

UNIVERSITY OF DUBLIN
TRINITY COLLEGE

Faculty of Engineering and Systems Sciences

DEPARTMENT OF COMPUTER SCIENCE

B.A.(Mod.) Computer Science

Junior Sophister Examination

Trinity Term 2004

3BA2 Artificial Intelligence

Tuesday, 25th May

Room 3074

9.30 – 12.30

T. Fernando, P. Cunningham and M. Brady

Answer **five** questions, at least **one** from each section. Each question is worth 20 marks.

Section A

1. (a) What is an *interpretation* and what does it have to do with the *Symbol System Hypothesis* in AI?
(b) What is *meta-interpretation* and why does it require a distinction between *base language* and *meta-language*?
(c) What is the difference between *declarative* and *procedural* semantics?
2. (a) What is a *non-deterministic Turing machine* (nTm) and what conditions on A* search should we impose so that A* considers all computations of a nTm? How do these conditions differ from those for non-deterministic finite state machines?
(b) From the perspective of STRIPS, what are the actions of a nTm. Briefly outline how STRIPS characterizes such actions. (Two well-chosen lines should do.) What restrictions on nTms are necessary for such characterizations to work?
3. Recall that a graph with arcs given by a predicate `arc` can be searched for a node `Node` satisfying `isGoal (Node)` via the following generic search procedure `search (Frontier)` (in Prolog):

```

search([Node|FrontierRest]) :- isGoal(Node) .
search([Node|FrontierRest]) :-
    findall(X,arc(Node,X),Children) ,
    addToFrontier(Children,FrontierRest,FrontierNew) ,
    search(FrontierNew) .

```

- (a) How can we get breadth-first search from the procedure above?
 - (b) How can we get depth-first search?
 - (c) How can we get A*? And how can we go from A* back to breadth-first and depth-first?
4. (a) What is the point behind the Clark completion of a knowledge base?
- (b) Form the Clark completion of the following knowledge base:
- ```

nat(zero) .
nat(succ(X)) :- nat(X) .

add(zero,X,X) .
add(succ(X),Y,succ(Z)) :- add(X,Y,Z) .

```
- (c) True or false: the Clark completion of a knowledge base optimizes the search for queries against the knowledge base. Justify your answer.
- (d) True or false: the Clark completion of a knowledge base changes the semantics of queries against the knowledge base. Justify your answer.
5. The following four statements express rules that are often accepted even though there may (or may not) be exceptions to them.

Birds fly.  
 Seagulls are birds.  
 Penguins are birds.  
 Penguins don't fly.

- (a) Use the universal predicate `prop` to encode each of the rules above as a fact. That is, write four `prop`-facts that express the four statements above.
- (b) Draw a semantic network corresponding to the facts in part (a). What use (if any) is this representation over and above that in part (a)?
- (c) What is *property inheritance* and what does it allow us to conclude if we add to (a) above a fact expressing
 

Tweety is a bird.
- (d) Briefly outline how to revise property inheritance so as to allow exceptions. Discuss how to deal with an extension of the knowledge base in (c) by the fact

Tweety is a penguin.

6. (a) Explain using examples the difference between supervised and unsupervised machine learning.
- (b) In supervised learning explain the difference between lazy and eager learning.
- (c) Explain in terms of the operation of a neuron why a single layer neural network can only learn patterns that are linearly separable.

## Section B

7. Explain the difference between *stable* and *unstable* sorts. Write a program to read a sequence of decimal numbers from a text file and to sort them by frequency: more frequently occurring numbers should appear before less frequently occurring numbers in the output.
8. Imagine you were introducing Prolog for the first time to a group of computer science students. Give an account of the important features of the language, assuming your audience had some knowledge of elementary logic and of an imperative language like C or Java. What features would you highlight, and what faults would you draw attention to?

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