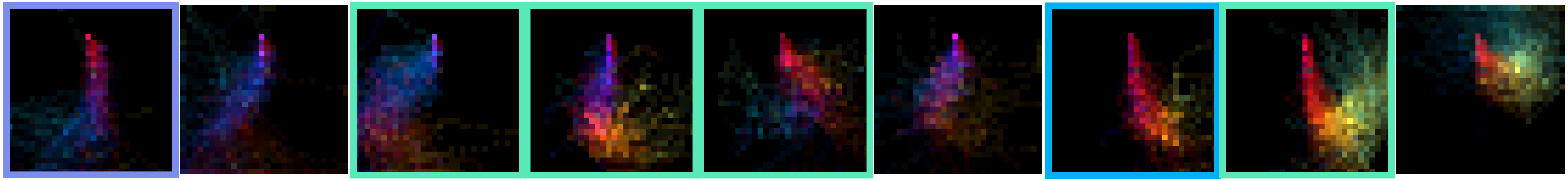
What kind of tasks are discovered?

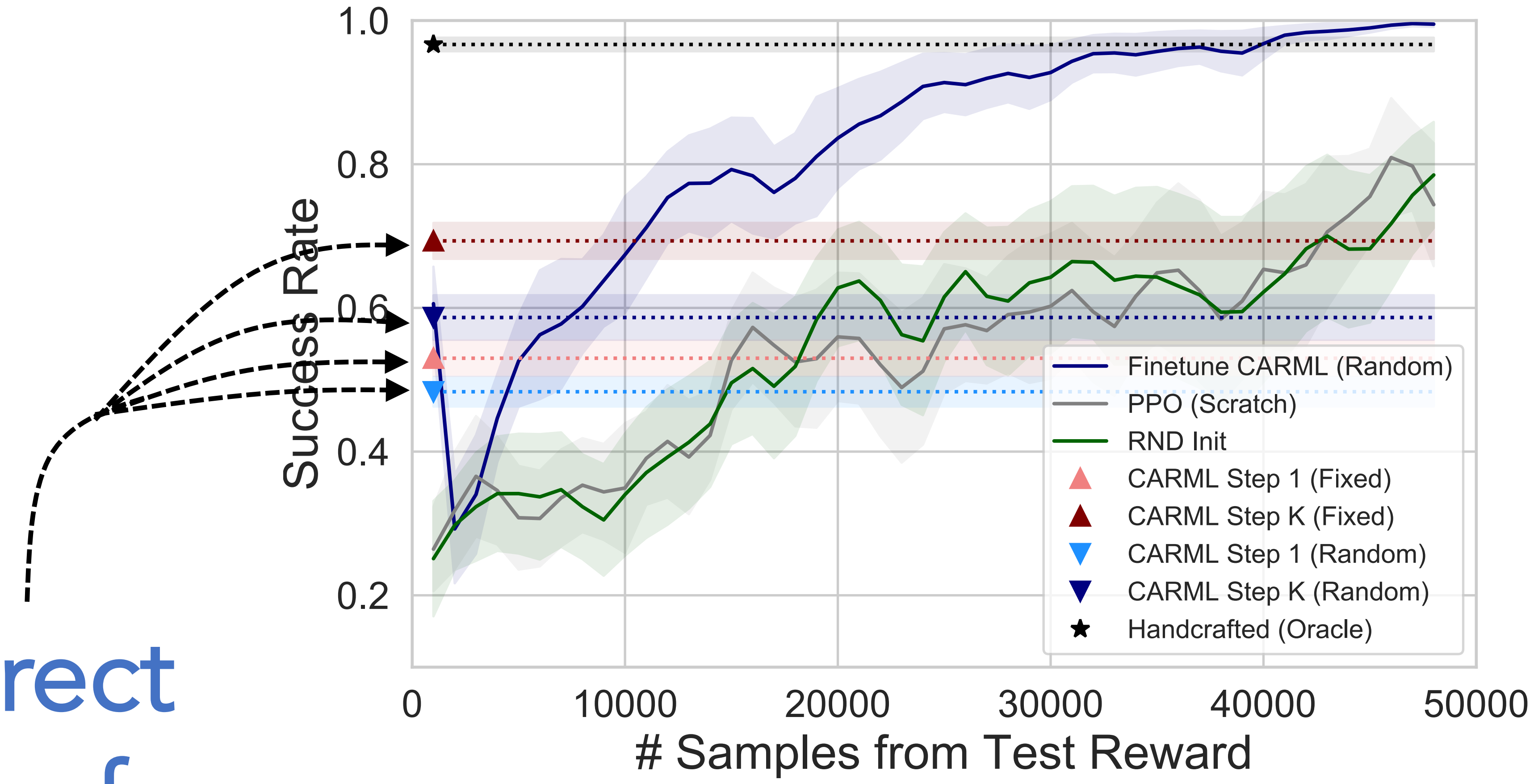
Step 1



Step 5

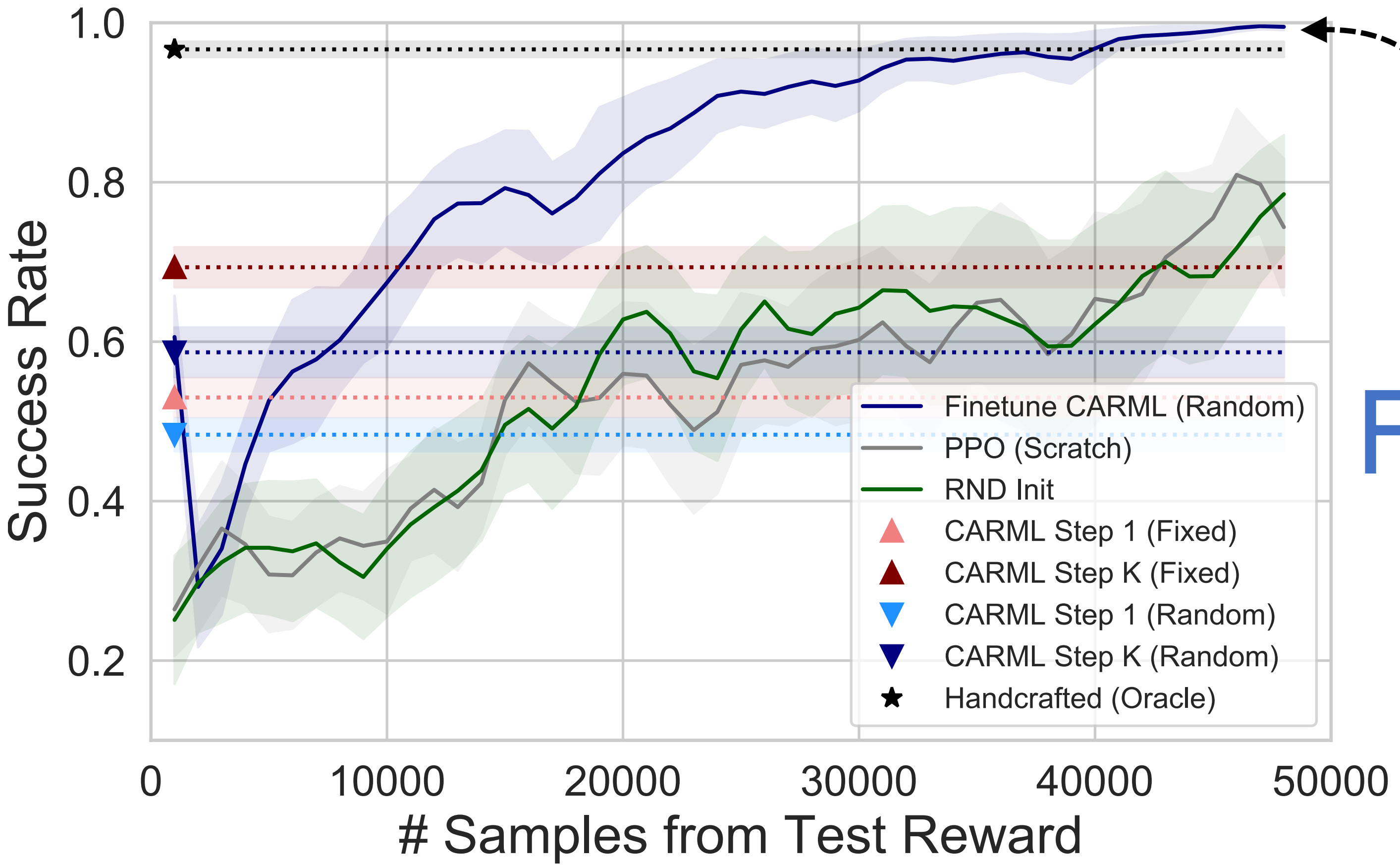


Transfer to Test Tasks – VizDoom



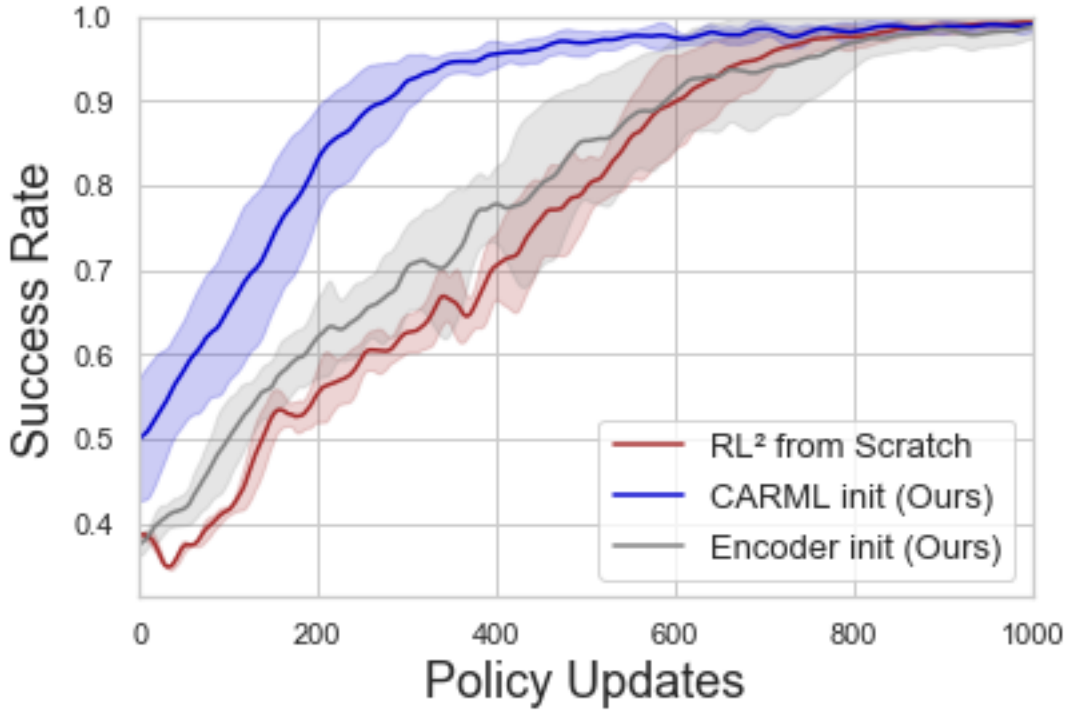
Direct Transfer

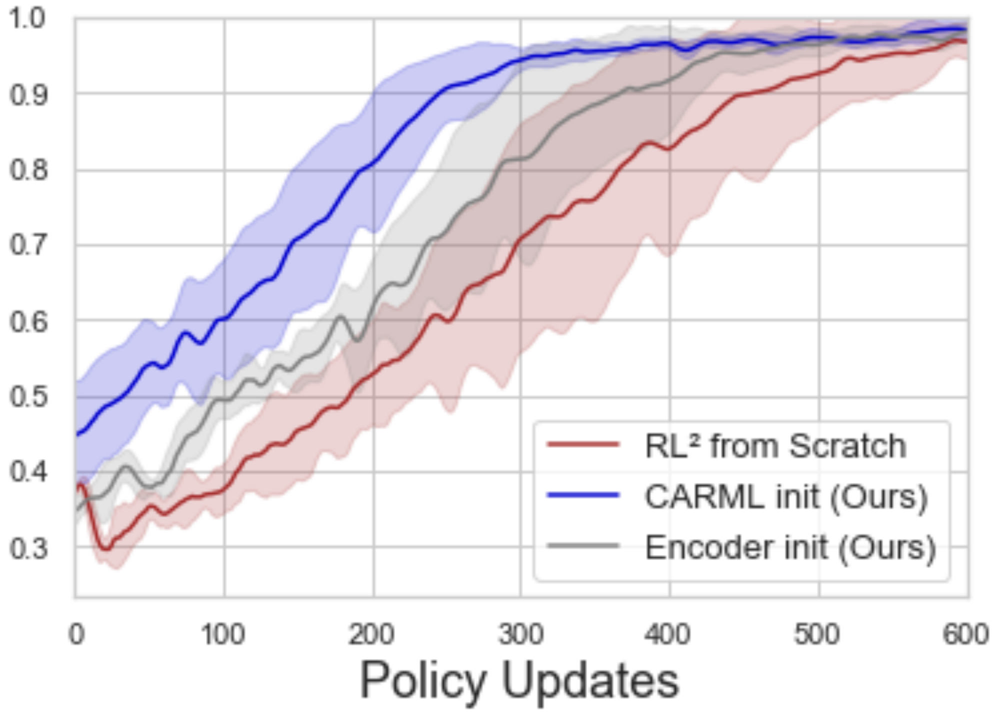
Transfer to Test Tasks – VizDoom



Faster Finetuning

Faster Supervised Meta-RL





Thank You

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Poster #35, East Exhibition Hall B + C

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