QUIZ #1 – COMP 3106 INTRODUCTION TO ARTIFICIAL INTELLIGENCE

OCTOBER 2, 2023
8:35AM – 9:55AM (80 MINUTES)
SOUTHAM HALL 416

Instructions

The quiz is open-book, and you may consult your notes and the textbook during quizzes. You may not use electronic devices (except non-programmable scientific calculators) during quizzes.

You must complete the quiz individually.

The quiz includes five multiple-choice questions and four written answer questions. Multiple-choice questions are worth 2 marks each. Written answer questions are worth 10 marks each.

For the multiple-choice questions, circle the correct answer. Justification of your answers is not required and will not be considered.

For the written answer questions, write your answer in the space provided below the question. You are not required to provide justification (unless specifically requested). However, if your final answer is incorrect, partial credit may be awarded for justification. If your final answer is incorrect and you do not provide justification, you may receive a grade of zero for that question.

Name:
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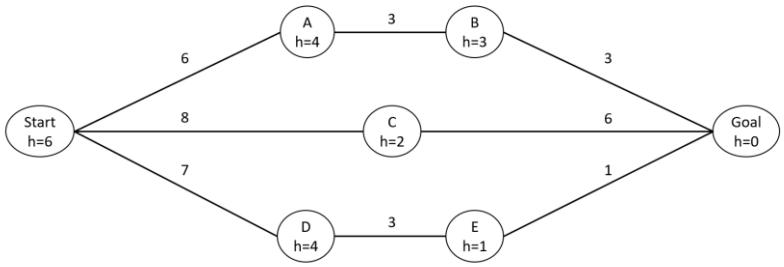
Question 1 [2 marks]

Consider an agent working in a restaurant environment. The agent delivers plated meals from a kitchen to customers throughout the dining room during dinner service. Which of the following is an appropriate performance measure for this task environment?

a) Average number of meals carried at the same time
b) Number of meals correctly delivered
c) Number of meals dropped on the floor
d) Number of times the kitchen is visited
e) Total distance travelled

Question 2 [2 marks]

Consider the graph indicated below with start state "Start" and goal state "Goal", and bidirectional edges with edge weights indicated beside the edge. Heuristic values are indicated in each node. What is the cost of the path from "Start" to "Goal" that is found by uniform cost search?



a) 6
b) 11
c) 12
d) 14
e) 20

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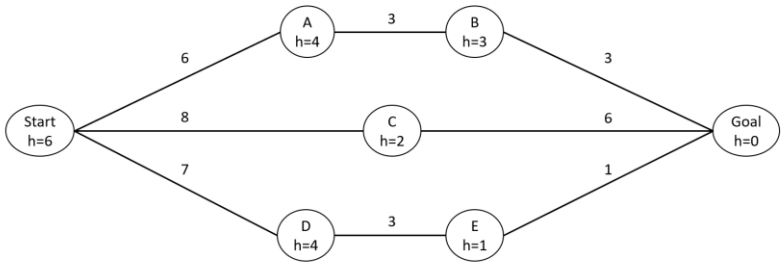
Question 3 [2 marks]

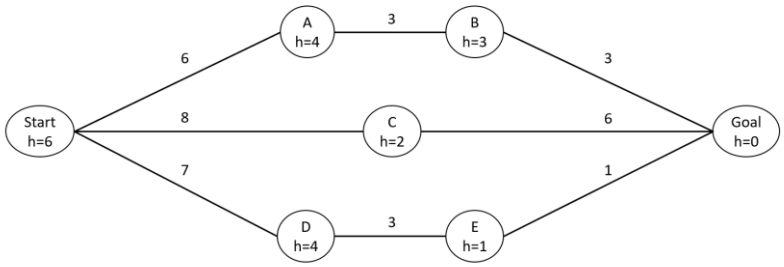
Consider the graph indicated below with start state “Start” and goal state “Goal”, and bidirectional edges with edge weights indicated beside the edge. Heuristic values are indicated in each node. What is the cost of the path from “Start” to “Goal” that is found by greedy heuristic search?



a) 6
b) 11
c) 12
d) 14
e) 20

Question 4 [2 marks]

Consider the graph indicated below with start state “Start” and goal state “Goal”, and bidirectional edges with edge weights indicated beside the edge. Heuristic values are indicated in each node. When uniform cost search is executed on this graph, all nodes are explored. When A* search is executed on this graph, not all nodes are explored. Which node in this graph is explored during uniform cost search but not during A* search?



a) A
b) B
c) C
d) D
e) E

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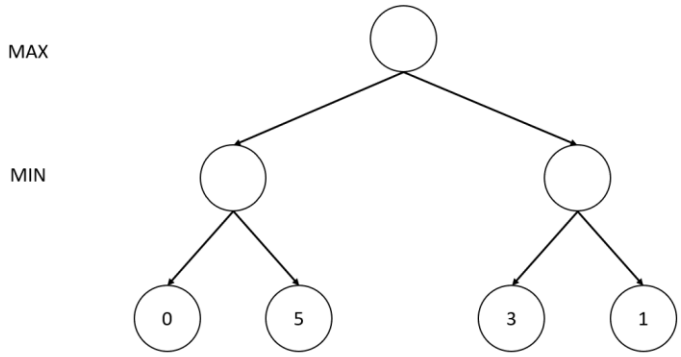
Question 5 [2 marks]

Consider an adversarial search on a turn-based two-player game illustrated below. Assume the first player wishes to maximize the score and the second player wishes to minimize the score. The score for each terminal state is indicated in each leaf node. What is the minimax value of the root node?



a) 0
b) 1
c) 3
d) 5
e) 9

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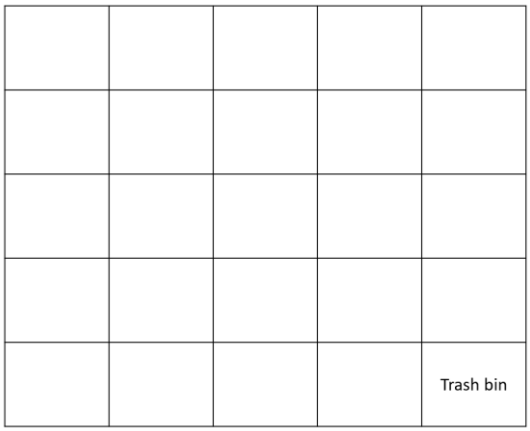
Question 6 [10 marks]

Consider a task environment for an agent that picks up trash from a park, with the following assumptions:

i. The park is divided into 25 square areas.
ii. The trash bin is located in the bottom-right area.
iii. The agent can only sense whether there is trash in the current square.
iv. The agent can only clean up trash in the current area.
v. After cleaning a square, the agent must return to the trash bin to empty its bag before cleaning any other square.
vi. Trash appears randomly in each area of the park with small chance at every point in time.
vii. The agent cannot tell exactly which square it is in but can tell which directions it is able to move.
viii. The agent knows its left/right and up/down orientation.



Fully describe this task environment by specifying each of the following.

a) Performance measure: Percentage of time the park is completely clean
b) Environment: Ground, trash, trash bin, fence
c) Actuators: Wheels, grabber
d) Sensors: Distance sensor (to walls), trash sensor

Characterize the task environment according to each of the following properties. For each property, provide a brief justification.

e) Fully observable vs. partially observable: Partially observable – Can only sense whether there is trash in the current square
f) Single agent vs. multiple agent: Single agent – we assume that trash appears randomly, rather than as a result of other agents
g) Deterministic vs. stochastic: Stochastic – trash appears with some chance at each square in the park
h) Static vs. dynamic: Dynamic – trash could appear while the agent is deliberating
i) Sequential vs. episodic: Sequential – current actions affect future state of the park and future actions of the agent
j) Discrete vs. continuous: Discrete – if time elapsed in discrete steps, the states and actions are discrete

(Note: there are many ways to answer this question; your answer should show you understand the properties of task environments; if you make any additional assumptions about the environment, state your assumptions)

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Question 7 [10 marks]

Consider a task environment for an agent that picks up trash from a park, with the following assumptions:

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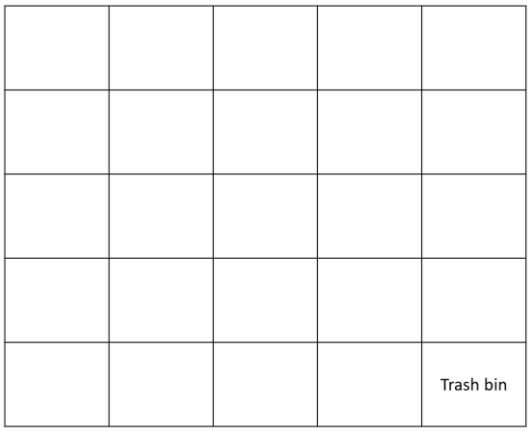
iv. The agent can only clean up trash in the current area.
v. After cleaning a square, the agent must return to the trash bin to empty its bag before cleaning any other square.
vi. Trash appears randomly in each area of the park with small chance at every point in time.
vii. The agent cannot tell exactly which square it is in but can tell which directions it is able to move.
viii. The agent knows its left/right and up/down orientation.



Suggest, at a high level, how each of the following types of agents might be implemented in this task environment.

a) Simple reflex agent
b) Model-based reflex agent
c) Goal-based agent (describe the goal state)
d) Utility-based agent (describe the utility function)

(Note: there are many ways to answer this question; your answer should show you understand how each type of agent works; if you make any additional assumptions about the environment, state your assumptions)

a) Use the following set of rules based only

IF bag is full and fence to the right THEN move down.
IF bag is full and fence not to the right THEN move right.
IF bag is empty and current square dirty THEN grab trash.
IF bag is empty and current square clean THEN move in random direction (if no fence).

b) Maintain a model of which square has trash in it as each square is traversed according to the above rules. Modify the last rule to be.

IF bag is empty and current square clean and trash upward THEN move up.
IF bag is empty and current square clean and trash left THEN move left.
IF bag is empty and current square clean and no trash upward nor left THEN move in random direction (if no fence).

c) Goal: Make all squares in the park clean.
d) Utility function: Percentage of squares in the park clean.

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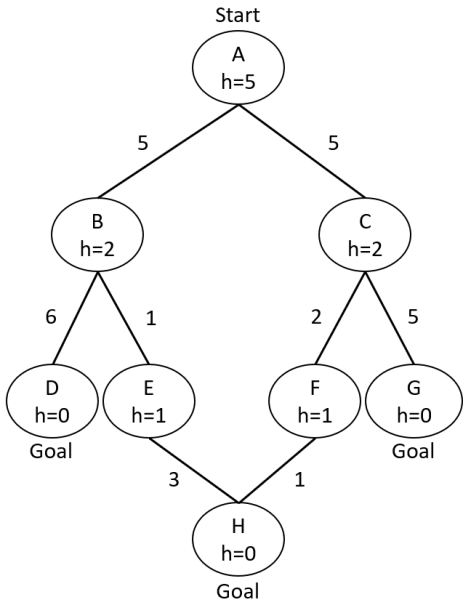
Question 8 [10 marks]

Perform A* search on the following graph to find the optimal path from the Start state to a Goal state (note there may be multiple goal states). Assume all edges are bidirectional. The edge weights are indicated beside each edge. The value of the heuristic function h(n) is indicated inside each node. Break any ties by first exploring the node that is first alphabetically. Note that there are multiple goal states.



In your answer, state the following:

a) The optimal path
b) The optimal path cost
c) The list of nodes explored during search, in order

a) A, C, F, H
b) 8
c) A, B, C, E, F, H

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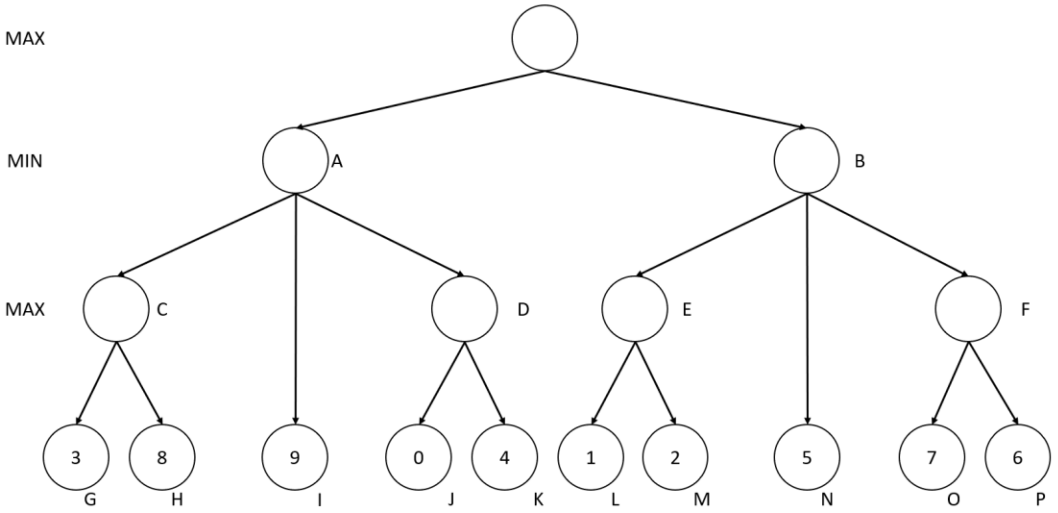
Question 9 [10 marks]

Consider playing the adversarial game illustrated by the graph below. Assume the score associated with the terminal state is indicated in each of the leaf nodes in the graph.

What is the optimal move the first player (MAX) should take to maximize the score, given the adversary makes the optimal moves to minimize the score? Use minimax search with alpha-beta pruning. Traverse child nodes in left-to-right order.



In your answer, state the following:

a) The minimax value for the root node
b) The optimal move the first player should take in their first ply
c) The list of nodes pruned during search (i.e. nodes not examined)

a) 4
b) Move left (to node A)
c) N, F, O, P