Foundations of Semantic Web Technologies

Tutorial 4

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Exercise 3.1. Model the following statements in OWL DL by giving the corrsponding OWL/RDF snippets:

- The class `Vegetable` is a subclass of `PizzaTopping`.
- The class `PizzaTopping` does not have common elements with the class `Pizza`.
- The individual `aubergine` is an element of the class `Vegetable`.
- The abstract role `hasTopping` connects only elements of the class `Pizza` with elements of the class `PizzaTopping`.
- Pizzas always have at least two toppings.
- Every Pizza from the class `PizzaMargarita` has `Tomato` as topping.
- The class `VegetarianPizza` consists of those individuals that are both in the class `PizzaWithoutMeat` and in the class `PizzaWithoutFish`.
- No Pizza from the class `PizzaMargarita` has a topping from the class `Meat`.

Exercise 3.2. Decide, if the following statements would make sense in the context of the pizza ontology from Exercise 3.1:

- The role `hasIngredient` is transitive.
- The role `hasTopping` is functional.
- The role `hasTopping` is inverse functional.
- The role `hasIngredient` is asymmetric.

Exercise 3.3. Assume a vocabulary with the individual names `bonny` and `clyde`, the class names `Honest`, `Wise`, `Crime` and `Human` as well as the role names `commits`, `marriedWith`, `suspects`, `report` and `know`.

Which of the following propositions can be made in OWL 1, which in OWL 2 and which ones not at all? In the positive case, provide the corresponding axioms.

(a) Everybody, who is honest and who commits a crime, reports himself.

(b) Who is wise and honest, doesn't commit crimes.

(c) Bonnie does not report Clyde.

(d) Nobody reports a human, which whom he has committed a crime jointly.

(e) Clyde has committed at least 10 crimes.

(f) Bonnie and Clyde have committed at least one crime together.

(g) Who committed a crime together with his/her spouse is not honest.

(h) Everybody knowing a suspect, is a suspect himself.

Exercise 3.4. We want to define the concept "vegetarian pizza". Which of the following definitions are appropriate for this? Provide a natural language description for each of the logical statements.

(a) $\texttt{VegetarianPizza} \equiv \texttt{Pizza} \sqcap \neg\exists\texttt{hasIngredient}.(\texttt{Meat} \sqcap \texttt{Fish})$

(b) $\texttt{VegetarianPizza} \equiv \texttt{Pizza} \sqcap \forall\texttt{hasTopping}.(\neg\texttt{Meat} \sqcup \neg\texttt{Fish})$

(c) $\texttt{VegetarianPizza} \equiv \texttt{Pizza} \sqcap \neg\exists\texttt{hasTopping}.\texttt{Meat} \sqcap \neg\exists\texttt{hasTopping}.\texttt{Fish}$

(d) $\texttt{VegetarianPizza} \equiv \texttt{Pizza} \sqcap \exists\texttt{hasTopping}.\neg\texttt{Meat} \sqcap \exists\texttt{hasTopping}.\neg\texttt{Fish}$

(e) $\texttt{VegetarianPizza} \equiv \texttt{Pizza} \sqcap \forall\texttt{hasIngredient}.(\neg\texttt{Meat} \sqcap \neg\texttt{Fish})$

Exercise 3.5. Let the following ontology in DL syntax be given:

$$\texttt{hasTopping} \sqsubseteq \texttt{hasIngredient} \qquad \exists\texttt{hasTopping}.\top \sqsubseteq \texttt{Pizza}$$
$$\texttt{Vegetable} \sqcap \texttt{Cheese} \sqsubseteq \bot \qquad \texttt{Cheese} \sqcap \texttt{Meat} \sqsubseteq \bot$$
$$\texttt{Vegetable} \sqcap \texttt{Meat} \sqsubseteq \bot \qquad \texttt{Cheese} \sqcap \texttt{Fish} \sqsubseteq \bot$$
$$\texttt{Vegetable} \sqcap \texttt{Fish} \sqsubseteq \bot \qquad \texttt{Meat} \sqcap \texttt{Fish} \sqsubseteq \bot$$
$$\top \sqsubseteq \forall\texttt{hasTopping}.\texttt{PizzaTopping}$$

Consider the following additional class definitions:

$$\begin{aligned}
\texttt{CheesePizza} &\equiv \texttt{Pizza} \sqcap \exists\texttt{hasTopping}.\texttt{Cheese} \\
\texttt{PizzaSpinach} &\equiv \exists\texttt{hasTopping}.\texttt{Spinach} \sqcap \exists\texttt{hasTopping}.\texttt{Cheese} \sqcap \\
&\qquad \forall\texttt{hasTopping}.(\texttt{Spinach} \sqcup \texttt{Cheese}) \\
\texttt{PizzaCarnivorus} &\equiv \texttt{Pizza} \sqcap \forall\texttt{hasTopping}.(\texttt{Meat} \sqcap \texttt{Fish}) \\
\texttt{EmptyPizza} &\equiv \texttt{Pizza} \sqcap \neg\exists\texttt{hasTopping}.\top
\end{aligned}$$

(a) Which of the classes given above would be recognized as subclass of $\texttt{VegetarianPizza}$ by a DL reasoner (according to a correct definition from Exercise 3.4? Explain your answers.

(b) The classification from (a) shows that some of the pizza classes do not model the intended concept. How could the definition be corrected?

(c) How would the result from (a) change, if one would use just $\sqsubseteq$ instead of $\equiv$ when defining `VegetarianPizza`?