

Chapter 4

The Relational Model

Chapter 4 - Objectives

- Terminology of relational model.
- How tables are used to represent data.
- Connection between mathematical relations and relations in the relational model.
- Properties of database relations.
- Meaning of entity integrity and referential integrity.
- Purpose and advantages of views.

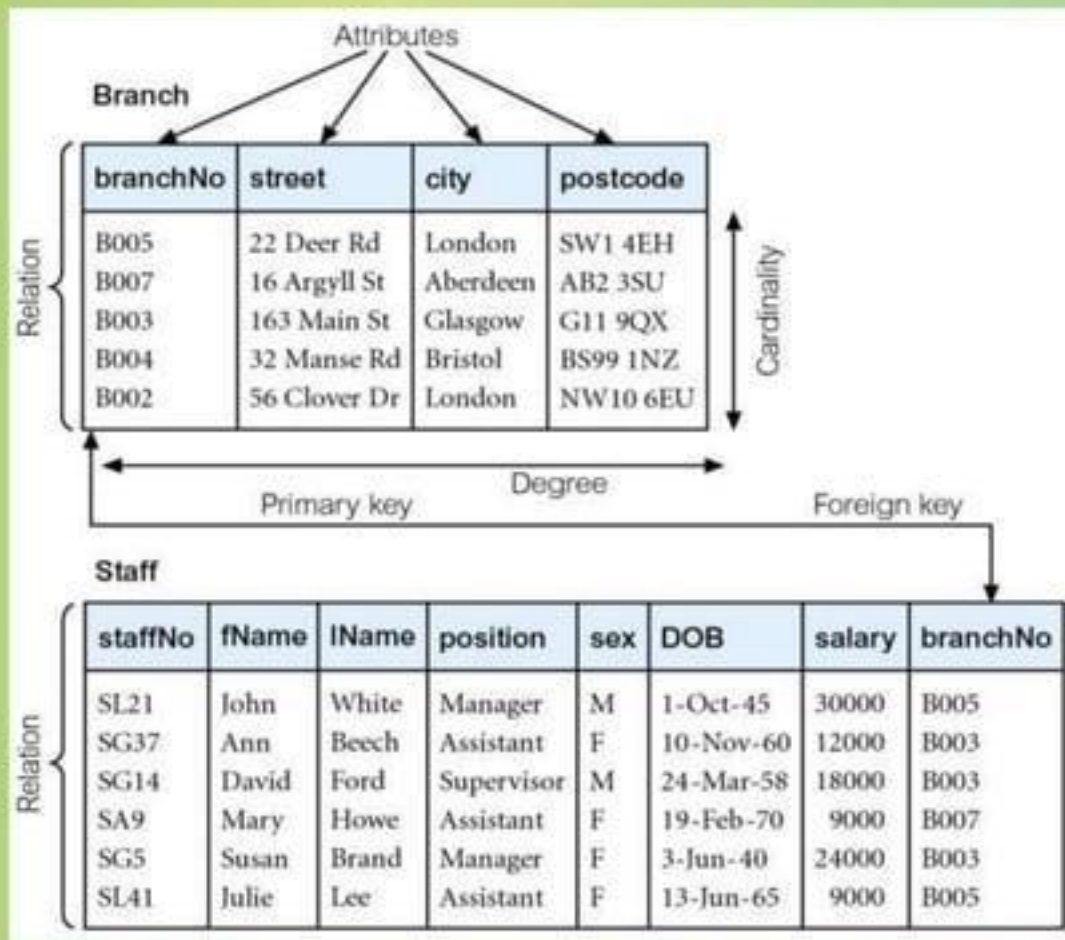
Relational Model Terminology

- **A relation is a table with columns and rows.**
 - Only applies to logical structure of the database, not the physical structure.
- **Attribute is a named column of a relation.**
- **Domain is the set of allowable values for one or more attributes.**

Relational Model Terminology

- **Tuple is a row of a relation.**
- **Degree is the number of attributes in a relation.**
- **Cardinality is the number of tuples in a relation.**
- **Relational Database is a collection of normalized relations with distinct relation names.**

Instances of Branch and Staff Relations



Examples of Attribute Domains

Attribute	Domain Name	Meaning	Domain Definition
branchNo	BranchNumbers	The set of all possible branch numbers	character: size 4, range B001–B999
street	StreetNames	The set of all street names in Britain	character: size 25
city	CityNames	The set of all city names in Britain	character: size 15
postcode	Postcodes	The set of all postcodes in Britain	character: size 8
sex	Sex	The sex of a person	character: size 1, value M or F
DOB	DatesOfBirth	Possible values of staff birth dates	date, range from 1-Jan-20, format dd-mmm-yy
salary	Salaries	Possible values of staff salaries	monetary: 7 digits, range 6000.00–40000.00

Alternative Terminology for Relational Model

Formal terms	Alternative 1	Alternative 2
Relation	Table	File
Tuple	Row	Record
Attribute	Column	Field

Mathematical Definition of Relation

- Consider two sets, D_1 & D_2 , where $D_1 = \{2, 4\}$ and $D_2 = \{1, 3, 5\}$.
- Cartesian product, $D_1 \times D_2$, is set of all ordered pairs, where first element is member of D_1 and second element is member of D_2 .

$$D_1 \times D_2 = \{(2, 1), (2, 3), (2, 5), (4, 1), (4, 3), (4, 5)\}$$

Mathematical Definition of Relation

- Any subset (including complete set and null set) of Cartesian product is a relation; e.g.

$$R = \{(2, 1), (4, 1)\}$$

- May specify which pairs are in relation using some condition for selection; e.g.

- second element is 1:

$$R = \{(x, y) \mid x \in D_1, y \in D_2, \text{ and } y = 1\}$$

- first element is always twice the second:

$$S = \{(x, y) \mid x \in D_1, y \in D_2, \text{ and } x = 2y\}$$

Mathematical Definition of Relation

- Consider three sets D_1, D_2, D_3 with Cartesian Product $D_1 \times D_2 \times D_3$; e.g.

$$D_1 = \{1, 3\} \quad D_2 = \{2, 4\} \quad D_3 = \{5, 6\}$$

$$D_1 \times D_2 \times D_3 = \{(1,2,5), (1,2,6), (1,4,5), (1,4,6), (3,2,5), (3,2,6), (3,4,5), (3,4,6)\}$$

- Any subset of these ordered triples is a relation.

Mathematical Definition of Relation

- Cartesian product of n sets (D_1, D_2, \dots, D_n) is:

$$D_1 \times D_2 \times \dots \times D_n = \{(d_1, d_2, \dots, d_n) \mid d_1 \in D_1, d_2 \in D_2, \dots, d_n \in D_n\}$$

usually written as:

$$\prod_{i=1}^n D_i$$

- Any set of n -tuples from this Cartesian product is a relation on the n sets.

Database Relations

- **Relation schema**
 - **Named relation defined by a set of attribute and domain name pairs.**
- **Relational database schema**
 - **Set of relation schemas, each with a distinct name.**

Properties of Relations

- **Relation name is distinct from all other relation names in relational schema.**
- **Each cell of relation contains exactly one atomic (single) value.**
- **Each attribute has a distinct name.**
- **Values of an attribute are all from the same domain.**

Properties of Relations

- **Each tuple is distinct; there are no duplicate tuples.**
- **Order of attributes has no significance.**
- **Order of tuples has no significance, theoretically.**

Relational Keys

• Superkey

- An attribute, or set of attributes, that uniquely identifies a tuple within a relation.

• Candidate Key

- Superkey (K) such that no proper subset is a superkey within the relation.
- In each tuple of R, values of K uniquely identify that tuple (uniqueness).
- No proper subset of K has the uniqueness property (irreducibility).

Relational Keys

- **Primary Key**

- Candidate key selected to identify tuples uniquely within relation.

- **Alternate Keys**

- Candidate keys that are not selected to be primary key.

- **Foreign Key**

- Attribute, or set of attributes, within one relation that matches candidate key of some (possibly same) relation.

Integrity Constraints

● Null

- Represents value for an attribute that is currently unknown or not applicable for tuple.
- Deals with incomplete or exceptional data.
- Represents the absence of a value and is not the same as zero or spaces, which are values.

Integrity Constraints

- **Entity Integrity**

- In a base relation, no attribute of a primary key can be null.

- **Referential Integrity**

- If foreign key exists in a relation, either foreign key value must match a candidate key value of some tuple in its home relation or foreign key value must be wholly null.

Integrity Constraints

- **General Constraints**
 - Additional rules specified by users or database administrators that define or constrain some aspect of the enterprise.

Views

- **Base Relation**

- **Named relation corresponding to an entity in conceptual schema, whose tuples are physically stored in database.**

- **View**

- **Dynamic result of one or more relational operations operating on base relations to produce another relation.**

Views

- **A virtual relation that does not necessarily actually exist in the database but is produced upon request, at time of request.**
- **Contents of a view are defined as a query on one or more base relations.**
- **Views are dynamic, meaning that changes made to base relations that affect view attributes are immediately reflected in the view.**

Purpose of Views

- Provides powerful and flexible security mechanism by hiding parts of database from certain users.
- Permits users to access data in a customized way, so that same data can be seen by different users in different ways, at same time.
- Can simplify complex operations on base relations.

Updating Views

- All updates to a base relation should be immediately reflected in all views that reference that base relation.
- If view is updated, underlying base relation should reflect change.

Updating Views

- **There are restrictions on types of modifications that can be made through views:**
 - Updates are allowed if query involves a single base relation and contains a candidate key of base relation.
 - Updates are not allowed involving multiple base relations.
 - Updates are not allowed involving aggregation or grouping operations.

Updating Views

- **Classes of views are defined as:**
 - theoretically not updateable;
 - theoretically updateable;
 - partially updateable.