UNIVERSITY OF SOUTHAMPTON COMP2208W1

SEMESTER 1 EXAMINATIONS 2016/17

INTELLIGENT SYSTEMS

Duration 120 mins (2 hours)

This paper contains 4 questions

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

All answers must be in separate answer books

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

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QUESTION 1.

a) What four things are needed to define a search problem? [4 marks]

b) For what kind of problem is local search applicable? [4 marks]

c) Which tree search strategy is defined by ordering nodes on the fringe such that the next node to be expanded is:

i) The last node added (most recently added node) to the fringe. [3 marks]

ii) The node that is estimated to be closest to the goal. [3 marks]

iii) The earliest node added to the fringe. [3 marks]

iv) The node that is estimated to be on the shortest path to the goal as calculated by summing the cost to reach that node from the start state and the estimated cost from that node to the goal. [3 marks]

d) What are the advantages and disadvantages of iterative deepening search compared to breadth first search? [8 marks]

e) Is breadth first search optimal when applied to the map routing problem (e.g. Romania map)? Explain briefly. [2 marks]

f) What characteristic makes straight line distance an admissible heuristic for A* tree search applied to the map routing problem (e.g. Romania map)? [3 marks]

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QUESTION 2.

For each part below, show your understanding by briefly summarizing the relevant concepts.

a) Briefly describe the following terms:

   i) Supervised learning; [2 marks]

   ii) Overfitting; [2 marks]

   iii) Hidden layer (in artificial neural nets). [2 marks]

b) In nearest neighbour methods:

   i) Briefly explain why it is useful to apply data normalisation on multi-dimensional data. [2 marks]

   ii) Name two distance types between data points that are frequently used. [2 marks]

   iii) Briefly explain what lazy learning is. [2 marks]

c) In plain language, briefly explain the concept of information gain within the context of decision trees, and how we can calculate it. [6 marks]

d) Explain why neural networks based technologies are significantly more efficient nowadays, compared to neural networks that were developed before the 2000s. [6 marks]

e) In bandit theory:

   i) Briefly explain why it is necessary to balance exploration with exploitation. [3 marks]

   ii) Briefly explain what regret is and why we use it to measure performance. [3 marks]

   iii) Briefly explain the concept of zero-regret algorithms. [3 marks]

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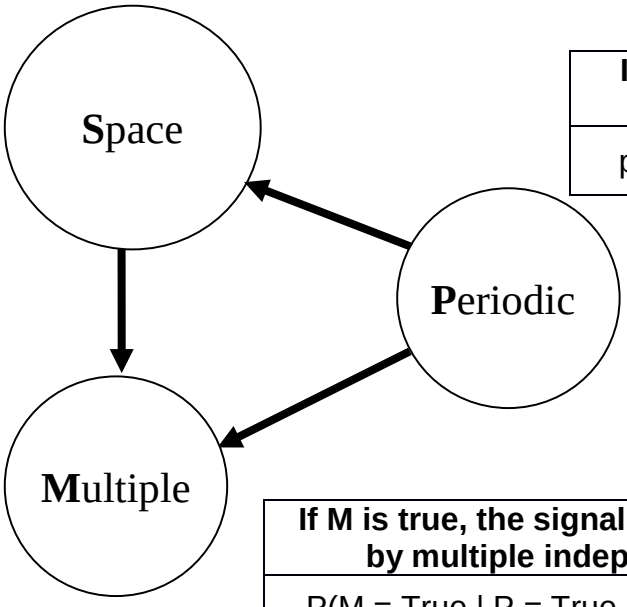
QUESTION 3.

In the quest for extra-terrestrial intelligence (ETI), scientists typically look for periodically repeating signals from space, which can be observed and confirmed by multiple independent research groups. Consider the Bayesian network below, which describes this process and the relationship between whether a signal is periodic (P), it is from outer space and not from Earth (S), and that multiple independent groups will investigate the same signal (M). The signal being periodic does not depend on the other two variables. But, the signal is more likely to be from Earth if it is periodic. Whether or not multiple research groups investigate the same signal depends on both of the other variables. The conditional probabilities are given in the tables.

If S is true, the signal is from the space.	
p(S = True | P = True)	0.2
p(S = True | P = False)	0.7



If P is true, the signal is periodic	
p(P = True)	0.3

If M is true, the signal will be investigated by multiple independent groups.	
P(M = True | P = True, S = True)	0.9
P(M = True | P = True, S= False)	0.1
P(M = True | P = False, S = True)	0.3
P(M = True | P = False, S = False)	0.05

Question continues

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a) What is the probability that a signal is from space? [4 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 for the variables P, S and M, respectively, to generate a single random state of the network: [0.2, 0.4, 0.25]. [6 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. [8 marks]

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

i) What is the probability that a particular signal is periodic given that multiple groups start investigating that signal? In other words, p(P=True | M=True)? [5 marks]

ii) What is the probability that the signal is from the space given that it was not confirmed by multiple groups? That is, p(S=True | M=False)? [5 marks]

iii) What is the probability that the signal was periodic given that the it was from the space and it was not confirmed by multiple groups? In other words, what is p(P=True | S=True, M=False)? [5 marks]

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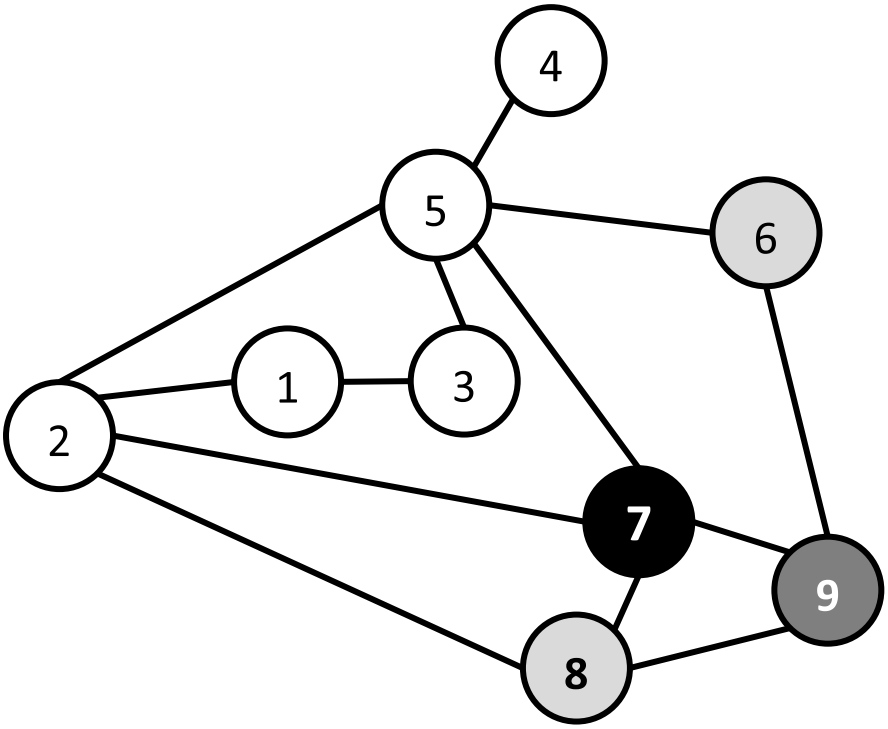
QUESTION 4.

a) Using points from the literature we have discussed in this module, including Turing and Searle, discuss the following statement: “The Turing Test is a good test of whether an AI system is intelligent” [9 marks]

b) Consider the following graph representing the constraints of a graph-colouring problem. The four shaded nodes (6, 7, 8 and 9) have already been assigned colours. Which node should we choose to assign a colour to next? Explain.



[9 marks]

QUESTION CONTINUES

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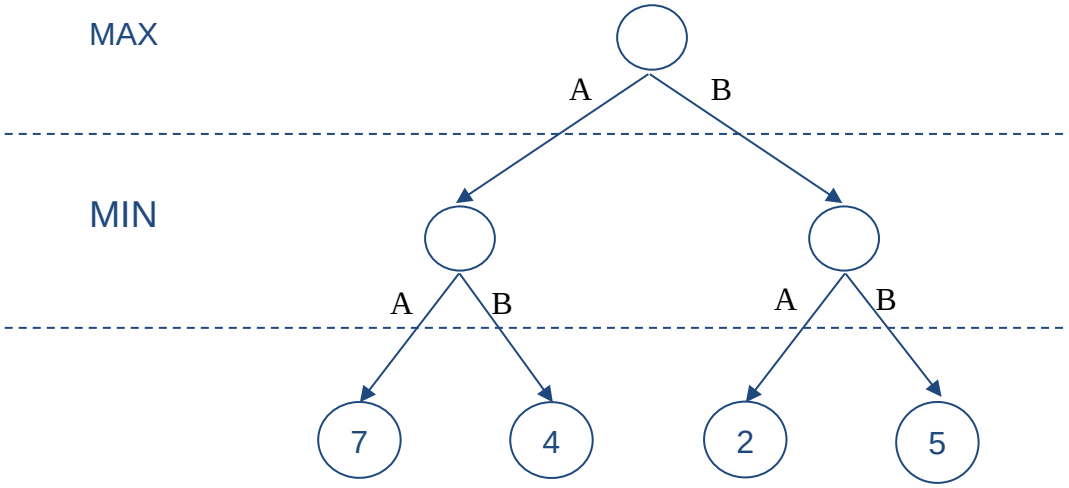
c) Consider the game tree shown below. Assume the top node is a max node. The labels on the edges are the moves. The numbers in the bottom layer are the values of the different outcomes of the game to the max player. What is the value of the game to the max player? What is the first move the max player 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)?



[6 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. [9 marks]

END OF PAPER

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