Homework Assignment #3

CS 589 Principles of Database Systems: Spring 2011

This assignment is due Thursday, 3 March, at the beginning of class. You may do this assignment with a partner. If you do so, turn in a single submission with both names. You may seek help from your partner, the instructor and the class mailing list, but not other sources.

3A (10 points): Prove the correctness of the equivalence

$$r \bowtie (s \cup u) \equiv (r \bowtie s) \cup (r \bowtie u)$$

A set-theoretic definition of join is

$$r(R) \bowtie s(S) = \{t[RS] \mid t[R] \in r \text{ and } t[S] \in s\}.$$

3B (12 points): Give a counter-example for each of the following equivalences. (You should assume they are well formed.) The relations have schemas r(R), s(S) and u(W) and X, Y and Z are sets of attributes.

a. $\pi_{XS}(r \bowtie s) \equiv \pi_X(r) \bowtie s$
b. r LOJ (s LOJ u) ≡ (r LOJ s) LOJ u
c. $\pi_X(G[Y; CA=sum(A)](r)) \equiv G[Y; CA=sum(A)](\pi_Z(r))$
d. $\pi_X(r - u) \equiv \pi_X(r) - \pi_X(u)$

3C (10 points): Give side conditions for the equivalences in 3B-a and 3B-c that will make the statement hold. Conditions should be at the schema level (rather than the relation-instance level). Try to make the conditions as permissive as possible.

3D (18 points): Which of the following equivalences hold? For those that don't, give a counterexample. Recall that $\cup^+$ (union-all) and π^+ (project-all) do not remove duplicates and that DE is the duplicate-elimination operator. Assume that intersection returns a set and that join preserves duplicates.

a. $(r \cup^+ s) \cap u \equiv (r \cap u) \cup^+ (s \cap u)$
b. $(r \cap s) \cup^+ u \equiv (r \cup^+ u) \cap (s \cup^+ u)$
c. $r \cup^+ r \equiv r$
d. $(r \cup^+ s) \cup^+ u \equiv r \cup^+ (s \cup^+ u)$
e. $DE(\pi^+_X(r)) \equiv \pi^+_X(DE(r))$
f. $DE(r \bowtie s) \equiv DE(r) \bowtie DE(s)$

3E (15 points) Minimize the following tableau query. (That is, find an equivalent tableau query with the fewest rows.) Show the substitution θ that maps the original tableau to the minimized tableau and, for each original row, say which row in the minimum tableau θ maps it to.

	T(A	B	C	D	E)
w1	a1	b	c1	d1	e1
w2	a2	b	c3	d2	e3
w3	5	b	c2	d1	e2
w4	a3	b1	c4	d1	3
w5	a4	b2	c	d3	e
w6	a5	b3	c	d5	e4
w7	a5	b4	c	d5	e
wr		b	c		e

3F (12 points) Synthesize a 3NF database schema from the dependencies
$F = \{A \rightarrow B, CD \rightarrow A, CB \rightarrow D, AE \rightarrow G, CE \rightarrow D\}$ over the schema R = ABCDEG.
Make sure your database schema has the lossless join property.