Universität Freiburg
Institut für Informatik
Prof. Dr. G. Lausen
Michael Schmidt

Georges-Köhler Allee, Geb. 51
D-79110 Freiburg
Tel. (0761) 203-8120
Tel. (0761) 203-8127

Formal Foundations of Information Systems
Summerterm 2009
28.04.2009

2. Exercise Set: Minimization and Unions of Conjunctive Queries, Constraints

Exercise 6 (Enthaltensein-Beziehungen und Minimierung, 3+3=6Punkte)
Consider the following four Conjunctive Queries, where c denotes a constant.

- $q_1 : ans(X, Y) \leftarrow R(X, A), R(A, B), R(B, Y)$
- $q_2 : ans(X, Y) \leftarrow R(X, A), R(A, B), R(B, C), R(C, Y)$
- $q_3 : ans(X, Y) \leftarrow R(X, A), R(B, C), R(D, Y), R(X, B), R(A, C), R(C, Y)$
- $q_4 : ans(X, Y) \leftarrow R(X, A), R(A, c), R(c, B), R(B, Y)$

a) Find all equivalences and containment relationships between the above queries.

b) Minimize all queries.

Exercise 7 (Vereinigung Konjunktiver Anfragen, 2+2=4 Punkte)
Let E(*src*,*dest*) denote the edge relation of a directed graph and consider the following three Conjunctive Queries.

Q_1 : ans(X,Y) :- E(X,Y), E(Y,Z)
Q_2 : ans(X,Y) :- E(X,W), E(W,Y)
Q_3 : ans(X,Y) :- E(X,Y), E(X,U), E(U,Y)

a) Check if $Q_i \sqsubseteq Q_j$ forall $i \neq j$, $1 \leq i \leq 3$, $1 \leq j \leq 3$. Whenever containment does not hold for a pair of queries, provide a sample instance that proves violation.

b) Show that $\{Q_1, Q_2\} \equiv \{Q_1, Q_2, Q_3\}$ holds.

Exercise 8 (Constraints in First-order Logic, 1+1+1+1+1=5 Punkte)
Consider the following database schema.

hasAirport(*c_id*)
fly(*c_id1*,*c_id2*,*dist*)
rail(*c_id1*,*c_id2*,*dist*)

Specify the constraints below in First-order Logic and indicate if your specification is a tuple-generating dependency, equality-generating dependency, or none of both. In case of tuple-generating or equality-generating dependencies additionally compute their *body* and *head*.

a) α_1: If a city has an airport, then there is at least one flight departing from this city.

b) α_2: The distance of a rail connection functionally depends on the departure and destination station.

c) α_3: There is at least one flight and one train connection listed in the database.

d) α_4: Starting from Frankfurt, all cities with airport can be reached either by direct flight or by a flight with only one intermediate stop.

e) α_5: All pairs of cities with airport that have a direct train connection also have a direct flight connection.

Due by: 05.05.2009

Further Reading: S. Abiteboul, R. Hull, V. Vianu: *Foundations of Databases*, Addison-Wesley, 1995. ISBN 0-201-53771-0. Download-Links to the individual chapters of the book are provided at

`http://www.inf.unibz.it/~nutt/FDBs0809`