



Relational Databases Anomalies Normalization

.NET CORE

A database is made up of a collection of **tables** that stores a specific set of structured data. A table contains a collection of rows (**tuples**) and columns (**attributes**). Each column in the table is designed to store a certain type of data.

[HTTPS://DOCS.MICROSOFT.COM/EN-US/SQL/RELATIONAL-DATABASES/DATABASES/DATABASES?VIEW=SQL-SERVER-VER15](https://docs.microsoft.com/en-us/sql/relational-databases/databases/databases?view=sql-server-ver15)

Databases – Instances/Users

<https://docs.microsoft.com/en-us/sql/relational-databases/databases/databases?view=sql-server-ver15>

There are one (or many) *schemas* within a database. Within each *schema* there are database objects such as *tables* and *views*.

This is a *table*. →→→→→

A row(Tuple) makes up an entity

Show 5 entries		Foreign Key Search:				
	Name	Position	Office	Age	Start date	Salary
	Tiger Nixon	System Architect	Edinburgh	61	2011/04/25	\$320,800
	Garrett Winters	Accountant	Tokyo	63	2011/07/25	\$170,750
	Ashton Cox	Junior Technical Author	San Francisco	66	2009/01/12	\$86,000
	Cedric Kelly	Senior Javascript Developer	Edinburgh	22	2012/03/29	\$433,060
	Airi Satou	Accountant	Tokyo	33	2008/11/28	\$162,700
	Name	Position	Office	Age	Start date	Salary
Showing 1 to 6 of 57 entries						
Previous		1	2	3	4	5 ... 12 Next

Primary Key

Attributes / keys

DBMS (Database Management System)

https://www.tutorialspoint.com/dbms/dbms_overview.htm

- Data is a collection of facts and figures that can be processed to produce information.
- A Database is a collection of related data.
- A **DBMS** stores data in such a way that it becomes easier to retrieve and manipulate.

If we have data about grades of all students, we can extrapolate average grades and highest grades.

Primary Key

Last Name	Birthday	Grade 1	Grade 2	Grade 3	Final Grade
Smith	June 7, 1987	100	98	89	95.67
Jones	October 5, 1986	75	89	84	82.67
Garcia	December 15, 1986	99	97	100	98.67
Kim	February 28, 1987	50	68	42	53.33
Washington	May 4, 1987	85	87	79	83.67
Hernandez	October 8, 1986	74	72	81	75.67
Gates	March 21, 1987	32	54	67	51.00
Papert	April 26, 1987	84	92	81	85.67
Kennedy-Onassis	January 18, 1987	92	90	88	90.00
Smith	February 8, 1987	72	65	99	78.67

DBMS - Benefits

https://www.tutorialspoint.com/dbms/dbms_overview.htm

Relation-based tables – A Relational DBMS allows *entities* and *relations* among them to form *tables*.

Separation of data and application – A database is separated from its data. A database is an active entity, whereas data on which the database works is said to be passive.

Less redundancy – DBMS follows the rules of *normalization*, which splits a relation when any of its attributes has redundancy.

Consistency – Consistency is the state where every relation in a database is *persisted*.

Query Language – DBMS (or RDBMS) is equipped with query language (usually **SQL**), which makes it more efficient to retrieve and manipulate data.

ACID Properties – A DBMS follows the concepts of *Atomicity*, *Consistency*, *Isolation*, and *Durability*.

Isolation Levels – A DBMS supports a multi-user environment and applies restrictions on the access and manipulation of data in parallel.

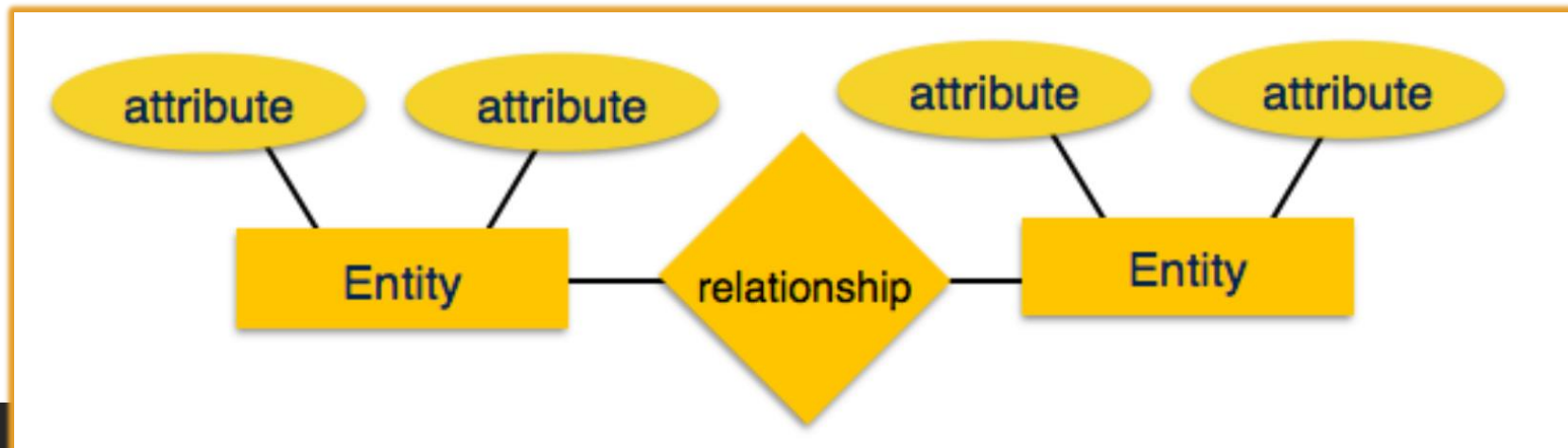
Database – Entity-Relationship Models

https://www.tutorialspoint.com/dbms/dbms_data_models.htm

Data models define the structure of a database. **Data Models** are *entities* that introduce abstraction in a **DBMS**.

Data models define how data is connected to each other and how they are processed and stored inside the database.

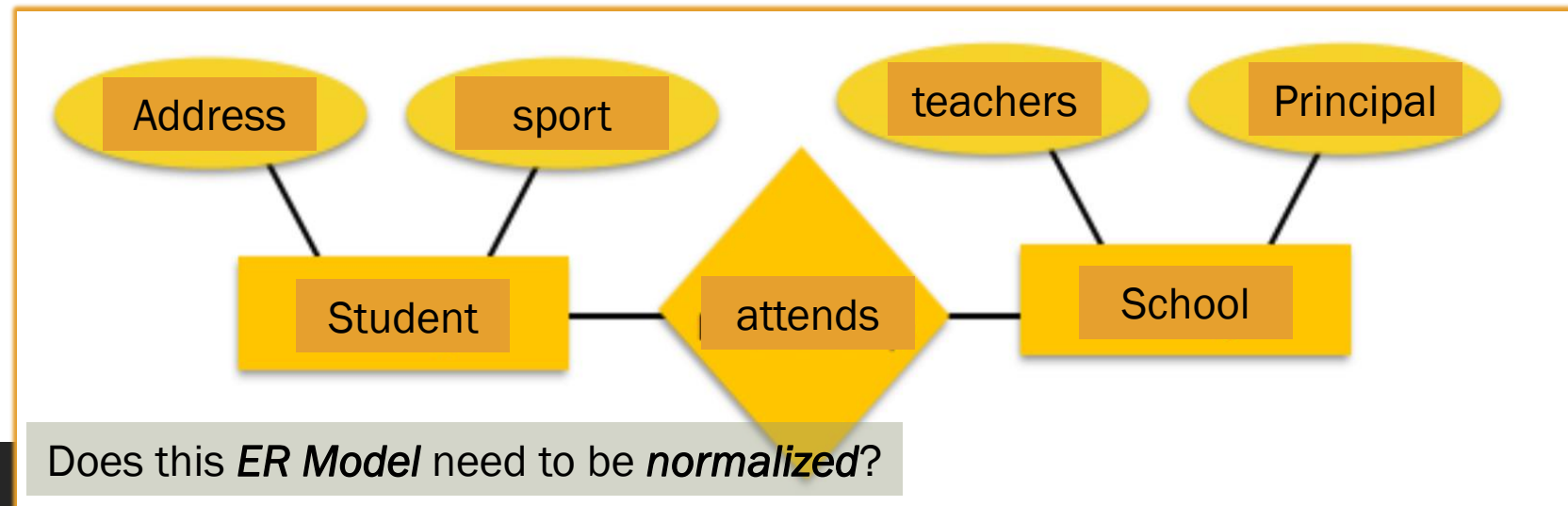
An **Entity-Relationship (ER) Model** is based on the notion of real-world entities and the relationships between them. An **ER Model** is used for the conceptual design of a database.



Database – Entity-Relationship Models

https://www.tutorialspoint.com/dbms/dbms_data_models.htm

- **Entity** – a real-world thing having properties called **attributes**.
- **Attribute** - the details about an **entity**.
- **Relationship** – The logical association among entities. Relationships are mapped with entities in various ways.
- Mapping cardinalities defines the number of associations between two entities.
- Mapping cardinalities –
 - *one to one*
 - *one to many*
 - *many to one*
 - *many to many*



Database – Schema Diagram

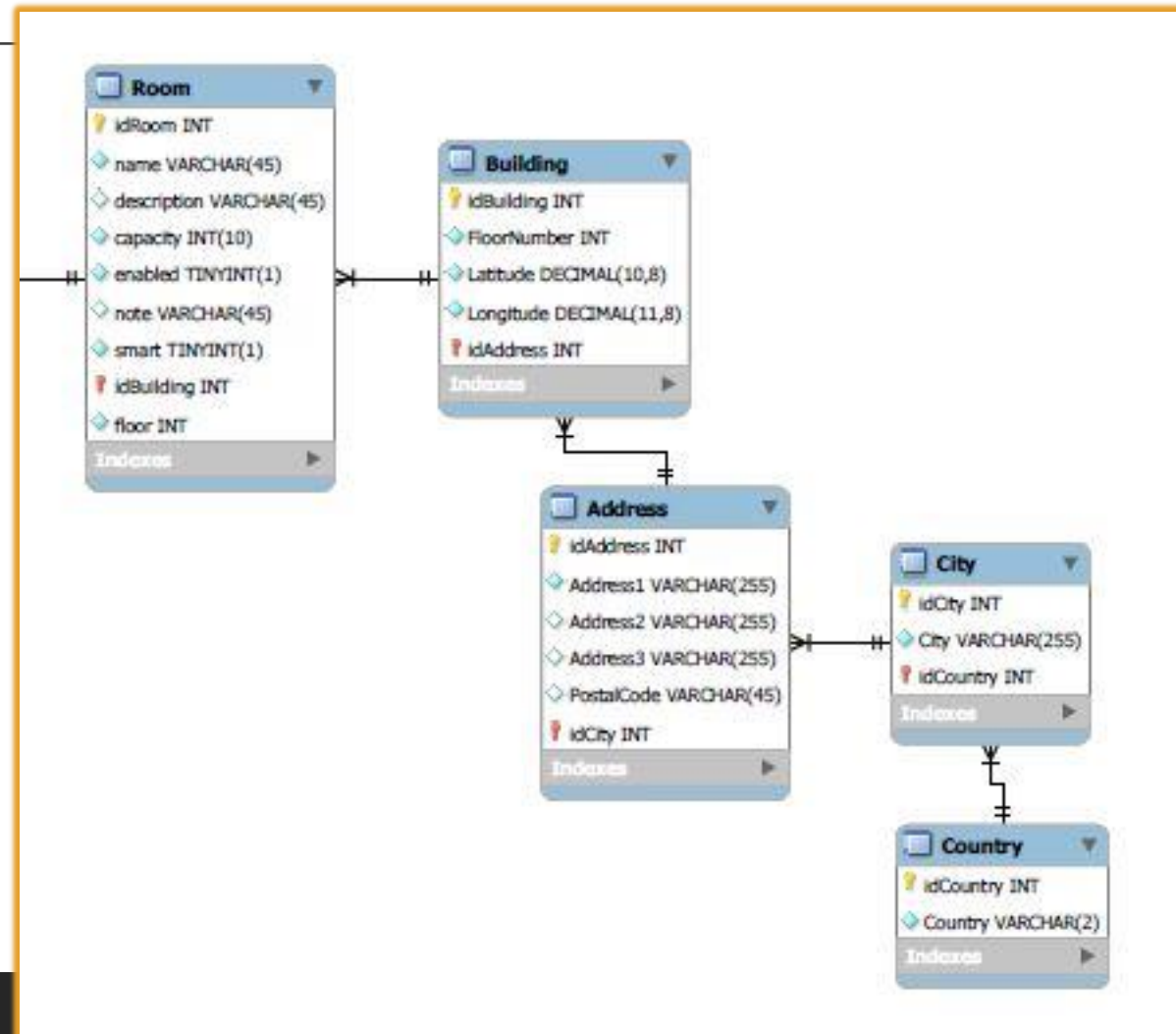
https://www.tutorialspoint.com/dbms/dbms_data_schemas.htm

A database **schema** is the skeleton structure that represents the logical view of the entire database.

It defines how the data is organized and how the **relations** among them are associated.

It displays all the **constraints** that are to be applied on the data.

A **schema diagram** contains a descriptive detail of the database.



Databases – Primary and Candidate Keys

https://www.tutorialspoint.com/dbms/er_model_basic_concepts.htm

<https://docs.microsoft.com/en-us/ef/core/modeling/keys?tabs=data-annotations>

Candidate Key – An *attribute* of an entity. An *entity* set may have more than one *candidate key*.

Primary Key – A *Candidate Key* chosen to uniquely identify the *entity* set(*tuple*).

Foreign Key – The *Primary Key* of another table. Used to represent to other entity.

The screenshot shows a database table with 7 columns: Name, Position, Office, Age, Start date, and Salary. The first row is highlighted in grey and labeled 'Tuple makes up an entity'. The 'Name' column is highlighted in orange and labeled 'Primary Key'. The 'Office' column is highlighted in blue and labeled 'Foreign Key'. The 'Age', 'Start date', and 'Salary' columns are highlighted in light blue and labeled 'Attributes / Keys'. The table contains 6 rows of data. The interface includes a 'Show 5 entries' dropdown, a 'Search:' input, and a pagination bar at the bottom showing 'Showing 1 to 6 of 57 entries' and page numbers 1 through 12.

Name	Position	Office	Age	Start date	Salary
Tiger Nixon	System Architect	Edinburgh	61	2011/04/25	\$320,800
Garrett Winters	Accountant	Tokyo	63	2011/07/25	\$170,750
Ashton Cox	Junior Technical Author	San Francisco	66	2009/01/12	\$86,000
Cedric Kelly	Senior Javascript Developer	Edinburgh	22	2012/03/29	\$433,060
Airi Satou	Accountant	Tokyo	33	2008/11/28	\$162,700

Database - Keys in Entity Framework

<https://docs.microsoft.com/en-us/ef/core/modeling/keys?tabs=data-annotations>

A **key** serves as a unique identifier for each **entity** instance. Most **entities** in **EF** have a single key, which maps to the concept of a **primary key** in relational databases. It's possible for an **entity** to have no keys. **Entities** can have additional **keys** (Alternate **Keys**) beyond the **Primary Key**. By convention, any property named **Id** or <type name>Id will be automatically configured by **EF** as the **Primary Key** of an **entity**.

You can force configure any single property to be the primary key of an entity.

```
class Car
{
    [Key]
    public string LicensePlate { get; set; }

    public string Make { get; set; }
    public string Model { get; set; }
}
```

Database – Relationships

https://www.tutorialspoint.com/dbms/er_model_basic_concepts.htm

Cardinality

One-to-one

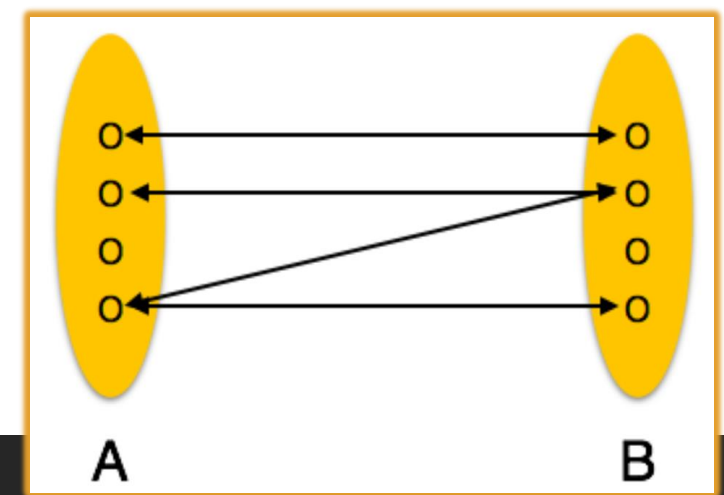
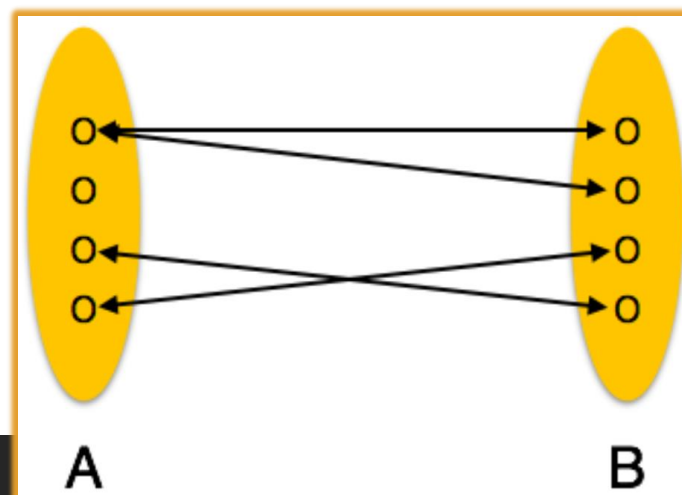
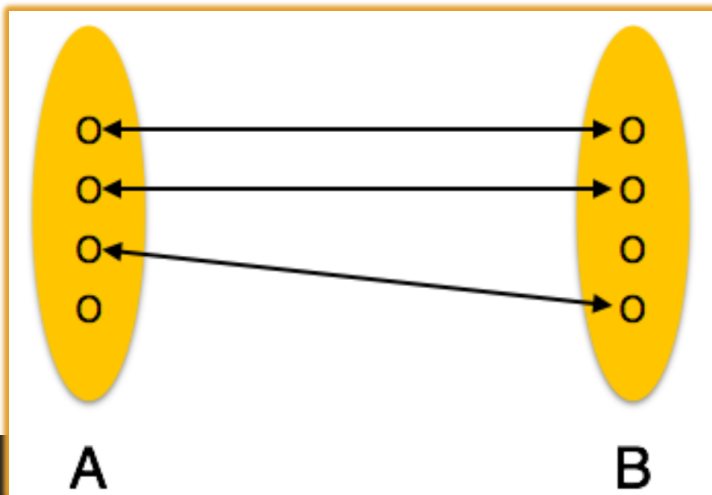
One **entity** from **entity** set A can be associated with at most one **entity** of **entity** set B and vice versa.

One-to-many

One **entity** from **entity** set A can be associated with more than one **entities** of **entity** set B. However, an **entity** from **entity** set B can be associated with at most one other **entity**

Many-to-many

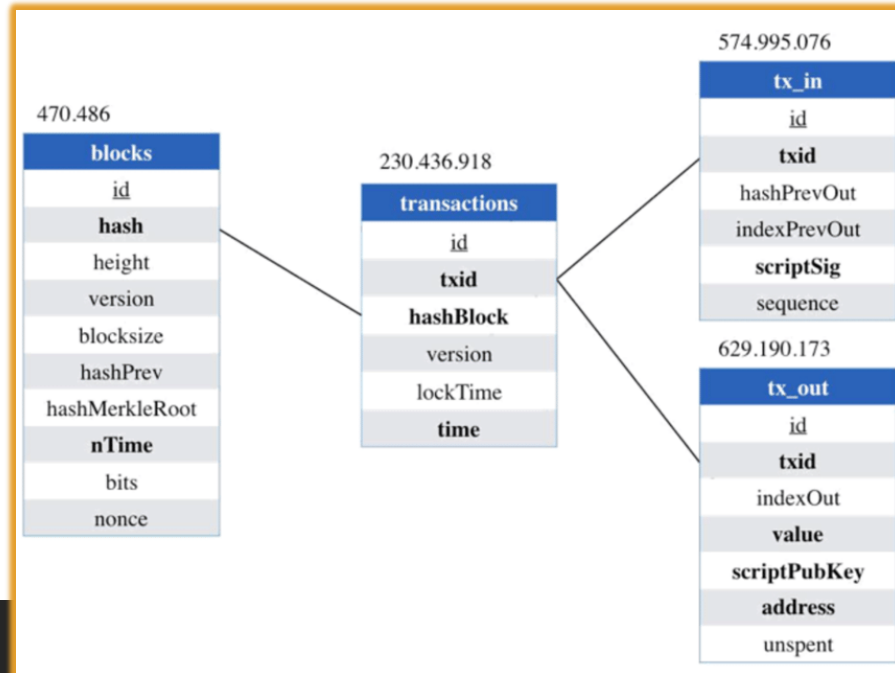
One **entity** from A can be associated with more than one **entity** from B and vice versa.



Relational Databases

https://en.wikipedia.org/wiki/Relational_database#RDBMS

A *RDBMS* allows *entities* to form *tables* with *relations* between them. One can understand the architecture of a database just by looking at the *table* names.



	StudentID	LastName	FirstName	State	Zip
+	151	Galla	Kristi	NJ	19038
+	152	McLaughlin	Liz	NY	19001
+	153	Greber	Christopher	DE	19446
+	154	Flowers	Lucy	DE	19002
+	155	Joranne	Scott	PA	19422
+	157	Kents	Brian	NY	19403
+	158	Keener	William	NJ	19444
+	159	Nguyen	Ted	DC	19401
+	160	Hauny	Mindy	DE	19426
+	161	Burcik	Reber	DE	19446
+	162	Fallows	Keith	NY	19440
+	163	Rahn	Sid	PA	19438
+	164	O'Mara	John	NY	19002
+	165	Welsh	Irma	NY	19473
+	166	Bewley	Red	NJ	19002
+	171	Edgar	Ernest	PA	19027
+	172	Legrow	Bill	DE	19415
+	173	Davenport	David	DE	19002

Record: 1 of 197

First Name	Last Name	Birthday	Grade 1	Grade 2	Grade 3	Final Grade
John	Smith	June 7, 1987	100	98	89	95.67
Kathleen	Jones	October 5, 1986	75	89	84	82.67
Juanita	Garcia	December 15, 1986	99	97	100	98.67
Charles	Kim	February 28, 1987	50	68	42	53.33
Natalie	Washington	May 4, 1987	85	87	79	83.67
James	Hernandez	October 8, 1986	74	72	81	75.67
William	Keener	March 21, 1987	32	54	67	51.00
Seymour	Papert	April 26, 1987	84	92	81	85.67
Jackie	Kennedy-Onassis	January 18, 1987	92	90	88	90.00
Timothy	Smith	February 8, 1987	72	65	99	78.67

Relational Databases – Concepts

https://www.tutorialspoint.com/dbms/relational_data_model.htm

Tables – relations are saved in table format. This format stores the relation among **entities**. A table has rows and columns, where rows represent **entities** and columns represent **attributes**.

Tuple – A single row of a **table**, which contains a single record for that **entity** is called a **tuple**.

Relation schema – A relation schema describes the relation name (table name), attributes, and their names.

Primary Key – Each row has one or more attributes, chosen as **Primary keys**. These identify the row in the **table** uniquely.

Composite Key – Multiple **Candidate Keys** that together form the **Primary Key**.

Index – A unique number given to each **tuple** in a **table** to serve as the **Primary Key**.

Relational Databases – Constraints

https://www.tutorialspoint.com/dbms/relational_data_model.htm

Key Constraints	Domain Constraints	Referential Integrity Constraints
<p><i>Candidate Keys</i> must uniquely identify an entity. A <i>Candidate Key</i> can not have NULL values.</p>	<p>Every <i>attribute</i> must have a specific range of values.</p>	<p>A <i>Foreign Key</i> refers to a <i>Primary key</i> of a different <i>table</i>.</p> <p>If a <i>tuple</i> has a <i>Foreign Key</i>, that <i>PK</i> must exist.</p>

Databases – Anomalies

https://www.tutorialspoint.com/dbms/database_normalization.htm

If a Database has inconsistent data, it will incur ***anomalies***. A DB with ***anomalies*** can give inconsistent data.

There are three types of ***anomalies***

- ***Update anomaly*** – If data items are not linked to each other properly, when one data item is updated, a few instances may get updated properly while a few others are left with old values
- ***Deletion anomaly*** – When a record is deleted, but linked parts of it were left undeleted because of unawareness or when deletion deletes other data unintentionally.
- ***Insertion anomaly*** – When data is inserted into a record that does not exist or cannot be inserted without an unrelated data.

Normalization Assignment-

Create an unnormalized table.

List the information of your family members.

There must be at least 5 attributes to each tuple and at least 5 entities.

Databases – Normalization

https://www.tutorialspoint.com/dbms/database_normalization.htm

<https://www.c-sharpcorner.com/UploadFile/0146e3/database-normalization/>

Normalization is a method to prevent **anomalies** and keep the database to a consistent state. **Fields** and **tables** of a relational DB are organized to minimize redundancy and dependency.

Normalization usually involves dividing large **tables** into smaller (and less redundant) **tables** and defining relationships among them.

There are many normal forms but there are **1NF**, **2NF**, and **3NF** are primarily used.



Databases – Normalization

https://www.tutorialspoint.com/dbms/database_normalization.htm

<https://www.c-sharpcorner.com/UploadFile/0146e3/database-normalization/>

This table is not normalized. All the information is stored in one table.

SALUTATION	CUSTOMER NAME	CITY	BOOK ISSUED
MR.	RAJ	BANGALORE	LET US C,ORACLE DATABSE,
MISS.	PRIYA	CHENNAI	PROGRAMMING WITH JAVA,C++ PROGRAMMING
MR.	RAJ	DELHI	DBA FUNDAMENTALS, ORACLE PROGRAMMING

Databases – Normalization

https://www.tutorialspoint.com/dbms/database_normalization.htm

<https://www.c-sharpcorner.com/UploadFile/0146e3/database-normalization/>

1st Normal Form (1NF) –

- each table cell should contain a single value.
- Each record needs to be unique.
- It contains atomic values only.

SALUTATION	CUSTOMER NAME	CITY	Book Issued
MR.	Raj	BANGALORE	LET US C
MR.	Raj	BANGALORE	ORACLE DATABSE
Miss	Priya	CHENNAI	PROGRAMMING WITH JAVA
Miss	Priya	CHENNAI	C+ + PROGRAMMING
MR.	Raj	DELHI	DBA FUNDAMENTALS
MR.	Raj	DELHI	ORACLE PROGRAMMING

Databases – Normalization

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<https://www.c-sharpcorner.com/UploadFile/0146e3/database-normalization/>

2nd Normal Form (2NF) –

- First, be in **1NF**.
- Have a single Column **Primary Key**.
- Remove subsets of data that apply to multiple rows of a **table** and place them in separate **tables** with **PK** → **FK** relationships among the new tables.
- If it is in **1NF** and every non-key attribute is dependent on the **Primary Key**. then 2NF is automatic.

MEMBERSHIP ID	SALUTATION	CUSTOMER NAME	CITY
1	MR.	RAJ	BANGALORE
2	MISS.	PRIYA	CHENNAI
3	MR.	RAJ	DELHI

The **1NF** table is divided into two tables.

Table 1 contains only member information.

Membership_id is created. It's the **Primary Key** for table 1.

Table 2 contains the information for each book. Table 2's new column is **book_id**. It is the **Primary Key** for table 2.

BOOK ID	MEMBERSHIP ID	BOOK ISSUED
1	1	LET US C
2	1	ORACLE DATABSE
3	2	PROGRAMMING WITH JAVA
4	2	C++ PROGRAMMING
5	3	ORACLE PROGRAMMING
6	3	DBA FUNDAMENTALS

Databases – Normalization

https://www.tutorialspoint.com/dbms/database_normalization.htm

<https://www.c-sharpcorner.com/UploadFile/0146e3/database-normalization/>

“Is field A dependent upon field B, or vice versa?” This means: "Given a value for A, do we then have only one possible value for B, and vice versa?"

MEMBERSHIP ID	SALUTATION	CUSTOMER NAME	CITY
1	MR.	RAJ	BANGALORE
2	MISS.	PRIYA	CHENNAI
3	MR.	RAJ	DELHI

If the answer is yes, then A and B should be put into a new table, with A becoming the **Primary Key**. A reference to A should be left in the original relation and marked as a **Foreign Key**.

BOOK ID	MEMBERSHIP ID	BOOK ISSUED
1	1	LET US C
2	1	ORACLE DATABASE
3	2	PROGRAMMING WITH JAVA
4	2	C++ PROGRAMMING
5	3	ORACLE PROGRAMMING
6	3	DBA FUNDAMENTALS

Databases – Normalization

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A **transitive functional dependency** occurs when changing a **Candidate Key** column might cause any of the other **Candidate Key** columns to change. Consider table 1. Changing the non-key column Customer Name may change Salutation.

ID	SALUTATION NAME
1	MR.
2	MISS
3	MRS.
4	DR.

Table 3

BOOK ID	MEMBERSHIP ID	BOOK ISSUED
1	1	LET US C
2	1	ORACLE DATABSE
3	2	PROGRAMMING WITH JAVA
4	2	C++ PROGRAMMING
5	3	ORACLE PROGRAMMING
6	3	DBA FUNDAMENTALS

Table 2

Table 1			
MEMBERSHIP ID	SALUTATION ID	CUSTOMER NAME	CITY
1	1	RAJ	BANGALORE
2	2	PRIYA	CHENNAI
3	1	RAJ	DELHI

The table is divided again and a new table is created that stores Salutation only. The database is now in **3NF**.

Assignment-

Convert your table to a 3NF table.

List the information of your family members.

There must be at least 5 attributes to each tuple and at least 5 entities.