

# CS221 Summer 2019 Homework 5

SUNet ID: jaigupta

Name: Jai Gupta

By turning in this assignment, I agree by the Stanford honor code and declare that all of this is my own work.

## Problem 1

- (a) If  $N$  is the number of ghosts and  $D$  is the max depth. The  $V_{minimax}(s, D)$  gives the solution, where  $V_{minimax}(s, d)$  follows the following recursion:

$$V_{minimax}(s, d) = \begin{cases} Utility(s) & \text{if } IsEnd(s) \\ Eval(s) & \text{if } d = 0 \\ \max_{a \in Actions(s)} V_{minimax}(Succ(s, a), d) & \text{if } Player(s) = a_0 \text{ (Pacman)} \\ \min_{a \in Actions(s)} V_{minimax}(Succ(s, a), d) & \text{if } Player(s) = a_i; i \in \{1, 2, \dots, N-1\} \\ \min_{a \in Actions(s)} V_{minimax}(Succ(s, a), d-1) & \text{if } Player(s) = a_N \text{ (last ghost)} \end{cases}$$

Note that  $Actions(s)$  is assumed to return only the list of legal possible actions at state  $s$ .

## Problem 3

- (a) If  $N$  is the number of ghosts and  $D$  is the max depth. The  $V_{expectimax}(s, D)$  gives the solution, where  $V_{expectimax}(s, d)$  follows the following recursion:

$$V_{expectimax}(s, d) = \begin{cases} Utility(s) & \text{if } IsEnd(s) \\ Eval(s) & \text{if } d = 0 \\ \max_{a \in Actions(s)} V_{expectimax}(Succ(s, a), d) & \text{if } Player(s) = a_0 \text{ (Pacman)} \\ \frac{\sum_{a \in Actions(s)} V_{expectimax}(Succ(s, a), d)}{|Actions(s)|} & \text{if } Player(s) = a_i; i \in \{1, 2, \dots, N-1\} \\ \frac{\sum_{a \in Actions(s)} V_{expectimax}(Succ(s, a), d-1)}{|Actions(s)|} & \text{if } Player(s) = a_N \text{ (last ghost)} \end{cases}$$

Note that  $Actions(s)$  is assumed to return only the list of legal possible actions at state  $s$ .