Oracle Database 11*g*: SQL Fundamentals II

Volume I • Student Guide

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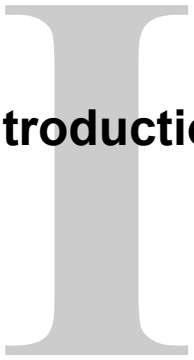
Additional Practices and Solutions



Introduction

Lesson Objectives

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

- Discuss the goals of the course
- Describe the database schema and tables that are used in the course
- Identify the available environments that can be used in the course
- Review some of the basic concepts of SQL

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Lesson Agenda

- Course objectives and course agenda
- The database schema and appendixes used in the course and the available development environment in this course
- Review of some basic concepts of SQL
- Oracle Database 11*g* documentation and additional resources

Course Objectives

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

- Control database access to specific objects
- Add new users with different levels of access privileges
- Manage schema objects
- Manage objects with data dictionary views
- Manipulate large data sets in the Oracle database by using subqueries
- Manage data in different time zones
- Write multiple-column subqueries
- Use scalar and correlated subqueries
- Use the regular expression support in SQL

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Course Prerequisites

The *Oracle Database 11g: SQL Fundamentals I* course is a prerequisite for this course.

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Course Prerequisites

Required preparation for this course is *Oracle Database 11g: SQL Fundamentals I*.

This course offers you an introduction to Oracle Database 11*g* database technology. In this course, you learn the basic concepts of relational databases and the powerful SQL programming language. This course provides the essential SQL skills that enable you to write queries against single and multiple tables, manipulate data in tables, create database objects, and query metadata.

Course Agenda

- Day 1:
  - Introduction
  - Controlling User Access
  - Managing Schema Objects
  - Managing Objects with Data Dictionary Views
- Day 2:
  - Manipulating Large Data Sets
  - Managing Data in Different Time Zones
  - Retrieving Data by Using Subqueries
  - Regular Expression Support

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Lesson Agenda

- Course objectives and course agenda
- The database schema and appendixes used in the course and the available development environment in this course
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Tables Used in This Course

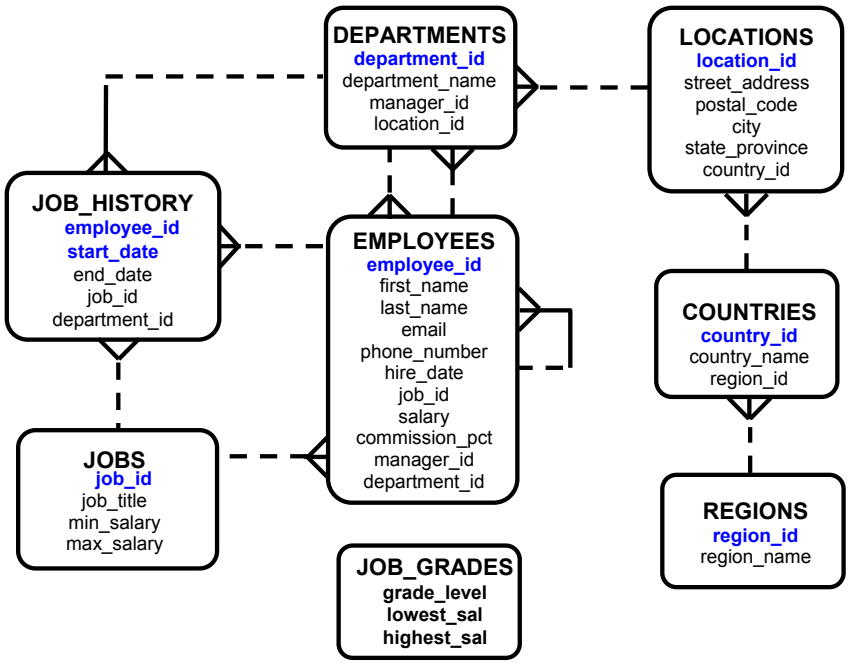

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Table Description

This course uses data from the following tables:

Table Descriptions

- The EMPLOYEES table contains information about all the employees, such as their first and last names, job IDs, salaries, hire dates, department IDs, and manager IDs. This table is a child of the DEPARTMENTS table.
- The DEPARTMENTS table contains information such as the department ID, department name, manager ID, and location ID. This table is the primary key table to the EMPLOYEES table.
- The LOCATIONS table contains department location information. It contains location ID, street address, city, state province, postal code, and country ID information. It is the primary key table to the DEPARTMENTS table and is a child of the COUNTRIES table.
- The COUNTRIES table contains the country names, country IDs, and region IDs. It is a child of the REGIONS table. This table is the primary key table to the LOCATIONS table.
- The REGIONS table contains region IDs and region names of the various countries. It is a primary key table to the COUNTRIES table.
- The JOB_GRADES table identifies a salary range per job grade. The salary ranges do not overlap.
- The JOB_HISTORY table stores job history of the employees.
- The JOBS table contains job titles and salary ranges.

Appendixes Used in This Course

- Appendix A: Practices and Solutions
- Appendix B: Table Descriptions
- Appendix C: Using SQL Developer
- Appendix D: Using SQL*Plus
- Appendix E: Using JDeveloper
- Appendix F: Generating Reports by Grouping Related Data
- Appendix G: Hierarchical Retrieval
- Appendix H: Writing Advanced Scripts
- Appendix I: Oracle Database Architectural Components

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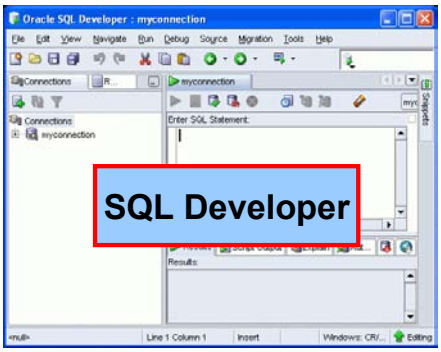
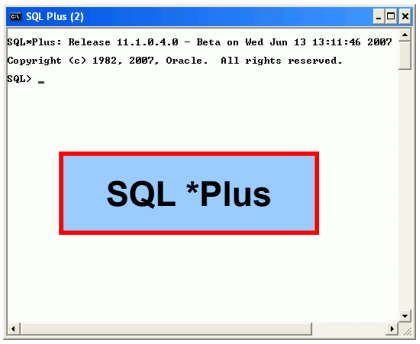
Development Environments

There are two development environments for this course:

- The primary tool is Oracle SQL Developer.
- You can also use SQL*Plus command-line interface.





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Development Environments

SQL Developer

This course has been developed using Oracle SQL Developer as the tool for running the SQL statements discussed in the examples in the slide and the practices.

- SQL Developer version 1.5.4 is shipped with Oracle Database 11*g* Release 2, and is the default tool for this class.
- In addition, SQL Developer version 1.5.4 is also available on the classroom machine, and may be installed for use. At the time of publication of this course, version 1.5.3 was the latest release of SQL Developer.

SQL*Plus

The SQL*Plus environment may also be used to run all SQL commands covered in this course.

Note

- See Appendix C titled “Using SQL Developer” for information about using SQL Developer, including simple instructions on installing version 1.5.4.
- See Appendix D titled “Using SQL*Plus” for information about using SQL*Plus.

Lesson Agenda

- Course objectives and course agenda
- The database schema and appendixes used in the course and the available development environment in this course
- Review of some basic concepts of SQL
- Oracle Database 11*g* documentation and additional resources

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Lesson Agenda

The next few slides provide a brief overview of some of the basic concepts that you learned in the course titled *Oracle Database 11g: SQL Fundamentals I*.

Review of Restricting Data

- Restrict the rows that are returned by using the `WHERE` clause.
- Use comparison conditions to compare one expression with another value or expression.

Operator	Meaning
`BETWEEN ...AND...`	Between two values (inclusive)
`IN(set)`	Match any of a list of values
`LIKE`	Match a character pattern

- Use logical conditions to combine the result of two component conditions and produce a single result based on those conditions.

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Review of Restricting Data

You can restrict the rows that are returned from the query by using the `WHERE` clause. A `WHERE` clause contains a condition that must be met, and it directly follows the `FROM` clause.

The `WHERE` clause can compare values in columns, literal values, arithmetic expression, or functions. It consists of three elements:

- Column name
- Comparison condition
- Column name, constant, or list of values

You use comparison conditions in the `WHERE` clause in the following format:

```
... WHERE expr operator value
```

Apart from those mentioned in the slide, you use other comparison conditions such as `=`, `<`, `>`, `<>`, `<=`, and `>=`.

Three logical operators are available in SQL:

- `AND`
- `OR`
- `NOT`

Review of Sorting Data

- 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

...

Review of Sorting Data

The order of rows that are returned in a query result is undefined. The ORDER BY clause can be used to sort the rows. If you use the ORDER BY clause, it must be the last clause of the SQL statement. You can specify an expression, an alias, or a column position as the sort condition.

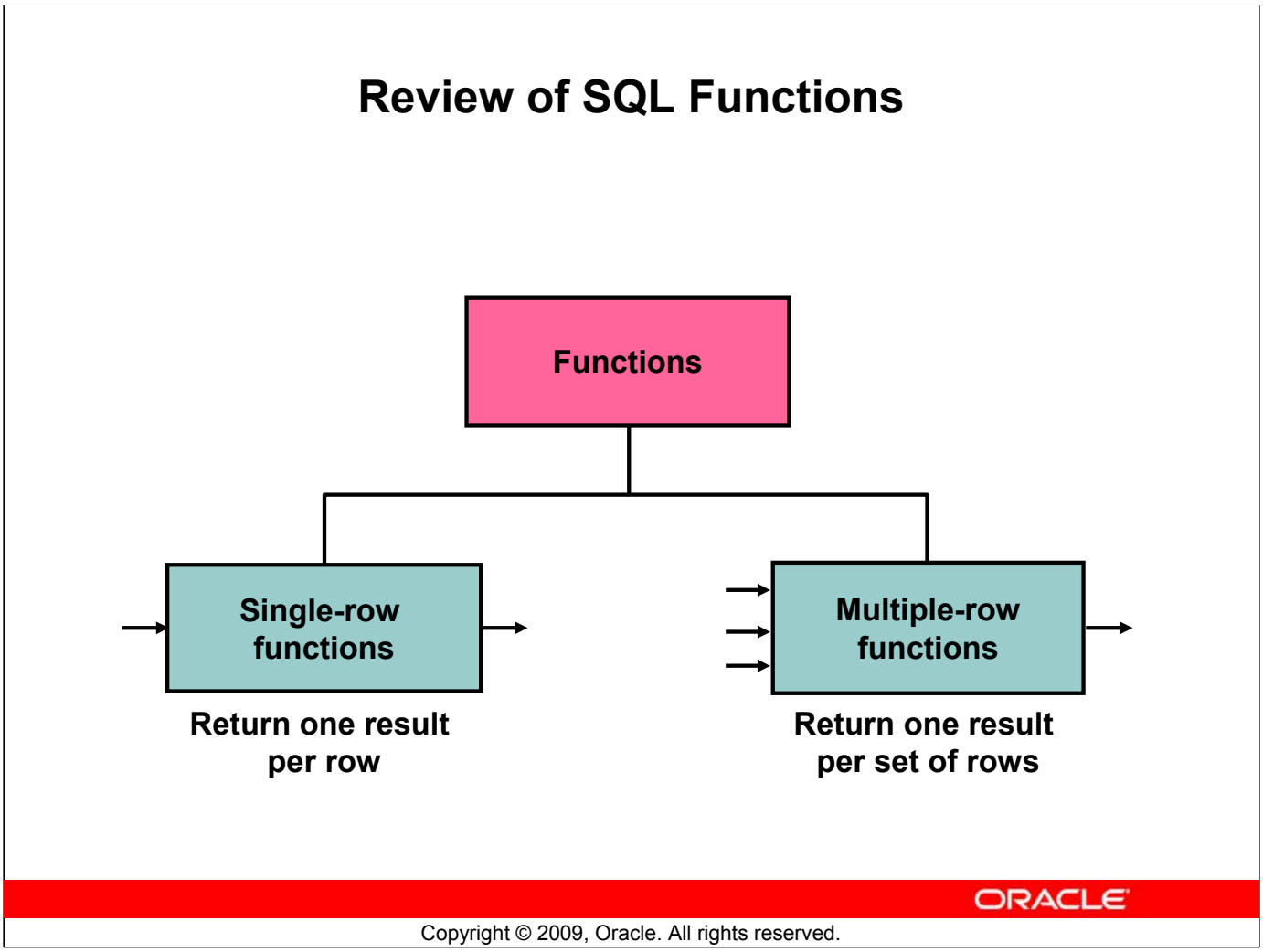
Syntax

```
SELECT          expr
FROM            table
[WHERE          condition(s)]
[ORDER BY  {column, expr, numeric_position} [ASC|DESC]];
```

In the syntax:

ORDER BY	Specifies the order in which the retrieved rows are displayed
ASC	Orders the rows in ascending order (This is the default order.)
DESC	Orders the rows in descending order

If the ORDER BY clause is not used, the sort order is undefined, and the Oracle server may not fetch rows in the same order for the same query twice. Use the ORDER BY clause to display the rows in a specific order.



Review of SQL Functions

There are two types of functions:

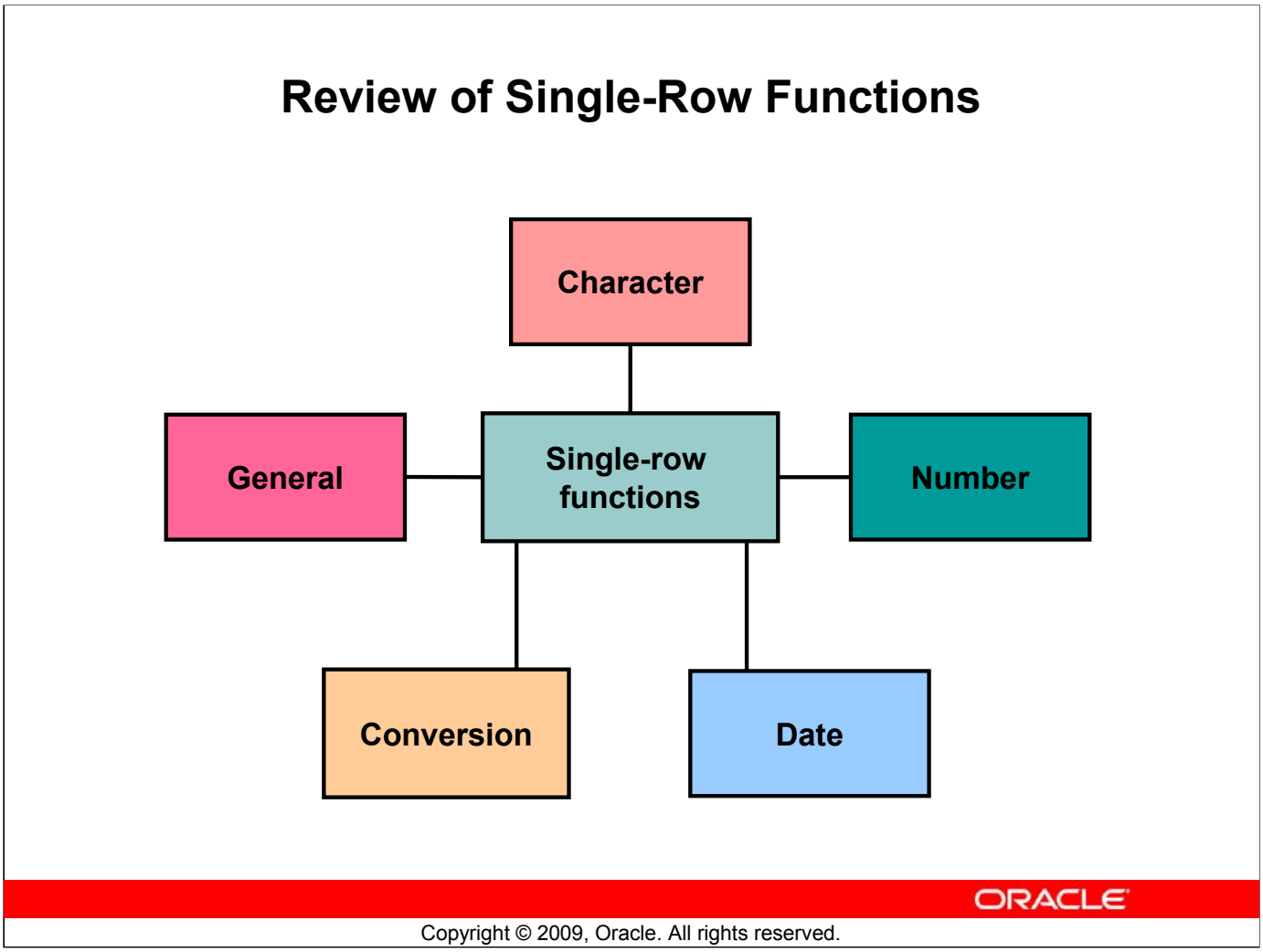
- Single-row functions
- Multiple-row functions

Single-Row Functions

These functions operate on single rows only and return one result per row. There are different types of single-row functions such as character, number, date, conversion, and general functions.

Multiple-Row Functions

Functions can manipulate groups of rows to give one result per group of rows. These functions are also known as *group functions*.



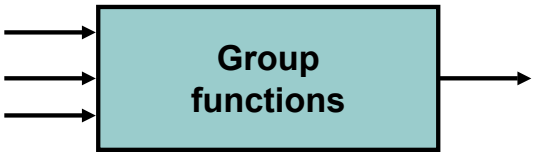
Review of Single-Row Functions

The following are different types of single-row functions:

- **Character functions:** Accept character input and can return both character and number values
- **Number functions:** Accept numeric input and return numeric values
- **Date functions:** Operate on values of the `DATE` data type (All date functions return a value of the `DATE` data type, except the `MONTHS_BETWEEN` function, which returns a number.)
- **Conversion functions:** Convert a value from one data type to another
- **General functions:**
  - `NVL`
  - `NVL2`
  - `NULLIF`
  - `COALESCE`
  - `CASE`
  - `DECODE`

Review of Types of Group Functions

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



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Review of Types of Group Functions

Each of the functions accepts an argument. The following table identifies the options that you can use in the syntax:

Function	Description
AVG([DISTINCT|ALL]*n*)	Average value of *n*, ignoring null values
COUNT({*|[DISTINCT|ALL]*expr*})	Number of rows, where *expr* evaluates to something other than null (count all selected rows using *, including duplicates and rows with nulls)
MAX([DISTINCT|ALL]*expr*)	Maximum value of *expr*, ignoring null values
MIN([DISTINCT|ALL]*expr*)	Minimum value of *expr*, ignoring null values
STDDEV([DISTINCT|ALL]*n*)	Standard deviation of *n*, ignoring null values
SUM([DISTINCT|ALL]*n*)	Sum values of *n*, ignoring null values
VARIANCE([DISTINCT|ALL]*n*)	Variance of *n*, ignoring null values

Review of Using Subqueries

- A subquery is a SELECT statement nested in a clause of another SELECT statement.
- Syntax:

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

- Types of subqueries:

Single-row subquery	Multiple-row subquery
Returns only one row	Returns more than one row
Uses single-row comparison operators	Uses multiple-row comparison operators

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Review of Using Subqueries

You can build powerful statements out of simple ones by using subqueries. Subqueries are useful when a query is based on a search criterion with unknown intermediate values.

You can place the subquery in a number of SQL clauses, including the following:

- WHERE clause
- HAVING clause
- FROM clause

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

A single-row subquery uses a single-row operator such as =, >, <, >=, <=, and <>. With a multiple-row subquery, you use a multiple-row operator such as IN, ANY, and ALL.

Example: Display details of employees whose salary is equal to the minimum salary.

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

In the example, the MIN group function returns a single value to the outer query.

Note: In this course, you learn how to use multiple-column subqueries. Multiple-column subqueries return more than one column from the inner SELECT statement.

Review of Manipulating Data

A data manipulation language (DML) statement is executed when you:

- Add new rows to a table
- Modify existing rows in a table
- Remove existing rows from a table

Function	Description
INSERT	Adds a new row to the table
UPDATE	Modifies existing rows in the table
DELETE	Removes existing rows from the table
MERGE	Updates, inserts, or deletes a row conditionally into/from a table

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Review of Manipulating Data

When you want to add, update, or delete data in the database, you execute a DML statement. A collection of DML statements that form a logical unit of work is called a transaction. You can add new rows to a table by using the INSERT statement. With the following syntax, only one row is inserted at a time.

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

You can use the INSERT statement to add rows to a table where the values are derived from existing tables. In place of the VALUES clause, you use a subquery. The number of columns and their data types in the column list of the INSERT clause must match the number of values and their data types in the subquery.

The UPDATE statement modifies specific rows if you specify the WHERE clause.

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

You can remove existing rows by using the DELETE statement. You can delete specific rows by specifying the WHERE clause in the DELETE statement.

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

You learn about the MERGE statement in the lesson titled “Manipulating Large Data Sets.”

Lesson Agenda

- Course objectives and course agenda
- The database schema and appendixes used in the course and the available development environment in this course
- Review of some basic concepts of SQL
- Oracle Database 11*g* documentation and additional resources

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Oracle Database 11*g* SQL Documentation

- *Oracle Database New Features Guide 11g Release 2 (11.2)*
- *Oracle Database Reference 11g Release 2 (11.2)*
- *Oracle Database SQL Language Reference 11g Release 2 (11.2)*
- *Oracle Database Concepts 11g Release 2 (11.2)*
- *Oracle Database SQL Developer User's Guide Release 1.2*

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Oracle Database 11*g* SQL Documentation

Navigate to http://www.oracle.com/pls/db112/homepage to access the Oracle Database 11*g* Release 2 documentation library.

Additional Resources

For additional information about the new Oracle 11*g* SQL, refer to the following:

- *Oracle Database 11g: New Features eStudies*
- *Oracle by Example series (OBE): Oracle Database 11g*

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Summary

In this lesson, you should have learned the following:

- The course objectives
- The sample tables used in the course

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Practice I: Overview

This practice covers the following topics:

- Running the SQL Developer online tutorial
- Starting SQL Developer and creating a new database connection and browsing the tables
- Executing SQL statements using the SQL Worksheet
- Reviewing the basic concepts of SQL

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Practice I: Overview

In this practice, you use SQL Developer to execute SQL statements.

Note: All written practices use SQL Developer as the development environment. Although it is recommended that you use SQL Developer, you can also use the SQL*Plus environment that is available in this course.

1

Controlling User Access

Objectives

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

- Differentiate system privileges from object privileges
- Grant privileges on tables
- Grant roles
- Distinguish between privileges and roles

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Objectives

In this lesson, you learn how to control database access to specific objects and add new users with different levels of access privileges.

Lesson Agenda

- System privileges
- Creating a role
- Object privileges
- Revoking object privileges

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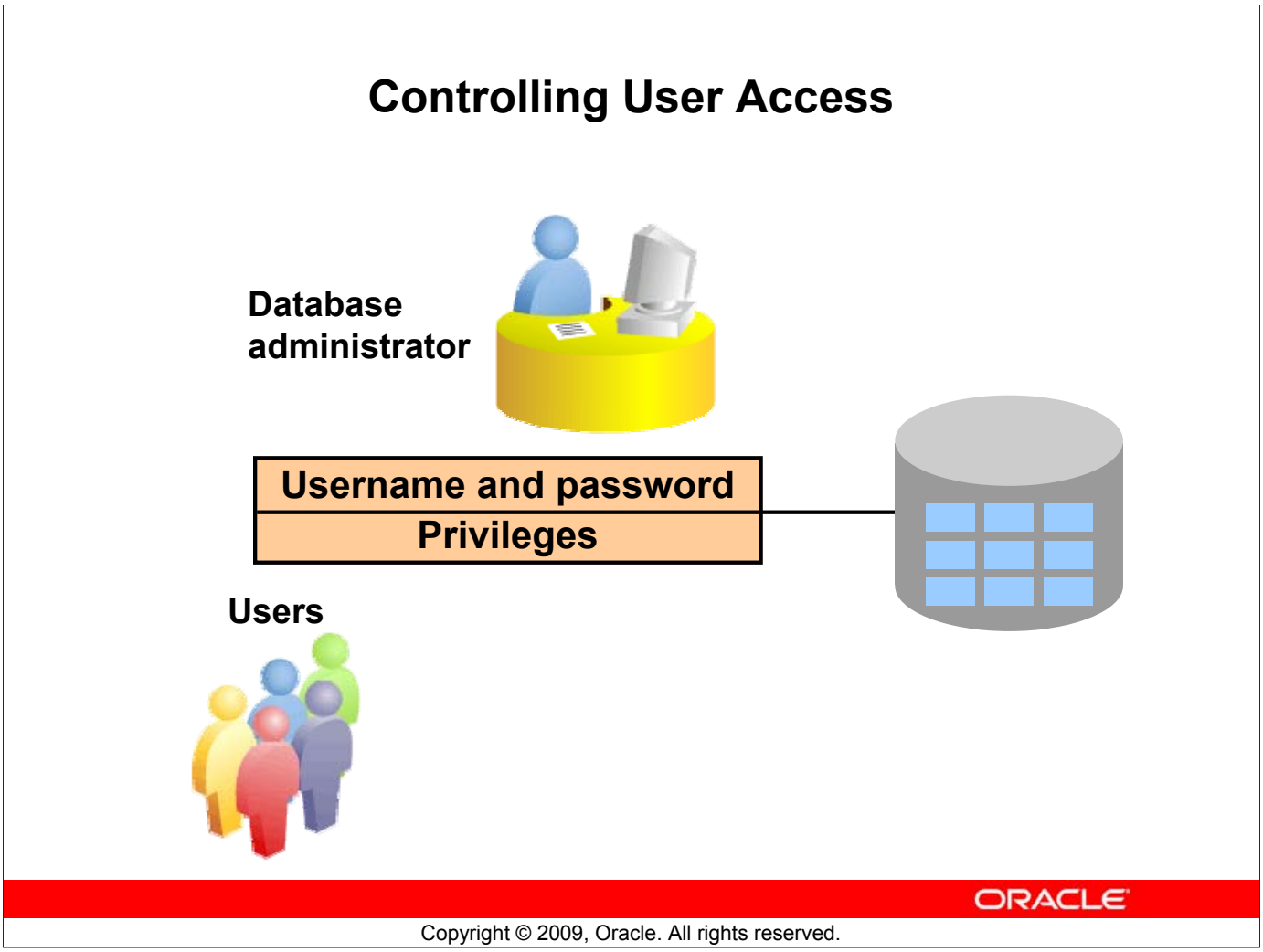

Controlling User Access

In a multiple-user environment, you want to maintain security of the database access and use. With Oracle Server database security, you can do the following:

- Control database access.
- Give access to specific objects in the database.
- Confirm given and received privileges with the Oracle data dictionary.

Database security can be classified into two categories: system security and data security. System security covers access and use of the database at the system level, such as the username and password, the disk space allocated to users, and the system operations that users can perform. Database security covers access and use of the database objects and the actions that those users can perform on the objects.

Privileges

- Database security:
  - System security
  - Data security
- System privileges: Performing a particular action within the database
- Object privileges: Manipulating the content of the database objects
- Schemas: Collection of objects such as tables, views, and sequences

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Privileges

A privilege is the right to execute particular SQL statements. The database administrator (DBA) is a high-level user with the ability to create users and grant users access to the database and its objects. Users require *system privileges* to gain access to the database and *object privileges* to manipulate the content of the objects in the database. Users can also be given the privilege to grant additional privileges to other users or to *roles*, which are named groups of related privileges.

Schemas

A *schema* is a collection of objects such as tables, views, and sequences. The schema is owned by a database user and has the same name as that user.

A system privilege is the right to perform a particular action, or to perform an action on any schema objects of a particular type. An object privilege provides the user the ability to perform a particular action on a specific schema object.

For more information, see the *Oracle Database 2 Day DBA 11g Release 2 (11.2)* reference manual.

System Privileges

- More than 100 privileges are available.
- The database administrator has high-level system privileges for tasks such as:
  - Creating new users
  - Removing users
  - Removing tables
  - Backing up tables

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System Privileges

More than 100 distinct system privileges are available for users and roles. Typically, system privileges are provided by the database administrator (DBA).

Typical DBA Privileges

System Privilege	Operations Authorized
CREATE USER	Grantee can create other Oracle users.
DROP USER	Grantee can drop another user.
DROP ANY TABLE	Grantee can drop a table in any schema.
BACKUP ANY TABLE	Grantee can back up any table in any schema with the export utility.
SELECT ANY TABLE	Grantee can query tables, views, or materialized views in any schema.
CREATE ANY TABLE	Grantee can create tables in any schema.

Creating Users

The DBA creates users with the `CREATE USER` statement.

```
CREATE USER user
IDENTIFIED BY   password;
```

```
CREATE USER  demo
IDENTIFIED BY demo;
```

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Creating Users

The DBA creates the user by executing the `CREATE USER` statement. The user does not have any privileges at this point. The DBA can then grant privileges to that user. These privileges determine what the user can do at the database level.

The slide gives the abridged syntax for creating a user.

In the syntax:

user	Is the name of the user to be created
Password	Specifies that the user must log in with this password

For more information, see the *Oracle Database11g SQL Reference*.

Note: Starting with Oracle Database 11*g*, passwords are case-sensitive.

User System Privileges

- After a user is created, the DBA can grant specific system privileges to that user.

```
GRANT privilege [, privilege...]
TO user [, user| role, PUBLIC...];
```

- An application developer, for example, may have the following system privileges:
  - CREATE SESSION
  - CREATE TABLE
  - CREATE SEQUENCE
  - CREATE VIEW
  - CREATE PROCEDURE

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Typical User Privileges

After the DBA creates a user, the DBA can assign privileges to that user.

System Privilege	Operations Authorized
CREATE SESSION	Connect to the database.
CREATE TABLE	Create tables in the user's schema.
CREATE SEQUENCE	Create a sequence in the user's schema.
CREATE VIEW	Create a view in the user's schema.
CREATE PROCEDURE	Create a stored procedure, function, or package in the user's schema.

In the syntax:

privilege	Is the system privilege to be granted
user | role | PUBLIC	Is the name of the user, the name of the role, or PUBLIC (which designates that every user is granted the privilege)

Note: Current system privileges can be found in the SESSION_PRIVS dictionary view. Data dictionary is a collection of tables and views created and maintained by the Oracle Server. They contain information about the database.

Granting System Privileges

The DBA can grant specific system privileges to a user.

```
GRANT  create session, create table,
       create sequence, create view
TO     demo;
```

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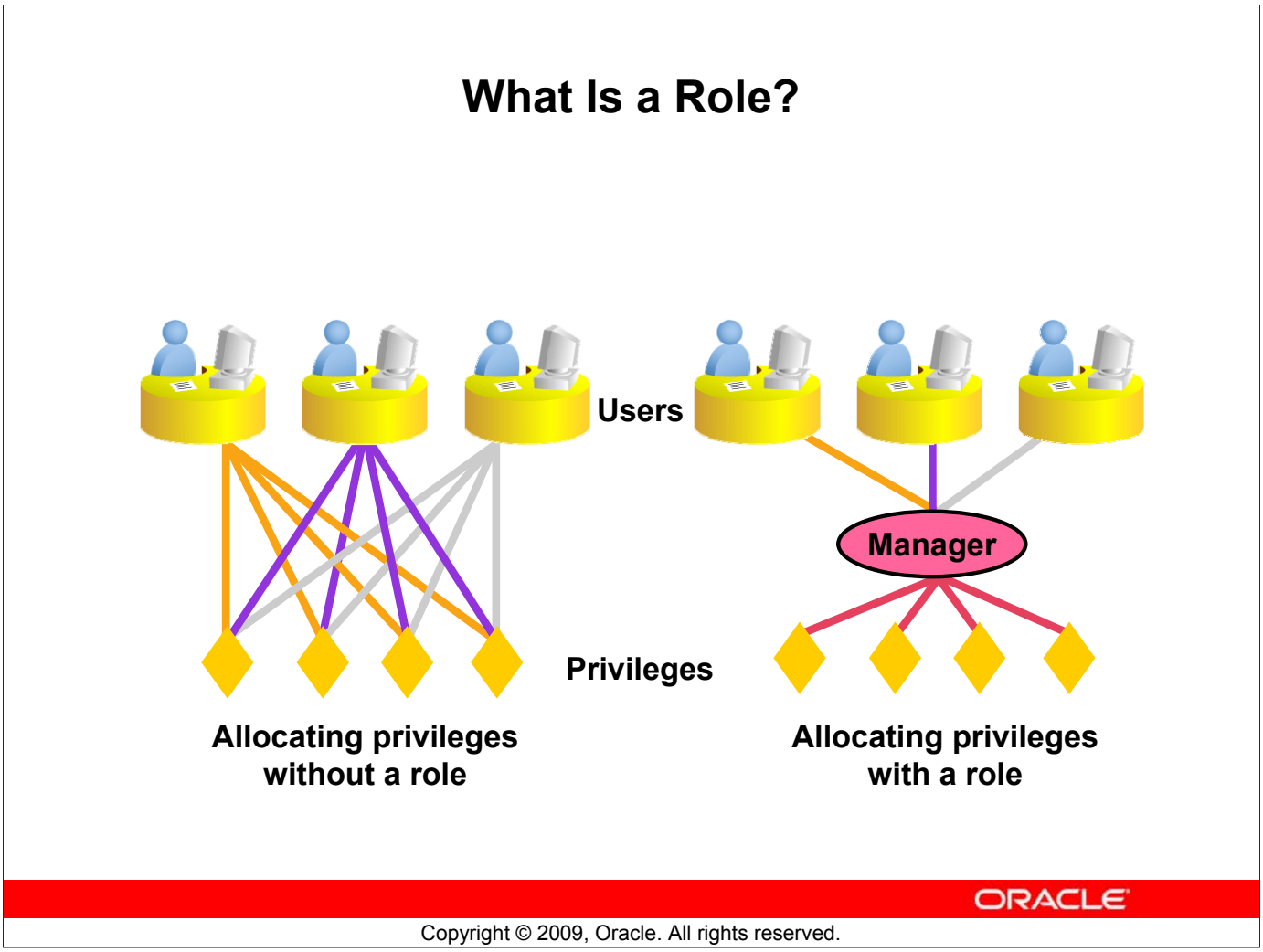
Granting System Privileges

The DBA uses the `GRANT` statement to allocate system privileges to the user. After the user has been granted the privileges, the user can immediately use those privileges.

In the example in the slide, the `demo` user has been assigned the privileges to create sessions, tables, sequences, and views.

Lesson Agenda

- System privileges
- Creating a role
- Object privileges
- Revoking object privileges



What Is a Role?

A role is a named group of related privileges that can be granted to the user. This method makes it easier to revoke and maintain privileges.

A user can have access to several roles, and several users can be assigned the same role. Roles are typically created for a database application.

Creating and Assigning a Role

First, the DBA must create the role. Then the DBA can assign privileges to the role and assign the role to users.

Syntax

```
CREATE   ROLE role;
```

In the syntax:

role	Is the name of the role to be created

After the role is created, the DBA can use the GRANT statement to assign the role to users as well as assign privileges to the role. A role is not a schema object, therefore any user can add privileges to a role.

Creating and Granting Privileges to a Role

- Create a role:

```
CREATE ROLE manager;
```

- Grant privileges to a role:

```
GRANT create table, create view
TO manager;
```

- Grant a role to users:

```
GRANT manager TO alice;
```

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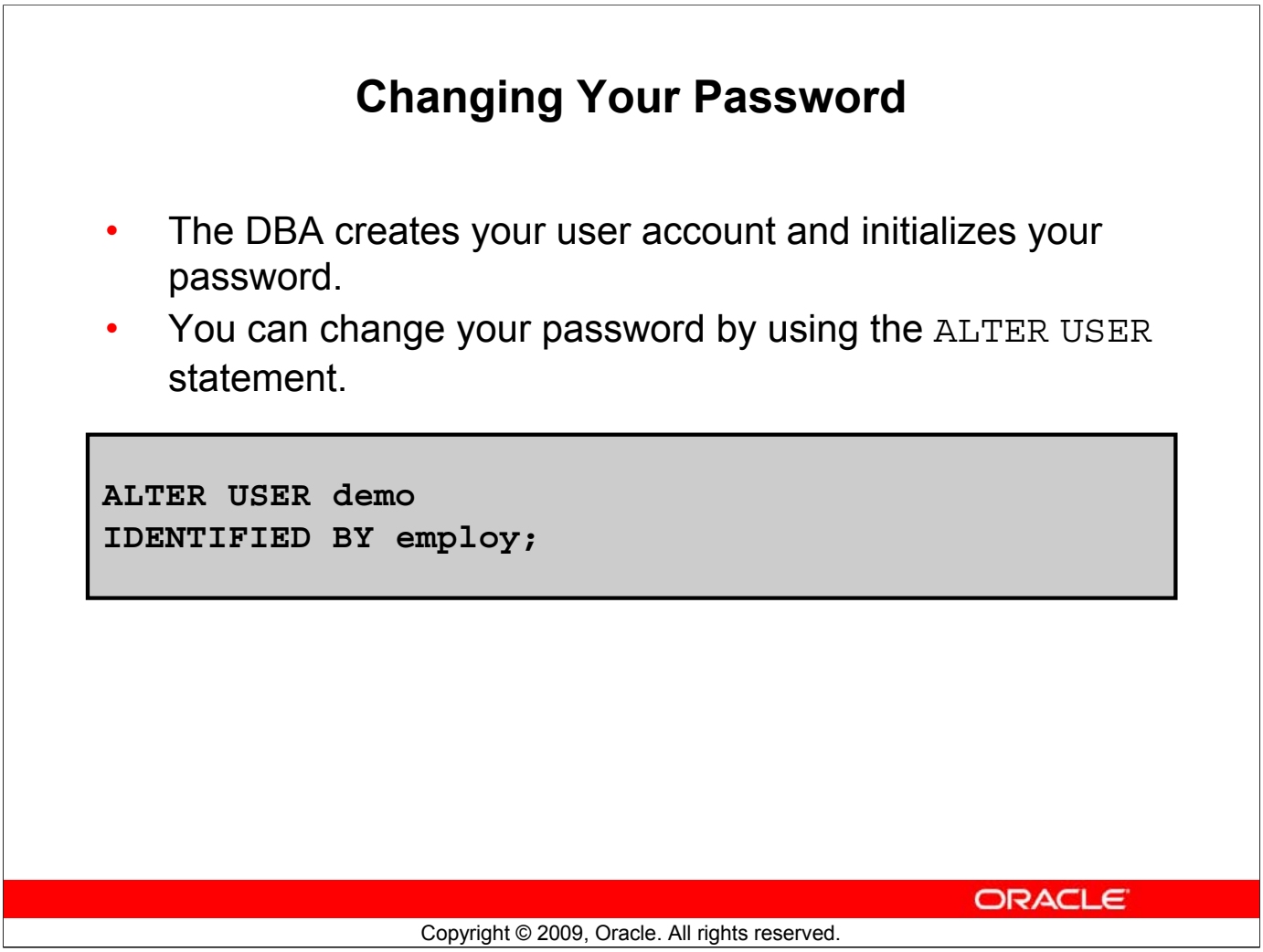
Creating a Role

The example in the slide creates a `manager` role and then enables the manager to create tables and views. It then grants user `alice` the role of a manager. Now `alice` can create tables and views.

If users have multiple roles granted to them, they receive all the privileges associated with all the roles.



Changing Your Password

The DBA creates an account and initializes a password for every user. You can change your password by using the `ALTER USER` statement.

The slide example shows that the `demo` user changes the password by using the `ALTER USER` statement.

Syntax

```
ALTER USER user IDENTIFIED BY password;
```

In the syntax:

user	Is the name of the user
password	Specifies the new password

Although this statement can be used to change your password, there are many other options. You must have the `ALTER USER` privilege to change any other option.

For more information, see the *Oracle Database11g SQL Reference* manual.

Note: SQL*Plus has a `PASSWORD` command (`PASSW`) that can be used to change the password of a user when the user is logged in. This command is not available in SQL Developer.

Lesson Agenda

- System privileges
- Creating a role
- Object privileges
- Revoking object privileges

Object Privileges

Object privilege	Table	View	Sequence
ALTER	✓		✓
DELETE	✓	✓	
INDEX	✓		
INSERT	✓	✓	
REFERENCES	✓		
SELECT	✓	✓	✓
UPDATE	✓	✓	

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Object Privileges

An *object privilege* is a privilege or right to perform a particular action on a specific table, view, sequence, or procedure. Each object has a particular set of grantable privileges. The table in the slide lists the privileges for various objects. Note that the only privileges that apply to a sequence are `SELECT` and `ALTER`. `UPDATE`, `REFERENCES`, and `INSERT` can be restricted by specifying a subset of updatable columns.

A `SELECT` privilege can be restricted by creating a view with a subset of columns and granting the `SELECT` privilege only on the view. A privilege granted on a synonym is converted to a privilege on the base table referenced by the synonym.

Note: With the `REFERENCES` privilege, you can ensure that other users can create `FOREIGN KEY` constraints that reference your table.

Object Privileges

- Object privileges vary from object to object.
- An owner has all the privileges on the object.
- An owner can give specific privileges on that owner's object.

```
GRANT       object_priv [(columns)]
ON          object
TO          {user|role|PUBLIC}
[WITH GRANT OPTION];
```

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Granting Object Privileges

Different object privileges are available for different types of schema objects. A user automatically has all object privileges for schema objects contained in the user's schema. A user can grant any object privilege on any schema object that the user owns to any other user or role. If the grant includes `WITH GRANT OPTION`, the grantee can further grant the object privilege to other users; otherwise, the grantee can use the privilege but cannot grant it to other users.

In the syntax:

object_priv	Is an object privilege to be granted
ALL	Specifies all object privileges
columns	Specifies the column from a table or view on which privileges are granted
ON *object*	Is the object on which the privileges are granted
TO	Identifies to whom the privilege is granted
PUBLIC	Grants object privileges to all users
WITH GRANT OPTION	Enables the grantee to grant the object privileges to other users and roles

Note: In the syntax, *schema* is the same as the owner's name.

Granting Object Privileges

- Grant query privileges on the EMPLOYEES table:

```
GRANT  select
ON     employees
TO     demo;
```

- Grant privileges to update specific columns to users and roles:

```
GRANT  update (department_name, location_id)
ON     departments
TO     demo, manager;
```


Guidelines

- To grant privileges on an object, the object must be in your own schema, or you must have been granted the object privileges WITH GRANT OPTION.
- An object owner can grant any object privilege on the object to any other user or role of the database.
- The owner of an object automatically acquires all object privileges on that object.

The first example in the slide grants the demo user the privilege to query your EMPLOYEES table. The second example grants UPDATE privileges on specific columns in the DEPARTMENTS table to demo and to the manager role.

For example, if your schema is oraxx, and the demo user now wants to use a SELECT statement to obtain data from your EMPLOYEES table, the syntax he or she must use is:

```
SELECT  * FROM oraxx.employees;
```

Alternatively, the demo user can create a synonym for the table and issue a SELECT statement from the synonym:

```
CREATE SYNONYM emp FOR oraxx.employees;
SELECT * FROM emp;
```

Note: DBAs generally allocate system privileges; any user who owns an object can grant object privileges.

Passing On Your Privileges

- Give a user authority to pass along privileges:

```
GRANT  select, insert
ON     departments
TO     demo
WITH   GRANT OPTION;
```

- Allow all users on the system to query data from Alice's DEPARTMENTS table:

```
GRANT  select
ON     alice.departments
TO     PUBLIC;
```

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Passing On Your Privileges

WITH GRANT OPTION Keyword

A privilege that is granted with the WITH GRANT OPTION clause can be passed on to other users and roles by the grantee. Object privileges granted with the WITH GRANT OPTION clause are revoked when the grantor's privilege is revoked.

The example in the slide gives the demo user access to your DEPARTMENTS table with the privileges to query the table and add rows to the table. The example also shows that user1 can give others these privileges.

PUBLIC Keyword

An owner of a table can grant access to all users by using the PUBLIC keyword.

The second example allows all users on the system to query data from Alice's DEPARTMENTS table.

Confirming Granted Privileges

Data Dictionary View	Description
ROLE_SYS_PRIVS	System privileges granted to roles
ROLE_TAB_PRIVS	Table privileges granted to roles
USER_ROLE_PRIVS	Roles accessible by the user
USER_SYS_PRIVS	System privileges granted to the user
USER_TAB_PRIVS_MADE	Object privileges granted on the user's objects
USER_TAB_PRIVS_RECD	Object privileges granted to the user
USER_COL_PRIVS_MADE	Object privileges granted on the columns of the user's objects
USER_COL_PRIVS_RECD	Object privileges granted to the user on specific columns

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Confirming Granted Privileges

If you attempt to perform an unauthorized operation, such as deleting a row from a table for which you do not have the DELETE privilege, the Oracle server does not permit the operation to take place.

If you receive the Oracle server error message "Table or view does not exist," you have done either of the following:

- Named a table or view that does not exist
- Attempted to perform an operation on a table or view for which you do not have the appropriate privilege

The data dictionary is organized in tables and views and contains information about the database. You can access the data dictionary to view the privileges that you have. The table in the slide describes various data dictionary views.

You learn more about data dictionary views in the lesson titled "Managing Objects with Data Dictionary Views."

Note: The ALL_TAB_PRIVS_MADE dictionary view describes all the object grants made by the user or made on the objects owned by the user.

Lesson Agenda

- System privileges
- Creating a role
- Object privileges
- Revoking object privileges

Revoking Object Privileges

- You use the REVOKE statement to revoke privileges granted to other users.
- Privileges granted to others through the WITH GRANT OPTION clause are also revoked.

```
REVOKE {privilege [, privilege...]|ALL}
ON     object
FROM   {user[, user...]|role|PUBLIC}
[CASCADE CONSTRAINTS];
```


Revoking Object Privileges

You can remove privileges granted to other users by using the REVOKE statement. When you use the REVOKE statement, the privileges that you specify are revoked from the users you name and from any other users to whom those privileges were granted by the revoked user.

In the syntax:

CASCADE	Is required to remove any referential integrity constraints made to the CONSTRAINTS object by means of the REFERENCES privilege

For more information, see the *Oracle Database11g SQL Reference*.

Note: If a user were to leave the company and you revoke his or her privileges, you must regrant any privileges that this user may have granted to other users. If you drop the user account without revoking privileges from it, the system privileges granted by this user to other users are not affected by this action.

Revoking Object Privileges

Revoke the SELECT and INSERT privileges given to the demo user on the DEPARTMENTS table.

```
REVOKE  select, insert
ON      departments
FROM    demo;
```

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Revoking Object Privileges (continued)

The example in the slide revokes SELECT and INSERT privileges given to the demo user on the DEPARTMENTS table.

Note: If a user is granted a privilege with the WITH GRANT OPTION clause, that user can also grant the privilege with the WITH GRANT OPTION clause, so that a long chain of grantees is possible, but no circular grants (granting to a grant ancestor) are permitted. If the owner revokes a privilege from a user who granted the privilege to other users, the revoking cascades to all the privileges granted.

For example, if user A grants a SELECT privilege on a table to user B including the WITH GRANT OPTION clause, user B can grant to user C the SELECT privilege with the WITH GRANT OPTION clause as well, and user C can then grant to user D the SELECT privilege. If user A revokes privileges from user B, the privileges granted to users C and D are also revoked.

Quiz

Which of the following statements are true?

1. After a user creates an object, the user can pass along any of the available object privileges to other users by using the `GRANT` statement.
2. A user can create roles by using the `CREATE ROLE` statement to pass along a collection of system or object privileges to other users.
3. Users can change their own passwords.
4. Users can view the privileges granted to them and those that are granted on their objects.

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Answers: 1, 3, 4

Summary

In this lesson, you should have learned how to:

- Differentiate system privileges from object privileges
- Grant privileges on tables
- Grant roles
- Distinguish between privileges and roles

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Summary

DBAs establish initial database security for users by assigning privileges to the users.

- The DBA creates users who must have a password. The DBA is also responsible for establishing the initial system privileges for a user.
- After the user has created an object, the user can pass along any of the available object privileges to other users or to all users by using the `GRANT` statement.
- A DBA can create roles by using the `CREATE ROLE` statement to pass along a collection of system or object privileges to multiple users. Roles make granting and revoking privileges easier to maintain.
- Users can change their passwords by using the `ALTER USER` statement.
- You can remove privileges from users by using the `REVOKE` statement.
- With data dictionary views, users can view the privileges granted to them and those that are granted on their objects.

Practice 1: Overview

This practice covers the following topics:

- Granting other users privileges to your table
- Modifying another user's table through the privileges granted to you

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Practice 1: Overview

Team up with other students for this exercise about controlling access to database objects.

2

Managing Schema Objects

Objectives

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

- Add constraints
- Create indexes
- Create indexes by using the `CREATE TABLE` statement
- Create function-based indexes
- Drop columns and set columns as `UNUSED`
- Perform `FLASHBACK` operations
- Create and use external tables

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Objectives

This lesson contains information about creating indexes and constraints and altering existing objects. You also learn about external tables and the provision to name the index at the time of creating a PRIMARY KEY constraint.

Lesson Agenda

- Using the `ALTER TABLE` statement to add, modify, and drop a column
- Managing constraints:
  - Adding and dropping a constraint
  - Deferring constraints
  - Enabling and disabling a constraint
- Creating indexes:
  - Using the `CREATE TABLE` statement
  - Creating function-based indexes
  - Removing an index
- Performing flashback operations
- Creating and using temporary tables
- Creating and using external tables

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ALTER TABLE Statement

Use the ALTER TABLE statement to:

- Add a new column
- Modify an existing column
- Define a default value for the new column
- Drop a column

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ALTER TABLE Statement

After you create a table, you may need to change the table structure because you omitted a column, your column definition needs to be changed, or you need to remove columns. You can do this by using the ALTER TABLE statement.

ALTER TABLE Statement

Use the ALTER TABLE statement to add, modify, or drop columns:

```
ALTER TABLE table
ADD         (column datatype [DEFAULT expr]
            [, column datatype]...);
```

```
ALTER TABLE table
MODIFY      (column datatype [DEFAULT expr]
            [, column datatype]...);
```

```
ALTER TABLE table
DROP (column [, column] …);
```

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ALTER TABLE Statement (continued)

You can add columns to a table, modify columns, and drop columns from a table by using the ALTER TABLE statement.

In the syntax:

table	Is the name of the table
ADD|MODIFY|DROP	Is the type of modification
column	Is the name of the column
datatype	Is the data type and length of the column
DEFAULT *expr*	Specifies the default value for a column

Adding a Column

- You use the ADD clause to add columns:

```
ALTER TABLE dept80
ADD        (job_id VARCHAR2(9));
```

```
ALTER TABLE dept80 succeeded.
```

- The new column becomes the last column:

	EMPLOYEE_ID	LAST_NAME	ANNSAL	HIRE_DATE	JOB_ID
1	145	Russell	14000	01-OCT-96	(null)
2	146	Partners	13500	05-JAN-97	(null)
3	147	Errazuriz	12000	10-MAR-97	(null)
4	148	Cambrault	11000	15-OCT-99	(null)
5	149	Zlotkey	10500	29-JAN-00	(null)

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Guidelines for Adding a Column

- You can add or modify columns.
- You cannot specify where the column is to appear. The new column becomes the last column.

The example in the slide adds a column named JOB_ID to the DEPT80 table. The JOB_ID column becomes the last column in the table.

Note: If a table already contains rows when a column is added, the new column is initially null or takes the default value for all the rows. You can add a mandatory NOT NULL column to a table that contains data in the other columns only if you specify a default value. You can add a NOT NULL column to an empty table without the default value.

Modifying a Column

- You can change a column's data type, size, and default value.

```
ALTER TABLE dept80
MODIFY      (last_name VARCHAR2(30));
```

```
ALTER TABLE dept80 succeeded.
```

- A change to the default value affects only subsequent insertions to the table.

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Modifying a Column

You can modify a column definition by using the `ALTER TABLE` statement with the `MODIFY` clause. Column modification can include changes to a column's data type, size, and default value.

Guidelines

- You can increase the width or precision of a numeric column.
- You can increase the width of character columns.
- You can decrease the width of a column if:
  - The column contains only null values
  - The table has no rows
  - The decrease in column width is not less than the existing values in that column
- You can change the data type if the column contains only null values. The exception to this is `CHAR`-to-`VARCHAR2` conversions, which can be done with data in the columns.
- You can convert a `CHAR` column to the `VARCHAR2` data type or convert a `VARCHAR2` column to the `CHAR` data type only if the column contains null values or if you do not change the size.
- A change to the default value of a column affects only subsequent insertions to the table.

Dropping a Column

Use the DROP COLUMN clause to drop columns that you no longer need from the table:

```
ALTER TABLE  dept80
DROP COLUMN  job_id;
```

```
ALTER TABLE dept80 succeeded.
```

	EMPLOYEE_ID	LAST_NAME	ANNSAL	HIRE_DATE
1	145	Russell	14000	01-OCT-96
2	146	Partners	13500	05-JAN-97
3	147	Errazuriz	12000	10-MAR-97
4	148	Cambrault	11000	15-OCT-99
5	149	Zlotkey	10500	29-JAN-00

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Dropping a Column

You can drop a column from a table by using the ALTER TABLE statement with the DROP COLUMN clause.

Guidelines

- The column may or may not contain data.
- Using the ALTER TABLE DROP COLUMN statement, only one column can be dropped at a time.
- The table must have at least one column remaining in it after it is altered.
- After a column is dropped, it cannot be recovered.
- A column cannot be dropped if it is part of a constraint or part of an index key unless the cascade option is added.
- Dropping a column can take a while if the column has a large number of values. In this case, it may be better to set it to be unused and drop it when there are fewer users on the system to avoid extended locks.

Note: Certain columns can never be dropped, such as columns that form part of the partitioning key of a partitioned table or columns that form part of the PRIMARY KEY of an index-organized table. For more information about index-organized tables and partitioned table, refer to *Oracle Database Concepts* and *Oracle Database Administrator's Guide.*

SET UNUSED Option

- You use the SET UNUSED option to mark one or more columns as unused.
- You use the DROP UNUSED COLUMNS option to remove the columns that are marked as unused.

```
ALTER TABLE  <table_name>
SET   UNUSED(<column_name> [ , <column_name>]);
OR
ALTER TABLE  <table_name>
SET   UNUSED COLUMN <column_name> [,<column_name>];
```

```
ALTER TABLE <table_name>
DROP  UNUSED COLUMNS;
```

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SET UNUSED Option

The SET UNUSED option marks one or more columns as unused so that they can be dropped when the demand on system resources is lower. Specifying this clause does not actually remove the target columns from each row in the table (that is, it does not restore the disk space used by these columns). Therefore, the response time is faster than if you executed the DROP clause. Unused columns are treated as if they were dropped, even though their column data remains in the table's rows. After a column has been marked as unused, you have no access to that column. A SELECT * query will not retrieve data from unused columns. In addition, the names and types of columns marked unused will not be displayed during a DESCRIBE statement, and you can add to the table a new column with the same name as an unused column. The SET UNUSED information is stored in the USER_UNUSED_COL_TABS dictionary view.

Note: The guidelines for setting a column to be UNUSED are similar to those for dropping a column.

SET UNUSED Option (continued)

DROP UNUSED COLUMNS Option

DROP UNUSED COLUMNS removes from the table all columns currently marked as unused. You can use this statement when you want to reclaim the extra disk space from unused columns in the table. If the table contains no unused columns, the statement returns with no errors.

```
ALTER TABLE  dept80
SET   UNUSED (last_name);

ALTER TABLE succeeded


ALTER TABLE  dept80
DROP  UNUSED COLUMNS;

ALTER TABLE succeeded
```

Lesson Agenda

- Using the `ALTER TABLE` statement to add, modify, and drop a column
- Managing constraints:
  - Adding and dropping a constraint
  - Deferring constraints
  - Enabling and disabling a constraint
- Creating indexes:
  - Using the `CREATE TABLE` statement
  - Creating function-based indexes
  - Removing an index
- Performing flashback operations
- Creating and using temporary tables
- Creating and using external tables

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Adding a Constraint Syntax

Use the ALTER TABLE statement to:

- Add or drop a constraint, but not modify its structure
- Enable or disable constraints
- Add a NOT NULL constraint by using the MODIFY clause

```
ALTER TABLE  <table_name>
ADD [CONSTRAINT <constraint_name>]
type (<column_name>);
```

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Adding a Constraint

You can add a constraint for existing tables by using the ALTER TABLE statement with the ADD clause.

In the syntax:

table	Is the name of the table
constraint	Is the name of the constraint
type	Is the constraint type
column	Is the name of the column affected by the constraint

The constraint name syntax is optional, although recommended. If you do not name your constraints, the system generates constraint names.

Guidelines

- You can add, drop, enable, or disable a constraint, but you cannot modify its structure.
- You can add a NOT NULL constraint to an existing column by using the MODIFY clause of the ALTER TABLE statement.

Note: You can define a NOT NULL column only if the table is empty or if the column has a value for every row.

Adding a Constraint

Add a FOREIGN KEY constraint to the EMP2 table indicating that a manager must already exist as a valid employee in the EMP2 table.

```
ALTER TABLE emp2
MODIFY employee_id PRIMARY KEY;
```

```
ALTER TABLE emp2 succeeded.
```

```
ALTER TABLE emp2
ADD CONSTRAINT emp_mgr_fk
  FOREIGN KEY(manager_id)
  REFERENCES emp2(employee_id);
```

```
ALTER TABLE  succeeded.
```

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Adding a Constraint (continued)

The first example in the slide modifies the EMP2 table to add a PRIMARY KEY constraint on the EMPLOYEE_ID column. Note that because no constraint name is provided, the constraint is automatically named by the Oracle Server. The second example in the slide creates a FOREIGN KEY constraint on the EMP2 table. The constraint ensures that a manager exists as a valid employee in the EMP2 table.

ON DELETE Clause

- Use the ON DELETE CASCADE clause to delete child rows when a parent key is deleted:

```
ALTER TABLE emp2 ADD CONSTRAINT emp_dt_fk
FOREIGN KEY (Department_id)
REFERENCES departments(department_id) ON DELETE CASCADE;
```

```
ALTER TABLE Emp2 succeeded.
```

- Use the ON DELETE SET NULL clause to set the child rows value to null when a parent key is deleted:

```
ALTER TABLE emp2 ADD CONSTRAINT emp_dt_fk
FOREIGN KEY (Department_id)
REFERENCES departments(department_id) ON DELETE SET NULL;
```

```
ALTER TABLE Emp2 succeeded.
```

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ON DELETE

By using the ON DELETE clause you can determine how Oracle Database handles referential integrity if you remove a referenced primary or unique key value.

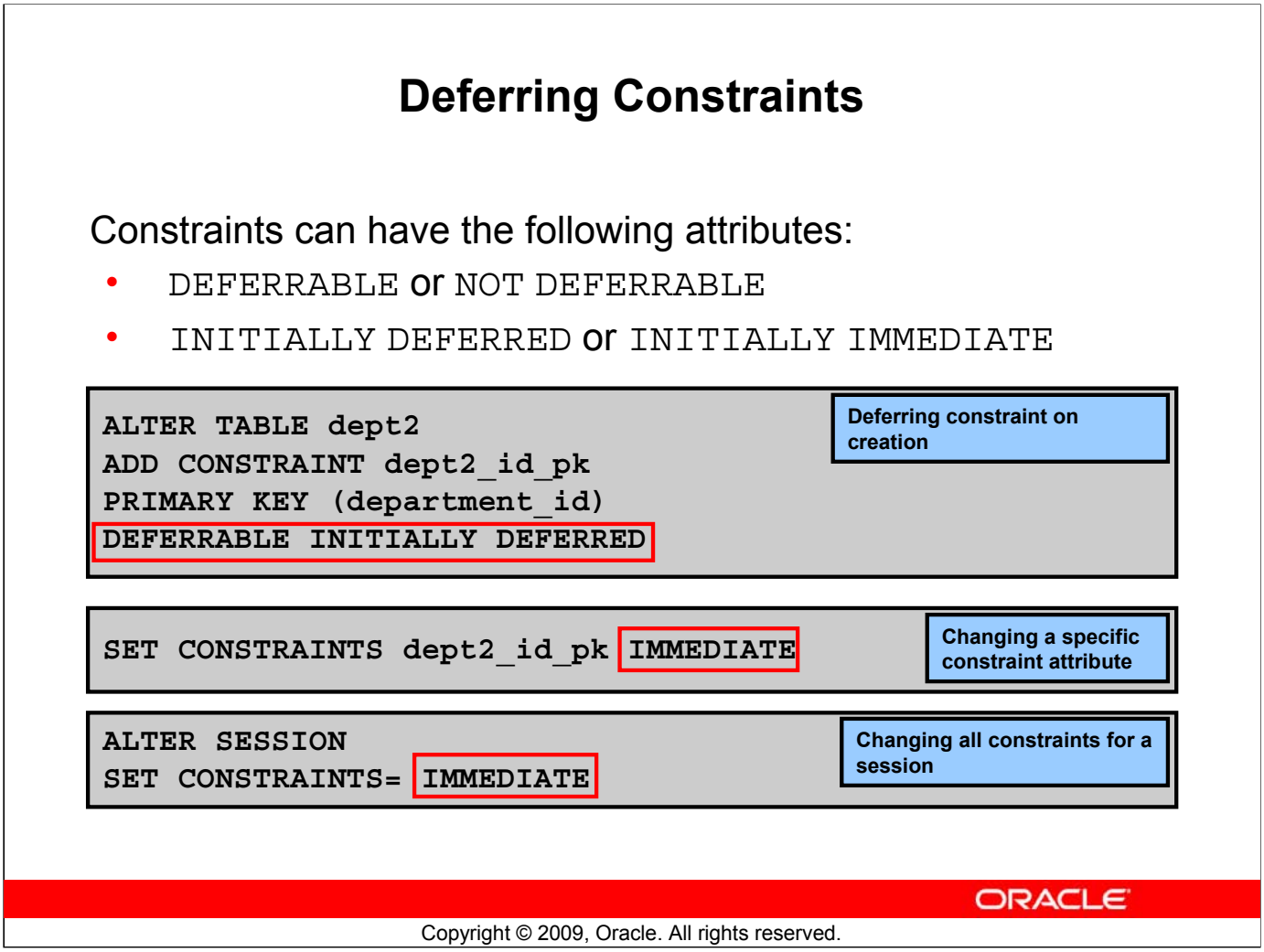
ON DELETE CASCADE

The ON DELETE CASCADE action allows parent key data that is referenced from the child table to be deleted, but not updated. When data in the parent key is deleted, all the rows in the child table that depend on the deleted parent key values are also deleted. To specify this referential action, include the ON DELETE CASCADE option in the definition of the FOREIGN KEY constraint.

ON DELETE SET NULL

When data in the parent key is deleted, the ON DELETE SET NULL action causes all the rows in the child table that depend on the deleted parent key value to be converted to null.

If you omit this clause, Oracle does not allow you to delete referenced key values in the parent table that have dependent rows in the child table.



Deferring Constraints

You can defer checking constraints for validity until the end of the transaction. A constraint is deferred if the system does not check whether the constraint is satisfied, until a COMMIT statement is submitted. If a deferred constraint is violated, the database returns an error and the transaction is not committed and it is rolled back. If a constraint is immediate (not deferred), it is checked at the end of each statement. If it is violated, the statement is rolled back immediately. If a constraint causes an action (for example, DELETE CASCADE), that action is always taken as part of the statement that caused it, whether the constraint is deferred or immediate. Use the SET CONSTRAINTS statement to specify, for a particular transaction, whether a deferrable constraint is checked following each data manipulation language (DML) statement or when the transaction is committed. To create deferrable constraints, you must create a nonunique index for that constraint.

You can define constraints as either deferrable or not deferrable, and either initially deferred or initially immediate. These attributes can be different for each constraint.

Usage scenario: Company policy dictates that department number 40 should be changed to 45. Changing the DEPARTMENT_ID column affects employees assigned to this department. Therefore, you make the PRIMARY KEY and FOREIGN KEYs deferrable and initially deferred. You update both department and employee information, and at the time of commit, all the rows are validated.

Difference Between INITIALLY DEFERRED and INITIALLY IMMEDIATE

INITIALLY DEFERRED	Waits to check the constraint until the transaction ends
INITIALLY IMMEDIATE	Checks the constraint at the end of the statement execution

```
CREATE TABLE emp_new_sal (salary NUMBER
        CONSTRAINT sal_ck
        CHECK (salary > 100)
        DEFERRABLE INITIALLY IMMEDIATE,
        bonus NUMBER
        CONSTRAINT bonus_ck
        CHECK (bonus > 0 )
        DEFERRABLE INITIALLY DEFERRED );
```

```
create table succeeded.
```

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Difference Between INITIALLY DEFERRED and INITIALLY IMMEDIATE

A constraint that is defined as deferrable can be specified as either INITIALLY DEFERRED or INITIALLY IMMEDIATE. The INITIALLY IMMEDIATE clause is the default.

In the slide example:

- The sal_ck constraint is created as DEFERRABLE INITIALLY IMMEDIATE
- The bonus_ck constraint is created as DEFERRABLE INITIALLY DEFERRED

After creating the emp_new_sal table as shown in the slide, you attempt to insert values into the table and observe the results. When both the sal_ck and bonus_ck constraints are satisfied, the rows are inserted without an error.

Example 1: Insert a row that violates sal_ck. In the CREATE TABLE statement, sal_ck is specified as an initially immediate constraint. This means that the constraint is verified immediately after the INSERT statement and you observe an error.

```
INSERT INTO emp_new_sal VALUES(90,5);
```

```
SQL Error: ORA-02290: check constraint (ORA21.SAL_CK) violated
02290. 00000 -  "check constraint (%s.%s) violated"
```

Example 2: Insert a row that violates bonus_ck. In the CREATE TABLE statement, bonus_ck is specified as deferrable and also initially deferred. Therefore, the constraint is not verified until you COMMIT or set the constraint state back to immediate.

Difference Between INITIALLY DEFERRED and INITIALLY IMMEDIATE (continued)

```
INSERT INTO emp_new_sal VALUES(110, -1);
```

```
1 rows inserted
```

The row insertion is successful. But, you observe an error when you commit the transaction.

```
COMMIT;
```

```
SQL Error: ORA-02091: transaction rolled back
ORA-02290: check constraint (ORA21.BONUS_CK) violated
02091. 00000 -  "transaction rolled back"
```

The commit failed due to constraint violation. Therefore, at this point, the transaction is rolled back by the database.

Example 3: Set the DEFERRED status to all constraints that can be deferred. Note that you can also set the DEFERRED status to a single constraint if required.

```
SET CONSTRAINTS ALL DEFERRED;
```

```
SET CONSTRAINTS succeeded.
```

Now, if you attempt to insert a row that violates the sal_ck constraint, the statement is executed successfully.

```
INSERT INTO emp_new_sal VALUES(90,5);
```

```
1 rows inserted
```

However, you observe an error when you commit the transaction. The transaction fails and is rolled back. This is because both the constraints are checked upon COMMIT.

```
COMMIT;
```

```
SQL Error: ORA-02091: transaction rolled back
ORA-02290: check constraint (ORA21.SAL_CK) violated
02091. 00000 -  "transaction rolled back"
```

Example 4: Set the IMMEDIATE status to both the constraints that were set as DEFERRED in the previous example.

```
SET CONSTRAINTS ALL IMMEDIATE;
```

```
SET CONSTRAINTS succeeded.
```

You observe an error if you attempt to insert a row that violates either sal_ck or bonus_ck.

```
INSERT INTO emp_new_sal VALUES(110, -1);
```

```
SQL Error: ORA-02290: check constraint (ORA21.BONUS_CK) violated
02290. 00000 -  "check constraint (%s.%s) violated"
```

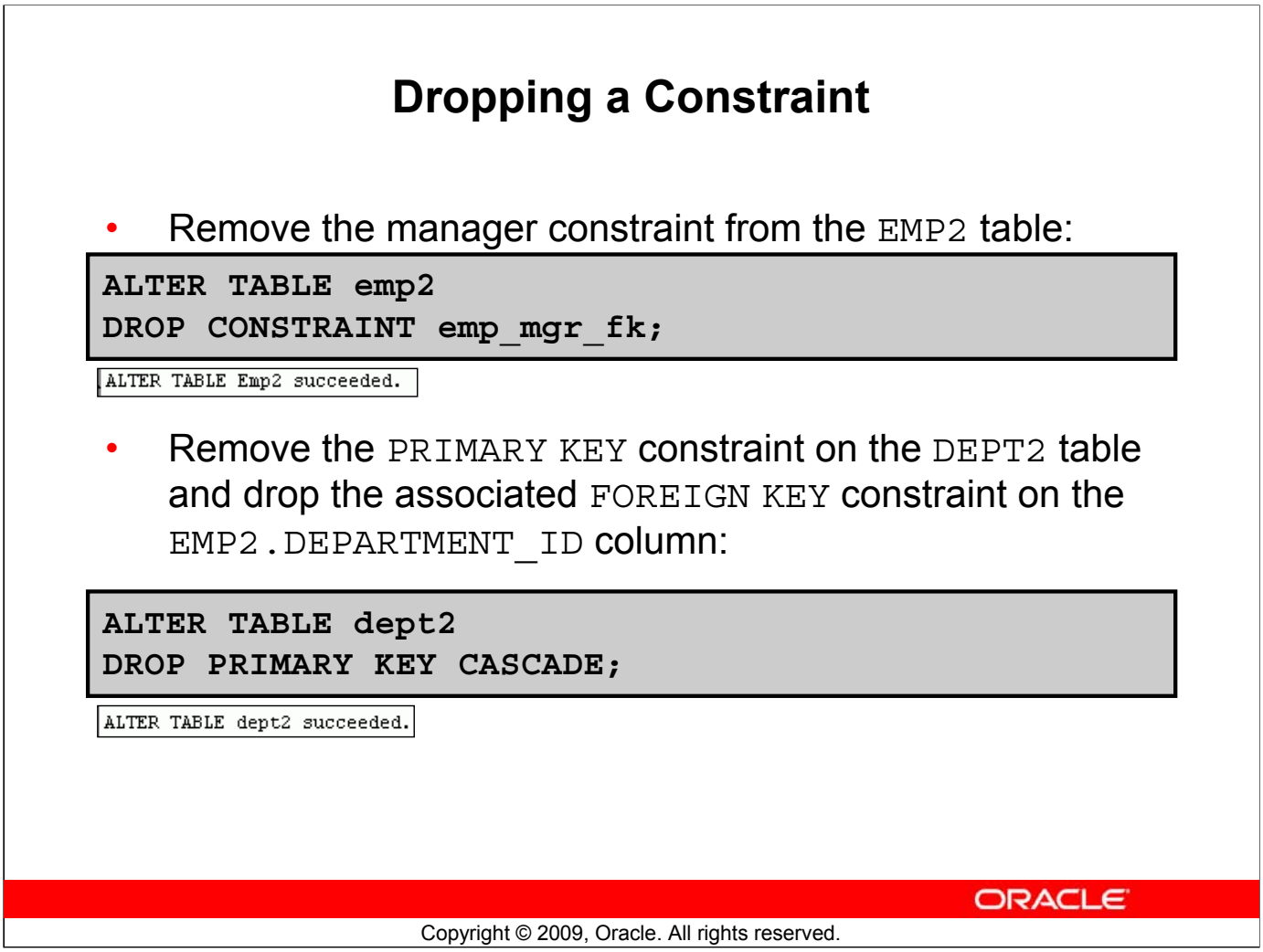
Note: If you create a table without specifying constraint deferability, the constraint is checked immediately at the end of each statement. For example, with the CREATE TABLE statement of the newemp_details table, if you do not specify the newemp_det_pk constraint deferability, the constraint is checked immediately.

```
CREATE TABLE newemp_details(emp_id NUMBER, emp_name
VARCHAR2(20),
CONSTRAINT newemp_det_pk PRIMARY KEY(emp_id));
```

When you attempt to defer the newemp_det_pk constraint that is not deferrable, you observe the following error:

```
SET CONSTRAINT newemp_det_pk DEFERRED;
```

```
SQL Error: ORA-02447: cannot defer a constraint that is not deferrable
```



Dropping a Constraint

To drop a constraint, you can identify the constraint name from the `USER_CONSTRAINTS` and `USER_CONS_COLUMNS` data dictionary views. Then use the `ALTER TABLE` statement with the `DROP` clause. The `CASCADE` option of the `DROP` clause causes any dependent constraints also to be dropped.

Syntax

```
ALTER TABLE   table
 DROP   PRIMARY KEY | UNIQUE (column) |
        CONSTRAINT    constraint   [CASCADE];
```

In the syntax:

table	Is the name of the table
column	Is the name of the column affected by the constraint
constraint	Is the name of the constraint

When you drop an integrity constraint, that constraint is no longer enforced by the Oracle Server and is no longer available in the data dictionary.

Disabling Constraints

- Execute the DISABLE clause of the ALTER TABLE statement to deactivate an integrity constraint.
- Apply the CASCADE option to disable dependent integrity constraints.

```
ALTER TABLE emp2
DISABLE CONSTRAINT emp_dt_fk;
```

```
ALTER TABLE Emp2 succeeded.
```

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Disabling a Constraint

You can disable a constraint without dropping it or re-creating it by using the ALTER TABLE statement with the DISABLE clause.

Syntax

```
ALTER   TABLE   table
 DISABLE CONSTRAINT constraint [CASCADE];
```

In the syntax:

table	Is the name of the table
constraint	Is the name of the constraint

Guidelines

- You can use the DISABLE clause in both the CREATE TABLE statement and the ALTER TABLE statement.
- The CASCADE clause disables dependent integrity constraints.
- Disabling a UNIQUE or PRIMARY KEY constraint removes the unique index.

Enabling Constraints

- Activate an integrity constraint currently disabled in the table definition by using the ENABLE clause.

```
ALTER TABLE       emp2
ENABLE CONSTRAINT emp_dt_fk;
```

```
ALTER TABLE Emp2 succeeded.
```

- A UNIQUE index is automatically created if you enable a UNIQUE key or a PRIMARY KEY constraint.

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Enabling a Constraint

You can enable a constraint without dropping it or re-creating it by using the ALTER TABLE statement with the ENABLE clause.

Syntax

```
ALTER   TABLE      table
ENABLE  CONSTRAINT constraint;
```

In the syntax:

table	Is the name of the table
constraint	Is the name of the constraint

Guidelines

- If you enable a constraint, that constraint applies to all the data in the table. All the data in the table must comply with the constraint.
- If you enable a UNIQUE key or a PRIMARY KEY constraint, a UNIQUE or PRIMARY KEY index is created automatically. If an index already exists, it can be used by these keys.
- You can use the ENABLE clause in both the CREATE TABLE statement and the ALTER TABLE statement.

Enabling a Constraint (continued)

- Enabling a PRIMARY KEY constraint that was disabled with the CASCADE option does not enable any FOREIGN KEYs that are dependent on the PRIMARY KEY.
- To enable a UNIQUE or PRIMARY KEY constraint, you must have the privileges necessary to create an index on the table.

Cascading Constraints

- The CASCADE CONSTRAINTS clause is used along with the DROP COLUMN clause.
- The CASCADE CONSTRAINTS clause drops all referential integrity constraints that refer to the PRIMARY and UNIQUE keys defined on the dropped columns.
- The CASCADE CONSTRAINTS clause also drops all multicolumn constraints defined on the dropped columns.

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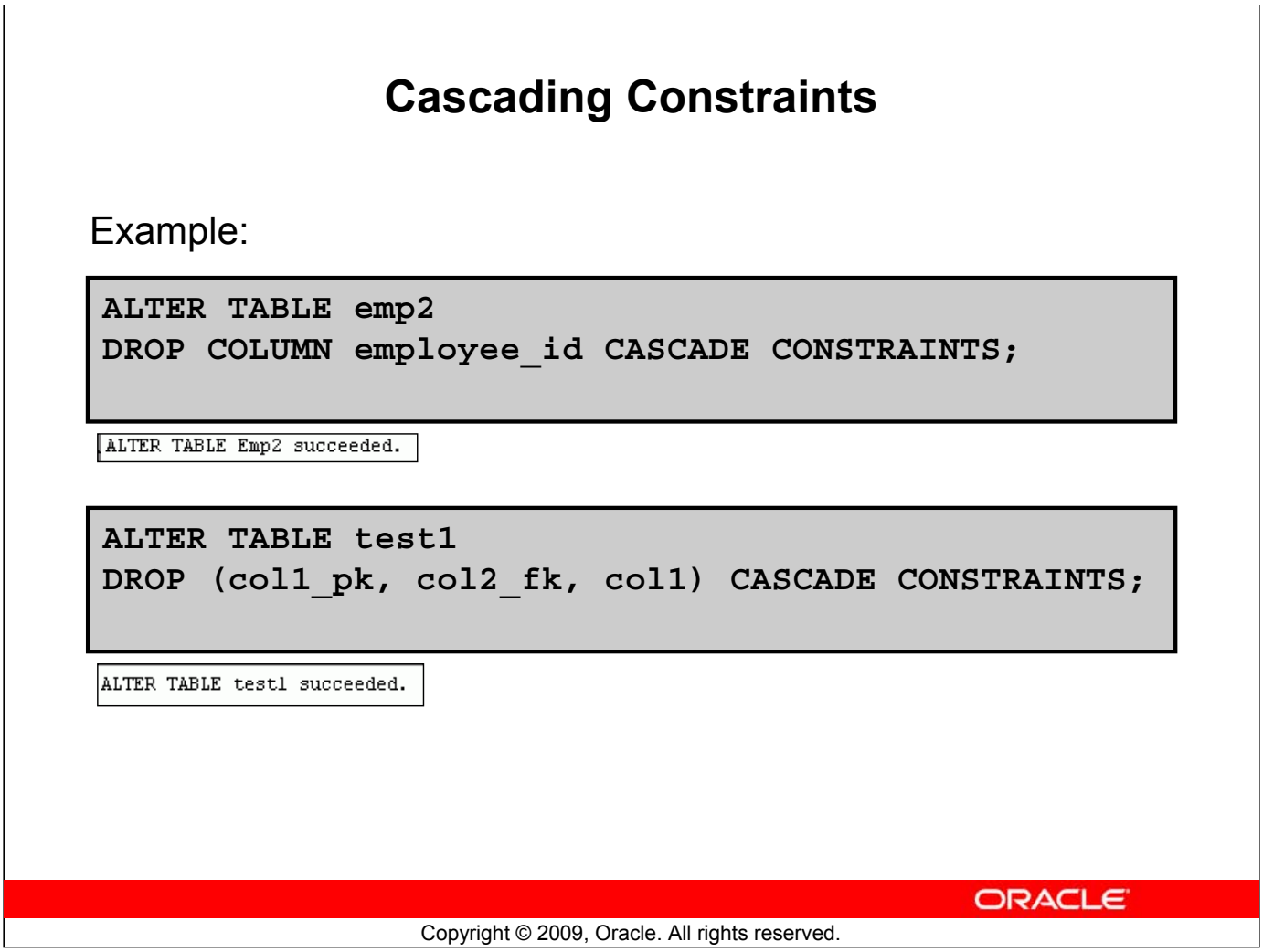
Cascading Constraints

This statement illustrates the usage of the CASCADE CONSTRAINTS clause. Assume that the TEST1 table is created as follows:

```
CREATE TABLE test1 (
  col1_pk NUMBER PRIMARY KEY,
  col2_fk NUMBER,
  col1 NUMBER,
  col2 NUMBER,
  CONSTRAINT fk_constraint FOREIGN KEY (col2_fk) REFERENCES
    test1,
  CONSTRAINT ck1 CHECK (col1_pk > 0 and col1 > 0),
  CONSTRAINT ck2 CHECK (col2_fk > 0));
```

An error is returned for the following statements:

```
ALTER TABLE test1 DROP (col1_pk);    —col1_pk is a parent key.
ALTER TABLE test1 DROP (col1); —col1 is referenced by the multicolumn
                                constraint, ck1.
```



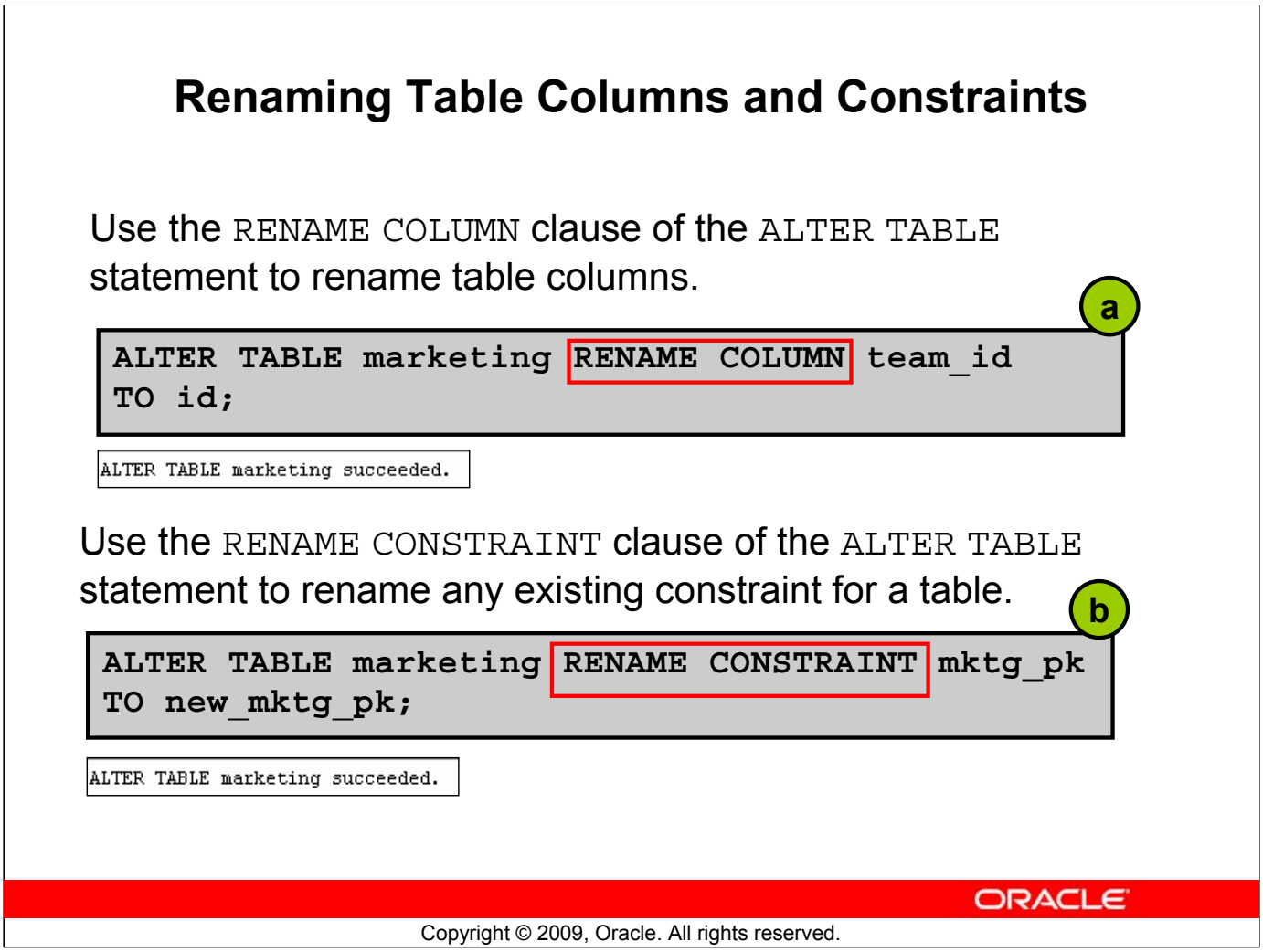
Cascading Constraints (continued)

Submitting the following statement drops the `EMPLOYEE_ID` column, the `PRIMARY KEY` constraint, and any `FOREIGN KEY` constraints referencing the `PRIMARY KEY` constraint for the `EMP2` table:

```
ALTER TABLE emp2 DROP COLUMN employee_id CASCADE CONSTRAINTS;
```

If all columns referenced by the constraints defined on the dropped columns are also dropped, `CASCADE CONSTRAINTS` is not required. For example, assuming that no other referential constraints from other tables refer to the `COL1_PK` column, it is valid to submit the following statement without the `CASCADE CONSTRAINTS` clause for the `TEST1` table created on the previous page:

```
ALTER TABLE test1 DROP (col1_pk, col2_fk, col1);
```



Renaming Table Columns and Constraints

When you rename a table column, the new name must not conflict with the name of any existing column in the table. You cannot use any other clauses in conjunction with the `RENAME COLUMN` clause.

The slide examples use the `marketing` table with the PRIMARY KEY `mktg_pk` defined on the `id` column.

```
CREATE TABLE marketing (team_id  NUMBER(10),
                        target  VARCHAR2(50),
CONSTRAINT mktg_pk PRIMARY KEY(team_id));
```

```
CREATE TABLE succeeded.
```

Example **a** shows that the `id` column of the marketing table is renamed `mktg_id`. Example **b** shows that `mktg_pk` is renamed `new_mktg_pk`.

When you rename any existing constraint for a table, the new name must not conflict with any of your existing constraint names. You can use the `RENAME CONSTRAINT` clause to rename system-generated constraint names.

Lesson Agenda

- Using the `ALTER TABLE` statement to add, modify, and drop a column
- Managing constraints:
  - Adding and dropping a constraint
  - Deferring constraints
  - Enabling and disabling a constraint
- Creating indexes:
  - Using the `CREATE TABLE` statement
  - Creating function-based indexes
  - Removing an index
- Performing flashback operations
- Creating and using temporary tables
- Creating and using external tables

ORACLE

Overview of Indexes

Indexes are created:

- Automatically
  - `PRIMARY KEY` creation
  - `UNIQUE KEY` creation
- Manually
  - The `CREATE INDEX` statement
  - The `CREATE TABLE` statement

ORACLE

Overview of Indexes

Two types of indexes can be created. One type is a unique index. The Oracle Server automatically creates a unique index when you define a column or group of columns in a table to have a `PRIMARY KEY` or a `UNIQUE` key constraint. The name of the index is the name given to the constraint.

The other type of index is a nonunique index, which a user can create. For example, you can create an index for a `FOREIGN KEY` column to be used in joins to improve retrieval speed.

You can create an index on one or more columns by issuing the `CREATE INDEX` statement.

For more information, see *Oracle Database 11g SQL Reference*.

Note: You can manually create a unique index, but it is recommended that you create a UNIQUE constraint, which implicitly creates a unique index.

CREATE INDEX with the CREATE TABLE Statement

```
CREATE TABLE NEW_EMP
(employee_id NUMBER(6)
             PRIMARY KEY USING INDEX
             (CREATE INDEX emp_id_idx ON
             NEW_EMP(employee_id)),
first_name   VARCHAR2(20),
last_name    VARCHAR2(25));
```

```
CREATE TABLE succeeded.
```

```
SELECT INDEX_NAME, TABLE_NAME
FROM   USER_INDEXES
WHERE  TABLE_NAME = 'NEW_EMP';
```

	INDEX_NAME	TABLE_NAME
1	EMP_ID_IDX	NEW_EMP

ORACLE

CREATE INDEX with the CREATE TABLE Statement

In the example in the slide, the CREATE INDEX clause is used with the CREATE TABLE statement to create a PRIMARY KEY index explicitly. You can name your indexes at the time of PRIMARY KEY creation to be different from the name of the PRIMARY KEY constraint.

You can query the USER_INDEXES data dictionary view for information about your indexes.

Note: You learn more about USER_INDEXES in the lesson titled "Managing Objects with Data Dictionary Views."

The following example illustrates the database behavior if the index is not explicitly named:

```
CREATE TABLE EMP_UNNAMED_INDEX
   (employee_id NUMBER(6) PRIMARY KEY ,
    first_name VARCHAR2(20),
    last_name VARCHAR2(25));
```

```
CREATE TABLE succeeded.
```

```
SELECT INDEX_NAME, TABLE_NAME
FROM   USER_INDEXES
WHERE  TABLE_NAME = 'EMP_UNNAMED_INDEX';
```

	INDEX_NAME	TABLE_NAME
1	SYS_C0017294	EMP_UNNAMED_INDEX

CREATE INDEX with the CREATE TABLE Statement (continued)

Observe that the Oracle Server gives a generic name to the index that is created for the PRIMARY KEY column.

You can also use an existing index for your PRIMARY KEY column—for example, when you are expecting a large data load and want to speed up the operation. You may want to disable the constraints while performing the load and then enable them, in which case having a unique index on the PRIMARY KEY will still cause the data to be verified during the load. Therefore, you can first create a nonunique index on the column designated as PRIMARY KEY, and then create the PRIMARY KEY column and specify that it should use the existing index. The following examples illustrate this process:

Step 1: Create the table:

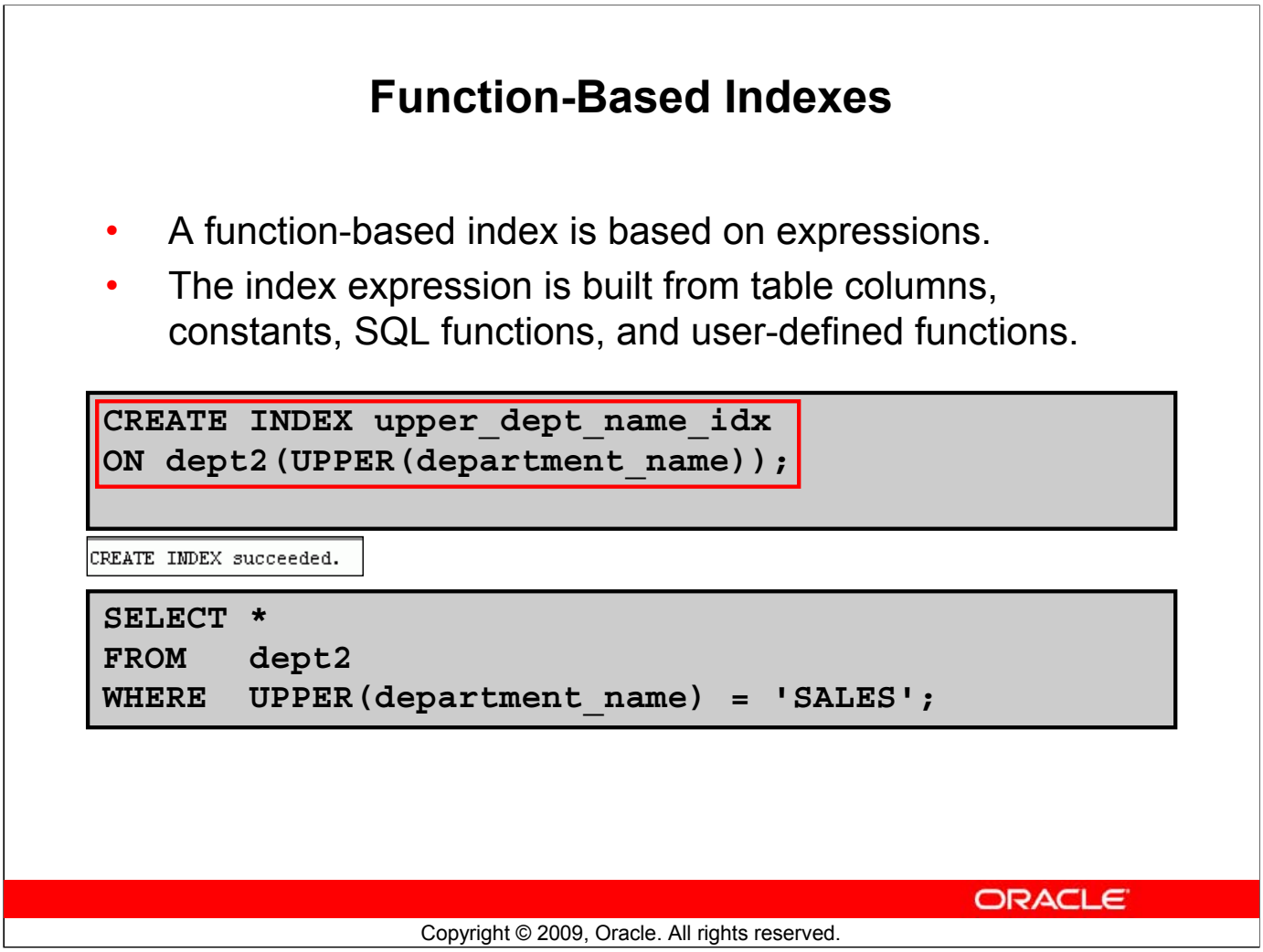
```
CREATE TABLE NEW_EMP2
 (employee_id NUMBER(6),
 first_name  VARCHAR2(20),
 last_name   VARCHAR2(25)
 );
```

Step 2: Create the index:

```
CREATE INDEX emp_id_idx2 ON
  new_emp2(employee_id);
```

Step 3: Create the PRIMARY KEY:

```
ALTER TABLE new_emp2 ADD PRIMARY KEY (employee_id) USING INDEX
 emp_id_idx2;
```



Function-Based Indexes

Function-based indexes defined with the `UPPER(column_name)` or `LOWER(column_name)` keywords allow non-case-sensitive searches. For example, consider the following index:

```
CREATE INDEX upper_last_name_idx ON emp2 (UPPER(last_name));
```

This facilitates processing queries such as:

```
SELECT * FROM emp2 WHERE UPPER(last_name) = 'KING';
```

The Oracle Server uses the index only when that particular function is used in a query. For example, the following statement may use the index, but without the `WHERE` clause, the Oracle Server may perform a full table scan:

```
SELECT   *
FROM     employees
WHERE    UPPER (last_name) IS NOT NULL
ORDER BY UPPER (last_name);
```

Note: The `QUERY_REWRITE_ENABLED` initialization parameter must be set to `TRUE` for a function-based index to be used.

The Oracle Server treats indexes with columns marked `DESC` as function-based indexes. The columns marked `DESC` are sorted in descending order.

Removing an Index

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

```
DROP INDEX index;
```

- Remove the UPPER_DEPT_NAME_IDX index from the data dictionary:

```
DROP INDEX upper_dept_name_idx;
```

```
DROP INDEX upper_dept_name_idx succeeded.
```

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

ORACLE

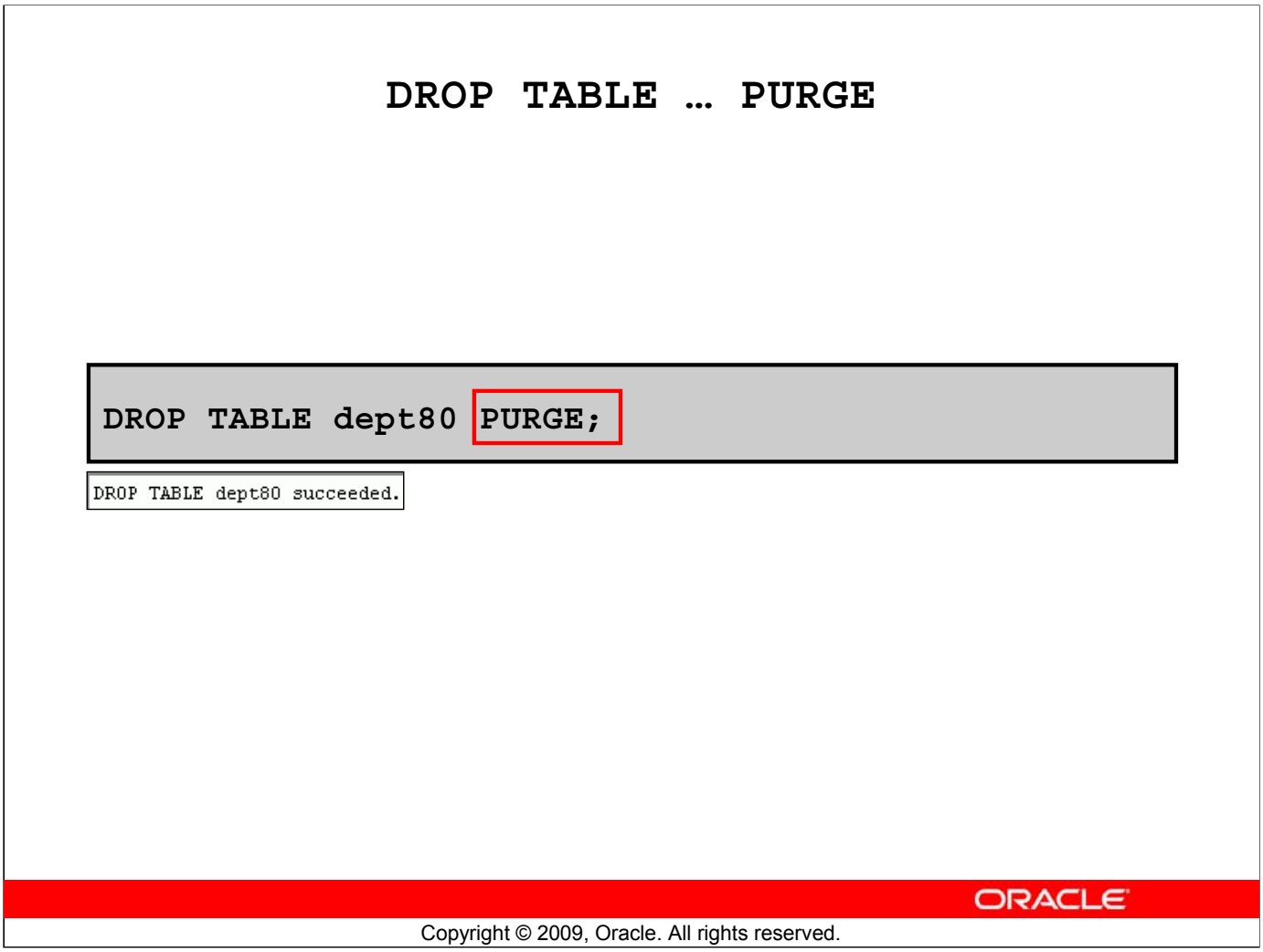
Removing an Index

You cannot modify indexes. To change an index, you must drop it and then re-create it. Remove an index definition from the data dictionary by issuing the DROP INDEX statement. To drop an index, you must be the owner of the index or have the DROP ANY INDEX privilege.

In the syntax:

index Is the name of the index

Note: If you drop a table, then indexes, constraints, and triggers are automatically dropped, but views and sequences remain.



DROP TABLE … PURGE

Oracle Database provides a feature for dropping tables. When you drop a table, the database does not immediately release the space associated with the table. Rather, the database renames the table and places it in a recycle bin, where it can later be recovered with the `FLASHBACK TABLE` statement if you find that you dropped the table in error. If you want to immediately release the space associated with the table at the time you issue the `DROP TABLE` statement, include the `PURGE` clause as shown in the statement in the slide.

Specify `PURGE` only if you want to drop the table and release the space associated with it in a single step. If you specify `PURGE`, the database does not place the table and its dependent objects into the recycle bin.

Using this clause is equivalent to first dropping the table and then purging it from the recycle bin. This clause saves you one step in the process. It also provides enhanced security if you want to prevent sensitive material from appearing in the recycle bin.

Lesson Agenda

- Using the `ALTER TABLE` statement to add, modify, and drop a column
- Managing constraints:
  - Adding and dropping a constraint
  - Deferring constraints
  - Enabling and disabling a constraint
- Creating indexes:
  - Using the `CREATE TABLE` statement
  - Creating function-based indexes
  - Removing an index
- Performing flashback operations
- Creating and using temporary tables
- Creating and using external tables

ORACLE

FLASHBACK TABLE Statement

- Enables you to recover tables to a specified point in time with a single statement
- Restores table data along with associated indexes and constraints
- Enables you to revert the table and its contents to a certain point in time or system change number (SCN)

ORACLE

FLASHBACK TABLE Statement

Oracle Flashback Table enables you to recover tables to a specified point in time with a single statement. You can restore table data along with associated indexes and constraints while the database is online, undoing changes to only the specified tables.

The Flashback Table feature is similar to a self-service repair tool. For example, if a user accidentally deletes important rows from a table and then wants to recover the deleted rows, you can use the `FLASHBACK TABLE` statement to restore the table to the time before the deletion and see the missing rows in the table.

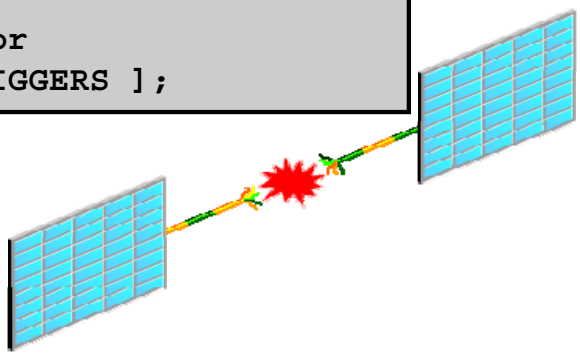
When using the `FLASHBACK TABLE` statement, you can revert the table and its contents to a certain time or to an SCN.

Note: The SCN is an integer value associated with each change to the database. It is a unique incremental number in the database. Every time you commit a transaction, a new SCN is recorded.

FLASHBACK TABLE Statement

- Repair tool for accidental table modifications
  - Restores a table to an earlier point in time
  - Benefits: Ease of use, availability, and fast execution
  - Is performed in place
- Syntax:

```
FLASHBACK TABLE[schema.]table[,
[ schema.]table ]...
TO { TIMESTAMP | SCN } expr
[ { ENABLE | DISABLE } TRIGGERS ];
```



ORACLE

FLASHBACK TABLE Statement (continued)

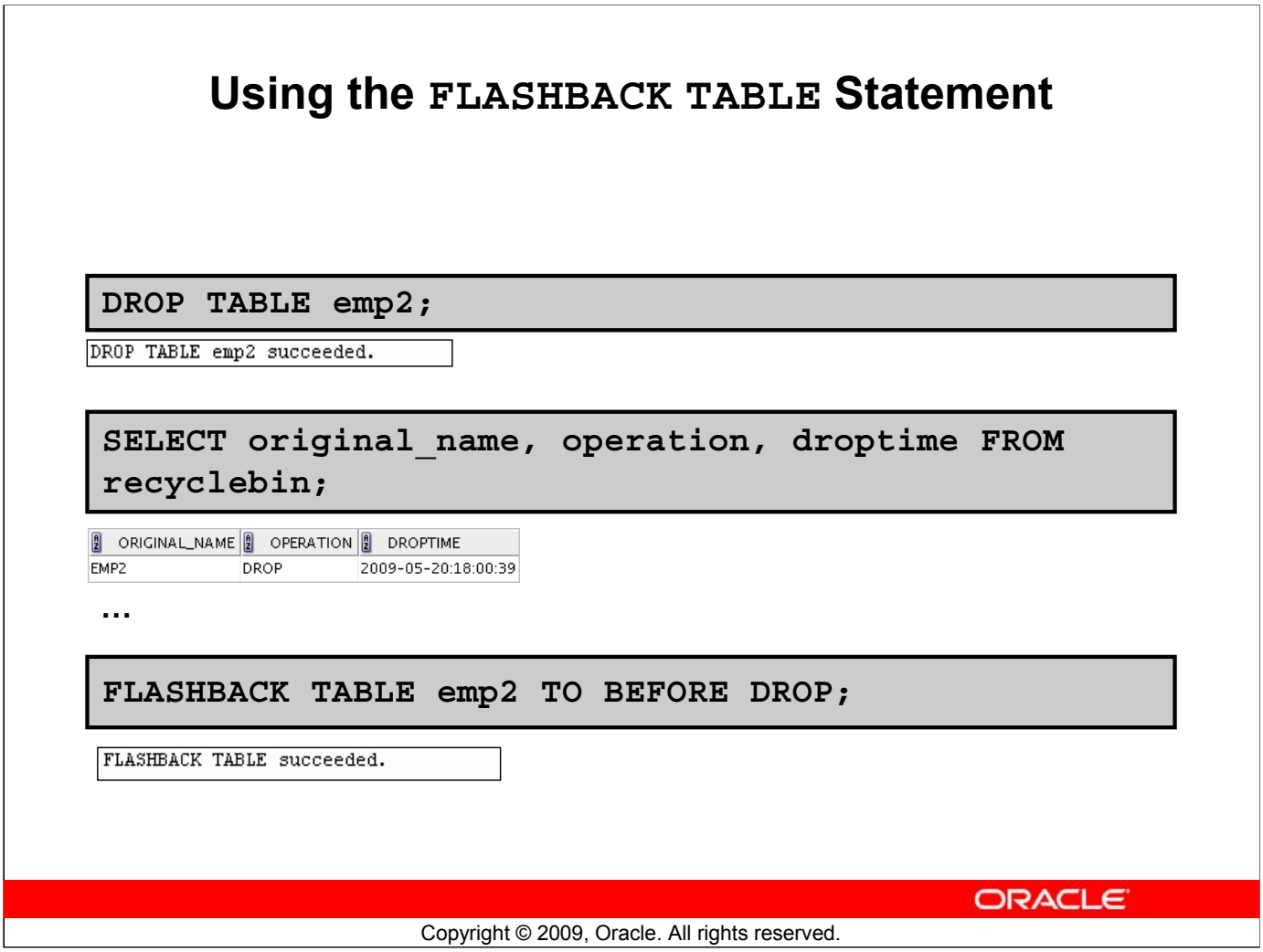
Self-Service Repair Facility

Oracle Database provides a SQL data definition language (DDL) command, `FLASHBACK TABLE`, to restore the state of a table to an earlier point in time in case it is inadvertently deleted or modified. The `FLASHBACK TABLE` command is a self-service repair tool to restore data in a table along with associated attributes such as indexes or views. This is done, while the database is online, by rolling back only the subsequent changes to the given table. Compared to traditional recovery mechanisms, this feature offers significant benefits such as ease of use, availability, and faster restoration. It also takes the burden off the DBA to find and restore application-specific properties. The flashback table feature does not address physical corruption caused because of a bad disk.

Syntax

You can invoke a `FLASHBACK TABLE` operation on one or more tables, even on tables in different schemas. You specify the point in time to which you want to revert by providing a valid time stamp. By default, database triggers are disabled during the flashback operation for all tables involved. You can override this default behavior by specifying the `ENABLE TRIGGERS` clause.

Note: For more information about recycle bin and flashback semantics, refer to *Oracle Database Administrator's Guide 11g Release 2 (11.2)*.



Using the FLASHBACK TABLE Statement

Syntax and Examples

The example restores the EMP2 table to a state before a DROP statement.

The recycle bin is actually a data dictionary table containing information about dropped objects. Dropped tables and any associated objects—such as, indexes, constraints, nested tables, and so on—are not removed and still occupy space. They continue to count against user space quotas until specifically purged from the recycle bin, or until they must be purged by the database because of tablespace space constraints.

Each user can be thought of as an owner of a recycle bin because, unless a user has the SYSDBA privilege, the only objects that the user has access to in the recycle bin are those that the user owns. A user can view his or her objects in the recycle bin by using the following statement:

```
SELECT * FROM RECYCLEBIN;
```

When you drop a user, any objects belonging to that user are not placed in the recycle bin and any objects in the recycle bin are purged.

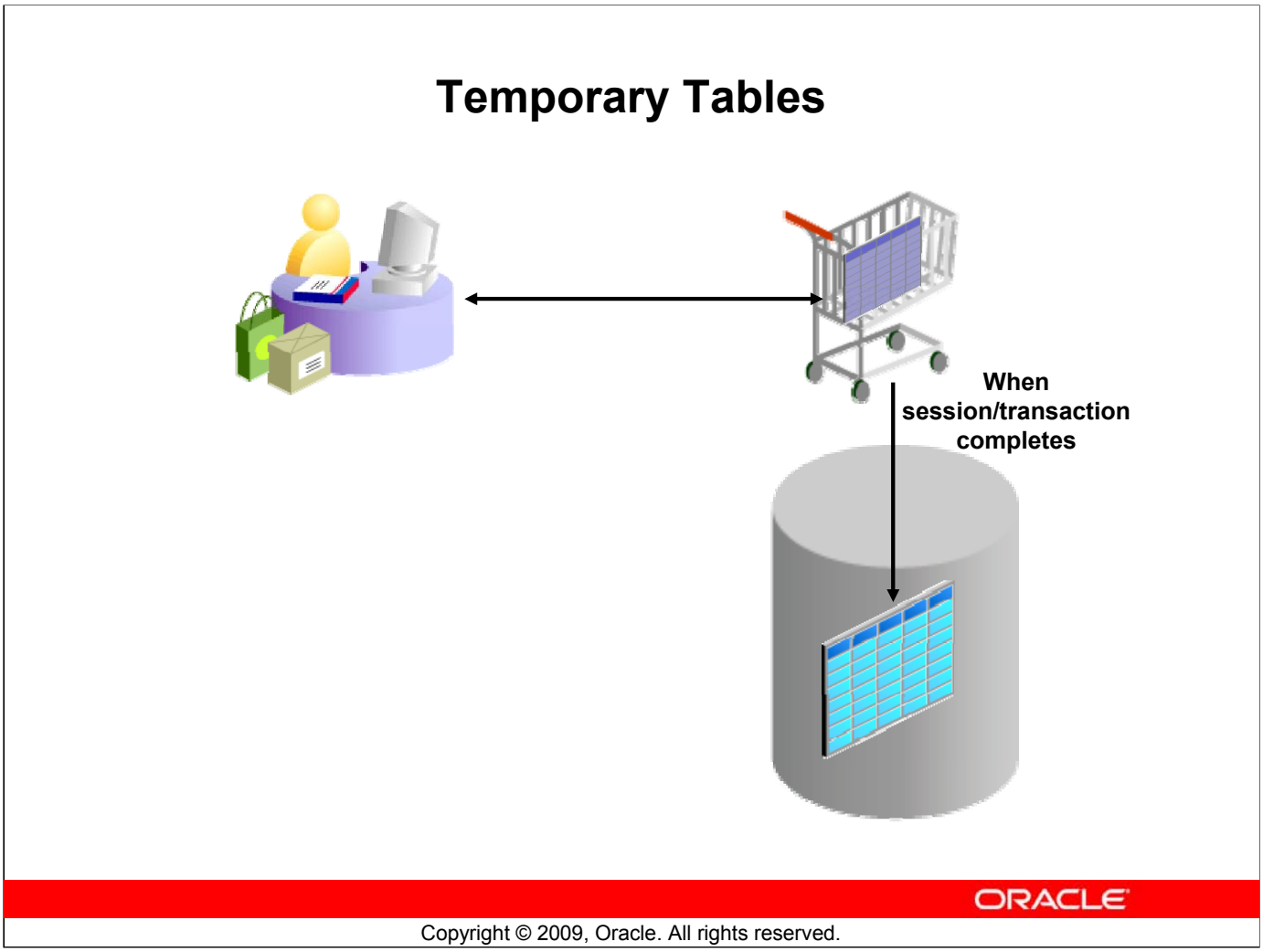
You can purge the recycle bin with the following statement:

```
PURGE RECYCLEBIN;
```

Lesson Agenda

- Using the `ALTER TABLE` statement to add, modify, and drop a column
- Managing constraints:
  - Adding and dropping a constraint
  - Deferring constraints
  - Enabling and disabling a constraint
- Creating indexes:
  - Using the `CREATE TABLE` statement
  - Creating function-based indexes
  - Removing an index
- Performing flashback operations
- Creating and using temporary tables
- Creating and using external tables

ORACLE

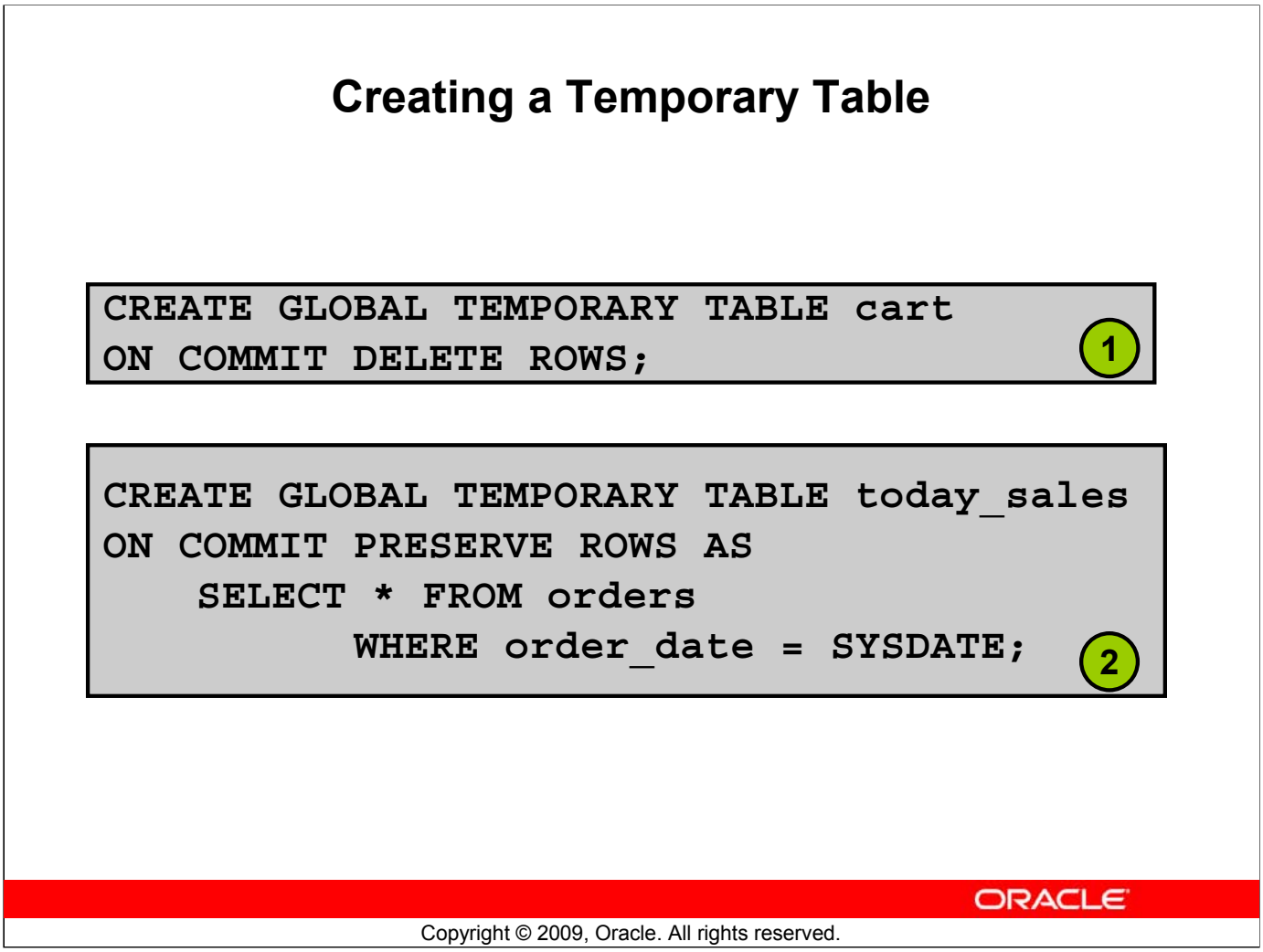


Temporary Tables

A temporary table is a table that holds data that exists only for the duration of a transaction or session. Data in a temporary table is private to the session, which means that each session can only see and modify its own data.

Temporary tables are useful in applications where a result set must be buffered. For example a shopping cart in an online application can be a temporary table. Each item is represented by a row in the temporary table. While you are shopping in an online store, you can keep on adding or removing items from your cart. During the session, this cart data is private. After you finalize your shopping and make the payments, the application moves the row for the chosen cart to a permanent table. At the end of the session, the data in the temporary data is automatically dropped.

Because temporary tables are statically defined, you can create indexes for them. Indexes created on temporary tables are also temporary. The data in the index has the same session or transaction scope as the data in the temporary table. You can also create a view or trigger on a temporary table.



Creating a Temporary Table

To create a temporary table you can use the following command:

```
CREATE GLOBAL TEMPORARY TABLE tablename
ON COMMIT [PRESERVE | DELETE] ROWS
```

By associating one of the following settings with the `ON COMMIT` clause, you can decide whether the data in the temporary table is transaction-specific (default) or session specific.

1. `DELETE ROWS`: As shown in example 1 in the slide, the `DELETE ROWS` setting creates a temporary table that is transaction specific. A session becomes bound to the temporary table with a transaction's first insert into the table. The binding goes away at the end of the transaction. The database truncates the table (delete all rows) after each commit.
2. `PRESERVE ROWS`: As shown in example 2 in the slide, the `PRESERVE ROWS` setting creates a temporary table that is session specific. Each sales representative session can store its own sales data for the day in the table. When a salesperson performs first insert on the `today_sales` table, his or her session gets bound to the `today_sales` table. This binding goes away at the end of the session or by issuing a `TRUNCATE` of the table in the session. The database truncates the table when you terminate the session.

When you create a temporary table in an Oracle database, you create a static table definition. Like permanent tables, temporary tables are defined in the data dictionary. However, temporary tables and their indexes do not automatically allocate a segment when created. Instead, temporary segments are allocated when data is first inserted. Until data is loaded in a session the table appears empty.

Lesson Agenda

- Using the `ALTER TABLE` statement to add, modify, and drop a column
- Managing constraints:
  - Adding and dropping a constraint
  - Deferring constraints
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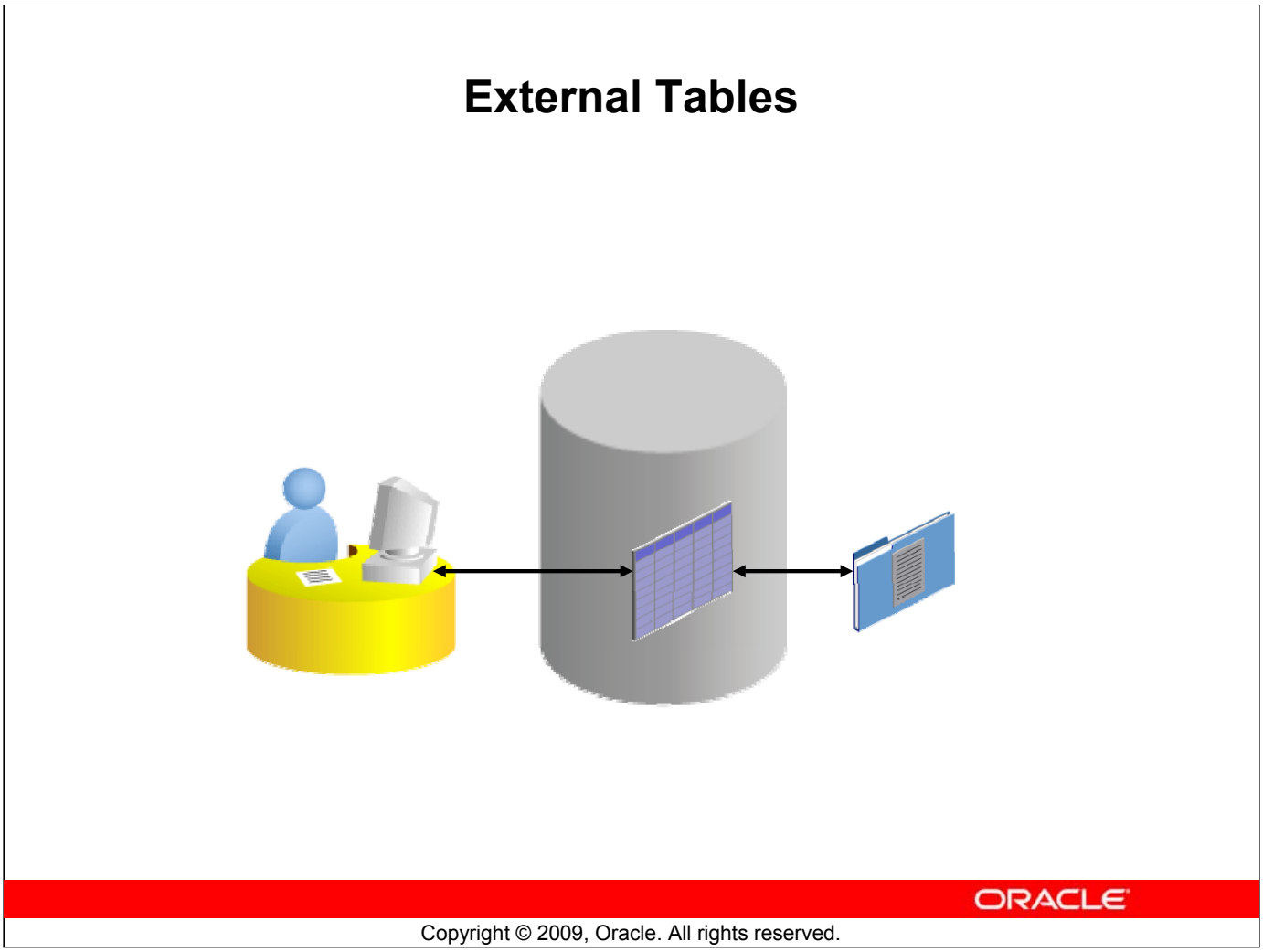
  - Using the `CREATE TABLE` statement
  - Creating function-based indexes
  - Removing an index
- Performing flashback operations
- Creating and using temporary tables
- Creating and using external tables

ORACLE



External Tables

An external table is a read-only table whose metadata is stored in the database but whose data is stored outside the database. This external table definition can be thought of as a view that is used for running any SQL query against external data without requiring that the external data first be loaded into the database. The external table data can be queried and joined directly and in parallel without requiring that the external data first be loaded in the database. You can use SQL, PL/SQL, and Java to query the data in an external table.

The main difference between external tables and regular tables is that externally organized tables are read-only. No data manipulation language (DML) operations are possible, and no indexes can be created on them. However, you can create an external table, and thus unload data, by using the `CREATE TABLE AS SELECT` command.

The Oracle Server provides two major access drivers for external tables. One, the loader access driver (or `ORACLE_LOADER`) is used for reading data from external files whose format can be interpreted by the SQL*Loader utility. Note that not all SQL*Loader functionality is supported with external tables. The `ORACLE_DATAPUMP` access driver can be used to both import and export data using a platform-independent format. The `ORACLE_DATAPUMP` access driver writes rows from a `SELECT` statement to be loaded into an external table as part of a `CREATE TABLE ...ORGANIZATION EXTERNAL...AS SELECT` statement. You can then use `SELECT` to read data out of that data file. You can also create an external table definition on another system and use that data file. This allows data to be moved between Oracle databases.

Creating a Directory for the External Table

Create a DIRECTORY object that corresponds to the directory on the file system where the external data source resides.

```
CREATE OR REPLACE DIRECTORY emp_dir
AS '/…/emp_dir';

GRANT READ ON DIRECTORY emp_dir TO ora_21;
```

ORACLE

Example of Creating an External Table

Use the CREATE DIRECTORY statement to create a directory object. A directory object specifies an alias for a directory on the server's file system where an external data source resides. You can use directory names when referring to an external data source, rather than hard code the operating system path name, for greater file management flexibility.

You must have CREATE ANY DIRECTORY system privileges to create directories. When you create a directory, you are automatically granted the READ and WRITE object privileges and can grant READ and WRITE privileges to other users and roles. The DBA can also grant these privileges to other users and roles.

A user needs READ privileges for all directories used in external tables to be accessed and WRITE privileges for the log, bad, and discard file locations being used.

In addition, a WRITE privilege is necessary when the external table framework is being used to unload data.

Oracle also provides the ORACLE_DATAPUMP type, with which you can unload data (that is, read data from a table in the database and insert it into an external table) and then reload it into an Oracle database. This is a one-time operation that can be done when the table is created. After the creation and initial population is done, you cannot update, insert, or delete any rows.

Example of Creating an External Table (continued)

Syntax

```
CREATE [OR REPLACE] DIRECTORY AS 'path_name';
```

In the syntax:

`OR REPLACE`	Specify `OR REPLACE` to re-create the directory database object if it already exists. You can use this clause to change the definition of an existing directory without dropping, re-creating, and regranting database object privileges previously granted on the directory. Users who were previously granted privileges on a redefined directory can continue to access the directory without requiring that the privileges be regranted.
`directory`	Specify the name of the directory object to be created. The maximum length of the directory name is 30 bytes. You cannot qualify a directory object with a schema name.
`'path_name'`	Specify the full path name of the operating system directory to be accessed. The path name is case-sensitive.

Creating an External Table

```
CREATE TABLE <table_name>
   ( <col_name> <datatype>, … )
ORGANIZATION EXTERNAL
    (TYPE <access_driver_type>
     DEFAULT DIRECTORY <directory_name>
     ACCESS PARAMETERS
      (… ) )
      LOCATION ('<location_specifier>')
REJECT LIMIT [0 | <number> | UNLIMITED];
```


Creating an External Table

You create external tables by using the `ORGANIZATION EXTERNAL` clause of the `CREATE TABLE` statement. You are not, in fact, creating a table. Rather, you are creating metadata in the data dictionary that you can use to access external data. You use the `ORGANIZATION` clause to specify the order in which the data rows of the table are stored. By specifying `EXTERNAL` in the `ORGANIZATION` clause, you indicate that the table is a read-only table located outside the database. Note that the external files must already exist outside the database.

`TYPE` *<access_driver_type>* indicates the access driver of the external table. The access driver is the application programming interface (API) that interprets the external data for the database. If you do not specify `TYPE`, Oracle uses the default access driver, `ORACLE_LOADER`. The other option is `ORACLE_DATAPUMP`.

You use the `DEFAULT DIRECTORY` clause to specify one or more Oracle database directory objects that correspond to directories on the file system where the external data sources may reside.

The optional `ACCESS PARAMETERS` clause enables you to assign values to the parameters of the specific access driver for this external table.

Creating an External Table (continued)

Use the LOCATION clause to specify one external locator for each external data source. Usually, <*location_specifier*> is a file, but it need not be.

The REJECT LIMIT clause enables you to specify how many conversion errors can occur during a query of the external data before an Oracle error is returned and the query is aborted. The default value is 0.

The syntax for using the ORACLE_DATAPUMP access driver is as follows:

```
CREATE TABLE extract_emps
ORGANIZATION EXTERNAL (TYPE ORACLE_DATAPUMP
                       DEFAULT DIRECTORY …
                       ACCESS PARAMETERS (… )
                       LOCATION (…)
                       PARALLEL 4
                       REJECT LIMIT UNLIMITED
AS
SELECT * FROM …;
```

Creating an External Table by Using ORACLE_LOADER

```
CREATE TABLE oldemp (
  fname char(25), lname CHAR(25))
  ORGANIZATION EXTERNAL
  (TYPE ORACLE_LOADER
  DEFAULT DIRECTORY emp_dir
  ACCESS PARAMETERS
  (RECORDS DELIMITED BY NEWLINE
   NOBADFILE
   NOLOGFILE
  FIELDS TERMINATED BY ','
  (fname POSITION ( 1:20) CHAR,
   lname POSITION (22:41) CHAR))
  LOCATION ('emp.dat'))
  PARALLEL 5
  REJECT LIMIT 200;
```

```
CREATE TABLE succeeded.
```

ORACLE

Example of Creating an External Table by Using the ORACLE_LOADER Access Driver

Assume that there is a flat file that has records in the following format:

```
10,jones,11-Dec-1934
20,smith,12-Jun-1972
```

Records are delimited by new lines, and the fields are all terminated by a comma (,). The name of the file is `/emp_dir/emp.dat`.

To convert this file as the data source for an external table, whose metadata will reside in the database, you must perform the following steps:

1. Create a directory object, `emp_dir`, as follows:
   ```
   CREATE DIRECTORY emp_dir AS '/emp_dir' ;
   ```
2. Run the `CREATE TABLE` command shown in the slide.

The example in the slide illustrates the table specification to create an external table for the file:

```
/emp_dir/emp.dat
```

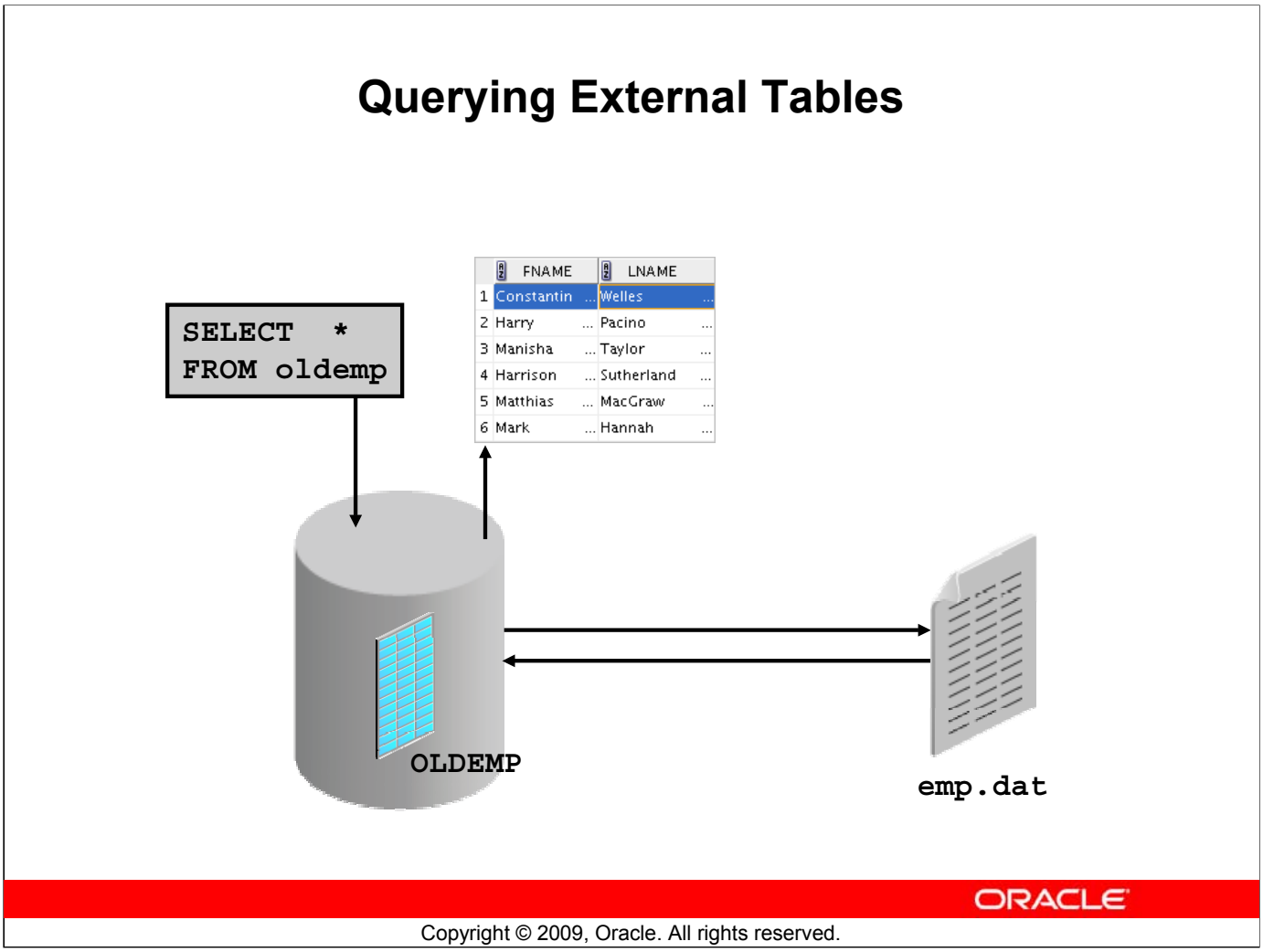
Example of Creating an External Table by Using the ORACLE_LOADER Access Driver (continued)

In the example, the TYPE specification is given only to illustrate its use. ORACLE_LOADER is the default access driver if not specified. The ACCESS PARAMETERS option provides values to parameters of the specific access driver, which are interpreted by the access driver, not by the Oracle Server.

The PARALLEL clause enables five parallel execution servers to simultaneously scan the external data sources (files) when executing the INSERT INTO TABLE statement. For example, if PARALLEL=5 were specified, more than one parallel execution server can be working on a data source. Because external tables can be very large, for performance reasons, it is advisable to specify the PARALLEL clause, or a parallel hint for the query.

The REJECT LIMIT clause specifies that if more than 200 conversion errors occur during a query of the external data, the query be aborted and an error be returned. These conversion errors can arise when the access driver tries to transform the data in the data file to match the external table definition.

After the CREATE TABLE command executes successfully, the OLDEMP external table can be described and queried in the same way as a relational table.



Querying External Tables

An external table does not describe any data that is stored in the database. It does not describe how data is stored in the external source. Instead, it describes how the external table layer must present the data to the server. It is the responsibility of the access driver and the external table layer to do the necessary transformations required on the data in the data file so that it matches the external table definition.

When the database server accesses data in an external source, it calls the appropriate access driver to get the data from an external source in a form that the database server expects.

It is important to remember that the description of the data in the data source is separate from the definition of the external table. The source file can contain more or fewer fields than there are columns in the table. Also, the data types for fields in the data source can be different from the columns in the table. The access driver takes care of ensuring that the data from the data source is processed so that it matches the definition of the external table.

Creating an External Table by Using ORACLE_DATAPUMP: Example

```
CREATE TABLE emp_ext
  (employee_id, first_name, last_name)
   ORGANIZATION EXTERNAL
    (
     TYPE ORACLE_DATAPUMP
     DEFAULT DIRECTORY emp_dir
     LOCATION
      ('emp1.exp','emp2.exp')
    )
   PARALLEL
AS
SELECT employee_id, first_name, last_name
FROM   employees;
```


Creating an External Table by Using ORACLE_DATAPUMP: Example

You can perform the unload and reload operations with external tables by using the ORACLE_DATAPUMP access driver.

Note: In the context of external tables, loading data refers to the act of data being read from an external table and loaded into a table in the database. Unloading data refers to the act of reading data from a table and inserting it into an external table.

The example in the slide illustrates the table specification to create an external table by using the ORACLE_DATAPUMP access driver. Data is then populated into the two files: emp1.exp and emp2.exp.

To populate data read from the EMPLOYEES table into an external table, you must perform the following steps:

1. Create a directory object, emp_dir, as follows:
   ```
   CREATE DIRECTORY emp_dir AS '/emp_dir' ;
   ```
2. Run the CREATE TABLE command shown in the slide.

Note: The emp_dir directory is the same as created in the previous example of using ORACLE_LOADER.

You can query the external table by executing the following code:

```
SELECT * FROM emp_ext;
```

Quiz

A `FOREIGN KEY` constraint enforces the following action: When the data in the parent key is deleted, all the rows in the child table that depend on the deleted parent key values are also deleted.

1. True
2. False

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Answer: 2

Quiz

In all the cases, when you execute a `DROP TABLE` command, the database renames the table and places it in a recycle bin, from where it can later be recovered by using the `FLASHBACK TABLE` statement.

1. True
2. False

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Answer: 2

Summary

In this lesson, you should have learned how to:

- Add constraints
- Create indexes
- Create indexes by using the `CREATE TABLE` statement
- Create function-based indexes
- Drop columns and set columns as `UNUSED`
- Perform `FLASHBACK` operations
- Create and use external tables

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Summary

In this lesson, you learned how to perform the following tasks for schema object management:

- Alter tables to add or modify columns or constraints.
- Create indexes and function-based indexes by using the `CREATE INDEX` statement.
- Drop unused columns.
- Use `FLASHBACK` mechanics to restore tables.
- Use the `ORGANIZATION EXTERNAL` clause of the `CREATE TABLE` statement to create an external table. An external table is a read-only table whose metadata is stored in the database but whose data is stored outside the database.
- Use external tables to query data without first loading it into the database.
- Name your `PRIMARY KEY` column indexes when you create the table with the `CREATE TABLE` statement.

Practice 2: Overview

This practice covers the following topics:

- Altering tables
- Adding columns
- Dropping columns
- Creating indexes
- Creating external tables

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Practice 2: Overview

In this practice, you use the `ALTER TABLE` command to modify columns and add constraints. You use the `CREATE INDEX` command to create indexes when creating a table, along with the `CREATE TABLE` command. You create external tables.

3

Managing Objects with Data Dictionary Views

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Objectives

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

- Use the data dictionary views to research data on your objects
- Query various data dictionary views

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Objectives

In this lesson, you are introduced to the data dictionary views. You learn that the dictionary views can be used to retrieve metadata and create reports about your schema objects.

Lesson Agenda

- Introduction to data dictionary
- Querying the dictionary views for the following:
  - Table information
  - Column information
  - Constraint information
- Querying the dictionary views for the following:
  - View information
  - Sequence information
  - Synonym information
  - Index information
- Adding a comment to a table and querying the dictionary views for comment information

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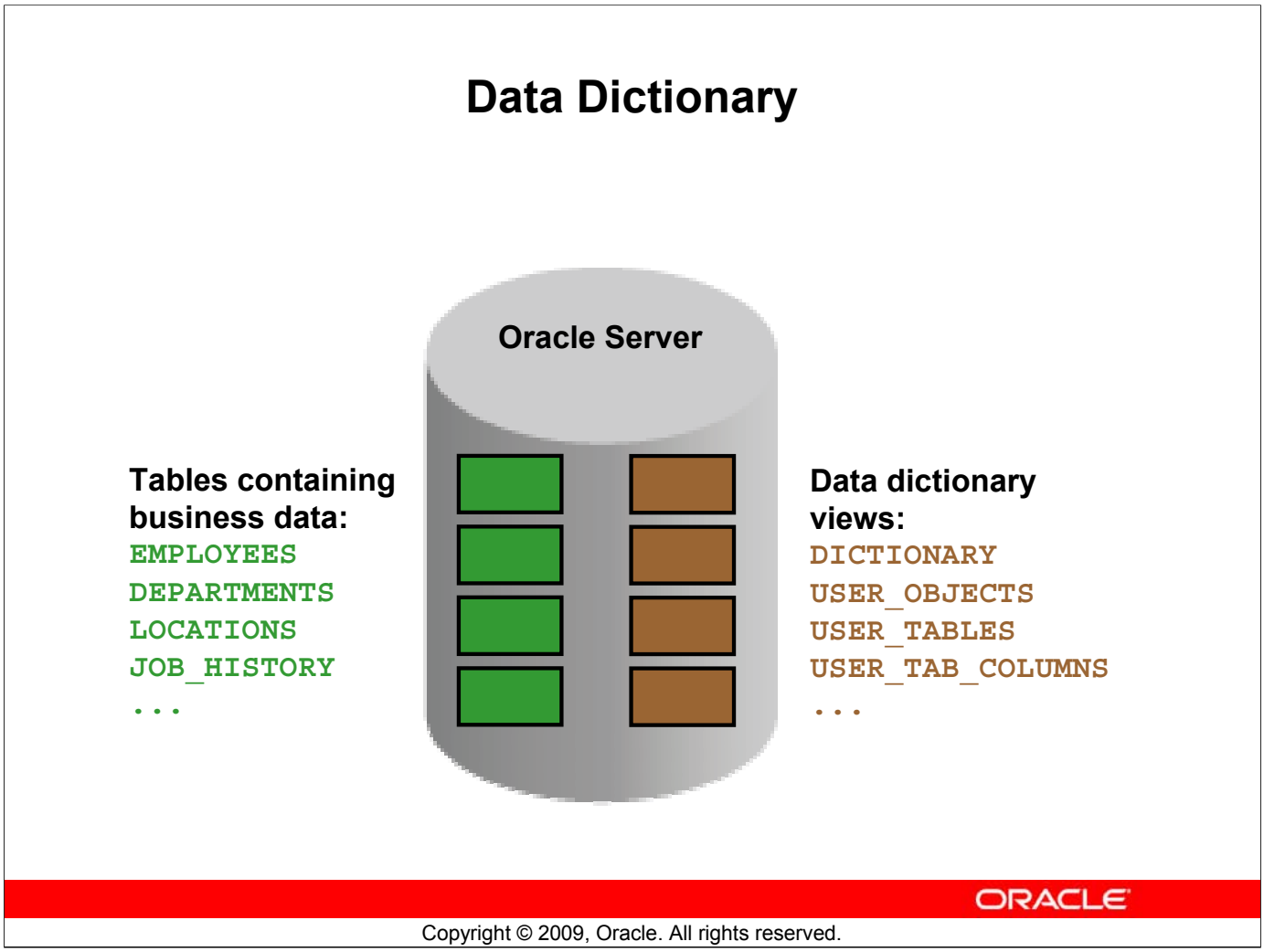


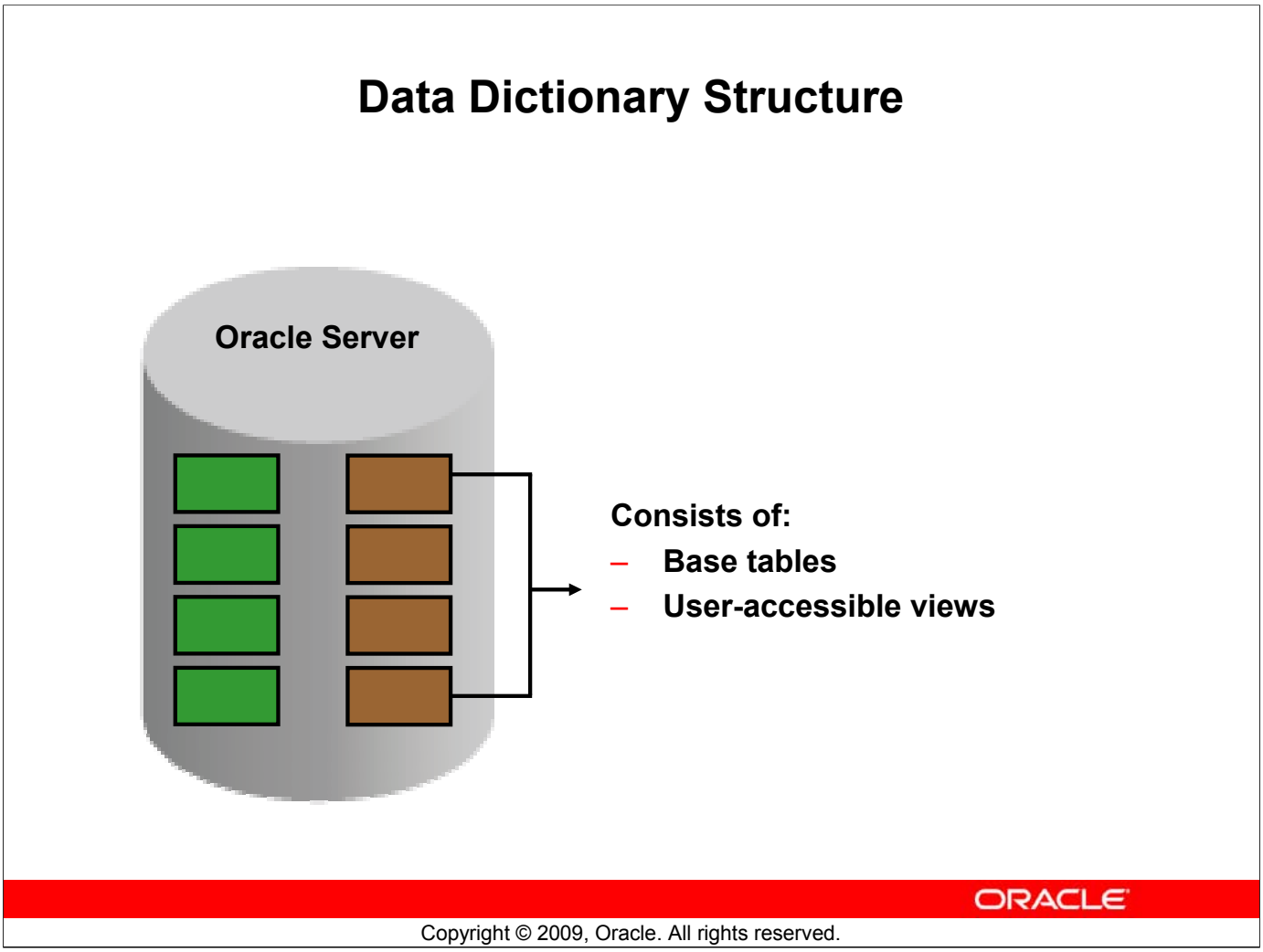
Data Dictionary

User tables are tables created by the user and contain business data, such as `EMPLOYEES`. There is another collection of tables and views in the Oracle database known as the *data dictionary*. This collection is created and maintained by the Oracle Server and contains information about the database. The data dictionary is structured in tables and views, just like other database data. Not only is the data dictionary central to every Oracle database, but it is also an important tool for all users, from end users to application designers and database administrators.

You use SQL statements to access the data dictionary. Because the data dictionary is read-only, you can issue only queries against its tables and views.

You can query the dictionary views that are based on the dictionary tables to find information such as:

- Definitions of all schema objects in the database (tables, views, indexes, synonyms, sequences, procedures, functions, packages, triggers, and so on)
- Default values for columns
- Integrity constraint information
- Names of Oracle users
- Privileges and roles that each user has been granted
- Other general database information



Data Dictionary Structure

Underlying base tables store information about the associated database. Only the Oracle Server should write to and read from these tables. You rarely access them directly.

There are several views that summarize and display the information stored in the base tables of the data dictionary. These views decode the base table data into useful information (such as user or table names) using joins and `WHERE` clauses to simplify the information. Most users are given access to the views rather than the base tables.

The Oracle user `SYS` owns all base tables and user-accessible views of the data dictionary. No Oracle user should *ever* alter (`UPDATE`, `DELETE`, or `INSERT`) any rows or schema objects contained in the `SYS` schema because such activity can compromise data integrity.

Data Dictionary Structure

View naming convention:

View Prefix	Purpose
USER	User's view (what is in your schema; what you own)
ALL	Expanded user's view (what you can access)
DBA	Database administrator's view (what is in everyone's schemas)
V$	Performance-related data

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Data Dictionary Structure (continued)

The data dictionary consists of sets of views. In many cases, a set consists of three views containing similar information and distinguished from each other by their prefixes. For example, there is a view named USER_OBJECTS, another named ALL_OBJECTS, and a third named DBA_OBJECTS.

These three views contain similar information about objects in the database, except that the scope is different. USER_OBJECTS contains information about objects that you own or created. ALL_OBJECTS contains information about all objects to which you have access. DBA_OBJECTS contains information about all objects that are owned by all users. For views that are prefixed with ALL or DBA, there is usually an additional column in the view named OWNER to identify who owns the object.

There is also a set of views that is prefixed with v$. These views are dynamic in nature and hold information about performance. Dynamic performance tables are not true tables, and they should not be accessed by most users. However, database administrators can query and create views on the tables and grant access to those views to other users. This course does not go into details about these views.

How to Use the Dictionary Views

Start with DICTIONARY. It contains the names and descriptions of the dictionary tables and views.

```
DESCRIBE DICTIONARY
```

```
Name                          Null     Type
----------------------------- -------- --------------
TABLE_NAME                             VARCHAR2(30)
COMMENTS                               VARCHAR2(4000)

2 rows selected
```

```
SELECT *
FROM   dictionary
WHERE  table_name = 'USER_OBJECTS';
```

	TABLE_NAME	COMMENTS
1	USER_OBJECTS	Objects owned by the user

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How to Use the Dictionary Views

To familiarize yourself with the dictionary views, you can use the dictionary view named DICTIONARY. It contains the name and short description of each dictionary view to which you have access.

You can write queries to search for information about a particular view name, or you can search the COMMENTS column for a word or phrase. In the example shown, the DICTIONARY view is described. It has two columns. The SELECT statement retrieves information about the dictionary view named USER_OBJECTS. The USER_OBJECTS view contains information about all the objects that you own.

You can write queries to search the COMMENTS column for a word or phrase. For example, the following query returns the names of all views that you are permitted to access in which the COMMENTS column contains the word *columns*:

```
SELECT table_name
FROM dictionary
WHERE LOWER(comments) LIKE '%columns%';
```

Note: The names in the data dictionary are in uppercase.

USER_OBJECTS and ALL_OBJECTS Views

USER_OBJECTS:

- Query USER_OBJECTS to see all the objects that you own.
- Using USER_OBJECTS, you can obtain a listing of all object names and types in your schema, plus the following information:
  - Date created
  - Date of last modification
  - Status (valid or invalid)

ALL_OBJECTS:

- Query ALL_OBJECTS to see all the objects to which you have access.

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USER_OBJECTS and ALL_OBJECTS Views

You can query the USER_OBJECTS view to see the names and types of all the objects in your schema. There are several columns in this view:

- **OBJECT_NAME:** Name of the object
- **OBJECT_ID:** Dictionary object number of the object
- **OBJECT_TYPE:** Type of object (such as TABLE, VIEW, INDEX, SEQUENCE)
- **CREATED:** Time stamp for the creation of the object
- **LAST_DDL_TIME:** Time stamp for the last modification of the object resulting from a data definition language (DDL) command
- **STATUS:** Status of the object (VALID, INVALID, or N/A)
- **GENERATED:** Was the name of this object system generated? (Y | N)

Note: This is not a complete listing of the columns. For a complete listing, see "USER_OBJECTS" in the *Oracle Database Reference*.

You can also query the ALL_OBJECTS view to see a listing of all objects to which you have access.

USER_OBJECTS View

```
SELECT object_name, object_type, created, status
FROM   user_objects
ORDER BY object_type;
```

	OBJECT_NAME	OBJECT_TYPE	CREATED	STATUS
1	LOC_COUNTRY_IX	INDEX	19-MAY-09	VALID

...

53	EMPLOYEES2	TABLE	22-MAY-09	VALID
54	SECURE_EMPLOYEES	TRIGGER	19-MAY-09	VALID
55	UPDATE_JOB_HISTORY	TRIGGER	19-MAY-09	VALID
56	EMP_DETAILS_VIEW	VIEW	19-MAY-09	VALID

...

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USER_OBJECTS View

The example shows the names, types, dates of creation, and status of all objects that are owned by this user.

The OBJECT_TYPE column holds the values of either TABLE, VIEW, SEQUENCE, INDEX, PROCEDURE, FUNCTION, PACKAGE, or TRIGGER.

The STATUS column holds a value of VALID, INVALID, or N/A. Although tables are always valid, the views, procedures, functions, packages, and triggers may be invalid.

The CAT View

For a simplified query and output, you can query the CAT view. This view contains only two columns: TABLE_NAME and TABLE_TYPE. It provides the names of all your INDEX, TABLE, CLUSTER, VIEW, SYNONYM, SEQUENCE, or UNDEFINED objects.

Note: CAT is a synonym for USER_CATALOG—a view that lists tables, views, synonyms and sequences owned by the user.

Lesson Agenda

- Introduction to data dictionary
- Querying the dictionary views for the following:
  - Table information
  - Column information
  - Constraint information
- Querying the dictionary views for the following:
  - View information
  - Sequence information
  - Synonym information
  - Index information
- Adding a comment to a table and querying the dictionary views for comment information

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Table Information

USER_TABLES:

```
DESCRIBE user_tables
```

Name	Null	Type
TABLE_NAME	NOT NULL	VARCHAR2(30)
TABLESPACE_NAME		VARCHAR2(30)
CLUSTER_NAME		VARCHAR2(30)
IOT_NAME		VARCHAR2(30)

...

```
SELECT table_name
FROM   user_tables;
```

	TABLE_NAME
1	REGIONS
2	LOCATIONS
3	DEPARTMENTS
4	JOBS
5	EMPLOYEES
6	JOB_HISTORY

...

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Table Information

You can use the USER_TABLES view to obtain the names of all your tables. The USER_TABLES view contains information about your tables. In addition to providing the table name, it contains detailed information about the storage.

The TABS view is a synonym of the USER_TABLES view. You can query it to see a listing of tables that you own:

```
SELECT table_name
FROM  tabs;
```

Note: For a complete listing of the columns in the USER_TABLES view, see "USER_TABLES" in the *Oracle Database Reference*.

You can also query the ALL_TABLES view to see a listing of all tables to which you have access.

Column Information

USER_TAB_COLUMNS:

```
DESCRIBE user_tab_columns
```

```
Name                           Null     Type
------------------------------ -------- --------------
TABLE_NAME                     NOT NULL VARCHAR2(30)
COLUMN_NAME                    NOT NULL VARCHAR2(30)
DATA_TYPE                               VARCHAR2(106)
DATA_TYPE_MOD                           VARCHAR2(3)
DATA_TYPE_OWNER                         VARCHAR2(30)
DATA_LENGTH                    NOT NULL NUMBER
DATA_PRECISION                          NUMBER
DATA_SCALE                              NUMBER
NULLABLE                                VARCHAR2(1)
...
```

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Column Information

You can query the USER_TAB_COLUMNS view to find detailed information about the columns in your tables. Although the USER_TABLES view provides information about your table names and storage, detailed column information is found in the USER_TAB_COLUMNS view.

This view contains information such as:

- Column names
- Column data types
- Length of data types
- Precision and scale for NUMBER columns
- Whether nulls are allowed (Is there a NOT NULL constraint on the column?)
- Default value

Note: For a complete listing and description of the columns in the USER_TAB_COLUMNS view, see "USER_TAB_COLUMNS" in the *Oracle Database Reference*.

Column Information

```
SELECT column_name, data_type, data_length,
       data_precision, data_scale, nullable
FROM   user_tab_columns
WHERE  table_name = 'EMPLOYEES';
```

	COLUMN_NAME	DATA_TYPE	DATA_LENGTH	DATA_PRECISION
1	EMPLOYEE_ID	NUMBER	22	6
2	FIRST_NAME	VARCHAR2	20	(null)
3	LAST_NAME	VARCHAR2	25	(null)
4	EMAIL	VARCHAR2	25	(null)
5	PHONE_NUMBER	VARCHAR2	20	(null)
6	HIRE_DATE	DATE	7	(null)
7	JOB_ID	VARCHAR2	10	(null)
8	SALARY	NUMBER	22	8
9	COMMISSION_PCT	NUMBER	22	2
10	MANAGER_ID	NUMBER	22	6
11	DEPARTMENT_ID	NUMBER	22	4

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Column Information (continued)

By querying the `USER_TAB_COLUMNS` table, you can find details about your columns such as the names, data types, data type lengths, null constraints, and default value for a column.

The example shown displays the columns, data types, data lengths, and null constraints for the `EMPLOYEES` table. Note that this information is similar to the output from the `DESCRIBE` command.

To view information about columns set as unused, you use the `USER_UNUSED_COL_TABS` dictionary view.

Note: Names of the objects in Data Dictionary are in uppercase.

Constraint Information

- `USER_CONSTRAINTS` describes the constraint definitions on your tables.
- `USER_CONS_COLUMNS` describes columns that are owned by you and that are specified in constraints.

```
DESCRIBE user_constraints
```

Name	Null	Type
OWNER	NOT NULL	VARCHAR2(30)
CONSTRAINT_NAME	NOT NULL	VARCHAR2(30)
CONSTRAINT_TYPE		VARCHAR2(1)
TABLE_NAME	NOT NULL	VARCHAR2(30)
SEARCH_CONDITION		LONG()
R_OWNER		VARCHAR2(30)
R_CONSTRAINT_NAME		VARCHAR2(30)
DELETE_RULE		VARCHAR2(9)
STATUS		VARCHAR2(8)

...

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Constraint Information

You can find out the names of your constraints, the type of constraint, the table name to which the constraint applies, the condition for check constraints, foreign key constraint information, deletion rule for foreign key constraints, the status, and many other types of information about your constraints.

Note: For a complete listing and description of the columns in the `USER_CONSTRAINTS` view, see "`USER_CONSTRAINTS`" in the *Oracle Database Reference*.

USER_CONSTRAINTS: Example

```
SELECT constraint_name, constraint_type,
       search_condition, r_constraint_name,
       delete_rule, status
FROM   user_constraints
WHERE  table_name = 'EMPLOYEES';
```

	CONSTRAINT_NAME	C...	SEARCH_CONDITION	R_CONSTR...	DELET...	STATUS
1	EMP_LAST_NAME_NN	C	"LAST_NAME" IS NOT NULL	(null)	(null)	ENABLED
2	EMP_EMAIL_NN	C	"EMAIL" IS NOT NULL	(null)	(null)	ENABLED
3	EMP_HIRE_DATE_NN	C	"HIRE_DATE" IS NOT NULL	(null)	(null)	ENABLED
4	EMP_JOB_NN	C	"JOB_ID" IS NOT NULL	(null)	(null)	ENABLED
5	EMP_SALARY_MIN	C	salary > 0	(null)	(null)	ENABLED
6	EMP_EMAIL_UK	U	(null)	(null)	(null)	ENABLED
7	EMP_EMP_ID_PK	P	(null)	(null)	(null)	ENABLED
8	EMP_DEPT_FK	R	(null)	DEPT_ID_PK	NO ACTION	ENABLED
9	EMP_JOB_FK	R	(null)	JOB_ID_PK	NO ACTION	ENABLED
10	EMP_MANAGER_FK	R	(null)	EMP_EMP_ID_PK	NO ACTION	ENABLED

USER_CONSTRAINTS: Example

In the example shown, the USER_CONSTRAINTS view is queried to find the names, types, check conditions, name of the unique constraint that the foreign key references, deletion rule for a foreign key, and status for constraints on the EMPLOYEES table.

The CONSTRAINT_TYPE can be:

- C (check constraint on a table , or NOT NULL)
- P (primary key)
- U (unique key)
- R (referential integrity)
- V (with check option, on a view)
- O (with read-only, on a view)

The DELETE_RULE can be:

- **CASCADE:** If the parent record is deleted, the child records are deleted too.
- **SET NULL**: If the parent record is deleted, change the respective child record to null.
- **NO ACTION:** A parent record can be deleted only if no child records exist.

The STATUS can be:

- **ENABLED:** Constraint is active.
- **DISABLED:** Constraint is made not active.

Querying USER_CONS_COLUMNS

```
DESCRIBE user_cons_columns
```

Name	Null	Type
OWNER	NOT NULL	VARCHAR2(30)
CONSTRAINT_NAME	NOT NULL	VARCHAR2(30)
TABLE_NAME	NOT NULL	VARCHAR2(30)
COLUMN_NAME		VARCHAR2(4000)
POSITION		NUMBER

```
SELECT constraint_name, column_name
FROM   user_cons_columns
WHERE  table_name = 'EMPLOYEES';
```

	CONSTRAINT_NAME	COLUMN_NAME
1	EMP_LAST_NAME_NN	LAST_NAME
2	EMP_EMAIL_NN	EMAIL
3	EMP_HIRE_DATE_NN	HIRE_DATE
4	EMP_JOB_NN	JOB_ID
5	EMP_SALARY_MIN	SALARY
6	EMP_EMAIL_UK	EMAIL

...

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Querying USER_CONS_COLUMNS

To find the names of the columns to which a constraint applies, query the USER_CONS_COLUMNS dictionary view. This view tells you the name of the owner of a constraint, the name of the constraint, the table that the constraint is on, the names of the columns with the constraint, and the original position of column or attribute in the definition of the object.

Note: A constraint may apply to more than one column.

You can also write a join between USER_CONSTRAINTS and USER_CONS_COLUMNS to create customized output from both tables.

Lesson Agenda

- Introduction to data dictionary
- Querying the dictionary views for the following:
  - Table information
  - Column information
  - Constraint information
- Querying the dictionary views for the following:
  - View information
  - Sequence information
  - Synonym information
  - Index information
- Adding a comment to a table and querying the dictionary views for comment information

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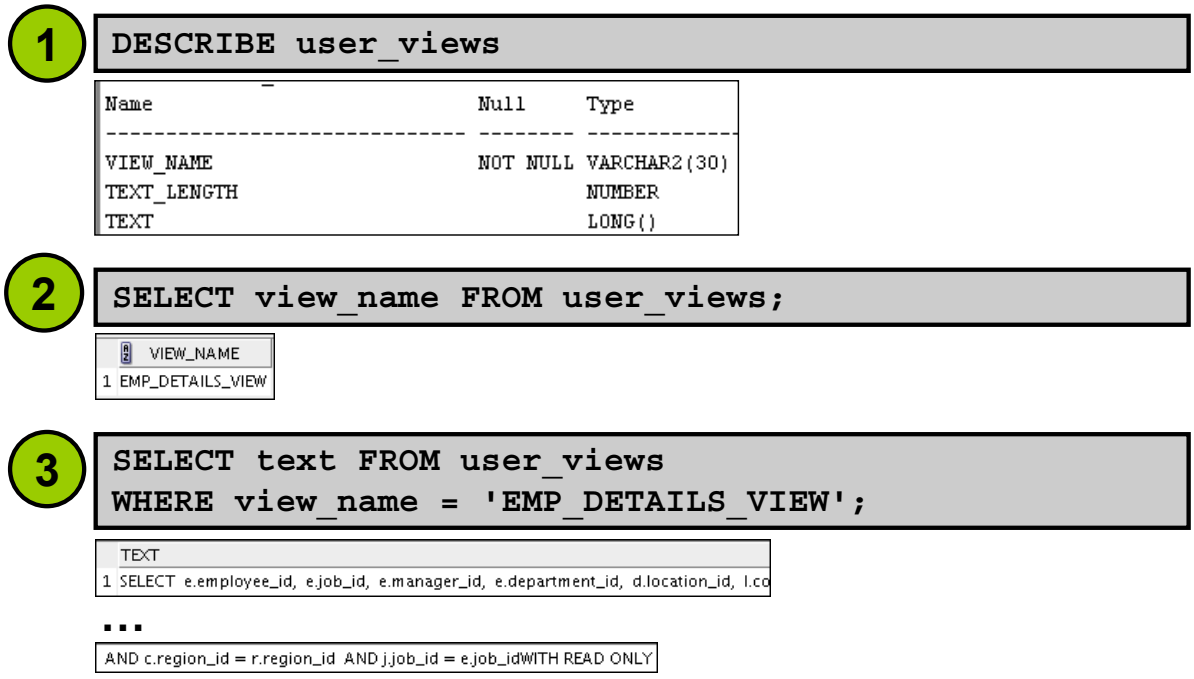
View Information



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View Information

After your view is created, you can query the data dictionary view called `USER_VIEWS` to see the name of the view and the view definition. The text of the `SELECT` statement that constitutes your view is stored in a `LONG` column. The `LENGTH` column is the number of characters in the `SELECT` statement. By default, when you select from a `LONG` column, only the first 80 characters of the column's value are displayed. To see more than 80 characters in SQL*Plus, use the `SET LONG` command:

```
SET LONG 1000
```

In the examples in the slide:

1. The `USER_VIEWS` columns are displayed. Note that this is a partial listing.
2. The names of your views are retrieved
3. The `SELECT` statement for the `EMP_DETAILS_VIEW` is displayed from the dictionary

Data Access Using Views

When you access data by using a view, the Oracle Server performs the following operations:

- It retrieves the view definition from the data dictionary table `USER_VIEWS`.
- It checks access privileges for the view base table.
- It converts the view query into an equivalent operation on the underlying base table or tables. That is, data is retrieved from, or an update is made to, the base tables.

Sequence Information

```
DESCRIBE user_sequences
```

Name	Null	Type
SEQUENCE_NAME	NOT NULL	VARCHAR2(30)
MIN_VALUE		NUMBER
MAX_VALUE		NUMBER
INCREMENT_BY	NOT NULL	NUMBER
CYCLE_FLAG		VARCHAR2(1)
ORDER_FLAG		VARCHAR2(1)
CACHE_SIZE	NOT NULL	NUMBER
LAST_NUMBER	NOT NULL	NUMBER

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Sequence Information

The USER_SEQUENCES view describes all sequences that you own. When you create the sequence, you specify criteria that are stored in the USER_SEQUENCES view. The columns in this view are:

- **SEQUENCE_NAME:** Name of the sequence
- **MIN_VALUE:** Minimum value of the sequence
- **MAX_VALUE:** Maximum value of the sequence
- **INCREMENT_BY:** Value by which the sequence is incremented
- **CYCLE_FLAG:** Does sequence wrap around on reaching the limit?
- **ORDER_FLAG:** Are sequence numbers generated in order?
- **CACHE_SIZE:** Number of sequence numbers to cache
- **LAST_NUMBER:** Last sequence number written to disk. If a sequence uses caching, the number written to disk is the last number placed in the sequence cache. This number is likely to be greater than the last sequence number that was used.

Confirming Sequences

- Verify your sequence values in the USER_SEQUENCES data dictionary table.

```
SELECT   sequence_name, min_value, max_value,
         increment_by, last_number
FROM     user_sequences;
```

	SEQUENCE_NAME	MIN_VALUE	MAX_VALUE	INCREMENT_BY	LAST_NUMBER
1	DEPARTMENTS_SEQ	1	9990	10	280
2	EMPLOYEES_SEQ	1	99999999999999...	1	207
3	LOCATIONS_SEQ	1	9900	100	3300

- The LAST_NUMBER column displays the next available sequence number if NOCACHE is specified.

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Confirming Sequences

After creating your sequence, it is documented in the data dictionary. Because a sequence is a database object, you can identify it in the USER_OBJECTS data dictionary table.

You can also confirm the settings of the sequence by selecting from the USER_SEQUENCES data dictionary view.

Viewing the Next Available Sequence Value Without Incrementing It

If the sequence was created with NOCACHE, it is possible to view the next available sequence value without incrementing it by querying the USER_SEQUENCES table.

Index Information

- USER_INDEXES provides information about your indexes.
- USER_IND_COLUMNS describes columns comprising your indexes and columns of indexes on your tables.

```
DESCRIBE user_indexes
```

Name	Null	Type
INDEX_NAME	NOT NULL	VARCHAR2(30)
INDEX_TYPE		VARCHAR2(27)
TABLE_OWNER	NOT NULL	VARCHAR2(30)
TABLE_NAME	NOT NULL	VARCHAR2(30)
TABLE_TYPE		VARCHAR2(11)
UNIQUENESS		VARCHAR2(9)

...

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Index Information

You query the USER_INDEXES view to find out the names of your indexes, the table name on which the index is created, and whether the index is unique.

Note: For a complete listing and description of the columns in the USER_INDEXES view, see "USER_INDEXES" in the *Oracle Database Reference 11g Release 2 (11.1)*.

USER_INDEXES: Examples

a

```
SELECT index_name, table_name,uniqueness
FROM   user_indexes
WHERE  table_name = 'EMPLOYEES';
```

	INDEX_NAME	TABLE_NAME	UNIQUENESS
1	EMP_EMAIL_UK	EMPLOYEES	UNIQUE
2	EMP_EMP_ID_PK	EMPLOYEES	UNIQUE
3	EMP_DEPARTMENT_IX	EMPLOYEES	NONUNIQUE
4	EMP_JOB_IX	EMPLOYEES	NONUNIQUE
5	EMP_MANAGER_IX	EMPLOYEES	NONUNIQUE
6	EMP_NAME_IX	EMPLOYEES	NONUNIQUE

b

```
SELECT index_name, table_name
FROM   user_indexes
WHERE  table_name = 'emp_lib';
```

	INDEX_NAME	TABLE_NAME
1	SYS_C0011777	EMP_LIB

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USER_INDEXES: Example

In the slide example **a**, the USER_INDEXES view is queried to find the name of the index, name of the table on which the index is created, and whether the index is unique.

In the slide example **b**, observe that the Oracle Server gives a generic name to the index that is created for the PRIMARY KEY column. The EMP_LIB table is created by using the following code:

```
CREATE TABLE EMP_LIB
   (book_id NUMBER(6)PRIMARY KEY ,
    title VARCHAR2(25),
    category VARCHAR2(20));
```

```
CREATE TABLE succeeded.
```

Querying USER_IND_COLUMNS

```
DESCRIBE user_ind_columns
```

Name	Null	Type
INDEX_NAME		VARCHAR2(30)
TABLE_NAME		VARCHAR2(30)
COLUMN_NAME		VARCHAR2(4000)
COLUMN_POSITION		NUMBER
COLUMN_LENGTH		NUMBER
CHAR_LENGTH		NUMBER
DESCEND		VARCHAR2(4)

```
SELECT index_name, column_name,table_name
FROM   user_ind_columns
WHERE  index_name = 'lname_idx';
```

	INDEX_NAME	COLUMN_NAME	TABLE_NAME
1	LNAME_IDX	LAST_NAME	EMP_TEST

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Querying USER_IND_COLUMNS

The USER_IND_COLUMNS dictionary view provides information such as the name of the index, name of the indexed table, name of a column within the index, and the column's position within the index.

For the slide example, the emp_test table and LNAME_IDX index are created by using the following code:

```
CREATE TABLE emp_test AS SELECT * FROM employees;
CREATE INDEX LNAME_IDX ON emp_test(Last_Name);
```

Synonym Information

```
DESCRIBE user_synonyms
```

Name	Null	Type
SYNONYM_NAME	NOT NULL	VARCHAR2(30)
TABLE_OWNER		VARCHAR2(30)
TABLE_NAME	NOT NULL	VARCHAR2(30)
DB_LINK		VARCHAR2(128)

```
SELECT *
FROM   user_synonyms;
```

	SYNONYM_NAME	TABLE_OWNER	TABLE_NAME	DB_LINK
1	TEAM2	ORA22	DEPARTMENTS	(null)

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Synonym Information

The USER_SYNONYMS dictionary view describes private synonyms (synonyms that you own).

You can query this view to find your synonyms. You can query ALL_SYNONYMS to find out the name of all the synonyms that are available to you and the objects on which these synonyms apply.

The columns in this view are:

- **SYNONYM_NAME:** Name of the synonym
- **TABLE_OWNER:** Owner of the object that is referenced by the synonym
- **TABLE_NAME:** Name of the table or view that is referenced by the synonym
- **DB_LINK:** Name of the database link reference (if any)

Lesson Agenda

- Introduction to data dictionary
- Querying the dictionary views for the following:
  - Table information
  - Column information
  - Constraint information
- Querying the dictionary views for the following:
  - View information
  - Sequence information
  - Synonym information
  - Index information
- Adding a comment to a table and querying the dictionary views for comment information

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Adding Comments to a Table

- You can add comments to a table or column by using the COMMENT statement:

```
COMMENT ON TABLE employees
IS 'Employee Information';
```

```
COMMENT ON COLUMN employees.first_name
IS 'First name of the employee';
```

- Comments can be viewed through the data dictionary views:
  - ALL_COL_COMMENTS
  - USER_COL_COMMENTS
  - ALL_TAB_COMMENTS
  - USER_TAB_COMMENTS

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Adding Comments to a Table

You can add a comment of up to 4,000 bytes about a column, table, view, or snapshot by using the COMMENT statement. The comment is stored in the data dictionary and can be viewed in one of the following data dictionary views in the COMMENTS column:

- ALL_COL_COMMENTS
- USER_COL_COMMENTS
- ALL_TAB_COMMENTS
- USER_TAB_COMMENTS

Syntax

```
COMMENT ON {TABLE table | COLUMN table.column}
    IS 'text';
```

In the syntax:

table	Is the name of the table
column	Is the name of the column in a table
text	Is the text of the comment

You can drop a comment from the database by setting it to empty string (''):

```
COMMENT ON TABLE  employees IS '';
```

Quiz

The dictionary views that are based on the dictionary tables contain information such as:

1. Definitions of all the schema objects in the database
2. Default values for the columns
3. Integrity constraint information
4. Privileges and roles that each user has been granted
5. All of the above

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Answer: 5

Summary

In this lesson, you should have learned how to find information about your objects through the following dictionary views:

- DICTIONARY
- USER_OBJECTS
- USER_TABLES
- USER_TAB_COLUMNS
- USER_CONSTRAINTS
- USER_CONS_COLUMNS
- USER_VIEWS
- USER_SEQUENCES
- USER_INDEXES
- USER_SYNONYMS

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Summary

In this lesson, you learned about some of the dictionary views that are available to you. You can use these dictionary views to find information about your tables, constraints, views, sequences, and synonyms.

Practice 3: Overview

This practice covers the following topics:

- Querying the dictionary views for table and column information
- Querying the dictionary views for constraint information
- Querying the dictionary views for view information
- Querying the dictionary views for sequence information
- Querying the dictionary views for synonym information
- Querying the dictionary views for index information
- Adding a comment to a table and querying the dictionary views for comment information

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Practice 3: Overview

In this practice, you query the dictionary views to find information about objects in your schema.

4

Manipulating Large Data Sets

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Objectives

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

- Manipulate data by using subqueries
- Specify explicit default values in the `INSERT` and `UPDATE` statements
- Describe the features of multitable `INSERT`s
- Use the following types of multitable `INSERT`s:
  - Unconditional `INSERT`
  - Pivoting `INSERT`
  - Conditional `INSERT ALL`
  - Conditional `INSERT FIRST`
- Merge rows in a table
- Track the changes to data over a period of time

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Objectives

In this lesson, you learn how to manipulate data in the Oracle database by using subqueries. You learn how to use the `DEFAULT` keyword in `INSERT` and `UPDATE` statements to identify a default column value. You also learn about multitable `INSERT` statements, the `MERGE` statement, and tracking changes in the database.

Lesson Agenda

- Manipulating data by using subqueries
- Specifying explicit default values in the `INSERT` and `UPDATE` statements
- Using the following types of multitable `INSERT`s:
  - Unconditional `INSERT`
  - Pivoting `INSERT`
  - Conditional `INSERT ALL`
  - Conditional `INSERT FIRST`
- Merging rows in a table
- Tracking the changes to data over a period of time

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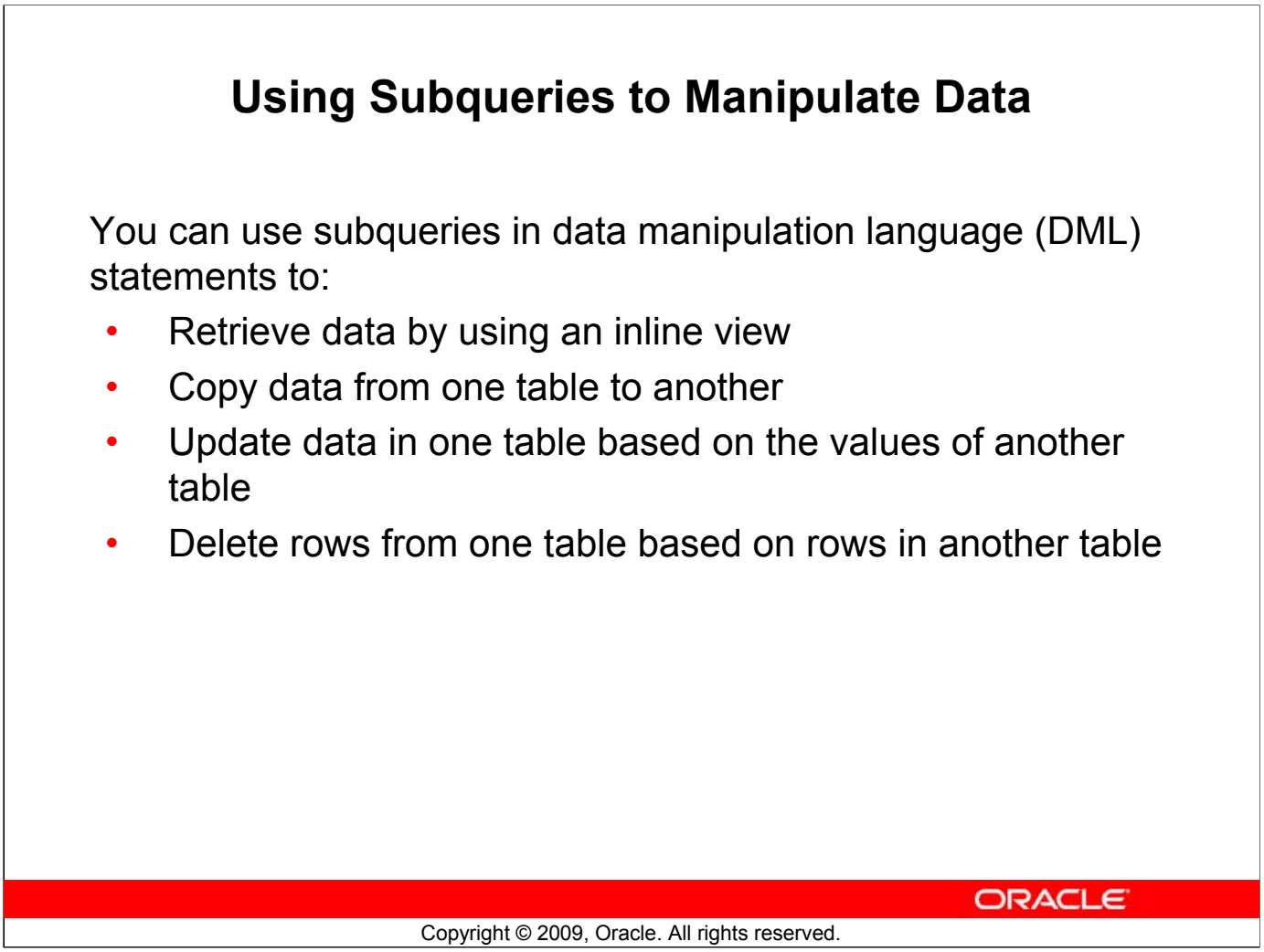

Using Subqueries to Manipulate Data

Subqueries can be used to retrieve data from a table that you can use as input to an `INSERT` into a different table. In this way, you can easily copy large volumes of data from one table to another with one single `SELECT` statement. Similarly, you can use subqueries to do mass updates and deletes by using them in the `WHERE` clause of the `UPDATE` and `DELETE` statements. You can also use subqueries in the `FROM` clause of a `SELECT` statement. This is called an inline view.

Note: You learned how to update and delete rows based on another table in the course titled *Oracle Database 11g: SQL Fundamentals I*.

Retrieving Data by Using a Subquery as Source

```
SELECT department_name, city
FROM   departments
NATURAL JOIN (SELECT l.location_id, l.city, l.country_id
              FROM   loc l
              JOIN   countries c
              ON(l.country_id = c.country_id)
              JOIN regions USING(region_id)
              WHERE region_name = 'Europe');
```

	DEPARTMENT_NAME	CITY
1	Human Resources	London
2	Sales	Oxford
3	Public Relations	Munich

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Retrieving Data by Using a Subquery as Source

You can use a subquery in the FROM clause of a SELECT statement, which is very similar to how views are used. A subquery in the FROM clause of a SELECT statement is also called an *inline* view. A subquery in the FROM clause of a SELECT statement defines a data source for that particular SELECT statement, and only that SELECT statement. As with a database view, the SELECT statement in the subquery can be as simple or as complex as you like.

When a database view is created, the associated SELECT statement is stored in the data dictionary. In situations where you do not have the necessary privileges to create database views, or when you would like to test the suitability of a SELECT statement to become a view, you can use an inline view.

With inline views, you can have all the code needed to support the query in one place. This means that you can avoid the complexity of creating a separate database view. The example in the slide shows how to use an inline view to display the department name and the city in Europe. The subquery in the FROM clause fetches the location ID, city name, and the country by joining three different tables. The output of the inner query is considered as a table for the outer query. The inner query is similar to that of a database view but does not have any physical name.

For the example in the slide, the loc table is created by running the following statement:

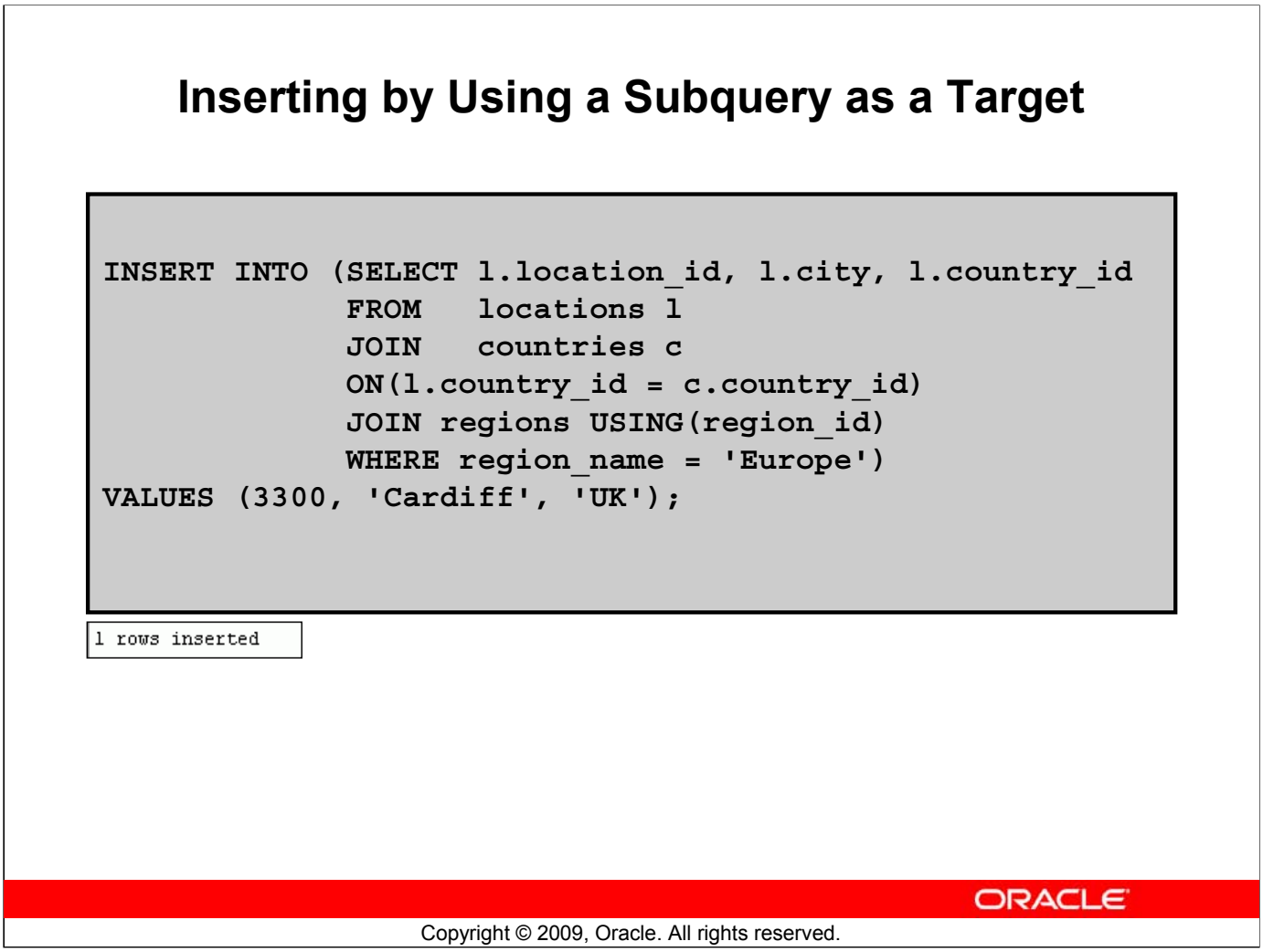
```
CREATE TABLE loc AS SELECT * FROM locations;
```

Retrieving Data by Using a Subquery as Source (continued)

You can display the same output as in the example in the slide by performing the following two steps:

1. Create a database view:
```
CREATE OR REPLACE VIEW european_cities
AS
SELECT l.location_id, l.city, l.country_id
FROM   loc l
JOIN   countries c
ON(l.country_id = c.country_id)
JOIN regions USING(region_id)
WHERE region_name = 'Europe';
```
2. Join the EUROPEAN_CITIES view with the DEPARTMENTS table:
```
SELECT department_name, city
FROM   departments
NATURAL JOIN european_cities;
```

Note: You learned how to create database views in the course titled *Oracle Database 11g: SQL Fundamentals I*.



Inserting by Using a Subquery as a Target

You can use a subquery in place of the table name in the `INTO` clause of the `INSERT` statement. The `SELECT` list of this subquery must have the same number of columns as the column list of the `VALUES` clause. Any rules on the columns of the base table must be followed in order for the `INSERT` statement to work successfully. For example, you cannot put in a duplicate location ID or leave out a value for a mandatory `NOT NULL` column.

This use of subqueries helps you avoid having to create a view just for performing an `INSERT`.

The example in the slide uses a subquery in the place of `LOC` to create a record for a new European city.

Note: You can also perform the `INSERT` operation on the `EUROPEAN_CITIES` view by using the following code:

```
INSERT INTO european_cities
VALUES (3300,'Cardiff','UK');
```

Inserting by Using a Subquery as a Target

Verify the results.

```
SELECT location_id, city, country_id
FROM   loc
```

	LOCATION_ID	CITY	COUNTRY_ID
20	2900	Geneva	CH
21	3000	Bern	CH
22	3100	Utrecht	NL
23	3200	Mexico City	MX
24	3300	Cardiff	UK

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Inserting by Using a Subquery as a Target (continued)

The example in the slide shows that the insert via the inline view created a new record in the base table LOC.

The following example shows the results of the subquery that was used to identify the table for the INSERT statement.

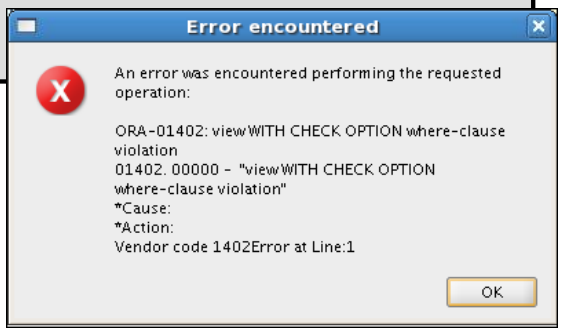
```
SELECT l.location_id, l.city, l.country_id
FROM   loc l
JOIN   countries c
ON(l.country_id = c.country_id)
JOIN regions USING(region_id)
WHERE region_name = 'Europe'
```

	LOCATION_ID	CITY	COUNTRY_ID
6	2700	Munich	DE
7	2900	Geneva	CH
8	3000	Bern	CH
9	3100	Utrecht	NL
10	3300	Cardiff	UK

Using the WITH CHECK OPTION Keyword on DML Statements

The WITH CHECK OPTION keyword prohibits you from changing rows that are not in the subquery.

```
INSERT INTO ( SELECT location_id, city, country_id
              FROM   loc
              WHERE  country_id IN
              (SELECT country_id
               FROM countries
               NATURAL JOIN regions
               WHERE region_name = 'Europe')
              WITH CHECK OPTION )
VALUES (3600, 'Washington', 'US');
```



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Using the WITH CHECK OPTION Keyword on DML Statements

Specify the WITH CHECK OPTION keyword to indicate that if the subquery is used in place of a table in an INSERT, UPDATE, or DELETE statement, no changes that produce rows that are not included in the subquery are permitted to that table.

The example in the slide shows how to use an inline view with WITH CHECK OPTION. The INSERT statement prevents the creation of records in the LOC table for a city that is not in Europe.

The following example executes successfully because of the changes in the VALUES list.

```
INSERT INTO (SELECT location_id, city, country_id
             FROM   loc
             WHERE  country_id IN
             (SELECT country_id
              FROM countries
              NATURAL JOIN regions
              WHERE region_name = 'Europe')
              WITH CHECK OPTION)
VALUES (3500, 'Berlin', 'DE');
```

Using the WITH CHECK OPTION Keyword on DML Statements (continued)

The use of an inline view with the WITH CHECK OPTION provides an easy method to prevent changes to the table.

To prevent the creation of a non-European city, you can also use a database view by performing the following steps:

1. Create a database view:

```
CREATE OR REPLACE VIEW european_cities
AS
SELECT location_id, city, country_id
FROM   locations
WHERE  country_id in
  (SELECT country_id
   FROM countries
   NATURAL JOIN regions
   WHERE region_name = 'Europe')
WITH CHECK OPTION;
```

2. Verify the results by inserting data:

```
INSERT INTO european_cities
VALUES (3400,'New York','US');
```

The second step produces the same error as shown in the slide.

Lesson Agenda

- Manipulating data by using subqueries
- Specifying explicit default values in the `INSERT` and `UPDATE` statements
- Using the following types of multitable `INSERT`s:
  - Unconditional `INSERT`
  - Pivoting `INSERT`
  - Conditional `INSERT ALL`
  - Conditional `INSERT FIRST`
- Merging rows in a table
- Tracking the changes to data over a period of time

Overview of the Explicit Default Feature

- Use the `DEFAULT` keyword as a column value where the default column value is desired.
- This allows the user to control where and when the default value should be applied to data.
- Explicit defaults can be used in `INSERT` and `UPDATE` statements.

Explicit Defaults

The `DEFAULT` keyword can be used in `INSERT` and `UPDATE` statements to identify a default column value. If no default value exists, a null value is used.

The `DEFAULT` option saves you from having to hard code the default value in your programs or querying the dictionary to find it, as was done before this feature was introduced. Hard coding the default is a problem if the default changes, because the code consequently needs changing. Accessing the dictionary is not usually done in an application; therefore, this is a very important feature.

Using Explicit Default Values

- DEFAULT with INSERT:

```
INSERT INTO deptm3
  (department_id, department_name, manager_id)
VALUES (300, 'Engineering', DEFAULT);
```

- DEFAULT with UPDATE:

```
UPDATE deptm3
SET manager_id = DEFAULT
WHERE department_id = 10;
```

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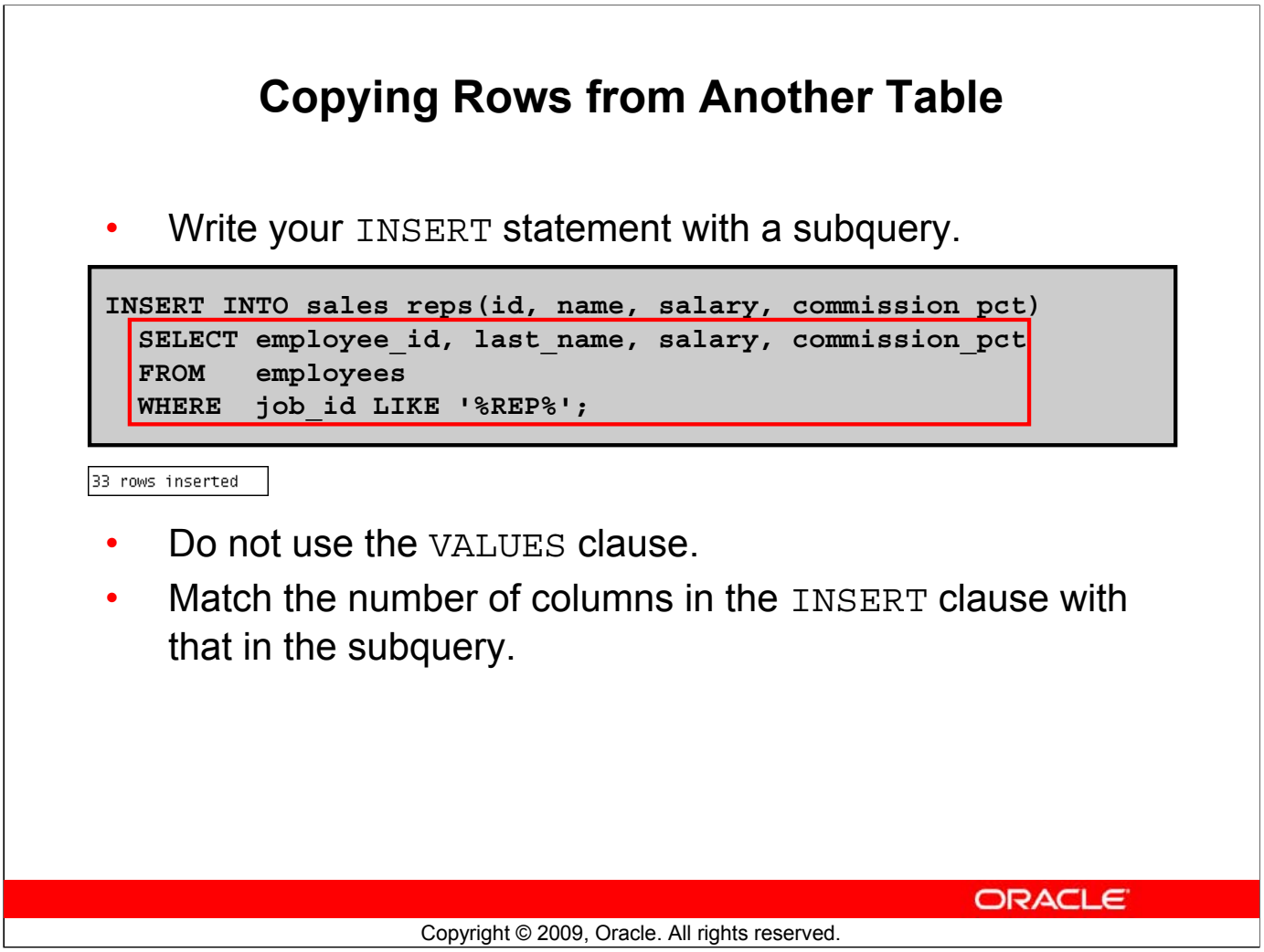
Using Explicit Default Values

Specify DEFAULT to set the column to the value previously specified as the default value for the column. If no default value for the corresponding column has been specified, the Oracle server sets the column to null.

In the first example in the slide, the INSERT statement uses a default value for the MANAGER_ID column. If there is no default value defined for the column, a null value is inserted instead.

The second example uses the UPDATE statement to set the MANAGER_ID column to a default value for department 10. If no default value is defined for the column, it changes the value to null.

Note: When creating a table, you can specify a default value for a column. This is discussed in *SQL Fundamentals I*.



Copying Rows from Another Table

You can use the `INSERT` statement to add rows to a table where the values are derived from existing tables. In place of the `VALUES` clause, you use a subquery.

Syntax

```
INSERT INTO table [ column (, column) ] subquery;
```

In the syntax:

table	Is the table name
column	Is the name of the column in the table to populate
subquery	Is the subquery that returns rows into the table

The number of columns and their data types in the column list of the `INSERT` clause must match the number of values and their data types in the subquery. To create a copy of the rows of a table, use `SELECT *` in the subquery.

```
INSERT INTO EMPL3
   SELECT *
   FROM   employees;
```

Note: You use the `LOG ERRORS` clause in your DML statement to enable the DML operation to complete regardless of errors. Oracle writes the details of the error message to an error-logging table that you have created. For more information, see *Oracle Database 11g SQL Reference*.

Lesson Agenda

- Manipulating data by using subqueries
- Specifying explicit default values in the `INSERT` and `UPDATE` statements
- Using the following types of multitable `INSERT`s:
  - Unconditional `INSERT`
  - Pivoting `INSERT`
  - Conditional `INSERT ALL`
  - Conditional `INSERT FIRST`
- Merging rows in a table
- Tracking the changes to data over a period of time

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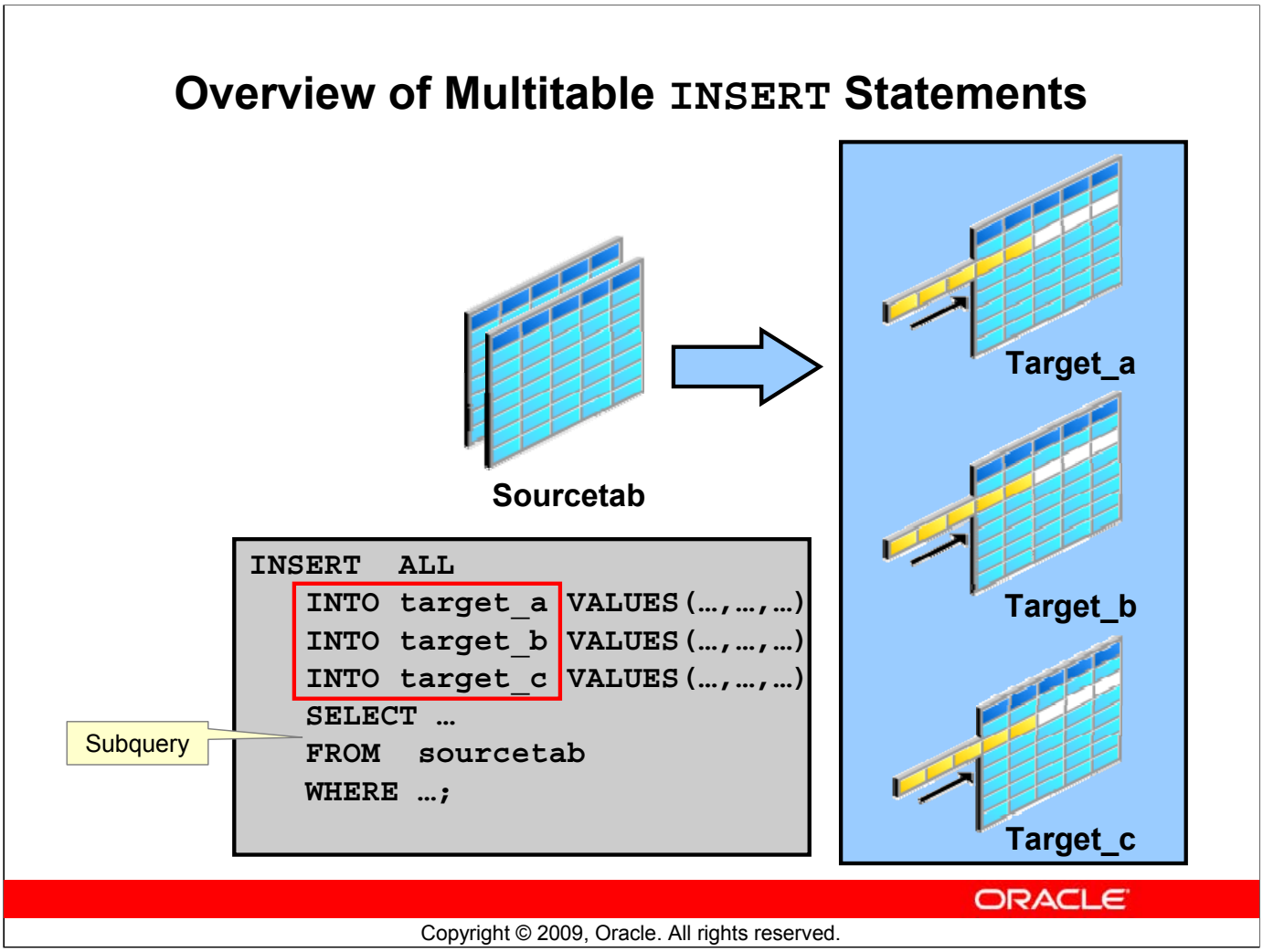

Overview of Multitable INSERT Statements

In a multitable INSERT statement, you insert computed rows derived from the rows returned from the evaluation of a subquery into one or more tables.

Multitable INSERT statements are useful in a data warehouse scenario. You need to load your data warehouse regularly so that it can serve its purpose of facilitating business analysis. To do this, data from one or more operational systems must be extracted and copied into the warehouse. The process of extracting data from the source system and bringing it into the data warehouse is commonly called ETL, which stands for extraction, transformation, and loading.

During extraction, the desired data must be identified and extracted from many different sources, such as database systems and applications. After extraction, the data must be physically transported to the target system or an intermediate system for further processing. Depending on the chosen means of transportation, some transformations can be done during this process. For example, a SQL statement that directly accesses a remote target through a gateway can concatenate two columns as part of the SELECT statement.

After data is loaded into the Oracle database, data transformations can be executed using SQL operations. A multitable INSERT statement is one of the techniques for implementing SQL data transformations.

Overview of Multitable INSERT Statements

- Use the INSERT…SELECT statement to insert rows into multiple tables as part of a single DML statement.
- Multitable INSERT statements are used in data warehousing systems to transfer data from one or more operational sources to a set of target tables.
- They provide significant performance improvement over:
  - Single DML versus multiple INSERT…SELECT statements
  - Single DML versus a procedure to perform multiple inserts by using the IF...THEN syntax

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Overview of Multitable INSERT Statements (continued)

Multitable INSERT statements offer the benefits of the INSERT . . . SELECT statement when multiple tables are involved as targets. Without multitable INSERT, you had to deal with *n* independent INSERT . . . SELECT statements, thus processing the same source data *n* times and increasing the transformation workload *n* times.

As with the existing INSERT . . . SELECT statement, the new statement can be parallelized and used with the direct-load mechanism for faster performance.

Each record from any input stream, such as a nonrelational database table, can now be converted into multiple records for a more relational database table environment. To alternatively implement this functionality, you were required to write multiple INSERT statements.

Types of Multitable INSERT Statements

The different types of multitable INSERT statements are:

- Unconditional INSERT
- Conditional INSERT ALL
- Pivoting INSERT
- Conditional INSERT FIRST

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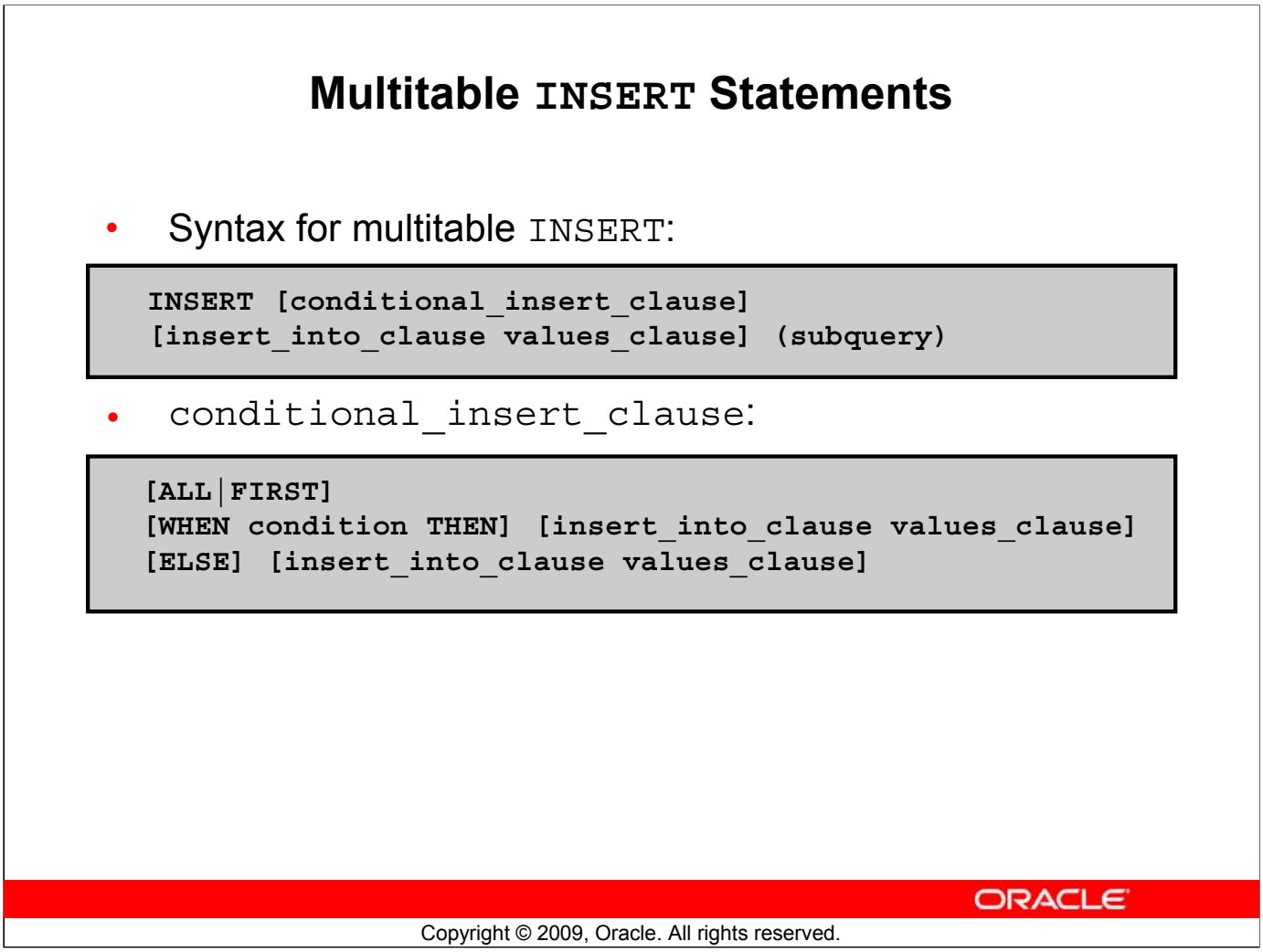
Types of Multitable INSERT Statements

You use different clauses to indicate the type of INSERT to be executed. The types of multitable INSERT statements are:

- **Unconditional INSERT:** For each row returned by the subquery, a row is inserted into each of the target tables.
- **Conditional INSERT ALL:** For each row returned by the subquery, a row is inserted into each target table if the specified condition is met.
- **Pivoting INSERT:** This is a special case of the unconditional INSERT ALL.
- **Conditional INSERT FIRST:** For each row returned by the subquery, a row is inserted into the very first target table in which the condition is met.



Multitable INSERT Statements

The slide displays the generic format for multitable INSERT statements.

Unconditional INSERT: ALL into_clause

Specify ALL followed by multiple insert_into_clauses to perform an unconditional multitable INSERT. The Oracle server executes each insert_into_clause once for each row returned by the subquery.

Conditional INSERT: conditional_insert_clause

Specify the conditional_insert_clause to perform a conditional multitable INSERT. The Oracle server filters each insert_into_clause through the corresponding WHEN condition, which determines whether that insert_into_clause is executed. A single multitable INSERT statement can contain up to 127 WHEN clauses.

Conditional INSERT: ALL

If you specify ALL, the Oracle server evaluates each WHEN clause regardless of the results of the evaluation of any other WHEN clause. For each WHEN clause whose condition evaluates to true, the Oracle server executes the corresponding INTO clause list.

Multitable INSERT Statements (continued)

Conditional INSERT: FIRST

If you specify FIRST, the Oracle server evaluates each WHEN clause in the order in which it appears in the statement. If the first WHEN clause evaluates to true, the Oracle server executes the corresponding INTO clause and skips subsequent WHEN clauses for the given row.

Conditional INSERT: ELSE Clause

For a given row, if no WHEN clause evaluates to true:

- If you have specified an ELSE clause, the Oracle server executes the INTO clause list associated with the ELSE clause
- If you did not specify an ELSE clause, the Oracle server takes no action for that row

Restrictions on Multitable INSERT Statements

- You can perform multitable INSERT statements only on tables, and not on views or materialized views.
- You cannot perform a multitable INSERT on a remote table.
- You cannot specify a table collection expression when performing a multitable INSERT.
- In a multitable INSERT, all insert_into_clauses cannot combine to specify more than 999 target columns.

Unconditional INSERT ALL

- Select the EMPLOYEE_ID, HIRE_DATE, SALARY, and MANAGER_ID values from the EMPLOYEES table for those employees whose EMPLOYEE_ID is greater than 200.
- Insert these values into the SAL_HISTORY and MGR_HISTORY tables by using a multitable INSERT.

```
INSERT  ALL
   INTO sal_history VALUES(EMPID,HIREDATE,SAL)
   INTO mgr_history VALUES(EMPID,MGR,SAL)
   SELECT employee_id EMPID, hire_date HIREDATE,
          salary SAL, manager_id MGR
   FROM  employees
   WHERE employee_id > 200;
```

```
12 rows inserted
```

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Unconditional INSERT ALL

The example in the slide inserts rows into both the SAL_HISTORY and the MGR_HISTORY tables.

The SELECT statement retrieves the details of employee ID, hire date, salary, and manager ID of those employees whose employee ID is greater than 200 from the EMPLOYEES table. The details of the employee ID, hire date, and salary are inserted into the SAL_HISTORY table. The details of employee ID, manager ID, and salary are inserted into the MGR_HISTORY table.

This INSERT statement is referred to as an unconditional INSERT because no further restriction is applied to the rows that are retrieved by the SELECT statement. All the rows retrieved by the SELECT statement are inserted into the two tables: SAL_HISTORY and MGR_HISTORY. The VALUES clause in the INSERT statements specifies the columns from the SELECT statement that must be inserted into each of the tables. Each row returned by the SELECT statement results in two insertions: one for the SAL_HISTORY table and one for the MGR_HISTORY table.

Unconditional INSERT ALL (continued)

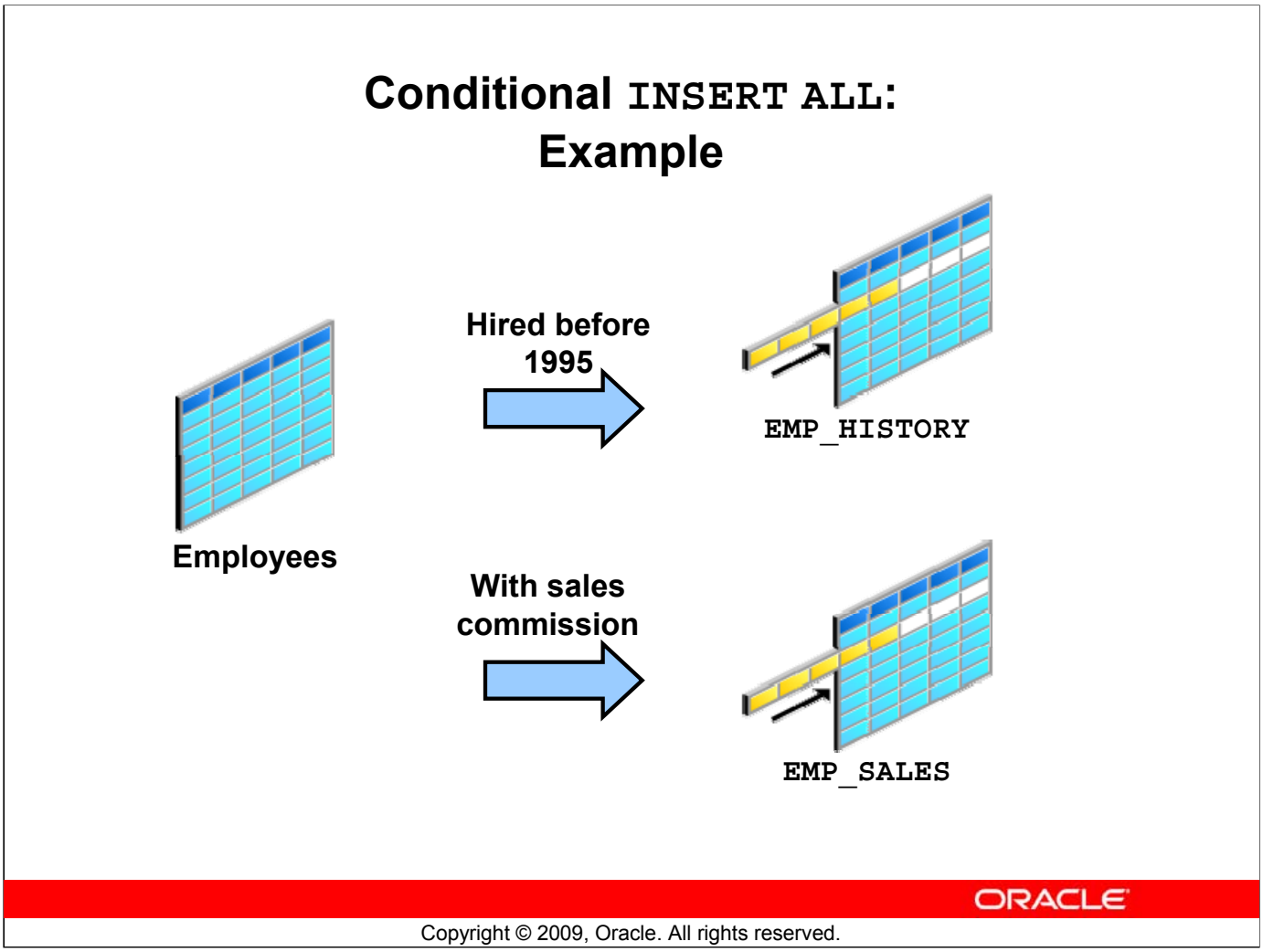
A total of 12 rows were selected:

```
SELECT COUNT(*) total_in_sal FROM sal_history;
```

	TOTAL_IN_SAL
1	6

```
SELECT COUNT(*) total_in_mgr FROM mgr_history;
```

	TOTAL_IN_MGR
1	6



Conditional INSERT ALL: Example

For all employees in the employees tables, if the employee was hired before 1995, insert that employee record into the employee history. If the employee earns a sales commission, insert the record information into the EMP_SALES table. The SQL statement is shown on the next page.

Conditional INSERT ALL

```
INSERT  ALL
 WHEN HIREDATE < '01-JAN-95' THEN
   INTO emp_history VALUES(EMPID,HIREDATE,SAL)
 WHEN COMM IS NOT NULL THEN
   INTO emp_sales VALUES(EMPID,COMM,SAL)
   SELECT employee_id EMPID, hire_date HIREDATE,
          salary SAL, commission_pct COMM
   FROM  employees
```

```
48 rows inserted
```

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Conditional INSERT ALL

The example in the slide is similar to the example in the previous slide because it inserts rows into both the EMP_HISTORY and the EMP_SALES tables. The SELECT statement retrieves details such as employee ID, hire date, salary, and commission percentage for all employees from the EMPLOYEES table. Details such as employee ID, hire date, and salary are inserted into the EMP_HISTORY table. Details such as employee ID, commission percentage, and salary are inserted into the EMP_SALES table.

This INSERT statement is referred to as a conditional INSERT ALL because a further restriction is applied to the rows that are retrieved by the SELECT statement. From the rows that are retrieved by the SELECT statement, only those rows in which the hire date was prior to 1995 are inserted in the EMP_HISTORY table. Similarly, only those rows where the value of commission percentage is not null are inserted in the EMP_SALES table.

```
SELECT count(*) FROM emp_history;
```

	COUNT(*)
1	13

```
SELECT count(*) FROM emp_sales;
```

	COUNT(*)
1	35

Conditional INSERT ALL (continued)

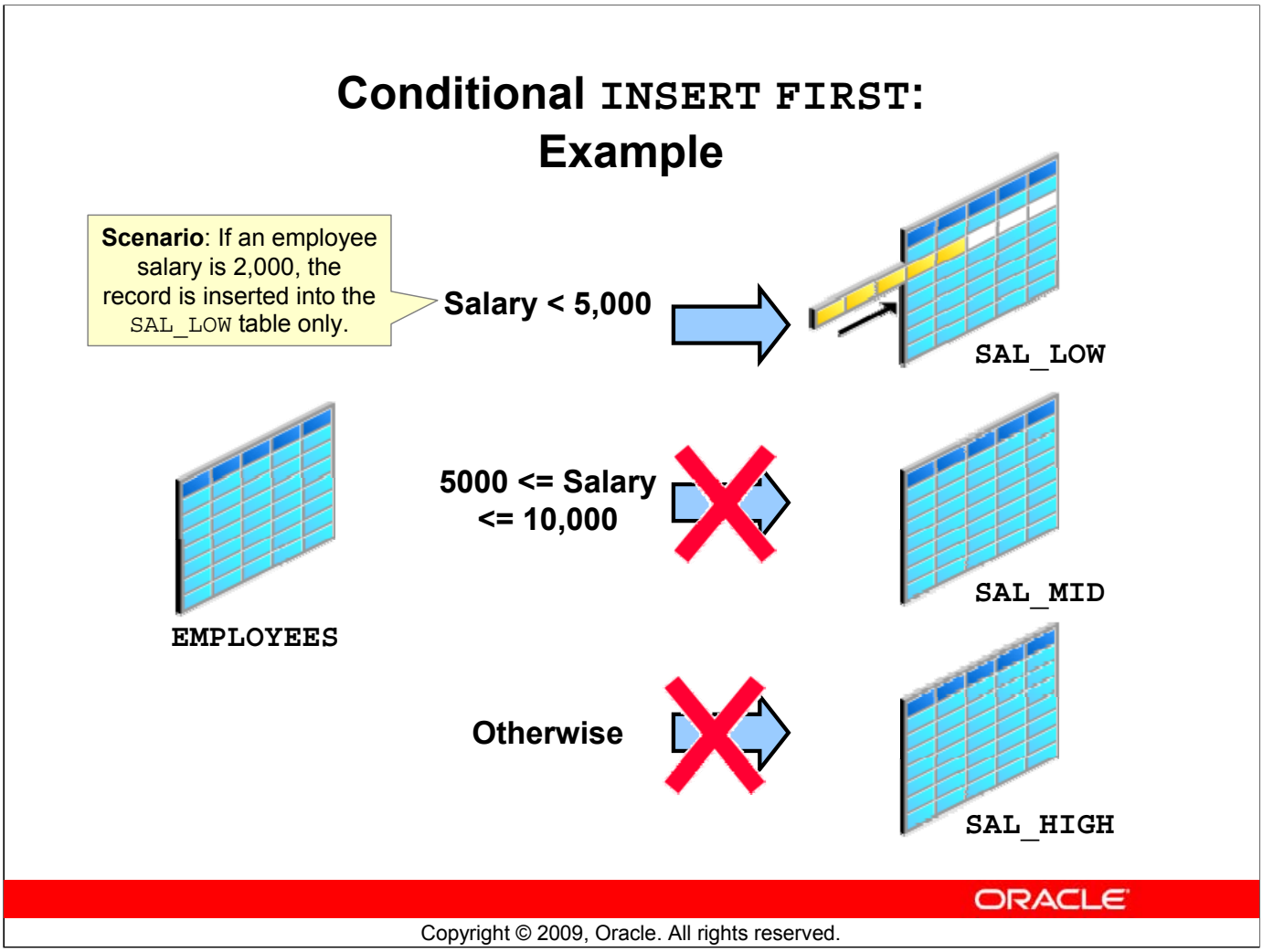
You can also optionally use the ELSE clause with the INSERT ALL statement.

Example:

```
INSERT ALL
WHEN job_id IN
(select job_id FROM jobs WHERE job_title LIKE '%Manager%') THEN
INTO managers2(last_name,job_id,SALARY)
VALUES (last_name,job_id,SALARY)
WHEN SALARY>10000 THEN
INTO richpeople(last_name,job_id,SALARY)
VALUES (last_name,job_id,SALARY)
ELSE
INTO poorpeople VALUES (last_name,job_id,SALARY)
SELECT * FROM employees;
```

Result:

```
116 rows inserted
```



Conditional INSERT FIRST: Example

For all employees in the EMPLOYEES table, insert the employee information into the first target table that meets the condition. In the example, if an employee has a salary of 2,000, the record is inserted into the SAL_LOW table only. The SQL statement is shown on the next page.

Conditional INSERT FIRST

```
INSERT FIRST
WHEN salary < 5000 THEN
  INTO sal_low VALUES (employee_id, last_name, salary)
WHEN salary between 5000 and 10000 THEN
  INTO sal_mid VALUES (employee_id, last_name, salary)
ELSE
  INTO sal_high VALUES (employee_id, last_name, salary)
SELECT employee_id, last_name, salary
FROM employees
```

```
107 rows inserted
```

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Conditional INSERT FIRST

The SELECT statement retrieves details such as employee ID, last name, and salary for every employee in the EMPLOYEES table. For each employee record, it is inserted into the very first target table that meets the condition.

This INSERT statement is referred to as a conditional INSERT FIRST. The WHEN salary < 5000 condition is evaluated first. If this first WHEN clause evaluates to true, the Oracle server executes the corresponding INTO clause and inserts the record into the SAL_LOW table. It skips subsequent WHEN clauses for this row.

If the row does not satisfy the first WHEN condition (WHEN salary < 5000), the next condition (WHEN salary between 5000 and 10000) is evaluated. If this condition evaluates to true, the record is inserted into the SAL_MID table, and the last condition is skipped.

If neither the first condition (WHEN salary < 5000) nor the second condition (WHEN salary between 5000 and 10000) is evaluated to true, the Oracle server executes the corresponding INTO clause for the ELSE clause.

Conditional INSERT FIRST (continued)

A total of 20 rows were inserted:

```
SELECT count(*) low FROM sal_low;
```

	LOW
1	49

```
SELECT count(*) mid FROM sal_mid;
```

	MID
1	43

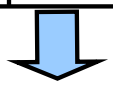
```
SELECT count(*) high FROM sal_high;
```

	HIGH
1	15

Pivoting INSERT

Convert the set of sales records from the nonrelational database table to relational format.

Emp_ID	Week_ID	MON	TUES	WED	THUR	FRI
176	6	2000	3000	4000	5000	6000



Employee_ID	WEEK	SALES
176	6	2000
176	6	3000
176	6	4000
176	6	5000
176	6	6000

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Pivoting INSERT

Pivoting is an operation in which you must build a transformation such that each record from any input stream, such as a nonrelational database table, must be converted into multiple records for a more relational database table environment.

Suppose you receive a set of sales records from a nonrelational database table:

```
SALES_SOURCE_DATA, in the following format:
      EMPLOYEE_ID, WEEK_ID, SALES_MON, SALES_TUE, SALES_WED,
SALES_THUR, SALES_FRI
```

You want to store these records in the SALES_INFO table in a more typical relational format:

```
EMPLOYEE_ID, WEEK, SALES
```

To solve this problem, you must build a transformation such that each record from the original nonrelational database table, SALES_SOURCE_DATA, is converted into five records for the data warehouse's SALES_INFO table. This operation is commonly referred to as *pivoting*.

The solution to this problem is shown on the next page.

Pivoting INSERT

```
INSERT ALL
  INTO sales_info VALUES (employee_id,week_id,sales_MON)
  INTO sales_info VALUES (employee_id,week_id,sales_TUE)
  INTO sales_info VALUES (employee_id,week_id,sales_WED)
  INTO sales_info VALUES (employee_id,week_id,sales_THUR)
  INTO sales_info VALUES (employee_id,week_id, sales_FRI)
  SELECT EMPLOYEE_ID, week_id, sales_MON, sales_TUE,
         sales_WED, sales_THUR,sales_FRI
  FROM sales_source_data;
```

```
5 rows inserted
```

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Pivoting INSERT (continued)

In the example in the slide, the sales data is received from the nonrelational database table SALES_SOURCE_DATA, which is the details of the sales performed by a sales representative on each day of a week, for a week with a particular week ID.

```
DESC SALES_SOURCE_DATA
```

```
Name                          Null     Type
----------------------------- -------- -------------
EMPLOYEE_ID                            NUMBER(6)
WEEK_ID                                NUMBER(2)
SALES_MON                              NUMBER(8,2)
SALES_TUE                              NUMBER(8,2)
SALES_WED                              NUMBER(8,2)
SALES_THUR                             NUMBER(8,2)
SALES_FRI                              NUMBER(8,2)
```

Pivoting INSERT (continued)

```
SELECT * FROM SALES_SOURCE_DATA;
```

	EMPLOYEE_ID	WEEK_ID	SALES_MON	SALES_TUE	SALES_WED	SALES_THUR	SALES_FRI
1	178	6	1750	2200	1500	1500	3000

```
DESC SALES_INFO
```

Name	Null	Type
EMPLOYEE_ID		NUMBER(6)
WEEK		NUMBER(2)
SALES		NUMBER(8,2)

```
SELECT * FROM sales_info;
```

	EMPLOYEE_ID	WEEK	SALES
1	178	6	1750
2	178	6	2200
3	178	6	1500
4	178	6	1500
5	178	6	3000

Observe in the preceding example that by using a pivoting INSERT, one row from the SALES_SOURCE_DATA table is converted into five records for the relational table, SALES_INFO.

Lesson Agenda

- Manipulating data by using subqueries
- Specifying explicit default values in the `INSERT` and `UPDATE` statements
- Using the following types of multitable `INSERT`s:
  - Unconditional `INSERT`
  - Pivoting `INSERT`
  - Conditional `INSERT ALL`
  - Conditional `INSERT FIRST`
- Merging rows in a table
- Tracking the changes to data over a period of time

MERGE Statement

- Provides the ability to conditionally update, insert, or delete data into a database table
- Performs an UPDATE if the row exists, and an INSERT if it is a new row:
  - Avoids separate updates
  - Increases performance and ease of use
  - Is useful in data warehousing applications

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MERGE Statement

The Oracle server supports the MERGE statement for INSERT, UPDATE, and DELETE operations. Using this statement, you can update, insert, or delete a row conditionally into a table, thus avoiding multiple DML statements. The decision whether to update, insert, or delete into the target table is based on a condition in the ON clause.

You must have the INSERT and UPDATE object privileges on the target table and the SELECT object privilege on the source table. To specify the DELETE clause of merge_update_clause, you must also have the DELETE object privilege on the target table.

The MERGE statement is deterministic. You cannot update the same row of the target table multiple times in the same MERGE statement.

An alternative approach is to use PL/SQL loops and multiple DML statements. The MERGE statement, however, is easy to use and more simply expressed as a single SQL statement.

The MERGE statement is suitable in a number of data warehousing applications. For example, in a data warehousing application, you may need to work with data coming from multiple sources, some of which may be duplicates. With the MERGE statement, you can conditionally add or modify rows.

MERGE Statement Syntax

You can conditionally insert, update, or delete rows in a table by using the MERGE statement.

```
MERGE INTO table_name table_alias
  USING (table|view|sub_query) alias
  ON (join condition)
  WHEN MATCHED THEN
    UPDATE SET
    col1 = col1_val,
    col2 = col2_val
 WHEN NOT MATCHED THEN
    INSERT (column_list)
    VALUES (column_values);
```

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Merging Rows

You can update existing rows, and insert new rows conditionally by using the MERGE statement. Using the MERGE statement, you can delete obsolete rows at the same time as you update rows in a table. To do this, you include a DELETE clause with its own WHERE clause in the syntax of the MERGE statement.

In the syntax:

INTO clause	Specifies the target table you are updating or inserting into
USING clause	Identifies the source of the data to be updated or inserted; can be a table, view, or subquery
ON clause	The condition on which the MERGE operation either updates or inserts
WHEN MATCHED | WHEN NOT MATCHED	Instructs the server how to respond to the results of the join condition

Note: For more information, see *Oracle Database 11g SQL Reference*.

Merging Rows: Example

Insert or update rows in the COPY_EMP3 table to match the EMPLOYEES table.

```
MERGE INTO copy_emp3 c
USING (SELECT * FROM EMPLOYEES ) e
ON (c.employee_id = e.employee_id)
WHEN MATCHED THEN
UPDATE SET
c.first_name = e.first_name,
c.last_name = e.last_name,
...
DELETE WHERE (E.COMMISSION_PCT IS NOT NULL)
WHEN NOT MATCHED THEN
INSERT VALUES(e.employee_id, e.first_name, e.last_name,
e.email, e.phone_number, e.hire_date, e.job_id,
e.salary, e.commission_pct, e.manager_id,
e.department_id);
```

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Merging Rows: Example

```
MERGE INTO copy_emp3 c
USING (SELECT * FROM EMPLOYEES ) e
ON (c.employee_id = e.employee_id)
WHEN MATCHED THEN
UPDATE SET
c.first_name = e.first_name,
c.last_name = e.last_name,
c.email = e.email,
c.phone_number = e.phone_number,
c.hire_date = e.hire_date,
c.job_id = e.job_id,
c.salary = e.salary*2,
c.commission_pct = e.commission_pct,
c.manager_id = e.manager_id,
c.department_id = e.department_id
DELETE WHERE (E.COMMISSION_PCT IS NOT NULL)
WHEN NOT MATCHED THEN
INSERT VALUES(e.employee_id, e.first_name, e.last_name,
e.email, e.phone_number, e.hire_date, e.job_id,
e.salary, e.commission_pct, e.manager_id,
e.department_id);
```

Merging Rows: Example (continued)

The COPY_EMP3 table is created by using the following code:

```
CREATE TABLE COPY_EMP3 AS SELECT * FROM EMPLOYEES
WHERE SALARY<10000;
```

Then query the COPY_EMP3 table.

```
SELECT employee_id, salary, commission_pct FROM COPY_EMP3;
```

	EMPLOYEE_ID	SALARY	COMMISSION_PCT
1	198	5200	(null)
2	199	5200	(null)
3	200	8800	(null)
4	202	12000	(null)
5	203	13000	(null)

...

64	197	6000	(null)
65	162	10500	0.25
66	146	13500	0.3
67	150	10000	0.3

...

Observe that there are some employees with SALARY < 10000 and there are two employees with COMMISSION_PCT.

The example in the slide matches the EMPLOYEE_ID in the COPY_EMP3 table to the EMPLOYEE_ID in the EMPLOYEES table. If a match is found, the row in the COPY_EMP3 table is updated to match the row in the EMPLOYEES table and the salary of the employee is doubled. The records of the two employees with values in the COMMISSION_PCT column are deleted. If the match is not found, rows are inserted into the COPY_EMP3 table.

Merging Rows: Example

```
TRUNCATE TABLE copy_emp3;
SELECT * FROM copy_emp3;
0 rows selected
```

```
MERGE INTO copy_emp3 c
USING (SELECT * FROM EMPLOYEES ) e
ON (c.employee_id = e.employee_id)
WHEN MATCHED THEN
UPDATE SET
c.first_name = e.first_name,
c.last_name = e.last_name,
...
DELETE WHERE (E.COMMISSION_PCT IS NOT NULL)
WHEN NOT MATCHED THEN
INSERT VALUES(e.employee_id, e.first_name, ...
```

```
SELECT * FROM copy_emp3;
107 rows selected.
```

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Merging Rows: Example (continued)

The examples in the slide show that the COPY_EMP3 table is empty. The `c.employee_id = e.employee_id` condition is evaluated. The condition returns false—there are no matches. The logic falls into the WHEN NOT MATCHED clause, and the MERGE command inserts the rows of the EMPLOYEES table into the COPY_EMP3 table. This means that the COPY_EMP3 table now has exactly the same data as in the EMPLOYEES table.

```
SELECT employee_id, salary, commission_pct from copy_emp3;
```

	EMPLOYEE_ID	SALARY	COMMISSION_PCT
1	144	2500	(null)
2	143	2600	(null)
3	202	6000	(null)
4	141	3500	(null)
5	174	11000	0.3
...			
15	149	10500	0.2
16	206	8300	(null)
17	176	8600	0.2
18	124	5800	(null)
19	205	12000	(null)
20	178	7000	0.15

Lesson Agenda

- Manipulating data by using subqueries
- Specifying explicit default values in the `INSERT` and `UPDATE` statements
- Using the following types of multitable `INSERT`s:
  - Unconditional `INSERT`
  - Pivoting `INSERT`
  - Conditional `INSERT ALL`
  - Conditional `INSERT FIRST`
- Merging rows in a table
- Tracking the changes to data over a period of time

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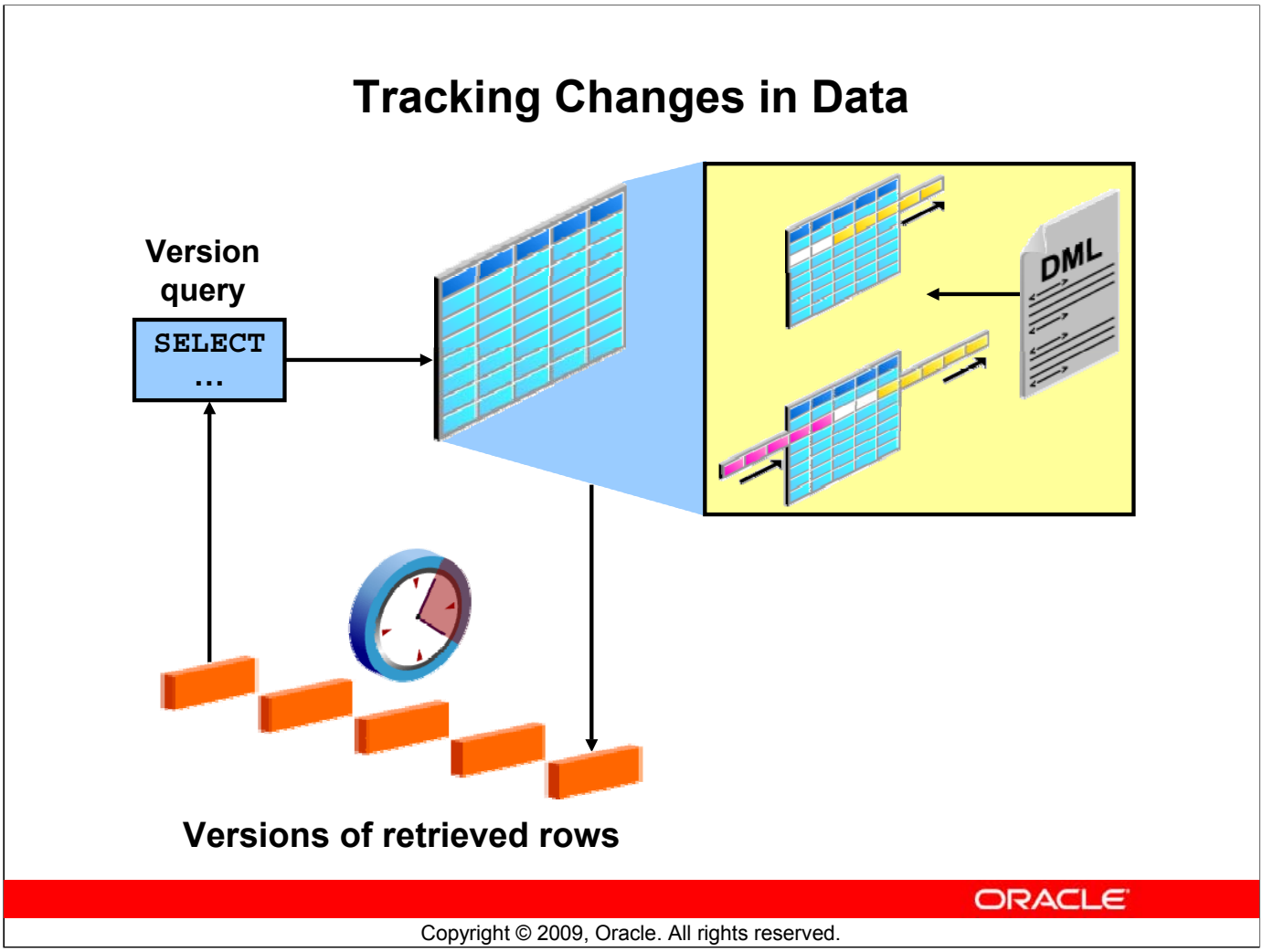

Tracking Changes in Data

You may discover that somehow data in a table has been inappropriately changed. To research this, you can use multiple flashback queries to view row data at specific points in time. More efficiently, you can use the Flashback Version Query feature to view all changes to a row over a period of time. This feature enables you to append a `VERSIONS` clause to a `SELECT` statement that specifies a system change number (SCN) or the time stamp range within which you want to view changes to row values. The query also can return associated metadata, such as the transaction responsible for the change.

Further, after you identify an erroneous transaction, you can use the Flashback Transaction Query feature to identify other changes that were done by the transaction. You then have the option of using the Flashback Table feature to restore the table to a state before the changes were made.

You can use a query on a table with a `VERSIONS` clause to produce all the versions of all the rows that exist or ever existed between the time the query was issued and the `undo_retention` seconds before the current time. `undo_retention` is an initialization parameter, which is an autotuned parameter. A query that includes a `VERSIONS` clause is referred to as a version query. The results of a version query behaves as though the `WHERE` clause were applied to the versions of the rows. The version query returns versions of the rows only across transactions.

System change number (SCN): The Oracle server assigns an SCN to identify the redo records for each committed transaction.

Example of the Flashback Version Query

```
SELECT salary FROM employees3
WHERE  employee_id = 107;
```

1

```
UPDATE employees3 SET salary = salary * 1.30
WHERE  employee_id = 107;

COMMIT;
```

2

```
SELECT salary FROM employees3
  VERSIONS BETWEEN SCN MINVALUE AND MAXVALUE
WHERE  employee_id = 107;
```

3

1

	SALARY
1	4200

3

	SALARY
1	5460
2	4200

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Example of the Flashback Version Query

In the example in the slide, the salary for employee 107 is retrieved (1). The salary for employee 107 is increased by 30 percent and this change is committed (2). The different versions of salary are displayed (3).

The `VERSIONS` clause does not change the plan of the query. For example, if you run a query on a table that uses the index access method, the same query on the same table with a `VERSIONS` clause continues to use the index access method. The versions of the rows returned by the version query are versions of the rows across transactions. The `VERSIONS` clause has no effect on the transactional behavior of a query. This means that a query on a table with a `VERSIONS` clause still inherits the query environment of the ongoing transaction.

The default `VERSIONS` clause can be specified as `VERSIONS BETWEEN {SCN|TIMESTAMP} MINVALUE AND MAXVALUE`.

The `VERSIONS` clause is a SQL extension only for queries. You can have DML and DDL operations that use a `VERSIONS` clause within subqueries. The row version query retrieves all the committed versions of the selected rows. Changes made by the current active transaction are not returned. The version query retrieves all incarnations of the rows. This essentially means that versions returned include deleted and subsequent reinserted versions of the rows.

Example of the Flashback Version Query (continued)

The row access for a version query can be defined in one of the following two categories:

- **`ROWID`-based row access:** In case of `ROWID`-based access, all versions of the specified `ROWID` are returned irrespective of the row content. This essentially means that all versions of the slot in the block indicated by the `ROWID` are returned.
- **All other row access:** For all other row access, all versions of the rows are returned.

VERSIONS BETWEEN Clause

```
SELECT versions_starttime "START_DATE",
       versions_endtime   "END_DATE",
       salary
FROM   employees
    VERSIONS BETWEEN SCN MINVALUE
    AND MAXVALUE
WHERE  last_name = 'Lorentz';
```

	START_DATE	END_DATE	SALARY
1	18-JUN-09 05.07.10.000000000 PM	(null)	5460
2	(null)	18-JUN-09 05.07.10.000000000 PM	4200

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VERSIONS BETWEEN Clause

You can use the VERSIONS BETWEEN clause to retrieve all the versions of the rows that exist or have ever existed between the time the query was issued and a point back in time.

If the undo retention time is less than the lower bound time or the SCN of the BETWEEN clause, the query retrieves versions up to the undo retention time only. The time interval of the BETWEEN clause can be specified as an SCN interval or a wall-clock interval. This time interval is closed at both the lower and the upper bounds.

In the example, Lorentz's salary changes are retrieved. The NULL value for END_DATE for the first version indicates that this was the existing version at the time of the query. The NULL value for START_DATE for the last version indicates that this version was created at a time before the undo retention time.

Quiz

When you use the `INSERT` or `UPDATE` command, the `DEFAULT` keyword saves you from hard-coding the default value in your programs or querying the dictionary to find it.

1. True
2. False

Answer: 1

Summary

In this lesson, you should have learned how to:

- Use DML statements and control transactions
- Describe the features of multitable `INSERT`s
- Use the following types of multitable `INSERT`s:
  - Unconditional `INSERT`
  - Pivoting `INSERT`
  - Conditional `INSERT ALL`
  - Conditional `INSERT FIRST`
- Merge rows in a table
- Manipulate data by using subqueries
- Track the changes to data over a period of time

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Summary

In this lesson, you should have learned how to manipulate data in the Oracle database by using subqueries. You also should have learned about multitable `INSERT` statements, the `MERGE` statement, and tracking changes in the database.

Practice 4: Overview

This practice covers the following topics:

- Performing multitable `INSERT`s
- Performing `MERGE` operations
- Tracking row versions

5

Managing Data in Different Time Zones

Objectives

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

- Use data types similar to DATE that store fractional seconds and track time zones
- Use data types that store the difference between two datetime values
- Use the following datetime functions:
  - CURRENT_DATE
  - CURRENT_TIMESTAMP
  - LOCALTIMESTAMP
  - DBTIMEZONE
  - SESSIONTIMEZONE
  - EXTRACT
  - TZ_OFFSET
  - FROM_TZ
  - TO_TIMESTAMP
  - TO_YMINTERVAL
  - TO_DSINTERVAL

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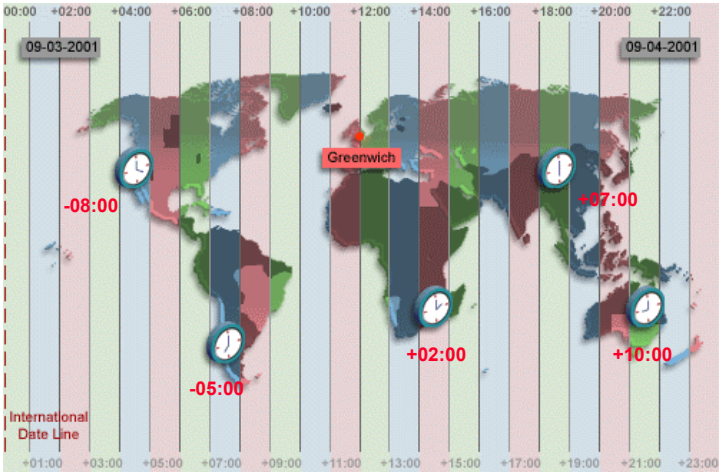
Objectives

In this lesson, you learn how to use data types similar to DATE that store fractional seconds and track time zones. This lesson addresses some of the datetime functions available in the Oracle database.

Lesson Agenda

- CURRENT_DATE, CURRENT_TIMESTAMP, and LOCALTIMESTAMP
- INTERVAL data types
- Using the following functions:
  - EXTRACT
  - TZ_OFFSET
  - FROM_TZ
  - TO_TIMESTAMP
  - TO_YMINTERVAL
  - TO_DSINTERVAL

Time Zones



The image represents the time for each time zone when Greenwich time is 12:00.

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Time Zones

The hours of the day are measured by the turning of the earth. The time of day at any particular moment depends on where you are. When it is noon in Greenwich, England, it is midnight along the International Date Line. The earth is divided into 24 time zones, one for each hour of the day. The time along the prime meridian in Greenwich, England, is known as Greenwich Mean Time (GMT). GMT is now known as Coordinated Universal Time (UTC). UTC is the time standard against which all other time zones in the world are referenced. It is the same all year round and is not affected by summer time or daylight saving time. The meridian line is an imaginary line that runs from the North Pole to the South Pole. It is known as zero longitude and it is the line from which all other lines of longitude are measured. All time is measured relative to UTC and all places have a latitude (their distance north or south of the equator) and a longitude (their distance east or west of the Greenwich meridian).

TIME_ZONE Session Parameter

TIME_ZONE may be set to:

- An absolute offset
- Database time zone
- OS local time zone
- A named region

```
ALTER SESSION SET TIME_ZONE = '-05:00';
ALTER SESSION SET TIME_ZONE = dbtimezone;
ALTER SESSION SET TIME_ZONE = local;
ALTER SESSION SET TIME_ZONE = 'America/New_York';
```

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TIME_ZONE Session Parameter

The Oracle database supports storing the time zone in your date and time data, as well as fractional seconds. The ALTER SESSION command can be used to change time zone values in a user's session. The time zone values can be set to an absolute offset, a named time zone, a database time zone, or the local time zone.

CURRENT_DATE, CURRENT_TIMESTAMP, and LOCALTIMESTAMP

- CURRENT_DATE:
  - Returns the current date from the user session
  - Has a data type of DATE
- CURRENT_TIMESTAMP:
  - Returns the current date and time from the user session
  - Has a data type of TIMESTAMP WITH TIME ZONE
- LOCALTIMESTAMP:
  - Returns the current date and time from the user session
  - Has a data type of TIMESTAMP

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CURRENT_DATE, CURRENT_TIMESTAMP, and LOCALTIMESTAMP

The CURRENT_DATE and CURRENT_TIMESTAMP functions return the current date and current time stamp, respectively. The data type of CURRENT_DATE is DATE. The data type of CURRENT_TIMESTAMP is TIMESTAMP WITH TIME ZONE. The values returned display the time zone displacement of the SQL session executing the functions. The time zone displacement is the difference (in hours and minutes) between local time and UTC. The TIMESTAMP WITH TIME ZONE data type has the format:

```
TIMESTAMP [ (fractional_seconds_precision) ] WITH TIME ZONE
```

where fractional_seconds_precision optionally specifies the number of digits in the fractional part of the SECOND datetime field and can be a number in the range 0 through 9. The default is 6.

The LOCALTIMESTAMP function returns the current date and time in the session time zone. The difference between LOCALTIMESTAMP and CURRENT_TIMESTAMP is that LOCALTIMESTAMP returns a TIMESTAMP value, whereas CURRENT_TIMESTAMP returns a TIMESTAMP WITH TIME ZONE value.

These functions are national language support (NLS)–sensitive—that is, the results will be in the current NLS calendar and datetime formats.

Note: The SYSDATE function returns the current date and time as a DATE data type. You learned how to use the SYSDATE function in the course titled *Oracle Database 11g: SQL Fundamentals I*.

Comparing Date and Time in a Session's Time Zone

The TIME_ZONE parameter is set to -5:00 and then SELECT statements for each date and time are executed to compare differences.

```
ALTER SESSION
SET NLS_DATE_FORMAT = 'DD-MON-YYYY HH24:MI:SS';
ALTER SESSION SET TIME_ZONE = '-5:00';

SELECT SESSIONTIMEZONE, CURRENT_DATE FROM DUAL;          1

SELECT SESSIONTIMEZONE, CURRENT_TIMESTAMP FROM DUAL;     2

SELECT SESSIONTIMEZONE, LOCALTIMESTAMP FROM DUAL;        3
```

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Comparing Date and Time in a Session's Time Zone

The ALTER SESSION command sets the date format of the session to 'DD-MON-YYYY HH24:MI:SS'—that is, day of month (1–31)-abbreviated name of month-4-digit year hour of day (0–23):minute (0–59):second (0–59).

The example in the slide illustrates that the session is altered to set the TIME_ZONE parameter to –5:00. Then the SELECT statement for CURRENT_DATE, CURRENT_TIMESTAMP, and LOCALTIMESTAMP is executed to observe the differences in format.

Note: The TIME_ZONE parameter specifies the default local time zone displacement for the current SQL session. TIME_ZONE is a session parameter only, not an initialization parameter. The TIME_ZONE parameter is set as follows:

```
TIME_ZONE = '[+ | -] hh:mm'
```

The format mask ([+ | -] hh:mm) indicates the hours and minutes before or after UTC.

Comparing Date and Time in a Session's Time Zone

Results of queries:

```
ALTER SESSION succeeded.
```

	SESSIONTIMEZONE	CURRENT_DATE
1	-05:00	23-JUN-2009 01:34:52

1

	SESSIONTIMEZONE	CURRENT_TIMESTAMP
1	-05:00	23-JUN-09 01.35.26.239882000 AM -05:00

2

	SESSIONTIMEZONE	LOCALTIMESTAMP
1	-05:00	23-JUN-09 01.36.21.811798000 AM

3

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Comparing Date and Time in a Session's Time Zone (continued)

In this case, the `CURRENT_DATE` function returns the current date in the session's time zone, the `CURRENT_TIMESTAMP` function returns the current date and time in the session's time zone as a value of the data type `TIMESTAMP WITH TIME ZONE`, and the `LOCALTIMESTAMP` function returns the current date and time in the session's time zone.

DBTIMEZONE and SESSIONTIMEZONE

- Display the value of the database time zone:

```
SELECT DBTIMEZONE FROM DUAL;
```

DBTIMEZONE
1 +00:00

- Display the value of the session's time zone:

```
SELECT SESSIONTIMEZONE FROM DUAL;
```

SESSIONTIMEZONE
1 -05:00

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DBTIMEZONE and SESSIONTIMEZONE

The DBA sets the database's default time zone by specifying the `SET TIME_ZONE` clause of the `CREATE DATABASE` statement. If omitted, the default database time zone is the operating system time zone. The database time zone cannot be changed for a session with an `ALTER SESSION` statement.

The `DBTIMEZONE` function returns the value of the database time zone. The return type is a time zone offset (a character type in the format: `'[+|-]TZH:TZM'`) or a time zone region name, depending on how the user specified the database time zone value in the most recent `CREATE DATABASE` or `ALTER DATABASE` statement. The example in the slide shows that the database time zone is set to "–05:00," as the `TIME_ZONE` parameter is in the format:

```
TIME_ZONE = '[+ | -] hh:mm'
```

The `SESSIONTIMEZONE` function returns the value of the current session's time zone. The return type is a time zone offset (a character type in the format `'[+|-]TZH:TZM'`) or a time zone region name, depending on how the user specified the session time zone value in the most recent `ALTER SESSION` statement. The example in the slide shows that the session time zone is offset to UTC by –8 hours. Observe that the database time zone is different from the current session's time zone.

TIMESTAMP Data Types

Data Type	Fields
TIMESTAMP	Year, Month, Day, Hour, Minute, Second with fractional seconds
TIMESTAMP WITH TIME ZONE	Same as the TIMESTAMP data type; also includes: TIMEZONE_HOUR, and TIMEZONE_MINUTE or TIMEZONE_REGION
TIMESTAMP WITH LOCAL TIME ZONE	Same as the TIMESTAMP data type; also includes a time zone offset in its value

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TIMESTAMP Data Types

The TIMESTAMP data type is an extension of the DATE data type.

```
TIMESTAMP (fractional_seconds_ precision)
```

This data type contains the year, month, and day values of date, as well as hour, minute, and second values of time, where significant fractional seconds precision is the number of digits in the fractional part of the SECOND datetime field. The accepted values of significant fractional_seconds_precision are 0 through 9. The default is 6.

```
TIMESTAMP (fractional_seconds_precision) WITH TIME ZONE
```

This data type contains all values of TIMESTAMP as well as time zone displacement value.

```
TIMESTAMP (fractional_seconds_precision) WITH LOCAL TIME ZONE
```

This data type contains all values of TIMESTAMP, with the following exceptions:

- Data is normalized to the database time zone when it is stored in the database.
- When the data is retrieved, users see the data in the session time zone.

TIMESTAMP Fields

Datetime Field	Valid Values
YEAR	–4712 to 9999 (excluding year 0)
MONTH	01 to 12
DAY	01 to 31
HOUR	00 to 23
MINUTE	00 to 59
SECOND	00 to 59.9(N) where 9(N) is precision
TIMEZONE_HOUR	–12 to 14
TIMEZONE_MINUTE	00 to 59

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TIMESTAMP Fields

Each datetime data type is composed of several of these fields. Datetimes are mutually comparable and assignable only if they have the same datetime fields.

Difference Between DATE and TIMESTAMP

A

```
-- when hire_date is
of type DATE

SELECT hire_date
FROM employees;
```

	HIRE_DATE
1	21-JUN-99
2	13-JAN-00
3	17-SEP-87
4	17-FEB-96
5	17-AUG-97
6	07-JUN-94
7	07-JUN-94
8	07-JUN-94

B

```
ALTER TABLE employees
MODIFY hire_date TIMESTAMP;

SELECT hire_date
FROM employees;
```

	HIRE_DATE
1	21-JUN-99 12.00.00.000000000 AM
2	13-JAN-00 12.00.00.000000000 AM
3	17-SEP-87 12.00.00.000000000 AM
4	17-FEB-96 12.00.00.000000000 AM
5	17-AUG-97 12.00.00.000000000 AM
6	07-JUN-94 12.00.00.000000000 AM
7	07-JUN-94 12.00.00.000000000 AM
8	07-JUN-94 12.00.00.000000000 AM

...

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TIMESTAMP Data Type: Example

In the slide, example A shows the data from the `hire_date` column of the `EMPLOYEES` table when the data type of the column is `DATE`. In example B, the table is altered and the data type of the `hire_date` column is made into `TIMESTAMP`. The output shows the differences in display. You can convert from `DATE` to `TIMESTAMP` when the column has data, but you cannot convert from `DATE` or `TIMESTAMP` to `TIMESTAMP WITH TIME ZONE` unless the column is empty.

You can specify the fractional seconds precision for time stamp. If none is specified, as in this example, it defaults to 6.

For example, the following statement sets the fractional seconds precision as 7:

```
ALTER TABLE employees
MODIFY hire_date TIMESTAMP(7);
```

Note: The Oracle date data type by default appears as shown in this example. However, the date data type also contains additional information such as hours, minutes, seconds, AM, and PM. To obtain the date in this format, you can apply a format mask or a function to the date value.

Comparing TIMESTAMP Data Types

```
CREATE TABLE web_orders
(order_date TIMESTAMP WITH TIME ZONE,
 delivery_time TIMESTAMP WITH LOCAL TIME ZONE);
```

```
INSERT INTO web_orders values
(current_date, current_timestamp + 2);
```

```
SELECT * FROM web_orders;
```

	ORDER_DATE	DELIVERY_TIME
1	23-JUN-09 01.56.39.000000000 AM -05:00	25-JUN-09 01.56.39.000000000 AM

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Comparing TIMESTAMP Data Types

In the example in the slide, a new table `web_orders` is created with a column of data type `TIMESTAMP WITH TIME ZONE` and a column of data type `TIMESTAMP WITH LOCAL TIME ZONE`. This table is populated whenever a `web_order` is placed. The time stamp and time zone for the user placing the order is inserted based on the `CURRENT_DATE value`. The local time stamp and time zone is populated by inserting two days from the `CURRENT_TIMESTAMP` value into it every time an order is placed. When a Web-based company guarantees shipping, they can estimate their delivery time based on the time zone of the person placing the order.

Lesson Agenda

- CURRENT_DATE, CURRENT_TIMESTAMP, and LOCALTIMESTAMP
- INTERVAL data types
- Using the following functions:
  - EXTRACT
  - TZ_OFFSET
  - FROM_TZ
  - TO_TIMESTAMP
  - TO_YMINTERVAL
  - TO_DSINTERVAL

INTERVAL Data Types

- INTERVAL data types are used to store the difference between two datetime values.
- There are two classes of intervals:
  - Year-month
  - Day-time
- The precision of the interval is:
  - The actual subset of fields that constitutes an interval
  - Specified in the interval qualifier

Data Type	Fields
INTERVAL YEAR TO MONTH	Year, Month
INTERVAL DAY TO SECOND	Days, Hour, Minute, Second with fractional seconds

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INTERVAL Data Types

INTERVAL data types are used to store the difference between two datetime values. There are two classes of intervals: year-month intervals and day-time intervals. A year-month interval is made up of a contiguous subset of fields of YEAR and MONTH, whereas a day-time interval is made up of a contiguous subset of fields consisting of DAY, HOUR, MINUTE, and SECOND. The actual subset of fields that constitute an interval is called the precision of the interval and is specified in the interval qualifier. Because the number of days in a year is calendar dependent, the year-month interval is NLS dependent, whereas day-time interval is NLS independent.

The interval qualifier may also specify the leading field precision, which is the number of digits in the leading or only field, and in case the trailing field is SECOND, it may also specify the fractional seconds precision, which is the number of digits in the fractional part of the SECOND value. If not specified, the default value for leading field precision is 2 digits, and the default value for fractional seconds precision is 6 digits.

INTERVAL Data Types (continued)

INTERVAL YEAR (year_precision) TO MONTH

This data type stores a period of time in years and months, where `year_precision` is the number of digits in the `YEAR` datetime field. The accepted values are 0 through 9. The default is 6.

INTERVAL DAY (day_precision) TO SECOND (fractional_seconds_precision)

This data type stores a period of time in days, hours, minutes, and seconds, where `day_precision` is the maximum number of digits in the `DAY` datetime field (accepted values are 0 through 9; the default is 2), and `fractional_seconds_precision` is the number of digits in the fractional part of the `SECOND` field. The accepted values are 0 through 9. The default is 6.

INTERVAL Fields

INTERVAL Field	Valid Values for Interval
YEAR	Any positive or negative integer
MONTH	00 to 11
DAY	Any positive or negative integer
HOUR	00 to 23
MINUTE	00 to 59
SECOND	00 to 59.9(N) where 9(N) is precision

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INTERVAL Fields

INTERVAL YEAR TO MONTH can have fields of YEAR and MONTH.

INTERVAL DAY TO SECOND can have fields of DAY, HOUR, MINUTE, and SECOND.

The actual subset of fields that constitute an item of either type of interval is defined by an interval qualifier, and this subset is known as the precision of the item.

Year-month intervals are mutually comparable and assignable only with other year-month intervals, and day-time intervals are mutually comparable and assignable only with other day-time intervals.

INTERVAL YEAR TO MONTH: Example

```
CREATE TABLE warranty
(prod_id number,  warranty_time INTERVAL YEAR(3) TO
MONTH);

INSERT INTO warranty VALUES (123, INTERVAL '8' MONTH);

INSERT INTO warranty VALUES (155, INTERVAL '200'
YEAR(3));

INSERT INTO warranty VALUES (678, '200-11');

SELECT * FROM warranty;
```

	PROD_ID	WARRANTY_TIME
1	123	0-8
2	155	200-0
3	678	200-11

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INTERVAL YEAR TO MONTH Data Type

INTERVAL YEAR TO MONTH stores a period of time using the YEAR and MONTH datetime fields. Specify INTERVAL YEAR TO MONTH as follows:

```
INTERVAL YEAR [(year_precision)] TO MONTH
```

where year_precision is the number of digits in the YEAR datetime field. The default value of year_precision is 2.

Restriction: The leading field must be more significant than the trailing field. For example, INTERVAL '0-1' MONTH TO YEAR is not valid.

Examples

- INTERVAL '123-2' YEAR(3) TO MONTH
  Indicates an interval of 123 years, 2 months
- INTERVAL '123' YEAR(3)
  Indicates an interval of 123 years, 0 months
- INTERVAL '300' MONTH(3)
  Indicates an interval of 300 months
- INTERVAL '123' YEAR
  Returns an error because the default precision is 2, and 123 has three digits

INTERVAL YEAR TO MONTH Data Type (continued)

The Oracle database supports two interval data types: INTERVAL YEAR TO MONTH and INTERVAL DAY TO SECOND; the column type, PL/SQL argument, variable, and return type must be one of the two. However, for interval literals, the system recognizes other American National Standards Institute (ANSI) interval types such as INTERVAL '2' YEAR or INTERVAL '10' HOUR. In these cases, each interval is converted to one of the two supported types.

In the example in the slide, a WARRANTY table is created, which contains a warranty_time column that takes the INTERVAL YEAR(3) TO MONTH data type. Different values are inserted into it to indicate years and months for various products. When these rows are retrieved from the table, you see a year value separated from the month value by a (-).

INTERVAL DAY TO SECOND
Data Type: Example

```
CREATE TABLE lab
( exp_id number, test_time INTERVAL DAY(2) TO SECOND);

INSERT INTO lab VALUES (100012, '90 00:00:00');
INSERT INTO lab VALUES (56098,
  INTERVAL '6 03:30:16' DAY  TO SECOND);
```

```
SELECT * FROM lab;
```

	EXP_ID	TEST_TIME
1	100012	90 0:0:0.0
2	56098	6 3:30:16.0

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INTERVAL DAY TO SECOND Data Type: Example

In the example in the slide, you create the lab table with a `test_time` column of the `INTERVAL DAY TO SECOND` data type. You then insert into it the value `'90 00:00:00'` to indicate 90 days and 0 hours, 0 minutes, and 0 seconds, and `INTERVAL '6 03:30:16' DAY TO SECOND` to indicate 6 days, 3 hours, 30 minutes, and 16 seconds. The `SELECT` statement shows how this data is displayed in the database.

Lesson Agenda

- CURRENT_DATE, CURRENT_TIMESTAMP, and LOCALTIMESTAMP
- INTERVAL data types
- Using the following functions:
  - EXTRACT
  - TZ_OFFSET
  - FROM_TZ
  - TO_TIMESTAMP
  - TO_YMINTERVAL
  - TO_DSINTERVAL

EXTRACT

- Display the YEAR component from the SYSDATE.

```
SELECT EXTRACT (YEAR FROM SYSDATE) FROM DUAL;
```

	EXTRACT(YEARFROMSYSDATE)
1	2009

- Display the MONTH component from the HIRE_DATE for those employees whose MANAGER_ID is 100.

```
SELECT last name, hire date,
       EXTRACT (MONTH FROM HIRE_DATE)
FROM employees
WHERE manager_id = 100;
```

	LAST_NAME	HIRE_DATE	EXTRACT(MONTHFROMHIRE_DATE)
1	Hartstein	17-FEB-1996 00:00:00	2
2	Kochhar	21-SEP-1989 00:00:00	9
3	De Haan	13-JAN-1993 00:00:00	1
4	Raphaely	07-DEC-1994 00:00:00	12
5	Weiss	18-JUL-1996 00:00:00	7

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EXTRACT

The EXTRACT expression extracts and returns the value of a specified datetime field from a datetime or interval value expression. You can extract any of the components mentioned in the following syntax using the EXTRACT function. The syntax of the EXTRACT function is:

```
SELECT  EXTRACT ([YEAR] [MONTH][DAY] [HOUR] [MINUTE][SECOND]
                 [TIMEZONE_HOUR] [TIMEZONE_MINUTE]
                 [TIMEZONE_REGION] [TIMEZONE_ABBR]
FROM [datetime_value_expression] [interval_value_expression]);
```

When you extract a TIMEZONE_REGION or TIMEZONE_ABBR (abbreviation), the value returned is a string containing the appropriate time zone name or abbreviation. When you extract any of the other values, the value returned is a date in the Gregorian calendar. When extracting from a datetime with a time zone value, the value returned is in UTC.

In the first example in the slide, the EXTRACT function is used to extract the YEAR from SYSDATE. In the second example in the slide, the EXTRACT function is used to extract the MONTH from the HIRE_DATE column of the EMPLOYEES table for those employees who report to the manager whose EMPLOYEE_ID is 100.

TZ_OFFSET

Display the time zone offset for the `'US/Eastern'`, `'Canada/Yukon'` and `'Europe/London'` time zones:

```
SELECT TZ_OFFSET('US/Eastern'),
       TZ_OFFSET('Canada/Yukon'),
       TZ_OFFSET('Europe/London')
 FROM DUAL;
```

	TZ_OFFSET('US/EASTERN')	TZ_OFFSET('CANADA/YUKON')	TZ_OFFSET('EUROPE/LONDON')
1	-04:00	-07:00	+01:00

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TZ_OFFSET

The `TZ_OFFSET` function returns the time zone offset corresponding to the value entered. The return value is dependent on the date when the statement is executed. For example, if the `TZ_OFFSET` function returns a value –08:00, this value indicates that the time zone where the command was executed is eight hours behind UTC. You can enter a valid time zone name, a time zone offset from UTC (which simply returns itself), or the keyword `SESSIONTIMEZONE` or `DBTIMEZONE`. The syntax of the `TZ_OFFSET` function is:

```
TZ_OFFSET ( ['time_zone_name'] '[+ | -] hh:mm']
            [ SESSIONTIMEZONE] [DBTIMEZONE]
```

The Fold Motor Company has its headquarters in Michigan, USA, which is in the US/Eastern time zone. The company president, Mr. Fold, wants to conduct a conference call with the vice president of the Canadian operations and the vice president of European operations, who are in the Canada/Yukon and Europe/London time zones, respectively. Mr. Fold wants to find out the time in each of these places to make sure that his senior management will be available to attend the meeting. His secretary, Mr. Scott, helps by issuing the queries shown in the example and gets the following results:

- The `'US/Eastern'` time zone is four hours behind UTC.
- The `'Canada/Yukon'` time zone is seven hours behind UTC.
- The `'Europe/London'` time zone is one hour ahead of UTC.

TZ_OFFSET (continued)

For a listing of valid time zone name values, you can query the V$TIMEZONE_NAMES dynamic performance view.

```
SELECT * FROM V$TIMEZONE_NAMES;
```

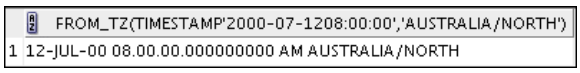
	TZNAME	TZABBREV
1	Africa/Abidjan	LMT
2	Africa/Abidjan	GMT
3	Africa/Accra	LMT
4	Africa/Accra	GMT
5	Africa/Accra	GHST

...

FROM_TZ

Display the TIMESTAMP value '2000-03-28 08:00:00' as a TIMESTAMP WITH TIME ZONE value for the 'Australia/North' time zone region.

```
SELECT FROM_TZ(TIMESTAMP
       '2000-07-12 08:00:00', 'Australia/North')
FROM DUAL;
```



	FROM_TZ(TIMESTAMP'2000-07-1208:00:00','AUSTRALIA/NORTH')
1	12-JUL-00 08.00.00.000000000 AM AUSTRALIA/NORTH

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FROM_TZ

The FROM_TZ function converts a TIMESTAMP value to a TIMESTAMP WITH TIME ZONE value.

The syntax of the FROM_TZ function is as follows:

FROM_TZ(TIMESTAMP timestamp_value, time_zone_value)

where time_zone_value is a character string in the format 'TZH:TZM' or a character expression that returns a string in TZR (time zone region) with an optional TZD format. TZD is an abbreviated time zone string with daylight saving information. TZR represents the time zone region in datetime input strings. Examples are 'Australia/North', 'PST' for US/Pacific standard time, 'PDT' for US/Pacific daylight time, and so on.

The example in the slide converts a TIMESTAMP value to TIMESTAMP WITH TIME ZONE.

Note: To see a listing of valid values for the TZR and TZD format elements, query the V$TIMEZONE_NAMES dynamic performance view.

TO_TIMESTAMP

Display the character string `'2007-03-06 11:00:00'` as a `TIMESTAMP` value:

```
SELECT TO_TIMESTAMP ('2007-03-06 11:00:00',
                     'YYYY-MM-DD HH:MI:SS')
FROM DUAL;
```

TO_TIMESTAMP('2007-03-0611:00:00','YYYY-MM-DDHH:MI:SS')
06-MAR-07 11.00.00.000000000

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TO_TIMESTAMP

The `TO_TIMESTAMP` function converts a string of `CHAR`, `VARCHAR2`, `NCHAR`, or `NVARCHAR2` data type to a value of the `TIMESTAMP` data type. The syntax of the `TO_TIMESTAMP` function is:

```
TO_TIMESTAMP (char,[fmt],['nlsparam'])
```

The optional `fmt` specifies the format of `char`. If you omit `fmt`, the string must be in the default format of the `TIMESTAMP` data type. The optional `nlsparam` specifies the language in which month and day names, and abbreviations are returned. This argument can have this form:

```
'NLS_DATE_LANGUAGE = language'
```

If you omit `nlsparams`, this function uses the default date language for your session.

The example in the slide converts a character string to a value of `TIMESTAMP`.

Note: You use the `TO_TIMESTAMP_TZ` function to convert a string of `CHAR`, `VARCHAR2`, `NCHAR`, or `NVARCHAR2` data type to a value of the `TIMESTAMP WITH TIME ZONE` data type. For more information about this function, see *Oracle Database SQL Language Reference 11g Release 1 (11.1)*.

TO_YMINTERVAL

Display a date that is one year and two months after the hire date for the employees working in the department with the DEPARTMENT_ID 20.

```
SELECT hire_date,
       hire_date + TO_YMINTERVAL('01-02') AS
       HIRE_DATE_YMININTERVAL
FROM   employees
WHERE department_id = 20;
```

	HIRE_DATE	HIRE_DATE_YMININTERVAL
1	17-FEB-1996 00:00:00	17-APR-1997 00:00:00
2	17-AUG-1997 00:00:00	17-OCT-1998 00:00:00

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TO_YMINTERVAL

The TO_YMINTERVAL function converts a character string of CHAR, VARCHAR2, NCHAR, or NVARCHAR2 data type to an INTERVAL YEAR TO MONTH data type. The INTERVAL YEAR TO MONTH data type stores a period of time using the YEAR and MONTH datetime fields. The format of INTERVAL YEAR TO MONTH is as follows:

```
INTERVAL YEAR [(year_precision)] TO MONTH
```

where year_precision is the number of digits in the YEAR datetime field. The default value of year_precision is 2.

The syntax of the TO_YMINTERVAL function is:

```
TO_YMINTERVAL (char)
```

where char is the character string to be converted.

The example in the slide calculates a date that is one year and two months after the hire date for the employees working in the department 20 of the EMPLOYEES table.

TO_DSINTERVAL

Display a date that is 100 days and 10 hours after the hire date for all the employees.

```
SELECT last_name,
 TO_CHAR(hire_date, 'mm-dd-yy:hh:mi:ss') hire_date,
  TO_CHAR(hire_date +
   TO_DSINTERVAL('100 10:00:00'),
     'mm-dd-yy:hh:mi:ss') hiredate2
FROM employees;
```

	LAST_NAME	HIRE_DATE	HIREDATE2
1	OConnell	06-21-99:12:00:00	09-29-99:10:00:00
2	Grant	01-13-00:12:00:00	04-22-00:10:00:00
3	Whalen	09-17-87:12:00:00	12-26-87:10:00:00
4	Hartstein	02-17-96:12:00:00	05-27-96:10:00:00
5	Fay	08-17-97:12:00:00	11-25-97:10:00:00
6	Mavris	06-07-94:12:00:00	09-15-94:10:00:00
7	Baer	06-07-94:12:00:00	09-15-94:10:00:00
8	Higgins	06-07-94:12:00:00	09-15-94:10:00:00

...

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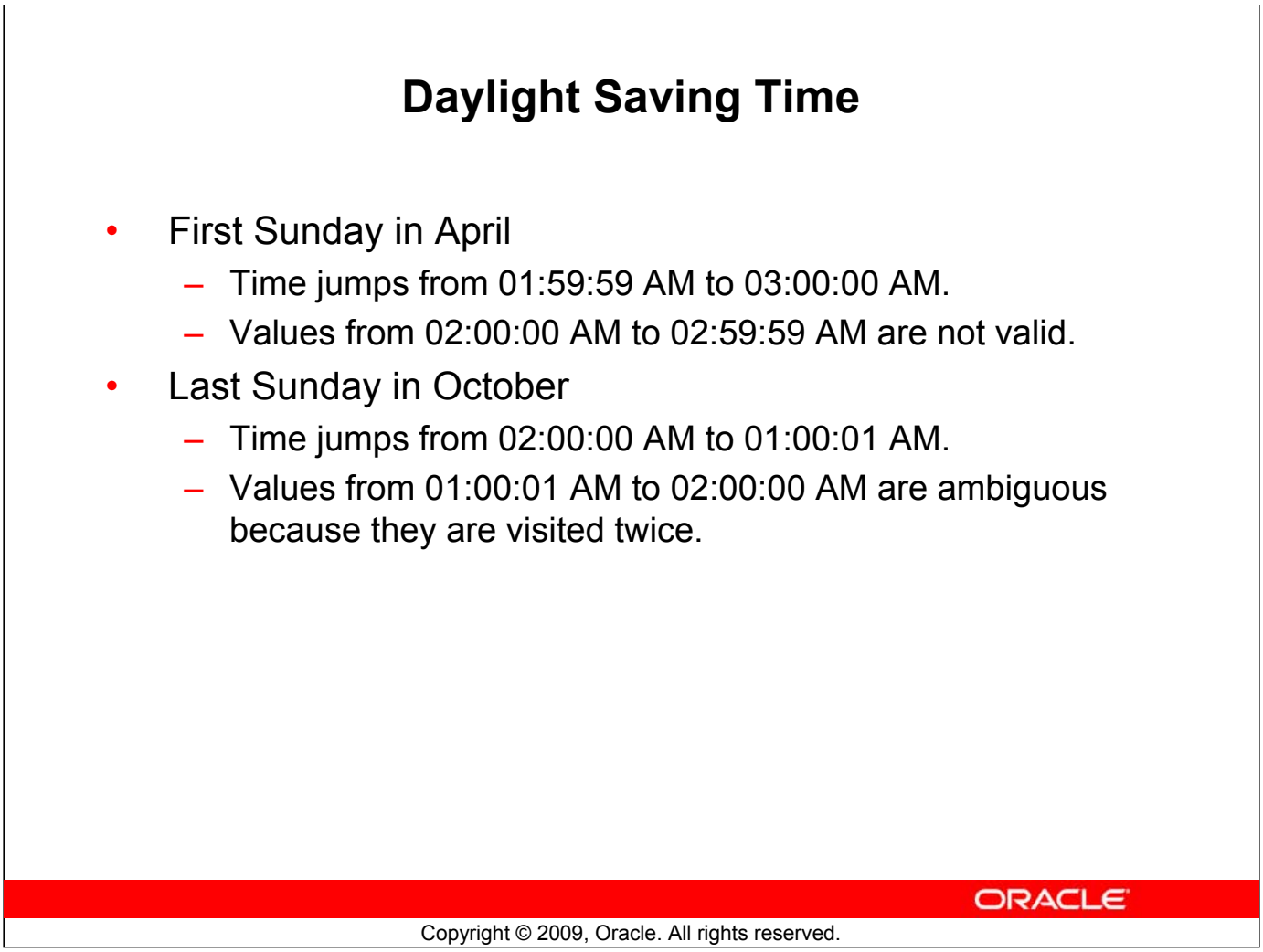
TO_DSINTERVAL

`TO_DSINTERVAL` converts a character string of the `CHAR`, `VARCHAR2`, `NCHAR`, or `NVARCHAR2` data type to an `INTERVAL DAY TO SECOND` data type.

In the example in the slide, the date 100 days and 10 hours after the hire date is obtained.



Daylight Saving Time (DST)

Most western nations advance the clock ahead one hour during the summer months. This period is called daylight saving time. Daylight saving time lasts from the first Sunday in April to the last Sunday in October in the most of the United States, Mexico, and Canada. The nations of the European Union observe daylight saving time, but they call it the summer time period. Europe's summer time period begins a week earlier than its North American counterpart, but ends at the same time.

The Oracle database automatically determines, for any given time zone region, whether daylight saving time is in effect and returns local time values accordingly. The datetime value is sufficient for the Oracle database to determine whether daylight saving time is in effect for a given region in all cases except boundary cases. A boundary case occurs during the period when daylight saving time goes into or out of effect. For example, in the US/Eastern region, when daylight saving time goes into effect, the time changes from 01:59:59 AM to 03:00:00 AM. The one-hour interval between 02:00:00 AM and 02:59:59 AM. does not exist. When daylight saving time goes out of effect, the time changes from 02:00:00 AM back to 01:00:01 AM, and the one-hour interval between 01:00:01 AM and 02:00:00 AM is repeated.

Daylight Saving Time (DST) (continued)

ERROR_ON_OVERLAP_TIME

The ERROR_ON_OVERLAP_TIME is a session parameter to notify the system to issue an error when it encounters a datetime that occurs in the overlapped period and no time zone abbreviation was specified to distinguish the period.

For example, daylight saving time ends on October 31, at 02:00:01 AM. The overlapped periods are:

- 10/31/2004 01:00:01 AM to 10/31/2004 02:00:00 AM (EDT)
- 10/31/2004 01:00:01 AM to 10/31/2004 02:00:00 AM (EST)

If you input a datetime string that occurs in one of these two periods, you need to specify the time zone abbreviation (for example, EDT or EST) in the input string for the system to determine the period. Without this time zone abbreviation, the system does the following:

If the ERROR_ON_OVERLAP_TIME parameter is FALSE, it assumes that the input time is standard time (for example, EST). Otherwise, an error is raised.

Quiz

The `TIME_ZONE` session parameter may be set to:

1. A relative offset
2. Database time zone
3. OS local time zone
4. A named region

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Answers: 2, 3, 4

Summary

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

- CURRENT_DATE
- CURRENT_TIMESTAMP
- LOCALTIMESTAMP
- DBTIMEZONE
- SESSIONTIMEZONE
- EXTRACT
- TZ_OFFSET
- FROM_TZ
- TO_TIMESTAMP
- TO_YMINTERVAL
- TO_DSINTERVAL

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Summary

This lesson addressed some of the datetime functions available in the Oracle database.

Practice 5: Overview

This practice covers using the datetime functions.

Practice 5: Overview

In this practice, you display time zone offsets, `CURRENT_DATE`, `CURRENT_TIMESTAMP`, and `LOCALTIMESTAMP`. You also set time zones and use the `EXTRACT` function.

6

Retrieving Data by Using Subqueries

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Objectives

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

- Write a multiple-column subquery
- Use scalar subqueries in SQL
- Solve problems with correlated subqueries
- Update and delete rows by using correlated subqueries
- Use the `EXISTS` and `NOT EXISTS` operators
- Use the `WITH` clause

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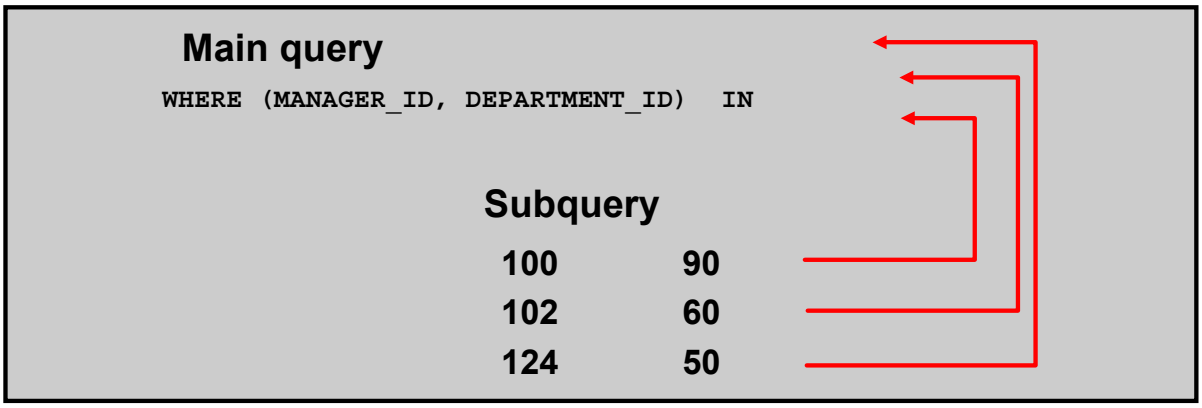
Objectives

In this lesson, you learn how to write multiple-column subqueries and subqueries in the `FROM` clause of a `SELECT` statement. You also learn how to solve problems by using scalar, correlated subqueries and the `WITH` clause.

Lesson Agenda

- Writing a multiple-column subquery
- Using scalar subqueries in SQL
- Solving problems with correlated subqueries
- Using the `EXISTS` and `NOT EXISTS` operators
- Using the `WITH` clause

Multiple-Column Subqueries



Each row of the main query is compared to values from a multiple-row and multiple-column subquery.

Multiple-Column Subqueries

So far, you have written single-row subqueries and multiple-row subqueries where only one column is returned by the inner `SELECT` statement and this is used to evaluate the expression in the parent `SELECT` statement. If you want to compare two or more columns, you must write a compound `WHERE` clause using logical operators. Using multiple-column subqueries, you can combine duplicate `WHERE` conditions into a single `WHERE` clause.

Syntax

```
SELECT     column, column, ...
FROM table
WHERE(column, column, ...) IN
            (SELECT column, column, ...
                                FROM   table
                                WHERE  condition);
```

The graphic in the slide illustrates that the values of `MANAGER_ID` and `DEPARTMENT_ID` from the main query are being compared with the `MANAGER_ID` and `DEPARTMENT_ID` values retrieved by the subquery. Because the number of columns that are being compared is more than one, the example qualifies as a multiple-column subquery.

Note: Before you run the examples in the next few slides, you need to create the `empl_demo` table and populate data into it by using the `lab_06_insert_empdata.sql` file.

Column Comparisons

Multiple-column comparisons involving subqueries can be:

- Nonpairwise comparisons
- Pairwise comparisons

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Pairwise Versus Nonpairwise Comparisons

Multiple-column comparisons involving subqueries can be nonpairwise comparisons or pairwise comparisons. If you consider the example "Display the details of the employees who work in the same department, and have the same manager, as 'Daniel'? ," you get the correct result with the following statement:

```
SELECT first_name, last_name, manager_id, department_id
FROM empl_demo
WHERE manager_id IN (SELECT manager_id
                     FROM empl_demo
                     WHERE first_name = 'Daniel')
AND department_id IN (SELECT department_id
                      FROM empl_demo
                      WHERE first_name = 'Daniel');
```

There is only one "Daniel" in the `EMPL_DEMO` table (Daniel Faviet, who is managed by employee 108 and works in department 100). However, if the subqueries return more than one row, the result might not be correct. For example, if you run the same query but substitute "John" for "Daniel," you get an incorrect result. This is because the combination of `department_id` and `manager_id` is important. To get the correct result for this query, you need a pairwise comparison.

Pairwise Comparison Subquery

Display the details of the employees who are managed by the same manager and work in the same department as employees with the first name of "John."

```
SELECT  employee_id, manager_id, department_id
FROM    empl_demo
WHERE   (manager_id, department_id) IN
                      (SELECT manager_id, department_id
                       FROM empl_demo
                       WHERE first_name = 'John')
AND first_name <> 'John';
```

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Pairwise Comparison Subquery

The example in the slide compares the combination of values in the MANAGER_ID column and the DEPARTMENT_ID column of each row in the EMPL_DEMO table with the values in the MANAGER_ID column and the DEPARTMENT_ID column for the employees with the FIRST_NAME of "John." First, the subquery to retrieve the MANAGER_ID and DEPARTMENT_ID values for the employees with the FIRST_NAME of "John" is executed. This subquery returns the following:

	MANAGER_ID	DEPARTMENT_ID
1	108	100
2	123	50
3	100	80

Pairwise Comparison Subquery (continued)

These values are compared with the MANAGER_ID column and the DEPARTMENT_ID column of each row in the EMPL_DEMO table. If the combination matches, the row is displayed. In the output, the records of the employees with the FIRST_NAME of "John" will not be displayed. The following is the output of the query in the slide:

	EMPLOYEE_ID	MANAGER_ID	DEPARTMENT_ID
1	113	108	100
2	112	108	100
3	111	108	100
4	109	108	100
5	195	123	50
6	194	123	50
7	193	123	50
8	192	123	50
9	140	123	50
10	138	123	50
11	137	123	50
12	149	100	80
13	148	100	80
14	147	100	80
15	146	100	80

Nonpairwise Comparison Subquery

Display the details of the employees who are managed by the same manager as the employees with the first name of "John" and work in the same department as the employees with the first name of "John."

```
SELECT  employee_id, manager_id, department_id
FROM    empl_demo
WHERE   manager_id IN
                (SELECT manager_id
                 FROM empl_demo
                 WHERE first_name = 'John')
AND department_id IN
               (SELECT department_id
                FROM empl_demo
                WHERE first_name = 'John')
AND first_name <> 'John';
```

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Nonpairwise Comparison Subquery

The example shows a nonpairwise comparison of the columns. First, the subquery to retrieve the MANAGER_ID values for the employees with the FIRST_NAME of "John" is executed. Similarly, the second subquery to retrieve the DEPARTMENT_ID values for the employees with the FIRST_NAME of "John" is executed. The retrieved values of the MANAGER_ID and DEPARTMENT_ID columns are compared with the MANAGER_ID and DEPARTMENT_ID columns for each row in the EMPL_DEMO table. If the MANAGER_ID column of the row in the EMPL_DEMO table matches with any of the values of MANAGER_ID retrieved by the inner subquery and if the DEPARTMENT_ID column of the row in the EMPL_DEMO table matches with any of the values of DEPARTMENT_ID retrieved by the second subquery, the record is displayed.

Nonpairwise Comparison Subquery (continued)

The following is the output of the query in the previous slide:

	EMPLOYEE_ID	MANAGER_ID	DEPARTMENT_ID
1	109	108	100
2	111	108	100
3	112	108	100
4	113	108	100
5	120	100	50
6	121	100	50
7	122	100	50
8	123	100	50
9	124	100	50
10	137	123	50
11	138	123	50
12	140	123	50
13	192	123	50
14	193	123	50
15	194	123	50
16	195	123	50
17	146	100	80
18	147	100	80
19	148	100	80
20	149	100	80

This query retrieves additional rows than the pairwise comparison (those with the combination of `manager_id`=100 and `department_id=50` or `80`, although no employee named “John” has such a combination).

Lesson Agenda

- Writing a multiple-column subquery
- Using scalar subqueries in SQL
- Solving problems with correlated subqueries
- Using the `EXISTS` and `NOT EXISTS` operators
- Using the `WITH` clause

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Scalar Subquery Expressions

- A scalar subquery expression is a subquery that returns exactly one column value from one row.
- Scalar subqueries can be used in:
  - The condition and expression part of DECODE and CASE
  - All clauses of SELECT except GROUP BY
  - The SET clause and WHERE clause of an UPDATE statement

Scalar Subqueries in SQL

A subquery that returns exactly one column value from one row is also referred to as a scalar subquery. Multiple-column subqueries that are written to compare two or more columns, using a compound WHERE clause and logical operators, do not qualify as scalar subqueries.

The value of the scalar subquery expression is the value of the select list item of the subquery. If the subquery returns 0 rows, the value of the scalar subquery expression is NULL. If the subquery returns more than one row, the Oracle server returns an error. The Oracle server has always supported the usage of a scalar subquery in a SELECT statement. You can use scalar subqueries in:

- The condition and expression part of DECODE and CASE
- All clauses of SELECT except GROUP BY
- The SET clause and WHERE clause of an UPDATE statement

However, scalar subqueries are not valid expressions in the following places:

- As default values for columns and hash expressions for clusters
- In the RETURNING clause of data manipulation language (DML) statements
- As the basis of a function-based index
- In GROUP BY clauses, CHECK constraints, and WHEN conditions
- In CONNECT BY clauses
- In statements that are unrelated to queries, such as CREATE PROFILE

Scalar Subqueries: Examples

- Scalar subqueries in `CASE` expressions:

```
SELECT employee_id, last_name,
       (CASE
        WHEN department_id =
                (SELECT department_id
                 FROM departments
                     WHERE location_id = 1800)
         THEN 'Canada' ELSE 'USA' END) location
FROM   employees;
```

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- Scalar subqueries in the `ORDER BY` clause:

```
SELECT   employee_id, last_name
FROM     employees e
ORDER BY (SELECT department_name
          FROM departments d
          WHERE e.department_id = d.department_id);
```

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Scalar Subqueries: Examples

The first example in the slide demonstrates that scalar subqueries can be used in `CASE` expressions. The inner query returns the value 20, which is the department ID of the department whose location ID is 1800. The `CASE` expression in the outer query uses the result of the inner query to display the employee ID, last names, and a value of Canada or USA, depending on whether the department ID of the record retrieved by the outer query is 20 or not.

The following is the result of the first example in the slide:

...

	EMPLOYEE_ID	LAST_NAME	LOCATION
1	198	OConnell	USA
2	199	Grant	USA
3	200	Whalen	USA
4	201	Hartstein	Canada
5	202	Fay	Canada
6	203	Mavris	USA

Scalar Subqueries: Examples (continued)

The second example in the slide demonstrates that scalar subqueries can be used in the `ORDER BY` clause. The example orders the output based on the `DEPARTMENT_NAME` by matching the `DEPARTMENT_ID` from the `EMPLOYEES` table with the `DEPARTMENT_ID` from the `DEPARTMENTS` table. This comparison is done in a scalar subquery in the `ORDER BY` clause. The following is the result of the second example:

	EMPLOYEE_ID	LAST_NAME
1	205	Higgins
2	206	Gietz
3	200	Whalen
4	100	King
5	101	Kochhar
6	102	De Haan
7	112	Urman
8	108	Greenberg
9	109	Faviet

...

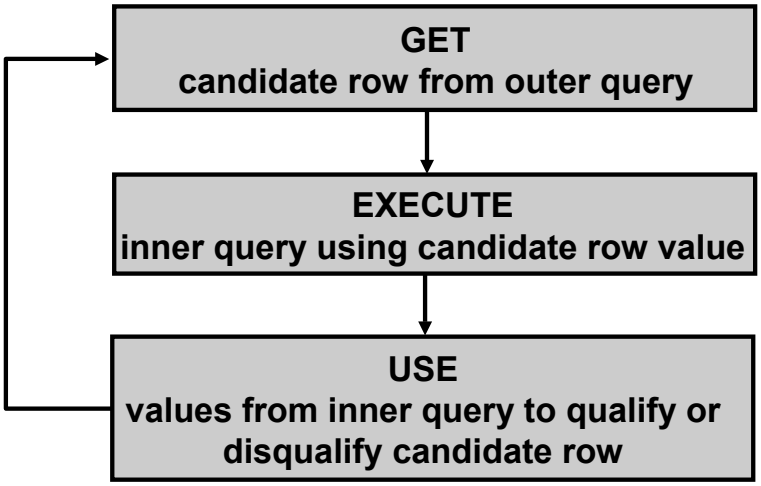
The second example uses a correlated subquery. In a correlated subquery, the subquery references a column from a table referred to in the parent statement. Correlated subqueries are explained later in this lesson.

Lesson Agenda

- Writing a multiple-column subquery
- Using scalar subqueries in SQL
- Solving problems with correlated subqueries
- Using the `EXISTS` and `NOT EXISTS` operators
- Using the `WITH` clause

Correlated Subqueries

Correlated subqueries are used for row-by-row processing. Each subquery is executed once for every row of the outer query.



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Correlated Subqueries

The Oracle server performs a correlated subquery when the subquery references a column from a table referred to in the parent statement. A correlated subquery is evaluated once for each row processed by the parent statement. The parent statement can be a `SELECT`, `UPDATE`, or `DELETE` statement.

Nested Subqueries Versus Correlated Subqueries

With a normal nested subquery, the inner `SELECT` query runs first and executes once, returning values to be used by the main query. A correlated subquery, however, executes once for each candidate row considered by the outer query. That is, the inner query is driven by the outer query.

Nested Subquery Execution

- The inner query executes first and finds a value.
- The outer query executes once, using the value from the inner query.

Correlated Subquery Execution

- Get a candidate row (fetched by the outer query).
- Execute the inner query using the value of the candidate row.
- Use the values resulting from the inner query to qualify or disqualify the candidate.
- Repeat until no candidate row remains.

Correlated Subqueries

The subquery references a column from a table in the parent query.

```
SELECT column1, column2, ...
FROM   table1   Outer_table
WHERE  column1 operator
                      (SELECT  column1, column2
                       FROM    table2
                       WHERE   expr1 =
                             Outer_table.expr2);
```


Correlated Subqueries (continued)

A correlated subquery is one way of reading every row in a table and comparing values in each row against related data. It is used whenever a subquery must return a different result or set of results for each candidate row considered by the main query. That is, you use a correlated subquery to answer a multipart question whose answer depends on the value in each row processed by the parent statement.

The Oracle server performs a correlated subquery when the subquery references a column from a table in the parent query.

Note: You can use the `ANY` and `ALL` operators in a correlated subquery.

Using Correlated Subqueries

Find all employees who earn more than the average salary in their department.

```
SELECT last_name, salary, department_id
FROM   employees outer_table
WHERE  salary >
          (SELECT AVG(salary)
           FROM   employees inner_table
           WHERE inner_table.department_id =
           outer_table.department_id);
```

Each time a row from the outer query is processed, the inner query is evaluated.

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Using Correlated Subqueries

The example in the slide determines which employees earn more than the average salary of their department. In this case, the correlated subquery specifically computes the average salary for each department.

Because both the outer query and inner query use the `EMPLOYEES` table in the `FROM` clause, an alias is given to `EMPLOYEES` in the outer `SELECT` statement for clarity. The alias makes the entire `SELECT` statement more readable. Without the alias, the query would not work properly because the inner statement would not be able to distinguish the inner table column from the outer table column.

Using Correlated Subqueries

Display details of those employees who have changed jobs at least twice.

```
SELECT e.employee_id, last_name,e.job_id
FROM   employees e
WHERE  2 <= (SELECT COUNT(*)
             FROM   job_history
             WHERE  employee_id = e.employee_id);
```

	EMPLOYEE_ID	LAST_NAME	JOB_ID
1	200	Whalen	AD_ASST
2	101	Kochhar	AD_VP
3	176	Taylor	SA_REP

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Using Correlated Subqueries (continued)

The example in the slide displays the details of those employees who have changed jobs at least twice. The Oracle server evaluates a correlated subquery as follows:

1. Select a row from the table specified in the outer query. This will be the current candidate row.
2. Store the value of the column referenced in the subquery from this candidate row. (In the example in the slide, the column referenced in the subquery is `E.EMPLOYEE_ID`.)
3. Perform the subquery with its condition referencing the value from the outer query's candidate row. (In the example in the slide, the `COUNT(*)` group function is evaluated based on the value of the `E.EMPLOYEE_ID` column obtained in step 2.)
4. Evaluate the `WHERE` clause of the outer query on the basis of results of the subquery performed in step 3. This determines whether the candidate row is selected for output. (In the example, the number of times an employee has changed jobs, evaluated by the subquery, is compared with 2 in the `WHERE` clause of the outer query. If the condition is satisfied, that employee record is displayed.)
5. Repeat the procedure for the next candidate row of the table, and so on, until all the rows in the table have been processed.

The correlation is established by using an element from the outer query in the subquery. In this example, you compare `EMPLOYEE_ID` from the table in the subquery with `EMPLOYEE_ID` from the table in the outer query.

Lesson Agenda

- Writing a multiple-column subquery
- Using scalar subqueries in SQL
- Solving problems with correlated subqueries
- Using the `EXISTS` and `NOT EXISTS` operators
- Using the `WITH` clause

Using the EXISTS Operator

- The EXISTS operator tests for existence of rows in the results set of the subquery.
- If a subquery row value is found:
  - The search does not continue in the inner query
  - The condition is flagged TRUE
- If a subquery row value is not found:
  - The condition is flagged FALSE
  - The search continues in the inner query

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EXISTS Operator

With nesting SELECT statements, all logical operators are valid. In addition, you can use the EXISTS operator. This operator is frequently used with correlated subqueries to test whether a value retrieved by the outer query exists in the results set of the values retrieved by the inner query. If the subquery returns at least one row, the operator returns TRUE. If the value does not exist, it returns FALSE. Accordingly, NOT EXISTS tests whether a value retrieved by the outer query is not a part of the results set of the values retrieved by the inner query.

Using the EXISTS Operator

```
SELECT employee_id, last_name, job_id, department_id
FROM   employees outer
WHERE  EXISTS ( SELECT 'X'
                FROM   employees
                WHERE  manager_id =
                       outer.employee_id);
```

	EMPLOYEE_ID	LAST_NAME	JOB_ID	DEPARTMENT_ID
1	201	Hartstein	MK_MAN	20
2	205	Higgins	AC_MGR	110
3	100	King	AD_PRES	90
4	101	Kochhar	AD_VP	90
5	102	De Haan	AD_VP	90
6	103	Hunold	IT_PROG	60
7	108	Greenberg	FI_MGR	100
8	114	Raphaely	PU_MAN	30

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Using the EXISTS Operator

The EXISTS operator ensures that the search in the inner query does not continue when at least one match is found for the manager and employee number by the condition:

```
WHERE manager_id = outer.employee_id.
```

Note that the inner SELECT query does not need to return a specific value, so a constant can be selected.

Find All Departments That Do Not Have Any Employees

```
SELECT department_id, department_name
FROM departments d
WHERE NOT EXISTS (SELECT 'X'
                  FROM   employees
                  WHERE  department_id = d.department_id);
```

	DEPARTMENT_ID	DEPARTMENT_NAME
1	120	Treasury
2	130	Corporate Tax
3	140	Control And Credit
4	150	Shareholder Services
5	160	Benefits
6	170	Manufacturing
7	180	Construction

...

All Rows Fetched: 16

Using the NOT EXISTS Operator

Alternative Solution

A NOT IN construct can be used as an alternative for a NOT EXISTS operator, as shown in the following example:

```
SELECT department_id, department_name
FROM   departments
WHERE  department_id NOT IN (SELECT department_id
                             FROM   employees);
```

All Rows Fetched: 0

However, NOT IN evaluates to FALSE if any member of the set is a NULL value. Therefore, your query will not return any rows even if there are rows in the departments table that satisfy the WHERE condition.

Correlated UPDATE

Use a correlated subquery to update rows in one table based on rows from another table.

```
UPDATE table1 alias1
SET    column = (SELECT expression
                 FROM   table2 alias2
                 WHERE  alias1.column =
                        alias2.column);
```

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Correlated UPDATE

In the case of the UPDATE statement, you can use a correlated subquery to update rows in one table based on rows from another table.

Using Correlated UPDATE

- Denormalize the EMPL6 table by adding a column to store the department name.
- Populate the table by using a correlated update.

```
ALTER TABLE empl6
ADD(department_name VARCHAR2(25));
```

```
UPDATE empl6 e
SET    department_name =
               (SELECT department_name
               FROM   departments d
               WHERE  e.department_id = d.department_id);
```

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Correlated UPDATE (continued)

The example in the slide denormalizes the EMPL6 table by adding a column to store the department name and then populates the table by using a correlated update.

Following is another example for a correlated update.

Problem Statement

The REWARDS table has a list of employees who have exceeded expectations in their performance. Use a correlated subquery to update rows in the EMPL6 table based on rows from the REWARDS table:

```
UPDATE empl6
SET    salary = (SELECT empl6.salary + rewards.pay_raise
                 FROM   rewards
                 WHERE  employee_id  =
                        empl6.employee_id
                 AND  payraise_date =
                      (SELECT MAX(payraise_date)
                      FROM   rewards
                      WHERE  employee_id = empl6.employee_id))
WHERE  empl6.employee_id
IN     (SELECT employee_id FROM rewards);
```

Correlated UPDATE (continued)

This example uses the REWARDS table. The REWARDS table has the following columns: EMPLOYEE_ID, PAY_RAISE, and PAYRAISE_DATE. Every time an employee gets a pay raise, a record with details such as the employee ID, the amount of the pay raise, and the date of receipt of the pay raise is inserted into the REWARDS table. The REWARDS table can contain more than one record for an employee. The PAYRAISE _DATE column is used to identify the most recent pay raise received by an employee.

In the example, the SALARY column in the EMPL6 table is updated to reflect the latest pay raise received by the employee. This is done by adding the current salary of the employee with the corresponding pay raise from the REWARDS table.

Correlated DELETE

Use a correlated subquery to delete rows in one table based on rows from another table.

```
DELETE FROM table1 alias1
WHERE  column operator
               (SELECT expression
                FROM   table2 alias2
                WHERE  alias1.column = alias2.column);
```

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Correlated DELETE

In the case of a DELETE statement, you can use a correlated subquery to delete only those rows that also exist in another table. If you decide that you will maintain only the last four job history records in the JOB_HISTORY table, when an employee transfers to a fifth job, you delete the oldest JOB_HISTORY row by looking up the JOB_HISTORY table for the MIN(START_DATE) for the employee. The following code illustrates how the preceding operation can be performed using a correlated DELETE:

```
DELETE FROM emp_history JH
WHERE employee_id =
      (SELECT employee_id
       FROM employees E
       WHERE JH.employee_id = E.employee_id
       AND START_DATE =
             (SELECT MIN(start_date)
              FROM job_history JH
              WHERE JH.employee_id = E.employee_id)
              AND 5 >  (SELECT COUNT(*)
                        FROM job_history JH
                        WHERE JH.employee_id = E.employee_id
                        GROUP BY EMPLOYEE_ID
                        HAVING COUNT(*) >= 4));
```

Using Correlated DELETE

Use a correlated subquery to delete only those rows from the EMPL6 table that also exist in the EMP_HISTORY table.

```
DELETE FROM empl6 E
WHERE employee_id =
           (SELECT employee_id
            FROM   emp_history
            WHERE  employee_id = E.employee_id);
```

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Correlated DELETE (continued)

Example

Two tables are used in this example. They are:

- The EMPL6 table, which provides details of all the current employees
- The EMP_HISTORY table, which provides details of previous employees

EMP_HISTORY contains data regarding previous employees, so it would be erroneous if the same employee's record existed in both the EMPL6 and EMP_HISTORY tables. You can delete such erroneous records by using the correlated subquery shown in the slide.

Lesson Agenda

- Writing a multiple-column subquery
- Using scalar subqueries in SQL
- Solving problems with correlated subqueries
- Using the `EXISTS` and `NOT EXISTS` operators
- Using the `WITH` clause

WITH Clause

- Using the WITH clause, you can use the same query block in a SELECT statement when it occurs more than once within a complex query.
- The WITH clause retrieves the results of a query block and stores it in the user's temporary tablespace.
- The WITH clause may improve performance.

WITH Clause

Using the WITH clause, you can define a query block before using it in a query. The WITH clause (formally known as subquery_factoring_clause) enables you to reuse the same query block in a SELECT statement when it occurs more than once within a complex query. This is particularly useful when a query has many references to the same query block and there are joins and aggregations.

Using the WITH clause, you can reuse the same query when it is costly to evaluate the query block and it occurs more than once within a complex query. Using the WITH clause, the Oracle server retrieves the results of a query block and stores it in the user's temporary tablespace. This can improve performance.

WITH Clause Benefits

- Makes the query easy to read
- Evaluates a clause only once, even if it appears multiple times in the query
- In most cases, may improve performance for large queries

WITH Clause: Example

Using the WITH clause, write a query to display the department name and total salaries for those departments whose total salary is greater than the average salary across departments.

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WITH Clause: Example

The problem in the slide would require the following intermediate calculations:

1. Calculate the total salary for every department, and store the result using a WITH clause.
2. Calculate the average salary across departments, and store the result using a WITH clause.
3. Compare the total salary calculated in the first step with the average salary calculated in the second step. If the total salary for a particular department is greater than the average salary across departments, display the department name and the total salary for that department.

The solution for this problem is provided on the next page.

WITH Clause: Example

```
WITH
dept_costs  AS (
   SELECT d.department_name, SUM(e.salary) AS dept_total
   FROM   employees e JOIN departments d
   ON     e.department_id = d.department_id
   GROUP BY d.department_name),
avg_cost    AS (
   SELECT SUM(dept_total)/COUNT(*) AS dept_avg
   FROM   dept_costs)
SELECT *
FROM   dept_costs
WHERE  dept_total >
        (SELECT dept_avg
         FROM avg_cost)
ORDER BY department_name;
```

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WITH Clause: Example (continued)

The SQL code in the slide is an example of a situation in which you can improve performance and write SQL more simply by using the WITH clause. The query creates the query names DEPT_COSTS and AVG_COST and then uses them in the body of the main query. Internally, the WITH clause is resolved either as an inline view or a temporary table. The optimizer chooses the appropriate resolution depending on the cost or benefit of temporarily storing the results of the WITH clause.

The output generated by the SQL code in the slide is as follows:

	DEPARTMENT_NAME	DEPT_TOTAL
1	Sales	304500
2	Shipping	156400

WITH Clause Usage Notes

- It is used only with SELECT statements.
- A query name is visible to all WITH element query blocks (including their subquery blocks) defined after it and the main query block itself (including its subquery blocks).
- When the query name is the same as an existing table name, the parser searches from the inside out, and the query block name takes precedence over the table name.
- The WITH clause can hold more than one query. Each query is then separated by a comma.

Recursive WITH Clause

The Recursive WITH clause

- Enables formulation of recursive queries.
- Creates query with a name, called the Recursive WITH element name
- Contains two types of query blocks member: anchor and a recursive
- Is ANSI-compatible

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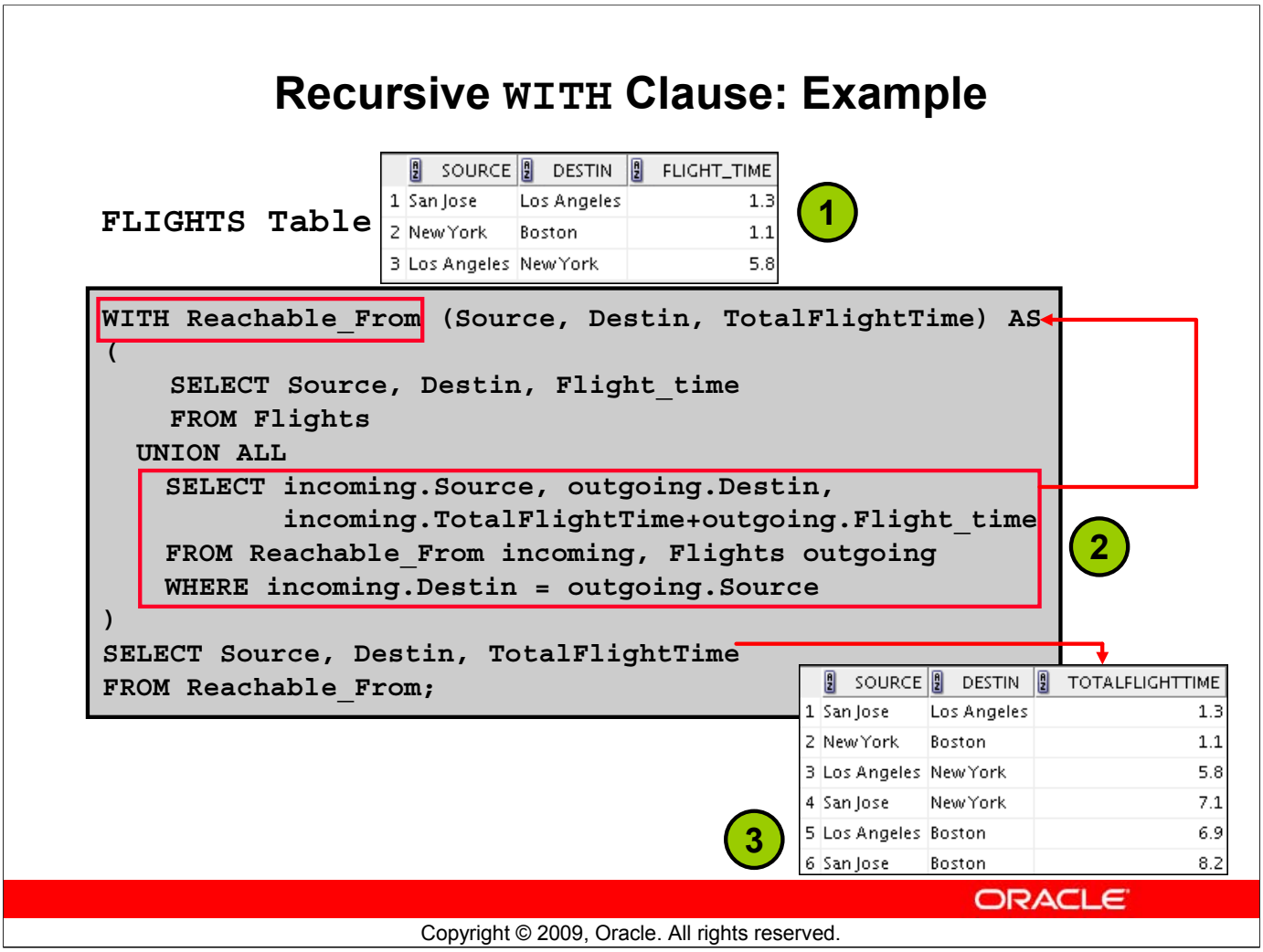
Recursive WITH Clause

In Oracle Database 11*g* Release 2, the WITH clause has been extended to enable formulation of recursive queries.

Recursive WITH defines a recursive query with a name, the *Recursive WITH element name*. The Recursive WITH element definition must contain at least two query blocks: an anchor member and a recursive member. There can be multiple anchor members but there can be only a single recursive member.

The recursive WITH clause, Oracle Database 11*g* Release 2 *partially* complies with the American National Standards Institute (ANSI). Recursive WITH can be used to query hierarchical data such as organization charts.



Recursive WITH Clause: Example

The example 1 in the slide displays records from a FLIGHTS table describing flights between two cities.

Using the query in example 2, you query the FLIGHTS table to display the total flight time between any source and destination. The WITH clause in the query, which is named Reachable_From, has a UNION ALL query with two branches. The first branch is the *anchor* branch, which selects all the rows from the Flights table. The second branch is the recursive branch. It joins the contents of Reachable_From to the Flights table to find other cities that can be reached, and adds these to the content of Reachable_From. The operation will finish when no more rows are found by the recursive branch.

Example 3 displays the result of the query that selects everything from the WITH clause element Reachable_From.

For details, see:

- *Oracle Database SQL Language Reference 11g Release 2.0*
- *Oracle Database Data Warehousing Guide 11g Release 2.0*

Quiz

With a correlated subquery, the inner `SELECT` statement drives the outer `SELECT` statement.

1. True
2. False

Answer: 2

Summary

In this lesson, you should have learned that:

- A multiple-column subquery returns more than one column
- Multiple-column comparisons can be pairwise or nonpairwise
- A multiple-column subquery can also be used in the `FROM` clause of a `SELECT` statement

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Summary

You can use multiple-column subqueries to combine multiple `WHERE` conditions in a single `WHERE` clause. Column comparisons in a multiple-column subquery can be pairwise comparisons or nonpairwise comparisons.

You can use a subquery to define a table to be operated on by a containing query.

Scalar subqueries can be used in:

- The condition and expression part of `DECODE` and `CASE`
- All clauses of `SELECT` except `GROUP BY`
- A `SET` clause and `WHERE` clause of the `UPDATE` statement

Summary

- Correlated subqueries are useful whenever a subquery must return a different result for each candidate row
- The `EXISTS` operator is a Boolean operator that tests the presence of a value
- Correlated subqueries can be used with `SELECT`, `UPDATE`, and `DELETE` statements
- You can use the `WITH` clause to use the same query block in a `SELECT` statement when it occurs more than once

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Summary (continued)

The Oracle server performs a correlated subquery when the subquery references a column from a table referred to in the parent statement. A correlated subquery is evaluated once for each row processed by the parent statement. The parent statement can be a `SELECT`, `UPDATE`, or `DELETE` statement. Using the `WITH` clause, you can reuse the same query when it is costly to reevaluate the query block and it occurs more than once within a complex query.

Practice 6: Overview

This practice covers the following topics:

- Creating multiple-column subqueries
- Writing correlated subqueries
- Using the `EXISTS` operator
- Using scalar subqueries
- Using the `WITH` clause

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Practice 6: Overview

In this practice, you write multiple-column subqueries, and correlated and scalar subqueries. You also solve problems by writing the `WITH` clause.

7

Regular Expression Support

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Objectives

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

- List the benefits of using regular expressions
- Use regular expressions to search for, match, and replace strings

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Objectives

In this lesson, you learn to use the regular expression support feature. Regular expression support is available in both SQL and PL/SQL.

Lesson Agenda

- Introduction to regular expressions
- Using metacharacters with regular expressions
- Using the regular expressions functions:
  - `REGEXP_LIKE`
  - `REGEXP_REPLACE`
  - `REGEXP_INSTR`
  - `REGEXP_SUBSTR`
- Accessing subexpressions
- Using the `REGEXP_COUNT` function
- Regular expressions and check constraints

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What Are Regular Expressions?

- You use regular expressions to search for (and manipulate) simple and complex patterns in string data by using standard syntax conventions.
- You use a set of SQL functions and conditions to search for and manipulate strings in SQL and PL/SQL.
- You specify a regular expression by using:
  - Metacharacters, which are operators that specify the search algorithms
  - Literals, which are the characters for which you are searching

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What Are Regular Expressions?

Oracle Database provides support for regular expressions. The implementation complies with the Portable Operating System for UNIX (POSIX) standard, controlled by the Institute of Electrical and Electronics Engineers (IEEE), for ASCII data-matching semantics and syntax. Oracle's multilingual capabilities extend the matching capabilities of the operators beyond the POSIX standard. Regular expressions are a method of describing both simple and complex patterns for searching and manipulating.

String manipulation and searching contribute to a large percentage of the logic within a Web-based application. Usage ranges from the simple, such as finding the word "San Francisco" in a specified text, to the complex task of extracting all URLs from the text and the more complex task of finding all words whose every second character is a vowel.

When coupled with native SQL, the use of regular expressions allows for very powerful search and manipulation operations on any data stored in an Oracle database. You can use this feature to easily solve problems that would otherwise involve complex programming.

Benefits of Using Regular Expressions

Regular expressions enable you to implement complex match logic in the database with the following benefits:

- By centralizing match logic in Oracle Database, you avoid intensive string processing of SQL results sets by middle-tier applications.
- Using server-side regular expressions to enforce constraints, you eliminate the need to code data validation logic on the client.
- The built-in SQL and PL/SQL regular expression functions and conditions make string manipulations more powerful and easier than in previous releases of Oracle Database 11*g*.

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Benefits of Using Regular Expressions

Regular expressions are a powerful text-processing component of programming languages such as PERL and Java. For example, a PERL script can process each HTML file in a directory, read its contents into a scalar variable as a single string, and then use regular expressions to search for URLs in the string. One reason for many developers writing in PERL is that it has a robust pattern-matching functionality. Oracle's support of regular expressions enables developers to implement complex match logic in the database. This technique is useful for the following reasons:

- By centralizing match logic in Oracle Database, you avoid intensive string processing of SQL results sets by middle-tier applications. The SQL regular expression functions move the processing logic closer to the data, thereby providing a more efficient solution.
- Before Oracle Database 10*g*, developers often coded data validation logic on the client, requiring the same validation logic to be duplicated for multiple clients. Using server-side regular expressions to enforce constraints solves this problem.
- The built-in SQL and PL/SQL regular expression functions and conditions make string manipulations more powerful and less cumbersome than in previous releases of Oracle Database 10*g*.

Using the Regular Expressions Functions and Conditions in SQL and PL/SQL

Function or Condition Name	Description
REGEXP_LIKE	Is similar to the LIKE operator, but performs regular expression matching instead of simple pattern matching (condition)
REGEXP_REPLACE	Searches for a regular expression pattern and replaces it with a replacement string
REGEXP_INSTR	Searches a string for a regular expression pattern and returns the position where the match is found
REGEXP_SUBSTR	Searches for a regular expression pattern within a given string and extracts the matched substring
REGEXP_COUNT	Returns the number of times a pattern match is found in an input sting

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Using the Regular Expressions Functions and Conditions in SQL and PL/SQL

Oracle Database provides a set of SQL functions that you use to search and manipulate strings by using regular expressions. You use these functions on a text literal, bind variable, or any column that holds character data such as CHAR, NCHAR, CLOB, NCLOB, NVARCHAR2, and VARCHAR2 (but not LONG). A regular expression must be enclosed within single quotation marks. This ensures that the entire expression is interpreted by the SQL function and can improve the readability of your code.

- REGEXP_LIKE: This condition searches a character column for a pattern. Use this condition in the WHERE clause of a query to return rows matching the regular expression that you specify.
- REGEXP_REPLACE: This function searches for a pattern in a character column and replaces each occurrence of that pattern with the pattern that you specify.
- REGEXP_INSTR: This function searches a string for a given occurrence of a regular expression pattern. You specify which occurrence you want to find and the start position to search from. This function returns an integer indicating the position in the string where the match is found.
- REGEXP_SUBSTR: This function returns the actual substring matching the regular expression pattern that you specify.
- REGEXP_COUNT: This function returns the number of times a pattern match is found in the input string.

Lesson Agenda

- Introduction to regular expressions
- Using metacharacters with regular expressions
- Using the regular expressions functions:
  - `REGEXP_LIKE`
  - `REGEXP_REPLACE`
  - `REGEXP_INSTR`
  - `REGEXP_SUBSTR`
- Accessing subexpressions
- Using the `REGEXP_COUNT` function

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What Are Metacharacters?

- Metacharacters are special characters that have a special meaning such as a wildcard, a repeating character, a nonmatching character, or a range of characters.
- You can use several predefined metacharacter symbols in the pattern matching.
- For example, the `^(f|ht)tps?:$` regular expression searches for the following from the beginning of the string:
  - The literals `f` or `ht`
  - The `t` literal
  - The `p` literal, optionally followed by the `s` literal
  - The colon ":" literal at the end of the string

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What Are Metacharacters?

The regular expression in the slide matches the http:, https:, ftp:, and ftps: strings.

Note: For a complete list of the regular expressions' metacharacters, see the *Oracle Database Advanced Application Developer's Guide 11g Release 2.*

Using Metacharacters with Regular Expressions

Syntax	Description
.	Matches any character in the supported character set, except NULL
+	Matches one or more occurrences
?	Matches zero or one occurrence
*	Matches zero or more occurrences of the preceding subexpression
{m}	Matches exactly *m* occurrences of the preceding expression
{m, }	Matches at least *m* occurrences of the preceding subexpression
{m,n}	Matches at least *m*, but not more than *n*, occurrences of the preceding subexpression
[...]	Matches any single character in the list within the brackets
|	Matches one of the alternatives
(...)	Treats the enclosed expression within the parentheses as a unit. The subexpression can be a string of literals or a complex expression containing operators.

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Using Metacharacters in Regular Expressions Functions

Any character, " **.** " **:** **a.b** matches the strings **abb**, **acb**, and **adb**, but not **acc**.

One or more, " **+** " **:** **a+** matches the strings **a**, **aa**, and **aaa**, but does not match **bbb**.

Zero or one, " **?** "**:** **ab?c** matches the strings **abc** and **ac**, but does not match **abbc**.

Zero or more, " ***** "**:** **ab*c** matches the strings **ac**, **abc**, and **abbc**, but does not match **abb**.

Exact count, " **{m}** "**:** **a{3}** matches the strings **aaa**, but does not match **aa**.

At least count, " {m,} ": **a{3,}** matches the strings **aaa** and **aaaa**, but not **aa**.

Between count, " **{m,n}** "**:** **a{3,5}** matches the strings **aaa**, **aaaa**, and **aaaaa**, but not **aa**.

Matching character list, " **[...]** "**:** **[abc]** matches the first character in the strings **all**, **bill**, and **cold**, but does not match any characters in **doll**.

Or, " | "**:** **a|b** matches character **a** or character **b**.

Subexpression, " (...) ": **(abc)?def** matches the optional string **abc**, followed by **def**. The expression matches **abcdefghi** and **def**, but does not match **ghi.** The subexpression can be a string of literals or a complex expression containing operators.

Using Metacharacters with Regular Expressions

Syntax	Description
^	Matches the beginning of a string
$	Matches the end of a string
\	Treats the subsequent metacharacter in the expression as a literal
\n	Matches the *n*th (1–9) preceding subexpression of whatever is grouped within parentheses. The parentheses cause an expression to be remembered; a backreference refers to it.
\d	A digit character
[:class:]	Matches any character belonging to the specified POSIX character class
[^:class:]	Matches any single character *not* in the list within the brackets

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Using Metacharacters in Regular Expressions Functions (continued)

Beginning/end of line anchor, " ^ " and "$": `^def` matches `def` in the string `defghi` but does not match `def` in `abcdef`. `def$` matches `def` in the string `abcdef` but does not match `def` in the string `defghi`.

Escape character " \ ": `\+` searches for a `+`. It matches the plus character in the string `abc+def`, but does not match `Abcdef`.

Backreference, " \n ": `(abc|def)xy\1` matches the strings `abcxyabc` and `defxydef`, but does not match `abcxydef` or `abcxy`. A backreference enables you to search for a repeated string without knowing the actual string ahead of time. For example, the expression `^(.*)\1$` matches a line consisting of two adjacent instances of the same string.

Digit character, "\d": The expression ^\[\d{3}\] \d{3}-\d{4}$ matches [650] 555-1212 but does not match 650-555-1212.

Character class, " [:class:] ": `[[:upper:]]+` searches for one or more consecutive uppercase characters. This matches `DEF` in the string `abcDEFghi` but does not match the string `abcdefghi`.

Nonmatching character list (or class), " [^...] ": `[^abc]` matches the character `d` in the string `abcdef`, but not `a`, `b`, or `c`.

Lesson Agenda

- Introduction to regular expressions
- Using metacharacters with regular expressions
- Using the regular expressions functions:
  - `REGEXP_LIKE`
  - `REGEXP_REPLACE`
  - `REGEXP_INSTR`
  - `REGEXP_SUBSTR`
- Accessing subexpressions
- Using the `REGEXP_COUNT` function

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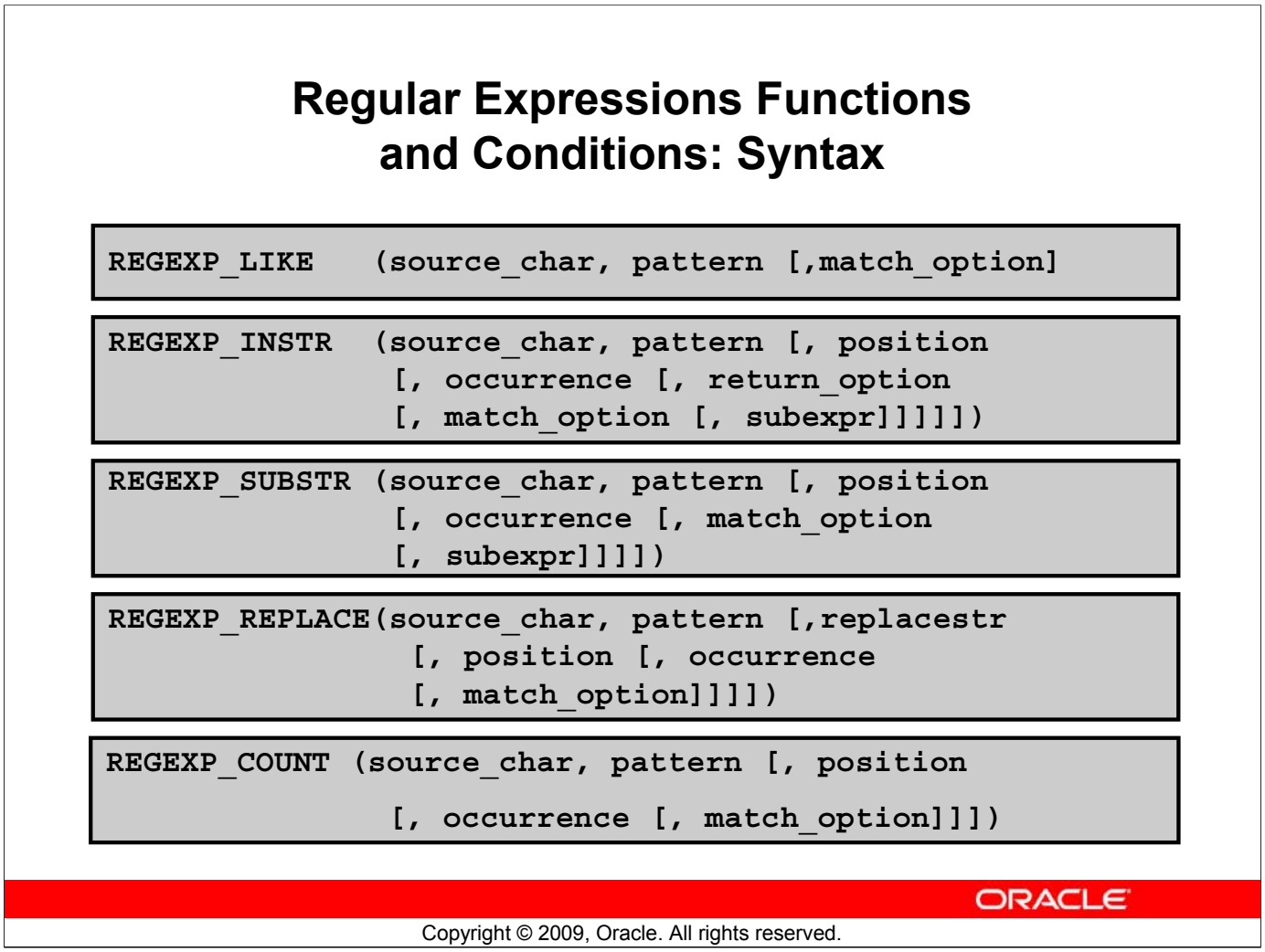

Regular Expressions Functions and Conditions: Syntax

The syntax for the regular expressions functions and conditions is as follows:

- `source_char`: A character expression that serves as the search value
- `pattern`: A regular expression, a text literal
- `occurrence`: A positive integer indicating which occurrence of pattern in `source_char` Oracle Server should search for. The default is 1.
- `position`: A positive integer indicating the character of `source_char` where Oracle Server should begin the search. The default is 1.
- `return_option`:
  - 0: Returns the position of the first character of the occurrence (default)
  - 1: Returns the position of the character following the occurrence
- `Replacestr`: Character string replacing pattern
- `match_parameter`:
  - " `c` ": Uses case-sensitive matching (default)
  - " `i` ": Uses non-case-sensitive matching
  - " `n` ": Allows match-any-character operator
  - " `m` ": Treats source string as multiple lines
- `subexpr`: Fragment of pattern enclosed in parentheses. You learn more about subexpressions later in this lesson.

Performing a Basic Search by Using the REGEXP_LIKE Condition

```
REGEXP_LIKE(source_char, pattern [, match_parameter ])
```

```
SELECT first_name, last_name
FROM employees
WHERE REGEXP_LIKE (first_name, '^Ste(v|ph)en$');
```

	FIRST_NAME	LAST_NAME
1	Steven	King
2	Steven	Markle
3	Stephen	Stiles

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Performing a Basic Search by Using the REGEXP_LIKE Condition

REGEXP_LIKE is similar to the LIKE condition, except that REGEXP_LIKE performs regular-expression matching instead of the simple pattern matching performed by LIKE. This condition evaluates strings by using characters as defined by the input character set.

Example of REGEXP_LIKE

In this query, against the EMPLOYEES table, all employees with first names containing either Steven or Stephen are displayed. In the expression used '^Ste(v|ph)en$ ':

- ^ indicates the beginning of the expression
- $ indicates the end of the expression
- | indicates either/or

Replacing Patterns by Using the REGEXP_REPLACE Function

```
REGEXP_REPLACE(source_char, pattern [,replacestr
[, position [, occurrence [, match_option]]]])
```

```
SELECT REGEXP_REPLACE(phone_number, '\.','-') AS phone
FROM employees;
```

Original

	LAST_NAME	PHONE
1	OConnell	650.507.9833
2	Grant	650.507.9844
3	Whalen	515.123.4444
4	Hartstein	515.123.5555

Partial results

	LAST_NAME	PHONE
1	OConnell	650-507-9833
2	Grant	650-507-9844
3	Whalen	515-123-4444
4	Hartstein	515-123-5555

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Replacing Patterns by Using the REGEXP_REPLACE Function

Using the REGEXP_REPLACE function, you reformat the phone number to replace the period (.) delimiter with a dash (-) delimiter. Here is an explanation of each of the elements used in the regular expression example:

- phone_number is the source column.
- '\.' is the search pattern.
  - Use single quotation marks (‘ ’) to search for the literal character period (.).
  - Use a backslash (\) to search for a character that is normally treated as a metacharacter.
- '-' is the replace string.

Finding Patterns by Using the REGEXP_INSTR Function

```
REGEXP_INSTR  (source_char, pattern [, position [,
   occurrence [, return_option [, match_option]]]])
```

```
SELECT street_address,
REGEXP_INSTR(street_address,'[[:alpha:]]') AS
   First_Alpha_Position
FROM  locations;
```

	STREET_ADDRESS	FIRST_ALPHA_POSITION
1	1297 Via Cola di Rie	6
2	93091 Calle della Testa	7
3	2017 Shinjuku-ku	6
4	9450 Kamiya-cho	6

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Finding Patterns by Using the REGEXP_INSTR Function

In this example, the REGEXP_INSTR function is used to search the street address to find the location of the first alphabetic character, regardless of whether it is in uppercase or lowercase. Note that `[:<class>:]` implies a character class and matches any character from within that class; `[:alpha:]` matches with any alphabetic character. The partial results are displayed.

In the expression used in the query `'[[:alpha:]]'`:

- `[` starts the expression
- `[:alpha:]` indicates alphabetic character class
- `]` ends the expression

Note: The POSIX character class operator enables you to search for an expression within a character list that is a member of a specific POSIX character class. You can use this operator to search for specific formatting, such as uppercase characters, or you can search for special characters such as digits or punctuation characters. The full set of POSIX character classes is supported. Use the syntax `[:class:]`, where `class` is the name of the POSIX character class to search for. The following regular expression searches for one or more consecutive uppercase characters : `[[:upper:]]+` .

Extracting Substrings by Using the REGEXP_SUBSTR Function

```
REGEXP_SUBSTR (source_char, pattern [, position
                [, occurrence [, match_option]]])
```

```
SELECT REGEXP_SUBSTR(street_address , ' [^ ]+ ') AS Road
FROM locations;
```

	ROAD
1	Via
2	Calle
3	(null)
4	(null)
5	Jabberwocky

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Extracting Substrings by Using the REGEXP_SUBSTR Function

In this example, the road names are extracted from the LOCATIONS table. To do this, the contents in the STREET_ADDRESS column that are after the first space are returned by using the REGEXP_SUBSTR function. In the expression used in the query ' [^]+ ':

- [starts the expression
- ^ indicates NOT
- indicates space
-] ends the expression
- + indicates 1 or more
- indicates space

Lesson Agenda

- Introduction to regular expressions
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- Using the regular expressions functions:
  - `REGEXP_LIKE`
  - `REGEXP_REPLACE`
  - `REGEXP_INSTR`
  - `REGEXP_SUBSTR`
- Accessing subexpressions
- Using the `REGEXP_COUNT` function

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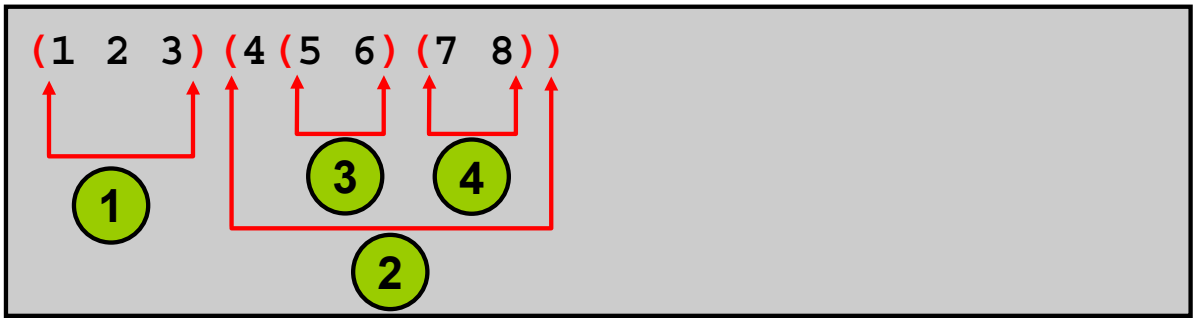
Subexpressions

Examine this expression:

```
(1 2 3)(4(5 6)(7 8))
```

The subexpressions are:



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Subexpressions

Oracle Database 11*g* provides regular expression support parameter to access a subexpression. In the slide example, a string of digits is shown. The parentheses identify the subexpressions within the string of digits. Reading from left to right, and from outer parentheses to the inner parentheses, the subexpressions in the string of digits are:

1. 123
2. 45678
3. 56
4. 78

You can search for any of those subexpressions with the `REGEXP_INSTR` and `REGEXP_SUBSTR` functions.

Using Subexpressions with Regular Expression Support

```
SELECT
  REGEXP_INSTR
① ('0123456789',       -- source char or search value
② '(123)(4(56)(78))', -- regular expression patterns
③ 1,                   -- position to start searching
④ 1,                   -- occurrence
⑤ 0,                   -- return option
⑥ 'i',                 -- match option (case insensitive)
⑦ 1)              -- sub-expression on which to search
   "Position"
FROM dual;
```

	Position
1	2

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Using Subexpressions with Regular Expression Support

`REGEXP_INSTR` and `REGEXP_SUBSTR` have an optional `SUBEXPR` parameter that lets you target a particular substring of the regular expression being evaluated.

In the example shown in the slide, you may want to search for the first subexpression pattern in your list of subexpressions. The example shown identifies several parameters for the `REGEXP_INSTR` function.

1. The string you are searching is identified.
2. The subexpressions are identified. The first subexpression is `123`. The second subexpression is `45678`, the third is `56`, and the fourth is `78`.
3. The third parameter identifies from which position to start searching.
4. The fourth parameter identifies the occurrence of the pattern you want to find. `1` means find the first occurrence.
5. The fifth parameter is the return option. This is the position of the first character of the occurrence. (If you specify `1`, the position of the character following the occurrence is returned.)
6. The sixth parameter identifies whether your search should be case-sensitive or not.
7. The last parameter is the parameter added in Oracle Database 11*g*. This parameter specifies which subexpression you want to find. In the example shown, you are searching for the first subexpression, which is `123`.

Why Access the *n*th Subexpression?

- A more realistic use: DNA sequencing
- You may need to find a specific subpattern that identifies a protein needed for immunity in mouse DNA.

```
SELECT
    REGEXP_INSTR('ccacctttccctccactcctcacgttctcacctgtaaagcgtccctc
    cctcatccccatgccccttaccctgcagggtagagtaggctagaaaccagagagctccaagc
    tccatctgtggagaggtgccatccttgggctgcagagagaggagaatttgccccaaagctgcc
    tgcagagcttcaccacccttagtctcacaaagccttgagttcatagcatttcttgagttttca
    ccctgcccagcaggacactgcagcacccaaagggcttcccaggagtagggttgccctcaagag
    gctcttgggtctgatggccacatcctggaattgttttcaagttgatggtcacagccctgaggc
    atgtaggggcgtggggatgcgctctgctctgctctcctctcctgaacccctgaaccctctggc
    taccccagagcacttagagccag',
                    '(gtc(tcac)(aaag))',
                     1, 1, 0, 'i',
                     1) "Position"
FROM dual;
```

	Position
1	195

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Why Access the *n*th Subexpression?

In life sciences, you may need to extract the offsets of subexpression matches from a DNA sequence for further processing. For example, you may need to find a specific protein sequence, such as the begin offset for the DNA sequence preceded by `gtc` and followed by `tcac` followed by `aaag`. To accomplish this goal, you can use the `REGEXP_INSTR` function, which returns the position where a match is found.

In the slide example, the position of the first subexpression `(gtc)` is returned. `gtc` appears starting in position 195 of the DNA string.

If you modify the slide example to search for the second subexpression `(tcac)`, the query results in the following output. `tcac` appears starting in position 198 of the DNA string.

	Position
1	198

If you modify the slide example to search for the third subexpression `(aaag)`, the query results in the following output. `aaag` appears starting in position 202 of the DNA string.

	Position
1	202

REGEXP_SUBSTR: Example

```
SELECT
  REGEXP_SUBSTR
①('acgctgcactgca', -- source char or search value
② 'acg(.*)gca',    -- regular expression pattern
③ 1,               -- position to start searching
④ 1,               -- occurrence
⑤ 'i',             -- match option (case insensitive)
⑥ 1)               -- sub-expression
 "Value"
FROM dual;
```

Value
1 ctgcact

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REGEXP_SUBSTR: Example

In the example shown in the slide:

1. `acgctgcactgca` is the source to be searched
2. `acg(.*)gca` is the pattern to be searched. Find `acg` followed by `gca` with potential characters between the `acg` and the `gca`.
3. Start searching at the first character of the source
4. Search for the first occurrence of the pattern
5. Use non-case-sensitive matching on the source
6. Use a nonnegative integer value that identifies the *n*th subexpression to be targeted. This is the subexpression parameter. In this example, `1` indicates the first subexpression. You can use a value from 0–9. A zero means that no subexpression is targeted. The default value for this parameter is 0.

Lesson Agenda

- Introduction to regular expressions
- Using metacharacters with regular expressions
- Using the regular expressions functions:
  - `REGEXP_LIKE`
  - `REGEXP_REPLACE`
  - `REGEXP_INSTR`
  - `REGEXP_SUBSTR`
- Accessing subexpressions
- Using the `REGEXP_COUNT` function

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Using the REGEXP_COUNT Function

```
REGEXP_COUNT (source_char, pattern [, position
                [, occurrence [, match_option]]])
```

```
SELECT REGEXP_COUNT(
    'ccacctttccctccactcctcacgttctcacctgtaaagcgtccctccctcatccccatgccccttaccctgcag
    ggtagagtaggctagaaaccagagagctccaagctccatctgtggagaggtgccatccttgggctgcagagagaggag
    aatttgccccaaagctgcctgcagagcttcaccacccttagtctcacaaagccttgagttcatagcatttcttgagtt
    ttcaccctgcccagcaggacactgcagcacccaaagggcttcccaggagtagggttgccctcaagaggctcttgggtc
    tgatggccacatcctggaattgttttcaagttgatggtcacagccctgaggcatgtaggggcgtggggatgcgctctg
    ctctgctctcctctcctgaacccctgaacccctctggctaccccagagcacttagagccag',
    'gtc') AS Count
FROM dual;
```

	COUNT
1	4

Using the REGEXP_COUNT Function

The REGEXP_COUNT function evaluates strings by using characters as defined by the input character set. It returns an integer indicating the number of occurrences of pattern. If no match is found, the function returns 0.

In the slide example, the number of occurrences for a DNA substring is determined by using the REGEXP_COUNT function.

The following example shows that the number of times the pattern 123 occurs in the string 123123123123 is three times. The search starts from the second position of the string.

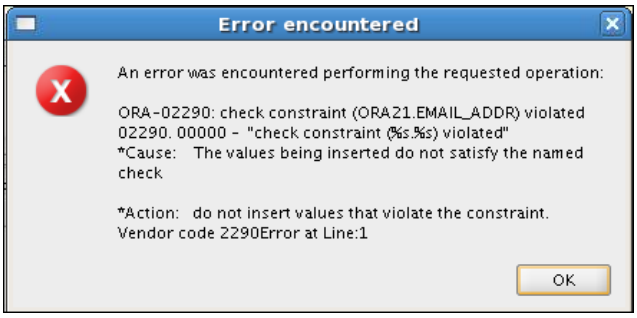
```
SELECT REGEXP_COUNT
   ('123123123123', -- source char or search value
   '123',           -- regular expression pattern
    2,              -- position where the search should start
   'i')             -- match option (case insensitive)
   As Count
FROM dual;
```

	COUNT
1	3

Regular Expressions and Check Constraints: Examples

```
ALTER TABLE emp8
  ADD CONSTRAINT email_addr
  CHECK(REGEXP_LIKE(email,'@')) NOVALIDATE;
```

```
INSERT INTO emp8 VALUES
  (500,'Christian','Patel','ChrisP2creme.com',
   1234567890,'12-Jan-2004','HR_REP',2000,null,102,40);
```



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Regular Expressions and Check Constraints: Examples

Regular expressions can also be used in CHECK constraints. In this example, a CHECK constraint is added on the EMAIL column of the EMPLOYEES table. This ensures that only strings containing an "@" symbol are accepted. The constraint is tested. The CHECK constraint is violated because the email address does not contain the required symbol. The NOVALIDATE clause ensures that existing data is not checked.

For the slide example, the emp8 table is created by using the following code:

```
CREATE TABLE emp8 AS SELECT * FROM employees;
```

Note: The example in the slide is executed by using the "Execute Statement" option in SQL Developer. The output format differs if you use the "Run Script" option.

Quiz

With the use of regular expressions in SQL and PL/SQL, you can:

1. Avoid intensive string processing of SQL result sets by middle-tier applications
2. Avoid data validation logic on the client
3. Enforce constraints on the server

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Answers: 1, 2, 3

Summary

In this lesson, you should have learned how to use regular expressions to search for, match, and replace strings.

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Summary

In this lesson, you have learned to use the regular expression support features. Regular expression support is available in both SQL and PL/SQL.

Practice 7: Overview

This practice covers using regular expressions functions to do the following:

- Searching for, replacing, and manipulating data
- Creating a new `CONTACTS` table and adding a `CHECK` constraint to the `p_number` column to ensure that phone numbers are entered into the database in a specific standard format
- Testing the adding of some phone numbers into the `p_number` column by using various formats

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Practice 7: Overview

In this practice, you use regular expressions functions to search for, replace, and manipulate data. You also create a new `CONTACTS` table and add a `CHECK` constraint to the `p_number` column to ensure that phone numbers are entered into the database in a specific standard format.