

Relational Schema Normalization

Exercise 1

Consider a relation representing the present position of molecules in a closed container. The attributes are an ID for the molecule, the u, v and w coordinates of the molecule, and its velocity in the u, v and w dimensions. (a) What FD's would you expect to hold? (b) What are the keys?

Exercise 2

Consider a relation with schema $R(A, B, C, D)$ and FD's $BC \rightarrow D$, $D \rightarrow A$ and $A \rightarrow B$. (a) What are the elementary FD's that follow from the given FD's? (b) What are all the keys of R? (c) What are all the superkeys of R?

Exercise 3

Repeat exercise 2 for the following schemas and sets of FD's :

- (a) $S(A, B, C, D)$ with $A \rightarrow B$, $A \rightarrow C$, and $C \rightarrow D$
- (b) $T(A, B, C, D)$ with $A \rightarrow B$, $B \rightarrow C$, $C \rightarrow D$, and $D \rightarrow A$
- (c) $U(A, B, C, D)$ with $AD \rightarrow B$, $AB \rightarrow C$, $BC \rightarrow D$, and $CD \rightarrow A$

Exercise 4

For each of the following relation schemas and sets of FD's (i) indicate all the 3NF violations, (ii) decompose the relations, as necessary, into collection of relations that are in 3NF.

- (a) $R(A, B, C, D)$ with FD's $B \rightarrow A$, $C \rightarrow B$, $D \rightarrow C$, and $A \rightarrow D$
- (b) $R(A, B, C, D)$ with FD's $BC \rightarrow D$, $D \rightarrow A$, and $A \rightarrow B$
- (c) $R(A, B, C, D)$ with FD's $A \rightarrow B$ and $A \rightarrow C$
- (d) $R(A, B, C, D)$ with FD's $AB \rightarrow D$, $BD \rightarrow C$, $CD \rightarrow A$, and $AC \rightarrow B$

Exercise 5

Consider the relation $Courses(C, T, H, R, S, G)$ whose attributes may be thought informally as course, teacher, hour, room, student, and grade. Let the set of FD's for Courses be $C \rightarrow T$, $HR \rightarrow C$, $HT \rightarrow R$, $HS \rightarrow R$ and $CS \rightarrow G$. (a) What are the keys for Course? (b) Decompose the relation into a collection of relations that are in 3NF.

Exercise 6

Consider the relation $Stocks(B, O, I, S, Q, D)$ whose attributes may be thought informally as broker, office (of the broker), investor, stock, quantity (of the stock owned by the investor), and dividend (of the stock). Let the set of FD's for Stocks be $S \rightarrow D$, $I \rightarrow B$, $IS \rightarrow Q$ and $B \rightarrow O$. Repeat exercise 5 for the relation Stocks.