

Knowledge Representation and Semantic Technologies

Exercises on OWL 2 profiles

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Exercise 1

Given the following TBox:

- (1) $\text{MALE} \sqsubseteq \text{PERSON}$
- (2) $\text{FEMALE} \sqsubseteq \text{PERSON}$
- (3) $\text{hasMother} \sqsubseteq \text{hasParent}$
- (4) $\text{hasFather} \sqsubseteq \text{hasParent}$
- (5) $\text{hasChild} \sqsubseteq \text{hasParent}^{-}$
- (6) $\text{MALE} \sqcap \text{FEMALE} \sqsubseteq \perp$
- (7) $\exists \text{hasParent} \sqsubseteq \text{IS-CHILD}$
- (8) $\text{IS-CHILD} \sqsubseteq \exists \text{hasParent}$
- (9) $\exists \text{hasParent.HAPPY-PARENT} \sqsubseteq \text{HAPPY-CHILD}$
- (10) $\exists \text{hasChild.HAPPY-CHILD} \sqsubseteq \text{HAPPY-PARENT}$
- (11) $\text{HAPPY-CHILD} \sqsubseteq \exists \text{hasParent}$
- (12) $\text{HAPPY-PARENT} \sqsubseteq \exists \text{hasChild}$
- (13) $\text{HAPPY-PARENT} \sqcap \text{HAPPY-CHILD} \sqsubseteq \text{HAPPY}$
- (14) $\text{HAPPY} \sqsubseteq \text{HAPPY-PARENT}$
- (15) $\text{HAPPY} \sqsubseteq \text{HAPPY-CHILD}$

Exercise 1

- (a) Tell which of these axioms can be expressed in DL-Lite_R , EL, and RL, respectively;

Exercise 1

(b) given the following ABox:

- (A1) MALE(Bob)
- (A2) MALE(Paul)
- (A3) FEMALE(Ann)
- (A4) hasMother(Paul,Ann)
- (A5) hasFather(Mary,Paul)
- (A6) hasChild(Paul,Jane)
- (A7) hasChild(Jane,Bob)
- (A8) HAPPY(Ann)
- (A9) HAPPY-CHILD(Jane)

and the TBox obtained from the previous one by discarding the axioms not expressible in RL, determine the instances of the concept HAPPY by applying forward chaining;

Exercise 1

(c) Given the above ABox and the TBox obtained from the previous one by discarding the axioms not expressible in DL_Lite_R :

(c1) determine the instances of the concept HAPPY by applying query rewriting;

(c2) determine the instances of the query $q(x) :- \text{hasParent}(x,y)$ by applying query rewriting.

Exercise 1(a): Solution

The axioms expressible in DL-Lite_R are:

(1), (2), (3), (4), (5), (6), (7), (8), (11), (12), (14), (15)

Notice that axiom (6) can be expressed in DL-Lite_R by the equivalent axiom $\text{MALE} \sqsubseteq \neg \text{FEMALE}$

The axioms expressible in EL are:

(1), (2), (7), (8), (9), (10), (11), (12), (13), (14), (15)

The axioms expressible in RL are:

(1), (2), (3), (4), (5), (6), (7), (9), (10), (13), (14), (15)

Exercise 1(b): Solution

The ABox obtained by chasing the initial ABox with the RL axioms of the TBox is obtained by adding to the initial ABox the following assertions:

- (A10) PERSON(Bob) (follows from (A1) and TBox axiom (1))
- (A11) PERSON(Paul) (follows from (A2) and TBox axiom (1))
- (A12) PERSON(Ann) (follows from (A3) and TBox axiom (2))
- (A13) hasParent(Paul,Ann) (follows from (A4) and TBox axiom (3))
- (A14) hasParent(Mary,Paul) (follows from (A5) and TBox axiom (4))
- (A15) hasParent(Jane,Paul) (follows from (A6) and TBox axiom (5))
- (A16) hasParent(Bob,Jane) (follows from (A7) and TBox axiom (5))
- (A17) IS-CHILD(Paul) (follows from (A13) and TBox axiom (7))
- (A18) IS-CHILD(Mary) (follows from (A14) and TBox axiom (7))
- (A19) IS-CHILD(Jane) (follows from (A15) and TBox axiom (7))
- (A20) IS-CHILD(Bob) (follows from (A16) and TBox axiom (7))

Exercise 1(b): Solution (cont'd)

- (A21) HAPPY-PARENT(Ann) (follows from (A8) and TBox axiom (14))
- (A22) HAPPY-CHILD(Ann) (follows from (A8) and TBox axiom (15))
- (A23) HAPPY-CHILD(Paul) (follows from (A13), (A21) and TBox axiom (9))
- (A24) HAPPY-PARENT(Paul) (follows from (A6), (A9) and TBox axiom (10))
- (A25) HAPPY(Paul) (follows from (A23), (A24) and TBox axiom (13))
- (A26) HAPPY-CHILD(Mary) (follows from (A14), (A24) and TBox axiom (9))

Therefore, the instances of the concept HAPPY are: {Ann, Paul}

Exercise 1(c1): Solution

The rewriting of the query

$$q(x) \text{ :- HAPPY}(x)$$

w.r.t. the DL-LiteR axioms of the TBox is simply:

$$q(x) \text{ :- HAPPY}(x)$$

since there are no subconcepts of HAPPY (notice that axiom (13) is not a DL-LiteR axiom, hence it is ignored).

By evaluating such a query on the initial ABox, we obtain the answers $\{\text{Ann}\}$.

Exercise 1(c2): Solution

The rewriting of the query

$q(x) \text{ :- hasParent}(x,y)$

w.r.t. the DL-LiteR axioms of the TBox is the following:

(Q1) $q(x) \text{ :- hasParent}(x,y)$ (initial query)

(Q2) $q(x) \text{ :- hasMother}(x,y)$ (obtained from (Q1) and TBox axiom (3))

(Q3) $q(x) \text{ :- hasFather}(x,y)$ (obtained from (Q1) and TBox axiom (4))

(Q4) $q(x) \text{ :- hasChild}(y,x)$ (obtained from (Q1) and TBox axiom (5))

(Q5) $q(x) \text{ :- IS-CHILD}(x)$ (obtained from (Q1) and TBox axiom (8))

(Q6) $q(x) \text{ :- HAPPY-CHILD}(x)$ (obtained (Q1) and TBox axiom (11))

(Q7) $q(x) \text{ :- HAPPY}(x)$ (obtained from (Q6) and TBox axiom (15))

By evaluating such a query on the initial ABox, we obtain the answers
{Paul, Mary, Jane, Bob, Ann}.