Knowledge Representation and Semantic Technologies – 23/6/2014

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

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

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

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

(c) given the ABox $\mathcal{A} = \{A(a)\}$, tell whether the concept assertion $\neg B(a)$ is entailed by $\langle \mathcal{T}, \mathcal{A} \rangle$, explaining your answer.

Exercise 2 Given the following ASP program P:

```
r(x,y) :- p(x,y).
t(x,y) :- r(x,z), t(z,y).
v(y) :- r(x,y).
s(x,y) :- t(x,y), not p(x,y).
p(a,b). p(b,c). p(c,d). p(d,d).
```

(a) tell whether P is stratified;

(b) compute the answer sets of P.

Exercise 3 We want to formalize knowledge about the domain of persons, students and employees. In particular, we want to formalize the following statements:

1. every student is a person
2. every employee is a person
3. every person knows at least a student
4. students only know students
5. every employee works with at least an employee
6. both students and employees live in a city
7. every employee who is also a student lives in a big city

(a) Choose the most appropriate knowledge representation language for expressing the above knowledge among the following: $\mathcal{ALC}$, Datalog, ASP, OWL, DL-Lite, RDFS;

(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 `Employee`, `Manager`, `Division`, `TopManager`, `Person`, `Man`, `Woman`, `City`, `livesIn`, `worksWith`, `isManagerOf`, `leadsDivision`, `locatedIn`, `Ann`, `Bob`, `Jane`, `Joe`, `Rome`, `Naples`, `ABC`, `XYZ`.

1. `Employee`, `Manager`, `TopManager`, `Division`, `Man`, `Woman` and `City` are classes;
2. `TopManager` is a subclass of `Manager` which is a subclass of `Employee`;
3. `worksWith`, `livesIn`, `isManagerOf`, `leadsDivision` and `locatedIn` are properties;
4. `isManagerOf` is a subproperty of `worksWith`;
5. `isManagerOf` has domain `Manager` and range `Employee`;
6. `worksWith` has domain `Employee` and range `Employee`;
7. `livesIn` has domain `Person` and range `City`;
8. `locatedIn` has domain `Division` and range `City`;
9. Jane is a manager;
10. Bob and Ann are employees;
11. Joe is manager of Bob;
12. Jane lives in Rome;

13. Mary leads division XYZ of the company;
14. division ABC is located in Naples.

(b) Write SPARQL queries corresponding to the following requests: (b1) "return all employees that work with an employee that lives in Naples"; (b2) "return every top manager that leads a division that is located in the same city where she/he lives".

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. `City` and `Division` are disjoint classes;
2. every manager manages at least three employees;
3. every division is located in exactly one city;
4. every employee works with at least one man and works with at least one woman.
5. every manager leads at most one division.

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 of the ontology? if so, identify and list such axioms.

Exercise 6

(a) Axiomatize the following variant of the Yale Shooting Scenario, appropriately with action precondition and effect axioms, and obtain successor state axioms.

Yale Shooting Scenario variant:

Fluents:

- `dead(s)` - The turkey is dead in situation s.
- `unloaded(s)` - The gun is unloaded in situation s.

Actions:

- `load` - Load the gun. This can be done if the gun is currently unloaded, and has the effect that the gun will be loaded (not unloaded).
- `shoot` - Shoot the gun. This requires that the gun be loaded (not unloaded), and has the effect that the turkey will be dead and the gun will be unloaded.
- `wait` - A no-op; it has no effect on any fluent, and can always be performed.

Initial situation description: Initially the turkey is alive (not dead) and the gun is unloaded.

(b) Show, by applying regression, that the turkey will be dead after the sequence of actions load, wait, shoot, and that the action is indeed executable.