Knowledge Representation and Semantic Technologies

Exercises on OWL 2 profiles

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Exercise 1

Given the following TBox:

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

Not 9,10,13

The axioms expressible in EL are:

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

Not 3,4,5,6

The axioms expressible in RL are:

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

Not 8,11,12

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) :- HAPPY(x)

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

q(x) :- 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 {Ann}.

Exercise 1(c2): Solution

The rewriting of the query

q(x) :- hasParent(x,y)

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

(Q1) q(x) :- hasParent(x,y) (initial query)
(Q2) q(x) :- hasMother(x,y) (obtained from (Q1) and TBox axiom (3))
(Q3) q(x) :- hasFather(x,y) (obtained from (Q1) and TBox axiom (4))
(Q4) q(x) :- hasChild(y,x) (obtained from (Q1) and TBox axiom (5))
(Q5) q(x) :- IS-CHILD(x) (obtained from (Q1) and TBox axiom (8))
(Q6) q(x) :- HAPPY-CHILD(x) (obtained (Q1) and TBox axiom (11))
(Q7) q(x) :- 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}.