BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF EDUCATIONAL TECHNOLOGY

BACHELOR OF SCIENCE EDUCATION IN COMPUTER SCIENCE

CS4I4/EDT414: ARTIFICIAL INTELLIGENCE AND INTELLIGENT SYSTEMS

TIME: 3 HOURS

AUG 2024

INSTRUCTIONS

Answer **ALL the questions.** Each question carries **20** marks.
The question paper has **five** questions
Multiple Choice questions have **NO** part marks

Question 1

i. Define the following terms as used in the course giving **two** examples of each:
   a. Artificial Intelligence [4]
   b. Machine learning [4]

ii. What are the **two** approaches to Artificial Intelligence [2]

iii. Explain combinatorial explosion using the travelling salesman example [4]

iv. Explain **any four** of the different regions in the State Space Diagram for Hill climbing [6]

Question 2

i. A Water Jug Problem: You are given two jugs, a 4-gallon one and a 3-gallon one, a pump which has unlimited water which you can use to fill the jug, and the ground on which water may be poured. Neither jug has any measuring markings on it. How can you get exactly 2 gallons of water in the 4-gallon jug in 2 ways?

State: (x, y) x= 0, 1, 2, 3, or 4 y= 0, 1, 2, 3
x represents quantity of water in 4-gallon jug and y represents quantity of water in 3-gallon jug.

•**Start state**: (0, 0).

•**Goal state:** (2, n) for any n. Attempting to end up in a goal state.(since the problem doesn't specify the quantity of water in 3-gallon jug)

The production rules for this water jug problem are given as follows:

1. (x, y) If x <4	→(4, y)	Fill the 4-gallon jug
2. (x, y) If y <3	→(x, 3)	Fill the 3-gallon jug
3. (x, y) If x >0	→(x −d, y)	Pour some water out of the 4-gallon jug
4. (x, y) If y >0	→(x, y −d)	Pour some water out of the 3-gallon jug
5. (x, y) If x >0	→(0, y)	Empty the 4-gallon jug on the ground
6. (x, y) If y >0	→(x, 0)	Empty the 3-gallon jug on the ground
7. (x, y) If x +y ≥4,y >0	→(4, y −(4 −x))	Pour water from the 3-gallon jug into the 4-gallon jug until the 4-gallon jug is full
8. (x, y) If x +y ≥3,x >0	→(x −(3 −y), 3)	Pour water from the 4-gallon jug into the 3-gallon jug until the 3-gallon jug is full
9. (x, y) If x +y ≤4,y >0	→(x +y, 0)	Pour all the water from the 3-gallon jug into the 4-gallon jug
10. (x, y) If x +y ≤3,x >0	→(0, x +y)	Pour all the water from the 4-gallon jug into the 3-gallon jug
11. (0, 2)	→(2, 0)	Pour the 2 gallons from the 3-gallon Jug into the 4-gallon jug
12. (2, y)	→(0, y)	Empty the 2 gallons in the 4-gallon Jug on the ground

Trace of steps involved in solving the water jug problem using a table with the following headings: Number of Steps; Rules applied; 4-g jug; and 3-g jug
Note that two solutions are expected **[10,10]**

Question 3

i. An AI model uses input only from the dynamic environment that does not include any labelled data. It uses a behavioural learning model and improves as it learns about the environment. As the learning agent interacts with the environment while moving from one state to another, it is rewarded for success but penalized for failure. Identify the learning model. **[2]**

a) Supervised Learning b) Unsupervised Learning
c) Reinforcement Learning d) All of the above

ii. Evil Robot has decided to toy with his victims by placing them in a puzzle maze. Victims are initially at the **Start** node and need to navigate to the **Finish** node. Other nodes $\mathbf{n_{i,j}}$ are laid out on a grid and connected by two kinds of edges. Fixed one-way edges (single-source, solid lines) allow a victim to pass from one node to another, left to right. For example, $\mathbf{n_{5,1}}$ to $\mathbf{n_{4,3}}$ in the diagram. Switched edges (single-source, solid and dotted lines) can be moved among destinations. For example, $n_{2,3}$ is currently connected to $\mathbf{n_{5,4}}$ but can be moved to connect to $n_{1,4}$ or $\mathbf{n_{2,4}}$ instead.

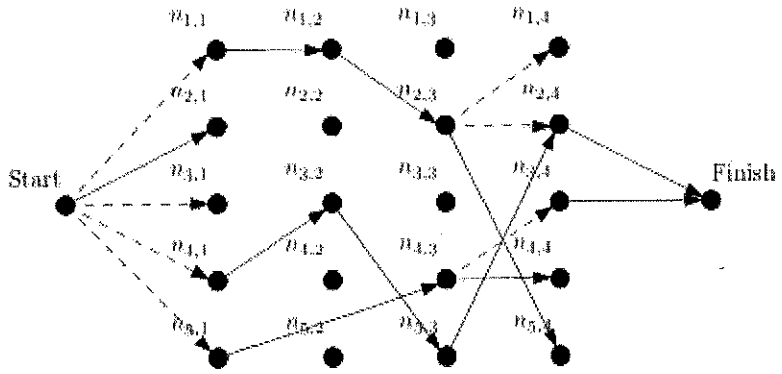

Figure 1: Evil Robot maze

A victim can set the switched edges as desired, but only if they have reached the switch's source node. Their aim is to cross the maze successfully. Formulate this as a Constraint Satisfaction Problem defining the following:

a. Variables **[2]**
b. Domain of each variable **[4]**
c. and Constraints **[4]**

iii. List **any four** of the prominent intelligent search algorithms **[4]**

iv. The following is the rule set of a simple weather forecast expert system:

1: IF cyclone THEN clouds
2: IF anticyclone THEN clear sky
3: IF pressure is low THEN cyclone
4: IF pressure is high THEN anticyclone
5: IF arrow is down THEN pressure is low
6: IF arrow is up THEN pressure is high

Use forward chaining to reason about the weather if the working memory contains the fact: *arrow is down*. Show your answer in a table naming the rules matching the current working memory (conflict set), which rule you apply, and how the working memory contents changes on the next cycle after a rule has fired:

Table 1: Rule Firing

Cycle	Working Memory	Conflict set	Rule fired
⋮	⋮	⋮	⋮

[4]

Question 4

i. What do Bayesian networks predict? **[4]**

ii. Describe the following **two** unsupervised tasks? **[6]**
   a. Clustering
   b. Visualisation

iii. Construct by hand a neural network that computes the XOR function of two inputs. Make sure to specify what sort of units you are using. **[10]**

Question 5

i. A doctor is called to see a sick child. The doctor has prior information that 90% of sick children in that neighbourhood have the Flu, while the other 10% are sick with measles. Let F stand for an event of a child being sick with Flu and M stand for an event of a child being sick with measles. Assume for simplicity that $F \cup M = \Omega$, i.e., that there no other maladies in that neighbourhood. A well-known symptom of measles is a rash (the event of having which we denote R). Assume that the probability of having a rash if one has measles is $P(R \mid M) = 0.95$. . However, occasionally children with Flu also develop rash, and the probability of having a rash if one has Flu is $P(R \mid F) = 0.08$. Upon examining the child, the doctor finds a rash. What is the probability that the child has measles? **[6]**

i. State the **two** supervised learning tasks **[2]**

ii. Define in your own words all the following terms **[12]**
   a. Constraint,
   b. Backtracking search,
   c. Arc consistency,
   d. Backjumping,
   e. Min-conflicts, and
   f. Cycle cutset.

THE END OF EXAMINATION PAPER