Knowledge Representation and Semantic Technologies – 14/6/2016

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Exercise 1 Given the following $\mathcal{ALC}$ TBox:

$$\begin{array}{rcl} C & \sqsubseteq & D \\ D \sqcap E & \sqsubseteq & \exists R.C \\ E & \sqsubseteq & F \\ D & \sqsubseteq & \forall R.\neg C \end{array}$$

(a) tell whether the TBox $\mathcal{T}$ is satisfiable, and if so, show a model for $\mathcal{T}$;

(b) tell whether the concept C is satisfiable with respect to $\mathcal{T}$, and if so, show a model for $\mathcal{T}$ where the interpretation of C is non-empty;

(c) given the ABox $\mathcal{A} = \{C \sqcap E(a)\}$, tell whether the knowledge base $\langle \mathcal{T}, \mathcal{A} \rangle$ is satisfiable (consistent), explaining your answer;

(d) given the ABox $\mathcal{A} = \{E(a)\}$, tell whether the knowledge base $\langle \mathcal{T}, \mathcal{A} \rangle$ is satisfiable (consistent), explaining your answer.

Exercise 2 Given the following ASP program P:

```
r(x,y) :- g(x,y).
r(x,z) :- g(x,y), r(y,z).
s(x,y) :- g(x,y).
t(x,y) :- r(x,y), not s(x,y).
v(x,y) :- s(x,y), not r(x,y).
w(x,z) :- g(x,y), t(x,y), not v(y,z).
g(a,b). g(b,c). g(d,e). g(e,f).
```

(a) tell whether P is stratified;

(b) compute the answer sets of P.

Exercise 3

We want to formalize knowledge about the domain of students and professors. In particular, we want to formalize the following statements:

1. every student is a person;
2. every professor is a person;
3. student and professor are disjoint classes;
4. the property "is friend of" has domain person and range person;
5. the property "is supervisor of" has domain professor and range student;
6. the property "studies with" has domain student and range student;
7. the property "studies with" is a subproperty of the property "is friend of";
8. every student is friend of someone.

(a) Choose the most appropriate knowledge representation language for expressing the above knowledge among the following: $\mathcal{ALC}$, Datalog, ASP, OWL, $DL\text{-}Lite_R$, $\mathcal{EL}$, RL, RDFS, motivating your choice;

(b) express the above knowledge in the formalism chosen at the previous point.

Exercise 4

(a) Write an RDF/RDFS model representing the following statements about URIs `Person`, `Director`, `Actor`, `Writer`, `Movie`, `Country`, `Comedy`, `Drama`, `Man`, `Woman`, `filmedIn`, `isDirectorOf`, `isWriterOf`, `actsIn`, `bornIn`, `Joe`, `Mary`, `Ann`, `Paul`, `Italy`, `France`, `ABC`, `XYZ`.

1. `Person`, `Director`, `Writer`, `Actor`, `Country`, `Movie`, `Comedy`, `Drama`, `Man`, and `Woman` are classes;
2. `Man` and `Woman` are subclasses of `Person`;
3. `Comedy` and `Drama` are subclasses of `Movie`;
4. `actsIn`, `bornIn`, `filmedIn`, `isDirectorOf` and `isWriterOf` are properties;
5. `isDirectorOf` has domain `Director` and range `Movie`;
6. `flmedIn` has domain `Movie` and range `Country`;
7. `bornIn` has domain `Person` and range `Country`;

8. `actsIn` has domain `Actor` and range `Movie`;
9. Ann is the director and the writer of movie XYZ;
10. Joe and Paul act in movie ABC;
11. ABC was filmed in France;
12. Ann is a woman;
13. Paul is a man.

(b) Write SPARQL queries corresponding to the following requests: (b1) "return every Italian movie whose director and writer are the same person; (b2) "return all the writers of comedies filmed in Italy, and, optionally, the country where the writer was born.

Exercise 5

(a) Write an OWL ontology that formalizes the domain described at point (a) of Exercise 4.

(b) Add to the above ontology the axioms formalizing the following statements:

1. add a new property `isWrittenBy` and state that it is the inverse of `isWriterOf`;
2. add a new class `WrittenByMultipleAuthors` and state that it corresponds to the class of movies written by at least two writers;
3. add the new class `ComedyWithWomanWriter` and state that such a class corresponds to the class consisting of every comedy movie that was written by a woman;
4. every movie is directed by at least one and at most six directors;
5. `bornIn` and `actsIn` are disjoint properties.

Then, tell whether the resulting OWL ontology is redundant, i.e.: can some of the axioms constituting the ontology be deleted without changing the meaning (that is, the models) of the ontology? if so, identify and list such axioms.

Exercise 6

(a) Axiomatize the following scenario, appropriately with action precondition and effect axioms, and obtain successor state axioms.

Fluents:

- `robotInsideRoom(s)` - The robot is inside the room in situation s.
- `chairInsideRoom(s)` - The chair is inside the room in situation s.
- `robotCloseToChair(s)` - The robot is close to the chair in situation s.
- `robotHoldsChair(s)` - The robot holds the chair in situation s.

Actions:

- `goOutsideRoom` - The robot goes out of the room. This can be done if the robot is inside the room, and has the effect that the robot will be outside the room, and, if the robot is holding the chair, the chair will be outside the room too.
- `goCloseToChair` - The robot moves close to the chair. This can be done if the robot is not close to the chair, and has the effect that the robot will be close to the chair.
- `holdChair` - The robot holds the chair. This can be done if the robot is close to the chair and the robot is not holding the chair, and has the effect that the robot will hold the chair.

Initial situation description: Initially the robot is inside the room, is not close to the chair, and is not holding the chair, and the chair is inside the room.

(b) Show, by applying regression, that the chair is outside the room after the sequence of actions `goCloseToChair, holdChair, goOutsideRoom`, and that the sequence of actions is indeed executable.