

DATABASE SYSTEMS

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Course Schedule

1. Introduction to Databases
 2. Database Environment
 - 3. The Relational Model**
 4. Relational Algebra
 5. Relational Calculus
 6. Database Planning, Design, and Administration
- 7 – 9 Entity-Relationship Modeling
 - 10–12 Normalization
 13. Conceptual Database Design
 14. Logical Database Design



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Chapter 3

The Relational Model



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Chapter 3 - 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.**
- **How to identify candidate, primary, and foreign keys.**
- **Meaning of entity integrity and referential integrity.**
- **Purpose and advantages of views.**



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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.**



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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.

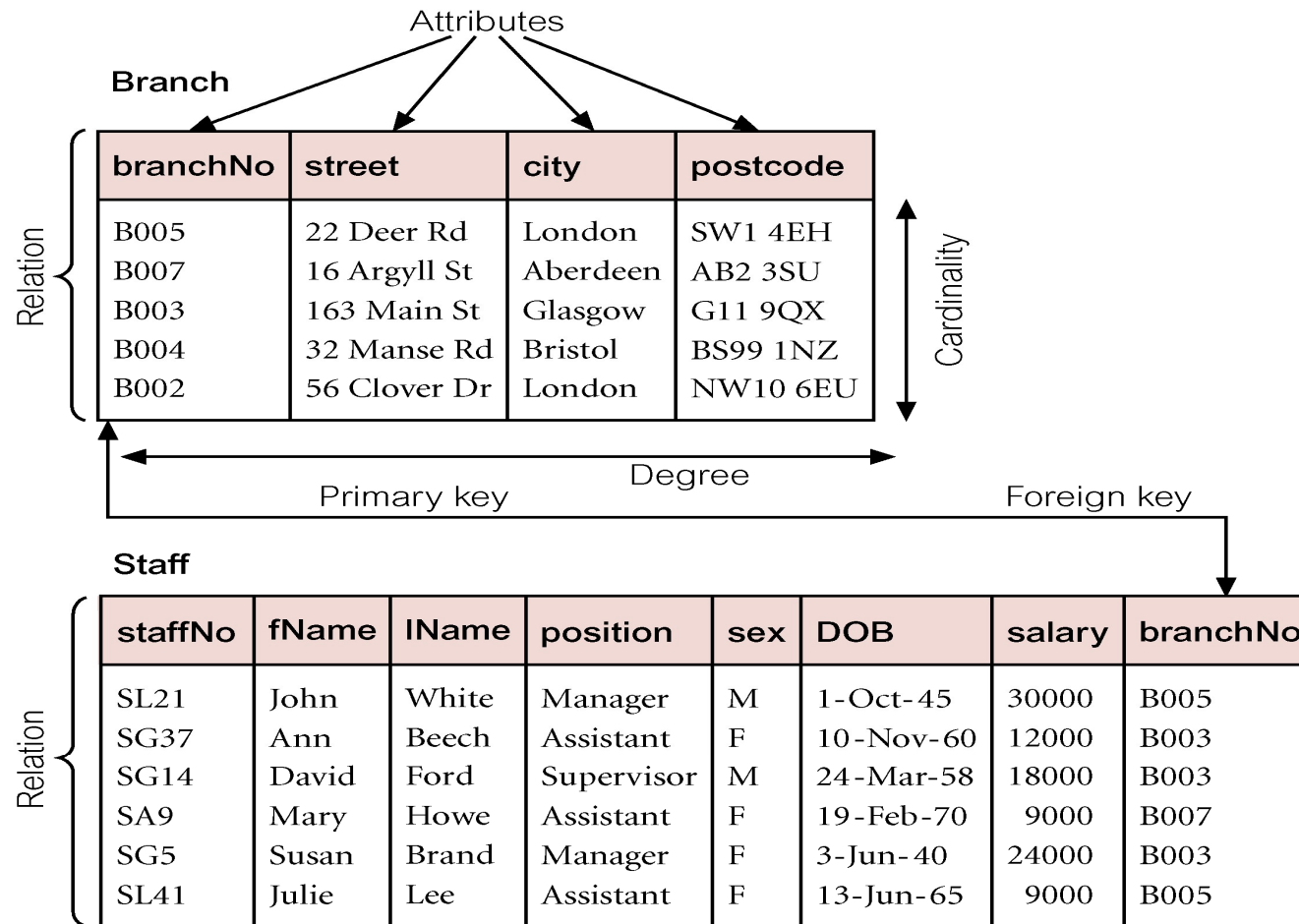


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Instances of Branch and Staff (part) Relations



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



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Alternative Terminology for Relational Model

Table 3.1 Alternative terminology for relational model terms.

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



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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 .

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

- Alternative way is to find all combinations of elements with first from D_1 and second from D_2 .



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Mathematical Definition of Relation

- Any subset 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:

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



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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.



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Mathematical Definition of Relation

- The 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.



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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.



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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.**



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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.



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Relational Keys

- **Superkey**
 - **An attribute, or a 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).**



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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.**



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Primary Key

Alternate Key

<u>StudentNo</u>	Reg No	FName	<u>LName</u>	Email
101	1	David	Reynaldo	Dav@gmail.com
102	2	Finn	Nathan	Finn@yahoo.com

Candidat Key



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Relational Integrity

- **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.**



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Relational Integrity

- **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.



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Relational Integrity

- **Enterprise Constraints**
 - Additional rules specified by users or database administrators.



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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.



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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.**



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Views

Table 1			
Column 1	Column 2	Column 3	Column 4

Table 2			
Column 1	Column 2	Column 3	Column 4

View _Table1_ Table		
Column 1	Column 2	Column 3

View is created from Table 1 (Column2 , Column 3)
and Table 2 (Column1)



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.**



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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.



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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.**



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Updating Views

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



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Example

EmpID	Name	Email	DeptID	Address

Superkey:

Candidate Key:

Primary Key:

Alternate Key:



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Thank You

Reference: Database Systems A Practical Approach to Design, Implementation, and Management Fourth Edition.

Thomas M. Connolly and Carolyn E. Begg



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