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Formal Foundations of Information Systems
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1. Exercise Set: Conjunctive Queries and Containment

Exercise 1 (Konjunktive Anfragen und SQL, 2+2+2=6Punkte)
Consider the following database scheme.

- `Sales`(*PName,SName,CName*)
- `Part`(*PName,Type*)
- `Cust`(*CName,CAddr*)
- `Supp`(*SName,SAddr*)

Further assume that the attributes *CAddr* and *SAddr* store the point of origin of the customers and suppliers, respectively. Specify the following queries in SQL and – whenever possible – as a Conjunctive Query.

a) Part-, supplier-, and customer name of all parts of type "*typ1*" that have been bought from a customer living in Freiburg.

b) All parts of type "*typ2*" that have been bought from both customer "*Meier*" and customer "*Smith*".

c) All parts that have never been sold.

Exercise 2 (Auswertung von konjunktiven Anfragen, 1+1+1+2=5 Punkte)
Consider the following sample instantiation $\mathcal{I}$ of the schema from Exercise 1.

Sales	PName	SName	CName
	Audi A7	Autohaus Wenz	Meier
	Audi A8	Autohaus Klein	Meier
	Audi A8	Autohaus Wenz	Smith
	Suzuki GSX	Motorsport AG	Hofmann

Part	PName	Type
	Audi A8	Auto
	Audi A7	Auto
	Suzuki GSX	Motorrad

Cust	CName	CAddr
	Meier	Freiburg
	Smith	Freiburg
	Hofmann	Mannheim

Supp	SName	SAddr
	Autohaus Wenz	Freiburg
	Autohaus Klein	Mannheim
	Motorsport AG	Mannheim

Compute the evaluation result of the following queries on instance $\mathcal{I}$ and informally describe their meaning. Note that constants inside the queries are distinguished by *italic* font.

a) q_1: ans(C) ← `Sales`(P,S,C), `Cust`(C,*Freiburg*), `Supp`(S,*Freiburg*)

b) q_2: ans(S,P) ← `Sales`(P,S,*Meier*), `Supp`(S,*Mannheim*), `Part`(P,*Auto*)

c) q_3: ans(S,P) ← Sales(P,S,*Meier*), Supp(S,*Mannheim*), Part(P2,*Auto*)

d) q_4: ans(C1,C2) ← Cust(C1,*Freiburg*), Cust(C2,*Freiburg*), Sales(P1,S1,C1),
Sales(P2,S2,C2), Supp(S1,X), Supp(S2,X)

Exercise 3 (Enthaltensein-Beziehungen, 2+2+2=6Punkte)

Consider the following pairs of Conjunctive Queries and decide for each pair q_i, q_i' if $q_i \sqsubseteq q_i'$, $q_i' \sqsubseteq q_i$, and $q_i \equiv q_i'$ holds. If such relationships hold provide the corresponding containment mappings. Otherwise, show that no such mapping exists.

a) q_1: ans(X,Y) ← R(X,Z), R(Z,T), S(T,Y) und q_1': ans(X,Z) ← R(X,X), S(X,Z)

b) q_2: ans(X) ← R(X,Y), S(Y,Z), S(Y',Z') und q_2': ans(Y) ← S(A,B), R(Y,A), R(Y',A)

c) q_3: ans(U,Z) ← R(U,V), R(X,Y), S(Y,Z), S(V,X) und q_3': ans(U,V) ← R(Y,U), R(U,X), S(U,V), S(X,Y)

Exercise 4 (Enthaltensein-Beziehungen und kanonische Instanz, 2+2=4Punkte)

Consider the following pairs of Conjunctive Queries and decide if $q_i \sqsubseteq q_i'$, $q_i' \sqsubseteq q_i$, and $q_i \equiv q_i'$ hold using the method of the canonical instance.

a) q_1: ans(X) ← R(X,Y,X), R(X,Z,Y), S(Y,X) und q_1': ans(X) ← R(X,Y,Z), S(Y,Z)

b) q_2: ans(X) ← R(X,Y), R(Y,Z), R(Z,X) und q_2': ans(X) ← R(X,Y), R(Y,Z), R(Z,U), R(U,V)

Exercise 5 (Enthaltensein-Beziehungen von Graph-Zyklen, 4 Punkte)

Consider the infinite sequence of Conjunctive Queries $Q_1, Q_2, \ldots$, where

$$Q_i: \text{ans}(X) \leftarrow \text{arc}(X,Z_1), \text{arc}(Z_1,Z_2), \ldots, \text{arc}(Z_{i-1},Z_i), \text{arc}(Z_i,X)$$

Q_i represents a cycle of length $i + 1$ in a directed graph with edge relation arc. Which containment relationships exist between the Q_i?

Due by: 04/28/2009