

OLLSCOIL NA hÉIREANN, GAILLIMH
THE NATIONAL UNIVERSITY OF IRELAND, GALWAY

SUMMER EXAMINATIONS 1999 - HONOURS

BSc (Part II) EXAMINATION

MA410 - ARTIFICIAL INTELLIGENCE

Professor James Wiegold,
Professor T. C. Hurley,
Dr. A. Christofides

Time allowed: *Two* hours.
Full marks for *three* questions.

1. (a) What is meant by two acceptable statements being logically equivalent.
Prove the following logical equivalences.

$$(i) p \rightarrow (q \rightarrow r) \iff q \rightarrow (p \rightarrow r) \quad (ii) (p \wedge q) \rightarrow r \iff \sim ((p \wedge q) \wedge \sim r).$$

Simplify the following acceptable statement.

$$(iii) (p \vee q) \wedge p \wedge (q \vee r) \wedge (p \vee \sim p \vee r) \wedge (\sim q \vee r)$$

and hence show that it is logically equivalent to $p \wedge r$.

- (b) Use resolution to prove that the following argument is valid

$$p \vee q, \quad \sim q \vee \sim r, \quad r, \quad \text{therefore } p.$$

2. Write the following well-formed formulae in clause form.

- (a) $\exists X (P(X) \wedge \forall Y ((E(Y) \rightarrow A(X, Y)))$,
(b) $\sim \exists X \exists Y (P(X) \wedge E(Y) \wedge O(Y) \wedge A(X, Y))$,
(c) $\exists Y (E(Y) \wedge O(Y))$.

Hence, or otherwise, show that the following argument is valid.

Some visitors attend all events,
No visitors attend outdoor events,
therefore
There are no outdoor events.

3. Give a brief description of the A-algorithm, i. e. the Best First Search algorithm with evaluation function $f(x) = g(x) + h(x)$, where $g(x)$ is the cost of a path from **Start** to x and $h(x)$ is the estimated cost from x to **Goal**. Illustrate this algorithm in the case of the 8-puzzle.

p.t.o.

4. (a) What are the following Prolog objects?

- (i) **Bob**
- (ii) **bob**
- (iii) **'Bob'**
- (iv) **'Bob is a student'**
- (v) **student(Bob)**

(b) Write the following argument in the form of a Prolog programme.

```
All children like chocolate.
Emma is a child.
Therefore
Emma likes chocolate.
```

How would you ask Prolog if this argument is valid? What is Prolog's answer?

(c) Consider the Prolog programme

```
parent(pam,bob).
parent(tom,bob).
parent(bob,pat).
parent(liz, pat).
parent(pat,jim).
```

Express the following questions in Prolog:

- (i) Who are Pat's parents?
- (ii) Who are Pat's grandparents?
- (iii) Does Liz have an aunt or uncle?

5. (a) Explain the Prolog answers to the following questions:

- (i) $?- [a|X] = [Y].$
- (ii) $?- [a|X] = [X].$
- (iii) $?- [a,b|c] = [X,Y].$
- (iv) $?- [a,b|c] = [X|Y].$

(b) Explain the function of the following predicate:

```
join([],L,L).
join([X|L1],L2,[X|L3]):-
join(L1,L2,L3).
```

Use the predicate **join**, (a) to obtain all the sublists of **[a,b,c]** and, (b) to check if a certain constant occurs in a given list.