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THE OPEN UNIVERSITY OF SRI LANKA
B.Sc DEGREE PROGRAMME: LEVEL 04
FINAL EXAMINATION: 2009/2010
CSU 2280: DEDUCTIVE REASONING AND PROLOG FOR ARTIFICIAL INTELLIGENCE – PAPER II

DURATION: **TWO AND HALF HOURS** (2 ½ HOURS)

Date: 10th January, 2010	Time: 9.30 am – 12.00 noon

Answer FOUR Questions ONLY

*(**Note:** All input values are represented with the (+) sign while the output values are represented with the (-) sign.)*

Q1.

a. What are the advantages of **Prolog** over the other programming languages?

b. Briefly describe the following terms in the context of Prolog.

   i. Facts
   ii. Rules
   iii. Variables

c. Consider the following Prolog program to answer the questions c(i) and c(ii).

```
male(Saman).
male(Nimal).
male(Somapala)

female(Sunila).
female(Kamala).
female(Seelawathi).

child(Nimal, Saman),
child(Nimal, Kamala).
child(Sunila, Saman).
child(Sunila, Kamala).
child(Saman, Somapala),
child(Kamala, Seelawathi).

mother(X,Y) :- child(Y,X), female(X).
telrelation(X,Y) -: child(X,Y), write(X),write(' is child of '),
                    write(Y).
telrelation(X,Y) :- mother(X,Y), write(X), write(' is mother of
                   '), write(Y).
```

After consulting the above program some errors and warnings are reported as follows.

Warning: (q1.pl:xx): Singleton variables: [Saman]

ERROR: q1.pl:xx:0: Syntax error: Operator expected
ERROR: (q1.pl:xx): Full stop in clause-body? Cannot redefine ,/2

i. Describe the above errors and the warning *(i.e. Singleton variables, Operator expected and Cannot redefine).*

ii. Rewrite the program by eliminating errors and the warning.

d. Write the following Prolog rules;

i. `father/2`
ii. `grandmother/2`
iii. `grandfather/2`

Q2.

a. What are the differences between `consult/1` and the `ensure_loaded/1` in Prolog predicates?

b. Briefly describe the following built-in predicates in the context of Prolog.

i. `assert/1`
ii. `dynamic/1`

c. Implement the following tables using Prolog.

Name	Age	Employee No.
S. R. Fernando	27	EP001
S. I. Hettige	32	EP002
K. R. Silva	45	EP003
T. K. Samarasinghe	19	EP004

Table 1: Employee

Area	Salary per hour
Colombo	1500.00
Kandy	1250.00
Matara	1125.00

Table 2: Salary

Employee No.	Area	No. of. Hours
EP001	Colombo	6
EP001	Kandy	13
EP002	Matara	16
EP003	Kandy	5

Table 3: Work

d. Write Prolog rules called `addemp/0`, `addsalary/0` and `addwork/0` in order to add a new employee, new salary and new work respectively by using the keyboard.

e. Write a Prolog rule called `edit_emp/1` to change the details of an employee for a given employee number.

f. Write a Prolog rule to display details of all employees in the format given below.

```
---------------------------------------------------
                Employee List
---------------------------------------------------
No      Name                   Employee No
---------------------------------------------------
1       S. R. Fernando         EP001
2       ..................     .........
3       ..................     .........
---------------------------------------------------
```

Q3.

Use the three tables in **question 02 (Q2.)** to answer the questions given below. (Assume that you have created Prolog predicates `employee/3`, `salary/2` and `work/3` for those three tables respectively.)

a. What are the differences between `setof/3` and `bagof/3` predicates in Prolog?

b. Write a Prolog rule called `'emp_area_list/2'` to generate a list of employee numbers who work in a given area.

```
emp_area_list(+Area, -List)
```

c. Write a Prolog rule to display a list of employees who work in a given area. Your output should be as follows;

```
---------------------------------------------------
                Employee List: Kandy
---------------------------------------------------
Name                           No. of. Hours
---------------------------------------------------
S. R. Frenando                 13
K. R. Silva                    5
---------------------------------------------------
```

d. Write a Prolog rule to display salary of a given employee number.

```
emp_salary(+EmployeeNo, -Salary)
```

e. Write a Prolog rule called `'emp_area_salary/3'` to get the salary for a given employee number and a given area.

```
emp_area_salary(+EmployeeNo, +Area, -Salary)
```

Q4.

a. Give a brief description on each of the following.

i. Backtracking
ii. If statement
iii. ! operator

b. Implement the following information in Prolog.

Marks < 20	Grade F
Marks >= 20 and Marks < 40	Grade E
Marks >= 40 and Marks < 60	Grade C
Marks >= 60 and Marks < 75	Grade B
Marks >= 75	Grade A

i. By using only the if statement, write a Prolog rule called `print_grade_if(+Marks, -Grade)` to print the grade of a given mark.

ii. Use set of rules (without using the if statement) to write a Prolog rule called `print_grade(+Marks, -Grade)` to print the grade of a given mark.

iii. How does Prolog answer the two rules stated above (`print_grade_if/2 and print_grade/2`)?

c. *"From an AI view point most real world problems can be interpreted as the changing the due to an action."* Do you agree with this statement? Justify your answer.

Q5.

a. What are the tasks of the following Built-in list operations in SWI Prolog?

   i. `memberchk/2`
   ii. `sort/2`
   iii. `length/2`

b. Write Prolog rules to perform the following list operations.

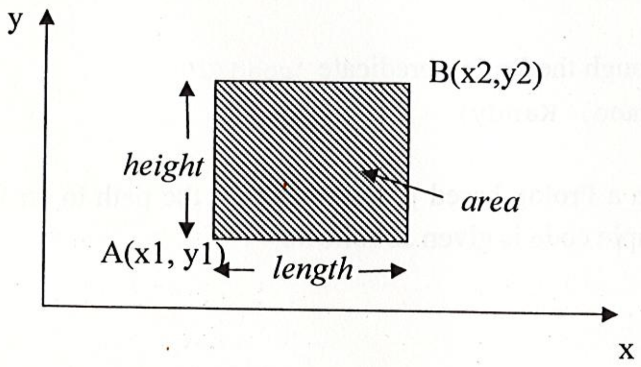
   i. Write a Prolog rule called `rev_list(+List)` to print the reverse order of a given list of numbers.

      Example:
```
?- rev_list([a,b,c]).
Output:
        c
        b
        a
```

   ii. Write a Prolog rule called `del_val(+List, +Val, -NewList)` to delete a given value in a given list.

   iii. Write a Prolog rule called `avg_list(+List, -NewList)` to get the average of a given list of numbers.

c. Consider the following graph to answer the questions given below.



   i. Write a Prolog rule called `shp_area(+X1,+Y1,+X2,+Y2,-Area)` to calculate the area of the shape.

   ii. Write a Prolog rule called `shp_length(+X1,+Y1,+X2,+Y2,-Length)` to calculate the length of the shape.

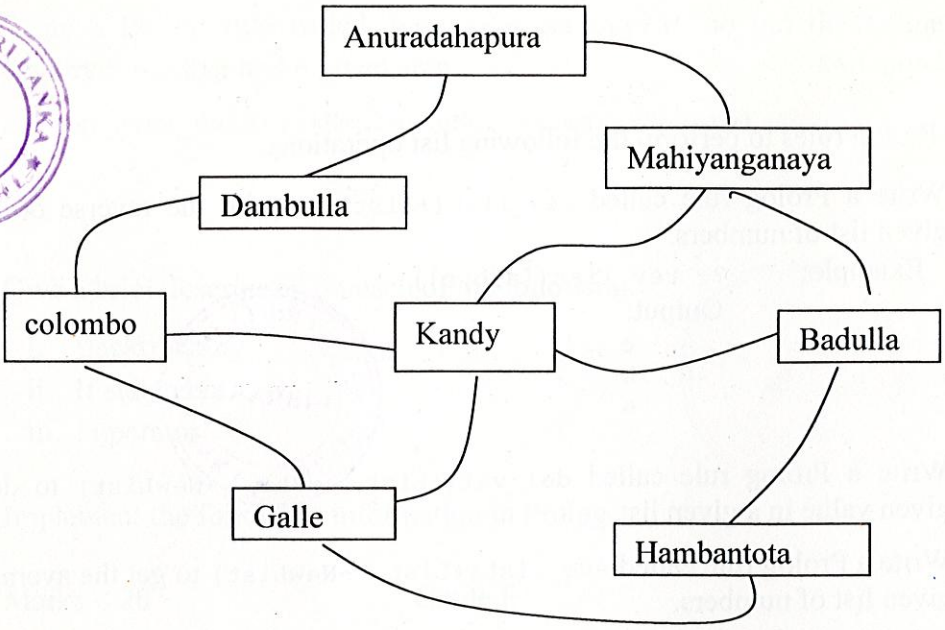
   iii. Write a Prolog rule called `shp_height(+X1,+Y1,+X2,+Y2,-Height)` to calculate the height of the shape.

   iv. Write a Prolog rule called `shape_type(+X1,+Y1,+X2,+Y2)` to print the type of a shape .

   ***(Hint:** if the length equals to height, type = Square,*
   If the length does not equal to height, type = Rectangle)

Q6.

Study the following road map and answer the questions from 06(a) to 06(f).



***(Hint:** The diagram shows the roads available in selected cities. (Colombo to Kandy, etc.))*

a. Implement the above facts through the Prolog predicate `'road/2'`
   Example: `road(Colombo, Kandy)`

Now you are ready to develop a Prolog based program to find the path to go from a given city to another city. Sample code is given as follows;

```
road(colombo, kandy).

member(X,[X|_]).
member(X,[_|T]):-member(X,T).
printLst([]).
printLst([H|T]) :- printLst(T),write(H),nl.
path(Goal,Goal,L) :-        write('Solution Path is: ' ), nl,
                      flatten(L,X),printLst(X).

path(State,Goal,L):-        travel(State,Next),not(member(Next,L)),
                      path(Next,Goal,[Next|L]),nl,!.

go(Start,Goal) :-     path(Start,Goal,Start).

travel(X,Y) :-  road(X,Y),
         write('go '),write(X),write(' to '),write(Y),nl.

gotocity(X,Y)  :- road(X,Y).
gotocity(X,Z)  :- road(X,Y), road(Y,Z).
gotocity(X,Z)  :- road(X,Y), gotocity(Y,Z).
```

b. What are the tasks of the following Prolog predicates?

i. Member/2
ii. Printlist/1
iii. Path/3

c. What is the output of the predicate go(Colombo, Hambantota)?

d. Why there is no output for the path go(Mahiyanganaya, Colombo)?

e. Add a new travel/2 predicate to solve the above issue in part (d).

f. Now, you need to block some road(s) (without removing the road/2 predicate). How do you improve your program by using not/1 predicate?

***(Hint:** You may update the predicate* travel/2*)*

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