THIS PAPER IS NOT TO BE REMOVED FROM THE EXAMINATION HALLS

UNIVERSITY OF LONDON **CO3310 ZB**

BSc Examination

COMPUTING AND INFORMATION SYSTEMS, CREATIVE COMPUTING and COMBINED DEGREE SCHEME

Artificial Intelligence

Monday 9 May 2016: 14.30 – 16.45

Duration: 2 hours 15 minutes

There are FIVE questions on this paper. Candidates should answer THREE questions. All questions carry equal marks, and full marks can be obtained for complete answers to THREE questions. The marks for each part of a question are indicated at the end of the part in [.] brackets.

Only your first THREE answers, in the order that they appear in your answer book, will be marked.

There are 75 marks available on this paper.

A handheld calculator may be used when answering questions on this paper but it must not be pre-programmed or able to display graphics, text or algebraic equations. The make and type of machine must be stated clearly on the front cover of the answer book.

QUESTION 1 Logic and Reasoning

a) Explain what is meant by:
   i. entailment
   ii. non-monotonic reasoning
   iii. logical equivalence

[6]

b) Express the following English sentences as formulas of Predicate Calculus:

   i. Everything that flies has wings.
   ii. There are no cold-blooded creatures that fly.
   iii. No mammal lays eggs except the platypus.

[6]

c) Explain the following terms in the context of probabilistic reasoning:

   i. False negative
   ii. False positive
   iii. Prior probability
   iv. Posterior probability

[4]

d) Suppose there are 90,000 adult citizens in the town of Drivetown, of whom 60,000 own cars and 25% ride bicycles. If only one in five cyclists owns a car, what is the probability of a car-owner riding a bicycle? Calculate your answer to two decimal places, and explain it with reference to Bayes' Rule.

[9]

QUESTION 2 Search and Planning

a) Compare the following search strategies in terms of their time and space complexity:

i. Breadth-first
ii. Depth-first
iii. Depth-first with iterative deepening.

[4]

b) Explain what is meant by **partial-order planning**, and give an example of an everyday activity for which it could be appropriate.

[6]

c) The following figures show two states of an 8-puzzle.

1	2	3
8		4
7	6	5

Figure 1. Goal state

7	6	5
8		4
1	2	3

Figure 2. Start state

Describe two types of heuristic function for this kind of problem, and explain the minimum solution cost each would estimate for moving from the state in Figure 2 to that in Figure 1.

[6]

d) Assume a configuration of the blocks world as shown in Figure 3:

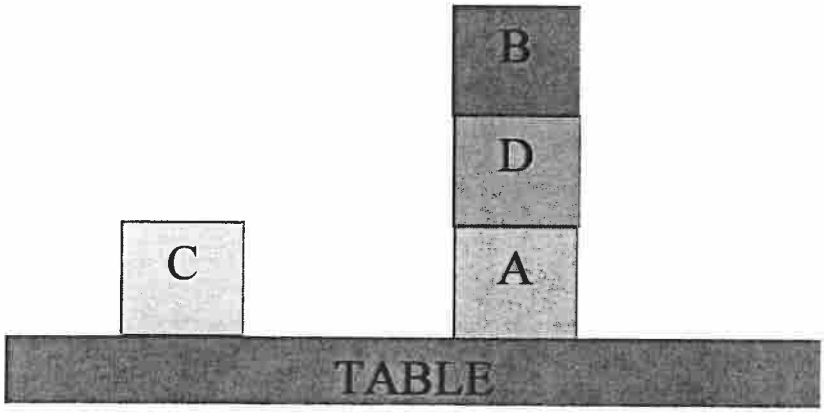

Figure 3. Start state

i. Define a set of actions in PDDL to move a single block on to another block (which may have blocks beneath it), or move a block onto the table.

ii. Using these actions, write down a solution to the problem of achieving the goal state in Figure 4, showing the effect of each move (note: the offset of the blocks is not significant).

[9]

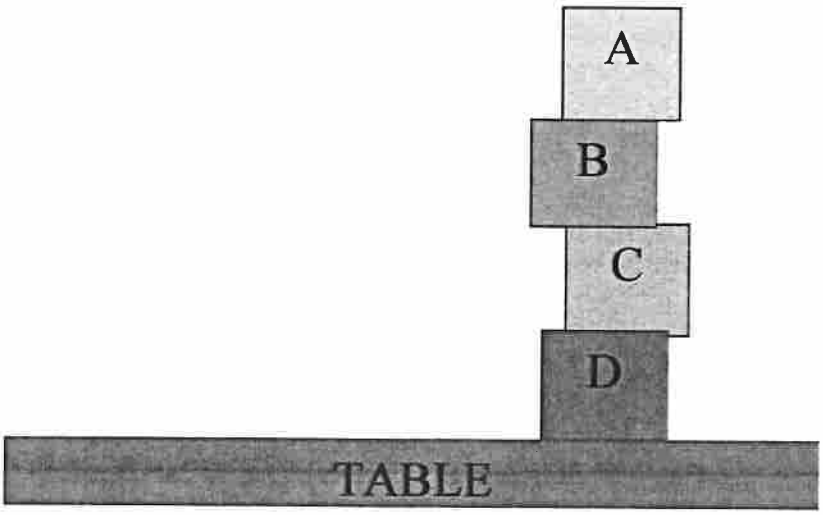

Figure 4. Goal state

QUESTION 3 Machine Learning and Decision Problems

a) In the context of machine learning, which of the following problems involve **classification** and which involve **regression**? Explain your answers.

i. Detecting spam email
ii. Forecasting the next day's weather
iii. Diagnosing a patient's condition on the basis of observed symptoms, lifestyle and medical history
iv. Predicting the effects of government policy on stock market prices
v. Automatic grading of student assignments
vi. Determining whether a book review is favourable or unfavourable.

[6]

b) Explain why it is important to use distinct **training** and **test** sets when developing a classifier.

[2]

c) Suppose you are developing a software tool to help high school students decide what subject to study at university, and you have access to various source of historical data. Discuss how machine learning techniques could be used to construct a **decision tree** to help in this choice.

[8]

d) Figure 5 represents a simple 4 x 3 world that presents a sequential decision problem. Draw a copy of this diagram and show an optimal policy for navigating it, given that:

- There are two terminal states with reward +100 and -100, and all other states have a reward of -1;
- The available actions are ←, ↑, → and ↓; each performs the intended action with a probability of 0.8, with probability of 0.1 of moving at 90 or 270 degrees respectively to the intended direction. Movement is one cell at a time and if an agent bumps against the outside boundary or a shaded cell, it stays where it is.
- There is no discounting.

Explain your answer.

[9]

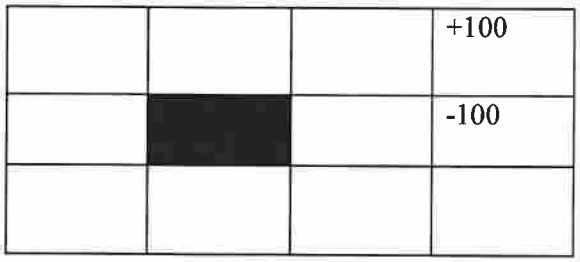

Figure 5.

QUESTION 4 Natural Language

a) Explain the differences between a **grammar**, a **lexicon**, a **parser** and a **recogniser** in the context of natural language processing.

[6]

b) Describe three different ways a sentence can be ambiguous, giving examples.

[6]

c) A natural language system has the following grammatical and lexical rules:

s → s conj s	conj → [and]
s → np vp	det → [the]
np → pn	det → [a]
np →det n	n → [cat]
vp → vp conj vp	n → [tree]
vp → v	n → [dormouse]
vp → v np	pn → [Alice]
	v → [saw]
	v → [slept]
	v → [climbed]
	v → [purred]

The start symbol is 's' which represents a sentence. Using the above grammar, draw syntax trees for the sentences:

i. Alice saw a cat.
ii. The dormouse slept and the cat climbed a tree.
iii. The cat climbed a tree and purred.

Explain how the grammar can be modified so that it still generates examples (i-iii) above and the new examples (iv) and (v), but not the starred (vi) and (vii):

iv. Alice saw a cat in a tree and a caterpillar on a mushroom
v. Alice drank some tea and ate a piece of cake
vi. *Alice saw in the tree.
vii. *The cat slept a tree.

[9]

d) Explain how an augmented grammar can generate a formal representation of the semantic content of the English sentence *Alice sees Humpty*.

[4]

QUESTION 5 Philosophy of AI and Social Issues

You should write no more than around 400-500 words for each of (a) and (b).

a)

Alan Turing's celebrated paper "Computing Machinery and Intelligence" anticipated several objections to the idea that digital computers can "think" and sought to rebut them. Briefly summarise two of the objections listed below, along with Turing's reply, and explain whether you find his replies convincing.

1. The Mathematical Objection
2. The Argument from Consiousness
3. Lady Lovelace's Objection.

[10]

b) Russell and Norvig's *Artificial Intelligence: A Modern Approach* (ch 26) considers a number of potential risks arising from the continuing development and deployment of AI systems, including:

1. People might lose their jobs to automation
2. People might have too much (or too little) leisure time
3. People might lose their sense of being unique
4. AI systems might be used towards undesirable ends
5. The use of AI systems might result in a loss of accountability.

Pick three of these issues and discuss whether you consider them to give genuine cause for concern.

[15]

END OF PAPER