

First/Masters Degrees in Engineering by Course Units

May 2015      14:30 - 17:00

ECS629U/759P      Artificial Intelligence

Duration: 2 hours 30 minutes

**YOU ARE NOT PERMITTED TO READ THE CONTENTS OF THIS QUESTION PAPER UNTIL INSTRUCTED TO DO SO BY AN INVIGILATOR.**

Answer ALL Questions

**ONLY NON-PROGRAMMABLE CALCULATORS ARE PERMITTED IN THIS EXAMINATION. PLEASE STATE ON YOUR ANSWER BOOK THE NAME AND TYPE OF MACHINE USED.**

**COMPLETE ALL ROUGH WORKINGS IN THE ANSWER BOOK AND CROSS THROUGH ANY WORK WHICH IS NOT TO BE ASSESSED.**

**IMPORTANT NOTE:**

**THE ACADEMIC REGULATIONS STATE THAT POSSESSION OF UNAUTHORISED MATERIAL AT ANY TIME WHEN A STUDENT IS UNDER EXAMINATION CONDITIONS IS AN ASSESSMENT OFFENCE AND CAN LEAD TO EXPULSION FROM QMUL.**

**PLEASE CHECK NOW TO ENSURE YOU DO NOT HAVE ANY NOTES, MOBILE PHONES OR UNAUTHORISED ELECTRONIC DEVICES ON YOUR PERSON. IF YOU HAVE ANY THEN PLEASE RAISE YOUR HAND AND GIVE THEM TO AN INVIGILATOR IMMEDIATELY. PLEASE BE AWARE THAT IF YOU ARE FOUND TO HAVE HIDDEN UNAUTHORISED MATERIAL ELSEWHERE, INCLUDING TOILETS AND CLOAKROOMS IT WILL BE TREATED AS BEING FOUND IN YOUR POSSESSION. UNAUTHORISED MATERIAL FOUND ON YOUR MOBILE PHONE OR OTHER ELECTRONIC DEVICE WILL BE CONSIDERED THE SAME AS BEING IN POSSESSION OF PAPER NOTES. MOBILE PHONES CAUSING A DISRUPTION IS ALSO AN ASSESSMENT OFFENCE.**

**EXAM PAPERS CANNOT BE REMOVED FROM THE EXAM ROOM.**

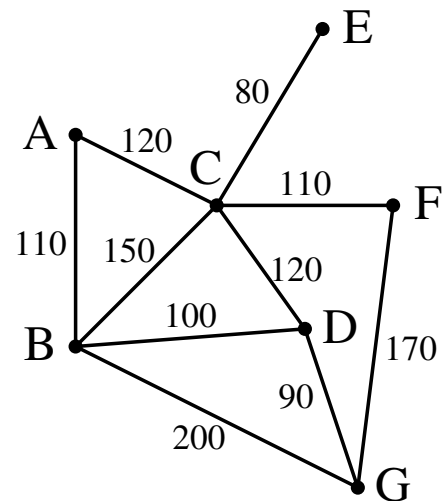
**Examiners:**

Dr S Dixon

Dr S Riis

## Question 1

Consider the problem of finding the cheapest flight routes between pairs of cities, where a map as show to the right is given. Vertices represent cities, and are labelled by upper case letters. Edges represent direct flights between pairs of cities, and are labelled with the price of the flight (in pounds). Where there is a direct flight between a pair of cities, it operates in both directions and it has the same price in each direction. The required utility function considers only the cost, ignoring the number of separate flights, timetabling of flights, reputation of airline, etc.



- a) Using depth-first search, what are the first 3 nodes expanded to find a path from F to B? (There is more than one correct answer. Just give one possible answer.)

[2 marks]

- b) Why is depth-first search not suitable for this problem? How can depth-first search be modified to make it suitable for this problem?

[4 marks]

- c) What are the first 3 nodes expanded to find a path from F to B using breadth-first search?

[2 marks]

- d) What advantages does breadth-first search have over depth-first search in general (i.e. not only for route-finding problems)? (Explain any terms you use.)

[4 marks]

- e) What disadvantages does breadth-first search have for this route-finding problem?

[4 marks]

- f) Execute uniform cost search to find a path from G to E. Show your working including the order of node expansion and the agenda at each step. What is the path and its cost found by this algorithm?

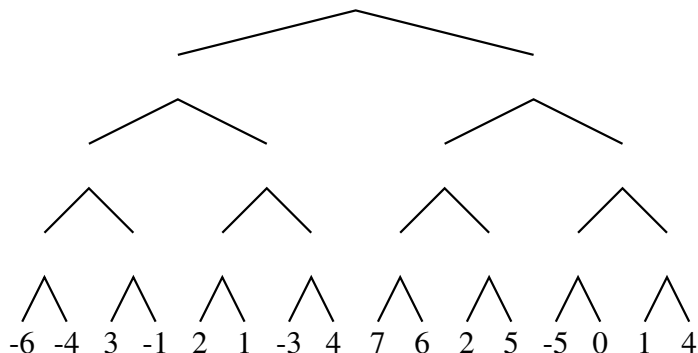
[6 marks]

- g) Would A\* be a better algorithm for this problem? Why or why not?

[3 marks]

## Question 2

A two-player game has the following game tree for the last four moves. MAX tries to find the goal with the largest value and MIN the smallest one. It is MAX's turn to play.



- a) Use the minimax algorithm to calculate the value at each node of the tree. (You will need to copy the whole tree into your answer book.)

[6 marks]

- b) What sequence of moves (left or right branch) is selected by each player at each level?

[2 marks]

- c) Simulate the execution of  $\alpha$ - $\beta$  pruning on the tree, searching from left to right. Which branches are pruned and why? Refer to nodes by  $(depth, position)$ , where *depth* is counted from the root (depth 1) and *position* from the left (also starting at 1). E.g. the fourth leaf, -1, is at node (5,4).

[6 marks]

- d) Neural Networks: What types of functions can be represented by an artificial neural network with an input and output layer only? Give an example of a function that can not be learnt by such a network.

[4 marks]

- e) Explain the backpropagation algorithm for training a multilayer neural network.

[7 marks]

**Question 3**

- a) Give the formula for entropy  $H(S)$  as used in decision tree learning, and define each variable in the formula.

[4 marks]

- b) You are trying to understand your neighbour's cycle riding habits, and you hypothesise that her choice of riding or not riding to work is based on the weather. Based on the following 7 observations of the weather and your neighbour's choice of transport, construct a decision tree classifier using the ID3 algorithm. Show all working and draw the resulting decision tree.

| Rain | Wind | Snow | RideBike |
|------|------|------|----------|
| Y    | Y    | N    | N        |
| N    | Y    | N    | Y        |
| N    | N    | Y    | Y        |
| N    | Y    | Y    | N        |
| Y    | Y    | Y    | N        |
| Y    | N    | N    | N        |
| N    | N    | N    | Y        |

[13 marks]

- c) Explain what overfitting is, and when it can cause problems with ID3.

[4 marks]

- d) Explain the function of training, testing and validation sets and their relationship to overfitting with ID3.

[4 marks]

**Question 4**

Consider the following situation:

Sam is a man with blue eyes and blonde hair. He is 1.8m tall. He likes dogs. Sally is a woman with green eyes and auburn hair. She is 1.6m tall. She owns a dog. Sally likes everyone who likes her dog.

- a) Write down the ontology required to express this situation in predicate calculus, identifying the three different kinds of syntactic object that can appear in an ontology, and saying which is which. You may assume real numbers and associated tests (i.e., you do not need to write them down).

[5 marks]

- b) Translate the situation into predicate calculus using your ontology.

[8 marks]

- c) Give a resolution proof, showing and explaining your working, of the claim that Sally likes Sam.

[12 marks]

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**End of Paper**