INF2217 – Exercícios 8

References

[Ko] Kowalski, R; *Logic for Problem Solving*. North Holland, 1979.

[CCP] Coelho, H.; Cotta, J.C.; Pereira, L.M. *How to Solve It with Prolog*. Laboratório Nacional de Engenharia Civil. Min. Equipamento Social. Lisboa, 1985.

[Ko, page 18] Exercise 5

1) Express the following sentences in Prolog:

x is a mother of y if
  x is a female and x is a parent of y.
x is a father of y if
  x is a male parent of y
x is human if
  y is a parent of x and y is human
An individual is human if
  his (or her) mother is human and
  his (or her) father is human.
If a person is human
  then his (or her) mother is human or
  his (or her) father is human.
No one is his (or her) own parent.

2) Write a Prolog program that defines the relationships

Father(x,y)	(x is father of y)
Mother(x,y)	(x is mother of y)
Male(x)	(x is male)
Female(X)	(x is female)
Parent(x,y)	(x is parent of y)
Diff(x,y)	(x is different from y)

and the following additional relationships

M(x)	(x is a mother)
F(x)	(x is a father)
S(x,y)	(x is a son of y)
D(x,y)	(x is a daughter of y)
Gf(x,y)	(x is a grandfather of y)
Sib(x,y)	(x is a sibling of y)

For example, the clause below

Aunt(x,y) :- Female(x), Sib(x,z), Parent(z,y)

defines the relationship Aunt(x,y) (c is an aunt of y) in terms of the Female, Sib and Parent relations.

[CCP, page 47] Problem 50

Consider a fact deduction machine which takes a collection of known facts and makes new conclusions, over a domain, of animals in a zoo.

Suppose the machine knowledge is composed of 15 recognition productions:

P1 If the animal has hair, then it is a mammal.

P2 If the animal gives milk, then it is a mammal.

P3 If the animal has feathers, then it is a bird.

P4 If the animal flies, and it lays eggs, then it is a bird.

P5 If the animal is a mammal and it eats meat, there it is a carnivore.

P6 If the animal is a mammal, it has pointed teeth, it has claws,
and its eyes point forward,
then it is a carnivore.

P7 If the animal is a mammal, and it has hoofs, then it is an ungulate.

P8 If the animal is a mammal, and it chews curd,
then it is an ungulate and it is even toed.

P9 If the animal is a carnivore, it has a tawny color, and it has dark spots,
then it is a cheetah.

P10 If the animal a carnivore, it has a tawny color, and it has black stripes
then it is a tiger.

P11 If the animal is an ungulate, it has long legs and a long neck,
it has a tawny color, and it has dark spots,
then it is a giraffe.

P12 If the animal is an ungulate, it has a white color, and it has black stripes,
then it j a zebra.

P13 If the animal is a bird, it does not fly, it has long legs and a long neck,

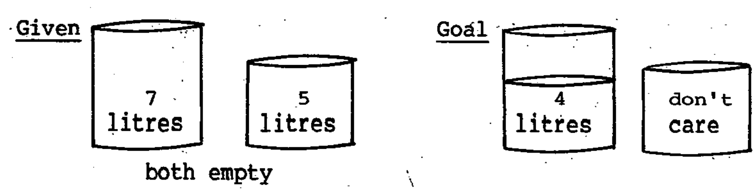
and it is black and white,
then it is an ostrich.

P14 If then animal is a bird, it does not fly, it swims,
and it is black arid white,
then it is a penguin.

P15 If the animal is a bird and it is a good flyer
then it is an albatross.

Write a Prolog program (simulating that machine) able to discover a certain animal by means of asking its characteristics using the recognition productions, and to describe the properties of any animal in its knowledge base.

[Ko, page 75] The water containers problem



Given both a seven and a five litre container, initially empty, the goal is to find a sequence of actions which leaves four litres of liquid in the seven litre container. There are three kinds of actions which can alter the state of the containers:

(1) A container can be filled.
(2) A container can be emptied.
(3) Liquid can be poured from one container into the other, until the first is empty or the second is full.

Interpret:

State(u,v) as expressing that there is a state in which the 7 litre container contains u litres of liquid and the 5 litre container contains v litres.

Assume that the relations

$x+y=z$ and $x<y$

are already defined (by infinitely many variable-free assertions, for example).

Formulate (and run) the water containers problem as a Prolog program.

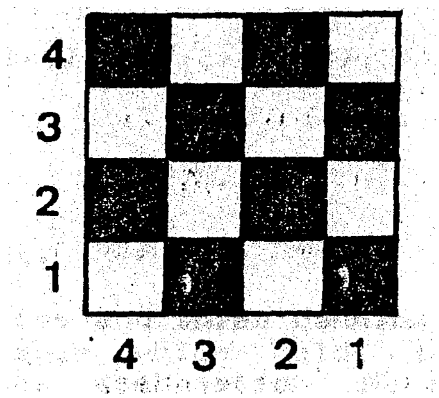
[Ko, page 131] [CCP, page 74] Problem 63

Write a Prolog program to solve the 4-queen problem, described as follows.

Consider a chess table 4x4 and put four queens on it, obeying the condition that each queen cannot attack any of the others.

Suggestion: Consider the following representation of the chess table where each square is

p(number of line, number of column)



[CCP, page 75] Problem 64

Three missionaries and three cannibals seek to cross a river. A boat is available which holds two people, and which can be navigated by any combination of missionaries and cannibals involving one or two people. If the missionaries on either bank of the river or 'en route' in the river are outnumbered at any time by the cannibals, the cannibals will indulge their anthropophagic tendencies and do away with the missionaries.

Find the simplest schedule of crossing that will permit all the missionaries and cannibals to cross the river safely.

Suggestion: Consider the representation of the left side of the river (for example) as s(M,C,B), where M is the number of missionaries, C is the number of cannibals, and B takes the value 0 or 1 according with the position of the boat (left side or right side respectively).

[CCP, page 125] Problem 87 (Solved as an example)

Write a simple program grammar G1 to analyse the sentences:

‘the giraffe dreams’
‘the giraffe eats apples’

Logic Program

```
sent(X,Y) <- np(X,U) ,vp(U,Y) .
np(X,Y) <- det(X,U), noun(U, Y) .

vp(X,Y) <- iverb(X,Y) .
vp(X,Y) <- iverb(X,U), np(U,Y) .

det([the :Y],Y) .

noun([giraffe :Y] ,Y).
noun([apples :Y],Y) .

iverb([dreams:Y],Y) .

tverb([dreams:Y],Y) .
tverb([eats:Y] ,Y) .
```

[CCP, page 125] Problem 88

Reconsider the previous grammar G1 in order to deal with the following context-sensitive aspects:

1) the number of a noun phrase agrees with that of the corresponding verb phrase;
2) the number of a noun phrase need not he determined by the noun only (this fish – these fish) and not by the ‘th-word’ only (the giraffe - the giraffes), but number is a feature of the entire noun phrase;
3) a noun phrase need not have a determiner (giraffes dream) presumably provided that the noun phrase is plural.

SOLUTIONS

[Ko, page 75] The water containers problem

WC1	State (0, 0) .
WC2	<- State(4,y)
WC3	State (7 ,y) <- State(x,y)
WC4	State (x, 5) <- State(x,y)
WC5	State (0 ,y) <- State(x,y)
WC6	State (x, 0) <- State(x,y)
WC7	State (0 ,y) <- State(u,v), u+v = y, y ≤ 5
WC8	State (x, 0) <- State(u,v), u+v = x, x ≤ 7
WC9	State (7 ,y) <- State(u,v), u+v = w, 7+y = w
WC10	State (x, 5) <- State(u,v), u+v = w, 5+x = w

Clauses WC1 and WC2 express the given and the goal states respectively. WC3 and WC4 define the action of filling a container. WC5 and WC6 define emptying a container. WC7 and WC8 define pouring from one container into another until the first is empty. WC9 and WC10 define pouring from one into another until the second is full.