QUALIFICATION: Bachelor of Computer Science (Honours): Software Development

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COURSE: Artificial Intelligence & Expert Systems

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SESSION: 2

DURATION: 2 Hours

MARKS: 100

SECOND OPPORTUNITY/SUPPLEMENTARY EXAMINATION QUESTION PAPER

EXAMINER(S) Dr. EDMORE CHIKOHORA

MODERATOR: MR. SIMBABRASHE NYIKA

THIS QUESTION PAPER CONSISTS OF 3 PAGES (Excluding this front page)

INSTRUCTIONS

1. Answer ALL questions.
2. Begin each section on a new page.
3. Write clearly and neatly.
4. Number the answers clearly.
Question 1:

a) Suppose we want to use the A* algorithm on the graph below to find the shortest path from node S to node G. Each node is labeled by a capital letter and the value of a heuristic function. Each edge is labeled by the cost to traverse that edge:

![Graph Diagram]

For this problem:
Perform the A* algorithm on this graph, filling in the table below. Indicate the f, g, and h values of each node on the queue as shown in the first two rows of the table. You need not write the contents of the (priority) queue in order in the table. Assume that if you find a path to a node already on the queue that you update its cost (using the lower f value) instead of adding another copy of that node to the queue. [18 Marks]

<table>
<thead>
<tr>
<th>Iteration</th>
<th>Expanded Nodes</th>
<th>Priority queue at end of this iteration</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>S</td>
<td>$S = 0 + 6 = 6$ (i.e. $S = g(S) + h(S) = f(S)$)</td>
</tr>
<tr>
<td>1</td>
<td>S</td>
<td>$A = 2 + 4 = 6$; $B = 3 + 4 = 7$</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**

\[ f(n) = g(n) + h(n), \] where \( g(n) \) is the cost of the path from the start node to \( n \), and \( h(n) \) is a heuristic that estimates the cost of the cheapest path from \( n \) to the goal.
b) Let P, Q and R be propositional symbols with the following semantics

P: "Our mayor is trustworthy,"
Q: "Our mayor is a good speller,"
R: "Our mayor is a patriot."

Express each of the following statements in logical form:

i. Although our mayor is not trustworthy, he is a good speller. [2 marks]
ii. Our mayor is a trustworthy patriot who spells well. [2 marks]
iii. Either our mayor is not trustworthy or not a patriot, yet he is an excellent speller. [2 marks]
iv. It may or may not be the case that our mayor is trustworthy. [2 marks]

Question 2:

a) Describe any Three (3) salient features of an agent you are familiar with, [6 marks]

b) Using the knowledge you have learnt about agents, consider the task of designing an automated taxi driver: Give two examples for each of the following aspects of the agent.

i. Performance measure [2 marks]
ii. Environment [2 marks]
iii. Actuators [2 marks]
iv. Sensors [2 marks]

c) With reference to agent architecture, explain what is meant by the following:
   a. A learning agent [4 marks]
   b. A goal based agent

Question 3:

a) Given a 4 liters bucket and a 3 liters bucket, how can we measure exactly 2 liters into one bucket? Note that there are no markings on the bucket and you must fill each bucket completely. S [10 marks]

b) Write correct PROLOG statements to implement the following family tree rules
   i. mother [3 marks]
   ii. grandfather [3 marks]
   iii. brother [3 marks]
   iv. sister [3 marks]
Question 4:

a) Using first order logic, negate the following logical statements
   i. Logic is easy and beautiful [2 marks]
   ii. All dogs are black [2 marks]
   iii. If I have money then I will buy pizza [2 marks]
   iv. Today is not Friday [2 marks]

d) Environments in which agents operate can be defined in different ways. Consider A chess playing system and characterise the agent’s environment with respect to:
   a. Observability [2 marks]
   b. Determinism [2 marks]
   c. Dynamism [2 marks]

Question 5:

a) Using a clearly labeled diagram, describe the main features of an Expert System [8 marks]

b) PROLOG programming language is based on Horn Clauses. Explain using example(s) of your choice each of the following horn clauses.
   i. Backward Chaining [4 marks]
   ii. Forward Chaining [4 marks]

c) Alan Turing is known for his theory called 'the Turing test' for intelligence. Briefly explain what the theory claimed [4 marks]