

Week 9: Worksheet

CSC 343 Winter 2021

University of Toronto Mississauga

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Recall

DB Design

1. Functional Dependencies

- How do you identify FDs?
 - Domain knowledge! Note: DBMSs can't identify (nor optimize) FDs for you!
- Trivial FDs, Splitting/Combining
- Armstrong's Axioms (Reflexivity, Augmentation, Transitivity, Union, Decomposition)
- Closure, Minimal Basis

2. Schema Decomposition

- Avoiding Anomalies
- Lossless Join Decomposition
- Dependency Preservation

3. Normalization

- 1NF, 2NF, 3NF, BCNF, ... and many more :)
- 1NF – no multi-valued attributes.
- 2NF – in 1NF and non-prime attributes depend the proper subset of any candidate key.
 - Consider a non-prime attribute A , then there exists a FD $X \rightarrow A$, and X is a candidate key.
- 3NF – in 2NF and non-prime attributes depend **only** on candidate keys.
 - Consider a FD $X \rightarrow A$, either X is a superkey or A is prime (part of a key).
 - Lossless Join and Dependency Preserving.
- BCNF – in 3NF and for every FD $X \rightarrow A$, X is a superkey.
 - Stricter version of 3NF, also know as 3.5NF.
 - If $X \rightarrow A$ is a non-trivial FD that holds in a relation and X is a superkey.
 - Lossless Join and Anomaly Free.

Task I

Consider a relation R with a set of attributes $\alpha = \{A, B, C, D, E, F\}$ and the set of Functional Dependencies $\mathcal{F} = \{A \rightarrow BC, B \rightarrow E, C \rightarrow BD, D \rightarrow A, E \rightarrow F, F \rightarrow BE\}$

- (a) Compute the closure of each attribute.
- (b) Find all candidate keys (i.e., minimal keys) of relation R .

Solution:

- (a) $A^+ \rightarrow BCEDFA$
 $B^+ \rightarrow EFB$
 $C^+ \rightarrow BDEAFC$
 $D^+ \rightarrow AD \dots$ you have A so it's closed
 $E^+ \rightarrow FBE$
 $F^+ \rightarrow BEF$
- (b) A, C , and D .

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Task II

Consider a relation R with a set of attributes $\alpha = \{A, B, C, D, E\}$ and the set of Functional Dependencies $\mathcal{F} = \{A \rightarrow B, BC \rightarrow E, ED \rightarrow A\}$

- (a) Is R in 3NF?
- (b) Is R in BCNF?

HINT 1: Compute the keys first, then solve (a) and (b).

HINT 2: Define 3NF and BCNF after **HINT 1**.

Solution:

(hint 1) The candidate keys are: CDE , ACD , and BCD .

- (a) R is in 3NF because A , B , and E are all ‘part of’ keys.
- (b) R is not in BCNF because none of $\{A, B, C, D, E\}$ contain a key.

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