PAPER CODE NO.	EXAMINER : **Dr TJM Bench-Capon**
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THE UNIVERSITY
of LIVERPOOL

SUMMER 2000 EXAMINATIONS

Bachelor of Arts : Year 3
Bachelor of Engineering : Year 3
Bachelor of Science : Year 3

KNOWLEDGE BASED SYSTEMS

TIME ALLOWED : Two Hours and a Half

INSTRUCTIONS TO CANDIDATES

CREDIT WILL BE GIVEN FOR THE BEST FOUR ANSWERS

If you attempt to answer more than the required number of questions (in any section), the marks awarded for the excess questions will be discarded (starting with your lowest mark).

1. (a). It is not the case that Paul likes both Mozart and Beethoven. If Paul likes Wagner, he doesn't like Mozart. Paul does like Wagner: therefore Paul likes Beethoven.

   (i) Represent this argument in propositional calculus. (2 marks)
   (ii) Use a truth table to show that it is unsound, and identify a counter example. (3 marks)

(b) Given that "t" stands for "Tony", "Cx" for "x is a Conservative", "Lx" for "x is a Liberal" and Rxy" for "x is to the right of y", express the following predicate calculus expressions in English.

   (i) $(\exists x)(Cx \,\&\, Rtx)$
   (ii) $(\forall x)(\forall y)((Cx \,\&\, Ly) \rightarrow Rxy)$
   (iii) $(\forall x)(Rxt \rightarrow Cx)$
   (iv) $(\exists x)(\forall y)(Lx \,\&\, Cy \,\&\, Rxy)$ (4 marks).

(c) Given the following set of Horn Clauses, prove by resolution that `supports(vlad,george):`

```
C1 supports(X,Y) := supports(X,Z),supports(Z,Y).
C2 supports(X,Y) := party_member(X),party_member(Y).
C3 supports(X,Y) := agrees_with(X,Y).
C4 agrees_with(X,Y) := believes_in(X,Z),
believes_in(Y,Z).
C5 party_member(vlad).
C6 party_member(leon).
C7 believes_in(leon,revolution).
C8 believes_in(revolution,george).
```
(8 marks)

(d) Discuss the expressive adequacy of Horn Clauses, as used in logic programming. Does allowing negation of the right hand side solve the problems? (8 marks)

2. A robot ice cream vendor accepts fifty pence coins and gives change. The robot has 20p, 5p and 1p coins, and tries to give change in as few coins as possible.

(a) Draw the search space for deciding which coins to use when giving 26p change. (4 marks)
(b) Would depth first search be appropriate here? Briefly explain your answer. (3 marks)
(c) Suggest a suitable evaluation function which could be used to apply heuristic search to this problem. (3 marks)
(d) Explain how a production rule system performs goal driven search. (4 marks)
(e) Write a set of production rules which would enable the robot to perform its change giving task. (6 marks)
(f) Show how the rules you gave in (e) could be used to give 26p change if the robot operates in a data driven manner. (5 marks)

3. (a) Express the following summary of part of *Romeo and Juliet* as a semantic network.

The Montague and Capulet families, which both lived in Verona, hated one another. Romeo was a Montague and Juliet a Capulet. Romeo married Juliet. Because of this, Tybalt, Juliet's cousin, challenged Romeo to a duel. In this duel Romeo killed Tybalt. Because of this the Prince of Verona banished Romeo from Verona to Mantua.

(10 marks).

(b) Represent the above information as a set of frames. Include both classes and instances.

(8 marks).

(c) List three advantages of frames over semantic networks. (3 marks)

(d) What is meant by "multiple inheritance"? Why is it useful? What problems are associated with multiple inheritance? (4 marks)

4

(a). Describe the typical architecture of a consultative expert system. (9 marks)

(b) List four benefits that might come from using an expert system. (4 marks)

(c) Most rule based expert systems use a depth first, backward chaining strategy. Why? Is this always the best strategy? (6 marks).

(d) Many research expert systems address medical diagnosis problems. Is this a good domain for expert systems? (6 marks)

5. a) In the context of argumentation-based reasoning, what is an argument?

(2 marks)

b) Describe how the notion of "acceptability" can be used to capture default reasoning using argumentation.

(8 marks)

5. c) Consider the following information about three friends, Maggie, Izzy, and Hopey:

Maggie is a mechanic.
Maggie lives with Hopey.
Maggie lives with Izzy.
Hopey is a graffiti artist.
Izzy talks to flies.
Izzy is not a graffitti artist.

Consider also the following general information:

Mechanics are stable.
Graffiti artists are not stable.
People who talk to flies are not stable.
People who live with people who are not stable are not stable.
People who are not stable are "loca".

The above information can be represented in predicate logic as:

mechanic(maggie)
lives_with(maggie, hopey)
lives_with(maggie, izzy)
artist(hopey)
talks_to(izzy, flies)
~artist(izzy)

mechanic(X) -> stable(X)
artist(X) -> ~stable(X)
talks_to(X, flies) -> ~stable(X)
lives_with(X, Y) & ~stable(Y) -> ~stable(X)
~stable(X) -> loca(X)

Give arguments supporting:

(i) loca(izzy)
(ii) loca(maggie)

(8 marks)

What can you say about the acceptability of these arguments?

(7 marks)