CSE 232

Practice Problem Set #2

1. Consder a relation R with attributes $ABCD$ and a decomposition $\rho = \{AB, BC, CD\}$ for R. Show that ρ has lossless join with respect to $F = \{B \to A, C \to B\}$.

2. Let R be a relation over attributes $ABCDE$, and

$$F = \{AB \to C, C \to E, E \to C, C \to D, AB \to E\}.$$

Show that the decomposition $\rho = \{ABC, ADE, CE\}$ is dependency preserving with respect to F.

3. Minimize the set of fds

$$G = \{A \to C, AB \to C, C \to DI, CD \to I, EC \to AB, EI \to C\}.$$

4. Suppose we have a database for an investment firm, consisting of the following attributes: B (broker), O (office of a broker), I (investor), S (stock), Q (quantity of stock owned by an investor), and D (divident paid by a stock), with the following functional dependencie: $S \to D, I \to B, IS \to Q, B \to O$.

(a) Find a key for the relation R over attributes $BOSQID$.

(b) How many keys does R have? Prove your answer.

(c) Find a lossless join decomposition of R into Boyce-Codd Normal Form.

(d) Find a decomposition of R into Third Normal Form, having lossless join and preserving dependencies.

5. Let R be a relation over attributes $ABCD$ and
$F = \{AB \to CD, D \to C, B \to C\}$.

(a) Find a BCNF decomposition for R and F that has lossless join.

(b) Is the decomposition found in (a) dependency preserving with respect to F? If not, go to (c).

(c) Find a 3NF decomposition for R and F that has lossless join and is dependency preserving.

6. Let R be a relation over $ABCDE$. Minimize the query

$$\pi_{ACE}(R) \bowtie \pi_{ADE}(R) \bowtie \pi_{BCD}(R)$$

knowing that it is only applied to instances of R satisfying the set of constraints $\{A \to B, E \to D, D \to\to E\}$.

7. Prove the following:

(i) (The schema is ABC.) If $A \to\to B$ and $C \to B$ then $A \to B$.

(ii) (The schema is $ABCD$.) If $A \to\to BC$ and $A \to\to C$ then $A \to\to B$.

8. Consider the following schedule in the lock/unlock model:
T3: lock(A)
T2: lock(B)
T3: unlock(A)
T1: lock(A)
T2: unlock(B)
T1: unlock(A)
T3: lock(B)
T2: lock(A)
T2: unlock(A)
T3: unlock(B)
i) Draw the serializability graph for this schedule. ii) Is the schedule serializable? (if yes, give an equivalent serial schedule).

9. Give an example of two transactions T1 and T2 that lock the same data entities, such that T1 satisfies two-phase locking, T2 violates two-phase locking, and there is a schedule for T1 and T2 that is not serializable.

10. Consider a concurrency control protocol requiring that every transaction request data entities in a fixed linear order (i.e., the data entities are $A_1 ... A_n$ and no transaction can request A_i after A_j if $i < j$).

(i) Does the above protocol ensure serializability of all resulting schedules ?

(ii) Does the protocol prevent deadlocks ? (Hint: consider a "waits-for" graph whose nodes are the transactions, and at a given time there is an edge from transaction t to transaction t' iff at that time t is waiting for a data entity held by t'. A deadlock occurs iff at some time the "waits-for" graph has a cycle.)

11. Show the B+-trees obtained by inserting the following key values in ascending order:

2, 3, 5, 7, 11, 17, 19, 23, 29, 31

Suppose the maximum number of values per node is 3. Next, show the B+-tree obtained by deleting 23.

12. Consider the relation

frequents: drinker, bar

providing the bars frequented by each drinker. Consider the query which on input *frequents*, returns as answer a relation of complex type $[drinker : \mathbf{dom}, bars : \{\mathbf{dom}\}]$ whose tuples provide, for each drinker, the *set* of bars the drinker frequents. Express this query in the complex object tuple calculus.