Assignment 1

Introduction to Artificial Intelligence and Logic Programming

Winter 2024

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Contents

Instructions

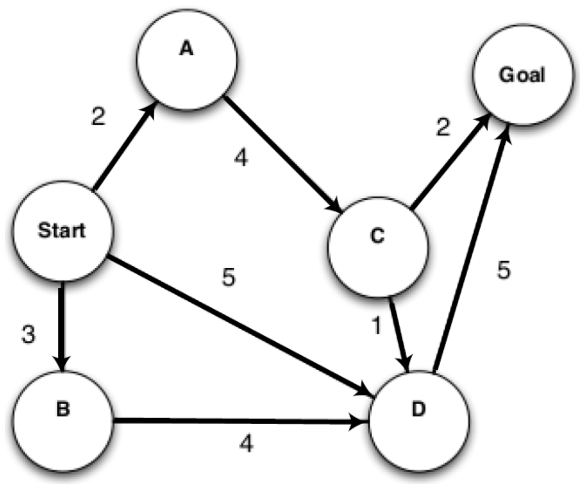
- This is an individual assignment.
- Copying another person's work is a breach of the academic integrity policy.
- Check eclass for due date and time.
- After completing this assignment, **submit only the answer file attached to this assignment**.

Part 1 – Uniformed Search (Questions 1 and 2)

Question 1

For each of the following graph search strategies, work out the order in which states are expanded, as well as the path returned by graph search. In all cases, assume ties resolve in such a way that states with earlier alphabetical order are expanded first. Remember that in DFS graph search, a state is expanded only once.

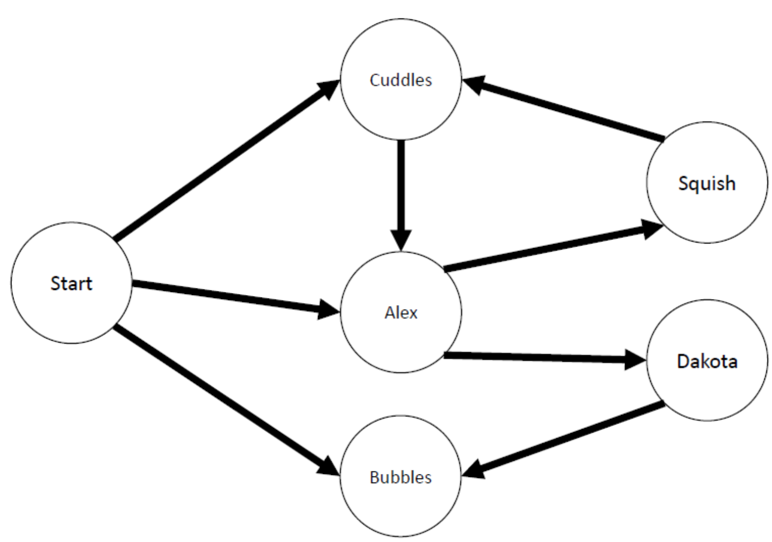
[1] This assignment is put together from material and questions provided by the authors of the textbook under an educational use license: All materials provided on this website are freely available for educational use http://ai.berkeley.edu/instructors_guide.html .



(Q.1.a) Depth-first graph search.
(Q.1.b) Breadth-first graph search.
(Q.1.c) Uniform cost graph search.

Question 2

Scorpblorg the snail is looking for a mate. It can visit different potential mates based on a trail of ooze to nearby snails, and then test them for chemistry, as represented in the below graph, where each node represents a snail. In all cases, nodes with equal priority should be visited in alphabetical order.



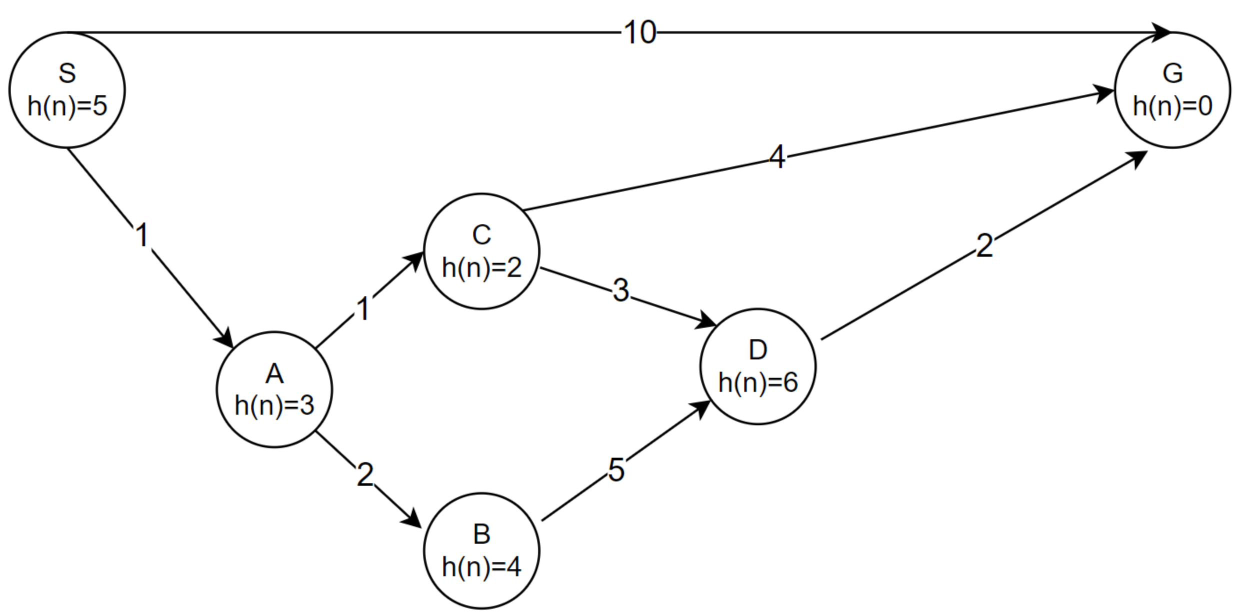
(a) Simple search

In this part, assume that the only match for Scorpblorg is Squish (i.e. Squish is the goal state). Which of the following are true when searching the above graph?
(Q2.a.1) True or False: BFS Tree Search expands more nodes than DFS Tree Search
(Q2.a.2) True or False: DFS Tree Search finds a path to the goal for this graph
(Q2.a.3) True or False: DFS Graph Search finds the shortest path to the goal for this graph
(Q2.a.4) Yes or No: If we remove the connection from Cuddles → Alex, can DFS Graph Search find a path to the goal for the altered graph?

(b) Third Time's A Charm
Now we assume that Scorpblorg's mate preferences have changed. The new criteria she is looking for in a mate is that she has **visited the mate twice before** (i.e. when she visits any state for the third time, she has found a path to the goal).
(Q2.b.1) What should the simplest yet sufficient new state space representation include?

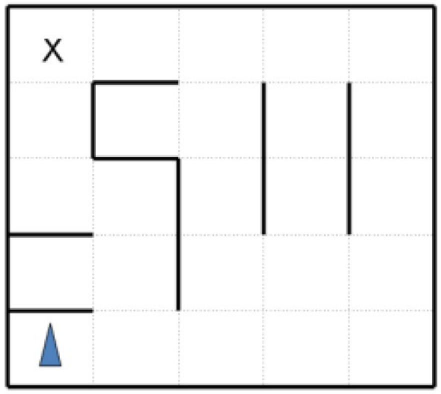
1. The current location of Scorpblorg
2. The total number of edges travelled so far
3. An array of booleans indicating whether each snail has been visited so far
4. An array of numbers indicating how many times each snail has been visited so far
5. The number of distinct snails visited so far

Part 2 – Informed Search (Questions 3 and 4)
Question 3
Consider the following graph search, assuming the heuristic is admissible and consistent, what is the returned path from S to G using an A* Optimal Search?



Question 4

Imagine a car-like agent wishes to exit a maze like the one shown below:



1. The agent is directional and at all times faces some direction d ∈ (N, S, E, W).
2. With a single action, the agent can either move forward at an adjustable velocity v or turn. The turning actions are left and right, which change the agent's direction by 90 degrees. Turning is only permitted when the velocity is zero (and leaves it at zero).
3. The moving actions are fast and slow. Fast increments the velocity by 1 and slow decrements the velocity by 1; in both cases, the agent then moves a number of squares equal to its NEW adjusted velocity (see example below).
4. A consequence of this formulation is that it is impossible for the agent to move in the same nonzero velocity for two consecutive timesteps.
5. Any action that would result in a collision with a wall or reduce v below 0/above a maximum speed Vmax is illegal.
6. The agent's goal is to find a plan which parks it (stationary) on the exit square using as few actions (time steps) as possible.

As an example: if at timestep t the agent's current velocity is 2, by taking the fast action, the agent first increases the velocity to 3 and move 3 squares forward, such that at timestep t + 1 the agent's current velocity will be 3 and will be 3 squares away from where it was at timestep t. If instead, the agent takes the slow action, it first decreases its velocity to 1 and then moves 1 square forward, such that at timestep t + 1 the agent's current velocity will be 1 and will be 1 square away from where it was at timestep t. If, with an instantaneous velocity of 1 at timestep t + 1, it takes the slow action again, the agent's current velocity will become 0, and it will not move at timestep t + 1. Then at timestep t + 2, it will be free to turn if it wishes. Note that the agent could not have turned at timestep t + 1 when it had a current velocity of 1, because it has to be stationary to turn.

(Q4.1): If the grid is M by N, what is the size of the state space? You should assume that all configurations are reachable from the start state.

(Q4.2): Is the Manhattan distance from the agent's location to the exit's location admissible? Give a specific example to support your answer. Answering yes or not alone without a supporting example will receive zero marks.