Assignment10 – Knowledge Representation

Problem 10.1 (Modeling in Description Logic)

Consider the following situation:

- Some beings are persons, some are animals.
- Persons and animals may like other persons or animals.
- Alice is a person, and she likes the animal Bubbles.

1. Model this situation as a semantic network. Explain the different kinds of nodes and edges occurring in your network.
2. Model the same situation in first-order logic and compare the results.
3. Explain the difference between inst and is-a edges.
4. Explain the difference between having a relation edge between two concepts vs. asserting a relation between two individuals.

Problem 10.2 (ALC)

Consider the following description logic signature

- *concept* symbols: i (for instructor), s (for student), c (for *course*), p (for program)
- *role* symbol m (for is-member-of) used for
  - *instructors* giving a *course*
  - *students* taking a *course*
  - *students* being enrolled in a *degree program*
  - *courses* being part of a *degree program*

We use an extension of $\mathcal{ALC}$, in which there are dual roles: there is a role m^{-1} that captures the relation has-as-member, e.g., $MK\ m\ AI$ iff $AI\ m^{-1}\ MK$.

1. For the *signature* above, give a *concept axiom* that captures that instructors can only be members of *courses*.
2. Give a *concept axiom* for the above *signature* that captures: *courses* that are taken by a *student*, must be given by an *instructor*.
3. Calculate the translation to *first-order logic* of $s \sqsubseteq \forall m.\exists m.p$.
4. Given a *first-order model* $\langle \mathcal{D}, \mathcal{I} \rangle$, define an appropriate case of the *interpretation* mapping for the formula $\forall r^{-1}.C$.

Problem 10.3 (ALC Semantics)

Consider the $\mathcal{ALC}$ *concepts* $\forall R.(C \sqcap D)$ and $\forall R.C \sqcap \forall R.D$.

1. By applying the semantics of $\mathcal{ALC}$, show that the two are equivalent.
2. Translate both formulas to first-order logic and state which FOL formula we would need to prove (e.g., with the ND calculus) to show that the two are equivalent.

Problem 10.4 (ALC TBox)

Consider $\mathcal{ALC}$ with the following

- primitive concepts: woman, man
- roles: has_child, has_parent, has_sibling, has_spouse

Give an $\mathcal{ALC}$ *TBox* that defines the *concepts* person, parent, mother, father, grandmother, aunt, uncle, sister, brother, onlychild, cousin, nephew, niece, fatherinlaw, motherinlaw.