Tutorial 3: Reasoning with Description Logics

Week 8

1. Check the consistency of the following knowledge graph: K=(T, A) where:

- $T = \{Cat \sqsubseteq \neg Person, Father \sqsubseteq Person\}$
- $A = \{Tom : Cat \sqcap Happy \sqcap Father\}$

2. Given the following schema T of a knowledge graph K:

- $T = \{ Father \sqsubseteq Person, Happy \sqcap Person \sqsubseteq HappyPerson\}$

Check if the following subsumption holds: $Happy \sqcap Father \sqsubseteq HappyPerson$

3. Given the following schema T of a knowledge graph K:

- $T = \{ Father \sqsubseteq Person, HappyPerson \sqsubseteq Happy \sqcap \exists hasFather.HappyPerson\}$

Check the satisfiability of the following concept description: *HappyPerson*

4. Consider the following TBox and ABox:

$$\mathcal{T} := \{\neg(A \sqcup B) \sqsubseteq \bot, \quad A \sqsubseteq \neg B \sqcap \exists r.B, \quad D \sqsubseteq \forall r.A, \quad B \sqsubseteq \neg A \sqcap \exists r.A\},$$

$$\mathcal{A} := \{r(a,b),\ r(a,c),\ r(a,d),\ r(d,c),\ (B \sqcap \forall r.D)(a),\ E(b),\ (\neg A)(c),\ (\exists s.\neg D)(d)\},$$

Check (1) the consistency of the TBox, (2) the consistency of the ABox, (3) the consistency of the TBox and the ABox.

5. Given the following knowledge graph: K=(T, A) where:

- T = {(1) AlpineClubM $\sqcap$ ¬Skier $\sqsubseteq$ Mountainclimber, (2) MountainClimber $\sqsubseteq$ ¬∃like.Rain, (3) ¬∃like.Snow $\sqsubseteq$¬Skier, (4) ∃like$^-$.{Mike} ≡ ¬∃like$^-$.{Tony}, (5) Rain $\sqsubseteq$ ∃like$^-$.{Tony}, (6) Snow $\sqsubseteq$ ∃like$^-$.{Tony}}
- A = { Tony: AlpineClubM, Mike: AlpineClubM, John: AlpineClubM}

Check if the above knowledge graph entails *Mike:MountainClimer*.

In order to support the above knowledge graph, one might need to use some of the following extra expansion rules:

- S1-rule: if x:N, and N $\sqsubseteq$ ∃r.{y} in the TBox, then add (x,y):r into the ABox;
- S2-rule: if x:N, and N $\sqsubseteq$ ∃r$^-$.{y} in the TBox, then add (y,x):r into the ABox;
- S3-rule: if x:N, and N $\sqsubseteq$ ¬∃r.{y} in the TBox, then add (x,y): ¬r into the ABox;

- S4-rule: if x:N, and N $\sqsubseteq \neg\exists r^{-}.\{y\}$ in the TBox, then add (y,x): $\neg$r into the ABox;
- S5-rule: if (y1,x): r1, and $\exists r1^{-}.\{y1\} \sqsubseteq \neg\exists r2^{-}.\{y2\}$ in the TBox, then add (y2,x): $\neg$r2 into the ABox.