T-79.5102 **Autumn 2007**
Special Course in Computational Logic
Tutorial 5

1. Determine the valid configurations for the following sets of rules:

(a) R_1: $a \,|\, b \leftarrow c.\;\; c.$

(b) R_2: $a \,|\, b \leftarrow c.\;\; c \oplus e \leftarrow d.\;\; d.$

(c) R_3: $a \,|\, b \leftarrow c.\;\; c \oplus e \leftarrow d.\;\; a \leftarrow d, \sim b.\;\; d.$

2. Consider the car configuration model given in Figure 1 which is adopted/abridged from (Soininen and Niemelä, 1999).

(a) Find out the intuitive interpretation of each rule.

(b) Formalize the following refinements to the model:
(i) An automatic opener and air-conditioning of type 2 require a large battery. (ii) Convertibles are not manufactured with a standard set of features/tweaks. (iii) A car with a small engine and a small battery does not tolerate air-conditioning.

(c) Find a valid configuration for the resulting model.

3. Reconsider the 8-queens problem and the rule

$$\begin{aligned}\leftarrow\; & \mathsf{Queen}(x1, y1; x2, y2),\ |x1 - x2| = |y1 - y2|,\\ & x1 \neq x2,\ y1 \neq y2,\ \mathsf{Number}(x1; y1; x2; y2).\end{aligned}$$

that forbids queens that threaten each other on some diagonal of the chess board. Analyze the complexity of the rule in terms of ground instances of rules created by it. Do you see any room for optimization?

4. Formalize the famous *knapsack* problem in the case of n items.

- Each item i has a specific cost $c(i)$ and value $v(i)$ associated with it.
- The goal is to select a subset I of the items so that the sum of costs $\sum_{i \in I} c(i)$ is less than a fixed limit c while maximizing the total value $\sum_{i \in I} v(i)$ of the items selected.

Pack(l) $\oplus$ Pack(dl) $\oplus$ Pack(std) $\leftarrow$ Pack.
Frame(conv) $\oplus$ Frame(sedan) $\oplus$ Frame(hb)
$\leftarrow$ Frame.
Engine(s) $\oplus$ Engine(m) $\oplus$ Engine(l) $\leftarrow$ Engine.
Battery(s) $\oplus$ Battery(m) $\oplus$ Battery(l) $\leftarrow$ Battery.
Sunroof(sr1) $\oplus$ Sunroof(sr2) $\leftarrow$ Sunroof.
Aircond(ac1) $\oplus$ Aircond(ac2) $\leftarrow$ Aircond.
Opener(auto) $\oplus$ Opener(manual) $\leftarrow$ Opener.
Battery(m) $\leftarrow$ Opener(auto), Aircond(ac1).
$\leftarrow$ Pack(std), Aircond(ac2).
$\leftarrow$ Pack(l), Aircond(ac1).

Pack.
Frame.
Engine.
Sunroof $\leftarrow$ Pack(l).
Aircond $\leftarrow$ Pack(l).
Sunroof $\leftarrow$ Pack(dl).
Opener $\leftarrow$ Sunroof(sr2).
Aircond $\leftarrow$ Sunroof(sr1).
Battery $\leftarrow$ Engine.
Sunroof $\leftarrow$ Opener.
$\leftarrow$ Sunroof(sr1), Opener.
$\leftarrow$ Frame(conv), Sunroof.

Figure 1: Car configuration model