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Database Design Issues, Part II

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CS252.HACD: Fundamentals of Relational Databases Section 9: Database Design Issues, Part II

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First Normal Form (1NF)

On CS252 we shall assume that every relation, and therefore every relvar, is in 1NF.

The term (due to E.F. Codd) is not clearly defined, partly because it depends on an ill-defined concept of "atomicity" (of attribute values).

Some authorities take it that a relation is in 1NF iff none of its attributes is relation-valued or tuple-valued. It is certainly recommended to avoid use of such attributes (especially RVAs) in database relvars.

2NF and 3NF

These normal forms, originally defined by E.F. Codd, were really "mistakes". You will find definitions in the textbooks but there is no need to learn them.

The faults with Codd's original definition of 3NF were reported to him by Raymond Boyce. Together they worked on an improved, simpler normal form, which became known as Boyce-Codd Normal Form (BCNF).

Boyce/Codd Normal Form (BCNF)

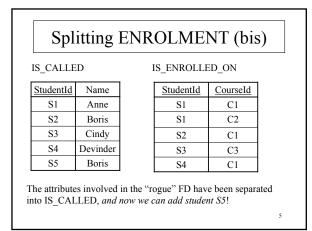
BCNF is defined thus:

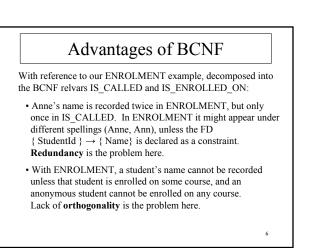
Relvar *R* is in BCNF if and only if for every nontrivial FD $A \rightarrow B$ satisfied by *R*, *A* is a superkey of *R*.

More loosely, "every nontrivial determinant is a [candidate] key".

BCNF addresses redundancy arising from JDs that are consequences of FDs.

(Not all JDs are consequences of FDs. We will look at the others later.)





Anot TUTORS_ON	her Ki	nd of R	ogue FI)
StudentId	TutorId	TutorName	CourseId	
S1	T1	Hugh	C1	
S1	T2	Mary	C2	
S2	T3	Lisa	C1	
S3	T4	Fred	C3	
S4	T1	Hugh	C1	

Assume the FD { TutorId } \rightarrow { TutorName } holds.

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		_	_BCNF	
TutorId Tu	itorName	StudentId	TutorId	CourseId
T1	Hugh	S1	T1	C1
T2	Mary	S1	T2	C2
T3	Lisa	S2	Т3	C1
T4	Fred	S3	T4	C3
T5	Zack	S4	T1	C1

Dep	endenc	ey Prese	ervati
COR			
StudentId	CourseId	Organiser	Room
S1	C1	Owen	13
S1	C2	Olga	24
S2	C1	Owen	13
ssume FDs:	{ Organise		ı} Ó

CR			СО	
StudentId	CourseId	Room	CourseId	Organise
S1	C1	13	C1	Owen
S1	C2	24	C2	Olga
S2	C1	13		
Loses" { Roo and {Orga	$m \} \rightarrow \{ Or \\ niser \} \rightarrow \{$	<i>,</i>		
				10

			OR	
StudentId	CourseId	Room	Organiser	Room
S1	C1	13	Owen	13
S1	C2	24	Olga	24
S2	C1	13		

CO			OR	
StudentId	CourseId	Organiser	Organiser	Room
S1	C1	Owen	Owen	13
S1	C2	Olga	Olga	24
S2	C1	Owen		
reserves all th But we must s		ose SCO, of co	ourse)	

This is a third kind of rogue FD.

n FD Tha	t Cannot B	e Preserved
UTOR_FOR		
StudentId	TutorId	CourseId
S1	T1	C1
S1	T2	C2
S2	Т3	C1
S3	T4	C3
S4	T1	C1

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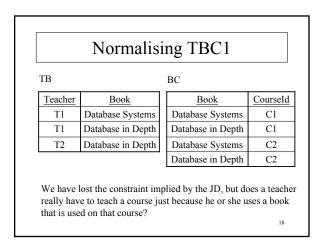
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UTORS		TEACHES	
StudentId	TutorId	TutorId	Courseld
S1	T1	T1	C1
S1	T2	T2	C2
S2	T3	Т3	C1
S3	T4	T4	C3
S4	T1		•

Reinstating The Lost FD Need to add the following constraint: CONSTRAINT KEY_OF_TUTORS_JOIN_TEACHES IS_EMPTY ((TUTORS JOIN TEACHES) GROUP { ALL BUT StudentId, CourseId } AS G WHERE COUNT (G)>1); or equivalently: CONSTRAINT KEY_OF_TUTORS_JOIN_TEACHES WITH TUTORS JOIN TEACHES AS TIT : COUNT (TJT { StudentId, CourseId });

And The Lost Foreign Key	
"last" faraian kay is anaian	
iost Toleign key is easier.	
NSTRAINT FK_FOR_TUTORS_JOIN_TEACHES	
_EMPTY ((TUTORS JOIN TEACHES) NOT MATCHING	
IS ENROLLED ON);	

BC1		
Teacher	Book	CourseId
T1	Database Systems	C1
T1	Database in Depth	C1
T1	Database Systems	C2
T1	Database in Depth	C2
T2	Database in Depth	C2



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Fifth Normal Form (5NF)

5NF caters for all harmful JDs.

Relvar *R* is in 5NF iff every nontrivial JD that holds in *R* is implied by the keys of *R*. (Fagin's definition, 1979)

Apart from a few weird exceptions, a JD is "implied by the keys" if every projection is a superkey. (Date's definition – but see the Notes for this slide)

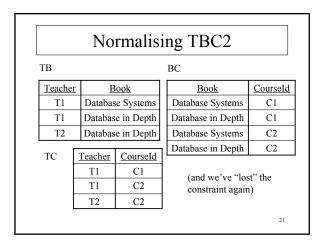
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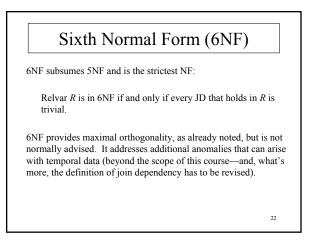
To explain "nontrivial": A JD is trivial if and only if one of its operands is the entire heading of R (because every such JD is clearly satisfied by R).

A JD of Degree > 2

TBC2

Teacher	Book	CourseId
T1	Database Systems	C1
T1	Database in Depth	C1
T1	Database Systems	C2
T1	Database in Depth	C2
T2	Database in Depth	C2





W_FN		W_LN		W_F	
Wife#	FirstName	Wife#	LastName	Wife#	Fate
1	Catherine	1	of Aragon	1	divorced
2	Anne	2	Boleyn	2	beheaded
3	Jane	3	Seymour	3	died
4	Anne	4	of Cleves	4	divorced
5	Catherine	5	Howard	5	beheaded
6	Catherine	6	Parr	6	survived

