

2003 Paper 12 Question 7

Artificial Intelligence I

The following Prolog relation appends a list A to a list B to give a list C .

```
append([],Y,Y).  
append([H|T],Y,[H|Z]) :- append(T,Y,Z).
```

- (a) Using the `append` relation, write a Prolog predicate `insert(X,Y,Z)` that is true if X can be inserted into a list Y to give a list Z . Your relation should be capable of using backtracking to generate all lists obtained from Y by inserting X at some point, using a query such as:

```
insert(c,[a,b],Z).
```

to obtain $Z=[c,a,b]$, $Z=[a,c,b]$, and $Z=[a,b,c]$ and it should generate each possibility exactly once. [5 marks]

- (b) Using the `insert` relation, write a Prolog predicate `perm(X,Y)` that is true if a list Y is a permutation of a list X . Your predicate should respond to a query such as

```
perm([a,b,c],Y)
```

by using backtracking to generate all permutations of the given list. [6 marks]

- (c) We have a list of events $[e_1, e_2, \dots, e_n]$. A partial order can be expressed in Prolog by stating

```
before(e3,e4).  
before(e1,e5).
```

and so on, where `before(a,b)` says that event a must happen before event b (although not necessarily immediately before). No ordering constraints are imposed other than those stated using `before`.

Given a list of events, a *linearisation* of the list is any ordering of its events for which none of the `before` constraints are broken. Given the example above and the list $[e_1, e_2, e_3, e_4, e_5]$, one valid linearisation would be $[e_3, e_1, e_2, e_5, e_4]$. However, $[e_4, e_2, e_1, e_5, e_3]$ is not a valid linearisation because the first `before` constraint does not hold.

Using the `perm` predicate or otherwise, and assuming that your Prolog program contains `before` constraints in the format suggested above, write a Prolog predicate `po(X,Y)` that is true if Y is a valid linearisation of the events in the list X . Your relation should be capable of using backtracking to generate all valid linearisations as a result of a query of the form

```
po([e1,e2,e3,e4,e5],Y). [9 marks]
```