

Gx2043

OLLSCOIL na hÉIREANN, GAILLIMH
NATIONAL UNIVERSITY of IRELAND, GALWAY

SUMMER EXAMINATIONS, 2004— HONOURS

B.Sc. (Part II) EXAMINATION
HIGHER DIPLOMA in MATHEMATICS

MA410 — Artificial Intelligence

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

1. (a) Construct the truth table for the compound proposition $p \rightarrow (\bar{q} \wedge r)$. Hence, or otherwise, find a *conjunctive* normal form for the proposition.
(b) A version of the game Nim starts with several piles of tokens, and the two players take turns to move. A move consists of dividing *one* of the piles into two *unequal* piles, and the player making the last move wins.
Draw the complete game tree (or graph) starting from (5,3) and use minimax to decide if the first player can force a win.
What can you say about the game starting from
(i) $3^n = (3, 3, \dots, 3)$ (ii) $43^n = (4, 3, 3, \dots, 3)$ or (iii) $53^n = (5, 3, 3, \dots, 3)$?
2. The predicates $On(x, y)$, and $B(z)$ represent ' x is on y ' and ' z is a brick' and the constant g represents 'the ground'. Write sentences H , K and C in the predicate calculus to say
 H : every brick is on the ground or on another brick
 K : no brick is on a brick which is also on a brick
 C : if one brick is on another, the second one is on the ground.
Convert H , K and $\sim C$ to clause form and use resolution to show that C is a logical consequence of H and K .

3. Consider a puzzle consisting of four tiles, two labelled by 'B' and two labelled by 'W' together with two empty spaces in the following configuration:

B	W		B	W	
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There are two kinds of allowable moves in the puzzle: a tile adjacent to an empty space may be slid into the empty space, and a tile may jump over one other tile into an empty space. The goal is to have all tiles labelled 'W' to the left of the tiles labelled by 'B'.

- Define a suitable heuristic $h(X)$ and use the Best First Search algorithm with the evaluation function $f(X) = g(X) + h(X)$ to solve this puzzle.
 - Define what is meant by 'Algorithm A^* '. With your definition of $h(X)$, is your algorithm A^* ?
 - What is the definition for a heuristic function to be *monotone*. Is your $h(X)$ monotone?
4. Consider the Prolog program:

```
permutation([], []).
```

```
permutation([X|L], P) :-  
    del(X, P, P1),  
    permutation(L, P1).
```

```
del(X, [X|Tail], Tail).
```

```
del(X, [Y|Tail], [Y|Tail1]) :- del(X, Tail, Tail1).
```

Trace the execution of the program in response to the query

```
|?- permutation([3,2,1], [1,2,3]).
```