RELATIONAL DB THEORY: FUNCTIONAL DEPENDENCIES AND DECOMPOSITION

1. Consider the relational schema R(A, B,C,D) and the following set of functional dependencies: S = {A -> B, BC -> A, D -> C}.

A functional dependency X->Y (e.g., BD->A) is said to "logically follow" from S if when you compute the closure X+ ({B, D}+ in this case) it contains Y (A in this case).

If X->Y does not logically follow from S, then there must be an instance of the relation R which satisfies the dependencies in S but does not satisfy X->Y. (\*Finding this may take a bit of thinking and working backward.)

For each of the functional dependencies X -> Y below show whether it logically follows from S or not. (So, if the answer, is "yes", start by computing X+. If the answer is "no", show the appropriate (\*smallest) instance.)

1. A -> C
2. BD -> A
3. CD -> A
4. BCD -> A

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

S = {A -> B, BC -> A, D -> C}

1. A -> C does not logically follow from S

|  |  |  |  |
| --- | --- | --- | --- |
| **A** | **B** | **C** | **D** |
| a1 | b1 | c1 | d1 |
| a1 | b1 | c2 | d2 |

1. BD -> A logically follows from S

X+ = {B,D} given

X+ = {B,C,D} using D -> C

X+ = {A,B,C,D} using BC -> A

1. CD -> B does not logically follow from S
2. BCD -> A logically follows from S

X+ = {B,C,D} given

X+ = {A,B,C,D} using BC->A

**Question 2** Consider a relation R(A,B,C,D,E) satisfying the following dependencies: A->B, BC->E,ED->A.

1. List all keys for R.
2. Is R in 3NF? Justify your answer.
3. R is not in BCNF. Explain why?
4. Show the first step in a BCNF decomposition of R, including computing the projection of the dependencies onto the decomposed relations, and identifying keys for each subrelation.
5. Is the above decomposition lossless? Is it dependency-preserving? Are the subrelations in BCNF? 3NF? Explain each of your answers BRIEFLY.
6. Repeat step (d), if necessary, till you have decomposed R into BCNF relations.
7. Argue whether there is a decomposition that preserves dependencies.

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

S = {A -> B, BC -> E, ED -> A}

1. List all keys for R.

|  |  |  |
| --- | --- | --- |
| **LHS** | **Both** | **RHS** |
| C, D | A, B, E |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Columns** | **Plus Set** | **Superkey?** | **Key?** |
| CD | CD |  |  |
| CDA | CDABE | Yes | Yes |
| CDB | CDBEA | Yes | Yes |
| CDE | CDEAB | Yes | Yes |
| CDAB | CDABE | Yes |  |
| CDAE | CDAEB | Yes |  |
| CDBE | CDBEA | Yes |  |
| CDABE | CDABE | Yes |  |

Keys: ACD, BCD, CDE

1. Is R in 3NF? Justify your answer.

3NF: Table R with non-trival FDs S is in 3NF if for every X->Y in S, either (1) X is a superkey OR (2) Y is part of a key

A -> B B is part of a key

BC -> E E is part of a key

ED -> A A is part of a key

So R is in 3NF.

1. R is not in BCNF. Explain why?

BCNF: Table R with non-trival FDs S is in BCNF if for every X->Y in S, X is a superkey.

A -> B A is not a superkey

BC -> E BC is not a superkey

ED -> A ED is not a superkey