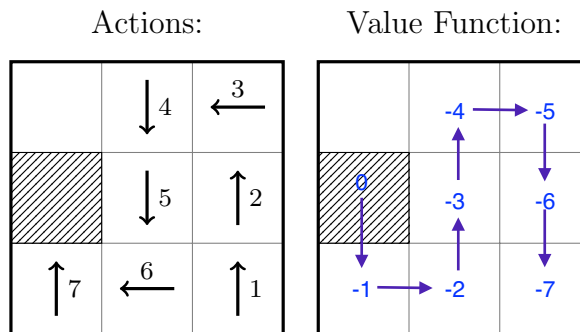


# Reinforcement Learning Exercise

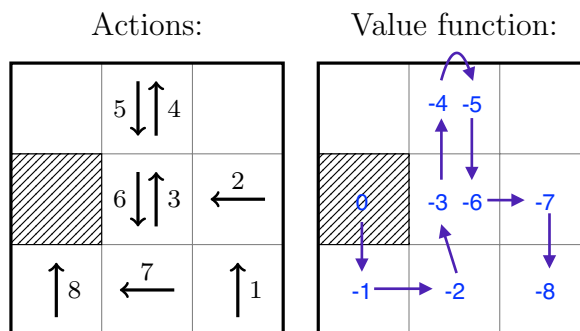
## Question 1: Monte Carlo Estimation

Given is a gridworld with possible actions in each direction and a reward of -1 for each action. The marked grid is the terminal state. The actions for two episodes have been calculated and are displayed below. The numbers indicate the order of the steps.

- (a) The first episode uses the following actions. Calculate the value function after the episode.




- (b) (8 points) Here are the actions for the second episode. What is the updated value function?



**Question 2: Time Difference Learning**









We would now like to use TD(0) prediction for the same problem. The actions are the same as above. The value function is initially -1 for every state except the terminal state. A constant step size  $\alpha = 0.2$  is used. Run the algorithm for 2 episodes.

Initiale Value Funktion:


-1.0	-1.0	-1.0
	-1.0	-1.0
-1.0	-1.0	-1.0

- (a) The following actions are used for the first episode. Specify the value function after the first episode.

Actions:










	 <sub>4</sub>	 <sub>3</sub>
	 <sub>5</sub>	 <sub>2</sub>
 <sub>7</sub>	 <sub>6</sub>	 <sub>1</sub>

Value function:


		

- (b) These are the actions for the second episode. What is the updated value function?

Actions:

	 <sub>5</sub>  <sub>4</sub>	
	 <sub>6</sub>  <sub>3</sub>	 <sub>2</sub>
 <sub>8</sub>	 <sub>7</sub>	 <sub>1</sub>

Value Function:

**Question 3: Q-Learning**

Instead of prediction, we now want to use Q-learning as the control algorithm. To do this, we want to calculate the action-value function and then a better policy in each case. You have already performed iterations, and the current action values for each state in the direction of the actions N, E, S, and W are as shown below.

Initial action-value function:

	-2.3	-3.2	-3.6
-2.4	-2.7	-2.0	-3.4
-1.0	-2.1	-2.8	
	-3.1	-3.2	
	-1.0	-3.2	-2.2
	-2.6	-3.4	
-1.0	-2.2	-2.7	
-2.2	-3.1	-2.1	-2.6
-2.1	-2.5	-3.7	

- (a) The actions drawn from the policy for each state are shown below. Calculate the action-value functions for the episode shown. This time, use a constant step size  $\alpha = 1$  for the update. Only enter the values that have changed.

Actions:

	5 ↓ ↑ 4	
	6 ↓ ↑ 3 ← 2	
↑ 8 ← 7		↑ 1

Update the action-value function  $Q$ :


- (b) Now calculate the greedy policy for all states from the values after the above update and plot them.

