

LAST NAME:

FIRST NAME:

ID (MATRICOLA):

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Exercise 1 Given the following *ALC* TBox:

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

- (a) 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, otherwise explain your answer;
- (b) tell whether the concept $D \sqcap E \sqcap G$ is satisfiable with respect to \mathcal{T} , and if so, show a model for \mathcal{T} where $D \sqcap E \sqcap G$ is satisfiable, otherwise explain your answer;
- (c) given the ABox $\mathcal{A} = \{D(a), G(a), r(a, b)\}$, tell whether the knowledge base $\langle \mathcal{T}, \mathcal{A} \rangle$ entails the assertion $\neg B(b)$, explaining your answer;
- (d) given the ABox $\mathcal{A} = \{D(a), E(a)\}$, tell whether the knowledge base $\langle \mathcal{T}, \mathcal{A} \rangle$ entails the assertion $K(a)$, explaining your answer.

Exercise 2 Given the following ASP program P:

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n(X,Z) :- e1(X,Y), e2(Y,Z).
n(X,Z) :- e2(X,Y), e1(Y,Z).
p(X,Z) :- n(X,Y), n(Y,Z).
q(X,Y) :- n(X,Y).
q(X,Y) :- p(X,Y).
r(X,Z) :- e1(X,Y), e2(Y,Z).
s(X,Y) :- q(X,Y), not r(X,Y).
t(X,Y) :- r(X,Y), not n(X,Y), not p(X,Y).
u(X,Z) :- s(X,Y), s(Z,Y).
u(X,Y) :- s(X,Y), not t(X,Y).
v(X,Y) :- u(X,Y), not t(X,Y), not s(X,Y), not r(X,Y), not q(X,Y).
e1(a,b). e1(b,c). e1(d,e).
e2(b,c). e2(c,d).
    
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- (a) tell whether P is stratified;
- (b) compute the answer sets of P;
- (c) tell whether the fact $v(c, a)$ is entailed by P.

Exercise 3

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

1. every student is a person;
 2. every worker is a person;
 3. student and worker are disjoint classes;
 4. every student is either a bachelor student or a master student;
 5. every student who is both a bachelor student and a master student is a special student;
 6. every student that has passed at least one exam is an active student.
- (a) Choose the most appropriate knowledge representation language for expressing the above knowledge among the following ones: *ALC*, Datalog, Datalog with constraints, ASP, OWL, *DL-Lite_R*, *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 pairs uncle-nephew (remember that a man x is the uncle of y if x has the same parents as z , where z is one of the parents of y); (b2) return every woman who lives in the same city as one of her grandparents; (b3) return all the ancestors of every grandfather.

Exercise 5

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

$$\begin{aligned}
 A \sqcap B \sqcap E &\sqsubseteq \perp \\
 C \sqcap D \sqcap \exists r.F &\sqsubseteq E \\
 E &\sqsubseteq F \\
 F \sqcap \exists r.A &\sqsubseteq B \\
 F \sqcap \exists r^-.A &\sqsubseteq D \\
 \exists s.\top \sqcap \exists s^-. \top &\sqsubseteq C
 \end{aligned}$$

and \mathcal{A} is the following ABox:

$$A(b), \quad D(c), \quad E(a), \quad r(a,b), \quad r(c,a), \quad s(c,d), \quad s(e,c)$$

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