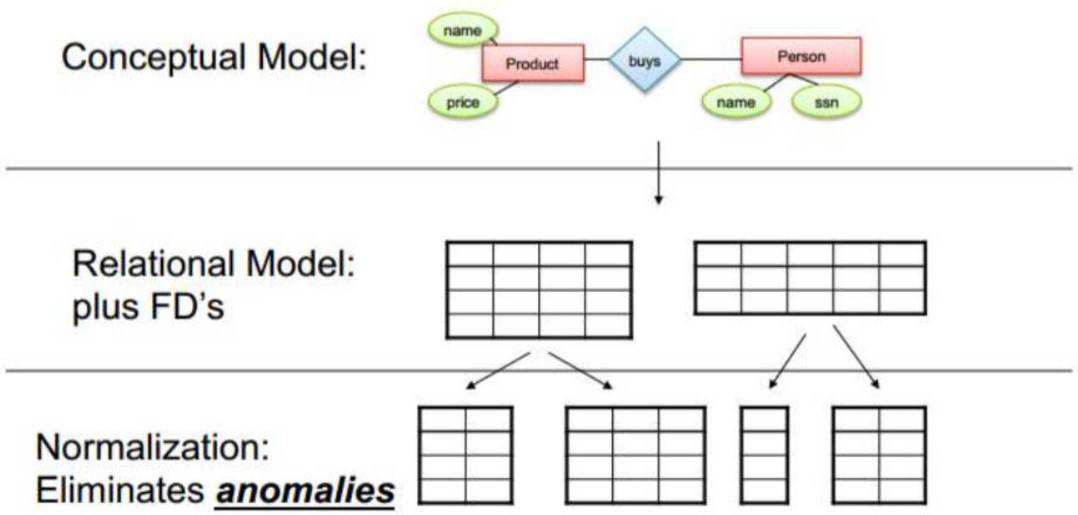
CSEP514 Section5:

- Conceptual Schema Design
- Functional Dependency & BCNF

Part I --- Conceptual Design

Normal forms and functional dependencies:

- Anomalies(redundancy, update/deletion anomalies), functional dependencies, attribute closures, BCNF decomposition



- The BCNF (Boyce-Codd Normal Form) ---- A relation R is in BCNF if every set of attributes is either a superkey or its closure is the same set.

Example 1.

Consider the following relational schema and set of functional dependencies. R(A,B,C,D,E,F,G) with functional dependencies:

A -->D

D --> C

F --> EG

DC --> BF

Decompose R into BCNF.

Example 1 -- Solution.

R(<u>A</u>,B,C,D,E,F,G)

A -->D
D --> C
F --> EG
DC --> BF

Solution: Watch-out! The first FD does NOT violate BCNF so we need to pick another one to decompose. We try the second one:
Try $\{D\}^+ = \{B, C, D, E, F, G\}$. Decompose into R1(B, C, <u>D</u>, E, F, G) and R2(<u>A</u>,D).

R2 has two attributes, so it is necessarily in BCNF.

For R1, again not all FDs violate BCNF so we need to be careful.
Try $\{F\}^+ = \{E, F, G\}$. Decompose into R11(E, <u>F</u>, G) and R12(B, C, <u>D</u>, F).

Both R11 and R12 are in BCNF.

Example 2.

Relation $R(A,B,C,D,E,F)$ and functional dependencies:

$A \rightarrow BC$ and $D \rightarrow AF$

Decompose R into BCNF.

Example 2 -- Solution.

Relation R(A,B,C,D,E,F) and FD's A → BC and D → AF

A→BC violates BCNF since A+ = ABC ≠ ABCDEF. So we split R into R1(<u>A</u>BC) and R2(<u>A</u>DEF).

The only non-trivial FD in R1 is A→BC, and A+ = ABC, so R1 is in BCNF.

R2 has a non-trivial dependency D→AF that violates BCNF because D+ = ADF ≠ ADEF. So we split R2 into R21(<u>D</u>AF) and R22(<u>D</u>E). Both of these are in BCNF since they have no non-trivial dependencies that are not superkeys.

Example 3

Relational schema: R(A,B,C,D,E),

functional dependencies: AB—>C, BC—>D

Decompose R into BCNF.

Example 3 -- solution

Relational schema: R(A,B,C,D,E),

functional dependencies: AB—>C, BC—>D

First step uses BC+=BCD and decomposes into R1(B,C,D), R2(A,B,C,E); second step decomposes R2 into R3(A,B,C) and R4(A,B,E)

Example 4

The relation is R (A, B, C, D, E) and the FDs :

A -> E, BC -> A, and DE -> B

Decompose R into BCNF.

Example 4 – solution 1

The relation is R (A, B, C, D, E) and the FDs :

A -> E, BC -> A, and DE -> B

Notice that {A}+ = {A,E}, violating the BCNF condition. We split R to R_1(A,E) and R_2(A,B,C,D).

R_1 satisfies BCNF now, but R_2 not because of: {B,C}+ = {B,C,A}. Notice that the fd D E -> B has now disappeared and we don't need to consider it! Split R_2 to: R_2A(B,C,A) and R_2B(B,C,D).

Example 4 – solution 2

The relation is R (A, B, C, D, E) and the FDs :

A -> E, BC -> A, and DE -> B

Can we split differently? Let's try with the violation {B,C}+ = {B,C,A,E}. We initially split to R_1(B,C,A,E) and R_2(B,C,D). Now we need to resolve for R_1 the violation {A}+ = {A,E}. So we split again R_1 to R_1A(A,E) and R_1B(A,B,C). The same!

We can also start splitting by considering the BCNF violation {D,E}+ = {D,E,B}. Which is the resulting BCNF decomposition in this case? (it will be a different one)