Assignment 2 – Ontologies / Description Logic
Due: Monday, February 7th (in class, after class)

Problem 1. (10+4+3 Points)
Consider the following (oversimplified!) description logic ontology (TBox):

1. Organism ≡ Animal ⊔ Plant
2. Person ⊑ Animal
3. Grass ⊑ Plant
4. Cow ⊑ Animal ⊓ ∀eats.Grass
5. Carnivore ≡ Organism ⊓ ∀eats.Animal

a) Translate the above description logic (DL) axioms into first-order predicate logic (FO) formulas. Hint: To translate the concept expressions on the left-hand-side and right-hand-side of the above axioms, use the translations $t_x$ and $t_y$ given in class. To translate an equivalence $C ≡ D$ or a concept inclusion $C ⊑ D$, compute $t_x$ for the lhs and rhs, respectively, and use
   - $∀x \ (t_x(C) ↔ t_x(D))$ for the equivalence or
   - $∀x \ (t_x(C) → t_x(D))$ for the implication.

b) When unfolding a concept expressions say $E$, we can replace a concept $C$ (occurring in $E$) by an equivalent concept $D$, i.e., for which $C ≡ D$ holds. If $C ⊑ D$ holds, we can also replace $C$ by $D$ but need to remember that the resulting expression $E'$ is no longer equivalent to $E$.

“Unfold” the expression $E = Person ⊓ ∀eats.Cow ⊓ ∃owns.Ranch$ (equivalent to Ranchers in the above ontology) until it contains only base concepts. Note that the resulting expression $E'$ might not be equivalent to $E$ (e.g., if one replaces Grass by Plant in a conjunction, then a possibly larger result is obtained).

c) In the above ontology, what is the relation between Rancher and Carnivore? For example, is every Rancher a Carnivore? How about the other way round? Explain.

Problem 2 (1+2+3 Points).

a) What is the difference between a TBox and an ABox, i.e., what kind of information is stored in either one?

b) What is the difference between evaluating a query and reasoning with a query (or with two queries)? Which problem is harder in general?

c) What is the relation between evaluating a formula ($val$ mapping on the slides) in logic and running a query? Say what corresponds to what (e.g., $A$ in logic corresponds to $X$ in databases, $B$ in logic corresponds to $Y$ in databases, etc.)