6 Databases (TGG)

We assume that for each base table $R$ in a relational database we have two update operations: $\text{insert}(R, t)$ which inserts tuple $t$ into table $R$ if $t$ does not violate any of the constraints declared for $R$ (fails otherwise), and $\text{delete}(R, p)$ which deletes all records in $R$ satisfying predicate $p$ (and fails if this would violate referential integrity constraints). Update operations are combined in programs to define transactions with ACID guarantees.

Suppose that we have defined a view $V = Q(R_1, R_2, \ldots, R_n)$, where the $R_i$ indicate the base tables used in query $Q$. The designers of a new database system want to allow users to update directly such a view. That is, if we have an update of the form $U = \text{insert}(V, t)$ or $U = \text{delete}(V, p)$, then the database system must automatically generate a transaction $T_U$ over the tables $R_i$ such that for any database instance $DB$ this diagram commutes:

$$
\begin{align*}
DB \xrightarrow{T_U} & DB' \\
\downarrow Q & \quad \downarrow Q \\
V \xrightarrow{U} & V'
\end{align*}
$$

In other words, applying the update $U$ directly to a view (as if it were a base table) produces the same result as applying $T_U$ to the database and then evaluating the view query.

A major problem with this approach is that there may be multiple distinct solutions for $T_U$. We explore this now.

(a) Explain the difference between a database query and a database view.  

[2 marks]

(b) Let $V = \pi_X(R)$ be a view for some base table $R$ and some subset $X$ of $R$'s attributes $Y$. How could this be translated into the desired transaction $T_U$? Discuss any problems with ambiguity that may arise.  

[5 marks]

(c) Let $V = \sigma_q(R)$ be a view for some base table $R$ and predicate $q$. How could this be translated into the desired transaction $T_U$? Discuss any problems with ambiguity that may arise.  

[5 marks]

(d) In the design of a database schema it was discovered that a relation $R$ violated Boyce-Codd normal form, and so it was replaced by two base tables $R_1$ and $R_2$ resulting from the standard decomposition process. Suppose users attempt to reconstruct the original relation using the view $V = R_1 \Join R_2$. Discuss the problems that might arise now in the construction of transaction $T_U$ for updates to $V$.  

[8 marks]