Relational Data Model

The relational Model was proposed by E.F. Codd to model data in the form of relations or tables. After designing the conceptual model of the Database using ER diagram, we need to convert the conceptual model into a relational model which can be implemented using any RDBMS language like Oracle SQL, MySQL, etc. So we will see what the Relational Model is.

What is the Relational Model?

The relational model represents how data is stored in Relational Databases. A relational database stores data in the form of relations (tables). Consider a relation STUDENT with attributes ROLL_NO, NAME, ADDRESS, PHONE, and AGE shown in Table 1.

STUDENT

ROLL_NO	NAME	ADDRESS	PHONE	AGE
1	RAM	DELHI	9455123451	18
2	RAMESH	GURGAON	9652431543	18
3	SUJIT	ROHTAK	9156253131	20
4	SURESH	DELHI		18

IMPORTANT TERMINOLOGIES

- **Attribute:** Attributes are the properties that define a relation. e.g.; **ROLL_NO**, **NAME**
- **Relation Schema:** A relation schema represents the name of the relation with its attributes. e.g.; STUDENT (ROLL_NO, NAME, ADDRESS, PHONE, and AGE) is the relation schema for STUDENT. If a schema has more than 1 relation, it is called Relational Schema.
- **Tuple:** Each row in the relation is known as a tuple. The above relation contains 4 tuples, one of which is shown as:

1 RAM DELHI 9455123451 18

- **Relation Instance:** The set of tuples of a relation at a particular instance of time is called a relation instance. Table 1 shows the relation instance of STUDENT at a particular time. It can change whenever there is an insertion, deletion, or update in the database.
- **Degree:** The number of attributes in the relation is known as the degree of the relation. The **STUDENT** relation defined above has degree 5.
- **Cardinality:** The number of tuples in a relation is known as cardinality. The **STUDENT** relation defined above has cardinality 4.
- **Column:** The column represents the set of values for a particular attribute. The column **ROLL_NO** is extracted from the relation STUDENT.

- **NULL Values:** The value which is not known or unavailable is called a NULL value. It is represented by blank space. e.g.; PHONE of STUDENT having ROLL_NO 4 is NULL.

Constraints in Relational Model

While designing the Relational Model, we define some conditions which must hold for data present in the database are called Constraints. These constraints are checked before performing any operation (insertion, deletion, and updation) in the database. If there is a violation of any of the constraints, the operation will fail.

Domain Constraints: These are attribute-level constraints. An attribute can only take values that lie inside the domain range. e.g; If a constraint AGE>0 is applied to STUDENT relation, inserting a negative value of AGE will result in failure.

Key Integrity: Every relation in the database should have at least one set of attributes that defines a tuple uniquely. Those set of attributes is called keys. e.g.; ROLL_NO in STUDENT is a key. No two students can have the same roll number. So a key has two properties:

- It should be unique for all tuples.
- It can’t have NULL values.

Referential Integrity: When one attribute of a relation can only take values from another attribute of the same relation or any other relation, it is called referential integrity. Let us suppose we have 2 relations

STUDENT

ROLL_NO	NAME	ADDRESS	PHONE	AGE	BRANCH_CODE
1	RAM	DELHI	9455123451	18	CS
2	RAMESH	GURGAON	9652431543	18	CS
3	SUJIT	ROHTAK	9156253131	20	ECE
4	SURESH	DELHI		18	IT

BRANCH

BRANCH_CODE	BRANCH_NAME
CS	COMPUTER SCIENCE
IT	INFORMATION TECHNOLOGY
ECE	ELECTRONICS AND COMMUNICATION ENGINEERING
CV	CIVIL ENGINEERING

Advantages:

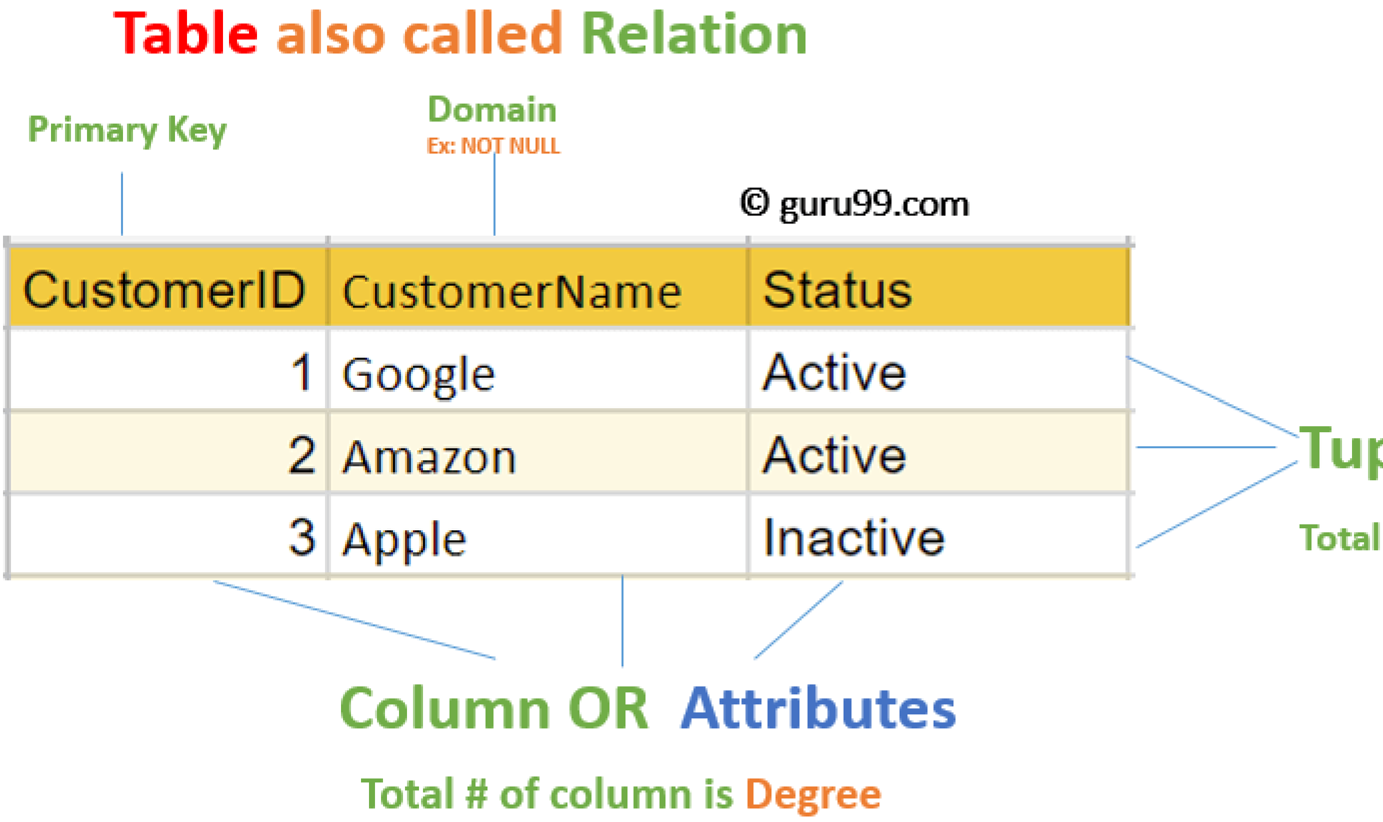
- Simple model
- It is Flexible
- It is Secure
- Data accuracy
- Data integrity
- Operations can be applied easily

Disadvantage:

- Not good for large database
- 2.Relation between tables become difficult some time

Relational Model Concepts in DBMS

1. **Attribute:** Each column in a Table. Attributes are the properties which define a relation. e.g., Student_Rollno, NAME,etc.
2. **Tables** – In the Relational model the, relations are saved in the table format. It is stored along with its entities. A table has two properties rows and columns. Rows represent records and columns represent attributes.
3. **Tuple** – It is nothing but a single row of a table, which contains a single record.
4. **Relation Schema:** A relation schema represents the name of the relation with its attributes.
5. **Degree:** The total number of attributes which in the relation is called the degree of the relation.
6. **Cardinality:** Total number of rows present in the Table.
7. **Column:** The column represents the set of values for a specific attribute.
8. **Relation instance** – Relation instance is a finite set of tuples in the RDBMS system. Relation instances never have duplicate tuples.
9. **Relation key** – Every row has one, two or multiple attributes, which is called relation key.
10. **Attribute domain** – Every attribute has some pre-defined value and scope which is known as attribute domain



CustomerID	CustomerName	Status
1	Google	Active
2	Amazon	Active
3	Apple	Inactive

Relational Integrity Constraints

Relational Integrity constraints in DBMS are referred to conditions which must be present for a valid relation. These Relational constraints in DBMS are derived from the rules in the mini-world that the database represents.

There are many types of Integrity Constraints in DBMS. Constraints on the Relational database management system is mostly divided into three main categories are:

1. Domain Constraints
2. Key Constraints
3. Referential Integrity Constraints

Domain Constraints

Domain constraints can be violated if an attribute value is not appearing in the corresponding domain or it is not of the appropriate data type.

Domain constraints specify that within each tuple, and the value of each attribute must be unique. This is specified as data types which include standard data types integers, real numbers, characters, Booleans, variable length strings, etc.

Example:

```
Create DOMAIN CustomerName
CHECK (value not NULL)
```

The example shown demonstrates creating a domain constraint such that CustomerName is not NULL

Key Constraints

An attribute that can uniquely identify a tuple in a relation is called the key of the table. The value of the attribute for different tuples in the relation has to be unique.

Example:

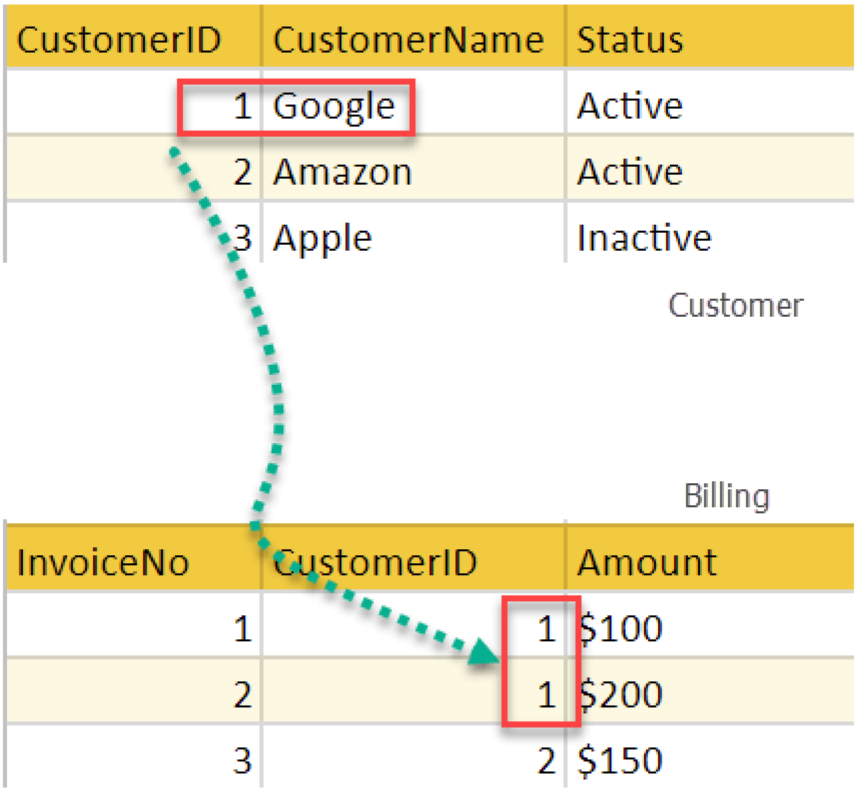
In the given table, CustomerID is a key attribute of Customer Table. It is most likely to have a single key for one customer, CustomerID =1 is only for the CustomerName =” Google”.

CustomerID	CustomerName	Status
1	Google	Active
2	Amazon	Active
3	Apple	Inactive

Referential Integrity Constraints

Referential Integrity constraints in DBMS are based on the concept of Foreign Keys. A foreign key is an important attribute of a relation which should be referred to in other relationships. Referential integrity constraint state happens where relation refers to a key attribute of a different or same relation. However, that key element must exist in the table.

Example:



CustomerID	CustomerName	Status
1	Google	Active
2	Amazon	Active
3	Apple	Inactive

Customer

Billing

InvoiceNo	CustomerID	Amount
1	1	$100
2	1	$200
3	2	$150

In the above example, we have 2 relations, Customer and Billing.

Tuple for CustomerID =1 is referenced twice in the relation Billing. So we know CustomerName=Google has billing amount $300

Operations in Relational Model

Four basic update operations performed on relational database model are

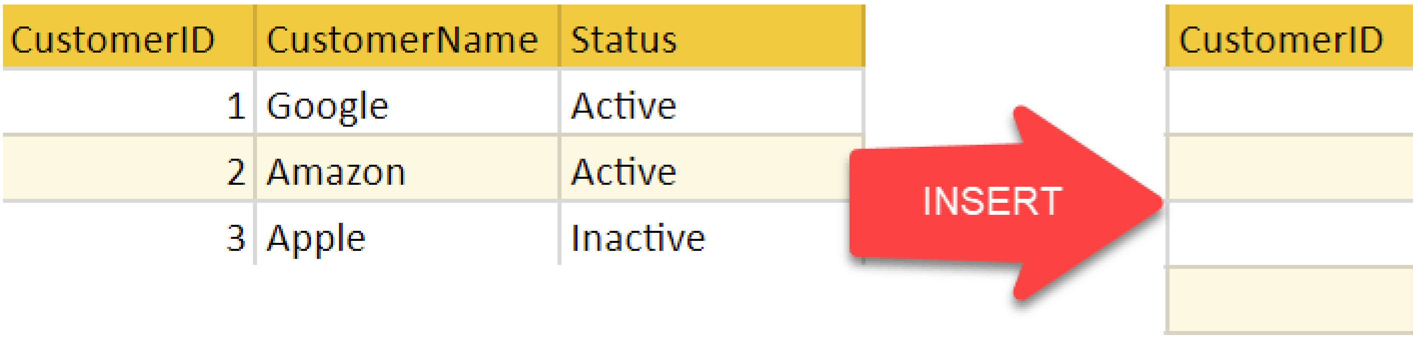
Insert, update, delete and select.

- Insert is used to insert data into the relation
- Delete is used to delete tuples from the table.
- Modify allows you to change the values of some attributes in existing tuples.
- Select allows you to choose a specific range of data.

Whenever one of these operations are applied, integrity constraints specified on the relational database schema must never be violated.

Insert Operation

The insert operation gives values of the attribute for a new tuple which should be inserted into a relation.

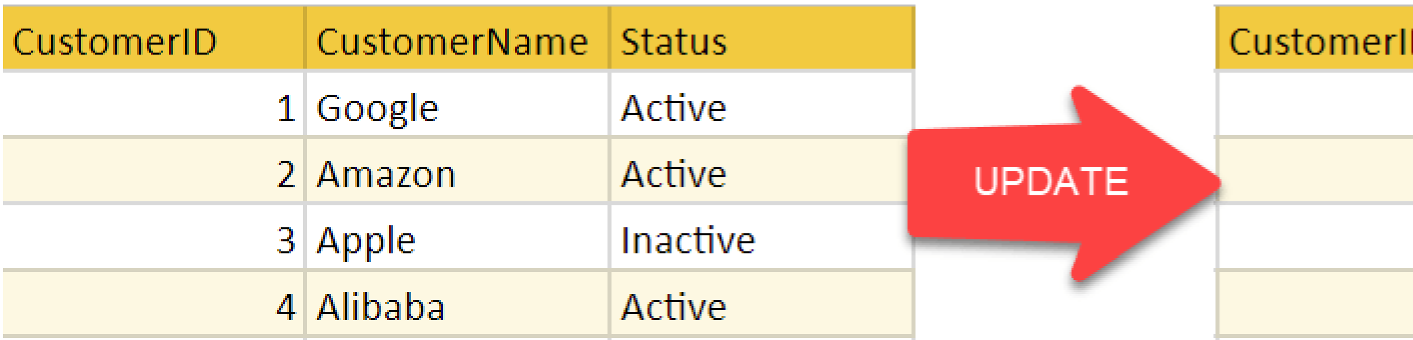


CustomerID	CustomerName	Status
1	Google	Active
2	Amazon	Active
3	Apple	Inactive

CustomerID

Update Operation

You can see that in the below-given relation table CustomerName= ‘Apple’ is updated from Inactive to Active.

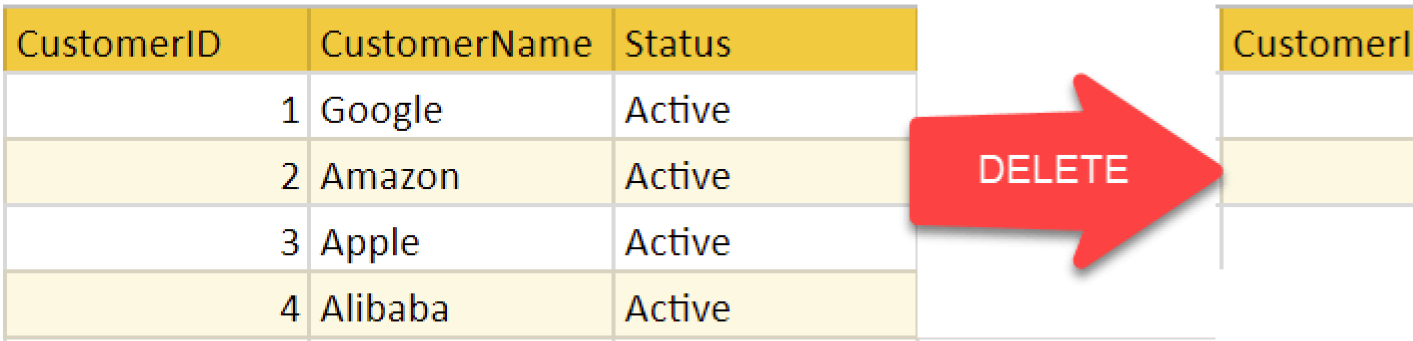


CustomerID	CustomerName	Status
1	Google	Active
2	Amazon	Active
3	Apple	Inactive
4	Alibaba	Active

CustomerI

Delete Operation

To specify deletion, a condition on the attributes of the relation selects the tuple to be deleted.



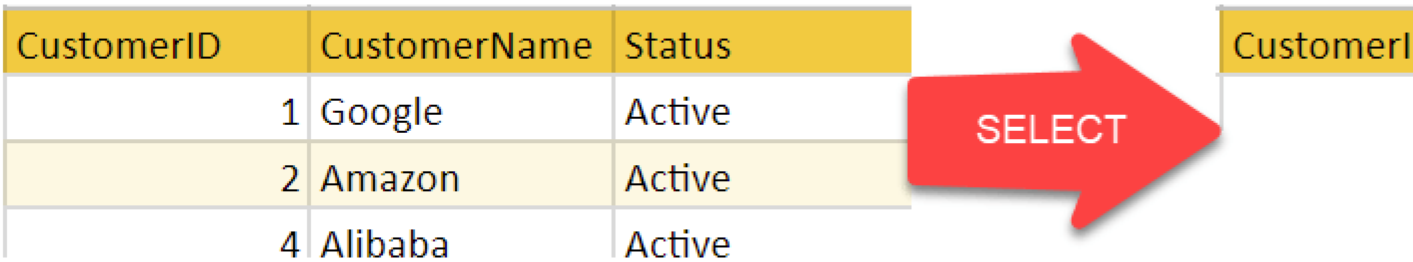
CustomerID	CustomerName	Status
1	Google	Active
2	Amazon	Active
3	Apple	Active
4	Alibaba	Active

CustomerI

In the above-given example, CustomerName= “Apple” is deleted from the table.

The Delete operation could violate referential integrity if the tuple which is deleted is referenced by foreign keys from other tuples in the same database.

Select Operation



CustomerID	CustomerName	Status
1	Google	Active
2	Amazon	Active
4	Alibaba	Active

SELECT
CustomerI

In the above-given example, CustomerName=”Amazon” is selected

Best Practices for creating a Relational Model

- Data need to be represented as a collection of relations
- Each relation should be depicted clearly in the table
- Rows should contain data about instances of an entity
- Columns must contain data about attributes of the entity
- Cells of the table should hold a single value
- Each column should be given a unique name
- No two rows can be identical
- The values of an attribute should be from the same domain

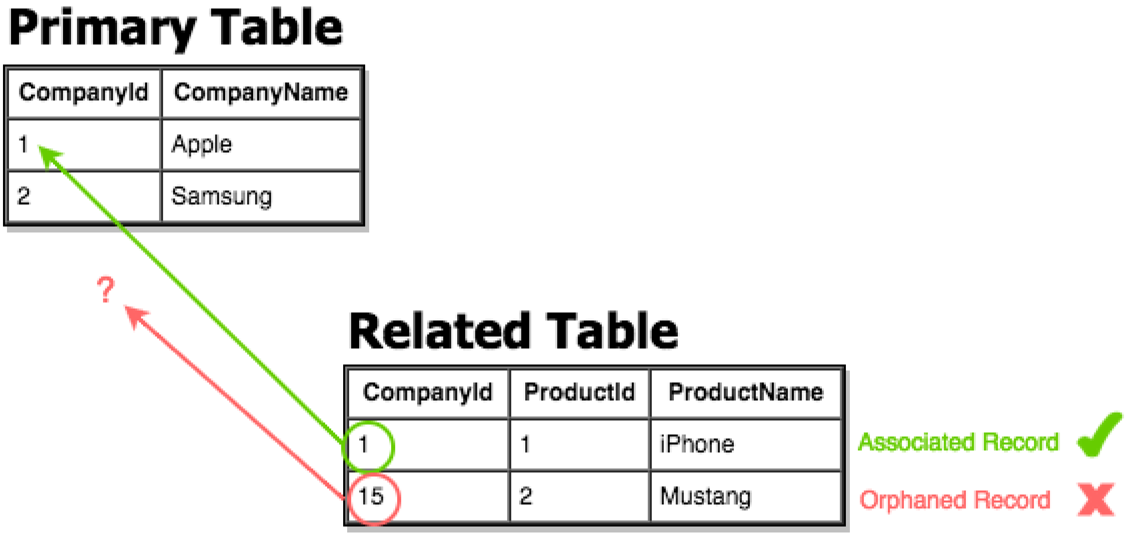
Advantages of Relational Database Model

- **Simplicity**: A Relational data model in DBMS is simpler than the hierarchical and network model.
- **Structural Independence**: The relational database is only concerned with data and not with a structure. This can improve the performance of the model.
- **Easy to use**: The Relational model in DBMS is easy as tables consisting of rows and columns are quite natural and simple to understand
- **Query capability**: It makes possible for a high-level query language like SQL to avoid complex database navigation.
- **Data independence**: The Structure of Relational database can be changed without having to change any application.
- **Scalable**: Regarding a number of records, or rows, and the number of fields, a database should be enlarged to enhance its usability.

Disadvantages of Relational Model

- Few relational databases have limits on field lengths which can’t be exceeded.
- Relational databases can sometimes become complex as the amount of data grows, and the relations between pieces of data become more complicated.
- Complex relational database systems may lead to isolated databases where the information cannot be shared from one system to another.

referential integrity



Primary Table

CompanyId	CompanyName
1	Apple
2	Samsung

Related Table

CompanyId	ProductId	ProductName
1	1	iPhone
15	2	Mustang

Associated Record ✓

Orphaned Record ✗