Tishk International University
Department of Information Technology
Database Systems 1
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# Keys, Normalization, Relationships

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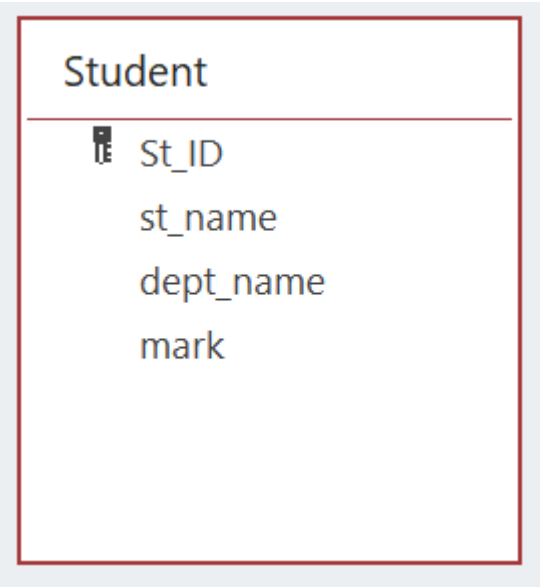
# Lecture Outcomes


- Primary Key
- Foreign Key
- Database Design Process
- Normalization
- Relationships

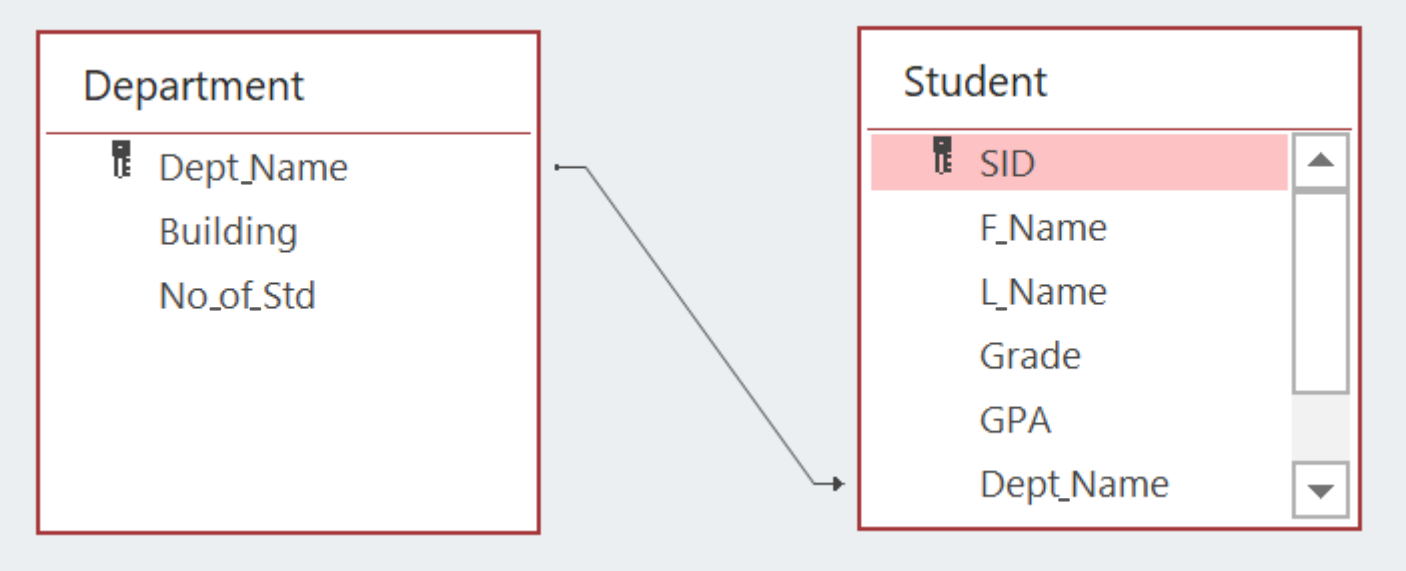
# Primary Key

- It is a key in a table that is unique for each record.
- It is a unique identifier.
- Ex: **ID**, **Passport No.**, **Driver License No.**, etc.
- A table in relational database must always have one and only one **primary key**.



# Foreign Key

- It is a field in a table that provides a link between data in two tables.
- It acts as a cross-reference between tables because it references to the **primary key** of another table.
- It is used for creating link between tables.



# Unique Values and Primary Keys

- Most of the time there is even not only a piece of unique data.

- So, we will add a field to the table to generate unique values, and that field will be the **Primary key** of that table.

| ID | student_name | dept_name | mark |
|---|---|---|---|
| 1 | Dara | IT | 78 |
| 2 | Zara | Computer Eng. | 76 |
| 3 | Nasrin | Architecture | 98 |
| 4 | Azad | IT | 96 |
| 5 | Hawre | Dentistry | 67 |

# Database Design Process

- **Step 1:** Define the Purpose of the Database
- **Step 2:** Find and organize the information required
- **Step 3:** Gather Data (field names), Organize in tables and Specify the Keys
- **Step 4:** Create Relationships among Tables
- **Step 5:** Refine & Normalize the Design

# Database Design Process (cont.)

- **Step 1:** Define the Purpose of the Database (Requirement Analysis).
    - This helps prepare for the remaining steps.

# Database Design Process (cont.)

- **Step 2:** Find and organize the information required.
  - Divide information items into major groups called tables (such as: Student, Department, etc.).

| ID | student_name | dept_name | mark |
|---|---|---|---|
| 1 | Dara | IT | 78 |
| 2 | Zara | Computer Eng. | 76 |
| 3 | Nasrin | Architecture | 98 |
| 4 | Azad | IT | 96 |
| 5 | Hawre | Dentistry | 67 |

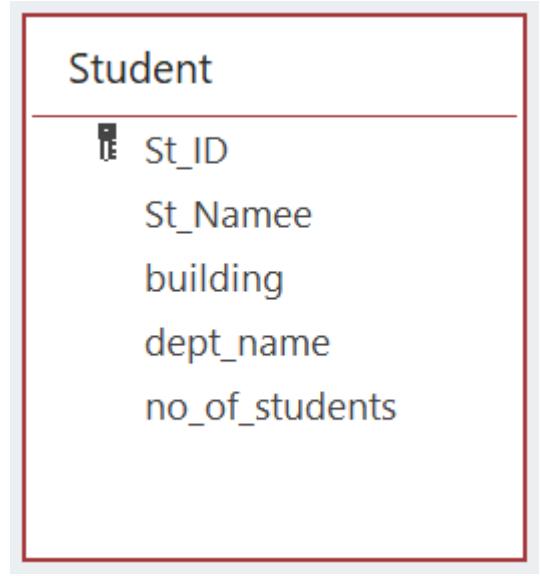
**Student** table

| dept_name | building | no_of_students |
|---|---|---|
| IT | Main Building | 80 |
| Computer Eng. | Main Building | 60 |
| Architecture | Main Building | 85 |
| Dentistry | Dentistry Building | 110 |
| Mathematics | Education Building | 40 |

**Department** table

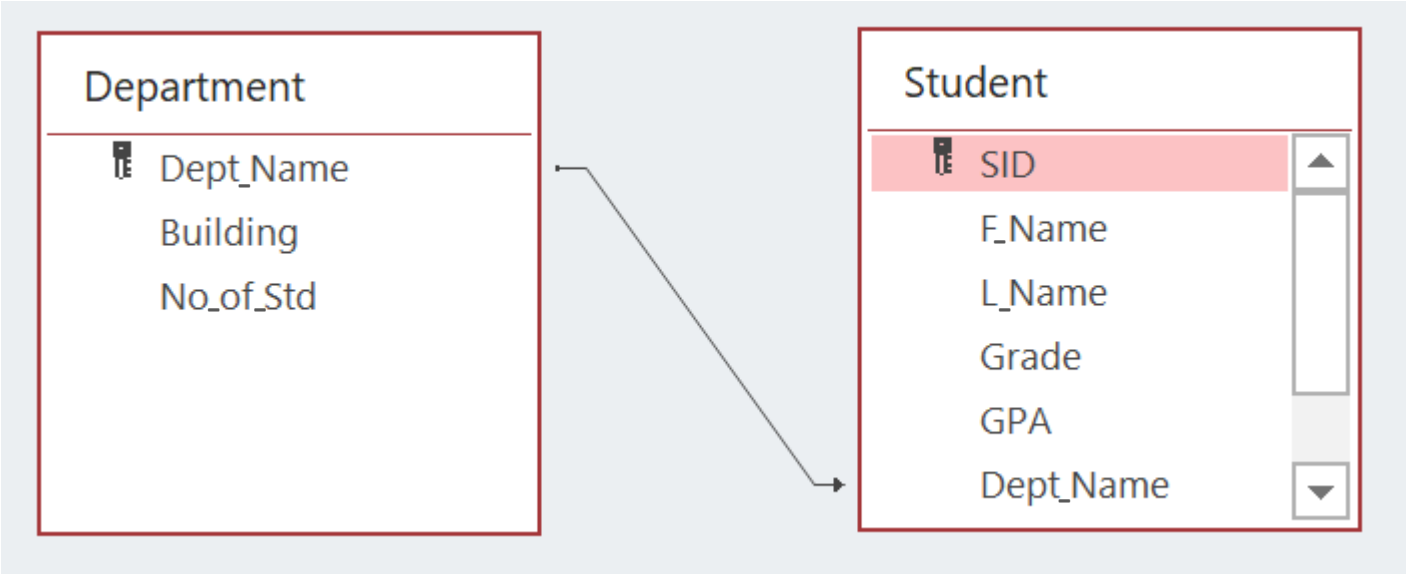
# Database Design Process (cont.)

- **Step 3:** Gather Data, Organize in tables and Specify the Keys.
  - Decide what information (field) need to be stored in each table.
  - Specify each table's primary key.



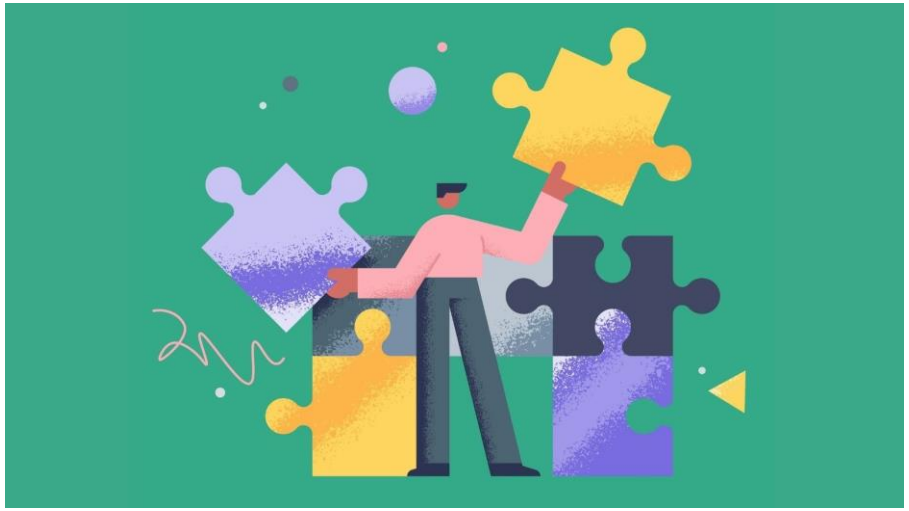
# Database Design Process (cont.)

- **Step 4:** Create Relationships among the tables.
  - Look at each table and decide how the data in one table is related to the data in the other tables.



# Database Design Process (cont.)

- **Step 5:** Refine and normalize the design.
  - Apply the **Normalization Rules** to check whether your database is structurally correct and optimal.



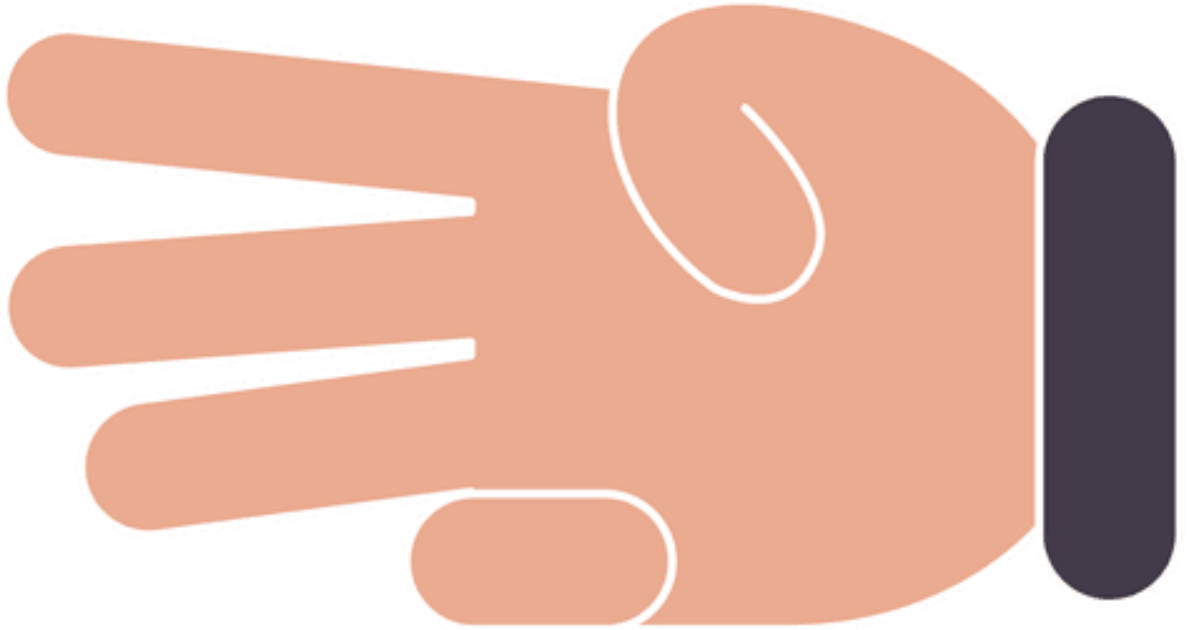
# Normalization

- There are 3 normalization rules called normal forms.

- **First Normal Form (1NF)**

- **Second Normal Form (2NF)**

- **Third Normal Form (3NF)**

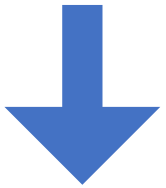


# Normalization (cont.)

- **First Normal Form (1NF):** A table is 1NF if every cell contains a single value, not multiple values.

- This properties is known as atomic.

| Full_name |
| --- |
| Dara Ahmed |
| Zara Ali |
| Serdar Mustafa |



| First_name |
| --- |
| Dara |
| Zara |
| Serdar |

| Last_name |
| --- |
| Ahmed |
| Ali |
| Mustafa |

# Normalization (cont.)

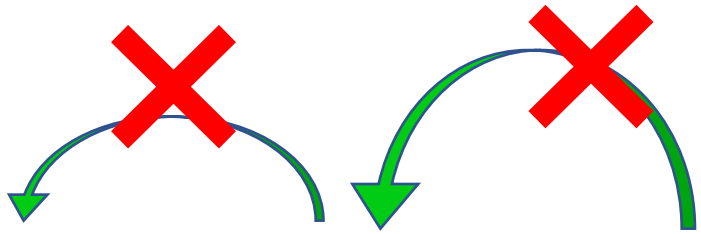
- **Second Normal Form (2NF):** A table is 2NF, if it is 1NF and every non-key fields are fully dependent on the primary key.

**Note:** If the primary key is made up of several fields, every non-key field should depend on the entire set and not part of it.

| st_id | st_name | dept_name | mark |
|---|---|---|---|
| 1 | Ali | IT | 80 |
| 2 | Ahmed | Computer Eng. | 92 |
| 3 | Dara | Architecture | 85 |
| 4 | Zara | Dentistry | 97 |

# Normalization (cont.)

- **Third Normal Form (3NF):** A table is 3NF, if it is 2NF and the non-key fields are independent of each others.



| st_id | st_name | dept_name | mark |
|---|---|---|---|
| 1 | Dara | IT | 80 |
| 2 | Ahmed | Computer Eng. | 92 |
| 3 | Dara | Architecture | 85 |
| 4 | Zara | Dentistry | 97 |

# Normalization Example 1

| SID | Full_Name | Grade | GPA | Faculty | Department | Building | No_of_Std |
|---|---|---|---|---|---|---|---|
| 1 | Dara Ahmed | 3 | 3.5 | Science | IT | Main | 350 |
| 2 | Zara Nadim | 2 | 4 | Engineering | Architecture | Main | 400 |
| 3 | Nawzad Ali | 4 | 3.5 | Dentistry | Dentistry | Dentistry | 450 |
| 4 | Nasrin Azad | 2 | 3 | Education | Math | Education | 250 |

| SID | F_Name | L_Name | Grade | GPA |
|---|---|---|---|---|
| 1 | Dara | Ahmed | 3 | 3.5 |
| 2 | Zara | Nadim | 2 | 4 |
| 3 | Nawzad | Ali | 4 | 3.5 |
| 4 | Nasrin | Azad | 2 | 3 |

| Faculty | Department | Building | No_of_Std |
|---|---|---|---|
| Science | IT | Main | 350 |
| Engineering | Architecture | Main | 400 |
| Dentistry | Dentistry | Dentistry | 450 |
| Education | Math | Education | 250 |

| SID | F_Name | L_Name | Grade | GPA |
|---|---|---|---|---|
| 1 | Dara | Ahmed | 3 | 3.5 |
| 2 | Zara | Nadim | 2 | 4 |
| 3 | Nawzad | Ali | 4 | 3.5 |
| 4 | Nasrin | Azad | 2 | 3 |

**Student**

| Department | Building | No_of_Std | Faculty |
|---|---|---|---|
| IT | Main | 350 | Science |
| Architecture | Main | 400 | Engineering |
| Dentistry | Dentistry | 450 | Dentistry |
| Math | Education | 250 | Education |

**Department**

# Normalization Example 2

| SID | Full_Name | Grade | GPA | Faculty | Department | Building | No_of_Std | Faculty_Budget |
|---|---|---|---|---|---|---|---|---|
| 1 | Dara Ahmed | 3 | 3.5 | Science | IT | Main | 350 | 120.000$ |
| 2 | Zara Nadim | 2 | 4 | Engineering | Architecture | Main | 400 | 180.000$ |
| 3 | Nawzad Ali | 4 | 3.5 | Dentistry | Dentistry | Dentistry | 450 | 140.000$ |
| 4 | Nasrin Azad | 2 | 3 | Education | Math | Education | 250 | 220.000$ |

| SID | F_Name | L_Name | Grade | GPA | Faculty | Department | Building | No_of_Std | Faculty_Budget |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Dara | Ahmed | 3 | 3.5 | Science | IT | Main | 350 | 120.000$ |
| 2 | Zara | Nadim | 2 | 4 | Engineering | Architecture | Main | 400 | 180.000$ |
| 3 | Nawzad | Ali | 4 | 3.5 | Dentistry | Dentistry | Dentistry | 450 | 140.000$ |
| 4 | Nasrin | Azad | 2 | 3 | Education | Math | Education | 250 | 220.000$ |

| SID | F_Name | L_Name | Grade | GPA |
|---|---|---|---|---|
| 1 | Dara | Ahmed | 3 | 3.5 |
| 2 | Zara | Nadim | 2 | 4 |
| 3 | Nawzad | Ali | 4 | 3.5 |
| 4 | Nasrin | Azad | 2 | 3 |

**Student**

| Department | Building | No_of_Std |
|---|---|---|
| IT | Main | 350 |
| Architecture | Main | 400 |
| Dentistry | Dentistry | 450 |
| Math | Education | 250 |

**Department**

| Faculty | Faculty_Budget |
|---|---|
| Science | 120.000$ |
| Engineering | 180.000$ |
| Dentistry | 140.000$ |
| Education | 220.000$ |

**Faculty**

| Product_name | Price | Employee_name | Employee_Salary |
|---|---|---|---|
| Biskrem | 500 IQD | Dara Azad | 800 $ |
| Pop cake | 250 IQD | Ahmed Kawa | 600 $ |
| Sprite | 500 IQD | Dara Kawa | 800 $ |

| Product_name | Price | Employee_first_name | Employee_last_name | Employee_Salary |
|---|---|---|---|---|
| Biskrem | 500 IQD | Dara | Azad | 800 $ |
| Pop cake | 250 IQD | Ahmed | Kawa | 600 $ |
| Sprite | 500 IQD | Dara | Kawa | 800 $ |

| Product_ID | Product_name | Price |
|---|---|---|
| 1 | Biskrem | 500 IQD |
| 2 | Pop cake | 250 IQD |
| 3 | Sprite | 500 IQD |

**Product**

| Employee_ID | Employee_first_name | Employee_last_name | Employee_Salary |
|---|---|---|---|
| 11 | Dara | Azad | 800 $ |
| 22 | Ahmed | Kawa | 600 $ |
| 33 | Dara | Kawa | 800 $ |

**Employee**

| Product_name | Price |
|---|---|
| Biskrem | 500 IQD |
| Pop cake | 250 IQD |
| Sprite | 500 IQD |

| Employee_name | Employee_Salary |
|---|---|
| Dara Azad | 800 $ |
| Ahmed Kawa | 600 $ |
| Dara Kawa | 800 $ |

| Customer_name | Customer_address |
|---|---|
| Zara Mustafa | Shorish |
| Darya Omer | Azadi |
| Ali Dana | Baxtiyari |

| Product_ name | Price | Employee_first_name | Employee_last_name | Employee_ Salary | Customer_first_name | Customer_last_name | Customer_ address |
|---|---|---|---|---|---|---|---|
| Biskrem | 500 IQD | Dara | Azad | 800 $ | Zara | Mustafa | Shorish |
| Pop cake | 250 IQD | Ahmed | Kawa | 600 $ | Darya | Omer | Azadi |
| Sprite | 500 IQD | Dara | Kawa | 800 $ | Ali | Dana | Baxtiyari |

| Product_ ID | Product_ name | Price |
|---|---|---|
| 1 | Biskrem | 500 IQD |
| 2 | Pop cake | 250 IQD |
| 3 | Sprite | 500 IQD |

**Product**

| Employee_ ID | Employee_first_ name | Employee_last_ name | Employee_ Salary |
|---|---|---|---|
| 11 | Dara | Azad | 800 $ |
| 22 | Ahmed | Kawa | 600 $ |
| 33 | Dara | Kawa | 800 $ |

**Employee**

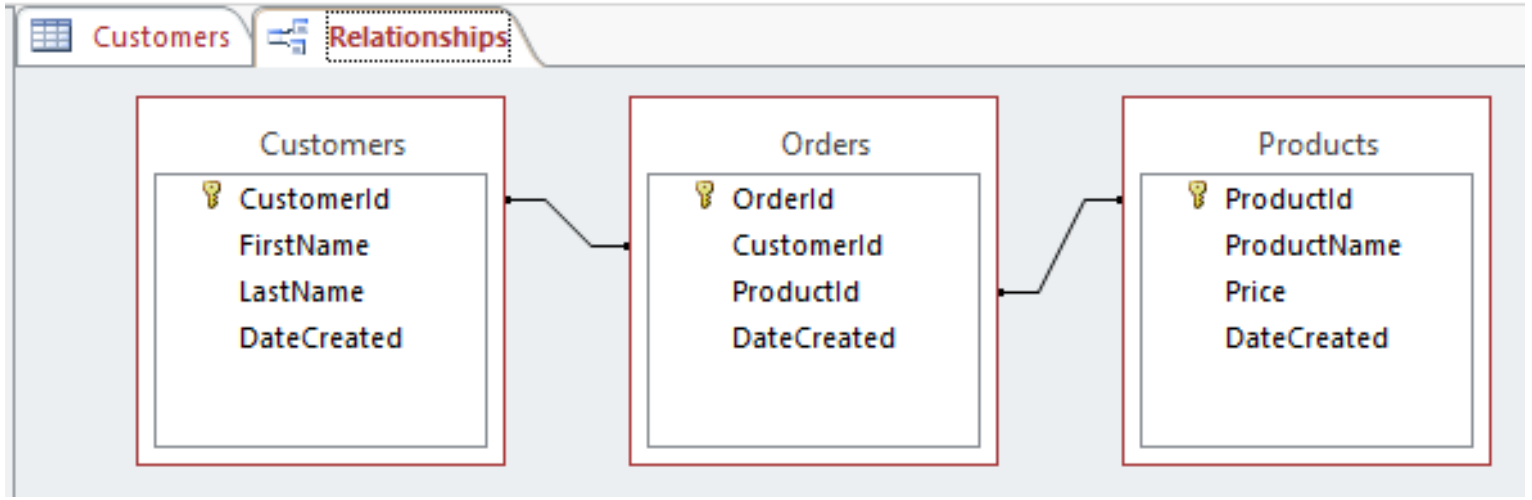
| Customer_ ID | Customer_first_ name | Customer_last_ name | Customer_ address |
|---|---|---|---|
| 1 | Zara | Mustafa | Shorish |
| 2 | Darya | Omer | Azadi |
| 3 | Ali | Dana | Baxtiyari |

**Customer**

# Relationships

- They are established to create link between two tables.

- One table uses a foreign key that references the primary key of another table.



# Relationships

There are three types of relationships:

- **One-to-One (1-1)** relationship
- **One-to-Many (1-m)** relationship
- **Many-to-Many (m-n)** relationship

# One-to-One Relationship


- **One** Student can have only **One** Contact information.
- So the relationship is **One-to-One** between **Student** and **Contact information** tables.
- It is not a common type of relationship.
- E.g.: **Student** ———— **Contact information (SID, Address, Phone)**

# One-to-One Relationship

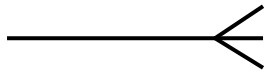
| SID | F_Name | L_Name | Grade | GPA |
|---|---|---|---|---|
| 1 | Dara | Ahmed | 3 | 3.5 |
| 2 | Zara | Nadim | 2 | 4 |
| 3 | Nawzad | Ali | 4 | 3.5 |
| 4 | Nasrin | Azad | 2 | 3 |

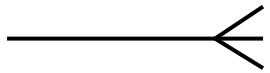
**Student**

| SID | House_No | Phone |
|---|---|---|
| 1 | 3432 | (750) 444-4444 |
| 2 | 5643 | (751) 555-5555 |
| 3 | 324 | (750) 666-6666 |
| 4 | 2345 | (751) 777-7777 |

**Student**

# One-to-Many Relationship

- **One** Department can have **Many** Students.
- So the relationship is **One-to-Many** between **Department** and **Student** tables.
- It is the most common relationship between tables in a relational databases.
- Information about Department and Student are different, but they are related to each other.
- E.g.: **Department**  **Students**

  **Faculty**  **Departments**

# One-to-Many Relationship (cont.)

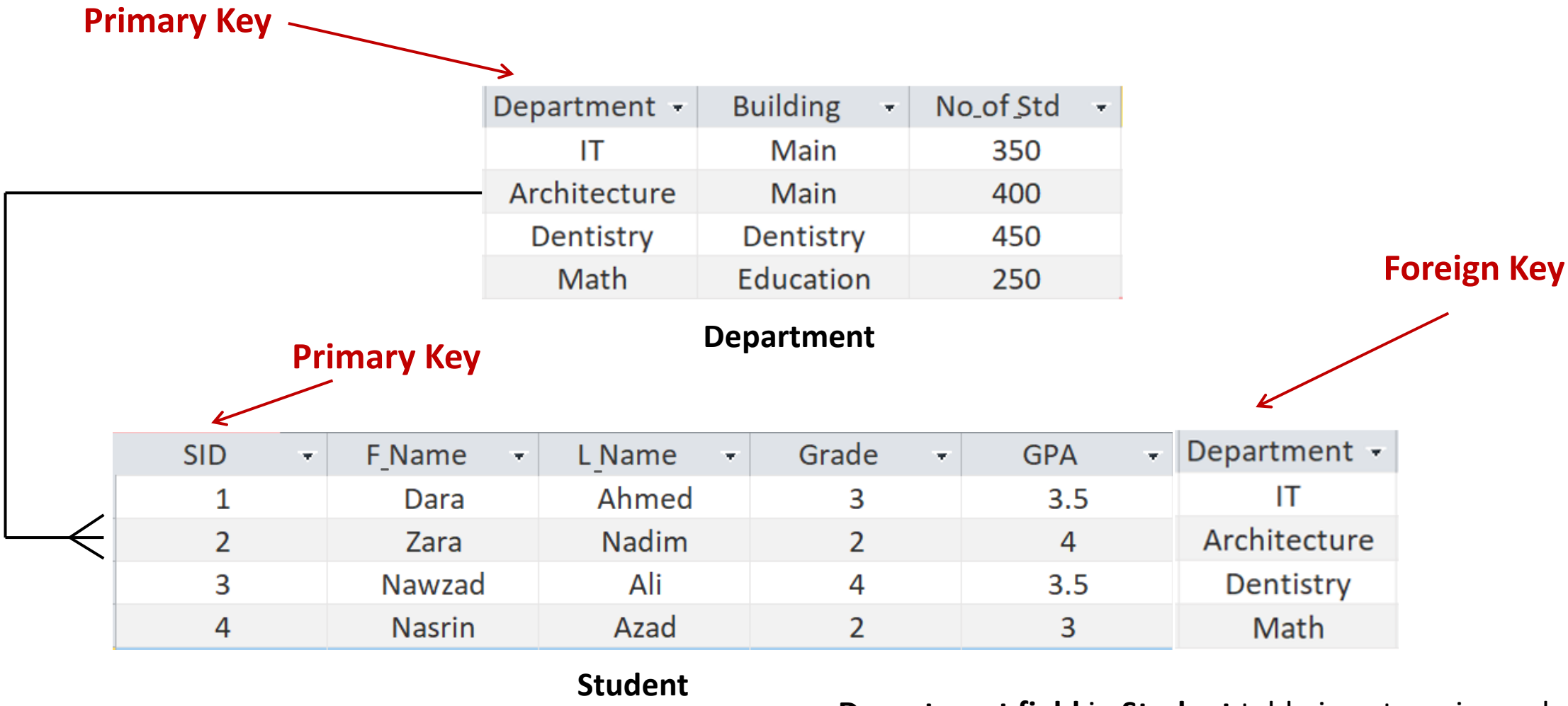
| Department | Building | No_of_Std |
|---|---|---|
| IT | Main | 350 |
| Architecture | Main | 400 |
| Dentistry | Dentistry | 450 |
| Math | Education | 250 |

**Department**

| SID | F_Name | L_Name | Grade | GPA |
|---|---|---|---|---|
| 1 | Dara | Ahmed | 3 | 3.5 |
| 2 | Zara | Nadim | 2 | 4 |
| 3 | Nawzad | Ali | 4 | 3.5 |
| 4 | Nasrin | Azad | 2 | 3 |

**Student**

# One-to-Many Relationship (cont.)




| Department | Building | No_of_Std |
|---|---|---|
| IT | Main | 350 |
| Architecture | Main | 400 |
| Dentistry | Dentistry | 450 |
| Math | Education | 250 |

**Department**

| SID | F_Name | L_Name | Grade | GPA | Department |
|---|---|---|---|---|---|
| 1 | Dara | Ahmed | 3 | 3.5 | IT |
| 2 | Zara | Nadim | 2 | 4 | Architecture |
| 3 | Nawzad | Ali | 4 | 3.5 | Dentistry |
| 4 | Nasrin | Azad | 2 | 3 | Math |

**Student**

**Department field** in **Student** table is not a primary key but **Foreign Key** and it is not unique.

# Many-to-Many Relationship

- **One** Course can have **Many** Students

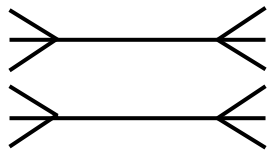
  And

  **One** Student can have **Many** Courses

- So, the relationship is **Many-to-Many** between **Course** and **Student** tables.

- Information about Course and Student are different, but they are related to each other.

- E.g.:



**Course** — **Students**

**Product** — **Customer**

# Many-to-Many Relationship

| SID | F_Name | L_Name | Grade | GPA |
|---|---|---|---|---|
| 1 | Dara | Ahmed | 3 | 3.5 |
| 2 | Zara | Nadim | 2 | 4 |
| 3 | Nawzad | Ali | 4 | 3.5 |
| 4 | Nasrin | Azad | 2 | 3 |

**Student**

| Student_&_Course ID | Student_ID | Course_ID |
|---|---|---|
| 111 | 1 | IT2015 |
| 222 | 2 | IT225 |
| 333 | 3 | IT310 |

**Student & Course ID**

**Junction (Linkage) table**

| Course_ID | Course_Name | Credit |
|---|---|---|
| IT2015 | Database | 4 |
| IT225 | Programming | 4 |
| IT310 | Multimedia | 3 |

**Course**

# Thank You