The Relational Model
Introduction and Relational Algebra

Objectives
- Review terminology
- Describe the relational model.
- Discuss the relational algebra.

Entities, Attributes, and Relationships
- **Entity** – a person, place, thing, or event
- **Attribute** – a property of an entity
  - For the entity "Person," attributes could include eye colour and height
- **Relationship** - an association between entities
  - Publishers are related to the books they publish, and a book is related to its publisher

Relational Databases
- Collection of tables
  - Each entity in own table
  - Attributes are fields (columns) in table
  - Relationships are common columns in two or more tables
- Order of rows and columns is immaterial
- Repeating groups are not permitted
  - e.g. Student having attributes of Course1, Course2, Course3, Course4, and so on
- Entries with repeating groups are unnormalized

Definition of a Relational Database
- A relational database is a collection of relations or two-dimensional tables.

EMPNO	ENAME	JOB	DEPTNO
1234	JONES	PRESIDENT	10
1245	SMITH	MANAGER	20
1344	BARKER	MANAGER	10
1432	WESTON	MANAGER	30

DEPTNO	DNAME	LOC
10	ACCOUNTS	VICTORIA
20	SALES	OAK BAY
30	IT	SAANICH
40	RESEARCH	VANCOUVER

Relations

- Two dimensional table in which:
  - Entries are single-valued
  - Each column (field or attribute) has a distinct name
  - All values in a column represent the same attribute
  - Order of columns is immaterial
  - Each row (record or tuple) is distinct
  - Order of rows is immaterial

Relating Multiple Tables

- Each rows of data in a table is uniquely identified by a primary key (PK)
- Can logically relate data from multiple tables using foreign keys (FK)

EMPNO	ENAME	JOB	DEPTNO
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Primary Key   Foreign Key   Primary Key
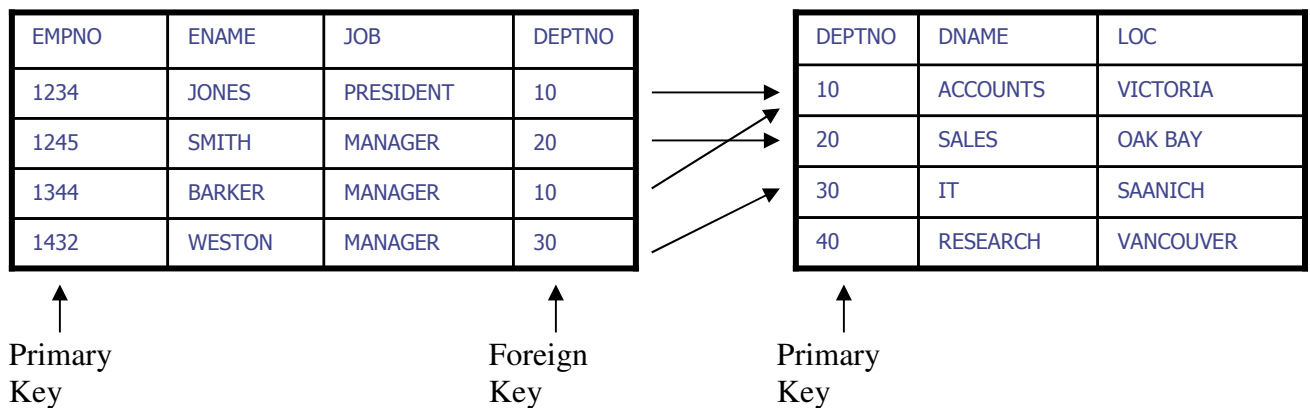
The Relational Structure

- The relational model has a firm mathematical foundation.
- Can address issues such as:
  - What data are derivable from other data?
  - Is there redundancy in these data?
  - Are there inconsistencies in these data?
- The structural components of the relational model are:
  - Relations
  - Attributes
  - Domains
  - Tuples
  - Keys
  - Representations
- Relation
  - Is a named table with columns and rows
  - The degree of a relation is its number of columns

EMPNO	SURNAME	DEPT
12	Bloggs	A45
74	Smith	C97

Degree = 3
3-ary relation

- Attributes
  - Each column has a name or attribute
  - The attributes in a relation can appear in any order.
- Domains
  - Attribute values are taken from domains.
  - For example, DATE_OF_BIRTH and HIRE_DATE would both be drawn from the DATE domain.
- Tuples
  - The elements of a relation are the rows, or tuples, in the table
  - Each row contains n values, one for each attribute.
  - When a relation represents an entity, each row represents an entity instance.
  - Rows or tuples, can appear in any order, and the table will convey the same meaning.
- Keys
  - Every relation has a set of candidate keys, one of which is selected as the primary key.
- Representation
  - Common convention for representing a relation is to give its name, followed by its attribute names, with its primary key underlined.
  - For Example:

EMPNO	SURNAME	DEPT
12	Bloggs	A45
74	Smith	C97

<- Instance table

EMPLOYEE (<u>EMPNO</u>, SURNAME, DEPT)   <- Intension or Schema

Relational Assertions
- Assertion
  - A constraint or qualification or restriction that applies to a model
- There are two assertions in the relational model that protect the integrity of a set of relations
  1. Primary key values
  2. Foreign key values

Relational Operators
− The relational operators' operands are always relations
− The result of applying a relational operator is always a relation
− The three basic relational operators which allow us to perform most of the data retrieval operations are:
    1. SELECT- command retrieves certain rows
    2. PROJECT- includes only certain columns
    3. JOIN- pulls data from more than one table
− JOIN allows the combination of information from two or more tables.
− JOIN is the real power behind the relational database.
− Many forms of a join:
    o The product (cartesian join)
    o The equijoin
    o The natural join
    o The outer join
    o The self-join

Set Operations

− The set operators (eg UNION, INTERSECT) can also be applied to relations.
− Must be sure that the operand relations really are comparable.

− Union of two tables
    o Result contains all rows that are in either the first table, the second table, or both
− Intersection of two tables
    o Result contains all rows common to both
− Difference of tables
    o Result is the set of rows in one table but not the other

Set Operator - UNION
− The union of two tables is a table containing all rows that are either the first table, the second table, or both.
− The tables must have the same attribute characteristics (the columns and domains must be identical).
− Oracle
    o UNION – Returns all unique rows selected by either query
    o UNION ALL – Returns all rows, including duplicates selected by either query

Set Operator - INTERSECTION
- The intersection of two tables is a table containing only rows that are common to both.
- The tables must have the same attribute characteristics.
- Oracle
    - INTERSECT – Returns rows selected from both queries

Set Operator – DIFFERENCE or SUBTRACT
- The difference of tables A & B is the set of all rows that are in A, but not in B.
- Is essentially, one table subtracted from the other.
- The tables must have the same attribute characteristics.
- Oracle:
    - MINUS – Returns unique rows selected by the first query but not the rows selected by the second query.

QBE
- A query is a question represented in a way that the database management system can recognize and process.
- Query-by-Example offers a very visual way to construct queries.

Simple and Compound Criteria
- Criteria are restrictions that the records to be retrieved must satisfy.
- A condition is put in the appropriate column as illustrated in the next slide.
- Compound criteria combines multiple criteria by using the commonly used operators AND and OR.