# Database Systems

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# Agenda

- Purpose and importance of SQL.
- How to retrieve data from database using SELECT

and:

  - Use compound WHERE conditions.
  - Sort query results using ORDER BY.
  - Use aggregate functions.

# Objectives of SQL

Ideally, database language should allow user to:
– create the database and relation structures;

– perform insertion, modification, deletion of data from relations;

– perform simple and complex queries.

Must perform these tasks with minimal user effort and command structure/syntax must be easy to learn.

It must be portable.

# Objectives of SQL

**SQL is a transform-oriented language with 2 major components:**

**– A DDL for defining database structure.**

**– A DML for retrieving and updating data.**

**Until SQL:1999, SQL did not contain flow of control commands. These had to be implemented using a programming or job-control language, or interactively by the decisions of user.**

# Objectives of SQL

**SQL is relatively easy to learn:**

**– it is non-procedural - you specify *what* information you require, rather than *how* to get it;**

**– it is essentially free-format**

# SQL Data Definition and Data Types

- Terminology:
  - **Table**, **row**, and **column** used for relational model terms relation, tuple, and attribute
- `CREATE` statement
  - Main SQL command for data definition

# Attribute Data Types and Domains in SQL

- Basic **data types**
  - **Numeric** data types
    - Integer numbers: `INTEGER`, `INT`, and `SMALLINT`
    - Floating-point (real) numbers: `FLOAT` or `REAL`, and `DOUBLE PRECISION`
  - **Character-string** data types
    - Fixed length: `CHAR(`*n*`)`, `CHARACTER(`*n*`)`
    - Varying length : `VARCHAR(`*n*`)`, `CHAR VARYING(`*n*`)`, `CHARACTER VARYING(`*n*`)`

# Attribute Data Types and Domains in SQL (cont'd.)

- **Bit-string** data types
  - Fixed length: `BIT(`*n*`)`
  - Varying length: `BIT VARYING(`*n*`)`
- **Boolean** data type
  - Values of `TRUE` or `FALSE` or `NULL`
- **DATE** data type
  - Ten positions
  - Components are `YEAR`, `MONTH`, and `DAY` in the form YYYY-MM-DD

# Attribute Data Types and Domains in SQL (cont'd.)

- Additional data types
  - **Timestamp** data type (`TIMESTAMP`)
    - Includes the `DATE` and `TIME` fields
    - Plus a minimum of six positions for decimal fractions of seconds
    - Optional `WITH TIME ZONE` qualifier
  - **`INTERVAL`** data type
    - Specifies a relative value that can be used to increment or decrement an absolute value of a date, time, or timestamp

# Attribute Data Types and Domains in SQL (cont'd.)

- Domain
  - Name used with the attribute specification
  - Makes it easier to change the data type for a domain that is used by numerous attributes
  - Improves schema readability
  - Example:
    - `CREATE DOMAIN SSN_TYPE AS CHAR(9);`

# Specifying Constraints in SQL

- Basic constraints:
  - Key and referential integrity constraints
  - Restrictions on attribute domains and NULLs
  - Constraints on individual tuples within a relation

# Objectives of SQL

Consists of standard English words:

1) CREATE TABLE Staff(staffNo VARCHAR(5),
lName VARCHAR(15),
salary DECIMAL(7,2));

2) INSERT INTO Staff VALUES (‘SG16’, ‘Brown’, 8300);

3) SELECT staffNo, lName, salary
FROM Staff
WHERE salary > 10000;

# History of SQL

**In 1974, D. Chamberlin (IBM San Jose Laboratory) defined language called ‘Structured English Query Language’ (SEQUEL).**

**A revised version, SEQUEL/2, was defined in 1976 but name was subsequently changed to SQL for legal reasons.**

# History of SQL

**In late 70s, ORACLE appeared and was probably first commercial RDBMS based on SQL.**

**In 1987, ANSI and ISO published an initial standard for SQL.**

**In 1989, ISO published an addendum that defined an 'Integrity Enhancement Feature'.**

**In 1992, first major revision to ISO standard occurred, referred to as SQL2 or SQL/92.**

**In 1999, SQL:1999 was released with support for object-oriented data management.**

**In late 2003, SQL:2003 was released**

# Importance of SQL

**SQL has become part of application architectures such as IBM's Systems Application Architecture.**

**It is strategic choice of many large and influential organizations (e.g. X/OPEN).**

**SQL is Federal Information Processing Standard (FIPS) to which conformance is required for all sales of databases to American Government.**

# History of SQL

**Still pronounced ‘see-quel’, though official pronunciation is ‘S-Q-L’.**

**IBM subsequently produced a prototype DBMS called *System R*, based on SEQUEL/2.**

**Roots of SQL, however, are in SQUARE (Specifying Queries as Relational Expressions), which predates System R project.**

# Importance of SQL

**SQL is used in other standards and even influences development of other standards as a definitional tool. Examples include:**

**– ISO's Information Resource Directory System (IRDS) Standard**
**– Remote Data Access (RDA) Standard.**

# Writing SQL Commands

SQL statement consists of *reserved words* and *userdefined words*.

– **Reserved** words are a fixed part of SQL and must be spelt exactly as required and cannot be split across lines.

– **User-defined** words are made up by user and represent names of various database objects such as relations, columns, views.

# Writing SQL Commands

Most components of an SQL statement are *case insensitive*, except for literal character data.

More readable with indentation and lineation:

– Each clause should begin on a new line.

– Start of a clause should line up with start of other clauses.

– If clause has several parts, should each appear on a separate line and be indented under start of clause.

# Writing SQL Commands

**Use extended form of BNF notation:**

- Upper-case letters represent reserved words.
- Lower-case letters represent user-defined words.
- | indicates a *choice* among alternatives.
- Curly braces indicate a *required element*.
- Square brackets indicate an *optional element*.
- … indicates *optional repetition* (0 or more).

# Literals

Literals are constants used in SQL statements.

All non-numeric literals must be enclosed in
single quotes (e.g. ‘London’).

All numeric literals must not be enclosed in quotes (e.g. 650.00)

# SELECT STATEMENT

# SELECT Statement

```
SELECT [DISTINCT | ALL]
   {* | [columnExpression [AS newName]] [,...] }
FROM       TableName [alias] [, ...]
[WHERE     condition]
[GROUP BY  columnList]  [HAVING condition]
[ORDER BY  columnList]
```

# SELECT Statement

| | |
|---|---|
| **FROM** | **Specifies table(s) to be used.** |
| **WHERE** | **Filters rows.** |
| **GROUP BY** | **Forms groups of rows with same column value.** |
| **HAVING** | **Filters groups subject to some condition.** |
| **SELECT** | **Specifies which columns are to appear in output.** |
| **ORDER BY** | **Specifies the order of the output.** |

# SELECT Statement

Order of the clauses cannot be changed.

Only SELECT and FROM are mandatory.

# Example - All Columns, All Rows

List full details of all staff.

```
SELECT staffNo, fName, lName, address,
       position, sex, DOB, salary, branchNo
FROM Staff;
```

- Can use * as an abbreviation for 'all columns':

```
SELECT *
FROM Staff;
```

# Example - All Columns, All Rows

| staffNo | fName | lName | position | sex | DOB | salary | branchNo |
|---|---|---|---|---|---|---|---|
| SL21 | John | White | Manager | M | 1-Oct-45 | 30000.00 | B005 |
| SG37 | Ann | Beech | Assistant | F | 10-Nov-60 | 12000.00 | B003 |
| SG14 | David | Ford | Supervisor | M | 24-Mar-58 | 18000.00 | B003 |
| SA9 | Mary | Howe | Assistant | F | 19-Feb-70 | 9000.00 | B007 |
| SG5 | Susan | Brand | Manager | F | 3-Jun-40 | 24000.00 | B003 |
| SL41 | Julie | Lee | Assistant | F | 13-Jun-65 | 9000.00 | B005 |

# Example - All Columns, All Rows

- Produce a list of salaries for all staff, showing only staff number, first and last names, and salary.

- SELECT staffNo, fName, lName, salary
- FROM Staff;

# Example - All Columns, All Rows

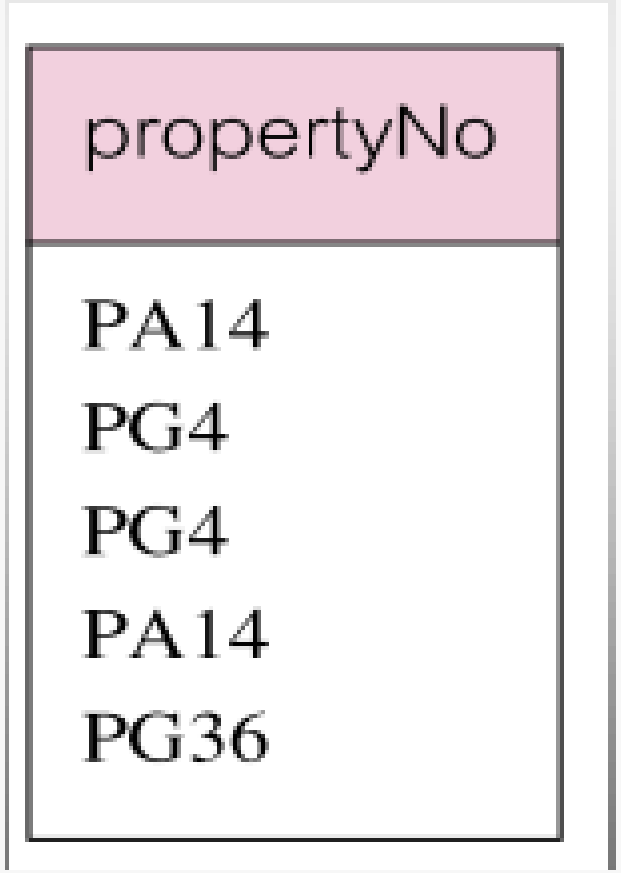
| staffNo | fName | lName | salary |
|---|---|---|---|
| SL21 | John | White | 30000.00 |
| SG37 | Ann | Beech | 12000.00 |
| SG14 | David | Ford | 18000.00 |
| SA9 | Mary | Howe | 9000.00 |
| SG5 | Susan | Brand | 24000.00 |
| SL41 | Julie | Lee | 9000.00 |

# Example - Use of DISTINCT

- List the property numbers of all properties that have been viewed.

- SELECT propertyNo

FROM Viewing;



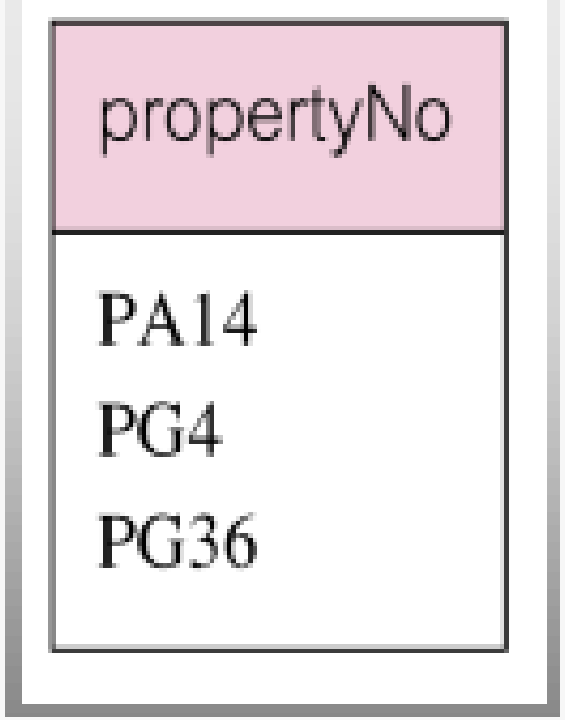
| propertyNo |
| --- |
| PA14 |
| PG4 |
| PG4 |
| PA14 |
| PG36 |

# Example - Use of DISTINCT

- Use DISTINCT to eliminate duplicates:

- SELECT DISTINCT propertyNo

FROM Viewing;



| propertyNo |
| --- |
| PA14 |
| PG4 |
| PG36 |

# Example  Calculated Fields

- Produce list of monthly salaries for all staff, showing staff number, first/last name, and salary.
- SELECT staffNo, fName, lName, salary/12
  FROM Staff

| staffNo | fName | lName | col4 |
|---|---|---|---|
| SL21 | John | White | 2500.00 |
| SG37 | Ann | Beech | 1000.00 |
| SG14 | David | Ford | 1500.00 |
| SA9 | Mary | Howe | 750.00 |
| SG5 | Susan | Brand | 2000.00 |
| SL41 | Julie | Lee | 750.00 |

# Example  Calculated Fields

- To name column, use AS clause:
- SELECT staffNo, fName, lName, salary/12

AS monthlySalary

FROM Staff;

# Example Comparison Search Condition

- List all staff with a salary greater than 10,000.

```
SELECT staffNo, fName, lName, position, salary
FROM Staff
WHERE salary > 10000;
```

| staffNo | fName | lName | position | salary |
|---|---|---|---|---|
| SL21 | John | White | Manager | 30000.00 |
| SG37 | Ann | Beech | Assistant | 12000.00 |
| SG14 | David | Ford | Supervisor | 18000.00 |
| SG5 | Susan | Brand | Manager | 24000.00 |

# Compound Comparison Search Condition

- List addresses of all branch offices in London or Glasgow.
- SELECT *

FROM Branch

WHERE city = ‘London’ OR city = ‘Glasgow’;

| branchNo | street | city | postcode |
|---|---|---|---|
| B005 | 22 Deer Rd | London | SW1 4EH |
| B003 | 163 Main St | Glasgow | G11 9QX |
| B002 | 56 Clover Dr | London | NW10 6EU |

# Example Range Search Condition

- List all staff with a salary between 20,000 and 30,000.
- SELECT staffNo, fName, lName, position, salary

FROM Staff

WHERE salary BETWEEN 20000 AND 30000;

**BETWEEN test includes the endpoints of range**

# Example Range Search Condition

| staffNo | fName | lName | position | salary |
|---|---|---|---|---|
| SL21 | John | White | Manager | 30000.00 |
| SG5 | Susan | Brand | Manager | 24000.00 |

# Example Range Search Condition

- Also a negated version NOT BETWEEN.
- BETWEEN does not add much to SQL's expressive power. Could also write:
- SELECT staffNo, fName, lName, position, salary

FROM Staff

WHERE salary>=20000 AND salary <= 30000;

- Useful, though, for a range of values.

# Example Set Membership

**List all managers and supervisors.**

```
SELECT staffNo, fName, lName, position
FROM Staff
WHERE position IN ('Manager', 'Supervisor');
```

**Table 5.8** Result table for Example 5.8.

| staffNo | fName | lName | position |
|---|---|---|---|
| SL21 | John | White | Manager |
| SG14 | David | Ford | Supervisor |
| SG5 | Susan | Brand | Manager |

# Example Set Membership

- Negated version (NOT IN)
- IN does not add much to SQL's expressive power. Could have expressed this as:

```
SELECT staffNo, fName, lName, position
FROM Staff
WHERE position='Manager' OR
      position='Supervisor';
```

- IN more efficient when set contains many values

# Example Pattern Matching

**Find all owners with the string 'Glasgow' in their address.**

```
SELECT ownerNo, fName, lName, address, telNo
FROM PrivateOwner
WHERE address LIKE '%Glasgow%';
```

**Table 5.9** Result table for Example 5.9.

| ownerNo | fName | lName | address | telNo |
|---|---|---|---|---|
| CO87 | Carol | Farrel | 6 Achray St, Glasgow G32 9DX | 0141-357-7419 |
| CO40 | Tina | Murphy | 63 Well St, Glasgow G42 | 0141-943-1728 |
| CO93 | Tony | Shaw | 12 Park Pl, Glasgow G4 0QR | 0141-225-7025 |

# Example Pattern Matching

- **SQL has two special pattern matching symbols:**
  - **%: sequence of zero or more characters**
  - **_ (underscore): any single character**
- **LIKE '%Glasgow%' means sequence of characters of any length containing '*Glasgow*'**

# Example NULL Search Condition

List details of all viewings on property PG4 where a comment has not been supplied.

- There are 2 viewings for property PG4, one with and one without a comment.
- Have to test for null explicitly using special keyword IS NULL:

```
SELECT clientNo, viewDate
FROM Viewing
WHERE propertyNo = 'PG4' AND
      comment IS NULL;
```

# Example NULL Search Condition

| clientNo | viewDate |
| --- | --- |
| CR56 | 26-May-04 |

- **Negated version (IS NOT NULL) can test for non-null values**

## Example Single Column Ordering

List salaries for all staff, arranged in descending order of salary.

```
SELECT staffNo, fName, lName, salary
FROM Staff
ORDER BY salary DESC;
```

# Example Single Column Ordering

**Table 5.11** Result table for Example 5.11.

| staffNo | fName | lName | salary |
|---|---|---|---|
| SL21 | John | White | 30000.00 |
| SG5 | Susan | Brand | 24000.00 |
| SG14 | David | Ford | 18000.00 |
| SG37 | Ann | Beech | 12000.00 |
| SA9 | Mary | Howe | 9000.00 |
| SL41 | Julie | Lee | 9000.00 |

## Example Multiple Column Ordering

**Produce abbreviated list of properties in order of property type.**

```
SELECT propertyNo, type, rooms, rent
FROM PropertyForRent
ORDER BY type;
```

# Example Multiple Column Ordering

**Table 5.12(a)** Result table for Example 5.12 with one sort key.

| propertyNo | type | rooms | rent |
|---|---|---|---|
| PL94 | Flat | 4 | 400 |
| PG4 | Flat | 3 | 350 |
| PG36 | Flat | 3 | 375 |
| PG16 | Flat | 4 | 450 |
| PA14 | House | 6 | 650 |
| PG21 | House | 5 | 600 |

# Example Multiple Column Ordering

- Four flats in this list - as no minor sort key specified, system arranges these rows in any order it chooses
- To arrange in order of rent, specify minor order:

```
SELECT propertyNo, type, rooms, rent
FROM PropertyForRent
ORDER BY type, rent DESC;
```

# Example Multiple Column Ordering

**Table 5.12(b)** Result table for Example 5.12 with two sort keys.

| propertyNo | type | rooms | rent |
|---|---|---|---|
| PG16 | Flat | 4 | 450 |
| PL94 | Flat | 4 | 400 |
| PG36 | Flat | 3 | 375 |
| PG4 | Flat | 3 | 350 |
| PA14 | House | 6 | 650 |
| PG21 | House | 5 | 600 |

# SELECT Statement - Aggregates

- **ISO standard defines five aggregate functions:**

**COUNT - returns number of values in specified column**

**SUM - returns sum of values in specified column**

**AVG - returns average of values in specified column**

**MIN - returns smallest value in specified column**

**MAX - returns largest value in specified column**

# SELECT Statement - Aggregates

- Each operates on single column of table and returns single value
- COUNT, MIN, and MAX apply to numeric and non-numeric fields
  - SUM and AVG used on numeric fields only
- Each function eliminates nulls first and operates only on remaining non-null values
  - Except COUNT

# SELECT Statement - Aggregates

- COUNT(*) counts all rows of table
  - Includes nulls and duplicate values
- Can use DISTINCT before column name to eliminate duplicates
- DISTINCT has no effect with MIN/MAX
  - Has effect with SUM/AVG

# SELECT Statement - Aggregates

- Aggregate functions used only in SELECT list and HAVING clause

- If SELECT list includes an aggregate function and there is no GROUP BY clause, SELECT list cannot reference column out with aggregate function
- Illegal:

```
SELECT staffNo, COUNT(salary)
FROM Staff;
```

# Example Use of COUNT(*)

**How many properties cost more than £350 per month to rent?**

```
SELECT COUNT(*) AS myCount
FROM PropertyForRent
WHERE rent > 350;
```

| myCount |
| --- |
| 5 |

# Example Use of COUNT(DISTINCT)

**How many different properties viewed in May ‘04?**

```
SELECT COUNT(DISTINCT propertyNo) AS myCount
FROM Viewing
WHERE viewDate BETWEEN ‘1-May-0
      AND ‘31-May-04’;
```

| myCount |
| --- |
| 2 |

# Example Use of COUNT and SUM

**Find number of Managers and sum of their salaries.**

```
SELECT COUNT(staffNo) AS myCount,
       SUM(salary) AS mySum
FROM Staff
WHERE position = 'Manager';
```

| myCount | mySum |
|---|---|
| 2 | 54000.00 |

# Example Use of MIN, MAX, AVG

**Find minimum, maximum, and average staff salary.**

```
SELECT MIN(salary) AS myMin,
  MAX(salary) AS myMax,
   AVG(salary) AS myAvg
FROM Staff;
```

| myMin | myMax | myAvg |
|---|---|---|
| 9000.00 | 30000.00 | 17000.00 |

# Agenda

- How to retrieve data from database using SELECT

and:

  - Group data using GROUP BY and HAVING.
  - Use sub queries.
  - Create, Insert, Delete, Update

# SELECT Statement - Grouping

- **Use GROUP BY clause to get sub-totals**
- **SELECT and GROUP BY closely integrated:**
  - **Each item in SELECT list must be *single-valued per group***
  - **SELECT clause may only contain:**
    - **column names**
    - **aggregate functions**
    - **constants**
    - **expression involving combinations of above**

# SELECT Statement - Grouping

- All column names in SELECT list must appear in GROUP BY clause unless name used only in aggregate function
- If WHERE used with GROUP BY:
  - WHERE applied first
  - Then groups formed from remaining rows satisfying predicate
- ISO considers two nulls to be equal for purposes of GROUP BY

# Example Use of GROUP BY

**Find number of staff in each branch and their total salaries.**

```
SELECT      branchNo,
            COUNT(staffNo) AS myCount,
            SUM(salary) AS mySum
FROM Staff
GROUP BY branchNo
ORDER BY branchNo;
```

# Example Use of GROUP BY

| branchNo | myCount | mySum |
|---|---|---|
| B003 | 3 | 54000.00 |
| B005 | 2 | 39000.00 |
| B007 | 1 | 9000.00 |

# Restricted Groupings – HAVING clause

- HAVING clause designed for use with GROUP BY to restrict groups that appear in final result table
- Similar to WHERE:
  - WHERE filters individual rows
  - HAVING filters groups
- Column names in HAVING clause must appear in GROUP BY list or be contained within aggregate function

# Example Use of HAVING

**For each branch with more than 1 member of staff, find number of staff in each branch and sum of their salaries.**

```
SELECT branchNo,
        COUNT(staffNo) AS myCount,
          SUM(salary) AS mySum
 FROM Staff
 GROUP BY branchNo
 HAVING COUNT(staffNo) > 1
 ORDER BY branchNo;
```

# Example Use of HAVING

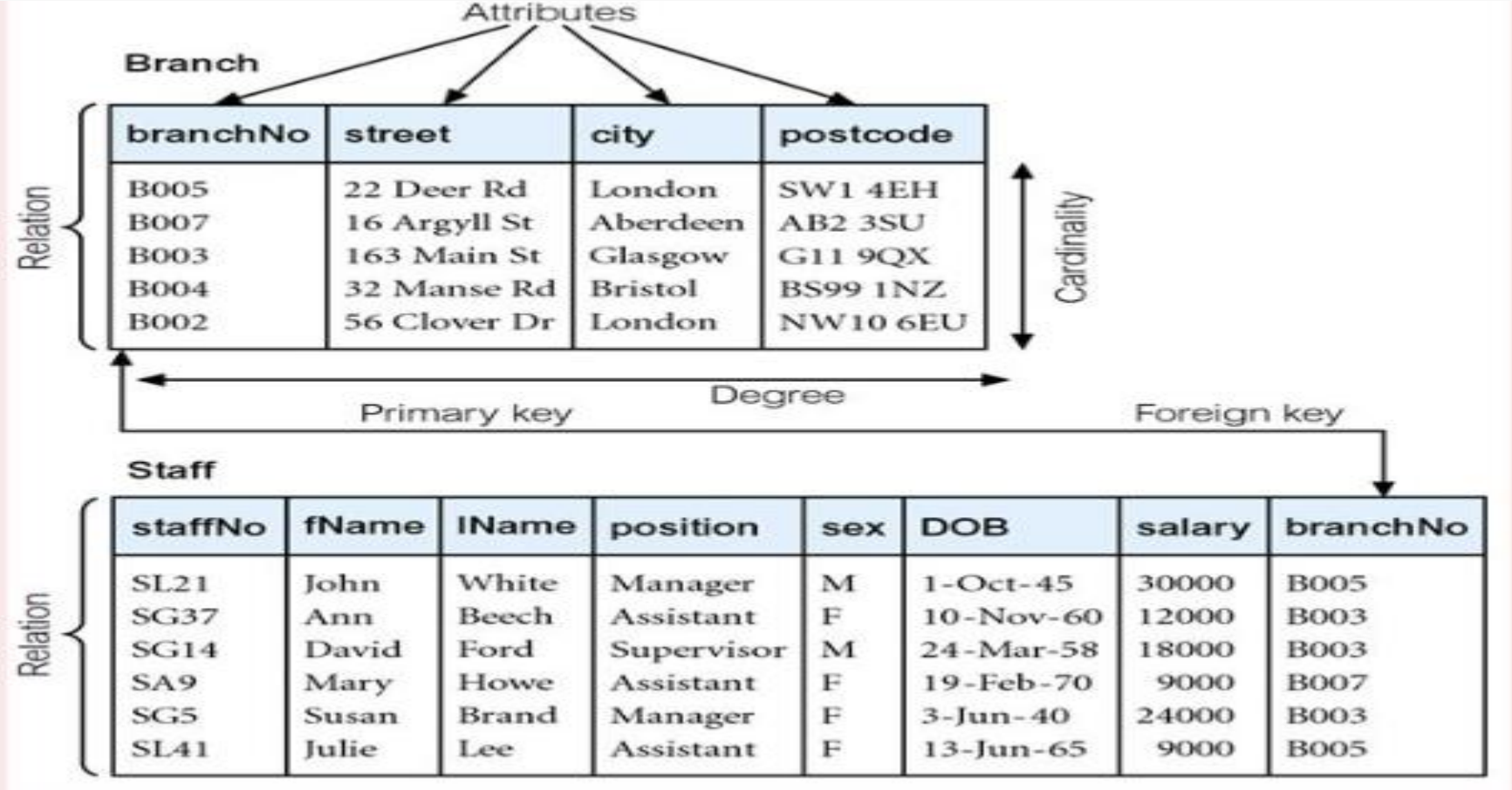
| branchNo | myCount | mySum |
|---|---|---|
| B003 | 3 | 54000.00 |
| B005 | 2 | 39000.00 |

# Subqueries

- **Some SQL statements can have SELECT embedded within them**
- **Ssubselect can be used in WHERE and HAVING clauses of an outer SELECT**
  - **Called *subquery* or *nested query***
- **Subselects may also appear in INSERT, UPDATE, and DELETE statements**

# Example Subquery with Equality

**List staff who work in branch at '163 Main St'.**




| branchNo | street | city | postcode |
|---|---|---|---|
| B005 | 22 Deer Rd | London | SW1 4EH |
| B007 | 16 Argyll St | Aberdeen | AB2 3SU |
| B003 | 163 Main St | Glasgow | G11 9QX |
| B004 | 32 Manse Rd | Bristol | BS99 1NZ |
| B002 | 56 Clover Dr | London | NW10 6EU |

| staffNo | fName | lName | position | sex | DOB | salary | branchNo |
|---|---|---|---|---|---|---|---|
| SL21 | John | White | Manager | M | 1-Oct-45 | 30000 | B005 |
| SG37 | Ann | Beech | Assistant | F | 10-Nov-60 | 12000 | B003 |
| SG14 | David | Ford | Supervisor | M | 24-Mar-58 | 18000 | B003 |
| SA9 | Mary | Howe | Assistant | F | 19-Feb-70 | 9000 | B007 |
| SG5 | Susan | Brand | Manager | F | 3-Jun-40 | 24000 | B003 |
| SL41 | Julie | Lee | Assistant | F | 13-Jun-65 | 9000 | B005 |

# Example Subquery with Equality

**List staff who work in branch at ‘163 Main St’.**

```
SELECT staffNo, fName, lName, position
FROM Staff
WHERE branchNo =
        (SELECT branchNo
         FROM Branch
         WHERE street = ‘163 Main St’);
```

# Example Subquery with Equality

- Inner SELECT finds branch number for branch at ‘163 Main St’ (‘B003’).
- Outer SELECT then retrieves details of all staff who work at this branch.
- Outer SELECT then becomes:

```
SELECT staffNo, fName, lName, position
FROM Staff
WHERE branchNo = ‘B003’;
```

# Example Subquery with Equality

**Table 5.19** Result table for Example 5.19.

| staffNo | fName | lName | position |
|---|---|---|---|
| SG37 | Ann | Beech | Assistant |
| SG14 | David | Ford | Supervisor |
| SG5 | Susan | Brand | Manager |

# Example Subquery with Aggregate

**List all staff whose salary is greater than the average salary,.**

```
SELECT staffNo, fName, lName, position,
  salary As SalDiff
FROM Staff
WHERE salary >
                (SELECT AVG(salary)
                 FROM Staff);
```

# Example Subquery with Aggregate

**List all staff whose salary is greater than the average salary, and show by how much.**

```
SELECT staffNo, fName, lName, position,
  salary – (SELECT AVG(salary) FROM Staff) As SalDiff
FROM Staff
WHERE salary >
                (SELECT AVG(salary)
                 FROM Staff);
```

# Example Subquery with Aggregate

- Cannot write 'WHERE salary > AVG(salary)'
- Instead, use subquery to find average salary (17000), and then use outer SELECT to find those staff with salary greater than this:

```
SELECT staffNo, fName, lName, position,
    salary – 17000 As salDiff
FROM Staff
WHERE salary > 17000;
```

# Example Subquery with Aggregate

**Table 5.20** Result table for Example 5.20.

| staffNo | fName | lName | position | salDiff |
|---|---|---|---|---|
| SL21 | John | White | Manager | 13000.00 |
| SG14 | David | Ford | Supervisor | 1000.00 |
| SG5 | Susan | Brand | Manager | 7000.00 |

# Subquery Rules

- **ORDER BY clause may not be used in subquery**
  - **May be used in outermost SELECT**
- **Subquery SELECT list must consist of single column name or expression**
  - **Except for subqueries that use EXISTS**
- **By default, column names refer to table name in FROM clause of subquery**
- **Can refer to table in FROM using *alias***

# Subquery Rules

- When subquery is operand in comparison
  - Subquery must appear on right-hand side
- Subquery may not be used as operand in an expression

# Example Nested subquery: use of IN

## List properties handled by staff at ‘163 Main St’.

```
SELECT propertyNo, street, city, postcode, type, rooms, rent
FROM PropertyForRent
WHERE staffNo IN
      (SELECT staffNo
       FROM Staff
       WHERE branchNo =
                (SELECT branchNo
                 FROM Branch
                 WHERE street = ‘163 Main St’));
```

# ANY and ALL

- ANY and ALL used with subqueries that produce single column of numbers
- ALL
  - Condition only true if satisfied by *all* values produced by subquery
- ANY
  - Condition true if satisfied by *any* values produced by subquery
- If subquery empty
  - ALL returns true
  - ANY returns false
- SOME may be used in place of ANY

# Example 6.22 Use of ANY/SOME

**Find staff whose salary is larger than salary of at least one member of staff at branch B003.**

```
SELECT staffNo, fName, lName, position, salary
 FROM Staff
 WHERE salary > SOME
                    (SELECT salary
                     FROM Staff
                     WHERE branchNo = 'B003');
```

# Example 6.22 Use of ANY/SOME

- **Inner query produces set {12000, 18000, 24000} and outer query selects those staff whose salaries are greater than any values in**

**Table 5.22** Result table for Example 5.22.

| staffNo | fName | lName | position | salary |
|---|---|---|---|---|
| SL21 | John | White | Manager | 30000.00 |
| SG14 | David | Ford | Supervisor | 18000.00 |
| SG5 | Susan | Brand | Manager | 24000.00 |

# Example 6.23 Use of ALL

**Find staff whose salary is larger than salary of every member of staff at branch B003.**

```
SELECT staffNo, fName, lName, position, salary
 FROM Staff
 WHERE salary > ALL
                    (SELECT salary
                     FROM Staff
                     WHERE branchNo = 'B003');
```

# Example 6.23 Use of ALL

**Table 5.23** Result table for Example 5.23.

| staffNo | fName | lName | position | salary |
|---|---|---|---|---|
| SL21 | John | White | Manager | 30000.00 |

# The CREATE TABLE Command in SQL

  - Provide name
  - Specify attributes and initial constraints
- Can optionally specify schema:
  - `CREATE TABLE COMPANY.EMPLOYEE ...`

    or
  - `CREATE TABLE EMPLOYEE ...`

```
CREATE TABLE EMPLOYEE
        ( Fname             VARCHAR(15)          NOT NULL,
          Minit             CHAR,
          Lname             VARCHAR(15)          NOT NULL,
          Ssn               CHAR(9)              NOT NULL,
          Bdate             DATE,
          Address           VARCHAR(30),
          Sex               CHAR,
          Salary            DECIMAL(10,2),
          Super_ssn         CHAR(9),
          Dno               INT                  NOT NULL,
        PRIMARY KEY (Ssn),
        FOREIGN KEY (Super_ssn) REFERENCES EMPLOYEE(Ssn),
        FOREIGN KEY (Dno) REFERENCES DEPARTMENT(Dnumber) );
CREATE TABLE DEPARTMENT
        ( Dname             VARCHAR(15)          NOT NULL,
          Dnumber           INT                  NOT NULL,
          Mgr_ssn           CHAR(9)              NOT NULL,
          Mgr_start_date    DATE,
        PRIMARY KEY (Dnumber),
        UNIQUE (Dname),
        FOREIGN KEY (Mgr_ssn) REFERENCES EMPLOYEE(Ssn) );
```

**Figure 4.1**
SQL CREATE TABLE data definition statements for defining the COMPANY schema from Figure 3.7.

```
CREATE TABLE DEPT_LOCATIONS
        ( Dnumber           INT             NOT NULL,
          Dlocation         VARCHAR(15)     NOT NULL,
        PRIMARY KEY (Dnumber, Dlocation),
        FOREIGN KEY (Dnumber) REFERENCES DEPARTMENT(Dnumber) );
CREATE TABLE PROJECT
        ( Pname             VARCHAR(15)     NOT NULL,
          Pnumber           INT             NOT NULL,
          Plocation         VARCHAR(15),
          Dnum              INT             NOT NULL,
        PRIMARY KEY (Pnumber),
        UNIQUE (Pname),
        FOREIGN KEY (Dnum) REFERENCES DEPARTMENT(Dnumber) );
CREATE TABLE WORKS_ON
        ( Essn              CHAR(9)         NOT NULL,
          Pno               INT             NOT NULL,
          Hours             DECIMAL(3,1)    NOT NULL,
        PRIMARY KEY (Essn, Pno),
        FOREIGN KEY (Essn) REFERENCES EMPLOYEE(Ssn),
        FOREIGN KEY (Pno) REFERENCES PROJECT(Pnumber) );
CREATE TABLE DEPENDENT
        ( Essn              CHAR(9)         NOT NULL,
          Dependent_name    VARCHAR(15)     NOT NULL,
          Sex               CHAR,
          Bdate             DATE,
          Relationship      VARCHAR(8),
        PRIMARY KEY (Essn, Dependent_name),
        FOREIGN KEY (Essn) REFERENCES EMPLOYEE(Ssn) );
```

**Figure 4.1**
SQL CREATE TABLE data definition statements for defining the COMPANY schema from Figure 3.7.

# The CREATE TABLE Command in SQL (cont'd.)

- Some foreign keys may cause errors
  - Specified either via:
    - Circular references
    - Or because they refer to a table that has not yet been created

# Specifying Constraints in SQL

- Basic constraints:
  - Key and referential integrity constraints
  - Restrictions on attribute domains and NULLs
  - Constraints on individual tuples within a relation

# Specifying Attribute Constraints and Attribute Defaults

- `NOT NULL`
  - `NULL` is not permitted for a particular attribute
- Default value
  - **`DEFAULT`** `<value>`
- **`CHECK`** clause
  - `Dnumber INT NOT NULL CHECK (Dnumber > 0 AND Dnumber < 21);`

```
CREATE TABLE DEPARTMENT
    ( . . . ,
      Mgr_ssn     CHAR(9)        NOT NULL          DEFAULT '888665555',
      . . . ,
    CONSTRAINT DEPTPK
      PRIMARY KEY(Dnumber),
    CONSTRAINT DEPTSK
      UNIQUE (Dname),
    CONSTRAINT DEPTMGRFK
      FOREIGN KEY (Mgr_ssn) REFERENCES EMPLOYEE(Ssn)
                  ON DELETE SET DEFAULT   ON UPDATE CASCADE);
CREATE TABLE DEPT_LOCATIONS
    ( . . . ,
    PRIMARY KEY (Dnumber, Dlocation),
    FOREIGN KEY (Dnumber) REFERENCES DEPARTMENT(Dnumber)
                  ON DELETE CASCADE          ON UPDATE CASCADE);
```

**Figure 4.2**
Example illustrating how default attribute values and referential integrity triggered actions are specified in SQL.

# Specifying Key and Referential Integrity Constraints

- **`PRIMARY KEY`** clause
  - Specifies one or more attributes that make up the primary key of a relation
  - `Dnumber INT PRIMARY KEY;`
- **`UNIQUE`** clause
  - Specifies alternate (secondary) keys
  - `Dname VARCHAR(15) UNIQUE;`

# Specifying Key and Referential Integrity Constraints (cont'd.)

- **`FOREIGN KEY`** clause
  - Default operation: reject update on violation
  - Attach **referential triggered action** clause
    - Options include `SET NULL`, `CASCADE`, and `SET DEFAULT`
    - Action taken by the DBMS for `SET NULL` or `SET DEFAULT` is the same for both `ON DELETE` and `ON UPDATE`
    - `CASCADE` option suitable for "relationship" relations

# Specifying Constraints on Tuples

- NOT NULL Constraint – Ensures that a column cannot have NULL value.
- DEFAULT Constraint – Provides a default value for a column when none is specified.
- UNIQUE Constraint – Ensures that all values in a column are different.
- PRIMARY Key – Uniquely identifies each row/record in a database table.
- FOREIGN Key – Uniquely identifies a row/record in any of the given database table.

# Specifying Constraints on Tuples

- `CHECK` clauses at the end of a `CREATE TABLE` statement
  - Apply to each tuple individually
  - `CHECK (Dept_create_date <= Mgr_start_date);`

# INSERT, DELETE, and UPDATE Statements in SQL

- Three commands used to modify the database:
  - `INSERT`, `DELETE`, and `UPDATE`

# The INSERT Command

- Specify the relation name and a list of values for the tuple

```
U1:   INSERT INTO   EMPLOYEE
      VALUES        ( 'Richard', 'K', 'Marini', '653298653', '1962-12-30', '98
                      Oak Forest, Katy, TX', 'M', 37000, '653298653', 4 );
```

```
U3B:  INSERT INTO   WORKS_ON_INFO ( Emp_name, Proj_name,
                    Hours_per_week )
      SELECT        E.Lname, P.Pname, W.Hours
      FROM          PROJECT P, WORKS_ON W, EMPLOYEE E
      WHERE         P.Pnumber=W.Pno AND W.Essn=E.Ssn;
```

# The DELETE Command

- Removes tuples from a relation
  - Includes a `WHERE` clause to select the tuples to be deleted

```
U4A:  DELETE FROM   EMPLOYEE
      WHERE         Lname='Brown';

U4B:  DELETE FROM   EMPLOYEE
      WHERE         Ssn='123456789';

U4C:  DELETE FROM   EMPLOYEE
      WHERE         Dno=5;

U4D:  DELETE FROM   EMPLOYEE;
```

# The UPDATE Command

- Modify attribute values of one or more selected tuples
- Additional **`SET`** clause in the `UPDATE` command
  - Specifies attributes to be modified and new values

```
U5:   UPDATE   PROJECT
      SET      Plocation = 'Bellaire', Dnum = 5
      WHERE    Pnumber=10;
```


Thank
You