UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For the following qualifications :-

B. Sc. *M.Sci.*

Comp Sci 3C51: Artificial Intelligence 1

COURSE CODE	:	COMP3C51
UNIT VALUE	:	0.50
DATE	:	04MAY-01
TIME	:	10.00
TIME ALLOWED	:	2 hours 30 minutes

Answer THREE questions, at least ONE from EACH of Sections A & B

SECTION A

1. **a. i. Give a definition for an inheritance hierarchy.**

   ii. **Give a definition for credulous reasoning in an inheritance hierarchy.**

   iii. **Explain why credulous reasoning for an inheritance hierarchy can be problematical in an application.**

[12 marks]

b. i. Draw an inheritance hierarchy that captures the following:

```
Nigel is an instance of a nautilus
Nautilus is a type of cephalopod
Cephalopod is a type of mollusc
Mollusc is a type of shell-bearer
Cephalopod is not a type of shell-bearer
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ii. **Give the set of inferences that can be obtained from the inheritance hierarchy** in (b)(i) **above using credulous reasoning.**

[11 marks]

c. Give an example of a temporal proposition about a mobile robot for each of the following categories:

i. Downward hereditary

ii. Upward hereditary

iii. Liquid

iv. **Gestalt**

v. Solid

[10 marks]

[Total: 33 marks]

TURN OVER

2. **a.** i. **Give 2 reasons why the Dempster-Shafer technique is a useful technique for handling uncertain information.**

ii. **What is a frame of discernment?**

iii. **Define a basic probability assignment.**

iv. Define a belief function.

v. **What is the role of normalisation in Dempster's rule of combination, and why is it problematical?**

[15 **marks]**

b. The following two basic probability assignments are defined for the frame of discernment = { a,p,Y }:

m1({al) = 0.8 m2({a}) = 0.5

m1({P J) = 0.0 m2({P)) = 0.0

m1({Yl) = 0.0 m2({Yl) = 0.5

m1(la,0 l) = 0.2 m2({a,p)) = 0.0

m **1({a,Y l) = 0.0 m2({a,Y l) = 0.0**

ml({R,YI) = **0.0 m2(tP,Y}) = 0.0**

ml({a,R,YI) = 0.0 m2({a,P,Yl) = 0.0

Give the combined basic probability assignment, the resulting belief function, and the resulting plausibility function. You can express your **calculations in terms of fractions. Explain your calculations.**

[10 marks]

c. Let *Bel* be a belief function. **Does the following equation hold?**

$$Bel(A) + Bel(Ac) = 1$$

Question 2 (c) continued over page

For your answer, give a proof based on the definition of a basic probability assignment.

[8 marks]

[Total: 33 marks]

3. a. i. What is a Bayesian network?

ii. Why is a Bayesian network of particular importance in developing probabilistic reasoning systems?

iii. What is a moral graph?

[9 marks]

b. Let a, P and y be random variables. Briefly explain each of the following 4 basic patterns of relevance between a and P.

is Marginal and conditional independence.

ii. Marginal and conditional dependence.

iii. Marginal independence and conditional dependence.

iv. Marginal dependence and conditional independence.

[12 marks]

c. Suppose we have the following Bayesian network for the random variables a, 0, y and b.

a <- 0 <- y <- S

i. Suppose each of the random variables a, ~, y and 8 takes a value either true or false. How many joint probability statements do we then require, to provide a total distribution?

Question 3 (c) continued over page

ii. Consider one joint probability statement for this. Rewrite it as a product of conditional probability statements using the multiplication theorem.

iii. Simplify the answer to (ii) using the information in the Bayesian network.

[12 marks]

[Total: 33 marks]

SECTION B

4. a. Describe in detail the Il?3 method, the "current best hypothesis" method, or a method based on version spaces, for learning generalisations from sets of examples.

[12 marks]

b. Suppose that you agree to help a football club manager who believes that some combination of captain, goalkeeper, training regime and breakfast food holds the secret of success (wins) for the team, and asks you to use one of the 3 methods given in (a) to find this formula from the data for the last 8 home games:

Question 4 (b) continued over page

GAME	CAPTAIN	GOALKEEPER	REGIME	FOOD	RESULT
1	**Rodilla**	**Manchot**	**relaxed**	**muesli**	win '-
2	**Rodilla**	**Knochelbisser**	**tough**	**steak**	draw
3	**('Hooligan**	**Sleep**	**tough**	**steak**	loss
4	**Rodilla**	**Sleep**	**relaxed**	**steak**	win
5	**Ungeheuer**	**Manchot**	**relaxed**	**none**	**win**
6	**('Hooligan**	**Knochelbisser**	**relaxed**	**none**	**loss**
7	**('Hooligan**	**Manchot**	**relaxed**	**none**	**draw**
8	**Rodilla**	**Sleep**	**tough**	**muesli**	**loss**

Which would you choose, and why? State the answer that it produces for this problem, and show how you reach it.

[12 **marks]**

c. What are the limitations of the method you have described in (a)? For each limitation, suggest some improvement or mention some alternative approach to learning which may avoid that problem. Justify your choices.

[9 marks]

[Total: 33 marks]

5. a. What is a "case", in artificial intelligence, and what is case-based reasoning? (CBR)

[8 marks]

b. Describe the successive steps of the process of CBR.

[10 marks]

Question 5 continued over page

c. **What are the key procedures or operations in CBR which cannot be expressed adequately in logics? How is each one carried out, and what precautions (if any) must be taken in setting each** up?

[7 marks]

d. Suppose that you were invited to help with the solution of the football problem stated in question 4 (b). Would you choose to apply CBR directly, regarding each game there as a case, or ask the club manager for additional information about each game? If the former, say how you would present the data as a case. If the latter, state what additional information you would want. For either answer, outline how your method of CBR would then process the case base to respond to the manager's request in question 4 (b).

[8 marks]

[Total: 33 marks]

6. **a. Scripts are often introduced in artificial intelligence as a type of knowledge representation, while plans are not. Are they nevertheless basically the same thing, or structures and concepts that are strongly overlapping, or weakly overlapping, or is it most sensible to regard them as separate topics? Justify your choice. Include in your argument an example or examples of situations that illustrate and support your conclusion.**

[11 marks]

Question 6 continued over page

b. Both scripts and plans imply some notion of time. State at least 3 ways of dealing with temporal information, and indicate (with reasons for your choice) what you believe to be the greatest weakness of each one. Also comment briefly, for each one, on whether or not it is equally useful for incorporation in scripts and in plans.

[10 marks]

c. The coursework exercise on representing knowledge about food and supermarkets was "static", in the sense that you were asked to represent information that would make it easier for a visitor to a supermarket to make a plan later for an efficient visit to buy ingredients for one or more meals. Give a planning algorithm, and indicate how and where it can operate on the information and representations you have used in your coursework answer, to make the plan that the visitor wants.

[12 marks]

[Total: 33 marks]

END OF PAPER