# INDIAN INSTITUTE OF TECHNOLOGY PATNA

## CS501- DATABASE SYSTEMS AND DATAMINING

Assignment -3

Date: 12-05-2024

Submitted By: BASKAR NATARAJAN
2403res19

problem:-

Find the highest normal form of relation R $(\alpha, \beta, \gamma, \delta, \varepsilon)$ with functional dependency set

$$\{\beta \to \alpha, \alpha \to \gamma, \beta\gamma \to \delta, \alpha\gamma \to \beta\varepsilon\}$$

solution:-

Find the Candidate key.

$\beta \to \alpha$

(i) $\alpha$ is functionaly dependent on $\beta$

(ii) $\alpha \to \gamma$

$\gamma$ is functionaly dependent on $\alpha$

(iii) $\beta\gamma \to \delta$

$\delta$ is functionaly dependent on $\beta\gamma$.

from the eqn (ii)

$\gamma$ can be determined by $\alpha\beta$.

so, $\gamma \subset$
$\delta$ can be determined from $\alpha\beta$

(iv) $\alpha\gamma \rightarrow \beta\epsilon$

$\beta\epsilon$ is functionally dependent on $\alpha\gamma$

Since, $\delta$ and $\gamma$ can be determined by $\alpha\beta$

Therefore, $\alpha\beta$ are the candidate keys.

1) Check 1NF

Condition:-

(i) each attributes should be atomic or indivisible

$R(\alpha, \beta, \gamma, \delta, \epsilon)$ does not have multi value attributes.

(2) Check 2NF

condition:-

(i) R should be 1NF - already verified.

(ii) All non-prime attributes are fully dependent on the entire candidate key

$\beta \rightarrow \alpha$ - $\beta$ is a candidate key and $\alpha$ is fully functionaly dependent on any proper subset of candidate key. satisfies 2NF

$\alpha \rightarrow \gamma$ : $\alpha$ is a candidate key, $\gamma$ is fully dependent on it. so it satisfies 2NF.

$\beta\gamma \rightarrow \delta$ : Both $\beta$ and $\gamma$ together form a composite candidate key on it, so it satisfies 2NF

$\alpha\gamma \rightarrow \beta\epsilon$ Both $\alpha$ and $\gamma$ together form a composite candidate key $\beta\epsilon$ is fully functionally dependent on $\alpha\gamma$. so it satisfies 2NF.

Since all functional dependencies satisfies 2NF, the relation already satisfy it.

## 3. 3NF (Third Normal Form)

* In 3NF, the relation must be 2NF.
* There should be no transitive dependency where a non-prime attribute depends on another non-prime attribute.

Let's evaluate the FD.

$\beta \rightarrow \alpha$, $\beta$ is a candidate key, and $\alpha$ is fully dependent on it so satisfies 3NF

$\alpha \rightarrow \gamma$ : $\alpha$ is a candidate key; and $\gamma$ is fully functional dependent on it so satisfies 3NF

$\beta\gamma \rightarrow \delta$ : $\delta$ is fully dependent on $\beta\gamma$, which is a Superkey. So it satisfies 3NF

$\delta\gamma \rightarrow \beta\varepsilon$ $\beta\varepsilon$ is fully functionally dependent on $\delta\gamma$, which is a Superkey, so it satisfies 3NF

Since all functional dependencies satisfy 3NF the relation already satisfies it.

# BCNF (BOYCE-CODD NORMAL FORM)

IN BCNF, every non-trivial functional dependency $X \to Y$, X must be a superkey.

Let's evaluate the functional dependencies

$\beta \to \alpha$ : $\beta$ is a candidate key, and $\alpha$ is fully functional dependent so it satisfies BCNF.

$\alpha \to \gamma$ : $\alpha$ is a candidate key, and $\gamma$ is fully functionaly dependent on it. so it satisfies BCNF.

$\beta\gamma \to \delta$ : $\beta\gamma$ is a candidate key, and $\delta$ is fully functionaly dependent on it, so it satisfies BCNF.

$\alpha\gamma \to \beta\epsilon$ : $\alpha\gamma$ is a candidate key, and $\beta\epsilon$ is fully functionaly dependent on it so satisfies BCNF.

in above, fD sets, left side keys, $\{\beta, \alpha, \beta\gamma, \alpha\gamma\}$ → all superkeys.

So relation satisfies BCNF.

BCNF is highest Normal Form.