PostgreSQL Database:
SQL Fundamentals I

Electronic Presentation

Introduction

Lesson Objectives

After completing this lesson, you should be able to do the following:
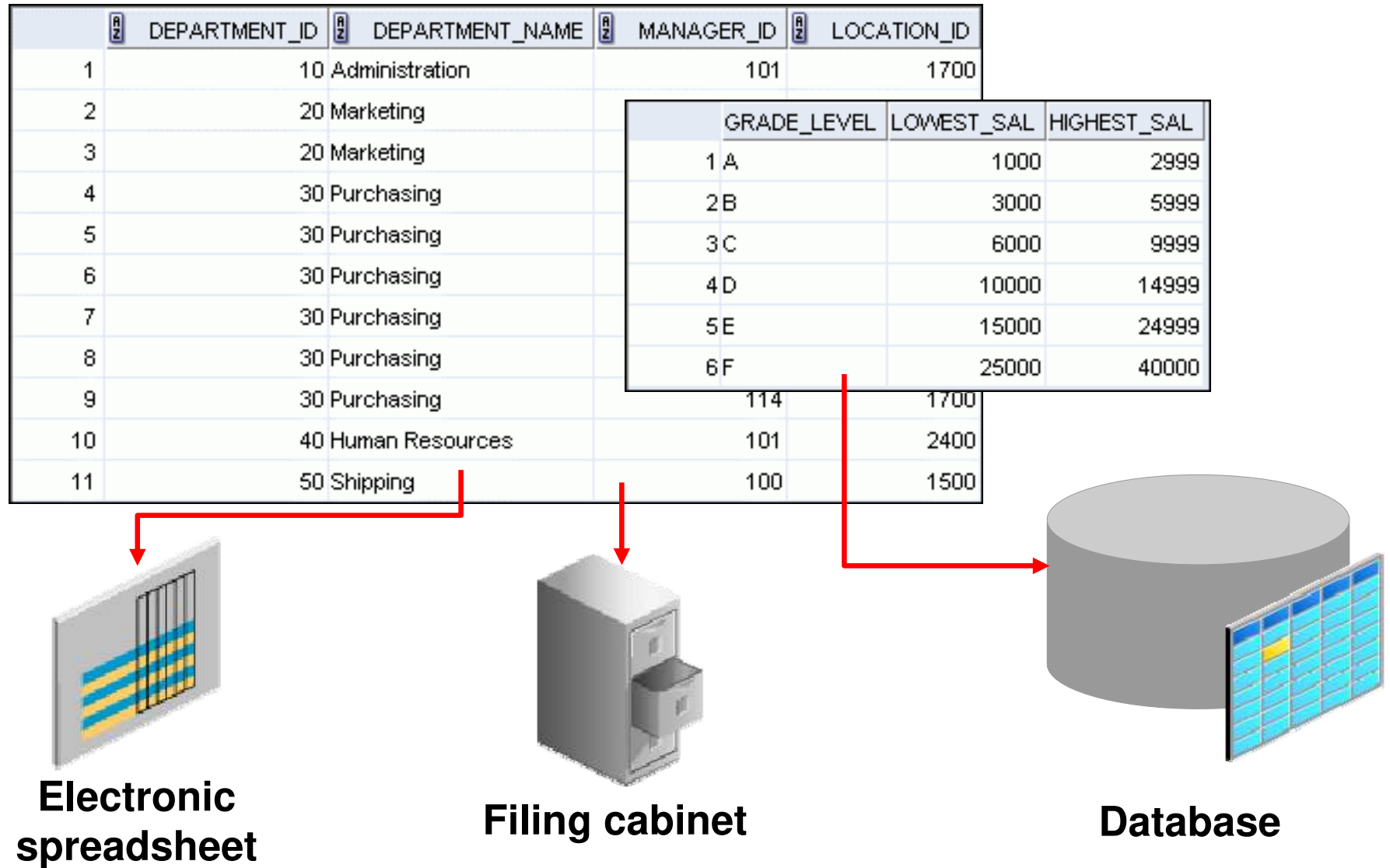
- Understand the goals of the course

- List the features of PosgreSQL Database

- Discuss the theoretical and physical aspects of a relational database

- Describe PostgreSQL server's implementation of RDBMS and object relational database management system

- Identify the development environments that can be used for this course

- Describe the database and schema used in this course

Relational and Object Relational Database Management Systems

- Relational model and object relational model
- User-defined data types and objects
- Fully compatible with relational database
- Supports multimedia and large objects
- High-quality database server features

Data Storage on Different Media

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	101	1700
2	20	Marketing		
3	20	Marketing		
4	30	Purchasing		
5	30	Purchasing		
6	30	Purchasing		
7	30	Purchasing		
8	30	Purchasing		
9	30	Purchasing	114	1700
10	40	Human Resources	101	2400
11	50	Shipping	100	1500

	GRADE_LEVEL	LOWEST_SAL	HIGHEST_SAL
1	A	1000	2999
2	B	3000	5999
3	C	6000	9999
4	D	10000	14999
5	E	15000	24999
6	F	25000	40000

Electronic spreadsheet
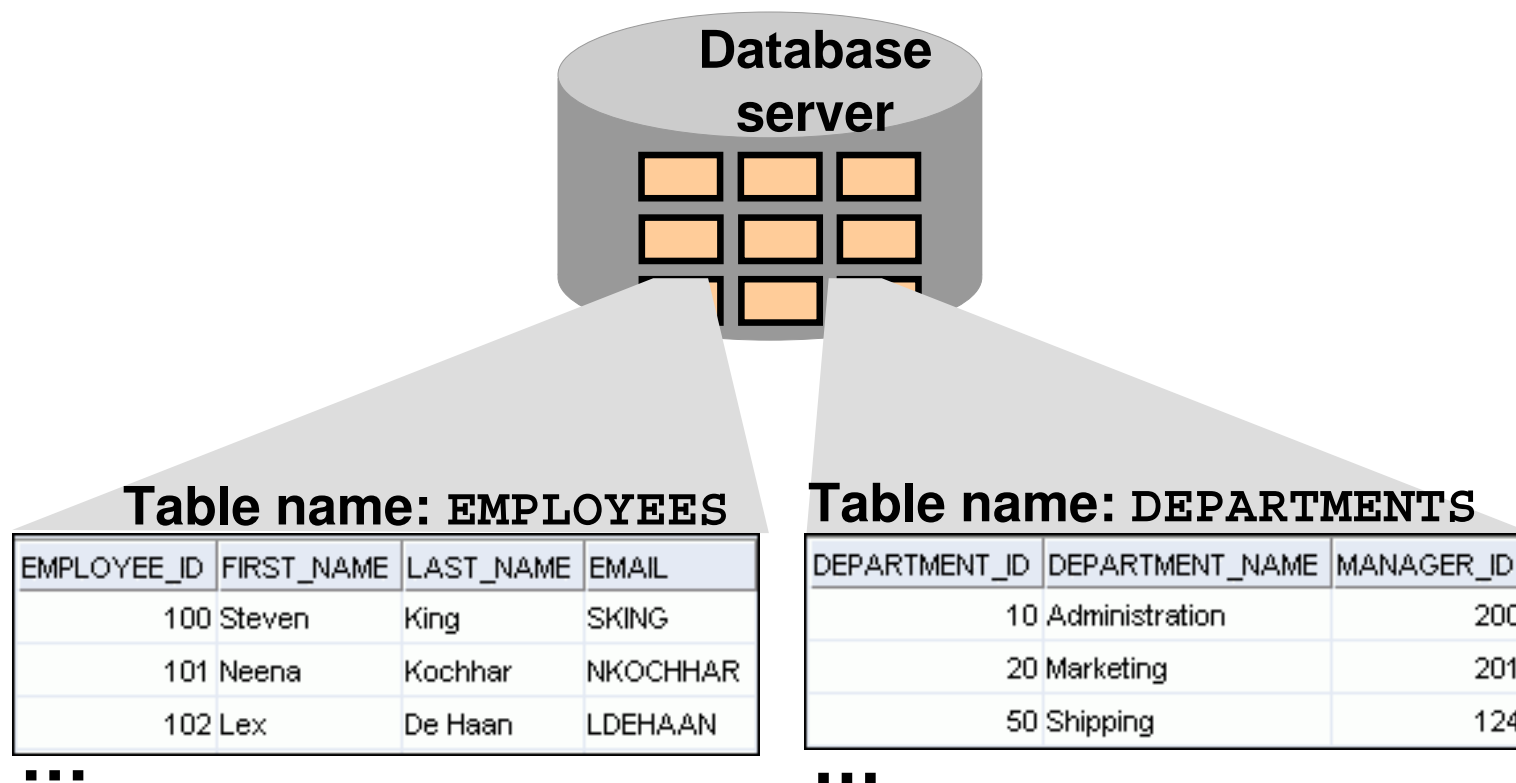
Filing cabinet

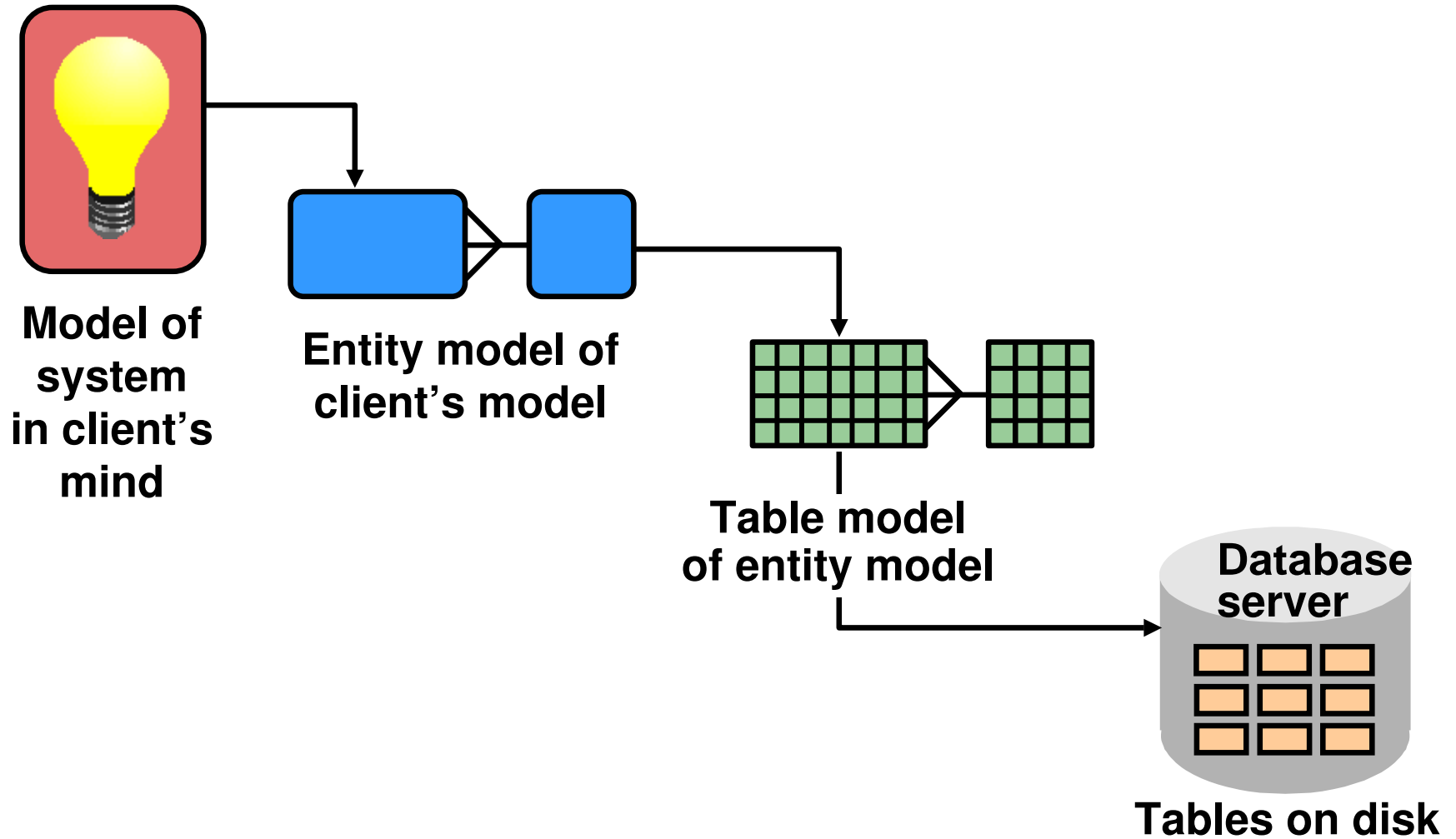**Database**

Relational Database Concept

- Dr. E. F. Codd proposed the relational model for database systems in 1970.

- It is the basis for the relational database management system (RDBMS).

- The relational model consists of the following:

  - Collection of objects or relations
  - Set of operators to act on the relations
  - Data integrity for accuracy and consistency

Definition of a Relational Database

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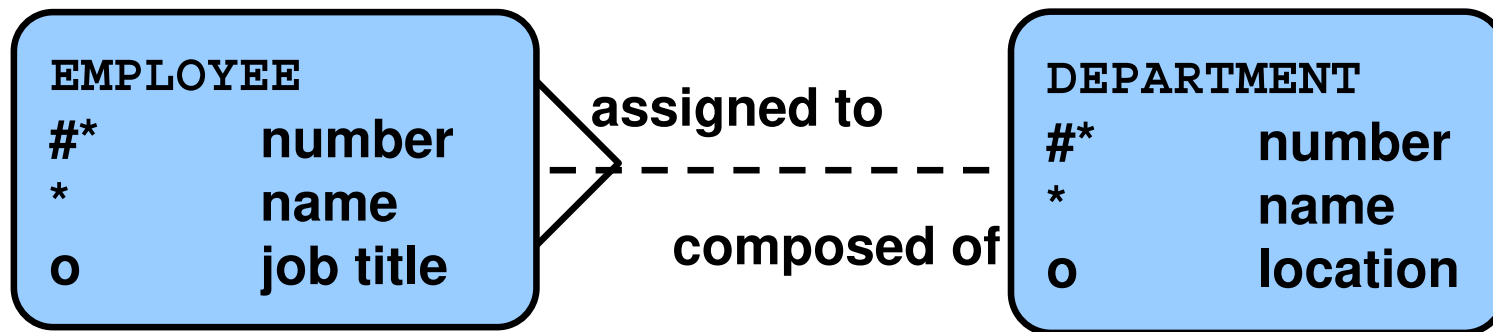

Database server

Table name: EMPLOYEES

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	EMAIL
100	Steven	King	SKING
101	Neena	Kochhar	NKOCHHAR
102	Lex	De Haan	LDEHAAN

...

Table name: DEPARTMENTS

DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID
10	Administration	200
20	Marketing	201
50	Shipping	124

...

Data Models

Model of system in client's mind → Entity model of client's model → Table model of entity model → Database server — Tables on disk

Entity Relationship Model

- Create an entity relationship diagram from business specifications or narratives:

EMPLOYEE		DEPARTMENT	
#*	number	#*	number
*	name	*	name
o	job title	o	location

assigned to / *composed of*

- Scenario:
  - ". . . Assign one or more employees to a department . . ."
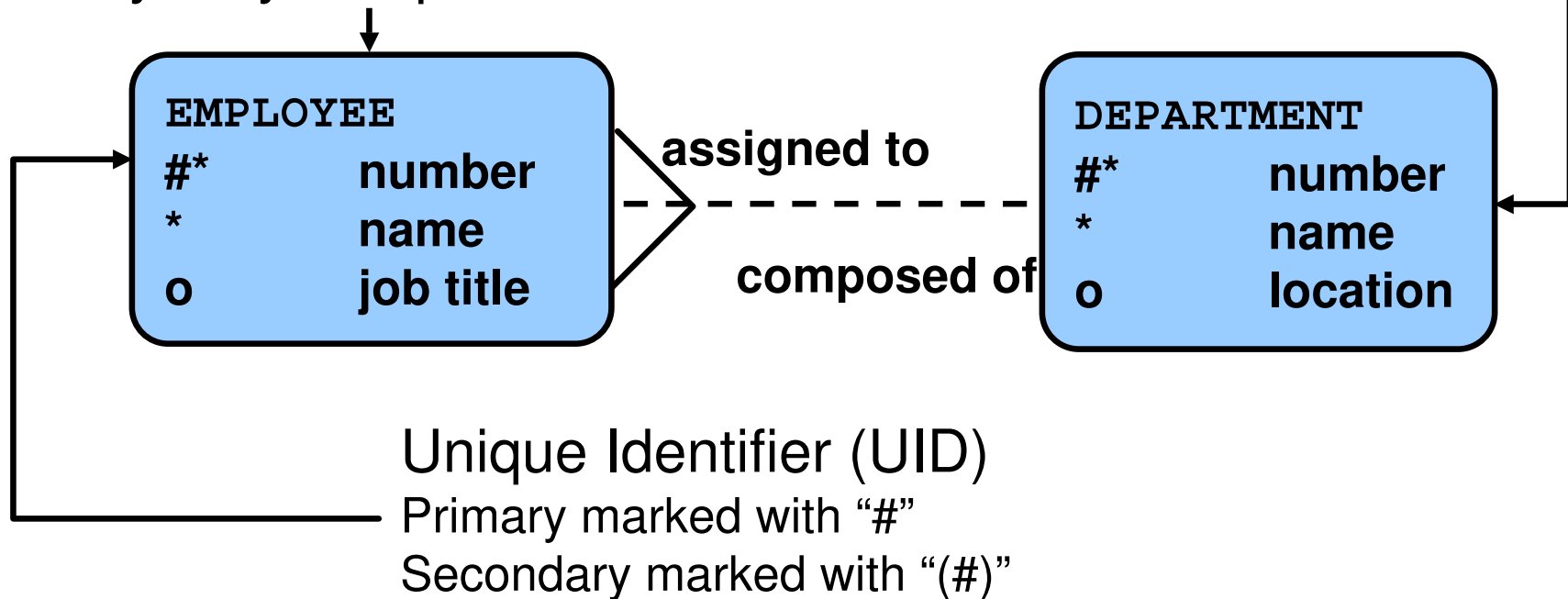 - ". . . Some departments do not yet have assigned employees . . ."

Entity Relationship Modeling Conventions

Entity:

- Singular, unique name
- Uppercase
- Soft box
- Synonym in parentheses

Attribute:

- Singular name
- Lowercase
- Mandatory marked with "*"
- Optional marked with "o"

EMPLOYEE
#*   number
*   name
o   job title

assigned to

composed of

DEPARTMENT
#*   number
*   name
o   location

Unique Identifier (UID)
Primary marked with "#"
Secondary marked with "(#)"

Relating Multiple Tables

- Each row of data in a table is uniquely identified by a primary key.

- You can logically relate data from multiple tables using foreign keys.

Table name: DEPARTMENTS

DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
10	Administration	200	1700
20	Marketing	201	1800
50	Shipping	124	1500
60	IT	103	1400
80	Sales	149	2500
90	Executive	100	1700
110	Accounting	205	1700
190	Contracting	(null)	1700

Table name: EMPLOYEES

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	DEPARTMENT_ID
100	Steven	King	90
101	Neena	Kochhar	90
102	Lex	De Haan	90
103	Alexander	Hunold	60
104	Bruce	Ernst	60
107	Diana	Lorentz	60

…

Primary key   **Foreign key**   **Primary key**

Relational Database Terminology

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	SALARY	COMMISSION_PCT	DEPARTMENT_ID
100	Steven	King	24000	(null)	90
101	Neena	Kochhar	17000	(null)	90
102	Lex	De Haan	17000	(null)	90
103	Alexander	Hunold	9000	(null)	60
104	Bruce	Ernst	6000	(null)	60
107	Diana	Lorentz	4200	(null)	60
124	Kevin	Mourgos	5800	(null)	50
141	Trenna	Rajs	3500		50
142	Curtis	Davies	3100	(null)	50
143	Randall	Matos	2600	(null)	50
144	Peter	Vargas	2500	(null)	50
149	Eleni	Zlotkey	10500	0.2	80
174	Ellen	Abel	11000	0.3	80
176	Jonathon	Taylor	8600	0.2	80
178	Kimberely	Grant	7000	0.15	(null)
200	Jennifer	Whalen	4400	(null)	10
201	Michael	Hartstein	13000	(null)	20
202	Pat	Fay	6000	(null)	20
205	Shelley	Higgins	12000	(null)	110
206	William	Gietz	8300	(null)	110

Using SQL to Query Your Database

Structured query language (SQL) is:

- The ANSI standard language for operating relational databases
- Efficient, easy to learn, and use
- Functionally complete (With SQL, you can define, retrieve, and manipulate data in the tables.)

```
SELECT department_name
FROM   departments;
```

DEPARTMENT_NAME
Administration
Marketing
Shipping
IT
Sales
Executive
Accounting
Contracting

Database server
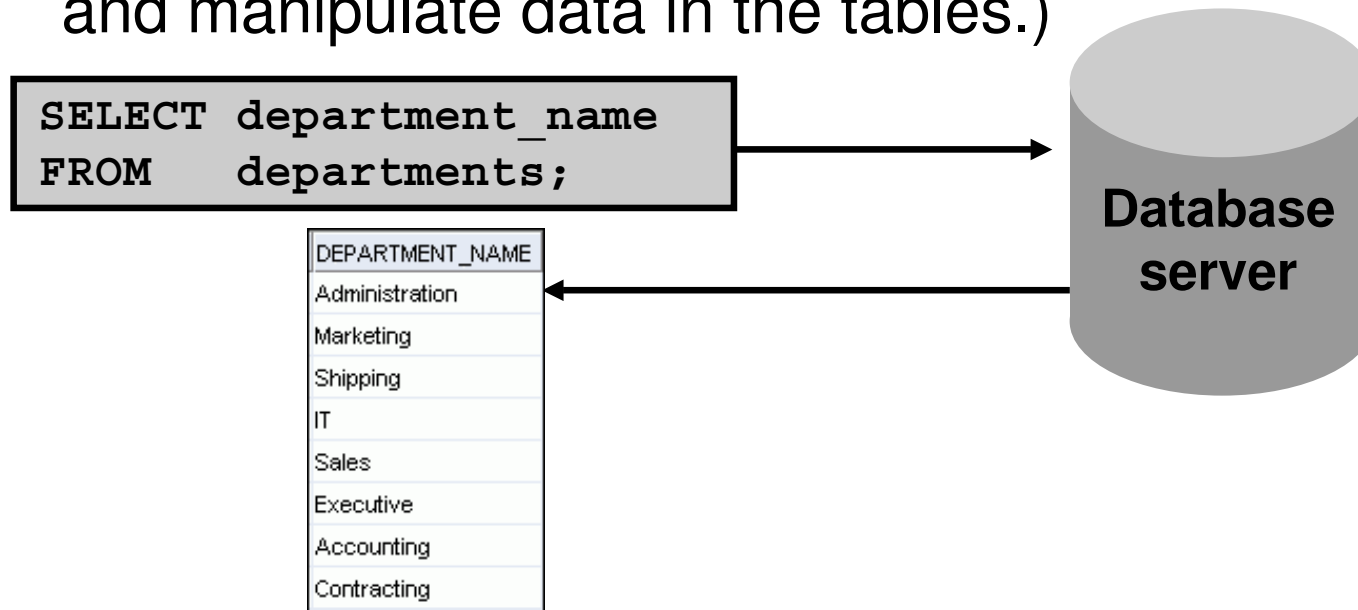
SQL Statements

SELECT INSERT UPDATE DELETE MERGE	Data manipulation language (DML)
CREATE ALTER DROP RENAME TRUNCATE COMMENT	Data definition language (DDL)
GRANT REVOKE	Data control language (DCL)
COMMIT ROLLBACK SAVEPOINT	Transaction control

The `Human Resources (HR)` Schema

DEPARTMENTS
department_id
department_name
manager_id
location_id

LOCATIONS
location_id
street_address
postal_code
city
state_province
country_id

JOB_HISTORY
employee_id
start_date
end_date
job_id
department_id

EMPLOYEES
employee_id
first_name
last_name
email
phone_number
hire_date
job_id
salary
commission_pct
manager_id
department_id

COUNTRIES
country_id
country_name
region_id

JOBS
job_id
job_title
min_salary
max_salary

REGIONS
region_id
region_name

Tables Used in the Course

EMPLOYEES

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	SALARY	COMMISSION_PCT	DEPARTMENT_ID	EMAIL	PHONE_NUMBER	HIRE_DATE
100	Steven	King	24000	(null)	90	SKING	515.123.4567	17-JUN-87
101	Neena	Kochhar	17000	(null)	90	NKOCHHAR	515.123.4568	21-SEP-89
102	Lex	De Haan	17000	(null)	90	LDEHAAN	515.123.4569	13-JAN-93
103	Alexander	Hunold	9000	(null)	60	AHUNOLD	590.423.4567	03-JAN-90
104	Bruce	Ernst	6000	(null)	60	BERNST	590.423.4568	21-MAY-91
107	Diana	Lorentz	4200	(null)	60	DLORENTZ	590.423.5567	07-FEB-99
124	Kevin	Mourgos	5800	(null)	50	KMOURGOS	650.123.5234	16-NOV-99
141	Trenna	Rajs	3500	(null)	50	TRAJS	650.121.8009	17-OCT-95
142	Curtis	Davies	3100	(null)	50	CDAVIES	650.121.2994	29-JAN-97
					50	RMATOS	650.121.2874	15-MAR-98

DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
10	Administration	200	1700
20	Marketing	201	1800
50	Shipping	124	1500
60	IT	103	1400
80	Sales	149	2500
90	Executive	100	1700
110	Accounting	205	1700
190	Contracting	(null)	1700

DEPARTMENTS

GRADE_LEVEL	LOWEST_SAL	HIGHEST_SAL
A	1000	2999
B	3000	5999
C	6000	9999
D	10000	14999
E	15000	24999
F	25000	40000

JOB_GRADES

Retrieving Data Using the SQL `SELECT` Statement

Objectives

After completing this lesson, you should be able to do the following:

- List the capabilities of SQL `SELECT` statements
- Execute a basic `SELECT` statement

Capabilities of SQL SELECT Statements

Projection

Selection

Table 1

Table 1

Join

Table 1

Table 2

Basic `SELECT` Statement

```
SELECT *|{[DISTINCT] column|expression [alias],...}
FROM     table;
```

- `SELECT` identifies the columns to be displayed.
- `FROM` identifies the table containing those columns.

Selecting All Columns

```
SELECT *
FROM    departments;
```

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	200	1700
2	20	Marketing	201	1800
3	50	Shipping	124	1500
4	60	IT	103	1400
5	80	Sales	149	2500
6	90	Executive	100	1700
7	110	Accounting	205	1700
8	190	Contracting	(null)	1700

Selecting Specific Columns

```
SELECT department_id, location_id
FROM    departments;
```

	DEPARTMENT_ID	LOCATION_ID
1	10	1700
2	20	1800
3	50	1500
4	60	1400
5	80	2500
6	90	1700
7	110	1700
8	190	1700

Writing SQL Statements

- SQL statements are not case-sensitive.

- SQL statements can be entered on one or more lines.

- Keywords cannot be abbreviated or split across lines.

- Clauses are usually placed on separate lines.

- Indents are used to enhance readability.

- In psql, SQL statements can optionally be terminated by a semicolon (;). Semicolons are required when you execute multiple SQL statements.

- In psql, you are required to end each SQL statement with a semicolon (;).

Arithmetic Expressions

Create expressions with number and date data by using arithmetic operators.

Operator	Description
+	Add
-	Subtract
*	Multiply
/	Divide

Using Arithmetic Operators

```
SELECT last_name, salary, salary + 300
FROM    employees;
```

	LAST_NAME	SALARY	SALARY+300
1	King	24000	24300
2	Kochhar	17000	17300
3	De Haan	17000	17300
4	Hunold	9000	9300
5	Ernst	6000	6300
6	Lorentz	4200	4500
7	Mourgos	5800	6100
8	Rajs	3500	3800
9	Davies	3100	3400
10	Matos	2600	2900

...

Operator Precedence

```
SELECT last_name, salary, 12*salary+100
FROM    employees;
```
1

	LAST_NAME	SALARY	12*SALARY+100
1	King	24000	288100
2	Kochhar	17000	204100
3	De Haan	17000	204100

...

```
SELECT last_name, salary, 12*(salary+100)
FROM    employees;
```
2

	LAST_NAME	SALARY	12*(SALARY+100)
1	King	24000	289200
2	Kochhar	17000	205200
3	De Haan	17000	205200

...

Defining a Null Value

- Null is a value that is unavailable, unassigned, unknown, or inapplicable.

- Null is not the same as zero or a blank space.

```
SELECT last_name, job_id, salary, commission_pct
FROM    employees;
```

	LAST_NAME	JOB_ID	SALARY	COMMISSION_PCT
1	King	AD_PRES	24000	(null)
2	Kochhar	AD_VP	17000	(null)

...

	LAST_NAME	JOB_ID	SALARY	COMMISSION_PCT
12	Zlotkey	SA_MAN	10500	0.2
13	Abel	SA_REP	11000	0.3
14	Taylor	SA_REP	8600	0.2

...

	LAST_NAME	JOB_ID	SALARY	COMMISSION_PCT
19	Higgins	AC_MGR	12000	(null)
20	Gietz	AC_ACCOUNT	8300	(null)

Null Values in Arithmetic Expressions

Arithmetic expressions containing a null value evaluate to null.

```
SELECT last_name, 12*salary*commission_pct
FROM    employees;
```

	LAST_NAME	12*SALARY*COMMISSION_PCT
1	King	(null)
2	Kochhar	(null)

...

12	Zlotkey	25200
13	Abel	39600
14	Taylor	20640

...

19	Higgins	(null)
20	Gietz	(null)

Defining a Column Alias

A column alias:

- Renames a column heading

- Is useful with calculations

- Immediately follows the column name (There can also be the optional `AS` keyword between the column name and alias.)

- Requires double quotation marks if it contains spaces or special characters, or if it is case-sensitive

Using Column Aliases

```
SELECT last_name AS name, commission_pct comm
FROM    employees;
```

NAME	COMM
1 King	(null)
2 Kochhar	(null)
3 De Haan	(null)

...

```
SELECT last_name "Name" , salary*12 "Annual Salary"
FROM    employees;
```

Name	Annual Salary
1 King	288000
2 Kochhar	204000
3 De Haan	204000

...

Concatenation Operator

A concatenation operator:

- Links columns or character strings to other columns
- Is represented by two vertical bars (||)
- Creates a resultant column that is a character expression

```
SELECT    last_name||job_id AS "Employees"
FROM      employees;
```

	Employees
1	AbelSA_REP
2	DaviesST_CLERK
3	De HaanAD_VP
4	ErnstIT_PROG
5	FayMK_REP

...

Literal Character Strings

- A literal is a character, a number, or a date that is included in the `SELECT` statement.

- Date and character literal values must be enclosed within single quotation marks.

- Each character string is output once for each row returned.

Using Literal Character Strings

```
SELECT last_name ||' is a '||job_id
       AS "Employee Details"
FROM    employees;
```

A↓Z Employee Details
1 Abel is a SA_REP
2 Davies is a ST_CLERK
3 De Haan is a AD_VP
4 Ernst is a IT_PROG
5 Fay is a MK_REP

...

18	Vargas is a ST_CLERK
19	Whalen is a AD_ASST
20	Zlotkey is a SA_MAN

Duplicate Rows

The default display of queries is all rows, including duplicate rows.

```
SELECT department_id
FROM    employees;
```
1

	DEPARTMENT_ID
1	90
2	90
3	90
4	60
5	60

...

```
SELECT DISTINCT department_id
FROM    employees;
```
2

	DEPARTMENT_ID
1	(null)
2	90
3	20
... 4	110

Displaying the Table Structure

- Use the `\d` command to display the structure of a table.

- Or, select the table in the Connections tree and use the Columns tab to view the table structure.

Using the `\d` Command

```
\d employees
```

```
postgres=# \d employees
                                    Table "hr.employees"
     Column     |             Type             | Collation | Nullable |                    Default
----------------+------------------------------+-----------+----------+-----------------------------------------------
 employee_id    | integer                      |           | not null | nextval('employees_employee_id_seq'::regclass)
 first_name     | character varying(20)        |           |          |
 last_name      | character varying(25)        |           | not null |
 email          | character varying(25)        |           | not null |
 phone_number   | character varying(20)        |           |          |
 hire_date      | timestamp without time zone  |           | not null |
 job_id         | character varying(10)        |           | not null |
 salary         | numeric(8,2)                 |           |          |
 commission_pct | numeric(2,2)                 |           |          |
 manager_id     | integer                      |           |          |
 department_id  | integer                      |           |          |
Indexes:
    "employees_pkey" PRIMARY KEY, btree (employee_id)
    "emp_department_ix" btree (department_id)
    "emp_email_uk" UNIQUE CONSTRAINT, btree (email)
    "emp_job_ix" btree (job_id)
    "emp_manager_ix" btree (manager_id)
    "emp_name_ix" btree (last_name, first_name)
Check constraints:
    "emp_salary_min" CHECK (salary > 0::numeric)
Foreign-key constraints:
    "employees_department_id_fkey" FOREIGN KEY (department_id) REFERENCES departments(department_id)
    "employees_job_id_fkey" FOREIGN KEY (job_id) REFERENCES jobs(job_id)
    "employees_manager_id_fkey" FOREIGN KEY (manager_id) REFERENCES employees(employee_id)
Referenced by:
    TABLE "departments" CONSTRAINT "dept_mgr_fk" FOREIGN KEY (manager_id) REFERENCES employees(employee_id)
    TABLE "employees" CONSTRAINT "employees_manager_id_fkey" FOREIGN KEY (manager_id) REFERENCES employees(employee_id)
    TABLE "job_history" CONSTRAINT "job_history_employee_id_fkey" FOREIGN KEY (employee_id) REFERENCES employees(employee_id)
```

Quiz

Identify the `SELECT` statements that execute successfully.

1.
```
SELECT first_name, last_name, job_id, salary*12
 AS Yearly Sal
FROM    employees;
```

2.
```
SELECT first_name, last_name, job_id, salary*12
 yearly sal
FROM    employees;
```

3.
```
SELECT first_name, last_name, job_id, salary AS
 yearly sal
FROM    employees;
```

4.
```
SELECT first_name+last_name AS name, job_Id,
 salary*12 yearly sal
FROM    employees;
```

Summary

In this lesson, you should have learned how to:

- Write a `SELECT` statement that:
    - Returns all rows and columns from a table
    - Returns specified columns from a table
    - Uses column aliases to display more descriptive column headings

```
SELECT *|{[DISTINCT] column|expression [alias],...}
FROM table;
```

Practice 1: Overview

This practice covers the following topics:

- Selecting all data from different tables

- Describing the structure of tables

- Performing arithmetic calculations and specifying column names

Restricting and Sorting Data

Objectives

After completing this lesson, you should be able to do the following:

- Limit the rows that are retrieved by a query
- Sort the rows that are retrieved by a query
- Use ampersand substitution to restrict and sort output at run time

Limiting Rows Using a Selection

EMPLOYEES

	EMPLOYEE_ID	LAST_NAME	JOB_ID	DEPARTMENT_ID
1	100	King	AD_PRES	90
2	101	Kochhar	AD_VP	90
3	102	De Haan	AD_VP	90
4	103	Hunold	IT_PROG	60
5	104	Ernst	IT_PROG	60
6	107	Lorentz	IT_PROG	60

…

**"retrieve all
employees in
department 90"**

	EMPLOYEE_ID	LAST_NAME	JOB_ID	DEPARTMENT_ID
1	100	King	AD_PRES	90
2	101	Kochhar	AD_VP	90
3	102	De Haan	AD_VP	90

Limiting the Rows That Are Selected

- Restrict the rows that are returned by using the `WHERE` clause:

```
SELECT  *|{[DISTINCT] column|expression [alias],...}
FROM    table
[WHERE condition(s)];
```

- The `WHERE` clause follows the `FROM` clause.

Using the `WHERE` Clause

```
SELECT  employee_id, last_name, job_id, department_id
FROM    employees
WHERE   department_id = 90 ;
```

	EMPLOYEE_ID	LAST_NAME	JOB_ID	DEPARTMENT_ID
1	100	King	AD_PRES	90
2	101	Kochhar	AD_VP	90
3	102	De Haan	AD_VP	90

Character Strings and Dates

- Character strings and date values are enclosed with single quotation marks.

- Character values are case-sensitive and date values are format-sensitive.

- The default date display format is `DD-MON-RR`.

```
SELECT  last_name, job_id, department_id
FROM    employees
WHERE   last_name = 'Whalen' ;
```

```
SELECT  last_name
FROM    employees
WHERE   hire_date = '17-FEB-96' ;
```

Comparison Operators

Operator	Meaning
=	Equal to
>	Greater than
>=	Greater than or equal to
<	Less than
<=	Less than or equal to
<>	Not equal to
BETWEEN ...AND...	Between two values (inclusive)
IN(set)	Match any of a list of values
LIKE	Match a character pattern
IS NULL	Is a null value

Using Comparison Operators

```
SELECT  last_name, salary
FROM    employees
WHERE   salary <= 3000 ;
```

	LAST_NAME	SALARY
1	Matos	2600
2	Vargas	2500

Range Conditions Using the `BETWEEN` Operator

Use the `BETWEEN` operator to display rows based on a range of values:

```
SELECT  last_name, salary
FROM    employees
WHERE   salary BETWEEN 2500 AND 3500 ;
```

↑ Lower limit   ↑ Upper limit

	LAST_NAME		SALARY
1	Rajs		3500
2	Davies		3100
3	Matos		2600
4	Vargas		2500

Membership Condition Using the `IN` Operator

Use the `IN` operator to test for values in a list:

```
SELECT employee_id, last_name, salary, manager_id
FROM    employees
WHERE   manager_id IN (100, 101, 201) ;
```

	EMPLOYEE_ID	LAST_NAME	SALARY	MANAGER_ID
1	101	Kochhar	17000	100
2	102	De Haan	17000	100
3	124	Mourgos	5800	100
4	149	Zlotkey	10500	100
5	201	Hartstein	13000	100
6	200	Whalen	4400	101
7	205	Higgins	12000	101
8	202	Fay	6000	201

Pattern Matching Using the `LIKE` Operator

- Use the `LIKE` operator to perform wildcard searches of valid search string values.

- Search conditions can contain either literal characters or numbers:
  - `%` denotes zero or many characters.
  - `_` denotes one character.

```
SELECT    first_name
FROM      employees
WHERE     first_name LIKE 'S%' ;
```

Combining Wildcard Characters

- You can combine the two wildcard characters (%, _) with literal characters for pattern matching:

```
SELECT last_name
FROM   employees
WHERE  last_name LIKE '_o%' ;
```

	LAST_NAME
1	Kochhar
2	Lorentz
3	Mourgos

- You can use the ESCAPE identifier to search for the actual % and _ symbols.

Using the `NULL` Conditions

Test for nulls with the `IS NULL` operator.

```
SELECT  last_name, manager_id
FROM    employees
WHERE   manager_id IS NULL ;
```

	LAST_NAME	MANAGER_ID
1	King	(null)

Defining Conditions Using the Logical Operators

Operator	Meaning
AND	Returns TRUE if *both* component conditions are true
OR	Returns TRUE if *either* component condition is true
NOT	Returns TRUE if the condition is false

Using the AND Operator

AND requires both the component conditions to be true:

```
SELECT  employee_id, last_name, job_id, salary
FROM    employees
WHERE   salary >= 10000
AND     job_id LIKE '%MAN%' ;
```

	EMPLOYEE_ID	LAST_NAME	JOB_ID	SALARY
1	149	Zlotkey	SA_MAN	10500
2	201	Hartstein	MK_MAN	13000

Using the `OR` Operator

`OR` requires either component condition to be true:

```
SELECT employee_id, last_name, job_id, salary
FROM    employees
WHERE   salary >= 10000
OR      job_id LIKE '%MAN%' ;
```

	EMPLOYEE_ID	LAST_NAME	JOB_ID	SALARY
1	100	King	AD_PRES	24000
2	101	Kochhar	AD_VP	17000
3	102	De Haan	AD_VP	17000
4	124	Mourgos	ST_MAN	5800
5	149	Zlotkey	SA_MAN	10500
6	174	Abel	SA_REP	11000
7	201	Hartstein	MK_MAN	13000
8	205	Higgins	AC_MGR	12000

Using the NOT Operator

```
SELECT last_name, job_id
FROM    employees
WHERE   job_id
        NOT IN ('IT_PROG', 'ST_CLERK', 'SA_REP') ;
```

	LAST_NAME	JOB_ID
1	De Haan	AD_VP
2	Fay	MK_REP
3	Gietz	AC_ACCOUNT
4	Hartstein	MK_MAN
5	Higgins	AC_MGR
6	King	AD_PRES
7	Kochhar	AD_VP
8	Mourgos	ST_MAN
9	Whalen	AD_ASST
10	Zlotkey	SA_MAN

Rules of Precedence

Operator	Meaning
1	Arithmetic operators
2	Concatenation operator
3	Comparison conditions
4	IS [NOT] NULL, LIKE, [NOT] IN
5	[NOT] BETWEEN
6	Not equal to
7	NOT logical condition
8	AND logical condition
9	OR logical condition

You can use parentheses to override rules of precedence.

Rules of Precedence

```
SELECT  last_name, job_id, salary
FROM    employees
WHERE   job_id = 'SA_REP'
OR      job_id = 'AD_PRES'
AND     salary > 15000;
```
1

	LAST_NAME	JOB_ID	SALARY
1	King	AD_PRES	24000
2	Abel	SA_REP	11000
3	Taylor	SA_REP	8600
4	Grant	SA_REP	7000

```
SELECT  last_name, job_id, salary
FROM    employees
WHERE   (job_id = 'SA_REP'
OR      job_id = 'AD_PRES')
AND     salary > 15000;
```
2

	LAST_NAME	JOB_ID	SALARY
1	King	AD_PRES	24000

Using the ORDER BY Clause

- Sort retrieved rows with the ORDER BY clause:
    - ASC: Ascending order, default
    - DESC: Descending order
- The ORDER BY clause comes last in the SELECT statement:

```
SELECT     last_name, job_id, department_id, hire_date
FROM       employees
ORDER BY hire_date ;
```

	LAST_NAME	JOB_ID	DEPARTMENT_ID	HIRE_DATE
1	King	AD_PRES	90	17-JUN-87
2	Whalen	AD_ASST	10	17-SEP-87
3	Kochhar	AD_VP	90	21-SEP-89
4	Hunold	IT_PROG	60	03-JAN-90
5	Ernst	IT_PROG	60	21-MAY-91
6	De Haan	AD_VP	90	13-JAN-93

...

Sorting

- Sorting in descending order:

```
SELECT    last_name, job_id, department_id, hire_date
FROM      employees
ORDER BY hire_date DESC ;
```
1

- Sorting by column alias:

```
SELECT employee_id, last_name, salary*12 annsal
FROM    employees
ORDER BY annsal ;
```
2

Sorting

- Sorting by using the column's numeric position:

```
SELECT     last_name, job_id, department_id, hire_date
FROM       employees
ORDER BY 3;
```
3

- Sorting by multiple columns:

```
SELECT last_name, department_id, salary
FROM    employees
ORDER BY department_id, salary DESC;
```
4

Quiz

Which of the following are valid operators for the `WHERE` clause?

1. `>=`

2. `IS NULL`

3. `!=`

4. `IS LIKE`

5. `IN BETWEEN`

6. `<>`

Summary

In this lesson, you should have learned how to:

- Use the `WHERE` clause to restrict rows of output:

  - Use the comparison conditions
  - Use the `BETWEEN`, `IN`, `LIKE`, and `NULL` operators
  - Apply the logical `AND`, `OR`, and `NOT` operators

- Use the `ORDER BY` clause to sort rows of output:
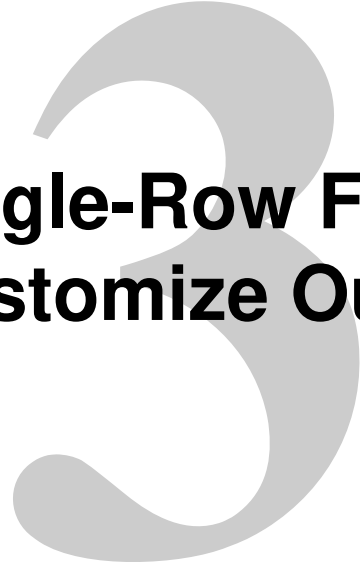
```
SELECT    *|{[DISTINCT] column/expression [alias],...}
FROM      table
[WHERE    condition(s)]
[ORDER BY {column, expr, alias} [ASC|DESC]] ;
```

- Use ampersand substitution to restrict and sort output at run time

Practice 2: Overview

This practice covers the following topics:

- Selecting data and changing the order of the rows that are displayed

- Restricting rows by using the `WHERE` clause

- Sorting rows by using the `ORDER BY` clause

- Using substitution variables to add flexibility to your SQL `SELECT` statements

Using Single-Row Functions to Customize Output

Objectives

After completing this lesson, you should be able to do the following:

- Describe various types of functions available in SQL
- Use character, number, and date functions in `SELECT` statements

SQL Functions
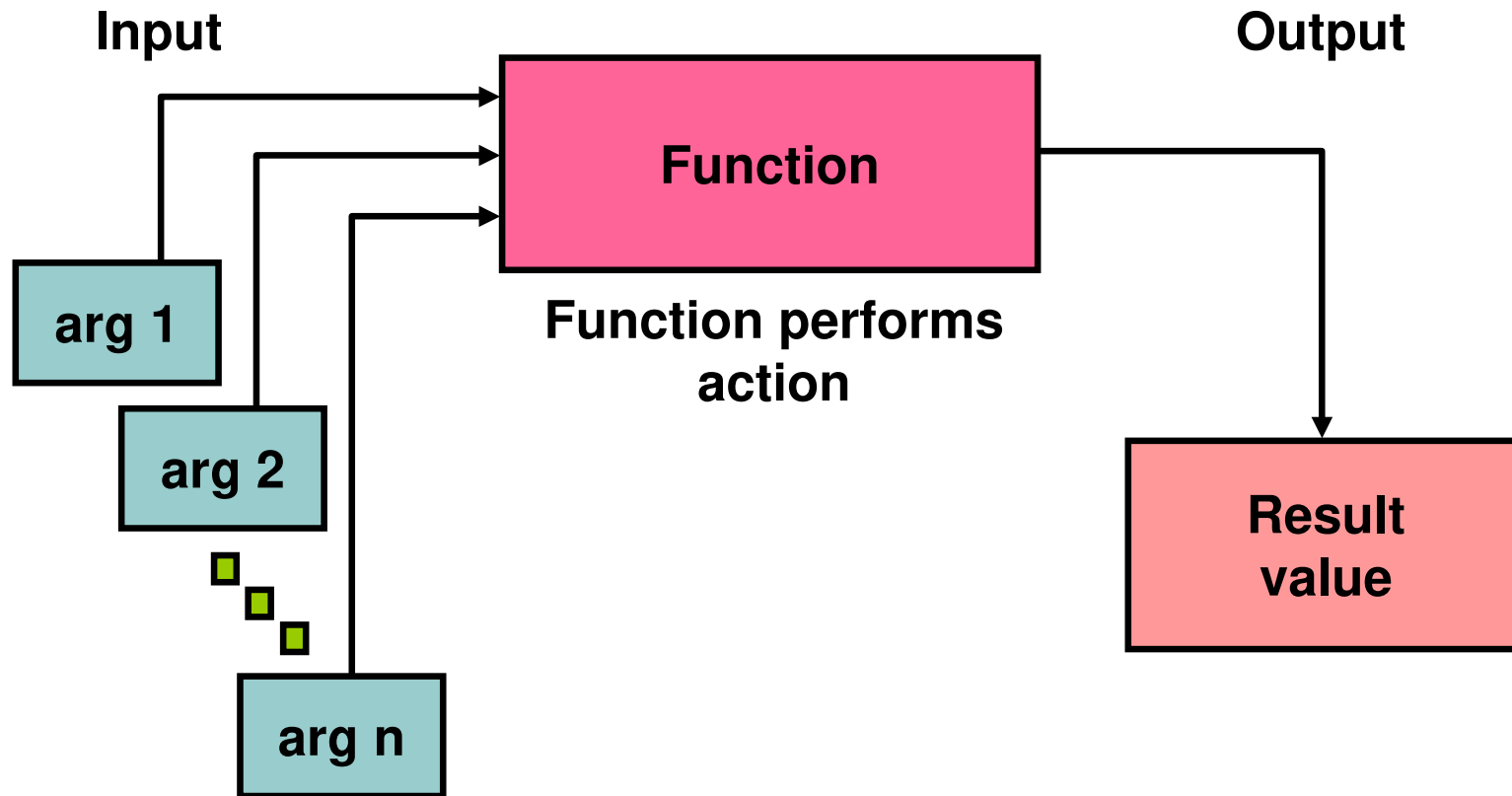
Two Types of SQL Functions

Functions

Single-row functions

Return one result per row

Multiple-row functions

Return one result per set of rows
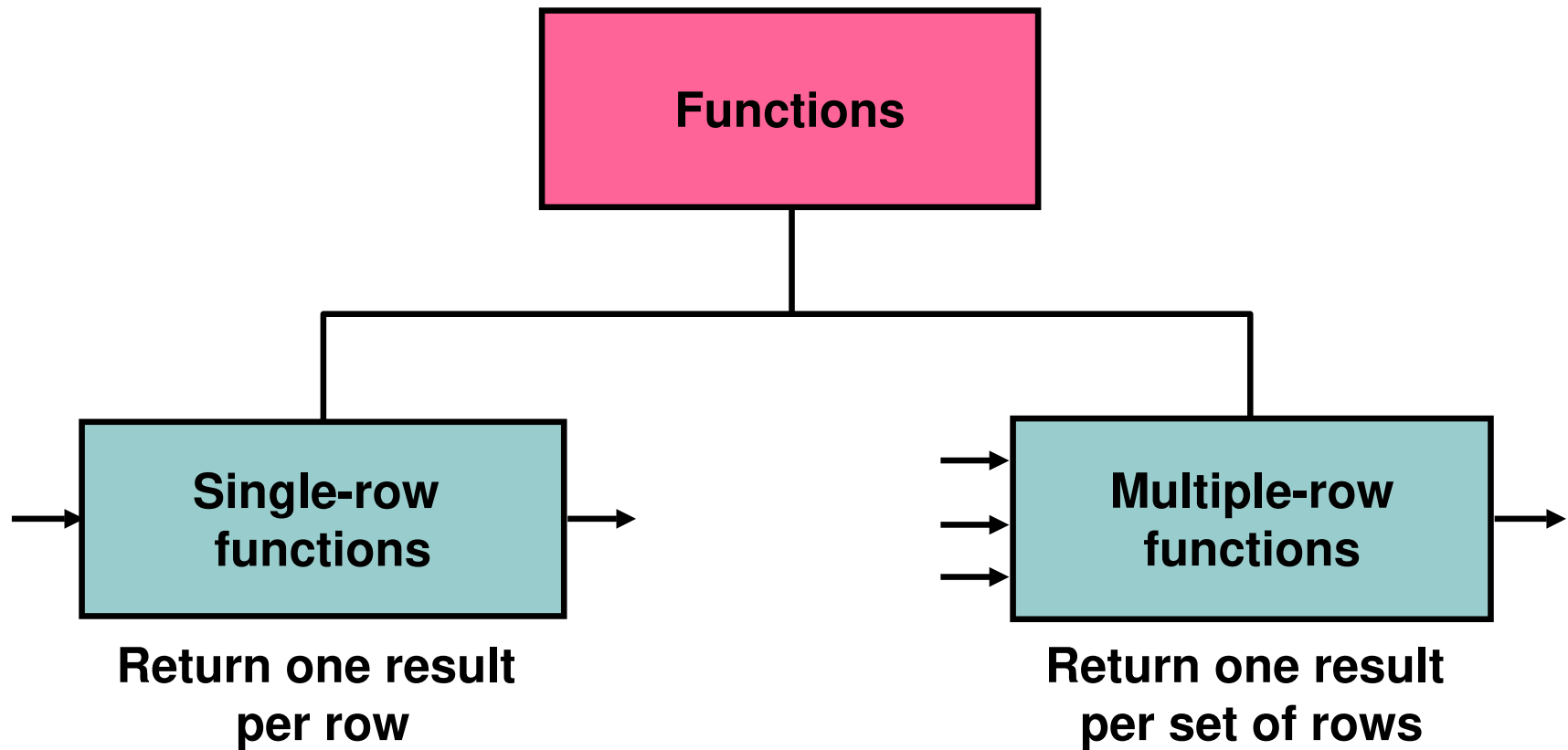
Single-Row Functions

Single-row functions:

- Manipulate data items

- Accept arguments and return one value

- Act on each row that is returned

- Return one result per row

- May modify the data type

- Can be nested

- Accept arguments that can be a column or an expression

```
function_name [(arg1, arg2,...)]
```

Single-Row Functions
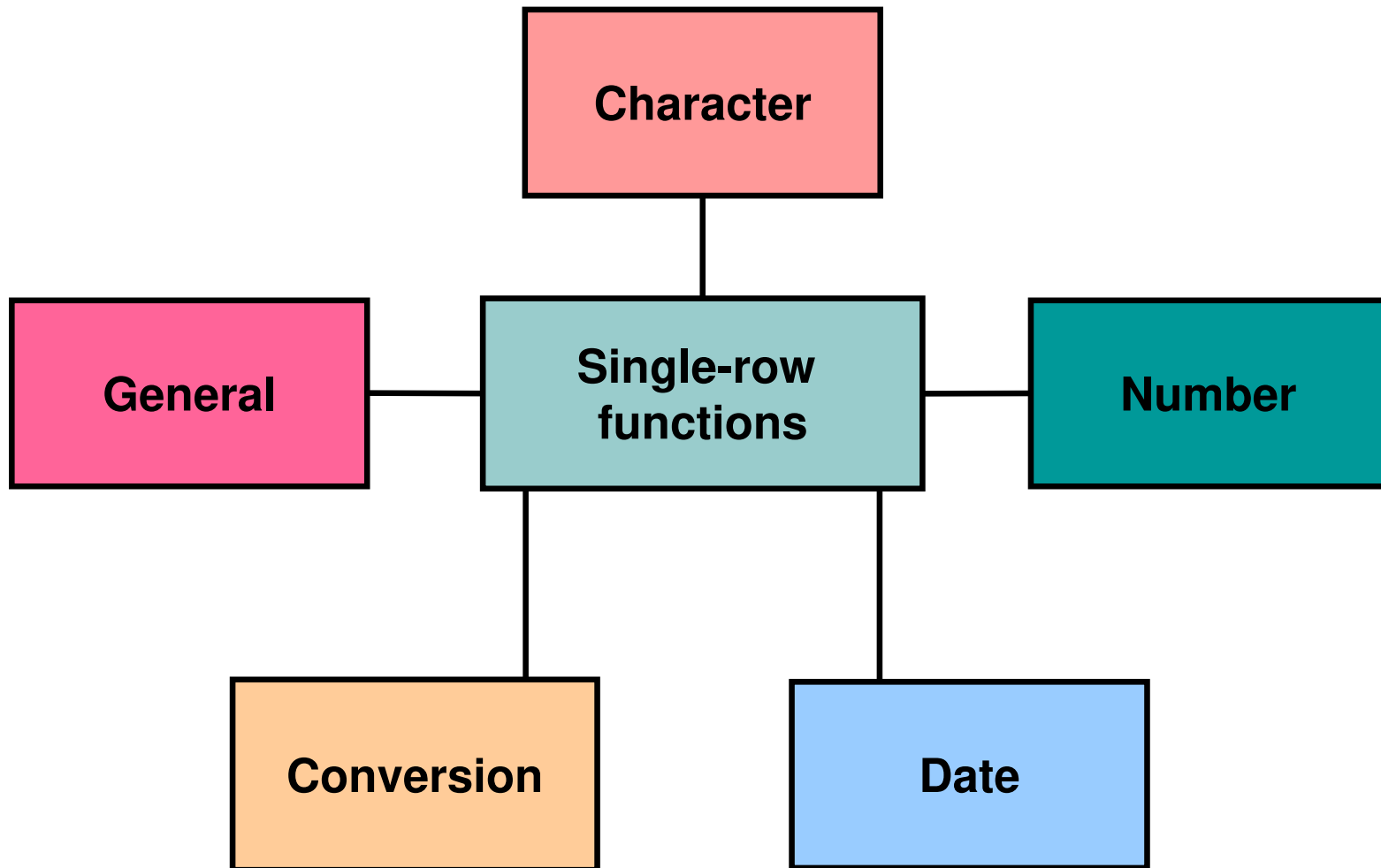
Lesson Agenda

- Single-row SQL functions
- **Character functions**
- Number functions
- Working with dates
- Date functions

Character Functions
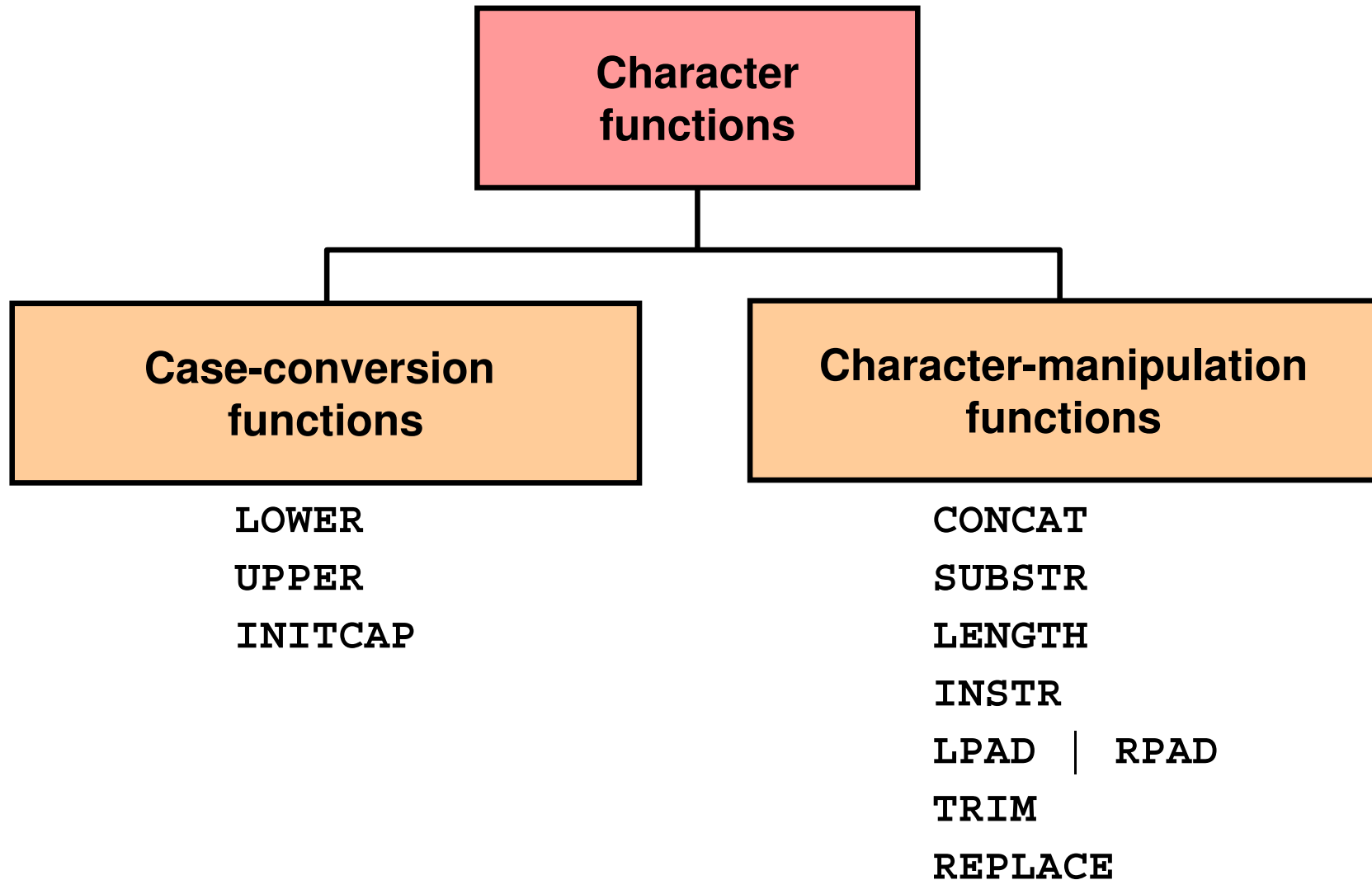
Case-Conversion Functions

These functions convert the case for character strings:

Function	Result
LOWER('SQL Course')	sql course
UPPER('SQL Course')	SQL COURSE
INITCAP('SQL Course')	Sql Course

Using Case-Conversion Functions

Display the employee number, name, and department number for employee Higgins:

```
SELECT  employee_id, last_name, department_id
FROM    employees
WHERE   last_name = 'higgins';
```
0 rows selected

```
SELECT  employee_id, last_name, department_id
FROM    employees
WHERE   LOWER(last_name) = 'higgins';
```

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
1	205	Higgins	110

Character-Manipulation Functions

These functions manipulate character strings:

Function	Result
CONCAT('Hello', 'World')	HelloWorld
SUBSTR('HelloWorld',1,5)	Hello
LENGTH('HelloWorld')	10
POSITION('W' IN 'HelloWorld')	6
LPAD(salary,10,'*')	*****24000
RPAD(salary, 10, '*')	24000*****
REPLACE ('JACK and JUE','J','BL')	BLACK and BLUE
TRIM('H' FROM 'HelloWorld')	elloWorld

Number Functions

- ROUND: Rounds value to a specified decimal
- TRUNC: Truncates value to a specified decimal
- MOD: Returns remainder of division

Function	Result
ROUND(45.926, 2)	45.93
TRUNC(45.926, 2)	45.92
MOD(1600, 300)	100

Using the ROUND Function

SELECT ROUND(45.923,2), ROUND(45.923,0),
        ROUND(45.923,-1)
FROM   DUAL;

	ROUND(45.923,2)	ROUND(45.923,0)	ROUND(45.923,-1)
1	45.92	46	50

DUAL is a dummy table that you can use to view results from functions and calculations.

Using the TRUNC Function

SELECT TRUNC(45.923,2), TRUNC(45.923),
       TRUNC(45.923,-1)
FROM   DUAL;

TRUNC(45.923,2)	TRUNC(45.923)	TRUNC(45.923,-1)
45.92	45	40

Using the MOD Function

For all employees with the job title of Sales Representative, calculate the remainder of the salary after it is divided by 5,000.

```
SELECT last_name, salary, MOD(salary, 5000)
FROM    employees
WHERE   job_id = 'SA_REP';
```

	LAST_NAME	SALARY	MOD(SALARY,5000)
1	Abel	11000	1000
2	Taylor	8600	3600
3	Grant	7000	2000

Lesson Agenda

- Single-row SQL functions

- Character functions

- Number functions

- **Working with dates**

- Date functions

Working with Dates

- The Oracle database stores dates in an internal numeric format: century, year, month, day, hours, minutes, and seconds.

- The default date display format is DD-MON-RR.

  – Enables you to store 21st-century dates in the 20th century by specifying only the last two digits of the year

  – Enables you to store 20th-century dates in the 21st century in the same way

```
SELECT last_name, hire_date
FROM    employees
WHERE   hire_date < '01-FEB-88';
```

	LAST_NAME	HIRE_DATE
1	King	17-JUN-87
2	Whalen	17-SEP-87

RR Date Format

Current Year	Specified Date	RR Format	YY Format
1995	27-OCT-95	1995	1995
1995	27-OCT-17	2017	1917
2001	27-OCT-17	2017	2017
2001	27-OCT-95	1995	2095

		If the specified two-digit year is:	
		0–49	50–99
If two digits of the current year are:	0–49	The return date is in the current century	The return date is in the century before the current one
	50–99	The return date is in the century after the current one	The return date is in the current century

Using the `NOW()` Function

`NOW()` is a function that returns:•

Date

•   Time

```
SELECT NOW();
```

```
postgres=# SELECT NOW();
              now
------------------------------
 2025-07-17 20:43:48.396309+05
(1 row)
```

Arithmetic with Dates

- Add or subtract a number to or from a date for a resultant date value.

- Subtract two dates to find the number of days between those dates.

- Add hours to a date by dividing the number of hours by 24.

Using Arithmetic Operators
with Dates

```
SELECT last_name, (NOW()-hire_date)/7 AS WEEKS
FROM    employees
WHERE   department_id = 90;
```

	LAST_NAME	WEEKS
1	King	1041.16823908730158730158730158730158730
2	Kochhar	923.02538194444444444444444444444444444444
3	De Haan	750.16823908730158730158730158730158730

Lesson Agenda

- Single-row SQL functions
- Character functions
- Number functions
- Working with dates
- **Date functions**

Summary

In this lesson, you should have learned how to:

- Perform calculations on data using functions
- Modify individual data items using functions

Practice 3: Overview

This practice covers the following topics:

- Writing a query that displays the current date

- Creating queries that require the use of numeric, character, and date functions

- Performing calculations of years and months of service for an employee

# Using Conversion Functions and Conditional Expressions

Objectives

After completing this lesson, you should be able to do the following:

- Describe various types of conversion functions that are available in SQL
- Use the `TO_CHAR`, `TO_NUMBER`, and `TO_DATE` conversion functions
- Apply conditional expressions in a `SELECT` statement

Lesson Agenda

- **Implicit and explicit data type conversion**
- `TO_CHAR, TO_DATE, TO_NUMBER` functions
- Nesting functions
- General functions:
  - NVL
  - NVL2
  - NULLIF
  - COALESCE
- Conditional expressions:
  - CASE
  - DECODE

Conversion Functions
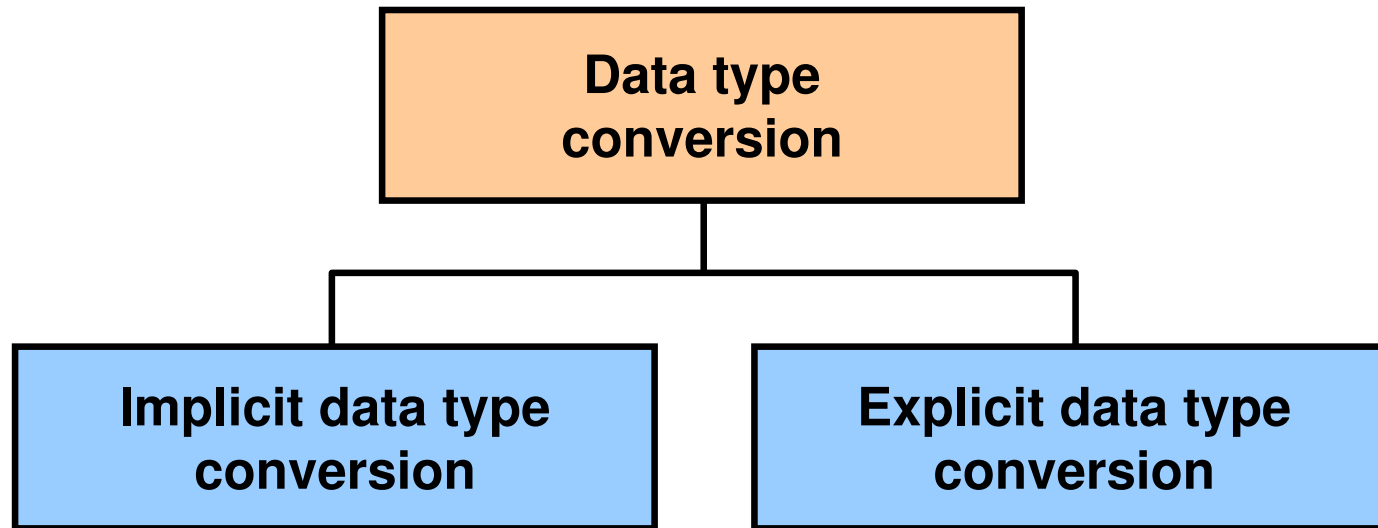
Implicit Data Type Conversion

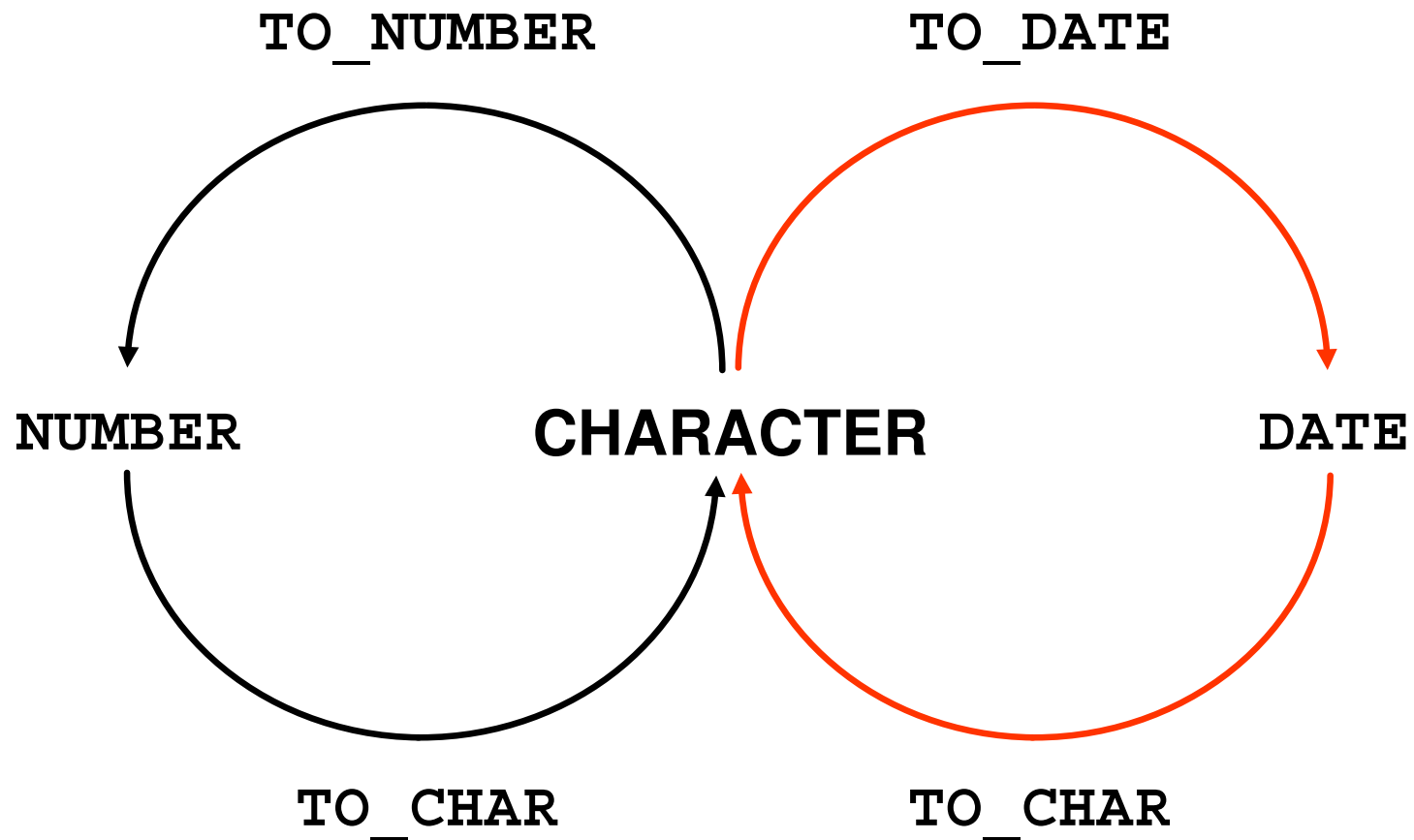In expressions, the Oracle server can automatically convert the following:

From	To
VARCHAR2 or CHAR	NUMBER
VARCHAR2 or CHAR	DATE

Implicit Data Type Conversion

For expression evaluation, the Oracle server can automatically convert the following:

From	To
NUMBER	VARCHAR2 or CHAR
DATE	VARCHAR2 or CHAR

Explicit Data Type Conversion

TO_NUMBER   TO_DATE

NUMBER   **CHARACTER**   DATE

TO_CHAR   TO_CHAR

Explicit Data Type Conversion

TO_NUMBER

TO_DATE

NUMBER

CHARACTER
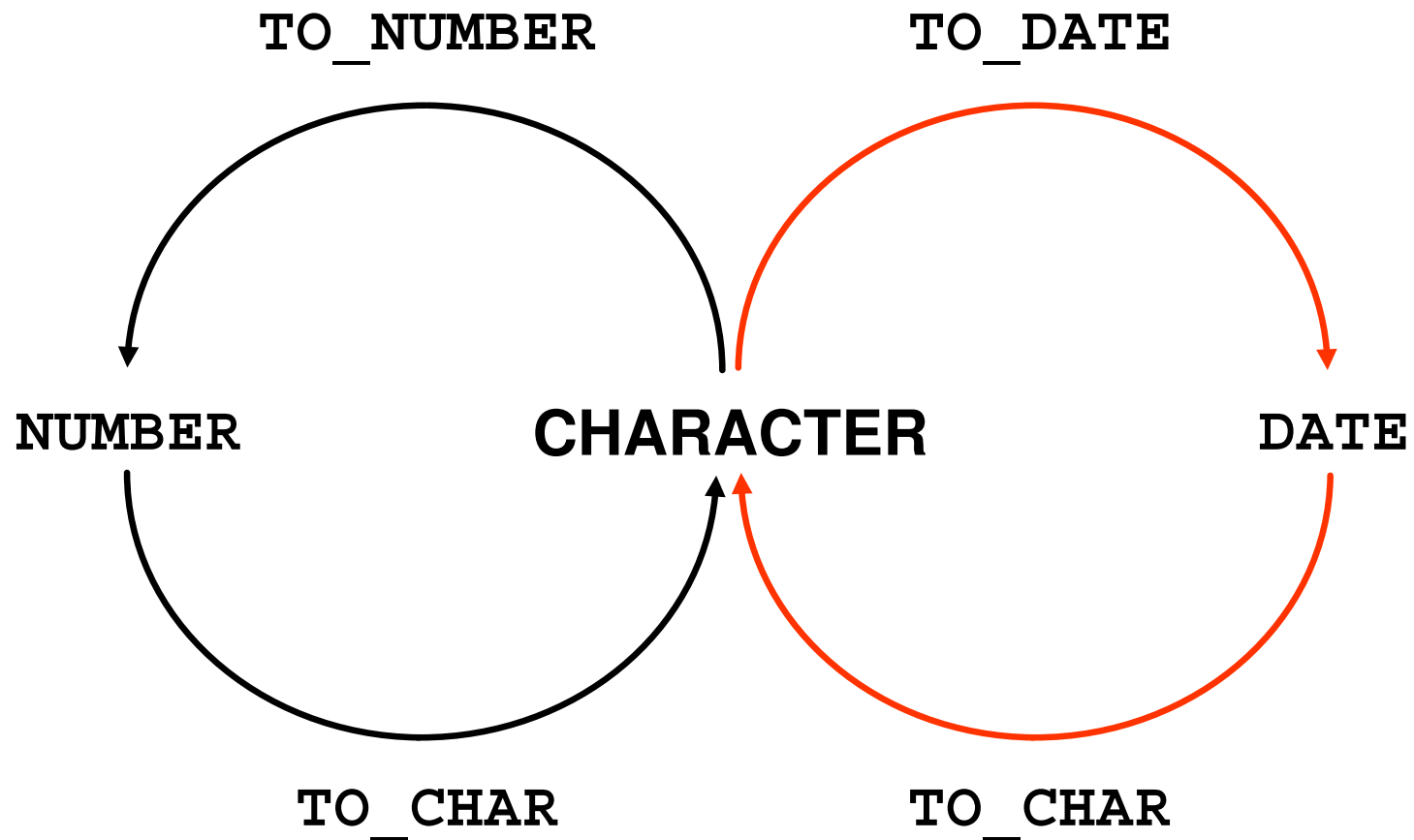
DATE

TO_CHAR

TO_CHAR

Using the `TO_CHAR` Function with Dates

```
TO_CHAR(date, 'format_model')
```

The format model:

- Must be enclosed with single quotation marks
- Is case-sensitive
- Can include any valid date format element
- Has an `fm` element to remove padded blanks or suppress leading zeros
- Is separated from the date value by a comma

Elements of the Date Format Model

Element	Result
YYYY	Full year in numbers
YEAR	Year spelled out (in English)
MM	Two-digit value for the month
MONTH	Full name of the month
MON	Three-letter abbreviation of the month
DY	Three-letter abbreviation of the day of the week
DAY	Full name of the day of the week
DD	Numeric day of the month

Elements of the Date Format Model

- Time elements format the time portion of the date:

`HH24:MI:SS AM`	`15:45:32 PM`

- Add character strings by enclosing them with double quotation marks:

`DD "of" MONTH`	`12 of OCTOBER`

- Number suffixes spell out numbers:

`ddspth`	`fourteenth`

Using the `TO_CHAR` Function with Dates

```
SELECT  last_name,
        TO_CHAR(hire_date, 'fmDD Month YYYY')
        AS HIREDATE
FROM    employees;
```

	LAST_NAME	HIREDATE
1	King	17 June 1987
2	Kochhar	21 September 1989
3	De Haan	13 January 1993
4	Hunold	3 January 1990
5	Ernst	21 May 1991
6	Lorentz	7 February 1999
7	Mourgos	16 November 1999
8	Rajs	17 October 1995
9	Davies	29 January 1997
10	Matos	15 March 1998

...

19	Higgins	7 June 1994
20	Gietz	7 June 1994

Using the `TO_CHAR` Function with Numbers

```
TO_CHAR(number, 'format_model')
```

These are some of the format elements that you can use with the `TO_CHAR` function to display a number value as a character:

Element	Result
9	Represents a number
0	Forces a zero to be displayed
$	Places a floating dollar sign
L	Uses the floating local currency symbol
.	Prints a decimal point
,	Prints a comma as a thousands indicator

Using the `TO_CHAR` Function with Numbers

```
SELECT  TO_CHAR(salary, '$99,999.00') SALARY
FROM    employees
WHERE   last_name = 'Ernst';
```

	SALARY
1	$6,000.00

Using the `TO_NUMBER` and `TO_DATE` Functions

- Convert a character string to a number format using the `TO_NUMBER` function:

```
TO_NUMBER(char[, 'format_model'])
```

- Convert a character string to a date format using the `TO_DATE` function:

```
TO_DATE(char[, 'format_model'])
```

- These functions have an `fx` modifier. This modifier specifies the exact match for the character argument and date format model of a `TO_DATE` function.

# Using the `TO_CHAR` and `TO_DATE` Function with `RR` Date Format

To find employees hired before 1990, use the `RR` date format, which produces the same results whether the command is run in 1999 or now:

```
SELECT last_name, TO_CHAR(hire_date, 'DD-Mon-YYYY')
FROM   employees
WHERE hire_date < TO_DATE('01-Jan-90','DD-Mon-RR');
```

	LAST_NAME	TO_CHAR(HIRE_DATE,'DD-MON-YYYY')
1	King	17-Jun-1987
2	Kochhar	21-Sep-1989
3	Whalen	17-Sep-1987

Nesting Functions

- Single-row functions can be nested to any level.
- Nested functions are evaluated from the deepest level to the least deep level.

```
F3(F2(F1(col,arg1),arg2),arg3)
```

Step 1 = Result 1

Step 2 = Result 2

Step 3 = Result 3
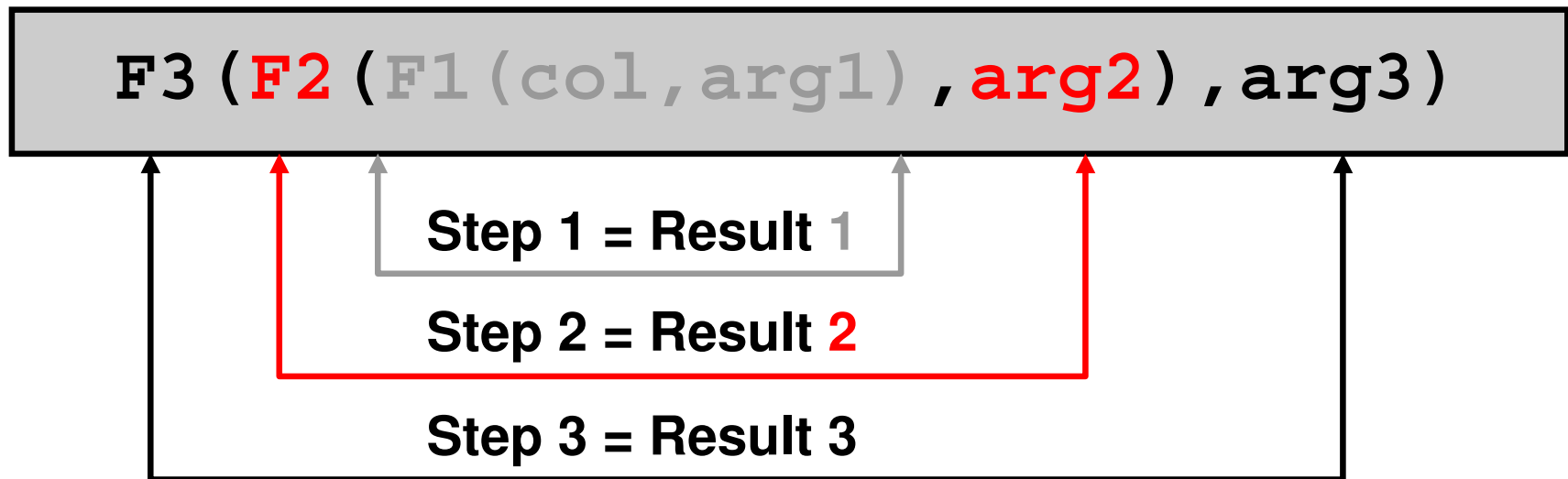
Nesting Functions

```
SELECT last_name,
  UPPER(CONCAT(SUBSTR (LAST_NAME, 1, 8), '_US'))
FROM    employees
WHERE   department_id = 60;
```

	LAST_NAME	UPPER(CONCAT(SUBSTR(LAST_NAME,1,8),'_US'))
1	Hunold	HUNOLD_US
2	Ernst	ERNST_US
3	Lorentz	LORENTZ_US

Lesson Agenda

- Implicit and explicit data type conversion
- `TO_CHAR`, `TO_DATE`, `TO_NUMBER` functions
- Nesting functions
- **General functions:**
  - `NVL`
  - `NVL2`
  - `NULLIF`
  - `COALESCE`
- Conditional expressions:
  - `CASE`
  - `DECODE`

General Functions

The following functions work with any data type and pertain to using nulls:

- `NVL (expr1, expr2)`
- `NVL2 (expr1, expr2, expr3)`
- `NULLIF (expr1, expr2)`
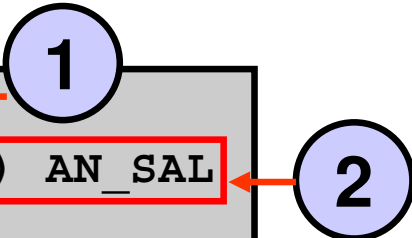- `COALESCE (expr1, expr2, ..., exprn)`

`NVL` Function

Converts a null value to an actual value:

- Data types that can be used are date, character, and number.

- Data types must match:
  - `NVL(commission_pct,0)`
  - `NVL(hire_date,'01-JAN-97')`
  - `NVL(job_id,'No Job Yet')`

Using the NVL Function

```
SELECT last_name, salary, NVL(commission_pct, 0),
    (salary*12) + (salary*12*NVL(commission_pct, 0)) AN_SAL
FROM employees;
```

①

②

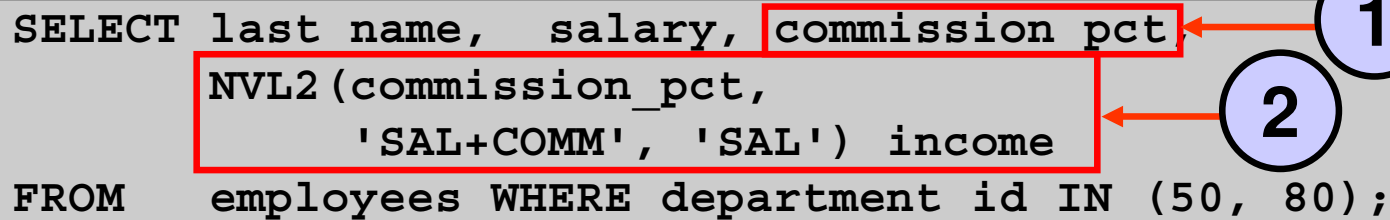|	LAST_NAME	SALARY	NVL(COMMISSION_PCT,0)	AN_SAL
1	King	24000	0	288000
2	Kochhar	17000	0	204000
3	De Haan	17000	0	204000
4	Hunold	9000	0	108000
5	Ernst	6000	0	72000
6	Lorentz	4200	0	50400
7	Mourgos	5800	0	69600
8	Rajs	3500	0	42000
9	Davies	3100	0	37200
10	Matos	2600	0	31200
11	Vargas	2500	0	30000
12	Zlotkey	10500	0.2	151200

...
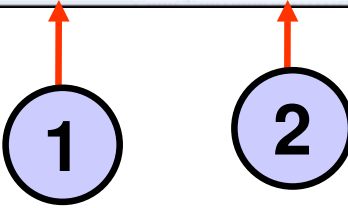
①   ②

Using the NVL2 Function

```
SELECT last_name,  salary, commission_pct    ①
       NVL2(commission_pct,
            'SAL+COMM', 'SAL') income          ②
FROM    employees WHERE department_id IN (50, 80);
```
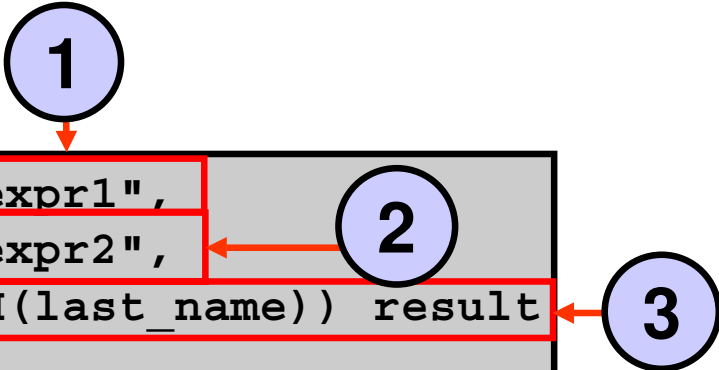
	LAST_NAME	SALARY	COMMISSION_PCT	INCOME
1	Mourgos	5800	(null)	SAL
2	Rajs	3500	(null)	SAL
3	Davies	3100	(null)	SAL
4	Matos	2600	(null)	SAL
5	Vargas	2500	(null)	SAL
6	Zlotkey	10500	0.2	SAL+COMM
7	Abel	11000	0.3	SAL+COMM
8	Taylor	8600	0.2	SAL+COMM

①   ②

Using the `NULLIF` Function

```
SELECT first_name, LENGTH(first_name) "expr1",
       last_name,  LENGTH(last_name)  "expr2",
       NULLIF(LENGTH(first_name), LENGTH(last_name)) result
FROM   employees;
```

1

2

3

	FIRST_NAME	expr1	LAST_NAME	expr2	RESULT
1	Ellen	5	Abel	4	5
2	Curtis	6	Davies	6	(null)
3	Lex	3	De Haan	7	3
4	Bruce	5	Ernst	5	(null)
5	Pat	3	Fay	3	(null)
6	William	7	Gietz	5	7
7	Kimberely	9	Grant	5	9

...

	FIRST_NAME	expr1	LAST_NAME	expr2	RESULT
19	Jennifer	8	Whalen	6	8
20	Eleni	5	Zlotkey	7	5

1 **2** **3**

Using the `COALESCE` Function

- The advantage of the `COALESCE` function over the `NVL` function is that the `COALESCE` function can take multiple alternate values.
- If the first expression is not null, the `COALESCE` function returns that expression; otherwise, it does a `COALESCE` of the remaining expressions.

Using the COALESCE Function

```
SELECT last_name, employee_id,
    COALESCE(
        TO_CHAR(commission_pct, '0.00'),
        TO_CHAR(manager_id, '9999'),
        'No commission and no manager'
    ) AS commission_or_manager
FROM employees;
```

	LAST_NAME	EMPLOYEE_ID	COALESCE(TO_CHAR(COM
1	King	100	No commission and no manager
2	Kochhar	101	100
3	De Haan	102	100
4	Hunold	103	102
5	Ernst	104	103
6	Lorentz	107	103
7	Mourgos	124	100
8	Rajs	141	124

...

12	Zlotkey	149	.2
13	Abel	174	.3
14	Taylor	176	.2
15	Grant	178	.15
16	Whalen	200	101

Conditional Expressions

- Provide the use of the `IF-THEN-ELSE` logic within a SQL statement
- Use two methods:
  - `CASE` expression

CASE Expression

Facilitates conditional inquiries by doing the work of an
IF-THEN-ELSE statement:

```
CASE expr WHEN comparison_expr1 THEN return_expr1
         [WHEN comparison_expr2 THEN return_expr2
          WHEN comparison_exprn THEN return_exprn
          ELSE else_expr]
END
```

Using the `CASE` Expression

Facilitates conditional inquiries by doing the work of an `IF-THEN-ELSE` statement:

```
SELECT  last_name, job_id, salary,
        CASE job_id WHEN 'IT_PROG'  THEN   1.10*salary
                    WHEN 'ST_CLERK' THEN   1.15*salary
                    WHEN 'SA_REP'   THEN   1.20*salary
        ELSE         salary END      "REVISED_SALARY"
FROM    employees;
```

	LAST_NAME	JOB_ID	SALARY	REVISED_SALARY
...				
5	Ernst	IT_PROG	6000	6600
6	Lorentz	IT_PROG	4200	4620
7	Mourgos	ST_MAN	5800	5800
8	Rajs	ST_CLERK	3500	4025
9	Davies	ST_CLERK	3100	3565
...				
13	Abel	SA_REP	11000	13200
14	Taylor	SA_REP	8600	10320
...				

Summary

In this lesson, you should have learned how to:

- Alter date formats for display using functions

- Convert column data types using functions

- Use `NVL` functions

- Use `IF-THEN-ELSE` logic and other conditional expressions in a `SELECT` statement

Practice 4: Overview

This practice covers the following topics:

- Creating queries that use `TO_CHAR`, `TO_DATE`, and other `DATE` functions

- Creating queries that use conditional expressions such as `CASE`

Reporting Aggregated Data Using the Group Functions

Objectives

After completing this lesson, you should be able to do the following:

- Identify the available group functions
- Describe the use of group functions
- Group data by using the `GROUP BY` clause
- Include or exclude grouped rows by using the `HAVING` clause

What Are Group Functions?

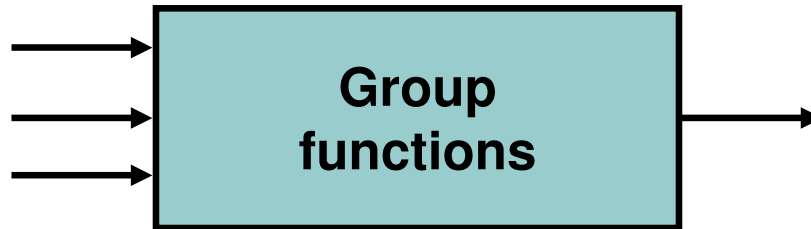Group functions operate on sets of rows to give one result per group.

EMPLOYEES

	DEPARTMENT_ID	SALARY
1	90	24000
2	90	17000
3	90	17000
4	60	9000
5	60	6000
6	60	4200
7	50	5800
8	50	3500
9	50	3100
10	50	2600

...

18	20	6000
19	110	12000
20	110	8300

Maximum salary in EMPLOYEES table

MAX(SALARY)
24000

Types of Group Functions

- AVG
- COUNT
- MAX
- MIN
- STDDEV
- SUM
- VARIANCE

Group functions

Group Functions: Syntax

```
SELECT      group_function(column), ...
FROM        table
[WHERE      condition]
[ORDER BY   column];
```

Using the `AVG` and `SUM` Functions

You can use `AVG` and `SUM` for numeric data.

```
SELECT  AVG(salary), MAX(salary),
        MIN(salary), SUM(salary)
FROM    employees
WHERE   job_id LIKE '%REP%';
```

	AVG(SALARY)	MAX(SALARY)	MIN(SALARY)	SUM(SALARY)
1	8150	11000	6000	32600

Using the `MIN` and `MAX` Functions

You can use `MIN` and `MAX` for numeric, character, and date
data types.

```
SELECT  MIN(hire_date), MAX(hire_date)
FROM        employees;
```

	MIN(HIRE_DATE)	MAX(HIRE_DATE)
1	17-JUN-87	29-JAN-00

Using the COUNT Function

COUNT(*) returns the number of rows in a table:

1

```
SELECT  COUNT(*)
FROM    employees
WHERE   department_id = 50;
```

	COUNT(*)
1	5

COUNT(*expr*) returns the number of rows with non-null values for *expr*:

2

```
SELECT  COUNT(commission_pct)
FROM    employees
WHERE   department_id = 80;
```

	COUNT(COMMISSION_PCT)
1	3

Using the `DISTINCT` Keyword

- `COUNT(DISTINCT expr)` returns the number of distinct non-null values of *expr*.

- To display the number of distinct department values in the `EMPLOYEES` table:

```
SELECT COUNT(DISTINCT department_id)
FROM   employees;
```

	COUNT(DISTINCTDEPARTMENT_ID)
1	7

Group Functions and Null Values

Group functions ignore null values in the column:

1
```
SELECT  AVG(commission_pct)
FROM    employees;
```

	AVG(COMMISSION_PCT)
1	0.2125

The NVL function forces group functions to include null values:

2
```
SELECT  AVG(NVL(commission_pct, 0))
FROM    employees;
```

	AVG(NVL(COMMISSION_PCT,0))
1	0.0425

Creating Groups of Data

EMPLOYEES

	DEPARTMENT_ID	SALARY		
1	10	4400	**4400**	
2	20	13000		
3	20	6000	**9500**	
4	50	5800		
5	50	2500		
6	50	2600	**3500**	
7	50	3100		
8	50	3500		
9	60	4200	**6400**	
10	60	6000		
11	60	9000		
12	80	11000	**10033**	
13	80	10500		
14	80	8600		
. . .				
19	110	12000		
20	(null)	7000		

Average salary in EMPLOYEES table for each department

	DEPARTMENT_ID	AVG(SALARY)
1	10	4400
2	20	9500
3	50	3500
4	60	6400
5	80	10033.333333333333...
6	90	19333.333333333333...
7	110	10150
8	(null)	7000

Creating Groups of Data:
GROUP BY Clause Syntax

```
SELECT      column, group_function(column)
FROM        table
[WHERE      condition]
[GROUP BY group_by_expression]
[ORDER BY column];
```

You can divide rows in a table into smaller groups by using the GROUP BY clause.

Using the GROUP BY Clause

All columns in the SELECT list that are not in group functions must be in the GROUP BY clause.

```
SELECT     department_id, AVG(salary)
FROM       employees
GROUP BY department_id ;
```

	DEPARTMENT_ID	AVG(SALARY)
1	(null)	7000
2	90	19333.33333333333...
3	20	9500
4	110	10150
5	50	3500
6	80	10033.33333333333...
7	60	6400
8	10	4400

Using the GROUP BY Clause

The GROUP BY column does not have to be in the SELECT list.

```
SELECT     AVG(salary)
FROM       employees
GROUP BY department_id ;
```


	AVG(SALARY)
1	7000
2	19333.33333333333333333333...
3	9500
4	10150
5	3500
6	10033.33333333333333333333...
7	6400
8	4400

Grouping by More than One Column

EMPLOYEES

	DEPARTMENT_ID	JOB_ID	SALARY
1	10	AD_ASST	4400
2	20	MK_MAN	13000
3	20	MK_REP	6000
4	50	ST_MAN	5800
5	50	ST_CLERK	2500
6	50	ST_CLERK	2600
7	50	ST_CLERK	3100
8	50	ST_CLERK	3500
9	60	IT_PROG	4200
10	60	IT_PROG	6000
11	60	IT_PROG	9000
12	80	SA_REP	11000
13	80	SA_MAN	10500
14	80	SA_REP	8600

...

19	110	AC_MGR	12000
20	(null)	SA_REP	7000

Add the salaries in the EMPLOYEES table for each job, grouped by department.

	DEPARTMENT_ID	JOB_ID	SUM(SALARY)
1	10	AD_ASST	4400
2	20	MK_MAN	13000
3	20	MK_REP	6000
4	50	ST_CLERK	11700
5	50	ST_MAN	5800
6	60	IT_PROG	19200
7	80	SA_MAN	10500
8	80	SA_REP	19600
9	90	AD_PRES	24000
10	90	AD_VP	34000
11	110	AC_ACCOUNT	8300
12	110	AC_MGR	12000
13	(null)	SA_REP	7000

Using the GROUP BY Clause
on Multiple Columns

```
SELECT     department_id, job_id, SUM(salary)
FROM       employees
WHERE       department_id > 40
GROUP BY department_id, job_id
ORDER BY department_id;
```

	DEPARTMENT_ID	JOB_ID	SUM(SALARY)
1	50	ST_CLERK	11700
2	50	ST_MAN	5800
3	60	IT_PROG	19200
4	80	SA_MAN	10500
5	80	SA_REP	19600
6	90	AD_PRES	24000
7	90	AD_VP	34000
8	110	AC_ACCOUNT	8300
9	110	AC_MGR	12000

Illegal Queries
Using Group Functions

Any column or expression in the `SELECT` list that is not an aggregate function must be in the `GROUP BY` clause:

```
SELECT department_id, COUNT(last_name)
FROM    employees;
```

ORA-00937: not a single-group group function
00937. 00000 - "not a single-group group function"

A `GROUP BY` clause must be added to count the last names for each `department_id`.

```
SELECT department_id, job_id, COUNT(last_name)
FROM    employees
GROUP BY department_id;
```

ORA-00979: not a GROUP BY expression
00979. 00000 - "not a GROUP BY expression"

Either add `job_id` in the `GROUP BY` or remove the `job_id` column from the `SELECT` list.

Illegal Queries
Using Group Functions

- You cannot use the `WHERE` clause to restrict groups.

- You use the `HAVING` clause to restrict groups.

- You cannot use group functions in the `WHERE` clause.

```
SELECT     department_id, AVG(salary)
FROM       employees
WHERE      AVG(salary) > 8000
GROUP BY department_id;
```

Cannot use the
`WHERE` clause to
restrict groups

Restricting Group Results

EMPLOYEES

The maximum salary per department when it is greater than $10,000

Restricting Group Results
with the `HAVING` Clause

When you use the `HAVING` clause, the Oracle server restricts groups as follows:

1. Rows are grouped.
2. The group function is applied.
3. Groups matching the `HAVING` clause are displayed.

```
SELECT     column, group_function
FROM       table
[WHERE     condition]
[GROUP BY  group_by_expression]
[HAVING    group_condition]
[ORDER BY  column];
```

Using the `HAVING` Clause

```
SELECT     department_id, MAX(salary)
FROM       employees
GROUP BY department_id
HAVING     MAX(salary)>10000 ;
```

	DEPARTMENT_ID	MAX(SALARY)
1	90	24000
2	20	13000
3	110	12000
4	80	11000

Using the `HAVING` Clause

```
SELECT     job_id, SUM(salary) PAYROLL
FROM       employees
WHERE      job_id NOT LIKE '%REP%'
GROUP BY job_id
HAVING     SUM(salary) > 13000
ORDER BY SUM(salary);
```

	JOB_ID	PAYROLL
1	IT_PROG	19200
2	AD_PRES	24000
3	AD_VP	34000

Nesting Group Functions

Display the maximum average salary:

```
SELECT    MAX(AVG(salary))
FROM      employees
GROUP BY department_id;
```

	MAX(AVG(SALARY))
1	19333.333333333333333333333333333333333

Quiz

Identify the guidelines for group functions and the `GROUP BY` clause.

1. You cannot use a column alias in the `GROUP BY` clause.
2. The `GROUP BY` column must be in the `SELECT` clause.
3. By using a `WHERE` clause, you can exclude rows before dividing them into groups.
4. The `GROUP BY` clause groups rows and ensures order of the result set.
5. If you include a group function in a `SELECT` clause, you cannot select individual results as well.

Summary

In this lesson, you should have learned how to:

- Use the group functions `COUNT`, `MAX`, `MIN`, `SUM`, and `AVG`
- Write queries that use the `GROUP BY` clause
- Write queries that use the `HAVING` clause

```
SELECT      column, group_function
FROM        table
[WHERE      condition]
[GROUP BY group_by_expression]
[HAVING     group_condition]
[ORDER BY column];
```

Practice 5: Overview

This practice covers the following topics:

- Writing queries that use the group functions
- Grouping by rows to achieve more than one result
- Restricting groups by using the `HAVING` clause

Displaying Data from Multiple Tables

Objectives

After completing this lesson, you should be able to do the following:

- Write `SELECT` statements to access data from more than one table using equijoins and nonequijoins

- Join a table to itself by using a self-join

- View data that generally does not meet a join condition by using `OUTER` joins

- Generate a Cartesian product of all rows from two or more tables

Obtaining Data from Multiple Tables

EMPLOYEES

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
1	100	King	90
2	101	Kochhar	90
3	102	De Haan	90

...

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
18	202	Fay	20
19	205	Higgins	110
20	206	Gietz	110

DEPARTMENTS

	DEPARTMENT_ID	DEPARTMENT_NAME	LOCATION_ID
1	10	Administration	1700
2	20	Marketing	1800
3	50	Shipping	1500
4	60	IT	1400
5	80	Sales	2500
6	90	Executive	1700
7	110	Accounting	1700
8	190	Contracting	1700

	EMPLOYEE_ID	DEPARTMENT_ID	DEPARTMENT_NAME
1	200	10	Administration
2	201	20	Marketing
3	202	20	Marketing
4	124	50	Shipping
5	144	50	Shipping

...

	EMPLOYEE_ID	DEPARTMENT_ID	DEPARTMENT_NAME
18	205	110	Accounting
19	206	110	Accounting

Types of Joins

Joins that are compliant with the SQL:1999 standard include the following:

- Natural joins:
    - `NATURAL JOIN` clause
    - `USING` clause
    - `ON` clause
- `OUTER` joins:
    - `LEFT OUTER JOIN`
    - `RIGHT OUTER JOIN`
    - `FULL OUTER JOIN`
- Cross joins

Joining Tables Using SQL:1999 Syntax

Use a join to query data from more than one table:

```
SELECT    table1.column, table2.column
FROM      table1
[NATURAL JOIN table2] |
[JOIN table2 USING (column_name)] |
[JOIN table2
  ON (table1.column_name = table2.column_name)]|
[LEFT|RIGHT|FULL OUTER JOIN table2
  ON (table1.column_name = table2.column_name)]|
[CROSS JOIN table2];
```

Qualifying Ambiguous Column Names

- Use table prefixes to qualify column names that are in multiple tables.

- Use table prefixes to improve performance.

- Instead of full table name prefixes, use table aliases.

- Table alias gives a table a shorter name:
  - Keeps SQL code smaller, uses less memory

- Use column aliases to distinguish columns that have identical names, but reside in different tables.

Creating Natural Joins

- The `NATURAL JOIN` clause is based on all columns in the two tables that have the same name.

- It selects rows from the two tables that have equal values in all matched columns.

- If the columns having the same names have different data types, an error is returned.

Retrieving Records with Natural Joins

```
SELECT department_id, department_name,
       location_id, city
FROM   departments
NATURAL JOIN locations ;
```

	DEPARTMENT_ID	DEPARTMENT_NAME	LOCATION_ID	CITY
1	60	IT	1400	Southlake
2	50	Shipping	1500	South San Francisco
3	10	Administration	1700	Seattle
4	90	Executive	1700	Seattle
5	110	Accounting	1700	Seattle
6	190	Contracting	1700	Seattle
7	20	Marketing	1800	Toronto
8	80	Sales	2500	Oxford

Creating Joins with the `USING` Clause

- If several columns have the same names but the data types do not match, use the `USING` clause to specify the columns for the equijoin.

- Use the `USING` clause to match only one column when more than one column matches.

- The `NATURAL JOIN` and `USING` clauses are mutually exclusive.

Joining Column Names

EMPLOYEES

DEPARTMENTS

Primary key

...

Foreign key

Retrieving Records with the USING Clause

```
SELECT  employee_id, last_name,
        location_id, department_id
FROM    employees JOIN departments
USING (department_id) ;
```

	EMPLOYEE_ID	LAST_NAME	LOCATION_ID	DEPARTMENT_ID
1	200	Whalen	1700	10
2	201	Hartstein	1800	20
3	202	Fay	1800	20
4	124	Mourgos	1500	50
5	144	Vargas	1500	50
6	143	Matos	1500	50
7	142	Davies	1500	50
8	141	Rajs	1500	50
9	107	Lorentz	1400	60
10	104	Ernst	1400	60

...

19	205	Higgins	1700	110

Using Table Aliases with the USING Clause

- Do not qualify a column that is used in the USING clause.
- If the same column is used elsewhere in the SQL statement, do not alias it.

```
SELECT l.city, d.department_name
FROM    locations l JOIN departments d
USING (location_id)
WHERE d.location_id = 1400;
```

Creating Joins with the ON Clause

- The join condition for the natural join is basically an equijoin of all columns with the same name.

- Use the ON clause to specify arbitrary conditions or specify columns to join.

- The join condition is separated from other search conditions.

- The ON clause makes code easy to understand.

Retrieving Records with the ON Clause

```
SELECT  e.employee_id, e.last_name, e.department_id,
        d.department_id, d.location_id
FROM    employees e JOIN departments d
ON      (e.department_id = d.department_id);
```

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_ID_1	LOCATION_ID
1	200	Whalen	10	10	1700
2	201	Hartstein	20	20	1800
3	202	Fay	20	20	1800
4	124	Mourgos	50	50	1500
5	144	Vargas	50	50	1500
6	143	Matos	50	50	1500
7	142	Davies	50	50	1500
8	141	Rajs	50	50	1500
9	107	Lorentz	60	60	1400
10	104	Ernst	60	60	1400

...

Creating Three-Way Joins with the ON Clause

```
SELECT  employee_id, city, department_name
FROM    employees e
JOIN    departments d
ON      d.department_id = e.department_id
JOIN    locations l
ON      d.location_id = l.location_id;
```

	EMPLOYEE_ID	CITY	DEPARTMENT_NAME
1	100	Seattle	Executive
2	101	Seattle	Executive
3	102	Seattle	Executive
4	103	Southlake	IT
5	104	Southlake	IT
6	107	Southlake	IT
7	124	South San Francisco	Shipping
8	141	South San Francisco	Shipping

...

Applying Additional Conditions to a Join

Use the `AND` clause or the `WHERE` clause to apply additional conditions:

```
SELECT  e.employee_id, e.last_name, e.department_id,
        d.department_id, d.location_id
FROM    employees e JOIN departments d
ON      (e.department_id = d.department_id)
AND     e.manager id = 149 ;
```

Or

```
SELECT  e.employee_id, e.last_name, e.department_id,
        d.department_id, d.location_id
FROM    employees e JOIN departments d
ON      (e.department_id = d.department_id)
WHERE    e.manager_id = 149 ;
```

Joining a Table to Itself

EMPLOYEES (WORKER)

	EMPLOYEE_ID	LAST_NAME	MANAGER_ID
1	100	King	(null)
2	101	Kochhar	100
3	102	De Haan	100
4	103	Hunold	102
5	104	Ernst	103
6	107	Lorentz	103
7	124	Mourgos	100
8	141	Rajs	124
9	142	Davies	124
10	143	Matos	124

EMPLOYEES (MANAGER)

EMPLOYEE_ID	LAST_NAME
100	King
101	Kochhar
102	De Haan
103	Hunold
104	Ernst
107	Lorentz
124	Mourgos
141	Rajs
142	Davies
143	Matos

MANAGER_ID in the WORKER table is equal to EMPLOYEE_ID in the MANAGER table.

Self-Joins Using the ON Clause

```
SELECT worker.last_name emp, manager.last_name mgr
FROM    employees worker JOIN employees manager
ON      (worker.manager_id = manager.employee_id);
```

	EMP	MGR
1	Hunold	De Haan
2	Fay	Hartstein
3	Gietz	Higgins
4	Lorentz	Hunold
5	Ernst	Hunold
6	Zlotkey	King
7	Mourgos	King
8	Kochhar	King
9	Hartstein	King
10	De Haan	King

...

Nonequijoins

EMPLOYEES

	LAST_NAME	SALARY
1	King	24000
2	Kochhar	17000
3	De Haan	17000
4	Hunold	9000
5	Ernst	6000
6	Lorentz	4200
7	Mourgos	5800
8	Rajs	3500
9	Davies	3100
10	Matos	2600

...

19	Higgins	12000
20	Gietz	8300

JOB_GRADES

	GRADE_LEVEL	LOWEST_SAL	HIGHEST_SAL
1	A	1000	2999
2	B	3000	5999
3	C	6000	9999
4	D	10000	14999
5	E	15000	24999
6	F	25000	40000

`JOB_GRADES` **table defines the** `LOWEST_SAL` **and** `HIGHEST_SAL` **range of values for each** `GRADE_LEVEL`. **Hence, the** `GRADE_LEVEL` **column can be used to assign grades to each employee.**

Retrieving Records
with Nonequijoins

```
SELECT  e.last_name, e.salary, j.grade_level
FROM    employees e JOIN job_grades j
ON      e.salary
        BETWEEN j.lowest_sal AND j.highest_sal;
```

	LAST_NAME	SALARY	GRADE_LEVEL
1	Vargas	2500	A
2	Matos	2600	A
3	Davies	3100	B
4	Rajs	3500	B
5	Lorentz	4200	B
6	Whalen	4400	B
7	Mourgos	5800	B
8	Ernst	6000	C
9	Fay	6000	C
10	Grant	7000	C

...

Returning Records with No Direct Match Using `OUTER` Joins

`DEPARTMENTS`

DEPARTMENT_NAME	DEPARTMENT_ID
Administration	10
Marketing	20
Shipping	50
IT	60
Sales	80
Executive	90
Accounting	110
Contracting	190

There are no employees in department 190.

Employee "Grant" has not been assigned a department ID.

Equijoin with `EMPLOYEES`

	DEPARTMENT_ID	LAST_NAME
1	90	King
2	90	Kochhar
3	90	De Haan
4	60	Hunold
5	60	Ernst
6	60	Lorentz
7	50	Mourgos
8	50	Rajs
9	50	Davies
10	50	Matos

. . .

18	110	Higgins
19	110	Gietz

`INNER` **Versus** `OUTER` **Joins**

- In SQL:1999, the join of two tables returning only matched rows is called an `INNER` join.

- A join between two tables that returns the results of the `INNER` join as well as the unmatched rows from the left (or right) table is called a left (or right) `OUTER` join.

- A join between two tables that returns the results of an `INNER` join as well as the results of a left and right join is a full `OUTER` join.

LEFT OUTER JOIN

```
SELECT  e.last_name, e.department_id, d.department_name
FROM    employees e LEFT OUTER JOIN departments d
ON     (e.department_id = d.department_id) ;
```

	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1	Whalen	10	Administration
2	Fay	20	Marketing
3	Hartstein	20	Marketing
4	Vargas	50	Shipping
5	Matos	50	Shipping

...

17	King	90	Executive
18	Gietz	110	Accounting
19	Higgins	110	Accounting
20	Grant	(null)	(null)

RIGHT OUTER JOIN

```
SELECT  e.last_name, d.department id, d.department_name
FROM    employees e RIGHT OUTER JOIN departments d
ON      (e.department_id = d.department_id) ;
```

	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1	Whalen	10	Administration
2	Hartstein	20	Marketing
3	Fay	20	Marketing
4	Mourgos	50	Shipping

...

18	Gietz	110	Accounting
19	Higgins	110	Accounting
20	(null)	190	Contracting

FULL OUTER JOIN

```
SELECT e.last_name, d.department id, d.department_name
FROM    employees e FULL OUTER JOIN departments d
ON    (e.department_id = d.department_id) ;
```

	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1	King	90	Executive
2	Kochhar	90	Executive
3	De Haan	90	Executive
4	Hunold	60	IT

...

15	Grant	(null)	(null)
16	Whalen	10	Administration
17	Hartstein	20	Marketing
18	Fay	20	Marketing
19	Higgins	110	Accounting
20	Gietz	110	Accounting
21	(null)	190	Contracting

Cartesian Products

- A Cartesian product is formed when:
  - A join condition is omitted
  - A join condition is invalid
  - All rows in the first table are joined to all rows in the second table
- To avoid a Cartesian product, always include a valid join condition.

Generating a Cartesian Product

EMPLOYEES (20 rows)

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
1	100	King	90
2	101	Kochhar	90
3	102	De Haan	90
4	103	Hunold	60

...

19	205	Higgins	110
20	206	Gietz	110

DEPARTMENTS (8 rows)

	DEPARTMENT_ID	DEPARTMENT_NAME	LOCATION_ID
1	10	Administration	1700
2	20	Marketing	1800
3	50	Shipping	1500
4	60	IT	1400
5	80	Sales	2500
6	90	Executive	1700
7	110	Accounting	1700
8	190	Contracting	1700

Cartesian product:
20 x 8 = 160 rows

	EMPLOYEE_ID	DEPARTMENT_ID	LOCATION_ID
1	100	90	1700
2	101	90	1700
3	102	90	1700
4	103	60	1700

...

159	205	110	1700
160	206	110	1700

Creating Cross Joins

- The `CROSS JOIN` clause produces the cross-product of two tables.

- This is also called a Cartesian product between the two tables.

```
SELECT last_name, department_name
FROM    employees
CROSS JOIN departments ;
```

	LAST_NAME	DEPARTMENT_NAME
1	Abel	Administration
2	Davies	Administration
3	De Haan	Administration
4	Ernst	Administration
5	Fay	Administration

...

159	Whalen	Contracting
160	Zlotkey	Contracting

Quiz

The SQL:1999 standard join syntax supports the following
types of joins. Which of these join types does Oracle join syntax
support?

1. Equijoins
2. Nonequijoins
3. Left `OUTER` join
4. Right `OUTER` join
5. Full `OUTER` join
6. Self joins
7. Natural joins
8. Cartesian products

Summary

In this lesson, you should have learned how to use joins to display data from multiple tables by using:

- Equijoins
- Nonequijoins
- `OUTER` joins
- Self-joins
- Cross joins
- Natural joins
- Full (or two-sided) `OUTER` joins

Practice 6: Overview

This practice covers the following topics:

- Joining tables using an equijoin
- Performing outer and self-joins
- Adding conditions

Using Subqueries to Solve Queries

Objectives

After completing this lesson, you should be able to do the following:

- Define subqueries
- Describe the types of problems that the subqueries can solve
- List the types of subqueries
- Write single-row and multiple-row subqueries

Using a Subquery to Solve a Problem

Who has a salary greater than Abel's?

Main query:

Which employees have salaries greater than Abel's salary?

Subquery:

What is Abel's salary?
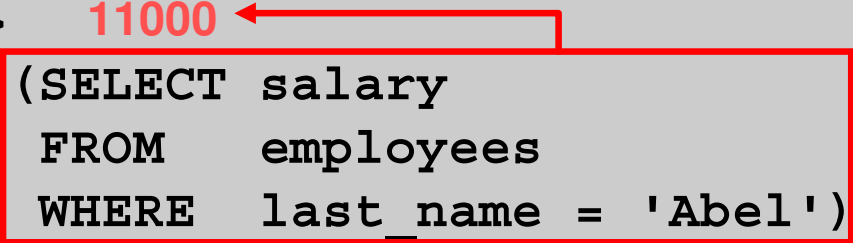
Subquery Syntax

```
SELECT     select_list
FROM       table
WHERE      expr operator
                      (SELECT         select_list
                       FROM           table);
```

- The subquery (inner query) executes *before* the main query (outer query).
- The result of the subquery is used by the main query.

Using a Subquery

```
SELECT last_name, salary
FROM    employees
WHERE   salary >    11000  ◄──────────────┐
               (SELECT salary             │
                FROM    employees         │
                WHERE   last_name = 'Abel');
```

	LAST_NAME	SALARY
1	King	24000
2	Kochhar	17000
3	De Haan	17000
4	Hartstein	13000
5	Higgins	12000

Guidelines for Using Subqueries

- Enclose subqueries in parentheses.

- Place subqueries on the right side of the comparison condition for readability (However, the subquery can appear on either side of the comparison operator.).

- Use single-row operators with single-row subqueries and multiple-row operators with multiple-row subqueries.

Types of Subqueries

- Single-row subquery

```
┌─────────────────────────┐
│ Main query              │
│   ┌─────────────────┐   │        returns
│   │    Subquery     │   │─────────────────────────►  ST_CLERK
│   └─────────────────┘   │
└─────────────────────────┘
```

- Multiple-row subquery

```
┌─────────────────────────┐
│ Main query              │
│   ┌─────────────────┐   │        returns            ST_CLERK
│   │    Subquery     │   │─────────────────────────► SA_MAN
│   └─────────────────┘   │
└─────────────────────────┘
```
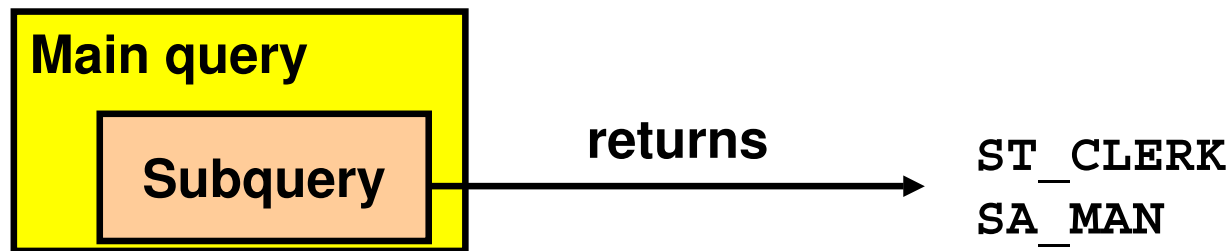
Single-Row Subqueries

- Return only one row
- Use single-row comparison operators

Operator	Meaning
=	Equal to
>	Greater than
>=	Greater than or equal to
<	Less than
<=	Less than or equal to
<>	Not equal to

Executing Single-Row Subqueries

```
SELECT  last_name, job_id, salary
FROM    employees
WHERE   job_id =                         SA_REP
                (SELECT job_id
                 FROM    employees
                 WHERE   last_name = 'Taylor')

AND     salary >                         8600
                (SELECT salary
                 FROM    employees
                 WHERE   last name = 'Taylor');
```

	LAST_NAME	JOB_ID	SALARY
1	Abel	SA_REP	11000
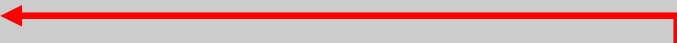
Using Group Functions in a Subquery

```
SELECT  last_name, job_id, salary
FROM    employees
WHERE   salary =           2500
            (SELECT MIN(salary)
             FROM    employees);
```

	LAST_NAME		JOB_ID		SALARY
1	Vargas		ST_CLERK		2500

The `HAVING` Clause with Subqueries

- The Oracle server executes the subqueries first.
- The Oracle server returns results into the `HAVING` clause of the main query.

```
SELECT     department_id, MIN(salary)
FROM       employees
GROUP BY   department_id
HAVING     MIN(salary)  >         2500
                              ←
                              (SELECT MIN(salary)
                               FROM    employees
                               WHERE   department_id = 50);
```

	DEPARTMENT_ID	MIN(SALARY)
1	(null)	7000
2	90	17000
3	20	6000
...		
7	10	4400

What Is Wrong with This Statement?

```
SELECT  employee_id, last_name
FROM    employees
WHERE   salary =
                (SELECT    MIN(salary)
                 FROM      employees
                 GROUP BY department_id);
```

Single-row operator with multiple-row subquery

No Rows Returned by the Inner Query

```
SELECT  last_name, job_id
FROM     employees
WHERE   job_id =
                   (SELECT  job_id
                    FROM     employees
                    WHERE   last_name = 'Haas');
0 rows selected
```

Subquery returns no rows because there is no employee named "Haas."

Multiple-Row Subqueries

- Return more than one row
- Use multiple-row comparison operators

Operator	Meaning
IN	Equal to any member in the list
ANY	Must be preceded by =, !=, >, <, <=, >=. Compares a value to each value in a list or returned by a query. Evaluates to FALSE if the query returns no rows.
ALL	Must be preceded by =, !=, >, <, <=, >=. Compares a value to every value in a list or returned by a query. Evaluates to TRUE if the query returns no rows.

Using the ANY Operator
in Multiple-Row Subqueries

```
SELECT  employee_id, last_name, job_id, salary
FROM    employees          9000, 6000, 4200
WHERE   salary < ANY
                (SELECT salary
                 FROM    employees
                 WHERE   job_id = 'IT_PROG')
AND     job_id <> 'IT_PROG';
```

	EMPLOYEE_ID	LAST_NAME	JOB_ID	SALARY
1	144	Vargas	ST_CLERK	2500
2	143	Matos	ST_CLERK	2600
3	142	Davies	ST_CLERK	3100
4	141	Rajs	ST_CLERK	3500
5	200	Whalen	AD_ASST	4400

...

9	206	Gietz	AC_ACCOUNT	8300
10	176	Taylor	SA_REP	8600

Using the `ALL` Operator
in Multiple-Row Subqueries

```
SELECT  employee_id, last_name, job_id, salary
FROM    employees        9000, 6000, 4200
WHERE   salary < ALL
                  (SELECT salary
                   FROM    employees
                   WHERE   job_id = 'IT_PROG')
AND     job_id <> 'IT_PROG';
```

	EMPLOYEE_ID	LAST_NAME	JOB_ID	SALARY
1	141	Rajs	ST_CLERK	3500
2	142	Davies	ST_CLERK	3100
3	143	Matos	ST_CLERK	2600
4	144	Vargas	ST_CLERK	2500

Null Values in a Subquery

```
SELECT  emp.last_name
FROM    employees emp
WHERE   emp.employee_id NOT IN
                            (SELECT mgr.manager_id
                             FROM    employees mgr);
```

0 rows selected

Quiz

Using a subquery is equivalent to performing two sequential queries and using the result of the first query as the search value(s) in the second query.

1. True
2. False

Summary

In this lesson, you should have learned how to:

- Identify when a subquery can help solve a problem
- Write subqueries when a query is based on unknown values

```
SELECT      select_list
FROM        table
WHERE       expr operator
                      (SELECT select_list
                       FROM      table);
```

Practice 7: Overview

This practice covers the following topics:

- Creating subqueries to query values based on unknown criteria

- Using subqueries to find out the values that exist in one set of data and not in another

Using the Set Operators

Objectives

After completing this lesson, you should be able to do the following:

- Describe set operators

- Use a set operator to combine multiple queries into a single query

- Control the order of rows returned

Set Operators

UNION/UNION ALL

INTERSECT

MINUS
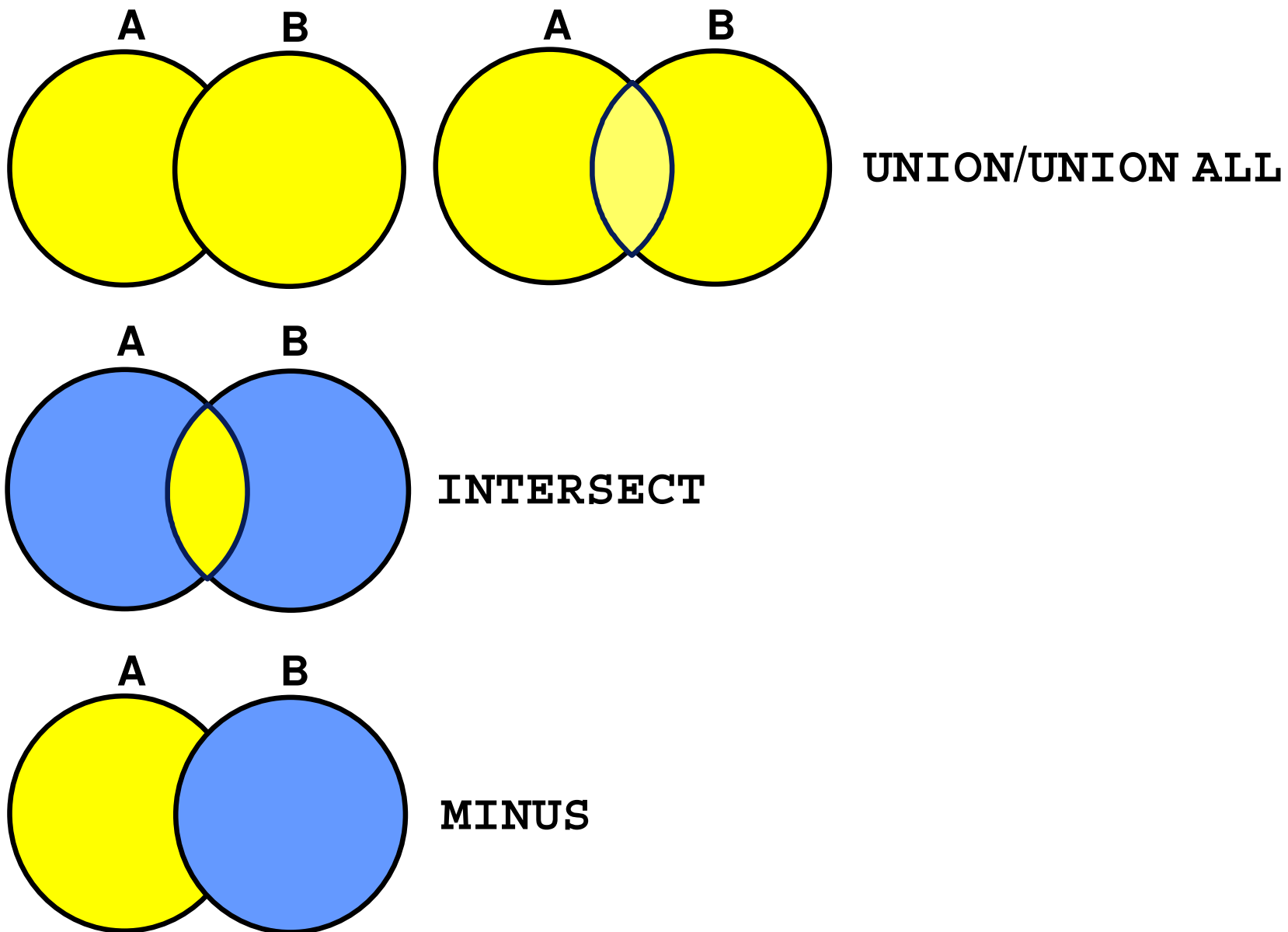
Set Operator Guidelines

- The expressions in the `SELECT` lists must match in number.

- The data type of each column in the second query must match the data type of its corresponding column in the first query.

- Parentheses can be used to alter the sequence of execution.

- `ORDER BY` clause can appear only at the very end of the statement.

The Oracle Server and Set Operators

- Duplicate rows are automatically eliminated except in `UNION ALL`.

- Column names from the first query appear in the result.

- The output is sorted in ascending order by default except in `UNION ALL`.

Tables Used in This Lesson

The tables used in this lesson are:

- `EMPLOYEES`: Provides details regarding all current employees

- `JOB_HISTORY`: Records the details of the start date and end date of the former job, and the job identification number and department when an employee switches jobs

`UNION` Operator

A   B
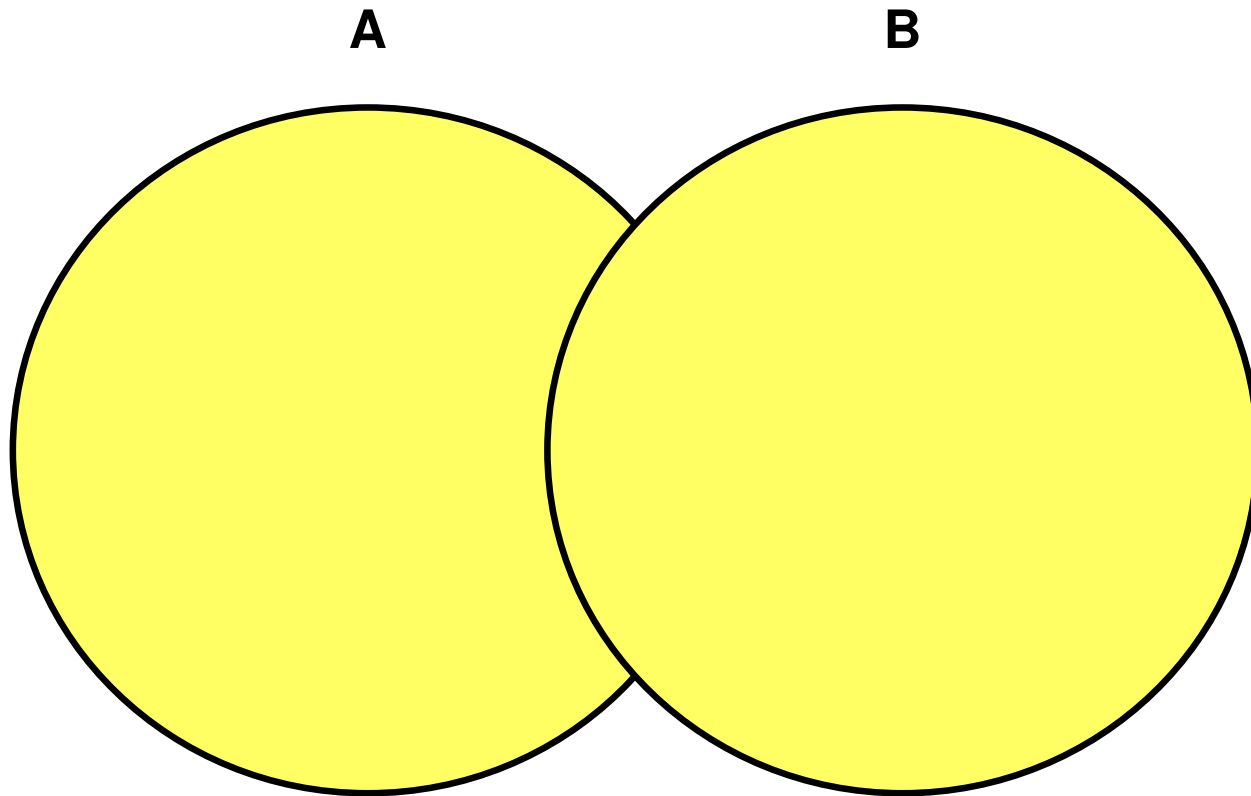
The `UNION` operator returns rows from both queries after eliminating duplications.

Using the `UNION` Operator

Display the current and previous job details of all employees. Display each employee only once.

```
SELECT  employee_id, job_id
FROM    employees
UNION
SELECT  employee_id, job_id
FROM    job_history;
```

	EMPLOYEE_ID	JOB_ID
1	100	AD_PRES
2	101	AC_ACCOUNT

...

	EMPLOYEE_ID	JOB_ID
22	200	AC_ACCOUNT
23	200	AD_ASST
24	201	MK_MAN

...

UNION ALL Operator

A **B**
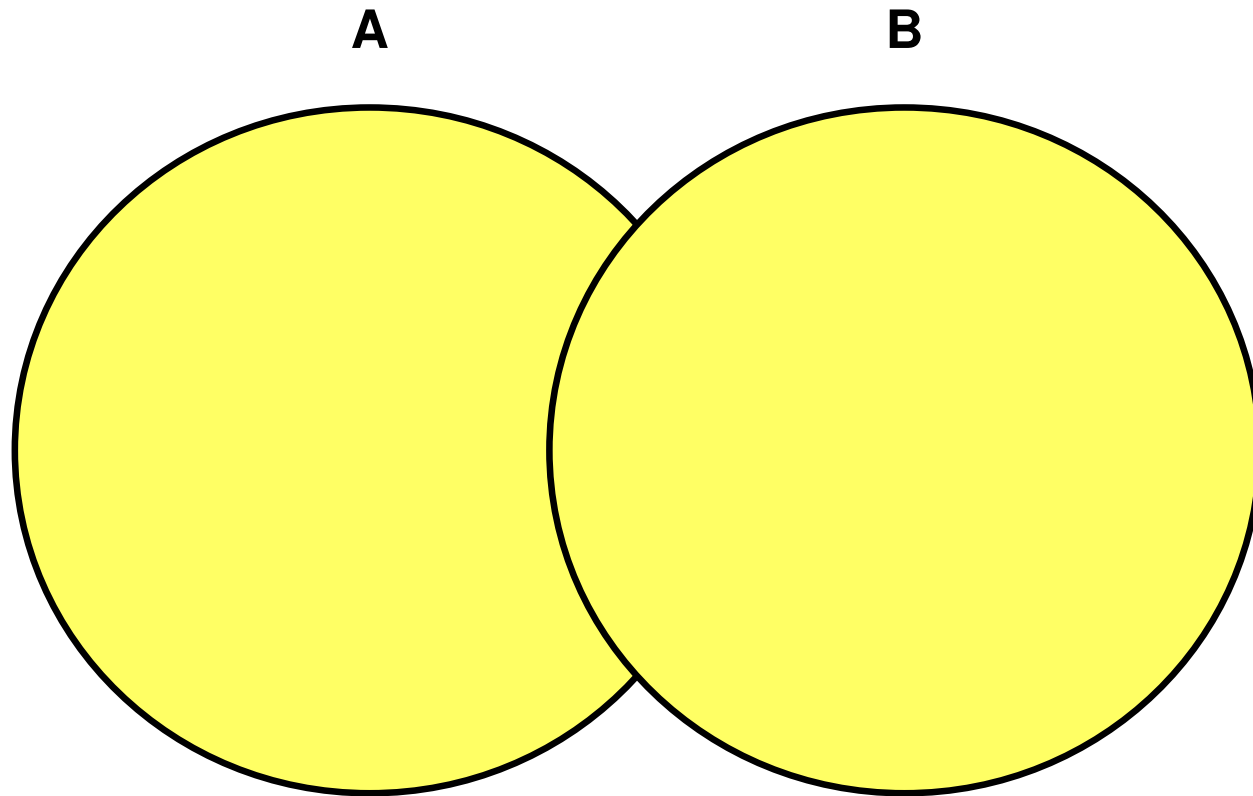
The `UNION ALL` operator returns rows from both queries, including all duplications.

Using the `UNION ALL` Operator

Display the current and previous departments of all employees.

```
SELECT employee_id, job_id, department_id
FROM    employees
UNION ALL
SELECT employee_id, job_id, department_id
FROM    job_history
ORDER BY  employee_id;
```

	EMPLOYEE_ID	JOB_ID	DEPARTMENT_ID
1	100	AD_PRES	90

...

	EMPLOYEE_ID	JOB_ID	DEPARTMENT_ID
16	144	ST_CLERK	50
17	149	SA_MAN	80
18	174	SA_REP	80
19	176	SA_REP	80
20	176	SA_MAN	80
21	176	SA_REP	80
22	178	SA_REP	(null)

...

	EMPLOYEE_ID	JOB_ID	DEPARTMENT_ID
30	206	AC_ACCOUNT	110

`INTERSECT` Operator

A

B
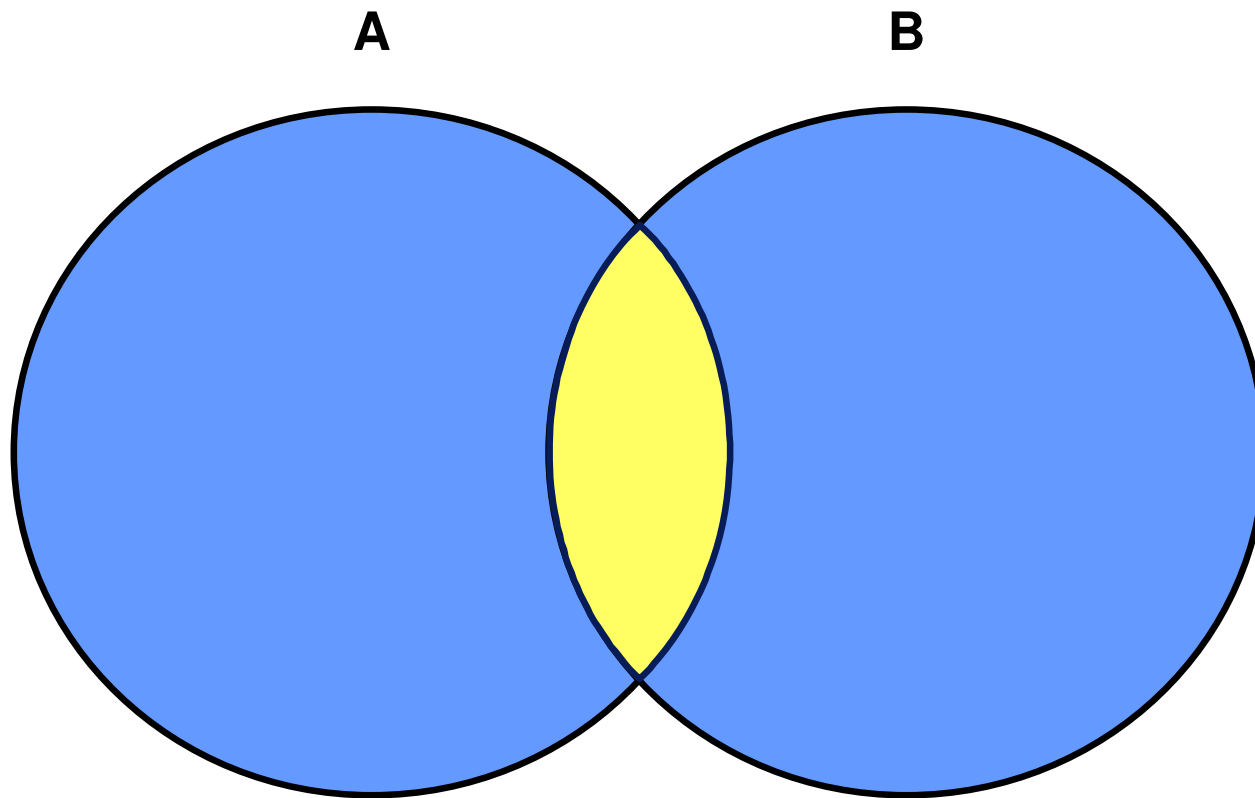
The `INTERSECT` operator returns rows that are common to both queries.

Using the `INTERSECT` Operator

Display the employee IDs and job IDs of those employees who currently have a job title that is the same as their previous one (that is, they changed jobs but have now gone back to doing the same job they did previously).

```
SELECT  employee_id, job_id
FROM    employees
INTERSECT
SELECT  employee_id, job_id
FROM    job_history;
```

	EMPLOYEE_ID	JOB_ID
1	176	SA_REP
2	200	AD_ASST

`MINUS` Operator
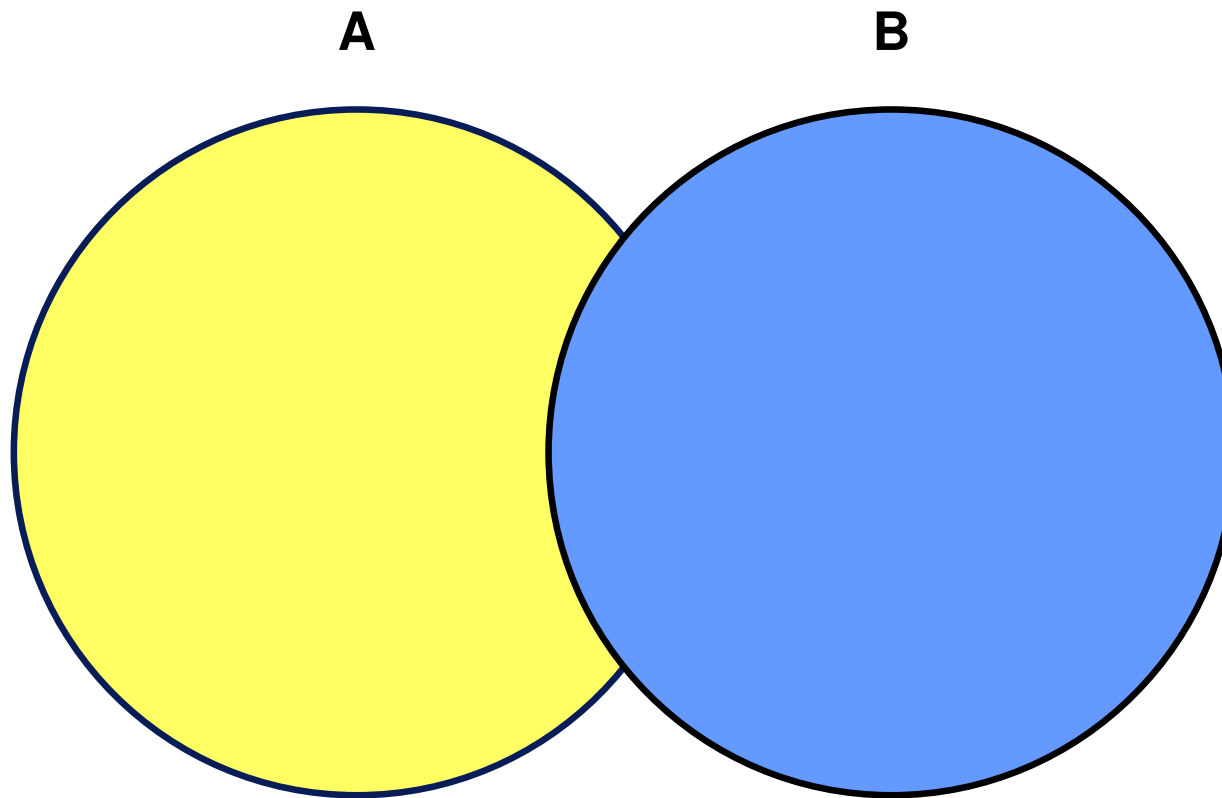
The `MINUS` operator returns all the distinct rows selected by the first query, but not present in the second query result set.

Using the `MINUS` Operator

Display the employee IDs of those employees who have not changed their jobs even once.

```
SELECT  employee_id
FROM    employees
MINUS
SELECT  employee_id
FROM    job_history;
```

	EMPLOYEE_ID
1	100
2	103
3	104
4	107
5	124

...

14	205
15	206

Matching the `SELECT` Statements

- Using the `UNION` operator, display the location ID, department name, and the state where it is located.
- You must match the data type (using the `TO_CHAR` function or any other conversion functions) when columns do not exist in one or the other table.

```
SELECT location_id, department_name "Department",
   TO_CHAR(NULL) "Warehouse location"
FROM departments
UNION
SELECT location_id, TO_CHAR(NULL) "Department",
   state_province
FROM locations;
```

Matching the `SELECT` Statement: Example

Using the `UNION` operator, display the employee ID, job ID, and salary of all employees.

```
SELECT  employee_id, job_id,salary
FROM    employees
UNION
SELECT  employee_id, job_id,0
FROM    job_history;
```

	EMPLOYEE_ID	JOB_ID	SALARY
1	100	AD_PRES	24000
2	101	AC_ACCOUNT	0
3	101	AC_MGR	0
4	101	AD_VP	17000
5	102	AD_VP	17000

…

29	205	AC_MGR	12000
30	206	AC_ACCOUNT	8300

Using the `ORDER BY` Clause in Set Operations

- The `ORDER BY` clause can appear only once at the end of the compound query.
- Component queries cannot have individual `ORDER BY` clauses.
- `ORDER BY` clause recognizes only the columns of the first `SELECT` query.
- By default, the first column of the first `SELECT` query is used to sort the output in an ascending order.

Quiz

Identify the set operator guidelines.

1. The expressions in the `SELECT` lists must match in number.

2. Parentheses may not be used to alter the sequence of execution.

3. The data type of each column in the second query must match the data type of its corresponding column in the first query.

4. The `ORDER BY` clause can be used only once in a compound query, unless a `UNION ALL` operator is used.

Summary

In this lesson, you should have learned how to use:

- `UNION` to return all distinct rows

- `UNION ALL` to return all rows, including duplicates

- `INTERSECT` to return all rows that are shared by both queries

- `MINUS` to return all distinct rows that are selected by the first query, but not by the second

- `ORDER BY` only at the very end of the statement

Practice 8: Overview

In this practice, you create reports by using:

- The `UNION` operator

- The `INTERSECTION` operator

- The `MINUS` operator

Manipulating Data

Objectives

After completing this lesson, you should be able to do the following:

- Describe each data manipulation language (DML) statement
- Insert rows into a table
- Update rows in a table
- Delete rows from a table
- Control transactions

Data Manipulation Language

- A DML statement is executed when you:
    - Add new rows to a table
    - Modify existing rows in a table
    - Remove existing rows from a table
- A *transaction* consists of a collection of DML statements that form a logical unit of work.

Adding a New Row to a Table

| | 70 | Public Relations | 100 | 1700 |

New row

DEPARTMENTS

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	200	1700
2	20	Marketing	201	1800
3	50	Shipping	124	1500
4	60	IT	103	1400
5	80	Sales	149	2500
6	90	Executive	100	1700
7	110	Accounting	205	1700
8	190	Contracting	(null)	1700

Insert new row into the DEPARTMENTS table.

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	200	1700
2	20	Marketing	201	1800
3	50	Shipping	124	1500
4	60	IT	103	1400
5	80	Sales	149	2500
6	90	Executive	100	1700
7	110	Accounting	205	1700
8	190	Contracting	(null)	1700

| 9 | 70 | Public Relations | 100 | 1700 |

`INSERT` Statement Syntax

- Add new rows to a table by using the `INSERT` statement:

```
INSERT INTO   table [(column [, column...])]
VALUES        (value [, value...]);
```

- With this syntax, only one row is inserted at a time.

Inserting New Rows

- Insert a new row containing values for each column.
- List values in the default order of the columns in the table.
- Optionally, list the columns in the `INSERT` clause.

```
INSERT INTO departments(department_id,
        department_name, manager_id, location_id)
VALUES (70, 'Public Relations', 100, 1700);
```
`1 rows inserted`

- Enclose character and date values within single quotation marks.

Inserting Rows with Null Values

- Implicit method: Omit the column from the column list.

```
INSERT INTO   departments (department_id,
                              department_name)
VALUES        (30, 'Purchasing');
1 rows inserted
```

- Explicit method: Specify the NULL keyword in the VALUES clause.

```
INSERT INTO   departments
VALUES        (100, 'Finance', NULL, NULL);
1 rows inserted
```

Inserting Special Values

The SYSDATE function records the current date and time.

```
INSERT INTO employees (employee_id,
                first_name, last_name,
                email, phone_number,
                hire_date, job_id, salary,
                commission_pct, manager_id,
                department_id)
VALUES          (113,
                'Louis', 'Popp',
                'LPOPP', '515.124.4567',
                SYSDATE, 'AC_ACCOUNT', 6900,
                NULL, 205, 110);
1 rows inserted
```

Inserting Specific Date and Time Values

- Add a new employee.

```
INSERT INTO employees
VALUES          (114,
                 'Den', 'Raphealy',
                 'DRAPHEAL', '515.127.4561',
                 TO_DATE('FEB 3, 1999', 'MON DD, YYYY'),
                 'SA_REP', 11000, 0.2, 100, 60);
```
```
1 rows inserted
```

- Verify your addition.

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	EMAIL	PHONE_NUMBER	HIRE_DATE	JOB_ID	SALARY	COMMISSION_PCT
114	Den	Raphealy	DRAPHEAL	515.127.4561	03-FEB-99	SA_REP	11000	0.2

Copying Rows
from Another Table

- Write your `INSERT` statement with a subquery:

```
INSERT INTO sales_reps(id, name, salary, commission_pct)
   SELECT employee_id, last_name, salary, commission_pct
   FROM    employees
   WHERE   job_id LIKE '%REP%';

4 rows inserted
```

- Do not use the `VALUES` clause.

- Match the number of columns in the `INSERT` clause to those in the subquery.

- Inserts all the rows returned by the subquery in the table, `sales_reps`.

Changing Data in a Table

EMPLOYEES

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	SALARY	MANAGER_ID	COMMISSION_PCT	DEPARTMENT_ID
100	Steven	King	24000	(null)	(null)	90
101	Neena	Kochhar	17000	100	(null)	90
102	Lex	De Haan	17000	100	(null)	90
103	Alexander	Hunold	9000	102	(null)	60
104	Bruce	Ernst	6000	103	(null)	60
107	Diana	Lorentz	4200	103	(null)	60
124	Kevin	Mourgos	5800	100	(null)	50

Update rows in the EMPLOYEES table:

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	SALARY	MANAGER_ID	COMMISSION_PCT	DEPARTMENT_ID
100	Steven	King	24000	(null)	(null)	90
101	Neena	Kochhar	17000	100	(null)	90
102	Lex	De Haan	17000	100	(null)	90
103	Alexander	Hunold	9000	102	(null)	80
104	Bruce	Ernst	6000	103	(null)	80
107	Diana	Lorentz	4200	103	(null)	80
124	Kevin	Mourgos	5800	100	(null)	50

`UPDATE` Statement Syntax

- Modify existing values in a table with the `UPDATE` statement:

```
UPDATE          table
SET             column = value [, column = value, ...]
 [WHERE         condition];
```

- Update more than one row at a time (if required).

Updating Rows in a Table

- Values for a specific row or rows are modified if you specify the `WHERE` clause:

```
UPDATE  employees
SET     department_id = 50
WHERE   employee id = 113;
1 rows updated
```

- Values for all the rows in the table are modified if you omit the `WHERE` clause:

```
UPDATE    copy_emp
SET       department_id = 110;
22 rows updated
```

- Specify `SET` *column_name*`= NULL` to update a column value to `NULL`.

Updating Two Columns with a Subquery

Update employee 113's job and salary to match those of employee 205.

```
UPDATE    employees
SET       job_id  = (SELECT   job_id
                      FROM     employees
                      WHERE    employee_id = 205),
          salary  = (SELECT   salary
                      FROM     employees
                      WHERE    employee_id = 205)
WHERE     employee_id     =   113;
```

```
1 rows updated
```

Updating Rows Based on Another Table

Use the subqueries in the `UPDATE` statements to update row values in a table based on values from another table:

```
UPDATE   copy_emp
SET      department_id  =  (SELECT department_id
                            FROM employees
                            WHERE employee id = 100)
WHERE    job_id          =  (SELECT job_id
                            FROM employees
                            WHERE employee_id = 200);

1 rows updated
```

Removing a Row from a Table

DEPARTMENTS

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	200	1700
2	20	Marketing	201	1800
3	50	Shipping	124	1500
4	60	IT	103	1400
5	80	Sales	149	2500
6	90	Executive	100	1700
7	110	Accounting	205	1700
8	190	Contracting	(null)	1700

Delete a row from the DEPARTMENTS table:

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	200	1700
2	20	Marketing	201	1800
3	50	Shipping	124	1500
4	60	IT	103	1400
5	80	Sales	149	2500
6	90	Executive	100	1700
7	110	Accounting	205	1700

DELETE Statement

You can remove existing rows from a table by using the DELETE statement:

```
DELETE [FROM]    table
[WHERE           condition];
```

Deleting Rows from a Table

- Specific rows are deleted if you specify the `WHERE` clause:

```
DELETE FROM departments
WHERE   department_name = 'Finance';
```
`1 rows deleted`

- All rows in the table are deleted if you omit the `WHERE` clause:

```
DELETE FROM  copy_emp;
```
`22 rows deleted`

Deleting Rows Based
on Another Table

Use the subqueries in the `DELETE` statements to remove rows
from a table based on values from another table:

```
DELETE FROM employees
WHERE   department_id =
                  (SELECT department_id
                   FROM    departments
                   WHERE   department_name
                           LIKE '%Public%');
1 rows deleted
```

`TRUNCATE` **Statement**

- Removes all rows from a table, leaving the table empty and the table structure intact

- Is a data definition language (DDL) statement rather than a DML statement; cannot easily be undone

- Syntax:

```
TRUNCATE TABLE table_name;
```

- Example:

```
TRUNCATE TABLE copy_emp;
```

Database Transactions

A database transaction consists of one of the following:

- DML statements that constitute one consistent change to the data

- One DDL statement

- One data control language (DCL) statement

Database Transactions: Start and End

- Begin when the first DML SQL statement is executed.
- End with one of the following events:
  - A `COMMIT` or `ROLLBACK` statement is issued.
  - A DDL or DCL statement executes (automatic commit).
  - The user exits SQL Developer or SQL*Plus.
  - The system crashes.

Advantages of COMMIT and ROLLBACK Statements

With COMMIT and ROLLBACK statements, you can:

- Ensure data consistency

- Preview data changes before making changes permanent

- Group logically-related operations

Explicit Transaction Control Statements
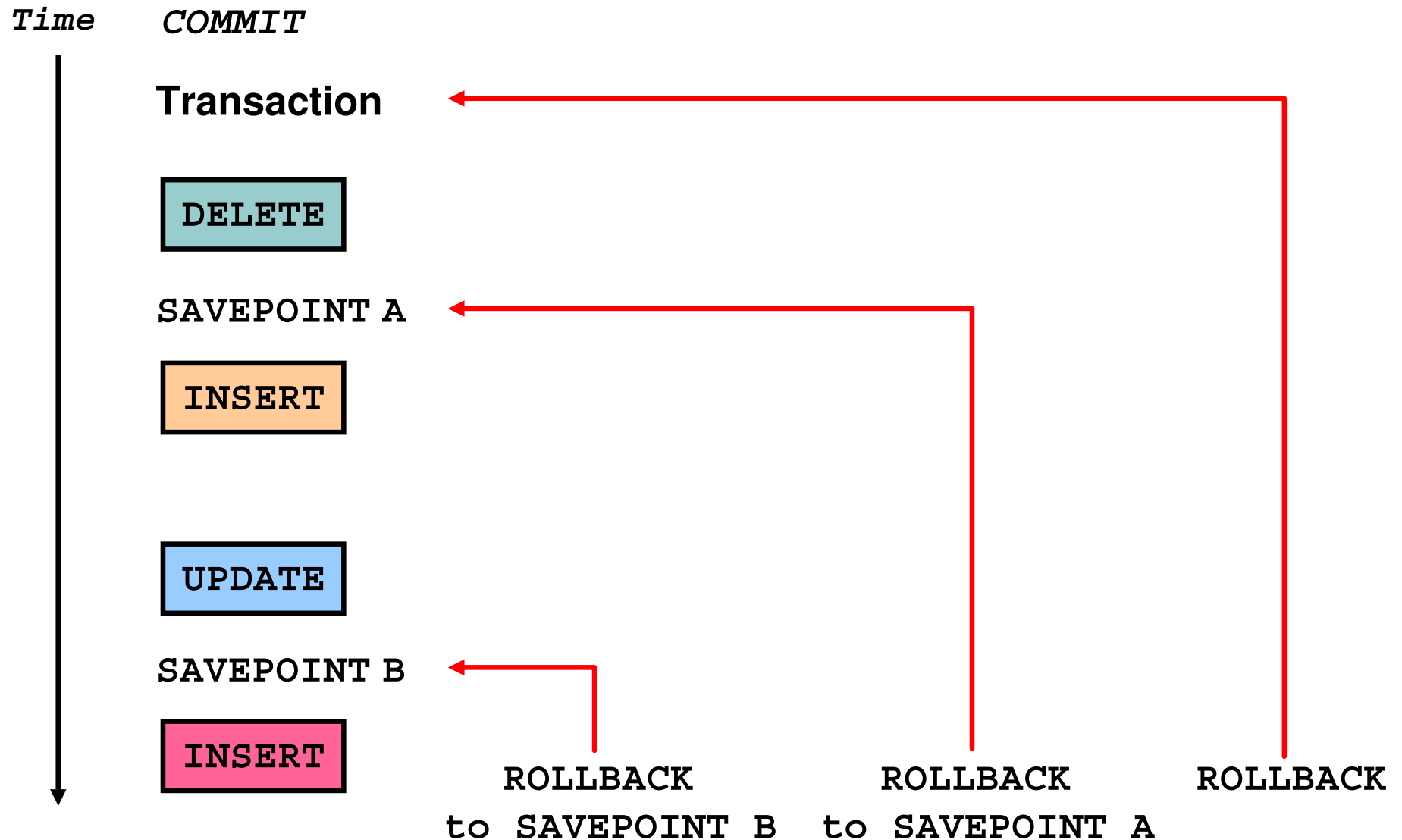
Rolling Back Changes to a Marker

- Create a marker in the current transaction by using the `SAVEPOINT` statement.

- Roll back to that marker by using the `ROLLBACK TO SAVEPOINT` statement.

```
UPDATE...
SAVEPOINT update_done;
SAVEPOINT update_done succeeded.
INSERT...
ROLLBACK TO update_done;
ROLLBACK TO succeeded.
```

Implicit Transaction Processing

- An automatic commit occurs in the following circumstances:
  - A DDL statement is issued
  - A DCL statement is issued
  - Normal exit from SQL Developer or SQL*Plus, without explicitly issuing `COMMIT` or `ROLLBACK` statements
- An automatic rollback occurs when there is an abnormal termination of SQL Developer or SQL*Plus or a system failure.

State of the Data
Before COMMIT or ROLLBACK

- The previous state of the data can be recovered.

- The current user can review the results of the DML operations by using the SELECT statement.

- Other users *cannot* view the results of the DML statements issued by the current user.

- The affected rows are *locked*; other users cannot change the data in the affected rows.

State of the Data After `COMMIT`

- Data changes are saved in the database.

- The previous state of the data is overwritten.

- All users can view the results.

- Locks on the affected rows are released; those rows are available for other users to manipulate.

- All savepoints are erased.

Committing Data

- Make the changes:

```
DELETE FROM employees
WHERE   employee_id = 99999;
```
`1 rows deleted`

```
INSERT INTO departments
VALUES (290, 'Corporate Tax', NULL, 1700);
```
`1 rows inserted`

- Commit the changes:

```
COMMIT;
```
`COMMIT succeeded.`

State of the Data After ROLLBACK

Discard all pending changes by using the ROLLBACK statement:

- Data changes are undone.
- Previous state of the data is restored.
- Locks on the affected rows are released.

```
DELETE FROM copy_emp;
ROLLBACK ;
```

State of the Data After ROLLBACK: Example

```
DELETE FROM test;
25,000 rows deleted.

ROLLBACK;
Rollback complete.

DELETE FROM test WHERE  id = 100;
1 row deleted.

SELECT * FROM   test WHERE  id = 100;
No rows selected.

COMMIT;
Commit complete.
```

Statement-Level Rollback

- If a single DML statement fails during execution, only that statement is rolled back.

- The Oracle server implements an implicit savepoint.

- All other changes are retained.

- The user should terminate transactions explicitly by executing a `COMMIT` or `ROLLBACK` statement.

Read Consistency

- Read consistency guarantees a consistent view of the data at all times.

- Changes made by one user do not conflict with the changes made by another user.

- Read consistency ensures that, on the same data:
  - Readers do not wait for writers
  - Writers do not wait for readers
  - Writers wait for writers

Implementing Read Consistency

User A

```
UPDATE employees
SET     salary = 7000
WHERE   last_name = 'Grant';
```

Data blocks

Undo segments

```
SELECT  *
FROM userA.employees;
```

Read-consistent image

Changed and unchanged data

Before change ("old" data)

User B
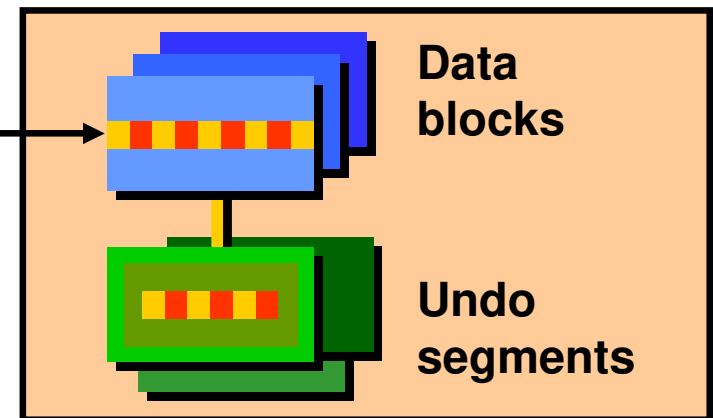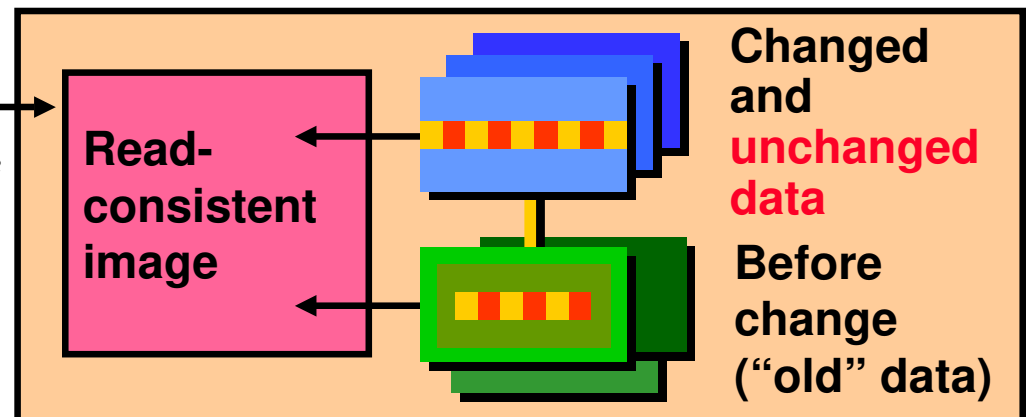
FOR UPDATE Clause in a SELECT Statement

- Locks the rows in the EMPLOYEES table where job_id is SA_REP.

```
SELECT employee_id, salary, commission_pct, job_id
FROM employees
WHERE job_id = 'SA_REP'
FOR UPDATE
ORDER BY employee_id;
```

- Lock is released only when you issue a ROLLBACK or a COMMIT.

- If the SELECT statement attempts to lock a row that is locked by another user, then the database waits until the row is available, and then returns the results of the SELECT statement.

`FOR UPDATE` Clause: Examples

- You can use the `FOR UPDATE` clause in a `SELECT` statement against multiple tables.

```
SELECT e.employee_id, e.salary, e.commission_pct
FROM employees e JOIN departments d
USING (department_id)
WHERE job_id = 'ST_CLERK'
AND location_id = 1500
FOR UPDATE
ORDER BY e.employee_id;
```

- Rows from both the `EMPLOYEES` and `DEPARTMENTS` tables are locked.

- Use `FOR UPDATE OF` *column_name* to qualify the column you intend to change, then only the rows from that specific table are locked.

Quiz

The following statements produce the same results:

```
DELETE FROM copy_emp;
```

```
TRUNCATE TABLE copy_emp;
```

1. True
2. False

Summary

In this lesson, you should have learned how to use the following statements:

Function	Description
`INSERT`	Adds a new row to the table
`UPDATE`	Modifies existing rows in the table
`DELETE`	Removes existing rows from the table
`TRUNCATE`	Removes all rows from a table
`COMMIT`	Makes all pending changes permanent
`SAVEPOINT`	Is used to roll back to the savepoint marker
`ROLLBACK`	Discards all pending data changes
`FOR UPDATE` clause in `SELECT`	Locks rows identified by the `SELECT` query

Practice 9: Overview

This practice covers the following topics:

- Inserting rows into the tables
- Updating and deleting rows in the table
- Controlling transactions

Using DDL Statements
to Create and Manage Tables

Objectives

After completing this lesson, you should be able to do the following:

- Categorize the main database objects
- Review the table structure
- List the data types that are available for columns
- Create a simple table
- Explain how constraints are created at the time of table creation
- Describe how schema objects work

Database Objects

Object	Description
Table	Basic unit of storage; composed of rows
View	Logically represents subsets of data from one or more tables
Sequence	Generates numeric values
Index	Improves the performance of some queries
Synonym	Gives alternative name to an object

Naming Rules

Table names and column names:

- Must begin with a letter

- Must be 1–30 characters long

- Must contain only A–Z, a–z, 0–9, _, $, and #

- Must not duplicate the name of another object owned by the same user

- Must not be an Oracle server–reserved word

CREATE TABLE Statement

- You must have:
  - CREATE TABLE privilege
  - A storage area

```
CREATE TABLE [schema.]table
        (column datatype [DEFAULT expr][, ...]);
```

- You specify:
  - Table name
  - Column name, column data type, and column size
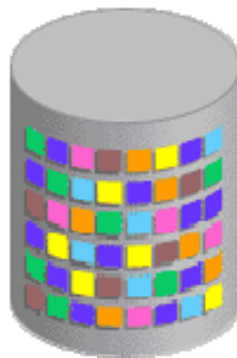
Referencing Another User's Tables

- Tables belonging to other users are not in the user's schema.

- You should use the owner's name as a prefix to those tables.

USERA

USERB

```
SELECT *
FROM userB.employees;
```

```
SELECT *
FROM userA.employees;
```
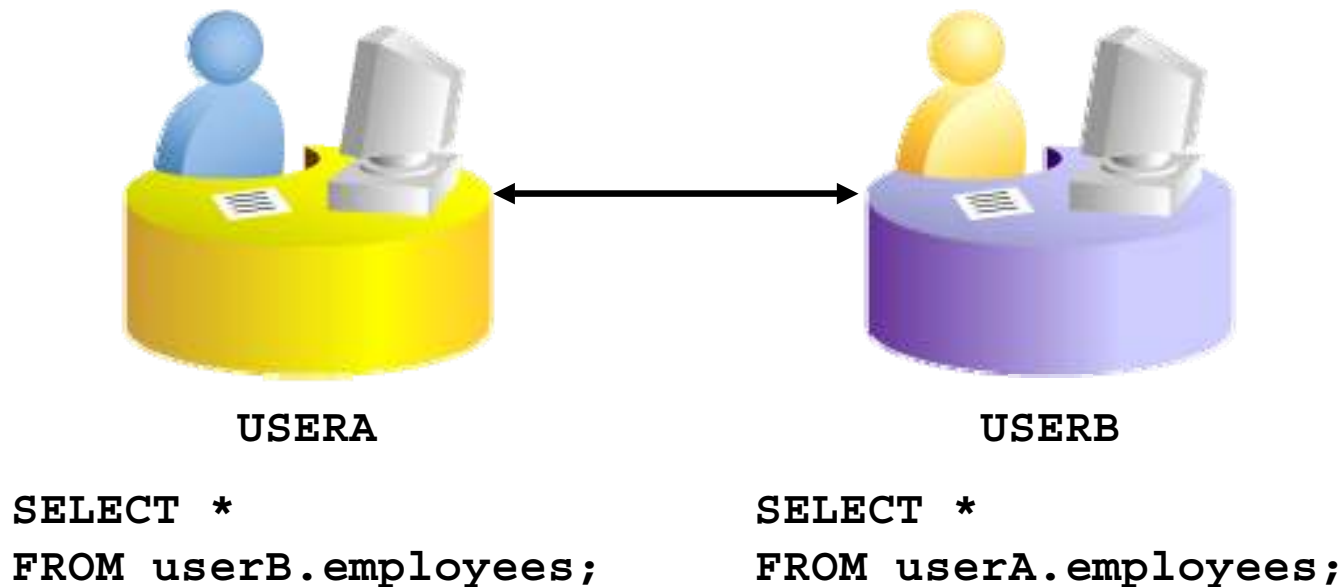
DEFAULT Option

- Specify a default value for a column during an insert.

```
... hire_date DATE DEFAULT SYSDATE, ...
```

- Literal values, expressions, or SQL functions are legal values.

- Another column's name or a pseudocolumn are illegal values.

- The default data type must match the column data type.

```
CREATE TABLE hire_dates
        (id              NUMBER(8),
         hire date DATE DEFAULT SYSDATE);
```
```
CREATE TABLE succeeded.
```

Creating Tables

- Create the table:

```
CREATE TABLE dept
        (deptno        NUMBER(2),
         dname         VARCHAR2(14),
         loc           VARCHAR2(13),
         create_date DATE DEFAULT SYSDATE);
CREATE TABLE succeeded.
```

- Confirm table creation:

```
DESCRIBE dept
```

```
DESCRIBE dept
Name                                Null      Type
----------------------------  --------  -------------
DEPTNO                                            NUMBER(2)
DNAME                                             VARCHAR2(14)
LOC                                               VARCHAR2(13)
CREATE_DATE                                       DATE
```

Data Types

PostgreSQL Equivalent	Description
VARCHAR(size) or TEXT	Variable-length character data
CHAR(size)	Fixed-length character data
NUMERIC(p,s) / DECIMAL(p,s) / BIGINT / INTEGER / SMALLINT	Variable-length numeric data
TIMESTAMP or DATE	Date and/or time values
TEXT	Variable-length character data
TEXT	Character data (up to 1 GB or more)
BYTEA	Binary data
BYTEA	Binary data
No exact equivalent (use BYTEA + external file management)	External binary file reference
CTID (system column in PostgreSQL)	Unique physical location of a row

Datetime Data Types

You can use several datetime data types:

Data Type	Description	Example
DATE	Calendar date (year, month, day)	'2025-07-18'
TIME [(p)]	Time of day (no time zone)	'14:30:00'
TIME [(p)] WITH TIME ZONE	Time of day with time zone	'14:30:00+05:00'
TIMESTAMP [(p)]	Date and time (no time zone)	'2025-07-18 14:30:00'
TIMESTAMP [(p)] WITH TIME ZONE	Date and time with time zone	'2025-07-18 14:30:00+05:00'
INTERVAL	Time span (years, months, days, hours, etc.)	'1 year 2 months 3 days'

Including Constraints

- Constraints enforce rules at the table level.
- Constraints prevent the deletion of a table if there are dependencies.
- The following constraint types are valid:
  - `NOT NULL`
  - `UNIQUE`
  - `PRIMARY KEY`
  - `FOREIGN KEY`
  - `CHECK`

Constraint Guidelines

- You can name a constraint, or the Oracle server generates a name by using the `SYS_Cn` format.

- Create a constraint at either of the following times:
  - At the same time as the creation of the table
  - After the creation of the table

- Define a constraint at the column or table level.

- View a constraint in the data dictionary.

Defining Constraints

- Syntax:

```
CREATE TABLE [schema.]table
     (column datatype [DEFAULT expr]
     [column_constraint],
     ...
     [table_constraint][,...]);
```

- Column-level constraint syntax:

```
column [CONSTRAINT constraint_name] constraint_type,
```

- Table-level constraint syntax:

```
column,...
  [CONSTRAINT constraint_name] constraint_type
  (column, ...),
```

Defining Constraints

- Example of a column-level constraint:

```
CREATE TABLE employees(
  employee_id  NUMBER(6)
    CONSTRAINT emp_emp_id_pk PRIMARY KEY,
  first_name   VARCHAR2(20),
  ...);
```

1

- Example of a table-level constraint:

```
CREATE TABLE employees(
  employee_id  NUMBER(6),
  first_name   VARCHAR2(20),
  ...
  job_id       VARCHAR2(10) NOT NULL,
  CONSTRAINT emp_emp_id_pk
    PRIMARY KEY (EMPLOYEE ID));
```

2

NOT NULL Constraint

Ensures that null values are not permitted for the column:

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	EMAIL	HIRE_DATE	JOB_ID	COMMISSION_PCT
100	Steven	King	SKING	17-JUN-87	AD_PRES	(null)
101	Neena	Kochhar	NKOCHHAR	21-SEP-89	AD_VP	(null)
102	Lex	De Haan	LDEHAAN	13-JAN-93	AD_VP	(null)
103	Alexander	Hunold	AHUNOLD	03-JAN-90	IT_PROG	(null)
104	Bruce	Ernst	BERNST	21-MAY-91	IT_PROG	(null)
107	Diana	Lorentz	DLORENTZ	07-FEB-99	IT_PROG	(null)
124	Kevin	Mourgos	KMOURGOS	16-NOV-99	ST_MAN	(null)
141	Trenna	Rajs	TRAJS	17-OCT-95	ST_CLERK	(null)
142	Curtis	Davies	CDAVIES	29-JAN-97	ST_CLERK	(null)
143	Randall	Matos	RMATOS	15-MAR-98	ST_CLERK	(null)
144	Peter	Vargas	PVARGAS	09-JUL-98	ST_CLERK	(null)
149	Eleni	Zlotkey	EZLOTKEY	29-JAN-00	SA_MAN	0.2
174	Ellen	Abel	EABEL	11-MAY-96	SA_REP	0.3

...

NOT NULL constraint (Primary Key enforces NOT NULL constraint.)

NOT NULL constraint

Absence of NOT NULL constraint (Any row can contain a null value for this column.)

`UNIQUE` Constraint

`UNIQUE` **constraint**

EMPLOYEES

EMPLOYEE_ID	LAST_NAME	EMAIL
100	King	SKING
101	Kochhar	NKOCHHAR
102	De Haan	LDEHAAN
103	Hunold	AHUNOLD
104	Ernst	BERNST
107	Lorentz	DLORENTZ

...

`INSERT INTO`

208	SMITH	JSMITH	← **Allowed**
209	SMITH	JSMITH	← **Not allowed:** **already exists**

UNIQUE Constraint

Defined at either the table level or the column level:

```
CREATE TABLE employees(
    employee_id       NUMBER(6),
    last_name         VARCHAR2(25) NOT NULL,
    email             VARCHAR2(25),
    salary            NUMBER(8,2),
    commission_pct    NUMBER(2,2),
    hire_date         DATE NOT NULL,
...
    CONSTRAINT emp_email_uk UNIQUE(email));
```

PRIMARY KEY **Constraint**

DEPARTMENTS   PRIMARY KEY

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	200	1700
2	20	Marketing	201	1800
3	50	Shipping	124	1500
4	60	IT	103	1400
5	80	Sales	149	2500
6	90	Executive	100	1700
7	110	Accounting	205	1700
8	190	Contracting	(null)	1700

**Not allowed
(null value)**

INSERT INTO

	Public Accounting	124	2500

50	Finance	124	1500

**Not allowed
(50 already exists)**

FOREIGN KEY Constraint

DEPARTMENTS

PRIMARY
KEY

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	200	1700
2	20	Marketing	201	1800
3	50	Shipping	124	1500
4	60	IT	103	1400
5	80	Sales	149	2500

...

EMPLOYEES

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
1	100	King	90
2	101	Kochhar	90
3	102	De Haan	90
4	103	Hunold	60
5	104	Ernst	60

FOREIGN
KEY

...

INSERT INTO

200	Ford	9
201	Ford	60

**Not allowed
(9 does not
exist)**

Allowed

FOREIGN KEY Constraint

Defined at either the table level or the column level:

```
CREATE TABLE employees(
    employee_id        NUMBER(6),
    last_name          VARCHAR2(25) NOT NULL,
    email              VARCHAR2(25),
    salary             NUMBER(8,2),
    commission_pct     NUMBER(2,2),
    hire_date          DATE NOT NULL,
...
    department_id      NUMBER(4),
    CONSTRAINT emp_dept_fk FOREIGN KEY (department_id)
      REFERENCES departments(department_id),
    CONSTRAINT emp_email_uk UNIQUE(email));
```

`FOREIGN KEY` Constraint: Keywords

- `FOREIGN KEY`: Defines the column in the child table at the table-constraint level
- `REFERENCES`: Identifies the table and column in the parent table
- `ON DELETE CASCADE`: Deletes the dependent rows in the child table when a row in the parent table is deleted
- `ON DELETE SET NULL`: Converts dependent foreign key values to null

`CHECK` **Constraint**

- Defines a condition that each row must satisfy
- The following expressions are not allowed:
  - References to `CURRVAL`, `NEXTVAL`, `LEVEL`, and `ROWNUM` pseudocolumns
  - Calls to `SYSDATE`, `UID`, `USER`, and `USERENV` functions
  - Queries that refer to other values in other rows

```
..., salary   NUMBER(2)
      CONSTRAINT emp_salary_min
            CHECK (salary > 0),...
```

CREATE TABLE: Example

```
CREATE TABLE employees
    ( employee_id      NUMBER(6)
        CONSTRAINT        emp_employee_id    PRIMARY KEY
    , first_name       VARCHAR2(20)
    , last_name        VARCHAR2(25)
        CONSTRAINT        emp_last_name_nn   NOT NULL
    , email            VARCHAR2(25)
        CONSTRAINT        emp_email_nn       NOT NULL
        CONSTRAINT        emp_email_uk       UNIQUE
    , phone_number     VARCHAR2(20)
    , hire_date        DATE
        CONSTRAINT        emp_hire_date_nn   NOT NULL
    , job_id           VARCHAR2(10)
        CONSTRAINT        emp_job_nn         NOT NULL
    , salary           NUMBER(8,2)
        CONSTRAINT        emp_salary_ck      CHECK (salary>0)
    , commission_pct   NUMBER(2,2)
    , manager_id       NUMBER(6)
        CONSTRAINT emp_manager_fk REFERENCES
          employees (employee_id)
    , department_id    NUMBER(4)
        CONSTRAINT        emp_dept_fk        REFERENCES
            departments (department_id));
```

Violating Constraints

```
UPDATE  employees
SET      department_id = 55
WHERE   department_id = 110;
```

```
Error starting at line 1 in command:
UPDATE employees
SET     department_id = 55
WHERE   department_id = 110
Error report:
SQL Error: ORA-02291: integrity constraint (ORA16.EMP_DEPT_FK) violated - parent key not found
02291. 00000 - "integrity constraint (%s.%s) violated - parent key not found"
*Cause:     A foreign key value has no matching primary key value.
*Action:    Delete the foreign key or add a matching primary key.
```

Department 55 does not exist.

Creating a Table
Using a Subquery

- Create a table and insert rows by combining the `CREATE TABLE` statement and the `AS subquery` option.

```
CREATE TABLE table
        [(column, column...)]
AS subquery;
```

- Match the number of specified columns to the number of subquery columns.

- Define columns with column names and default values.

Creating a Table
Using a Subquery

```
CREATE TABLE  dept80
  AS
    SELECT   employee_id, last_name,
             salary*12 ANNSAL,
             hire_date
    FROM     employees
    WHERE    department id = 80;
CREATE TABLE succeeded.
```

```
DESCRIBE dept80
```

```
Name                            Null      Type
------------------------------- --------  -------------
EMPLOYEE_ID                                NUMBER(6)
LAST_NAME                       NOT NULL  VARCHAR2(25)
ANNSAL                                     NUMBER
HIRE_DATE                       NOT NULL  DATE
```

`ALTER TABLE` **Statement**

Use the `ALTER TABLE` statement to:

- Add a new column

- Modify an existing column definition

- Define a default value for the new column

- Drop a column

- Rename a column

- Change table to read-only status

Read-Only Tables

You can use the `ALTER TABLE` syntax to:

- Put a table into read-only mode, which prevents DDL or DML changes during table maintenance
- Put the table back into read/write mode

```
ALTER TABLE employees READ ONLY;

-- perform table maintenance and then
-- return table back to read/write mode

ALTER TABLE employees READ WRITE;
```

Dropping a Table

- Moves a table to the recycle bin
- Removes the table and all its data entirely if the `PURGE` clause is specified
- Invalidates dependent objects and removes object privileges on the table

```
DROP TABLE dept80;
```
```
DROP TABLE dept80 succeeded.
```

Quiz

You can use constraints to do the following:

1. Enforce rules on the data in a table whenever a row is inserted, updated, or deleted.

2. Prevent the deletion of a table.

3. Prevent the creation of a table.

4. Prevent the creation of data in a table.

Summary

In this lesson, you should have learned how to use the `CREATE TABLE` statement to create a table and include constraints:

- Categorize the main database objects
- Review the table structure
- List the data types that are available for columns
- Create a simple table
- Explain how constraints are created at the time of table creation
- Describe how schema objects work

Practice 10: Overview

This practice covers the following topics:

- Creating new tables
- Creating a new table by using the `CREATE TABLE AS` syntax
- Verifying that tables exist
- Setting a table to read-only status
- Dropping tables

Creating Other Schema Objects

Objectives

After completing this lesson, you should be able to do the following:

- Create simple and complex views
- Retrieve data from views
- Create, maintain, and use sequences
- Create and maintain indexes
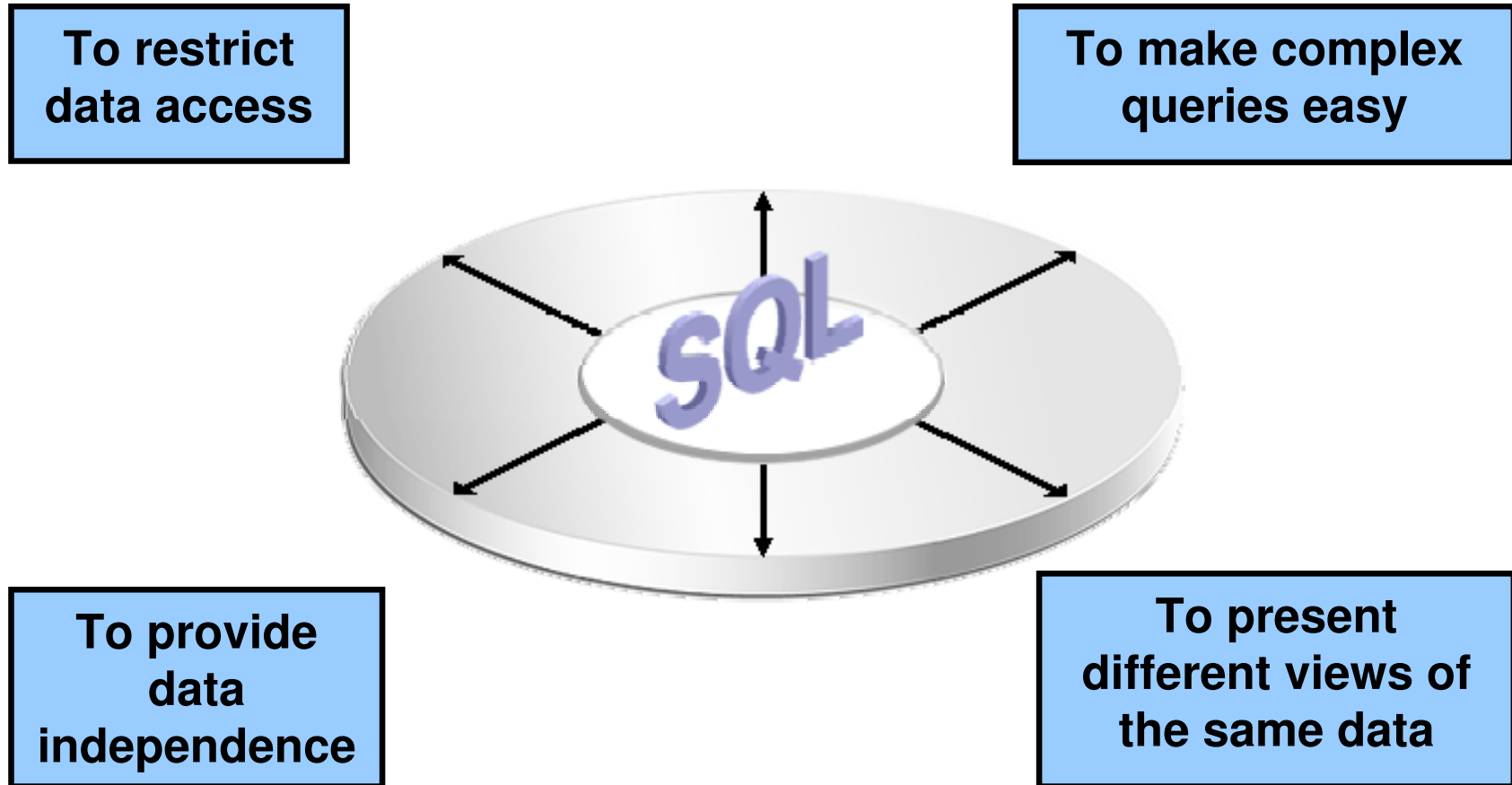- Create private and public synonyms

Database Objects

Object	Description
Table	Basic unit of storage; composed of rows
View	Logically represents subsets of data from one or more tables
Sequence	Generates numeric values
Index	Improves the performance of data retrieval queries
Synonym	Gives alternative names to objects

What Is a View?

EMPLOYEES table

Advantages of Views

To restrict
data access

To make complex
queries easy

To provide
data
independence

To present
different views of
the same data

SQL

Simple Views and Complex Views

Feature	Simple Views	Complex Views
Number of tables	One	One or more
Contain functions	No	Yes
Contain groups of data	No	Yes
DML operations through a view	Yes	Not always

Creating a View

- You embed a subquery in the `CREATE VIEW` statement:

```
CREATE [OR REPLACE]  [FORCE|NOFORCE] VIEW view
  [(alias[, alias]...)]
 AS subquery
[WITH CHECK OPTION [CONSTRAINT constraint]]
[WITH READ ONLY [CONSTRAINT constraint]];
```

- The subquery can contain complex `SELECT` syntax.

Creating a View

- Create the `EMPVU80` view, which contains details of the employees in department 80:

```
CREATE VIEW   empvu80
 AS SELECT    employee_id, last_name, salary
    FROM      employees
    WHERE     department_id = 80;
CREATE VIEW succeeded.
```

- Describe the structure of the view by using the *i*SQL*Plus `DESCRIBE` command:

```
DESCRIBE empvu80
```

Creating a View

- Create a view by using column aliases in the subquery:

```
CREATE VIEW   salvu50
 AS SELECT    employee_id ID_NUMBER, last_name NAME,
              salary*12 ANN_SALARY
    FROM      employees
    WHERE     department_id = 50;
CREATE VIEW succeeded.
```

- Select the columns from this view by the given alias names.

Retrieving Data from a View

```
SELECT *
FROM   salvu50;
```

	ID_NUMBER	NAME	ANN_SALARY
1	124	Mourgos	69600
2	141	Rajs	42000
3	142	Davies	37200
4	143	Matos	31200
5	144	Vargas	30000

Modifying a View

- Modify the `EMPVU80` view by using a `CREATE OR REPLACE VIEW` clause. Add an alias for each column name:

```
CREATE OR REPLACE VIEW empvu80
  (id_number, name, sal, department_id)
AS SELECT   employee_id, first_name || ' '
            || last_name, salary, department_id
   FROM     employees
   WHERE    department_id = 80;
CREATE OR REPLACE VIEW succeeded.
```

- Column aliases in the `CREATE OR REPLACE VIEW` clause are listed in the same order as the columns in the subquery.

Creating a Complex View

Create a complex view that contains group functions to display values from two tables:

```
CREATE OR REPLACE VIEW dept_sum_vu
   (name, minsal, maxsal, avgsal)
AS SELECT    d.department_name, MIN(e.salary),
             MAX(e.salary),AVG(e.salary)
   FROM      employees e JOIN departments d
   ON        (e.department_id = d.department_id)
   GROUP BY d.department_name;
CREATE OR REPLACE VIEW succeeded.
```

Rules for Performing
DML Operations on a View

- You can usually perform DML operations on simple views. ✔

- You cannot remove a row if the view contains the following:
  – Group functions
  – A `GROUP BY` clause
  – The `DISTINCT` keyword
  – The pseudocolumn `ROWNUM` keyword

Rules for Performing
DML Operations on a View

You cannot modify data in a view if it contains:

- Group functions

- A `GROUP BY` clause

- The `DISTINCT` keyword

- The pseudocolumn `ROWNUM` keyword

- Columns defined by expressions

Rules for Performing
DML Operations on a View

You cannot add data through a view if the view includes:

- Group functions

- A `GROUP BY` clause

- The `DISTINCT` keyword

- The pseudocolumn `ROWNUM` keyword

- Columns defined by expressions

- `NOT NULL` columns in the base tables that are not selected by the view

Using the `WITH CHECK OPTION` Clause

- You can ensure that DML operations performed on the view stay in the domain of the view by using the `WITH CHECK OPTION` clause:

```
CREATE OR REPLACE VIEW empvu20
AS SELECT      *
   FROM       employees
   WHERE      department_id = 20
   WITH CHECK OPTION CONSTRAINT empvu20_ck ;
```
```
CREATE OR REPLACE VIEW succeeded.
```

- Any attempt to `INSERT` a row with a `department_id` other than 20, or to `UPDATE` the department number for any row in the view fails because it violates the `WITH CHECK OPTION` constraint.

Denying DML Operations

- You can ensure that no DML operations occur by adding the `WITH READ ONLY` option to your view definition.

- Any attempt to perform a DML operation on any row in the view results in an Oracle server error.

Denying DML Operations

```
CREATE OR REPLACE VIEW empvu10
     (employee_number, employee_name, job_title)
AS SELECT      employee_id, last_name, job_id
   FROM        employees
   WHERE       department_id = 10
   WITH READ ONLY ;
```

CREATE OR REPLACE VIEW succeeded.

Removing a View

You can remove a view without losing data because a view is based on underlying tables in the database.

```
DROP VIEW view;
```

```
DROP VIEW empvu80;
```
DROP VIEW empvu80 succeeded.

Practice 11: Overview of Part 1

This practice covers the following topics:

- Creating a simple view
- Creating a complex view
- Creating a view with a check constraint
- Attempting to modify data in the view
- Removing views

Sequences

Object	Description
Table	Basic unit of storage; composed of rows
View	Logically represents subsets of data from one or more tables
Sequence	Generates numeric values
Index	Improves the performance of some queries

Sequences

A sequence:

- Can automatically generate unique numbers
- Is a shareable object
- Can be used to create a primary key value
- Replaces application code
- Speeds up the efficiency of accessing sequence values when cached in memory
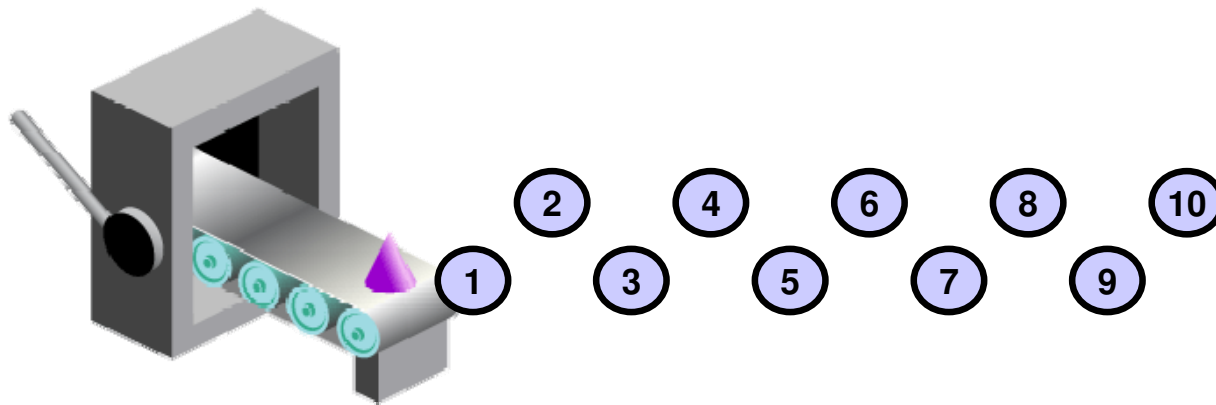
CREATE SEQUENCE Statement: Syntax

Define a sequence to generate sequential numbers automatically:

```
CREATE SEQUENCE sequence
        [INCREMENT BY n]
        [START WITH n]
        [{MAXVALUE n | NOMAXVALUE}]
        [{MINVALUE n | NOMINVALUE}]
        [{CYCLE | NOCYCLE}]
        [{CACHE n | NOCACHE}];
```

Creating a Sequence

- Create a sequence named `DEPT_DEPTID_SEQ` to be used for the primary key of the `DEPARTMENTS` table.

- Do not use the `CYCLE` option.

```
CREATE SEQUENCE dept_deptid_seq
                INCREMENT BY 10
                START WITH 120
                MAXVALUE 9999
                NOCACHE
                NOCYCLE;
CREATE SEQUENCE succeeded.
```

NEXTVAL and CURRVAL Pseudocolumns

- NEXTVAL returns the next available sequence value. It returns a unique value every time it is referenced, even for different users.

- CURRVAL obtains the current sequence value.

- NEXTVAL must be issued for that sequence before CURRVAL contains a value.

Using a Sequence

- Insert a new department named "Support" in location ID 2500:

```
INSERT INTO departments(department_id,
            department_name, location_id)
VALUES      (dept_deptid_seq.NEXTVAL,
            'Support', 2500);
```
`1 rows inserted`

- View the current value for the DEPT_DEPTID_SEQ sequence:

```
SELECT    dept_deptid_seq.CURRVAL
FROM      dual;
```

Caching Sequence Values

- Caching sequence values in memory gives faster access to those values.

- Gaps in sequence values can occur when:
    - A rollback occurs
    - The system crashes
    - A sequence is used in another table

Modifying a Sequence

Change the increment value, maximum value, minimum value, cycle option, or cache option:

```
ALTER SEQUENCE dept_deptid_seq
               INCREMENT BY 20
               MAXVALUE 999999
               NOCACHE
               NOCYCLE;
```

ALTER SEQUENCE dept_deptid_seq succeeded.

Guidelines for Modifying a Sequence

- You must be the owner or have the `ALTER` privilege for the sequence.

- Only future sequence numbers are affected.

- The sequence must be dropped and re-created to restart the sequence at a different number.

- Some validation is performed.

- To remove a sequence, use the `DROP` statement:

```
DROP SEQUENCE dept_deptid_seq;
```
DROP SEQUENCE dept_deptid_seq succeeded.

Indexes

Object	Description
Table	Basic unit of storage; composed of rows
View	Logically represents subsets of data from one or more tables
Sequence	Generates numeric values
Index	Improves the performance of some queries

Indexes

An index:

- Is a schema object

- May be used by the Oracle server to speed up the retrieval of rows by using a pointer

- Can reduce disk input/output (I/O) by using a rapid path access method to locate data quickly

- Is independent of the table that it indexes

- Is used and maintained automatically by the Oracle server
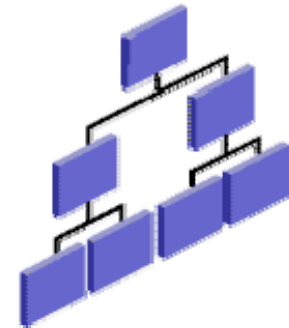
How Are Indexes Created?

- Automatically: A unique index is created automatically when you define a `PRIMARY KEY` or `UNIQUE` constraint in a table definition.

- Manually: Users can create nonunique indexes on columns to speed up access to the rows.

Creating an Index

- Create an index on one or more columns:

```
CREATE [UNIQUE][BITMAP]INDEX index
ON table (column[, column]...);
```

- Improve the speed of query access to the LAST_NAME column in the EMPLOYEES table:

```
CREATE INDEX  emp_last_name_idx
ON            employees(last_name);
```
```
CREATE INDEX succeeded.
```

Index Creation Guidelines

	Create an index when:	
✓	A column contains a wide range of values	
✓	A column contains a large number of null values	
✓	One or more columns are frequently used together in a `WHERE` clause or a join condition	
✓	The table is large and most queries are expected to retrieve less than 2% to 4% of the rows in the table	
	Do not create an index when:	
✗	The columns are not often used as a condition in the query	
✗	The table is small or most queries are expected to retrieve more than 2% to 4% of the rows in the table	
✗	The table is updated frequently	
✗	The indexed columns are referenced as part of an expression	

Removing an Index

- Remove an index from the data dictionary by using the `DROP INDEX` command:

```
DROP INDEX index;
```

- Remove the `emp_last_name_idx` index from the data dictionary:

```
DROP INDEX emp_last_name_idx;
DROP INDEX emp_last_name_idx succeeded.
```

- To drop an index, you must be the owner of the index or have the `DROP ANY INDEX` privilege.

Quiz

Indexes must be created manually and serve to speed up access to rows in a table.

1. True
2. False

Summary

In this lesson, you should have learned how to:

- Create, use, and remove views
- Automatically generate sequence numbers by using a sequence generator
- Create indexes to improve speed of query retrieval
- Use synonyms to provide alternative names for objects

Practice 11: Overview of Part 2

This practice covers the following topics:

- Creating sequences

- Using sequences

- Creating nonunique indexes

- Creating synonyms

Postgres Join Syntax

Objectives

After completing this appendix, you should be able to do the following:

- Write `SELECT` statements to access data from more than one table using equijoins and nonequijoins

- Join a table to itself by using a self-join

- View data that generally does not meet a join condition by using outer joins

- Generate a Cartesian product of all rows from two or more tables

Obtaining Data from Multiple Tables

EMPLOYEES

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
1	100	King	90
2	101	Kochhar	90
3	102	De Haan	90

...

18	202	Fay	20
19	205	Higgins	110
20	206	Gietz	110

DEPARTMENTS

	DEPARTMENT_ID	DEPARTMENT_NAME	LOCATION_ID
1	10	Administration	1700
2	20	Marketing	1800
3	50	Shipping	1500
4	60	IT	1400
5	80	Sales	2500
6	90	Executive	1700
7	110	Accounting	1700
8	190	Contracting	1700

	EMPLOYEE_ID	DEPARTMENT_ID	DEPARTMENT_NAME
1	200	10	Administration
2	201	20	Marketing
3	202	20	Marketing
4	124	50	Shipping
5	144	50	Shipping

...

| 18 | 205 | 110 | Accounting |
| 19 | 206 | 110 | Accounting |

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Cartesian Products

- A Cartesian product is formed when:
  - A join condition is omitted
  - A join condition is invalid
  - All rows in the first table are joined to all rows in the second table
- To avoid a Cartesian product, always include a valid join condition in a `WHERE` clause.

Generating a Cartesian Product

EMPLOYEES (20 rows)

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
1	100	King	90
2	101	Kochhar	90
3	102	De Haan	90
4	103	Hunold	60

...

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
19	205	Higgins	110
20	206	Gietz	110

DEPARTMENTS (8 rows)

	DEPARTMENT_ID	DEPARTMENT_NAME	LOCATION_ID
1	10	Administration	1700
2	20	Marketing	1800
3	50	Shipping	1500
4	60	IT	1400
5	80	Sales	2500
6	90	Executive	1700
7	110	Accounting	1700
8	190	Contracting	1700

Cartesian product:
20 x 8 = 160 rows

	EMPLOYEE_ID	DEPARTMENT_ID	LOCATION_ID
1	100	90	1700
2	101	90	1700
3	102	90	1700
4	103	60	1700

...

	EMPLOYEE_ID	DEPARTMENT_ID	LOCATION_ID
159	205	110	1700
160	206	110	1700

Types of Oracle-Proprietary Joins

- Equijoin
- Nonequijoin
- Outer join
- Self-join

Joining Tables Using Oracle Syntax

Use a join to query data from more than one table:

```
SELECT    table1.column, table2.column
FROM      table1, table2
WHERE     table1.column1 = table2.column2;
```

- Write the join condition in the WHERE clause.

- Prefix the column name with the table name when the same column name appears in more than one table.

Qualifying Ambiguous Column Names

- Use table prefixes to qualify column names that are in multiple tables.

- Use table prefixes to improve performance.

- Instead of full table name prefixes, use table aliases.

- Table aliases give a table a shorter name.

  - Keeps SQL code smaller, uses less memory

- Use column aliases to distinguish columns that have identical names, but reside in different tables.

Equijoins

EMPLOYEES

	EMPLOYEE_ID		DEPARTMENT_ID
	100		90
	101		90
	102		90
	103		60
	104		60
	107		60
	124		50
	141		50
	142		50
	143		50
	144		50
	149		80
	174		80
	176		80

...

DEPARTMENTS

		DEPARTMENT_ID		DEPARTMENT_NAME
1		10		Administration
2		20		Marketing
3		50		Shipping
4		60		IT
5		80		Sales
6		90		Executive
7		110		Accounting
8		190		Contracting

Primary key

Foreign key

Retrieving Records with Equijoins

```
SELECT  e.employee_id, e.last_name, e.department_id,
        d.department_id, d.location_id
FROM    employees e, departments d
WHERE   e.department_id = d.department_id;
```

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_ID_1	LOCATION_ID
1	200	Whalen	10	10	1700
2	201	Hartstein	20	20	1800
3	202	Fay	20	20	1800
4	124	Mourgos	50	50	1500
5	144	Vargas	50	50	1500
6	143	Matos	50	50	1500
7	142	Davies	50	50	1500
8	141	Rajs	50	50	1500
9	107	Lorentz	60	60	1400
10	104	Ernst	60	60	1400

...

Retrieving Records with Equijoins: Example

```
SELECT d.department_id, d.department_name,
       d.location_id, l.city
FROM   departments d, locations l
WHERE  d.location_id = l.location_id;
```

	DEPARTMENT_ID	DEPARTMENT_NAME	LOCATION_ID	CITY
1	60	IT	1400	Southlake
2	50	Shipping	1500	South San Francisco
3	10	Administration	1700	Seattle
4	90	Executive	1700	Seattle
5	110	Accounting	1700	Seattle
6	190	Contracting	1700	Seattle
7	20	Marketing	1800	Toronto
8	80	Sales	2500	Oxford

Additional Search Conditions
Using the AND Operator

```
SELECT   d.department_id, d.department_name, l.city
FROM     departments d, locations l
WHERE    d.location_id = l.location_id
AND d.department id IN (20, 50);
```

	DEPARTMENT_ID	DEPARTMENT_NAME	CITY
1	20	Marketing	Toronto
2	50	Shipping	South San Francisco

Joining More than Two Tables

DEPARTMENTS   LOCATIONS

	LAST_NAME		DEPARTMENT_ID
1	King		90
2	Kochhar		90
3	De Haan		90
4	Hunold		60
5	Ernst		60
6	Lorentz		60
7	Mourgos		50
8	Rajs		50
9	Davies		50
10	Matos		50

...

	DEPARTMENT_ID		LOCATION_ID
	10		1700
	20		1800
	50		1500
	60		1400
	80		2500
	90		1700
	110		1700
	190		1700

	LOCATION_ID		CITY
	1400		Southlake
	1500		South San Francisco
	1700		Seattle
	1800		Toronto
	2500		Oxford

To join *n* tables together, you need a minimum of n–1 join conditions. For example, to join three tables, a minimum of two joins is required.

Nonequijoins

EMPLOYEES

	LAST_NAME	SALARY
1	King	24000
2	Kochhar	17000
3	De Haan	17000
4	Hunold	9000
5	Ernst	6000
6	Lorentz	4200
7	Mourgos	5800
8	Rajs	3500
9	Davies	3100
10	Matos	2600

...

19	Higgins	12000
20	Gietz	8300

JOB_GRADES

	GRADE_LEVEL	LOWEST_SAL	HIGHEST_SAL
1	A	1000	2999
2	B	3000	5999
3	C	6000	9999
4	D	10000	14999
5	E	15000	24999
6	F	25000	40000

`JOB_GRADES` **table defines** `LOWEST_SAL` **and** `HIGHEST_SAL` **range of values for each** `GRADE_LEVEL`. **Hence, the** `GRADE_LEVEL` **column can be used to assign grades to each employee.**

Retrieving Records
with Nonequijoins

```
SELECT  e.last_name, e.salary, j.grade_level
FROM    employees e, job_grades j
WHERE   e.salary
        BETWEEN j.lowest_sal AND j.highest_sal;
```

	LAST_NAME	SALARY	GRADE_LEVEL
1	Vargas	2500	A
2	Matos	2600	A
3	Davies	3100	B
4	Rajs	3500	B
5	Lorentz	4200	B
6	Whalen	4400	B
7	Mourgos	5800	B
8	Ernst	6000	C
9	Fay	6000	C
10	Grant	7000	C

...

Returning Records with No Direct Match with Outer Joins

DEPARTMENTS

DEPARTMENT_NAME	DEPARTMENT_ID
Administration	10
Marketing	20
Shipping	50
IT	60
Sales	80
Executive	90
Accounting	110
Contracting	190

EMPLOYEES

	DEPARTMENT_ID	LAST_NAME
1	90	King
2	90	Kochhar
3	90	De Haan
4	60	Hunold
5	60	Ernst
6	60	Lorentz
7	50	Mourgos
8	50	Rajs
9	50	Davies
10	50	Matos

. . .

19	110	Higgins
20	110	Gietz

There are no employees in department 190.

Using Right Outer Joins

```
SELECT e.last_name, e.department_id, d.department_name
FROM employees e RIGHT JOIN departments d
ON e.department_id = d.department_id;
```

	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1	Whalen	10	Administration
2	Hartstein	20	Marketing
3	Fay	20	Marketing
4	Davies	50	Shipping
5	Vargas	50	Shipping
6	Rajs	50	Shipping
7	Mourgos	50	Shipping
8	Matos	50	Shipping
9	Hunold	60	IT
10	Ernst	60	IT

...

19	Gietz	110	Accounting
20	(null)	(null)	Contracting

Left Outer Join: Another Example

```
SELECT e.last_name, e.department_id, d.department_nameFROM
employees e LEFT JOIN departments d
ON e.department_id = d.department_id;
```

	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1	Whalen	10	Administration
2	Fay	20	Marketing
3	Hartstein	20	Marketing
4	Vargas	50	Shipping
5	Matos	50	Shipping

...

17	King	90	Executive
18	Gietz	110	Accounting
19	Higgins	110	Accounting
20	Grant	(null)	(null)

Joining a Table to Itself

EMPLOYEES (WORKER)

	EMPLOYEE_ID	LAST_NAME	MANAGER_ID
1	100	King	(null)
2	101	Kochhar	100
3	102	De Haan	100
4	103	Hunold	102
5	104	Ernst	103
6	107	Lorentz	103
7	124	Mourgos	100
8	141	Rajs	124
9	142	Davies	124
10	143	Matos	124

EMPLOYEES (MANAGER)

EMPLOYEE_ID	LAST_NAME
100	King
101	Kochhar
102	De Haan
103	Hunold
104	Ernst
107	Lorentz
124	Mourgos
141	Rajs
142	Davies
143	Matos

`MANAGER_ID` in the `WORKER` table is equal to `EMPLOYEE_ID` in the `MANAGER` table.

Self-Join: Example

```
SELECT worker.last_name || ' works for '
       || manager.last_name
FROM    employees worker, employees manager
WHERE  worker.manager_id = manager.employee_id ;
```

	WORKER.LAST_NAME||'WORKSFOR'||MANAGER.LAST_NAME
1	Hunold works for De Haan
2	Fay works for Hartstein
3	Gietz works for Higgins
4	Lorentz works for Hunold
5	Ernst works for Hunold
6	Zlotkey works for King
7	Mourgos works for King
8	Kochhar works for King
9	Hartstein works for King
10	De Haan works for King

...

Summary

In this appendix, you should have learned how to use joins to display data from multiple tables by using Oracle-proprietary syntax.

Practice C: Overview

This practice covers the following topics:

- Joining tables by using an equijoin
- Performing outer and self-joins
- Adding conditions