Knowledge Representation and Semantic Technologies – 23/6/2014

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

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

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

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

(c) given the ABox $\mathcal{A} = \{A(a)\}$, tell whether the concept assertion $\exists R.D(a)$ 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).
r(x,y) :- r(x,z), p(z,y).
s(x) :- r(x,y).
v(x,y) :- r(x,y), not p(x,y).
p(a,c). p(a,d). p(c,b). p(d,e).
```

(a) tell whether P is stratified;

(b) compute the answer sets of P.

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

1. every employee is a person
2. every manager is a person
3. every employee has a manager
4. every employee works with at most two employees
5. every employee is not a manager
6. every manager is not an employee
7. every employee has a salary that is an integer

(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 `Person`, `Employee`, `Manager`, `Man`, `Woman`, `City`, `livesIn`, `worksWith`, `manages`, `isManagerOf`, `Ann`, `Bob`, `Jane`, `Joe`, `Rome`.

1. `Person`, `Employee`, `Manager`, `Man`, `Woman` and `City` are classes;
2. `Manager` is a subclass of `Employee` which is a subclass of `Person`;
3. `Man` and `Woman` are subclasses of `Person`;
4. `worksWith`, `livesIn`, `manages` and `isManagerOf` are properties;
5. `isManagerOf` is a subproperty of `worksWith`;
6. `isManagerOf` has domain `Manager` and range `Employee`;
7. `worksWith` has domain `Employee` and range `Employee`;
8. `livesIn` has domain `Person` 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. Ann is a woman.

(b) Write SPARQL queries corresponding to the following requests: (b1) "return all persons that work with Joe and live in the same city where Joe lives in"; (b2) "return every employee that works with a woman".

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. the property `manages` is the inverse of `isManagerOf`;
2. every employee has exactly one manager;
3. every person lives in at most one city;
4. every employee works with at least one man and works with at least one woman.

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 variant of the Yale Shooting Scenario, appropriately with action precondition and effect axioms, and obtain successor state axioms.

Yale Shooting Scenario variant:

Fluents:

- `alive(s)` - The turkey is alive in situation s.
- `loaded(s)` - The gun is loaded in situation s.

Actions:

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

Initial situation description: Initially the turkey is alive and the gun is not loaded.

(b) Show, by applying regression, that the turkey will be dead (not alive) after the sequence of actions load, wait, shoot, and that the action is indeed executable.