CSE 544 Homework 3 Solutions

May 22, 2006

1. (a) $\exists a\ F(d,a) \wedge (\forall a\ F(d,a) \Rightarrow (\forall e\ S(a,e) \Rightarrow L(d,e)))$

   (b) $\exists a\ F(d,a) \wedge (\forall a\ F(d,a) \Rightarrow (\exists e\ S(a,e) \wedge L(d,e)))$

   (c) $\exists a\ (F(d,a) \wedge (\forall e\ S(a,e) \Rightarrow L(d,e)))$

   (d) $\exists a\ F(d,a) \wedge (\forall a\ F(d,a) \Rightarrow \neg(\exists e\ S(a,e) \wedge L(d,e)))$

2. (a) T

   (b) T

   (c) F

   (d) T

   (e) T

   (f) F

3. (a) $adom(x) \equiv\ S(x) \vee \exists y\ (R(x,y) \vee R(y,x) \vee U(x,y) \vee U(y,x))$

   (b) i. Finite, safe. The equivalent range-restricted formula is
       $adom(x) \wedge S(x) \wedge \forall y\ (adom(y) \Rightarrow \neg R(x,y))$

      ii. Finite, safe. The equivalent range-restricted formula is
       $adom(x) \wedge S(x) \wedge \forall y\ (adom(y) \Rightarrow (R(x,y) \Rightarrow \exists z\ adom(z) \wedge (S(z) \vee U(y,z))))$

      iii. Not finite, not safe. No equivalent range-restricted formula.

      iv. Finite, not safe. No equivalent range-restricted formula.

      v. Finite, safe. The equivalent range-restricted formula is
       $adom(x) \wedge S(x) \wedge \forall y\ (adom(y) \Rightarrow (U(x,y) \vee \forall z\ (adom(z) \Rightarrow \neg R(y,z))))$

      vi. Not finite, not safe. No equivalent range-restricted formula.

4. (a) Parent(x,y) :– T(x,y,z)
      Parent(x,z) :– T(x,y,z)

Same(y, z) :– Parent(x, y), Parent(x, z)
Same(y, z) :– Same(u, v), Parent(u, y), Parent(v, z)
Answer(x) :– Same(a, x)

(b) The datalog program is shown below. The predicate MovesA(x)
will be true for those nodes x where Alice wins if she moves first.
The predicate MovesB(x) will be true for those x where Alice
wins if Bob moves first.
MovesA(x) :– A(x)
MovesB(x) :– A(x)
MovesA(x) :– T(x, y, z), MovesB(y)
MovesA(x) :– T(x, y, z), MovesB(z)
MovesB(x) :– T(x, y, z), MovesA(y), MovesA(z)
Answer(x) :– MovesB(x)

5. (a)   i. Yes. Consider the homomorphism from q' to q given by
        $\{(x, x), (y, y), (z, z), (u, x), (v, y)\}$.
      ii. No. Let I be the canonical database for query q.
     iii. Yes. We will check containment separately for two possible
        cases for the variables x, y in q. If $x \neq y$, the homomorphism
        given by $\{(u, u), (x, x), (y, y)\}$ shows containment. If $x =
        y$, then the homomorphism given by $\{(u, x), (x, v), (y, w)\}$
        shows containment.
      iv. No. Consider the database instance I where R has the two
        tuples (x, y) and (y, y).

   (b) $q(x)$:– $R(x, y), R(y, z), R(a, b), R(b, c), R(c, d)$

   (c) $q(x)$:– $R(x, y_1), R(y_1, z_1), R(a, z_1), R(x, y_2), R(y_2, z_2), R(z_2, u_2), R(y_2, b)$
       $q'(x)$:– $R(x, y), R(y, z)$

6. (a) T
   (b) F
   (c) T
   (d) T
   (e) T