UNIVERSITY OF
STIRLING

DEPARTMENT OF COMPUTING
SCIENCE & MATHEMATICS

Computing Science Examination
Autumn Semester 2009

CSC9YE: Artificial Intelligence

Wednesday 9 December 2009 **09:00 – 10:30 hours**

Attempt **ANY TWO** questions.

All questions carry equal marks.

The distribution of marks among the parts of each question is indicated.

IMPORTANT NOTE

Read the instructions on the front of each answer book carefully.

It is essential that you write your registration number on the front of each answer book.

Also, when you have completed the examination, the number of answer books that you have used must be prominently written on the front of one book.

1. Imagine you are in an area of New York with a grid road system. Every intersection has three choices: left, right, straight on (you never turn back). You are looking for the Empire State Building, which you know is just two blocks from where you are, but you don't know which direction it is in.

   (a) Represent your current location as a single node at the root of a tree and then add the next two levels of the search tree to your diagram, labelling the arcs but not the nodes. Then pick one node and label it as the goal. **[3]**

   (b) You choose to make a depth first search of the area until you find the building. Refer to your diagram and say how many arcs of the tree you need to traverse before you reach your goal. **[2]**

   (c) Now repeat the process from part (b) above, but use a breadth first search this time. **[2]**

   (d) In general, with longer search paths, which of the two methods listed above would be most memory efficient? There is a potential problem in using depth first search – what is it and what other method could be used to avoid it? Why does the other method avoid the problem? **[5]**

   (e) Suggest one improvement to the search algorithm that could be made to reduce the number of nodes in the tree. **[5]**

   (f) Imagine you wanted to try to use a genetic algorithm (GA) to search for the fastest route to New York landmarks instead of using a search tree. Describe the concepts behind how a GA works and explain how it might be used in this case. What extra information would you need during your search to allow a GA to work? **[8]**

2. (a) What is the difference between deductive inference and inductive inference? Which of the two is performed using logic? **[3]**

(b) Suggest a situation or a type of task where inference using logic is not appropriate. **[2]**

(c) Consider the logical equivalence $P \rightarrow Q \equiv (\neg Q \rightarrow \neg P)$

(i) Re-write it as a sentence in English language. **[2]**

(ii) Explain why the equivalence holds. **[2]**

(iii) Draw the truth table for both sides of the equivalence to show they are the same. **[1]**

(iv) Is it also true that $P \rightarrow Q \equiv (\neg P \rightarrow \neg Q)$. Why? Give an example where P and Q are replaced by facts of your choice. **[3]**

(d) Use first order logic to represent the following sentences, using only the predicates Brown(x), Furry(x), Bear(x), Lives(x,y), Woods(y).

(i) Some bears are brown. **[2]**

(ii) All bears are furry. **[2]**

(iii) Some bears live in the woods. **[2]**

(e) Consider the statement: $\forall x$ Water(x) $\rightarrow$Wet(x).

(i) Say what it means in English, first as a literal translation of the symbols and then as a more natural sentence. **[2]**

(ii) In an environment where there is only water, trees and bears, expand the statement as a series of conjunctions. **[4]**

3. (a) Define the following types of learning: supervised, unsupervised and reinforcement learning, each in terms of the feedback required from the environment. **[6]**

(b) A neural network usually contains neurons, synapses, and an activation function. Explain the role of each of these three ingredients. **[6]**

(c) The Hebb rule is a simple associative network learning rule. Explain how it works between two neurons. **[2]**

(d) Imagine we want to teach a neural network to detect fraudulent insurance claims. We have chosen a multi-layer perceptron (MLP) for the job:

(i) We need to collect data representing the input and the output of the MLP. Suggest an example input variable (use your imagination) and say what the output would be. **[2]**

(ii) Name the three different types of neuron found in a MLP. **[3]**

(iii) What do we mean by the 'error' made by a MLP during training? **[2]**

(iv) To what use is the error put during training? **[2]**

(v) What do we mean when we say that MLPs can suffer from over training, and what can we do to avoid this problem? **[2]**

END OF EXAMINATION