

FINAL EXAMINATION

Course: Artificial Intelligence

Time: 120 minutes

Term: 3 – Academic Year: 2018-2019

Lecturer: Châu Thành Đức – Nguyễn Hải Minh – Nguyễn Ngọc Thảo

Student Name:

Student ID:

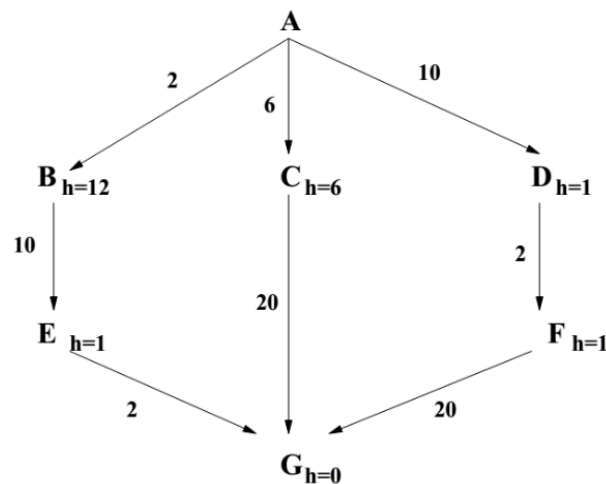
(Notes: Neither books nor laptops, phones allowed)

Write your answer directly in this test paper

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PART I: Obligatory Section

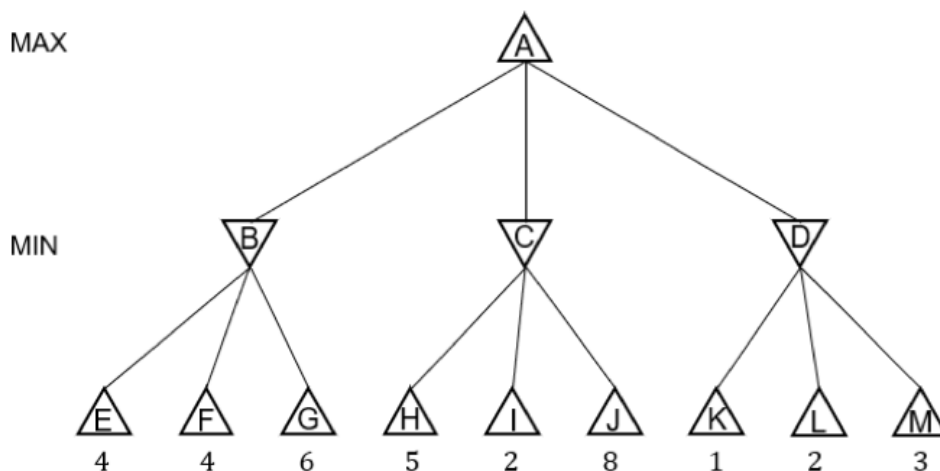
Question 1 (2.0pts): Consider the following graph, which is a representation of a search problem. S is the start node and G is the goal node. Heuristic function $h(n)$ is also denoted in the graph. Perform A* algorithm on this graph and answer the following questions:



- (1.0pt) Draw the search tree, calculate the value of evaluation function for each state during the expanding process.
- (0.5pt) Show the list of expanded states:
- (0.25pt) The returned path is:
- (0.25pt) Is this the shortest path from S to G ? Why?

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Question 2 (2.0pts): Run the algorithm α - β pruning on the following 2-ply game tree. The utility value is for MAX. Will any nodes be pruned? Explain your answer. (You can write minimax value directly on the game tree)



Question 3 (2.0pts):

- a. (0.5pt) Consider the following KB consisting of 4 sentences. Prove via resolution that KB entails the sentence R.

$$\neg(\neg P \wedge Q), P \rightarrow (\neg T \vee R), Q, T$$

Rewrite the sentences in KB and the query in appropriate format for resolution. For every new clause, show the indices of the pair of clauses being resolved. You do not have to enumerate all new clauses, just consider some clauses that you think they might be useful.

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b. (1.0pt) For each English sentence below, write the FOL sentence that best expresses its intended meaning using only the following given predicates:

- MEMBER(x, y) for “x is a member of y”.
- STUDENT(x) for “x is a student”.
- UNIFORM(x) for “x wears uniform”.
- STAFF(x) for “x is a staff”.

1. Every staff has to wear uniform.

2. Not every student has to wear uniform.

3. Every member of University of Science can be either a staff or a student (but not both).

4. There is exactly one staff who does not wear uniform.

c. (0.5pt) Every problem that can be solved with resolution can be solved with forward/backward chaining and vice versa. Is this statement TRUE or FALSE? Explain briefly.

Question 4 (2.0pts):

a. (0.5pt) Machine learning methods are often categorised in three main types: supervised, unsupervised and reinforcement learning methods.

- Explain the given terms in not more than one sentence each.

- Explain in which category does Decision Tree Learning fall and why?

b. (1.5pts) Using the decision tree learning algorithm (ID3), draw the decision tree for the following dataset step-by-step

Name	Hair	Height	Weight	Lotion	Result
<i>Sarah</i>	Blonde	Average	Light	No	Sunburned
<i>Dana</i>	Blonde	Tall	Average	Yes	None
<i>Alex</i>	Brown	Short	Average	Yes	None
<i>Annie</i>	Blonde	Short	Average	No	Sunburned
<i>Julie</i>	Blonde	Average	Light	No	None
<i>Pete</i>	Brown	Tall	Heavy	No	None
<i>John</i>	Brown	Average	Heavy	No	None
<i>Ruth</i>	Blonde	Average	Light	No	None

PART II: OPTIONAL SECTION (*Students choose to answer 2 questions from 5, 6, 7*)

Question 5 (2.0pts): Given a statement as follows:

- (1) Every considered object is red, green or blue.
- (2) If x is to the left of y then x is not to the right of y .
- (3) Red objects are to the left of green objects.
- (4) Object a is to the right of object b .
- (5) Object b is green and object a is not green.

The given statement can be represented in first-order logic with the following predicates

- $RED(x)$ for “ x is red”
- $GREEN(x)$ for “ x is green” $BLUE(x)$ for “ x is blue”
- $LEFT(x, y)$ for “ x is to the left of y ”
- $RIGHT(x, y)$ for “ x is to the right of y ”

Answer the following questions:

a. Translate the sentences above into FOL sentences

- (1). _____

- (2). _____

- (3). _____

- (4). _____

- (5). _____

b. Convert the FOL sentences in a. into Conjunctive Normal Form

- (1). _____

- (2). _____

- (3). _____

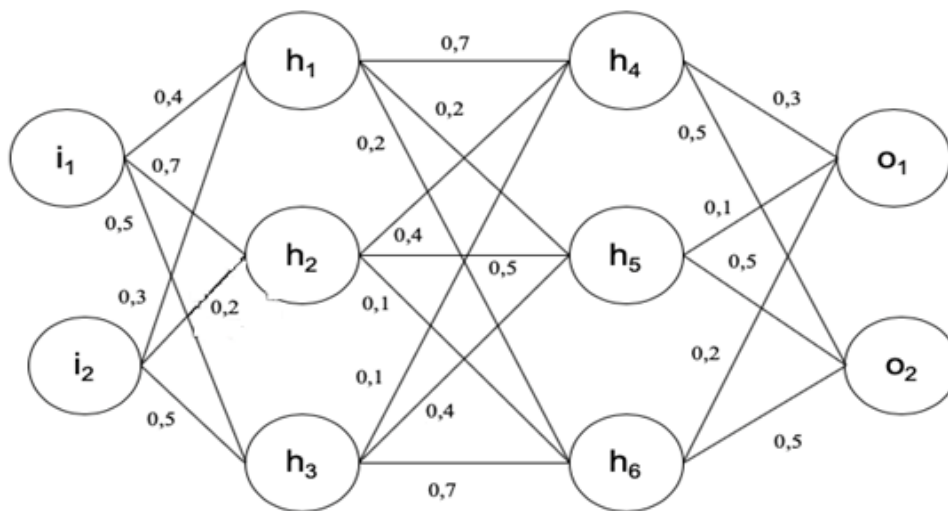
- (4). _____

- (5). _____

c. Prove via resolution that “Object a is blue.” For every step, show the new clause, indices of the pair of clauses being resolved, and the corresponding substitutions.

- _____
- _____

Question 6 (2.0pts): Given a neural network as follows



In which:

- i_1 and i_2 are input nodes.
- $h_1, h_2, h_3, h_4, h_5, h_6$ are hidden nodes, and o_1, o_2 are output nodes. Each of them use sigmoid activation function.
- weights are initiated as on the figure.

1. **(1.5pts)** Given the input $(i_1, i_2) = (0.5, 1.0)$. Calculate the results of the network at o_1 and o_2 .

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2. **(0.5pts)** Given the target output $(o_1, o_2) = (0.1, 0.9)$. Calculate the loss of network, which is defined as follows:

$$Loss_{total} = \sum \frac{1}{2} (target - output)^2$$

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