Formula 1

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Machine and Reinforcement Learning in Control Applications

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Problem

Learn to follow a track.
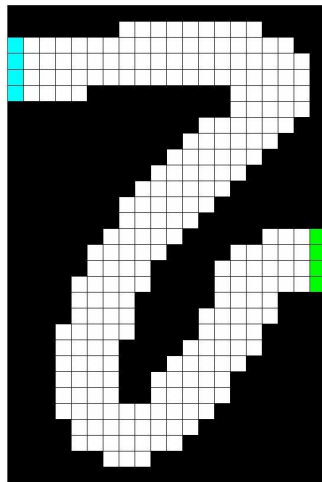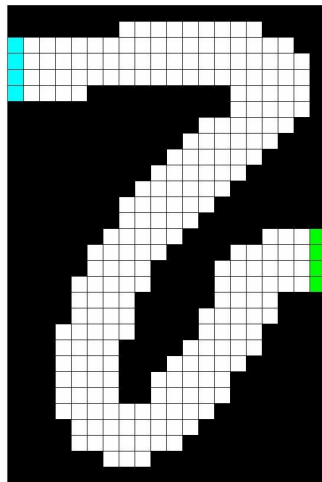
Learn to follow a track.

Problem formulation

- The car starts from the starting line (cyan);

- The car must reach the finish line (green);

- The goal is to find the shortest path to the finish line;

Problem formulation

- The car can move in 8 directions:
  N, S, E, W, NE, NW, SE, SW;

- Reward:
  - $-dist$ for each step
  - -10^6 for hitting the boundary

Model

- The **state** is the position of the car in the track
    - we have $X \cdot Y$ states.

- The **action** is the direction along which the car moves
    - we have 8 actions.

Planning: Dynamic Programming

- Model the problem as an **MDP**;

- Compute the transition matrix **P**;

- Compute the reward matrix **R**;

- Find the optimal policy $\pi_\star$ using **Dynamic Programming** method (PI or VI).

Learning: Monte Carlo

- **Model-free**: no knowledge of MDP transitions and rewards;

- Simulate episodes:

$$S_0, A_0, R_0, S_1, A_1, R_1..., S_T, A_T, R_T$$

- Use experience to estimate $q_\star$:

$$\pi_\star(s) = \arg \max_a q_\star(s, a)$$

Assignment #3

- Learn to play Blackjack.
    - The goal is to obtain cards whose sum is the closest to 21;
    - All face cards count as 10, an ace counts as 1 or as 11;
    - Player start with two cards;
    - Dealer starts with two cards, one face up and one face down;
    - The player can request additional cards (hit) or stop (stick);
    - The dealer plays according to a fixed strategy:
        - Stick on any sum of 17 or greater, and hit otherwise.
    - If the player exceeds 21, he goes burst an loses the game.
    - If the dealer goes burst, the player wins; otherwise, the outcome is determined by whose final sum is closer to 21;
    - Reward:
        - $+1$ for winning;
        - -1 for losing;
    - Do not discount ($\gamma = 1$).
    - Find the best strategy based on the player's cards and the dealer's face-up card.