

LAST NAME:

FIRST NAME:

ID (MATRICOLA):

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.....

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

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

- tell whether the TBox \mathcal{T} is satisfiable, and if so, show a model for \mathcal{T} ;
- tell whether the concept $E \sqcap G$ is satisfiable with respect to \mathcal{T} , and if so, show a model for \mathcal{T} where $E \sqcap G$ is satisfiable;
- tell whether the concept $E \sqcap H$ is satisfiable with respect to \mathcal{T} , and if so, show a model for \mathcal{T} where $E \sqcap H$ is satisfiable;
- given the ABox $\mathcal{A} = \{E(a), R(a, b)\}$, 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:

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

- tell whether P is stratified;
- 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:

- every person has a father and has a mother;
 - fathers are male and mothers are female;
 - the father of a father is a grandfather;
 - the mother of a mother is a grandmother;
 - the brother of a parent is an uncle.
- Choose the most appropriate knowledge representation language for expressing the above knowledge among the following ones: \mathcal{ALC} , Datalog, Datalog with constraints, ASP, OWL, $DL\text{-}Lite_R$, \mathcal{EL} , RL , RDFS, motivating your choice;
 - express the above knowledge in the formalism chosen at the previous point.

Exercise 4

- Write an RDF/RDFS model representing the following statements about URIs `Employee`, `Manager`, `Division`, `TopManager`, `Person`, `Man`, `Woman`, `City`, `livesIn`, `worksWith`, `isManagerOf`, `leadsDivision`, `worksInDivision`, `locatedIn`, `Ann`, `Bob`, `Jane`, `Joe`, `Rome`, `Naples`, `Milan`, `ABC`, `XYZ`.
 - `Employee`, `Manager`, `TopManager`, `Division`, `Man`, `Woman` and `City` are classes;
 - `TopManager` is a subclass of `Manager` which is a subclass of `Employee`;
 - `worksWith`, `livesIn`, `isManagerOf`, `leadsDivision` and `locatedIn` are properties;
 - `isManagerOf` is a subproperty of `worksWith`;
 - `isManagerOf` has domain `Manager` and range `Employee`;

6. both `worksInDivision` and `leadsDivision` have domain `Employee` and range `Division`;
 7. `worksWith` has domain `Employee` and range `Employee`;
 8. `livesIn` has domain `Person` and range `City`;
 9. `locatedIn` has domain `Division` and range `City`;
 10. Jane is a manager;
 11. Bob and Ann are employees;
 12. Joe is manager of Bob;
 13. Jane lives in Rome;
 14. Mary leads division XYZ of the company;
 15. division ABC is located in Milan.
- (b) Write SPARQL queries corresponding to the following requests: (b1) return every employee that works in a division located in Naples, and, optionally, the manager of such an employee; (b2) return every division that is located in the city where the manager that leads the division lives in; (b3) return every top manager that leads a division for which Ann works, and, optionally, the city where the manager lives.

Exercise 5

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

$$\begin{aligned}
 &hasMother \sqsubseteq hasParent \\
 &hasFather \sqsubseteq hasParent \\
 &hasParent^- \sqsubseteq hasChild \\
 &\exists hasChild.\top \sqsubseteq PARENT \\
 &\exists hasChild.PARENT \sqsubseteq GRANDPARENT \\
 &\exists hasChild.GRANDPARENT \sqsubseteq GREAT-GRANDPARENT
 \end{aligned}$$

and \mathcal{A} is the following ABox:

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

1. compute the materialization of the ABox \mathcal{A} with respect to the TBox \mathcal{T} ;
2. tell whether the concept assertion $GREAT-GRANDPARENT(Liz)$ is entailed by $\langle \mathcal{T}, \mathcal{A} \rangle$.