Project Website

Discrete Codebook World Models for Continuous Control

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Aalto University

World Models

$$p(s_{t+1}, r_t \mid s_t, a_t)$$

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$$p(\boxed{s_{t+1}}, r_t \mid s_t, a_t)$$

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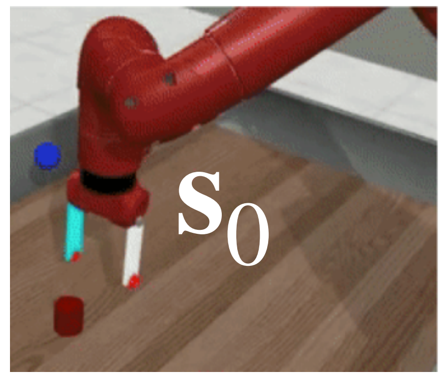

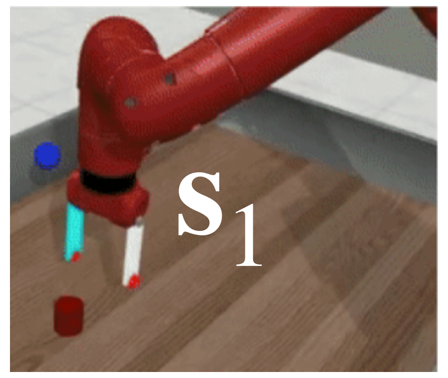

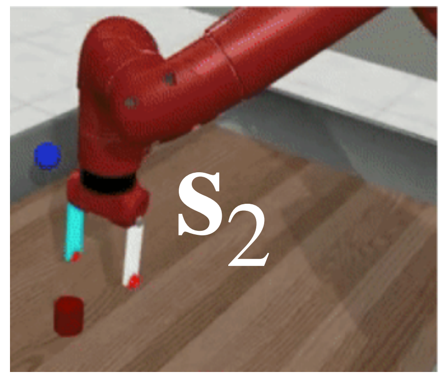

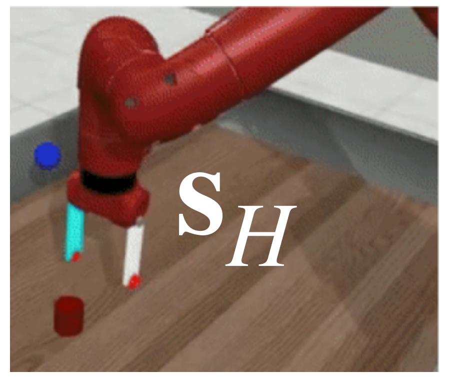

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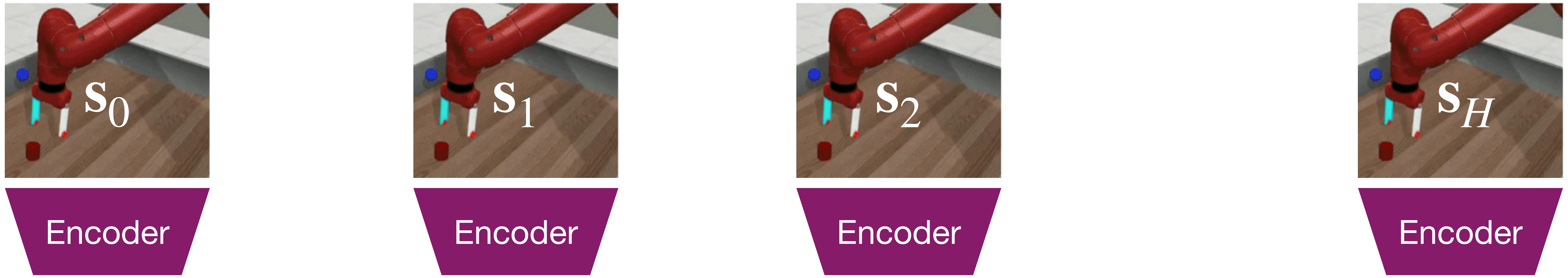

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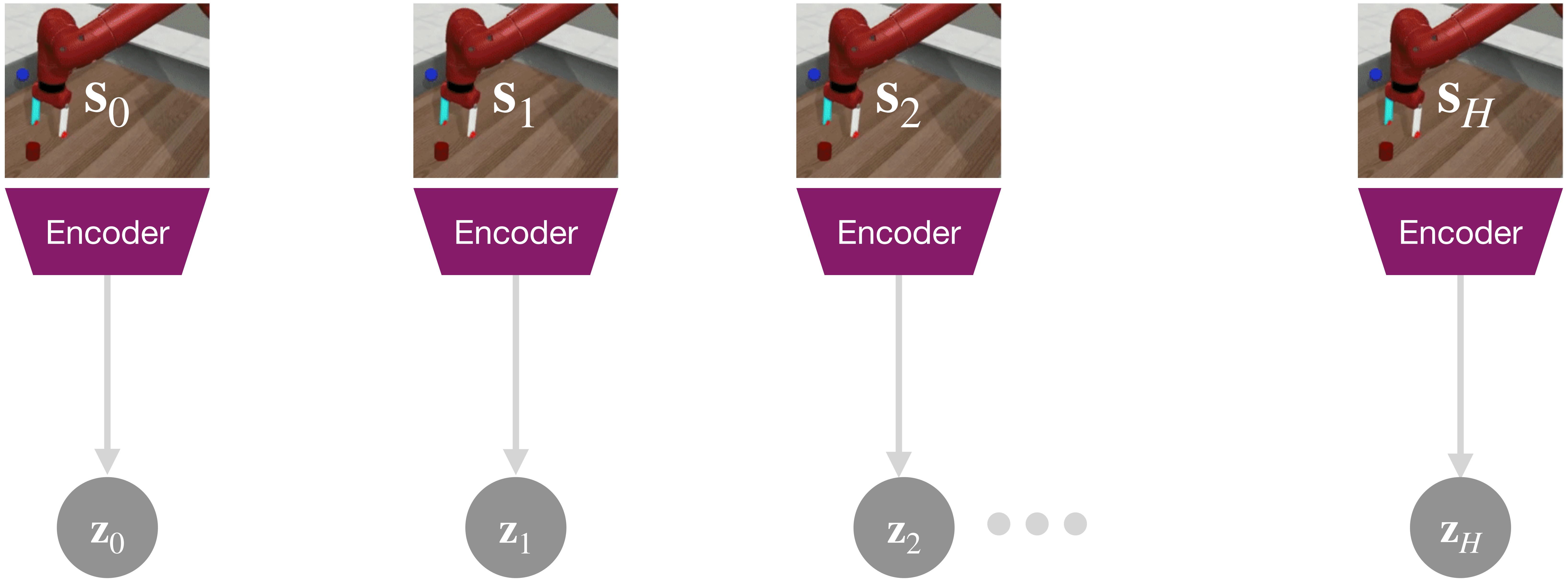

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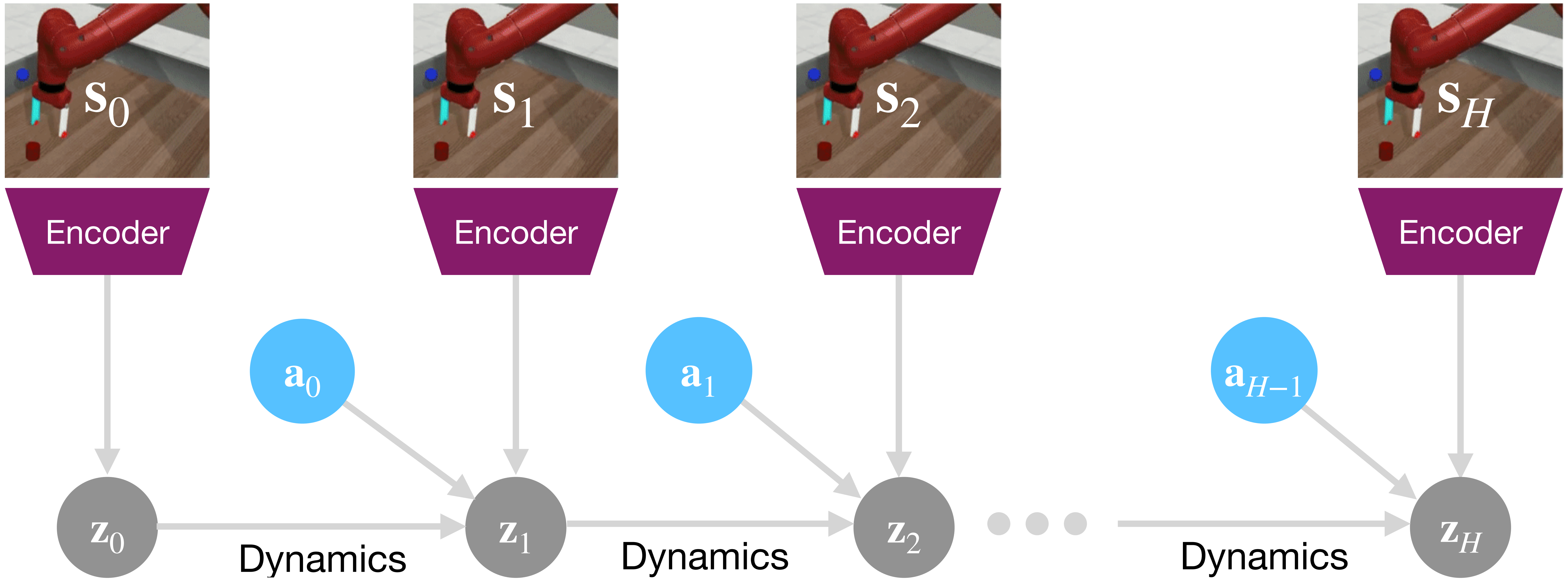

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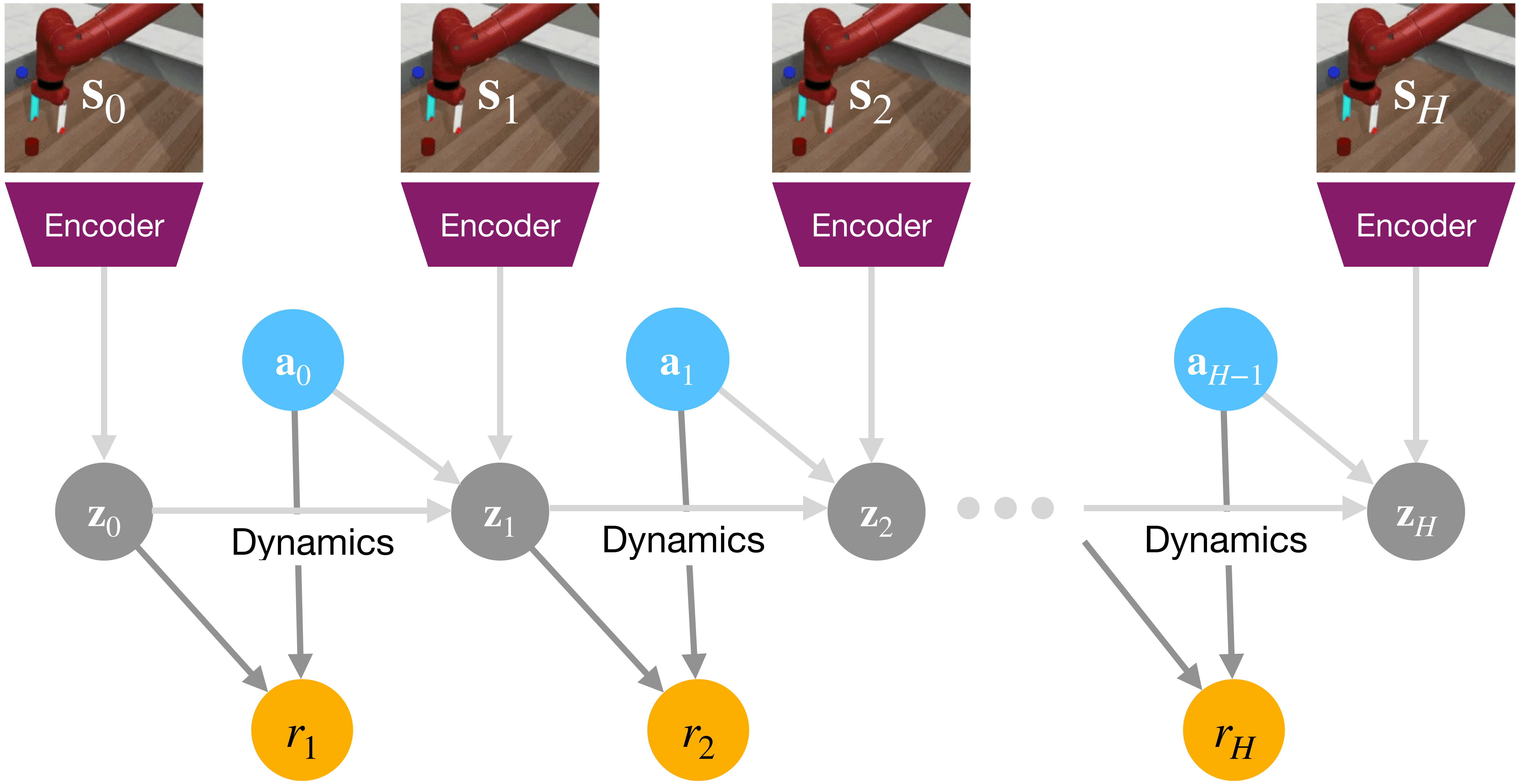

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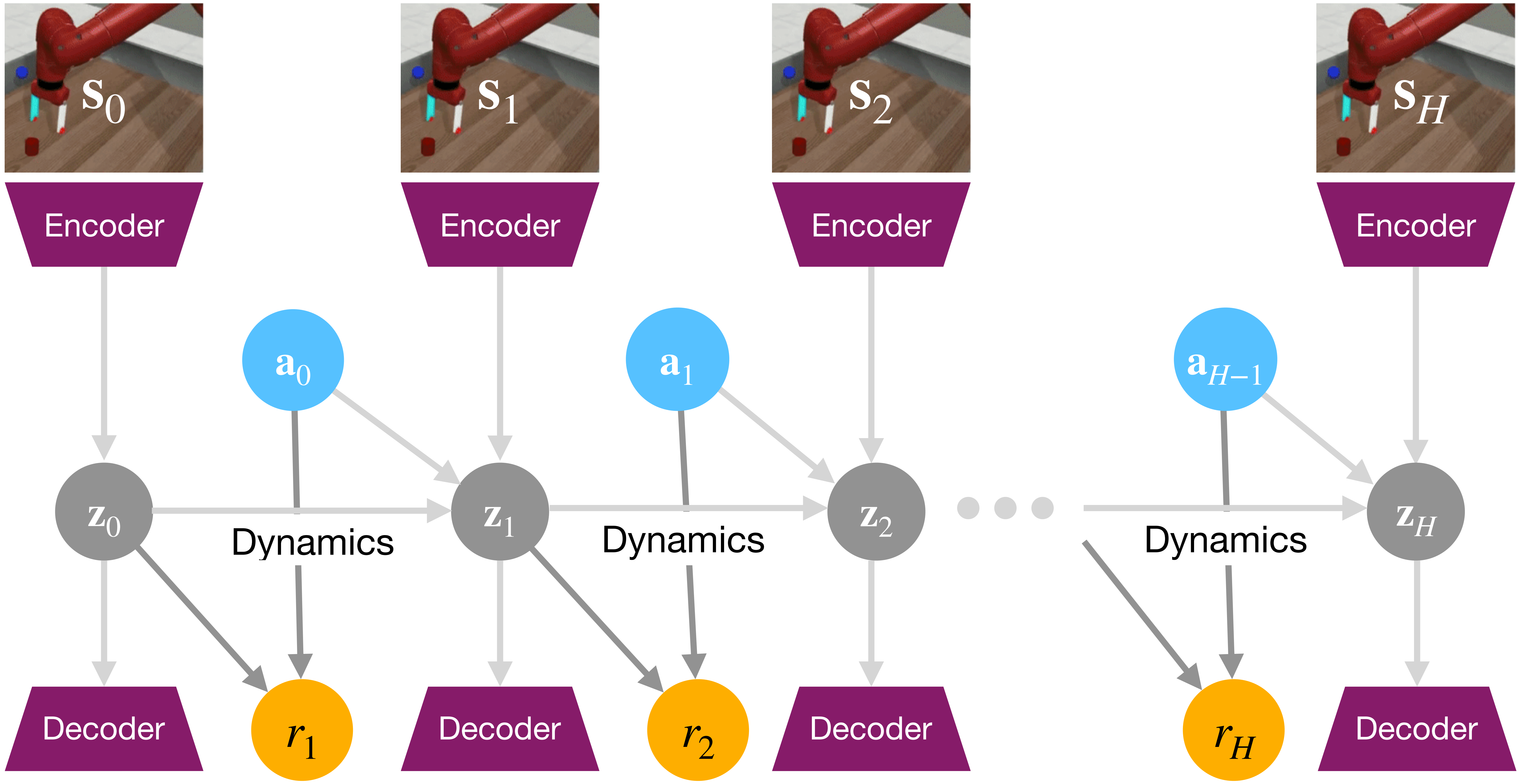

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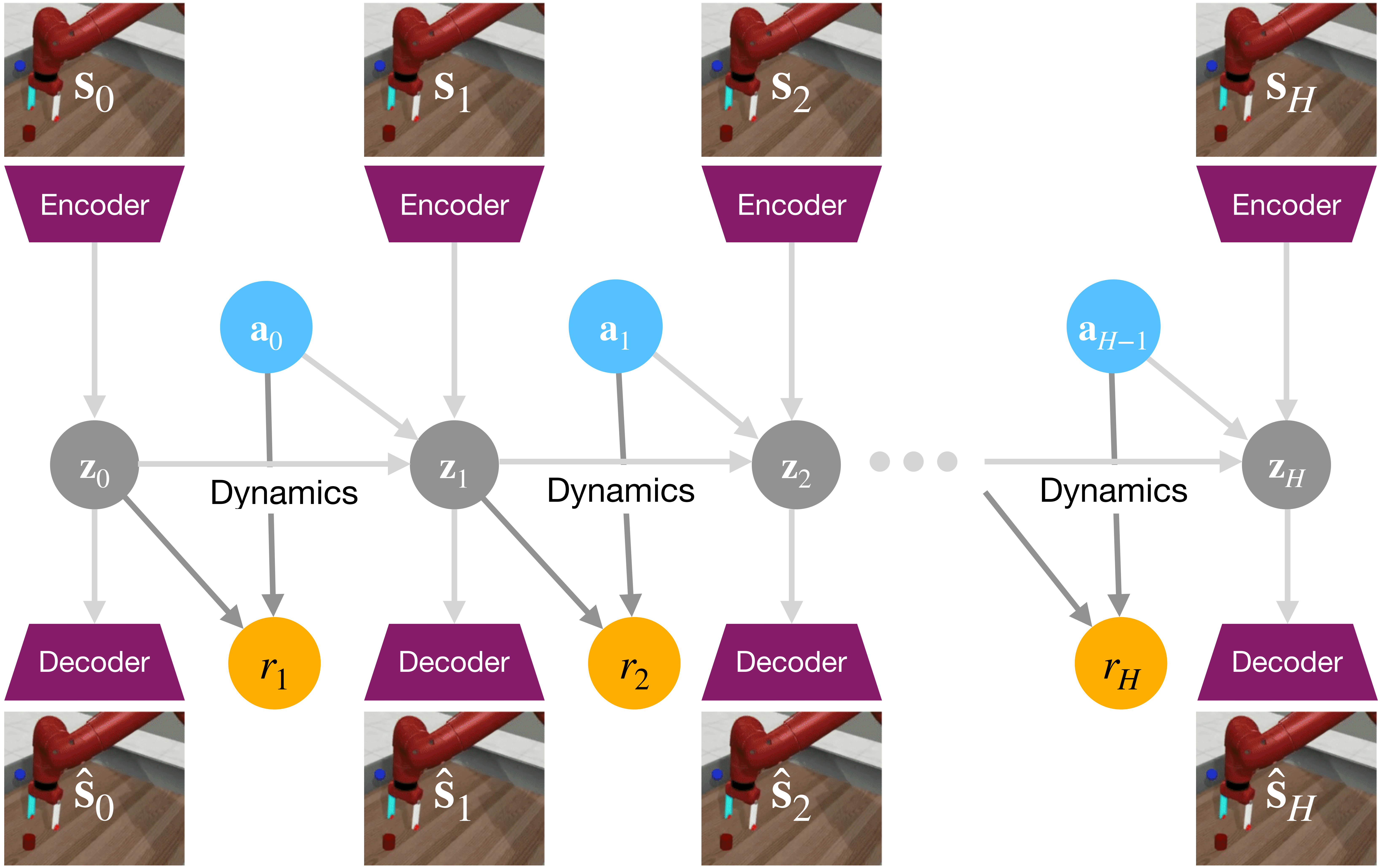

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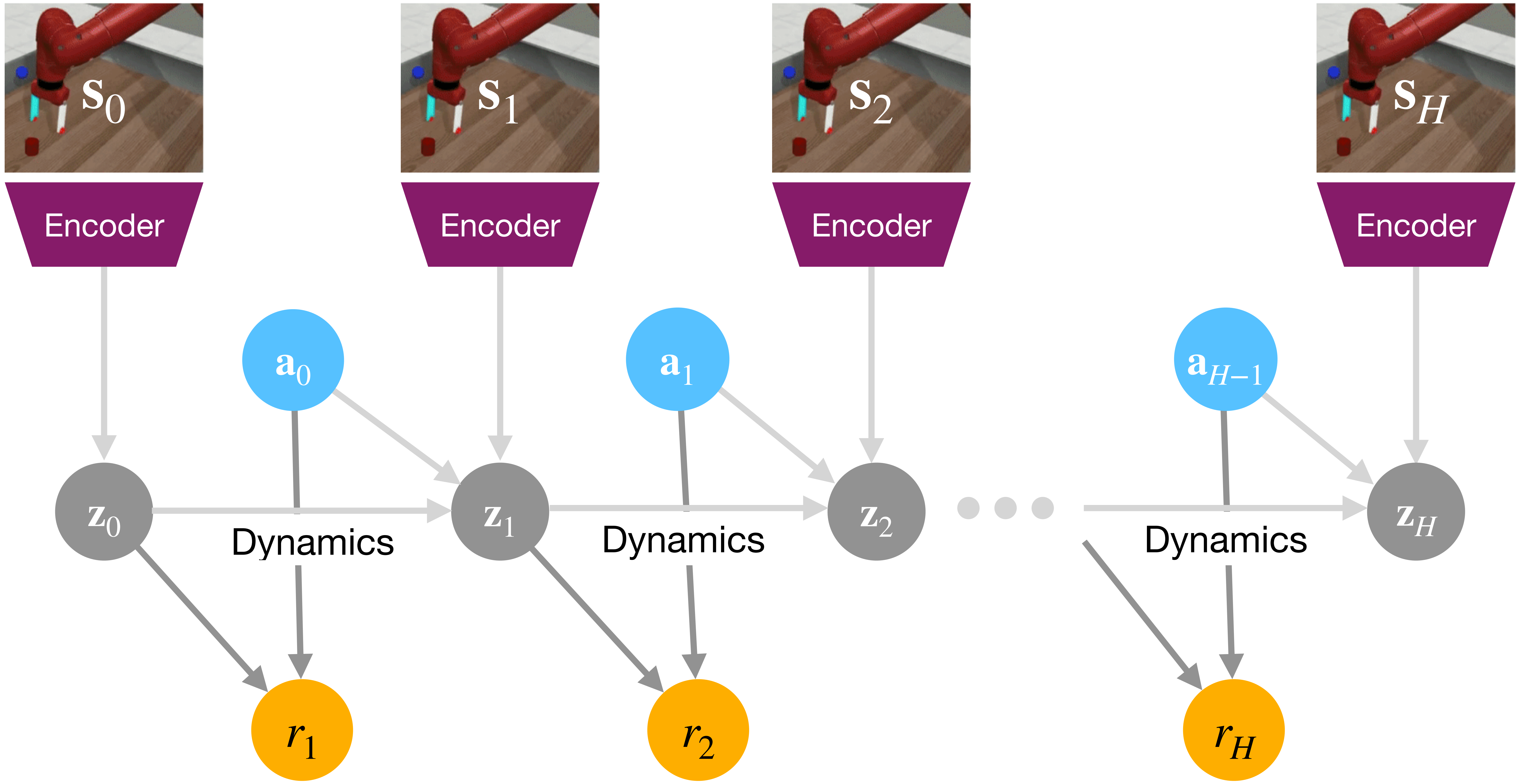

Latent Space Design Choices

Latent Space Design Choices

	Discrete Latent States?	Discrete Encoding Type	Stochastic Dynamics?	Reconstruction?
DreamerV3	✅	One-hot	✅	✅
TD-MPC2	❌	N/A	❌	❌

Danijar Hafner, et al. Mastering diverse domains through world models. arXiv preprint arXiv:2301.04104, 2023.

Nicklas Hansen, et al. TD-MPC2: Scalable, Robust World Models for Continuous Control. In The Twelfth International Conference on Learning Representations, October 2023.

Latent Space Design Choices

1. Do discrete latent spaces offer benefits over continuous ones?

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1. Do discrete latent spaces offer benefits over continuous ones?
2. How does the choice of discrete encoding (e.g., one-hot, label, or codebook encodings) affect performance?
3. Are there advantages to modelling the latent dynamics stochastically rather than deterministically?

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DreamerV3	✅	One-hot	✅	✅
TD-MPC2	❌	N/A	❌	❌
DC-MPC (ours)	✅	Codebook	✅	❌

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DC-MPC: World Model Training

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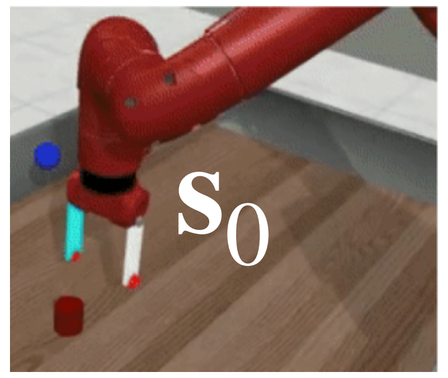

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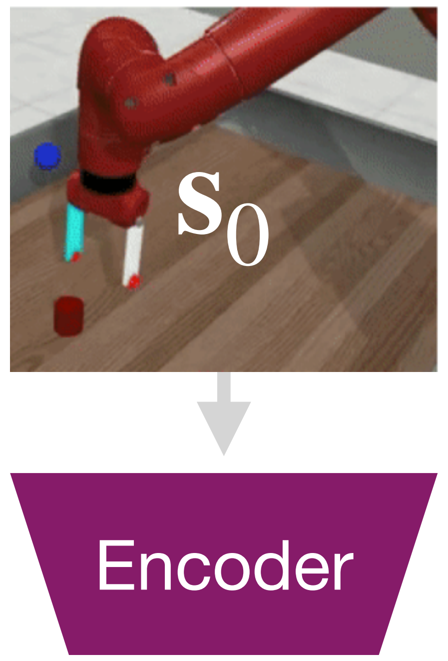

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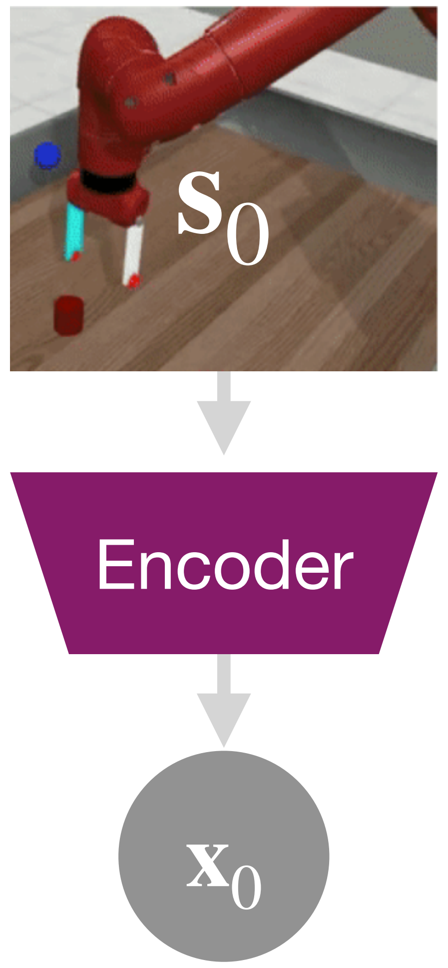

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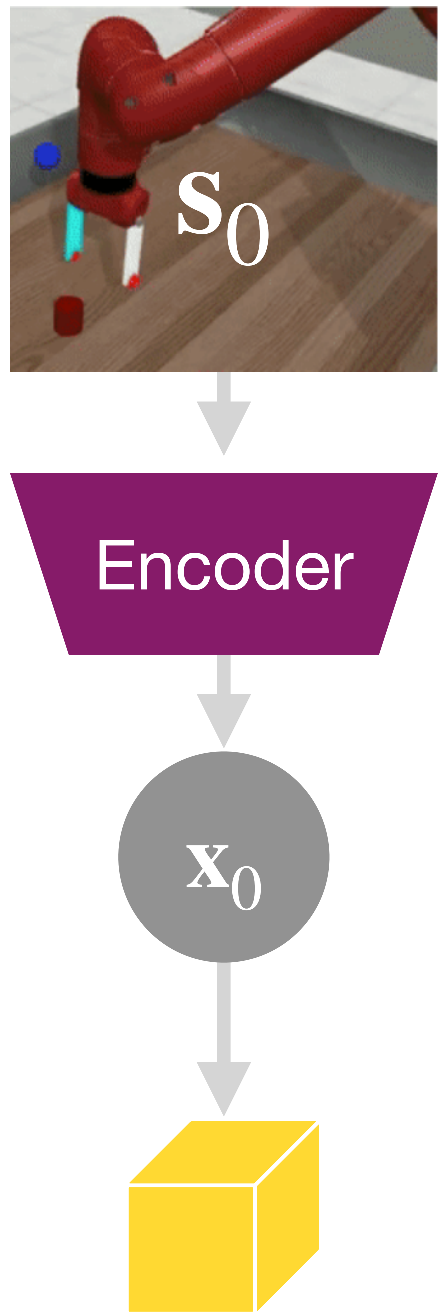

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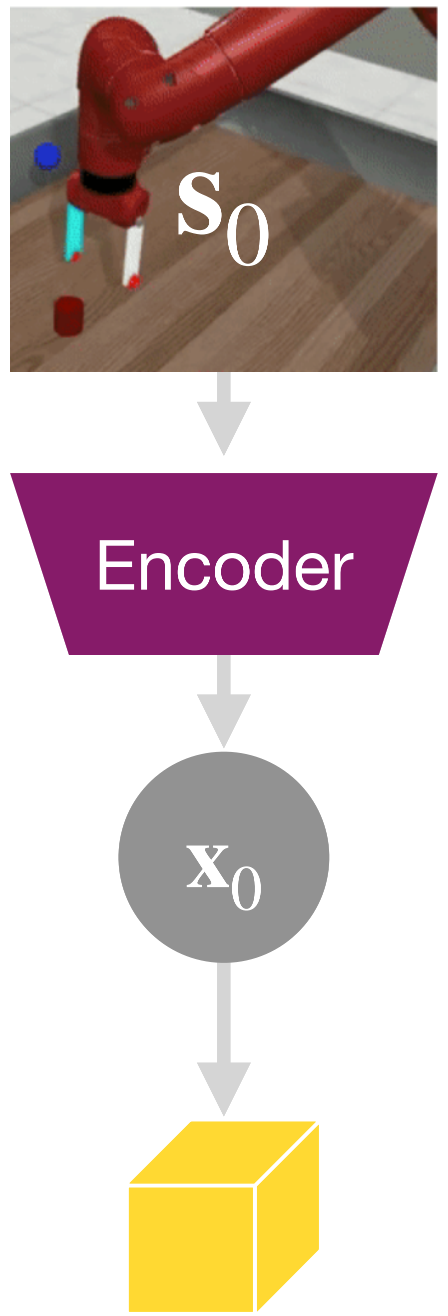

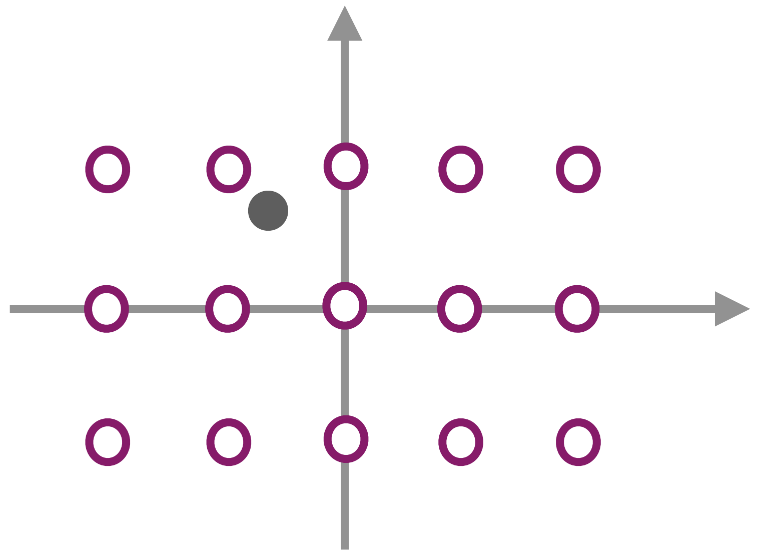

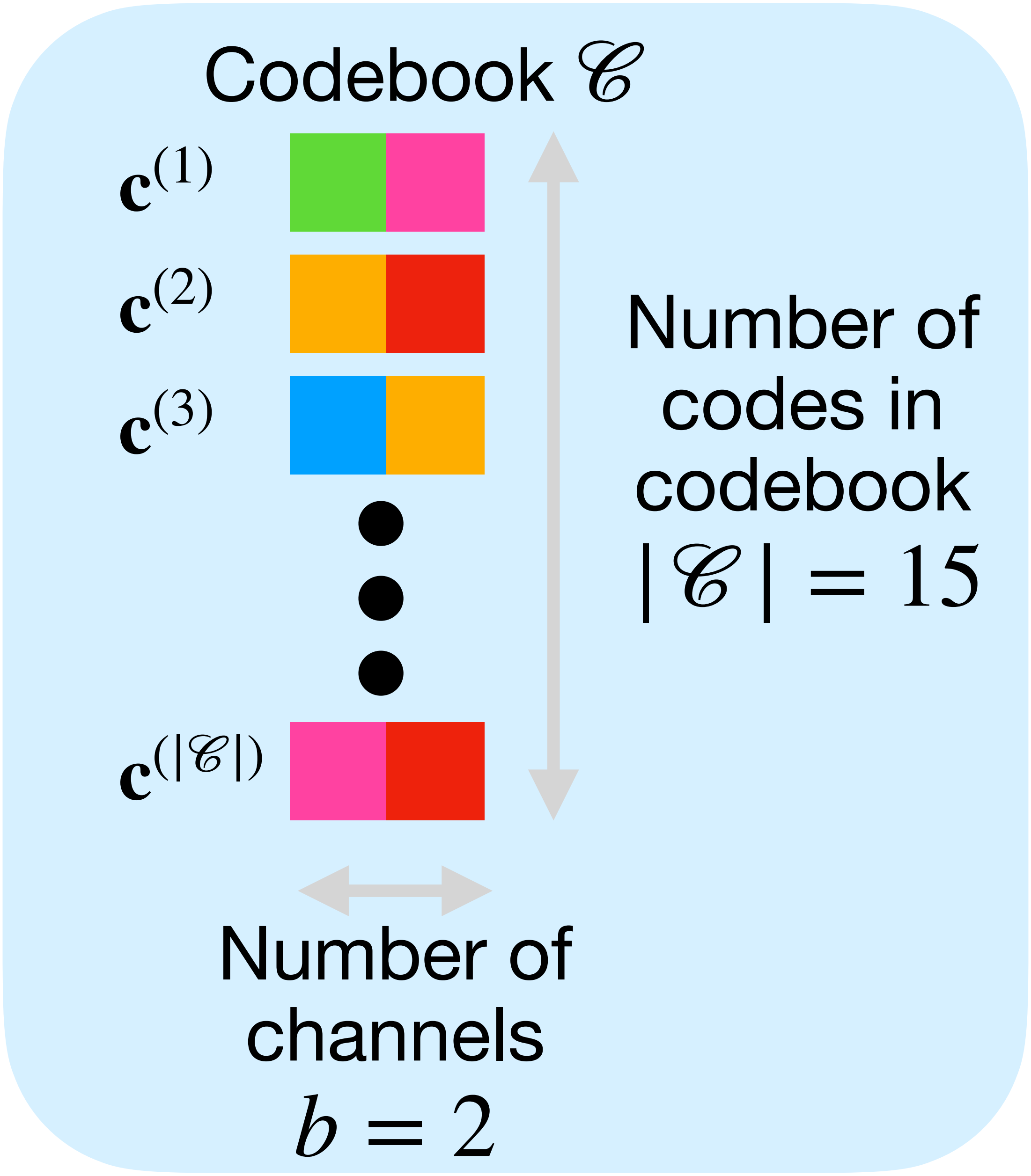

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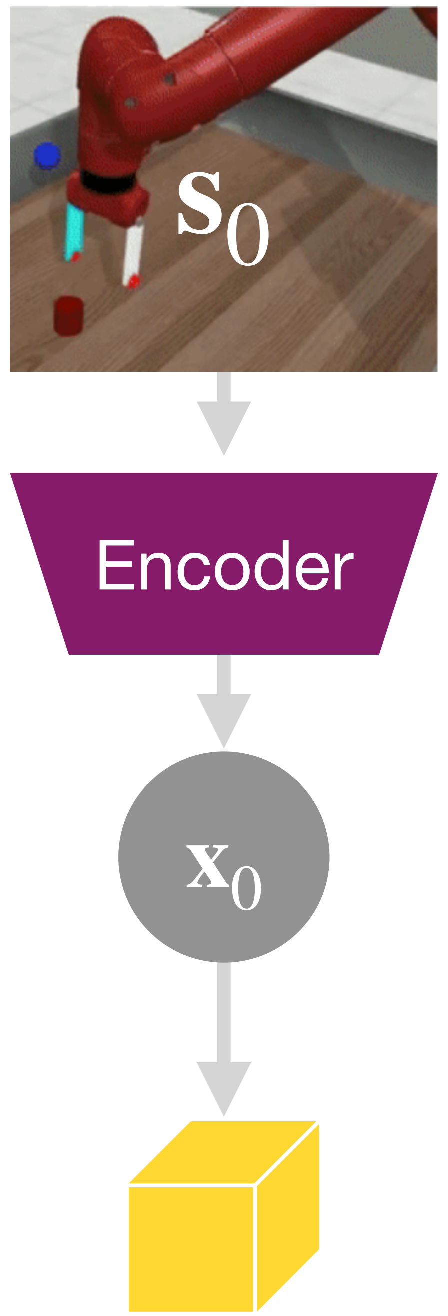

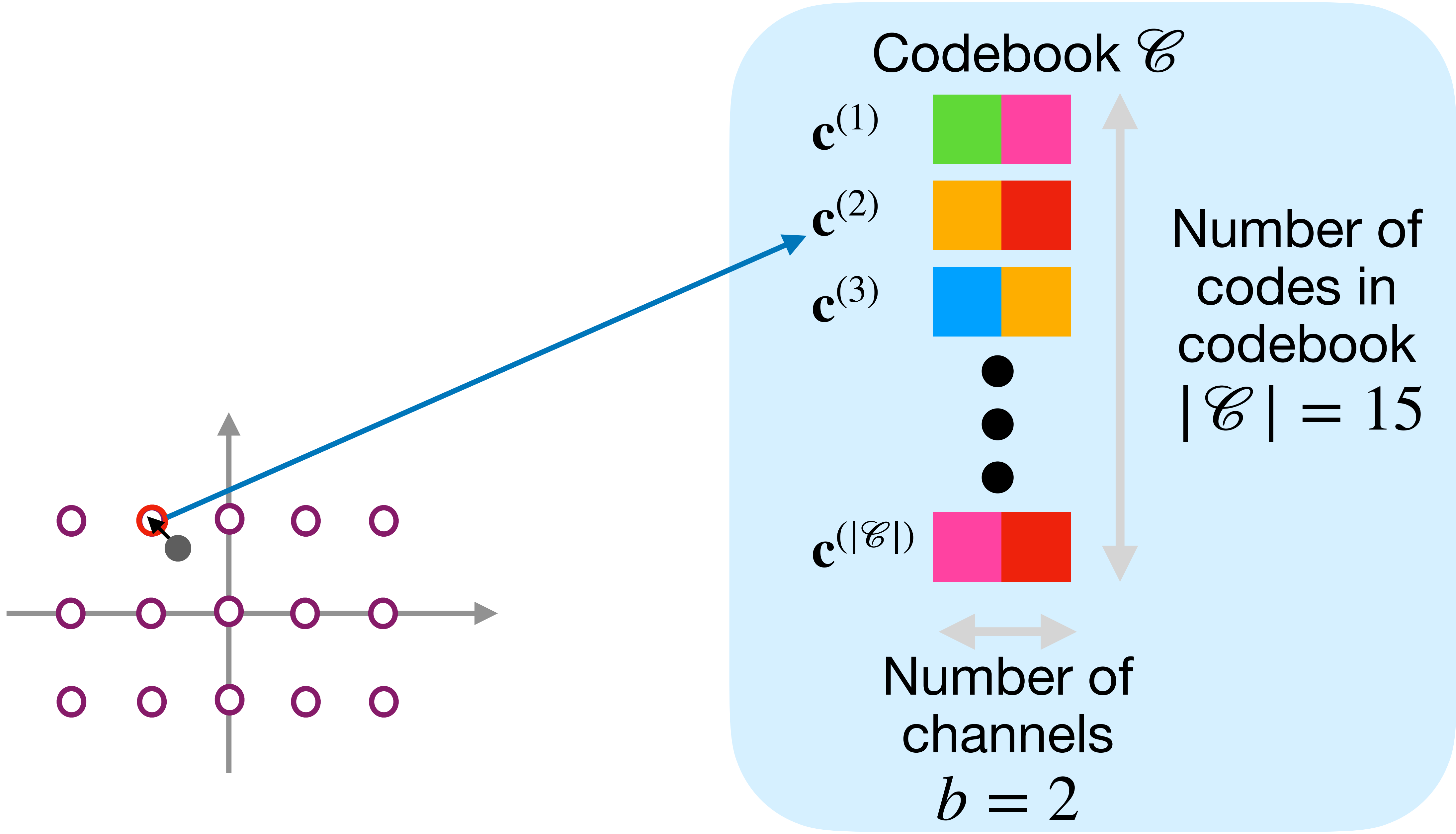

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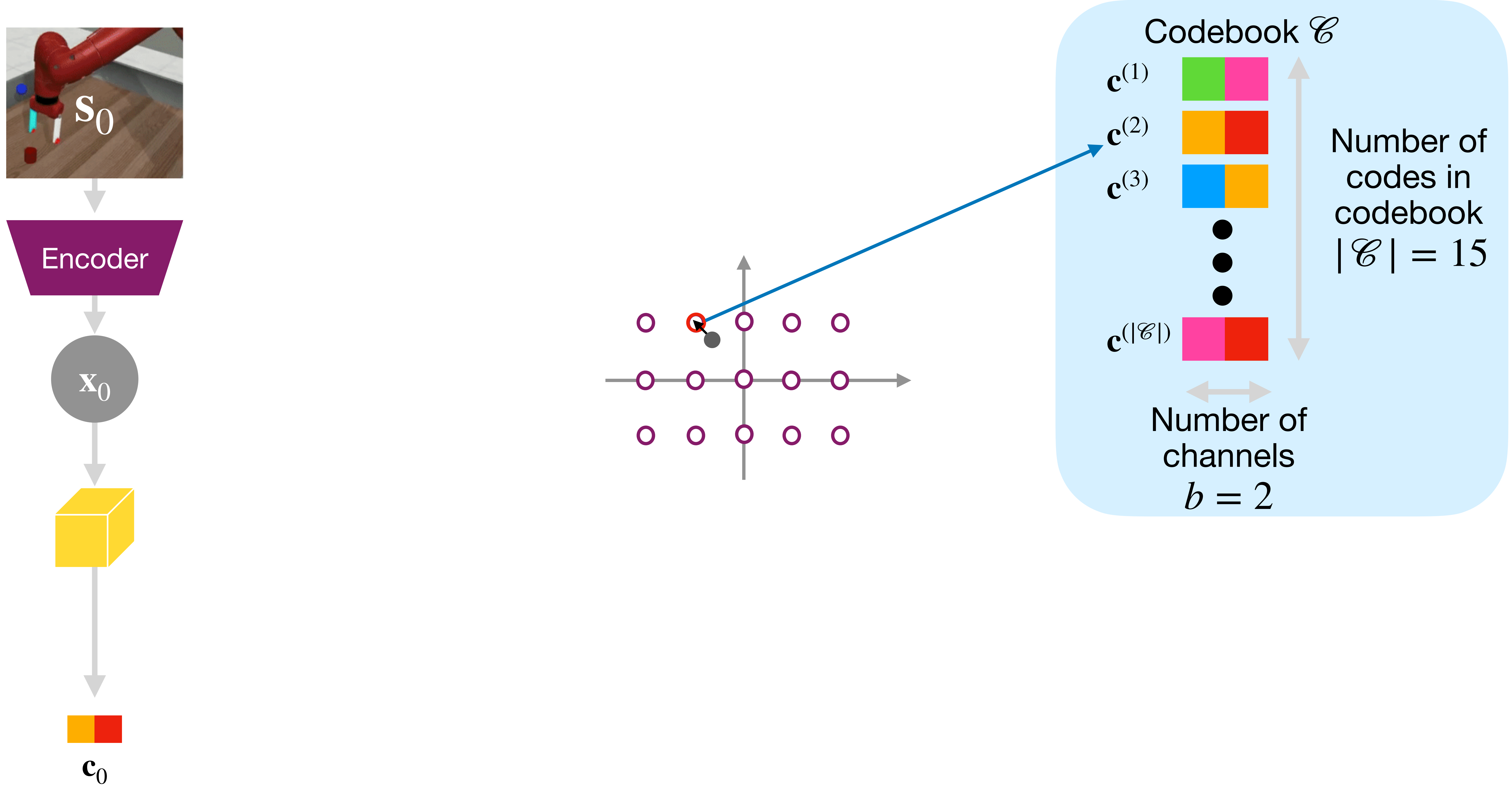

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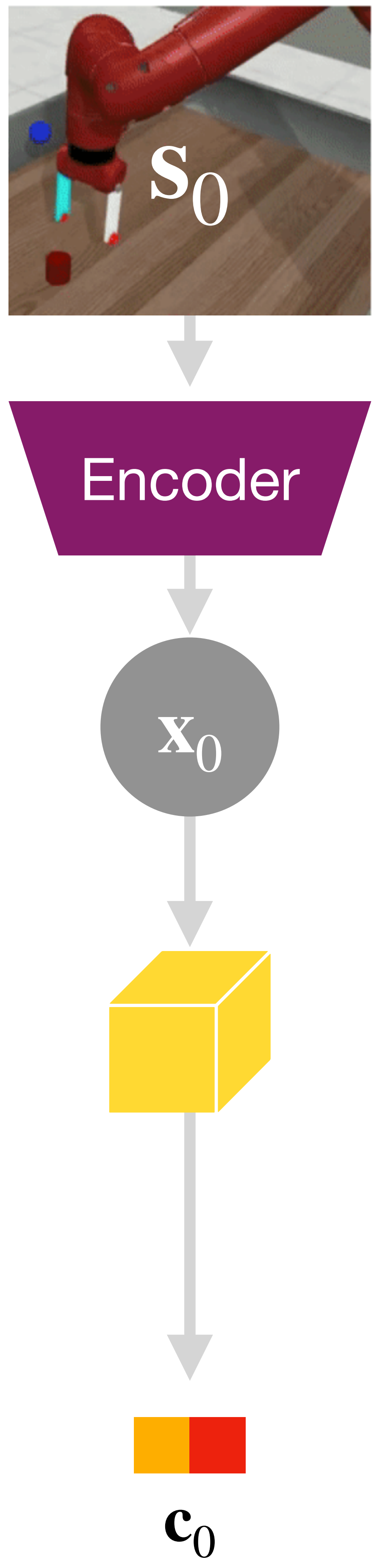

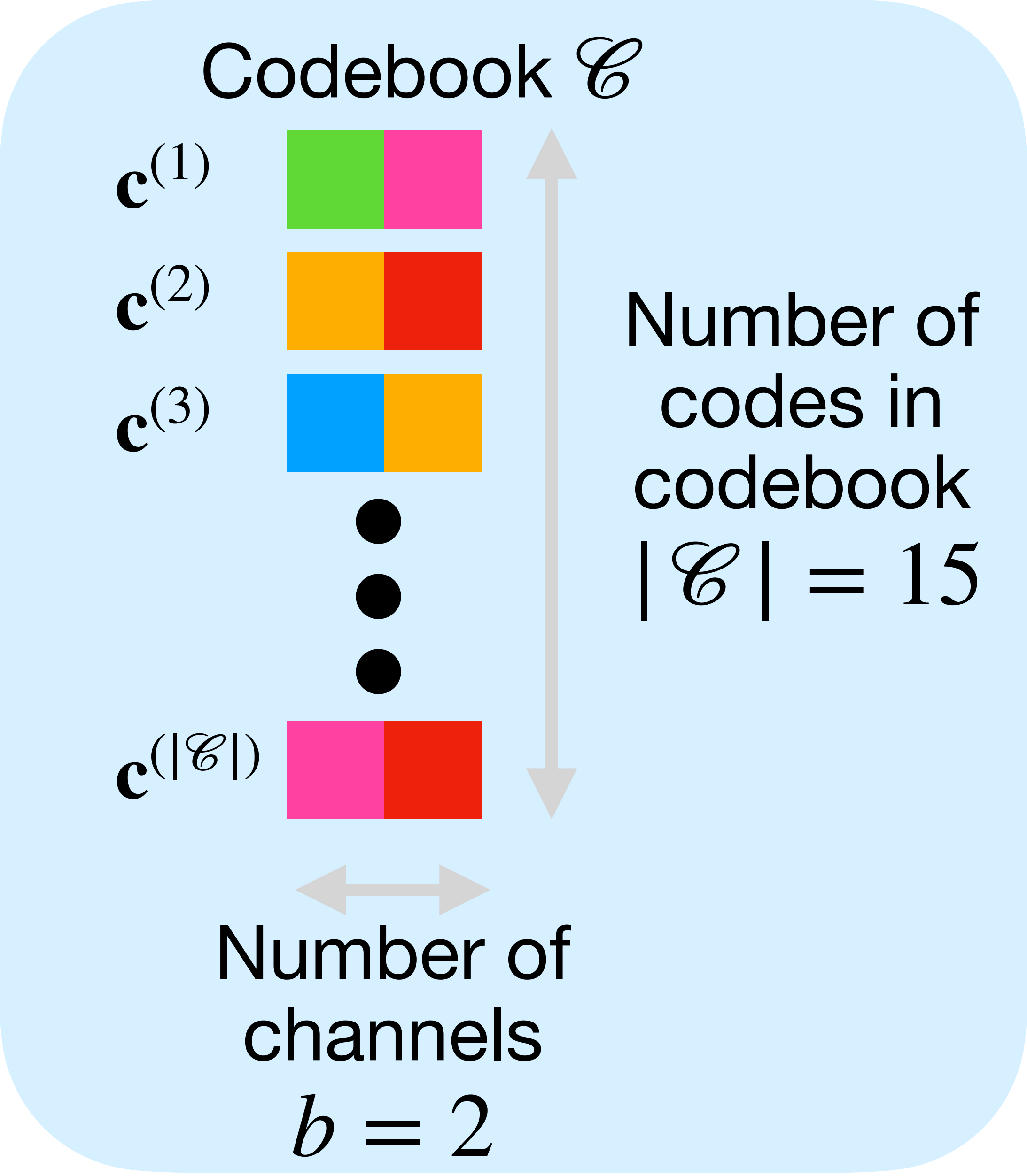

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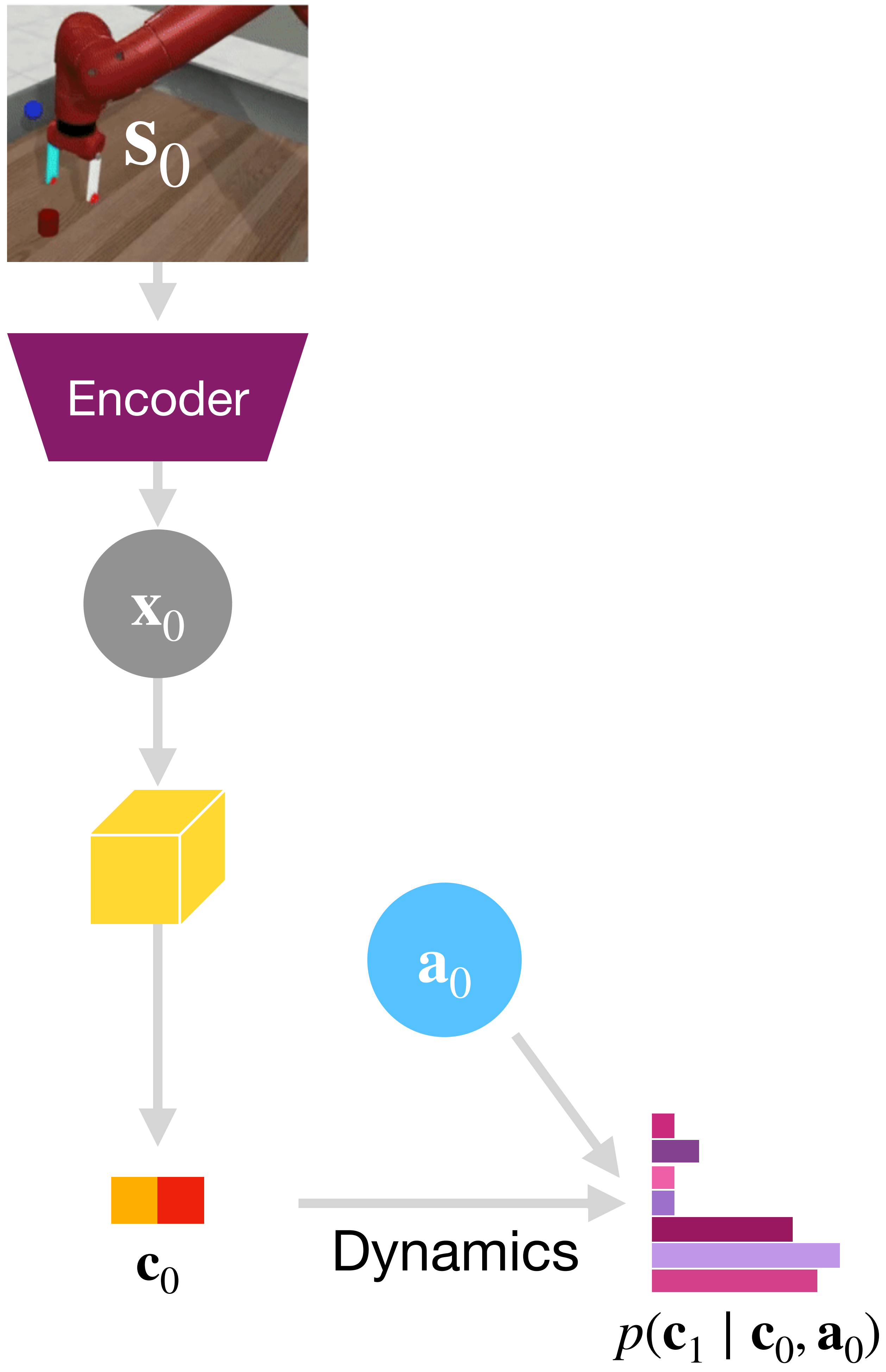

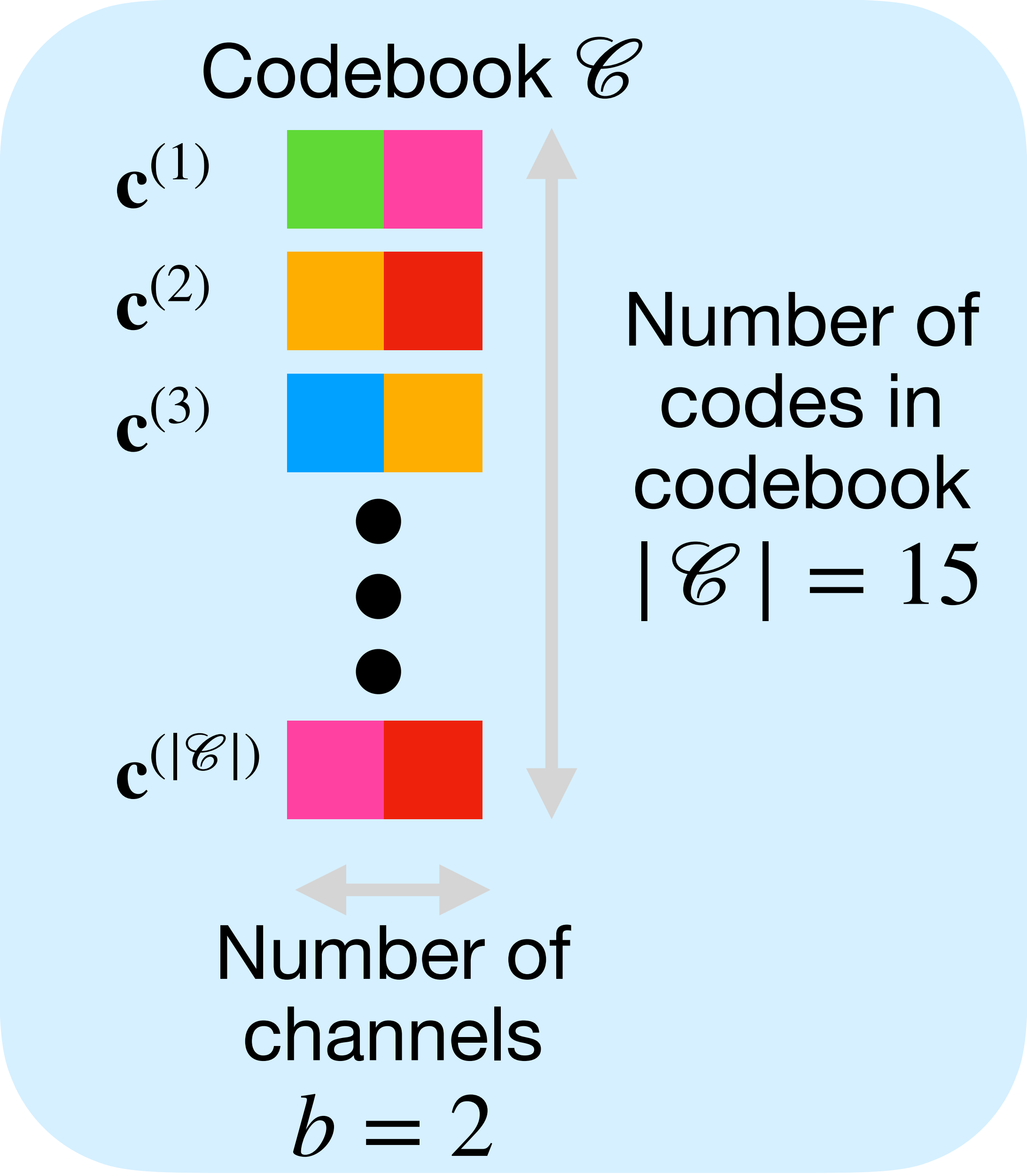

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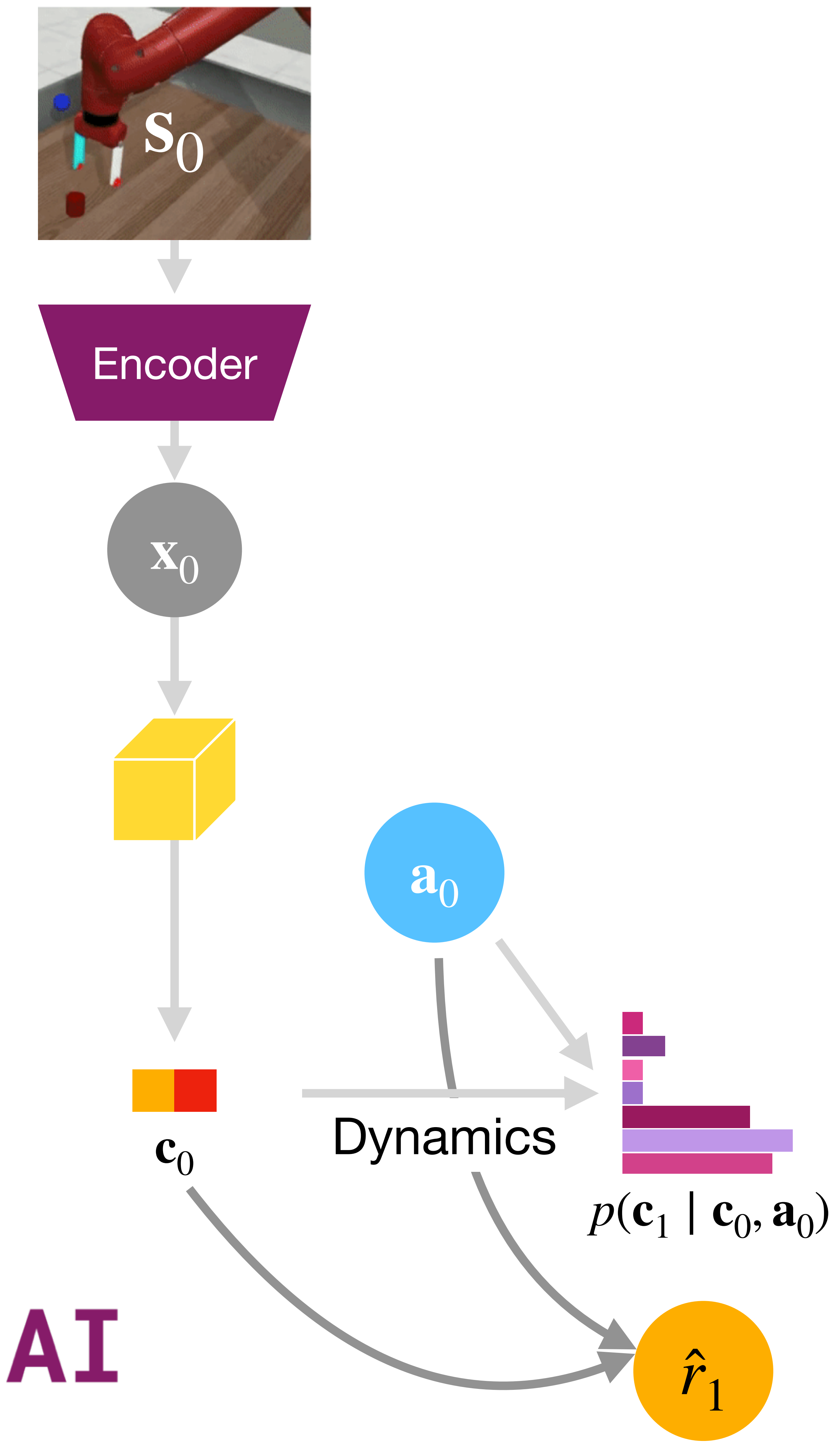

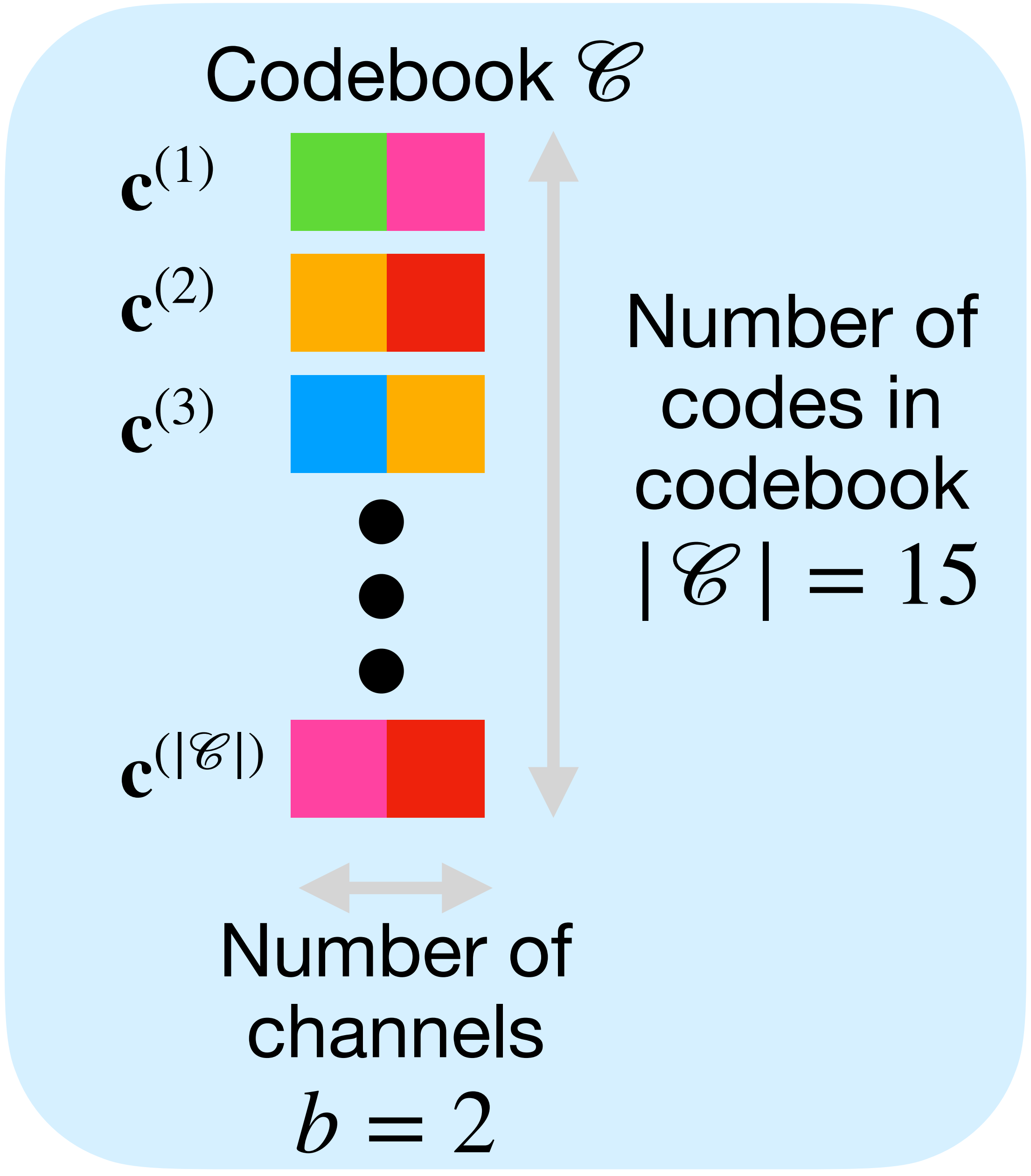

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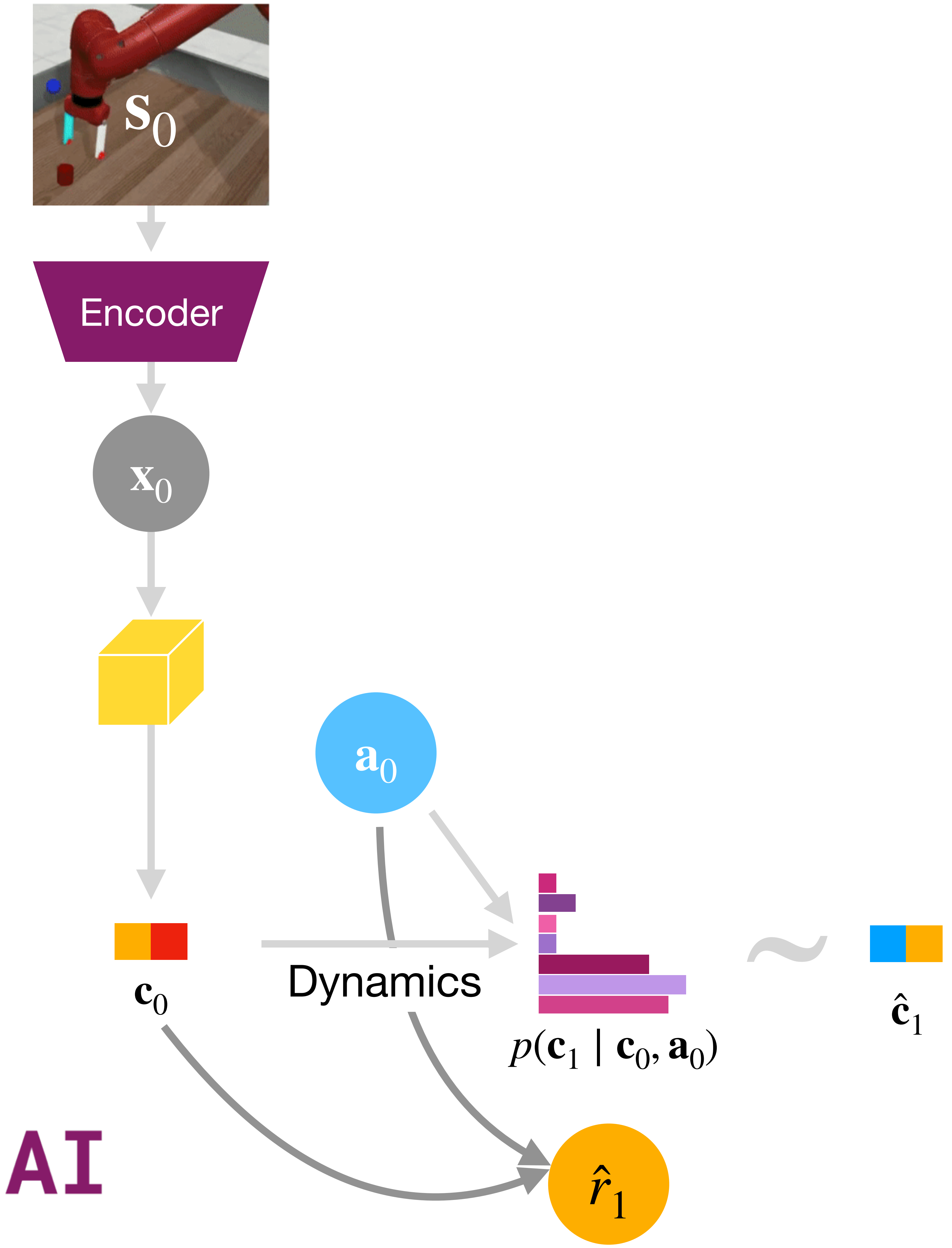

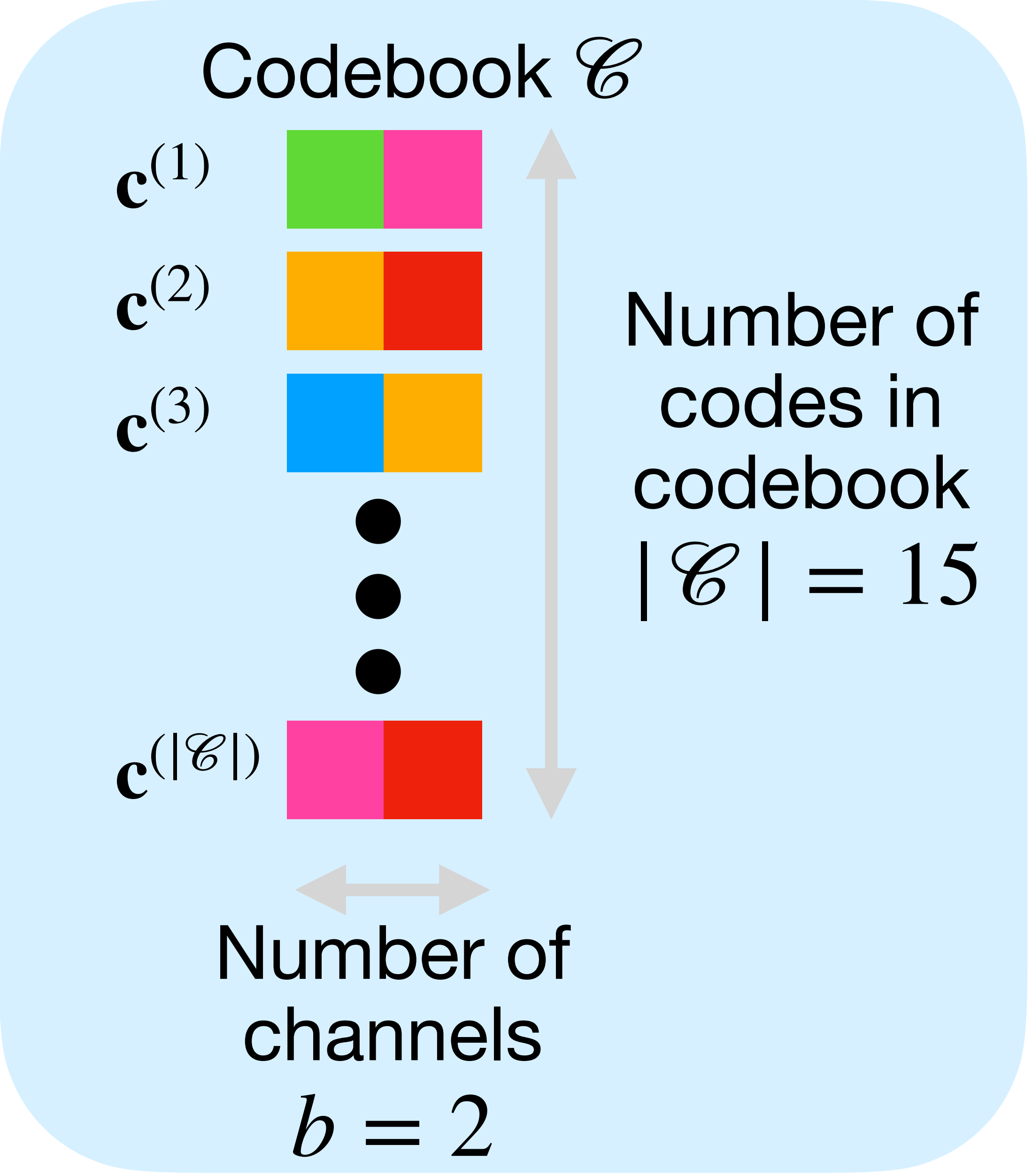

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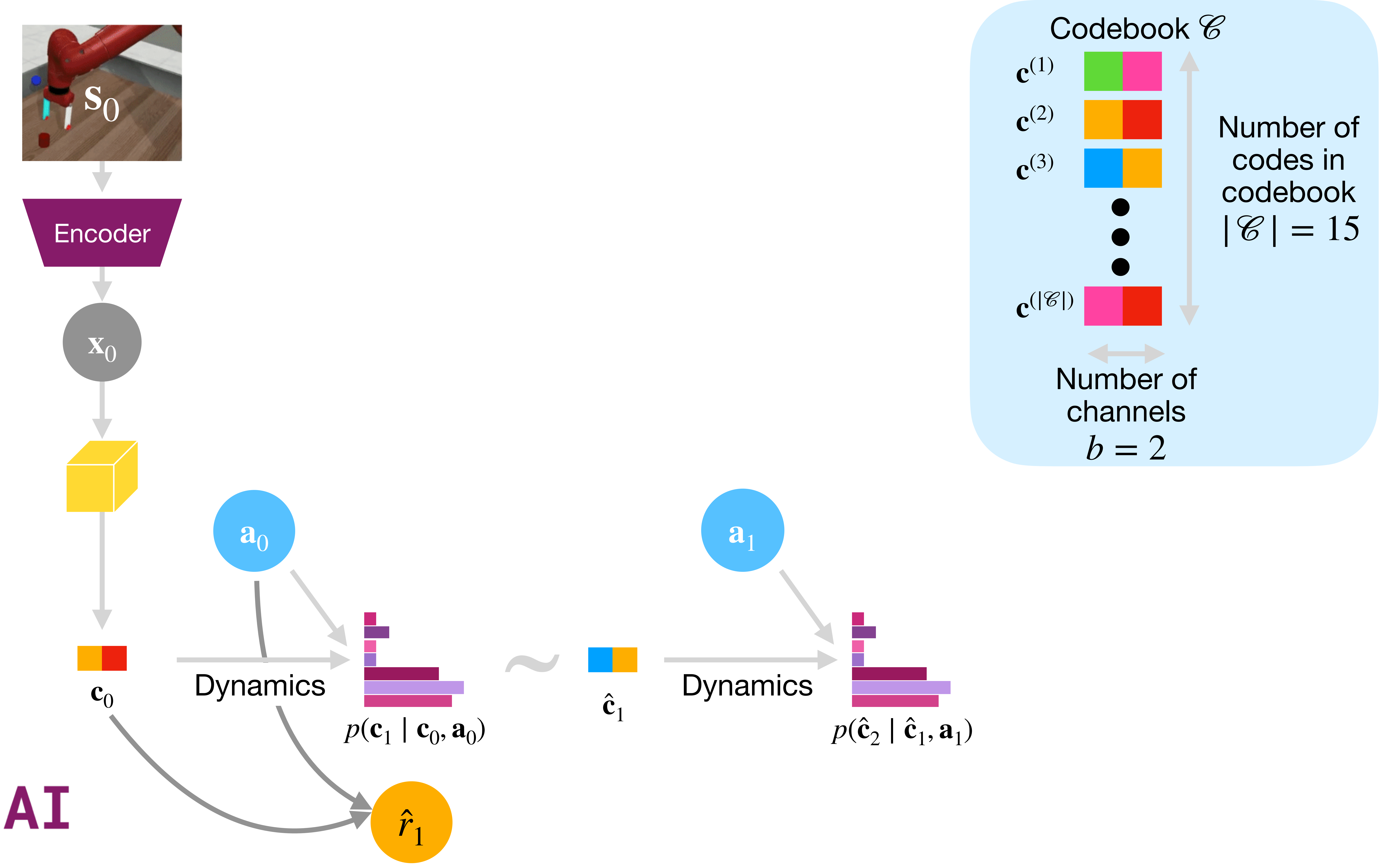

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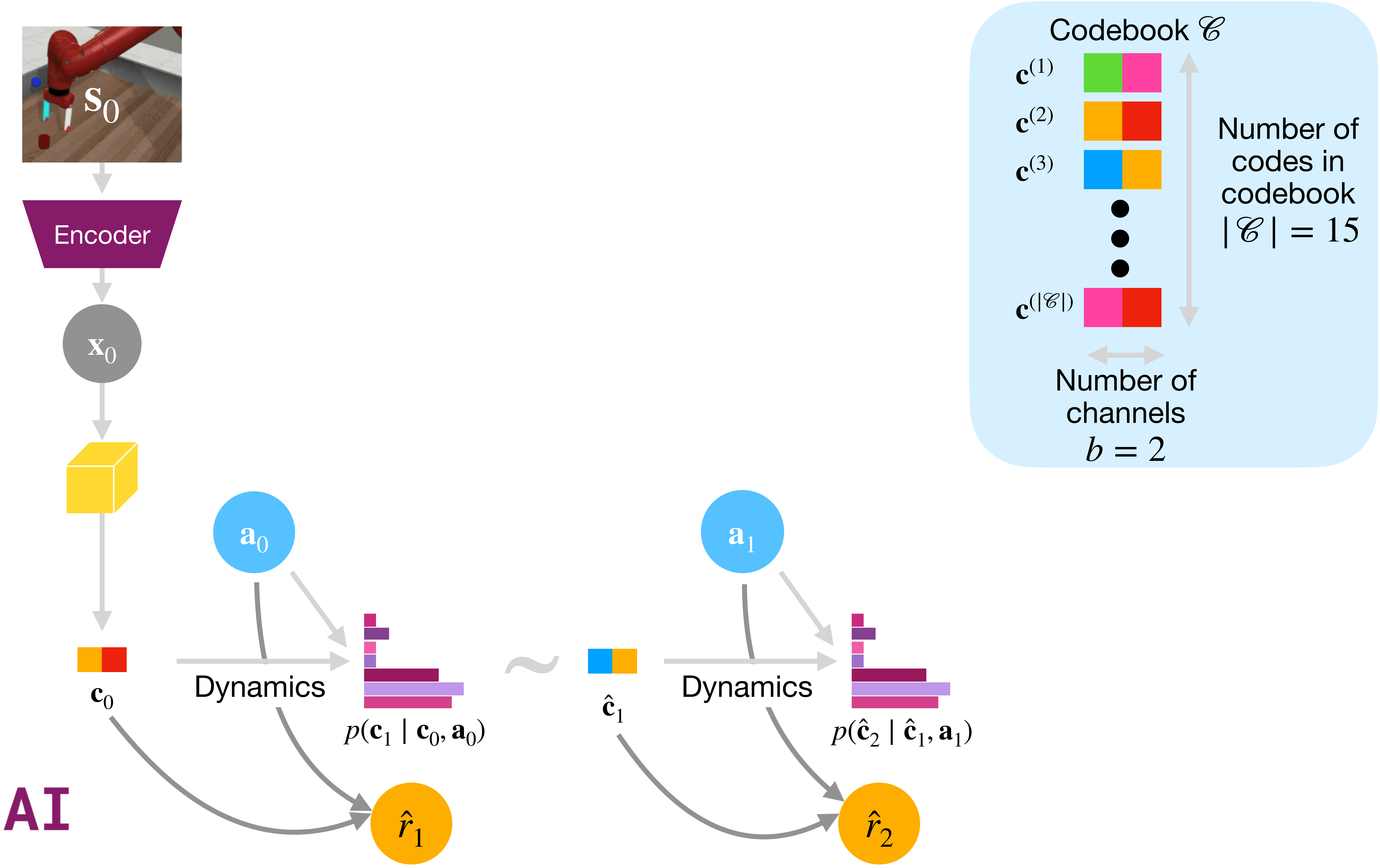

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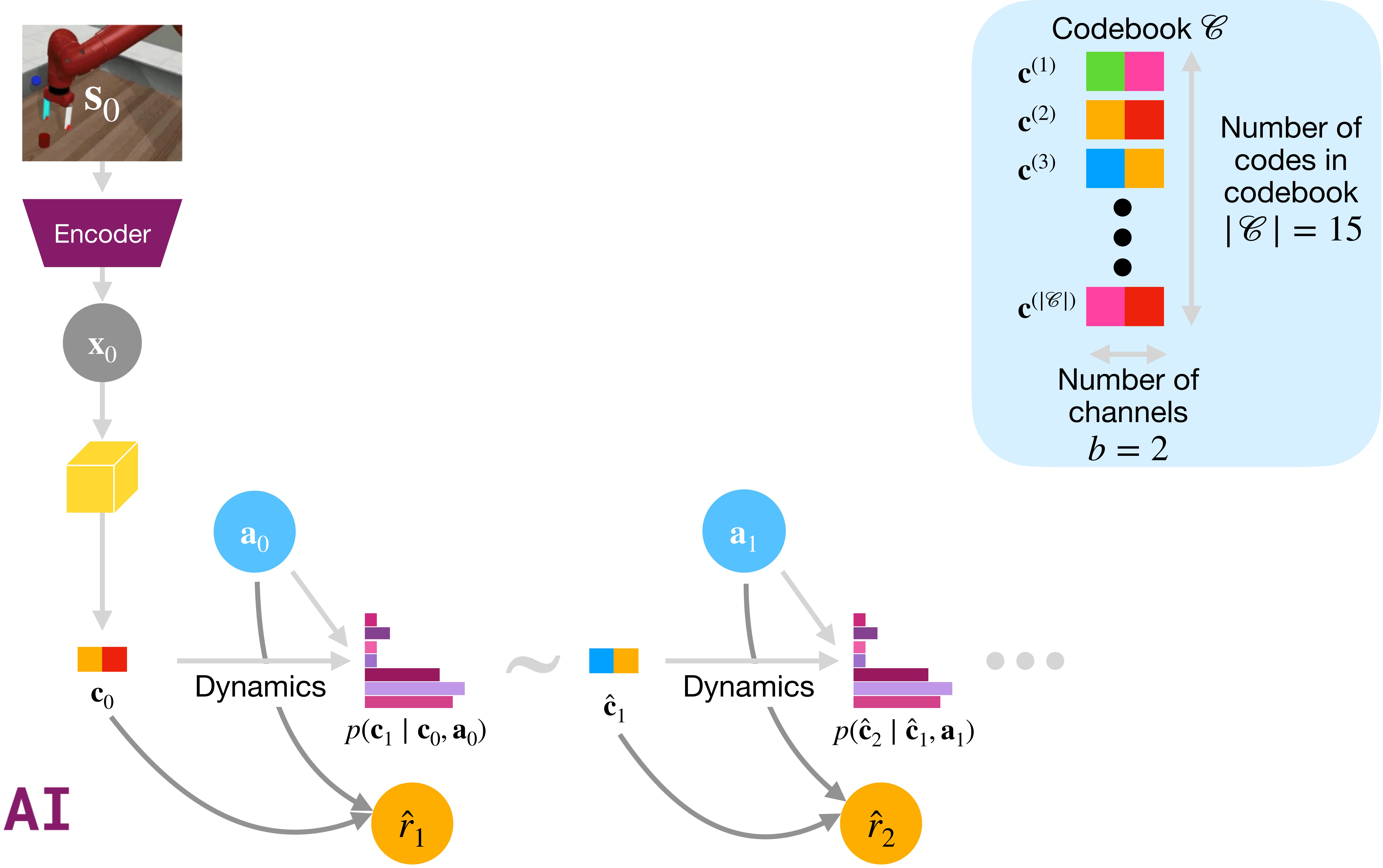

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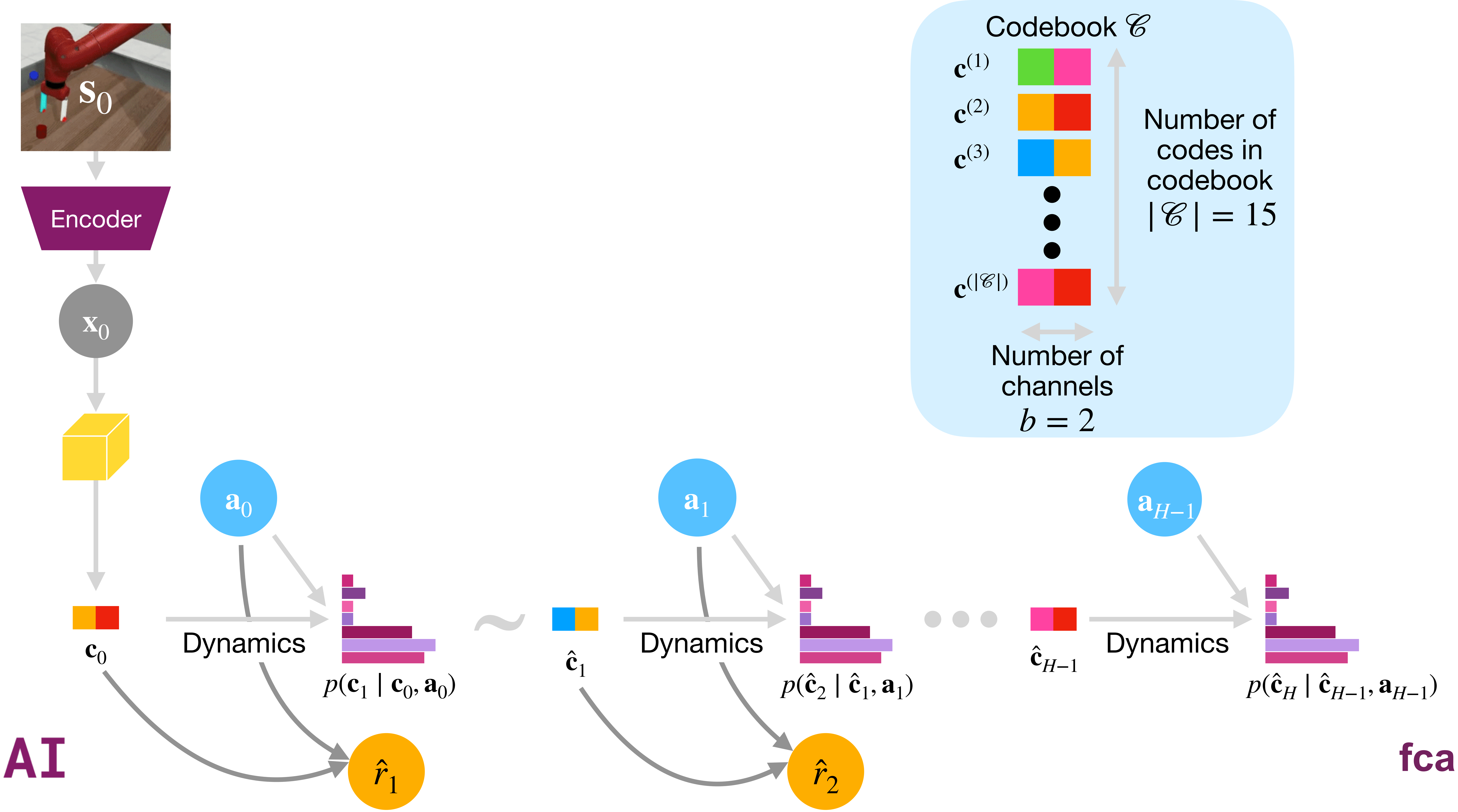

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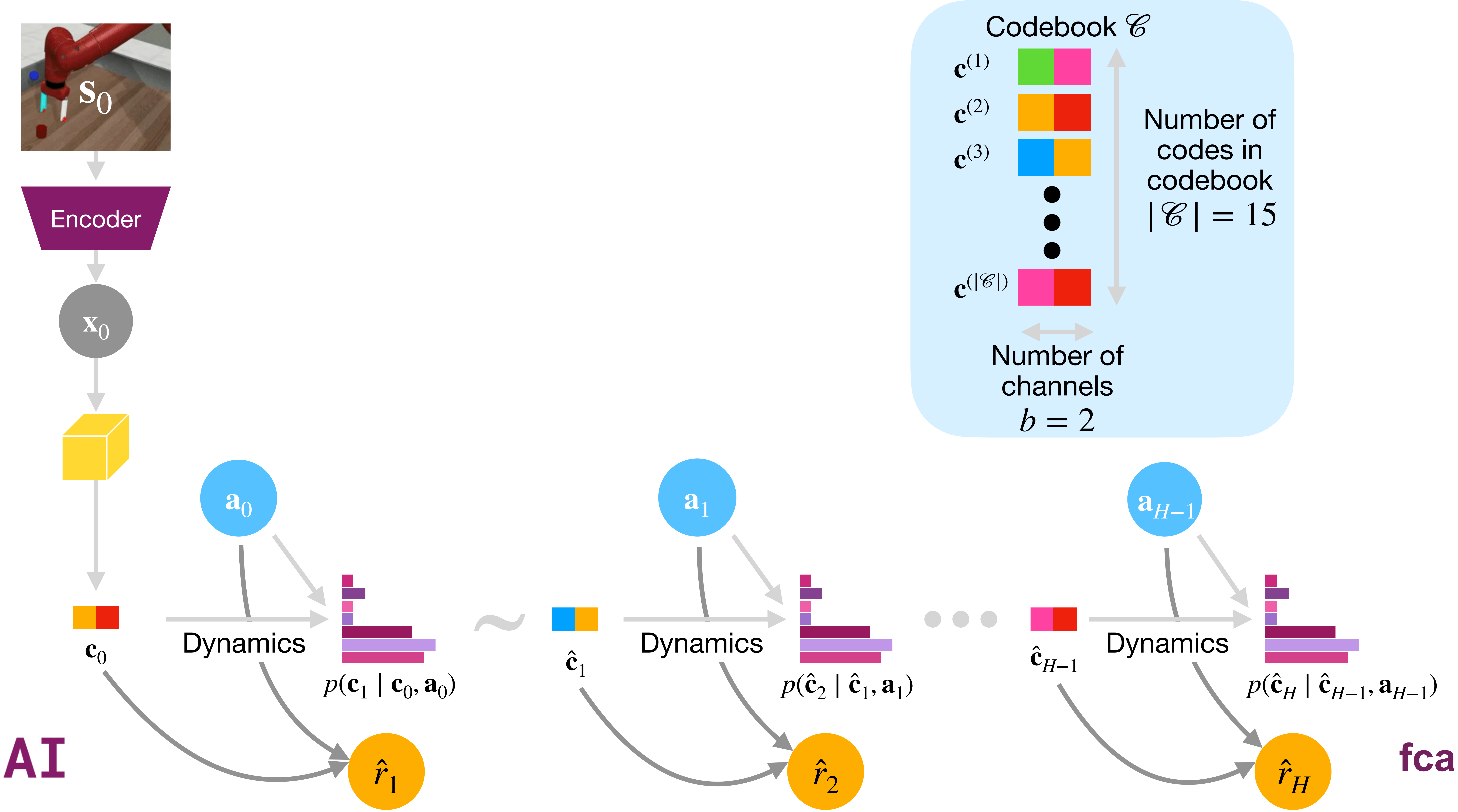

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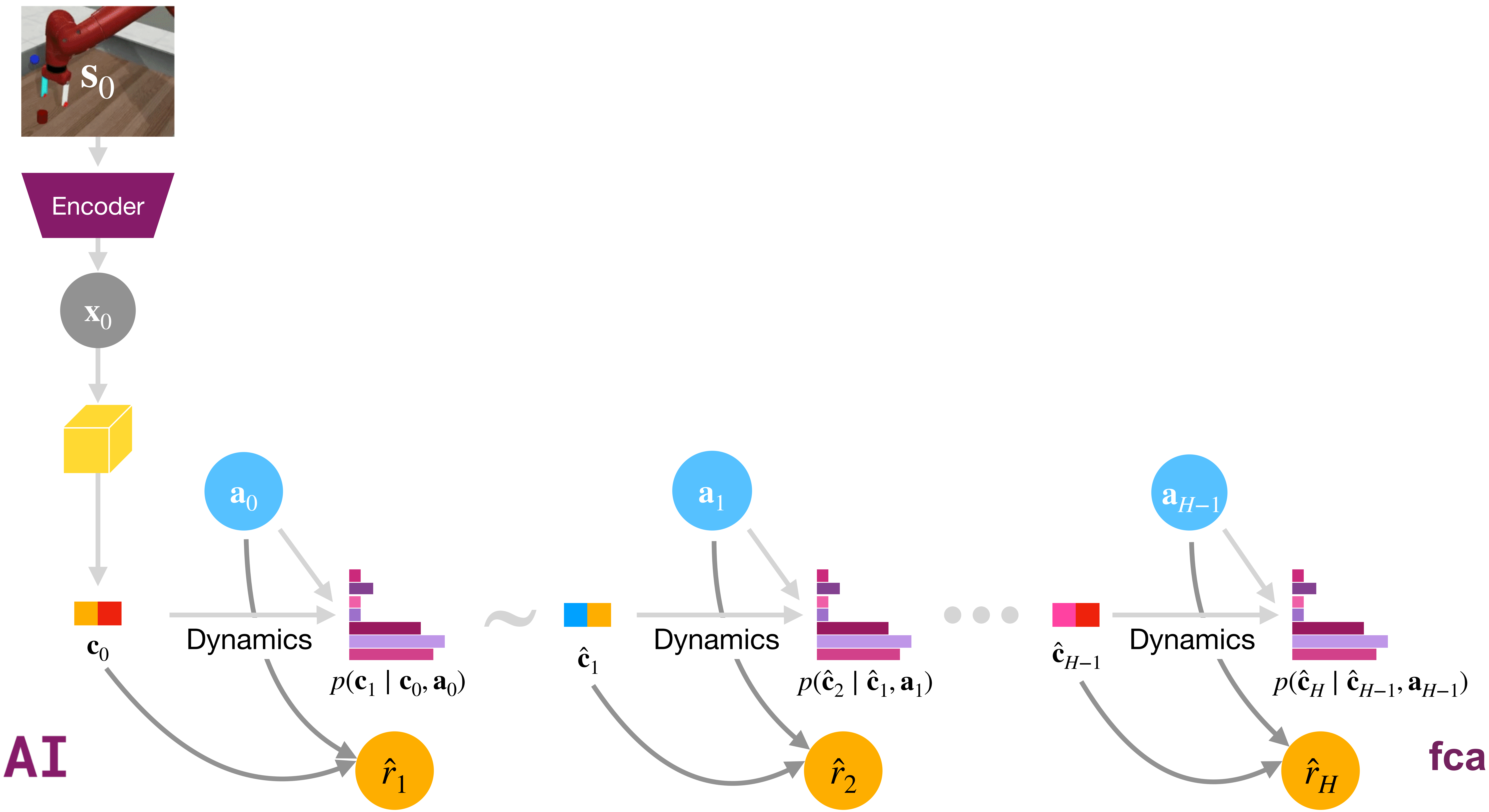

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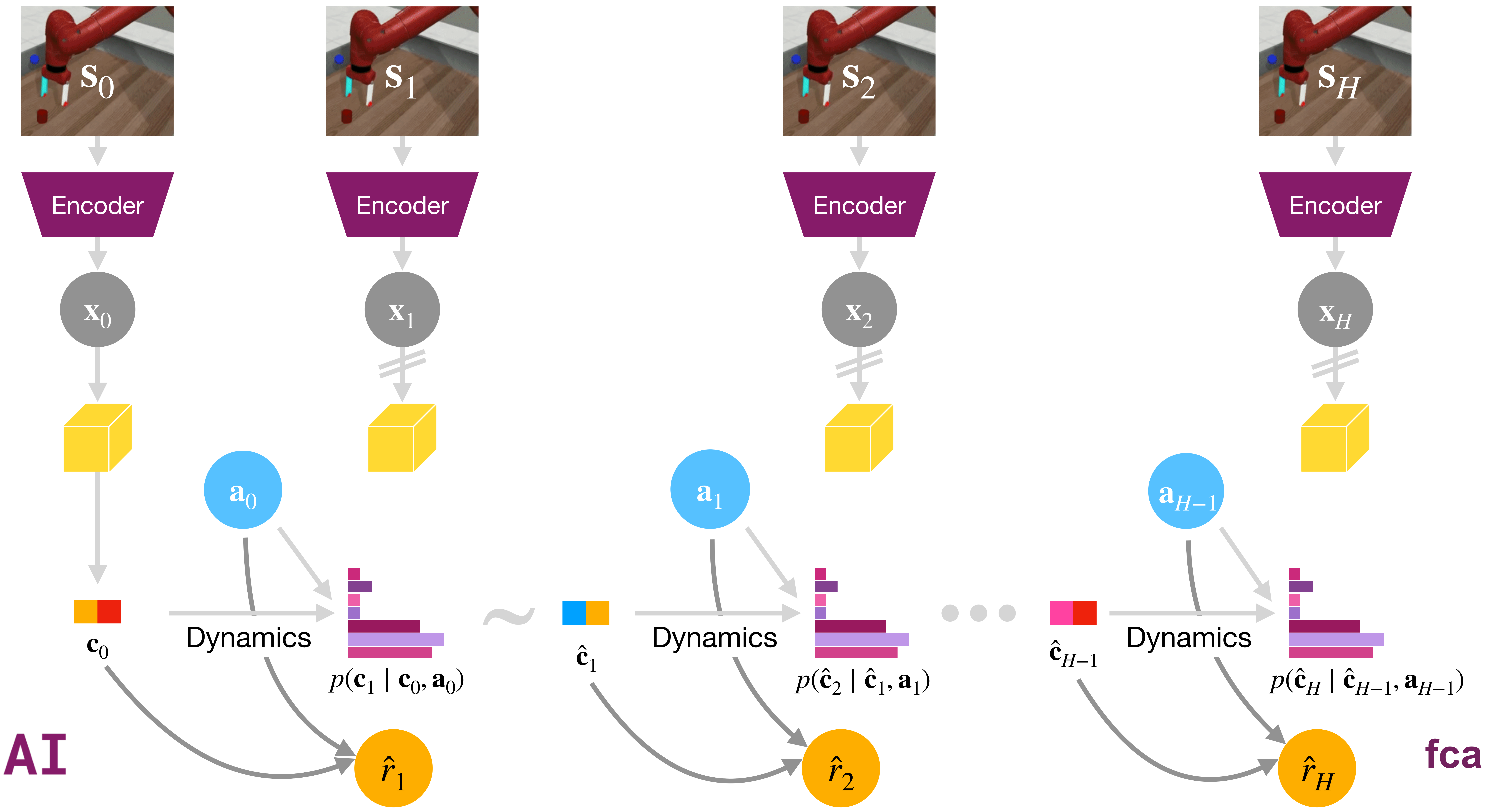

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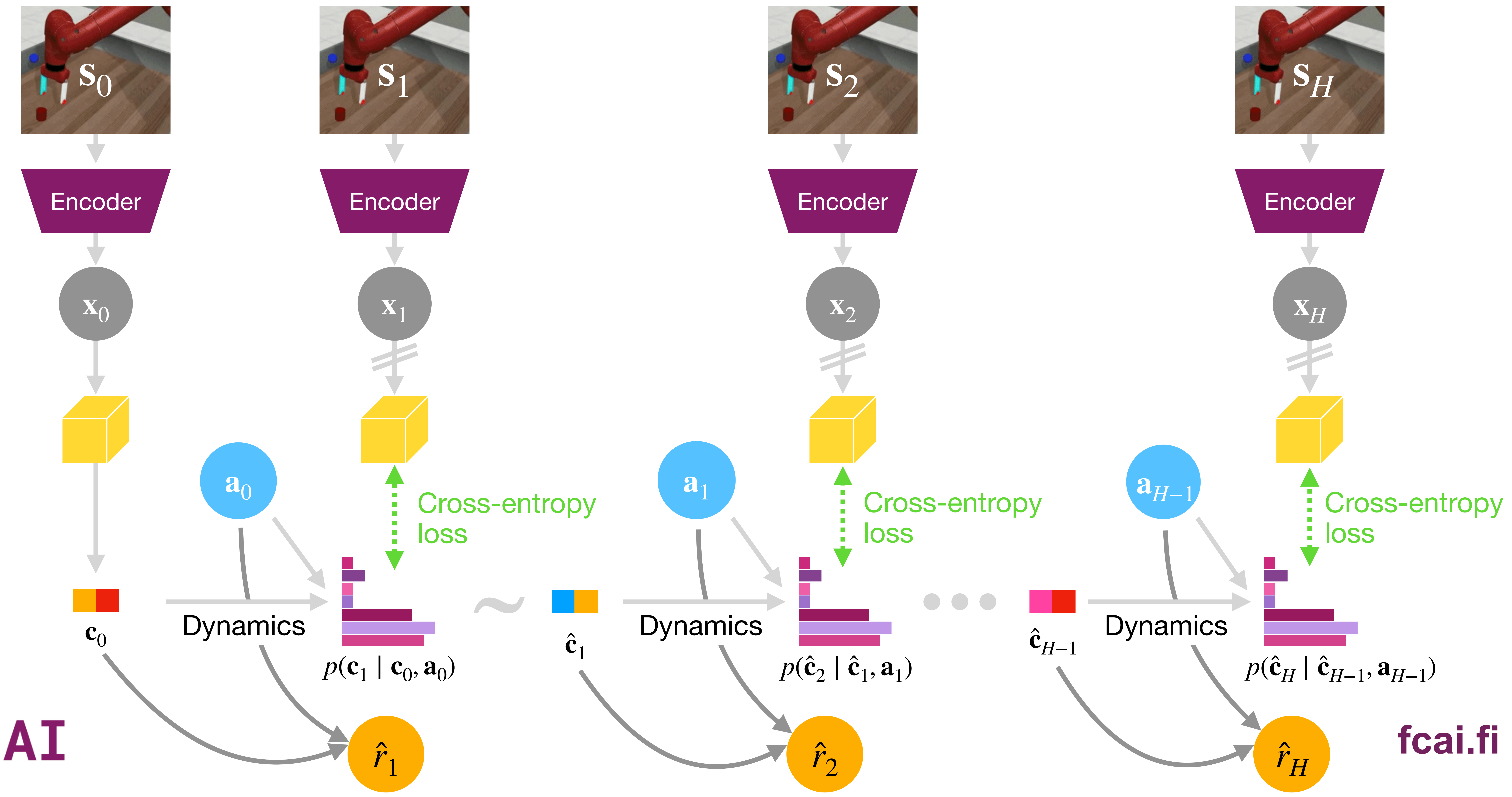

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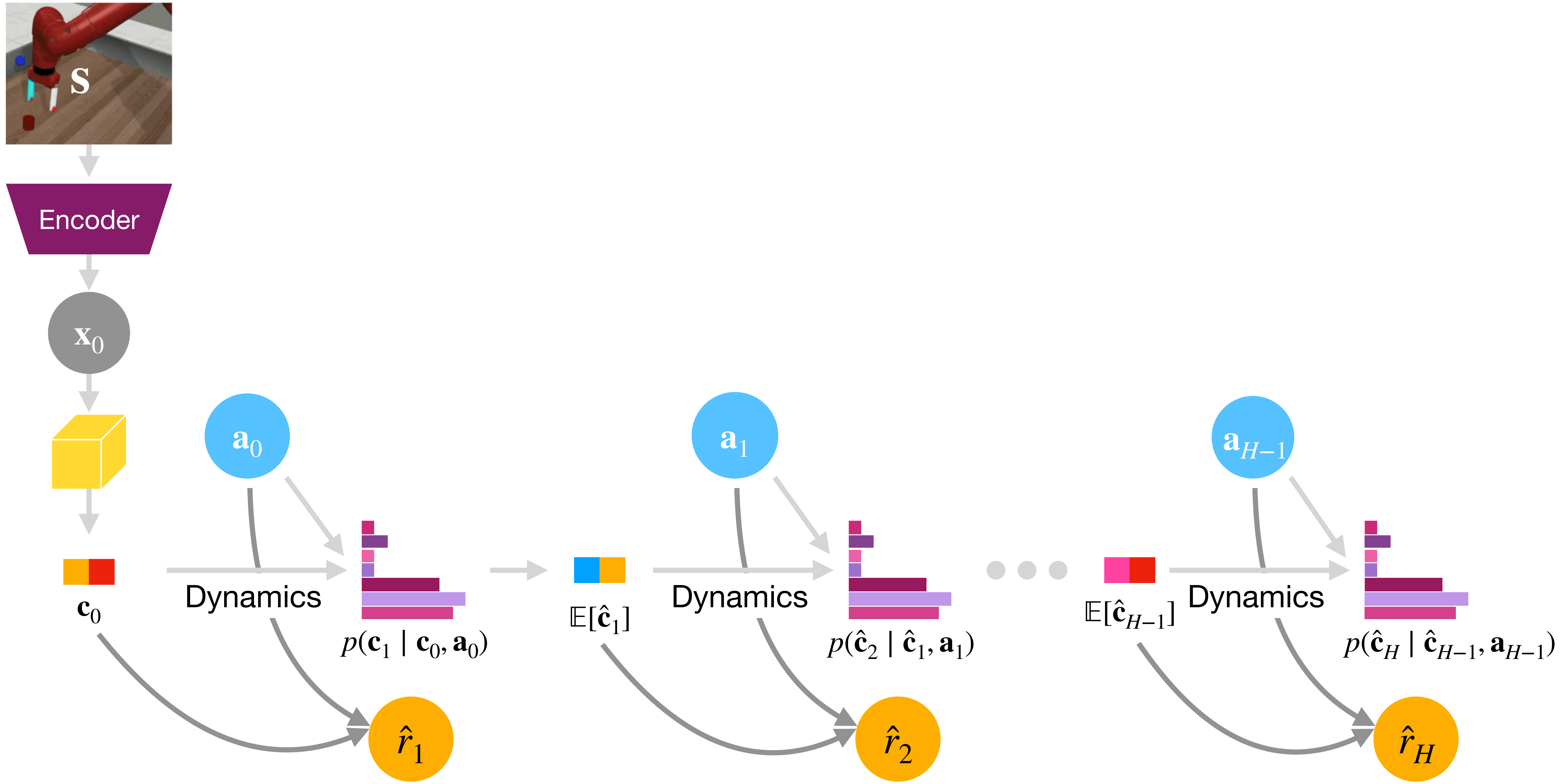
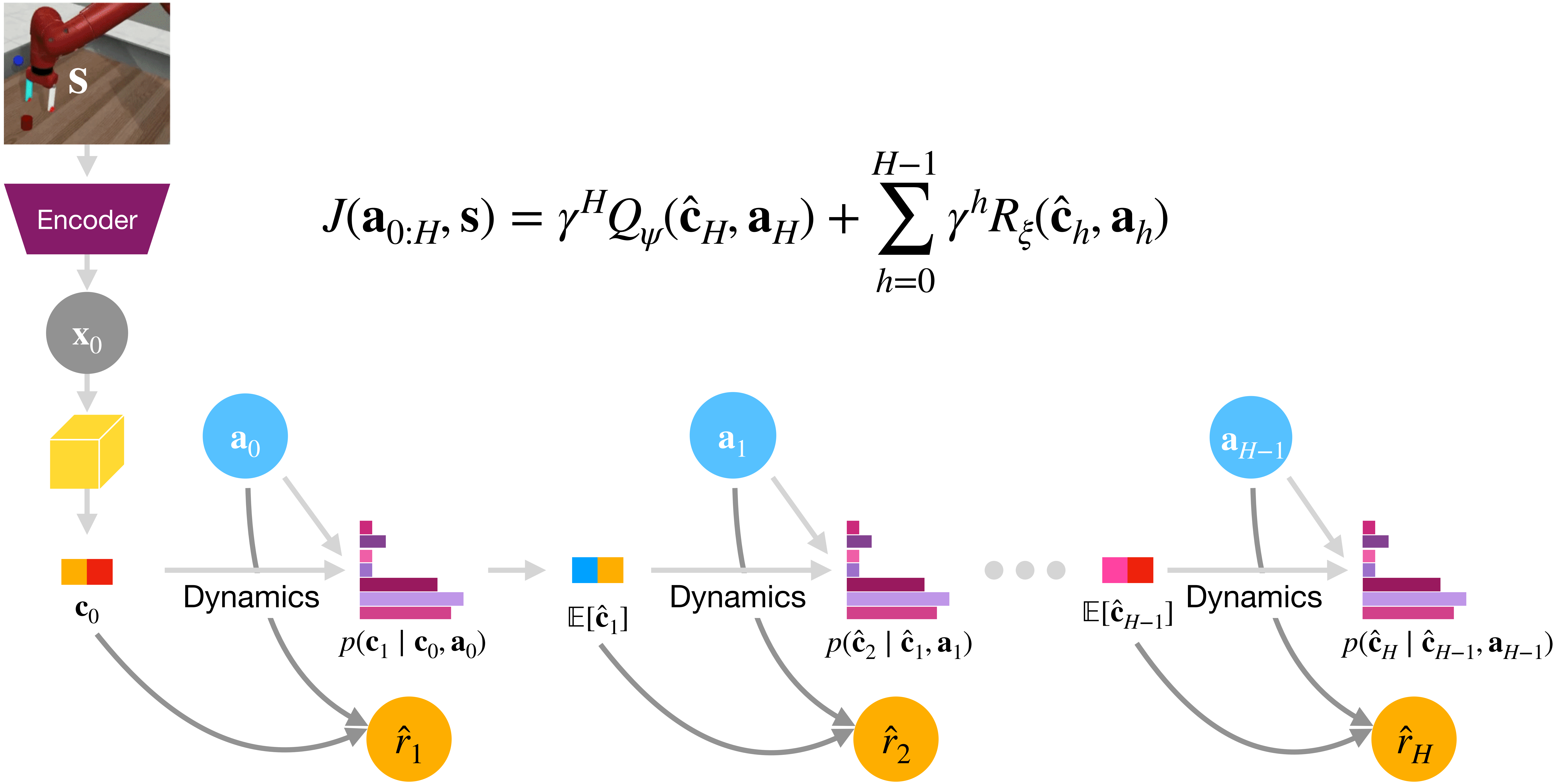
DC-MPC: Decision-time Planning



DC-MPC: Decision-time Planning

$$J(\mathbf{a}_{0:H}, \mathbf{s}) = \gamma^H Q_\psi(\hat{\mathbf{c}}_H, \mathbf{a}_H) + \sum_{h=0}^{H-1} \gamma^h R_\xi(\hat{\mathbf{c}}_h, \mathbf{a}_h)$$



DC-MPC: Decision-time Planning

Reward func.

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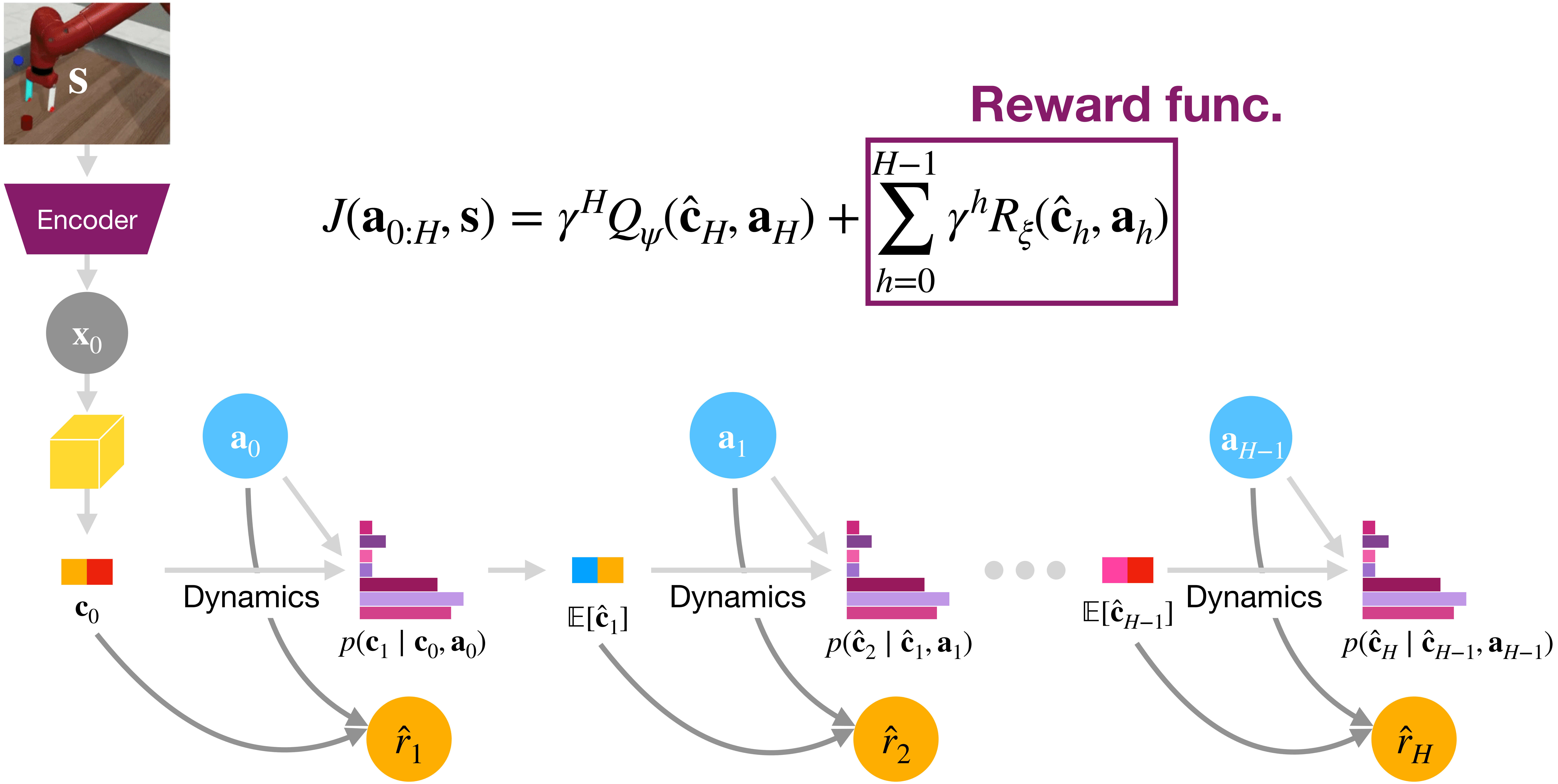

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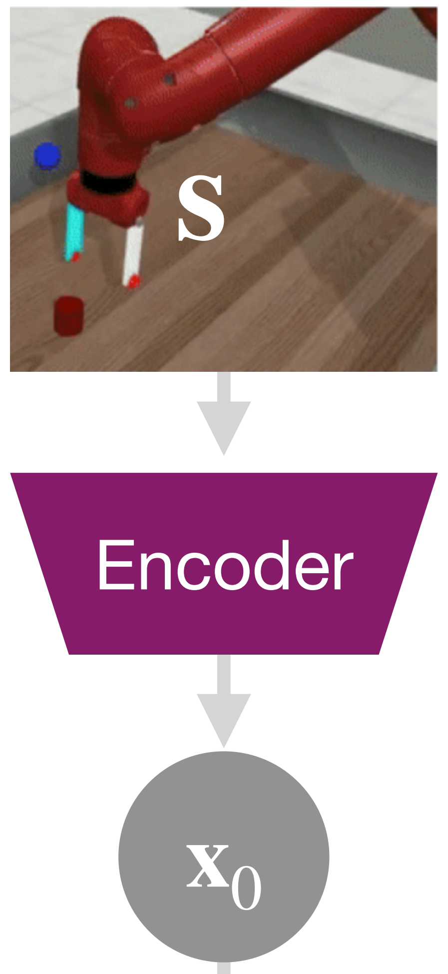
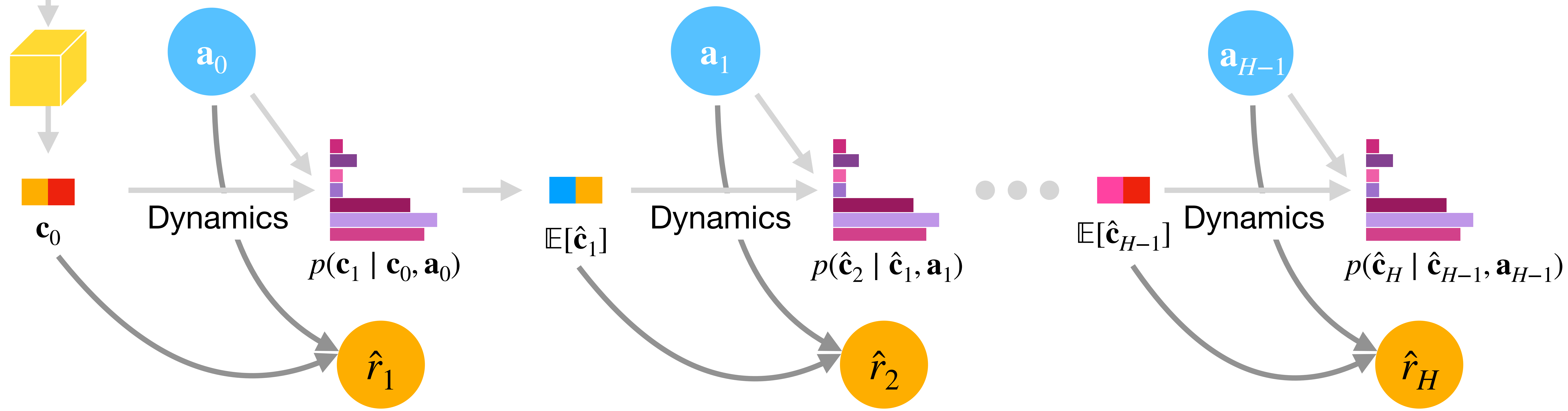


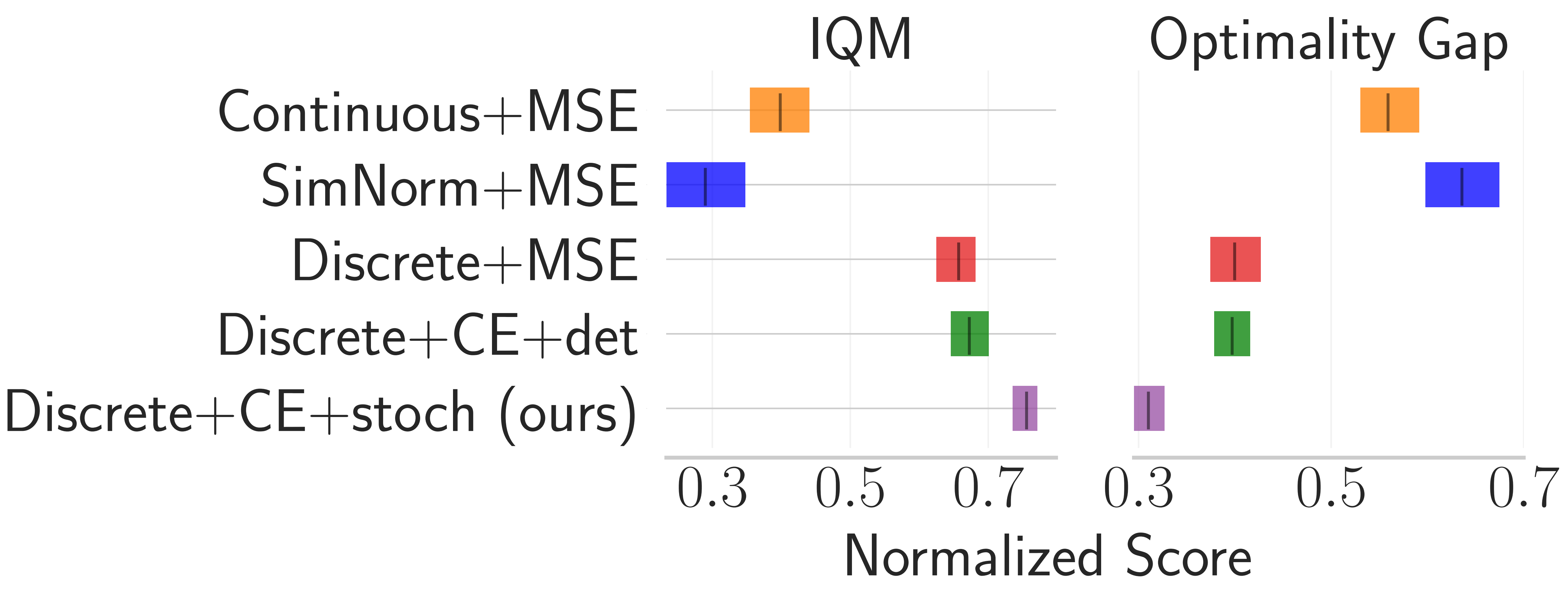
Bootstrap with action-value **Reward func.**

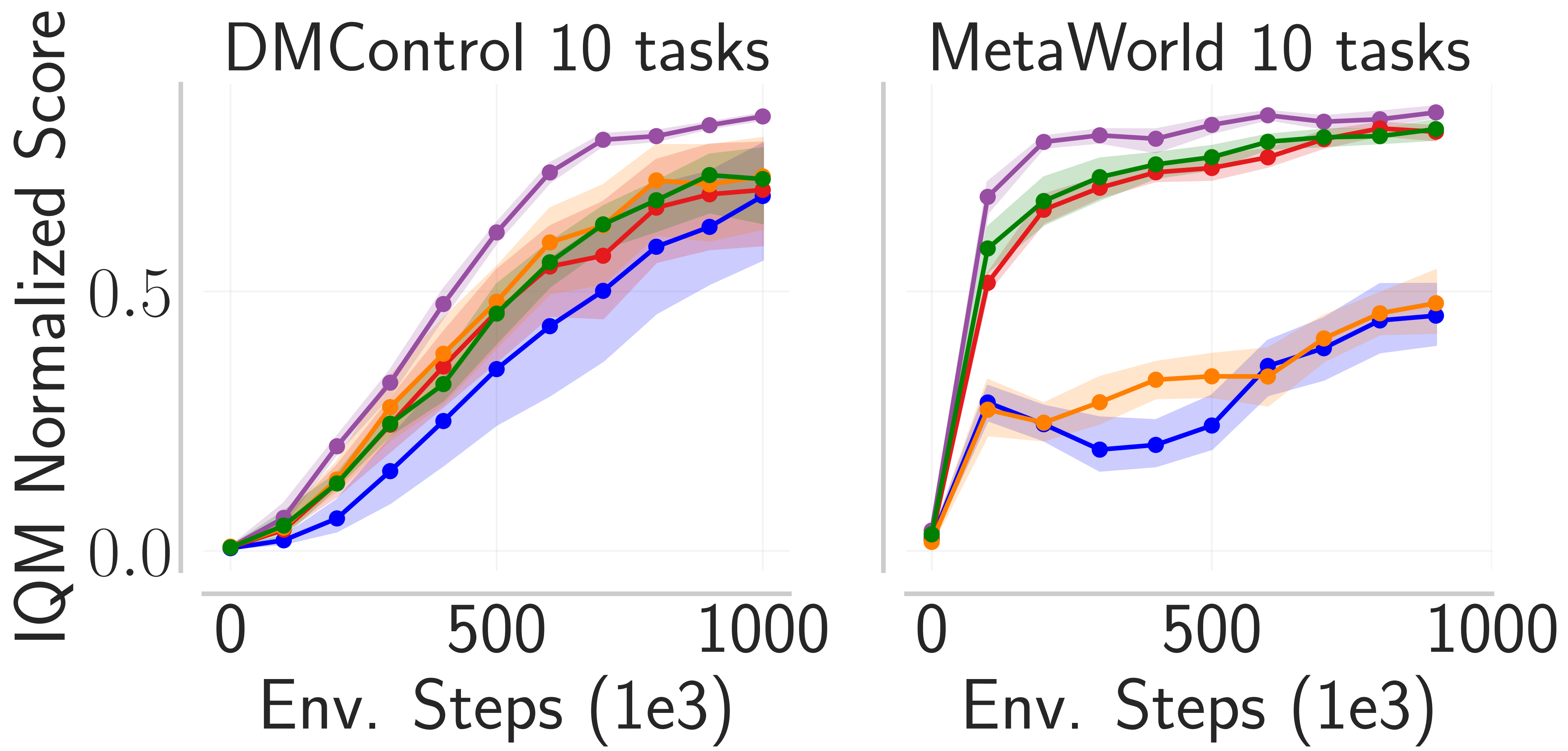
$$J(\mathbf{a}_{0:H}, \mathbf{s}) = \boxed{\gamma^H Q_\psi(\hat{\mathbf{c}}_H, \mathbf{a}_H)} + \boxed{\sum_{h=0}^{H-1} \gamma^h R_\xi(\hat{\mathbf{c}}_h, \mathbf{a}_h)}$$



Why Does DC-MPC Work So Well?

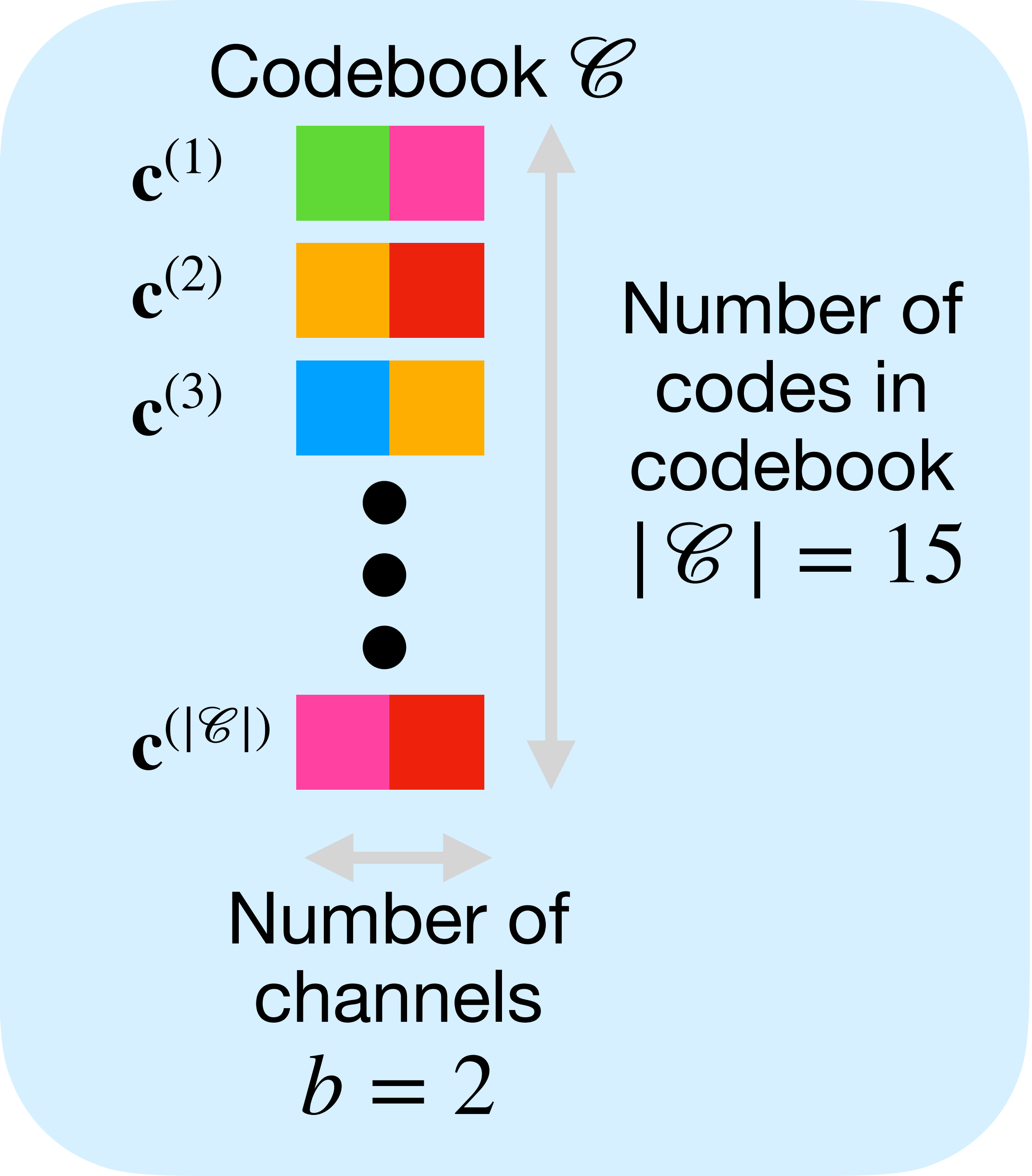
Combination of Discrete Codebook and Stochastic Dynamics

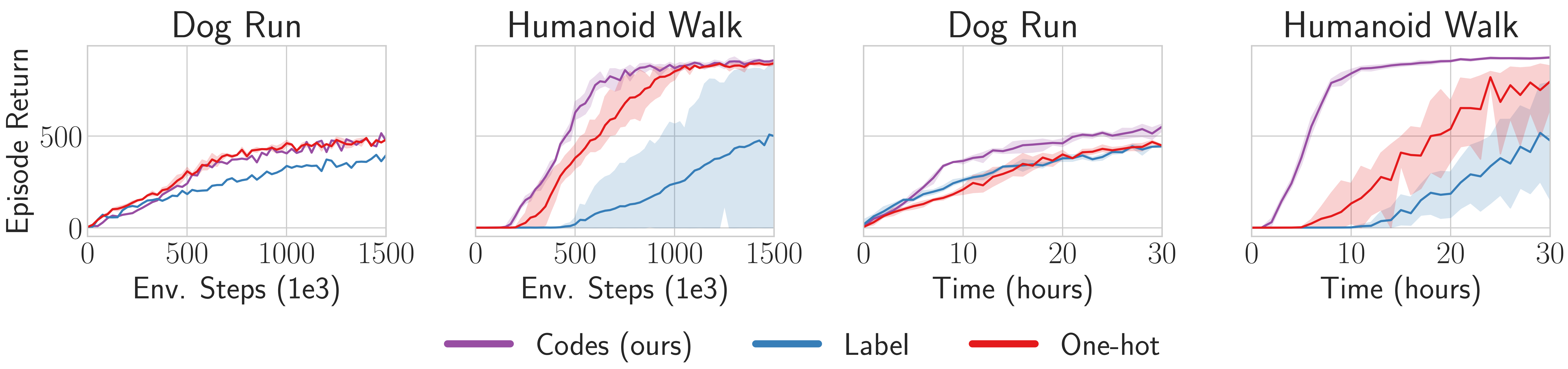




Comparison of Different Discrete Encodings

Codebook > One-hot > Label





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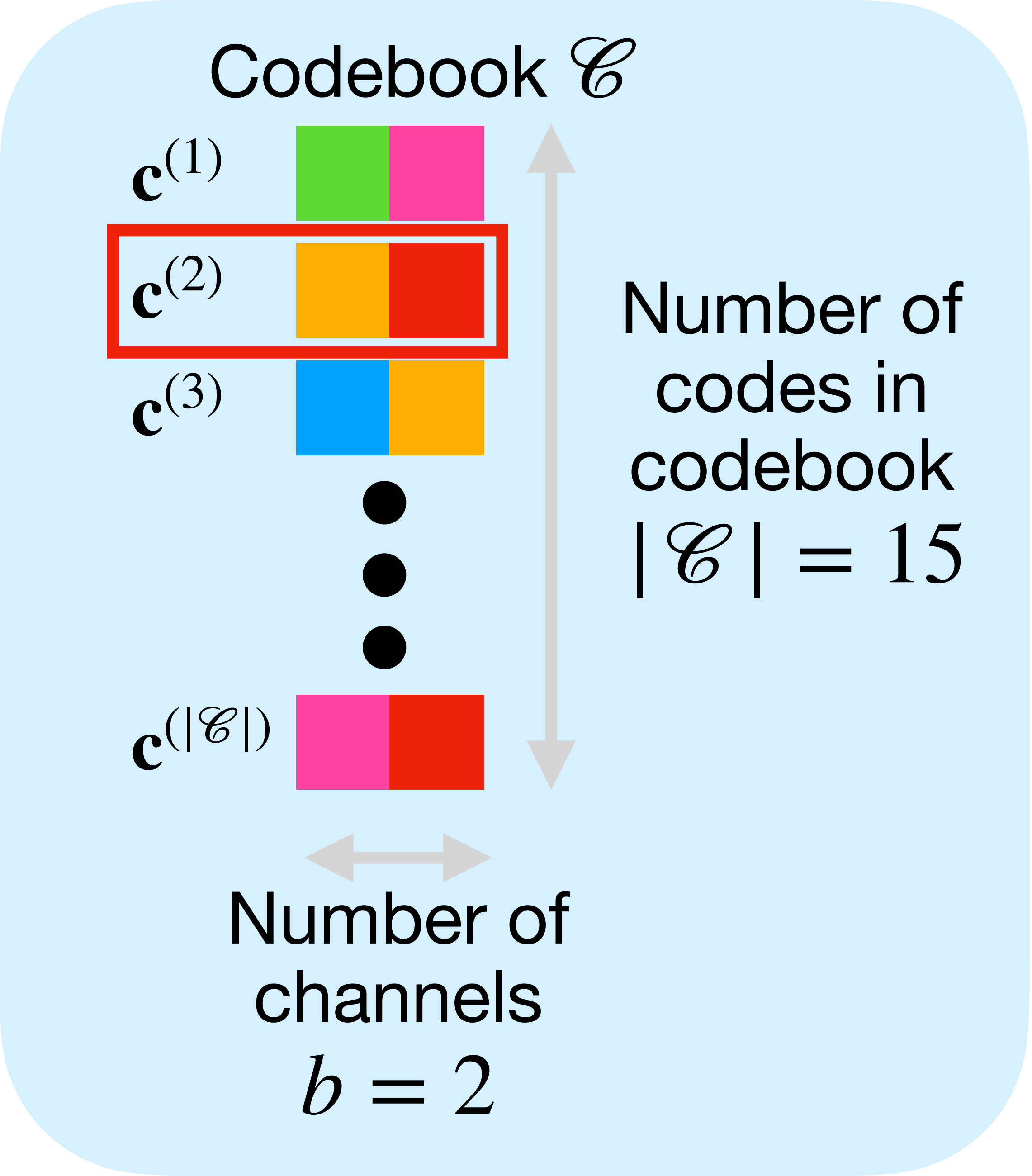

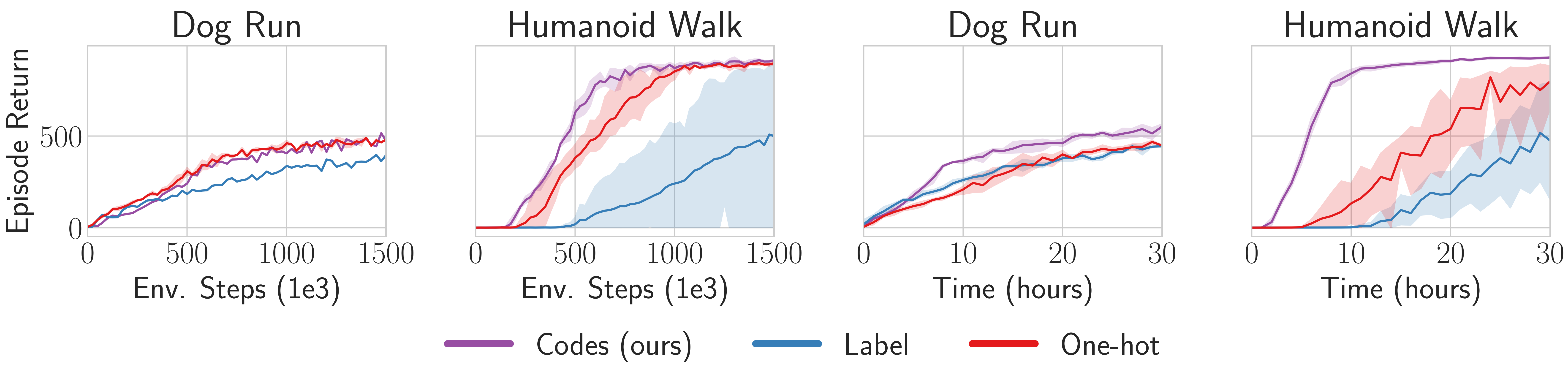

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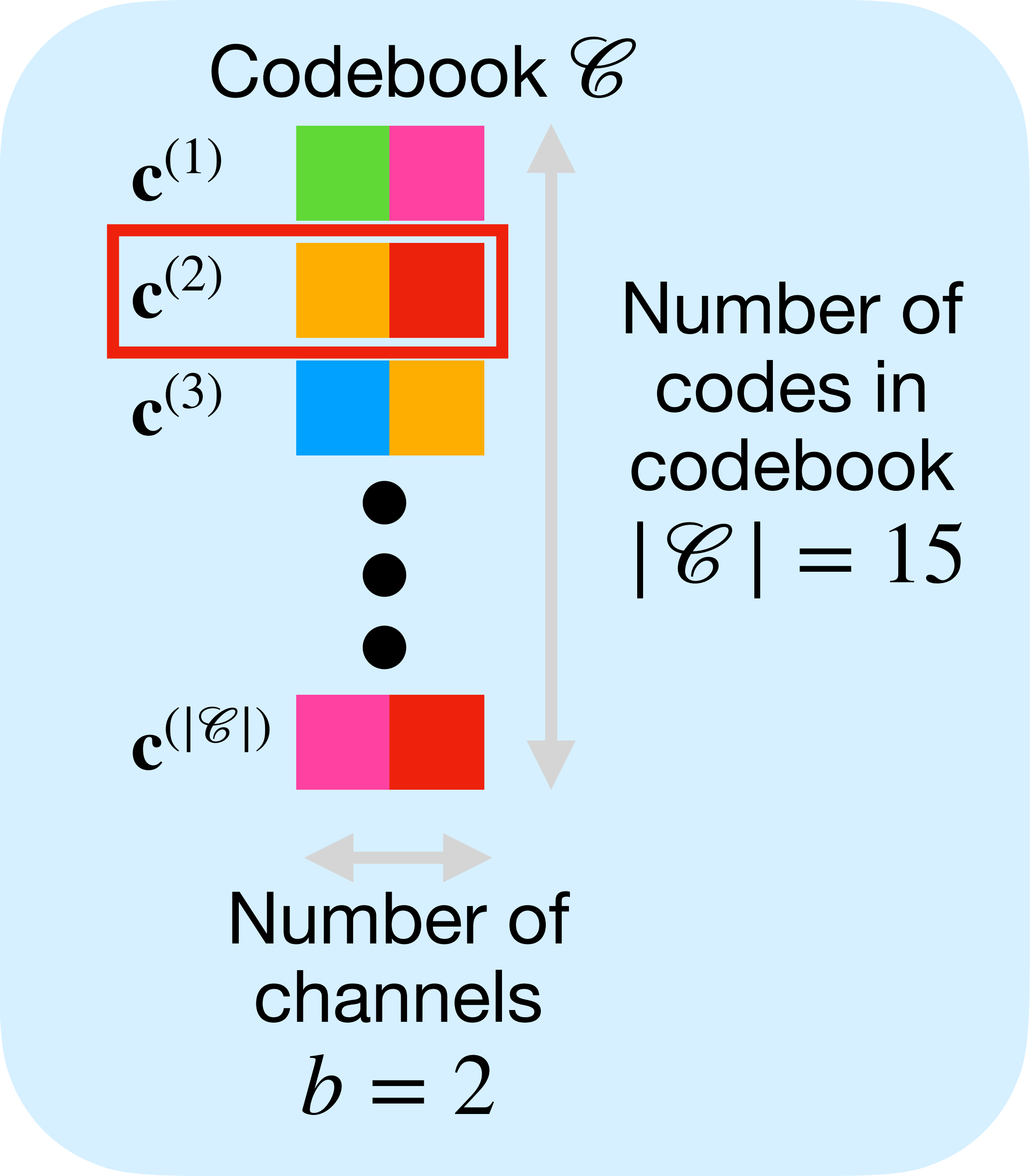
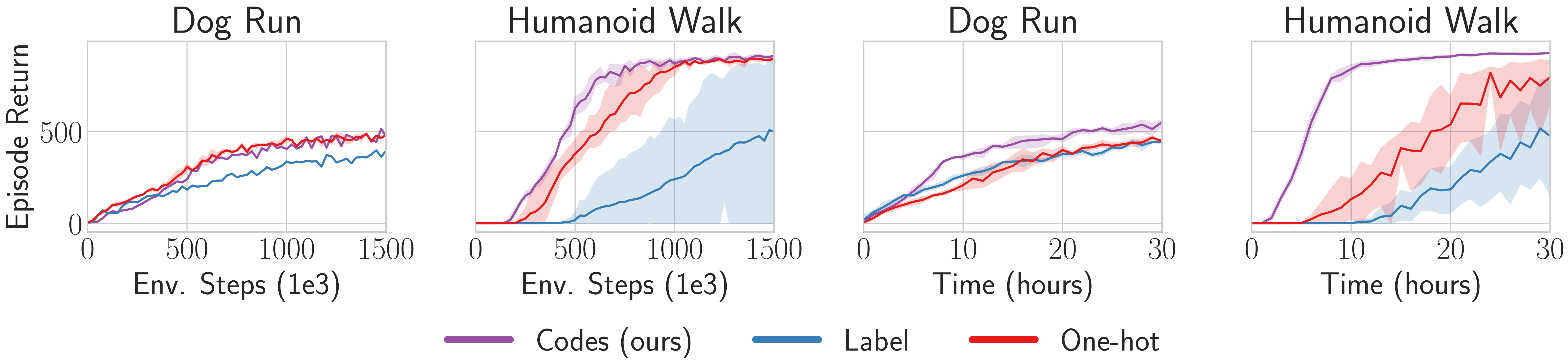


$$\mathbf{e}_{\text{code}} = \mathbf{c}^{(2)} = \{-0.5, 1\}$$



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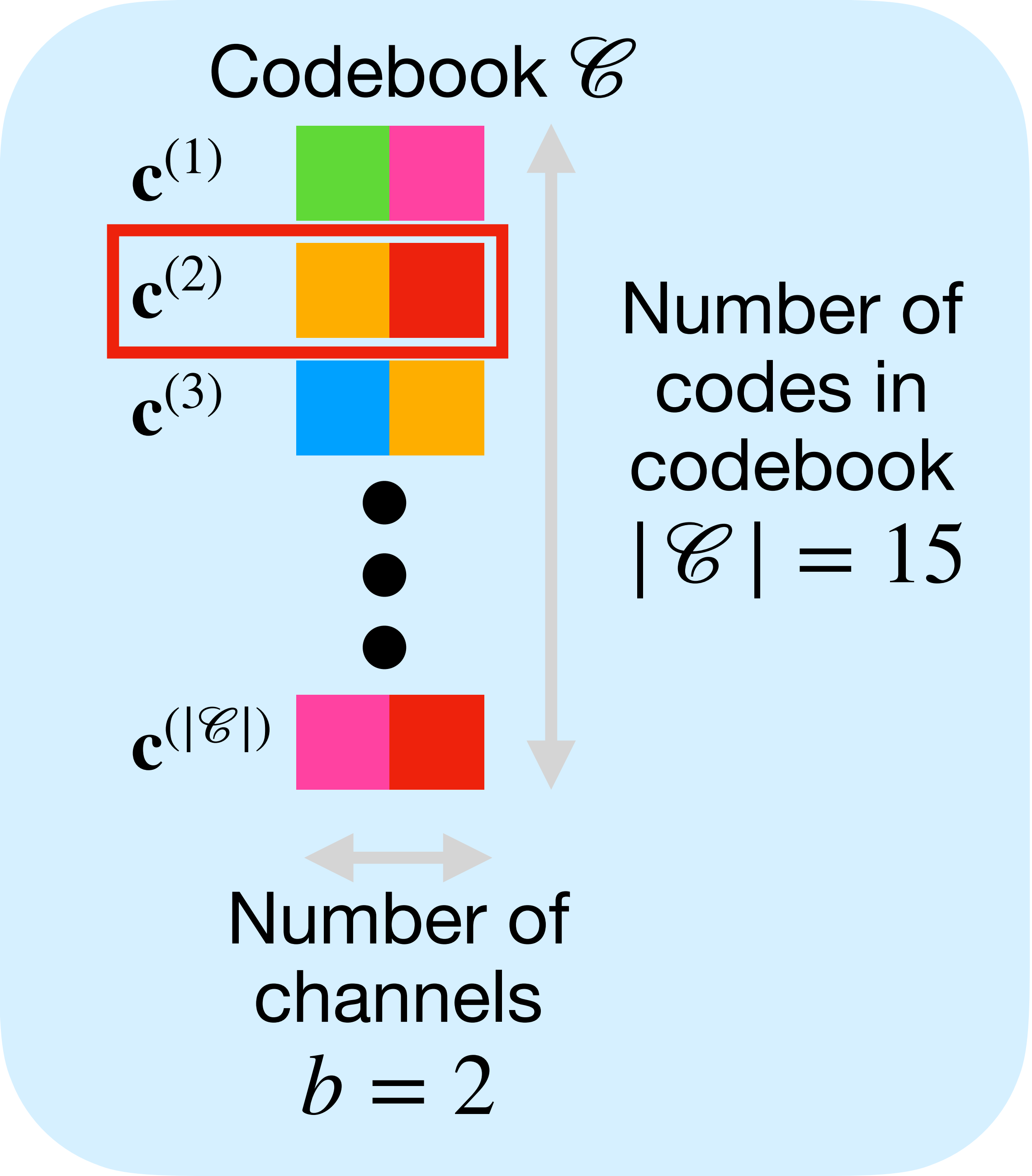
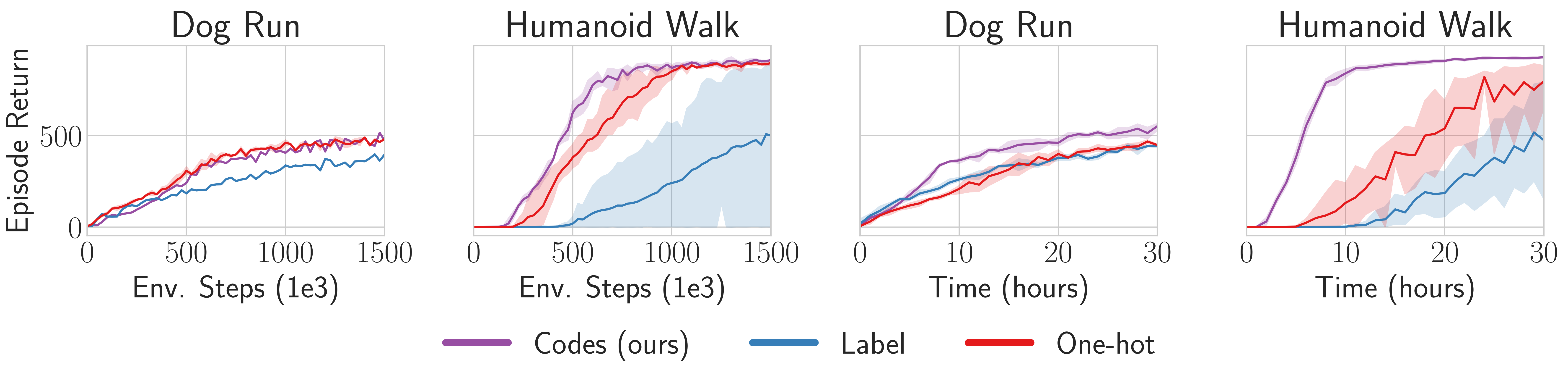


$$\mathbf{e}_{\text{code}} = \mathbf{c}^{(2)} = \{-0.5, 1\}$$

$$\mathbf{e}_{\text{label}} = 2$$



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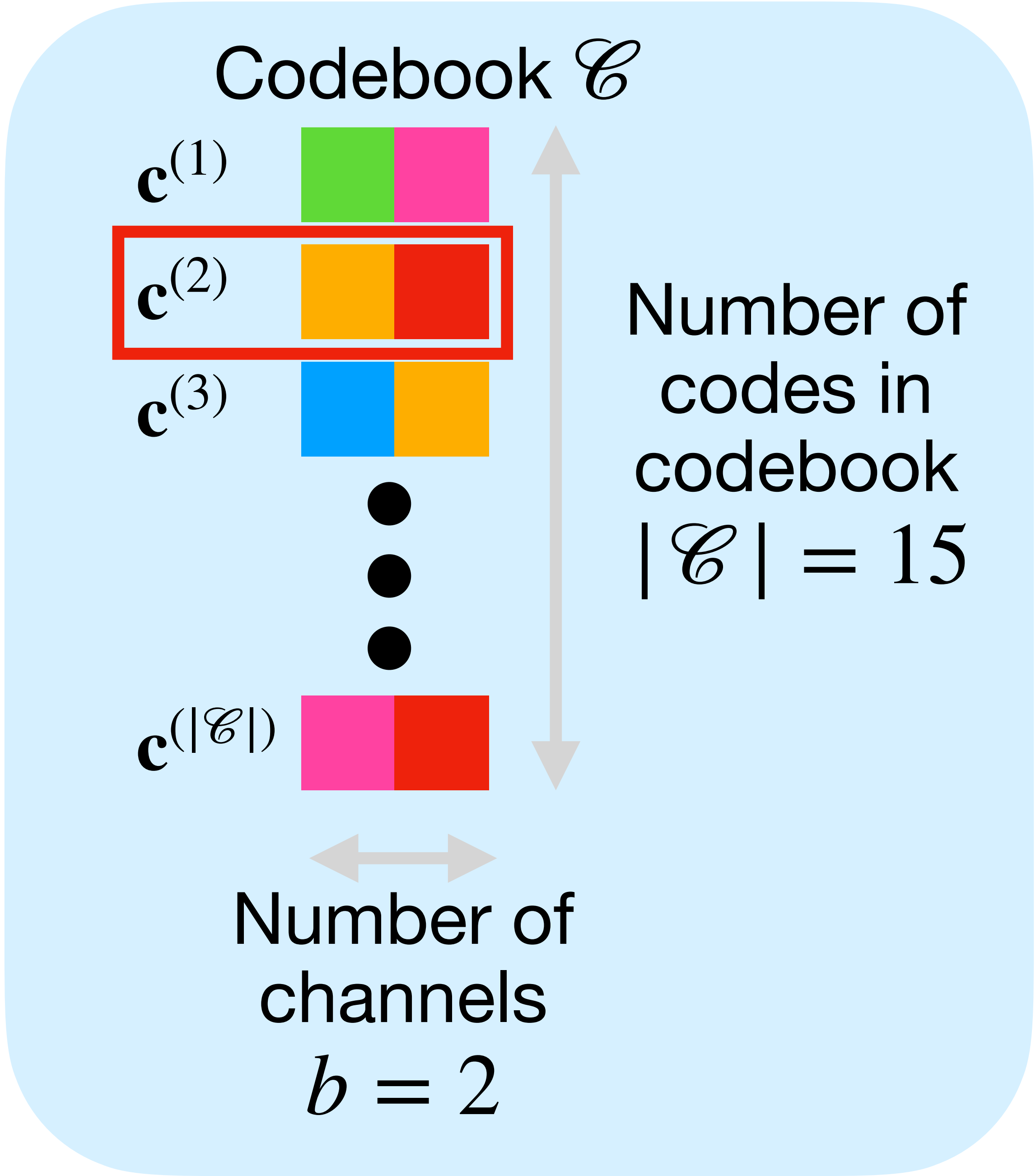
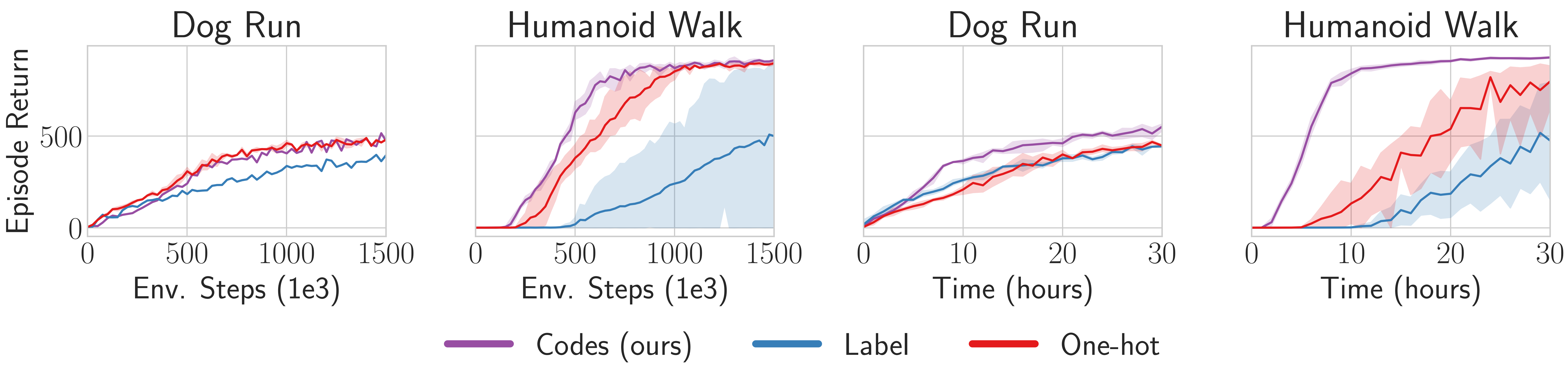


$$\mathbf{e}_{\text{code}} = \mathbf{c}^{(2)} = \{-0.5, 1\}$$

$$\mathbf{e}_{\text{label}} = 2$$

$$\mathbf{e}_{\text{one-hot}} = \{0,1,0,0,0,0,0,0,0,0,0,0,0,0,0\}$$



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Poster 28506:

Wednesday 23rd April 10 am - 12.30 pm (GMT+8)