

Foundations of Databases and Query Languages

**Exercise 11: Datalog Evaluation**

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**Exercise 11.1** Consider the following program  $P$ :

$$\begin{aligned} T(x) &\leftarrow e(x) \\ T(x) &\leftarrow a(x, y) \wedge T(y) \wedge b(x, z) \wedge T(z) \end{aligned}$$

- (a) Describe, in your own words, the kind of structures that the query  $\langle T, P \rangle$  recognises.
- (b) Give the rules for semi-naive evaluation of  $P$ .
- (c) Compute the semi-naive evaluation of  $P$  for the database that contains the following facts:

$e(1) \quad e(2) \quad e(6) \quad a(3, 1) \quad a(4, 3) \quad a(5, 3) \quad a(7, 5) \quad b(3, 2) \quad b(5, 3) \quad b(7, 6)$

Specify for each newly derived fact which of the rule(s) of (b) will produce it at the given point in the derivation.

**Exercise 11.2** Consider the “Same generation” Datalog program given in the lecture (predicates  $S$  “same generation”,  $p$  “parent”,  $h$  “human”):

$$\begin{aligned} S(x, x) &\leftarrow h(x) \\ S(x, y) &\leftarrow p(x, w) \wedge S(v, w) \wedge p(y, v) \end{aligned}$$

and the adorned version for query  $S(1, x)$ :

$$\begin{aligned} \text{(Rule } a) \quad \text{Query}^f(x) &\leftarrow S^{bf}(1, x) \\ \text{(Rule } b) \quad S^{bf}(x, x) &\leftarrow h(x) \\ \text{(Rule } c) \quad S^{bf}(x, y) &\leftarrow p(x, w) \wedge S^{fb}(v, w) \wedge p(y, v) \\ \text{(Rule } d) \quad S^{fb}(x, x) &\leftarrow h(x) \\ \text{(Rule } e) \quad S^{fb}(x, y) &\leftarrow p(x, w) \wedge S^{fb}(v, w) \wedge p(y, v) \end{aligned}$$

together with the database that contains the following facts for predicate  $p$ :

$h(1) \quad h(2) \quad h(3) \quad h(4) \quad h(5) \quad h(6) \quad h(7)$   
 $p(1, 2) \quad p(2, 3) \quad p(4, 3) \quad p(5, 4) \quad p(6, 1) \quad p(7, 1).$

Sketch the database as a tree. What are the expected answers to the query? Apply the QSQR algorithm to compute the answer to the query.

**Exercise 11.3** Consider the following modified version of the same generation program:

$$\begin{aligned} S(x, x) &\leftarrow h(x) \\ S(x, y) &\leftarrow p(x, w) \wedge p(y, v) \wedge S(v, w) \end{aligned}$$

What is the adorned version of this program for query  $S(1, x)$ ? Use this program to show that it is possible that some tuples in an input-relation are not copied to the  $\text{sup}_0$  relation of a rule during the execution of the QSQR algorithm.

**Exercise 11.4 (Abiteboul, Hull and Vianu; Exercise 13.14)** Consider the following program:

$$\begin{aligned} Sv(x, y) &\leftarrow \text{flat}(x, y) \\ Sv(x, y) &\leftarrow \text{up}(x, z_1) \wedge Sv(z_1, z_2) \wedge \text{flat}(z_2, z_3) \wedge Sv(z_3, z_4) \wedge \text{down}(z_4, y) \end{aligned}$$

Give the magic set transformation for this program and query  $Sv(a, y)$ , where  $a$  is a constant.