GALGOTIAS UNIVERSITY

School of Computing Science and Engineering

Program: BCA

Course Code:BCAC2102

Course Name: Database Management System

Lecture-22

Topic- Other Normalization Forms

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Lecture-21(RECAP)

Topic- BCNF

Objective : To acquire knowledge about BCNF-Normal Forms

Lecture-21

- A table is in Boyce-Codd normal form (BCNF) if every determinant in the table is a candidate key.

  (A determinant is any attribute whose value determines other values with a row.)

- If a table contains only one candidate key, the 3NF and the BCNF are equivalent.
- BCNF is a special case of 3NF.

Boyce-Codd Normal Form (BCNF)

- BCNF does not allow dependencies between attributes that belong to candidate keys.
- BCNF is a refinement of the third normal form in which it drops the restriction of a non-key attribute from the 3rd normal form.
- Third normal form and BCNF are not same if the following conditions are true:
  - The table has two or more candidate keys
  - At least two of the candidate keys are composed of more than one attribute
  - The keys are not disjoint i.e. The composite candidate keys share some attributes

Example 1 - Address (Not in BCNF)

Scheme → {City, Street, ZipCode }

1. Key1 → {City, Street }
2. Key2 → {ZipCode, Street}
3. No non-key attribute hence 3NF
4. {City, Street} → {ZipCode}
5. {ZipCode} → {City}
6. Dependency between attributes belonging to a key

Boyce Codd Normal Form (BCNF)

Example 2 - Movie (Not in BCNF)

Scheme → {MovieTitle, MovieID, PersonName, Role, Payment }

1. Key1 → {MovieTitle, PersonName}
2. Key2 → {MovieID, PersonName}
3. Both role and payment functionally depend on both candidate keys thus 3NF
4. {MovieID} → {MovieTitle}
5. Dependency between MovieID & MovieTitle Violates BCNF

Example 3 - Consulting (Not in BCNF)

Scheme → {Client, Problem, Consultant}

1. Key1 → {Client, Problem}
2. Key2 → {Client, Consultant}
3. No non-key attribute hence 3NF
4. {Client, Problem} → {Consultant}
5. {Client, Consultant} → {Problem}
6. Dependency between attributess belonging to keys violates BCNF

BCNF - Decomposition

1. Place the two candidate primary keys in separate entities
2. Place each of the remaining data items in one of the resulting entities according to its dependency on the primary key.

Example 1 (Convert to BCNF)

Old Scheme → {City, Street, ZipCode }

New Scheme1 → {ZipCode, Street}

New Scheme2 → {City, Street}

- Loss of relation {ZipCode} → {City}

Alternate New Scheme1 → {ZipCode, Street }

Alternate New Scheme2 → {ZipCode, City}

Decomposition – Loss of Information

1. If decomposition does not cause any loss of information it is called a **lossless** decomposition.
2. If a decomposition does not cause any dependencies to be lost it is called a **dependency-preserving** decomposition.
3. Any table scheme can be decomposed in a lossless way into a collection of smaller schemas that are in BCNF form. However the dependency preservation is not guaranteed.
4. Any table can be decomposed in a lossless way into 3rd normal form that also preserves the dependencies.
   - 3NF may be better than BCNF in some cases

Use your own judgment when decomposing schemas

BCNF - Decomposition

Example 2 (Convert to BCNF)

Old Scheme → {MovieTitle, MovieID, PersonName, Role, Payment }

New Scheme → {MovieID, PersonName, Role, Payment}

New Scheme → {MovieTitle, PersonName}

- Loss of relation {MovieID} → {MovieTitle}

New Scheme → {MovieID, PersonName, Role, Payment}

New Scheme → {MovieID, MovieTitle}

- We got the {MovieID} → {MovieTitle} relationship back

Example 3 (Convert to BCNF)

Old Scheme → {Client, Problem, Consultant}

New Scheme → {Client, Consultant}

New Scheme → {Client, Problem}

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Topic- Other Normalization Form

Objective : To acquire knowledge about Other Normalization Form

Lecture-22

Multivalued Dependencies

- Let R be a relation schema, and X and Y be disjoint subsets of R (i.e., X ⊆R, Y⊆ R, X∩Y=ϕ), and Z = R- XY.A relation r(R) satisfies X↠ Y if for any two tuples t_1 and t_2,
  - $t_1(X)=t_2(X)$, then there exist t_3 in r such that
  - $t_3(X)=t_1(X)$, $t_3(Y)=t_1(Y)$, $t_3(Z)=t_2(Z)$.
  - By symmetry, there exist t4 in r such that
  - $t_4(X)=t_1(X)$, $t_4(Y)=t_2(Y)$, $t_4(Z)=t_1(Z)$.

	X	Y	Z
t1	x1	y1	z1
t2	x1	y2	z2
t3	x1	y1	z2
t4	x1	y2	z1

- The MVD X↠ Y says that the relationship between X and Y is independent of the relationship between X and R-Y
- For example consider the table **Employee**:

Employee-name	Project-name	Dependant-name
Smith	X	John
Smith	Y	Ann
Smith	X	Ann
Smith	Y	John

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- MVDs Employee-name↠ Project-name and Employee-name↠ Dependant-name hold in the relation
- The employee named Smith works on projects X and Y, and has two dependents John and Ann.
- If we store only the first two tuples in the relation, it would incorrectly show the associations among attributes
- If we have MVDs in a relation, we may have to repeat values redundantly in the tuples. In the Employee relation, values X and Y of Project-name are repeated with each value of Dependant-name--- clearly undesirable
- Problem: Employee schema is in BCNF because no FDs hold for it
- Trivial MVD: If MVD X Y is satisfied by all relations whose schemas include X and Y, it is called trivial MVD.
  - $X \twoheadrightarrow Y$ is trivial whenever $Y \subseteq X$ or $X \cup Y = R$
- If a relation r fails to satisfy a given MVD, a relation r' that satisfies the MVD can be constructed by adding tuples to r.
  - MVD is called "tuple generating dependency"
  - compare it with FD: need to delete tuples to make the relation to satisfy a given FD

Fourth Normal Form (4NF)

- Fourth normal form eliminates independent many-to-one relationships between columns.
- To be in Fourth Normal Form,
  - a relation must first be in Boyce-Codd Normal Form.
  - a given relation may not contain more than one multi-valued attribute.

Example (Not in 4NF)

Scheme → {MovieName, ScreeningCity, Genre)

Primary Key: {MovieName, ScreeningCity, Genre)

1. All columns are a part of the only candidate key, hence BCNF
2. Many Movies can have the same Genre
3. Many Cities can have the same movie
4. Violates 4NF

Movie	ScreeningCity	Genre
Hard Code	Los Angles	Comedy
Hard Code	New York	Comedy
Bill Durham	Santa Cruz	Drama
Bill Durham	Durham	Drama
The Code Warrier	New York	Horror

Fourth Normal Form (4NF)

Example 2 (Not in 4NF)

Scheme → {Manager, Child, Employee}

1. Primary Key → {Manager, Child, Employee}
2. Each manager can have more than one child
3. Each manager can supervise more than one employee
4. 4NF Violated

Manager	Child	Employee
Jim	Beth	Alice
Mary	Bob	Jane
Mary	NULL	Adam

Example 3 (Not in 4NF)

Scheme → {Employee, Skill, ForeignLanguage}

1. Primary Key → {Employee, Skill, Language }
2. Each employee can speak multiple languages
3. Each employee can have multiple skills
4. Thus violates 4NF

Employee	Skill	Language
1234	Cooking	French
1234	Cooking	German
1453	Carpentry	Spanish
1453	Cooking	Spanish
2345	Cooking	Spanish

4NF - Decomposition

1. Move the two multi-valued relations to separate tables
2. Identify a primary key for each of the new entity.

Example 1 (Convert to 3NF)

Old Scheme → {MovieName, ScreeningCity, Genre}

New Scheme → {MovieName, ScreeningCity}

New Scheme → {MovieName, Genre}

Movie	Genre
Hard Code	Comedy
Bill Durham	Drama
The Code Warrier	Horror

Movie	ScreeningCity
Hard Code	Los Angles
Hard Code	New York
Bill Durham	Santa Cruz
Bill Durham	Durham
The Code Warrier	New York

4NF - Decomposition

Example 2 (Convert to 4NF)

Old Scheme → {Manager, Child, Employee}

New Scheme → {Manager, Child}

New Scheme → {Manager, Employee}

Manager	Child
Jim	Beth
Mary	Bob

Manager	Employee
Jim	Alice
Mary	Jane
Mary	Adam

Example 3 (Convert to 4NF)

Old Scheme → {Employee, Skill, ForeignLanguage}

New Scheme → {Employee, Skill}

New Scheme → {Employee, ForeignLanguage}

Employee	Skill
1234	Cooking
1453	Carpentry
1453	Cooking
2345	Cooking

Employee	Language
1234	French
1234	German
1453	Spanish
2345	Spanish

Fifth Normal Form (5NF)

- Fifth normal form is satisfied when all tables are broken into as many tables as possible in order to avoid redundancy. Once it is in fifth normal form it cannot be broken into smaller relations without changing the facts or the meaning.

Domain Key Normal Form (DKNF)

- The relation is in DKNF when there can be no insertion or deletion anomalies in the database.


Thank You