

DBMS (Database Management System)

1. Data Attribute

A **data attribute** is a property or characteristic of an entity. Think of it as a column in a table.

Example:

Imagine a **student** database. The entity is **Student**, and its attributes could be:

- **Name** (John Doe)
- **Age** (20)
- **Email** (john@example.com)

Each row in the database stores specific values for these attributes.



2. Entity

An **entity** is an object or thing in the real world that can be stored in a database.

Example:

- A **student** in a school database
- A **car** in a vehicle database
- A **product** in an e-commerce store

Each entity has attributes (like a student has a name and roll number).



3. Cardinality

Cardinality defines the number of relationships between entities.

Types:

1. **One-to-One (1:1)**: A person has **one passport**.
2. **One-to-Many (1:N)**: A teacher can teach **many students**.

3. **Many-to-Many (N:N)**: A student can enroll in **many courses**, and a course can have **many students**.



4. DB Design (Database Design)

Database design is about organizing data efficiently. It ensures that:

- ✓ Data is stored properly
- ✓ There are no duplicate records
- ✓ Queries run fast

Example:

If you're making a library database, you should have tables like:

1. **Books (ISBN, Title, Author, Category)**
2. **Students (ID, Name, Email)**
3. **BorrowedBooks (StudentID, ISBN, BorrowDate, ReturnDate)**

This way, the **BorrowedBooks** table links students and books without storing duplicate data.



5. Relationships

Relationships connect different tables in a database.

- **One-to-One (1:1)** → Each person has **one** unique ID card.
- **One-to-Many (1:N)** → A customer can place **many** orders.
- **Many-to-Many (N:N)** → A student enrolls in **many** courses, and a course has **many** students.

Example:

A **Users** table and an **Orders** table are connected because one user can place many orders.



6. Data Types

Each column in a database has a **data type**, which defines what kind of values it can store.

Common Data Types:

- **INT** → Numbers (e.g., age, price)
- **VARCHAR** → Text (e.g., names, addresses)
- **DATE** → Dates (e.g., 2025-03-07)
- **BOOLEAN** → True or False

Example:

A **Student** table may have:

- **Name** → `VARCHAR(100)`
- **Age** → `INT`
- **Enrollment Date** → `DATE`



7. Difference Between Primary and Unique Key

Feature	Primary Key	Unique Key
Purpose	Uniquely identifies each record	Ensures uniqueness but allows NULL values
NULL Allowed?	No	Yes
Number per Table	Only one primary key	Multiple unique keys allowed

Example:

A **Student** table may have:

- **StudentID (Primary Key)** → Always unique
- **Email (Unique Key)** → Ensures no two students have the same email



8. 1:1, 1:N, N:N Relationships

One-to-One (1:1): Each employee has **one** company car.

One-to-Many (1:N): A teacher teaches **many** students.

Many-to-Many (N:N): Students enroll in **many** courses, and a course has **many** students.

Example:

A **Library Database** may have:

- **Books** (BookID, Title)
- **Students** (StudentID, Name)
- **BorrowedBooks** (StudentID, BookID, BorrowDate) → (N:N relationship)



9. Normalization and its Types

Normalization

Organizing the tables and columns in a way that minimize **redundancy** and **dependency**

Anomalies

Anomalies

- **INSERT**
 - Unable to insert customer before invoice is created.
- **UPDATE**
 - Customer contact details with each invoice. Need to update multiple places.
- **DELETE**
 - Customer details are lost when invoice is deleted.

1NF

First normal form(1NF)

- Attributes/Columns are uniquely named.
- The order of columns and rows is insignificant.
- Every row and column intersection contains exactly one value of the applicable domain, and nothing else.
- No duplicate rows

2NF

Second Normal Form (2NF)

Candidate Key Non-prime attributes

<u>a</u>	<u>b</u>	c	d	e

Note: A non-prime attribute of a table is an attribute that is not part of any candidate key of the table.

Every non-prime attribute of the table is dependent on the complete key (whole of a candidate key)

Example

PARTS SUPPLY

<u>Supplier Id</u>	<u>Part Id</u>	Part Name	Quantity
supplier1	BA	Base Assembly	10
supplier1	CS	Crank Shaft	5
supplier2	BA	Base Assembly	40
supplier2	BU	Battery Unit	35
supplier3	BA	Base Assembly	8
supplier3	CS	Crank Shaft	2
supplier3	BU	Battery Unit	12

- Here there are 2 candidate keys
 - supplier id
 - part id
- The non prime attributes here are
 - Part name
 - Quantity

- 2nf says that every non prime attribute is dependent on the complete key (both the candidate keys)
- Lets check each non prime attribute one by one
 - **Part name**
 - Part name is determined by Part ID
 - But its not determined by supplier ID as well
 - So its partially dependent on the complete key
 - **Quantity**
 - Quantity is determined by the combination of supplier ID and quantity
- Transforming it into 2NF
 - We need to split into 2 tables where 2nf is satisfied

PARTS SUPPLY

<u>Supplier Id</u>	<u>Part Id</u>	Quantity
supplier1	BA	10
supplier1	CS	5
supplier2	BA	40
supplier2	BU	35
supplier3	BA	8
supplier3	CS	2
supplier3	BU	12

PARTS

<u>Part Id</u>	Part Name
BA	Base Assembly
CS	Crank Shaft
BU	Battery Unit

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- Now quantity is determined by combination of supplier ID and part ID
- Part name is determined by Part ID
- Both tables follow 2nf

3NF

Third Normal Form (3NF)

Diagram illustrating a table structure for 3NF:

Key	Non-prime attributes	
<u>a</u>	b	c



Every non-prime attribute of the table is directly dependent on the key
(non transitively dependent on the key)

Example

SALES

Order No	Customer	Product	Coupon Code	Discount(%)	Net Amount
ORD1001	Alice Cooper	Video Camera	NEWYEAR40	40	600.00
ORD1002	Barbara Park	Keyboard	NEWYEAR40	40	30.00
ORD1003	Cynthia Nixon	LCD Monitor	SUMMER30	30	70.00
ORD1004	Mohan Lal	Mobile phone	SUMMER30	30	350.00
ORD1005	Zoya Afrose	Hard Disk	SPRING25	25	450
ORD1006	Steve Smith	Printer	SPRING25	25	150.00
ORD1007	Barbara Park	Network Router	NOCOUPON	00	45.00

- Here our key is Order No, other columns are non prime attributes
- Here Discount depends on Coupon Code
- And coupon code depends on Order number
- So this is Transitively dependent
 - Discount -> Coupon Code -> Order Number
 - This is not allowed in 3NF
- We need to split the tables such that the transitive dependencies are removed
- We need a separate table for the columns in the transitive dependency

- The columns are Coupon code and discount

COUPON

Coupon Code	Discount(%)
NEWYEAR40	40
SUMMER30	30
SPRING25	25
NOCOUPON	00

SALES

Order No	Customer	Product	Coupon Code	Net Amount
ORD1001	Alice Cooper	Video Camera	NEWYEAR40	600.00
ORD1002	Barbara Park	Keyboard	NEWYEAR40	30.00
ORD1003	Cynthia Nixon	LCD Monitor	SUMMER30	70.00
ORD1004	Mohan Lal	Mobile phone	SUMMER30	350.00
ORD1005	Zoya Afrose	Hard Disk	SPRING25	450
ORD1006	Steve Smith	Printer	SPRING25	150.00
ORD1007	Barbara Park	Network Router	NOCOUPON	45.00

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- Now the Tables follow 3NF

BCNF

Boyce-Codd Normal Form(BCNF)

- Developed by Raymond F. **Boyce** and E.F. **Codd**
- A table is in BCNF if every determinant is a candidate key

- Determinant is the value which can determine other attributes

PRODUCT SPECIALIST ASSIGNMENT

Customer Id	Product Id	Specialist Id	Date	Status
C10001	LED Television	Peter	01-Dec-2014	Active
C10002	Personal Computer	Reshmi	03-Jan-2014	Active
C10002	Network Router	Mallik	11-Feb-2014	Active
C10003	Mobile Phone	Roonie	07-Nov-2014	Inactive
C10005	LED Television	Peter	17-Oct-2014	Inactive
C10006	Network Router	Mallik	19-Mar-2014	Active

- Here the determinants are
- CustomerID, SpecialistID, ProductId are determinants
- Combination of customerid, productid and customerid, specialist ID can be keys
- We need to split the tables

PRODUCT SPECIALIST

Specialist Id	Product Id	Specialization Level
Peter	LED Television	L1
Reshmi	Personal Computer	L1
Mallik	Network Router	L2
Roonie	Mobile Phone	L1

PRODUCT SPECIALIST ASSIGNMENT

Customer Id	Specialist Id	Date	Status
C10001	Peter	01-Dec-2014	Active
C10002	Reshmi	03-Jan-2014	Active
C10002	Mallik	11-Feb-2014	Active
C10003	Roonie	07-Nov-2014	Inactive
C10005	Peter	17-Oct-2014	Inactive
C10006	Mallik	19-Mar-2014	Active