

Homework 1: due 15:30, 22-March-2016

- (1) **(2.5 points)** Consider the same three relations EMPL, MANAGING and JUNIORS as in Tutorial 1. Write the FO queries that output the following.
 - (a) The names of the junior employees who are managed by somebody.
 - (b) The names of the junior employees who are *not* managed by somebody.
 - (c) The names of the junior employees who are managed by somebody in the same department.
 - (d) The names of the junior employees who manage somebody.
 - (e) The names of the junior employees who manage somebody in *different* department.
- (2) **(2.5 points)** Do the same as in question (1) but in relational algebra expressions.
- (3) **(3 points)** Show that “there is a cycle in a graph” is not expressible in FO.
- (4) **(3 points)** Write a datalog program that output the set of vertices in the input graph through which there is a cycle of *even* length.
- (5) **(4 points)** Describe an algorithm for the following problem.

Input: An FO formula φ and a database DB.

Task: Compute $\varphi(\text{DB})$.

Note: Both the formula and the database are over the same vocabulary $\tau = \{R_1, \dots, R_k\}$.

- (6) **(5 points)** You are working as a programmer in a company SUPER-TRANSPORT, which provides transportation service from one town to another. It has a huge server that stores the graph/network G of its service, i.e., the graph G that contains all the edges (u, v) , whenever SUPER-TRANSPORT provides a direct service from town u to town v .

One day, your CEO, Mr. X, would like to analyse the network, and he bought a primitive SQL system that only implements relational algebra. Being a ruthless boss, he asked you to come up with an SQL query that computes all the reachable pairs in G , i.e., a pair (x, y) is reachable if there is a path from x to y . Failure to do so will certainly get you fired.

Write a note (say, 100-200 words) to convince him that it is an impossible task, and that it takes more than SQL to do that. Your note must be convincing, yet not too technical, as your CEO knows only SQL and nothing else. Remember your note must also be neat and precise, since he is your boss.