Database Management Systems (CSN-351)
Relational Database Design (contd.)

BTech 3rd Year (CS) + Minor + Audit

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Indian Institute of Technology Roorkee
Roorkee, Uttarakhand - 247 667, India

1NF

EMP_PROJ

		Projs	
Ssn	Ename	Pnumber	Hours

1NF

EMP_PROJ

		Projs	
Ssn	Ename	Pnumber	Hours

Ssn	Ename	Pnumber	Hours
123456789	Smith, John B.	1	32.5
		2	7.5
666884444	Narayan, Ramesh K.	3	40.0
453453453	English, Joyce A.	1	20.0
		2	20.0
333445555	Wong, Franklin T.	2	10.0
		3	10.0
		10	10.0
		20	10.0
999887777	Zelaya, Alicia J.	30	30.0
		10	10.0
987987987	Jabbar, Ahmad V.	10	35.0
		30	5.0
987654321	Wallace, Jennifer S.	30	20.0

1NF

EMP_PROJ		Projs	
Ssn	Ename	Pnumber	Hours

1NF

EMP_PROJ

		Projs	
Ssn	Ename	Pnumber	Hours

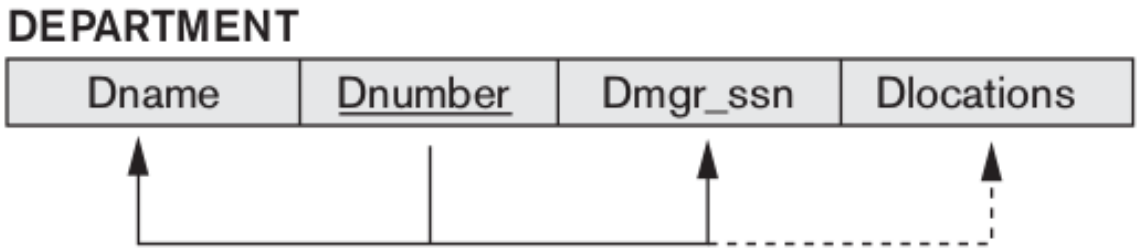
EMP_PROJ1

Ssn	Ename

EMP_PROJ2

Ssn	Pnumber	Hours

1NF



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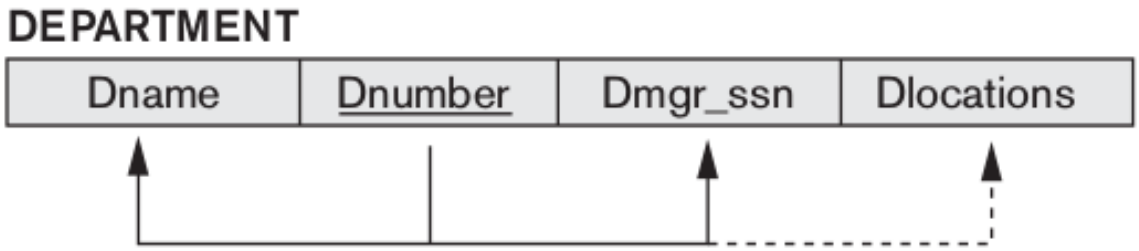
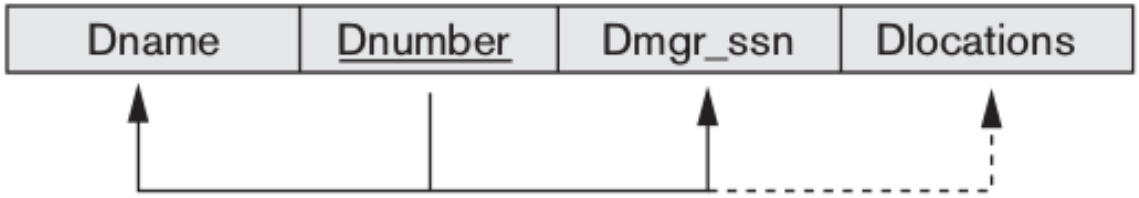


DEPARTMENT

Dname	Dnumber	Dmgr_ssn	Dlocations
Research	5	333445555	{Bellaire, Sugarland, Houston}
Administration	4	987654321	{Stafford}
Headquarters	1	888665555	{Houston}

1NF

DEPARTMENT



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Research	5	333445555	Sugarland
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2NF

Definition (2NF)

A relation schema R is in 2NF if every *nonprime* attribute A in R is *fully functionally dependent* on the primary key of R.

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Definition (Prime and Nonprime Attributes)

An attribute of relation schema R is called a prime attribute of R if it is a member of some candidate key of R. An attribute is called nonprime if it is not a prime attribute — that is, if it is not a member of any candidate key.

2NF

Definition (Full Functional Dependency)

A functional dependency $X \rightarrow Y$ is a full functional dependency if removal of any attribute A from X means that the dependency does not hold any more; that is, for any attribute $A \in X, (X - \{A\})$ does not functionally determine Y.

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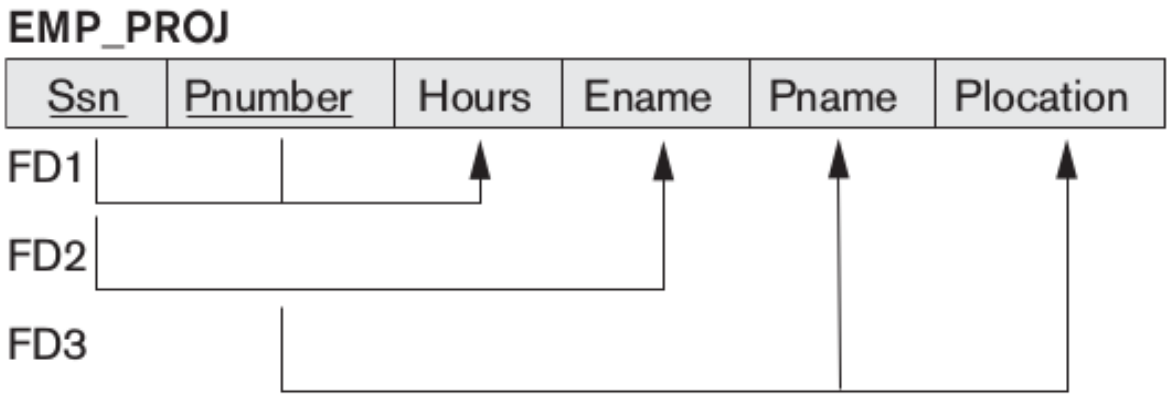
Definition (Partial Functional Dependency)

A functional dependency $X \rightarrow Y$ is a partial dependency if some attribute $A \in X$ can be removed from X and the dependency still holds; that is, for some $A \in X, (X - \{A\}) \rightarrow Y$.

2NF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FD1
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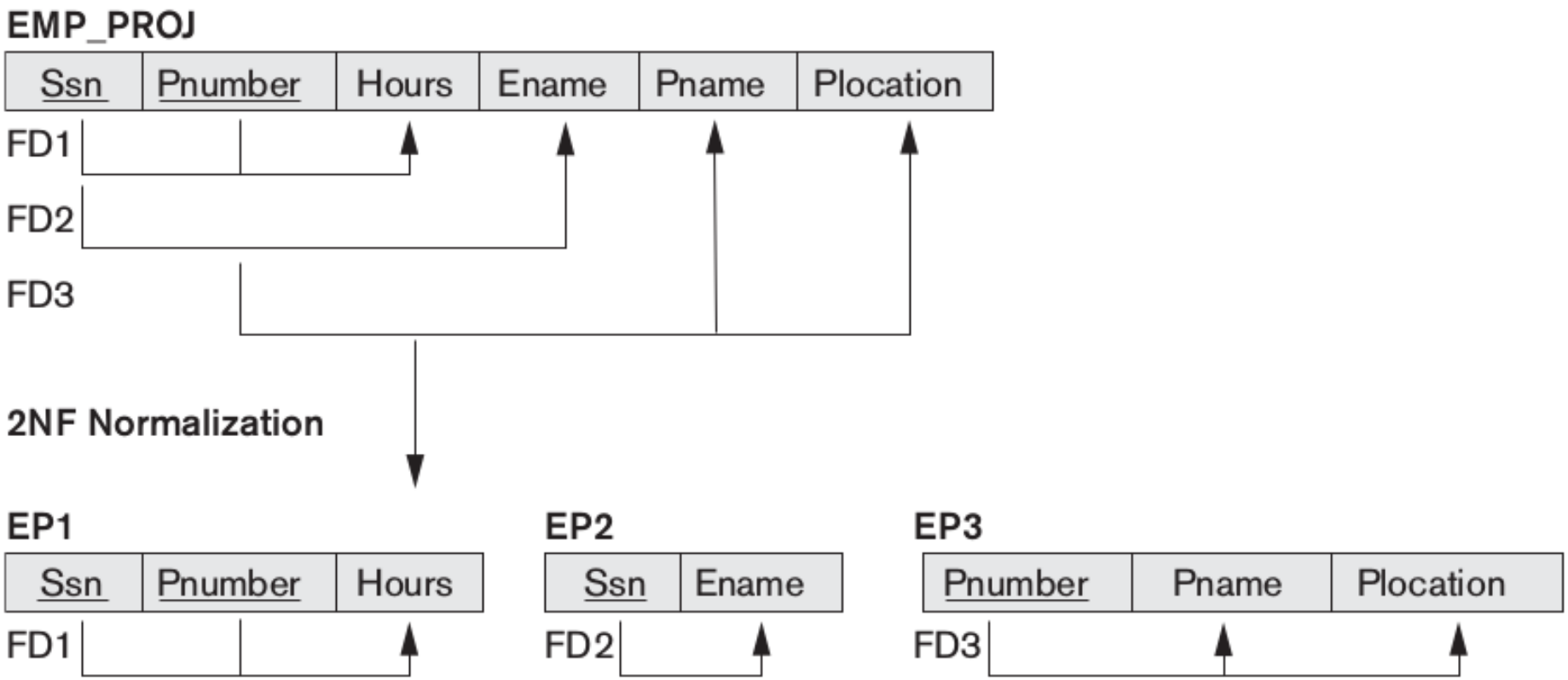
FD3

2NF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2NF Normalization
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Hours
FD1
EP2
Ssn
Ename
FD2
EP3
Pnumber
Pname
Plocation
FD3

3NF

Definition (3NF)

A relation schema R is in 3NF if it satisfies 2NF and no nonprime attribute of R is *transitively dependent* on the primary key.

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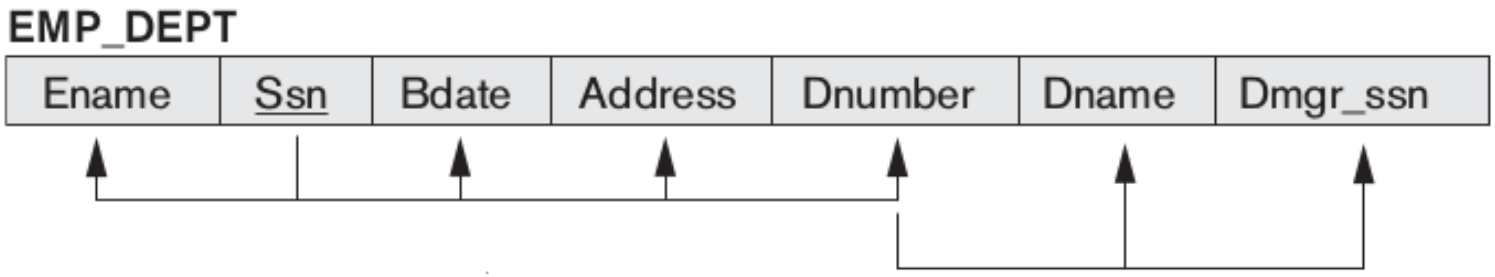
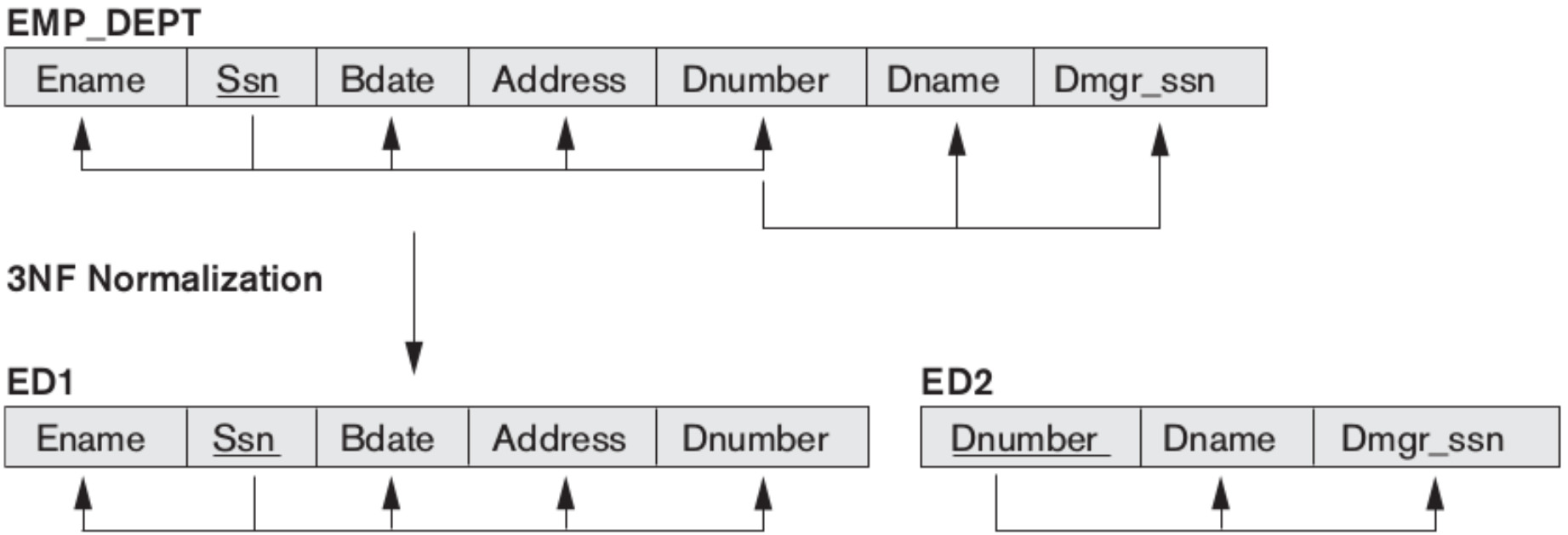
Definition (Transitive Dependency)

A functional dependency $X \rightarrow Y$ in a relation schema R is a transitive dependency if there exists a set of attributes Z in R that is neither a candidate key nor a subset of any key of R and both $X \rightarrow Z$ and $Z \rightarrow Y$ hold.

3NF



3NF


EMP_DEPT
Ename
Ssn
Bdate
Address
Dnumber
Dname
Dmgr_ssn
3NF Normalization
ED1
Ename
Ssn
Bdate
Address
Dnumber
ED2
Dnumber
Dname
Dmgr_ssn

Summary of Normal Forms

Normal Form	Test	Remedy (Normalization)
First (1NF)	Relation should have no multivalued attributes or nested relations.	Form new relations for each multivalued attribute or nested relation.
Second (2NF)	For relations where primary key contains multiple attributes, no nonkey attribute should be functionally dependent on a part of the primary key.	Decompose and set up a new relation for each partial key with its dependent attribute(s). Make sure to keep a relation with the original primary key and any attributes that are fully functionally dependent on it.
Third (3NF)	Relation should not have a nonkey attribute functionally determined by another nonkey attribute (or by a set of nonkey attributes). That is, there should be no transitive dependency of a nonkey attribute on the primary key.	Decompose and set up a relation that includes the nonkey attribute(s) that functionally determine(s) other nonkey attribute(s).

General Definitions: 2NF

Definition (2NF — Old)

A relation schema R is in 2NF if every nonprime attribute A in R is fully functionally dependent on the primary key of R.

General Definitions: 2NF

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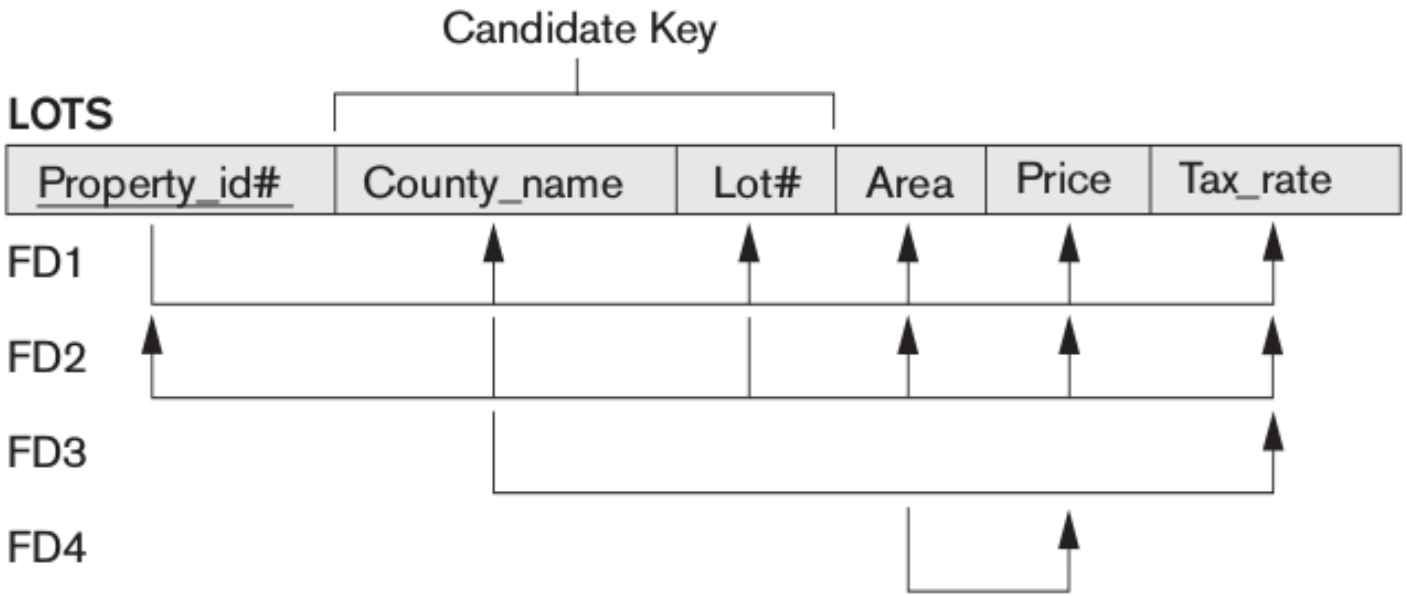
A relation schema R is in 2NF if every nonprime attribute A in R is fully functionally dependent on the primary key of R.

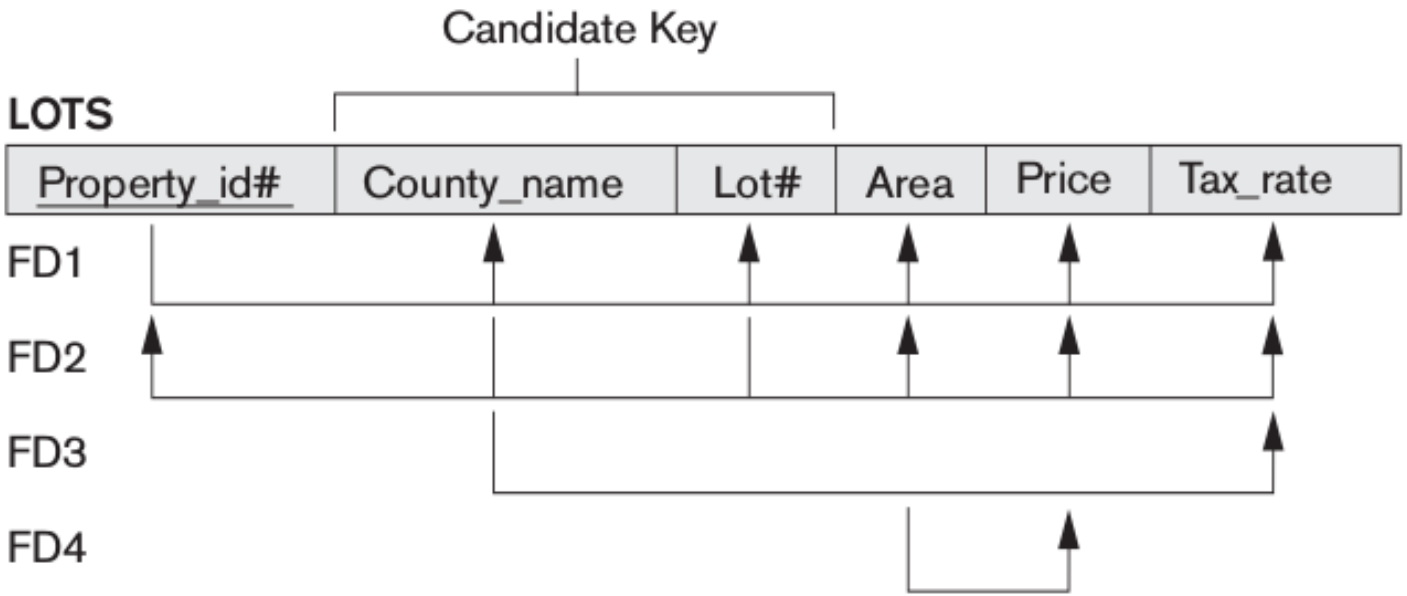
Definition (2NF — General)

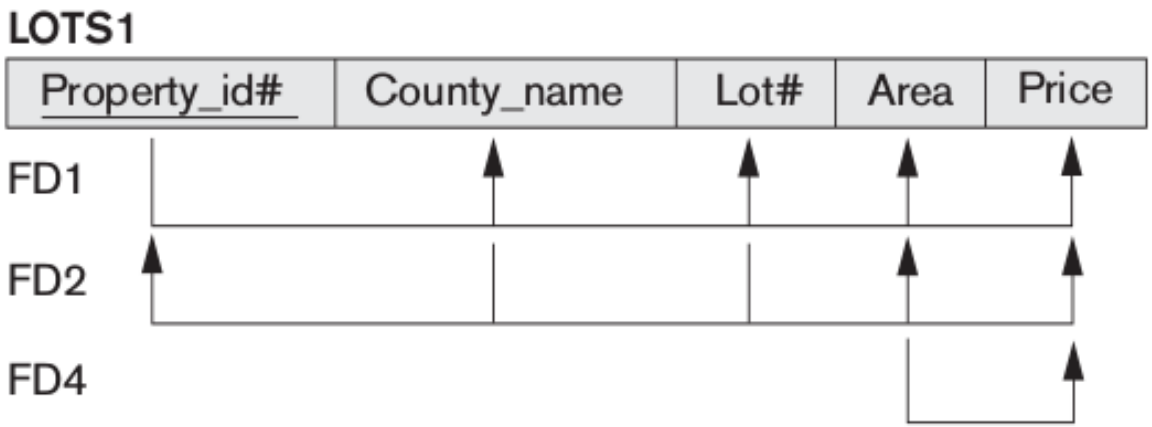
A relation schema R is in second normal form (2NF) if every nonprime attribute A in R is not partially dependent on any key of R.

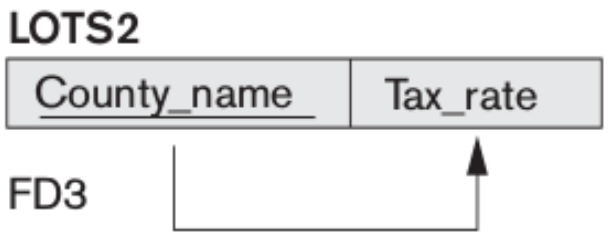
General Definitions: 2NF



General Definitions: 2NF







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Definition (3NF — Old)

A relation schema R is in 3NF if it satisfies 2NF and no nonprime attribute of R is transitively dependent on the primary key.

Definition (3NF — General)

A relation schema R is in third normal form (3NF) if, whenever a nontrivial functional dependency $X \rightarrow A$ holds in R, either (a) X is a superkey of R, or (b) A is a prime attribute of R.

General Definitions: 3NF

Definition (3NF — Old)

A relation schema R is in 3NF if it satisfies 2NF and no nonprime attribute of R is transitively dependent on the primary key.

Definition (3NF — General)

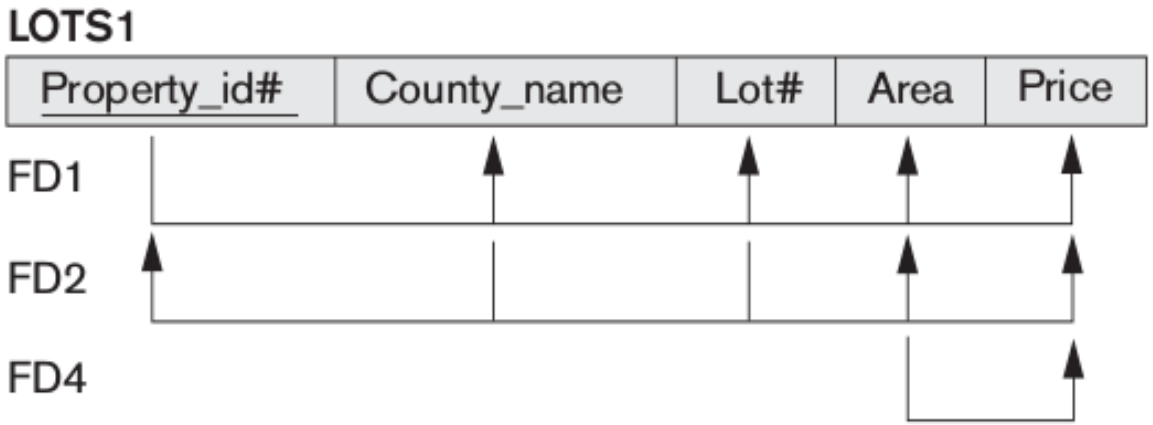
A relation schema R is in third normal form (3NF) if, whenever a nontrivial functional dependency $X \rightarrow A$ holds in R, either (a) X is a superkey of R, or (b) A is a prime attribute of R.

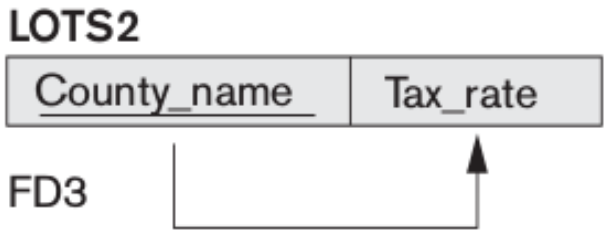
Definition (3NF — General Alternative)

A relation schema R is in 3NF if every nonprime attribute of R meets both of the following conditions:

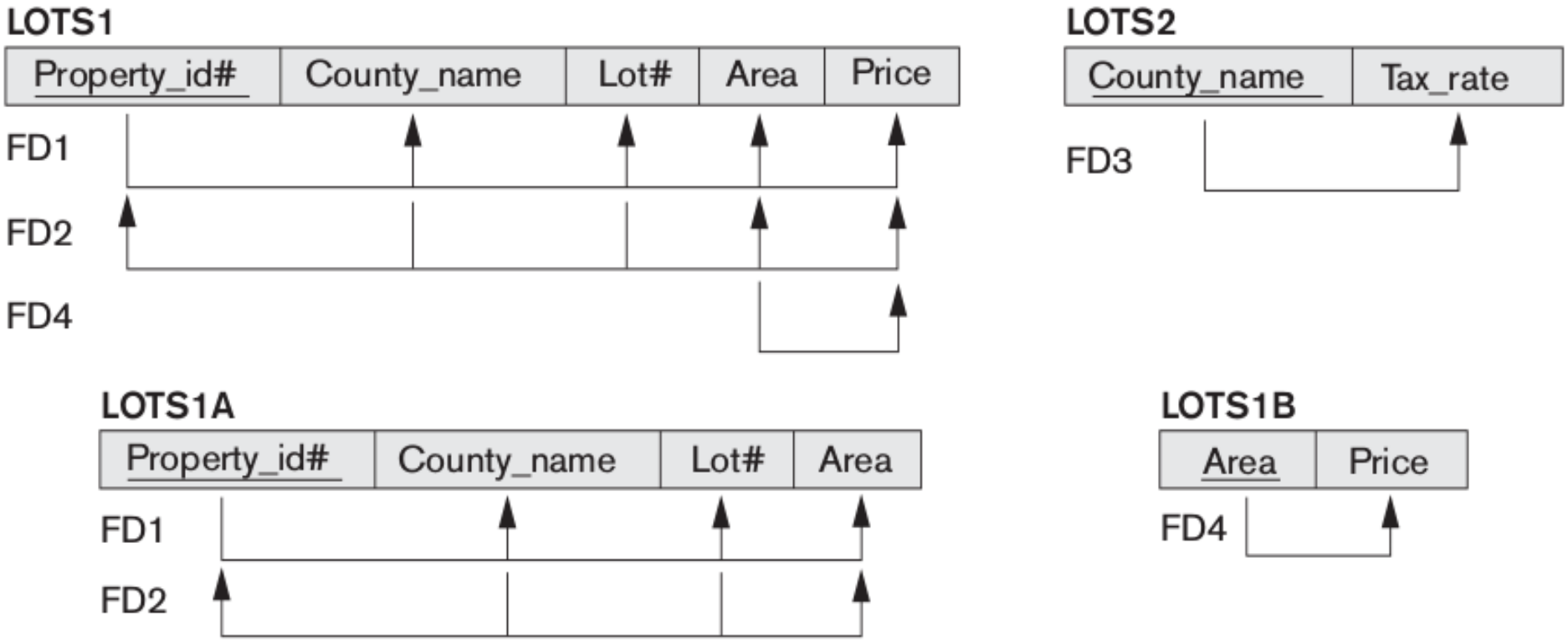
- It is fully functionally dependent on every key of R.
- It is nontransitively dependent on every key of R.

General Definitions: 3NF





General Definitions: 3NF



BCNF

Definition (BCNF)

A relation schema R is in Boyce-Codd normal form (BCNF) if whenever a nontrivial functional dependency $X \rightarrow A$ holds in R, then X is a superkey of R.

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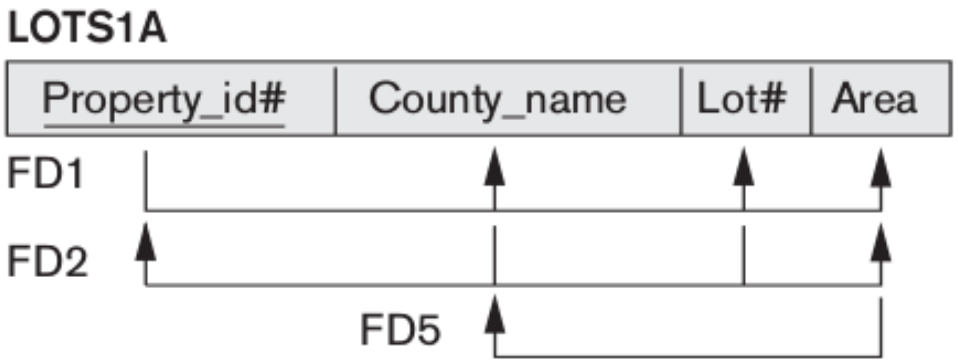

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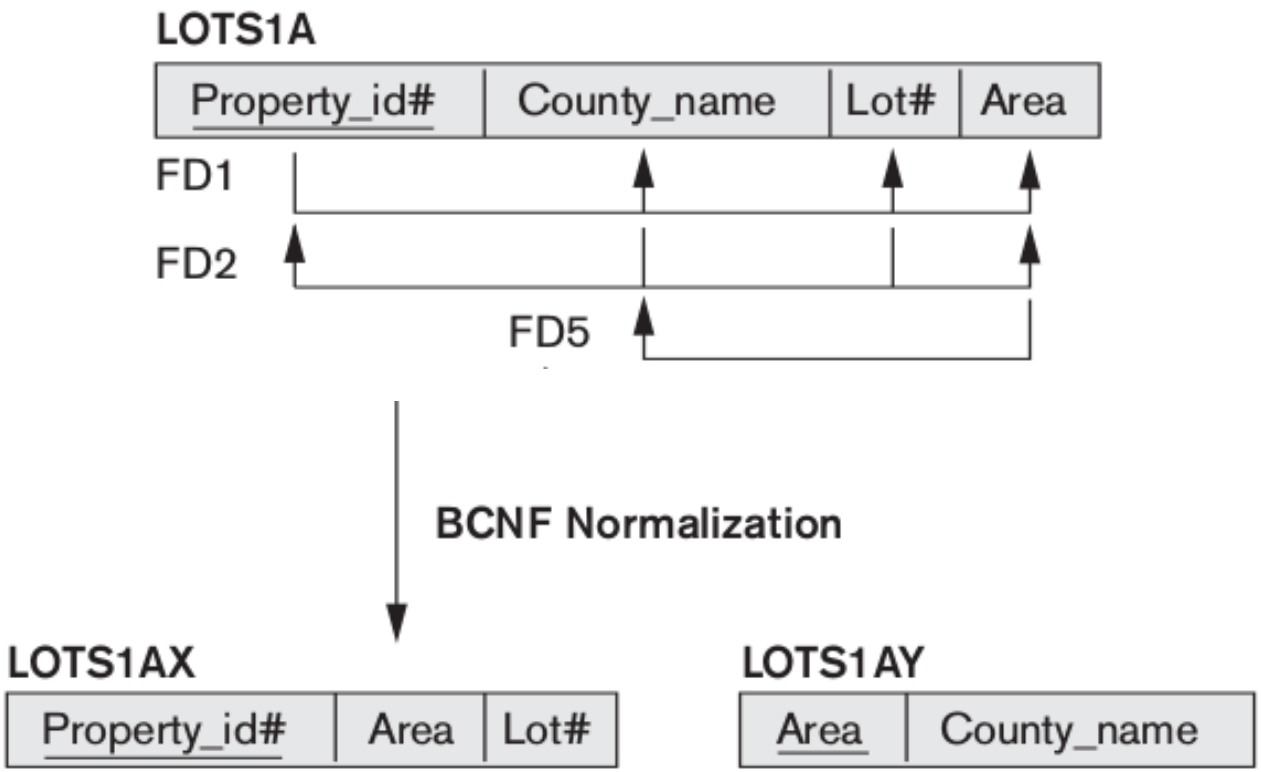
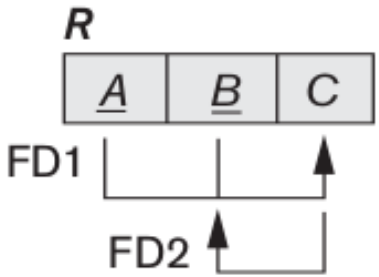
A relation schema R is in Boyce-Codd normal form (BCNF) if whenever a nontrivial functional dependency $X \rightarrow A$ holds in R, then X is a superkey of R.



3NF, but not BCNF



Example

TEACH

Student	Course	Instructor
Narayan	Database	Mark
Smith	Database	Navathe
Smith	Operating Systems	Ammar
Smith	Theory	Schulman
Wallace	Database	Mark
Wallace	Operating Systems	Ahamad
Wong	Database	Omiecinski
Zelaya	Database	Navathe
Narayan	Operating Systems	Ammar