UNIVERSITY OF SOUTHAMPTON COMP2208W1

SEMESTER 1 EXAMINATIONS 2013-14

INTELLIGENT SYSTEMS

DURATION 120 MINS (2 Hours)

This paper contains 4 questions – Answer **only THREE** questions (*25 marks each, 75 marks total*).

An outline marking scheme is shown in brackets to the right of each question.

Only University approved calculators may be used.

A foreign language translation dictionary (paper version) is permitted provided it contains no notes, additions or annotations.

QUESTION 1)

(a) In relation to search algorithms, what do the terms *completeness*, *time complexity*, *space complexity*, and *optimality* mean? How do breadth-first and depth-first search compare in terms of these properties? [9 marks]

(b) When is iterative deepening search superior to depth-first or breadth-first search and in what respects? [4 marks]

(c) Discuss the truth of the statement: “Heuristic search requires guessing, so it can never be guaranteed optimal”. Explain your answer. [9 marks]

(d) What does it mean for one heuristic to dominate another? Give an example. [3 marks]

QUESTION 2)

Below are five questions about general concepts in statistically and biologically inspired artificial intelligence. For each question, your answer should be around 50 to 100 words in length. There is no need to write a long essay: the important thing is to show your understanding by briefly summarizing the relevant concepts.

(a) Briefly describe the difference between supervised learning, unsupervised learning, and reinforcement learning. [5 marks]

(b) Explain in your own words Valentino Braitenberg's "law of uphill analysis and downhill invention". With this law in mind, what does Braitenberg suggest we should do in order to better understand cognition? [5 marks]

(c) In plain language, what does Bayes' theorem allow us to do? Why has Bayesian thinking been so popular in AI contexts in which probabilities are used to represent knowledge about an uncertain world? [5 marks]

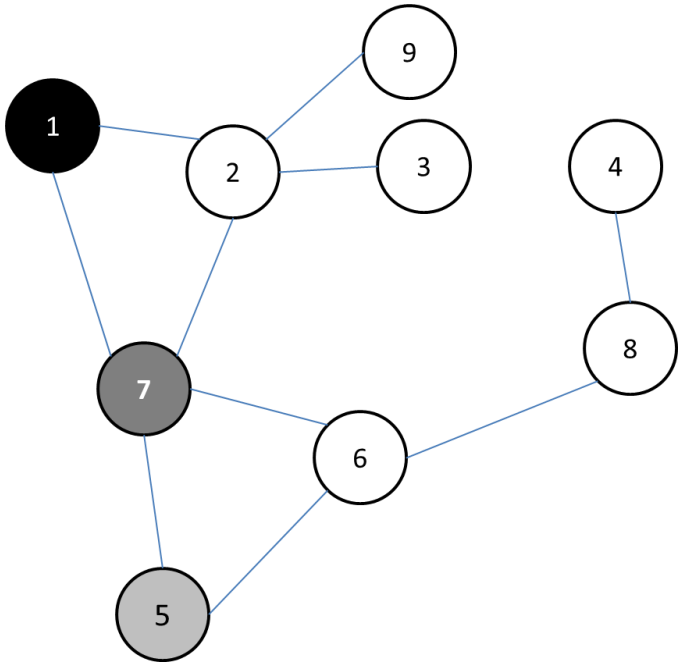
(d) Using points from the literature we have discussed in this module, discuss the following statement: "There is no good way to test whether an AI system is intelligent". [5 marks]

(e) In terms of classification tasks, what can a neural network with a hidden layer do that a simple perceptron cannot do? [5 marks]

TURN OVER

QUESTION 3)

(a) Consider the following graph representing the constraints of a graph-colouring problem. The three shaded nodes (1, 5 and 7) have already been assigned colours. Which node should be choose to assign a colour to next? Explain.

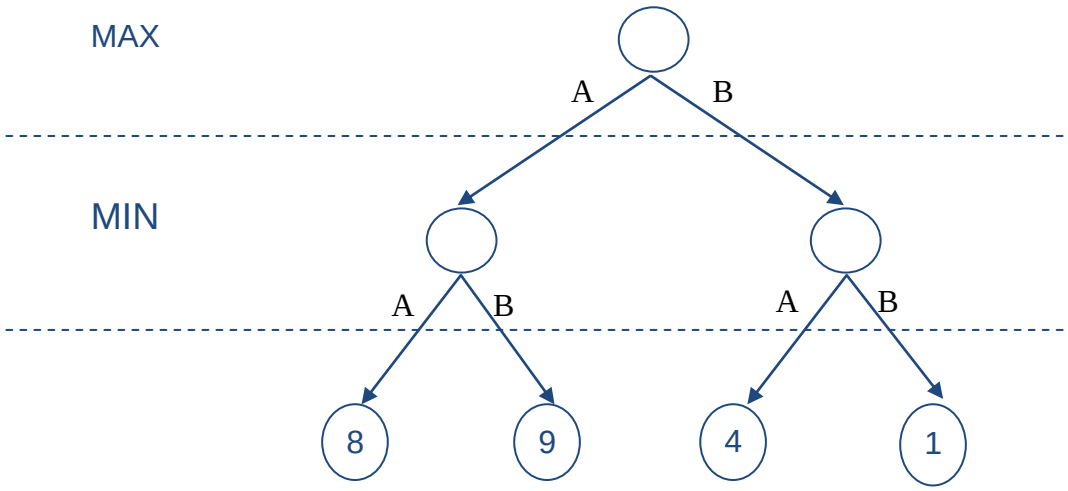


[8 marks]

(b) What are the advantages of searching the space of partially ordered plans rather than fully-ordered plans? [6 marks]

Question 3 continues on the next page

(c) Consider the game tree shown below. Assume the top node is a max node. The labels on the edges are the moves. The numbers in the bottom layer are the values of the different outcomes of the game to the max player. What is the value of the game to the max player? What is the first move the max player should make? Assuming that the max player makes that move, what is the best next move for the min player (assuming that this is the entire game tree)?



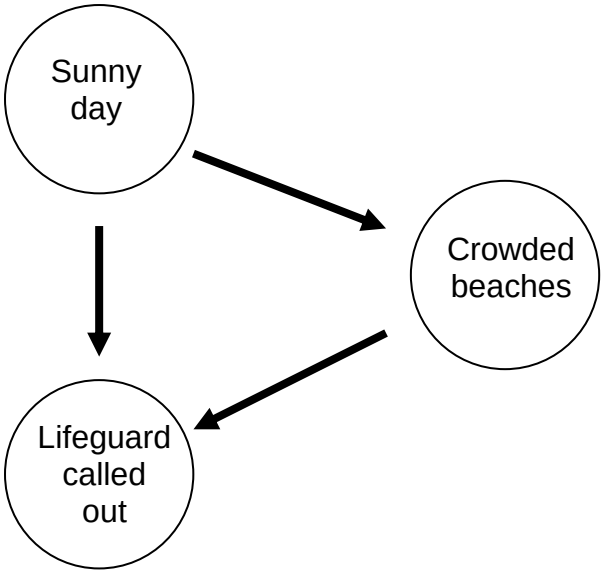
[4 marks]

(d) Consider the alpha-beta pruning algorithm applied to the game tree shown in part (c). Assume the tree is traversed in the usual depth-first left-to-right order. What will the values of alpha and beta be after evaluating the first three leaf nodes? Explain why the value of the fourth leaf node does not matter in deciding what move to make. [7 marks]

TURN OVER

QUESTION 4)

Consider the Bayesian network below. It describes the relationship between sunny weather (S), crowded beaches (C), and lifeguard callouts (L). The weather is not dependent on the other two variables. The beaches are more likely to be crowded when it is sunny. Whether or not the lifeguard will be called out today is dependent on both of the other variables.



The following tables describe the ways in which each of these three Boolean variables (S, C, and L) are connected.

If S is true, it is sunny today. If S is false, it is not sunny.	
p(S = True)	0.4

If C is true, the beaches are crowded. If C is false, they are not.	
p(C = True | S = True)	0.8
p(C = True | S = False)	0.3

If L is true, the lifeguards are called out at least once today. If L is false, they are not.	
p(L = True | S = True, C = True)	0.3
p(L = True | S = True, C = False)	0.05
p(L = True | S = False, C = True)	0.5
p(L = True| S = False, C = False	0.1

Question 4 continues on the next page

(a) Imagine that we observe this system over an infinitely large number of days.

(i) What proportion of the time will the weather be sunny? [1 mark]

(ii) What proportion of the time will the beaches be crowded? [2 marks]

(b) We can use Monte Carlo simulation to study the behaviour of a Bayesian network. Assume that we generate random states by taking a random value from zero to one inclusive, and set a given state to True if the random value **is less than or equal to** the relevant probability of that state being True.

We need three such random values to generate one set of state values for the network. Take these three random values and use them in sequence to generate a single random state of the network: [0.55, 0.13, 0.67]. [4 marks]

(c) In the form of a truth table, with an additional column showing the relevant probability, use the Bayesian network diagram to reconstruct the full joint probability distribution across the three Boolean state variables. [9 marks]

(d) Using Bayes' theorem, calculate the following conditional probabilities.

(i) What is the probability that it is sunny given that the lifeguards have been called out today? In other words, p(S=True | L=True)? [3 marks]

(ii) What is the probability that the beaches are crowded given that the lifeguards were not called out today? That is, p(C=True | L=False)? [3 marks]

(iii) What is the probability that it is sunny today given that the beaches are crowded and the lifeguards were not called out? In other words, what is p(S=True | C=True, L=False)? [3 marks]

END OF PAPER

