CS315: Introduction to Database Systems

Assignment #2

Due: 11 Feb. 2013, 18:00 HRS 2 Feb. 2013
Max Marks: 190

This assignment is on ER, EER models and relational algebra. Please submit pdf files (can either use Latex or handwrite and scan).

1. Consider a standard banking system consisting of customers and their accounts (types are savings, cheque, current, term deposit). Each account has an account number, details of the account holder(s) (name, address, phone number(s), Aadhar no. emailId). Customers carry out transactions like depositing or withdrawing money from their accounts. Term deposit accounts are for fixed durations and carry different rates of interest based on the duration. One cannot withdraw or deposit into term deposits but they can be closed before the due period is over with a 1% interest penalty.

   Construct an ER/EER model for the above application. Annotate the model suitably so that multiplicities, keys and other details of the model are clear.

   [25]

2. Consider a maternity hospital where each baby birth is associated with a mother, one or more nurses and one or more doctors. A tuple has the form $(baby, mother, nurse, doctor)$ where for each nurse doctor combination a row is present with the same baby and mother's name.

   (a) Represent the *birth* relation as a 4-way relation and incorporate the following constraints in each case:
      i. Every baby has a unique mother.
      ii. For a combination of *baby*, *nurse* and *doctor* there is a unique *mother*.
      iii. For every combination of *baby* and *mother* there is a unique *doctor*.

   (b) A different way to model it is to make *birth* an entity set and relate it with the other entity sets. Represent the model with the following constraints in each case:
      i. Every *baby* is associated with a unique *birth* and vice-versa.
      ii. In addition to 2(b)i) every *baby* has unique mother.
      iii. In addition to 2(b)i), 2(b)ii) for every birth there is a unique doctor.

   Indicate the keys in each case and the referential integrity constraints.
   Comment on the pros-cons of the two designs above.

   [40]

3. If we let a *birth* be associated with more than one *baby* (e.g. twins) born to a *mother* then represent the fact that each baby still has a unique *mother* for both the designs in question 2 above.

   [10]

4. We are given entity sets $E_1, \ldots, E_n$ with keys $K_1, \ldots, K_n$ respectively. Assume that R is a n-ary relation where all n entity sets participate.

   (a) For $n = 2$ give the minimum size of the key for R in terms of the attributes of E_1 and E_2 under the conditions:
      i. R is many-many.

ii. R is many-one from E_1 to E_2.

iii. R is 1-1.

(b) For general n what will be the smallest possible key for R in terms of K_is using only information about which edges from R to E_i are $x-1$, x is $1|N$.

[25]

5. Convert your ER diagram in question 1 to relations (i.e. tables).

[15]

6. Consider the following schema where domain types are mentioned and key attributes are underlined:

```
Supplier(sid:integer, sname:string, address:string)
Part(pid:integer pname:string, colour:string)
Catalogue(sid:integer, pid:integer, cost:real)
```

Write relational algebra expressions for the following:

(a) Find the names of suppliers who supply some *red* part.

(b) Find the `sids` of suppliers who supply some *red* or *green* part.

(c) Find the `sids` of suppliers who supply some *red* part or are located at *'Shopping Center IITK'*.

(d) Find the `sids` of suppliers who supply some *red* part and some *green* part.

(e) Find the `sids` of suppliers who supply every part.

(f) Find the `sids` of suppliers who supply every*red* part.

(g) Find the `sids` of suppliers who supply every*red* or *green* part.

(h) Find the `sids` of suppliers who supply every *red* part or supply every *gree*n part.

(i) Find pairs of `sids` such that the supplier with the first `sid` charges more for some part than the supplier with the second `sid`.

(j) Find the `pids` of parts supplied by at least two different suppliers.

(k) Find the `pids` of the most expensive parts supplied by suppliers named *Tata*.

(l) Find the *pids* of parts supplied by every supplier at less than Rs. 200. (If any supplier either does not supply the part or charges more than Rs. 200 for it, the part is not selected.)

[36]

7. Let us define two new relational operations the *semi-join* $\ltimes$ and the *anti semi-join* $\overline{\ltimes}$. Where $R \ltimes S$ is the bag of tuples $t \in R$ such that there is at least one tuple in S that agrees with t in all attributes that R and S have in common. Write 3 relational expressions that are equivalent to $R \ltimes S$. $R\,\overline{\ltimes}$ is the set of $t \in R$ that do not agree with any tuple of S in the attributes R and S have in common. Write a relational expression (with extensions, if needed) for $R\,\overline{\ltimes}$.

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8. Let R be the schema $R = (A_1, \ldots, A_n, B_1, \ldots, B_m)$ and S be the schema $S = (B_1, \ldots, B_m)$. The quotient R/S is the set of tuples t over $A_1, \ldots, A_n$ such that for every tuple $s \in S$ the tuple ts is in R. Write a relational expression (with extensions, if needed) for R/S.

[15]