

Lecture 2: Relational model part 1

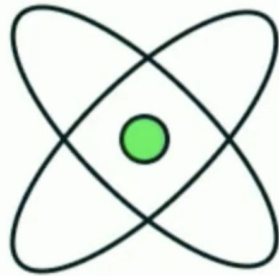
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Assistant Professor
Department of Computing Science

Learning objectives

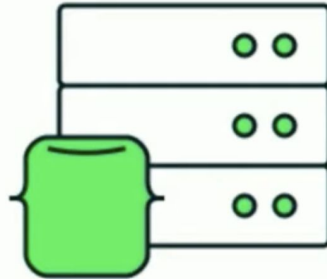
- Understand the components and properties of relations
 - Differentiate and apply key types
 - Apply integrity rules
-

Why do we model?

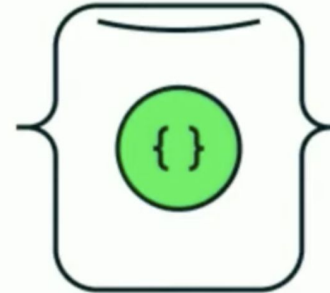
We model to face constraints and answer to constraints
So we can store, query, and use resources optimally!



physical



hardware

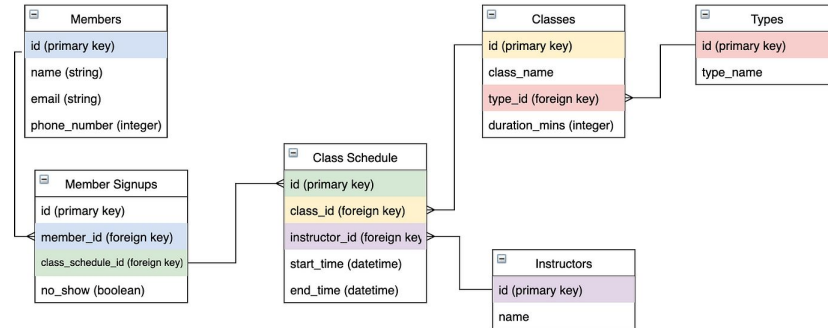


software

Relational model

Objectives

- To promote high degree of data independence.
- Eliminate redundancy and consistency problems.
- Ease of use of DBA as well as normal users.
- To provide a community view of the data, so that a wide variety of users can interact with a common model.



Relational database

1. **Relation:** A relation is nothing but a table with rows and columns.
2. **Attributes:** Attributes are the properties that define a relation.
3. **Tuple:** Each row in the relation is known as a tuple.
4. **Domain:** A domain is a unique set of values permitted for an attribute in a table.
5. **Degree:** The number of attributes in a relation.
6. **Cardinality:** The number of tuples in a relation.

Example:

Fields (Attributes, Columns)

sid	Name	login	age	Gross
1111	Dave	dave@cs	19	1.2
2222	Jones	Jones@cs	18	2.3
333	Smith	smith@ee	18	3.4
4444	Smith	smith@math	19	4.5

Field names

Tuples (Records, Rows)

relation

attributes

in Products : Table

Product ID	Product Name	Supplier	Category	Quantity Per Unit	Unit Price	Units In Stock
1	Chai	1	1	10 boxes x 20 bags	\$18.00	39
2	Chang	1	1	24 - 12 oz bottles	\$19.00	17
3	Aniseed Syrup	1	2	12 - 560 ml bottles	\$10.00	13
4	Chef Anton's Cajun Seasoning	2	2	48 - 6 oz jars	\$22.00	53
5	Chef Anton's Gumbo Mix	2	2	36 boxes	\$21.35	0
6	Grandma's Boysenberry Spread	3	2	12 - 8 oz jars	\$25.00	120
7	Uncle Bob's Organic Dried Pears	3	7	12 - 1 lb pkgs.	\$30.00	15
8	Northwoods Cranberry Sauce	3	2	12 - 12 oz jars	\$40.00	6
9	Mishi Kobe Niku	4	6	18 - 500 g pkgs.	\$97.00	29
10	Ikura	4	8	12 - 200 ml jars	\$31.00	31
11	Queso Cabrales	5	4	1 kg pkg.	\$21.00	22

tuples

Record: 14 of 77

Degree = 7
Cardinality = 77

Domain of Unit Price is currency.

Properties of relational database

Unique Relation Name:

- Each relation (table) must have a unique name within the database.

Atomic Values (Single Values per Cell):

- Each cell in a relation contains exactly one value.

Distinct Attribute Names:

- Each attribute (column) within a relation must have a unique name. No two columns can share the same name within the same relation.

Example:

Fields (Attributes, Columns)

sid	Name	login	Age	Gross
1111	Dave	dave@cs	19	1.2
2222	Jones	Jones@cs	18	2.3
333	Smith	smith@ee	18	3.4
4444	Smith	smith@math	19	4.5

Field names

Tuples (Records, Rows)

Properties of relational database

Unique Tuples (Rows):

Order of Tuples and Attributes is Irrelevant:

Attribute Domain:

- Each attribute (column) in a relation is associated with a domain, which is the set of permissible values that the attribute can hold. For example, a column for "age" might have a domain restricting the values to integers between 0 and 120.

Null Values:

- A relation can contain **NULL** values for attributes, representing missing or unknown data. However, primary keys cannot contain null values to ensure uniqueness.

Diagram illustrating a relation (table) with attributes (columns) and tuples (rows).

The relation is labeled "Products : Table". The attributes are: Product ID, Product Name, Supplier, Category, Quantity Per Unit, Unit Price, and Units In Stock.

The tuples (rows) are:

Product ID	Product Name	Supplier	Category	Quantity Per Unit	Unit Price	Units In Stock
1	Chai	1	1	10 boxes x 20 bags	\$18.00	39
2	Chang	1	1	24 - 12 oz bottles	\$19.00	17
3	Aniseed Syrup	1	2	12 - 550 ml bottles	\$10.00	13
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9	Mishi Kobe Niku	4	6	18 - 500 g pkgs.	\$97.00	29
10	Ikura	4	8	12 - 200 ml jars	\$31.00	31
11	Queso Cabrales	5	4	1 kg pkg.	\$21.00	22
12	Queso Manchego La Pastora	5	4	10 - 500 g pkgs.	\$20.00	0

Record: 1 of 12 of 77

Annotations:

- relation**: Points to the entire table structure.
- attributes**: Points to the column headers.
- tuples**: Points to the rows of data.
- Degree = 7**: Points to the number of attributes (columns).
- Cardinality = 77**: Points to the total number of tuples (rows).
- Domain of Unit Price is currency.**: Points to the Unit Price column.

Exercise 1

Discuss in pair, give example of the following terms:

1. **Relation**
2. **Attributes**
3. **Tuple**
4. **Domain**
5. **Degree**
6. **Cardinality**

Books Table

BookID	Title	Genre	Price	AuthorID
1	The Great Gatsby	Fiction	10.99	101
2	To Kill a Mockingbird	Fiction	8.99	102
3	A Brief History of Time	Non-Fiction	15.99	103

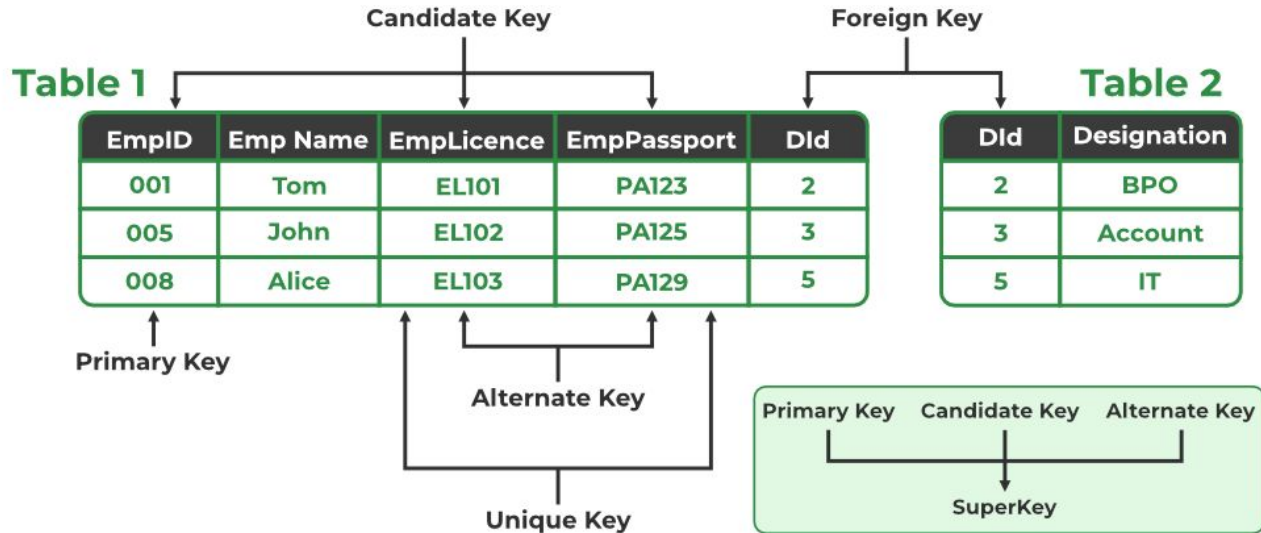
Authors Table

AuthorID	FirstName	LastName
101	F. Scott	Fitzgerald
102	Harper	Lee
103	Stephen	Hawking

Keys

In a relational database model, keys are used to uniquely identify records and establish relationships between tables.

- Primary Key
- Foreign Key
- Candidate Key
- Composite Key
- Super Key



Primary key

- A primary key is a column or a set of columns that uniquely identifies each row in a table.
- Each table can have only one primary key.
- Primary keys cannot contain NULL values.

Primary Key

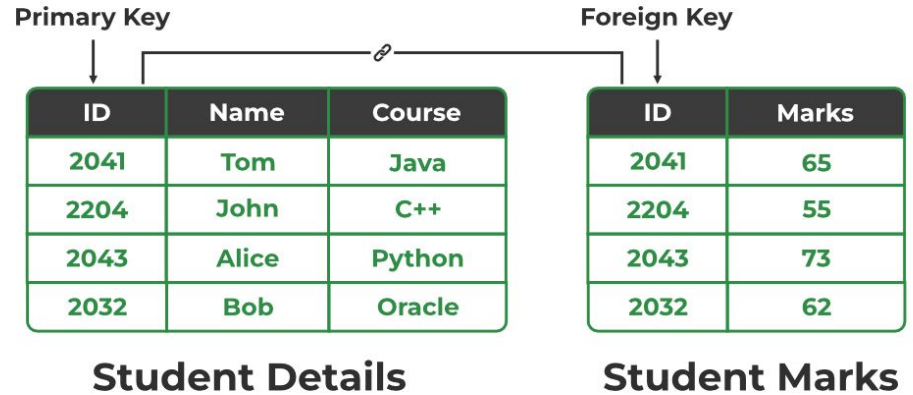


ID	Name	Course
2041	Tom	Java
2204	John	C++
2043	Alice	Python
2032	Bob	Oracle

Student Details

Foreign key

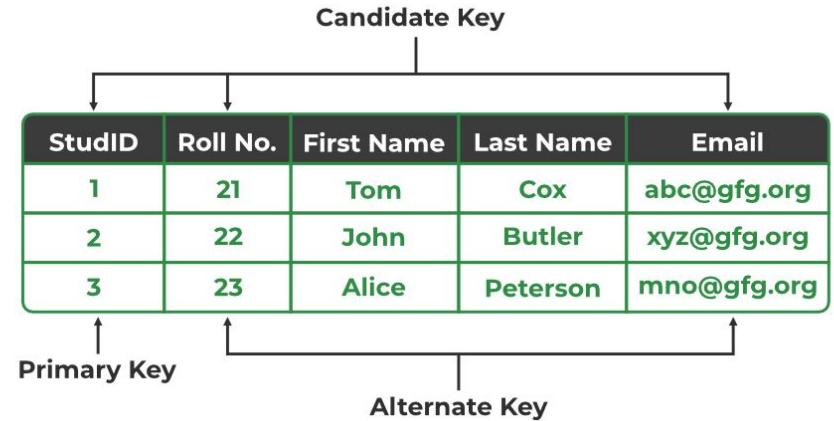
- A foreign key is a column or a set of columns in one table that refers to the primary key in another table.
- Foreign keys establish relationships between tables.
- They ensure **referential integrity** by enforcing that the value in the foreign key column must match a value in the primary key column of the referenced table.



Candidate key

- A candidate key is a column or a set of columns that can uniquely identify any row in a table.
- A table can have multiple candidate keys.
- One of the candidate keys is chosen as the primary key.

Alternate keys are any candidate keys which are not a primary key

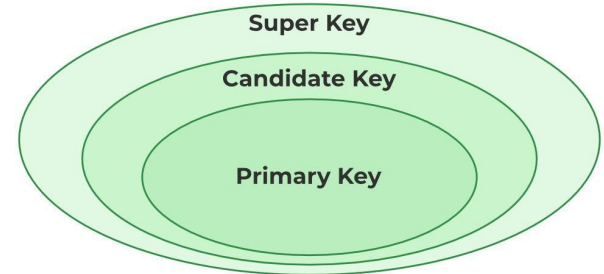


Superkey

- A super key is a set of one or more columns (attributes) that can uniquely identify a row in a table.
- It may contain additional attributes that are not necessary for unique identification.
- There can be many super keys in a table.

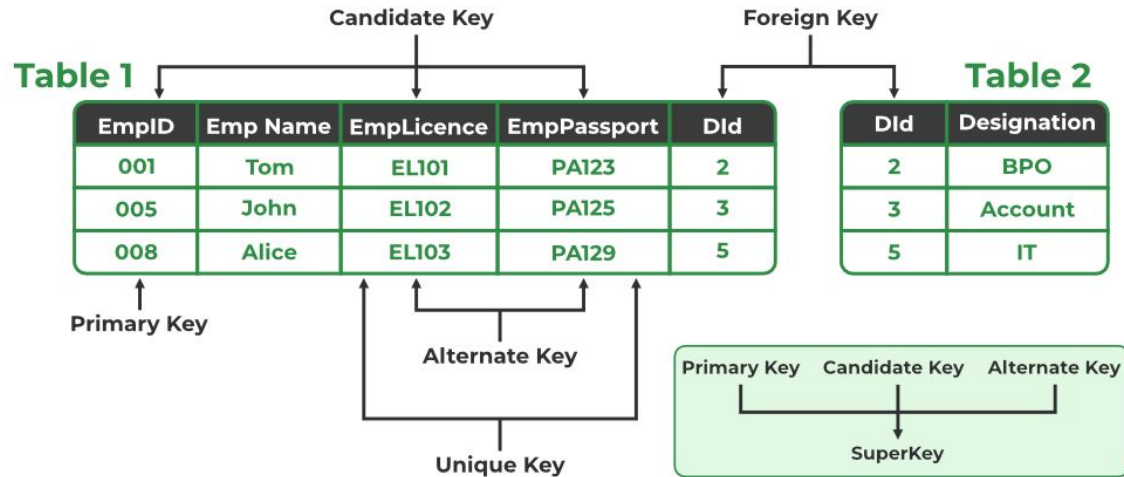
StudentID	FirstName	LastName	Email	CourseID
1	Alice	Smith	alice@example.com	101
2	Bob	Johnson	bob@example.com	102
3	Charlie	Brown	charlie@example.com	101

- **Super Keys:** StudentID, Email, StudentID, Email, StudentID, FirstName
- **Candidate Keys:** StudentID, Email
- **Primary Key:** StudentID (if chosen as the primary key)



Composite key

- A key that consists of two or more columns.
- Acts as a primary key if it doesn't exist
- It is used when a single column is not sufficient to uniquely identify a row.



Exercise 2

Discuss in pair, give example of the following terms:

1. Primary Key
2. Foreign Key
3. Candidate Key
4. Composite Key
5. Super Key

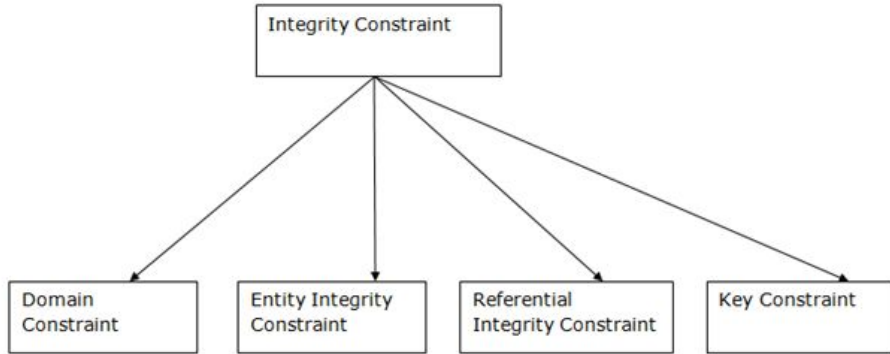
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Authors Table

AuthorID	FirstName	LastName
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102	Harper	Lee
103	Stephen	Hawking

Integrity rules



Integrity rules

Stud_ID	First	Last	Email	CourseID
1	Alice	Smith	alice@example.com	101
2	Bob	Johnson	bob@example.com	102
3	Charlie	Brown	charlie@example.com	101

CourseID	CourseName
101	Computer Science
102	Mathematics
103	Physics

Entity Integrity

- **Rule:** Each table must have a primary key, and the primary key must be unique and not null.
- **Example:**
 - In the **Students** table, **StudentID** is the primary key. Each **StudentID** must be unique and not null.
 - In the **Courses** table, **CourseID** is the primary key. Each **CourseID** must be unique and not null.

Integrity rules

Stud_ID	First	Last	Email	CourseID
1	Alice	Smith	alice@example.com	101
2	Bob	Johnson	bob@example.com	102
3	Charlie	Brown	charlie@example.com	101

CourseID	CourseName
101	Computer Science
102	Mathematics
103	Physics

Referential Integrity

- **Rule:** A foreign key must reference a valid, existing primary key in another table.
- **Example:**
 - In the **Students** table, **CourseID** is a foreign key that references **CourseID** in the **Courses** table. Every **CourseID** in the **Students** table must match a valid **CourseID** in the **Courses** table.
 - What happen if you try to insert a student with **CourseID 104**?

Integrity rules

Stud_ID	First	Last	Email	CourseID
1	Alice	Smith	alice@example.com	101
2	Bob	Johnson	bob@example.com	102
3	Charlie	Brown	charlie@example.com	101

CourseID	CourseName
101	Computer Science
102	Mathematics
103	Physics

Domain Integrity

- **Rule:** All values in a column must fall within a defined domain (set of permissible values).
- **Example:**
 - The **Email** column in the **Students** table should only contain valid email addresses.
 - The **CourseID** column in the **Students** table should only contain integer values that match the **CourseID** in the **Courses** table.

Integrity rules

Stud_ID	First	Last	Email	CourseID
1	Alice	Smith	alice@example.com	101
2	Bob	Johnson	bob@example.com	102
3	Charlie	Brown	charlie@example.com	101

CourseID	CourseName
101	Computer Science
102	Mathematics
103	Physics

User-defined Integrity

- **Rule:** Custom rules defined by the user to enforce specific business requirements.
- **Example:**
 - A rule that ensures a student's **FirstName** and **LastName** are not empty.
 - A rule that ensures the **CourseID** in the **Students** table must be one of the **CourseID** values in the **Courses** table.

Exercise 3

Discuss in pair, give example of when this integrity rule is being violated

1. Entity integrity
2. Referential integrity
3. Domain integrity
4. User-defined integrity

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