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 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 Logic and Reasoning

a) Explain what is meant by **soundness** and **completeness** of an inference procedure, with particular reference to Propositional Logic.

[4]

b) Give the meaning of each the following formulas of Predicate Calculus in ordinary English, and write a logically equivalent expression for each formula using the existential quantifier $\exists$ rather than the universal $\forall$:

i. $\forall x(Swims(x) \rightarrow \sim Bird(x))$
ii. $\sim\forall x(Flies(x) \rightarrow WarmBlooded(x))$
iii. $\forall x(Cat(x) \ \& \sim Fly(x))$

[6]

c) Explain what is meant by **prior** and **conditional** probabilities, and calculate the value of P(A|B) to two significant figures, given the following probability distribution:

P	A	~A
B	0.1	0.25
~B	0.45	0.1

[6]

d) Suppose there are 120,000 people of voting age in the town of Suburbiton. There are two major political parties, the Blue Party and the Red Party. 30,000 residents of Suburbiton support the Red Party. A referendum was held to decide whether or not the country should leave the Continental Federation (CF) or remain a member, and 55% of the population of Suburbiton voted to leave.

If two out of five who voted to leave are Red supporters, what is the probability of a Red supporter voting to leave? Calculate your answer to two significant figures, and explain it with reference to Bayes' Rule.

[9]

QUESTION 2 Search and Planning

a) Explain in your own words the difference between **uninformed** and **informed** search. Describe one informed and one uninformed search strategy.

[4]

b) Explain in your own words the difference between **progressive** and **regressive** planning, and describe some potential advantages and disadvantages of each approach.

[6]

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

A	B	C
H		D
G	F	E

Figure 1.

A	C	D
F	B	
H	G	E

Figure 2.

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:

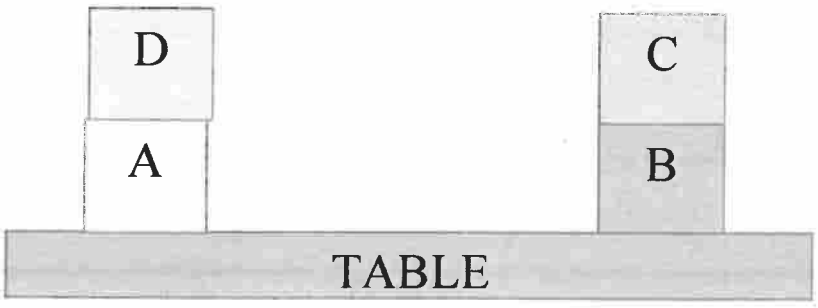

Figure 3.

i. Define an appropriate 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. You may assume the table is of infinite length.

[5]

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]

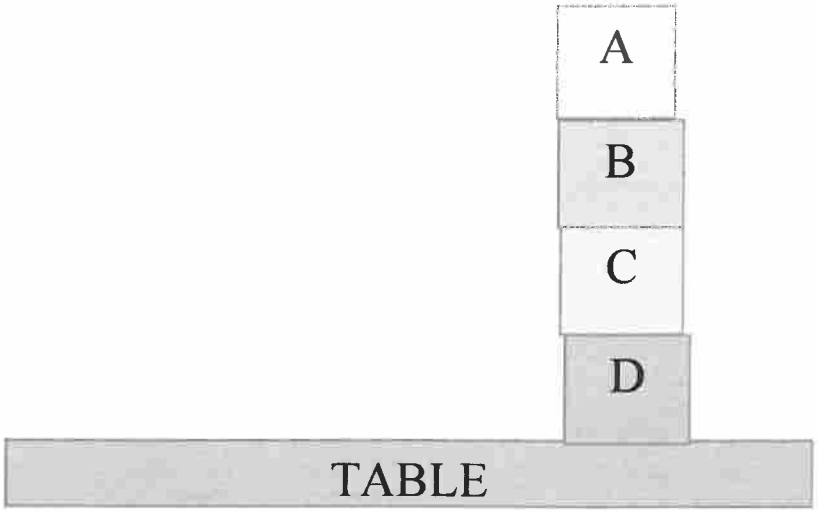

Figure 4.

QUESTION 3 Learning Agents

a) Describe two main types of **supervised learning** and propose a suitable application for each. Make sure to include a description of each type, and do not simply list them.

[6]

b) Explain what is meant by **overfitting** in the context of machine learning. How do analysts generally aim to avoid overfitting?

[4]

c)

i. Explain in general terms what is meant by **reinforcement learning.**

ii. One way of modelling a reinforcement learning agent's environment is as a tuple <S, A, P, C>. Explain what each of these items stands for.

iii. What is meant by the Markov property in the context of machine learning, and why is it useful?

[7]

d) There is increased interest in developing robot assistants for use in hospitals and residential care homes. A list of typical tasks carried out by assistants in these institutions, variously referred to as orderlies, nurse assistants or hospital porters, is given below:

- transferring patients to and from wards and departments
- dealing with incoming and outgoing mail
- delivering clean linen to wards from the laundry
- collecting domestic and clinical waste, some of which may be hazardous
- moving furniture and medical equipment safely
- transferring files, specimen samples and pharmacy boxes to different parts of the hospital

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? Explain your answer.

[3]

Note: correction in red

QUESTION 4 Natural Language

a) Describe three ways that natural language expressions can be ambiguous, giving examples.

[6]

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

i. S → a B
   B → b B
   B → b

ii. S → A b
   S → A S b
   A b → c b
   A c → b c

iii. S → a S b
   S → c

[6]

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

s → np vp	det → [the]
np → np pp	det → [a]
np → det n	n → [student]
np → pn	n → [book]
pp → p np	n → [hall]
vp → v np	v → [read]
vp → v	v → [slept]
	p → [in]

i. Write out the shortest sentence generated by this grammar, and the longest which does not repeat any words. Draw syntax trees for both sentences. **[3]**

ii. Explain how the grammar can be modified so that it still generates your examples and the new examples (1-3), but not the starred (4) and (5):

1. The student sat in the hall and read a book.
2. The student read a book and a newspaper.
3. The student slept and dreamed.
4. *The student slept a book.
5. *Saw a book.

[5]

d) Explain how the formula *sees(Alice, Humpty)* can be derived from the English sentence *Alice sees Humpty*, using the lambda-calculus.

[5]

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) Describe John Searle's "Chinese Room" thought experiment, which is claimed to demonstrate the impossibility of digital computers manifesting "strong AI". If a digital computer were to be proved capable of conversing in a natural language, fluently enough to pass the "Turing Test", would it be manifesting **strong** or **weak** AI in Searle's terms? Justify your answer.

[15]

b) Discuss the claim that "No machine can lie. Nor can it tell the truth". (GK Chesterton)

[10]

END OF PAPER