Computer Engineering Department
CMPS458: Reinforcement Learning
Ayman AboElHassan, PhD

Fall 2025

Assignment 1

The **goal** of this assignment is to implement a custom Gym environment, implement/apply Policy Iteration approach on the custom-built environment, and understand the limitation of classical dynamic programming approach.

Summary

1. Install the libraries needed
    - Python, Gymnasium, PyGame, NumPy
2. Create a custom stochastic Gym Environment for a “Grid Maze”
3. Create Environment Rendering using PyGame
4. Implement the “Policy Iteration” Dynamic Programming approach
5. Apply the Policy Iteration approach to the Grid Maze environment
6. Use “RecordVideo” Wrapper to record the RL agent in-action
7. Answer the following questions

Questions

1. What is the state-space size of the 5x5 Grid Maze problem?
2. How to optimize the policy iteration for the Grid Maze problem?
3. How many iterations did it take to converge on a stable policy for 5x5 maze?
4. Explain, with an example, how policy iteration behaves with multiple goal cells.
5. Can policy iteration work on a 10x10 maze? Explain why?
6. Can policy iteration work on a continuous-space maze? Explain why?
7. Can policy iteration work with moving bad cells (like Packman moving ghosts)? Explain why?

Deliverables

1. GitHub repository with Python codes (Gym Environment, Policy Iteration model)
2. Recorded videos of the trained agent in action
3. Report with the outcome summary and answers to the questions asked (kindly follow this latex template).

Due date

23 Oct 2025

Helping Materials

- https://gymnasium.farama.org/index.html
- https://gymnasium.farama.org/introduction/create_custom_env/
- https://gymnasium.farama.org/tutorials/gymnasium_basics/environment_creation/
- https://gymnasium.farama.org/introduction/record_agent/
- https://gibberblot.github.io/rl-notes/single-agent/policy-iteration.html

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Grid Maze Environment Description

The objective of this problem is to traverse a 5x5 grid-based maze from a random starting cell “S” to reach a randomly generated goal cell “G” while avoiding 2 randomly generated bad cells “X”. Fig 1 shows an example of the randomly generated maze, where the 4 cells are placed randomly.

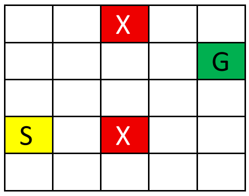


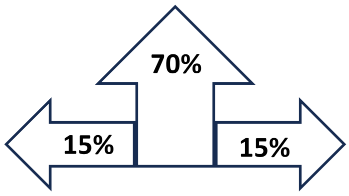
Fig 1: Example of a randomly generated maze

Observation Space

A set of 8 discrete integers representing the coordinates (x, y) of the current agent’s cell location, the goal cell location, and the 2 bad cell locations.

Action Space

A set of 4 discrete actions {right, up, left, down} indicating the movement direction. The agent moves in a stochastic way, with 70% probability of reaching the intended direction, and 15% of reaching any perpendicular directions. Hence, taking the action “up” will move the agent one cell up with 70% probability, right with 15% and left with 15%.



Reward Function:

- Design the proper reward function giving reasons for your own choice.