COS4851 Assignment 2 (2016)

Important: The main purpose of this assignment is to develop your skills regarding the use of built-in predicates in Prolog, the control of backtracking and the way in which Prolog can be used for simple arithmetic procedures.

Please note that you need to submit screen shots (using *fn+prt sc* for Windows in most instances) of results for questions where a program/procedure or query is required. This will assist us to see whether you obtained the correct results and if not, try to point out where you went wrong.

Your programs should also be *robust*. This means that it should check whether all the input arguments for a specific procedure are legal. For example, if you know you are working with integers, an input of the constant that is not an integer is not acceptable.

Important note: It is not advisable that you search for Prolog solutions to the questions in this assignment on the internet. You may find a solution to a specific problem but that will not assist you in acquiring the necessary skills for mastering this programming paradigm.

Question 1   [10]

(a)   Write a Prolog procedure to split a given list into two separate lists, one containing integers and the other one real numbers. All other items in the given list should be ignored.   (6)

(b)   Briefly discuss the difference between green cuts and red cuts.   (4)

Question 2   [12]

(a)   Write a procedure `filter(List,PredName,Result)` that removes all the elements `X` in `List` for which `PredName(X)` *fails*, and returns the resulting list in `Result`. The predicate `PredName/1` should be defined when calling the procedure `filter`.

Let `test` be defined as `test(N):- atomic(N).`

`?- filter([a,b,-6,7,A,-1,0,B],test,L).`

`L = [a,b,-6,7,-1,0],`

Hint: Use the Prolog built-in predicate `=..`   (6)

(b)   Write a procedure `map(List,PredName,Result)` that applies the predicate `PredName(Arg,Res)` to all the elements in `List,` and returns the result in the list `Result.`

Let `test` be defined as `test(N,R):- R is N^3.`

```
?- map([3,5,-2],test,L).

L = [27,125,-8]                                                    (6)
```

Question 3   [24]

3.1   Use the database you defined for question 1 of assignment 1 to determine the
       following using `setof, bagof` or `findall`:

(a)   How many different kinds of birds are listed in the database?   (4)
(b)   How many birds defined in the database include insects in their diet? (5)
(c)   How many different sizes of bird are defined in the database?   (4)

3.2   Lists can be used to represent sets in Prolog. Write the following Prolog procedures
       using the Prolog built-in predicates `setof`, `bagof` or `findall`.

(a)   The procedure `intersection(A,B,L)` returns the intersection `L` of sets `A` and `B`, i.e.
       the set `L` contains all elements that belong to `A` and to `B`.   (5)

(b)   The procedure `complement(A,U,C)` returns the complement `L` of set `A` given the
       universal set `U` (`A` is a subset of `U`). The complement of set `A` consists of all those
       elements that belong to `U` but not to `A`.   (6)

Question 4   [5]

Consider the following set of Prolog clauses concerning big cats in the National Parks in
South Africa.

```
leopard(X):-
     not lion(X),
     not cheetah(X).
lion(simba).
lion(mufasa).
lion(scar).
```

Sometimes Prolog returns unexpected results, e.g. if the query `leopard(sylvester)` is
entered using the information given above, Prolog retuns `yes`. (For those of you not familiar
with Sylvester the lion: he was declared a habitual criminal after escaping twice from one of
our national parks. His new home is the Addo Elephant Park in the Eastern Cape.)

(a)   Explain why this happens.   (4)
(b)   What assumption causes the phenomenon mentioned above?   (1)

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Question 5 [4]

Construct a table listing the symbols that can be used to compare two terms X and Y and state the meaning of each. (For your own benefit, make sure you understand the meaning of each.)

Question 6 [11]

The way in which cryptarithmetic puzzles can be solved in Prolog is discussed in section 4.4 of Bratko. Use the guidelines given by Bratko to solve the following puzzle:

CROSS + ROADS = DANGER.

Question 7 [10]

The Russian Multiplication problem can be defined as follows: Say you want to multiply x with y giving z. The problem is solved using the following iterative loop:

With each iteration, x gets the value $x/2$ and y gets the value $y*2$. If x is even, the y-entry is ignored. If x is odd, y is added to a running total. The loop terminates when $x = 0$.

For example:

Calculate $z = 24 * 52$.

x	y	Calculation of total (T)	Total
24	52		0
12	104		0
6	208		0
3	416	T = T + 416	416
1	832	T = T + 832	1248
0			**1248**

Write a Prolog program to implement the Russian Multiplication Problem.

Question 8 [10]

Assume that your database currently contains the following facts:

```
p(a).        q(a,1).       r(1,1).  r(3,5).
p(b).        q(a,2).       r(1,2).  r(3,6).
             q(b,3).       r(2,3).  r(4,7).
             q(b,4).       r(2,4).  r(4,8).
```

What are the effects of the following queries?

(a)   ?- p(X),q(X,Y),r(Y,Z).

(b)   ?- p(X),!,q(X,Y),r(Y,Z).

(c)   ?- p(X),q(X,Y),!,r(Y,Z).

(d)   ?- p(X),once(q(X,Y)),r(Y,Z).

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