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

Wednesday 9 May 2018: 14.30 – 16.45

Time allowed: 2 hours and 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 Agents and Learning

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 anonymous emails
ii. Predicting levels of rainfall
iii. Calculating car insurance premiums based on an applicant's age, location, driving experience and claims history.
iv. Automatic grading of student assignments
v. Determining whether individuals who comment on social media are likely to favour particular political parties.

[5]

b) The Subject Guide and Russell and Norvig's textbook describe a number of different dimensions along which agent tasks may vary, including:

- fully versus partially observable
- feterministic versus stochastic
- static versus dynamic.
- discrete versus continuous.

Consider a domestic cleaning robot which includes a vacuum cleaner and the ability to scrub the floor and wipe it dry. Classify the agent's tasks in terms of the above dimensions, giving reasons for your answers.

[8]

c) The Appendix contains a copy of Figure 7.2 from the Subject Guide, with example data for learning whether to take a taxi or walk home.

i. Briefly explain how a decision tree can be constructed using **information gain**.
ii. Use the data to construct a **decision tree**, splitting first on the attribute Nearby and making intuitive decisions on which attributes to split on at subsequent levels.
iii. Do you think your results will generalise well to new input data?

Justify your answers.

[12]

QUESTION 2 Logic and Reasoning

a) Show which literals can be inferred from the following knowledge base, using

i. Reasoning patterns
ii. Truth tables

You should show all steps in your reasoning.

$\sim(P \vee Q)$
$R \rightarrow Q$
$R \vee S$

[10]

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 universal quantifier $\forall$ rather than the existential $\exists$:

i. $\sim\exists x$ (fish(x) & has_wings(x))
ii. $\exists x$(fish(x) & leaps(x))
iii. $\sim\exists x$(fish(x) &~shark(x) & blinks(x))

[6]

c) Suppose the city of Brighthelm has two universities, the University of Brighthelm (UoB) and Brighthelm Metropolitan University (BMU) with 12,000 and 8,000 students respectively. 75% of UoB students use a bus pass to travel to campus but only 15% of BMU students. What is the probability of a student bus-pass holder studying at BMU? Calculate your answer to two significant figures, and explain it with reference to Bayes' Rule, showing your working.

[9]

QUESTION 3 Natural Language

a) Identify and explain three kinds of ambiguity in the following passage: *The White House announced that the communications director had resigned this week. A spokesperson for the President said that she planned to write a book.* **[4]**

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. $S \rightarrow A\ a$
$A \rightarrow A\ a$
$A \rightarrow B\ b$
$B \rightarrow b$

ii. $S \rightarrow a\ S\ B$
$S \rightarrow b\ S\ B$
$S \rightarrow \varepsilon$
$a\ B \rightarrow a\ a$
$b\ B \rightarrow b\ b$

iii. $S \rightarrow a\ S\ b$
$S \rightarrow c$ **[6]**

c)

i. Write a formal grammar that will generate the sentences in the example text below. You may ignore punctuation symbols and the use of upper or lower case. **[6]**

ii. Explain which constructions you need to cover in your grammar, and how your rules accomplish this. **[5]**

iii. Write out the shortest sentence generated by your grammar, and one at least 10 words long which is not in the example text. Draw a syntax tree for each available parse of both sentences. **[4]**

Text

I visited Sherlock Holmes in the autumn of last year and found him in deep conversation with a stout elderly gentleman with fiery red hair. The stout gentleman rose from his chair and gave a bob of greeting. He proudly pulled a dirty and wrinkled newspaper from the inside pocket of his greatcoat.

QUESTION 4 Search and Planning

a)

This question is about uninformed search. Explain your answers.

i. What is meant by the **frontier** in the context of AI search?
ii. Describe the characteristics of the frontier assuming **depth-first** search.
iii. Describe the characteristics of the frontier assuming **breadth-first** search.
iv. Describe the characteristics of the frontier assuming **uniform-cost** search.
v. A search strategy that combines some benefits of depth-first and breadth-first search is **iterative deepening search**. This involves repeated exploration of initial states of the search tree: explain why this should or should not be considered an inefficiency.

[10]

b) Explain the difference between a heuristic search method and a heuristic function, and describe an example of each.

[6]

c) Assume the following planning problem for going on vacation:

Goal(OnVacation); Init(Passport&CreditCard&Suitcase&Clothes)

Action(BuyTicket):
Precondition(CreditCard)
Effect(Ticket)
Action(BuyInsurance)
Precondition(CreditCard)
Effect(Insured)
Action(Pack):
Precondition(Suitcase&Clothes)
Effect(PackedSuitcase)
Action(GoOnVacation):
Precondition(Passport&Ticket&PackedSuitcase&Insured)
Effect(OnVacation)

Show the sequence of states that would be visited by a breadth-first planner to solve this problem, using

i. Progressive planning **[5]**
ii. Regressive planning **[4]**

Explain your answers.

QUESTION 5 Theory of AI and Social Issues

a) The CO3310 Subject Guide opens with some possible definitions of AI, taken from Russell and Norvig's classic textbook, and asks which most closely matches your intuitive idea of what AI is. With the advantage of having completed this course, which of the definitions listed below now best matches the view of AI you have formed as a result of your studies and any independent reading? Give reasons for your answer, and discuss any deficiencies your selected definition may still have.

The quoted definitions are:

1. *'[The automation of] activities that we associate with human thinking'* (Bellman, 1978)
2. *'The study of the computations that make it possible to perceive, reason, and act.'* (Winston, 1992)
3. *' ... how to make computers do things at which, at the moment, people are better.'* (Rich and Knight, 1991)
4. *' ... intelligent behaviour in artifacts.'* (Nilsson, 1998)

[10]

b) A common business model for social media and news websites involves targetted content, employing machine learning techniques to build up "profiles" of individual users in order to select suitable advertisements or news items. Discuss the **social** and **ethical** implications of these techniques, with particular reference to **privacy**.

[15]

APPENDIX Example data for Q1(c).

#	Raining	Cold	Late	Nearby	Umbrella	Warmly Dressed	*Taxi?*
1	Yes	No	Yes	Yes	Yes	No	No
2	No	No	Yes	Yes	No	No	No
3	No	Yes	Yes	Yes	No	No	Yes
4	Yes	No	Yes	No	Yes	Yes	No
5	Yes	No	No	No	No	Yes	Yes
6	No	No	No	Yes	Yes	No	No
7	No	Yes	Yes	No	Yes	Yes	Yes
8	No	Yes	No	No	No	Yes	Yes
9	Yes	No	No	No	No	No	Yes
10	No	Yes	Yes	No	Yes	No	Yes
11	Yes	No	No	No	Yes	Yes	No
12	No	Yes	No	Yes	No	Yes	No
13	No	Yes	Yes	Yes	Yes	Yes	No
14	Yes	No	Yes	Yes	No	No	Yes

Figure 7.2: Example data for the learning to determine whether to take a taxi or walk home.

END OF PAPER