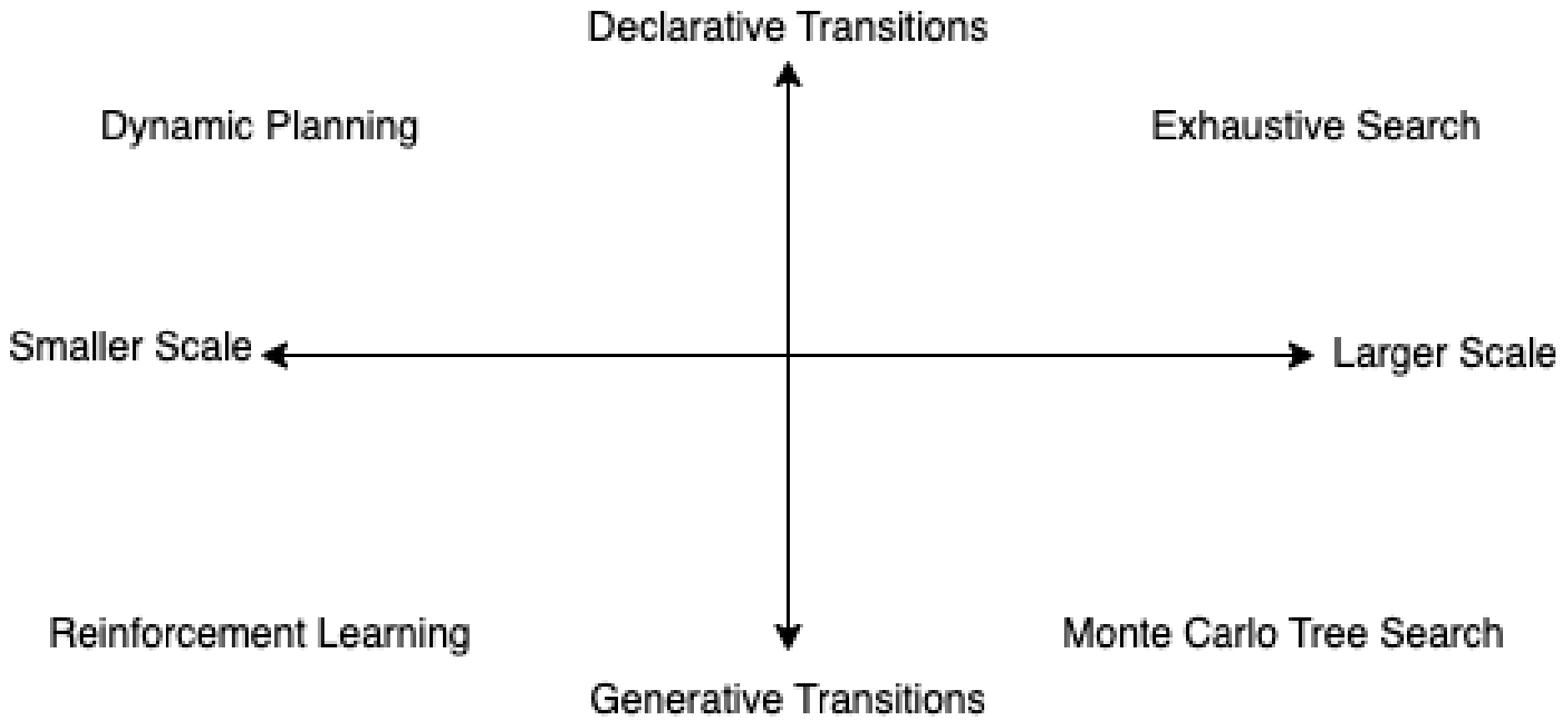
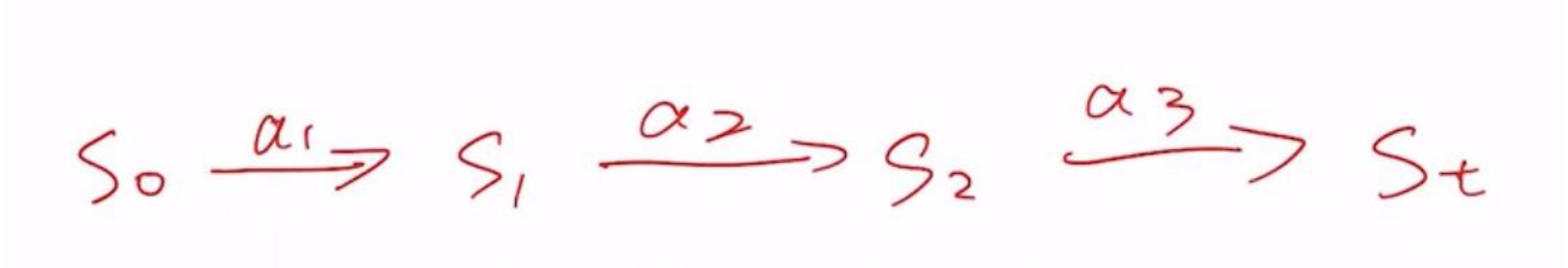
Workshop 8

Big Picture


Declarative Transitions
Dynamic Planning
Exhaustive Search
Smaller Scale
Larger Scale
Reinforcement Learning
Monte Carlo Tree Search
Generative Transitions

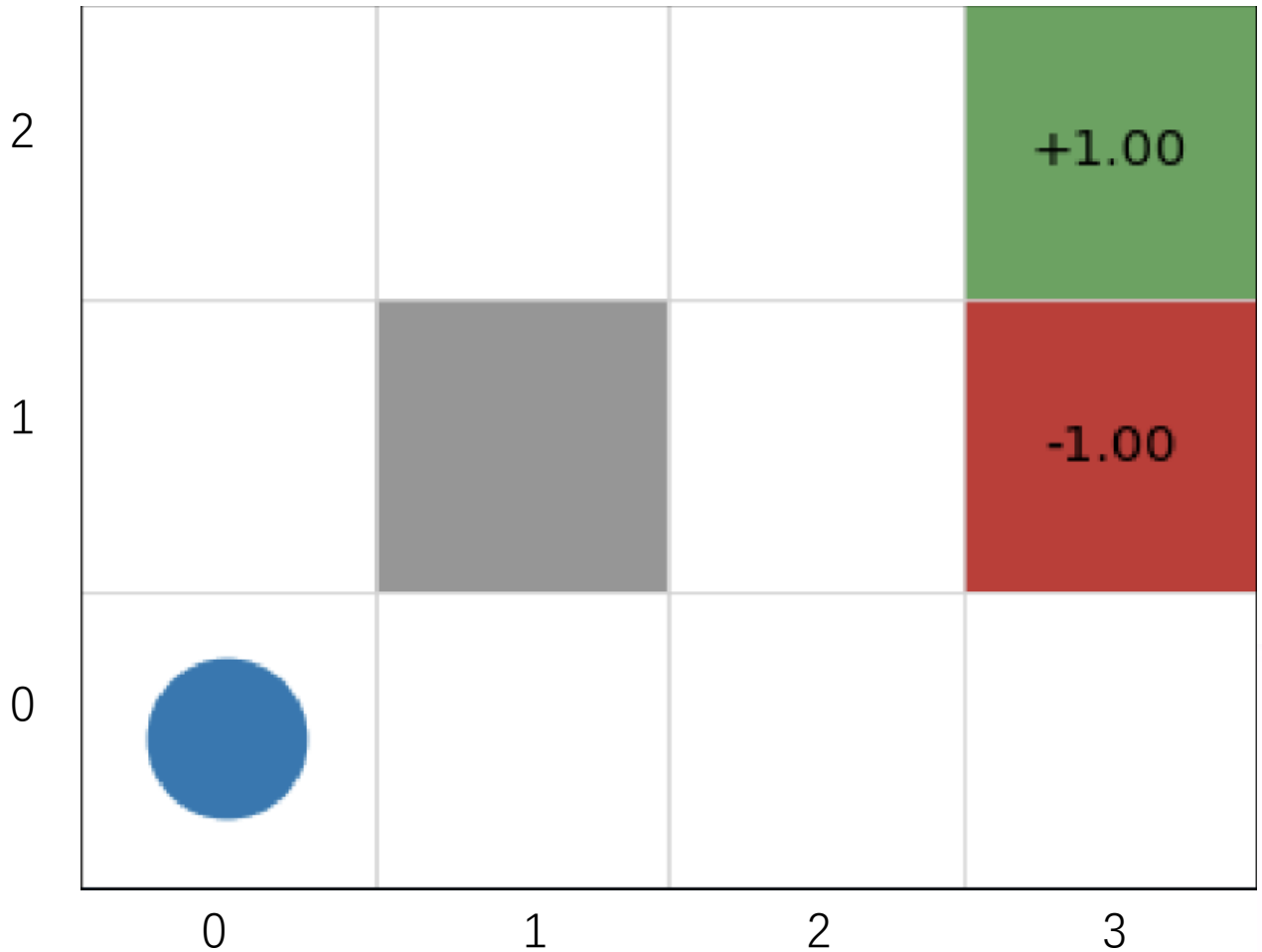
Temporal difference learning

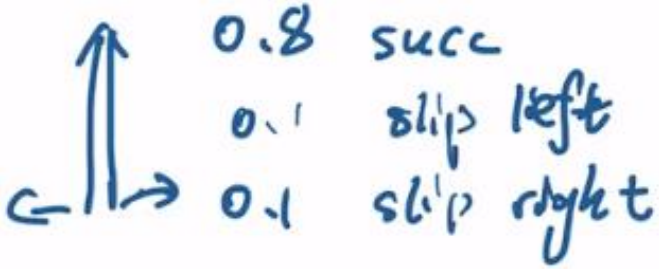


$$\delta \leftarrow [\overbrace{r}^{\text{reward}} + \overbrace{\gamma}^{\text{discount factor}} \cdot \overbrace{\max_{a'} Q(s', a')}^{V(s') \text{ estimate}}]_{\text{TD target}} - \overbrace{Q(s, a)}^{\text{do not count extra } Q(s,a)}$$

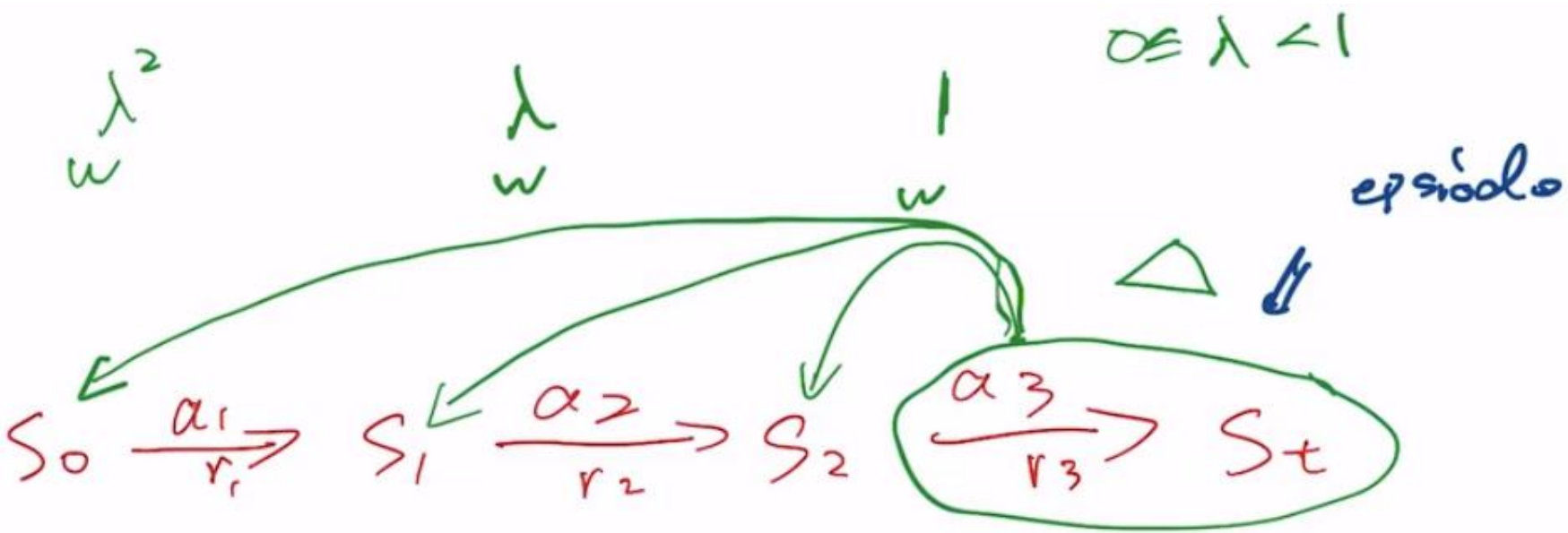
$$Q(s, a) \leftarrow \underbrace{Q(s, a)}_{\text{old value}} + \overbrace{\alpha}^{\text{learning rate}} \cdot \underbrace{\delta}_{\text{delta value}}$$

Lecture Example

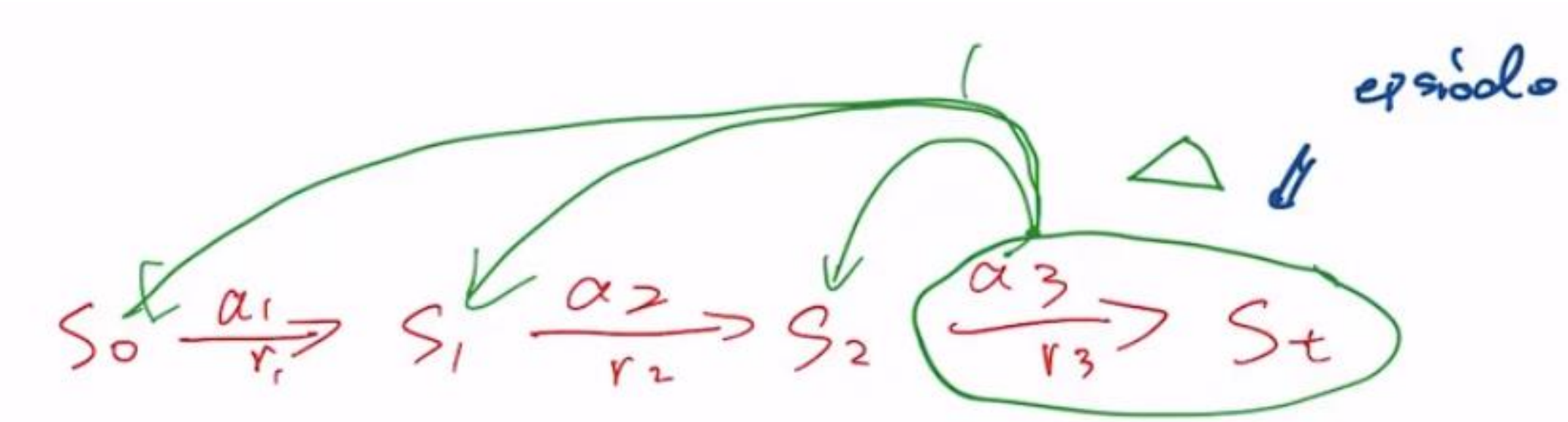




How to update Q(s, a)? TD-lambda



N-step TD



Q-learning

Repeat (for each episode)

$s \leftarrow$ the first state in episode e

Repeat (for each step in episode e)

Select action a to apply in s; e.g. Q and a multi-armed bandit algorithm

Execute action a in state s

Observe reward r and new state s'

$\delta \leftarrow r + \gamma \cdot \max_{a'} Q(s', a') - Q(s, a)$

$Q(s, a) \leftarrow Q(s, a) + \alpha \cdot \delta$

$s \leftarrow s'$

Until s is the last state of episode e (a terminal state)

Sarsa

Repeat (for each episode)

$s \leftarrow$ the first state in episode e

Select action a to apply in s using Q and a multi-armed bandit algorithm

Repeat (for each step in episode e)

Execute action a in state s

Observe reward r and new state s'

Select action a' to apply in s' using Q and a multi-armed bandit algorithm

$\delta \leftarrow r + \gamma \cdot Q(s', a') - Q(s, a)$

$Q(s, a) \leftarrow Q(s, a) + \alpha \cdot \delta$

$s \leftarrow s'$

$a \leftarrow a'$

Until s is the last state of episode e (a terminal state)

Original Q(s, a) Updating function

$$\delta \leftarrow [\overbrace{r}^{\text{reward}} + \overbrace{\gamma}^{\text{discount factor}} \cdot \overbrace{\max_{a'} Q(s', a')}^{V(s') \text{ estimate}} \underbrace{- Q(s, a)}_{\text{do not count extra } Q(s,a)}]$$

TD target

$$Q(s, a) \leftarrow \underbrace{Q(s, a)}_{\text{old value}} + \overbrace{\alpha}^{\text{learning rate}} \cdot \underbrace{\delta}_{\text{delta value}}$$

How delta differ for Q-learning and Sarsa

$$Q(s,a) \leftarrow \underbrace{Q(s,a)}_{\text{old value}} + \overbrace{\alpha}^{\text{learning rate}} \cdot \underbrace{\delta}_{\text{delta value}}$$

Q-learning

$$\delta \leftarrow r + \gamma \cdot \max_{a'} Q(s',a') - Q(s,a)$$

Sarsa

$$\delta \leftarrow r + \gamma \cdot Q(s',a') - Q(s,a)$$

Question 2

$$Q(s,a) \leftarrow \underbrace{Q(s,a)}_{\text{old value}} + \overbrace{\alpha}^{\text{learning rate}} \cdot \underbrace{\delta}_{\text{delta value}}$$

$$\delta \leftarrow r + \gamma \cdot \max_{a'} Q(s',a') - Q(s,a)$$

$$\begin{aligned} Q(S,P) &= Q(S,P) + 0.4 \cdot [r(S,P) + 0.9 \cdot \max_{a' \in A(M)} Q(M,a') - Q(S,P)] \\ &= -0.7 + 0.4 \cdot [(-1) + 0.9 \cdot (-0.4) - (-0.7)] \\ &= -0.7 + 0.4 \times (-0.66) \\ &= -0.964 \end{aligned}$$

Question 2

$$Q(s,a) \leftarrow \underbrace{Q(s,a)}_{\text{old value}} + \overbrace{\alpha}^{\text{learning rate}} \cdot \underbrace{\delta}_{\text{delta value}}$$

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$$\begin{aligned} Q(S,P) &= Q(S,P) + 0.4 \cdot [r(S,P) + 0.9 \cdot \max_{a' \in A(M)} Q(M,a') - Q(S,P)] \\ &= -0.7 + 0.4 \cdot [(-1) + 0.9 \cdot (-0.4) - (-0.7)] \\ &= -0.7 + 0.4 \times (-0.66) \\ &= -0.964 \end{aligned}$$

Question 3

$$Q(s,a) \leftarrow \underbrace{Q(s,a)}_{\text{old value}} + \overbrace{\alpha}^{\text{learning rate}} \cdot \underbrace{\delta}_{\text{delta value}}$$

$$\delta \leftarrow r + \gamma \cdot Q(s', a') - Q(s, a)$$

$$\begin{aligned} Q(S,P) &= Q(S,P) + 0.4 \cdot [r(S,P) + 0.9 \cdot Q(M, \pi(M)) - Q(S,P)] \\ &= -0.7 + 0.4 \cdot [(-1) + 0.9 \cdot (-0.8) - (-0.7)] \\ &= -0.7 + 0.4 \times (-1.102) \\ &= -1.108 \end{aligned}$$