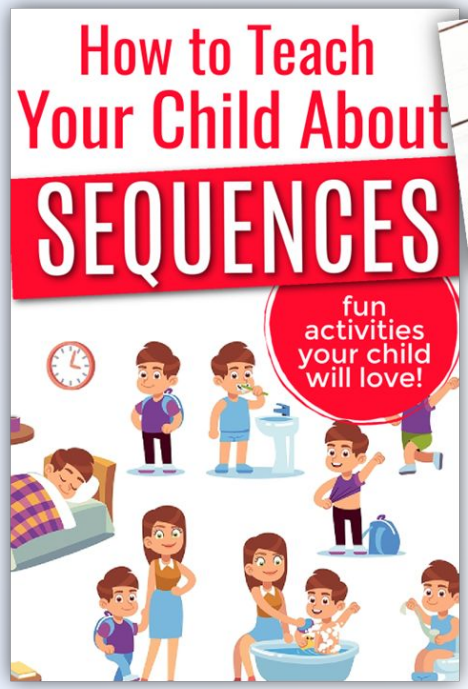
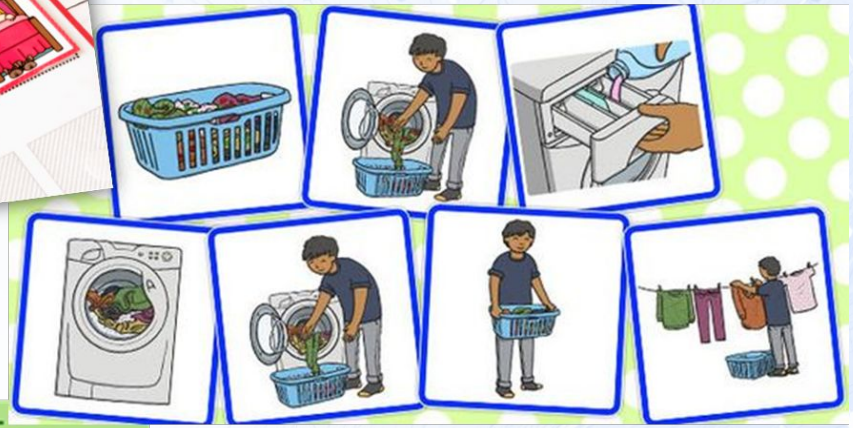
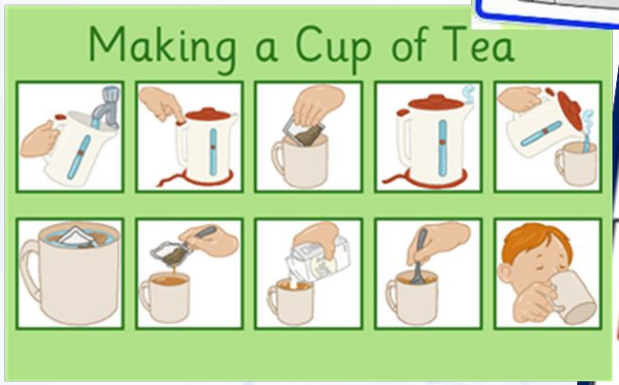
Lesson 2:

Sequence learning in a Tree task







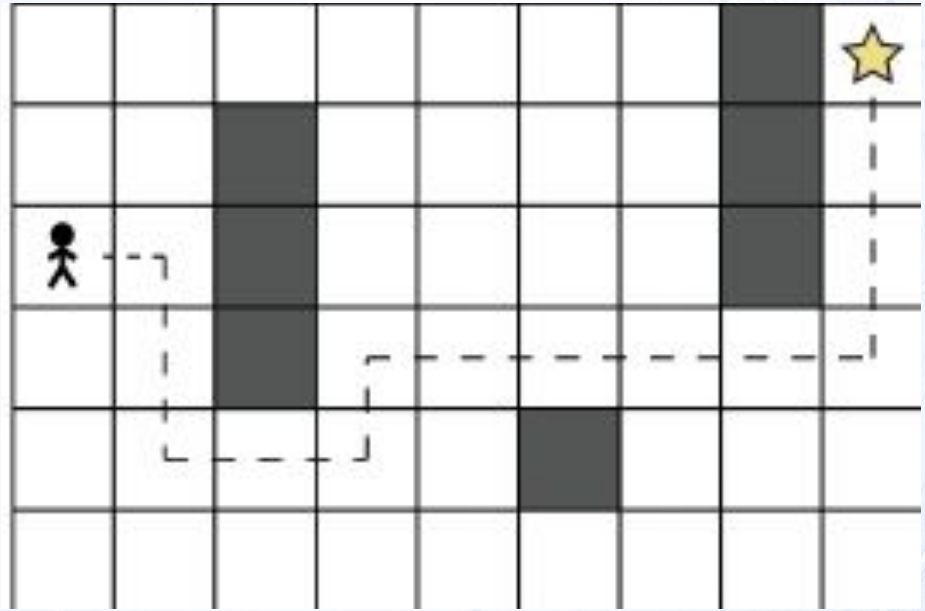
(Lehmann et al., 2019; Singh & Sutton, 1996)

https://empoweredparents.co/sequencing-for-preschoolers/

https://lifeovercs.com/daily-tasks-story-sequencing-activities-for-preschoolers/

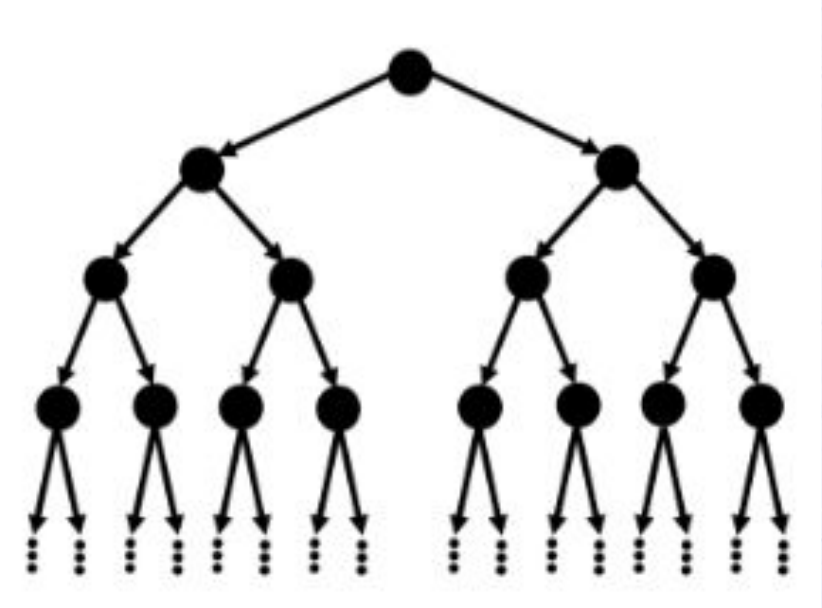
Sequence Learning

Sequence Learning



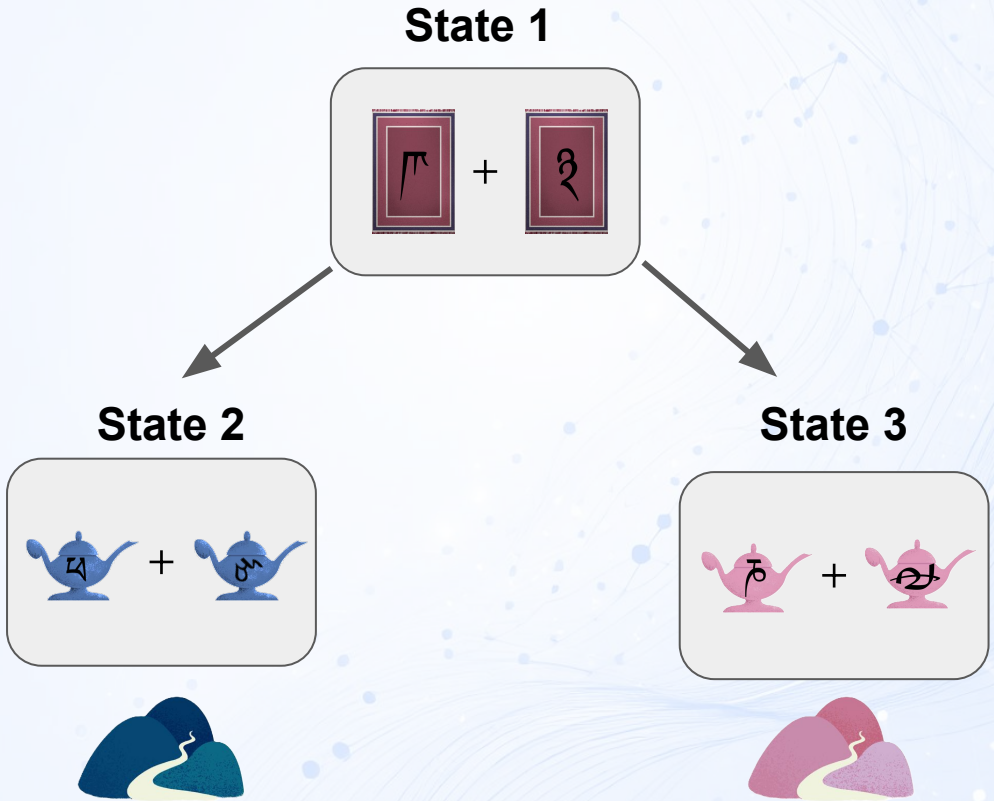
Melnikov, Alexey & Makmal, Adi & Briegel, Hans. (2014). Projective simulation applied to the grid-world and the mountain-car problem. 3. 10.5430/air.v3n3p24.

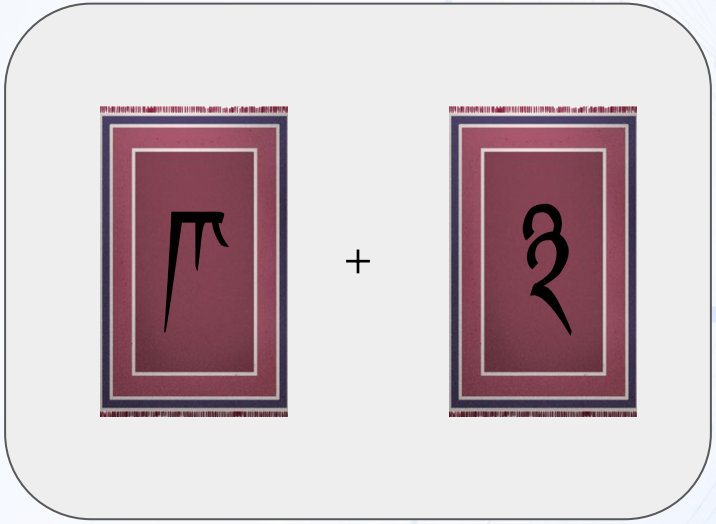
Sequence Learning

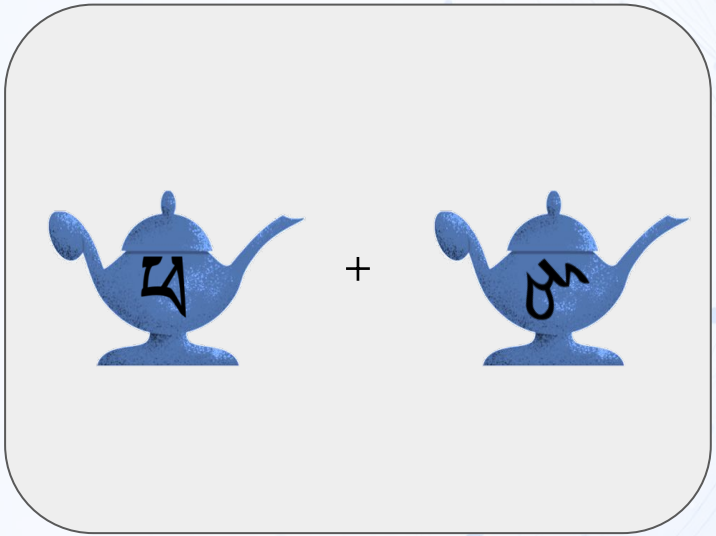


Model-free learning

(Two-step task with terministic transitions)


State 1
State 2
State 3





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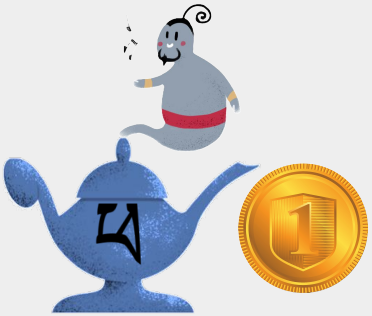
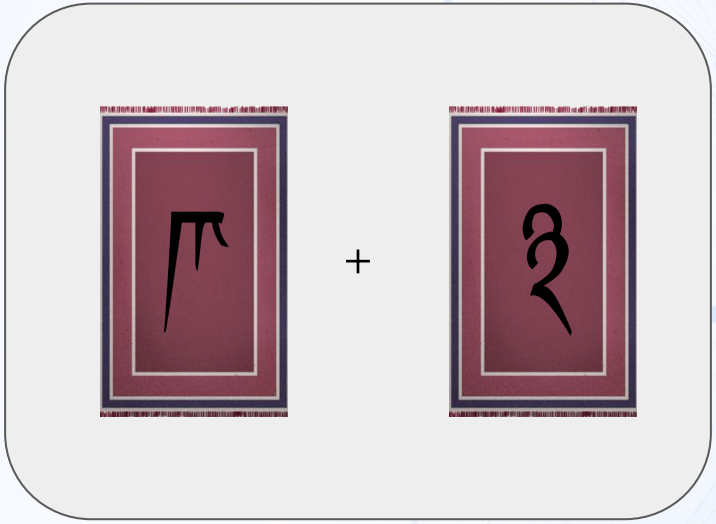
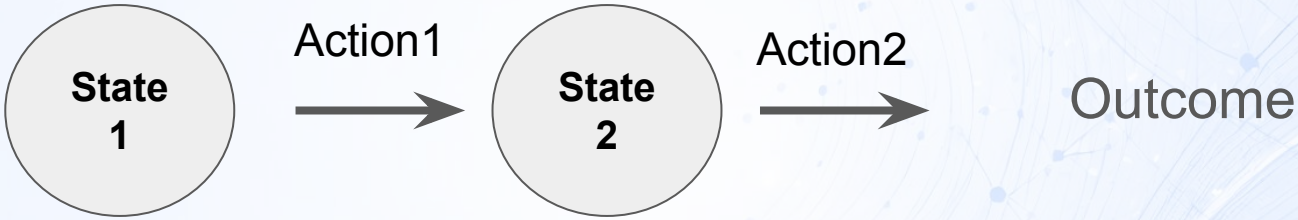
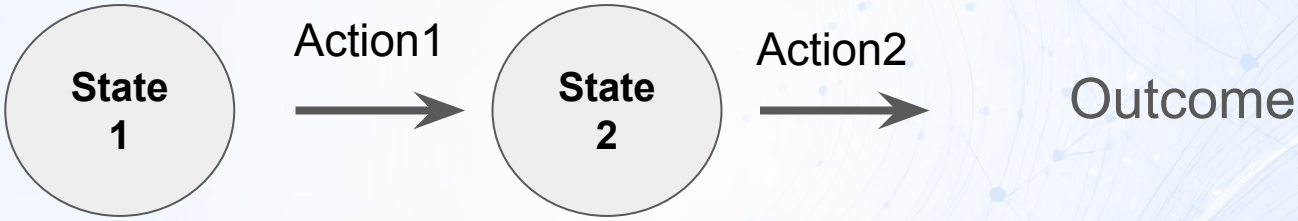




Model-free sequence learning



Model-free sequence learning



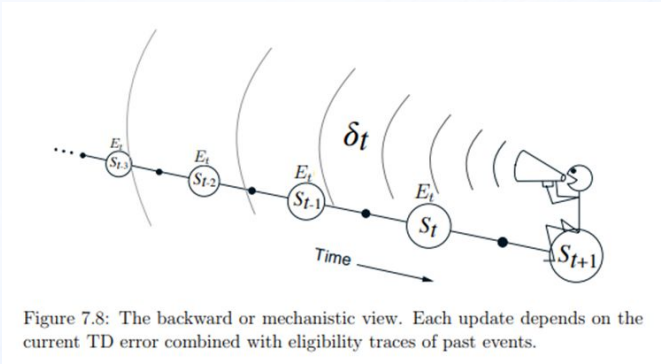
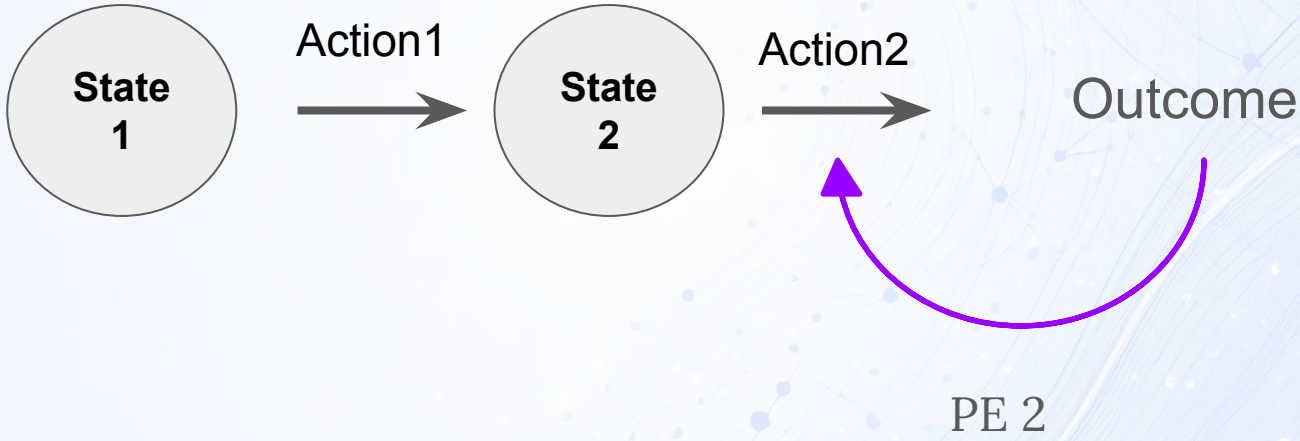


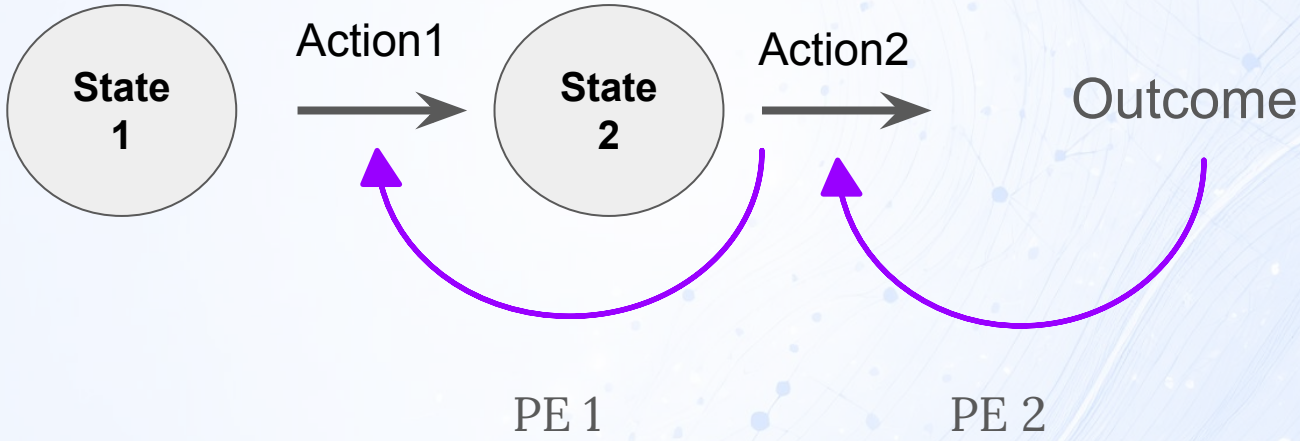
Figure 7.8: The backward or mechanistic view. Each update depends on the current TD error combined with eligibility traces of past events.

Sutton and Barto, 1981

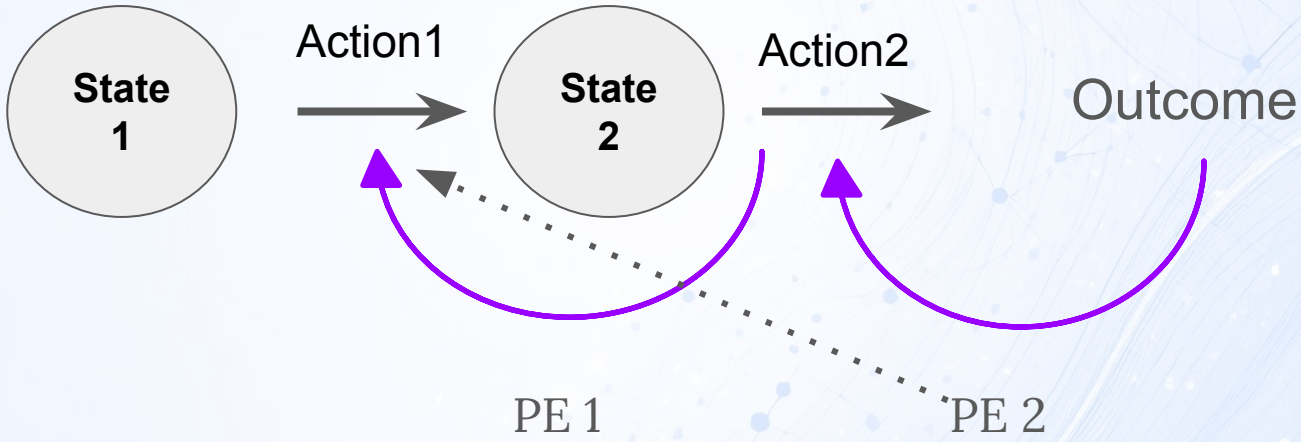
Model-free sequence learning



Model-free sequence learning



Model-free sequence learning



Model-free sequence learning

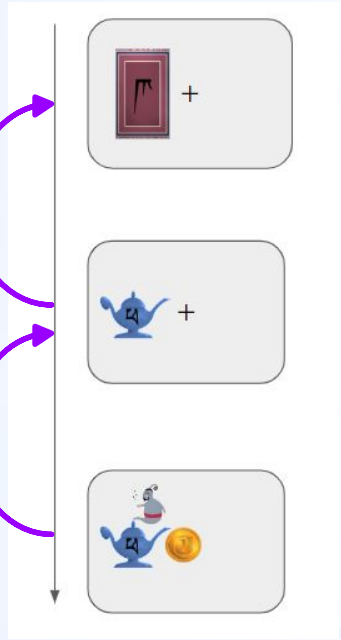
Parameters

α - Learning rate

β - Inverse temperature

λ - Eligibility factor, determines the decay rate of the eligibility traces

Model-free sequence learning



Action value updating

$$PE_1 = Q(s_2, a_1)_t - Q(s_1, a_1)_t$$

$$PE_2 = r_t - Q(s_2, a_1)_t$$

$$Q(s_1, a_1)_{t+1} = Q(s_1, a_1)_t + \alpha \cdot PE_1 + \alpha \cdot \lambda \cdot PE_2$$

$$Q(s_2, a_1)_{t+1} = Q(s_2, a_1)_t + \alpha \cdot PE_2$$

Model-free sequence learning

Action selection

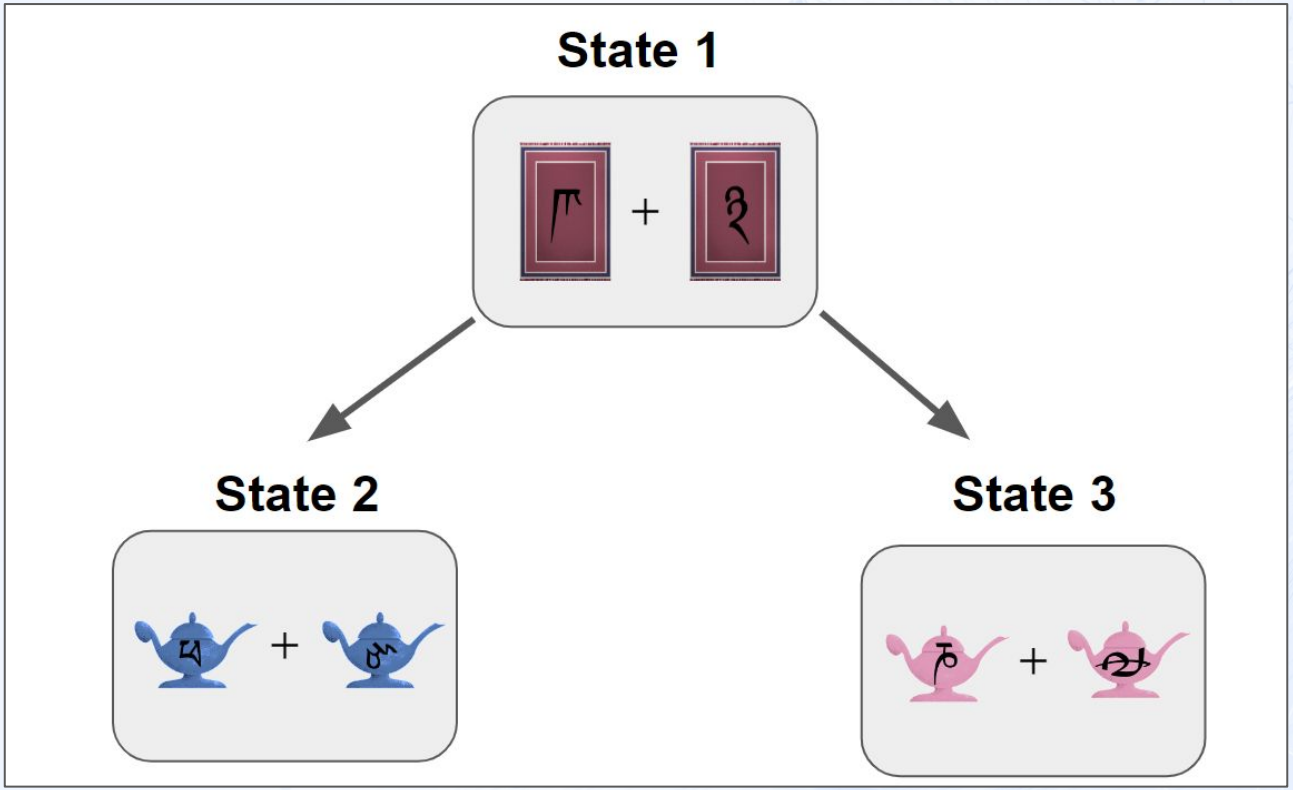
$$P(s_1, a_t = 1) = \frac{e^{\beta \cdot Q_{(s_1,a_1)t}}}{e^{\beta \cdot Q_{(s_1,a_1)t}} + e^{\beta \cdot Q_{(s_1,a_2)t}}}$$

$$P(s_2, a_t = 1) = \frac{e^{\beta \cdot Q_{(s_2,a_1)t}}}{e^{\beta \cdot Q_{(s_2,a_1)t}} + e^{\beta \cdot Q_{(s_2,a_2)t}}}$$

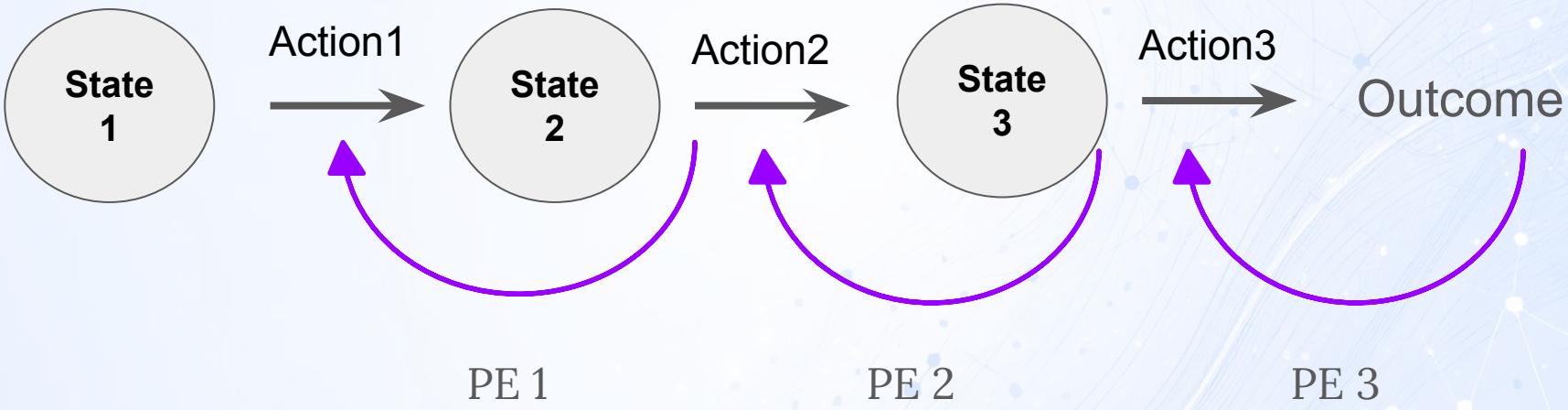
Model-free sequence learning

Step-by-step:

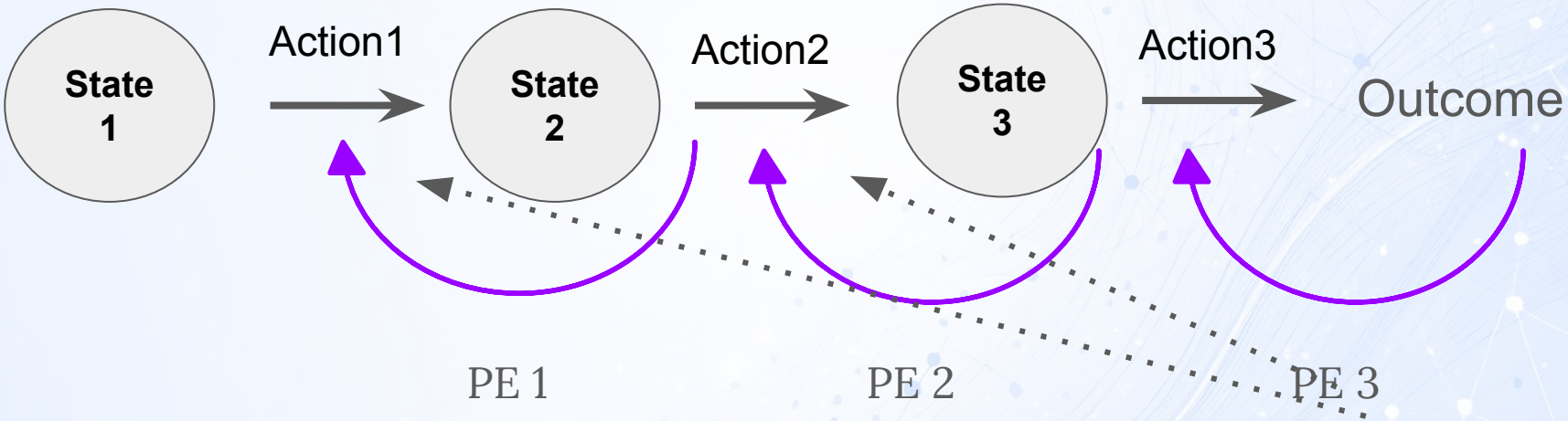
1. simulating artificial behavior
2. estimate parameters


State 1
+
State 2
+
State 3
+

Model-free sequence learning



Model-free sequence learning



Model-free sequence learning