

Tables

Notes:

1. {A, B} means a composite key containing both A and B.
 2. ComplaintID = Complaint ID (to distinguish from Employees' ID)
 3. EmployeeID = Employee ID (to distinguish from Complaints' ID)
 4. For R14, assume that the composite of Start-date and End-date are unique for each product in a particular shop; in other words, for a specific product of a specific shop, it cannot have multiple prices on/in any particular date/period
 5. Relations that are highlighted gray like this are not in 3NF hence are decomposed and are not themselves part of the normalized database schema.
-

R1(UserID, UName) - **USERS**

Keys: UserID

Primary Key: UserID

FDs: UserID → UName

The relation is in 3NF.

R2(OrderID, Date_time, Shipping_address, UserID) - **ORDERS**

Keys: OrderID

Primary Key: OrderID

FDs: OrderID → Date_time, Shipping_address, UserID

The relation is in 3NF.

R3(UserID, PName, SName, OrderID, Rating, Date-time, Comment) - **FEEDBACKS**

Keys: {UserID, PName, SName, OrderID}

Primary Key: {UserID, PName, SName, OrderID}

FDs: {UserID, PName, SName, OrderID} → Rating, Date-time, Comment

The relation is in 3NF.

R4(ComplaintID, Status, Text, Filed-date-time, UserID, EmployeeID) - COMPLAINTS

Keys: ComplaintID

Primary Keys: ComplaintID

FDs: ComplaintID -> Status, Text, Filed-date-time, UserID

The relation is in 3NF.

R5(EmployeeID, Handled-date-time, ComplaintID) - HANDLED

Keys: {EmployeeID, ComplaintID}

Primary Key: {EmployeeID, ComplaintID}

FDs: {EmployeeID, ComplaintID} -> Handled-date-time

ComplaintID -> Handled-date-time

The relation is in 3NF.

R6(EmployeeID, EName, Salary) - EMPLOYEES

Keys: EmployeeID

Primary Key: EmployeeID

FDs: EmployeeID -> EName, Salary

The relation is in 3NF.

R7(ComplaintID, OrderID) - COMPLAINTS-ON-ORDERS

Keys: ComplaintID

Primary Key: ComplaintID

FDs: ComplaintID -> OrderID

The relation is in 3NF.

R8(ComplaintID, SName) - COMPLAINTS-ON-SHOPS

Keys: ComplaintID

Primary Key: ComplaintID

FDs: ComplaintID -> SName

The relation is in 3NF.

R9(SName) - SHOPS

Keys: SName

Primary Key: Sname

FDs: SName \rightarrow SName

The relation is in 3NF.

R10(PName, Maker, Category) - PRODUCTS

Keys: PName

Primary Key: PName

FDs: PName \rightarrow Maker, Category

The relation is in 3NF.

R11(PName, SQuantity, SPID, SPrice, SName) - PRODUCTS-IN-ORDERS

Keys: {PName, SName}

Primary Key: {PName, SName}

FDs: {PName, SName} \rightarrow SQuantity, SPID, SPrice

SPID \rightarrow SQuantity, SPrice

The relation is not in 3NF at this stage because the second FD (SPID \rightarrow SQuantity, SPrice) does not contain the key on the left side nor the attributes on the right side are contained in the key of R11.

3NF Decomposition process:

1) Minimal Basis: {PName, SName} \rightarrow SPID

SPID \rightarrow SPrice

SPID \rightarrow SQuantity

2) Combine FDs with the same LHS:

a) After combining FDs:

PName, SName \rightarrow SPID

SPID \rightarrow SPrice, SQuantity

3) For each FD, create a table containing all its attributes: R12(PName, SName, SPID), R13(SPID, SPrice, SQuantity)

4) Add a table that contains a key of the original table: No additional table required as R12 contains {PName, SName}.

5) Remove redundant tables: No table is redundant.

Resultant tables: R12(PName, SName, SPID), R13(SPID, SPrice, SQuantity)

R12(PName, SName, SPID) - PRODUCTS-IN-SHOPS-1

Keys: {PName, SName}

Primary Key: {PName, SName}

FDs: {PName, SName} -> SPID

The relation is in 3NF.

R13(SPID, SPrice, SQuantity) - PRODUCTS-IN-SHOPS-2

Keys: SPID

Primary Key: SPID

FDs: SPID -> SPrice, SQuantity

The relation is in 3NF.

R14(End-date, Start-date, PName, SName, Price) - PRICE-HISTORY

Keys: {End-date, Start-date, PName, SName}

Primary Key: {End-date, Start-date, PName, SName}

FDs: {End-date, Start-date, PName, SName} -> Price

The relation is in 3NF.

R15(Order_status, OPID, OPrice, OQuantity, PName, SName, OrderID, Delivery-date) -
PRODUCTS-IN-ORDERS

Keys: {PName, SName, OrderID}

Primary Key: {PName, SName, OrderID}

FDs: {PName, SName, OrderID} -> Order_status, OPID, OPrice, OQuantity, Delivery-date

OPID -> OPrice, OQuantity, Order_status, Delivery-date

OPID -> OrderID, PName, SName

The relation is not in 3NF at this stage because the second FD (OPID -> OPrice, OQuantity, Order_status, Delivery-date) does not contain the key on the left side nor the attributes on the right side are contained in the key of R15.

3NF Decomposition process:

1) Minimal Basis:

a) Transforming into one-attribute-RHS FDs:

- i) PName, SName, OrderID -> Order_status
- ii) PName, SName, OrderID -> OPID
- iii) PName, SName, OrderID -> OPrice
- iv) PName, SName, OrderID -> OQuantity
- v) PName, SName, OrderID -> Delivery-date
- vi) OPID -> OPrice
- vii) OPID -> OQuantity

- viii) OPID \rightarrow Order_status
- ix) OPID \rightarrow Delivery-date
- x) OPID \rightarrow OrderID
- xi) OPID \rightarrow PName
- xii) OPID \rightarrow SName

b) Removing redundant FDs:

- i) FDs a(i) to a(iv) are redundant as the closure of {PName, SName, OrderID}, derived using just FDs a(v) to a(xii), would contain each FD's RHS attribute

- ii) Example (showing redundancy of a(i)):

Using the Axiom of Transitivity,

{PName, SName, OrderID} \rightarrow OPID

OPID \rightarrow Status

Derived FD: PName, SName, OrderID \rightarrow Status

- iii) Final FDs:

PName, SName, OrderID \rightarrow OPID

OPID \rightarrow Order_status

OPID \rightarrow OPrice

OPID \rightarrow OQuantity

OPID \rightarrow Delivery-date

OPID \rightarrow OrderID

OPID \rightarrow PName

OPID \rightarrow SName

- c) Removing redundant attributes on the LHS: No attributes to be removed. There is only 1 FD that has more than 1 attribute on its LHS, and its LHS attributes only appear in this FD, thus they are not redundant.

2) Combine FDs with the same LHS:

- a) After combining FDs:

PName, SName, OrderID \rightarrow OPID

OPID \rightarrow Order_status, OPrice, OQuantity, Delivery-date, OrderID, PName, SName

- 3) For each FD, create a table containing all its attributes: R16(PName, SName, OrderID, OPID), R17(OPID, Order_status, OPrice, OQuantity, Delivery-date, OrderID, PName, SName)
- 4) Add a table that contains a key of the original table: No additional table required as both R16 and R17 contains {PName, SName, OrderID}.
- 5) Remove redundant tables: R16 is redundant as it is a subset of R17. R17 contains all the attributes of R16, namely PName, SName, OrderID, OPID.

Resultant tables: R17(OPID, Order_status, OPrice, OQuantity, Delivery-date, OrderID, PName, SName)

R17(OPID, Order_status, OPrice, OQuantity, Delivery-date, OrderID, PName, SName) -

PRODUCTS-IN-ORDERS

Keys: OPID

Primary Key: OPID

FDs: OPID → Order_status, OPrice, OQuantity, Delivery-date, OrderID, PName, SName

The relation is in 3NF.