Deep Reinforcement Learning in a Handful of Trials with Probabilistic Dynamics Models

Kurtland Chua, Roberto Calandra, Rowan McAllister, Sergey Levine

University of California, Berkeley

What is Reinforcement Learning?

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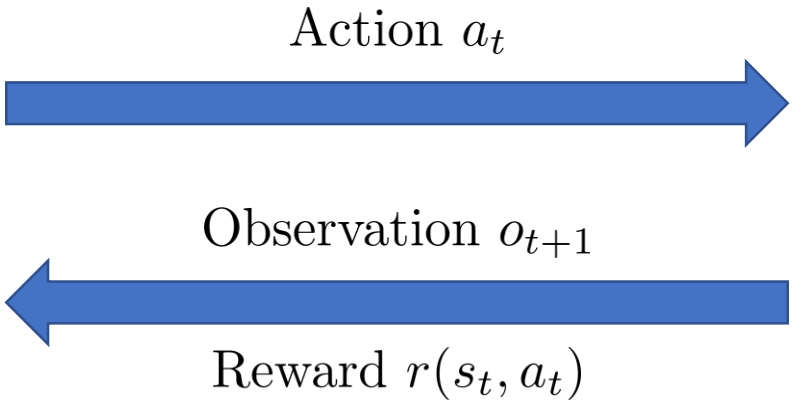
Action a_t

What is Reinforcement Learning?



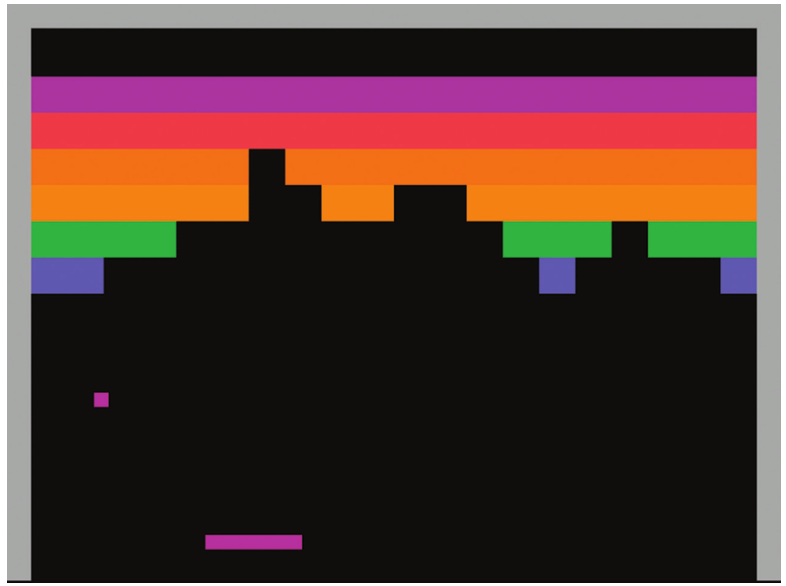
What is Reinforcement Learning?

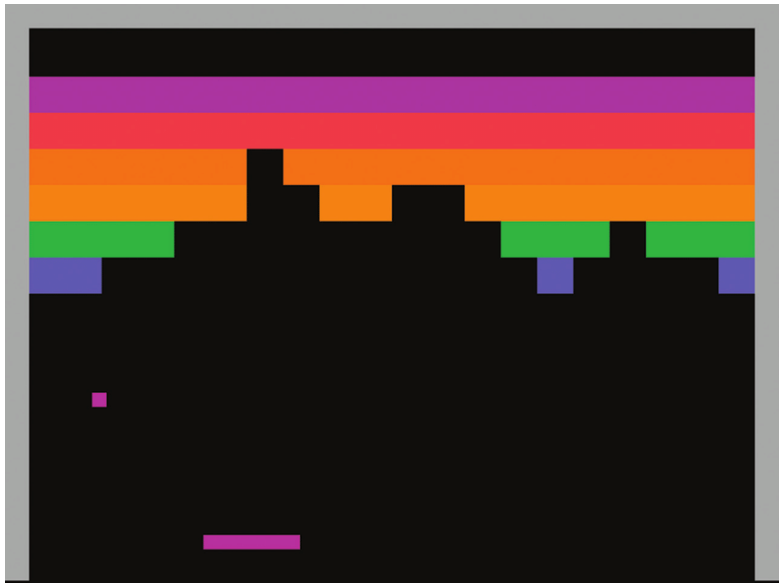
Action a_t

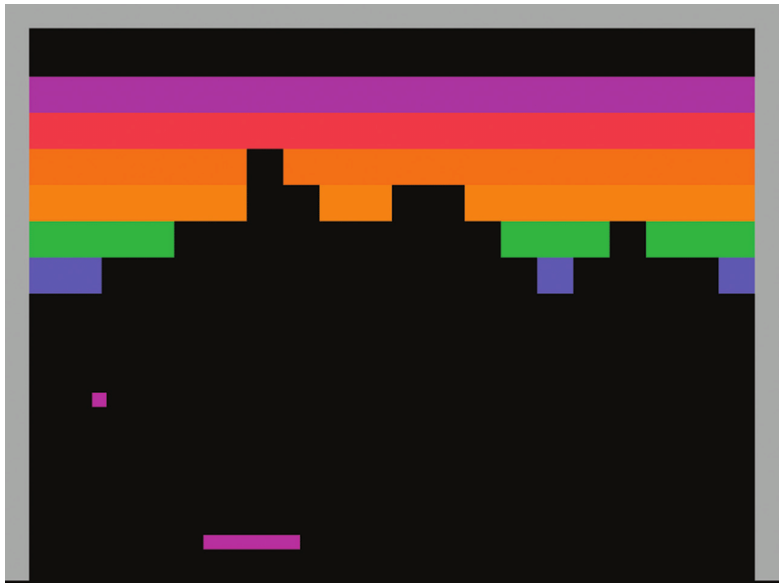
Observation o_{t+1}

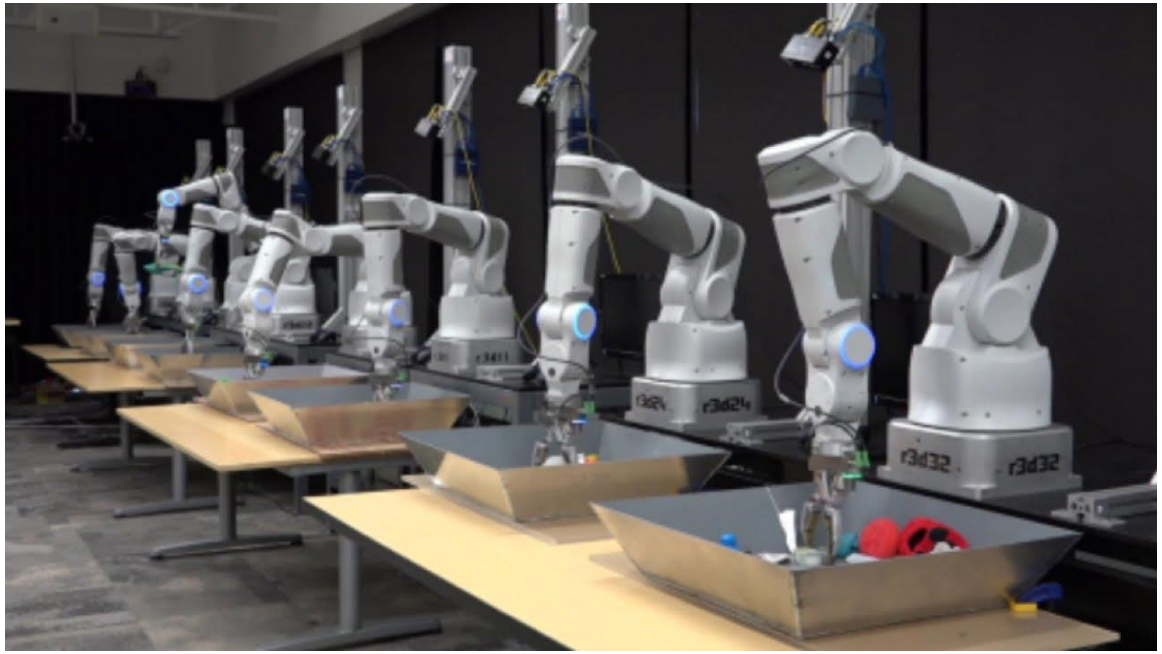
Reward $r(s_t, a_t)$

$$\max_{a_1,\ldots,a_{T-1}} \sum_{i=1}^{T-1} r(s_t, a_t)$$









Current Approaches to Reinforcement Learning

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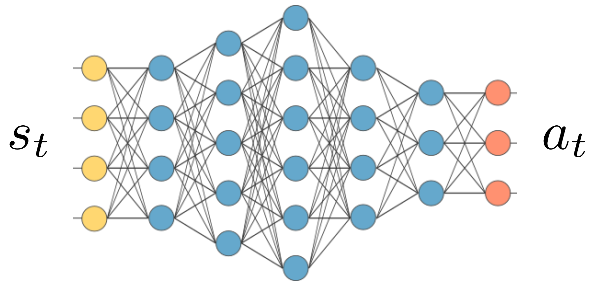
Policy Gradients



PPO, TRPO

(Schulman et al. ‘15, Schulman et al. ‘17)

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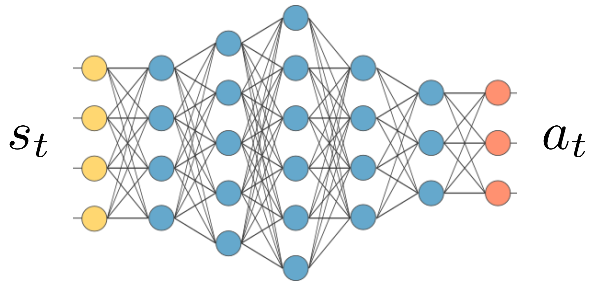

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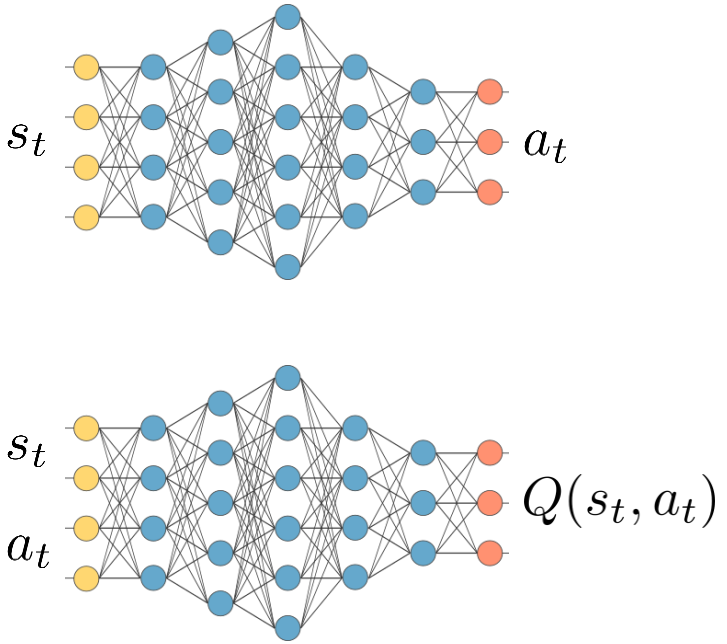
Actor-Critic



SAC, DDPG

(Haarnoja et al., Lillicrap et al.)

Current Approaches to Reinforcement Learning

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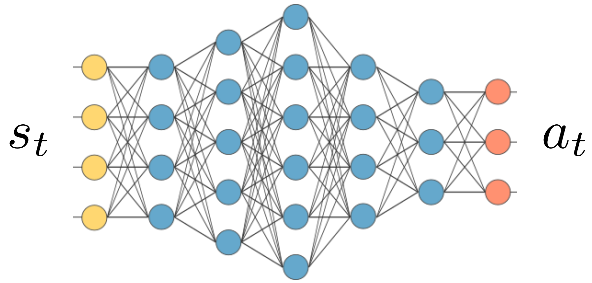

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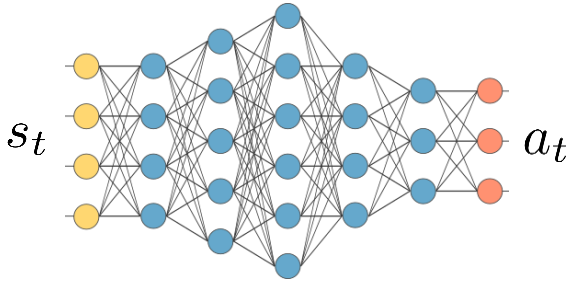

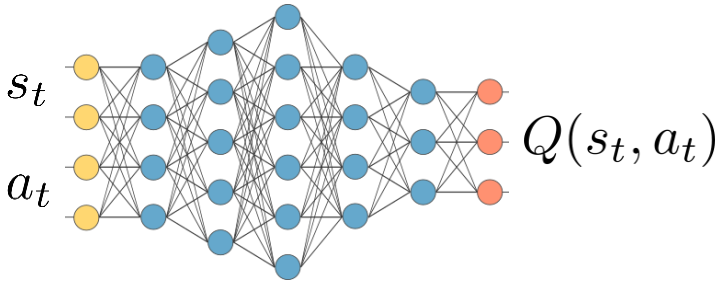

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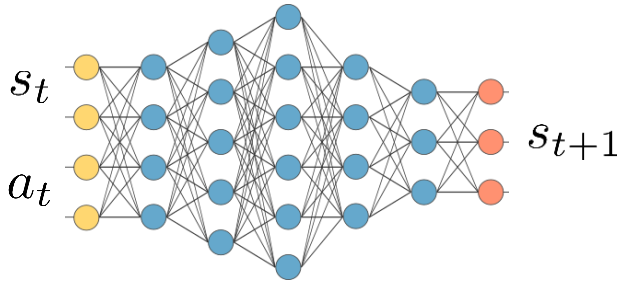
Model-based RL



MBMF

(Nagabandi et al.)

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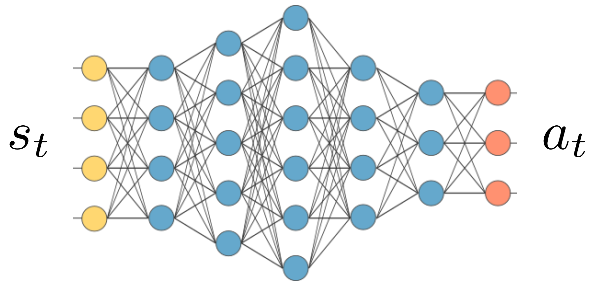

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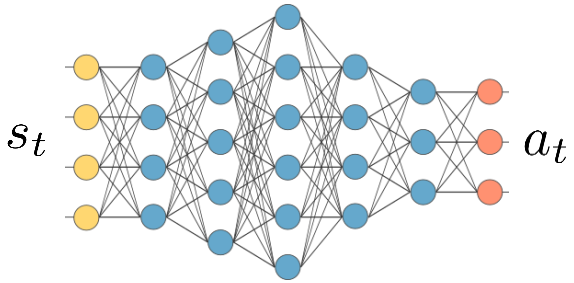

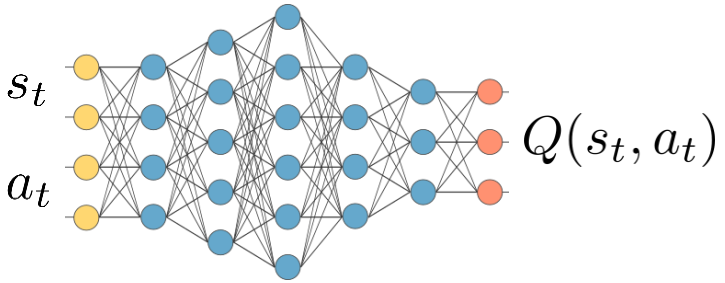

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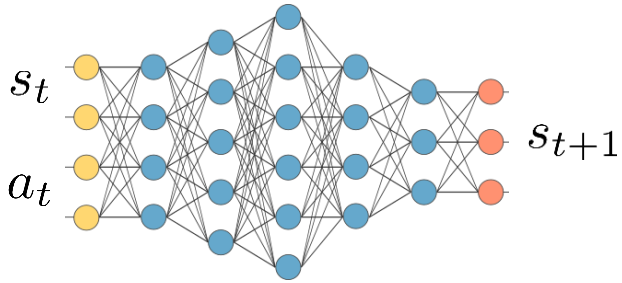

MBMF

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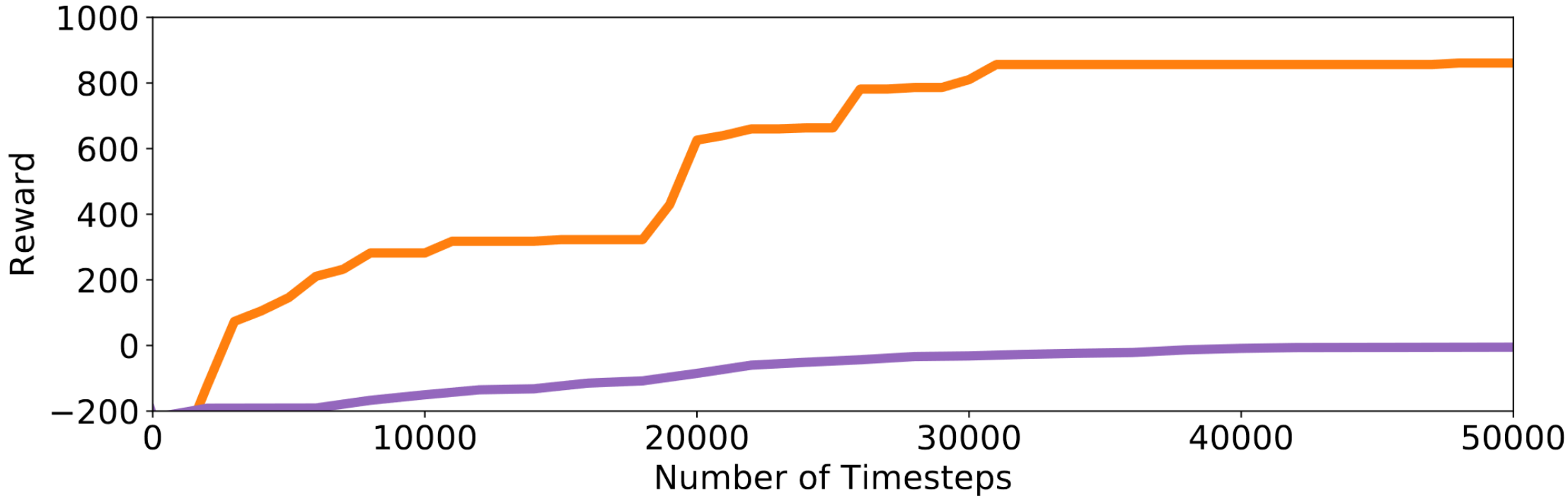
Least Efficient — Most efficient

Data Efficiency

Comparative Performance on HalfCheetah

Comparative Performance on HalfCheetah

PPO [Nagabandi et al. 2017]



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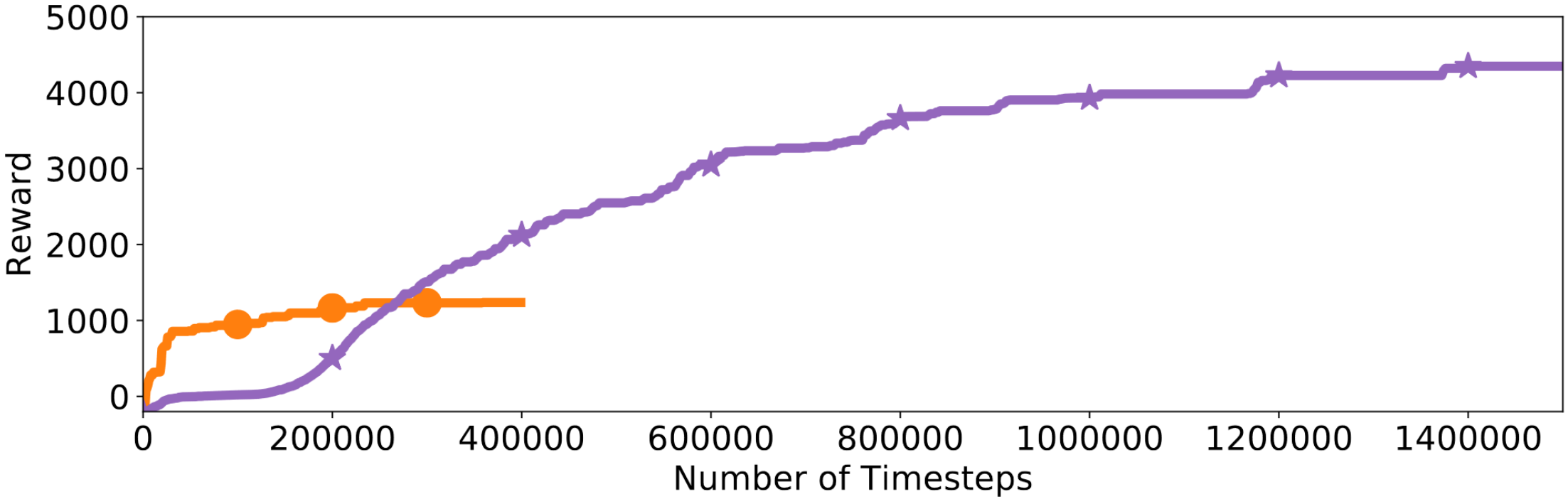

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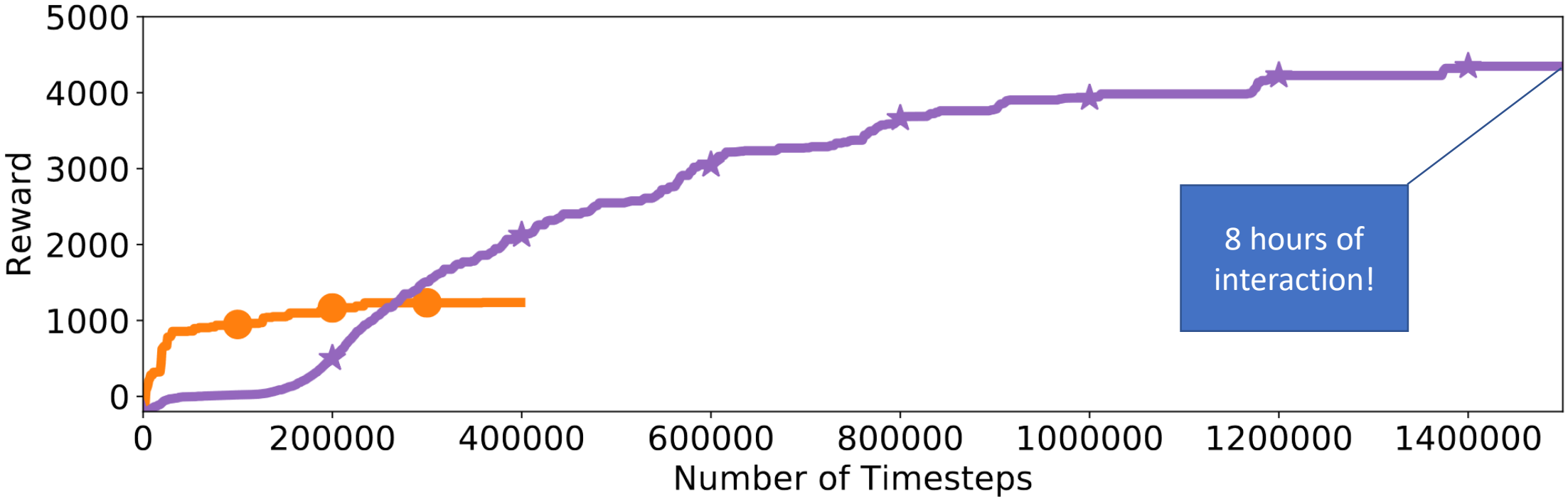

Model-based Reinforcement Learning

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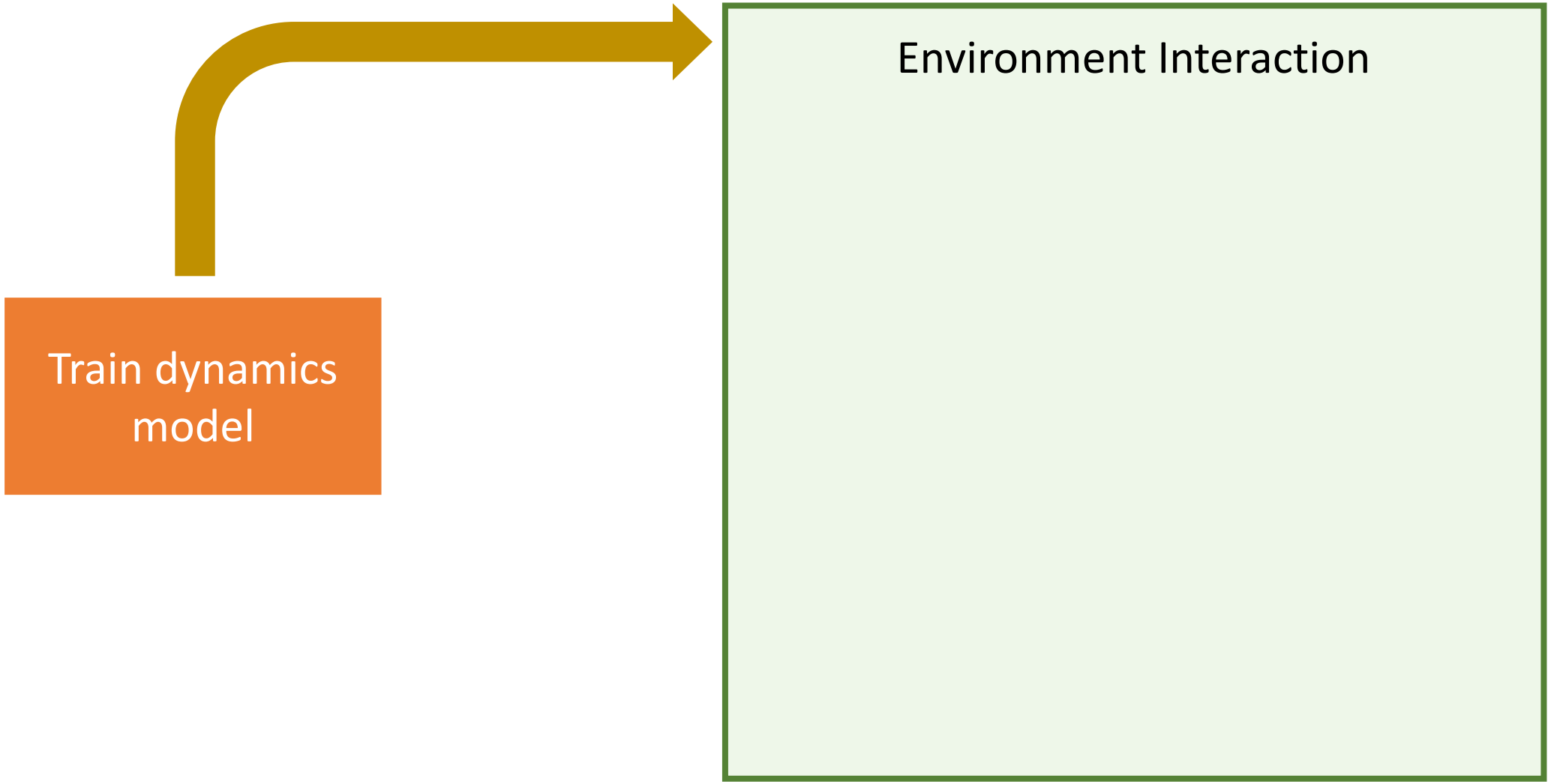
Train dynamics model

Model-based Reinforcement Learning



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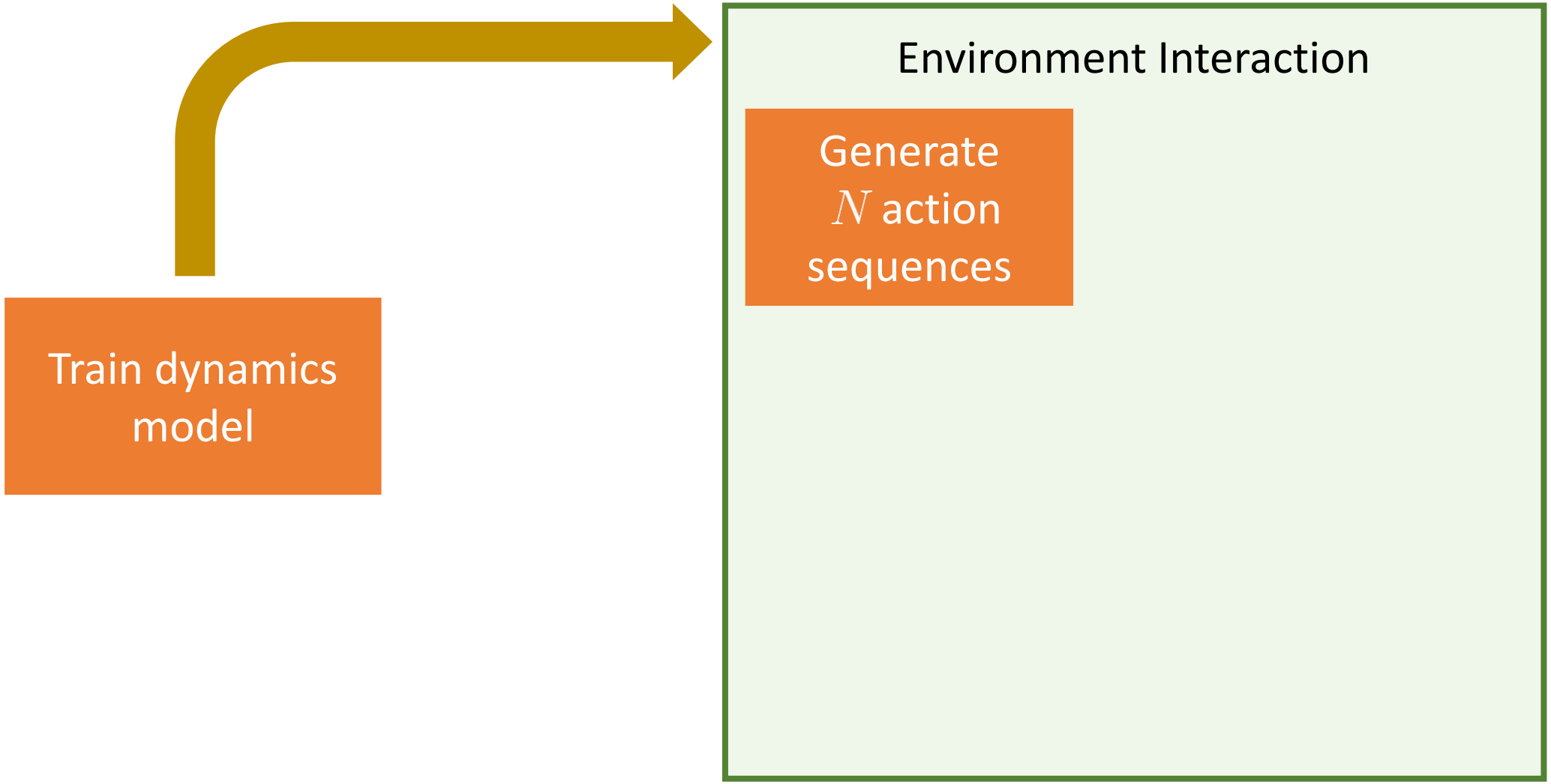

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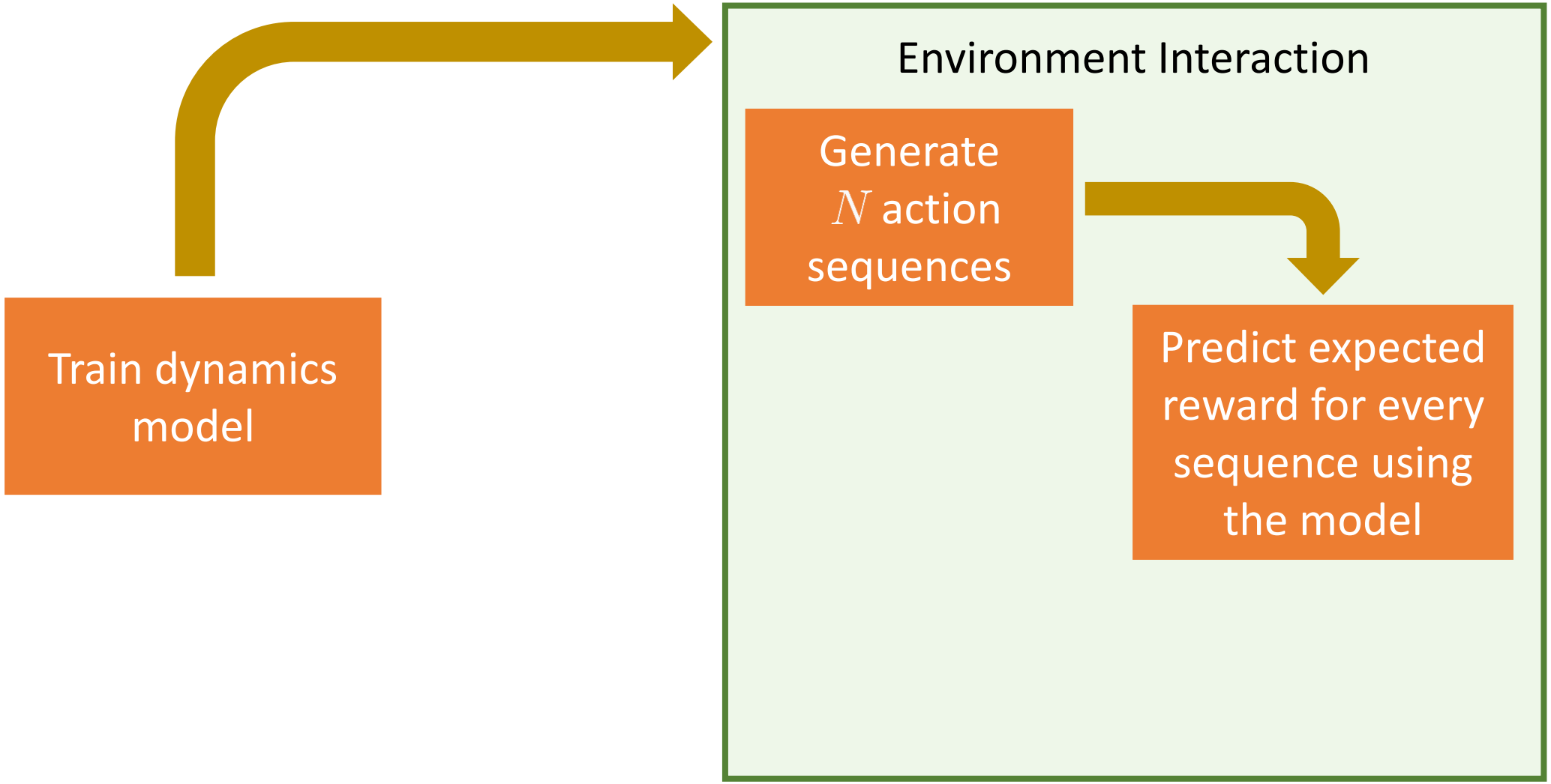

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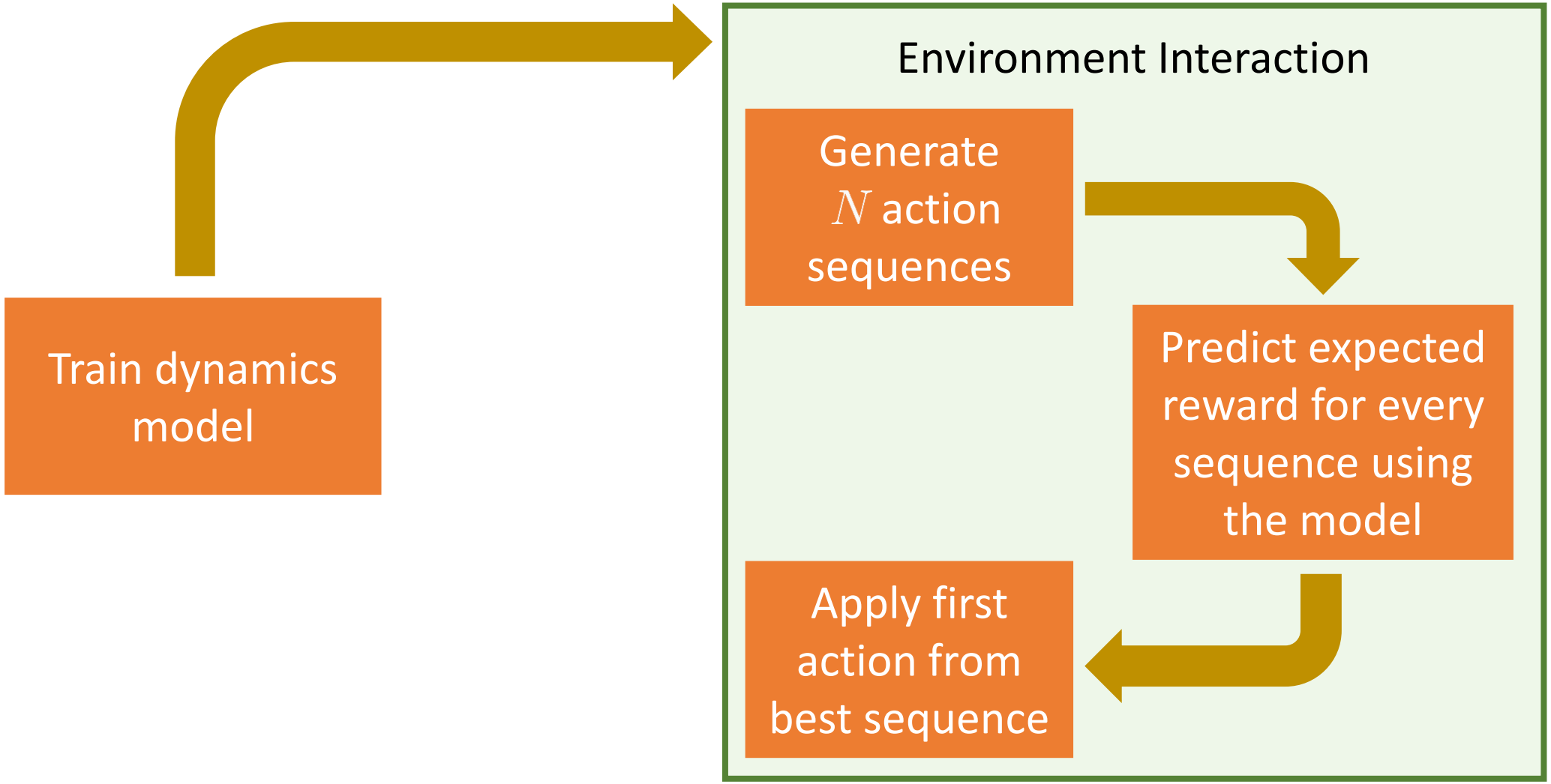

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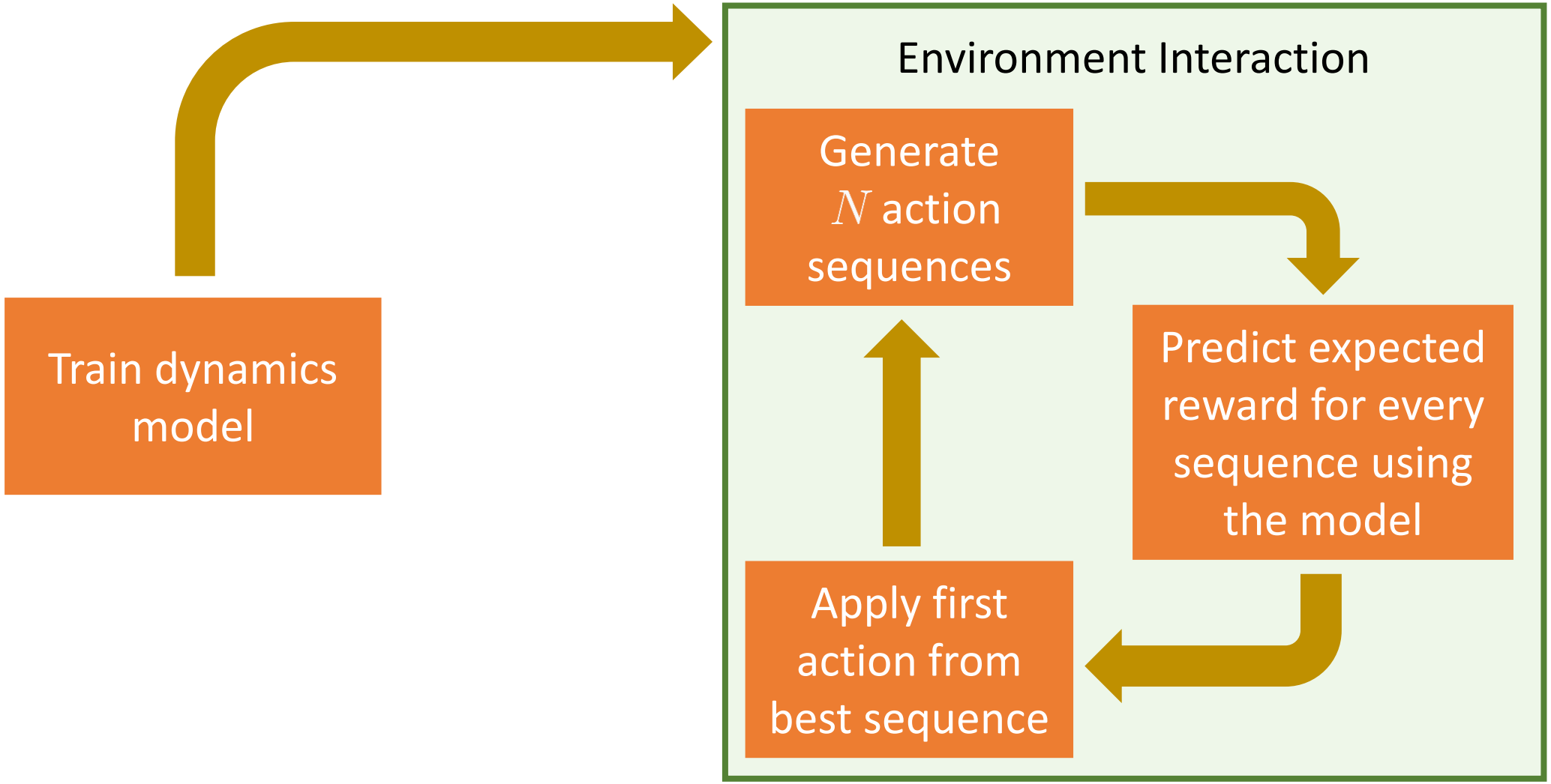

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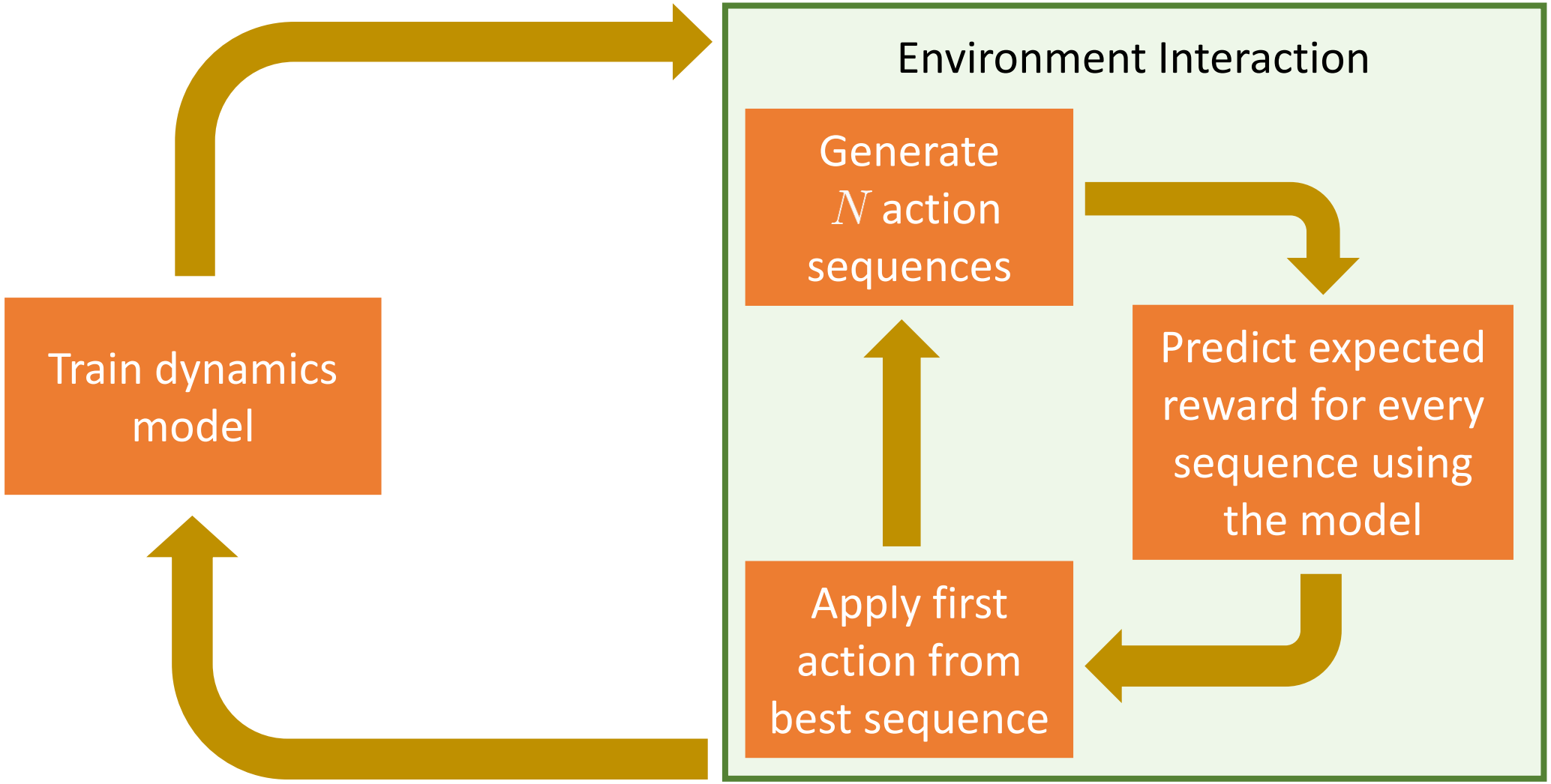

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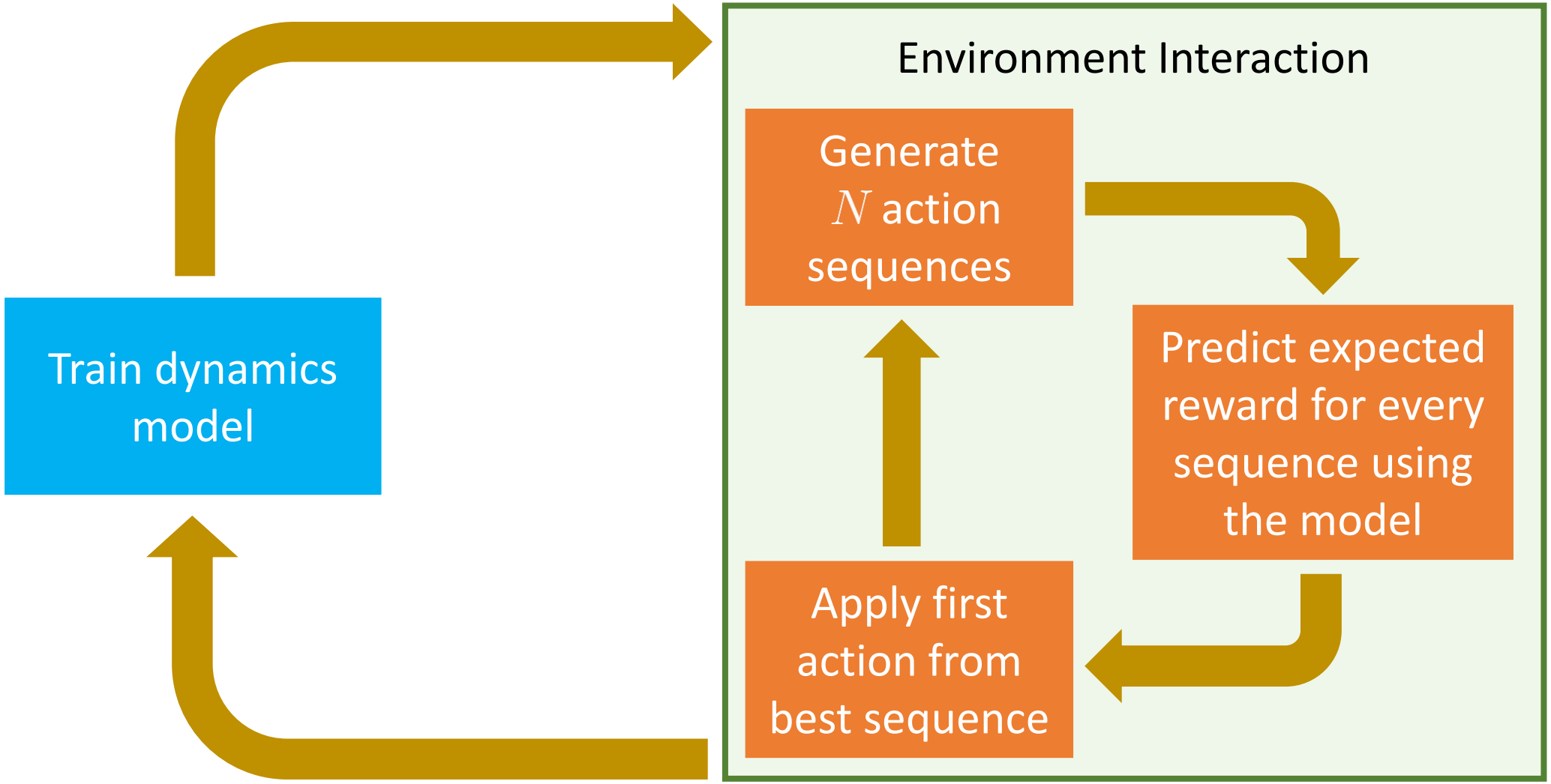

Deterministic Neural Nets as Models

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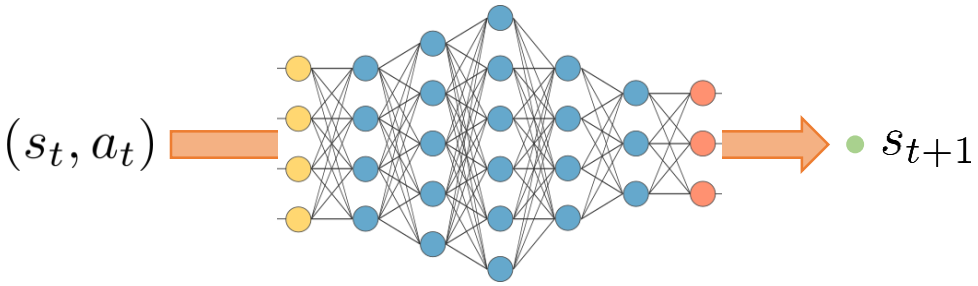
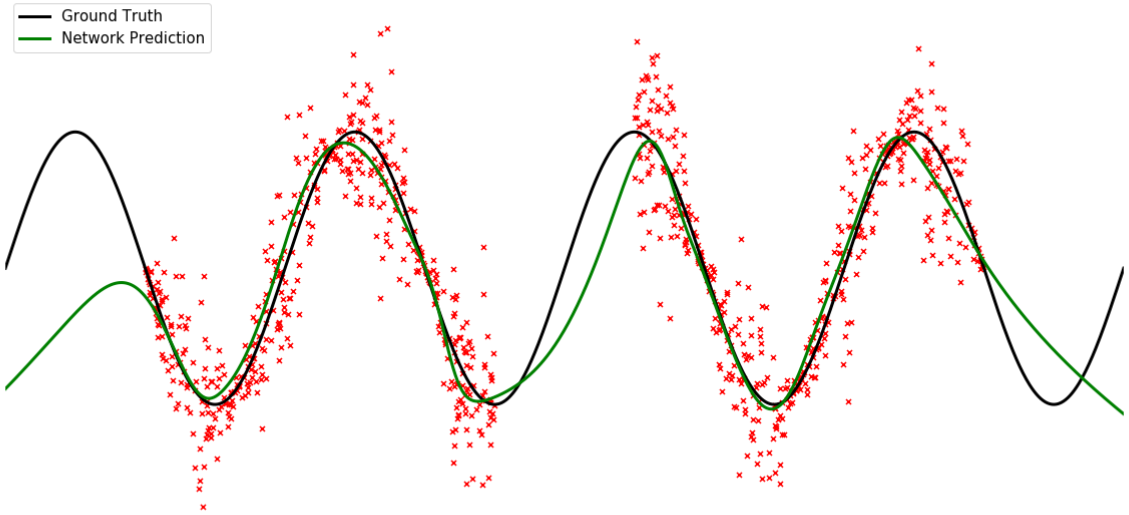
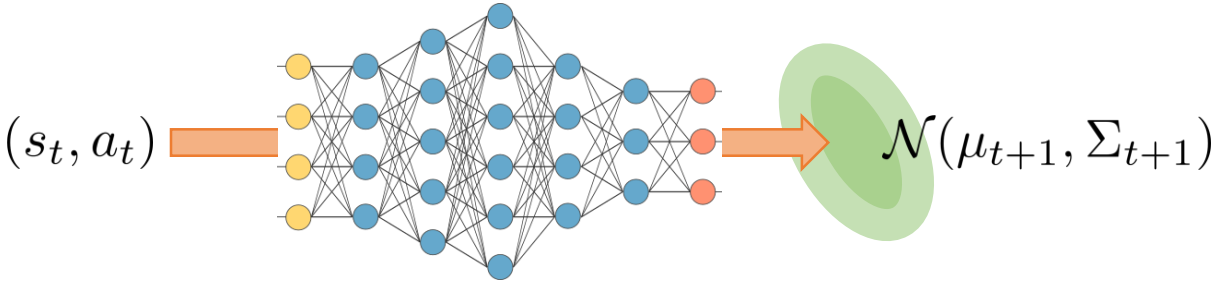
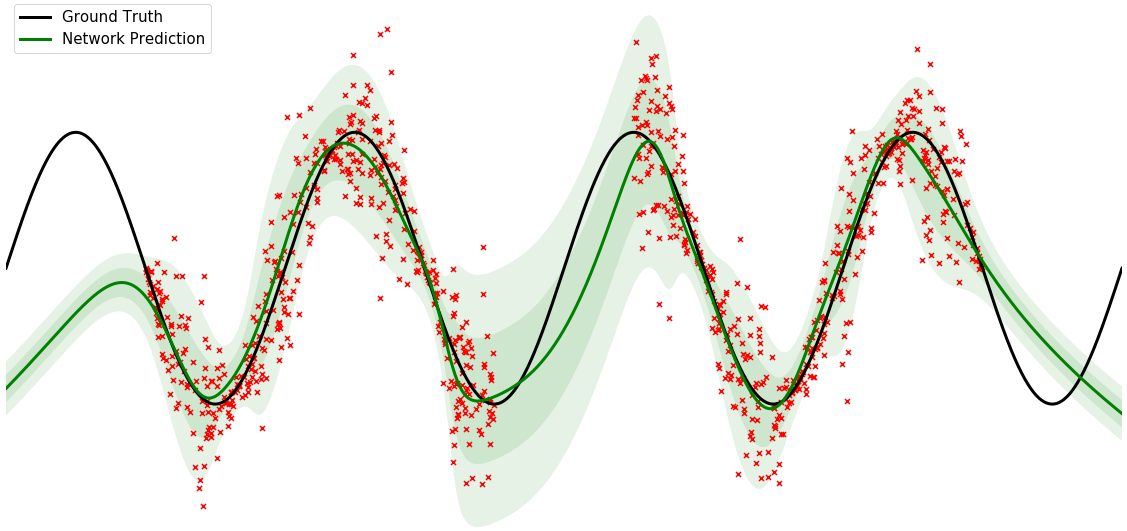


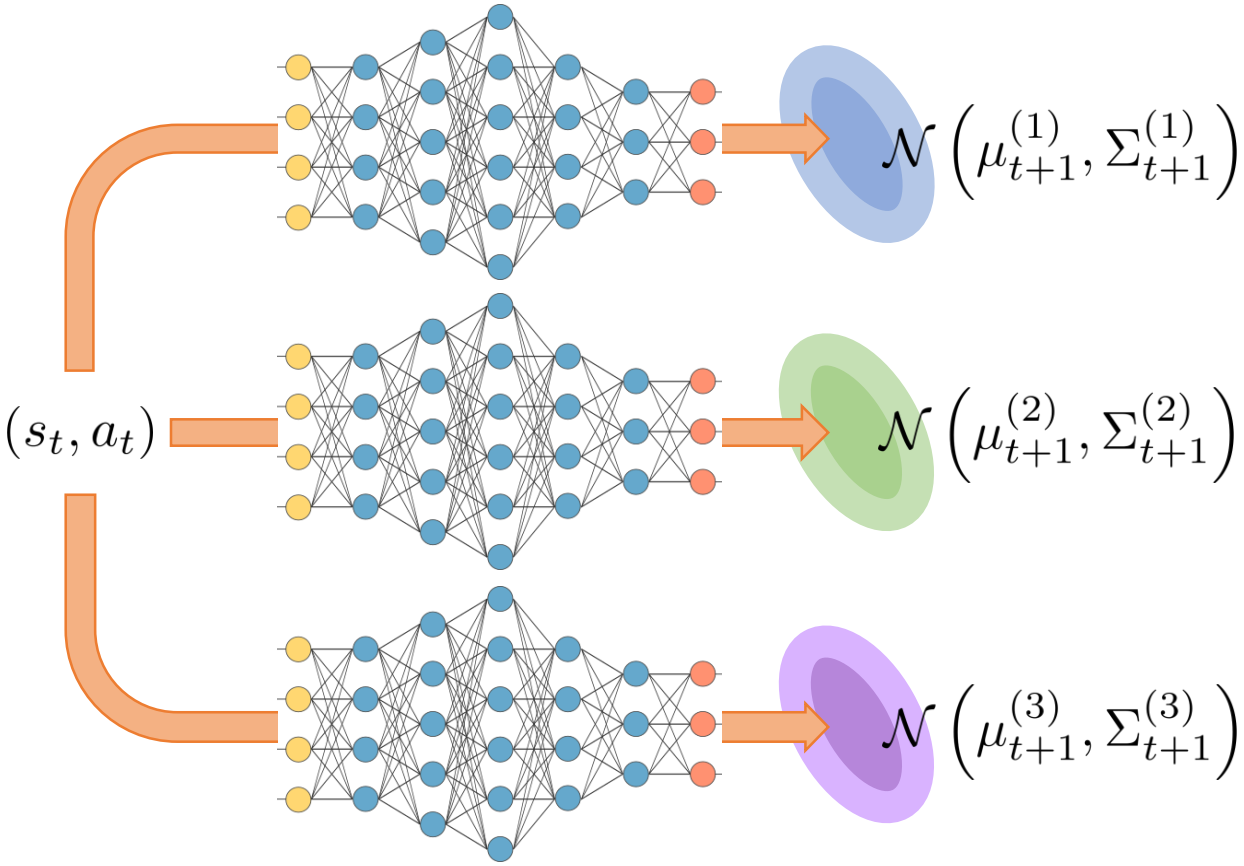


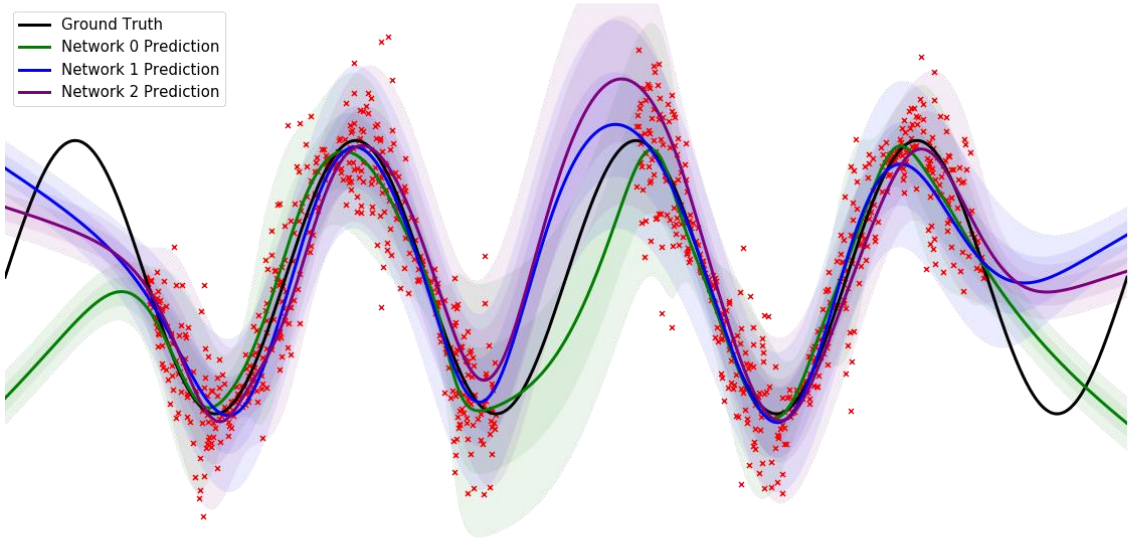
Probabilistic Neural Nets as Models



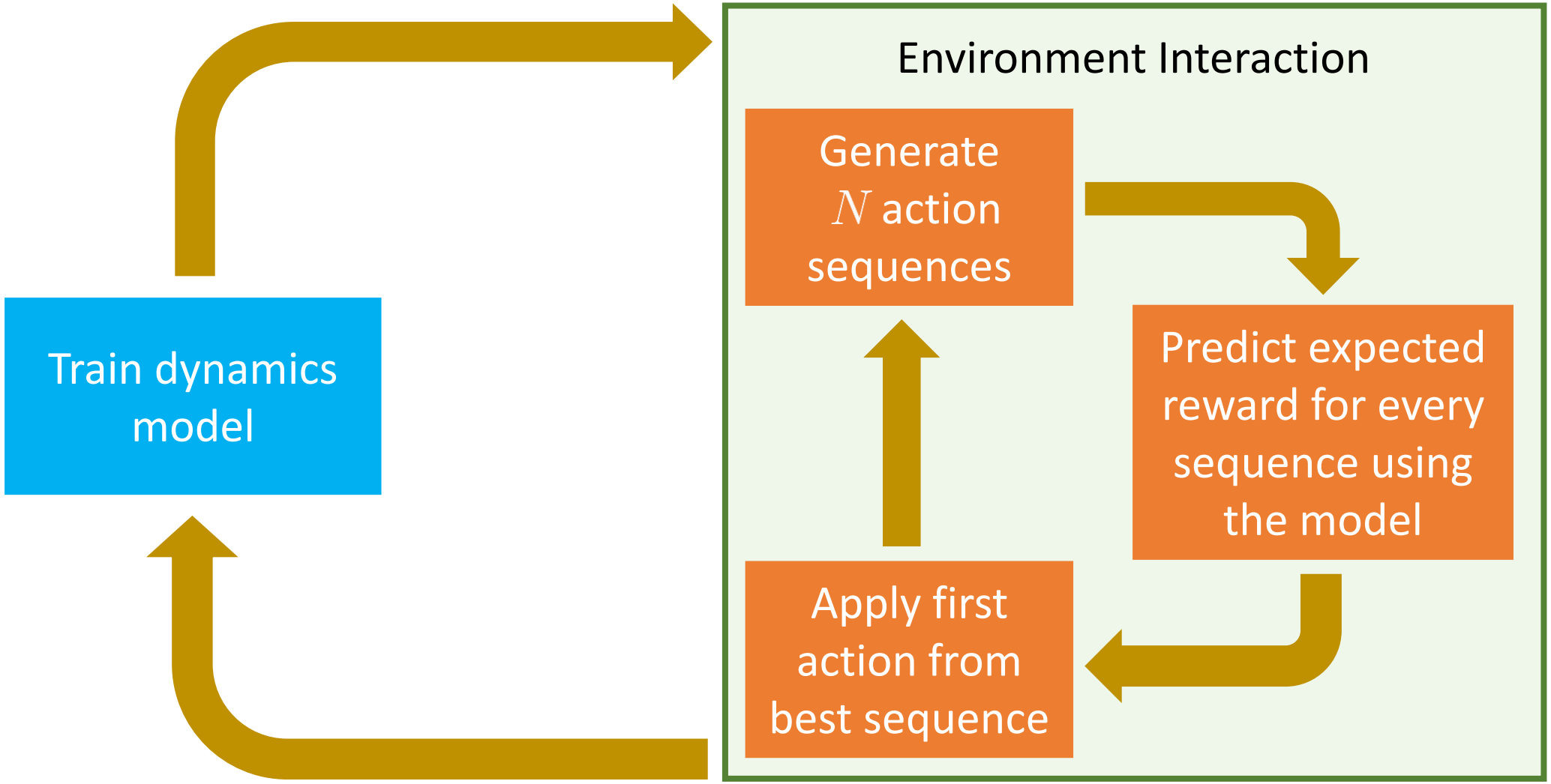


Probabilistic Ensembles as Models





Model-based Reinforcement Learning



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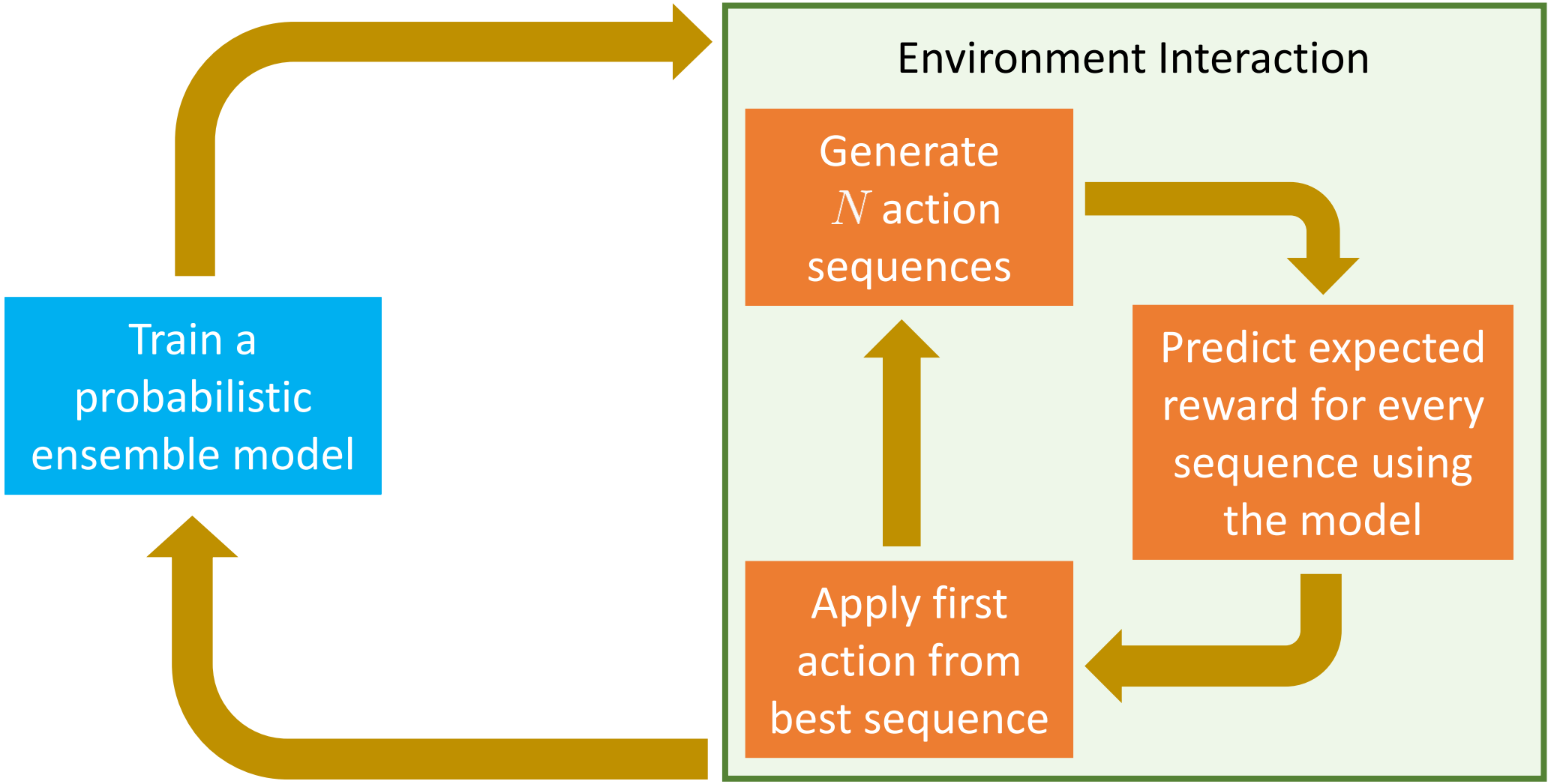

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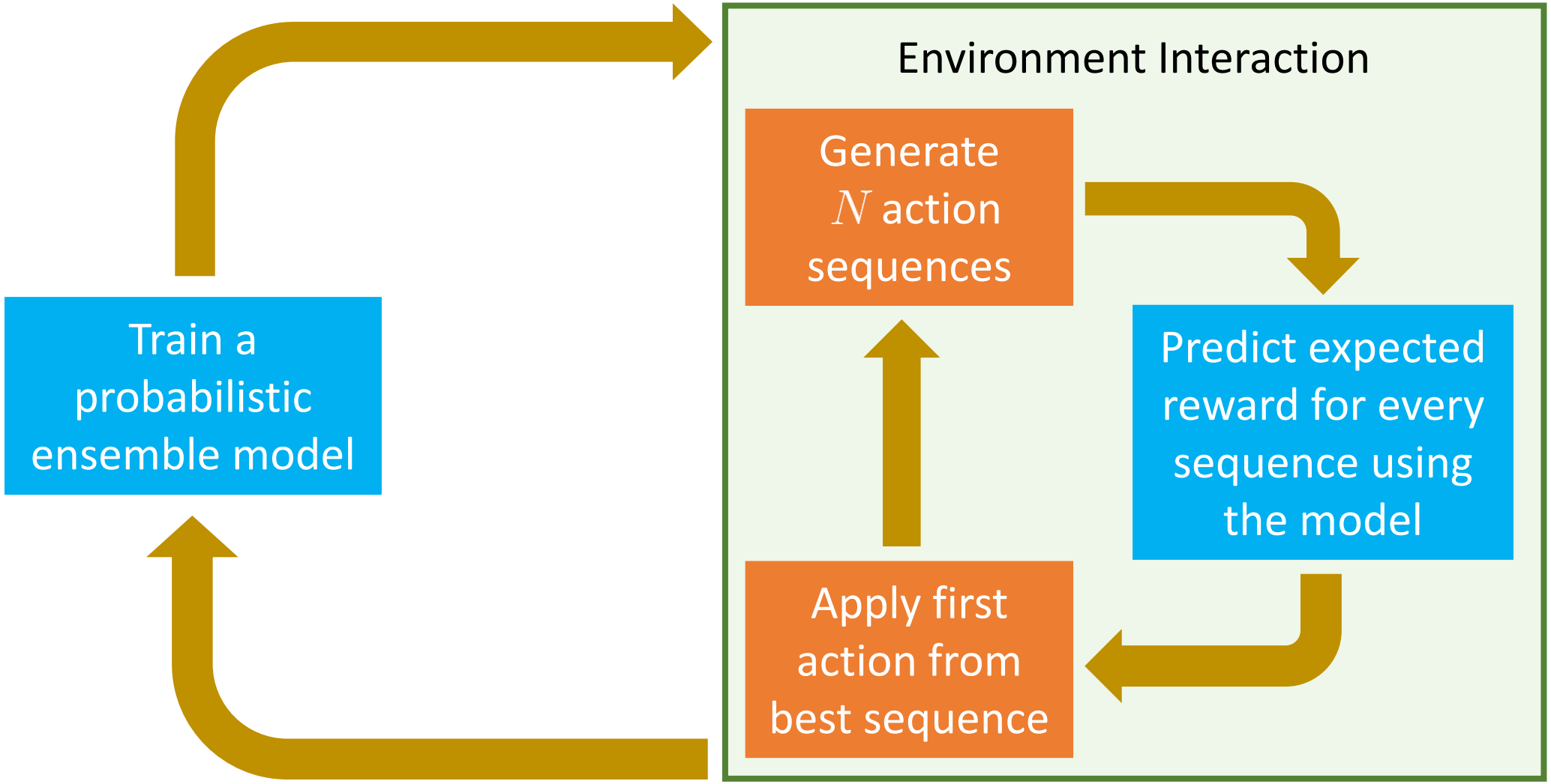

Trajectory Sampling for State Propagation

Trajectory Sampling for State Propagation

x_t

Trajectory Sampling for State Propagation

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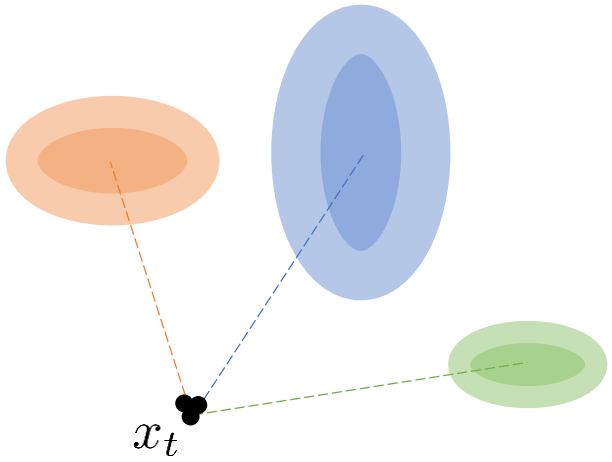

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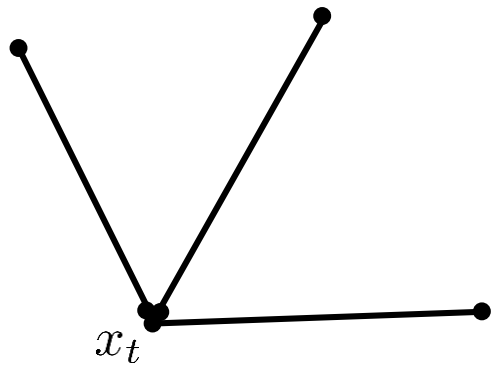

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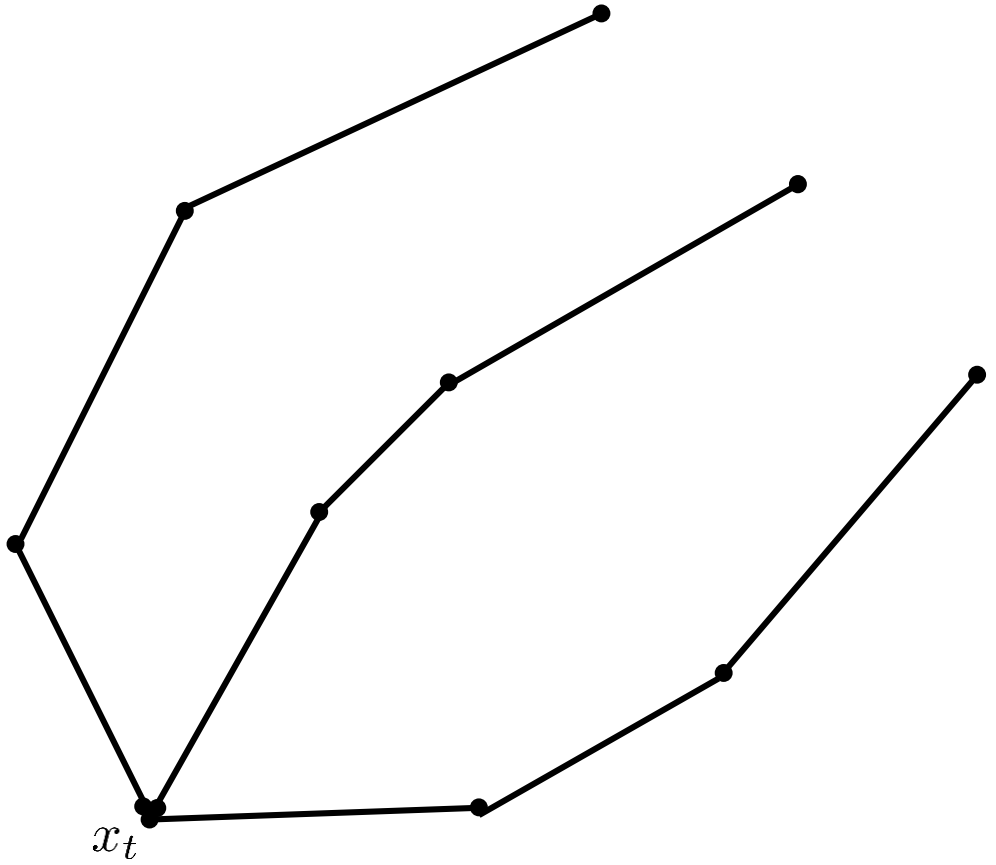

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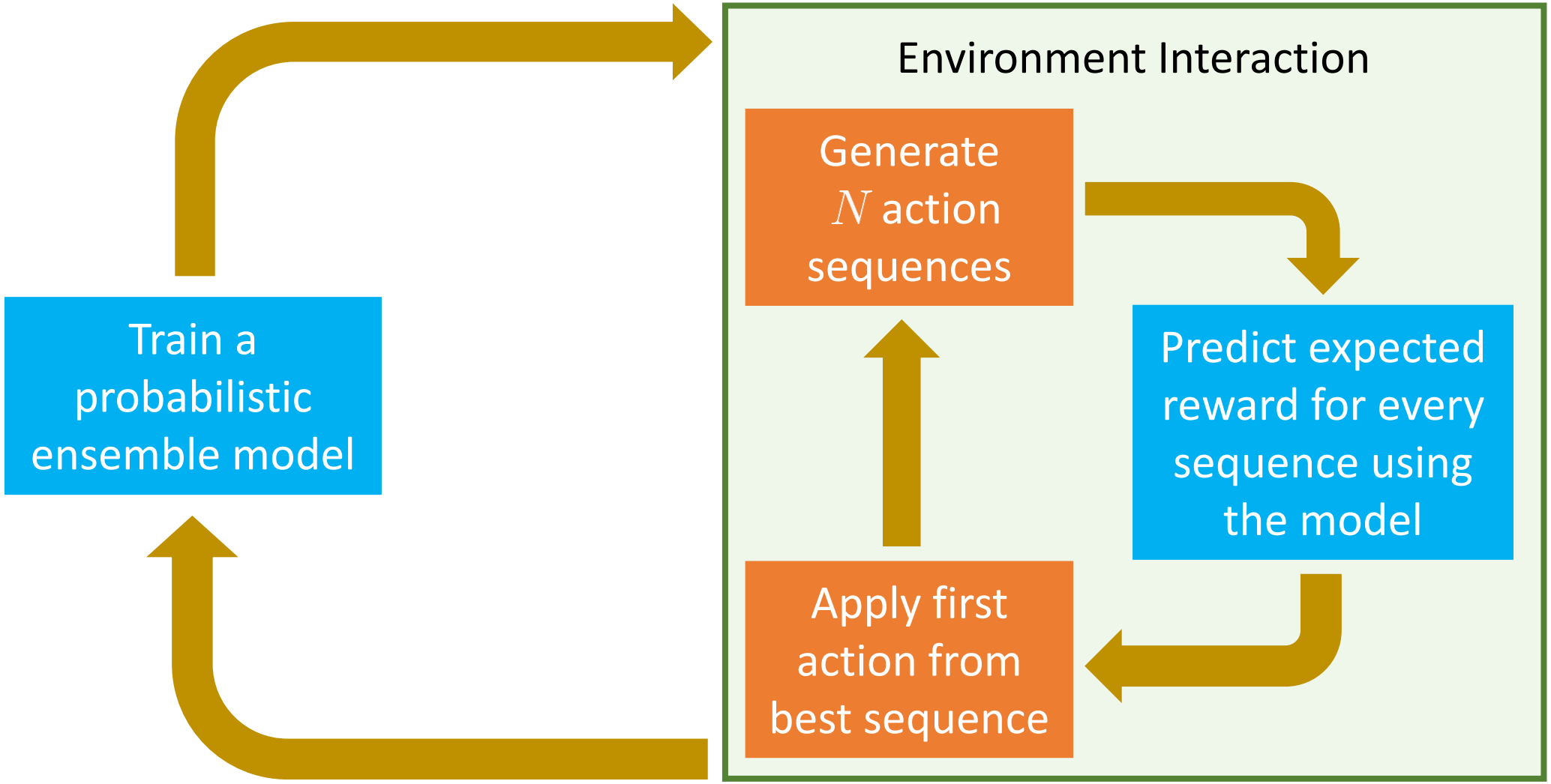

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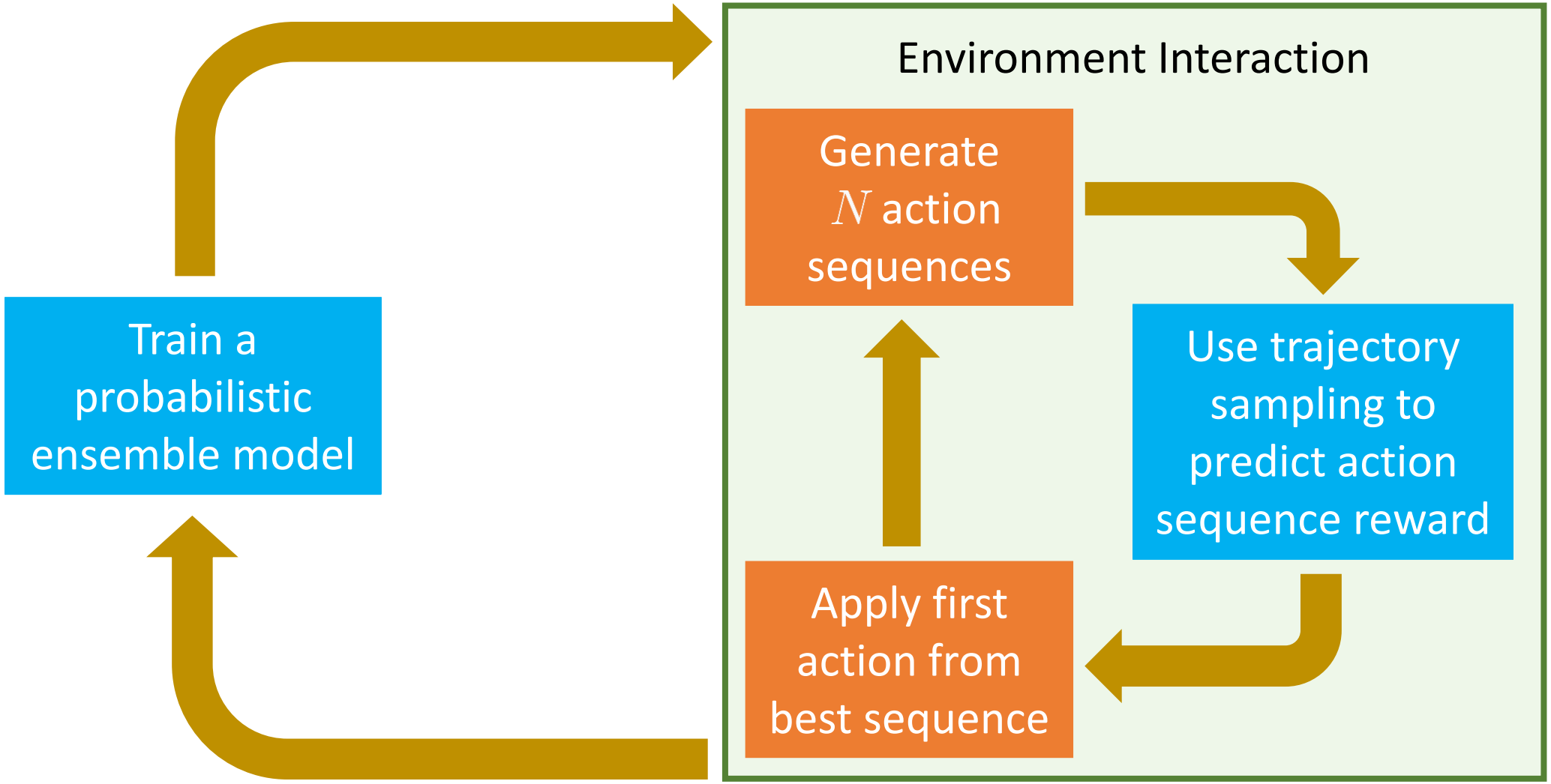
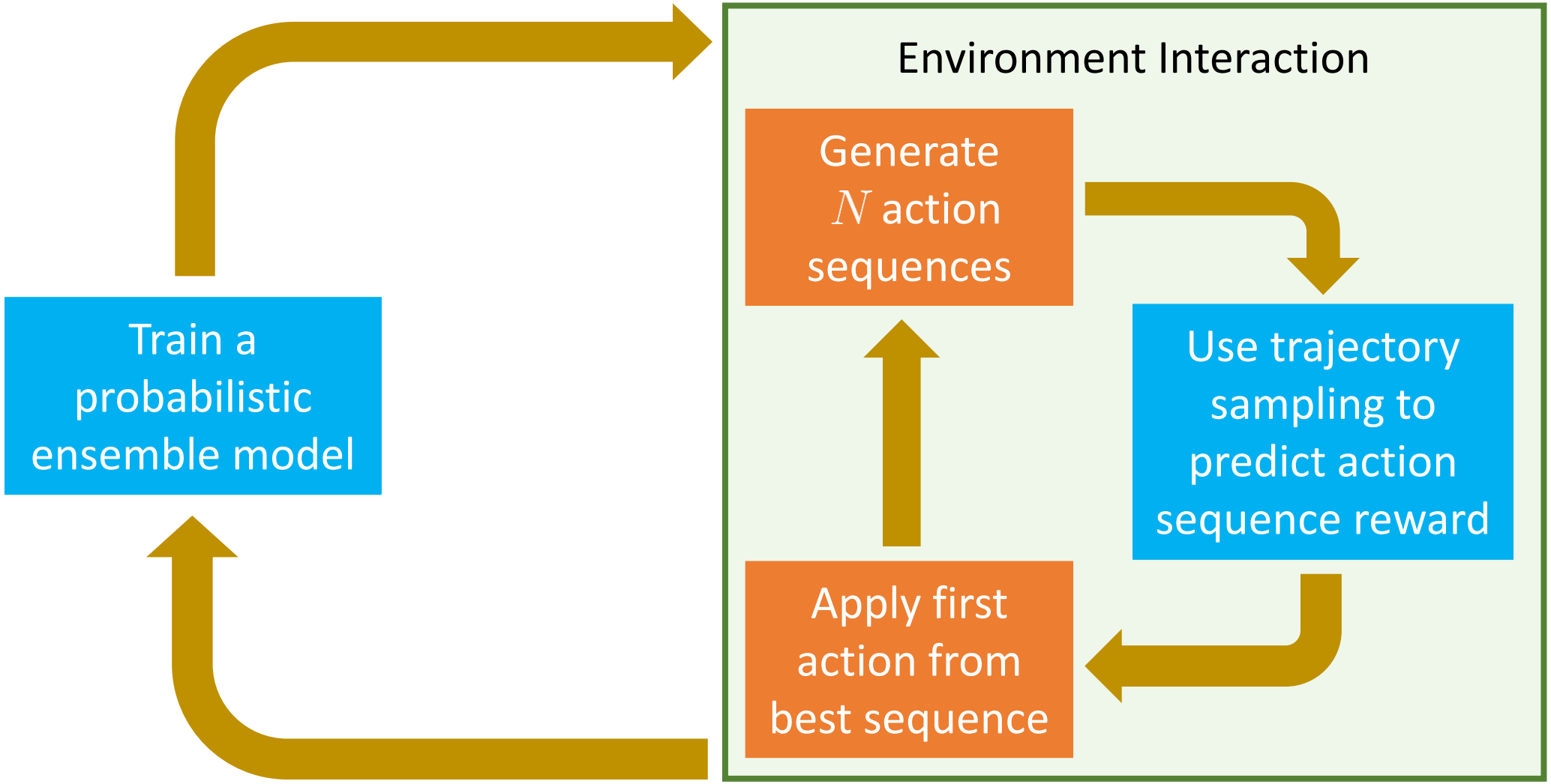
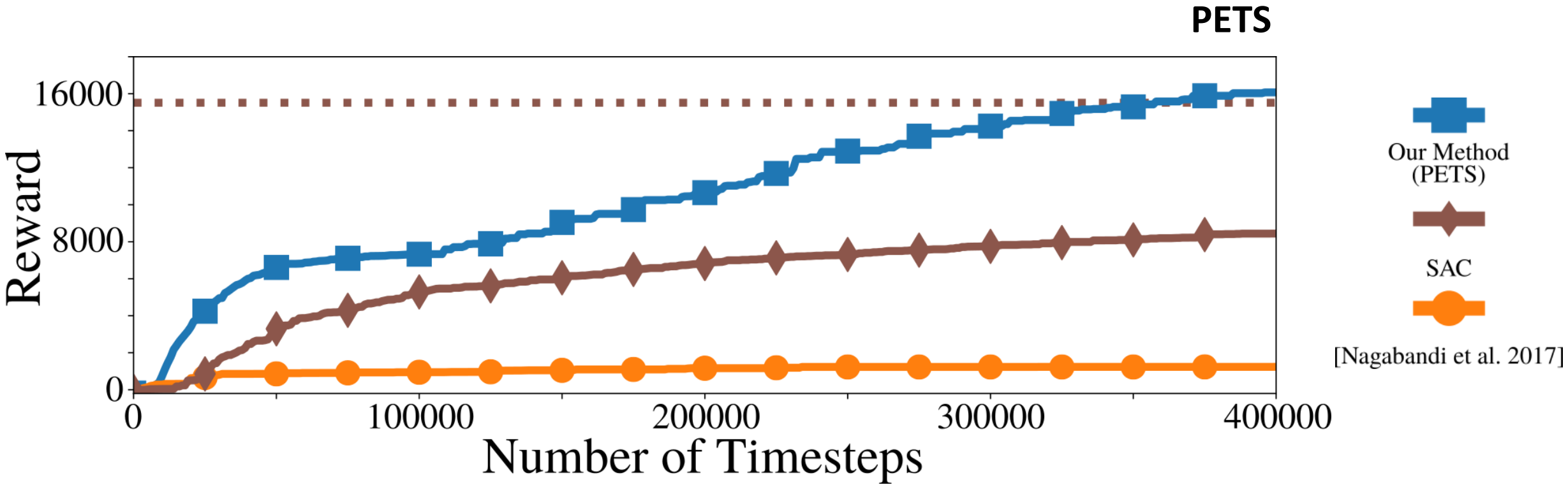


Our Method: Probabilistic Ensembles with Trajectory Sampling (PETS)



Experimental Results



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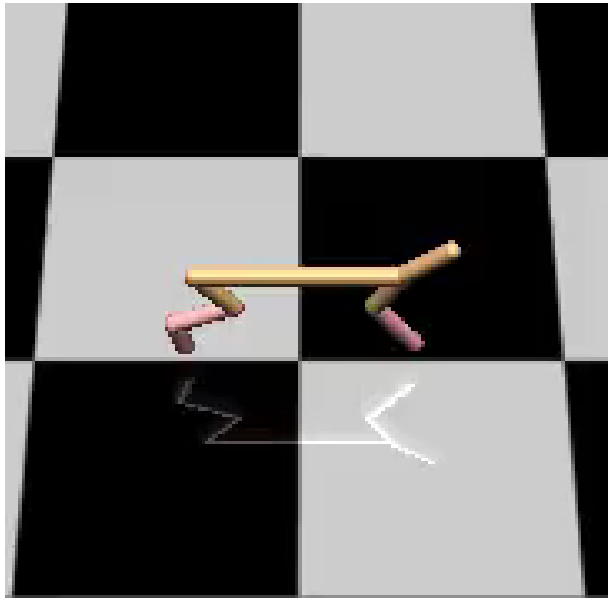
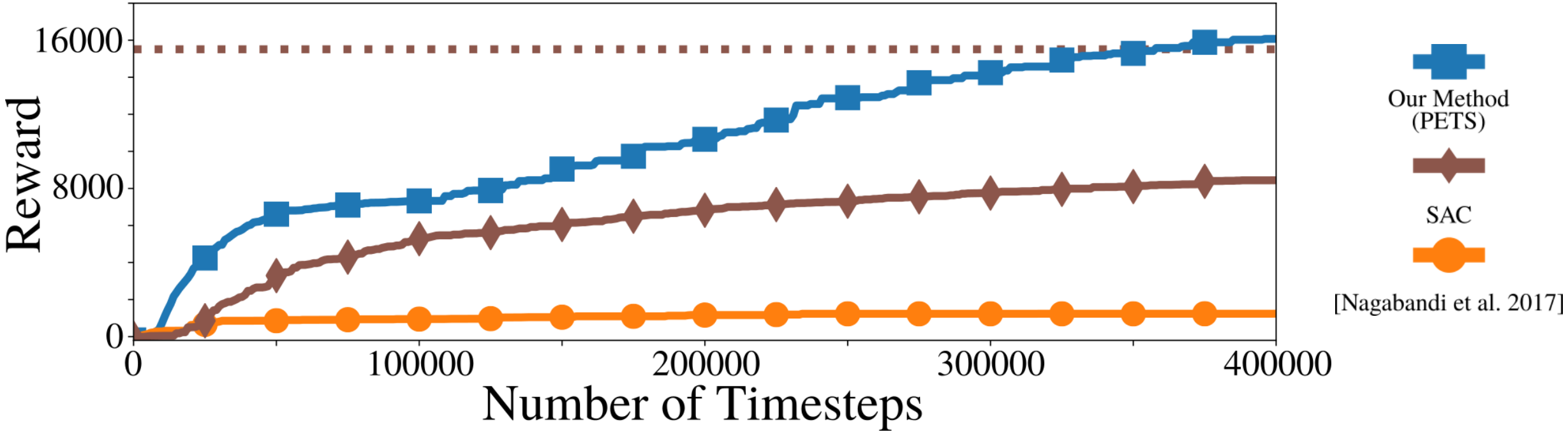


PETS



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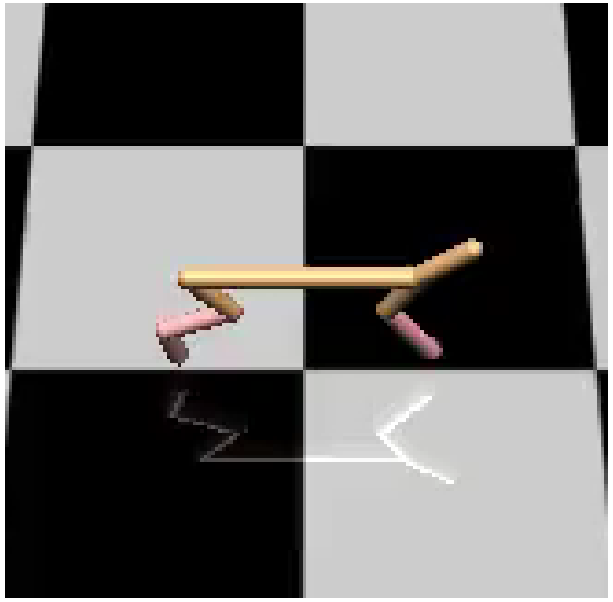

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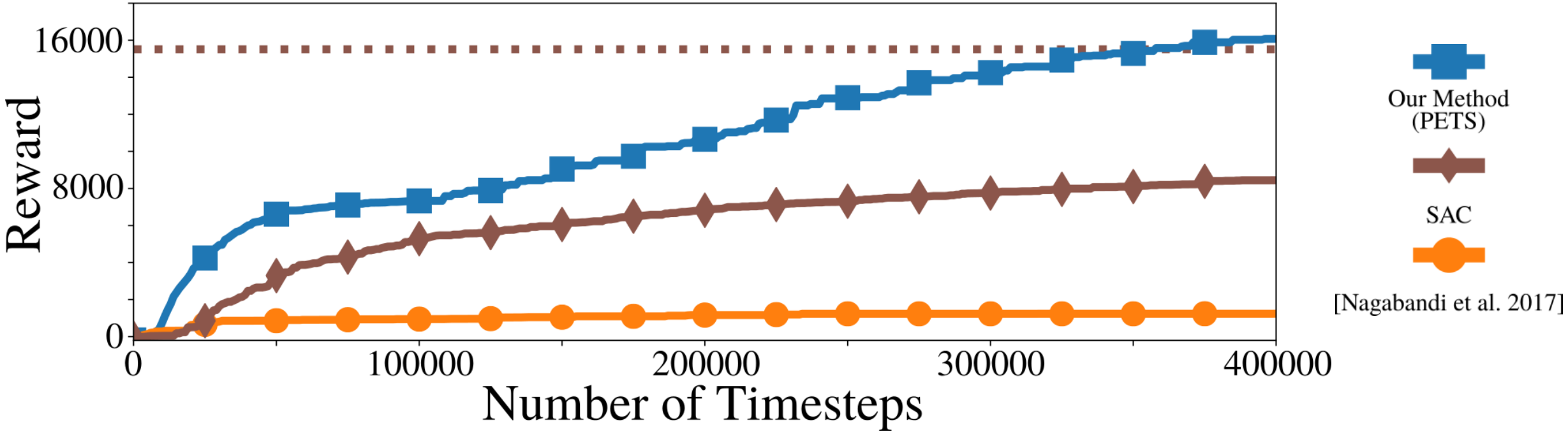

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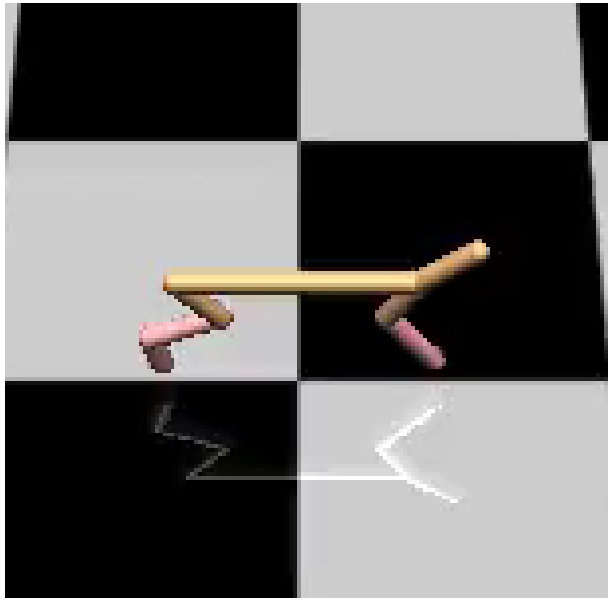

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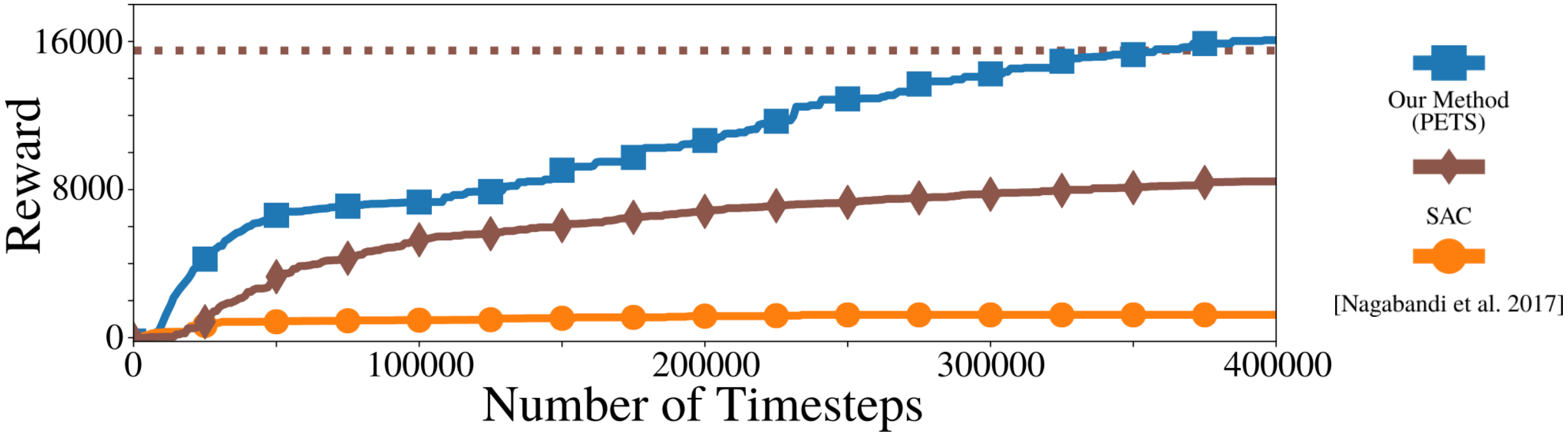

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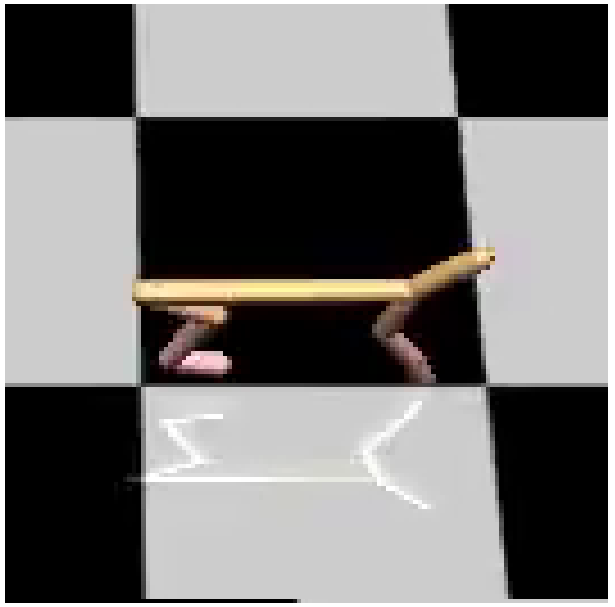
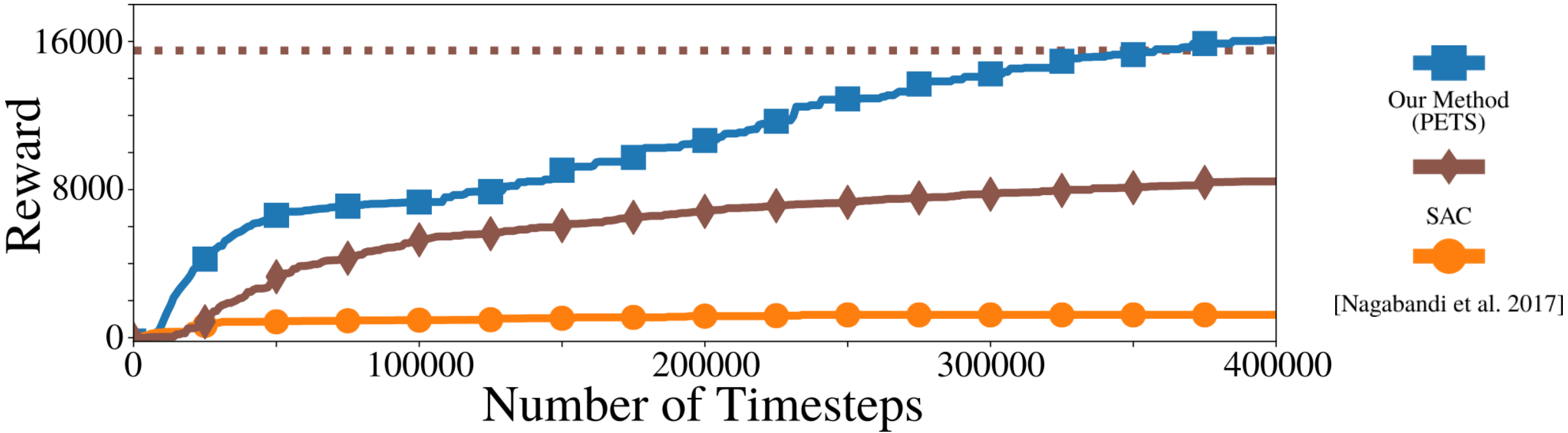


PETS



Why use PETS?

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- ✓Data efficiency

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- ✓Data efficiency
- ✓Competitive asymptotic performance

Why use PETS?

- ✓Data efficiency
- ✓Competitive asymptotic performance
- ✓Ease of implementation

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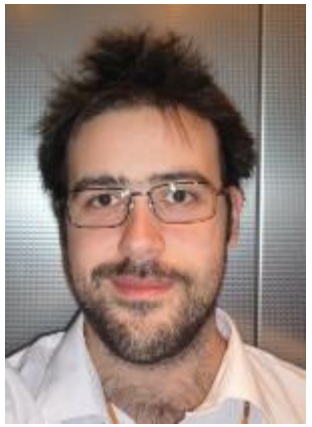
Code: https://github.com/kchua/handful-of-trials
Website: https://sites.google.com/view/drl-in-a-handful-of-trials
Paper: https://arxiv.org/abs/1805.12114


Kurtland Chua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Sergey Levine