



Relational Design Theory

Shortcomings of BCNF/4NF

Boyce-Codd Normal Form

Relation R with FDs is in BCNF if:

For each $A \rightarrow B$, A is a key

Fourth Normal Form

Relation R with MVDs is in 4NF if:

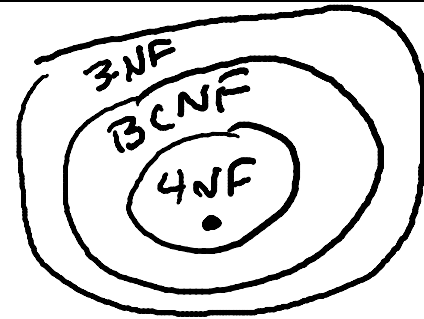
For each nontrivial $A \twoheadrightarrow B$, A is a key

Example: College application info.

Apply(SSN, cName, date, major)

Can apply to each college once for one major ✓

Colleges have non-overlapping application dates ✓



FDs: $SSN, cName \rightarrow date, major$ $date \rightarrow cName$

Keys: $SSN, cName$

BCNF: No. $A1 (date, cName)$ $A2 (SSN, \underline{date}, \underline{major})$ (?)

Good design? Not necessarily. 3rd Normal Form

Example #2

Student(SSN, HSname, GPA, priority)

Multiple HS okay, priority determined from GPA

FDs: SSN \rightarrow GPA GPA \rightarrow priority SSN \rightarrow priority \leftarrow
 Keys: SSN, HSname SSN \rightarrow GPA, priority

BCNF: No. \rightarrow $S_1(SSN, \overset{GPA}{priority})$ \leftarrow
 ~~$S_2(SSN, HSname, GPA)$~~ \leftarrow
 ~~$S_3(SSN, GPA)$~~
 $\rightarrow S_4(SSN, HSname)$

Good design?

Not necessarily.

Boyce-Codd Normal Form

Relation R with FDs is in BCNF if:

For each $A \rightarrow B$, A is a key

Fourth Normal Form

Relation R with MVDs is in 4NF if:

For each nontrivial $A \twoheadrightarrow B$, A is a key

After decomposition, no guarantee
dependencies can be checked on
decomposed relations

Example #3

Scores(SSN, sName, SAT, ACT)

"Denormalized"
relation

Multiple SATs and ACTs allowed

All queries return name + composite score for SSN

FDs + keys: SSN \rightarrow sName. No Key.

MVDs: SSN, sName \twoheadrightarrow SAT * "rest"
(ACT)

4NF: No.

~~S1(SSN, sName, SAT)~~ \leftarrow
~~S2(SSN, sName, ACT)~~ \leftarrow 4NF \downarrow

S3(SSN, sName) S5(SSN, ACT)
 S4(SSN, SAT)

Example #4

College(cName, state)

CollegeSize(cName, enrollment)

CollegeScores(cName, avgSAT)

CollegeGrades(cName, avgGPA)

...

“Too decomposed”

BCNF/4NF? *Yes.*

Good Design? *Not necessarily.*

Designing a database schema

- Usually many designs possible
- Some are (much) better than others!
- How do we choose?

❖ Very nice theory for relational database design

- Normal forms – “good” relations
- Design by decomposition
- Usually intuitive and works well
- Some shortcomings
 - Dependency enforcement ✓
 - Query workload ✓
 - Over-decomposition ✓