Normalisation – Part 2

From BCNF to 3NF

- Facts

(2) However, a BCNF-decomposition that is **both lossless and dependency-preserving** do

- 3NF is **a less restrictive normal form** such that a lossless and dependency preserving decomposition can always be found.

3NF - Definition

- A r *A* holds in R, t

- 3NF allows data redundancy but excludes relati kinds of FDs (i.e. partial FDs and transitive FDs)

Normalisation to 3NF

- Consider the following FDs of ENROL:
  - {StudentID, CourseNo, Semester} → {ConfirmedBy_ID, StaffName},
  - ConfirmedBy_ID → StaffName .

				ffName
				ane
123458	COMP2400	2008 S2		
123458	COMP2600	2008 S2		

- **Is ENROL in 3NF?**
  - {StudentID, CourseNo, Semester} is the only key.
  - ENROL is not in 3NF because {ConfirmedBy_ID} → {StaffName}, {ConfirmedBy_ID} is not a superkey and {StaffName} is not prime attribute.

Normalisation to 3NF

- **Algorithm** for a dependency-preserving and lossless 3NF-decomposition

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- Group FDs in Σ' by their left-hand-side attribue sets
- For each distinct left-hand-side X_i o
  - $X_i \to A_1, X_i \to A_2 \ldots, X_i \to A_k$
    - Add $R_i = X_i \cup \{A_1\} \cup \{A_2\} \cdots \cup \{$

- Remove all redundant ones from $\mathcal{S}$ (i.e., remove R_i if $R_i \subseteq R_j$)
- if $\mathcal{S}$ does not contain a superkey of R, add a key of R as R_0 into $\mathcal{S}$.
- Project the FDs in Σ' onto each relation schema in $\mathcal{S}$

Normalisation to 3NF

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Minimal Cover – The Hard Part!

- Let Σ be a set of FDs. A **minimal cover** Σ_m of Σ is a set of FDs such that

1. Σ_m ith $X \to A_1, \ldots, X \to A_k$;
2. **No determinant:** each FD has as few attribu of X to possible, i.e., for each FD $X \to A$ in see if we can replace $X \to A$ with $(X - B) \to A$ in Σ_m;
3. Remove a FD from Σ_m if it is redundant.

Minimal Cover

- **Theorem:**

ys

- **Examples:** Consider the following set of functi

$$\Sigma = \{A \to BC, B \to C,$$

Σ has two different minimal covers:

- $\Sigma_1 = \{A \to B, B \to C, C \to A\}$
- $\Sigma_2 = \{A \to C, C \to B, B \to A\}$

Minimal Cover - Examples

- The set $\{A \to B, B \to C, A \to C\}$ can be reduced to $\{A \to B, B \to C\}$, because $\{A \to C\}$ is implied by the other two.
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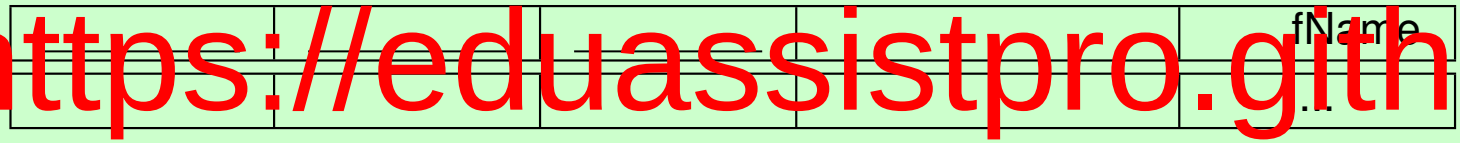
1.
2. check whether all the FDs in Σ hav hand side (look good);
3. determine if $AB \to D$ has any redund ($AB \to D$ can be replaced by $B \to$
4. look for a redundant FD in $\{B \to A, D \to A, B \to D\}$ ($B \to A$ is redundant);

   Therefore, the minimal cover of Σ is $\{D \to A, B \to D\}$.

Normalisation to 3NF – Example

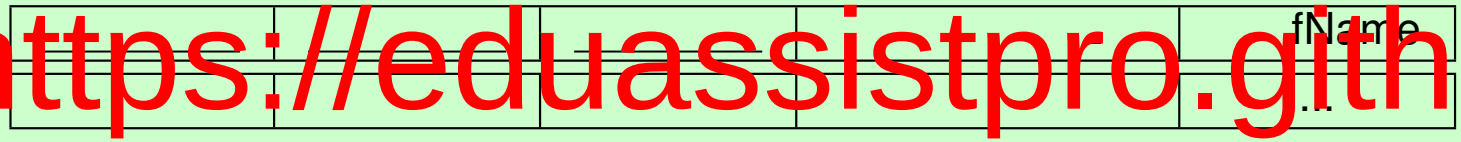
- Consider ENROL again:
  - {StudentID, CourseNo, Semester} → {ConfirmedBy_ID, StaffName}
  - ConfirmedBy_ID StaffName



- **Can we normalise ENROL into 3NF by a los preserving decomposition?**

Normalisation to 3NF – Example

- Consider ENROL again:
  - {StudentID, CourseNo, Semester} → {ConfirmedBy_ID, StaffName}
  - ConfirmedBy_ID → StaffName



- A **minimal cover** is {{StudentID, Course → {ConfirmedBy_ID}, {ConfirmedBy_ID} → {

- Hence, we have:
  - R_1={StudentID, CourseNo, Semester, ConfirmedBy_ID} with {StudentID, CourseNo, Semester} → {ConfirmedBy_ID}
  - R_2={ConfirmedBy_ID, StaffName} with {ConfirmedBy_ID} → {StaffName}
  - Omit R_0 because R_1 is a superkey of ENROL.

3NF - Exercises

- Let us do some exercises for the 3NF-decomposition algorithm.
  - **Exercise 1:** $R = \quad A, B, C, D \quad$ and $\Sigma = \quad A \quad B, B \quad C, AC \rightarrow D\}$:

  - **Exercise 2:** $R = \{A, B, C, D\}$ and $B\}$:

3NF - Exercises

- Let us do some exercises for the 3NF-decomposition algorithm.

- **Exercise 1:** $R = A, B, C, D$ and $\Sigma = A \quad B, B \quad C, AC \rightarrow D\}$:
  - of R
  - The 3NF-decomposition is {ABD, BC .

- **Exercise 2:** $R = \{A, B, C, D\}$ and $B\}$:
  - Σ is its own minimal cover.
  - $R_1 = ABD$, $R_2 = ABC$, $R_3 = CB$ (omit R_3 because $R_3 \subseteq R_2$ and omit R_0 because R_1 is a superkey of R)
  - The 3NF-decomposition is {ABD, ABC} .