CS 533 Intelligent Agents and Decision Making, Spring 2018

Homework #1: Pac-Man Markov Decision Process
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Markov Decision Process:

Markov Decision Process is a four tuple defined by {S,A,T,R}, where:

S: state space of all the possible states 's'

A: Action space of all the possible actions 'a'

T: Transition function that describes how the states will change based on the current state   and action

R: Reward for taking an action based on current state, or just being in a particular state

The essence of a MDP is that there is all the information you need in the state space S for the agent to take an action. In an even more simpler language, it means that "how you ended up in a particular state does not matter", and the current state representation has all the information you need.

It is important to note that the Markov Decision Process is based on the state representation of the problem, and not the problem itself.

State Space (S):

- Coordinates (x, y) and direction (up, down, left, right, stuck at wall) for Pac-Man
- Coordinates (x, y) and directions for all the ghosts
- Coordinates of the in game reward system (dots, fruits, etc.)
- Coordinates of the walls of the maze
- Life(s) of Pac-Man remaining
- Vulnerability state and remaining vulnerability time for the ghosts. Ghosts are vulnerable for a certain time after Pac-Man gets a Power-Pellet

Action Space (A):

- Up
- Down
- Left
- Right
- No-op

Transition function (T):

- At the start of the game, Pac-Man starts at a certain position in the map
- At the start of the game, Ghosts start at the center of the map
- When the game starts, the ghosts select a random direction [up, down, left, right]
- When the any ghost encounters a wall, it randomly choses a different direction
- If 'up' action is taken, change current direction and go up (unless there is a wall in the immediate 'up' direction
- If 'down' action is taken, change current direction and go down (unless there is a wall in the immediate 'down' direction
- If 'left' action is taken, change current direction and go left (unless there is a wall in the immediate 'left' direction
- If 'right' action is taken, change current direction and go right (unless there is a wall in the immediate 'right' direction
- If no action is taken, keep going in the current direction until it hits a wall
- While moving in any direction if Pac-Man runs over any ghost:
  - If the ghost is vulnerable, the ghost re-spawns from the center of the maze
  - Else, Pac-Man loses a life
- If Pac-Man encounters a 'dot', the dot disappears from the screen
- If all the 'dots' have been eaten by Pac-Man, the level is completed

Note: When Pac-Man eats a power pellet, there is a timer countdown for the time ghosts become edible.

Reward function (R):

- Reward is initialized with 0
- +1 reward for eating a dot
- +100 reward for eating a ghost
- + 1000 points for clearing a board and moving to the next board