Homework Assignment #3

CS 589 Principles of Database Systems: Spring 2016

This assignment is due Thursday, 26 May, at the beginning of class. You are welcome to work this assignment alone or with a partner. If you work with a partner, please turn in just one paper with both of your names on it.

4A (20 points) Synthesize a 3NF database schema from the dependencies
F = {A → B, ACE → DG, CD → A, CB → D, ABE → G, CE → AD} over the schema R = ABCDEG. Show your intermediate steps (maximum rights sides, minimum cover, reduced cover). Make sure your database schema has the lossless join property.

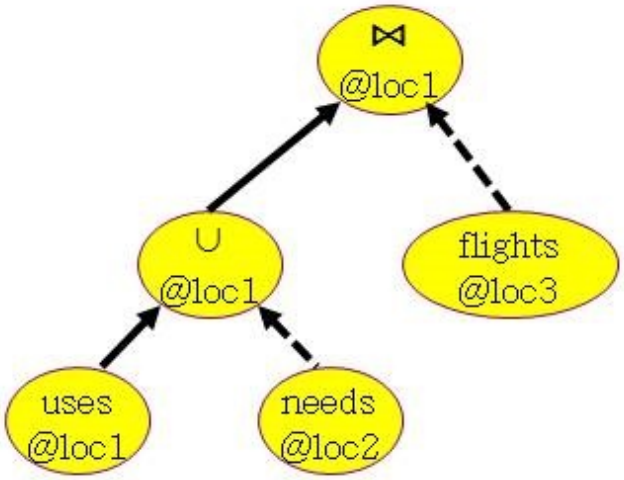
4B (10 points): Prove the correctness of the equivalence below, where A is an attribute in the schema of R.

$$\sigma_{A=a}(r \bowtie s) \equiv \sigma_{A=a}(r) \bowtie s$$

A set-theoretic definition of join is

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

4C (20 points): Consider executing relational queries in a distributed setting, and we are interested in minimizing data movement. The figure below shows an algebra query labeled with the locations where data is stored or operations are performed. We are interested in the dashed arrows, as they represent places we need to move data between locations. (Note that I switched the order of arrows relative to lectures, to emphasize data flow.)



Suggest two relational query transformations (other than the semi-join optimization shown in class) that have the potential for reducing the amount of data movement. For each transformation, explain under what conditions its use is likely to reduce data movement. ***Note:*** *The transformations can be for any operators, not just the ones in the example.*

4D (24 points): Which of the following equivalences hold? For those that don't, give a counter-example. Recall that $\cup^+$ (union-all) and π^+ (project-all) do not remove duplicates and that DE is the duplicate-elimination operator. Assume that join preserves duplicates.

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

4E (20 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	a3	b2	c	d3	e
w6	a4	b4	c	d5	e
w7	a4	b3	c	d5	e4
w		b	c		e