CS-344 Database Management System

Lecture Notes – 29th August, 2011

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Revisiting Normal forms:

1. **First NF** :For a relation R to be in first NF , all its attributes should be atomic.
   If we don't have to split a attribute to perform a query, it is in first NF.

2. **Second NF** : A relation R is said to be in second NF if it does not have a functional dependency of the form a -> b where
   - RHS attributes are not part of any candidate key of the schema
   - LHS attributes form a proper subset of candidate key.

3. **Third NF:** A relation R is said to be in 3NF if it has functional dependencies of the form a->b which satisfies one of the following:
   - a->b is a trivial functional dependency
   - 'a' forms a superkey for R
   - each attribute in (b-a) is contained in a candidate key of R.

4. **BCNF:** A relation R is said to be in BCNF if it has functional dependencies of the form a->b where either a->b is a trivial functional dependency or 'a' forms a superkey for the relation R.

Lossless Decomposition : A relation R is decomposed into two relations R1 and R2 then decomposition will be lossless if R1 intersection R2 forms a superkey of either R1 and R2.

Dependency Preversing : If relation R with F as the set of functional dependencies is decomposed into R1, R2, ... with set of functional dependencies F1, F2... , we call it dependency preserving if the closure of F is equal to closure of (F1 U F2 U...) .

Example of schema violating 2NF :

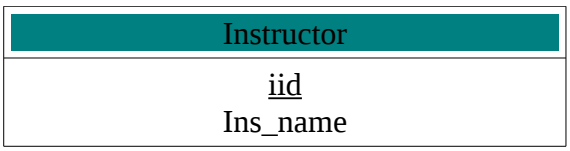
Ques1. consider the following instructor relation .

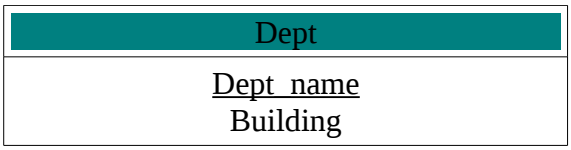
Instructor
iid
Ins_name
Dept_name
Building

The functional dependencies Dept_name -> Building and iid->Ins_name holds on the above relation . Does this relation belong to second NF ?

Sol. If we consider the functional dependency Dept_name -> Building , Building is not a part of candidate key and it depends on the attribute Dept_name which forms a proper subset of candidate key. Similar explanation for iid->Ins_name. Hence it is not in second NF.

Ques2. If we decompose the above relation into two new relations as given below, will the schema be in 2NF ?And state whether the decomposition is lossless or not.





Sol.

Functional dependencies : iid->Ins_name and Dept_name-> Building

Here iid is not a proper subset of candidate key of instructor relation and Dept_name is not proper subset of Dept relation. In both the cases the RHS attribute which is not a part of candidate key doesn't depend on attributes which form a proper subset of candidate key. Hence both the relations are in 2NF.

For a lossless decomposition the intersection of two relations should yield a set of attributes which form a superkey of either relations. Because here intersection of two relations gives a null set, it is not a lossless decomposition.

Theorems:

- **If every candidate key has only one attribute then the schema will be in 2NF.**

  Proof by contradiction :

  Let us assume that every candidate key has only one attribute and schema is not in 2NF.
  It means that attributes not part of candidate key depends on attributes which form proper subset of candidate key.
  But here as we have only one attribute in candidate key, proper subset will be empty set and LHS of a functional dependency can't be a empty set. Hence our assumption that schema will not be in 2NF is wrong.

- **If a relation has only two attributes then it is in BCNF.**

  Proof:

  Let a, b be the two attributes in a relation R. The possible functional dependencies are:
  case 1: LHS contains both attributes
  a b -> ---
  clearly this is a trivial functional dependency because RHS attributes form subset of LHS attributes .
  Case 2 : LHS contains only one attribute.
  a->---
  b->---
  clearly in this case, the LHS attribute will be candidate key
  Hence the possible functional dependencies are either trivial or the LHS attributes form a superkey.
  So, the relation having only two attributes will be in BCNF.