Semantic and Declarative Technologies

Final exam sample, 2013

Time: 80 minutes.

Part I – 50 minutes

1. Build a $\mathcal{SHIQ}$ TBox, representing the statements below. You can only use the concept names shown in $\mathsf{grotesque}$ font, and the role names $\mathsf{hasChild}$ and $\mathsf{hasFriend}$.

   A Person is Lucky if she or he has a Happy grandparent and has at least two Clever children. We know that a Lucky Person either has no friends or all her/his parents are not Happy. We also know that no one can be both Clever and Lucky.

2. Consider the $\mathcal{SH}$ TBox $\mathcal{T} = \{\mathsf{O} \sqsubseteq \exists\mathsf{hC}^-.\mathsf{O}, \exists\mathsf{hF}.\mathsf{O} \sqsubseteq \mathsf{B}, \mathsf{hC}^- \sqsubseteq \mathsf{hF}\}$ and the reasoning task of deciding the satisfiability of concept B wrt. $\mathcal{T}$.

   Write down the concept C' and the TBox $\mathcal{T}'$ obtained by the internalisation of this reasoning task, i.e. reduce this task to deciding the satisfiability of concept C' wrt. TBox $\mathcal{T}'$, where $\mathcal{T}'$ contains role axioms only.

3. Transform the following concept C_0 into an equivalent concept C_1 in NNF:

$$C_0 \quad = \quad \neg((\geqslant 1R) \sqcap \forall R.(\neg B \sqcup \exists R.\neg B) \sqcap \exists R.(\leqslant 5R) \sqcap (\geqslant 2\, R.B)).$$

Part II – 30 minutes

5. Consider the following tableau state $\mathbf{T}$, which was obtained in the process of deciding the satisfiability of the concept $C_0 = \exists\mathsf{hC}.\exists\mathsf{hC}.\mathsf{O} \sqcap \exists\mathsf{hC}.\exists\mathsf{hC}.\mathsf{B} \sqcap (\geqslant 2\,\mathsf{hC}) \sqcap \forall\mathsf{hC}.(\leqslant 1\mathsf{hC}) \sqcap ((\exists\mathsf{hC}.(\geqslant 2\mathsf{hC})) \sqcup (\leqslant 1\,\mathsf{hC}))$:

   $\mathsf{b}\bullet \{C_0, \exists\mathsf{hC}.\exists\mathsf{hC}.\mathsf{O}, \exists\mathsf{hC}.\exists\mathsf{hC}.\mathsf{B}, (\geqslant 2\,\mathsf{hC}), \forall\mathsf{hC}.(\leqslant 1\,\mathsf{hC}), (\exists\mathsf{hC}.(\geqslant 2\mathsf{hC})) \sqcup (\leqslant 1\,\mathsf{hC})\}$

   hC   hC

   $\mathsf{c}\bullet \{\exists\mathsf{hC}.\mathsf{O}\}$ $\mathsf{d}\bullet \{\exists\mathsf{hC}.\mathsf{B}\}$

   Which transformation rules of the $\mathcal{ALCN}$ tableau algorithm for empty TBoxes are applicable in tableau $\mathbf{T}$? For each applicable rule

   - give the node(s) and the concept it applies to;
   - construct its output, the set of tableau states $S_{\mathbf{T}}$;
   - check if any of the new states contains a clash.

   (Note that you only have to deal with tableau states reachable from $\mathbf{T}$ by a **single** rule application.)

   When drawing tableau states, you don't have to copy the unchanged node and edge labels. You can refer to a list of concepts in a node label of $\mathbf{T}$ by $\ldots$, i.e. when a rule extends a node label by a concept D you can use the node label $\{\ldots, D\}$.