Assignment 1

CP468 – Artificial Intelligence

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June 5, 2023

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Question 1

a.

Agent Type	Performance Measure	Environment	Actuators	Sensors
Small Towers of Hanoi	All disks moved to another rod, with the following rules: 1) only one disk can be moved at a time, 2) each move consists of taking the upper disk at one rod, and sliding it onto another rod, placing it on top of any disk already present in that rod, 3) No disk may be placed on top of a smaller disk	Players	Three vertical rods (R1,R2,R3), and three disks (D1,D2,D3) with holes in the center. Disk D1 is small, disk D2 is mediumsized and disk D3 is large	Player's movement of the disks on each rod

b.

Agent Type	Performance Measure	Environment	Actuators	Sensors
PAC MAN	Pac Man eats all the pellets	A wall, a pellet, Pac Man, or nothing	Pac Man's body and mouth	Vision

Question 2

a. In a fully observable, deterministic, discrete, single-agent, and static environment, an agent is perfectly rational if it always selects the action that leads to the optimal outcome, given its current percept. Agents A and B can be perfectly rational if the function f produces the optimal action every time. However, agent C cannot be, because it depends on the past percepts, so if the past percepts do not lead the optimal solution, then C will not as well.

b. In a partially observable, deterministic, discrete, single-agent, and static environment, an agent cannot be perfectly rational for every such environment, regardless of the function *f* it chooses. Since the agent cannot observe the full state of the environment, it cannot guarantee to make the best decision for each percept.

c. In a partially observable, stochastic, discrete, single-agent, and dynamic environment, an agent cannot be perfectly rational for every such environment, regardless of the function *f* it chooses. This is because a stochastic environment introduces randomness. Even if an agent chooses a function f that produces the optimal decision for each percept, it won't guarantee to always make the best decision due to a stochastic environment.

Question 3

a. Each disk is represented by N_i where N_i is smaller than Nj for all i<j. You can represent this problem using three stacks S_1, S_2, S_3 which store which disks are on which pegs. Each stack represents a peg, while the numbers in increasing size, corresponds to which discs are on that peg and the topmost (disk 1) element of the stack represents the top disk. **b.** 3^N

c. S_1: $\{N_1 \ldots N_i\}$
S_2: {}
S_3: {}

d. You can pop the first integer from any of the stacks and push it to the front of another stack as long as it is smaller than the one at the front of the stack being added to.

Move the disk (N_1) from S_1 to S_2

Move the disk (N_1) from S_1 to S_3

Move the disk (N_2) from S_1 to S_3

Move the disk (N_2) from S_1 to S_2

Move the disk (N_1) from S_3 to S_1

Move the disk (N_2) from S_3 to S_2

Move the disk (N_1) from S_1 to S_2

Move the disk (N_1) from S_2 to S_1

Move the disk (N_2) from S_2 to S_3

Move the disk (N_1) from S_1 to S_2

Move the disk (N_2) from S_3 to S_2

Move the disk (N_1) from S_2 to S_1

Move the disk (N_3) from S_2 to S_3

Move the disk (N_1) from S_1 to S_2

Move the disk (N_2) from S_1 to S_3

Move the first disk (N_1) from S_2 to S_3

e. Does the state match
S_1: {}
S_2: {}
S_3: {$N_1 \ldots N_i$ }

Question 4

a. **False.** A hill-climbing algorithm with a lower value (or higher cost) that never visits states would not be able to find solutions that are optimal within the set of states it visits because if it unable to explore all the regions of the search space, it could miss the global optimum. This would lead it to reach a local optimum and stop.
    a. Ex. The traveling salesman problem: if the salesman does not visit each state, it will not be able to explore other possible paths that may be shorter.
b. **False.** If the temperature is fixed, then it has randomness associated with it so it cannot guarantee an optimal state.
c. **False.** Even starting from a neighbor of a neighbor of a globally optimal state does not guarantee that the algorithm will find the global optimum as the neighbor could be a local minimum and the current state is on another path that leads to the local maximum. Ex. N-queens problem: If it starts at a state where all the queens are in non-attacking positions except for one pair that are attacking each other, the algorithm would stay at this local optimum and will not be able to explore the other possible solutions that may be better
d. **False.** Stochastic hill climbing can help to avoid getting stuck in local optima, but it does not guarantee that the global optimum will be found. The randomness of the algorithm can miss the global optimum even if it in the search space.
   Ex. Randomized Knapsack Problem: When the different items are being randomly selected to be put in the knapsack to maximize the value, the random search may never explore the best set of items
e. **True.** Gradient descent finds the global optimum from any starting point if and only if the function is convex because a convex function is when the second derivative is positive throughout the function so any local optimum is also the global optimum