

Knowledge Representation and Semantic Technologies – 11/1/2022

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

$$\begin{aligned}
 A &\sqsubseteq \exists r.G \\
 B \sqcap G &\sqsubseteq \exists r.E \\
 C &\sqsubseteq F \\
 D &\sqsubseteq \forall r.C \\
 F &\sqsubseteq \neg G
 \end{aligned}$$

- (a) tell whether the TBox \mathcal{T} is satisfiable, and if so, show a model for \mathcal{T} ;
- (b) tell whether the concept D is satisfiable with respect to \mathcal{T} , and if so, show a model for \mathcal{T} where D is satisfiable;
- (c) tell whether the concept $A \sqcap D$ is satisfiable with respect to \mathcal{T} , and if so, show a model for \mathcal{T} where $A \sqcap D$ is satisfiable;
- (d) given the ABox $\mathcal{A} = \{D(a), r(a, b)\}$, use the tableau method to establish whether the knowledge base $\langle \mathcal{T}, \mathcal{A} \rangle$ entails the assertion $F(b)$.

Exercise 2 Given the following ASP program P:

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r(x,z) :- q(x,y), p(y,z).
s(x,z) :- p(x,y), q(y,z).
t(x,y,z) :- r(x,y), s(y,z).
u(x,y) :- s(x,y), not r(x,y).
v(x,y) :- u(y,x).
w(x,z) :- r(x,y), s(y,z), not v(y,z).
w(y,z) :- r(x,y), s(y,z), not u(y,z).
p(b,c). p(d,e). p(f,b).
q(a,b). q(b,d). q(c,f). q(e,g).
    
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- (a) tell whether P is stratified;
- (b) compute the answer sets of P.

Exercise 3

We want to formalize knowledge about persons and kinship relationships. In particular, we want to formalize the following statements:

1. every mother is a person;
 2. every father is a person;
 3. for every x, y, z, if x has child y, then y has parent x;
 4. for every x, y, z, if x has mother y and y has mother z, then x has grandmother z;
 5. for every x, y, z, w, if x and y have mother z and x and y have father w, then x and y are siblings;
 6. for every x, y, if x has child y, then y does not have child x.
- (a) Choose the most appropriate knowledge representation language for expressing the above knowledge among the following ones: \mathcal{ALC} , Datalog, Datalog with constraints, ASP, OWL, $DL-Lite_R$, \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**, **HasParent**, **HasMother**, **HasFather**, **Man**, **Woman**, **City**, **livesIn**, **Ann**, **Bob**, **Jane**, **Mary**, **Paul**, **Sandy**, **Rome**, **Milan**,
 1. **Person**, **Man**, **Woman**, and **City** are classes;
 2. **Man** and **Woman** are subclasses of **Person**;
 3. **HasParent**, **HasMother**, **HasFather**, **livesIn**, are properties;
 4. **IsMother** and **HasFather** are subproperties of **HasParent**;
 5. **HasParent** has domain **Person** and range **Person**;
 6. **HasMother** has domain **Person** and range **Woman**;
 7. **HasFather** has domain **Person** and range **Man**;
 8. **livesIn** has domain **Person** and range **City**;

9. Jane is a woman;
 10. Jane has father Bob;
 11. Paul is the son of Ann;
 12. Mary and Bob are the children of Paul and Sandy;
 13. Jane and Bob live in Milan.
- (b) Write SPARQL queries corresponding to the following requests: (b1) return all the grandparents (i.e., the persons who are parents of parents of someone); (b2) return all the aunts and uncles of Jane; (b3) return every grandchild of Sandy, and, optionally, the city where the grandchild lives.

Exercise 5

Given the *RL* knowledge base $\langle \mathcal{T}, \mathcal{A} \rangle$, where \mathcal{T} is the following TBox:

$$\begin{aligned}
 &hasMother \sqsubseteq hasParent \\
 &hasFather \sqsubseteq hasParent \\
 &hasParent^- \sqsubseteq hasChild \\
 &\exists hasChild.\top \sqsubseteq PARENT \\
 &\exists hasChild.PARENT \sqsubseteq GRANDPARENT \\
 &\exists hasMother^-. \top \sqsubseteq WOMAN \\
 &\exists hasFather^-. \top \sqsubseteq MAN \\
 &WOMAN \sqcap GRANDPARENT \sqsubseteq GRANDMOTHER \\
 &MAN \sqcap GRANDPARENT \sqsubseteq GRANDFATHER
 \end{aligned}$$

and \mathcal{A} is the following ABox:

$$\begin{aligned}
 &hasMother(John, Ann), \quad hasFather(John, Bob), \quad hasMother(Ann, Mary), \\
 &hasFather(Ann, Paul), \quad hasMother(Bob, Jane), \quad hasFather(Mary, Nick)
 \end{aligned}$$

1. compute the materialization of the ABox \mathcal{A} with respect to the TBox \mathcal{T} ;
2. tell whether the concept assertion $GRANDMOTHER(Jane)$ is entailed by $\langle \mathcal{T}, \mathcal{A} \rangle$;
3. write a Datalog program corresponding to the above TBox.