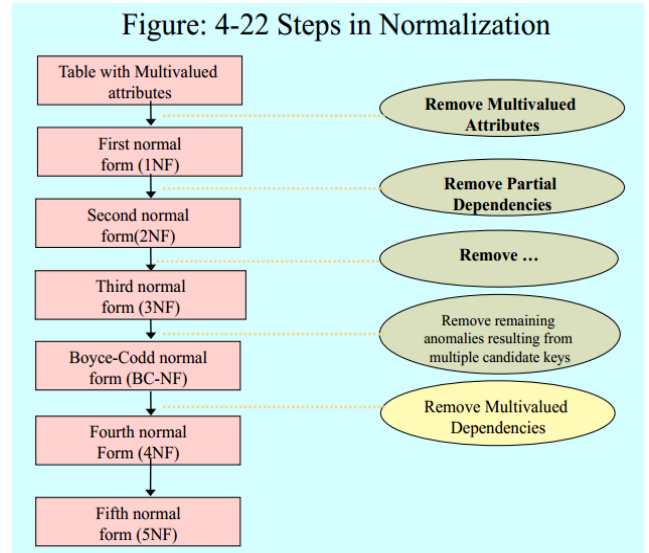


Further Normalization

- Boyce-Codd Normal form (BCNF)
 - Slight difference with 3NF
 - To be in 3NF but not in BNF, needs two composite candidate keys, with one attribute of one key depending on one attribute of the other
 - Not very common ☺
 - If a table contains only one candidate key, the 3NF and the BCNF are equivalent.
- Fourth Normal Form (4NF)
 - To break it, need to have multivalued dependencies, a generalization of functional dependencies
- Usually, if you're in 3NF you're in BCNF, 4NF, ...



4NF

- **A multi-valued dependency exists when**
 - There are at least 3 attributes A, B, C in a relation and
 - For each value of A there is a well defined set of values for B, and a well defined set of values for C,
 - But the set of values for B is independent on the set of values for C
- **4NF = 3NF with no multi-valued dependency**

4NF Example

- **Assume that**
 - Each subject is taught by many Instructors
 - The same books are used in many subjects
 - Each Instructor uses a different book

Course, Instructor → Text
 Course, Text → Instructor

| Course | Instructor | Text |
|--------|--------------|--------------------|
| CS 121 | Dr. A. James | Int to Com Science |
| CS 121 | Dr. P. Hold | Comp Scien Int |

| Course | Instructor | Text |
|--------|---------------|--------------------|
| CS 141 | Dr. T. Watson | Int to Com Science |
| CS 141 | Dr. P. Hold | Comp Scien Int |
| CS 101 | Dr. M. Jones | COMP SCIEN |

4NF: Decompose into (Course, Instructor) and (Course, Text)