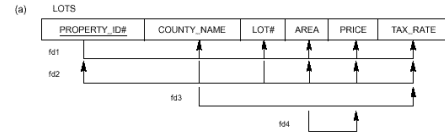


Normalization (Continued)

1

2NF but not in generalized 2NF

Figure 12.11



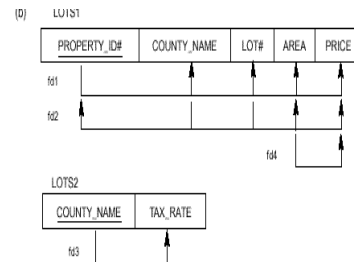
4

2NF - Definition

- ▶ A relation that is in 1NF and every non-primary-key attribute is fully functionally dependent on the primary key.

2

In General 2NF



5

Generalized 2NF - Definition

- ▶ A relation that is in 1NF and every non-primary-key attribute is fully functionally dependent on the *every key*
- ▶ Note that the definition of prime attribute is now modified to mean any attribute that is part of any candidate key

3

3NF - Definition

- ▶ A relation that is in 1NF and 2NF and in which NO non-primary-key attribute is transitively dependent on the primary key. {CODD's Original definition}

6

Generalized 3NF - Definition

- ▶ A relation that is in 3NF whenever a nontrivial functional dependency $X \rightarrow A$ holds in R, either:
 - X is a superkey of R
 - A is a prime attribute of R

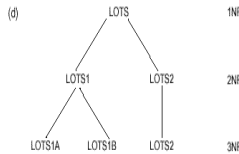
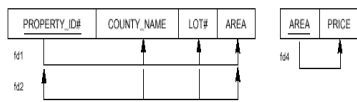
7

Boyce-Codd Normal Form (BCNF)

- ▶ Based on functional dependencies that takes into account all candidate keys in a relation.
- ▶ For a relation with only one candidate key, 3NF and BCNF are equivalent.
- ▶ A relation is in BCNF, if and only if every determinant is a candidate key.

10

In 3NF and generalized 3NF



8

Boyce-Codd Normal Form (BCNF)

- ▶ Violation of BCNF may occur in a relation that:
 - ▶ contains two (or more) composite keys
 - ▶ which overlap and share at least one attribute in common.

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Boyce-Codd Normal Form (BCNF)

3NF to BCNF

- ▶ Identify all candidate keys in the relation.
- ▶ Identify all functional dependencies in the relation.
- ▶ If functional dependencies exists in the relation where their determinants are not candidate keys for the relation, remove the functional dependencies by placing them in a new relation along with a copy of their determinant.

9

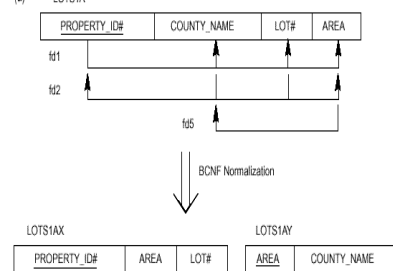
12

Normalization 3NF to BCNF Relations

Client Interview Relation

Client_No	Interview_Date	Interview_Time	Staff_No	Room_No
CR76	13-May-98	10.30	SG5	G101
CR56	13-May-98	12.00	SG5	G101
CR74	13-May-98	12.00	SG37	G102
CR56	1-Jul-98	10.30	SG5	G102

Another example (from book)



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Normalization 3NF to BCNF

Interview Relation

Client_No	Interview_Date	Interview_Time	Staff_No
CR76	13-May-98	10.30	SG5
CR56	13-May-98	12.00	SG5
CR74	13-May-98	12.00	SG37
CR56	1-Jul-98	10.30	SG5

Staff_Room Relation

Staff_No	Interview_Date	Room_No
SG5	13-May-98	G101
SG37	13-May-98	G102
SG5	1-Jul-98	G102

Normalization Report

Page 1		DreamHome		Date 1-Oct-98	
		Property Inspection Report			
Property Number PG4		Property Address 6 Lawrence St, Glasgow			
Inspection Date	Inspection Time	Comments	Staff Number	Staff Name	Car Reg
18-Oct-96	10.00	Need to replace crockery	SG37	Ann Beech	M231 JGR
22-Apr-97	09.00	In good order	SG14	David Ford	M533 HDR
1-Oct-98	12.00	Damp rot in bathroom	SG14	David Ford	N721 HFR

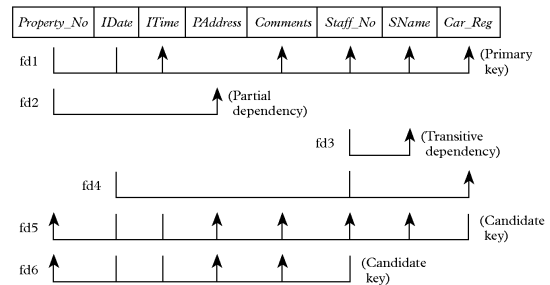
BCNF Definition

- A relational schema R is in BCNF if whenever a nontrivial functional dependency $X \rightarrow A$ holds in R then X is a superkey (candidate suffices) of R.
- Note the main difference between generalized 3NF and BCNF is the lack of the second condition
 - A is prime attribute of R. is ABSENT

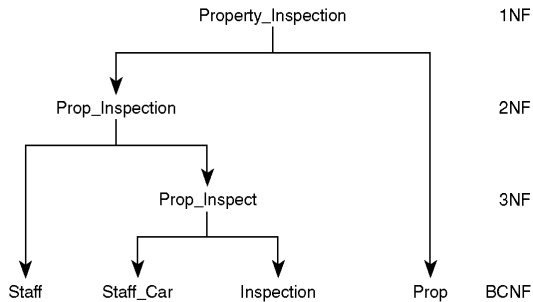
15

Example - Normalization FDs of Property_Inspection Relation

Primary Key



Normalization Review Process of Decomposition



4NF - Definition

- ▶ A relation that is in Boyce-Codd Normal Form and contains no MVDs.
- ▶ BCNF to 4NF involves the removal of the MVD from the relation by placing the attribute(s) in a new relation along with a copy of the determinant(s).

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Fourth Normal Form (4NF)

- ▶ Associated with a dependency called multi-valued dependency (MVD).

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Normalization BCNF to 4NF Relations

Branch_Staff_Client relation

<i>Branch_No</i>	<i>SName</i>	<i>CName</i>
B3	Ann Beech	Aline Stewart
B3	David Ford	Aline Stewart
B3	Ann Beech	Mike Richie
B3	David Ford	Mike Richie

- ▶ Represents a dependency between attributes (for example, A, B, and C) in a relation, such that for each value of A there is a set of values for B, and a set of values for C. However, the set of values for B and C are independent of each other.

- ▶ MVD between attributes A, B, and C in a relation using the following notation:

A \twoheadrightarrow B
A \twoheadrightarrow C

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Normalization BCNF to 4NF Relations

Branch_Staff relation

<i>Branch_No</i>	<i>SName</i>
B3	Ann Beech
B3	David Ford

Branch_Client relation

<i>Branch_No</i>	<i>CName</i>
B3	Aline Stewart
B3	Mike Richie