THIS PAPER IS NOT TO BE REMOVED FROM THE EXAMINATION HALLS

UNIVERSITY OF LONDON **CO3310 ZA**

BSc Examination

COMPUTING AND INFORMATION SYSTEMS, CREATIVE COMPUTING and COMBINED DEGREE SCHEME

Artificial Intelligence

Monday 08 May 2017: 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 hand held 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 Learning Agents

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

i. Identifying the authorship of literary texts
ii. Predicting stock market prices
iii. Calculating health insurance premiums based on an applicant's lifestyle, age and medical history
iv. Tagging words in a text with grammatical categories
v. Automatic grading of student assignments
vi. Determining whether a product review is favourable or unfavourable.

[6]

b) Explain the differences between **supervised**, **unsupervised** and **reinforcement** learning.

[6]

c) Consider the case of an automated taxi which needs to learn how to navigate a busy city such as London, Saõ Paulo or Mumbai.

i. Characterise the agent's **task environment** in terms of the dimensions:

- Fully vs partially observable
- Single vs multiagent
- Deterministic vs stochastic
- Episodic vs sequential
- Static vs dynamic

[5]

ii. What would constitute an appropriate **performance measure** for this type of agent?

[3]

iii. Would it be more feasible to train the agent on the city streets, or in a virtual (simulated) environment?

[5]

Justify your answers.

QUESTION 2 Logic and Reasoning

a) Explain what is meant by the following terms, in the context of probabilistic reasoning:

i. Discrete random variable
ii. Continuous random variable
iii. Probability distribution

[6]

b) Express the following English sentences as formulas of Predicate Calculus, explaining the intended meaning of any constants that you use:

i. All fish have fins.
ii. There are no reptiles that fly.
iii. No mammals fly except bats.

[6]

c) Show that the following logical equivalences are true, using truth tables:

i. Contraposition (A $\rightarrow$B) iff (~B $\rightarrow$ ~A)
ii. Implication elimination (A $\rightarrow$B) iff (~A v B)

[4]

d) Suppose there are 100,000 adult citizens in the town of Drivetown, of whom 45,000 own cars and 30% 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 significant figures, and explain it with reference to Bayes' Rule.

[9]

QUESTION 3 Natural Language

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

[6]

b) Explain whether each of the following sets of production rules makes up a **regular**, **context-free** or **context-sensitive** grammar, and write out the shortest string generated by each.

i. $S \rightarrow Y\ z$
$Y \rightarrow Z\ z$
$Z \rightarrow z$

ii. $S \rightarrow x\ Y$
$S \rightarrow x\ S\ Y$
$x\ Y \rightarrow x\ w$
$w\ Y \rightarrow w\ y$

iii. $S \rightarrow x\ S\ y$
$S \rightarrow z$

[6]

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

s → np vp	det → [the]
np → pn	det → [a]
np → det n	n → [cat]
vp → adv vp	n → [dog]
vp → v np	n → [mouse]
	pn → [Tom]
	pn → [Jerry]
	v → [saw]
	v → [chased]
	adv → [often]

i. Write out the shortest sentence which is generated by the above grammar, and the longest which does not repeat any words. Draw syntax trees for both sentences. NB by "the shortest/longest sentence" is meant the sentence with the fewest/most words.

[3]

ii. Explain how the grammar can be modified so that it still generates your examples and the new examples (1-3) below, but not the starred (4) and (5). Note that you are not required to provide a complete new grammar, only to explain how the grammar rules need to be modified, with appropriate worked examples.

1. The dog often chased Tom and Jerry up a tree.
2. Tom ran from a big black angry dog.
3. The dog chased Tom and Jerry hid up a tree.
4. *Jerry up a tree.
5. *The dog chased Jerry hid up a tree. **[5]**

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

[5]

QUESTION 4 Search and Planning

a)

i. Explain what is meant by **completeness** and **optimality** as applied to search algorithms.

ii. Under what conditions is breadth-first search considered to be both complete and optimal?

[6]

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

1	2	3
8		4
7	6	5

Figure 1.

8	1	3
2	4	5
7	6	

Figure 2.

i. Describe two types of heuristic function for this kind of problem.

ii. Explain whether each of these is an **admissible** heuristic.

iii. Explain the minimum solution cost each would estimate for moving from the state in Figure 2 to that in Figure 1.

[9]

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

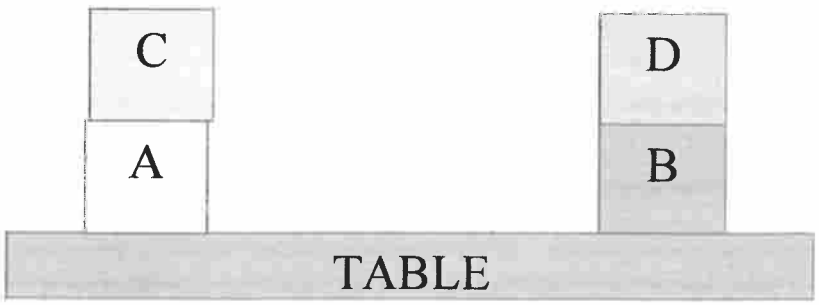

Figure 3.

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

[6]

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:

[4]

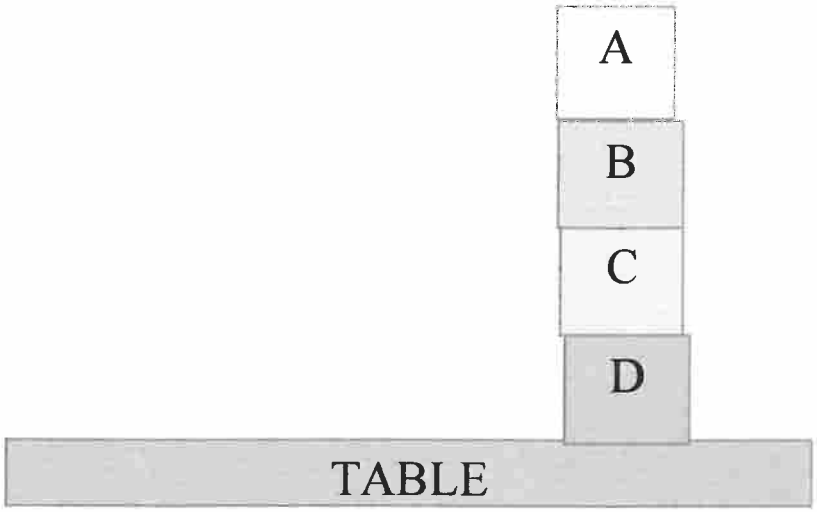

Figure 4.

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 Informality of Behaviour
3. The Argument from Disability.

[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. AI systems might be used towards undesirable ends
3. The use of AI systems might result in a loss of accountability.

Discuss whether you consider any of these issues to give genuine cause for concern.

[15]

END OF PAPER