SEMESTER 1 EXAMINATIONS 2019/20

INTELLIGENT SYSTEMS

Duration 120 mins (2 hours)

This paper contains 4 questions

Answer **THREE** questions**.**

**Please start a new page for each question.**

Each question carries 1/3 of the total marks for the exam paper and you should aim to spend about 40 minutes on each.

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

Only University approved calculators may be used.

A foreign language dictionary is permitted ONLY IF it is a paper version of a direct ‘Word to Word’ translation dictionary AND it contains no notes, additions or annotations.

7 page examination paper

**Question 1.**

a) Considering the uninformed tree search algorithms depth first search, breadth first search and iterative deepening search, explain which of these has

I. a time complexity advantage over the others? [6 marks]

II. a space complexity advantage over the others? [6 marks]

III. an optimality advantage over the others? [6 marks]

b) Describe two heuristics for the 8-puzzle that are admissible for A* search. Which of these is dominant? Explain. [8 marks]

c) Describe a general approach to creating an admissible heuristic for a new search problem. [7 marks]

**Question 2.**

For each part below, show your understanding by briefly answering the following questions.

a) Describe the differences between supervised and unsupervised learning; [6 marks]

b) What does overfitting mean in the context of a learning algorithm; [6 marks]

c) In k-nearest neighbour methods, explain why it is useful to apply data normalisation on multi-dimensional data. [3 marks]

d) Explain why it is necessary to balance exploration with exploitation. [6 marks]

e) In Bandit theory, explain the concept of zero-regret algorithms. [6 marks]

f) Explain what the Markov property is and how it can be utilised in MDPs. [6 marks]

**TURN OVER**

**Question 3.**

a) We would like to predict tomorrow's weather based on two binary attributes: today's temperature (hot or cool) and humidity (high or normal). We have a data set of 1,000 samples. As shown below, half of the days sampled are Sunny and half are Rainy.

| Number of days | Temperature | Humidity | Weather |
|---|---|---|---|
| 200 | Hot | High | Sunny |
| 200 | Hot | Normal | Sunny |
| 100 | Hot | Normal | Rainy |
| 100 | Cool | High | Sunny |
| 100 | Cool | High | Rainy |
| 300 | Cool | Normal | Rainy |

We use a decision tree to predict the target variable (Weather) from the input variables (Temperature and Humidity). Answer the following questions. (Use the base-2 logarithm. For your information, $\log_2 3 = 1.48$ and $\log_2 5 = 2.32$).

i. What is the initial entropy of the weather variable, i.e., H(Weather)? [3 marks]

ii. Compute the conditional entropy for initially choosing the Temperature attribute and for initially choosing the Humidity attribute, respectively. That is, compute H(Weather | Temperature) and H(Weather | Humidity). [10 marks]

iii. Compute the information gain of initially choosing the Temperature attribute and for initially choosing the Humidity attribute, respectively. Based on this, which attribute should be used as the root of the decision tree? [2 marks]

b) Let C stand for the event “has Cancer” and M stand for “Medical test is positive.” A statistical study has produced the following observations.

- The prior probability that a person has cancer is 0.01.
- The probability of testing positive when a person has cancer is 90%.
- The probability of testing negative when a person does not have cancer is 89.9%.

i. What is the prior probability of having a positive test, i.e., what is Pr(M)? [6 marks]

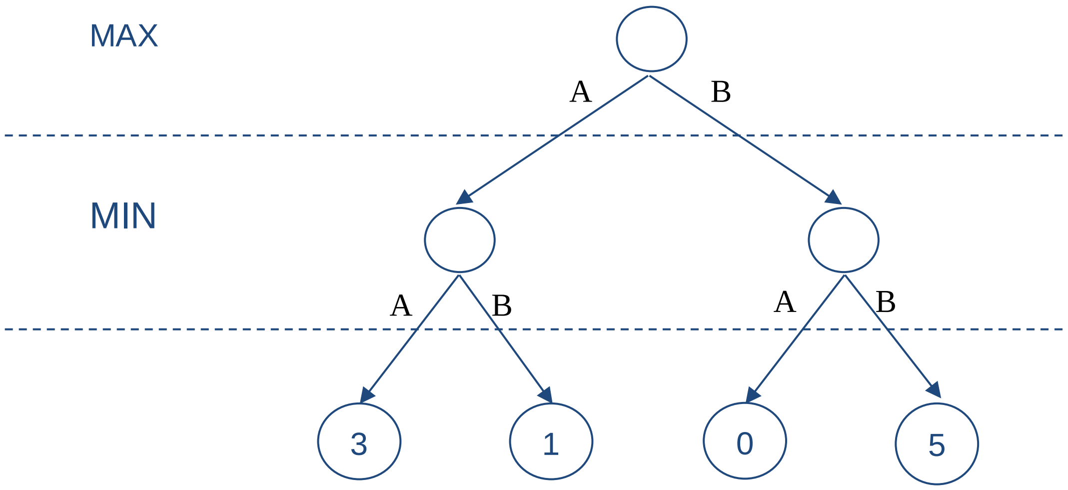
ii. If a person has a positive medical test, what is the probability that the person has cancer? That is, compute Pr(C **|** M). [6 marks]

iii. If a person has a negative medical test, what is the probability that the person has cancer? That is, compute Pr(C **|** ~M). [6 marks]

**TURN OVER**

**Question 4.**

a) 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)?



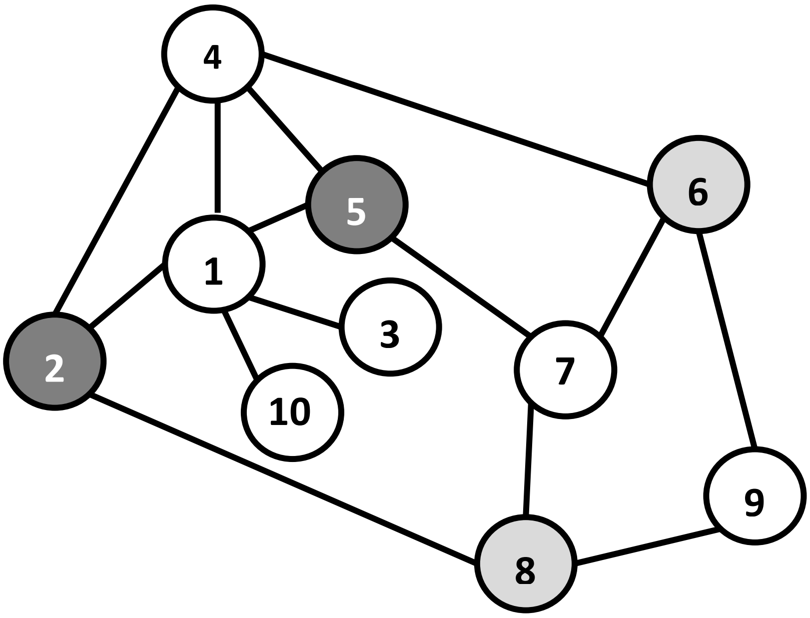

[6 marks]

b) 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? Does the value of the fourth leaf node need to be considered in deciding what move to make? Explain? [9 marks]

c) List 8 of the main strengths and weaknesses of the Turing test as a test of intelligence. (One sentence each is sufficient) [9 marks]

d) Consider the following graph representing the constraints of a graph-colouring problem. The four shaded nodes (2, 5, 6 and 8) have already been assigned colours. 2 and 5 are the same colour. 6 and 8 are the same colour. Given common heuristics for this problem, which will be the next node chosen to assign a colour to? Explain.




[9 marks]

**END OF PAPER**