

# Standard Query Language

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## SQL: Data Manipulation Transparencies

# Objectives

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- ◆ **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.**
  - **Group data using GROUP BY and HAVING.**
  - **Use subqueries.**

## Objectives

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- Join tables together.
- Perform set operations (**UNION, INTERSECT, EXCEPT**).
- ◆ How to update database using **INSERT, UPDATE, and DELETE**.

## Objectives of SQL

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- ◆ 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

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- ◆ **SQL is a transform-oriented language with 2 major components:**
  - **A DDL for defining database structure.**
  - **A DML for retrieving and updating data.**

## Objectives of SQL

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- ◆ 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.

## Objectives of SQL

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◆ Consists of standard English words:

- 1) **CREATE TABLE Staff(staffNo VARCHAR(5),  
IName VARCHAR(15),  
salary DECIMAL(7,2));**
- 2) **INSERT INTO Staff VALUES ('SG16', 'Brown',  
8300);**
- 3) **SELECT staffNo, IName, salary  
FROM Staff  
WHERE salary > 10000;**

## Objectives of SQL

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- ◆ Can be used by range of users including DBAs, management, application developers, and other types of end users.
- ◆ An ISO standard now exists for SQL, making it both the formal and *de facto* standard language for relational databases.



## Writing SQL Commands

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- ◆ SQL statement consists of *reserved words* and *user-defined 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.

# Literals

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- ◆ 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

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**SELECT [DISTINCT | ALL]**

**{\* | [columnExpression [AS newName]] [,...]}**

**FROM            TableName [alias] [, ...]**

**[WHERE           condition]**

**[GROUP BY       columnList] [HAVING condition]**

**[ORDER BY       columnList]**

## **SELECT Statement**

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

## **SELECT Statement**

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- ◆ **Order of the clauses cannot be changed.**
- ◆ **Only SELECT and FROM are mandatory.**

## Example 5.1 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 5.1 All Columns, All Rows

**Table 5.1** Result table for Example 5.1.

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 5.2 Specific 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 5.2 Specific Columns, All Rows

**Table 5.2** Result table for Example 5.2.

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 5.3 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 5.3 Use of DISTINCT

---

- ◆ Use **DISTINCT** to eliminate duplicates:

```
SELECT DISTINCT propertyNo  
FROM Viewing;
```

propertyNo
PA14
PG4
PG36

## Example 5.4 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;
```

**Table 5.4** Result table for Example 5.4.

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 5.4 Calculated Fields

---

- ◆ To name column, use AS clause:

```
SELECT staffNo, fName, lName, salary/12  
      AS monthlySalary  
FROM Staff;
```

## Example 5.5 Comparison Search Condition

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

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

**Table 5.5** Result table for Example 5.5.

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

## Example 5.6 Compound Comparison Search Condition

List addresses of all branch offices in London or Glasgow.

**SELECT \***

**FROM Branch**

**WHERE city = 'London' OR city = 'Glasgow';**

**Table 5.6** Result table for Example 5.6.

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 5.7 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 5.7 Range Search Condition

**Table 5.7** Result table for Example 5.7.

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

## Example 5.7 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 5.8 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 5.8 Set Membership

---

- ◆ There is a 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** is more efficient when set contains many values.

## Example 5.9 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 5.9 Pattern Matching

---

- ◆ SQL has two special pattern matching symbols:
  - %: sequence of zero or more characters;
  - \_ (underscore): any single character.
- ◆ LIKE ‘%Glasgow%’ means a sequence of characters of any length containing ‘*Glasgow*’.

## Example 5.10 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 5.10 NULL Search Condition

---

clientNo	viewDate
CR56	26-May-04

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



## Example 5.11 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 5.11 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 5.12 Multiple Column Ordering**

---

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

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

## Example 5.12 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 5.12 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 5.12 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**

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◆ **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 a single column of a table and returns a single value.**
- ◆ **COUNT, MIN, and MAX apply to numeric and non-numeric fields, but SUM and AVG may be used on numeric fields only.**
- ◆ **Apart from COUNT(\*), each function eliminates nulls first and operates only on remaining non-null values.**



## **SELECT Statement - Aggregates**

---

- ◆ **COUNT(\*) counts all rows of a table, regardless of whether nulls or duplicate values occur.**
- ◆ **Can use DISTINCT before column name to eliminate duplicates.**
- ◆ **DISTINCT has no effect with MIN/MAX, but may have with SUM/AVG.**

## **SELECT Statement - Aggregates**

---

- ◆ **Aggregate functions can be used only in SELECT list and in HAVING clause.**
- ◆ **If SELECT list includes an aggregate function and there is no GROUP BY clause, SELECT list cannot reference a column out with an aggregate function. For example, the following is illegal:**

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

## Example 5.13 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 5.14 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-04'  
AND '31-May-04';
```

myCount
2

## Example 5.15 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 5.16 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

## 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*, and **SELECT** clause may only contain:
  - column names
  - aggregate functions
  - constants
  - expression involving combinations of the above.

## **SELECT Statement - Grouping**

---

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



## Example 5.17 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 5.17 Use of GROUP BY

---

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

## Restricted Groupings – HAVING clause

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- ◆ **HAVING clause is designed for use with GROUP BY to restrict groups that appear in final result table.**
- ◆ **Similar to WHERE, but WHERE filters individual rows whereas HAVING filters groups.**
- ◆ **Column names in HAVING clause must also appear in the GROUP BY list or be contained within an aggregate function.**

## **Example 5.18 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 5.18 Use of HAVING

---

branchNo	myCount	mySum
B003	3	54000.00
B005	2	39000.00

## Subqueries

---

- ◆ Some SQL statements can have a **SELECT** embedded within them.
- ◆ A subselect can be used in **WHERE** and **HAVING** clauses of an outer **SELECT**, where it is called a *subquery* or *nested query*.
- ◆ Subselects may also appear in **INSERT**, **UPDATE**, and **DELETE** statements.

## Example 5.19 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 5.19 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 5.19 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 5.20 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 5.20 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 5.20 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 a subquery (although it may be used in outermost **SELECT**).
- ◆ Subquery **SELECT** list must consist of a 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 a table in **FROM** using an *alias*.

## Subquery Rules

---

- ◆ **When subquery is an operand in a comparison, subquery must appear on right-hand side.**
- ◆ **A subquery may not be used as an operand in an expression.**

## **Example 5.21 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’));
```

## Example 5.21 Nested subquery: use of IN

**Table 5.21** Result table for Example 5.21.

propertyNo	street	city	postcode	type	rooms	rent
PG16	5 Novar Dr	Glasgow	G12 9AX	Flat	4	450
PG36	2 Manor Rd	Glasgow	G32 4QX	Flat	3	375
PG21	18 Dale Rd	Glasgow	G12	House	5	600



## ANY and ALL

---

- ◆ ANY and ALL may be used with subqueries that produce a single column of numbers.
- ◆ With ALL, condition will only be true if it is satisfied by *all* values produced by subquery.
- ◆ With ANY, condition will be true if it is satisfied by *any* values produced by subquery.
- ◆ If subquery is empty, ALL returns true, ANY returns false.
- ◆ SOME may be used in place of ANY.

## Example 5.22 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 5.22 Use of ANY/SOME

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

**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 5.23 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 5.23 Use of ALL

---

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

staffNo	fName	lName	position	salary
SL21	John	White	Manager	30000.00

## Multi-Table Queries

---

- ◆ Can use subqueries provided result columns come from same table.
- ◆ If result columns come from more than one table must use a join.
- ◆ To perform join, include more than one table in FROM clause.
- ◆ Use comma as separator and typically include WHERE clause to specify join column(s).

## Multi-Table Queries

---

- ◆ Also possible to use an alias for a table named in **FROM** clause.
- ◆ Alias is separated from table name with a space.
- ◆ Alias can be used to qualify column names when there is ambiguity.

## Example 5.24 Simple Join

---

List names of all clients who have viewed a property along with any comment supplied.

```
SELECT c.clientNo, fName, lName,  
        propertyNo, comment  
FROM Client c, Viewing v  
WHERE c.clientNo = v.clientNo;
```



## Example 5.24 Simple Join

- ◆ Only those rows from both tables that have identical values in the clientNo columns ( $c.clientNo = v.clientNo$ ) are included in result.
- ◆ Equivalent to equi-join in relational algebra.

**Table 5.24** Result table for Example 5.24.

clientNo	fName	lName	propertyNo	comment
CR56	Aline	Stewart	PG36	
CR56	Aline	Stewart	PA14	too small
CR56	Aline	Stewart	PG4	
CR62	Mary	Tregear	PA14	no dining room
CR76	John	Kay	PG4	too remote

## Alternative JOIN Constructs

---

- ◆ SQL provides alternative ways to specify joins:

**FROM Client c JOIN Viewing v ON c.clientNo = v.clientNo**

**FROM Client JOIN Viewing USING clientNo**

**FROM Client NATURAL JOIN Viewing**

- ◆ In each case, **FROM** replaces original **FROM** and **WHERE**. However, first produces table with two identical **clientNo** columns.

## Example 5.25 Sorting a join

---

For each branch, list numbers and names of staff who manage properties, and properties they manage.

```
SELECT s.branchNo, s.staffNo, fName, lName,  
       propertyNo  
FROM Staff s, PropertyForRent p  
WHERE s.staffNo = p.staffNo  
ORDER BY s.branchNo, s.staffNo, propertyNo;
```

## Example 5.25 Sorting a join

**Table 5.25** Result table for Example 5.25.

branchNo	staffNo	fName	lName	propertyNo
B003	SG14	David	Ford	PG16
B003	SG37	Ann	Beech	PG21
B003	SG37	Ann	Beech	PG36
B005	SL41	Julie	Lee	PL94
B007	SA9	Mary	Howe	PA14

## Example 5.26 Three Table Join

---

For each branch, list staff who manage properties, including city in which branch is located and properties they manage.

```
SELECT b.branchNo, b.city, s.staffNo, fName, lName,  
       propertyNo  
FROM Branch b, Staff s, PropertyForRent p  
WHERE b.branchNo = s.branchNo AND  
       s.staffNo = p.staffNo  
ORDER BY b.branchNo, s.staffNo, propertyNo;
```

## Example 5.26 Three Table Join

**Table 5.26** Result table for Example 5.26.

branchNo	city	staffNo	fName	lName	propertyNo
B003	Glasgow	SG14	David	Ford	PG16
B003	Glasgow	SG37	Ann	Beech	PG21
B003	Glasgow	SG37	Ann	Beech	PG36
B005	London	SL41	Julie	Lee	PL94
B007	Aberdeen	SA9	Mary	Howe	PA14

◆ **Alternative formulation for FROM and WHERE:**

**FROM (Branch b JOIN Staff s USING branchNo) AS  
bs JOIN PropertyForRent p USING staffNo**

## Example 5.27 Multiple Grouping Columns

---

Find number of properties handled by each staff member.

```
SELECT s.branchNo, s.staffNo, COUNT(*) AS myCount
FROM Staff s, PropertyForRent p
WHERE s.staffNo = p.staffNo
GROUP BY s.branchNo, s.staffNo
ORDER BY s.branchNo, s.staffNo;
```

## Example 5.27 Multiple Grouping Columns

---

branchNo	staffNo	myCount
B003	SG14	1
B003	SG37	2
B005	SL41	1
B007	SA9	1



## Computing a Join

---

Procedure for generating results of a join are:

1. Form Cartesian product of the tables named in **FROM** clause.
2. If there is a **WHERE** clause, apply the search condition to each row of the product table, retaining those rows that satisfy the condition.
3. For each remaining row, determine value of each item in **SELECT** list to produce a single row in result table.

## Computing a Join

---

4. If **DISTINCT** has been specified, eliminate any duplicate rows from the result table.
  5. If there is an **ORDER BY** clause, sort result table as required.
- ◆ **SQL provides special format of SELECT for Cartesian product:**

```
SELECT [DISTINCT | ALL] { * | columnList }  
FROM Table1 CROSS JOIN Table2
```

## Outer Joins

- ◆ If one row of a joined table is unmatched, row is omitted from result table.
- ◆ Outer join operations retain rows that do not satisfy the join condition.
- ◆ Consider following tables:

Branch1		PropertyForRent1	
branchNo	bCity	propertyNo	pCity
B003	Glasgow	PA14	Aberdeen
B004	Bristol	PL94	London
B002	London	PG4	Glasgow

## Outer Joins

- ◆ The (inner) join of these two tables:

```
SELECT b.*, p.*
```

```
FROM Branch1 b, PropertyForRent1 p
```

```
WHERE b.bCity = p.pCity;
```

**Table 5.27(b)** Result table for inner join of Branch1 and PropertyForRent1 tables.

branchNo	bCity	propertyNo	pCity
B003	Glasgow	PG4	Glasgow
B002	London	PL94	London

## Outer Joins

---

- ◆ **Result table has two rows where cities are same.**
- ◆ **There are no rows corresponding to branches in Bristol and Aberdeen.**
- ◆ **To include unmatched rows in result table, use an Outer join.**

## Example 5.28 Left Outer Join

---

List branches and properties that are in same city along with any unmatched branches.

```
SELECT b.*, p.*  
FROM Branch1 b LEFT JOIN  
PropertyForRent1 p ON b.bCity = p.pCity;
```

## Example 5.28 Left Outer Join

- ◆ Includes those rows of first (left) table unmatched with rows from second (right) table.
- ◆ Columns from second table are filled with NULLs.

**Table 5.28** Result table for Example 5.28.

branchNo	bCity	propertyNo	pCity
B003	Glasgow	PG4	Glasgow
B004	Bristol	NULL	NULL
B002	London	PL94	London

## Example 5.29 Right Outer Join

---

List branches and properties in same city and any unmatched properties.

```
SELECT b.*, p.*  
FROM Branch1 b RIGHT JOIN  
PropertyForRent1 p ON b.bCity = p.pCity;
```



## Example 5.29 Right Outer Join

- ◆ Right Outer join includes those rows of second (right) table that are unmatched with rows from first (left) table.
- ◆ Columns from first table are filled with NULLs.

**Table 5.29** Result table for Example 5.29.

branchNo	bCity	propertyNo	pCity
NULL	NULL	PA14	Aberdeen
B003	Glasgow	PG4	Glasgow
B002	London	PL94	London

## Example 5.30 Full Outer Join

---

List branches and properties in same city and any unmatched branches or properties.

```
SELECT b.*, p.*  
FROM Branch1 b FULL JOIN  
PropertyForRent1 p ON b.bCity = p.pCity;
```

## Example 5.30 Full Outer Join

- ◆ Includes rows that are unmatched in both tables.
- ◆ Unmatched columns are filled with NULLs.

**Table 5.30** Result table for Example 5.30.

branchNo	bCity	propertyNo	pCity
NULL	NULL	PA14	Aberdeen
B003	Glasgow	PG4	Glasgow
B004	Bristol	NULL	NULL
B002	London	PL94	London

## Union, Intersect, and Difference (Except)

---

- ◆ Can use normal set operations of Union, Intersection, and Difference to combine results of two or more queries into a single result table.
- ◆ Union of two tables, A and B, is table containing all rows in either A or B or both.
- ◆ Intersection is table containing all rows common to both A and B.
- ◆ Difference is table containing all rows in A but not in B.
- ◆ Two tables must be *union compatible*.

## Union, Intersect, and Difference (Except)

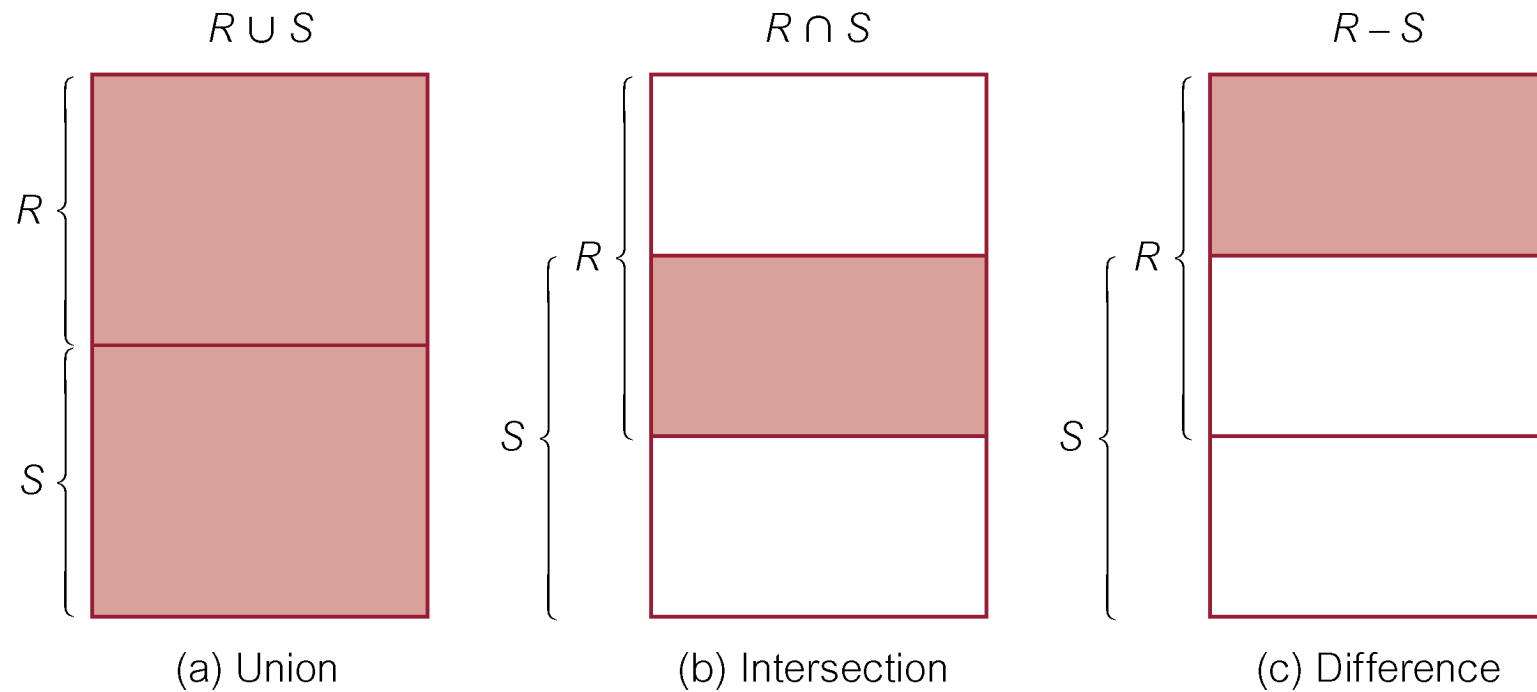
---

- ◆ Format of set operator clause in each case is:

*op* [ALL] [CORRESPONDING [BY {column1 [, ...]}]]

- ◆ If **CORRESPONDING BY** specified, set operation performed on the named column(s).
- ◆ If **CORRESPONDING** specified but not **BY** clause, operation performed on common columns.
- ◆ If **ALL** specified, result can include duplicate rows.

# Union, Intersect, and Difference (Except)



## **Example 5.32 Use of UNION**

---

**List all cities where there is either a branch office or a property.**

```
(SELECT city  
FROM Branch  
WHERE city IS NOT NULL) UNION  
(SELECT city  
FROM PropertyForRent  
WHERE city IS NOT NULL);
```

## Example 5.32 Use of UNION

---

◆ Or

```
(SELECT *  
FROM Branch  
WHERE city IS NOT NULL)  
UNION CORRESPONDING BY city  
(SELECT *  
FROM PropertyForRent  
WHERE city IS NOT NULL);
```



## Example 5.32 Use of UNION

- ◆ Produces result tables from both queries and merges both tables together.

**Table 5.32** Result table for Example 5.32.

city
London
Glasgow
Aberdeen
Bristol

## **Example 5.33 Use of INTERSECT**

---

**List all cities where there is both a branch office and a property.**

**(SELECT city FROM Branch)**

**INTERSECT**

**(SELECT city FROM PropertyForRent);**

## Example 5.33 Use of INTERSECT

◆ Or

```
(SELECT * FROM Branch)  
INTERSECT CORRESPONDING BY city  
(SELECT * FROM PropertyForRent);
```

**Table 5.33** Result table for Example 5.33.

city
Aberdeen
Glasgow
London

## Example 5.33 Use of INTERSECT

---

- ◆ Could rewrite this query without INTERSECT operator:

```
SELECT b.city
FROM Branch b PropertyForRent p
WHERE b.city = p.city;
```

## Example 5.34 Use of EXCEPT

List of all cities where there is a branch office but no properties.

```
(SELECT city FROM Branch)
```

```
EXCEPT
```

```
(SELECT city FROM PropertyForRent);
```

◆ Or

```
(SELECT * FROM Branch)
```

```
EXCEPT CORRESPONDING BY city
```

```
(SELECT * FROM PropertyForRent);
```

Table 5.34 Result table for Example 5.34.

city
Bristol

## Example 5.34 Use of EXCEPT

---

- ◆ Could rewrite this query without EXCEPT:

```
SELECT DISTINCT city FROM Branch  
WHERE city NOT IN  
(SELECT city FROM PropertyForRent);
```

# INSERT

---

```
INSERT INTO TableName [ (columnList) ]  
VALUES (dataValueList)
```

- ◆ *columnList* is optional; if omitted, SQL assumes a list of all columns in their original CREATE TABLE order.
- ◆ Any columns omitted must have been declared as NULL when table was created, unless DEFAULT was specified when creating column.

# INSERT

---

- ◆ *dataValueList* must match *columnList* as follows:
  - number of items in each list must be same;
  - must be direct correspondence in position of items in two lists;
  - data type of each item in *dataValueList* must be compatible with data type of corresponding column.



## **Example 5.35 INSERT ... VALUES**

---

**Insert a new row into Staff table supplying data for all columns.**

```
INSERT INTO Staff
```

```
VALUES ('SG16', 'Alan', 'Brown', 'Assistant',  
        'M', '1957-05-25', 8300, 'B003');
```

## Example 5.36 INSERT using Defaults

---

Insert a new row into Staff table supplying data for all mandatory columns.

```
INSERT INTO Staff (staffNo, fName, lName,  
                  position, salary, branchNo)  
VALUES ('SG44', 'Anne', 'Jones',  
        'Assistant', 8100, 'B003');
```

◆ Or

```
INSERT INTO Staff  
VALUES ('SG44', 'Anne', 'Jones', 'Assistant', NULL,  
        NULL, 8100, 'B003');
```

## INSERT ... SELECT

---

- ◆ Second form of INSERT allows multiple rows to be copied from one or more tables to another:

```
INSERT INTO TableName [ (columnList) ]  
SELECT ...
```

## **Example 5.37 INSERT ... SELECT**

---

**Assume there is a table StaffPropCount that contains names of staff and number of properties they manage:**

**StaffPropCount(staffNo, fName, lName, propCnt)**

**Populate StaffPropCount using Staff and PropertyForRent tables.**

## Example 5.37 INSERT ... SELECT

---

```
INSERT INTO StaffPropCount
  (SELECT s.staffNo, fName, lName, COUNT(*))
FROM Staff s, PropertyForRent p
WHERE s.staffNo = p.staffNo
GROUP BY s.staffNo, fName, lName)
UNION
(SELECT staffNo, fName, lName, 0
FROM Staff
WHERE staffNo NOT IN
  (SELECT DISTINCT staffNo
  FROM PropertyForRent));
```

## Example 5.37 INSERT ... SELECT

**Table 5.35** Result table for Example 5.37.

staffNo	fName	lName	propCount
SG14	David	Ford	1
SL21	John	White	0
SG37	Ann	Beech	2
SA9	Mary	Howe	1
SG5	Susan	Brand	0
SL41	Julie	Lee	1

- ◆ If second part of UNION is omitted, excludes those staff who currently do not manage any properties.

# UPDATE

---

**UPDATE TableName**

**SET columnName1 = dataValue1**

**[, columnName2 = dataValue2...]**

**[WHERE searchCondition]**

- ◆ *TableName* can be name of a base table or an updatable view.
- ◆ SET clause specifies names of one or more columns that are to be updated.

# UPDATE

---

- ◆ **WHERE clause is optional:**
  - if omitted, named columns are updated for all rows in table;
  - if specified, only those rows that satisfy *searchCondition* are updated.
- ◆ **New *dataValue(s)* must be compatible with data type for corresponding column.**



## **Example 5.38/39 UPDATE All Rows**

---

**Give all staff a 3% pay increase.**

```
UPDATE Staff  
SET salary = salary*1.03;
```

**Give all Managers a 5% pay increase.**

```
UPDATE Staff  
SET salary = salary*1.05  
WHERE position = 'Manager';
```

## **Example 5.40 UPDATE Multiple Columns**

---

**Promote David Ford (staffNo='SG14') to Manager and change his salary to £18,000.**

**UPDATE Staff**

**SET position = 'Manager', salary = 18000**

**WHERE staffNo = 'SG14';**

# DELETE

---

**DELETE FROM TableName**  
**[WHERE searchCondition]**

- ◆ *TableName* can be name of a base table or an updatable view.
- ◆ *searchCondition* is optional; if omitted, all rows are deleted from table. This does not delete table. If *search\_condition* is specified, only those rows that satisfy condition are deleted.

## **Example 5.41/42 DELETE Specific Rows**

---

**Delete all viewings that relate to property PG4.**

```
DELETE FROM Viewing  
WHERE propertyNo = 'PG4';
```

**Delete all records from the Viewing table.**

```
DELETE FROM Viewing;
```