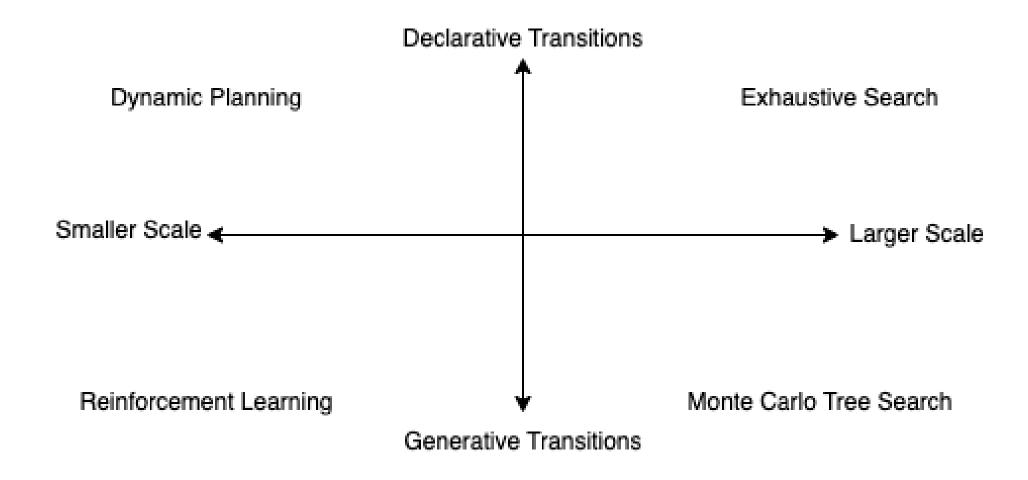
Workshop 8

Big Picture



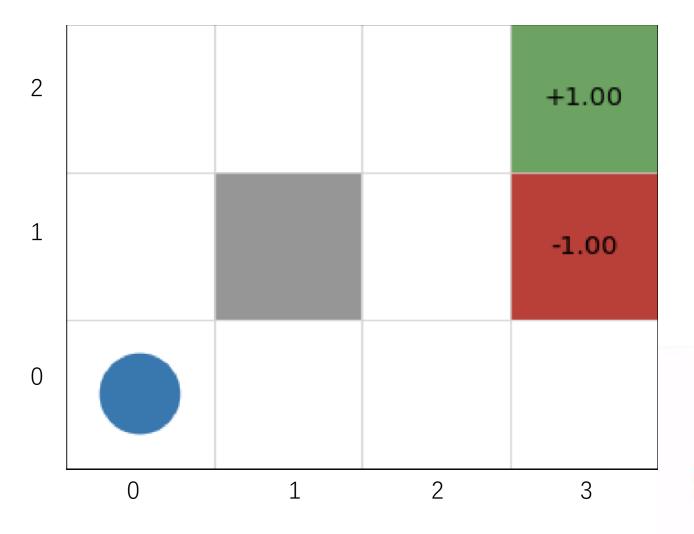
Temporal difference learning

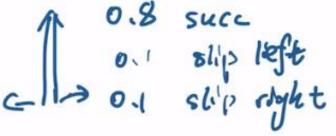
$$\delta \leftarrow [\overbrace{r}^{\text{reward}} + \overbrace{\gamma}^{\text{discount factor}} \underbrace{-Q(s,a)}^{V(s') \text{ estimate}} \underbrace{-Q(s,a)}^{\text{do not count extra } Q(s,a)}_{-Q(s,a)}]$$

$$TD \text{ target}$$

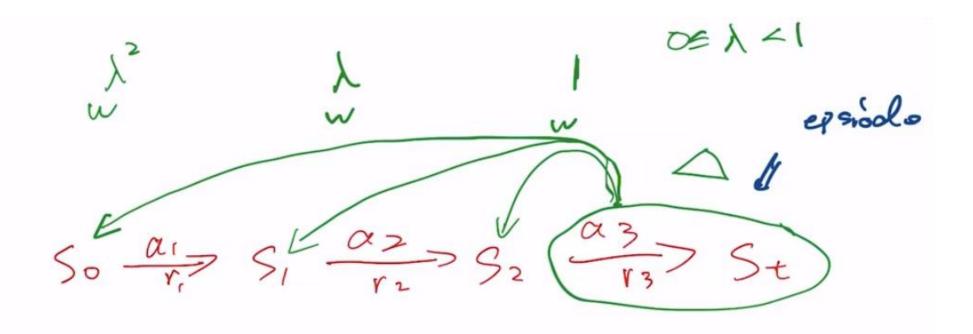
$$Q(s,a) \leftarrow \underbrace{Q(s,a)}_{\text{old value}} + \overbrace{\alpha}^{\text{learning rate}} \cdot \underbrace{\delta}_{\text{delta value}}$$

Lecture Example

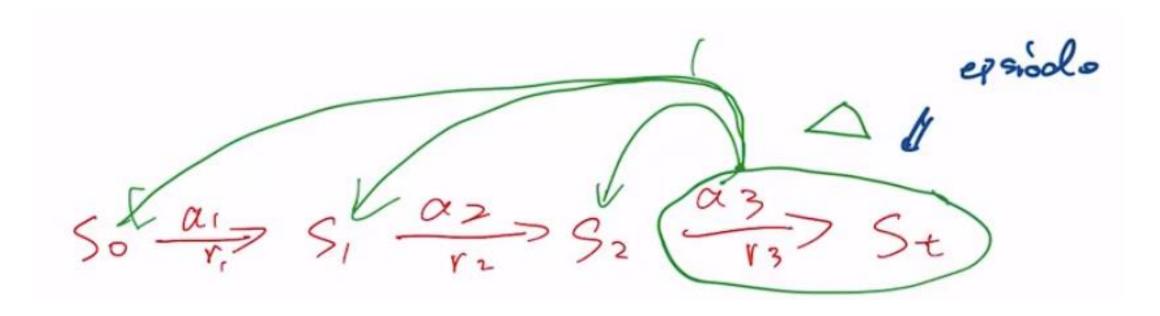




How to update Q(s, a)? TD-lambda



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^\prime to apply in s^\prime using Q and a multi-armed bandit algorithm

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

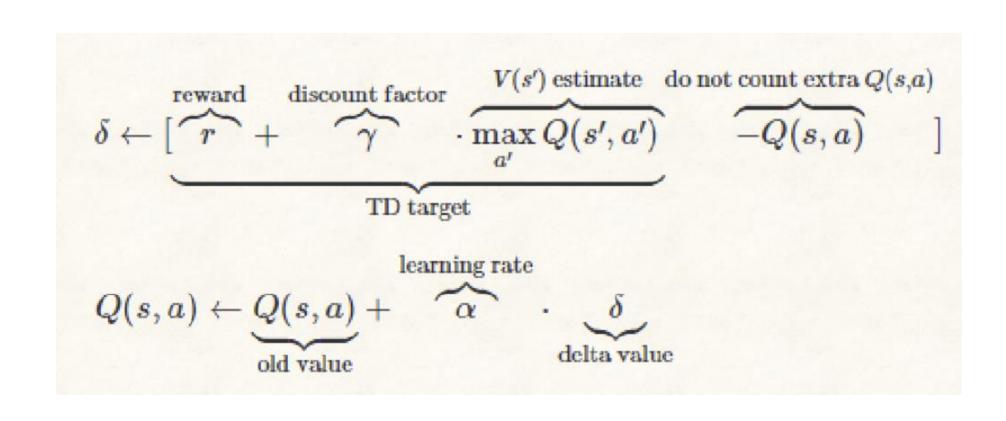
$$Q(s,a) \leftarrow Q(s,a) + \alpha \cdot \delta$$

$$s \leftarrow s'$$

$$a \leftarrow a'$$

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

Original Q(s, a) Updating function



How delta differ for Q-learning and Sarsa

$$Q(s,a) \leftarrow \underbrace{Q(s,a)}_{ ext{old value}} + \underbrace{\alpha}_{ ext{old value}} \cdot \underbrace{\delta}_{ ext{delta value}}$$

Q-learning

Sarsa

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

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

Question 2

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

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

$$Q(S,P) = Q(S,P) + 0.4 \cdot [r(S,P) + 0.9 \cdot \max_{a' \in A(M)} Q(M,a') - Q(S,P)]$$

$$= -0.7 + 0.4 \cdot [(-1) + 0.9 \cdot (-0.4) - (-0.7)]$$

$$= -0.7 + 0.4 \times (-0.66)$$

$$= -0.964$$

Question 2

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

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$$= -0.7 + 0.4 \cdot [(-1) + 0.9 \cdot (-0.4) - (-0.7)]$$

$$= -0.7 + 0.4 \times (-0.66)$$

$$= -0.964$$

Question 3

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

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

$$Q(S,P) = Q(S,P) + 0.4 \cdot [r(S,P) + 0.9 \cdot Q(M,\pi(M)) - Q(S,P)]$$

$$= -0.7 + 0.4 \cdot [(-1) + 0.9 \cdot (-0.8) - (-0.7)]$$

$$= -0.7 + 0.4 \times (-1.102)$$

$$= -1.108$$