Homework: Chapter 6

6.1 Suppose that we decompose the schema R = (A, B, C, D, E) into

R1 = (A, B, C)

R2 = (A, D, E)

Show that this decomposition is a lossless-join decomposition if the following set F of functional dependencies holds:

A → BC

CD → E

B → D

E → A

Answer：A decomposition {*R*1, *R*2} is a lossless-join decomposition if *R*1 ∩ *R*2 → *R*1 or *R*1 ∩ *R*2 → *R*2. Let *R*1 = (*A*, *B*, *C*), *R*2 =(*A*, *D*, *E*), and *R*1 ∩ *R*2 = *A*. Since *A* is a candidate key (see Practice Exercise 8.6), Therefore *R*1 ∩ *R*2 → *R*1.

6.2 List all functional dependencies satisfied by the relation of Table 1.

Table 1 Relation

|  |  |  |
| --- | --- | --- |
| A | B | C |
| a1 | b1 | c1 |
| a1 | b1 | c2 |
| a2 | b1 | c1 |
| a2 | b1 | c3 |

**Answer:** The nontrivial functional dependencies are: *A* → *B* and *C* → *B*, and a dependency they logically imply: *AC* → *B*. There are trivial functional dependencies of the form a → b, where b ⊆ a. *C* does not functionally determine*A*because the first and third tuples have the same *C* but different *A* values. The same tuples also show *B* does not functionally determine *A*. Likewise, *A* does not functionally determine *C* because the first two tuples have the same *A* value and different *C* values. The same tuples also show *B* does not functionally determine *C*.

6.3 Explain how functional dependencies can be used to indicate the following:

(1) A one-to-one relationship set exists between entity sets student and instructor.

(2) A many-to-one relationship set exists between entity sets student and instructor.

**Answer:** Let *Pk*(*r* ) denote the primary key attribute of relation *r* .

• The functional dependencies *Pk*(*student*)→ *Pk* (*instructor*) and *Pk*(*instructor*)→ *Pk*(*student*) indicate a one-to-one relationship because any two tuples with the same value for student must have the same value for instructor, and any two tuples agreeing on instructor must have the same value for student.

• The functional dependency *Pk*(*student*)→ *Pk*(*instructor*) indicates a many-to-one relationship since any student value which is repeated will have the same instructor value, but many student values may have the same instructor value.

6.4 Compute the closure of the following set F of functional dependencies for relation schema R = (A, B, C, D, E).

A→BC

CD→E

B→D

E→A

List the candidate keys for R.

**Answer:** Note: It is not reasonable to expect students to enumerate all of *F*+. Some shorthand representation of the result should be acceptable as long as the nontrivial members of *F*+ are found.

Starting with *A* → *BC*, we can conclude: *A* → *B* and *A* → *C*.

Since *A* → *B* and *B* → *D*, *A* → *D* (decomposition,transitive)

Since *A* → *CD*and *CD* → *E*, *A* → *E* (union, decomposition, transitive)

Since *A* → *A*, we have (reflexive)

*A* → *ABCDE* from the above steps (union)

Since *E* → *A*, *E* → *ABCDE* (transitive)

Since *CD* → *E*, *CD* → *ABCDE* (transitive)

Since *B* → *D* and *BC* → *CD*, *BC* →*ABCDE* (augmentative, transitive)

Also, *C* → *C*, *D* → *D*, *BD* → *D*, etc.

Therefore, any functional dependency with *A*, *E*, *BC*, or *CD* on the left hand side of the arrow is in *F*+, no matter which other attributes appear in the FD. Allow \* to represent any set of attributes in *R*, then *F*+ is *BD* → *B*, *BD* → *D*, *C* → *C*, *D* → *D*, *BD* → *BD*, *B* → *D*, *B* → *B*, *B* → *BD*, and all FDs of the form *A* ∗ → a, *BC* ∗ → a, *CD* ∗ → a, *E* ∗ → a where a is any subset of {*A*, *B*, *C*, *D*, *E*}. The candidate keys are *A*, *BC*, *CD*, and *E*.

6.5 Using the functional dependencies of Practice Exercise 6.4, compute the canonical cover Fc .]

Answer: The given set of FDs F is:-

A→BC

CD→E

B→D

E→A

The left side of each FD in F is unique. Also none of the attributes in the left side or right side of any of the FDs is extraneous. Therefore the canonical cover Fc is equal to F.