

# FUNCTIONAL DEPENDENCIES AND NORMALIZATION

## FUNCTIONAL DEPENDENCY SET:

Customer\_ID → CustomerName  
Customer\_ID → ContactNumber  
Customer\_ID → Email  
Customer\_ID → Gender  
Customer\_ID → City  
Customer\_ID → DOB  
ContactNumber → Customer\_ID  
ContactNumber → CustomerName  
ContactNumber → Email  
ContactNumber → Gender  
ContactNumber → City  
ContactNumber → DOB  
Destination\_Name → Type of Place  
Destination\_Name → City  
Destination\_Name → Nearby Landmark  
Destination\_Name → Area  
Destination\_Name → Pincode  
Destination\_Name → Bus\_Station(Distance)  
Destination\_Name → Railway\_Station(Distance)  
Pincode → Area  
Pincode → City  
{City, Pincode} → Area  
{Area, Pincode} → City  
{Nearby Landmark, Pincode} → City  
{Nearby Landmark, Pincode} → Area  
{Landmark, Area, City} → Pincode  
{Dest\_Name, Sight\_Name} → Timing  
{Dest\_Name, Sight\_Name} → TicketPrice  
{Dest\_Name, Sight\_Name} → Distance\_from\_Dest  
{Cust\_ID, Destination\_Name} → Start\_Date  
{Cust\_ID, Destination\_Name} → No\_of\_Days  
Tour\_ID → Company Name  
Tour\_ID → Website  
Tour\_ID → Email\_ID  
Tour\_ID → Rating  
{Destination\_Name, Tour\_ID, Customer\_ID} → StartDate  
{Destination\_Name, Tour\_ID, Customer\_ID} → EndDate  
{Destination\_Name, Tour\_ID, Customer\_ID} → Budget\_Constraint  
{Destination\_Name, Tour\_ID, Customer\_ID} → Children  
{Destination\_Name, Tour\_ID, Customer\_ID} → Adults  
{Tour\_ID, Destination\_Name} → Consultant\_Fee  
{Tour\_ID, Destination\_Name} → Refund Percentage  
{Tour\_ID, Destination\_Name, Days} → Amount  
Hotel\_ID → Hotel Name  
Hotel\_ID → Type of Hotel  
Hotel\_ID → Distance from Destination  
Hotel\_ID → Rating  
Hotel\_ID → Website  
Website → Hotel\_ID

Website → Type of Hotel  
Website → Distance from Destination  
Website → Hotel Name  
Website → Rating  
{Hotel\_ID, Room\_Type} → Total Rooms  
{Hotel\_ID, Room\_Type} → Price  
{RoomType, Hotel\_ID, Days} → Amount Percentage  
Hotel\_ID → ContactNumber  
{Hotel\_ID, Room\_Type, Room\_No, Startdate} → Cust\_ID  
{Hotel\_ID, Room\_Type, Room\_No, Startdate} → EndDate  
{Hotel\_ID, Room\_Type, Room\_No, Startdate} → Tour\_ID  
{Hotel\_ID, Room\_Type, Room\_No, Startdate} → Children  
{Hotel\_ID, Room\_Type, Room\_No, Startdate} → Adults  
{Hotel\_ID, Room\_Type, Startdate, Cust\_ID} → Tour\_ID  
{Hotel\_ID, Room\_Type, StartDate, Cust\_ID} → CancellationDate  
{Hotel\_ID, Room\_Type, StartDate, Cust\_ID} → EndDate  
{Hotel\_ID, Cust\_ID} → Stars  
{Dest\_Name, Cust\_ID} → Stars  
{Tour\_ID, Cust\_ID} → Stars  
{Cust\_ID, StartDate} → Hotel\_ID

## MINIMAL FUNCTIONAL DEPENDENCY SET:

Customer\_ID → CustomerName  
Customer\_ID → ContactNumber  
Customer\_ID → Email  
Customer\_ID → Gender  
Customer\_ID → City  
Customer\_ID → DOB  
ContactNumber → Customer\_ID  
ContactNumber → CustomerName  
ContactNumber → Email  
ContactNumber → Gender  
ContactNumber → City  
ContactNumber → DOB  
Destination\_Name → Type of Place  
Destination\_Name → City  
Destination\_Name → Nearby Landmark  
Destination\_Name → Area  
Destination\_Name → Pincode  
Destination\_Name → Bus\_Station(Distance)  
Destination\_Name → Railway\_Station(Distance)  
Pincode → Area  
Pincode → City  
{Landmark, Area, City} → Pincode  
{Dest\_Name, Sight\_Name} → Timing  
{Dest\_Name, Sight\_Name} → TicketPrice  
{Dest\_Name, Sight\_Name} → Distance\_from\_Dest  
{Cust\_ID, Destination\_Name} → Start\_Date  
{Cust\_ID, Destination\_Name} → No\_of\_Days  
Tour\_ID → Company Name  
Tour\_ID → Website  
Tour\_ID → Email\_ID  
Tour\_ID → Rating  
{Destination\_Name, Tour\_ID, Customer\_ID} → StartDate  
{Destination\_Name, Tour\_ID, Customer\_ID} → EndDate  
{Destination\_Name, Tour\_ID, Customer\_ID} → Budget\_Constraint  
{Destination\_Name, Tour\_ID, Customer\_ID} → Children  
{Destination\_Name, Tour\_ID, Customer\_ID} → Adults  
{Tour\_ID, Destination\_Name} → Consultant\_Fee  
{Tour\_ID, Destination\_Name} → Refund Percentage  
{Tour\_ID, Destination\_Name, Days} → Amount  
Hotel\_ID → Hotel Name  
Hotel\_ID → Type of Hotel  
Hotel\_ID → Distance from Destination  
Hotel\_ID → Rating  
Hotel\_ID → Website  
Website → Hotel\_ID  
Website → Type of Hotel  
Website → Distance from Destination  
Website → Hotel Name  
Website → Rating  
{Hotel\_ID, Room\_Type} → Total Rooms  
{Hotel\_ID, Room\_Type} → Price  
{RoomType, Hotel\_ID, Days} → Amount Percentage

Hotel\_ID → ContactNumber  
{Hotel\_ID, Room\_Type, Room\_No, Startdate} → Cust\_ID  
{Hotel\_ID, Room\_Type, Room\_No, Startdate} → EndDate  
{Hotel\_ID, Room\_Type, Room\_No, Startdate} → Tour\_ID  
{Hotel\_ID, Room\_Type, Room\_No, Startdate} → Children  
{Hotel\_ID, Room\_Type, Room\_No, Startdate} → Adults  
{Hotel\_ID, Room\_Type, Startdate, Cust\_ID} → Tour\_ID  
{Hotel\_ID, Room\_Type, StartDate, Cust\_ID} → CancellationDate  
{Hotel\_ID, Room\_Type, StartDate, Cust\_ID} → EndDate  
{Hotel\_ID, Cust\_ID} → Stars  
{Dest\_Name, Cust\_ID} → Stars  
{Tour\_ID, Cust\_ID} → Stars  
{Cust\_ID, StartDate} → Hotel\_ID

## NORMALIZATION PROOFS:

**CUSTOMER** (Customer\_ID, CustomerName, ContactNumber, Email, Gender, City, DOB) :

Customer\_ID  $\rightarrow$  {CustomerName, ContactNumber, Email, Gender, City, DOB}

ContactNumber  $\rightarrow$  {Customer\_ID, CustomerName, Email, Gender, City, DOB}

Computing the primary key:

{Customer\_ID} $^+$   $\rightarrow$  {Customer\_ID, CustomerName, ContactNumber, Email, Gender, City, DOB}

{ContactNumber} $^+$   $\rightarrow$  {Customer\_ID, CustomerName, ContactNumber, Email, Gender, City, DOB}

Customer\_ID and ContactNumber can both be the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have Customer\_ID or ContactNumber on the left.

**DESTINATION** (Destination\_Name, Type of Place, City, Nearby Landmark, Area, Pincode, Bus\_Station(Distance), Railway\_Station(Distance)):

Destination\_Name  $\rightarrow$  {Type of Place, City, Nearby Landmark, Area, Pincode, Bus\_Station(Distance), Railway\_Station(Distance)}

Pincode  $\rightarrow$  Area

Pincode  $\rightarrow$  City

{Landmark, Area, City}  $\rightarrow$  Pincode

Computing the primary key:

{Destination\_Name} $^+$   $\rightarrow$  {Destination\_Name, Type of Place, City, Nearby Landmark, Area, Pincode, Bus\_Station(Distance), Railway\_Station(Distance)}

{Destination\_Name} is the primary key.

BCNF Proof:

The relation is not in BCNF because the last three functional dependencies do not have the primary key on left.

**SIGHTSEEING PLACES** (Dest\_Name, Sight\_Name, Timing, Ticket\_price, Distance\_from\_Dest):

{Dest\_Name, Sight\_Name}  $\rightarrow$  {Timing, TicketPrice, Distance\_from\_Dest}

Computing the primary key:

{Dest\_Name, Sight\_Name} $^+$   $\rightarrow$  {Dest\_Name, Sight\_Name, Timing, TicketPrice, Distance\_from\_Dest}

{Dest\_Name, Sight\_Name} is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key {Dest\_Name, Sight\_Name} on the left.

**VISITED** (Destination\_Name, Customer\_ID, No\_of\_Days, StartDate):

{Destination\_Name, Customer\_ID}  $\rightarrow$  {No\_of\_Days, StartDate}

Computing the primary key:

{Destination\_Name, Customer\_ID} $^+$   $\rightarrow$  {Destination\_Name, Customer\_ID, No\_of\_Days, StartDate}

{Destination\_Name, Customer\_ID} is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key {Desination\_Name, Customer\_ID} on the left.

**TOURS & TRAVELS** (Tour\_ID, Company Name, Website, Email\_ID, Rating):

$\text{Tour\_ID} \rightarrow \{\text{Company Name, Website, Email\_ID, Rating}\}$

Computing the primary key:

$\{\text{Tour\_ID}\}_+ \rightarrow \{\text{Tour\_ID, Company Name, Website, Email\_ID, Rating}\}$

{Tour\_ID} is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key {Tour\_ID} on the left.

**TOURIST** (Destination\_Name, Tour\_ID, Customer\_ID, StartDate, EndDate, Budget\_Constraint, Children, Adults):

$\{\text{Destination\_Name, Tour\_ID, Customer\_ID}\} \rightarrow \{\text{StartDate, EndDate, Budget\_Constraint, Children, Adults}\}$

Computing the primary key:

$\{\text{Destination\_Name, Tour\_ID, Customer\_ID}\}_+ \rightarrow \{\text{Destination\_Name, Tour\_ID, Customer\_ID, StartDate, EndDate, Budget\_Constraint, Children, Adults}\}$

{Destination\_Name, Tour\_ID, Customer\_ID} is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key {Destination\_Name, Tour\_ID, Customer\_ID} on the left.

**PRICING CONDITIONS** (Tour\_ID, Destination\_Name, Consultant\_Fee, Refund\_Percentage):

$\{\text{Tour\_ID, Destination\_Name}\} \rightarrow \{\text{Consultant\_Fee, Refund\_Percentage}\}$

Computing the primary key:

$\{\text{Tour\_ID, Destination\_Name}\}_+ \rightarrow \{\text{Tour\_ID, Destination\_Name, Consultant\_Fee, Refund\_Percentage}\}$

{Tour\_ID, Destination\_Name} is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key {Destination\_Name, Tour\_ID} on the left.

**PACKAGES** (Tour\_ID, Destination\_Name, Day, Amount):

$\{\text{Tour\_ID, Destination\_Name, Days}\} \rightarrow \text{Amount}$

Computing the primary key:

$\{\text{Tour\_ID, Destination\_Name, Days}\}_+ \rightarrow \text{Amount}$

{Tour\_ID, Destination\_Name, Days} is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key {Tour\_ID, Destination\_Name, Days} on the left.

**HOTELS** (Hotel\_ID, Hotel Name, Type of Hotel, Distance from Destination, Rating, Website):

Hotel\_ID  $\rightarrow$  {Hotel Name, Type of Hotel, Distance from Destination, Rating, Website}

Website  $\rightarrow$  {Hotel\_ID, Hotel Name, Type of Hotel, Distance from Destination, Rating}

Computing the primary key:

{Hotel\_ID} $^+_r \rightarrow$  {Hotel\_ID, Hotel Name, Type of Hotel, Distance from Destination, Rating, Website}

{Website} $^+_r \rightarrow$  {Hotel\_ID, Hotel Name, Type of Hotel, Distance from Destination, Rating, Website}

{Hotel\_ID} and {Website} can both be the primary keys.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key {Hotel\_ID} or {Website} on the left.

**ROOM TYPE** (Hotel\_ID, Room\_Type, Total Rooms, Price):

{Hotel\_ID, Room\_Type}  $\rightarrow$  {Total Rooms, Price}

Computing the primary key:

{Hotel\_ID, Room\_Type} $^+_r \rightarrow$  {Hotel\_ID, Room\_Type, Total Rooms, Price}

{Hotel\_ID, Room\_Type} is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key {Hotel\_ID, Room\_Type} on the left.

**REFUND POLICY** (RoomType, Hotel\_ID, Days, Amount Percentage):

{RoomType, Hotel\_ID, Days}  $\rightarrow$  Amount Percentage

Computing the primary key:

{RoomType, Hotel\_ID, Days} $^+_r \rightarrow$  {RoomType, Hotel\_ID, Days, Amount Percentage}

{RoomType, Hotel\_ID, Days} is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key {RoomType, Hotel\_ID, Days} on the left.

**BOOKINGS** (Hotel\_ID, Room\_Type, Room\_No, Startdate, Cust\_ID, Enddate, Tour\_ID, Children, Adults):

{Hotel\_ID, Room\_Type, Room\_No, Startdate}  $\rightarrow$  {Cust\_ID, Enddate, Tour\_ID, Children, Adults}

Computing the primary key:

{Hotel\_ID, Room\_Type, Room\_No, Startdate} $^+_r \rightarrow$  {Hotel\_ID, Room\_Type, Room\_No, Startdate, Cust\_ID, Enddate, Tour\_ID, Children, Adults}

{Hotel\_ID, Room\_Type, Room\_No, Startdate} is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key {Hotel\_ID, Room\_Type, Room\_No, Startdate} on the left.

**CANCELLATIONS** (Hotel\_ID, Room\_Type, Startdate, Cust\_ID, Tour\_ID, CancellationDate, EndDate):

$\{\text{Hotel\_ID, Room\_Type, Startdate, Cust\_ID}\} \rightarrow \{\text{Tour\_ID, CancellationDate, EndDate}\}$

Computing the primary key:

$\{\text{Hotel\_ID, Room\_Type, Startdate, Cust\_ID}\}_+ \rightarrow \{\text{Hotel\_ID, Room\_Type, Startdate, Cust\_ID, Tour\_ID, CancellationDate, EndDate}\}$

$\{\text{Hotel\_ID, Room\_Type, Startdate, Cust\_ID}\}$  is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key  $\{\text{Hotel\_ID, Room\_Type, Startdate, Cust\_ID}\}$  on the left.

**RATING\_HOTEL** (Hotel\_ID, Cust\_ID, Stars):

$\{\text{Hotel\_ID, Cust\_ID}\} \rightarrow \text{Stars}$

Computing the primary key:

$\{\text{Hotel\_ID, Cust\_ID}\}_+ \rightarrow \{\text{Hotel\_ID, Cust\_ID, Stars}\}$

$\{\text{Hotel\_ID, Cust\_ID}\}$  is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key  $\{\text{Hotel\_ID, Cust\_ID}\}$  on the left.

**RATING\_DEST** (Dest\_Name, Cust\_ID, Stars):

$\{\text{Dest\_Name, Cust\_ID}\} \rightarrow \text{Stars}$

Computing the primary key:

$\{\text{Dest\_Name, Cust\_ID}\}_+ \rightarrow \{\text{Dest\_Name, Cust\_ID, Stars}\}$

$\{\text{Dest\_Name, Cust\_ID}\}$  is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key  $\{\text{Dest\_Name, Cust\_ID}\}$  on the left.

**RATING\_T&T** (Tour\_ID, Cust\_ID, Stars):

$\{\text{Tour\_ID, Cust\_ID}\} \rightarrow \text{Stars}$

Computing the primary key:

$\{\text{Tour\_ID, Cust\_ID}\}_+ \rightarrow \{\text{Tour\_ID, Cust\_ID, Stars}\}$

$\{\text{Tour\_ID, Cust\_ID}\}$  is the primary key.

BCNF Proof:

The relation is in BCNF because all functional dependencies have the primary key  $\{\text{Tour\_ID, Cust\_ID}\}$  on the left.

**ROOM NUMBER** (Hotel\_ID, Room\_Type, Room\_No):

Computing the primary key:

$\{\text{Hotel\_ID, Room\_Type, Room\_No}\}_+ \rightarrow \{\text{Hotel\_ID, Room\_Type, Room\_No}\}$

$\{\text{Hotel\_ID, Room\_Type, Room\_No}\}$  is the primary key.



This relation only has a non-trivial functional dependency. So, it is in BCNF, as all functional dependencies only have the primary key on the left.

**TOUR CONTACT DETAILS** (Tour\_ID, TContactNumber):

Computing the primary key:

$\{Tour\_ID, TContactNumber\}^+ \rightarrow \{Tour\_ID, ContactNumber\}$

$\{Tour\_ID, TContactNumber\}$  is the primary key.

This relation only has a non-trivial functional dependency. So, it is in BCNF, as all functional dependencies only have the primary key on the left.

**AVAILABLE HOTEL** (Destination Name, Hotel\_ID) :

Computing the primary key:

$\{Destination\ Name, Hotel\_ID\}^+ \rightarrow \{Destination\ Name, Hotel\_ID\}$

$\{Destination\ Name, Hotel\_ID\}$  is the primary key.

This relation only has a non-trivial functional dependency. So, it is in BCNF, as all functional dependencies only have the primary key on the left.

**HOTEL CONTACT DETAILS** (Hotel\_ID,HContactNumber):

Computing the primary key:

$\{Hotel\_ID, HContactNumber\}^+ \rightarrow \{Hotel\_ID, ContactNumber\}$

$\{Hotel\_ID, HContactNumber\}$  is the primary key.

This relation only has a non-trivial functional dependency. So, it is in BCNF, as all functional dependencies only have the primary key on the left.