Assignment four

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Submitted By – Anurag Pandey

Solution 1

Functional Dependency:

Functional Dependency is a constraint between two sets of attributes in relation to a database. A functional dependency is denoted by an arrow (→). If an attribute A functionally determines B, then it is written as A → B.
For example, employee I. D→ name means employee_id functionally determines the name of the employee. As another example in a timetable database, {student_id, time} → {lecture_room}, student ID and time determine the lecture room where the student should be.

A function dependency A → B means for all instances of a particular value of A, there is the same value of B.

For example, in the below table A → B is true, but B → A is not true as there are different values of A for B = 3.

A	B
1	3
2	3
4	0
1	3
4	0

Trivial Functional Dependency:

X → Y is trivial only when Y is subset of X.
Examples

ABC → AB

ABC → A ABC → ABC

Non-Trivial Functional Dependencies:

X → Y is a non-trivial functional dependency when Y is not a subset of X.
X → Y is called completely non-trivial when X intersect Y is NULL.

Id → Name, Name → DOB

Transitive Dependency

When an indirect relationship causes functional dependency, it is called Transitive Dependency.

If P → Q and Q → R is true, then P → R is a transitive dependency.

First Normal Form –

If a relation contains composite or multi-valued attribute, it violates first normal form, or a relation is in first normal form if it does not contain any composite or multi-valued attribute. A relation is in first normal form if every attribute in that relation is **singled valued attribute**.

Eg 1 – Relation STUDENT in table 1 is not in 1NF because of multi-Valued attribute STUD_PHONE. Its decomposition into 1NF has been shown in

STUD_NO	STUD_NAME	STUD_PHONE	STUD_STATE	STUD_COUNTRY
1	RAM	9716271721, 9871717178	HARYANA	INDIA
2	RAM	9898297281	PUNJAB	INDIA
3	SURESH		PUNJAB	INDIA

Table 1

Conversion to first normal form

STUD_NO	STUD_NAME	STUD_PHONE	STUD_STATE	STUD_COUNTRY
1	RAM	9716271721	HARYANA	INDIA
1	RAM	9871717178	HARYANA	INDIA
2	RAM	9898297281	PUNJAB	INDIA
3	SURESH		PUNJAB	INDIA

Table 2

Second Normal Form –

To be in second normal form, a relation must be in first normal form and relation must not contain any partial dependency. A relation is in 2NF if it has **No Partial Dependency.** 2NF tries to reduce the redundant data getting stored in memory.

Eg-

STUD_NO	COURSE_NO	COURSE_FEE
1	C1	1000
2	C2	1500
1	C4	2000
4	C3	1000
4	C1	1000
2	C5	2000

In above table COURSE_FEE is dependent on a proper subset of the candidate key, which is a partial dependency and so this relation is not in 2NF.

To convert the above relation to 2NF,
we need to split the table into two tables such as:
Table 1: STUD_NO, COURSE_NO
Table 2: COURSE_NO, COURSE_FEE

Table 1		Table 2	
STUD_NO	COURSE_NO	COURSE_NO	COURSE_FEE
1	C1	C1	1000
2	C2	C2	1500
1	C4	C3	1000
4	C3	C4	2000
4	C1	C5	2000

Third Normal Form –A relation is in third normal form, if there is **no transitive dependency** for non-prime attributes as well as it is in second normal form.
A relation is in 3NF if **at least one of the following condition holds** in every non-trivial function dependency X –> Y

1.X is a super key.

2.Y is a prime attribute (each element of Y is part of some candidate key).

Eg-

Consider relation R (A, B, C, D, E)
A -> BC,
CD -> E,
B -> D,
E -> A
All possible candidate keys in above relation are {A, E, CD, BC} All attributes are on right sides of all functional dependencies are prime.

Boyce-Codd Normal Form (BCNF) –

A relation R is in BCNF if R is in Third Normal Form and for every FD, LHS is super key. A relation is in BCNF if in every non-trivial functional dependency X –> Y, X is a super key.

Eg-

Student ID	Subject	Professor
1DT15ENG01	SQL	Prof. Mishra
1DT15ENG02	JAVA	Prof. Anand
1DT15ENG02	C++	Prof. Kanthi
1DT15ENG03	JAVA	Prof. Anand
1DT15ENG04	DBMS	Prof. Lokesh

- One student can enrol for multiple subjects.
- There can be multiple professors teaching one subject
- And, For each subject, a professor is assigned to the student

In this table, all the normal forms are satisfied except BCNF.

Now in order to satisfy the BCNF, we will be dividing the table into two parts

Student ID	Professor ID
1DT15ENG01	1DTPF01
1DT15ENG02	1DTPF02
1DT15ENG02	1DTPF03
:	:

And in the second table, we will have the columns Professor ID, Professor and Subject.

Professor ID	Professor	Subject
1DTPF01	Prof. Mishra	SQL
1DTPF02	Prof. Anand	JAVA
1DTPF03	Prof. Kanthi	C++
:	:	:

Solution 2

Given the relation R = {P, Q, R, S, T, U, V, W, X, Y, Z} and the set of functional dependencies F = { {P,

R}→{Q}, {P}→{S, T}, {R}→{U}, {U}→{V, W}, {S}→{X, Y}, {U}→{Z}}. Find the key for R? Decompose R into 2NF and then 3NF relations and then to BCNF (show the steps of decomposition steps clearly)

Soln. – The key is { P, R } because it is the only key candidate key and it satisfies the requirement for being a key.
Now, we start with the relation R = { P, Q, R, S, T, U, V, W, X, Y, Z }
Since, R is not in 2NF because there is a functional dependency (P) →(S,T)
Where (S,T) is not a subset of the key.
We will decompose R into relations
R1 → (P,Q,R,S,T)
R2 →(P,U,V,W,Z) which are both in 2NF.

R1 is not in 3NF because there is a functional dependency (P,R) →(Q) where Q is not a subset of the key.
We will now, decompose the R1 into the relation R1' = (P,Q,R) , R1" = (P,S,T) which is now in 3NF.
R1' and R1" is in BCNF because they are in 3NF and and every FD is dependent on key.
Therefore the key for R is (P,R).

Solution No.3

Functional Dependencies are as follows-

Registration number	→	Model number
Model number	→	Capacity
Aadhar number	→	Address, name, phone no., salary
Test number	→	Name, maximum score

Test Number, Registration Number, Aadhar Number → date, No. of hours, Bus score.
Let, Reg. No., Model No., Aadhar No., Test Number be the Primary key.
There are various dependencies in the given description, so we will have to remove them from the database to create a relational schema.

Relational Schema in the 3rd Normal form will contain, Primary Keys and Foreign Keys.

Mode(Model_No(Primary key), capacity)
Bus(Reg_no(Primary Key), Model_No(Foreign Key))
Technician (adhar_No(Primary key), address, salary, name, Ph_No)
Test(Test_no(Primary Key), Name, max_score)
Test_Score(date, no_of_hours, bus_score, test_no(Foreign key), Reg_no(foreign Key), adhar_No(Foreign key))
Expert(adhar_No(Foreign key), Model_No(Foreign Key))

Relationship Table:

Entity 1	Relation Type	Entity 2
Model	One to many	Bus
Test	Many to one	Bus
Technician	Many to many	Model
Test score	Many to one	Test
Technician	One to many	Test Score