Waterfall Gridworld

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Machine and Reinforcement Learning in Control Applications

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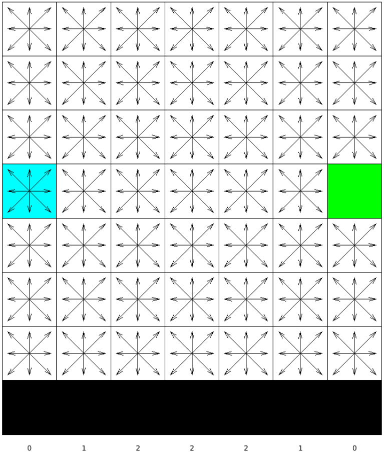
Problem

Learn to move in an unknown map with external disturbances

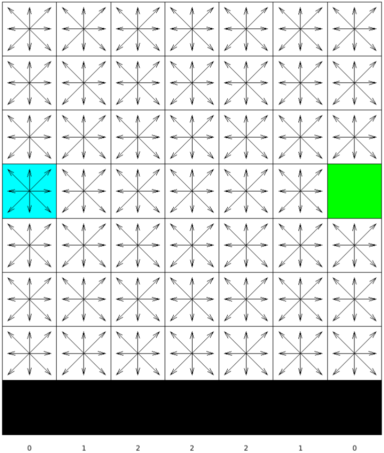
Problem formulation

- Consider the grid world on the right;
- The goal is to reach the green box;
- A waterfall pushes the agent toward the bottom of the grid



Problem formulation

- 8 possible directions:
  N, S, E, W, NE, NW, SE, SW;
- Reward:
  - -1 for each step



Model

- The **state** is the position in the Gridworld
  - we have $X \cdot Y$ states.
- The **action** is the direction of the movement
  - we have 8 actions.

TD(λ)

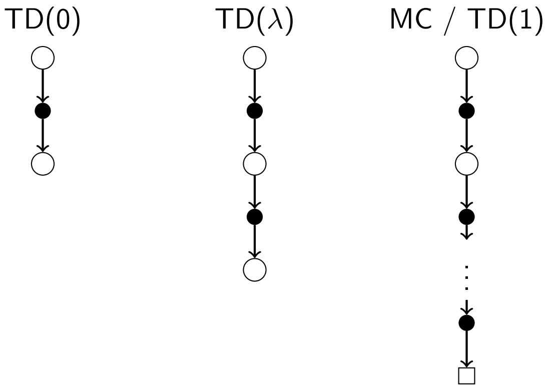
TD(0)

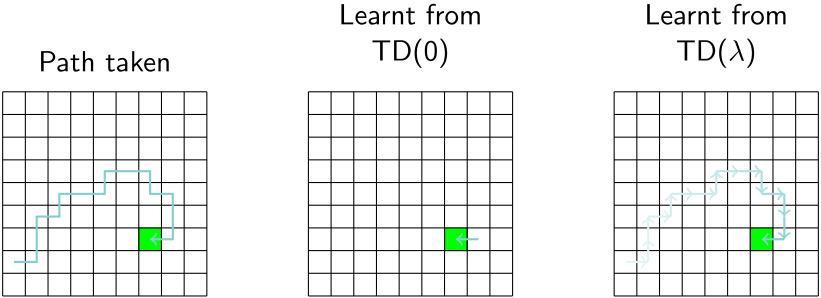
TD(λ)

TD(0)

MC / TD(1)

TD(λ)




Path taken
Learnt from TD(0)
Learnt from TD(λ)

Eligibility traces

- The eligibility traces keep memory of the visited states;
- At each step, the eligibility trace of visited state is updated:
  - **Accumulating traces**:

$$E_{t+1}(s,a) = E_t(s,a) + 1$$

  - **Replacing traces**:

$$E_{t+1}(s,a) = 1$$

  - **Dutch traces**:

$$E_{t+1}(s,a) = (1-\alpha)E_t(s,a) + 1$$

- At each step, the eligibility trace of non-visited states decays

$$E_{t+1}(s,a) = \gamma\lambda E_t(s,a)$$

Estimates update

- Apply the TD(λ) prediction method to state–action pairs.
- The TD error for state-value prediction is

$$\delta_t = R_{t+1} + \gamma Q_t(S_{t+1}, A_{t+1}) - Q_t(S_t, A_t)$$

- The updates are

$$Q_{t+1}(s,a) = Q_t(s,a) + \alpha \delta_t E_t(s,a), \quad \forall s, a$$