

Lab 5, Week 7

Functional Dependencies (Exercises)

The purpose of this lab is to deepen your understanding of the notion of functional dependencies (FDs). We will first do some exercises on identifying FDs using sample data or following data requirements, then will practice on finding implied FDs and keys. In addition to these, we will also look into minimal cover (e.g., how is a minimal cover computed).

1 Update anomalies

To motivate the study of FDs, we start with discussing several update anomalies that may occur when database design allows the existence of redundant data.

(1) Consider the relation shown in Figure 1 which has the primary key $\{SSN, Pnumber\}$ together with the following functional dependencies. What update anomalies may occur in the relation? Give an example if possible.

$\{SSN\} \rightarrow \{EmployeeName\}$ and $\{Pnumber\} \rightarrow \{ProjectName, Plocation\}$

<u>SSN</u>	<u>Pnumber</u>	Hours	EmployeeName	ProjectName	Plocation
11	1	32.5	Smith	Newbenefit	Bellaire
11	2	7.5	Smith	Databases	Sugarland
22	3	40	Narayan	Softwares	Houston
33	1	20	English	Newbenefit	Bellaire
33	2	7.5	English	Databases	Sugarland

Figure 1: A relation for Exercise (1)

2 Functional Dependencies and Implication

(2) Consider a relation schema $R = \{A, B, C, D, E, F\}$ with the following set Σ of functional dependencies:

$$AB \rightarrow C, CF \rightarrow B, BC \rightarrow AD \text{ and } D \rightarrow E.$$

- (2.1) Does $AB \rightarrow D$ hold on any relation of R that satisfies Σ ? If so, explain why; otherwise, give a counterexample.
- (2.2) Does $B \rightarrow C$ hold on any relation of R that satisfies Σ ? If so, explain why; otherwise, give a counterexample.

3 Identifying Functional Dependencies

(3) Consider the following relation schema $\text{INTERVIEW} = \{\text{Client_ID}, \text{Client_Name}, \text{Staff_No}, \text{Date}, \text{Room}\}$ based on the following constraints:

- Each staff member is allocated to a specific room on any given day.
- Each client has a unique ID.
- Each client is only interviewed by one staff member on any given day.

Your task is to find FDs over INTERVIEW based on the above requirements.

(4) Consider the relation shown in Figure 2.

X	Y	Z
a_1	b	c_1
a_1	b	c_2
a_2	b	c_1
a_2	b	c_3

Figure 2: A relation for Exercise (2)

- (4.1) List all the FDs that this relation satisfies.

- (4.2) Assume that the value of attribute Z of the last record in the relation in Figure 2 is changed from c_3 to c_1 . Now list all the functional dependencies that this relation instance satisfies.

4 Finding keys

- (5) Consider a relation $R = \{A, B, C, D\}$ with the following functional dependencies:

$$C \rightarrow D, AB \rightarrow C \text{ and } D \rightarrow A$$

- (5.1) List all the keys of R .
(5.2) Find all the prime attributes of R .

5 Equivalence of functional dependencies

- (6) Consider a relation $R = \{A, B, C, D\}$. For each two sets of FDs given below, identify whether or not these two sets of FDs are equivalent

(6.1) $\Sigma_1 = \{A \rightarrow B, AB \rightarrow C\}$ and $\Sigma_2 = \{A \rightarrow B, A \rightarrow C\}$

(6.2) $\Sigma_1 = \{A \rightarrow B, A \rightarrow C\}$ and $\Sigma_2 = \{B \rightarrow A, A \rightarrow C\}$

6 Minimal cover

- (7) Consider a relation $R = \{A, B, C, D\}$. For each set of FDs given below, identify whether or not the set of FDs is a minimal cover. If not, find a minimal cover for the set of FDs.

(7.1) $\{A \rightarrow B, AB \rightarrow C\}$.

(7.2) $\{A \rightarrow B, A \rightarrow CB, B \rightarrow C\}$.

(7.3) $\{A \rightarrow B, B \rightarrow A, B \rightarrow C\}$.

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