Chapter3: Homework

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Exercise 2.3.1:

Consider a relation with schema $R(A, B, C, D)$ and FD's $AB \to C, C \to D \text{and} D \to A$

a) What are all the non-trivial FD's that follow from the given FD's? You should restrict yourself to FD's with single attributes on the right side.

1. $A^+ = A, B^+ = B, C^+ = ACD, D^+ = AD$, so, $C \to A$.
2. $AB^+ = ABCD, AC+ = ACD, AD^+ = AD, BC^+ = ABCD, BD^+ = ABCD, CD^+ = ACD$, so, $AB \to D$ $AC \to D$ $BC \to A$ $BC \to D$ $BD \to A$ $BD \to C$ $CD \to A$
3. $ABC^+ = ABCD, ABD^+ = ABCD, ACD^+ = ACD, BCD^+ = ABCD$,so, $ABC \to D$ $ABD \to C$ $BCD \to A$
4. $ABCD^+ = ABCD$

So, there are total 14 non-trivial FD's.

b) What are all the keys of R?

The keys are AB, BC, BD.

c) What are all the superkeys for R that are not keys?

The superkeys are $ABC, ABD, BCD, ABCD$

Exercise 3.5.2:

Consider the relation Courses(C, T, H, R, S, G),whose attributes may be thought of informally as course, teacher, hour, room, student and grade. FD's: $C \to T, HR \to C, HT \to R, HS \to R, CS \to G$. intuitively, the first says that a course has a unique teacher, and the second says that only one course can meet in a given room at a given hour. The third says that a teacher can be only on room at a given hour, and the fourth says the same about students. The last says that students get only one grad in a course.

a) What are all the keys for Courses?

The key for Courses is HS.

b) Verify that the given FD's are their own minimal basis.

First, check whether any of the FD's can be removed, there's no FD's can be removed. Second, checjk whether any of the left sides of FD's can be removed, there's no one can be removed. So, the given FD's are their own minimal basis.

Use the 3NF synthesis algorithm to find a lossless-join, dependency-preserving decomposition of R into 3NF relations. Are any of the relations not in BCNF?

First, the given FD's is the minimal basis, so we see the following FD's: 1. $C \rightarrow T$, so we get schema (CT) 2. $HR \rightarrow C$, so we get schema (HRC) 3. $HT \rightarrow R$, so we get schema (HTR) 4. $HS \rightarrow R$, so we get schema (HSR) 5. $CS \rightarrow G$, so we get schema (CSG)

Since there is key contained in an FD, so we have totally 5 schemas in the 3NF relations.

None of the relations are not in BCFN.

Exercise 3.6.3:

For each of the following relation schemas and dependencies a) $R(A, B, C, D)$ with MVD's $A \rightarrow\rightarrow B, A \rightarrow\rightarrow C$ b) A relation $R(A, B, C, D)$ with MVD $AB \rightarrow\rightarrow C$, and FD $B \rightarrow D$ Do the following:

(i) Find all the 4NF violations.

a) The key of relation R is $ABCD$, so all the MVD's $A \rightarrow\rightarrow B, A \rightarrow\rightarrow C$ violates 4NF.

b) The key of relation R is ABC, so $AB \rightarrow\rightarrow C$ and $B \rightarrow\rightarrow D$ violated 4NF.

(ii)Decompose the relations into a collection of relation schemas in 4NF.

a) Decompose R to R1(AB), R2(ACD), R3(AC), R4(ABD), and continue decompose R2 into R5(AC), R6(AD) So the final collection of relation schemas is AB, AC, AD.

b) Decompose R to R1(ABC), R2(ABD), R3(BD), and contimue decompose R2 into R4(AB) So the final collection of relation schemas is ABC and BD.