# PRIFYSGOL CYMRU; UNIVERSITY OF WALES

# DEGREE EXAMINATIONS MAY/JUNE 2002

# SWANSEA

# Computer Science

## CS 125 Logic Programming

**Attempt 2 questions out of 3**

**Time allowed: 2 hours**

**Students are permitted to use the dictionaries provided by the University**

**Students are NOT permitted to use calculators**

**CS_125**
**LOGIC PROGRAMMING**
***(Attempt 2 questions out of 3)***

**Question 1.**

(a) Say for the following queries whether they will fail or succeed or cause an error. If the query fails or causes an error, explain why this is the case. If the query succeeds, give the answers that Prolog will return.

(i) `?- X = 1+1.`

(ii) `?- X == 1+1.`

(iii) `?- X is 1+1.`

(iv) `?- Y is X+X.`

(v) `?- [H|T] = [2,3].`

**[6 marks]**

(b) Define a predicate `product/2` computing the product of a list of numbers.

For example, the query `?- product([3,2,2],P)` should return the answer `P = 12`. By convention, the product of the empty list is 1.

**[7 marks]**

(c) Consider the following Prolog program:

```
even(0).
even(s(s(X))) :- even(X).
```

(i) What is the least Herbrand model of this program?

(ii) Consider the following queries:

```
?- even(Y).

?- even(s(Y)).

?- even(Y), even(s(Y)).

?- even(Y), !, even(s(Y)).
```

For each of these queries draw a part of the SLD-tree and find out what Prolog's response will be. If there is more than one answer give the first two answers.

**[12 marks]**

**Question 2.**

(a) Assume that a Prolog program contains definitions of the predicates `mother(Mother,Child)` and `father(Father,Child)`.

(i) Formulate queries that correspond to the following questions:

- Is Anne Peter's mother?
- Who is Peter's mother?

(ii) Define a predicate `grandmother/2`.

(iii) Suppose the program also contains facts of the form

```
mother(maria,susan).
mother(maria,peter).
   .
   .
   .
```

and the clauses

```
sibling(X,Y) :- not(X = Y), mother(M,X), mother(M,Y).
sibling(X,Y) :- not(X = Y), father(M,X), father(M,Y).
```

What would be Prolog's answers be to the query

```
?- sibling(X,susan).
```

Explain what is wrong with the definition of the predicate `sibling`. Modify the definition such that the query above is answered correctly.

[**10 marks**]

(b) Use the Martelli-Montanari Algorithm to decide which of the following pairs of terms are unifiable; if they are, compute a most general unifier:

(i) `f(g(X),X,X)` `f(g(Y),a,h(a,Z))`

(ii) `f(X,g(X),X)` `f(h(Y,Y),Z,h(a,Y))`

[**6 marks**]

(c) Write a Prolog program defining a predicate `write_pairs/2` writing for given lists $L_1, L_2$ all pairs $(a, b)$, where $a$ is a member of $L_1$ and $b$ is a member of $L_2$, to the standard output. Each pair should be written in a new line and be displayed as shown above, that is, within round brackets and left and right component separated by a comma.

Hint: Use a failure driven loop. You may use the predicate `member/2`.

[**9 marks**]

**Question 3.**

(a) (i) Explain the effect of the cut predicate on Prolog's search tree.

(ii) How is the meta-predicate `not` defined?

[**7 marks**]

(b) Consider the following program:

```
max(X,Y,Y) :- X =< Y, !.
max(X,Y,X) :- X > Y.
```

(i) What is the effect of the cut in the program above? Is this cut a 'green cut' or a 'red cut'? Explain the difference between a green cut and a red cut in general.

(ii) How would the behavior of the program change if in the second clause the test `X > Y` were removed? Show the difference by a suitable query and explain it.

(iii) Define a predicate `max_list/2` computing the maximum of a nonempty list of numbers. You may use the predicate `max`.

[**11 marks**]

(c) Consider the following program:

```
in(anne).
out(X) :- not(in(X)).
```

What will be Prolog's response to the following queries:

```
?- out(john).
```

```
?- out(X).
```

Justify your answers by drawing the corresponding SLD-trees. [**7 marks**]