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1 Assignment 2: Reinforcement Learning

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Please submit a PDF containing all outputs to gradescope by March 26th at 11:59 PM.

In this assignment you will learn how to train a simple environment using Q-learning as taught in class.

First you will use a popular python package called gymnasium to create a simple Grid World environment.

After you have a working environment you will implement Q-Learning and use it to solve your implementation of grid world.

Finally, you will show that you have implemented everything correctly by showing that you can use your Q-Learning algorithm to train an environment already included in the gymnasium package.

2 Part 1: Implementing a Gymnasium Environment

We will start by implementing a simple gymnasium environment. You can find documentation for the whole package here https://gymnasium.farama.org/index.html#.

First let's install the necessary packaged

```
[259]: # Install the necessary packages
| pip install gymnasium pyvirtualdisplay > /dev/null 2>&1
| pip install pygame
```

Requirement already satisfied: pygame in /usr/local/lib/python3.10/dist-packages (2.5.2)

Next we'll import the packages you'll need

```
[260]: import gymnasium as gym from gymnasium import spaces
```

```
import numpy as np
import pygame
import random
```

First we will initialize our new class. This class will need to take in 3 arguments. The width and height of the grid as well as the description for our grid world environment.

Your environment must be able to handle any given width and height as well as any given description. The description will come in the form of a string that specify the block order from left to right. There are three possible types of blocks.

- 1. "I" specifies that a block should be ice
- 2. "H" specifies that a block should be a hole
- 3. "G" specifies that a block should be the goal.

For example an environment with width 3, height 3 and a description "IIHHIIIIG" looks like this

Every gymnasium class must define an observation and an action space of type "space." You can find a description of spaces here https://gymnasium.farama.org/api/spaces/. In addition to the space you will probably want to include other information in the init function such as the location of the agent and the description of the grid. These are style choices please represent these however you would like.

```
[261]: class FrozenLake(gym.Env):
         def __init__(self, grid_width, grid_height, grid_description):
             self.width = grid_width
             self.height = grid_height
             self.grid_description = grid_description
             self.number_of_holes = sum(1 for char in grid_description if char == 'H')
             self.num_holes_after = 0
             grid_map = \{'A': 1, 'I': 0, 'G': 3, 'H': 2\}
             self.state = np.array([grid_map[char] for char in grid_description]).
        →reshape(grid_height, grid_width)
             ice positions = np.argwhere(self.state == 0)
             self.agent_position = tuple((0,0))
             self.state[self.agent_position] = 1
             self.observation_space = spaces.Box(low=0, high=3, shape=(grid_height,_
        ⇒grid_width), dtype=np.uint8)
             self.action_space = spaces.Discrete(4)
```

The next method you will define for your class is the _get_obs method. This should return the observation for your environment. Think of how we defined an observation in class and return that here.

```
[262]: class FrozenLake(FrozenLake):
    def _get_obs(self):
        return self.state
```

Next, please define a reset function. This should return your environment to its original state. We have returned the correct output for you. All you need to do is reset any necessary variables.

```
[263]: class FrozenLake(FrozenLake):
        def reset(self, seed=None, options=None):
          super().reset(seed=seed)
          self.cumulative_reward = 0
          grid_map = {'A': 1, 'I': 0, 'G': 3, 'H': 2}
          self.state = np.array([grid_map[char] for char in self.grid_description]).
        →reshape(self.height, self.width)
          self.agent position = tuple((0,0))
          self.state[self.agent_position] = 1
          observation = self._get_obs()
          info = None
          return observation, info
       #*********
       # Define the environment parameters
      grid_width = 3
      grid_height = 3
      grid_description = "IIHHIIIIG"
       # Create an instance of the FrozenLake environment
      frozen_lake_env = FrozenLake(grid_width, grid_height, grid_description)
       # Call the reset method to reset the environment
      observation, info = frozen_lake_env.reset()
       # Now observation contains the initial observation of the environment
       # and info contains any additional information you might need
      print("Initial observation:\n", type(observation))
      print("Info:", info)
```

```
Initial observation:
     <class 'numpy.ndarray'>
Info: None
```

Now write the method that will return the reward for a given observation.

Hint: In addition to thinking about rewards in the grid you will need to account for rewards when the agent "escapes" the grid.

```
class FrozenLake(FrozenLake):
    def compute_reward(self, observation):
        self.num_holes_after = np.count_nonzero(self.state == 2)
        if self.num_holes_after < self.number_of_holes and any(1 in row for row in_u
        observation):
            return -1
        elif not any(3 in row for row in observation) and any(1 in row for row in_u
        observation):
            return 10
        elif not any(1 in row for row in observation):
            return -10
        elif any(3 in row for row in observation) and any(2 in row for row in_u
        observation) and any(0 in row for row in observation):
            return -0.2
```

Given an action you will want to modify the current state of your environment to account for the action. Additionally, given the observation and reward determine if the episode is over or not.

Hint: you will need to determine if the agent is out of the grid(either out of bounds or in a hole) or at the goal.

```
[265]: class FrozenLake(FrozenLake):
         def step(self, action):
             old_state = np.copy(self.state)
             current_position = np.argwhere(self.state == 1)[0]
             movements = {
                 0: (-1,0),
                 1: (1,0),
                 2: (0,1),
                 3: (0,-1)
             movement = movements[action]
             new_position = tuple(current_position + movement)
             if 0 <= new_position[0] < self.height and 0 <= new_position[1] < self.
        ⇒width:
                   if self.state[new_position[0], new_position[1]] == 3:
                     if self.num_holes_after < self.number_of_holes:</pre>
                       self.state[current position[0], current position[1]] = 2
                     else:
```

```
self.state[current_position[0], current_position[1]] = 0
              self.state[new_position[0], new_position[1]] = 1
              reward = self.compute_reward(self.state)
              terminated = True
            elif self.state[new_position[0], new_position[1]] == 2:
              self.num_holes_after = np.count_nonzero(self.state == 2)
              if self.num_holes_after < self.number_of_holes:</pre>
                self.state[current_position[0], current_position[1]] = 2
              else:
                self.state[current_position[0], current_position[1]] = 0
              self.state[new_position[0], new_position[1]] = 1
              reward = self.compute reward(self.state)
              terminated = True
            else: #if newposition = I
              self.num_holes_after = np.count_nonzero(self.state == 2)
              if self.num_holes_after < self.number_of_holes:</pre>
                self.state[current_position[0], current_position[1]] = 2
              else:
                self.state[current_position[0], current_position[1]] = 0
              self.state[new_position[0], new_position[1]] = 1
              reward = self.compute reward(self.state)
              terminated = False
      else:
        reward = self.compute_reward(self.state)
        self.state[current_position[0], current_position[1]] = 0
        terminated = True
      observation = self._get_obs()
      #TODO: Set terminated to true if the episode is completed and false \Box
 \rightarrow otherwise
      return observation, old_state, reward, terminated, False, None
#**************
# Define the environment parameters
grid_width = 3
grid_height = 3
grid_description = "IIHHIIIIG"
# Create an instance of the FrozenLake environment
frozen_lake env = FrozenLake(grid width, grid height, grid_description)
frozen_lake_env._get_obs()
```

Use pygame to render your environment (https://www.pygame.org/docs/). You will need to obtain the current observation as well as the description of the grid to do this. If you want to render it the same way we did you should be able to complete this function using only the pygame.draw.rect and pygame.draw.circle functions. You're welcome to make something that looks better, but it's not required.

```
[266]: class FrozenLake(FrozenLake):
         def _render_frame(self, screen, window_width, window_height):
           block_size = 50 # Size of each grid block
           agent_color = (255, 0, 0) # Color of the agent
           ice_color = (173, 216, 230) # Color of ice blocks
           hole_color = (0, 0, 0) # Color of holes
           goal_color = (0, 255, 0) # Color of the goal
           screen.fill((255, 255, 255)) # Fill the screen with white color
           # Draw each block of the grid
           for y in range(self.height):
               for x in range(self.width):
                   if self.state[y][x] == 0:
                       color = ice_color
                   elif self.state[y][x] == 2:
                       color = hole_color
                   elif self.state[y][x] == 3:
                       color = goal_color
                   else:
                   pygame.draw.rect(screen, color, (x * block_size, y * block_size, u
        ⇔block_size, block_size))
           # Draw the agent
           agent_x, agent_y = np.where(self.state == 1)
           if agent_x.size > 0 and agent_y.size > 0:
             agent_x, agent_y = agent_x[0], agent_y[0]
             if 0 <= agent_x < self.height and 0 <= agent_y < self.width:</pre>
               pygame.draw.circle(screen, agent_color, (agent_y * block_size +_
        ublock_size // 2, agent_x * block_size + block_size // 2), block_size // 3)
           pygame.display.flip() # Update the display
         def render(self, screen, window_width, window_height):
           return self._render_frame(screen, window_width, window_height)
```

If you have implemented everything correctly, the following code should render your environment and move the agent randomly. Make sure to include these images in your saved PDF.

```
[267]: import cv2
       from IPython.display import clear_output
       from google.colab.patches import cv2_imshow
       import time
       lake = FrozenLake(3, 3, "IIHHIIIIG")
       window width = 400
       window_height = 400
       pygame.init()
       screen = pygame.display.set_mode((window_width, window_height))
       for i in range(0, 1):
         observation, info = lake.reset()
         terminated = False
         while not terminated:
           action = lake.action_space.sample()
           print(action)
           observation, old_state, reward, terminated, truncated, info = lake.
        ⇔step(action)
           print(reward)
           print(terminated)
           if terminated:
             break
           lake.render(screen, window_width, window_height)
           view = pygame.surfarray.array3d(screen)
           view = view.transpose([1, 0, 2])
           img_bgr = cv2.cvtColor(view, cv2.COLOR_RGB2BGR)
           cv2_imshow(img_bgr)
           time.sleep(.5)
```

1 -1 True

3 Part 2: Implement Q-Learning

We will implement a simple algorithm that should be able to solve any gymnasium environment with discrete observation and action spaces.

In the init function we will pass in the environment as well as the percentage of time the policy should explore versus exploit. We will also pass in gamma and alpha as defined in the bellman equation you learned in class. obs_space_n and action_space_n should represent the dimensions of the observation and action spaces.

We have defined everything for you except the Q-Table. Please design this however you want.

```
[268]: import random
      class QLearning():
        def __init__(self, env, exploration, gamma, alpha, obs_space_n,_
        →action_space_n):
          self.env = env
          self.exploration = exploration
          self.gamma = gamma
          self.alpha = alpha
          self.obs_space_n = obs_space_n
          self.action_space_n = action_space_n
          #TODO: Define your q table such that you can easily access the q value for
        \hookrightarrow (s,a)
          self.q table = np.zeros((obs space n, action space n))
      #***************
      obs_space_n = 3
      action_space_n = 4
      # Create an instance of QLearning
      q_learning = QLearning(env=None, exploration=None, gamma=None, alpha=None,
        →obs_space_n=obs_space_n, action_space_n=action_space_n)
```

Define a method that should sample an action from the policy. Remember to balance the amount of exploring you do versus the amount of exploiting.

```
[269]: #observation is the position of the agent, states in the q table are
        →cooridinates on the grid, as the agent moves on the grid map the position of ⊔
        →the agen twith the coordinate, preprocessing in both funcs sample and update_
        →mapping (preprocessing)
       class QLearning(QLearning):
         def sample_action(self, observation):
           for i in range(len(observation)):
             for j in range(len(observation[i])):
               if (observation[i][j])== 1:
                 coordinateX = i
                 coordinateY = j
                 break
           oneD_location = (coordinateX * 3) + coordinateY
           epsilon = self.exploration # Exploration rate
           if random.uniform(0, 1) < epsilon:</pre>
             # Explore: select a random action with probability epsilon
             return random.randint(0, self.action_space_n - 1)
```

Define a method that updates your q-table.

```
[270]: class QLearning(QLearning):
         def update_table(self, observation, action, reward, new_observation, __
        →terminated):
           coordinateX = 0
           coordinateY = 0
           coordinateX1 = 0
           coordinateY1 = 0
           for i in range(len(observation)):
             for j in range(len(observation[i])):
               if observation[i][j] == 1:
                 coordinateX = i
                 coordinateY = j
                 break
           oneD_location = (coordinateX * 3) + coordinateY
           for i in range(len(new observation)):
             for j in range(len(new_observation[i])):
               if new observation[i][j] == 1:
                 coordinateX1 = i
                 coordinateY1 = j
           oneD location1 = (coordinateX1 * 3) + coordinateY1
           if terminated == False:
```

```
new_q_value = (1 - self.alpha) * self.q_table[oneD_location] [action] +__
 self.alpha * (reward + self.gamma * np.max(self.q table[oneD_location1]))
   else:
      new_q_value = (1 - self.alpha) * self.q_table[oneD_location] [action] +__
 ⇒self.alpha * reward
   self.q_table[oneD_location] [action] = new_q_value
#*********
# lake = FrozenLake(3, 3, "IIHHIIIIG")
# q_learning = QLearning(lake, .3, .99, .9, lake.width * lake.height, lake.
\rightarrow action_space.n)
# a = [[0, 0, 2],
        [2, 1, 0],
        [0, 0, 3]]
# b = [[0, 0, 2],
        [2, 0, 1].
         [0, 0, 3]]
# q_learning.update_table(a, 2, -0.1, b, False)
```

Use the two classes defined below to train your policy so that it solves the environment.

```
[271]: lake = FrozenLake(5, 5, "IIIHIHHHHIIIIGIIIIHIIIH")
       q_learning = QLearning(lake, .4, .99, .9, lake.width * lake.height, lake.
        →action_space.n)
       # TODO: Train your policy using QLearning
       num_episodes = 4000
       for episode in range(num_episodes):
         observation, info = lake.reset()
         terminated = False
         while not terminated:
          action = q_learning.sample_action(observation)
          new_observation,old_state, reward, terminated, _ , _ = lake.step(action)
          q_learning.update_table(old_state, action, reward, new_observation, u
        →terminated)
          obervation = new_observation
        print("Q-table after episode", episode)
         print(q_learning.q_table)
```

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                              7.47069448
                                           8.11149325]
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                                           7.61092273]
 [ 8.08886973 -0.19999934
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 [ 8.36203858 -0.2
                              6.73854788
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```

```
[ 7.14131971 -0.2
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Q-table after episode 3810
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                                           8.06488212]
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Q-table after episode 3811
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                             7.84012342 -0.2
 [ 7.62601442
                7.99850581
                             7.47069448
                                          8.06488212]
                7.41907761
                             7.95577537
                                           7.68766745]
 [-0.07367777
                7.32879402
                             8.04286516
                                           7.51346167]
 [ 8.19707613  7.52991069  7.43114481
                                           7.79919727]
```

```
[ 7.52269034 6.63797188
                              6.9003399
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 [ 8.08886973 -0.19999934
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Q-table after episode 3812
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                7.41907761
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 [ 7.52269034 6.63797188
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 [ 7.69262925 -0.19999934
                              6.46431835 -0.19993019]
 [ 8.36203858 -0.2
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Q-table after episode 3813
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                             7.43114481
                                           7.66035354]
 T 7.52269034
                6.63797188
                             6.9003399
                                           7.610922737
 [ 7.69262925 -0.19999934
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                                           7.55055525]
 [ 7.98424032 -0.2
                              6.2177663
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Q-table after episode 3814
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 [ 7.41308212
                7.4501389
                              7.39267904
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                7.52991069
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                                           7.50025089]
 [ 7.52269034
                6.63797188
                             6.9003399
                                           7.61092273]
                             6.46431835 -0.19993019]
 [ 7.28375728 -0.19999934
 [ 8.36203858 -0.2
                              6.73854788
                                           7.55055525]
 [ 7.98424032 -0.2
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Q-table after episode 3815
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                             7.95577537
                                          7.68766745]
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                             7.39267904
                                          0.57134617]
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                7.52991069
                             7.43114481
                                          7.500250891
 [ 7.52269034 6.63797188
                             6.9003399
                                           7.61092273]
 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                             6.73854788
                                          7.55055525]
 [ 7.98424032 -0.2
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                                           6.62702869]
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Q-table after episode 3816
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                            7.32521299 7.29980359]
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                7.29093734 -1.
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                7.48459777
                             7.73068102 -0.2
 「7.06879512
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                             7.47069448
                                          7.49246199]
                7.41907761
                             7.95577537
 Γ-1.
                                          7.68766745]
                7.4501389
                             7.39267904
 [ 7.41308212
                                          0.57134617]
 [ 7.28331611  7.52991069
                             7.43114481
                                          7.50025089]
 [ 7.52269034 6.63797188
                             6.9003399
                                           7.61092273]
 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                             6.73854788
                                          7.55055525]
 「7.98424032 -0.2
                             6.2177663
                                           6.627028691
 [ 7.14131971 -0.2
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Q-table after episode 3817
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                             7.73068102 -0.2
 [ 7.06879512  7.32624293
                             7.47069448
                                         7.49246199]
                             7.95577537
                7.41907761
                                          7.68766745]
 Γ-1.
 [ 7.41308212  7.4501389
                             7.39267904
                                          0.57134617]
 [ 7.28331611
                7.52991069
                             7.43114481
                                          7.50025089]
 [ 7.52269034 6.63797188
                             6.9003399
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 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                                          7.55055525]
                             6.73854788
 [ 7.98424032 -0.2
                             6.2177663
                                          6.62702869]
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Q-table after episode 3818
[[-0.2
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                                         7.29980359]
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 [ 7.06879512  7.32624293
                             7.47069448
                                         7.49246199]
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                7.41907761
                             7.95577537
                                          7.68766745]
 [ 7.41308212  7.4501389
                             7.39267904
                                          0.57134617]
 T 7.28331611
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                             7.43114481
                                          7.500250891
 [ 7.52269034 6.63797188
                             6.9003399
                                          7.61092273]
 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                             6.73854788
                                         7.55055525]
 [ 7.98424032 -0.2
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Q-table after episode 3819
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                                          7.49246199]
                7.41907761
                             7.95577537
                                          7.68766745]
 Γ-1.
 [ 7.41308212
                7.4501389
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 [ 7.28331611
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                             7.43114481
                                          7.50025089]
 [ 7.52269034
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                                           7.61092273]
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                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
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                                          7.55055525]
 「7.98424032 -0.2
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Q-table after episode 3820
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                             7.25365129
                                          7.687667451
 Γ-1.
 [-0.15869179
                7.4501389
                             7.39267904
                                          0.57134617]
 [ 7.28331611
               7.52991069
                             7.43114481
                                          7.50025089]
 [ 7.52269034 6.63797188
                             6.9003399
                                           7.61092273]
 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                             6.73854788
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Q-table after episode 3821
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                7.4501389
                              7.39267904
                                           0.57134617]
 Γ 7.28331611
                7.52991069
                              7.43114481
                                           7.500250891
                6.63797188
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 [ 7.28375728 -0.19999934
                              6.46431835 -0.19993019]
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                              6.73854788
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Q-table after episode 3822
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                              7.25365129
                                           7.26455038]
 Γ-1.
 [-0.15869179
                7.4501389
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 [ 7.98424032 -0.2
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Q-table after episode 3823
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                             7.23750724 -0.2
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                                           7.26455038]
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 [-0.15869179]
                7.4501389
                              7.39267904
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 [ 7.28331611
                8.02356744
                             7.43114481
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 [ 7.52269034 6.63797188
                             6.9003399
                                           7.61092273]
 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                             6.73854788
                                          7.55055525]
 [ 7.98424032 -0.2
                              6.2177663
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Q-table after episode 3824
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                             6.91201189 6.55891965]
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                             7.23750724 - 0.2
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                                           7.45728299]
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                7.41907761 7.25365129
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[-0.15869179 7.4501389
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                                          0.57134617]
 [ 7.28331611 8.02356744
                             7.43114481
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 [ 7.52269034 6.63797188
                             6.9003399
                                           7.61092273]
 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                             6.73854788
                                          7.550555251
 [ 7.98424032 -0.2
                             6.2177663
                                           6.62702869]
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Q-table after episode 3825
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                7.07727069
                             6.91201189 6.55891965]
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                             7.43527823
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                7.41907761
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                                          7.26455038]
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                7.4501389
                             7.39267904
                                          0.57134617]
                8.02356744
                             7.43114481
                                          7.50025089]
 [ 7.28331611
 [ 7.52269034
                6.63797188
                             6.9003399
                                           7.61092273]
 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                             6.73854788
                                          7.55055525]
 [ 7.98424032 -0.2
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Q-table after episode 3826
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                             6.9003399
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 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                             6.73854788
                                         7.55055525]
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 [ 7.98424032 -0.2
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Q-table after episode 3827
                             6.68733652 -0.2
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                6.93028433
                             6.91201189
                                          6.558919657
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 [-1.
                             7.23750724 -0.2
 [ 6.93019957
                7.26177472
                             7.43527823
                                          7.45728299]
                7.41907761
                             7.25365129
                                          7.26455038]
 [-0.15869179
               7.4501389
                             7.39267904
                                          0.57134617]
 [ 7.28331611 8.02356744
                             7.43114481
                                          7.50025089]
 [ 7.52269034 6.63797188
                             6.9003399
                                          7.61092273]
 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                             6.73854788
                                          7.55055525]
 [ 7.98424032 -0.2
                             6.2177663
                                          6.62702869]
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Q-table after episode 3828
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                                          7.45728299]
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                             7.25365129
                                          7.264550381
 [-0.15869179
                7.4501389
                             7.39267904
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                8.02356744
                             7.43114481
                                          7.500250891
 [ 7.52269034 6.63797188
                             6.9003399
                                          7.61092273]
 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                                          7.55055525]
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 [ 7.98424032 -0.2
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Q-table after episode 3829
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                7.26177472
                             7.17392597
                                          7.45728299]
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                7.41907761
                             7.25365129
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                             7.39267904
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 [ 7.28331611 8.02356744
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 [ 7.52269034 6.63797188
                             6.9003399
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 [ 7.28375728 -0.19999934
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 [ 8.36203858 -0.2
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Q-table after episode 3830
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                                          7.26455038]
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                             7.39267904
 [-0.15869179
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                                           7.61092273]
 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                             6.73854788
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 [ 7.98424032 -0.2
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Q-table after episode 3831
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 Γ 7.28331611
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 [ 7.28375728 -0.19999934
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Q-table after episode 3832
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                                           7.26455038]
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                7.4501389
                              7.39267904
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 [ 7.28375728 -0.19999934
                              6.46431835 -0.19993019]
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Q-table after episode 3833
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                              7.17392597
                                           7.45728299]
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                7.41907761
                              7.25365129
                                           7.26455038]
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                              7.39267904
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                8.02356744
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                                           7.61092273]
 [ 7.28375728 -0.19999934
                              6.46431835 -0.19993019]
 [ 8.36203858 -0.2
                              6.73854788
                                           7.55055525]
 [ 7.98424032 -0.2
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Q-table after episode 3834
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                             7.39267904
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                                          7.50025089]
 [ 7.52269034 6.63797188
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 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
                             6.73854788
 [ 8.36203858 -0.2
                                         7.550555251
 [ 7.98424032 -0.2
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Q-table after episode 3835
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 [ 7.28331611 8.07293312 7.43114481
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[ 7.52269034 6.63797188
                              6.9003399
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 [ 7.28375728 -0.19999934
                              6.46431835 -0.19993019]
 [ 8.36203858 -0.2
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 [ 7.98424032 -0.2
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Q-table after episode 3836
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                7.41907761
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                                           7.26455038]
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                7.4501389
                              7.39267904 -0.12286538]
 [ 7.28331611
                7.62533187
                              7.43114481
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 [ 7.52269034 6.63797188
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 [ 7.28375728 -0.19999934
                              6.46431835 -0.19993019]
 [ 7.39952927 -0.2
                              6.73854788
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Q-table after episode 3837
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                7.62533187
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                                           7.610922737
 [ 7.28375728 -0.19999934
                             6.46431835 -0.19993019]
 [ 7.39952927 -0.2
                             6.73854788
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Q-table after episode 3838
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                             7.13039765 -0.2
 [ 6.93019957
                7.3924208
                             7.17392597
                                          7.21222711]
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                6.97910565
                                          7.26455038]
 [-0.15869179
                6.96814038
                             7.01065288 -0.19228654]
 [ 7.19277075
                7.14398837
                             7.26583157
                                           6.7453882 ]
 Γ 7.18266718
                6.63797188
                             6.9003399
                                           7.029658881
                             6.46431835 -0.19993019]
 [ 7.12552197 -0.19999934
 [ 7.39952927 -0.2
                             7.60781291
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 [ 7.39975618 -0.2
                             6.2177663
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Q-table after episode 3839
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                7.3924208
                             7.17392597
                                          7.212227117
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                             7.25365129
                                          7.26455038]
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                             7.01065288 -0.19228654]
                                          6.7453882 1
 [ 7.19277075  7.14398837
                             7.26583157
 [ 7.18266718  6.63797188
                             6.9003399
                                          7.02965888]
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19993019]
 [ 7.39952927 -0.2
                             7.60781291
                                          7.06488326]
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Q-table after episode 3840
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                             7.13039765 -0.2
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                             7.17392597
                                         7.21222711]
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                             7.25365129
                                          7.26455038]
                             7.01065288 -0.19228654]
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                6.96814038
 [ 7.19277075  7.14398837
                             7.26583157
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                             6.46431835 -0.19993019]
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 [ 7.39952927 -0.2
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Q-table after episode 3841
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                             9.70106529 -0.19228654]
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                             7.26583157
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                                          7.02965888]
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19993019]
 [ 7.39952927 -0.2
                             7.60781291
                                          7.06488326]
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Q-table after episode 3842
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                             9.70106529 -0.19228654]
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                7.14398837
                             7.26583157
                                         6.7453882 1
 [ 7.18266718  6.63797188
                             6.9003399
                                          7.02965888]
 [ 7.12552197 -0.19999934
                             6.46431835 -0.199930197
 [ 7.39952927 -0.2
                             7.60781291
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Q-table after episode 3843
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                                          7.21222711]
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 [-0.15869179
                6.96814038
                             9.70106529 -0.19228654]
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                7.14398837
                             7.26583157
                                          6.7453882 ]
 [ 7.18266718
                6.63797188
                             6.9003399
                                           7.02965888]
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19993019]
 [ 7.39952927 -0.2
                             7.60781291
                                          7.06488326]
 Γ 7.39975618 -0.2
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Q-table after episode 3844
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                             6.99372508 7.21222711]
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                             6.79185685
                                          7.264550381
 Γ-1.
 [-0.15869179
                6.96814038
                             9.70106529 -0.19228654]
                                          6.7453882 ]
 [ 6.96537143
               7.14398837
                             7.26583157
 [ 7.18266718  6.63797188
                             6.9003399
                                           7.02965888]
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19993019]
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                             7.60781291
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Q-table after episode 3845
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                6.96814038
                              9.70106529 -0.19228654]
 Γ 6.96537143
                7.14398837
                              7.26583157
                                           6.7453882 1
 [ 7.18266718
                6.63797188
                              6.9003399
                                           7.02965888]
 [ 7.12552197 -0.19999934
                              6.46431835 -0.19993019]
 [ 7.39952927 -0.2
                              7.60781291
                                           7.064883261
 [ 7.39975618 -0.2
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Q-table after episode 3846
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                                           7.26455038]
 [-0.15869179
                6.96814038
                              9.70106529 -0.19228654]
 [ 6.96537143
                7.14398837
                              7.26583157
                                           6.7453882 1
 [ 7.18266718
                6.63797188
                              6.9003399
                                           7.02965888]
 [ 7.12552197 -0.19999934
                              6.46431835 -0.19993019]
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[ 7.39952927 -0.2
                              7.60781291
                                           7.064883261
 [ 7.39975618 -0.2
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Q-table after episode 3847
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                              7.13039765 -0.2
                              6.99208689
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                7.03309801
                                           7.21222711]
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                6.97910565
                              6.79185685
                                           7.26455038]
 [-0.15869179]
                6.96814038
                              9.70106529 -0.19228654]
 [ 6.96537143
                7.14398837
                              7.26583157
                                           6.7453882 ]
 [ 7.18266718  6.63797188
                              6.9003399
                                           7.02965888]
 [ 7.12552197 -0.19999934
                              6.46431835 -0.19993019]
 [ 7.39952927 -0.2
                              7.60781291
                                           7.06488326]
 [ 7.39975618 -0.2
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Q-table after episode 3848
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                              6.7816714
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                              7.13039765 -0.2
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                                           7.21222711]
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                6.97910565
                              6.79185685
                                          7.26455038]
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[-0.15869179 6.96814038
                             9.70106529 -0.19228654]
 [ 6.96537143 7.14398837
                             7.26583157 6.7453882 ]
 [ 7.18266718
                6.63797188
                             6.9003399
                                           7.02965888]
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19993019]
 [ 7.39952927 -0.2
                             7.60781291
                                           7.064883261
 [ 7.39975618 -0.2
                             6.2177663
                                           6.62702869]
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Q-table after episode 3849
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                             6.7816714
                                           6.26512529]
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                6.94032074 -1.
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                             7.13039765 -0.2
 [ 6.88902889
                7.03309801
                             6.99208689 7.21222711]
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                6.97910565
                             6.79185685
                                          7.26455038]
 [-0.15869179
                6.96814038
                             9.70106529 -0.19228654]
 [ 6.96537143
                7.14398837
                             7.26583157
                                          6.7453882 ]
 [ 7.18266718  6.63797188
                             6.9003399
                                           7.02965888]
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19993019]
 [ 7.39952927 -0.2
                             7.60781291
                                          7.06488326]
 [ 7.39975618 -0.2
                                           6.62702869]
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 [ 7.14131971 -0.2
                            -0.9999999
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Q-table after episode 3850
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                             6.99208689
                                          6.89440702]
                6.97910565
                             9.14283486
                                         7.26455038]
 [-0.15869179
                6.96814038
                             9.97010653 -0.192286541
 [ 6.96537143
                7.14398837
                             6.94633962
                                         6.7453882 ]
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                             6.9003399
                                          7.02965888]
 [ 7.12552197 -0.19999934
                             6.46431835 -0.199930197
 [ 7.39952927 -0.2
                             7.60781291
                                         7.06488326]
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Q-table after episode 3851
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                             6.99208689
                                         6.89440702]
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                             9.14283486
                                          7.26455038]
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                6.96814038
                             9.97010653 -0.19228654]
                                         6.7453882 ]
 [ 6.96537143
                7.14398837
                             6.94633962
 [ 7.0109811
                6.63797188
                             6.9003399
                                          7.02965888]
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19993019]
 [ 7.39952927 -0.2
                             7.60781291
                                          7.06488326]
 [ 7.39975618 -0.2
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                                          6.62702869]
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Q-table after episode 3852
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                6.96814038
                             9.97010653 -0.19228654]
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                7.14398837
                                          6.7453882 1
                             6.94633962
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                                           7.02965888]
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19993019]
 [ 7.39952927 -0.2
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Q-table after episode 3853
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                                          7.26455038]
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                             9.97010653 -0.19228654]
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Q-table after episode 3854
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                             6.20083053 6.250393451
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                                          7.26455038]
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                6.96814038
                             9.97010653 -0.19228654]
 [ 6.96537143
                7.31296014
                             6.94633962
                                          6.7453882 ]
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                6.63797188
                             6.9003399
                                           7.02965888]
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19999302]
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Q-table after episode 3855
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                             6.99208689
                                           6.89440702]
                6.97910565
                             9.14283486
                                          7.264550381
 [-0.15869179
                6.96814038
                             9.97010653 -0.19228654]
 Γ 6.96537143
                7.31296014
                             6.94633962
                                           6.7453882 1
 [ 7.0109811
                6.63797188
                             6.9003399
                                           7.02965888]
 [ 7.12552197 -0.19999934
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Q-table after episode 3856
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                              6.79953009 -0.2
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                6.88501021
                              8.66547455
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                6.97910565
                              9.6176484
                                           7.26455038]
 [-0.15869179
                6.96814038
                              9.99701065 -0.19228654]
 [ 6.96537143
                7.31296014
                              6.94633962
                                           6.7453882 ]
 [ 7.0109811
                6.63797188
                              6.9003399
                                           7.02965888]
 [ 7.12552197 -0.19999934
                              6.46431835 -0.19999302]
                              7.60781291
 [ 7.39952927 -0.2
                                           6.8753284 ]
 [ 7.39975618 -0.2
                              6.2177663
                                           6.62702869]
 Γ 7.14131971 -0.2
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Q-table after episode 3857
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                              6.20083053
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                6.81495149
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                6.88501021
                              9.25587218 6.89440702]
 [-1.
                6.97910565
                              9.68910133
                                           7.26455038]
 [-0.15869179
                6.96814038
                              9.99970107 -0.19228654]
 [ 6.96537143
                7.31296014
                              6.94633962
                                           6.7453882 ]
 [ 7.0109811
                6.63797188
                              6.9003399
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 [ 7.12552197 -0.19999934
                              6.46431835 -0.19999302]
 [ 7.39952927 -0.2
                              7.60781291
                                           6.8753284 ]
 [ 7.39975618 -0.2
                              6.2177663
                                           6.62702869]
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Q-table after episode 3858
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                             9.25587218 6.89440702]
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                             9.68910133
                                          7.264550381
 [-0.15869179
                6.96814038
                             9.99970107 -0.19228654]
 [ 6.96537143
                7.31296014
                             6.94633962 6.7453882 ]
 Γ 7.0109811
                6.63797188
                             6.9003399
                                           7.029658881
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19999302]
 [ 7.39952927 -0.2
                             7.60781291
                                          6.8753284 1
 [ 7.39975618 -0.2
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Q-table after episode 3859
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                             9.25587218 6.89440702]
                6.97910565
                             9.68910133 7.26455038]
 [-0.15869179
                6.96814038
                             9.99970107 -0.19228654]
 [ 6.96537143 7.31296014
                             6.94633962 6.7453882 ]
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Γ 7.0109811
                6.63797188
                             6.9003399
                                           7.029658881
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19999302]
 [ 7.39952927 -0.2
                              7.60781291
                                           6.8753284 ]
 [ 7.39975618 -0.2
                             6.2177663
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Q-table after episode 3860
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 [-0.2]
                7.78393548
                             6.20083053
                                          6.25039345]
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 Γ 6.2192154
                8.21341764 -1.
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                             6.79953009 -0.2
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                6.88501021
                             9.25587218 6.894407021
 Γ-1.
                6.97910565
                             9.68910133
                                         7.26455038]
 [-0.15869179
                6.96814038
                             9.99970107 -0.19228654]
 [ 6.96537143
                7.31296014
                             6.94633962
                                           6.7453882 ]
                                           7.02965888]
 [ 7.0109811
                6.63797188
                             6.9003399
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19999302]
 [ 7.39952927 -0.2
                              7.60781291
                                           6.8753284 ]
 [ 7.39975618 -0.2
                             6.2177663
                                           6.62702869]
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                            -0.9999999
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Q-table after episode 3861
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                             6.20083053 6.25039345]
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[ 6.88902889  6.88501021
                             9.25587218 6.89440702]
 Γ-1.
                6.97910565
                             9.68910133 7.26455038]
 [-0.15869179
                6.96814038
                             9.99970107 -0.19228654]
 [ 6.96537143
                7.31296014
                             6.94633962 6.7453882 ]
 Γ 7.0109811
                6.63797188
                             6.9003399
                                           7.029658881
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19999302]
 [ 7.39952927 -0.2
                             7.60781291
                                          6.8753284 ]
 [ 7.39975618 -0.2
                             6.2177663
                                           6.627028691
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Q-table after episode 3862
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                7.78393548
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                             6.79953009 -0.2
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                             9.25587218 6.89440702]
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                             9.68910133
                                          7.26455038]
 [-0.15869179
                6.96814038
                             9.99970107 -0.19228654]
 [ 6.96537143
                7.31296014
                             6.94633962
                                          6.7453882 ]
 [ 7.0109811
                6.63797188
                             6.9003399
                                          7.029658881
 [ 7.12552197 -0.19999934
                             6.46431835 -0.19999302]
 [ 7.39952927 -0.2
                             7.60781291
                                          6.8753284 ]
 [ 7.39975618 -0.2
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Q-table after episode 3863
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 [-0.2
                7.91654866
                             6.20083053 7.01624573]
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                             6.79953009 -0.2
 Γ 6.88902889
                7.02434851
                             9.25587218 6.89440702]
 Γ-1.
                6.97910565
                             7.2399417
                                           7.26455038]
 [ 7.240215
                6.96814038
                             9.68845405 -0.19228654]
 Γ 6.96537143
                7.14596631
                             7.98790026
                                          6.991738357
 [ 9.1540874
                6.63797188
                             6.9003399
                                           8.22102815]
 Γ 8.3025267
              -0.19999934
                             6.46431835 -0.19999302]
 [ 7.66960094 -0.2
                             7.17396405
                                          6.85637292]
 [ 7.39975618 -0.2
                             6.2177663
                                           7.07568345]
 [ 7.14131971 -0.2
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Q-table after episode 3864
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                             7.62294442 -0.2
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                8.53115144
                             6.20083053 7.01624573]
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                             6.79953009 -0.2
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                7.02434851
                             6.99261821 6.89440702]
 Γ-1.
                6.97910565
                             9.17640673 6.97796177]
 [ 7.240215
                6.96814038
                             9.9688454
                                         -0.19228654]
 [ 6.96537143 7.14596631
                             7.98790026 6.99173835]
 [ 9.1540874
                6.63797188
                             6.9003399
                                           8.22102815]
 [ 8.3025267 -0.19999934
                             6.46431835 -0.19999302]
 [ 7.66960094 -0.2
                             7.17396405
                                          6.85637292]
 Γ 7.39975618 -0.2
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Q-table after episode 3865
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 Γ 6.88902889
                8.47270125
                             6.99261821 6.89440702]
                             9.61988193
                                         7.32472788]
 Γ-1.
                6.97910565
 [ 7.240215
                6.96814038
                             9.99688454 -0.19228654]
 [ 6.96537143
                8.1086662
                             8.62478455
                                          6.99173835]
 [ 8.88733711
                8.34036837
                             6.9003399
                                          8.36930337]
 [ 8.3025267 -0.19999934
                             6.46431835 -0.19999302]
 [ 8.55630545 -0.2
                             7.17396405
                                          6.85637292]
 [ 8.62340922 -0.2
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                                          7.07568345]
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Q-table after episode 3866
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                             6.99261821 6.89440702]
 Γ-1.
                                          7.32472788]
                6.97910565
                             9.61988193
 [ 7.240215
                6.96814038
                             9.99688454 -0.19228654]
 Γ 6.96537143
                8.1086662
                             8.62478455
                                         6.991738357
 [ 8.88733711
                8.34036837
                             6.9003399
                                          8.36930337]
 [ 8.3025267 -0.19999934
                             6.46431835 -0.19999302]
 [ 8.55630545 -0.2
                             7.17396405
                                         6.85637292]
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Q-table after episode 3867
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                             6.79953009 -0.2
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                                          7.32472788]
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 [ 8.62340922 -0.2
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Q-table after episode 3868
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                                          6.89440702]
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                8.87646445
                             9.69864364
                                          7.324727881
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                6.96814038
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Q-table after episode 3869
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                                          7.32472788]
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                6.96814038
                             9.99968845
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                              9.09614651
                8.34036837
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 [ 9.40061123
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 [ 8.3025267 -0.19999934
                             6.46431835 -0.19999302]
 [ 8.55630545 -0.2
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 [ 8.62340922 -0.2
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Q-table after episode 3870
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                                           6.89440702]
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                             9.69864364
                                           7.32472788]
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                                           8.44226283]
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                              9.09614651
                                           6.99173835]
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                             6.9003399
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 [ 8.3025267 -0.19999934
                             6.46431835 -0.19999302]
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[ 8.55630545 -0.2
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                                           6.856372921
 [ 8.62340922 -0.2
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Q-table after episode 3871
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                              6.99261821
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                              9.69864364
                                           7.32472788]
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                6.96814038
                              9.99968845
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 [ 6.96537143
                8.1086662
                              9.09614651
                                           6.99173835]
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 Γ 9.40061123
                              6.9003399
                                           8.76743091]
 [ 8.3025267 -0.19999934
                              6.46431835 -0.19999302]
 [ 8.55630545 -0.2
                              7.17396405
                                           6.85637292]
 [ 8.62340922 -0.2
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                                           7.07568345]
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Q-table after episode 3872
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                7.1033941
                              6.79953009 -0.2
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                8.79940756
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                                           6.89440702]
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                8.87646445
                              9.69958678
                                          7.32472788]
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[ 7.240215
                7.91436533
                             9.99996885
                                           8.442262831
 [ 6.96537143 8.1086662
                             9.10555926
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                8.34036837
                             6.9003399
                                           8.76743091]
 [ 9.55997508 -0.19999934
                             6.46431835 -0.19999302]
 [ 8.55630545 -0.2
                             7.17396405
                                           6.856372921
 [ 8.62340922 -0.2
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                                           7.07568345]
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Q-table after episode 3873
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                                          7.32472788]
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                             9.99996885
                                          8.44226283]
 [ 6.96537143 8.1086662
                             9.10555926
                                           6.99173835]
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                8.34036837
                             6.9003399
                                           8.76743091]
 [ 9.55997508 -0.19999934
                             6.46431835 -0.19999302]
 [ 8.55630545 -0.2
                             7.17396405
                                          6.85637292]
 [ 8.62340922 -0.2
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Q-table after episode 3874
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                                          6.89440702]
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                             9.99996885
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                             6.46431835 -0.19999302]
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                             7.17396405
                                          6.85637292]
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Q-table after episode 3875
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                                          6.89440702]
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                                          7.32472788]
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                             9.99996885
                                          8.44226283]
 [ 6.96537143 8.1086662
                             9.10555926
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                                          6.85637292]
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Q-table after episode 3876
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                             9.16159364
                                          6.89440702]
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                8.87646445
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 [ 7.240215
                7.91436533
                             9.9999688
                                          8.44226283]
                             9.10555926
 [ 6.96537143 8.1086662
                                          6.991738357
                8.34036837
 [ 9.40155261
                             6.9003399
                                           8.76743091]
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                             6.46431835 -0.19999302]
 [ 8.55630545 -0.2
                             7.17396405
                                          6.85637292]
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Q-table after episode 3877
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                             9.16159364
                                          6.89440702]
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                8.87646445
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                                          7.32472788]
 [ 7.240215
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 [ 6.96537143 8.25453477
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                                          8.97917658]
 [ 9.40279371
                8.34036837
                             6.9003399
                                           8.81138241]
 [ 9.55997508 -0.19999934
                             6.46431835 -0.199993027
 [ 8.78868385 -0.2
                             7.17396405
                                          6.85637292]
 [ 8.62340922 -0.2
                             6.2177663
                                           7.075683451
                                           6.4624257 ]
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Q-table after episode 3878
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Q-table after episode 3879
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Q-table after episode 3880
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 [ 8.8136663 -0.2
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Q-table after episode 3881
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Q-table after episode 3882
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 [ 9.67819928 -0.19999934
                             6.46431835 -0.19999302]
 [ 8.8136663 -0.2
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Q-table after episode 3883
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                             9.4959946
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Q-table after episode 3884
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Q-table after episode 3885
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Q-table after episode 3886
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Q-table after episode 3887
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                             6.46431835 -0.19999302]
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Q-table after episode 3888
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                             8.43129244
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                8.33749446
                             6.9003399
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 [ 9.67819928 -0.19999993
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 [ 8.8136663 -0.2
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                                          9.02357509]
 [ 8.62340922 -0.2
                             6.2177663
                                           8.358285651
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Q-table after episode 3889
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                8.89526251
                             6.79953009 - 0.2
 [ 8.08423379
                9.2711271
                             8.64508919
                                          6.83856485]
                                          7.32472788]
                8.6187966
                             9.4959946
 Γ-1.
                9.35835318
                             8.90852925
                                          0.66422628]
 [ 6.87314565
 [ 6.96537143
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 [ 8.43940202
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 [ 9.67819928 -0.19999993
                             6.46431835 -0.19999302]
 [8.8136663 -0.2
                                          9.02357509]
                             7.17396405
 [ 8.62340922 -0.2
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Q-table after episode 3890
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 [ 8.08423379
                9.2711271
                             8.64508919 6.83856485]
                                          7.32472788]
 Γ-1.
                8.6187966
                             9.4959946
 [ 6.87314565
                9.35835318
                             8.90852925
                                          0.66422628]
 Γ 6.96537143
                8.70984842
                             8.43129244
                                          8.888011097
 [ 8.43940202 8.33749446
                             6.9003399
                                          8.69060479]
 [ 9.67819928 -0.19999993
                             6.46431835 -0.19999302]
 [ 8.8136663 -0.2
                             7.17396405
                                         9.02357509]
 [ 8.62340922 -0.2
                             6.2177663
                                          8.35828565]
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Q-table after episode 3891
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                             6.14966216 7.6906073 ]
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                             6.79953009 -0.2
 [ 8.08423379
                9.2711271
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                                          6.83856485]
                8.6187966
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 Γ-1.
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                8.70984842
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                                          8.88801109]
 [ 8.43940202
                8.33749446
                             6.9003399
                                          8.69060479]
 [ 9.67819928 -0.19999993
                             6.46431835 -0.19999302]
 [ 8.8136663 -0.2
                             7.17396405
                                          9.02357509]
 [ 8.62340922 -0.2
                             6.2177663
                                          8.358285651
 [ 7.14131971 -0.2
                            -0.9999999
                                          6.4624257 ]
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Q-table after episode 3892
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                8.89526251
                             6.79953009 -0.2
 [ 8.08423379
                9.2711271
                             9.14544011
                                          6.83856485]
                8.6187966
                             9.10789214
                                          7.324727881
 Γ-1.
 [ 6.87314565
                9.35835318
                             9.89085292
                                          0.66422628]
 [ 6.96537143
                8.70984842
                             8.43129244
                                          8.88801109]
 [ 8.43940202
                8.33749446
                             6.9003399
                                          8.69060479]
 [ 9.67819928 -0.19999993
                             6.46431835 -0.19999302]
 [8.8136663 -0.2
                             7.17396405
                                          9.02357509]
 [ 8.62340922 -0.2
                             6.2177663
                                          8.35828565]
 [ 7.14131971 -0.2
                            -0.9999999
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Q-table after episode 3893
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                8.2439606
                             6.14966216 7.6906073 ]
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                8.89526251
                             6.79953009 -0.2
 [ 8.08423379
                9.2711271
                             9.14544011
                                           6.83856485]
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                8.6187966
                             9.10789214
                                           7.32472788]
 [ 6.87314565
                9.35835318
                             9.89085292
                                           0.66422628]
 6.96537143
                8.70984842
                             8.43129244
                                           8.888011097
 [ 8.43940202
                8.33749446
                             6.9003399
                                           8.69060479]
 [ 9.67819928 -0.19999993
                             6.46431835 -0.19999302]
 [ 8.8136663 -0.2
                             7.17396405
                                           9.023575091
 [ 8.62340922 -0.2
                             6.2177663
                                           8.35828565]
 [ 7.14131971 -0.2
                            -0.9999999
                                           6.4624257 ]
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Q-table after episode 3894
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                             6.14966216
                                          7.6906073 ]
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                             6.79953009 -0.2
 [ 8.08423379
                9.2711271
                             9.14544011
                                           6.83856485]
 Γ-1.
                8.6187966
                             9.10789214
                                           7.32472788]
 [ 6.87314565
                9.35835318
                             9.89085292
                                           0.66422628]
 [ 6.96537143
                8.70984842
                             8.43129244
                                           8.88801109]
 [ 8.43940202
                8.33749446
                             6.9003399
                                           8.69060479]
 [ 9.67819928 -0.19999993
                             6.46431835 -0.19999302]
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[8.8136663 -0.2
                             7.17396405
                                           9.023575091
 [ 8.62340922 -0.2
                             6.2177663
                                           8.35828565]
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Q-table after episode 3895
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                8.93349953 -1.
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                8.89526251
                             6.79953009 -0.2
                9.2711271
 [ 8.08423379
                              9.14544011
                                           6.83856485]
 Γ-1.
                8.6187966
                              9.10789214
                                           7.32472788]
 Γ 6.87314565
                9.35835318
                             9.89085292
                                           0.664226281
 [ 6.96537143
                8.70984842
                             8.43129244
                                           8.88801109]
 [ 8.43940202  8.33749446
                             6.9003399
                                           8.69060479]
 [ 9.67819928 -0.19999993
                             6.46431835 -0.19999302]
 [ 8.8136663 -0.2
                                          9.02357509]
                             7.17396405
 [ 8.62340922 -0.2
                             6.2177663
                                           8.35828565]
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Q-table after episode 3896
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                             7.84807667
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                              6.79953009 -0.2
 [ 8.08423379
                8.66633059
                             8.84967591
                                           6.83856485]
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                8.6187966
                              9.0690819
                                           7.32472788]
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[ 6.87314565 8.90575656
                             9.92927873
                                          0.664226281
 [ 8.66512428  8.70984842
                             8.40645811
                                          9.52155106]
 [ 8.43940202  8.33720706
                             6.9003399
                                           9.17276248]
 [ 9.01433425 -0.19999993
                             6.46431835 -0.19999302]
 [ 8.8136663 -0.2
                             7.17396405
                                          9.023575091
 [ 8.42566979 -0.2
                             6.2177663
                                           8.35828565]
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Q-table after episode 3897
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                             7.84807667 7.68277623]
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                             8.84967591 6.83856485]
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                             9.0690819
                                           7.32472788]
 [ 6.87314565
                8.90575656
                             9.92927873
                                          0.66422628]
                                          9.52155106]
 [ 8.66512428
                8.70984842
                             8.40645811
 [ 8.43940202
                8.33720706
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                                           9.17276248]
 [ 9.01433425 -0.19999993
                             6.46431835 -0.19999302]
 [ 8.8136663
              -0.2
                             7.17396405
                                          9.02357509]
 [ 8.42566979 -0.2
                             6.2177663
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Q-table after episode 3898
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 [8.28310348 8.60245366 -1.
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 Γ-1.
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                                          7.32472788]
 Γ-0.21268544
                8.90575656
                             9.92927873
                                          0.664226281
 [ 8.66512428
                8.70984842
                             8.40645811
                                          9.52155106]
 [ 8.43940202
                8.33720706
                             6.9003399
                                          9.17276248]
 [ 9.01433425 -0.19999993
                             6.46431835 -0.19999302]
 [ 8.8136663 -0.2
                             7.17396405
                                          9.02357509]
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 [ 8.42566979 -0.2
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Q-table after episode 3899
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                8.68378075
                             7.84807667
                                          7.682776231
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                             6.79953009 -0.2
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                8.66633059
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                                          6.83856485]
                8.6187966
                             9.57389554
                                          7.32472788]
 [-0.21268544
                8.90575656
                             9.92927873
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 [ 8.66512428
                             8.40645811
                8.70984842
                                          9.52155106]
 [ 8.43940202  8.33720706
                             6.9003399
                                          9.17276248]
 [ 9.01433425 -0.19999993
                             6.46431835 -0.19999302]
 [ 8.8136663 -0.2
                             7.17396405
                                          9.02357509]
 [ 8.42566979 -0.2
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Q-table after episode 3900
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                                          9.02357509]
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Q-table after episode 3901
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Q-table after episode 3902
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                                           9.17276248]
 [ 9.01433425 -0.19999993
                             6.46431835 -0.19999302]
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Q-table after episode 3903
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 [ 8.43940202 8.33720706
                             6.9003399
                                           9.17276248]
 [ 9.01433425 -0.19999993
                             6.46431835 -0.19999302]
 [ 8.8136663 -0.2
                             7.17396405
                                          9.02357509]
 [ 8.42566979 -0.2
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Q-table after episode 3904
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                              9.6243769
                                           7.32472788]
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                              9.99292787
                                           0.66422628]
 [ 8.66512428
                8.70984842
                              8.40645811
                                           9.52155106]
 [ 8.43940202
                8.33720706
                              6.9003399
                                           9.17276248]
 [ 9.01433425 -0.19999993
                              6.46431835 -0.19999302]
 [ 8.8136663 -0.2
                              7.17396405
                                           9.02357509]
 [ 8.42566979 -0.2
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Q-table after episode 3905
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                                           6.83856485]
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                              6.9003399
                                           9.17276248]
 [ 9.01433425 -0.19999993
                              6.46431835 -0.19999302]
 [8.8136663 -0.2
                              7.17396405
                                           9.02357509]
 [ 8.42566979 -0.2
                              6.2177663
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Q-table after episode 3906
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 [ 8.08423379
                8.66633059
                             9.31820911
                                          6.83856485]
 Γ-1.
                8.85481103
                             9.6243769
                                           7.324727881
                                          0.66422628]
 [-0.21268544
                9.37907169
                             8.82376048
 [ 8.66512428
                8.70984842
                             8.83357718
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 [8.43940202 8.50852828
                             6.9003399
                                           8.810737257
 [ 9.68621195 -0.19999993
                             6.46431835 -0.1999993 ]
 [ 8.8136663 -0.2
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                                          8.754129327
 [ 8.83549835 -0.2
                             6.2177663
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Q-table after episode 3907
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                             9.6243769
                                           7.32472788]
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 [ 8.66512428  8.70984842
                             8.83357718
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[ 8.43940202  8.50852828
                             6.9003399
                                           8.810737257
 [ 9.68621195 -0.19999993
                             6.46431835 -0.1999993 ]
 [8.8136663 -0.2
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                                           8.75412932]
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Q-table after episode 3908
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 Γ-1.
                8.85481103
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                                           7.324727881
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 [-0.21268544
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                             8.82376048
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                             8.83357718
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                6.16291587 -0.25356817 -0.1999993 ]
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                                          8.75412932]
 [ 8.83549835 -0.2
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Q-table after episode 3909
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 [-0.21268544
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                             9.88237605
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                6.16291587 -0.25356817 -0.1999993 ]
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                                          8.75412932]
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Q-table after episode 3910
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                             8.8104354
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 [ 8.08423379
                8.66633059
                             8.85625778
                                          8.42953538]
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                8.85481103
                             8.59145922
                                          7.32472788]
 [-0.21268544
                8.44389186
                             9.88237605
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                                          9.0004448 ]
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                             6.9003399
                                          8.81073725]
                6.16291587 -0.25356817 -0.1999993 ]
 [ 8.67836302
 [8.8136663 -0.2
                             7.17396405
                                          8.75412932]
 [ 8.83549835 -0.2
                             6.2177663
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Q-table after episode 3911
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                8.74100481 8.00783755
                                         7.68277623]
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                6.16291587 -0.25356817 -0.1999993 ]
 [ 8.8136663 -0.2
                             7.17396405
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                             6.2177663
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Q-table after episode 3912
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                8.74100481
                             8.00783755 7.68277623]
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                             8.85625778
                                          8.429535381
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                                          7.32472788]
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                8.44389186
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                                          8.73007649]
 [ 8.66512428  8.70984842
                             8.83357718
                                          9.0004448 ]
 [ 8.43940202
                8.50852828
                             6.9003399
                                           8.81073725]
 [ 8.67836302
                6.16291587 -0.25356817 -0.1999993 ]
 [ 8.8136663 -0.2
                             7.17396405
                                          8.75412932]
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Q-table after episode 3913
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                                          8.42953538]
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                             8.59145922
                                          7.32472788]
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                                          8.73007649]
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                             8.83357718
                                          9.0004448 ]
                             6.9003399
 [ 8.43940202
                8.50852828
                                          8.81073725]
 [ 8.67836302
                6.16291587 -0.25356817 -0.1999993 ]
 [8.8136663 -0.2
                             7.17396405
                                          8.75412932]
 [ 8.83549835 -0.2
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Q-table after episode 3914
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                             8.02381364
                                         7.68277623]
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                8.70602938
                             8.85625778
                                          8.58863244]
                                          7.32472788]
 Γ-1.
                8.85481103
                             8.59145922
 [-0.21268544
                8.65184796
                             8.81714656
                                          8.73007649]
 Γ 8.66512428
                8.70984842
                             8.44531127
                                          8.5815348 ]
 [ 8.43940202
                8.54328185
                             6.9003399
                                          8.75967078]
 [ 8.96988429
                6.16291587 -0.25356817 -0.199999931
 [ 8.8136663 -0.2
                             7.17396405
                                         8.75412932]
 [ 8.47348864 -0.2
                             6.2177663
                                          8.69583397]
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Q-table after episode 3915
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                8.74135217
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                             8.59196922 -0.2
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                8.70602938
                             8.85625778
                                          8.58863244]
 Γ-1.
                8.85481103
                             8.59145922
                                          7.32472788]
                                          8.73007649]
 [-0.21268544
                8.65184796
                             8.81714656
 [ 8.66512428
                8.70984842
                             8.44531127
                                          8.5815348 ]
 [ 8.43940202
                8.54328185
                             6.9003399
                                          8.75967078]
 [ 8.96988429
                6.16291587 -0.25356817 -0.19999993]
 [ 8.8136663 -0.2
                             7.17396405
                                          8.75412932]
 [ 8.47348864 -0.2
                             6.2177663
                                          8.695833971
 [ 8.26655342 -0.2
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Q-table after episode 3916
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 Γ-1.
                8.56560383
                             8.59196922 -0.2
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                             8.5952624
                                          8.60454214]
                             8.59145922
                                          7.324727881
 Γ-1.
                8.85481103
 [-0.21268544
                8.65184796
                             8.4621896
                                          8.73007649]
 [ 8.57743811
                8.54396152
                             8.44531127
                                          8.5815348 ]
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                             6.9003399
                                          8.75967078]
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                6.16291587 -0.25356817 -0.19999993]
 [ 8.42199236 -0.2
                             7.17396405
                                          8.75412932]
 [ 8.47348864 -0.2
                             6.2177663
                                          8.69583397]
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Q-table after episode 3917
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                             8.02381364 8.16452548]
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                8.70602938
                             8.5952624
                                          8.60454214]
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                             8.59145922
                                          7.32472788]
 [-0.21268544
                8.65184796
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                                           8.73007649]
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                             8.44531127
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 [ 8.43940202
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                6.16291587 -0.25356817 -0.19999993]
 Γ 8.42199236 -0.2
                             7.17396405
                                          8.754129327
 [ 8.47348864 -0.2
                             6.2177663
                                          8.69583397]
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Q-table after episode 3918
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                                           8.60454214]
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                8.85481103
                             8.59145922
                                          7.32472788]
 [-0.21268544
                8.65184796
                             8.4621896
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 [ 8.57743811
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                             8.44531127
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                6.16291587 -0.92535682 -0.19999993]
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[ 8.42199236 -0.2
                             8.28538447
                                          8.754129327
 [ 8.47348864 -0.2
                             7.80727572
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Q-table after episode 3919
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                             8.5952624
                                          8.60454214]
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                8.85481103
                             8.59145922
                                          7.32472788]
 Γ-0.21268544
                8.65184796
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                                           8.730076491
 [ 8.57743811
                8.47432538
                             8.44531127
                                          8.5815348 ]
                8.54328185
                             6.9003399
 [ 8.43940202
                                           8.75967078]
 [ 8.96988429
                6.16291587 -0.92535682 -0.19999993]
 [ 8.42199236 -0.2
                             8.28538447
                                          8.75412932]
 [ 8.47348864 -0.2
                             7.80727572
                                          8.69583397]
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Q-table after episode 3920
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                             8.59196922 -0.2
 [ 8.08423379
                8.33675044
                             8.5952624
                                           8.60454214]
 [-1.
                8.85481103 8.59145922 7.32472788]
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[-0.21268544 8.65184796
                             8.4621896
                                          8.730076491
 [ 8.57743811  8.47432538
                             8.44531127
                                          8.5815348 ]
 [ 8.43940202  8.54328185
                             6.9003399
                                          8.75967078]
 [ 8.96988429  6.16291587  -0.92535682  -0.19999993]
 Γ 8.42199236 -0.2
                             8.28538447
                                          8.754129327
 [ 8.47348864 -0.2
                             7.80727572
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Q-table after episode 3921
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                8.16670082 8.02541125 8.16452548]
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 [ 8.08423379  8.33675044
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                8.85481103
                             8.59145922
                                          7.32472788]
 [-0.21268544
                8.65184796
                             8.4621896
                                          8.73007649]
 [ 8.57743811
                8.47432538
                             8.44531127
                                          8.5815348 ]
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                             6.9003399
                                          8.75967078]
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                6.16291587 -0.92535682 -0.19999993]
 [ 8.42199236 -0.2
                             8.28538447
                                          8.754129327
 [ 8.47348864 -0.2
                             7.80727572
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Q-table after episode 3922
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                8.16670082 8.02541125
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 [8.43682699 8.43430567 -1.
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 [-0.21268544 8.65184796
                             8.4621896
                                          8.730076491
 [ 8.57743811
                8.47432538
                             8.44531127
                                          8.5815348 ]
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                                          8.75967078]
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 Γ 8.96988429
 [ 8.42199236 -0.2
                             8.28538447
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 [ 8.47348864 -0.2
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Q-table after episode 3923
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                                         7.662140587
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                                          8.308675521
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 [ 8.08423379
                8.33675044
                             8.5952624
                                          8.60454214]
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                             8.59145922
                                          7.32472788]
 [-0.21268544
                8.65184796
                             8.4621896
                                          8.73007649]
 [ 8.57743811
                8.47432538
                             8.44531127
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 [ 8.43940202
                8.54328185
                             6.9003399
                                          8.75967078]
 [ 8.96988429  6.16291587 -0.92535682 -0.19999993]
 [ 8.42199236 -0.2
                             8.28538447
                                          8.75412932]
 [ 8.47348864 -0.2
                             7.80727572
                                          8.69583397]
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Q-table after episode 3924
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                8.29982255
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                                          8.60454214]
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                8.85481103
                             8.59145922
                                          7.324727881
 [-0.21268544
                8.65184796
                             8.4621896
                                          0.69300765]
 [ 8.57743811
                8.47432538
                             8.44531127
                                          8.456651637
 [ 8.43940202  8.54328185
                             6.9003399
                                          8.75967078]
 [ 8.96988429
                6.16291587 -0.92535682 -0.19999993]
 [ 8.42199236 -0.2
                             8.28538447
                                          8.75412932]
 [ 8.47348864 -0.2
                             7.80727572
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Q-table after episode 3925
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                             7.86921323 -0.2
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                8.05713462 8.02541125 7.66214058]
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                8.31965481 -1.
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 Γ-1.
                8.56560383
                             8.31432104 -0.2
 [ 8.08423379
                8.29982255
                             8.33190645
                                          8.33589879]
 Γ-1.
                8.28309891
                             8.59145922
                                          7.32472788]
 [-0.21268544
                8.65184796
                             8.21684287
                                          0.69300765]
                8.40806617
 [ 8.34439086
                             8.44531127
                                          8.456651637
 [ 8.43940202
                8.42231625
                             6.9003399
                                          8.33846443]
 Γ 8.42578496
                6.16291587 -0.92535682 -0.199999991
 [ 8.42199236 -0.2
                             8.28538447
                                          8.19613238]
 [ 8.47348864 -0.2
                             7.80727572
                                          8.489512637
 [ 8.63882224 -0.2
                            -0.9999999
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Q-table after episode 3926
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                             8.31432104 -0.2
 [ 8.08423379
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                             8.33190645
                                          8.33589879]
                8.28309891
                             8.59145922
                                          7.32472788]
 [-0.21268544
                8.65184796
                             8.21684287
                                          0.69300765]
 [ 8.34439086
                8.40806617
                             8.44531127
                                          8.45665163]
 [ 8.43940202
                8.42231625
                             6.9003399
                                          8.33846443]
 [ 8.42578496  6.16291587 -0.92535682 -0.19999999]
 [ 8.42199236 -0.2
                             8.28538447
                                          8.19613238]
 [ 8.47348864 -0.2
                             7.80727572
                                          8.48951263]
 [ 8.63882224 -0.2
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Q-table after episode 3927
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                             8.02541125
                                          7.66214058]
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                8.36733223
                             8.31432104 -0.2
 [ 8.08423379
                8.29982255
                             8.33190645 8.28554289]
                8.28309891
                             8.59145922
                                          7.324727881
 [ 7.27008447
                8.65184796
                             8.21684287 -0.11069924]
 Γ 8.34439086
                8.40806617
                             8.44531127
                                          8.456651637
 [ 8.43940202  8.42231625
                             6.9003399
                                          8.33846443]
 [ 8.42578496
                6.16291587 -0.92535682 -0.19999999]
 [ 8.42199236 -0.2
                             8.28538447
                                          8.19613238]
 [ 8.47348864 -0.2
                             7.80727572
                                          8.48951263]
 [ 8.63882224 -0.2
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Q-table after episode 3928
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                             8.31432104 -0.2
 [ 8.08423379
                8.29982255
                             8.33190645
                                          8.28554289]
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                8.28309891
                             8.59145922
                                          7.32472788]
 [ 7.27008447
                8.65184796
                             8.21684287 -0.11069924]
 [ 8.34439086
                8.40806617
                             8.44531127
                                          8.45665163]
 [ 8.43940202
                8.42231625
                             6.9003399
                                          8.33846443]
 6.16291587 -0.92535682 -0.199999991
 [ 8.42199236 -0.2
                             8.28538447
                                          8.19613238]
 [ 8.47348864 -0.2
                             7.80727572
                                          8.48951263]
 [ 8.63882224 -0.2
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Q-table after episode 3929
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                             8.30818081 8.28554289]
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                8.28309891
                             8.38794246
                                          7.32472788]
 [-0.17299155
                8.65184796
                             8.21684287 -0.11069924]
 [ 8.34439086
                8.40806617
                             8.44531127
                                          8.45665163]
 [ 8.43940202
                8.42231625
                             6.9003399
                                          8.33846443]
 [ 8.42578496
                6.16291587 -0.92535682 -0.19999999]
 [ 8.42199236 -0.2
                             8.28538447
                                          8.19613238]
 [ 8.47348864 -0.2
                             7.80727572 8.48951263]
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[ 8.63882224 -0.2
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Q-table after episode 3930
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                             8.31432104 -0.2
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                8.29982255
                             8.30818081 8.28554289]
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                8.28309891
                             8.38794246
                                         7.324727881
 [-0.17299155
                8.65184796
                             8.21684287 -0.11069924]
 [ 8.34439086
                8.40806617
                             8.44531127
                                         8.45665163]
 [ 8.43940202
                8.42231625
                             6.9003399
                                          8.338464431
 [ 8.42578496
                6.16291587 -0.92535682 -0.19999999]
 [ 8.42199236 -0.2
                             8.28538447
                                          8.19613238]
 [ 8.47348864 -0.2
                             7.80727572
                                          8.48951263]
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Q-table after episode 3931
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                7.8224655
                             8.02541125 7.47223494]
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                                          8.308675521
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                             8.31432104 -0.2
 [ 8.08423379
                8.29982255
                             8.30818081 8.28554289]
                8.28309891
                             8.38794246 7.32472788]
 [-0.17299155
                8.65184796
                             8.21684287 -0.11069924]
 [ 8.34439086  8.40806617  8.44531127  8.45665163]
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[ 8.43940202  8.42231625
                             6.9003399
                                          8.338464431
 [ 8.42578496  6.16291587 -0.92535682 -0.19999999]
 [ 8.42199236 -0.2
                             8.28538447
                                          8.19613238]
 [ 8.47348864 -0.2
                             7.80727572
                                          8.48951263]
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Q-table after episode 3932
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                             8.02541125
                                         7.47223494]
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                8.29982255
                             8.30818081 8.285542897
 Γ-1.
                8.28309891
                             8.38794246
                                         7.324727881
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                8.65184796
                             8.21684287 -0.11069924]
 [ 8.34439086
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                                          8.19613238]
 [ 8.47348864 -0.2
                             7.80727572
                                          8.48951263]
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Q-table after episode 3933
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                             7.57382843 7.30665972]
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[ 8.08423379  8.29982255
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                6.16291587 -0.92535682 -0.19999999]
 [ 8.42199236 -0.2
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                                          8.19613238]
 [ 8.47348864 -0.2
                             7.80727572
                                          8.489512637
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Q-table after episode 3934
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                             8.17656089 -0.19106992]
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                8.42231625
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                                          8.33846443]
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                6.16291587 -0.92535682 -0.19999999]
 [ 8.42199236 -0.2
                             8.28538447
                                          8.19613238]
 [ 8.47348864 -0.2
                             7.80727572
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Q-table after episode 3935
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                7.74776487
                            7.57382843
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                             8.28538447
                                           8.19613238]
 [ 8.47348864 -0.2
                             8.29791819
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Q-table after episode 3936
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                             7.57382843 7.30665972]
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                             8.12447481
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                                          7.32472788]
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                8.14106549
                             7.95836449
                8.1925592
                             8.17656089
                                           7.18113414]
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                8.40806617
                             8.44531127
                                           7.96523541]
 [ 7.94146523
                8.22638737
                             6.9003399
                                           8.33846443]
                6.16291587 -0.92535682 -0.19999999]
 [ 7.9837855
 [ 8.42199236 -0.2
                             8.28538447
                                           8.19613238]
 [ 8.47348864 -0.2
                             8.29791819
                                          8.489512637
 [ 8.63882224 -0.2
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Q-table after episode 3937
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                7.97775998
                             8.31432104 -0.2
 [ 7.77902319
                8.17475459
                             8.12447481 8.1038473 ]
                8.14106549
                             7.95836449
                                          7.32472788]
 Γ-1.
 [ 7.25638786
                7.7528088
                             8.16242843
                                          7.18113414]
 [ 8.34439086
                8.40806617
                             8.09410294
                                          7.91609379]
 [ 7.86783587
                8.22638737
                             6.9003399
                                          8.33846443]
 [ 7.90369431
                6.16291587 -0.92535682 -0.19999999]
 [ 8.42199236 -0.2
                             8.28538447
                                          8.19613238]
 [ 8.47348864 -0.2
                             8.29791819
                                          8.48951263]
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Q-table after episode 3938
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                8.17475459
                             8.12447481
                                          8.1038473 ]
                                          7.32472788]
 Γ-1.
                8.14106549
                             7.95836449
 [ 7.25638786
                7.7528088
                             8.16242843
                                          7.18113414]
 [ 8.34439086
                8.40806617
                             8.09410294
                                          7.916093797
 [ 7.86783587
                8.22638737
                             6.9003399
                                          8.33846443]
 Γ 7.90369431
                6.16291587 -0.92535682 -0.199999991
 [ 8.42199236 -0.2
                             8.28538447
                                          8.19613238]
 [ 8.47348864 -0.2
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                                          8.48951263]
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Q-table after episode 3939
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 [ 7.77902319
                8.17475459
                                          8.1038473 ]
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                                          7.32472788]
 Γ-1.
                                          7.18113414]
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                7.7528088
                             8.16242843
 [ 8.34439086
                8.40806617
                             8.09410294
                                          7.91609379]
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                             6.9003399
                                           8.33846443]
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                6.16291587 -0.92535682 -0.19999999]
 [ 8.42199236 -0.2
                             8.28538447
                                          8.19613238]
 [ 8.47348864 -0.2
                             8.29791819
                                          8.489512637
 [ 8.63882224 -0.2
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Q-table after episode 3940
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                                          8.1038473 ]
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                                          7.324727881
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                8.14106549
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                             8.16242843
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                             8.09410294
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                8.22638737
                             6.9003399
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                6.16291587 -0.92535682 -0.19999999]
 [ 8.09705149 -0.2
                             8.28538447
                                          8.19613238]
 [ 8.47348864 -0.2
                             8.29791819
                                          8.48951263]
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Q-table after episode 3941
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                             8.12447481
                                          8.1038473 ]
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                6.16291587 -0.92535682 -0.19999999]
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                             8.28538447
                                           8.19613238]
 [ 8.47348864 -0.2
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                                           8.48951263]
 [ 8.63882224 -0.2
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Q-table after episode 3942
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                                          8.1038473 ]
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 Γ-1.
 [ 7.25638786
                7.7528088
                              8.16242843
                                           7.18113414]
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                8.01875775
                             8.09410294
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                             6.9003399
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                6.16291587 -0.92535682 -0.19999999]
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[ 8.09705149 -0.2
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Q-table after episode 3943
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                7.97775998
                              8.31432104 -0.2
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                7.90774465
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                8.06367836
                              7.95836449
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                              8.16242843
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                8.01875775
                              8.09410294
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                8.22638737
                              6.9003399
                                           8.33846443]
 Γ 7.79152101
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                6.16291587 -0.92535682 -0.19999999]
 [ 8.09705149 -0.2
                              8.28538447
                                           8.19613238]
 [ 8.47348864 -0.2
                              8.29791819
                                           8.48951263]
 [ 8.63882224 -0.2
                             -0.9999999
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Q-table after episode 3944
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                              7.88613683
                            7.95836449
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[ 7.25638786  7.7528088
                             8.16242843
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                             6.9003399
                                          8.33846443]
 [7.90369431 6.16291587 -0.92535682 -0.19999999]
 Γ 8.09705149 -0.2
                             8.28538447
                                          8.196132387
 [ 8.47348864 -0.2
                             8.29791819
                                          8.48951263]
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Q-table after episode 3945
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                7.82547337 -1.
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                             8.31432104 -0.2
 [ 7.59176604  7.90774465
                             7.7933511
                                          8.1038473 ]
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                8.05593965
                             7.95836449
                                          7.77300073]
 [ 7.25638786
                7.7528088
                             8.16242843
                                          7.18113414]
                8.00415334
                             8.09410294
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                                          7.91609379]
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                8.03608384
                             6.9003399
                                           7.86569216]
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                6.16291587 -0.92535682 -0.19999999]
 [ 8.09705149 -0.2
                             8.1911478
                                          8.196132387
 [ 7.99706001 -0.2
                             8.29791819
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Q-table after episode 3946
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                             7.95836449
                                          7.77300073]
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                8.03608384
                             6.9003399
                                           7.86569216]
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                6.16291587 -0.92535682 -0.19999999]
 [ 8.09705149 -0.2
                             8.1911478
                                           8.19613238]
 [ 7.99706001 -0.2
                             8.29791819
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Q-table after episode 3947
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                7.57690884
                             7.57382843
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                             7.95836449
                                          7.77300073]
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                7.7528088
                             8.16242843
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                8.00415334
                                          7.91609379]
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                             8.09410294
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                             6.9003399
                                           7.86569216]
 [7.90369431 6.16291587 -0.92535682 -0.19999999]
 [ 8.09705149 -0.2
                             8.1911478
                                           8.19613238]
 [ 7.99706001 -0.2
                             8.29791819
                                          7.98646179]
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Q-table after episode 3948
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                             7.7933511
                                           7.73202862]
                                           7.773000731
 Γ-1.
                8.05593965
                             7.95836449
 [ 7.25638786
                7.7528088
                             8.16242843
                                           7.18113414]
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                8.00415334
                             8.09410294
                                          7.916093797
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                8.03608384
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                                           7.86569216]
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 [ 8.09705149 -0.2
                                           8.19613238]
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Q-table after episode 3949
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                                           7.73202862]
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 [ 8.09705149 -0.2
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Q-table after episode 3950
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                6.16291587 -0.92535682 -0.19999999]
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                                           8.19613238]
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Q-table after episode 3951
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                             8.1911478
                                           8.19613238]
 [ 7.99706001 -0.2
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Q-table after episode 3952
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                                           7.86569216]
 Γ 7.88309316
                7.32022339 -0.92535682 -0.19999999]
 [ 8.09705149 -0.2
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                                           8.19613238]
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Q-table after episode 3953
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                8.01705349
                              6.9003399
                                           7.86569216]
 [ 7.88309316
                7.32022339 -0.92535682 -0.19999999]
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                              8.1911478
                                           8.19613238]
 [ 7.99706001 -0.2
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Γ 7.63479901 -0.2
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Q-table after episode 3954
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Q-table after episode 3955
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Q-table after episode 3956
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Q-table after episode 3957
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Q-table after episode 3958
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Q-table after episode 3959
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Q-table after episode 3960
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Q-table after episode 3961
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Q-table after episode 3962
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Q-table after episode 3963
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Q-table after episode 3964
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Q-table after episode 3965
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Q-table after episode 3966
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Q-table after episode 3967
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Q-table after episode 3968
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                                           8.974545521
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Q-table after episode 3969
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Q-table after episode 3970
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Q-table after episode 3971
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Q-table after episode 3972
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Q-table after episode 3973
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Q-table after episode 3974
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Q-table after episode 3975
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Q-table after episode 3976
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Q-table after episode 3978
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Q-table after episode 3979
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Q-table after episode 3980
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                0.55202234 -0.92535682 -0.2
 [ 8.09705149 -0.2
                             8.1911478
                                           8.97454552]
 [ 7.99706001 -0.2
                             7.45730416
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Q-table after episode 3981
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                                          8.97454552]
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Q-table after episode 3982
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                                         -0.19217098]
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Q-table after episode 3983
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Q-table after episode 3984
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                                          8.26185369]
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                                         -0.19217098]
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Q-table after episode 3985
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                            8.36699738 -0.19217098]
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Q-table after episode 3986
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                            8.36699738 -0.19217098]
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                8.67718376
                            7.77260495
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                7.75126714
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 7.80612174 -0.2
 [ 8.69353813 -0.2
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 [ 7.99706001 -0.2
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Q-table after episode 3987
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                8.28286302
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 Γ 7.99706001 -0.2
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Q-table after episode 3988
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 [ 8.23060101  8.28286302
                             8.38807047 -0.1992171 ]
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                8.68472391
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                                          8.20534998]
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Q-table after episode 3989
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 [ 8.39266145
                0.55202234
                             7.80612174 -0.2
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                                           8.205349981
 [ 7.99706001 -0.2
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Q-table after episode 3990
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                             8.38807047 -0.1992171 ]
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                8.68472391
                              7.77260495
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                0.55202234
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[ 8.42683206 -0.2
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 [ 7.99706001 -0.2
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Q-table after episode 3991
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                7.60623418
                                           8.26185369]
                             8.54911165
 Γ 8.23060101
                8.28286302
                             8.38807047 -0.19992171]
 [ 8.2166179
                8.68472391
                             7.77260495
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 [ 8.39266145
                0.55202234
                             7.80612174 -0.2
 [ 8.42683206 -0.2
                             8.1911478
                                           8.20534998]
 [ 7.99706001 -0.2
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Q-table after episode 3992
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                7.60623418
                             8.54911165
                                          8.26185369]
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[ 8.23060101  8.28286302
                             8.38807047 -0.19992171]
 [ 8.12427023  8.19677976
                             8.68374042 8.14929203]
 [ 8.21641058
               7.75126714
                             6.9003399
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 [ 8.39266145  0.55202234
                             7.80612174 -0.2
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                                           8.205349981
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Q-table after episode 3993
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                             8.38807047 -0.19992171]
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                             8.68374042 8.14929203]
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                                           9.07573504]
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                             7.80612174 -0.2
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                             8.1911478
                                          8.205349981
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Q-table after episode 3994
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                                          8.24446928]
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 [ 8.23060101
                8.28286302
                             8.38807047 -0.19992171]
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Q-table after episode 3995
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                             8.54911165 8.26185369]
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                8.28286302
                             8.38807047 -0.19992171]
 [ 8.12427023
                8.19677976
                             8.68374042 8.14929203]
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                7.75126714
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 [ 8.39266145  0.55202234
                             7.80612174 -0.2
 [ 7.98368976 -0.2
                             8.1911478
                                          8.20534998]
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Q-table after episode 3996
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                                          8.261853697
 [ 8.23060101
                8.28286302
                             8.38807047 -0.19992171]
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                8.19677976
                             8.68374042
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 [ 8.21641058
                7.75126714
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                             7.80612174 -0.2
 [ 7.98368976 -0.2
                             8.1911478
                                          8.20534998]
 [ 7.99706001 -0.2
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Q-table after episode 3997
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                                          8.24446928]
 Γ-1.
                7.60623418
                             8.54911165
                                          8.26185369]
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                8.28286302
                             8.38807047 -0.19992171]
 [ 8.12427023
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Q-table after episode 3998
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```

If you have trained everything right this method should demonstrate a solved environment. Please make sure to include these results in your saved PDF.

```
[272]: q_learning.exploration = 0.0
       for i in range(0, 1):
         observation, info = lake.reset()
         terminated = False
         lake.render(screen, window_width, window_height)
         view = pygame.surfarray.array3d(screen)
         view = view.transpose([1, 0, 2])
         img_bgr = cv2.cvtColor(view, cv2.COLOR_RGB2BGR)
         cv2_imshow(img_bgr)
         time.sleep(.5)
         clear_output()
         while not terminated:
           action = q_learning.sample_action(observation)
           observation,old_state, reward, terminated, truncated, info = lake.

step(action)
           lake.render(screen, window_width, window_height)
           view = pygame.surfarray.array3d(screen)
           view = view.transpose([1, 0, 2])
           img_bgr = cv2.cvtColor(view, cv2.COLOR_RGB2BGR)
           cv2_imshow(img_bgr)
           time.sleep(.5)
```











