Master in Computational Logics & Mestrado em Engenharia Informática
Universidade Nova de Lisboa

Knowledge Representation and Reasoning

First Test – Closed book – 1h30m

10th November 2012

Group 1

1) Reduce the following sentences to clausal form:

   S1 $\forall x \forall y \left(R\left(x,y\right) \supset \left(R\left(y,x\right) \wedge Q\left(y\right)\right)\right)$
   S2 $\forall x \exists y \forall z \left(P\left(x,y,z\right) \supset \exists u R\left(x,u,z\right)\right)$
   S3 $\forall x \left(\neg \exists y P\left(x,y\right) \wedge \neg \left(Q\left(x\right) \wedge \neg R\left(x\right)\right)\right)$

2) Derive, by resolution, an empty clause from the following clauses.

   C1 $\left[\neg P\left(x_1\right), Q\left(x_1\right)\right]$
   C2 $\left[P\left(x_2\right), \neg Q\left(x_2\right)\right]$
   C3 $\left[\neg Q\left(x_3\right), Q\left(f\left(x_3\right)\right)\right]$
   C4 $\left[\neg P\left(x_4\right), \neg P\left(f\left(x_4\right)\right)\right]$
   C5 $\left[P\left(a\right)\right]$ *where a is a constant.*

3) Use resolution with answer extraction to prove that **S4** below follows from **S1** – **S3** and to extract the answer (a substitution for x which makes $Like\left(anne,x\right) \wedge Student\left(x\right)$ true).:

   S1 $\forall x \forall y \left(Friend\left(x,y\right) \supset Like\left(x,y\right)\right)$
   S2 $Friend\left(anne,ben\right)$
   S3 $Student\left(ben\right)$
   S4 $\exists x \left(Like\left(anne,x\right) \wedge Student\left(x\right)\right)$

Group 2

Contrast, in a clear and concise manner, *First Order Entailment*, *Entailment with the Closed World Assumption*, and *Minimal Entailment* (aka. *Circunscription*), illustrating with concrete examples.

Group 3

Hitori is played with a grid of squares or cells, and each cell contains a number. The objective is to eliminate numbers by filling in the cells such that the remaining unfilled cells do not contain numbers that appear more than once in either a given row or column. Filled-in cells cannot be horizontally or vertically adjacent, although they can be diagonally adjacent. The remaining unfilled cells must form a single component connected horizontally and vertically i.e. every unfilled cell must be *reachable* from every other unfilled cell (considering horizontal and vertical adjacency only).

4	8	1	6	3	2	5	7
3	6	7	2	1	6	5	4
2	3	4	8	2	8	6	1
4	1	6	5	7	7	3	5
7	2	3	1	8	5	1	2
3	5	6	7	3	1	8	4
6	4	2	3	5	4	7	8
8	7	1	4	2	3	5	6

Figure 1: Problem

	8		6	3	2		7
3	6	7	2	1		5	4
	3	4		2	8	6	1
4	1		5	7		3	
7		3		8	5	1	2
	5	6	7		1	8	
6		2	3	5	4	7	8
8	7	1	4		3		6

Figure 2: One solution

Input Format: A particular instance of this problem is described by facts of the form `state(X,Y,N)` to express that the cell in column X and row Y contains number N.

Output Format: The output is a filling of cells encoded through the predicate `fill(X,Y)` indicating that the cell in column X and row Y is filled.

Write an Answer Set Program whose answer-sets correspond to the solutions of the problem.