AI6101 Reinforcement Learning Assignment

Goh Jun Hao G21202327

In [1]:
```
from typing import List, Tuple
import copy
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
%matplotlib inline
```

The following class defines the grid world environment. The grid world looks like:

```
 ____________________________________________________________
|___|_0_|_1_|_2_|_3_|_4_|_5_|_6_|_7_|_8_|_9_|_10|_11|_12|_13|
|_0_|___|___|___|___|___|___|_x_|_x_|___|___|___|___|___|___|
|_1_|___|___|___|___|___|___|_x_|_x_|___|___|___|___|___|___|
|_2_|___|___|___|_x_|___|___|_x_|_x_|___|___|___|___|_x_|___|
|_3_|___|___|___|_x_|___|___|_x_|___|___|___|___|_x_|_x_|___|
|_4_|___|_B_|___|_x_|___|___|___|___|___|___|___|_x_|_x_|_G_|
|_5_|_A_|___|___|_x_|___|___|___|___|___|___|___|_x_|_x_|___|
```

In [2]:
```
AGENT = 'A'
BOX = 'B'
GOAL = 'G'
DANGER = 'x'
GRID = '_'


class CliffBoxGridWorld:
    """
    Cliff Box Pushing Grid World.
    """
    action_space = [1, 2, 3, 4]
    forces = {
        1: np.array([-1, 0]),
        2: np.array([1,  0]),
        3: np.array([0, -1]),
        4: np.array([0,  1]),
    }
    world_width = 14
    world_height = 6
    goal_pos = np.array([4, 13])
    init_agent_pos = np.array([5, 0])
    init_box_pos = np.array([4, 1])
    danger_region = [
        [(2, 3), (5, 3)],
        [(0, 6), (3, 6)],
        [(0, 7), (2, 7)],
        [(3, 11), (5, 11)],
        [(2, 12), (5, 12)],
    ]

    def __init__(self,
                 episode_length=100,
                 render=False,
                 ):
        """
```

```python
        The grid world looks like:
        _____________________________________________________________
        |___|_0_|_1_|_2_|_3_|_4_|_5_|_6_|_7_|_8_|_9_|_10|_11|_12|_13|
        |_0_|___|___|___|___|___|___|_x_|_x_|___|___|___|___|___|___|
        |_1_|___|___|___|___|___|___|_x_|_x_|___|___|___|___|___|___|
        |_2_|___|___|___|_x_|___|___|_x_|_x_|___|___|___|___|_x_|___|
        |_3_|___|___|___|_x_|___|___|_x_|___|___|___|___|_x_|_x_|___|
        |_4_|___|_B_|___|_x_|___|___|___|___|___|___|___|_x_|_x_|_G_|
        |_5_|_A_|___|___|_x_|___|___|___|___|___|___|___|_x_|_x_|___|
        """
        # Environment configurations.
        self.episode_length = episode_length
        self.render = render
        self.agent_pos = self.init_agent_pos
        self.box_pos = self.init_box_pos

        # Visualization.
        if self.render:
            self.world = np.chararray((self.world_height, self.world_width))
            self.last_agent_pos = copy.deepcopy(self.agent_pos)
            self.last_box_pos = copy.deepcopy(self.box_pos)
            self.world[:] = GRID
            for region in self.danger_region:
                A, B = region
                assert A[1] == B[1], "A[1] != B[1]"
                self.world[A[0]:B[0]+1, A[1]] = DANGER
            self.world[self.agent_pos[0], self.agent_pos[1]] = AGENT
            self.world[self.box_pos[0], self.box_pos[1]] = BOX
            self.world[self.goal_pos[0], self.goal_pos[1]] = GOAL

    def reset(self):
        """
        Resets the environment.

        Returns:
            The initial state (agent position and box position).
        """
        self.timesteps = 0
        self.action_history = []
        self.agent_pos = self.init_agent_pos
        self.box_pos = self.init_box_pos

        return tuple([*self.agent_pos.tolist(), *self.box_pos.tolist()])

    def step(self, actions: int):
        """
        Args: actions (a list of int).

        Returns:
            The next state, reward, done, info.
        """
        self.action_history.append(actions)

        # Update the state.
        force = self.forces[actions]
        # check if the agent is near the box
        if np.sum(np.abs(self.agent_pos - self.box_pos)) == 1:
            # check if box is moved
            if all(self.agent_pos + force == self.box_pos):
                # check out of boundary
                self.box_pos = self._check_pos_boundary(pos=self.box_pos + force, box_ha
        # move the agent
        new_agent_pos = self._check_pos_boundary(self.agent_pos + force)
        if not all(new_agent_pos == self.box_pos):
            self.agent_pos = new_agent_pos
        state = tuple([*self.agent_pos.tolist(), *self.box_pos.tolist()])
```

```
        # Calculate the rewards
        done = self.timesteps == self.episode_length - 1
        # the distance between agents and box
        dist = np.sum(np.abs(self.agent_pos - self.box_pos))
        reward = -1  # -1 for each step
        reward -= dist
        # if agents or box is off the cliff
        if self._check_off_cliff(self.agent_pos) or self._check_off_cliff(self.box_pos):
            reward += -1000
            done = True

        if all(self.box_pos == self.goal_pos):
            reward += 1000
            done = True

        reward -= np.sum(np.abs(self.box_pos - self.goal_pos))

        if self.render:
            self._update_render()

        self.timesteps += 1
        info = {}

        return state, reward, done, info

    def print_world(self):
        """
        Render the world in the command line.
        """
        if len(self.action_history) > 0:
            print(f'Action: {self.action_history[-1]}')
        print(self.world)

    def _check_pos_boundary(self, pos, box_hard_boundary: bool = False):
        """
        Move the given position within the world bound.
        """
        if pos[0] < 0:
            pos[0] = 0
        if pos[0] >= self.world_height:
            pos[0] = self.world_height - 1
        if pos[1] < 0:
            pos[1] = 0
        if pos[1] >= self.world_width:
            pos[1] = self.world_width - 1

        if box_hard_boundary:
            if pos[0] == 0:
                pos[0] += 1
            elif pos[0] == self.world_height - 1:
                pos[0] = self.world_height - 2
            if pos[1] == 0:
                pos[1] += 1

        return pos

    def _check_off_cliff(self, pos):
        """
        Check if the given position is off cliff.
        """
        for region in self.danger_region:
            A, B = region
            assert A[1] == B[1], "A[1] != B[1]"
            if A[0] <= pos[0] <= B[0] and pos[1] == A[1]:
                return True
```

```
            return False

    def _update_render(self):
        """
        Update the render information.
        """
        if not all(self.last_agent_pos == self.agent_pos):
                pos = self.last_agent_pos
                if (pos[0] != self.goal_pos[0]) or (pos[1] != self.goal_pos[1]):
                    self.world[pos[0], pos[1]] = GRID

        if not all(self.last_box_pos == self.box_pos):
            pos = self.last_box_pos
            if self.world[pos[0], pos[1]].decode('UTF-8') not in {AGENT}:
                self.world[pos[0], pos[1]] = GRID

        if (self.agent_pos[0] != self.goal_pos[0]) or (self.agent_pos[1] != self.goal_po
            self.world[self.agent_pos[0], self.agent_pos[1]] = AGENT
        self.world[self.box_pos[0], self.box_pos[1]] = BOX
        self.last_box_pos = copy.deepcopy(self.box_pos)
        self.last_agent_pos = copy.deepcopy(self.agent_pos)
```

Q-learning Agent

Q-learning is a value-based method that uses a Q- table to record the estimated Q-values for various actions in different states. The Q-table is initialized prior to exploring the environment. As the agent interacts with the environment, it updates the Q(s, a) values using the Bellman equation, allowing the agent to continually learn and improve its under- standing of the environment. The Q-function continues to be updated until it reaches convergence or the specified number of iterations

In [3]:

```
class QAgent:
    def __init__(self, env, num_episodes, epsilon=0.1, alpha=0.1, gamma=0.99):
        self.action_space = env.action_space
        self.q_table = dict() # Store all Q-values in a dictionary
        # Loop through all possible grid spaces, create sub-dictionary for each
        for agent_x in range(env.world_height):
            for agent_y in range(env.world_width):
                for box_x in range(env.world_height):
                    for box_y in range(env.world_width):
                        # Populate sub-dictionary with zero values for possible moves
                        self.q_table[(agent_x, agent_y, box_x, box_y)] = {k: 0 for k in

        self.env = env
        self.num_episodes = num_episodes
        self.epsilon = epsilon
        self.alpha = alpha
        self.gamma = gamma
        self.action_seq = [] # Initialize empty action sequence list
        self.total_action_seq = [] # Initialize empty action sequence list
        self.max_agent_seq = []

    def act(self, state):
        """Returns the (epsilon-greedy) optimal action from Q-Value table."""
        if np.random.uniform(0,1) < self.epsilon:
            action = self.action_space[np.random.randint(0, len(self.action_space))]
        else:
            q_values_of_state = self.q_table[state]
            maxValue = max(q_values_of_state.values())
            action = np.random.choice([k for k, v in q_values_of_state.items() if v == m

        return action
```

```python
    def learn(self):
        """Runs Q-learning algorithm to learn optimal policy."""
        rewards_per_episode = []

        for episode in range(self.num_episodes):
            # Initialize variables for storing state and action sequences
            action_seq = []
            state = self.env.reset()
            total_reward = 0
            done = False
            while not done:
                action = self.act(state)
                next_state, reward, done, _ = self.env.step(action)

                # Update Q-Table using Q-Learning algorithm
                old_qvalue = self.q_table[state][action]
                next_max = max(self.q_table[next_state].values())
                new_qvalue = (1 - self.alpha) * old_qvalue + self.alpha * (reward + self
                self.q_table[state][action] = new_qvalue

                # Update total reward and current state
                total_reward += reward
                state = next_state
                action_seq.append(action)
                self.action_seq = action_seq # Append action to the action sequence list

            self.total_action_seq.append(action_seq)
            rewards_per_episode.append(total_reward)
            max_reward = max(rewards_per_episode)
            index_max_reward = rewards_per_episode.index(max_reward)
            self.max_action_seq = self.total_action_seq[index_max_reward]

        #print(rewards_per_episode)
        print('Maximum reward =', max_reward)
        print('Episode of maximum reward achieved =', index_max_reward)
        print('Action sequence of maximum reward =', self.max_action_seq)
        return rewards_per_episode
```

Training Q-learning Agent

In [4]:

```python
env = CliffBoxGridWorld()
agent = QAgent(env, epsilon=0.01, alpha=0.1, gamma=0.99, num_episodes=15000)
rewards = agent.learn()
```

```
Maximum reward = 642
Episode of maximum reward achieved = 6225
Action sequence of maximum reward = [4, 1, 1, 1, 3, 1, 4, 4, 4, 4, 1, 4, 2, 2, 2, 3, 2,
4, 4, 4, 4, 4, 2, 4, 1, 1, 1, 3, 1, 4, 4, 4, 1, 4, 2, 2, 2]
```

Q-Learning Episodes vs Episode Rewards Curve

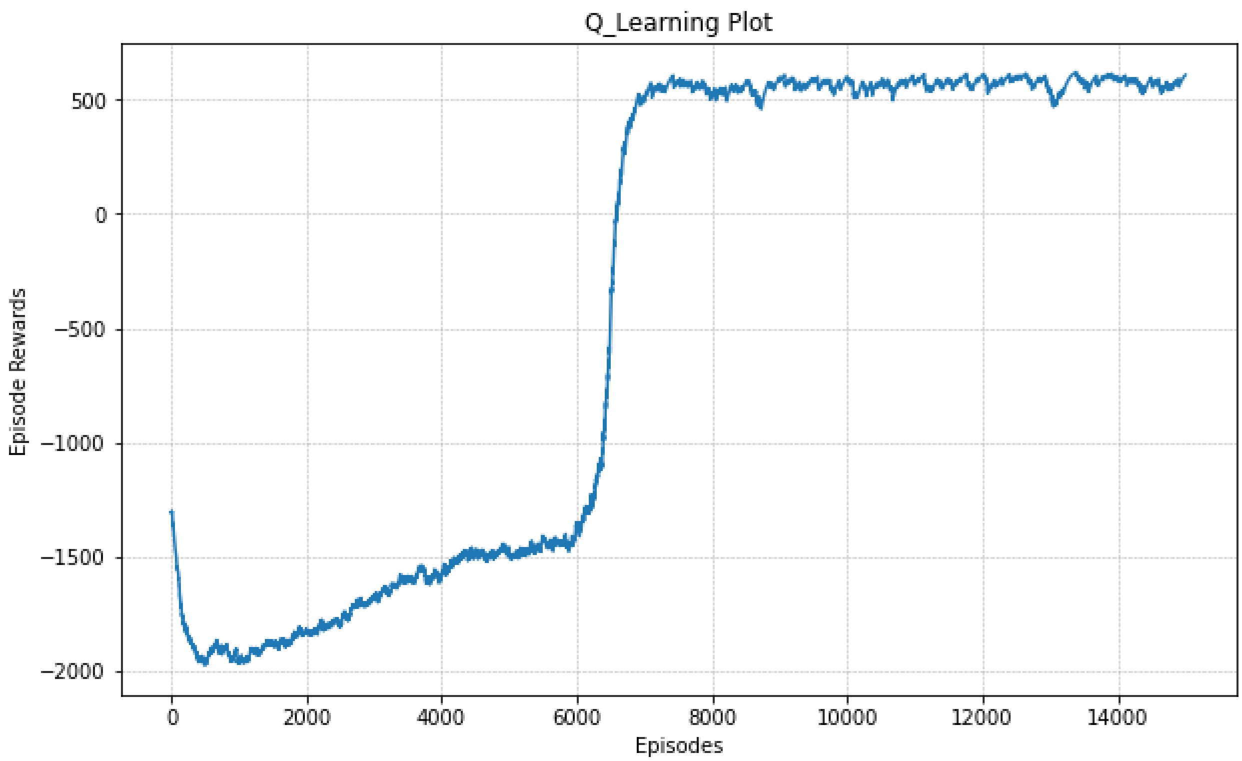
It can be observed from the plot below that the q-learning agent converge nicely at the maximum reward of 642 by about episode 7000

In [5]:

```python
# Smooth plot
weight = 0.99
last = rewards[0]
smoothed = []
for v in rewards:
    smoothed_val = last * weight + (1 - weight) * v
    smoothed.append(smoothed_val)
```

```
    last = smoothed_val

# Plot the learning curve
plt.figure(figsize=(10, 6))
plt.plot(smoothed)
plt.xlabel("Episodes")
plt.ylabel("Episode Rewards")
plt.title('Q_Learning Plot')
plt.grid(linestyle='--', linewidth=0.5)
plt.show()
```



Q-learning V_table Visualization

Finding the 'V' for the agent

In [6]:

```
v_table = {}
for state_, actions_ in agent.q_table.items():
    v_table['('+','.join(map(str, state_))+')'] = list(actions_.values())
df = pd.DataFrame.from_dict(v_table).transpose()
df['state'] = list(df.index)
df['Agent_Position'] = df['state'].apply(lambda x:x[1:5].rstrip(','))
df_group = df.groupby('Agent_Position')[[0, 1, 2, 3]].mean()

df_group = df.groupby('Agent_Position')[[0, 1, 2, 3]].mean().reset_index()
df_group['V'] = df_group[[0, 1, 2, 3]].mean(axis=1)
df_group[['agent_x', 'agent_y']] = df_group['Agent_Position'].str.split(',', expand=True

# showing the data frame in terms of x and y coordinate of agent, and 'V'
df_group = df_group[['agent_x', 'agent_y', 'V']]
df_group
```

Out[6]:

	agent_x	agent_y	V
0	0	0	-38.931412
1	0	1	-39.317577
2	0	10	-30.111324

3	0	11	-26.464634
4	0	12	-20.204145
...	...	...	...
79	5	5	-37.677345
80	5	6	-37.081845
81	5	7	-35.447405
82	5	8	-34.693796
83	5	9	-28.446331

84 rows × 3 columns

Presentation of V_table in the template of the Cliff Box Grid World

It can be observed from the grid view of the 'V' that the obstacles 'V' are all zero, which by intuition make sense.

In [16]:
```
# create a 6x14 array of NaN values
grid = np.empty((6, 14))
grid[:] = np.nan

# fill in the grid with the V values from the dataframe
for _, row in df_group.iterrows():
    x = int(row['agent_x'])
    y = int(row['agent_y'])
    grid[x, y] = round(row['V'], 2)

# create a dataframe from the grid
grid_df = pd.DataFrame(grid, columns=range(14), index=range(6))

# set format for V values
grid_df = grid_df.style.format("{:.2f}")

# add borders and show row/column indices
grid_df = grid_df.set_table_styles([
    {"selector": "th", "props": [("border", "1px solid #ccc"), ("text-align", "center")]
    {"selector": "td", "props": [("border", "1px solid #ccc"), ("text-align", "center")]
    {"selector": "th.row_heading", "props": [("background-color", "transparent"),]}
])

# display formatted grid of v_table
print('V_table Visualization')
display(grid_df)
```

V_table Visualization

	0	1	2	3	4	5	6	7	8	9	10	11	12	13
0	-38.93	-39.32	-39.80	-37.75	-33.89	-44.51	0.00	0.00	-41.71	-30.93	-30.11	-26.46	-20.20	-16.49
1	-31.63	-30.82	-32.17	-41.92	-36.60	-43.60	0.00	0.00	-38.03	-23.32	-22.88	-22.87	-32.19	-17.33
2	-35.12	-31.17	-42.79	0.00	-42.38	-44.70	0.00	0.00	-39.77	-25.62	-22.80	-40.08	0.00	-30.02
3	-38.24	-32.12	-43.18	0.00	-42.91	-43.18	0.00	-48.01	-33.66	-28.79	-37.37	0.00	0.00	-32.47
4	-38.79	-32.82	-42.27	0.00	-41.20	-30.67	-40.94	-28.66	-28.00	-29.62	-38.21	0.00	0.00	-31.42
5	-34.93	-32.86	-46.04	0.00	-45.23	-37.68	-37.08	-35.45	-34.69	-28.45	-38.33	0.00	0.00	-31.05

Q-learning Policy Visualization

Below is the presentation of policy of the agent following the action sequence taken for the maximum reward, which is 642.

As observed shown below, the agent is travelling correctly with the action sequence = [4, 1, 1, 1, 3, 1, 4, 4, 4, 4, 1, 4, 2, 2, 2, 3, 2, 4, 4, 4, 4, 4, 2, 4, 1, 1, 1, 3, 1, 4, 4, 4, 1, 4, 2, 2, 2]

In [8]:
```
env = CliffBoxGridWorld(render=True)
state = env.reset()
env.print_world()
done = False
rewards = []
step = 0

while not done:
    action = agent.max_action_seq[step]
    state, reward, done, info = env.step(action)
    rewards.append(reward)
    print(f'step: {env.timesteps}, state: {state}, action taken: {agent.action_seq[actio
    env.print_world()
    step += 1

print(f'rewards: {sum(rewards)}')
print(f'action history: {env.action_history}')
```

```
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'B' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'A' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 1, state: (5, 1, 4, 1), action taken: 3, reward: -14
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'B' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'A' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 2, state: (4, 1, 3, 1), action taken: 1, reward: -15
Action: 1
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'B' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'A' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 3, state: (3, 1, 2, 1), action taken: 1, reward: -16
Action: 1
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'B' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'A' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 4, state: (2, 1, 1, 1), action taken: 1, reward: -17
Action: 1
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'B' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'A' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
```

```
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 5, state: (2, 0, 1, 1), action taken: 1, reward: -18
Action: 3
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'B' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'A' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 6, state: (1, 0, 1, 1), action taken: 1, reward: -17
Action: 1
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'A' b'B' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 7, state: (1, 1, 1, 2), action taken: 3, reward: -16
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'A' b'B' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 8, state: (1, 2, 1, 3), action taken: 3, reward: -15
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'A' b'B' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 9, state: (1, 3, 1, 4), action taken: 3, reward: -14
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'A' b'B' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 10, state: (1, 4, 1, 5), action taken: 3, reward: -13
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'A' b'B' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 11, state: (0, 4, 1, 5), action taken: 1, reward: -14
Action: 1
[[b'_' b'_' b'_' b'_' b'A' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'B' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 12, state: (0, 5, 1, 5), action taken: 3, reward: -13
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'A' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'B' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 13, state: (1, 5, 2, 5), action taken: 1, reward: -12
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Action: 2
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'A' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'B' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 14, state: (2, 5, 3, 5), action taken: 1, reward: -11
Action: 2
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'A' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'B' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 15, state: (3, 5, 4, 5), action taken: 1, reward: -10
Action: 2
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'A' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'B' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 16, state: (3, 4, 4, 5), action taken: 1, reward: -11
Action: 3
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'A' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'B' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 17, state: (4, 4, 4, 5), action taken: 1, reward: -10
Action: 2
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'A' b'B' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 18, state: (4, 5, 4, 6), action taken: 3, reward: -9
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'A' b'B' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 19, state: (4, 6, 4, 7), action taken: 3, reward: -8
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'A' b'B' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 20, state: (4, 7, 4, 8), action taken: 3, reward: -7
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'A' b'B' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 21, state: (4, 8, 4, 9), action taken: 3, reward: -6
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
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 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'A' b'B' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 22, state: (4, 9, 4, 10), action taken: 3, reward: -5
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'A' b'B' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 23, state: (5, 9, 4, 10), action taken: 1, reward: -6
Action: 2
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'B' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'A' b'_' b'x' b'x' b'_']]
step: 24, state: (5, 10, 4, 10), action taken: 3, reward: -5
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'B' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'A' b'x' b'x' b'_']]
step: 25, state: (4, 10, 3, 10), action taken: 1, reward: -6
Action: 1
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'B' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'A' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 26, state: (3, 10, 2, 10), action taken: 1, reward: -7
Action: 1
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'B' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'A' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 27, state: (2, 10, 1, 10), action taken: 1, reward: -8
Action: 1
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'B' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'A' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 28, state: (2, 9, 1, 10), action taken: 1, reward: -9
Action: 3
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'B' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'A' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 29, state: (1, 9, 1, 10), action taken: 1, reward: -8
Action: 1
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'A' b'B' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
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 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 30, state: (1, 10, 1, 11), action taken: 3, reward: -7
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'A' b'B' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 31, state: (1, 11, 1, 12), action taken: 3, reward: -6
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'A' b'B' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 32, state: (1, 12, 1, 13), action taken: 3, reward: -5
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'A' b'B']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 33, state: (0, 12, 1, 13), action taken: 1, reward: -6
Action: 1
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'A' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'B']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 34, state: (0, 13, 1, 13), action taken: 3, reward: -5
Action: 4
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'A']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'B']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 35, state: (1, 13, 2, 13), action taken: 1, reward: -4
Action: 2
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'A']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'B']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 36, state: (2, 13, 3, 13), action taken: 1, reward: -3
Action: 2
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'A']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'B']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'G']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
step: 37, state: (3, 13, 4, 13), action taken: 1, reward: 998
Action: 2
[[b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'_' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'x' b'_' b'_' b'_' b'_' b'x' b'_']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'x' b'x' b'A']
 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'B']
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 [b'_' b'_' b'_' b'x' b'_' b'_' b'_' b'_' b'_' b'_' b'_' b'x' b'x' b'_']]
rewards: 642
action history: [4, 1, 1, 1, 3, 1, 4, 4, 4, 4, 1, 4, 2, 2, 2, 3, 2, 4, 4, 4, 4, 4, 2, 4,
1, 1, 1, 3, 1, 4, 4, 4, 1, 4, 2, 2, 2]
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