

Oracle Database 11g: SQL Fundamentals II

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Authors

Chaitanya Koratamaddi
Brian Pottle
Tulika Srivastava

Technical Contributors and Reviewers

Claire Bennett
Ken Cooper
Yanti Chang
Laszlo Czinkoczki
Burt Demchick
Gerlinde Frenzen
Joel Goodman
Laura Garza
Richard Green
Nancy Greenberg
Akira Kinutani
Wendy Lo
Isabelle Marchand
Timothy Mcglue
Alan Paulson
Srinivas Putrevu
Bryan Roberts
Clinton Shaffer
Abhishek Singh
Jenny Tsai Smith
James Spiller
Lori Tritz
Lex van der Werff
Marcie Young

Editors

Amitha Narayan
Daniel Milne

Graphic Designer

Satish Bettgowda

Publisher

Veena Narasimhan

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I Introduction

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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 11g documentation and additional resources

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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 11g 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

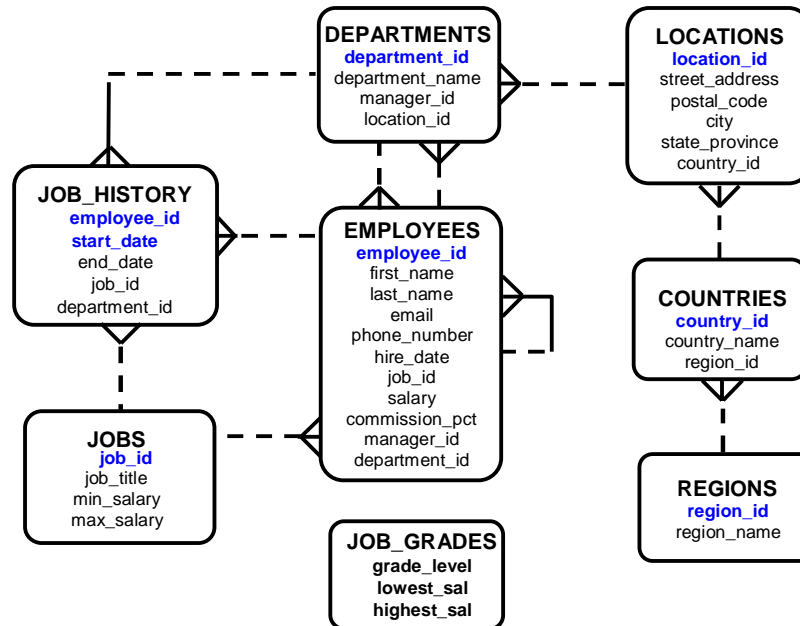
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Lesson Agenda

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

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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

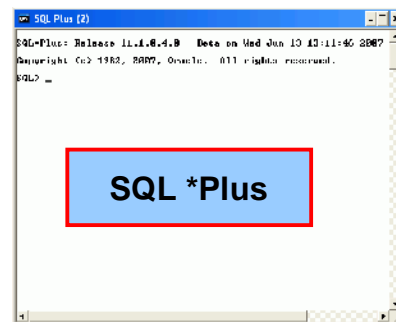
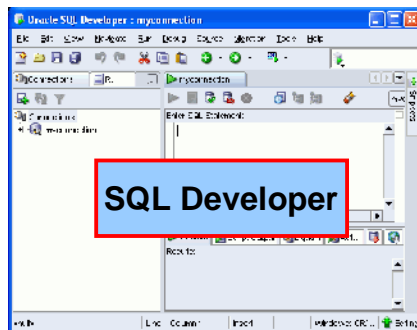
- Appendix A: Practices and Solutions
- Appendix B: Table Descriptions
- Appendix C: Using SQL Developer
- Appendix D: Using SQL*Plus
- Appendix E: Using JDeveloper
- Appendix F: Generating Reports by Grouping Related Data
- Appendix G: Hierarchical Retrieval
- Appendix H: Writing Advanced Scripts
- 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 11g 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 11g 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
<code>BETWEEN</code> <code>...AND...</code>	Between two values (inclusive)
<code>IN(set)</code>	Match any of a list of values
<code>LIKE</code>	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

...

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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

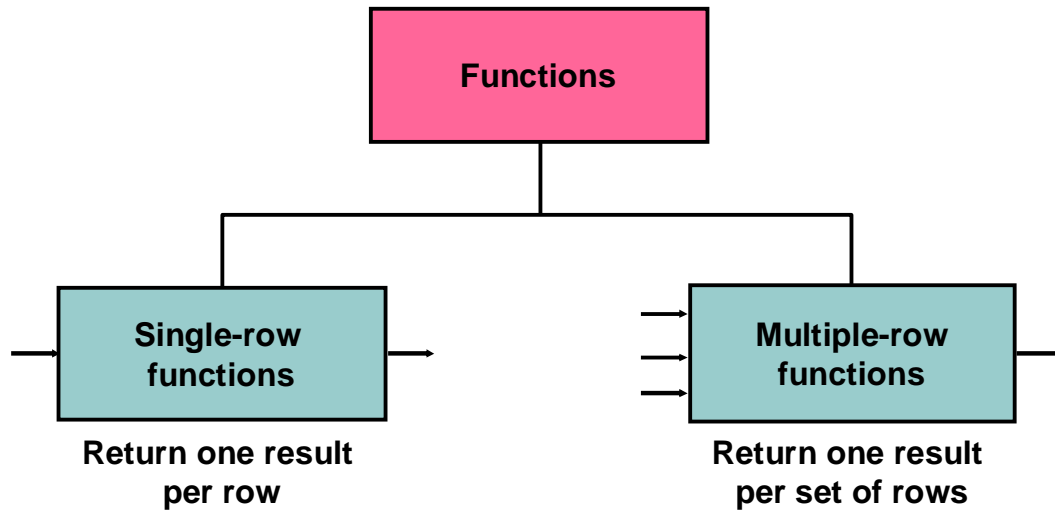
```
SELECT          expr
FROM            table
[WHERE          condition(s)]
[ORDER BY {column, expr, numeric_position} [ASC|DESC]];
```

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



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Review of SQL Functions

There are two types of functions:

- Single-row functions
- Multiple-row functions

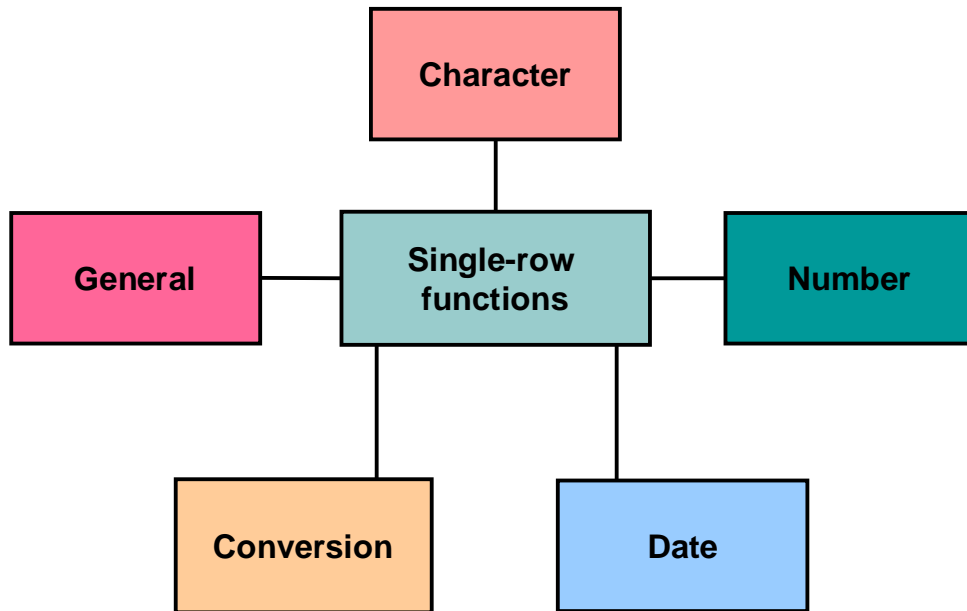
Single-Row Functions

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



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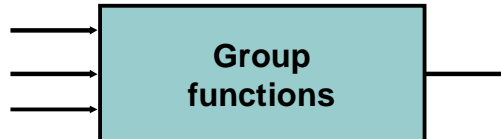
Review of Single-Row Functions

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 <u>ALL</u>] <i>n</i>)	Average value of <i>n</i> , ignoring null values
COUNT ({ * [DISTINCT <u>ALL</u>] <i>expr</i> })	Number of rows, where <i>expr</i> evaluates to something other than null (count all selected rows using *, including duplicates and rows with nulls)
MAX ([DISTINCT <u>ALL</u>] <i>expr</i>)	Maximum value of <i>expr</i> , ignoring null values
MIN ([DISTINCT <u>ALL</u>] <i>expr</i>)	Minimum value of <i>expr</i> , ignoring null values
STDDEV ([DISTINCT <u>ALL</u>] <i>n</i>)	Standard deviation of <i>n</i> , ignoring null values
SUM ([DISTINCT <u>ALL</u>] <i>n</i>)	Sum values of <i>n</i> , ignoring null values
VARIANCE ([DISTINCT <u>ALL</u>] <i>n</i>)	Variance of <i>n</i> , 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 11g documentation and additional resources**

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Oracle Database 11g 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 11g SQL Documentation

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

Additional Resources

For additional information about the new Oracle 11g 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.

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Controlling User Access

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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

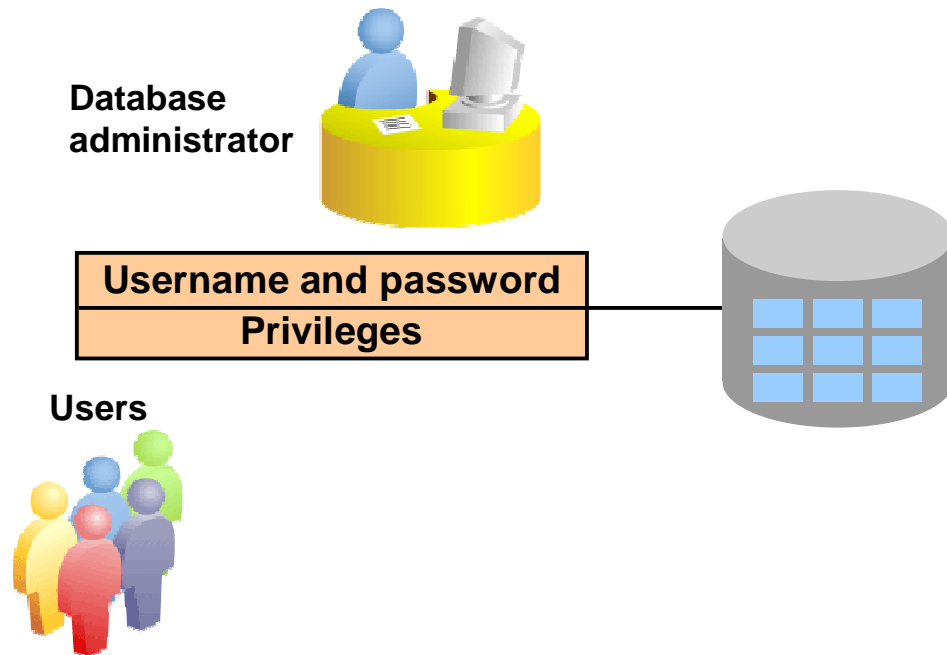
In this lesson, you learn how to control database access to specific objects and add new users with different levels of access privileges.

Lesson Agenda

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

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Controlling User Access



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:

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

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

Note: Starting with Oracle Database 11g, 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.

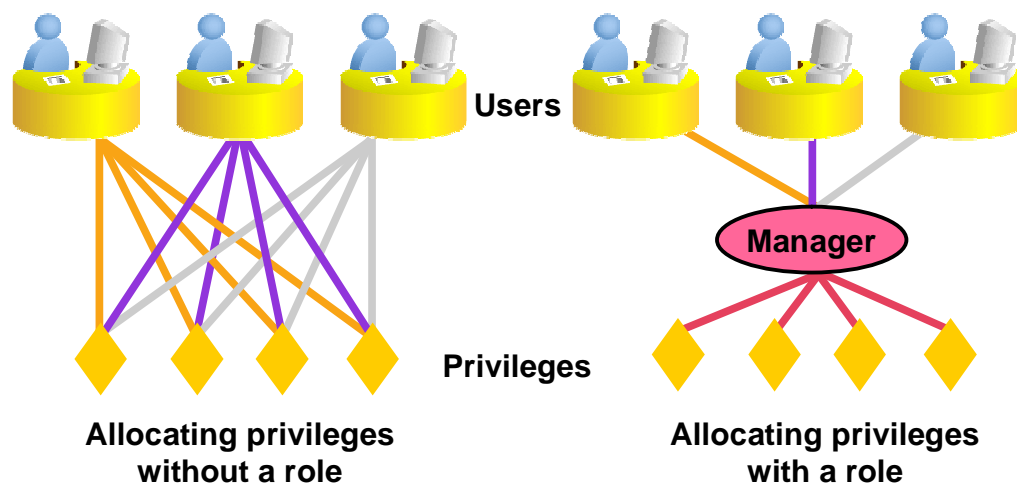
In the example in the slide, the demo user has been assigned the privileges to create sessions, tables, sequences, and views.

Lesson Agenda

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

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What Is a Role?



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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 your user account and initializes your password.
- You can change your password by using the ALTER USER statement.

```
ALTER USER demo  
IDENTIFIED BY employ;
```

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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:

<i>user</i>	Is the name of the user
<i>password</i>	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 Database 11g 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

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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:

<i>object_priv</i>	Is an object privilege to be granted
ALL	Specifies all object privileges
<i>columns</i>	Specifies the column from a table or view on which privileges are granted
ON <i>object</i>	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;
```

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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

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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];
```

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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:

<code>CASCADE</code>	Is required to remove any referential integrity constraints made to the <code>CONSTRAINTS</code> object by means of the <code>REFERENCES</code> 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.

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Managing Schema Objects

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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:

<i>table</i>	Is the name of the table
ADD MODIFY DROP	Is the type of modification
<i>column</i>	Is the name of the column
<i>datatype</i>	Is the data type and length of the column
DEFAULT <i>expr</i>	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:

<i>table</i>	Is the name of the table
<i>constraint</i>	Is the name of the constraint
<i>type</i>	Is the constraint type
<i>column</i>	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

Constraints can have the following attributes:

- DEFERRABLE or NOT DEFERRABLE
- INITIALLY DEFERRED or INITIALLY IMMEDIATE

```
ALTER TABLE dept2  
ADD CONSTRAINT dept2_id_pk  
PRIMARY KEY (department_id)  
DEFERRABLE INITIALLY DEFERRED
```

Deferring constraint on creation

```
SET CONSTRAINTS dept2_id_pk IMMEDIATE
```

Changing a specific constraint attribute

```
ALTER SESSION  
SET CONSTRAINTS= IMMEDIATE
```

Changing all constraints for a session

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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

- Remove the manager constraint from the EMP2 table:

```
ALTER TABLE emp2
DROP CONSTRAINT emp_mgr_fk;
```

```
ALTER TABLE Emp2 succeeded.
```

- Remove the PRIMARY KEY constraint on the DEPT2 table and drop the associated FOREIGN KEY constraint on the EMP2.DEPARTMENT_ID column:

```
ALTER TABLE dept2
DROP PRIMARY KEY CASCADE;
```

```
ALTER TABLE dept2 succeeded.
```

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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:

<i>table</i>	Is the name of the table
<i>column</i>	Is the name of the column affected by the constraint
<i>constraint</i>	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

Example:

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

```
ALTER TABLE Emp2 succeeded.
```

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

```
ALTER TABLE test1 succeeded.
```

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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

Use the RENAME COLUMN clause of the ALTER TABLE statement to rename table columns.

a

```
ALTER TABLE marketing RENAME COLUMN team_id  
TO id;
```

```
ALTER TABLE marketing succeeded.
```

Use the RENAME CONSTRAINT clause of the ALTER TABLE statement to rename any existing constraint for a table.

b

```
ALTER TABLE marketing RENAME CONSTRAINT mktg_pk  
TO new_mktg_pk;
```

```
ALTER TABLE marketing succeeded.
```

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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

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Overview of Indexes

Indexes are created:

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

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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

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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

- A function-based index is based on expressions.
- The index expression is built from table columns, constants, SQL functions, and user-defined functions.

```
CREATE INDEX upper_dept_name_idx  
ON dept2(UPPER(department_name));
```

```
CREATE INDEX succeeded.
```

```
SELECT *  
FROM   dept2  
WHERE  UPPER(department_name) = 'SALES';
```

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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.

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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

```
DROP TABLE dept80 PURGE;
```

```
DROP TABLE dept80 succeeded.
```

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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
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 - Enabling and disabling a constraint
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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

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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)



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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.

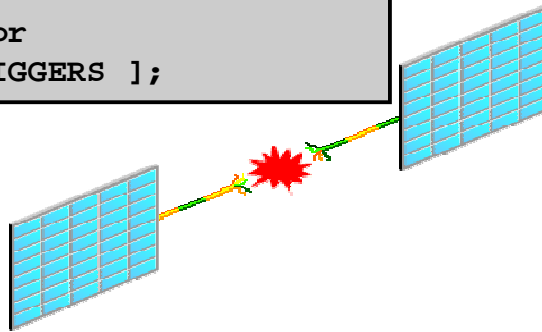
When using the `FLASHBACK TABLE` statement, you can revert the table and its contents to a certain time or to an SCN.

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 ];
```



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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

```
DROP TABLE emp2;
```

```
DROP TABLE emp2 succeeded.
```

```
SELECT original_name, operation, droptime FROM  
recyclebin;
```

ORIGINAL_NAME	OPERATION	DROPTIME
EMP2	DROP	2009-05-20:18:00:39

...

```
FLASHBACK TABLE emp2 TO BEFORE DROP;
```

```
FLASHBACK TABLE succeeded.
```

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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:

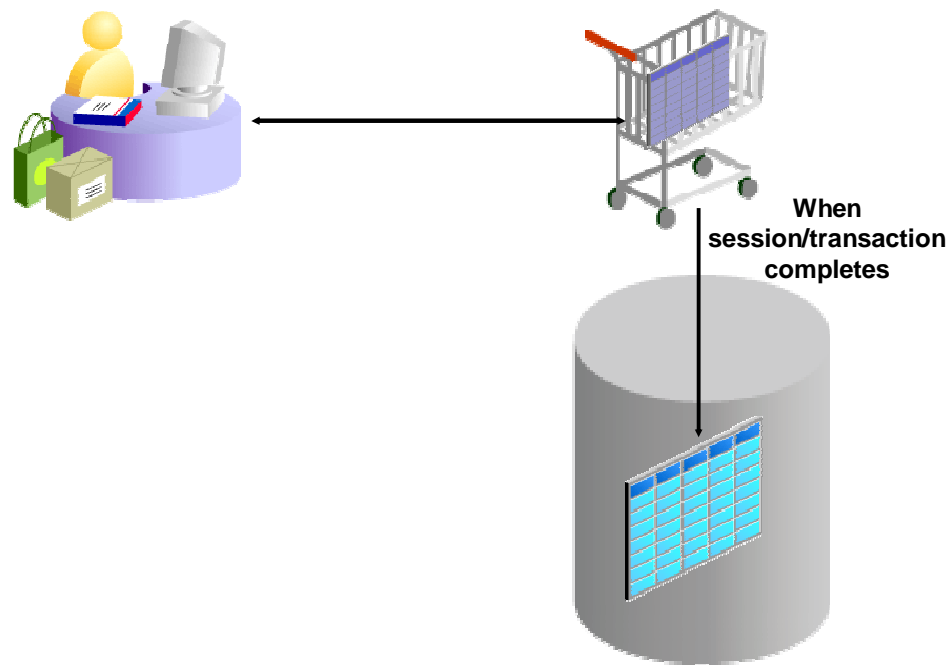
```
PURGE RECYCLEBIN;
```

Lesson Agenda

- Using the `ALTER TABLE` statement to add, modify, and drop a column
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 - Creating function-based indexes
 - Removing an index
- Performing flashback operations
- **Creating and using temporary tables**
- Creating and using external tables

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Temporary Tables



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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

```
CREATE GLOBAL TEMPORARY TABLE cart
ON COMMIT DELETE ROWS;
```

1

```
CREATE GLOBAL TEMPORARY TABLE today_sales
ON COMMIT PRESERVE ROWS AS
  SELECT * FROM orders
  WHERE order_date = SYSDATE;
```

2

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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.

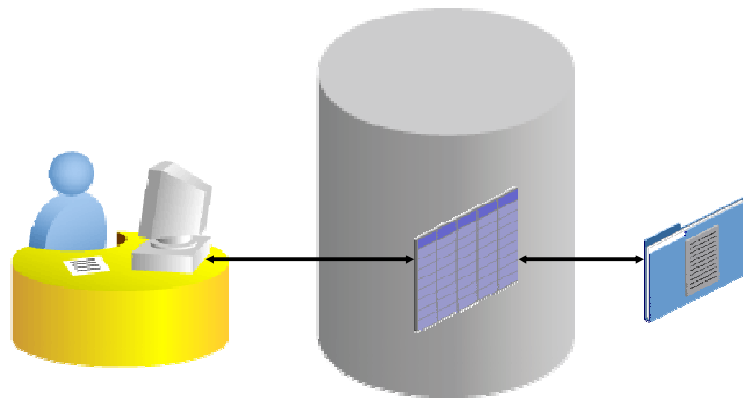
When you create a temporary table in an Oracle database, you create a static table definition. Like permanent tables, temporary tables are defined in the data dictionary. However, temporary tables and their indexes do not automatically allocate a segment when created. Instead, temporary segments are 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
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 - Creating function-based indexes
 - Removing an index
- Performing flashback operations
- Creating and using temporary tables
- **Creating and using external tables**

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External Tables



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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;
```

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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];
```

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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.

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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)

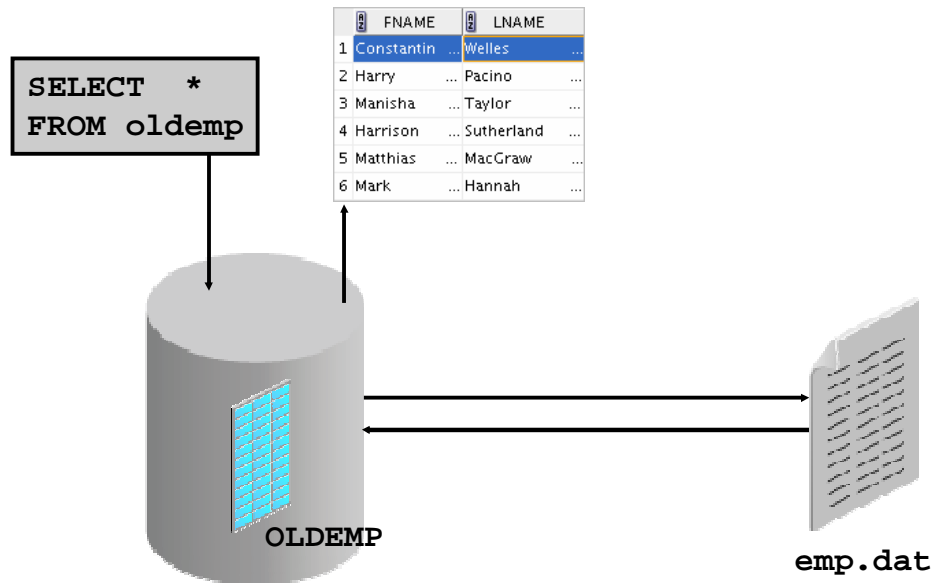
In the example, the TYPE specification is given only to illustrate its use. ORACLE_LOADER is the default access driver if not specified. The ACCESS PARAMETERS option provides values to parameters of the specific access driver, which are interpreted by the access driver, not by the Oracle Server.

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



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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;
```

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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

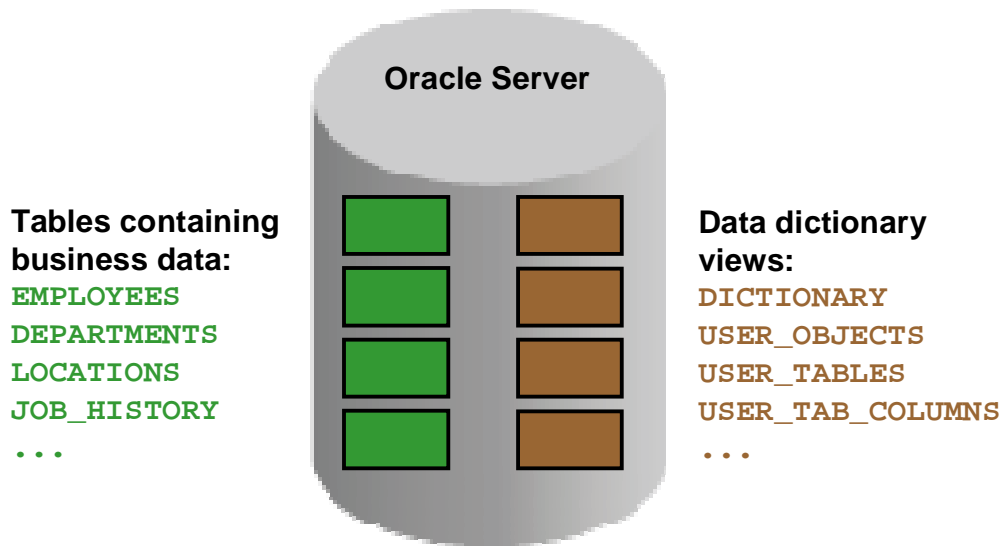
In this lesson, you are introduced to the data dictionary views. You learn that the dictionary views can be used to retrieve metadata and create reports about your schema objects.

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



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Data Dictionary

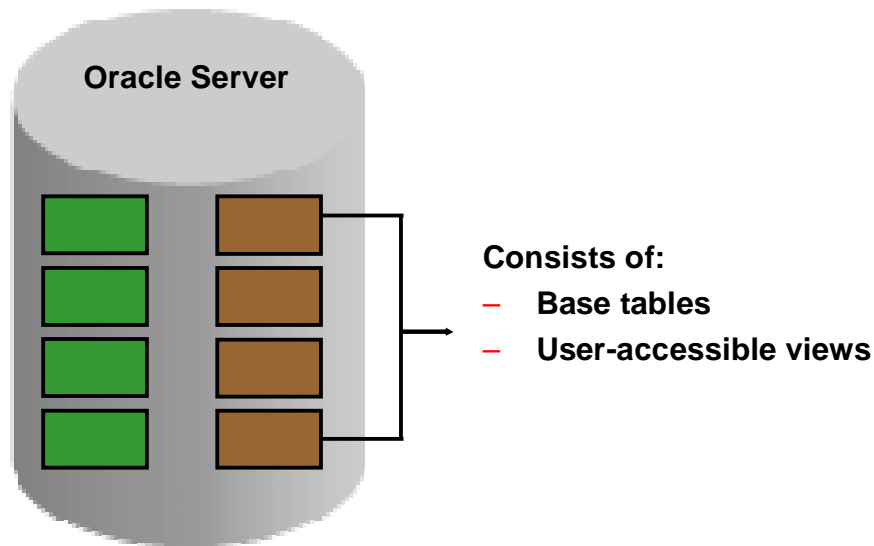
User tables are tables created by the user and contain business data, such as EMPLOYEES. There is another collection of tables and views in the Oracle database known as the *data dictionary*. This collection is created and maintained by the Oracle Server and contains information about the database. The 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



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

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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

1

```
DESCRIBE user_views
```

Name	Null	Type
-----	-----	-----
VIEW_NAME	NOT NULL	VARCHAR2(30)
TEXT_LENGTH		NUMBER
TEXT		LONG()

2

```
SELECT view_name FROM user_views;
```

VIEW_NAME
1 EMP_DETAILS_VIEW

3

```
SELECT text FROM user_views  
WHERE view_name = 'EMP_DETAILS_VIEW';
```

TEXT
1 SELECT e.employee_id, e.job_id, e.manager_id, e.department_id, d.location_id, l.co
...
AND c.region_id = r.region_id AND j.job_id = e.job_id WITH READ ONLY

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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	999999999999999...	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 `INSERTs`
- Use the following types of multitable `INSERTs`:
 - 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

You can use subqueries in data manipulation language (DML) statements to:

- Retrieve data by using an inline view
- Copy data from one table to another
- Update data in one table based on the values of another table
- Delete rows from one table based on rows in another table

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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

```
INSERT INTO (SELECT l.location_id, l.city, l.country_id
              FROM   locations l
              JOIN   countries c
              ON(l.country_id = c.country_id)
              JOIN regions USING(region_id)
              WHERE region_name = 'Europe')
VALUES (3300, 'Cardiff', 'UK');
```

1 rows inserted

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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
```

R2	LOCATION_ID	R2	CITY	R2	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.

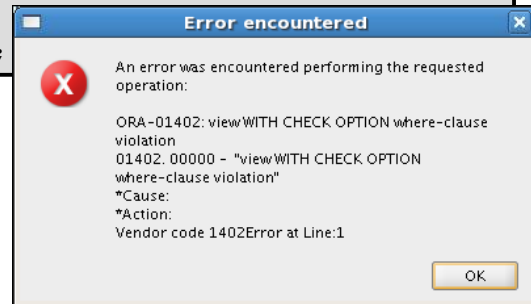
```
SELECT l.location_id, l.city, l.country_id
FROM   loc l
JOIN   countries c
ON(l.country_id = c.country_id)
JOIN regions USING(region_id)
WHERE region_name = 'Europe'
```

R2	LOCATION_ID	R2	CITY	R2	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');
```



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 INSERTs:
 - 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 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.

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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

- Write your INSERT statement with a subquery.

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

33 rows inserted

- Do not use the VALUES clause.
- Match the number of columns in the INSERT clause with that in the subquery.

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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:

<i>table</i>	Is the table name
<i>column</i>	Is the name of the column in the table to populate
<i>subquery</i>	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;
```

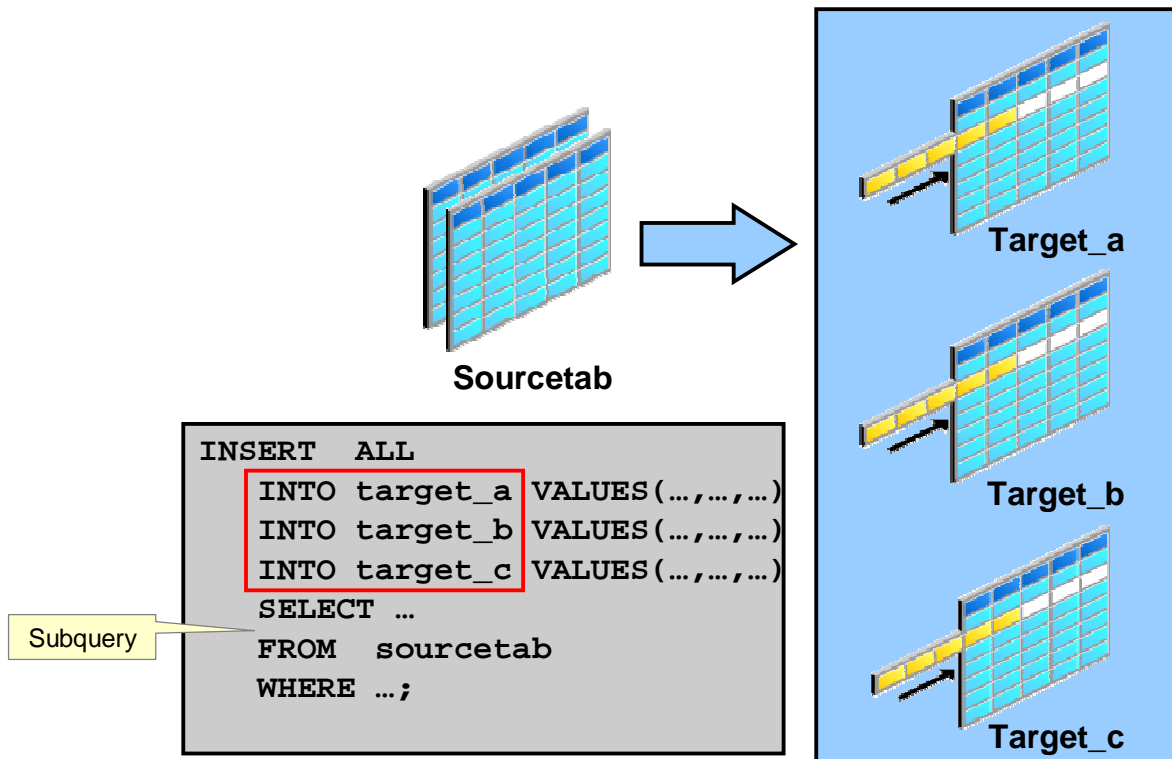
Note: You use the LOG ERRORS clause in your DML statement to enable the DML operation to complete regardless of errors. Oracle writes the details of the error message to an error-logging table that you have created. For more information, see *Oracle Database 11g SQL Reference*.

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



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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

- Syntax for multitable INSERT:

```
INSERT [conditional_insert_clause]
[insert_into_clause values_clause] (subquery)
```

- conditional_insert_clause:

```
[ALL|FIRST]
[WHEN condition THEN] [insert_into_clause values_clause]
[ELSE] [insert_into_clause values_clause]
```

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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:

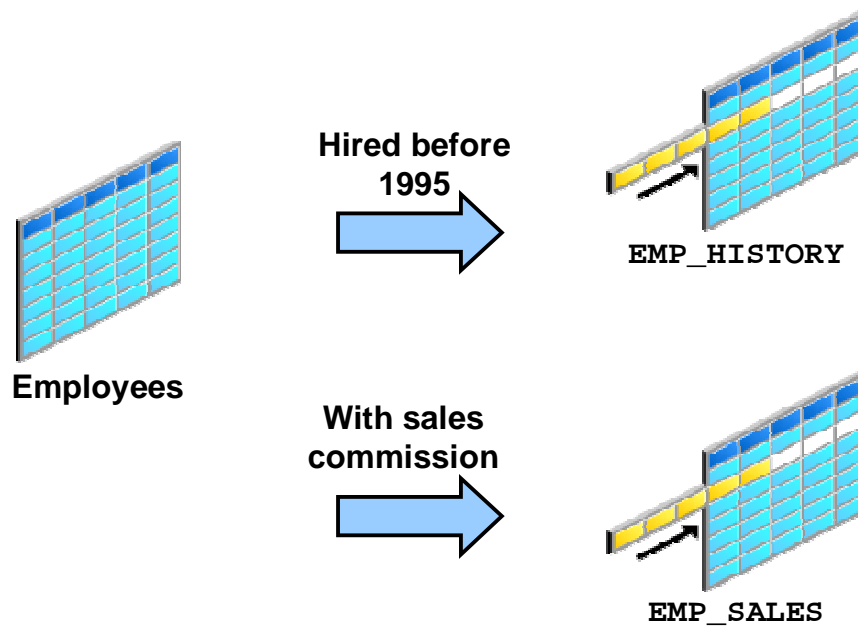
```
SELECT COUNT(*) total_in_sal FROM sal_history;
```

TOTAL_IN_SAL	
1	6

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

TOTAL_IN_MGR	
1	6

Conditional INSERT ALL: Example



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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;
```

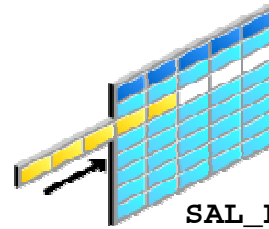
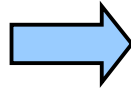
Result:

116 rows inserted

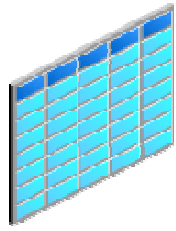
Conditional INSERT FIRST: Example

Scenario: If an employee salary is 2,000, the record is inserted into the SAL_LOW table only.

Salary < 5,000

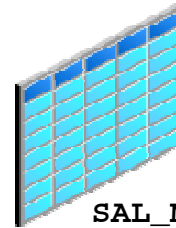


SAL_LOW



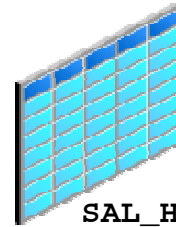
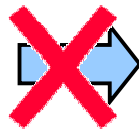
EMPLOYEES

5000 <= Salary
<= 10,000



SAL_MID

Otherwise



SAL_HIGH

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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

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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	Instructs the server how to respond to the results of the join condition
WHEN NOT MATCHED	

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;
```

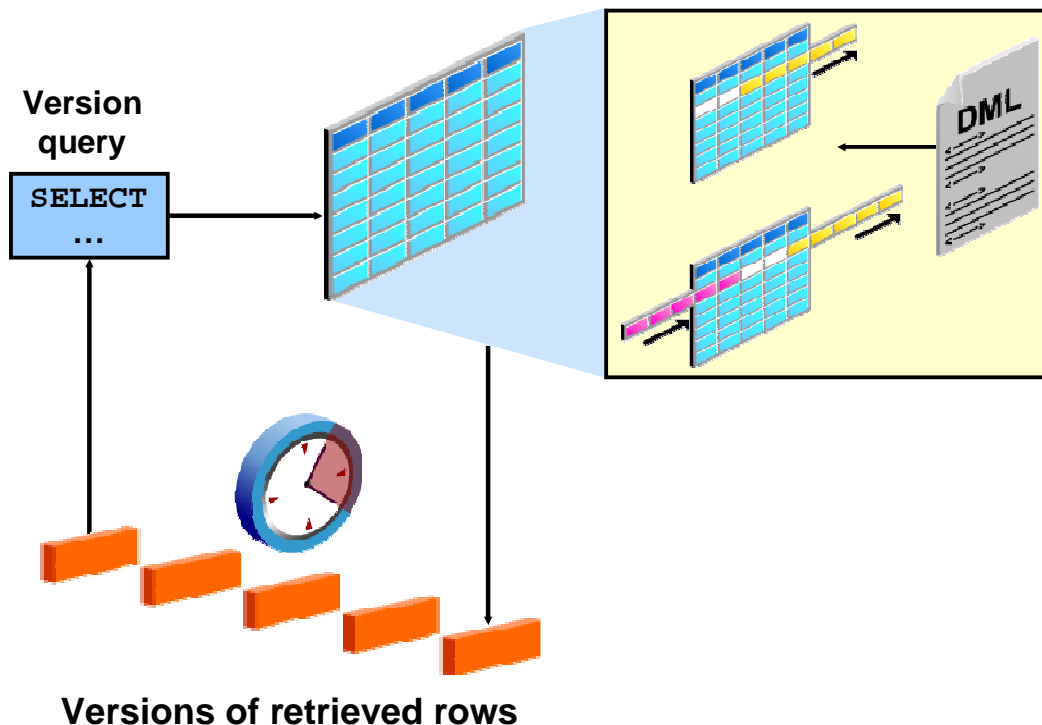
	EMPLOYEE_ID	SALARY	COMMISSION_PCT
1	144	2500	(null)
2	143	2600	(null)
3	202	6000	(null)
4	141	3500	(null)
5	174	11000	0.3
...			
15	149	10500	0.2
16	206	8300	(null)
17	176	8600	0.2
18	124	5800	(null)
19	205	12000	(null)
20	178	7000	0.15

Lesson Agenda

- Manipulating data by using subqueries
- Specifying explicit default values in the `INSERT` and `UPDATE` statements
- Using the following types of multitable `INSERTs`:
 - 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



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;
```

2

```
COMMIT;
```

```
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

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Answer: 1

Summary

In this lesson, you should have learned how to:

- Use DML statements and control transactions
- Describe the features of multitable INSERTs
- Use the following types of multitable INSERTs:
 - 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 `INSERTs`
- Performing `MERGE` operations
- Tracking row versions

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5

Managing Data in Different Time Zones

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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

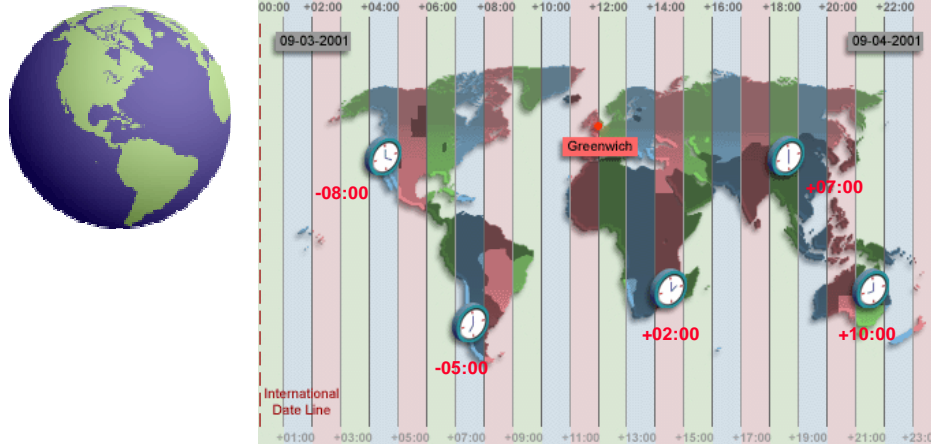
In this lesson, you learn how to use data types similar to `DATE` that store fractional seconds and track time zones. This lesson addresses some of the datetime functions available in the Oracle database.

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

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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 DTIMEZONE FROM DUAL;
```

DTIMEZONE
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
HOURL	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`

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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
 - 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
HOURL	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`

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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'2000-07-12 08:00:00','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('2007-03-06 11:00:00','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

- First Sunday in April
 - Time jumps from 01:59:59 AM to 03:00:00 AM.
 - Values from 02:00:00 AM to 02:59:59 AM are not valid.
- Last Sunday in October
 - Time jumps from 02:00:00 AM to 01:00:01 AM.
 - Values from 01:00:01 AM to 02:00:00 AM are ambiguous because they are visited twice.

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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.

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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

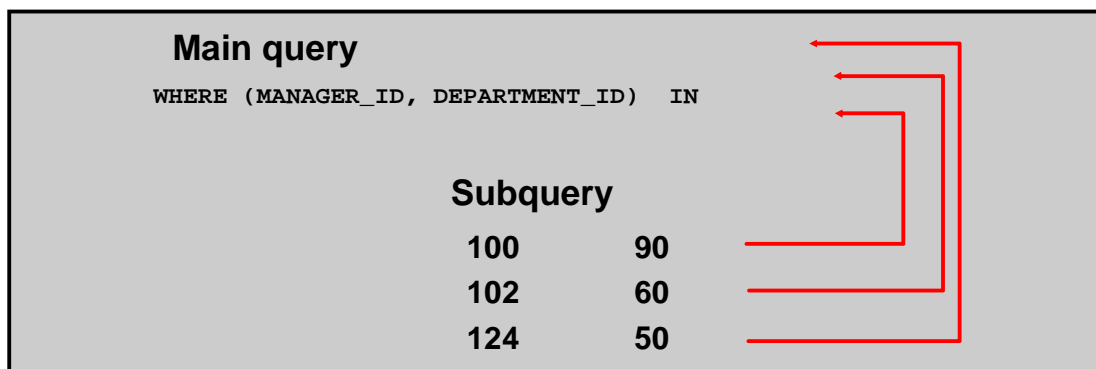
In this lesson, you learn how to write multiple-column subqueries and subqueries in the `FROM` clause of a `SELECT` statement. You also learn how to solve problems by using scalar, correlated subqueries and the `WITH` clause.

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

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Multiple-Column Subqueries



Each row of the main query is compared to values from a multiple-row and multiple-column subquery.

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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 Faviat, 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:

R Z	EMPLOYEE_ID	R Z	MANAGER_ID	R Z	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

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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 = 20  
           (SELECT department_id  
            FROM departments  
            WHERE location_id = 1800)  
         THEN 'Canada' ELSE 'USA' END) location  
FROM   employees;
```

- 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:

...

	R2	EMPLOYEE_ID	R2	LAST_NAME	R2	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.

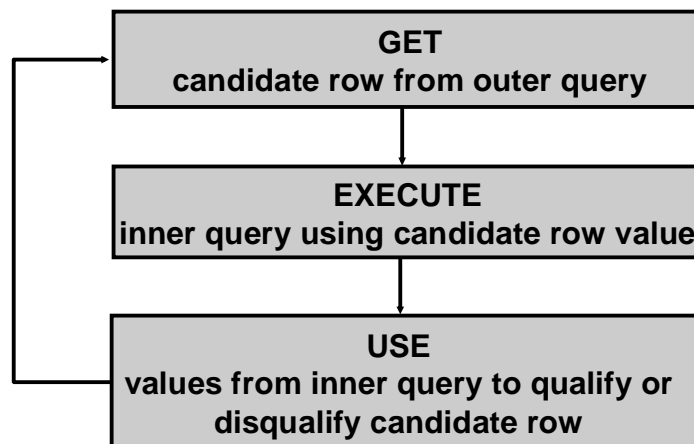
Lesson Agenda

- 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

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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);
```

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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.

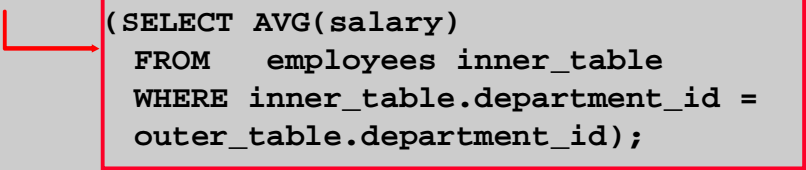
The Oracle server performs a correlated subquery when the subquery references a column from a table in the parent query.

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

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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	FL_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

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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

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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.

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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

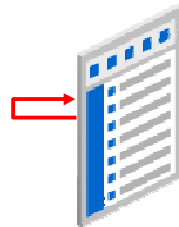
WITH Clause Usage Notes

- 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 11g 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 11g 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

FLIGHTS Table			
	SOURCE	DESTIN	FLIGHT_TIME
1	San Jose	Los Angeles	1.3
2	New York	Boston	1.1
3	Los Angeles	New York	5.8


```

WITH Reachable_From (Source, Destin, TotalFlightTime) AS
(
    SELECT Source, Destin, Flight_time
    FROM Flights
    UNION ALL
    SELECT incoming.Source, outgoing.Destin,
           incoming.TotalFlightTime+outgoing.Flight_time
    FROM Reachable_From incoming, Flights outgoing
    WHERE incoming.Destin = outgoing.Source
)
SELECT Source, Destin, TotalFlightTime
FROM Reachable_From;

```


	SOURCE	DESTIN	TOTALFLIGHTTIME
1	San Jose	Los Angeles	1.3
2	New York	Boston	1.1
3	Los Angeles	New York	5.8
4	San Jose	New York	7.1
5	Los Angeles	Boston	6.9
6	San Jose	Boston	8.2

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

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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.



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 11g.

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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 10g, 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 10g.

Using the Regular Expressions Functions and Conditions in SQL and PL/SQL

Function or Condition Name	Description
REGEXP_LIKE	Is similar to the <code>LIKE</code> 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 string

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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 <i>m</i> occurrences of the preceding expression
{m, }	Matches at least <i>m</i> occurrences of the preceding subexpression
{m, n}	Matches at least <i>m</i> , but not more than <i>n</i> , 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
<code>^</code>	Matches the beginning of a string
<code>\$</code>	Matches the end of a string
<code>\</code>	Treats the subsequent metacharacter in the expression as a literal
<code>\n</code>	Matches the <i>n</i> th (1–9) preceding subexpression of whatever is grouped within parentheses. The parentheses cause an expression to be remembered; a backreference refers to it.
<code>\d</code>	A digit character
<code>[:class:]</code>	Matches any character belonging to the specified POSIX character class
<code>[^:class:]</code>	Matches any single character <i>not</i> 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

```
REGEXP_LIKE (source_char, pattern [,match_option]
```

```
REGEXP_INSTR (source_char, pattern [, position  
[, occurrence [, return_option  
[, match_option [, subexpr]]]])
```

```
REGEXP_SUBSTR (source_char, pattern [, position  
[, occurrence [, match_option  
[, subexpr]]]])
```

```
REGEXP_REPLACE(source_char, pattern [,replacestr  
[, position [, occurrence  
[, match_option]]]])
```

```
REGEXP_COUNT (source_char, pattern [, position  
[, occurrence [, match_option]]])
```

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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
- 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

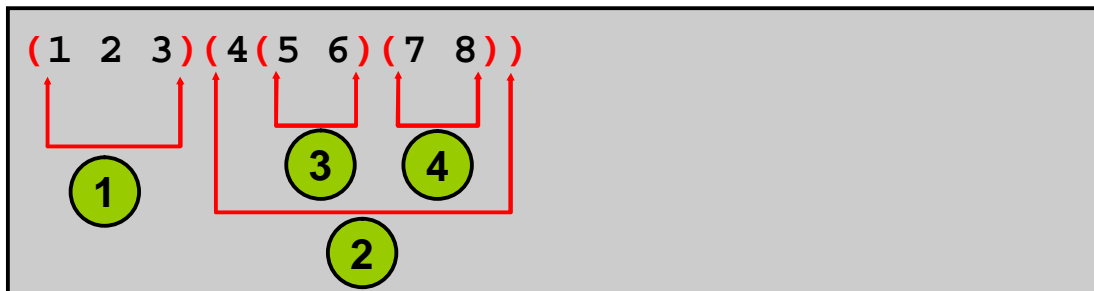
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Subexpressions

Examine this expression:

```
(1 2 3)(4(5 6)(7 8))
```

The subexpressions are:



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Subexpressions

Oracle Database 11g 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 11g. 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('ccacctttccctccactcctcacgttctcacctgtaaagcgctccctc
cctcatcccatgcccccttaccctgcagggtagtaggctagaaccagagagctccaagc
tccatctgtggagaggtgccatccttgggctgcagagagaggagaatttgcccaaagctgcc
tgcagagcttcaccacccttagtctcacaaagccttgagttcatagcatttcttgagtttca
ccctgccagcaggacactgcagcacccaaagggcttcccaggagtagggttgccctcaagag
gctcttgggtctgatggccacatcctggaattgttttcaagttgatggtcacagccctgaggc
atgtagggcggtgggatgcgctctgctctgctctcctctcctgaacccctgaaccctctggc
taccagagcacttagagccag',
    '(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(  
  'ccacctttccctccactcctcacgttctcacctgtaaagcgccctccctcatccccatgcccccttaccctgcag  
  ggtagagtaggctagaaccagagagctccaagctccatctgtggagaggtgccatccttgggctgcagagagaggag  
  aatttgccccaaagctgcctgcagagcttcaccacccttagtctcaciaagccttgagttcatagcatttcttgagtt  
  ttcacctgcccagcaggacactgcagcacccaaagggctccaggagtagggttgcctcaagaggctcttgggtc  
  tgatggccacatcctggaattgtttcaagttgatggtcacagccctgaggcatgtagggcggtgggatgcgctctg  
  ctctgctctcctcctgaaccctgaaccctctggctacccagagcacttagagccag',  
  'gtc') AS Count  
  
FROM dual;
```

COUNT
4

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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.

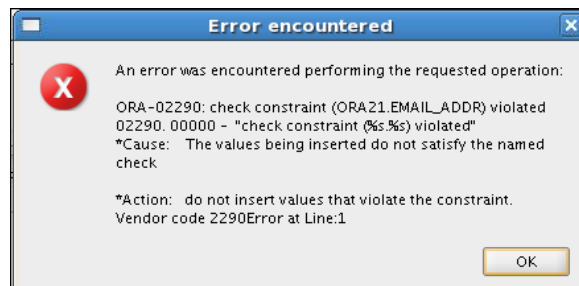
```
SELECT REGEXP_COUNT  
  ('123123123123', -- source char or search value  
  '123',           -- regular expression pattern  
  2,               -- position where the search should start  
  'i')             -- match option (case insensitive)  
  AS Count  
FROM dual;
```

COUNT
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);
```



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.

Appendix A

Practices and Solutions

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Practices and Solutions for Lesson I

In this practice, you review the available SQL Developer resources. You also learn about your user account that you use in this course. You then start SQL Developer, create a new database connection, and browse your HR tables. You also set some SQL Developer preferences, execute SQL statements, and execute an anonymous PL/SQL block by using SQL Worksheet. Finally, you access and bookmark the Oracle Database 11g documentation and other useful Web sites that you can use in this course.

Practice I-1: Accessing SQL Developer Resources

In this practice, you do the following:

- 1) Access the SQL Developer home page.
 - a. Access the online SQL Developer home page available at:
http://www.oracle.com/technology/products/database/sql_developer/index.html
 - b. Bookmark the page for easier future access.
- 2) Access the SQL Developer tutorial available online at:
<http://st-curriculum.oracle.com/tutorial/SQLDeveloper/index.htm>. Then review the following sections and associated demos:
 - a) What to Do First
 - b) Working with Database Objects
 - c) Accessing Data

Practice I-2: Using SQL Developer

- 1) Start SQL Developer by using the desktop icon.
- 2) Create a database connection using the following information:
 - a) Connection Name: myconnection
 - b) Username: oraxx, where xx is the number of your PC (Ask your instructor to assign you an ora account out of the ora21-ora40 range of accounts.)
 - c) Password: oraxx
 - d) Hostname: localhost
 - e) Port: 1521
 - f) SID: orcl (or the value provided to you by the instructor)
- 3) Test the new connection. If the status is Success, connect to the database by using this new connection.
 - a) Click the Test button in the New/Select Database Connection window.
 - b) If the status is Success, click the Connect button.
- 4) Browse the structure of the EMPLOYEES table and display its data.
 - a) Expand the myconnection connection by clicking the plus sign next to it.
 - b) Expand the Tables icon by clicking the plus sign next to it.
 - c) Display the structure of the EMPLOYEES table.
 - d) View the data of the DEPARTMENTS table.
- 5) Execute some basic SELECT statements to query the data in the EMPLOYEES table in the SQL Worksheet area. Use both the Execute Statement (or press F9) and the Run Script (or press F5) icons to execute the SELECT statements. Review the results of both methods of executing the SELECT statements on the appropriate tabbed pages.
 - a) Write a query to select the last name and salary for any employee whose salary is less than or equal to \$3,000.
 - b) Write a query to display last name, job ID, and commission for all employees who are not entitled to receive a commission.
- 6) Set your script pathing preference to /home/oracle/labs/sql2.
 - a) Select Tools > Preferences > Database > Worksheet Parameters.
 - b) Enter the value in the Select default path to look for scripts field.
- 7) Enter the following in the Enter SQL Statement box.

```
SELECT employee_id, first_name, last_name,  
       FROM employees;
```
- 8) Save the SQL statement to a script file by using the File > Save As menu item.
 - a) Select File > Save As.
 - b) Name the file intro_test.sql.

Practice I-2: Using SQL Developer (continued)

- c) Place the file under your /home/oracle/labs/sql2/labs folder.
- 9) Open and run `confidence.sql` from your /home/oracle/labs/sql2/labs folder, and observe the output.

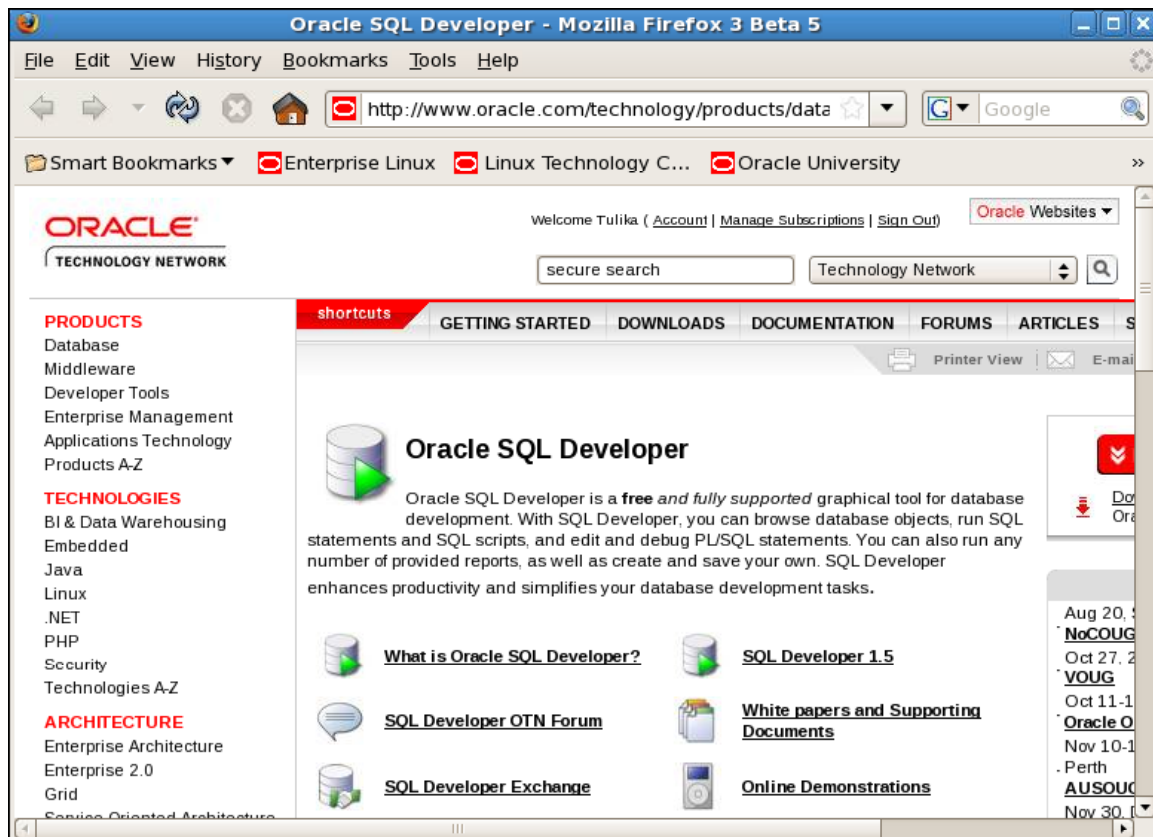
Practice Solutions I-1: Accessing SQL Developer Resources

1) Access the SQL Developer home page.

a) Access the online SQL Developer home page available online at:

http://www.oracle.com/technology/products/database/sql_developer/index.html

The SQL Developer home page is displayed as follows:



b) Bookmark the page for easier future access.

2) Access the SQL Developer tutorial available online at:

<http://st-curriculum.oracle.com/tutorial/SQLDeveloper/index.htm>

Then, review the following sections and associated demos:

a) What to Do First

b) Working with Database Objects

c) Accessing Data

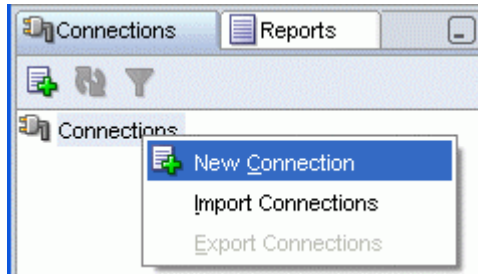
Practice Solutions I-2: Using SQL Developer

1) Start SQL Developer by using the desktop icon.



2) Create a database connection using the following information:

- a. Connection Name: myconnection
- b. Username: oraxx (Ask your instructor to assign you one ora account out of the ora21–ora40 range of accounts.)
- c. Password: oraxx
- d. Hostname: localhost
- e. Port: 1521
- f. SID: orcl (or the value provided to you by the instructor)



Practice Solutions I-2: Using SQL Developer (continued)

Connection Na... Connection Det...

Connection Name myconnection

Username ora21

Password *****

☒ Save Password

Oracle

Role default

Connection Type Basic

☐ OS Authentication

☐ Kerberos Authentication

☐ Proxy Connection

Hostname localhost

Port 1521

☒ SID orcl

☐ Service name

Status :

Help Save Clear Test Connect Cancel

3) Test the new connection. If the status is Success, connect to the database by using this new connection.

a) Click the Test button in the New/Select Database Connection window.

Status :

Help Save Clear Test Connect Cancel

b) If the status is Success, click the Connect button.

Status : Success

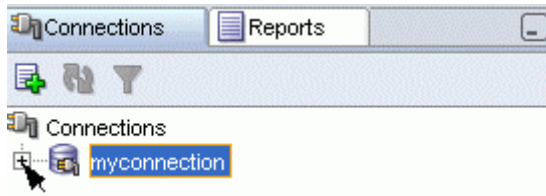
Help Save Clear Test Connect Cancel

Browsing the Tables

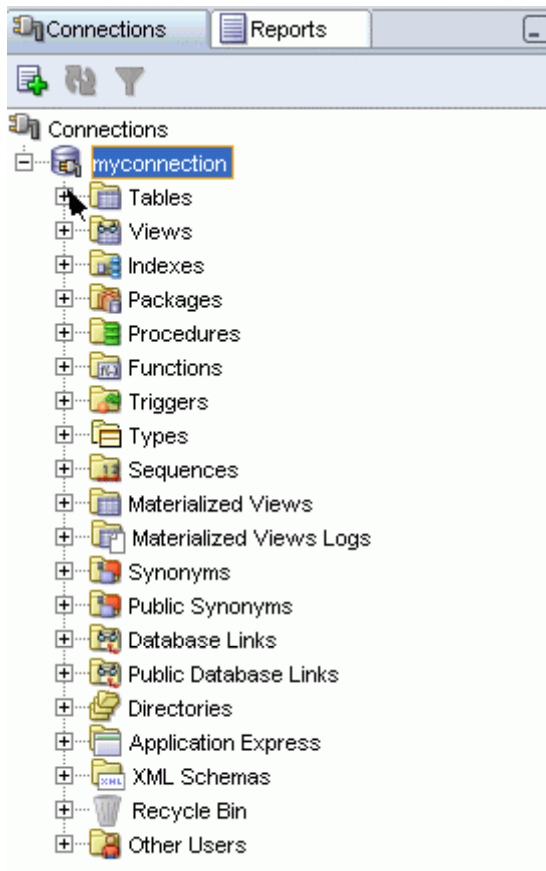
4) Browse the structure of the EMPLOYEES table and display its data.

a) Expand the myconnection connection by clicking the plus sign next to it.

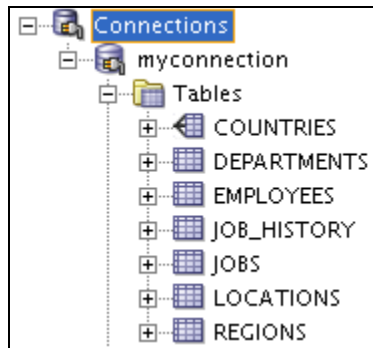
Practice Solutions I-2: Using SQL Developer (continued)



b) Expand the Tables icon by clicking the plus sign next to it.



Practice Solutions I-2: Using SQL Developer (continued)




c) Display the structure of the EMPLOYEES table.

Click the **EMPLOYEES** table. The Columns tab displays the columns in the EMPLOYEES table as follows:

myconnection

EMPLOYEES

Columns | Data | Constraints | Grants | Statistics | Triggers | Flashback | Dependencies | Details | Indexes | SQL

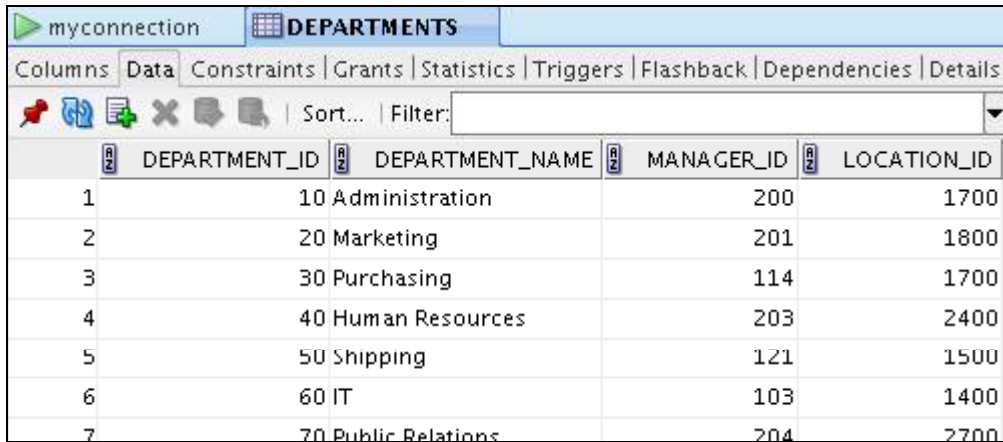
 Actions...

Column Name	Data Type	Nullable	Data Default	COLUMN ID	Primary Key	COMMENTS
EMPLOYEE_ID	NUMBER(6,0)	No	(null)	1	1	Primary key of employee
FIRST_NAME	VARCHAR2(20 BYTE)	Yes	(null)	2	(null)	First name of the employee
LAST_NAME	VARCHAR2(25 BYTE)	No	(null)	3	(null)	Last name of the employee
EMAIL	VARCHAR2(25 BYTE)	No	(null)	4	(null)	Email id of the employee
PHONE_NUMBER	VARCHAR2(20 BYTE)	Yes	(null)	5	(null)	Phone number of the employee
HIRE_DATE	DATE	No	(null)	6	(null)	Date when the employee was hired
JOB_ID	VARCHAR2(10 BYTE)	No	(null)	7	(null)	Current job of the employee
SALARY	NUMBER(8,2)	Yes	(null)	8	(null)	Monthly salary of the employee
COMMISSION_PCT	NUMBER(2,2)	Yes	(null)	9	(null)	Commission percentage of the employee
MANAGER_ID	NUMBER(6,0)	Yes	(null)	10	(null)	Manager id of the employee
DEPARTMENT_ID	NUMBER(4,0)	Yes	(null)	11	(null)	Department id where employee works

d) View the data of the DEPARTMENTS table.

In the Connections navigator, click the **DEPARTMENTS** table. Then click the Data tab.

Practice Solutions I-2: Using SQL Developer (continued)



The screenshot shows the SQL Developer interface with the 'DEPARTMENTS' table selected. The 'Data' tab is active, displaying a grid of data. The columns are DEPARTMENT_ID, DEPARTMENT_NAME, MANAGER_ID, and LOCATION_ID. The data is as follows:

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	200	1700
2	20	Marketing	201	1800
3	30	Purchasing	114	1700
4	40	Human Resources	203	2400
5	50	Shipping	121	1500
6	60	IT	103	1400
7	70	Public Relations	204	2700

- 5) Execute some basic SELECT statements to query the data in the EMPLOYEES table in the SQL Worksheet area. Use both the Execute Statement (or press F9) and the Run Script icons (or press F5) to execute the SELECT statements. Review the results of both methods of executing the SELECT statements on the appropriate tabbed pages.

- a) Write a query to select the last name and salary for any employee whose salary is less than or equal to \$3,000.

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

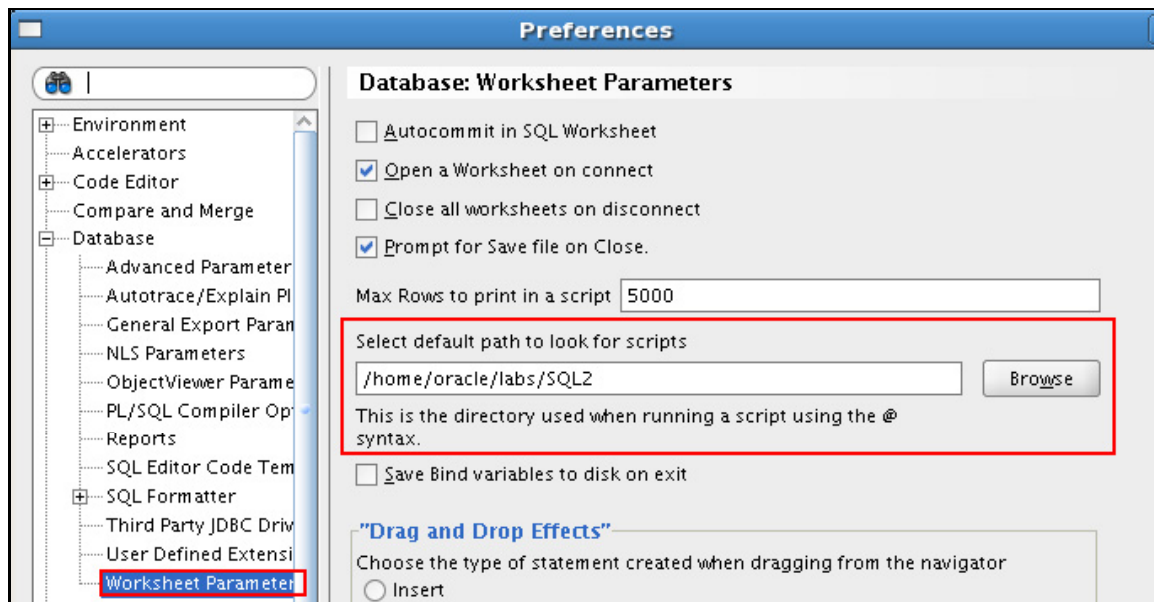
- b) Write a query to display last name, job ID, and commission for all employees who are not entitled to receive a commission.

```
SELECT last_name, job_id, commission_pct
FROM employees
WHERE commission_pct IS NULL;
```

- 6) Set your script pathing preference to /home/oracle/labs/sql2.

- a) Select Tools > Preferences > Database > Worksheet Parameters.
b) Enter the value in the **Select default path to look for scripts** field. Then, click OK.

Practice Solutions I-2: Using SQL Developer (continued)

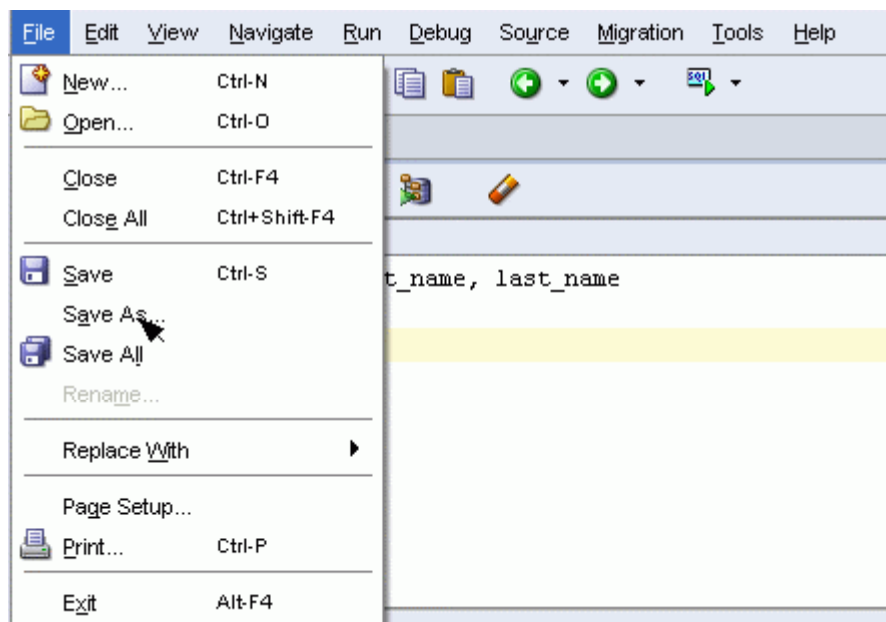


7) Enter the following SQL statement:

```
SELECT employee_id, first_name, last_name
FROM employees;
```

8) Save the SQL statement to a script file by using the File > Save As menu item.

a) Select File > Save As.

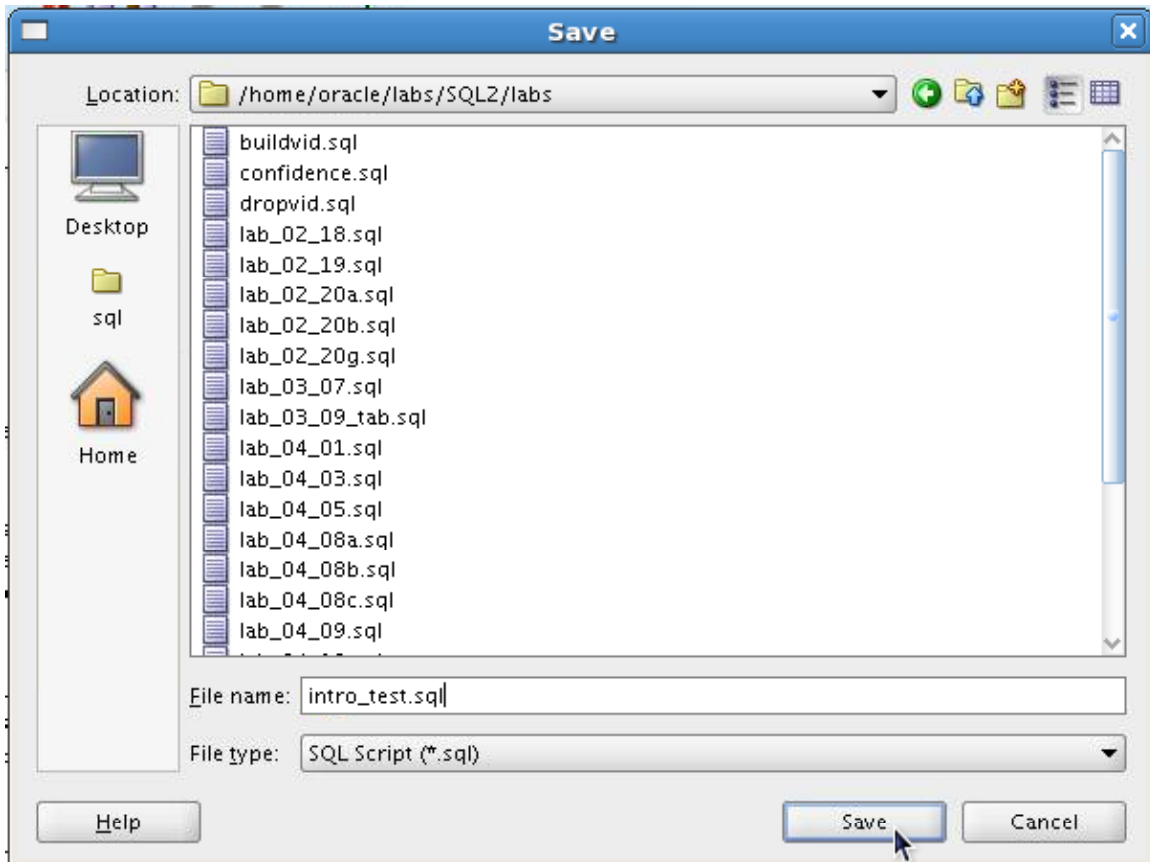


b) Name the file **intro_test.sql**.

Practice Solutions I-2: Using SQL Developer (continued)

Enter `intro_test.sql` in the File_name text box.

c) Place the file under the `/home/oracle/labs/SQL2/labs` folder.

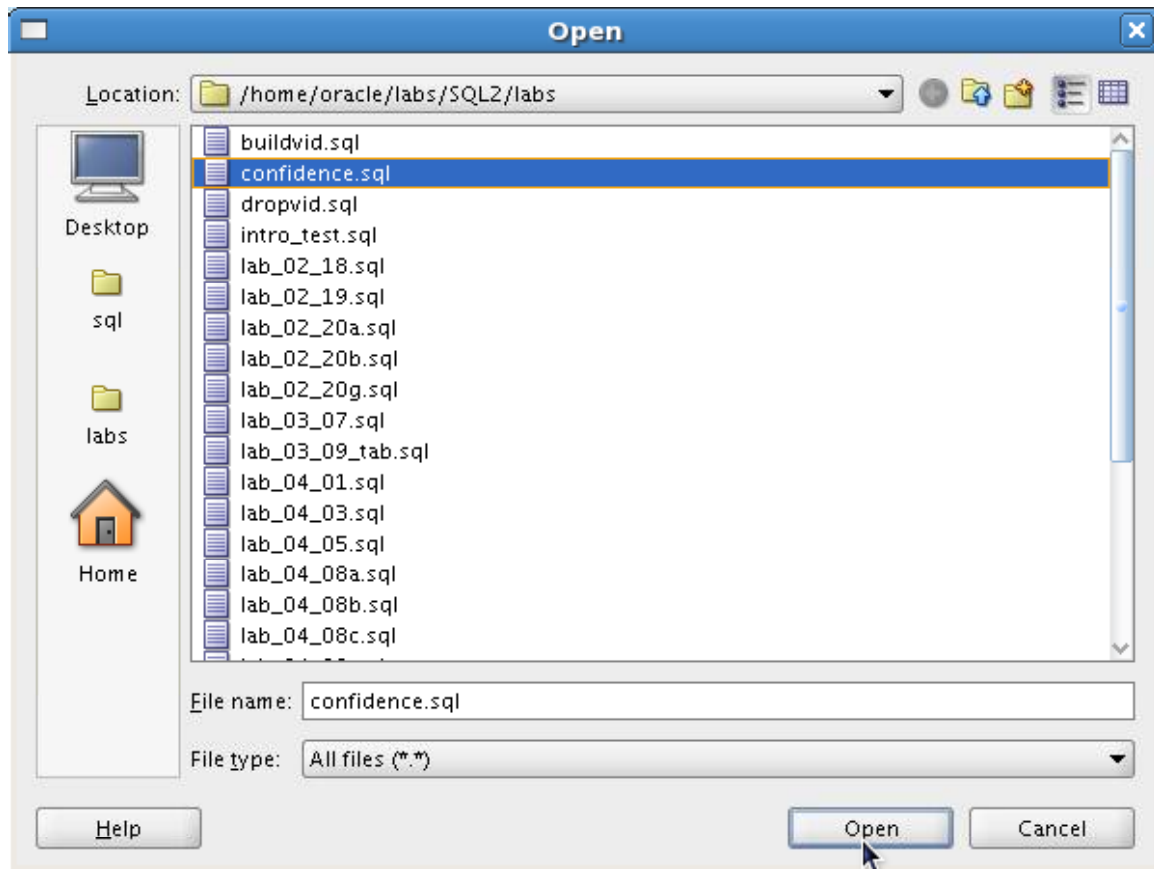


Then, click Save.

9) Open and run `confidence.sql` from your `/home/oracle/labs/SQL2/labs` folder and observe the output.

Practice Solutions I-2: Using SQL Developer (continued)

Open the confidence.sql script file by using the File > Open menu item.



Then, press F5 to execute the script.

The following is the expected result:

```
COUNT (*)
-----
8

1 rows selected

COUNT (*)
-----
107

1 rows selected

COUNT (*)
-----
25

1 rows selected
```

Practice Solutions I-2: Using SQL Developer (continued)

```
COUNT (*)  
-----  
4
```

1 rows selected

```
COUNT (*)  
-----  
23
```

1 rows selected

```
COUNT (*)  
-----  
27
```

1 rows selected

```
COUNT (*)  
-----  
19
```

1 rows selected

```
COUNT (*)  
-----  
10
```

1 rows selected

Practices and Solutions for Lesson 1

Practice 1-1: Controlling User Access

1. What privilege should a user be given to log on to the Oracle server? Is this a system privilege or an object privilege?

2. What privilege should a user be given to create tables?

3. If you create a table, who can pass along privileges to other users in your table?

4. You are the DBA. You create many users who require the same system privileges. What should you use to make your job easier?

5. What command do you use to change your password?

6. User21 is the owner of the EMP table and grants the DELETE privilege to User22 by using the WITH GRANT OPTION clause. User22 then grants the DELETE privilege on EMP to User23. User21 now finds that User23 has the privilege and revokes it from User22. Which user can now delete from the EMP table?

7. You want to grant SCOTT the privilege to update data in the DEPARTMENTS table. You also want to enable SCOTT to grant this privilege to other users. What command do you use?

To complete question 8 and the subsequent ones, you need to connect to the database by using SQL Developer. If you are already not connected, do the following to connect:

1. Click the SQL Developer desktop icon.
 2. In the Connections Navigator, use the **oraxx** account and the corresponding password provided by your instructor to log on to the database.
-
8. Grant another user query privilege on your table. Then, verify whether that user can use the privilege.
Note: For this exercise, team up with another group. For example, if you are user ora21, team up with another user ora22.
 - a. Grant another user privilege to view records in your REGIONS table. Include an option for this user to further grant this privilege to other users.
 - b. Have the user query your REGIONS table.
 - c. Have the user pass on the query privilege to a third user (for example, ora23).

Practice 1-1: Controlling User Access (continued)

- d. Take back the privilege from the user who performs step b.
- Note:** Each team can run exercises 9 and 10 independently.
9. Grant another user query and data manipulation privileges on your COUNTRIES table. Make sure that the user cannot pass on these privileges to other users.
10. Take back the privileges on the COUNTRIES table granted to another user.
- Note:** For exercises 11 through 17, team up with another group.
11. Grant another user access to your DEPARTMENTS table. Have the user grant you query access to his or her DEPARTMENTS table.
12. Query all the rows in your DEPARTMENTS table.

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	200	1700
2	20	Marketing	201	1800
3	30	Purchasing	114	1700
4	40	Human Resources	203	2400
5	50	Shipping	121	1500
6	60	IT	103	1400
7	70	Public Relations	204	2700
8	80	Sales	145	2500

...

13. Add a new row to your DEPARTMENTS table. Team 1 should add Education as department number 500. Team 2 should add Human Resources as department number 510. Query the other team's table.
14. Create a synonym for the other team's DEPARTMENTS table.
15. Query all the rows in the other team's DEPARTMENTS table by using your synonym.

Team 1 SELECT statement results:

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
15	150	Shareholder Services	(null)	1700
16	160	Benefits	(null)	1700
17	170	Manufacturing	(null)	1700
18	180	Construction	(null)	1700
19	190	Contracting	(null)	1700
20	200	Operations	(null)	1700
21	210	IT Support	(null)	1700
22	220	NOC	(null)	1700
23	230	IT Helpdesk	(null)	1700
24	240	Government Sales	(null)	1700
25	250	Retail Sales	(null)	1700
26	260	Recruiting	(null)	1700
27	270	Payroll	(null)	1700
28	510	Human Resources	(null)	(null)

Practice 1-1: Controlling User Access (continued)

Team 2 SELECT statement results:

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
15	150	Shareholder Services	(null)	1700
16	160	Benefits	(null)	1700
17	170	Manufacturing	(null)	1700
18	180	Construction	(null)	1700
19	190	Contracting	(null)	1700
20	200	Operations	(null)	1700
21	210	IT Support	(null)	1700
22	220	NOC	(null)	1700
23	230	IT Helpdesk	(null)	1700
24	240	Government Sales	(null)	1700
25	250	Retail Sales	(null)	1700
26	260	Recruiting	(null)	1700
27	270	Payroll	(null)	1700
28	500	Education	(null)	(null)

16. Revoke the SELECT privilege from the other team.

17. Remove the row that you inserted into the DEPARTMENTS table in step 13 and save the changes.

Practice Solutions 1-1: Controlling User Access

To complete question 8 and the subsequent ones, you need to connect to the database by using SQL Developer.

1. What privilege should a user be given to log on to the Oracle server? Is this a system or an object privilege?
The CREATE SESSION system privilege
2. What privilege should a user be given to create tables?
The CREATE TABLE privilege
3. If you create a table, who can pass along privileges to other users in your table?
You can, or anyone you have given those privileges to, by using WITH GRANT OPTION
4. You are the DBA. You create many users who require the same system privileges.
What should you use to make your job easier?
Create a role containing the system privileges and grant the role to the users.
5. What command do you use to change your password?
The ALTER USER statement
6. User21 is the owner of the EMP table and grants DELETE privileges to User22 by using the WITH GRANT OPTION clause. User22 then grants DELETE privileges on EMP to User23. User21 now finds that User23 has the privilege and revokes it from User22. Which user can now delete data from the EMP table?
Only User21
7. You want to grant SCOTT the privilege to update data in the DEPARTMENTS table. You also want to enable SCOTT to grant this privilege to other users. What command do you use?
GRANT UPDATE ON departments TO scott WITH GRANT OPTION;

Practice Solutions 1-1: Controlling User Access (continued)

8. Grant another user query privilege on your table. Then, verify whether that user can use the privilege.

Note: For this exercise, team up with another group. For example, if you are user ora21, team up with another user ora22.

- a) Grant another user privilege to view records in your REGIONS table. Include an option for this user to further grant this privilege to other users.

Team 1 executes this statement:

```
GRANT select
ON regions
TO <team2_oraxx> WITH GRANT OPTION;
```

- b) Have the user query your REGIONS table.

Team 2 executes this statement:

```
SELECT * FROM <team1_oraxx>.regions;
```

- c) Have the user pass on the query privilege to a third user (for example, ora23).

Team 2 executes this statement.

```
GRANT select
ON <team1_oraxx>.regions
TO <team3_oraxx>;
```

- d) Take back the privilege from the user who performs step b.

Team 1 executes this statement.

```
REVOKE select
ON regions
FROM <team2_oraxx>;
```

9. Grant another user query and data manipulation privileges on your COUNTRIES table. Make sure the user cannot pass on these privileges to other users.

Team 1 executes this statement.

```
GRANT select, update, insert
ON COUNTRIES
TO <team2_oraxx>;
```

Practice Solutions 1-1: Controlling User Access (continued)

10. Take back the privileges on the COUNTRIES table granted to another user.

Team 1 executes this statement.

```
REVOKE select, update, insert ON COUNTRIES FROM <team2_oraxx>;
```

Note: For the exercises 11 through 17, team up with another group.

11. Grant another user access to your DEPARTMENTS table. Have the user grant you query access to his or her DEPARTMENTS table.

Team 2 executes the GRANT statement.

```
GRANT select  
ON departments  
TO <team1_oraxx>;
```

Team 1 executes the GRANT statement.

```
GRANT select  
ON departments  
TO <team2_oraxx>;
```

Here, <team1_oraxx> is the username of Team 1 and <team2_oraxx> is the username of Team 2.

12. Query all the rows in your DEPARTMENTS table.

```
SELECT  *  
FROM    departments;
```

13. Add a new row to your DEPARTMENTS table. Team 1 should add Education as department number 500. Team 2 should add Human Resources as department number 510. Query the other team's table.

Team 1 executes this INSERT statement.

```
INSERT INTO departments(department_id, department_name)  
VALUES (500, 'Education');  
COMMIT;
```

Team 2 executes this INSERT statement.

```
INSERT INTO departments(department_id, department_name)  
VALUES (510, 'Human Resources');  
COMMIT;
```

Practice Solutions 1-1: Controlling User Access (continued)

14. Create a synonym for the other team's DEPARTMENTS table.

Team 1 creates a synonym named team2.

```
CREATE SYNONYM team2
      FOR <team2_oraxx>.DEPARTMENTS;
```

Team 2 creates a synonym named team1.

```
CREATE SYNONYM team1
      FOR <team1_oraxx>. DEPARTMENTS;
```

15. Query all the rows in the other team's DEPARTMENTS table by using your synonym.

Team 1 executes this SELECT statement.

```
SELECT *
      FROM   team2;
```

Team 2 executes this SELECT statement.

```
SELECT *
      FROM   team1;
```

16. Revoke the SELECT privilege from the other team.

Team 1 revokes the privilege.

```
REVOKE select
      ON departments
      FROM   <team2_oraxx>;
```

Team 2 revokes the privilege.

```
REVOKE select
      ON departments
      FROM   <team1_oraxx>;
```

Practice Solutions 1-1: Controlling User Access (continued)

17. Remove the row that you inserted into the DEPARTMENTS table in step 8 and save the changes.

Team 1 executes this DELETE statement.

```
DELETE FROM departments
WHERE department_id = 500;
COMMIT;
```

Team 2 executes this DELETE statement.

```
DELETE FROM departments
WHERE department_id = 510;
COMMIT;
```


Practices and Solutions for Lesson 2

Practice 2-1: Managing Schema Objects

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.

1. Create the `DEPT2` table based on the following table instance chart. Enter the syntax in the SQL Worksheet. Then, execute the statement to create the table. Confirm that the table is created.

Column Name	ID	NAME
Key Type		
Nulls/Unique		
FK Table		
FK Column		
Data type	NUMBER	VARCHAR2
Length	7	25

Name	Null	Type
-----	-----	-----
ID		NUMBER (7)
NAME		VARCHAR2 (25)
2 rows selected		

2. Populate the `DEPT2` table with data from the `DEPARTMENTS` table. Include only the columns that you need.
3. Create the `EMP2` table based on the following table instance chart. Enter the syntax in the SQL Worksheet. Then execute the statement to create the table. Confirm that the table is created.

Column Name	ID	LAST_NAME	FIRST_NAME	DEPT_ID
Key Type				
Nulls/Unique				
FK Table				
FK Column				
Data type	NUMBER	VARCHAR2	VARCHAR2	NUMBER
Length	7	25	25	7

Practice 2-1: Managing Schema Objects (continued)

Name	Null	Type

ID		NUMBER(7)
LAST_NAME		VARCHAR2(25)
FIRST_NAME		VARCHAR2(25)
DEPT_ID		NUMBER(7)
4 rows selected		

4. Modify the EMP2 table to allow for longer employee last names. Confirm your modification.

Name	Null	Type

ID		NUMBER(7)
LAST_NAME		VARCHAR2(50)
FIRST_NAME		VARCHAR2(25)
DEPT_ID		NUMBER(7)
4 rows selected		

5. Create the EMPLOYEES2 table based on the structure of the EMPLOYEES table. Include only the EMPLOYEE_ID, FIRST_NAME, LAST_NAME, SALARY, and DEPARTMENT_ID columns. Name the columns in your new table ID, FIRST_NAME, LAST_NAME, SALARY, and DEPT_ID, respectively.
6. Drop the EMP2 table.
7. Query the recycle bin to see whether the table is present.

	ORIGINAL_NAME	OPERATION	DROPTIME

17	EMP_NEW_SAL	DROP	2009-05-22:14:44:15
18	EMP2	DROP	2009-05-22:14:57:57

8. Restore the EMP2 table to a state before the DROP statement.

Name	Null	Type

ID		NUMBER(7)
LAST_NAME		VARCHAR2(50)
FIRST_NAME		VARCHAR2(25)
DEPT_ID		NUMBER(7)
4 rows selected		

9. Drop the FIRST_NAME column from the EMPLOYEES2 table. Confirm your modification by checking the description of the table.

Practice 2-1: Managing Schema Objects (continued)

Name	Null	Type
ID		NUMBER(6)
LAST_NAME	NOT NULL	VARCHAR2(25)
SALARY		NUMBER(8,2)
DEPT_ID		NUMBER(4)
4 rows selected		

10. In the EMPLOYEES2 table, mark the DEPT_ID column as UNUSED. Confirm your modification by checking the description of the table.

Name	Null	Type
ID		NUMBER(6)
LAST_NAME	NOT NULL	VARCHAR2(25)
SALARY		NUMBER(8,2)
3 rows selected		

11. Drop all the UNUSED columns from the EMPLOYEES2 table. Confirm your modification by checking the description of the table.
12. Add a table-level PRIMARY KEY constraint to the EMP2 table on the ID column. The constraint should be named at creation. Name the constraint my_emp_id_pk.
13. Create a PRIMARY KEY constraint to the DEPT2 table using the ID column. The constraint should be named at creation. Name the constraint my_dept_id_pk.
14. Add a foreign key reference on the EMP2 table that ensures that the employee is not assigned to a nonexistent department. Name the constraint my_emp_dept_id_fk.
15. Modify the EMP2 table. Add a COMMISSION column of the NUMBER data type, precision 2, scale 2. Add a constraint to the COMMISSION column that ensures that a commission value is greater than zero.
16. Drop the EMP2 and DEPT2 tables so that they cannot be restored. Verify the recycle bin.
17. Create the DEPT_NAMED_INDEX table based on the following table instance chart. Name the index for the PRIMARY KEY column as DEPT_PK_IDX.

Column Name	Deptno	Dname
Primary Key	Yes	
Data Type	Number	VARCHAR2
Length	4	30

18. Create an external table library_items_ext. Use the ORACLE_LOADER access driver.

Practice 2-1: Managing Schema Objects (continued)

Note: The `emp_dir` directory and `library_items.dat` file are already created for this exercise. `library_items.dat` has records in the following format:

```
2354, 2264, 13.21, 150,  
2355, 2289, 46.23, 200,  
2355, 2264, 50.00, 100,
```

- Open the `lab_02_18.sql` file. Observe the code snippet to create the `library_items_ext` external table. Then replace `<TODO1>`, `<TODO2>`, `<TODO3>`, and `<TODO4>` as appropriate and save the file as `lab_02_18_soln.sql`. Run the script to create the external table.
- Query the `library_items_ext` table.

	CATEGOR...	BOO...	BOOK_P...	QUAN...
1	2354	2264	13.21	150
2	2355	2289	46.23	200
3	2355	2264	50	100

- The HR department needs a report of the addresses of all departments. Create an external table as `dept_add_ext` using the `ORACLE_DATAPUMP` access driver. The report should show the location ID, street address, city, state or province, and country in the output. Use a `NATURAL JOIN` to produce the results.

Note: The `emp_dir` directory is already created for this exercise.

- Open the `lab_02_19.sql` file. Observe the code snippet to create the `dept_add_ext` external table. Then, replace `<TODO1>`, `<TODO2>`, and `<TODO3>` with the appropriate code. Replace `<oraxx_emp4.exp>` and `<oraxx_emp5.exp>` with the appropriate file names. For example, if you are the `ora21` user, your file names are `ora21_emp4.exp` and `ora21_emp5.exp`. Save the script as `lab_02_19_soln.sql`.
- Run the `lab_02_19_soln.sql` script to create the external table.
- Query the `dept_add_ext` table.

Practice 2-1: Managing Schema Objects (continued)

	LOCAT...	STREET_ADDRESS	CITY	STATE_PROVINCE	COUNTRY_NAME
1	1000	1297 Via Cola di Rie	Roma	(null)	Italy
2	1100	93091 Calle della Testa	Venice	(null)	Italy
3	1200	2017 Shinjuku-ku	Tokyo	Tokyo Prefecture	Japan
4	1300	9450 Kamiya-cho	Hiroshima	(null)	Japan
5	1400	2014 Jabberwocky Rd	Southlake	Texas	United States of Amer
6	1500	2011 Interiors Blvd	South San Francisco	California	United States of Amer
7	1600	2007 Zagora St	South Brunswick	New Jersey	United States of Amer
8	1700	2004 Charade Rd	Seattle	Washington	United States of Amer

Note: When you perform the preceding step, two files `oraxx_emp4.exp` and `oraxx_emp5.exp` are created under the default directory `emp_dir`.

20. Create the `emp_books` table and populate it with data. Set the primary key as deferred and observe what happens at the end of the transaction.
- Run the `lab_02_20_a.sql` file to create the `emp_books` table. Observe that the `emp_books_pk` primary key is not created as deferrable.

```
create table succeeded.
```

- Run the `lab_02_20_b.sql` file to populate data into the `emp_books` table. What do you observe?

```
1 rows inserted

Error starting at line 2 in command:
insert into emp_books values(300,'Change Management')
Error report:
SQL Error: ORA-00001: unique constraint (ORA21.EMP_BOOKS_PK) violated
00001. 00000 - "unique constraint (%s.%s) violated"
*Cause:      An UPDATE or INSERT statement attempted to insert a duplicate key.
              For Trusted Oracle configured in DBMS MAC mode, you may see
              this message if a duplicate entry exists at a different level.
*Action:     Either remove the unique restriction or do not insert the key.
```

- Set the `emp_books_pk` constraint as deferred. What do you observe?

```
Error starting at line 1 in command:
set constraint emp_books_pk deferred
Error report:
SQL Error: ORA-02447: cannot defer a constraint that is not deferrable
02447. 00000 - "cannot defer a constraint that is not deferrable"
*Cause:      An attempt was made to defer a nondeferrable constraint
*Action:     Drop the constraint and create a new one that is deferrable
```

- Drop the `emp_books_pk` constraint.

```
alter table emp_books succeeded.
```

- Modify the `emp_books` table definition to add the `emp_books_pk` constraint as deferrable this time.

Practice 2-1: Managing Schema Objects (continued)

```
alter table emp_books succeeded.
```

f. Set the emp_books_pk constraint as deferred.

```
set constraint succeeded.
```

g. Run the lab_02_20_g.sql file to populate data into the emp_books table.

What do you observe?

```
1 rows inserted
1 rows inserted
1 rows inserted
```

h. Commit the transaction. What do you observe?

```
Error report:
SQL Error: ORA-02091: transaction rolled back
ORA-00001: unique constraint (ORA21.EMP_BOOKS_PK) violated
02091. 00000 - "transaction rolled back"
*Cause:      Also see error 2092. If the transaction is aborted at a remote
              site then you will only see 2091; if aborted at host then you will
              see 2092 and 2091.
*Action:     Add rollback segment and retry the transaction.
```

Practice Solutions 2-1: Managing Schema Objects

1. Create the DEPT2 table based on the following table instance chart. Enter the syntax in the SQL Worksheet. Then, execute the statement to create the table. Confirm that the table is created.

Column Name	ID	NAME
Key Type		
Nulls/Unique		
FK Table		
FK Column		
Data type	NUMBER	VARCHAR2
Length	7	25

```
CREATE TABLE dept2
  (id NUMBER(7),
   name VARCHAR2(25));

DESCRIBE dept2
```

2. Populate the DEPT2 table with data from the DEPARTMENTS table. Include only the columns that you need.

```
INSERT INTO dept2
SELECT department_id, department_name
FROM departments;
```

3. Create the EMP2 table based on the following table instance chart. Enter the syntax in the SQL Worksheet. Then execute the statement to create the table. Confirm that the table is created.

Column Name	ID	LAST_NAME	FIRST_NAME	DEPT_ID
Key Type				
Nulls/Unique				
FK Table				
FK Column				
Data type	NUMBER	VARCHAR2	VARCHAR2	NUMBER
Length	7	25	25	7

Practice Solutions 2-1: Managing Schema Objects (continued)

```
CREATE TABLE emp2
(id          NUMBER(7),
 last_name   VARCHAR2(25),
 first_name  VARCHAR2(25),
 dept_id     NUMBER(7));

DESCRIBE emp2
```

4. Modify the EMP2 table to allow for longer employee last names. Confirm your modification.

```
ALTER TABLE emp2
MODIFY (last_name   VARCHAR2(50));

DESCRIBE emp2
```

5. Create the EMPLOYEES2 table based on the structure of the EMPLOYEES table. Include only the EMPLOYEE_ID, FIRST_NAME, LAST_NAME, SALARY, and DEPARTMENT_ID columns. Name the columns in your new table ID, FIRST_NAME, LAST_NAME, SALARY, and DEPT_ID, respectively.

```
CREATE TABLE employees2 AS
SELECT  employee_id id, first_name, last_name, salary,
        department_id dept_id
FROM    employees;
```

6. Drop the EMP2 table.

```
DROP TABLE emp2;
```


Practice Solutions 2-1: Managing Schema Objects (continued)

7. Query the recycle bin to see whether the table is present.

```
SELECT original_name, operation, droptime
FROM recyclebin;
```

8. Restore the EMP2 table to a state before the DROP statement.

```
FLASHBACK TABLE emp2 TO BEFORE DROP;
DESC emp2;
```

9. Drop the FIRST_NAME column from the EMPLOYEES2 table. Confirm your modification by checking the description of the table.

```
ALTER TABLE employees2
DROP COLUMN first_name;

DESCRIBE employees2
```

10. In the EMPLOYEES2 table, mark the DEPT_ID column as UNUSED. Confirm your modification by checking the description of the table.

```
ALTER TABLE    employees2
SET    UNUSED  (dept_id);

DESCRIBE employees2
```

11. Drop all the UNUSED columns from the EMPLOYEES2 table. Confirm your modification by checking the description of the table.

```
ALTER TABLE employees2
DROP UNUSED COLUMNS;

DESCRIBE employees2
```

Practice Solutions 2-1: Managing Schema Objects (continued)

12. Add a table-level PRIMARY KEY constraint to the EMP2 table on the ID column. The constraint should be named at creation. Name the constraint my_emp_id_pk.

```
ALTER TABLE emp2
ADD CONSTRAINT my_emp_id_pk PRIMARY KEY (id);
```

13. Create a PRIMARY KEY constraint to the DEPT2 table using the ID column. The constraint should be named at creation. Name the constraint my_dept_id_pk.

```
ALTER TABLE dept2
ADD CONSTRAINT my_dept_id_pk PRIMARY KEY(id);
```

14. Add a foreign key reference on the EMP2 table that ensures that the employee is not assigned to a nonexistent department. Name the constraint my_emp_dept_id_fk.

```
ALTER TABLE emp2
ADD CONSTRAINT my_emp_dept_id_fk
FOREIGN KEY (dept_id) REFERENCES dept2(id);
```

15. Modify the EMP2 table. Add a COMMISSION column of the NUMBER data type, precision 2, scale 2. Add a constraint to the COMMISSION column that ensures that a commission value is greater than zero.

```
ALTER TABLE emp2
ADD commission NUMBER(2,2)
CONSTRAINT my_emp_comm_ck CHECK (commission > 0);
```

16. Drop the EMP2 and DEPT2 tables so that they cannot be restored. Check in the recycle bin.

```
DROP TABLE emp2 PURGE;
DROP TABLE dept2 PURGE;

SELECT original_name, operation, droptime
FROM recyclebin;
```

17. Create the DEPT_NAMED_INDEX table based on the following table instance chart. Name the index for the PRIMARY KEY column as DEPT_PK_IDX.

Column Name	Deptno	Dname
Primary Key	Yes	
Data Type	Number	VARCHAR2
Length	4	30

Practice Solutions 2-1: Managing Schema Objects (continued)

```
CREATE TABLE DEPT_NAMED_INDEX
(deptno NUMBER(4)
PRIMARY KEY USING INDEX
(CREATE INDEX dept_pk_idx ON
DEPT_NAMED_INDEX(deptno)),
dname VARCHAR2(30));
```

18. Create an external table `library_items_ext`. Use the `ORACLE_LOADER` access driver.

Note: The `emp_dir` directory and `library_items.dat` are already created for this exercise.

`library_items.dat` has records in the following format:

`2354, 2264, 13.21, 150,`

`2355, 2289, 46.23, 200,`

`2355, 2264, 50.00, 100,`

- a) Open the `lab_02_18.sql` file. Observe the code snippet to create the `library_items_ext` external table. Then, replace `<TODO1>`, `<TODO2>`, `<TODO3>`, and `<TODO4>` as appropriate and save the file as `lab_02_18_soln.sql`.
Run the script to create the external table.

```
CREATE TABLE library_items_ext ( category_id  number(12)
                                , book_id  number(6)
                                , book_price number(8,2)
                                , quantity   number(8)
                                )

ORGANIZATION EXTERNAL
(TYPE ORACLE_LOADER
DEFAULT DIRECTORY emp_dir
ACCESS PARAMETERS (RECORDS DELIMITED BY NEWLINE
                   FIELDS TERMINATED BY ','))
LOCATION ('library_items.dat')
)
REJECT LIMIT UNLIMITED;
```

Practice Solutions 2-1: Managing Schema Objects (continued)

b) Query the `library_items_ext` table.

```
SELECT * FROM library_items_ext;
```

19. The HR department needs a report of addresses of all the departments. Create an external table as `dept_add_ext` using the `ORACLE_DATAPUMP` access driver. The report should show the location ID, street address, city, state or province, and country in the output. Use a `NATURAL JOIN` to produce the results.

Note: The `emp_dir` directory is already created for this exercise.

- a) Open the `lab_02_19.sql` file. Observe the code snippet to create the `dept_add_ext` external table. Then, replace `<TODO1>`, `<TODO2>`, and `<TODO3>` with appropriate code. Replace `<oraxx_emp4.exp>` and `<oraxx_emp5.exp>` with appropriate file names. For example, if you are user `ora21`, your file names are `ora21_emp4.exp` and `ora21_emp5.exp`. Save the script as `lab_02_19_soln.sql`.

```
CREATE TABLE dept_add_ext (location_id,
                           street_address, city,
                           state_province,
                           country_name)

ORGANIZATION EXTERNAL (
  TYPE ORACLE_DATAPUMP
  DEFAULT DIRECTORY emp_dir
  LOCATION ('oraxx_emp4.exp', 'oraxx_emp5.exp'))
PARALLEL
AS
SELECT location_id, street_address, city, state_province,
       country_name
FROM locations
NATURAL JOIN countries;
```

Note: When you perform the preceding step, two files `oraxx_emp4.exp` and `oraxx_emp5.exp` are created under the default directory `emp_dir`.

Run the `lab_02_19_soln.sql` script to create the external table.

Practice Solutions 2-1: Managing Schema Objects (continued)

b) Query the dept_add_ext table.

```
SELECT * FROM dept_add_ext;
```

20. Create the emp_books table and populate it with data. Set the primary key as deferred and observe what happens at the end of the transaction.

a) Run the lab_02_20a.sql script to create the emp_books table. Observe that the emp_books_pk primary key is not created as deferrable.

```
CREATE TABLE emp_books (book_id number,  
                          title varchar2(20), CONSTRAINT  
emp_books_pk PRIMARY KEY (book_id));
```

b) Run the lab_02_20b.sql script to populate data into the emp_books table.

What do you observe?

```
INSERT INTO emp_books VALUES(300, 'Organizations');  
INSERT INTO emp_books VALUES(300, 'Change Management');
```

The first row is inserted. However, you see the ora-00001 error with the second row insertion.

c) Set the emp_books_pk constraint as deferred. What do you observe?

```
SET CONSTRAINT emp_books_pk DEFERRED;
```

You see the following error: “ORA-02447: Cannot defer a constraint that is not deferrable.”

d) Drop the emp_books_pk constraint.

```
ALTER TABLE emp_books DROP CONSTRAINT emp_books_pk;
```

e) Modify the emp_books table definition to add the emp_books_pk constraint as deferrable this time.

```
ALTER TABLE emp_books ADD (CONSTRAINT emp_books_pk PRIMARY KEY  
(book_id) DEFERRABLE);
```

f) Set the emp_books_pk constraint as deferred.

```
SET CONSTRAINT emp_books_pk DEFERRED;
```

Practice Solutions 2-1: Managing Schema Objects (continued)

g) Run the lab_02_20g.sql script to populate data into the emp_books table.

What do you observe?

```
INSERT INTO emp_books VALUES (300, 'Change Management');  
INSERT INTO emp_books VALUES (300, 'Personality');  
INSERT INTO emp_books VALUES (350, 'Creativity');
```

You see that all the rows are inserted.

h) Commit the transaction. What do you observe?

```
COMMIT;
```

You see that the transaction is rolled back.

Practices and Solutions for Lesson 3

Practice 3-1: Managing Objects with Data Dictionary Views

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

1. Query the USER_TABLES data dictionary view to see information about the tables that you own.

	TABLE_NAME
1	REGIONS
2	LOCATIONS
3	DEPARTMENTS
4	JOBS
5	EMPLOYEES
6	JOB_HISTORY
7	EMP_NEW_SAL
8	EMPLOYEES2
9	DEPT_NAMED_INDEX

...

2. Query the ALL_TABLES data dictionary view to see information about all the tables that you can access. Exclude the tables that you own.

Note: Your list may not exactly match the following list:

	TABLE_NAME	OWNER
1	DUAL	SYS
2	SYSTEM_PRIVILEGE_MAP	SYS
3	TABLE_PRIVILEGE_MAP	SYS

...

98	PLAN_TABLE\$	SYS
99	WRI\$_ADV_ASA_RECO_DATA	SYS
100	PSTUBTBL	SYS

3. For a specified table, create a script that reports the column names, data types, and data types' lengths, as well as whether nulls are allowed. Prompt the user to enter the table name. Give appropriate aliases to the DATA_PRECISION and DATA_SCALE columns. Save this script in a file named lab_03_01.sql.

For example, if the user enters DEPARTMENTS, the following output results:

Practice 3-1: Managing Objects with Data Dictionary Views (continued)

	COLUMN_NAME	DATA_TYPE	DATA_LENGTH	PRECISION	SCALE	NULLABLE
1	DEPARTMENT_ID	NUMBER	22	4	0	N
2	DEPARTMENT_NAME	VARCHAR2	30	(null)	(null)	N
3	MANAGER_ID	NUMBER	22	6	0	Y
4	LOCATION_ID	NUMBER	22	4	0	Y

4. Create a script that reports the column name, constraint name, constraint type, search condition, and status for a specified table. You must join the USER_CONSTRAINTS and USER_CONS_COLUMNS tables to obtain all this information. Prompt the user to enter the table name. Save the script in a file named lab_03_04.sql. For example, if the user enters DEPARTMENTS, the following output results:

	COLUMN_NAME	CONSTRAINT_NAME	CONSTR...	SEARCH_CONDITION	STATUS
1	DEPARTMENT_NAME	DEPT_NAME_NN	C	"DEPARTMENT_NAME" IS NOT ...	ENABLED
2	DEPARTMENT_ID	DEPT_ID_PK	P	(null)	ENABLED
3	LOCATION_ID	DEPT_LOC_FK	R	(null)	ENABLED
4	MANAGER_ID	DEPT_MGR_FK	R	(null)	ENABLED

5. Add a comment to the DEPARTMENTS table. Then query the USER_TAB_COMMENTS view to verify that the comment is present.

	COMMENTS
1	Company department information including name, code, and location.

6. Create a synonym for your EMPLOYEES table. Call it EMP. Then find the names of all synonyms that are in your schema.

	SYNONYM_NAME	TABLE_OWNER	TABLE_NAME	DB_LINK
1	TEAM2	ORA22	DEPARTMENTS	(null)
2	EMP	ORA21	EMPLOYEES	(null)

7. Run lab_03_07.sql to create the dept50 view for this exercise. You need to determine the names and definitions of all the views in your schema. Create a report that retrieves view information: the view name and text from the USER_VIEWS data dictionary view.

Note: The EMP_DETAILS_VIEW was created as part of your schema.

Note: You can see the complete definition of the view if you use Run Script (or press F5) in SQL Developer. If you use Execute Statement (or press F9) in SQL Developer, scroll horizontally in the result pane. If you use SQL*Plus, to see more contents of a LONG column, use the SET LONG n command, where n is the value of the number of characters of the LONG column that you want to see.

Practice 3-1: Managing Objects with Data Dictionary Views (continued)

R	VIEW_NAME	TEXT
1	DEPT50	SELECT employee_id empno, last_name employee, department_id deptno
2	EMP_DETAILS_VIEW	SELECT e.employee_id, e.job_id, e.manager_id, e.department_id, d.location_id,

8. Find the names of your sequences. Write a query in a script to display the following information about your sequences: sequence name, maximum value, increment size, and last number. Name the script `lab_03_08.sql`. Run the statement in your script.

[illegible]

Run the `lab_03_09_tab.sql` script as a prerequisite for exercises 9 through 11. Alternatively, open the script file to copy the code and paste it into your SQL Worksheet. Then execute the script. This script:

- Drops if there are existing tables DEPT2 and EMP2
- Creates the DEPT2 and EMP2 tables

Note: In Practice 2, you should have already dropped the DEPT2 and EMP2 tables so that they cannot be restored.

9. Confirm that both the DEPT2 and EMP2 tables are stored in the data dictionary.

	A2	TABLE_NAME
1		DEPT2
2		EMP2




10. Confirm that the constraints were added by querying the `USER_CONSTRAINTS` view. Note the types and names of the constraints.

R2	CONSTRAINT_NAME	R2	CONSTRAINT_TYPE
1	MY_DEPT_ID_PK		P
2	MY_EMP_ID_PK		P
3	MY_EMP_DEPT_ID_FK		R

11. Display the object names and types from the USER_OBJECTS data dictionary view for the EMP2 and DEPT2 tables.
12. Create the SALES_DEPT table based on the following table instance chart. Name the index for the PRIMARY KEY column SALES_PK_IDX. Then query the data dictionary view to find the index name, table name, and whether the index is unique.

***Practice 3-1: Managing Objects with Data Dictionary Views
(continued)***

Column Name	Team_Id	Location
Primary Key	Yes	
Data Type	Number	VARCHAR2
Length	3	30

 INDEX_NAME	 TABLE_NAME	 UNIQUENESS
1 SALES_PK_IDX	SALES_DEPT	NONUNIQUE

Practice Solutions 3-1: Managing Objects with Data Dictionary Views

1. Query the data dictionary to see information about the tables you own.

```
SELECT table_name
FROM   user_tables;
```

2. Query the dictionary view to see information about all the tables that you can access. Exclude tables that you own.

```
SELECT table_name, owner
FROM   all_tables
WHERE  owner <> 'ORAXX';
```

3. For a specified table, create a script that reports the column names, data types, and data types' lengths, as well as whether nulls are allowed. Prompt the user to enter the table name. Give appropriate aliases to the DATA_PRECISION and DATA_SCALE columns. Save this script in a file named lab_03_01.sql.

```
SELECT column_name, data_type, data_length,
       data_precision PRECISION, data_scale SCALE, nullable
FROM   user_tab_columns
WHERE  table_name = UPPER('&tab_name');
```

To test, run the script and enter DEPARTMENTS as the table name.

4. Create a script that reports the column name, constraint name, constraint type, search condition, and status for a specified table. You must join the USER_CONSTRAINTS and USER_CONS_COLUMNS tables to obtain all this information. Prompt the user to enter the table name. Save the script in a file named lab_03_04.sql.

```
SELECT ucc.column_name, uc.constraint_name,
       uc.constraint_type,
       uc.search_condition, uc.status
FROM   user_constraints uc JOIN user_cons_columns ucc
ON     uc.table_name = ucc.table_name
AND    uc.constraint_name = ucc.constraint_name
AND    uc.table_name = UPPER('&tab_name');
```

To test, run the script and enter DEPARTMENTS as the table name.

Practice Solutions 3-1: Managing Objects with Data Dictionary Views (continued)

5. Add a comment to the DEPARTMENTS table. Then query the USER_TAB_COMMENTS view to verify that the comment is present.

```
COMMENT ON TABLE departments IS
    'Company department information including name, code, and
    location.';

SELECT COMMENTS
FROM   user_tab_comments
WHERE  table_name = 'DEPARTMENTS';
```

6. Create a synonym for your EMPLOYEES table. Call it EMP. Then, find the names of all the synonyms that are in your schema.

```
CREATE SYNONYM emp FOR EMPLOYEES;
SELECT *
FROM   user_synonyms;
```

7. Run lab_03_07.sql to create the dept50 view for this exercise. You need to determine the names and definitions of all the views in your schema. Create a report that retrieves view information: the view name and text from the USER_VIEWS data dictionary view.

Note: The EMP_DETAILS_VIEW was created as part of your schema.

Note: You can see the complete definition of the view if you use Run Script (or press F5) in SQL Developer. If you use Execute Statement (or press F9) in SQL Developer, scroll horizontally in the result pane. If you use SQL*Plus to see more contents of a LONG column, use the SET LONG n command, where n is the value of the number of characters of the LONG column that you want to see.

```
SELECT   view_name, text
FROM     user_views;
```

Practice Solutions 3-1: Managing Objects with Data Dictionary Views (continued)

8. Find the names of your sequences. Write a query in a script to display the following information about your sequences: sequence name, maximum value, increment size, and last number. Name the script `lab_03_08.sql`. Run the statement in your script.

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

Run the `lab_03_09_tab.sql` script as a prerequisite for exercises 9 through 11. Alternatively, open the script file to copy the code and paste it into your SQL Worksheet. Then execute the script. This script:

- Drops the DEPT2 and EMP2 tables
- Creates the DEPT2 and EMP2 tables

Note: In Practice 2, you should have already dropped the DEPT2 and EMP2 tables so that they cannot be restored.

9. Confirm that both the DEPT2 and EMP2 tables are stored in the data dictionary.

```
SELECT    table_name
FROM      user_tables
WHERE     table_name IN ('DEPT2', 'EMP2');
```

10. Query the data dictionary to find out the constraint names and types for both the tables.

```
SELECT    constraint_name, constraint_type
FROM      user_constraints
WHERE     table_name IN ('EMP2', 'DEPT2');
```

11. Query the data dictionary to display the object names and types for both the tables.

```
SELECT    object_name, object_type
FROM      user_objects
WHERE     object_name LIKE 'EMP%'
OR        object_name LIKE 'DEPT%';
```

Practice Solutions 3-1: Managing Objects with Data Dictionary Views (continued)

12. Create the SALES_DEPT table based on the following table instance chart. Name the index for the PRIMARY KEY column as SALES_PK_IDX. Then query the data dictionary view to find the index name, table name, and whether the index is unique.

Column Name	Team_Id	Location
Primary Key	Yes	
Data Type	Number	VARCHAR2
Length	3	30

```
CREATE TABLE SALES_DEPT
  (team_id NUMBER(3)
   PRIMARY KEY USING INDEX
   (CREATE INDEX sales_pk_idx ON
    SALES_DEPT(team_id),
    location VARCHAR2(30));

SELECT INDEX_NAME, TABLE_NAME, UNIQUENESS
FROM USER_INDEXES
WHERE TABLE_NAME = 'SALES_DEPT';
```

Practices and Solutions for Lesson 4

Practice 4-1: Manipulating Large Data Sets

In this practice, you perform multitable INSERT and MERGE operations, and track row versions.

1. Run the lab_04_01.sql script in the lab folder to create the SAL_HISTORY table.
2. Display the structure of the SAL_HISTORY table.

Name	Null	Type
EMPLOYEE_ID		NUMBER(6)
HIRE_DATE		DATE
SALARY		NUMBER(8,2)
3 rows selected		

3. Run the lab_04_03.sql script in the lab folder to create the MGR_HISTORY table.
4. Display the structure of the MGR_HISTORY table.

Name	Null	Type
EMPLOYEE_ID		NUMBER(6)
MANAGER_ID		NUMBER(6)
SALARY		NUMBER(8,2)
3 rows selected		

5. Run the lab_04_05.sql script in the lab folder to create the SPECIAL_SAL table.
6. Display the structure of the SPECIAL_SAL table.

Name	Null	Type
EMPLOYEE_ID		NUMBER(6)
SALARY		NUMBER(8,2)
2 rows selected		

7. a. Write a query to do the following:
 - Retrieve details such as the employee ID, hire date, salary, and manager ID of those employees whose employee ID is less than 125 from the EMPLOYEES table.
 - If the salary is more than \$20,000, insert details such as the employee ID and salary into the SPECIAL_SAL table.

Practice 4-1: Manipulating Large Data Sets (continued)

- Insert details such as the employee ID, hire date, and salary into the SAL_HISTORY table.
- Insert details such as the employee ID, manager ID, and salary into the MGR_HISTORY table.

- b. Display the records from the SPECIAL_SAL table.

	EMPLOYEE_ID	SALARY
1	100	24000

- c. Display the records from the SAL_HISTORY table.

	EMPLOYEE_ID	HIRE_DATE	SALARY
1	101	21-SEP-89	17000
2	102	13-JAN-93	17000
3	103	03-JAN-90	9000
4	104	21-MAY-91	6000
5	105	25-JUN-97	4800
6	106	05-FEB-98	4800
7	107	07-FEB-99	4200

- d. Display the records from the MGR_HISTORY table.

	EMPLOYEE_ID	MANAGER_ID	SALARY
1	101	100	17000
2	102	100	17000
3	103	102	9000
4	104	103	6000
5	105	103	4800
6	106	103	4800
7	107	103	4200

8.

- Run the lab_04_08a.sql script in the lab folder to create the SALES_WEEK_DATA table.
- Run the lab_04_08b.sql script in the lab folder to insert records into the SALES_WEEK_DATA table.

Practice 4-1: Manipulating Large Data Sets (continued)

- c. Display the structure of the SALES_WEEK_DATA table.

Name	Null	Type
ID		NUMBER(6)
WEEK_ID		NUMBER(2)
QTY_MON		NUMBER(8,2)
QTY_TUE		NUMBER(8,2)
QTY_WED		NUMBER(8,2)
QTY_THUR		NUMBER(8,2)
QTY_FRI		NUMBER(8,2)
7 rows selected		

- d. Display the records from the SALES_WEEK_DATA table.

ID	WEEK_ID	QTY_MON	QTY_TUE	QTY_WED	QTY_THUR	QTY_FRI	
1	200	6	2050	2200	1700	1200	3000

- e. Run the lab_04_08_e.sql script in the lab folder to create the EMP_SALES_INFO table.
- f. Display the structure of the EMP_SALES_INFO table.

Name	Null	Type
ID		NUMBER(6)
WEEK		NUMBER(2)
QTY_SALES		NUMBER(8,2)
3 rows selected		

- g. Write a query to do the following:
- Retrieve details such as ID, week ID, sales quantity on Monday, sales quantity on Tuesday, sales quantity on Wednesday, sales quantity on Thursday, and sales quantity on Friday from the SALES_WEEK_DATA table.
 - Build a transformation such that each record retrieved from the SALES_WEEK_DATA table is converted into multiple records for the EMP_SALES_INFO table.
- Hint:** Use a pivoting INSERT statement.

- h. Display the records from the EMP_SALES_INFO table.

	ID	WEEK	QTY_SALES
1	200	6	2050
2	200	6	2200
3	200	6	1700
4	200	6	1200
5	200	6	3000

9. You have the data of past employees stored in a flat file called emp.data. You want to store the names and email IDs of all employees, past and present, in a table. To do

Practice 4-1: Manipulating Large Data Sets (continued)

this, first create an external table called EMP_DATA using the emp.dat source file in the emp_dir directory. Use the lab_04_09.sql script to do this.

10. Next, run the lab_04_10.sql script to create the EMP_HIST table.

- Increase the size of the email column to 45.
- Merge the data in the EMP_DATA table created in the last lab into the data in the EMP_HIST table. Assume that the data in the external EMP_DATA table is the most up-to-date. If a row in the EMP_DATA table matches the EMP_HIST table, update the email column of the EMP_HIST table to match the EMP_DATA table row. If a row in the EMP_DATA table does not match, insert it into the EMP_HIST table. Rows are considered matching when the employee's first and last names are identical.
- Retrieve the rows from EMP_HIST after the merge.

	FIRST_NAME	LAST_NAME	EMAIL
1	Ellen	Abel	EABEL
2	Sundar	Ande	SANDE
3	Mozhe	Atkinson	MATKINSO
4	David	Austin	DAUSTIN
5	Hermann	Baer	HBAER
6	Shelli	Baida	SBAIDA
7	Amit	Banda	ABANDA
8	Elizabeth	Bates	EBATES
9	Sarah	Bell	SBELL
10	David	Bernstein	DBERNSTE
11	Laura	Bissot	LBISSOT

11. Create the EMP3 table by using the lab_04_11.sql script. In the EMP3 table, change the department for Kochhar to 60 and commit your change. Next, change the department for Kochhar to 50 and commit your change. Track the changes to Kochhar by using the Row Versions feature.

	START_DATE	END_DATE	DEPARTMENT_ID
1	18-JUN-09 06.04.26.000000000 PM	(null)	50
2	18-JUN-09 06.04.26.000000000 PM	18-JUN-09 06.04.26.000000000 PM	60
3	(null)	18-JUN-09 06.04.26.000000000 PM	90

Practice Solutions 4-1: Manipulating Large Data Sets

1. Run the `lab_04_01.sql` script in the lab folder to create the `SAL_HISTORY` table.
2. Display the structure of the `SAL_HISTORY` table.

```
DESC sal_history
```

3. Run the `lab_04_03.sql` script in the lab folder to create the `MGR_HISTORY` table.
4. Display the structure of the `MGR_HISTORY` table.

```
DESC mgr_history
```

5. Run the `lab_04_05.sql` script in the lab folder to create the `SPECIAL_SAL` table.
6. Display the structure of the `SPECIAL_SAL` table.

```
DESC special_sal
```

7. a) Write a query to do the following:
 - Retrieve details such as the employee ID, hire date, salary, and manager ID of those employees whose employee ID is less than 125 from the `EMPLOYEES` table.
 - If the salary is more than \$20,000, insert details such as the employee ID and salary into the `SPECIAL_SAL` table.
 - Insert details such as the employee ID, hire date, and salary into the `SAL_HISTORY` table.
 - Insert details such as the employee ID, manager ID, and salary into the `MGR_HISTORY` table.

Practice Solutions 4-1: Manipulating Large Data Sets (continued)

```
INSERT ALL
WHEN SAL > 20000 THEN
INTO special_sal VALUES (EMPID, SAL)
ELSE
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 < 125;
```

b) Display the records from the SPECIAL_SAL table.

```
SELECT * FROM special_sal;
```

c) Display the records from the SAL_HISTORY table.

```
SELECT * FROM sal_history;
```

d) Display the records from the MGR_HISTORY table.

```
SELECT * FROM mgr_history;
```

8. a) Run the lab_04_08a.sql script in the lab folder to create the SALES_WEEK_DATA table.

b) Run the lab_04_08b.sql script in the lab folder to insert records into the SALES_WEEK_DATA table.

c) Display the structure of the SALES_WEEK_DATA table.

```
DESC sales_week_data
```

d) Display the records from the SALES_WEEK_DATA table.

```
SELECT * FROM SALES_WEEK_DATA;
```

Practice Solutions 4-1: Manipulating Large Data Sets (continued)

e) Run the lab_04_08_e.sql script in the lab folder to create the EMP_SALES_INFO table.

f) Display the structure of the EMP_SALES_INFO table.

```
DESC emp_sales_info
```

g) Write a query to do the following:

- Retrieve details such as the employee ID, week ID, sales quantity on Monday, sales quantity on Tuesday, sales quantity on Wednesday, sales quantity on Thursday, and sales quantity on Friday from the SALES_WEEK_DATA table.
- Build a transformation such that each record retrieved from the SALES_WEEK_DATA table is converted into multiple records for the EMP_SALES_INFO table.

Hint: Use a pivoting INSERT statement.

```
INSERT ALL
  INTO emp_sales_info VALUES (id, week_id, QTY_MON)
  INTO emp_sales_info VALUES (id, week_id, QTY_TUE)
  INTO emp_sales_info VALUES (id, week_id, QTY_WED)
  INTO emp_sales_info VALUES (id, week_id, QTY_THUR)
  INTO emp_sales_info VALUES (id, week_id, QTY_FRI)
SELECT ID, week_id, QTY_MON, QTY_TUE, QTY_WED,
       QTY_THUR, QTY_FRI FROM sales_week_data;
```

h) Display the records from the SALES_INFO table.

```
SELECT * FROM emp_sales_info;
```

Practice Solutions 4-1: Manipulating Large Data Sets (continued)

9. You have the data of past employees stored in a flat file called `emp.dat`. You want to store the names and email IDs of all employees past and present in a table. To do this, first create an external table called `EMP_DATA` using the `emp.dat` source file in the `emp_dir` directory. You can use the script in `lab_04_09.sql` to do this.

```
CREATE TABLE emp_data
  (first_name  VARCHAR2(20)
  ,last_name   VARCHAR2(20)
  , email      VARCHAR2(30)
  )
ORGANIZATION EXTERNAL
(
  TYPE oracle_loader
  DEFAULT DIRECTORY emp_dir
  ACCESS PARAMETERS
  (
    RECORDS DELIMITED BY NEWLINE CHARACTERSET US7ASCII
    NOBADFILE
    NOLOGFILE
    FIELDS
    ( first_name POSITION ( 1:20) CHAR
    , last_name POSITION (22:41) CHAR
    , email      POSITION (43:72) CHAR )
  )
  LOCATION ('emp.dat') ) ;
```

10. Next, run the `lab_04_10.sql` script to create the `EMP_HIST` table.
- a) Increase the size of the email column to 45.

```
ALTER TABLE emp_hist MODIFY email varchar(45);
```

- b) Merge the data in the `EMP_DATA` table created in the last lab into the data in the `EMP_HIST` table. Assume that the data in the external `EMP_DATA` table is the most up-to-date. If a row in the `EMP_DATA` table matches the `EMP_HIST` table, update the email column of the `EMP_HIST` table to match the `EMP_DATA` table row. If a row in the `EMP_DATA` table does not match, insert it into the `EMP_HIST` table. Rows are considered matching when the employee's first and last names are identical.

```
MERGE INTO EMP_HIST f USING EMP_DATA h
ON (f.first_name = h.first_name
AND f.last_name = h.last_name)
```

Practice Solutions 4-1: Manipulating Large Data Sets (continued)

```
WHEN MATCHED THEN
  UPDATE SET f.email = h.email
WHEN NOT MATCHED THEN
  INSERT (f.first_name
        , f.last_name
        , f.email)
VALUES (h.first_name
      , h.last_name
      , h.email);
```

- c) Retrieve the rows from EMP_HIST after the merge.

```
SELECT * FROM emp_hist;
```

11. Create the EMP3 table using the lab_04_11.sql script. In the EMP3 table, change the department for Kochhar to 60 and commit your change. Next, change the department for Kochhar to 50 and commit your change. Track the changes to Kochhar using the Row Versions feature.

```
UPDATE emp3 SET department_id = 60
WHERE last_name = 'Kochhar';
COMMIT;
UPDATE emp3 SET department_id = 50
WHERE last_name = 'Kochhar';
COMMIT;
```

```
SELECT VERSIONS_STARTTIME "START_DATE",
       VERSIONS_ENDTIME "END_DATE",  DEPARTMENT_ID
FROM EMP3
      VERSIONS BETWEEN SCN MINVALUE AND MAXVALUE
WHERE LAST_NAME = 'Kochhar';
```

Practices and Solutions for Lesson 5

Practice 5-1: Managing Data in Different Time Zones

In this practice, you display time zone offsets, `CURRENT_DATE`, `CURRENT_TIMESTAMP`, and `LOCALTIMESTAMP`. You also set time zones and use the `EXTRACT` function.

1. Alter the session to set `NLS_DATE_FORMAT` to `DD-MON-YYYY HH24:MI:SS`.
2. a. Write queries to display the time zone offsets (`TZ_OFFSET`) for the following time zones.

- *US/Pacific-New*

	TZ_OFFSET('US/PACIFIC-NEW')
1	-07:00

- *Singapore*

	TZ_OFFSET('SINGAPORE')
1	+08:00

- *Egypt*

	TZ_OFFSET('EGYPT')
1	+03:00

- b. Alter the session to set the `TIME_ZONE` parameter value to the time zone offset of US/Pacific-New.
- c. Display `CURRENT_DATE`, `CURRENT_TIMESTAMP`, and `LOCALTIMESTAMP` for this session.
- d. Alter the session to set the `TIME_ZONE` parameter value to the time zone offset of Singapore.
- e. Display `CURRENT_DATE`, `CURRENT_TIMESTAMP`, and `LOCALTIMESTAMP` for this session.

Note: The output might be different based on the date when the command is executed.

	CURRENT_DATE	CURRENT_TIMESTAMP	LOCALTIMESTAMP
1	23-JUN-2009 15:12:08	23-JUN-09 03.12.08.000000000 PM +08:00	23-JUN-09 03.12.08.000000000 PM

Note: Observe in the preceding practice that `CURRENT_DATE`, `CURRENT_TIMESTAMP`, and `LOCALTIMESTAMP` are sensitive to the session time zone.

3. Write a query to display `DBTIMEZONE` and `SESSIONTIMEZONE`.

	DBTIMEZONE	SESSIONTIMEZONE
1	+00:00	+08:00

4. Write a query to extract the `YEAR` from the `HIRE_DATE` column of the `EMPLOYEES` table for those employees who work in department 80.

Practice 5-1: Managing Data in Different Time Zones (continued)

	LAST_NAME	EXTRACT(YEARFROMHIRE_DATE)
1	Russell	1996
2	Partners	1997
3	Errazuriz	1997
4	Cambrault	1999
5	Zlotkey	2000
6	Tucker	1997
7	Bernstein	1997

5. Alter the session to set NLS_DATE_FORMAT to DD-MON-YYYY.
6. Examine and run the lab_05_06.sql script to create the SAMPLE_DATES table and populate it.
 - a. Select from the table and view the data.

	DATE_COL
1	23-JUN-2009

- b. Modify the data type of the DATE_COL column and change it to TIMESTAMP. Select from the table to view the data.

	DATE_COL
1	23-JUN-09 02.14.52.000000000 PM

- c. Try to modify the data type of the DATE_COL column and change it to TIMESTAMP WITH TIME ZONE. What happens?
7. Create a query to retrieve last names from the EMPLOYEES table and calculate the review status. If the year hired was 1998, display Needs Review for the review status; otherwise, display not this year! Name the review status column Review. Sort the results by the HIRE_DATE column.
Hint: Use a CASE expression with the EXTRACT function to calculate the review status.

	LAST_NAME	Review
1	King	not this year!
2	Whalen	not this year!
3	Kochhar	not this year!
4	Hunold	not this year!
5	Ernst	not this year!
6	De Haan	not this year!
7	Mavris	not this year!

...

Practice 5-1: Managing Data in Different Time Zones (continued)

8. Create a query to print the last names and the number of years of service for each employee. If the employee has been employed for five or more years, print 5 years of service. If the employee has been employed for 10 or more years, print 10 years of service. If the employee has been employed for 15 or more years, print 15 years of service. If none of these conditions match, print maybe next year! Sort the results by the HIRE_DATE column. Use the EMPLOYEES table.

Hint: Use CASE expressions and TO_YMINTERVAL.

	LAST_NAME		HIRE_DATE		SYSDATE		Awards
1	OConnell		21-JUN-1999		23-JUN-2009		10 years of service
2	Grant		13-JAN-2000		23-JUN-2009		5 years of service
3	Whalen		17-SEP-1987		23-JUN-2009		15 years of service
4	Hartstein		17-FEB-1996		23-JUN-2009		10 years of service
5	Fay		17-AUG-1997		23-JUN-2009		10 years of service
6	Mavris		07-JUN-1994		23-JUN-2009		15 years of service

...

Practice Solutions 5-1: Managing Data in Different Time Zones

1. Alter the session to set NLS_DATE_FORMAT to DD-MON-YYYY HH24:MI:SS.

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

2. a. Write queries to display the time zone offsets (TZ_OFFSET) for the following time zones: *US/Pacific-New*, *Singapore*, and *Egypt*.

US/Pacific-New

```
SELECT TZ_OFFSET ('US/Pacific-New') from dual;
```

Singapore

```
SELECT TZ_OFFSET ('Singapore') from dual;
```

Egypt

```
SELECT TZ_OFFSET ('Egypt') from dual;
```

- b. Alter the session to set the TIME_ZONE parameter value to the time zone offset of US/Pacific-New.

```
ALTER SESSION SET TIME_ZONE = '-7:00';
```

- c. Display CURRENT_DATE, CURRENT_TIMESTAMP, and LOCALTIMESTAMP for this session.

Note: The output may be different based on the date when the command is executed.

```
SELECT CURRENT_DATE, CURRENT_TIMESTAMP,  
LOCALTIMESTAMP FROM DUAL;
```

- d. Alter the session to set the TIME_ZONE parameter value to the time zone offset of Singapore.

```
ALTER SESSION SET TIME_ZONE = '+8:00';
```

- e. Display CURRENT_DATE, CURRENT_TIMESTAMP, and LOCALTIMESTAMP for this session.

Note: The output might be different, based on the date when the command is executed.

```
SELECT CURRENT_DATE, CURRENT_TIMESTAMP,  
LOCALTIMESTAMP FROM DUAL;
```

Practice Solutions 5-1: Managing Data in Different Time Zones (continued)

Note: Observe in the preceding practice that `CURRENT_DATE`, `CURRENT_TIMESTAMP`, and `LOCALTIMESTAMP` are all sensitive to the session time zone.

3. Write a query to display `DBTIMEZONE` and `SESSIONTIMEZONE`.

```
SELECT DBTIMEZONE, SESSIONTIMEZONE
FROM DUAL;
```

4. Write a query to extract `YEAR` from the `HIRE_DATE` column of the `EMPLOYEES` table for those employees who work in department 80.

```
SELECT last_name, EXTRACT (YEAR FROM HIRE_DATE)
FROM employees
WHERE department_id = 80;
```

5. Alter the session to set `NLS_DATE_FORMAT` to `DD-MON-YYYY`.

```
ALTER SESSION SET NLS_DATE_FORMAT = 'DD-MON-YYYY';
```

6. Examine and run the `lab_05_06.sql` script to create the `SAMPLE_DATES` table and populate it.

- a. Select from the table and view the data.

```
SELECT * FROM sample_dates;
```

- b. Modify the data type of the `DATE_COL` column and change it to `TIMESTAMP`.
Select from the table to view the data.

```
ALTER TABLE sample_dates MODIFY date_col TIMESTAMP;
SELECT * FROM sample_dates;
```

- c. Try to modify the data type of the `DATE_COL` column and change it to `TIMESTAMP WITH TIME ZONE`. What happens?

```
ALTER TABLE sample_dates MODIFY date_col
TIMESTAMP WITH TIME ZONE;
```

Practice Solutions 5-1: Managing Data in Different Time Zones (continued)

You are unable to change the data type of the DATE_COL column because the Oracle server does not permit you to convert from TIMESTAMP to TIMESTAMP WITH TIMEZONE by using the ALTER statement.

7. Create a query to retrieve last names from the EMPLOYEES table and calculate the review status. If the year hired was 1998, display Needs Review for the review status; otherwise, display not this year! Name the review status column Review. Sort the results by the HIRE_DATE column.

Hint: Use a CASE expression with the EXTRACT function to calculate the review status.

```
SELECT e.last_name
       , (CASE extract(year from e.hire_date)
           WHEN 1998 THEN 'Needs Review'
           ELSE 'not this year!'
         END ) AS "Review "
FROM   employees e
ORDER BY e.hire_date;
```

8. Create a query to print the last names and the number of years of service for each employee. If the employee has been employed five or more years, print 5 years of service. If the employee has been employed 10 or more years, print 10 years of service. If the employee has been employed 15 or more years, print 15 years of service. If none of these conditions match, print maybe next year! Sort the results by the HIRE_DATE column. Use the EMPLOYEES table.

Hint: Use CASE expressions and TO_YMINTERVAL.

```
SELECT e.last_name, hire_date, sysdate,
       (CASE
         WHEN (sysdate -TO_YMINTERVAL('15-0'))>=
              hire_date THEN      '15 years of service'
         WHEN (sysdate -TO_YMINTERVAL('10-0'))>= hire_date
              THEN      '10 years of service'
         WHEN (sysdate - TO_YMINTERVAL('5-0'))>= hire_date
              THEN '5 years of service'
         ELSE 'maybe next year!'
       END) AS "Awards"
FROM   employees e;
```

Practices and Solutions for Lesson 6

Practice 6-1: Retrieving Data by Using Subqueries

In this practice, you write multiple-column subqueries, and correlated and scalar subqueries. You also solve problems by writing the WITH clause.

1. Write a query to display the last name, department number, and salary of any employee whose department number and salary both match the department number and salary of any employee who earns a commission.

	LAST_NAME	DEPARTMENT_ID	SALARY
1	Russell	80	14000
2	Partners	80	13500
3	Errazuriz	80	12000

2. Display the last name, department name, and salary of any employee whose salary and commission match the salary and commission of any employee located in location ID 1700.

	LAST_NAME	DEPARTMENT_NAME	SALARY
1	Whalen	Administration	4400
2	Higgins	Accounting	12000
3	Greenberg	Finance	12000
4	Gietz	Accounting	8300

3. Create a query to display the last name, hire date, and salary for all employees who have the same salary and commission as Kochhar.

Note: Do not display Kochhar in the result set.

	LAST_NAME	HIRE_DATE	SALARY
1	De Haan	13-JAN-1993	17000

4. Create a query to display the employees who earn a salary that is higher than the salary of all the sales managers (JOB_ID = 'SA_MAN'). Sort the results from the highest to the lowest.

Practice 6-1: Retrieving Data by Using Subqueries (continued)

	LAST_NAME	JOB_ID	SALARY
1	King	AD_PRES	24000
2	De Haan	AD_VP	17000
3	Kochhar	AD_VP	17000

5. Display details such as the employee ID, last name, and department ID of those employees who live in cities the names of which begin with *T*.

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
1	202	Fay	20
2	201	Hartstein	20

6. Write a query to find all employees who earn more than the average salary in their departments. Display last name, salary, department ID, and the average salary for the department. Sort by average salary and round to two decimals. Use aliases for the columns retrieved by the query as shown in the sample output.

R	ENAME	SALARY	R	DEPTNO	R	DEPT_AVG
1	Fripp	8200		50	3475.5555555555555555555555555556	
2	Kaufling	7900		50	3475.5555555555555555555555555556	
3	Chung	3800		50	3475.5555555555555555555555555556	
4	Mourgos	5800		50	3475.5555555555555555555555555556	
5	Bell	4000		50	3475.5555555555555555555555555556	
6	Rajs	3500		50	3475.5555555555555555555555555556	
7	Bull	4100		50	3475.5555555555555555555555555556	
8	Everett	3800		50	3475.5555555555555555555555555556	

7. Find all employees who are not supervisors.
 - a. First, do this using the NOT EXISTS operator.

Practice 6-1: Retrieving Data by Using Subqueries (continued)

R 2	LAST_NAME
1	Abel
2	Ande
3	Atkinson
4	Austin
5	Baer
6	Baida

- b. Can this be done by using the NOT IN operator? How, or why not?
8. Write a query to display the last names of the employees who earn less than the average salary in their departments.

R 2	LAST_NAME
1	Chen
2	Sciarra
3	Urman
4	Popp
5	Khoo
6	Baida

9. Write a query to display the last names of the employees who have one or more coworkers in their departments with later hire dates but higher salaries.

R 2	LAST_NAME
1	Vargas
2	Patel
3	Olson
4	Marlow
5	Landry
6	Perkins

10. Write a query to display the employee ID, last names, and department names of all the employees.

Note: Use a scalar subquery to retrieve the department name in the SELECT statement.



R2	EMPLOYEE_ID	R2	LAST_NAME	R2	DEPARTMENT
1	205	Higgins	Accounting		
2	206	Gietz	Accounting		
3	200	Whalen	Administration		
4	100	King	Executive		
5	101	Kochhar	Executive		

...

Practice 6-1: Retrieving Data by Using Subqueries (continued)

105	196 Walsh	Shipping
106	197 Feeney	Shipping
107	178 Grant	(null)

11. Write a query to display the department names of those departments whose total salary cost is above one-eighth (1/8) of the total salary cost of the whole company. Use the WITH clause to write this query. Name the query SUMMARY.

	DEPARTMENT_NAME		DEPT_TOTAL
1	Sales		304500
2	Shipping		156400

Practice Solutions 6-1: Retrieving Data by Using Subqueries

1. Write a query to display the last name, department number, and salary of any employee whose department number and salary match the department number and salary of any employee who earns a commission.

```
SELECT last_name, department_id, salary
FROM   employees
WHERE  (salary, department_id) IN
      (SELECT salary, department_id
       FROM   employees
       WHERE  commission_pct IS NOT NULL);
```

2. Display the last name, department name, and salary of any employee whose salary and commission match the salary and commission of any employee located in location ID1700.

```
SELECT e.last_name, d.department_name, e.salary
FROM   employees e, departments d
WHERE  e.department_id = d.department_id
AND    (salary, NVL(commission_pct,0)) IN
      (SELECT salary, NVL(commission_pct,0)
       FROM   employees e, departments d
       WHERE  e.department_id = d.department_id
       AND d.location_id = 1700);
```

3. Create a query to display the last name, hire date, and salary for all employees who have the same salary and commission as Kochhar.

Note: Do not display Kochhar in the result set.

```
SELECT last_name, hire_date, salary
FROM   employees
WHERE  (salary, NVL(commission_pct,0)) IN
      (SELECT salary, NVL(commission_pct,0)
       FROM   employees
       WHERE  last_name = 'Kochhar')
AND last_name != 'Kochhar';
```

4. Create a query to display the employees who earn a salary that is higher than the salary of all the sales managers (JOB_ID = 'SA_MAN'). Sort the results on salary from the highest to the lowest.

```
SELECT last_name, job_id, salary
FROM   employees
WHERE  salary > ALL
      (SELECT salary
       FROM   employees
       WHERE  job_id = 'SA_MAN')
ORDER BY salary DESC;
```

Practice Solutions 6-1: Retrieving Data by Using Subqueries (continued)

5. Display details such as the employee ID, last name, and department ID of those employees who live in cities the names of which begin with *T*.

```
SELECT employee_id, last_name, department_id
FROM   employees
WHERE  department_id IN (SELECT department_id
                        FROM departments
                        WHERE location_id IN
                              (SELECT location_id
                               FROM locations
                               WHERE city LIKE 'T%'));
```

6. Write a query to find all employees who earn more than the average salary in their departments. Display last name, salary, department ID, and the average salary for the department. Sort by average salary. Use aliases for the columns retrieved by the query as shown in the sample output.

```
SELECT e.last_name ename, e.salary salary,
       e.department_id deptno, AVG(a.salary) dept_avg
FROM   employees e, employees a
WHERE  e.department_id = a.department_id
AND    e.salary > (SELECT AVG(salary)
                  FROM   employees
                  WHERE  department_id = e.department_id )
GROUP BY e.last_name, e.salary, e.department_id
ORDER BY AVG(a.salary);
```

Practice Solutions 6-1: Retrieving Data by Using Subqueries (continued)

7. Find all employees who are not supervisors.
 - a. First, do this by using the NOT EXISTS operator.

```
SELECT outer.last_name
FROM   employees outer
WHERE  NOT EXISTS (SELECT 'X'
                   FROM employees inner
                   WHERE inner.manager_id =
                       outer.employee_id);
```

- b. Can this be done by using the NOT IN operator? How, or why not?

```
SELECT outer.last_name
FROM   employees outer
WHERE  outer.employee_id
NOT IN (SELECT inner.manager_id
       FROM   employees inner);
```

This alternative solution is not a good one. The subquery picks up a NULL value, so the entire query returns no rows. The reason is that all conditions that compare a NULL value result in NULL. Whenever NULL values are likely to be part of the value set, *do not* use NOT IN as a substitute for NOT EXISTS.

8. Write a query to display the last names of the employees who earn less than the average salary in their departments.

```
SELECT last_name
FROM   employees outer
WHERE  outer.salary < (SELECT AVG(inner.salary)
                     FROM employees inner
                     WHERE inner.department_id
                         = outer.department_id);
```

Practice Solutions 6-1: Retrieving Data by Using Subqueries (continued)

9. Write a query to display the last names of employees who have one or more coworkers in their departments with later hire dates but higher salaries.

```
SELECT last_name
FROM employees outer
WHERE EXISTS (SELECT 'X'
              FROM employees inner
              WHERE inner.department_id =
                    outer.department_id
              AND inner.hire_date > outer.hire_date
              AND inner.salary > outer.salary);
```

10. Write a query to display the employee ID, last names, and department names of all employees.

Note: Use a scalar subquery to retrieve the department name in the SELECT statement.

```
SELECT employee_id, last_name,
       (SELECT department_name
        FROM departments d
        WHERE e.department_id =
              d.department_id ) department
FROM employees e
ORDER BY department;
```

11. Write a query to display the department names of those departments whose total salary cost is above one-eighth (1/8) of the total salary cost of the whole company. Use the WITH clause to write this query. Name the query SUMMARY.

```
WITH
summary AS (
  SELECT d.department_name, SUM(e.salary) AS dept_total
  FROM employees e, departments d
  WHERE e.department_id = d.department_id
  GROUP BY d.department_name)
SELECT department_name, dept_total
FROM summary
WHERE dept_total > ( SELECT SUM(dept_total) * 1/8
                    FROM summary )
ORDER BY dept_total DESC;
```

Practices and Solutions for Lesson 7

Practice 7-1: Regular Expression Support

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.

1. Write a query to search the EMPLOYEES table for all the employees whose first names start with “Ki” or “Ko.”

	FIRST_NAME	LAST_NAME
1	Janette	King
2	Steven	King
3	Neena	Kochhar

2. Create a query that removes the spaces in the STREET_ADDRESS column of the LOCATIONS table in the display. Use “Street Address” as the column heading.

	Street Address
1	1297ViaColadiRie
2	93091CalledeIlaTesta
3	2017Shinjuku-ku
4	9450Kamiya-cho
5	2014JabberwockyRd
6	2011InteriorsBlvd
7	2007ZagoraSt

3. Create a query that displays “St” replaced by “Street” in the STREET_ADDRESS column of the LOCATIONS table. Be careful that you do not affect any rows that already have “Street” in them. Display only those rows that are affected.

	REGEXP_REPLACE(STREET_ADDRESS,'ST\$','STREET')
1	2007 Zagora Street
2	6092 Boxwood Street
3	12-98 Victoria Street
4	8204 Arthur Street

4. Create a contacts table and add a check constraint to the p_number column to enforce the following format mask to ensure that phone numbers are entered into the database in the following standard format: (XXX) XXX-XXXX. The table should have the following columns:

- l_name varchar2(30)
- p_number varchar2(30)

Practice 7-1: Regular Expression Support (continued)

5. Run the SQL script `lab_07_05.sql` to insert the following seven phone numbers into the `contacts` table. Which numbers are added?

l_name Column Value	p_number Column Value
NULL	'(650) 555-5555'
NULL	'(215) 555-3427'
NULL	'650 555-5555'
NULL	'650 555 5555'
NULL	'650-555-5555'
NULL	'(650)555-5555'
NULL	' (650) 555-5555'

6. Write a query to find the number of occurrences of the DNA pattern `ctc` in the string `gtctcgtctcgttctgtctgtcgttctg`. Ignore case-sensitivity.

COUNT_DNA	
1	2

Practice Solutions 7-1: Regular Expression Support

1. Write a query to search the EMPLOYEES table for all employees whose first names start with “Ki” or “Ko.”

```
SELECT first_name, last_name
FROM employees
WHERE REGEXP_LIKE (last_name, '^K(i|o).');
```

2. Create a query that removes the spaces in the STREET_ADDRESS column of the LOCATIONS table in the display. Use “Street Address” as the column heading.

```
SELECT regexp_replace (street_address, ' ', '') AS "Street
Address"
FROM locations;
```

3. Create a query that displays “St” replaced by “Street” in the STREET_ADDRESS column of the LOCATIONS table. Be careful that you do not affect any rows that already have “Street” in them. Display only those rows, which are affected.

```
SELECT regexp_replace (street_address, 'St$',
'Street')
FROM locations
WHERE regexp_like (street_address, 'St');
```

4. Create a contacts table and add a check constraint to the p_number column to enforce the following format mask to ensure that phone numbers are entered into the database in the following standard format: (XXX) XXX-XXXX. The table should have the following columns:

- l_name varchar2(30)
- p_number varchar2 (30)

```
CREATE TABLE contacts
(
  l_name      VARCHAR2(30),
  p_number    VARCHAR2(30)
  CONSTRAINT p_number_format
  CHECK ( REGEXP_LIKE ( p_number, '^\\(\\d{3}\\) \\d{3}-
\\d{4}$' ) )
);
```


Practice Solutions 7-1: Regular Expression Support (continued)

5. Run the `lab_07_05.sql` SQL script to insert the following seven phone numbers into the `contacts` table. Which numbers are added?
Only the first two `INSERT` statements use a format that conforms to the `c_contacts_pnf` constraint; the remaining statements generate `CHECK` constraint errors.
6. Write a query to find the number of occurrences of the DNA pattern `ctc` in the string
`gtctcgtctcgttctgtctgtcgttctg`. Use the alias `Count_DNA`. Ignore case-sensitivity.

```
SELECT REGEXP_COUNT('gtctcgtctcgttctgtctgtcgttctg','ctc')
AS Count_DNA
FROM dual;
```

Practice Solutions 7-1: Regular Expression Support (continued)

Generating Reports by Grouping Related Data

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Objectives

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

- ROLLUP operation to produce subtotal values
- CUBE operation to produce cross-tabulation values
- GROUPING function to identify the row values created by ROLLUP or CUBE
- GROUPING SETS to produce a single result set

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Objectives

In this appendix, you learn how to:

- Group data to obtain the subtotal values by using the ROLLUP operator
- Group data to obtain the cross-tabulation values by using the CUBE operator
- Use the GROUPING function to identify the level of aggregation in the result set produced by a ROLLUP or CUBE operator
- Use GROUPING SETS to produce a single result set that is equivalent to a UNION ALL approach

Review of Group Functions

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

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

- Example:

```
SELECT AVG(salary), STDDEV(salary),
       COUNT(commission_pct), MAX(hire_date)
FROM   employees
WHERE  job_id LIKE 'SA%';
```

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Group Functions

You can use the GROUP BY clause to divide the rows in a table into groups. You can then use group functions to return summary information for each group. Group functions can appear in select lists and in ORDER BY and HAVING clauses. The Oracle server applies the group functions to each group of rows and returns a single result row for each group.

Types of group functions: Each of the group functions—AVG, SUM, MAX, MIN, COUNT, STDDEV, and VARIANCE—accepts one argument. The AVG, SUM, STDDEV, and VARIANCE functions operate only on numeric values. MAX and MIN can operate on numeric, character, or date data values. COUNT returns the number of non-NULL rows for the given expression. The example in the slide calculates the average salary, standard deviation on the salary, number of employees earning a commission, and the maximum hire date for those employees whose JOB_ID begins with SA.

Guidelines for Using Group Functions

- The data types for the arguments can be CHAR, VARCHAR2, NUMBER, or DATE.
- All group functions except COUNT (*) ignore null values. To substitute a value for null values, use the NVL function. COUNT returns either a number or zero.
- The Oracle server implicitly sorts the result set in ascending order of the grouping columns specified, when you use a GROUP BY clause. To override this default ordering, you can use DESC in an ORDER BY clause.

Review of the GROUP BY Clause

- Syntax:

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

- Example:

```
SELECT  department_id, job_id, SUM(salary),
        COUNT(employee_id)
FROM    employees
GROUP BY department_id, job_id ;
```

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Review of the GROUP BY Clause

The example illustrated in the slide is evaluated by the Oracle server as follows:

- The SELECT clause specifies that the following columns be retrieved:
 - Department ID and job ID columns from the EMPLOYEES table
 - The sum of all the salaries and the number of employees in each group that you have specified in the GROUP BY clause
- The GROUP BY clause specifies how the rows should be grouped in the table. The total salary and the number of employees are calculated for each job ID within each department. The rows are grouped by department ID and then grouped by job within each department.

Review of the HAVING Clause

- Use the HAVING clause to specify which groups are to be displayed.
- You further restrict the groups on the basis of a limiting condition.

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

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HAVING Clause

Groups are formed and group functions are calculated before the HAVING clause is applied to the groups. The HAVING clause can precede the GROUP BY clause, but it is recommended that you place the GROUP BY clause first because it is more logical.

The Oracle server performs the following steps when you use the HAVING clause:

1. It groups rows.
2. It applies the group functions to the groups and displays the groups that match the criteria in the HAVING clause.

GROUP BY with ROLLUP and CUBE Operators

- Use ROLLUP or CUBE with GROUP BY to produce superaggregate rows by cross-referencing columns.
- ROLLUP grouping produces a result set containing the regular grouped rows and the subtotal values.
- CUBE grouping produces a result set containing the rows from ROLLUP and cross-tabulation rows.

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GROUP BY with the ROLLUP and CUBE Operators

You specify ROLLUP and CUBE operators in the GROUP BY clause of a query. ROLLUP grouping produces a result set containing the regular grouped rows and subtotal rows. The ROLLUP operator also calculates a grand total. The CUBE operation in the GROUP BY clause groups the selected rows based on the values of all possible combinations of expressions in the specification and returns a single row of summary information for each group. You can use the CUBE operator to produce cross-tabulation rows.

Note: When working with ROLLUP and CUBE, make sure that the columns following the GROUP BY clause have meaningful, real-life relationships with each other; otherwise, the operators return irrelevant information.

ROLLUP Operator

- ROLLUP is an extension to the GROUP BY clause.
- Use the ROLLUP operation to produce cumulative aggregates, such as subtotals.

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

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ROLLUP Operator

The ROLLUP operator delivers aggregates and superaggregates for expressions within a GROUP BY statement. The ROLLUP operator can be used by report writers to extract statistics and summary information from result sets. The cumulative aggregates can be used in reports, charts, and graphs.

The ROLLUP operator creates groupings by moving in one direction, from right to left, along the list of columns specified in the GROUP BY clause. It then applies the aggregate function to these groupings.

Note

- To produce subtotals in n dimensions (that is, n columns in the GROUP BY clause) without a ROLLUP operator, $n+1$ SELECT statements must be linked with UNION ALL. This makes the query execution inefficient because each of the SELECT statements causes table access. The ROLLUP operator gathers its results with just one table access. The ROLLUP operator is useful when there are many columns involved in producing the subtotals.
- Subtotals and totals are produced with ROLLUP. CUBE produces totals as well but effectively rolls up in each possible direction, producing cross-tabular data.

ROLLUP Operator: Example

```
SELECT  department_id, job_id, SUM(salary)
FROM    employees
WHERE   department_id < 60
GROUP BY ROLLUP(department_id, job_id);
```

	DEPARTMENT_ID	JOB_ID	SUM(SALARY)
1	10	AD_ASST	4400
2	10	(null)	4400
3	20	MK_MAN	13000
4	20	MK_REP	6000
5	20	(null)	19000
6	30	PU_MAN	11000
7	30	PU_CLERK	13900
8	30	(null)	24900
9	40	HR_REP	6500
10	40	(null)	6500
11	50	ST_MAN	36400
12	50	SH_CLERK	64300
13	50	ST_CLERK	55700
14	50	(null)	156400
15	(null)	(null)	211200

1

2

3

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Example of a ROLLUP Operator

In the example in the slide:

- Total salaries for every job ID within a department for those departments whose department ID is less than 60 are displayed by the GROUP BY clause
- The ROLLUP operator displays:
 - The total salary for each department whose department ID is less than 60
 - The total salary for all departments whose department ID is less than 60, irrespective of the job IDs

In this example, 1 indicates a group totaled by both DEPARTMENT_ID and JOB_ID, 2 indicates a group totaled only by DEPARTMENT_ID, and 3 indicates the grand total.

The ROLLUP operator creates subtotals that roll up from the most detailed level to a grand total, following the grouping list specified in the GROUP BY clause. First, it calculates the standard aggregate values for the groups specified in the GROUP BY clause (in the example, the sum of salaries grouped on each job within a department). Then it creates progressively higher-level subtotals, moving from right to left through the list of grouping columns. (In the example, the sum of salaries for each department is calculated, followed by the sum of salaries for all departments.)

- Given n expressions in the ROLLUP operator of the GROUP BY clause, the operation results in $n + 1$ (in this case, $2 + 1 = 3$) groupings.
- Rows based on the values of the first n expressions are called rows or regular rows, and the others are called superaggregate rows.

CUBE Operator

- CUBE is an extension to the GROUP BY clause.
- You can use the CUBE operator to produce cross-tabulation values with a single SELECT statement.

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

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CUBE Operator

The CUBE operator is an additional switch in the GROUP BY clause in a SELECT statement. The CUBE operator can be applied to all aggregate functions, including AVG, SUM, MAX, MIN, and COUNT. It is used to produce result sets that are typically used for cross-tabular reports. ROLLUP produces only a fraction of possible subtotal combinations, whereas CUBE produces subtotals for all possible combinations of groupings specified in the GROUP BY clause, and a grand total.

The CUBE operator is used with an aggregate function to generate additional rows in a result set. Columns included in the GROUP BY clause are cross-referenced to produce a superset of groups. The aggregate function specified in the select list is applied to these groups to produce summary values for the additional superaggregate rows. The number of extra groups in the result set is determined by the number of columns included in the GROUP BY clause.

In fact, every possible combination of the columns or expressions in the GROUP BY clause is used to produce superaggregates. If you have n columns or expressions in the GROUP BY clause, there will be 2^n possible superaggregate combinations. Mathematically, these combinations form an n -dimensional cube, which is how the operator got its name.

By using application or programming tools, these superaggregate values can then be fed into charts and graphs that convey results and relationships visually and effectively.

CUBE Operator: Example

```
SELECT  department_id, job_id, SUM(salary)
FROM    employees
WHERE   department_id < 60
GROUP BY CUBE (department_id, job_id) ;
```

	DEPARTMENT_ID	JOB_ID	SUM(SALARY)	
1	(null)	(null)	211200	1
2	(null)	HR_REP	6500	
3	(null)	MK_MAN	13000	
4	(null)	MK_REP	6000	
5	(null)	PU_MAN	11000	
6	(null)	ST_MAN	36400	
7	(null)	AD_ASST	4400	2
8	(null)	PU_CLERK	13900	
9	(null)	SH_CLERK	64300	
10	(null)	ST_CLERK	55700	
11	10	(null)	4400	3
12	10	AD_ASST	4400	
13	20	(null)	19000	
14	20	MK_MAN	13000	
15	20	MK_REP	6000	
16	30	(null)	24900	4

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Example of a CUBE Operator

The output of the `SELECT` statement in the example can be interpreted as follows:

- The total salary for every job within a department (for those departments whose department ID is less than 60)
- The total salary for each department whose department ID is less than 60
- The total salary for each job irrespective of the department
- The total salary for those departments whose department ID is less than 60, irrespective of the job titles

In this example, 1 indicates the grand total, 2 indicates the rows totaled by `JOB_ID` alone, 3 indicates some of the rows totaled by `DEPARTMENT_ID` and `JOB_ID`, and 4 indicates some of the rows totaled by `DEPARTMENT_ID` alone.

The CUBE operator has also performed the ROLLUP operation to display the subtotals for those departments whose department ID is less than 60 and the total salary for those departments whose department ID is less than 60, irrespective of the job titles. Further, the CUBE operator displays the total salary for every job irrespective of the department.

Note: Similar to the ROLLUP operator, producing subtotals in n dimensions (that is, n columns in the GROUP BY clause) without a CUBE operator requires that 2^n SELECT statements be linked with UNION ALL. Thus, a report with three dimensions requires $2^3 = 8$ SELECT statements to be linked with UNION ALL.

GROUPING Function

The GROUPING function:

- Is used with either the CUBE or ROLLUP operator
- Is used to find the groups forming the subtotal in a row
- Is used to differentiate stored NULL values from NULL values created by ROLLUP or CUBE
- Returns 0 or 1

```
SELECT    [column,] group_function(column) .. ,  
          GROUPING(expr)  
FROM      table  
[WHERE    condition]  
[GROUP BY [ROLLUP][CUBE] group_by_expression]  
[HAVING   having_expression]  
[ORDER BY column];
```

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GROUPING Function

The GROUPING function can be used with either the CUBE or ROLLUP operator to help you understand how a summary value has been obtained.

The GROUPING function uses a single column as its argument. The *expr* in the GROUPING function must match one of the expressions in the GROUP BY clause. The function returns a value of 0 or 1.

The values returned by the GROUPING function are useful to:

- Determine the level of aggregation of a given subtotal (that is, the group or groups on which the subtotal is based)
- Identify whether a NULL value in the expression column of a row of the result set indicates:
 - A NULL value from the base table (stored NULL value)
 - A NULL value created by ROLLUP or CUBE (as a result of a group function on that expression)

A value of 0 returned by the GROUPING function based on an expression indicates one of the following:

- The expression has been used to calculate the aggregate value.
- The NULL value in the expression column is a stored NULL value.

A value of 1 returned by the GROUPING function based on an expression indicates one of the following:

- The expression has not been used to calculate the aggregate value.
- The NULL value in the expression column is created by ROLLUP or CUBE as a result of grouping.

GROUPING Function: Example

```
SELECT  department_id DEPTID, job_id JOB,
        SUM(salary),
        GROUPING(department_id) GRP_DEPT,
        GROUPING(job_id) GRP_JOB
FROM    employees
WHERE   department_id < 50
GROUP BY ROLLUP(department_id, job_id);
```

	DEPTID	JOB	SUM(SALARY)	GRP_DEPT	GRP_JOB
1	10	AD_ASST	4400	0	0
2	10	(null)	4400	0	1
3	20	MK_MAN	13000	0	0
4	20	MK_REP	6000	0	0
5	20	(null)	19000	0	1
6	30	PU_MAN	11000	0	0
7	30	PU_CLERK	13900	0	0
8	30	(null)	24900	0	1
9	40	HR_REP	6500	0	0
10	40	(null)	6500	0	1
11	(null)	(null)	54800	1	1

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Example of a GROUPING Function

In the example in the slide, consider the summary value 4400 in the first row (labeled 1). This summary value is the total salary for the job ID of AD_ASST within department 10. To calculate this summary value, both the DEPARTMENT_ID and JOB_ID columns have been taken into account. Thus, a value of 0 is returned for both the GROUPING(department_id) and GROUPING(job_id) expressions.

Consider the summary value 4400 in the second row (labeled 2). This value is the total salary for department 10 and has been calculated by taking into account the DEPARTMENT_ID column; thus, a value of 0 has been returned by GROUPING(department_id). Because the JOB_ID column has not been taken into account to calculate this value, a value of 1 has been returned for GROUPING(job_id). You can observe similar output in the fifth row.

In the last row, consider the summary value 54800 (labeled 3). This is the total salary for those departments whose department ID is less than 50 and all job titles. To calculate this summary value, neither of the DEPARTMENT_ID and JOB_ID columns have been taken into account. Thus, a value of 1 is returned for both the GROUPING(department_id) and GROUPING(job_id) expressions.

GROUPING SETS

- The GROUPING SETS syntax is used to define multiple groupings in the same query.
- All groupings specified in the GROUPING SETS clause are computed and the results of individual groupings are combined with a UNION ALL operation.
- Grouping set efficiency:
 - Only one pass over the base table is required.
 - There is no need to write complex UNION statements.
 - The more elements GROUPING SETS has, the greater is the performance benefit.

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GROUPING SETS

GROUPING SETS is a further extension of the GROUP BY clause that you can use to specify multiple groupings of data. Doing so facilitates efficient aggregation and, therefore, facilitates analysis of data across multiple dimensions.

A single SELECT statement can now be written using GROUPING SETS to specify various groupings (which can also include ROLLUP or CUBE operators), rather than multiple SELECT statements combined by UNION ALL operators. For example:

```
SELECT department_id, job_id, manager_id, AVG(salary)
FROM employees
GROUP BY
GROUPING SETS
((department_id, job_id, manager_id),
 (department_id, manager_id), (job_id, manager_id));
```

This statement calculates aggregates over three groupings:

```
(department_id, job_id, manager_id), (department_id,
manager_id) and (job_id, manager_id)
```

Without this feature, multiple queries combined together with UNION ALL are required to obtain the output of the preceding SELECT statement. A multiquery approach is inefficient because it requires multiple scans of the same data.

GROUPING SETS (continued)

Compare the previous example with the following alternative:

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

This statement computes all the 8 (2 * 2 * 2) groupings, though only the (department_id, job_id, manager_id), (department_id, manager_id), and (job_id, manager_id) groups are of interest to you.

Another alternative is the following statement:

```
SELECT department_id, job_id, manager_id, AVG(salary)
FROM employees
GROUP BY department_id, job_id, manager_id
UNION ALL
SELECT department_id, NULL, manager_id, AVG(salary)
FROM employees
GROUP BY department_id, manager_id
UNION ALL
SELECT NULL, job_id, manager_id, AVG(salary)
FROM employees
GROUP BY job_id, manager_id;
```

This statement requires three scans of the base table, which makes it inefficient.

CUBE and ROLLUP can be thought of as grouping sets with very specific semantics and results.

The following equivalencies show this fact:

CUBE(a, b, c) is equivalent to	GROUPING SETS ((a, b, c), (a, b), (a, c), (b, c), (a), (b), (c), ())
ROLLUP(a, b, c) is equivalent to	GROUPING SETS ((a, b, c), (a, b), (a), ())

GROUPING SETS: Example

```
SELECT  department_id, job_id,
        manager_id,AVG(salary)
FROM    employees
GROUP BY GROUPING SETS
        ((department_id,job_id), (job_id,manager_id));
```

	DEPARTMENT_ID	JOB_ID	MANAGER_ID	AVG(SALARY)
1	(null)	SH_CLERK	122	3200
2	(null)	AC_MGR	101	12000
3	(null)	ST_MAN	100	7280
4	...	(null)	ST_CLERK	2675

1

	DEPARTMENT_ID	JOB_ID	MANAGER_ID	AVG(SALARY)
39	110	AC_MGR	(null)	12000
40	90	AD_PRES	(null)	24000
41	60	IT_PROG	(null)	5760
42	100	FI_MGR	(null)	12000

2

...

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GROUPING SETS: Example

The query in the slide calculates aggregates over two groupings. The table is divided into the following groups:

- Department ID, Job ID
- Job ID, Manager ID

The average salaries for each of these groups are calculated. The result set displays the average salary for each of the two groups.

In the output, the group marked as 1 can be interpreted as the following:

- The average salary of all employees with the SH_CLERK job ID under manager 122 is 3,200.
- The average salary of all employees with the AC_MGR job ID under manager 101 is 12,000, and so on.

The group marked as 2 in the output is interpreted as the following:

- The average salary of all employees with the AC_MGR job ID in department 110 is 12,000.
- The average salary of all employees with the AD_PRES job ID in department 90 is 24,000, and so on.

GROUPING SETS: Example (continued)

The example in the slide can also be written as:

```
SELECT department_id, job_id, NULL as manager_id,  
       AVG(salary) as AVGSAL  
FROM employees  
GROUP BY department_id, job_id  
UNION ALL  
SELECT NULL, job_id, manager_id, avg(salary) as AVGSAL  
FROM employees  
GROUP BY job_id, manager_id;
```

In the absence of an optimizer that looks across query blocks to generate the execution plan, the preceding query would need two scans of the base table, EMPLOYEES. This could be very inefficient. Therefore, the usage of the GROUPING SETS statement is recommended.

Composite Columns

- A composite column is a collection of columns that are treated as a unit.
`ROLLUP (a, (b, c) , d)`
- Use parentheses within the GROUP BY clause to group columns, so that they are treated as a unit while computing ROLLUP or CUBE operations.
- When used with ROLLUP or CUBE, composite columns would require skipping aggregation across certain levels.

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Composite Columns

A composite column is a collection of columns that are treated as a unit during the computation of groupings. You specify the columns in parentheses as in the following statement: ROLLUP (a, (b, c), d)

Here, (b, c) forms a composite column and is treated as a unit. In general, composite columns are useful in ROLLUP, CUBE, and GROUPING SETS. For example, in CUBE or ROLLUP, composite columns would require skipping aggregation across certain levels.

That is, GROUP BY ROLLUP(a, (b, c)) is equivalent to:

```
GROUP BY a, b, c UNION ALL
GROUP BY a UNION ALL
GROUP BY ( )
```

Here, (b, c) is treated as a unit and ROLLUP is not applied across (b, c). It is as though you have an alias—for example, z as an alias for (b, c), and the GROUP BY expression reduces to: GROUP BY ROLLUP(a, z).

Note: GROUP BY () is typically a SELECT statement with NULL values for the columns a and b and only the aggregate function. It is generally used for generating grand totals.

```
SELECT    NULL, NULL, aggregate_col
FROM      <table_name>
GROUP BY ( );
```

Composite Columns (continued)

Compare this with the normal ROLLUP as in:

```
GROUP BY ROLLUP(a, b, c)
```

This would be:

```
GROUP BY a, b, c UNION ALL
GROUP BY a, b UNION ALL
GROUP BY a UNION ALL
GROUP BY ()
```

Similarly:

```
GROUP BY CUBE((a, b), c)
```

This would be equivalent to:

```
GROUP BY a, b, c UNION ALL
GROUP BY a, b UNION ALL
GROUP BY c UNION ALL
GROUP BY ()
```

The following table shows the GROUPING SETS specification and the equivalent GROUP BY specification.

GROUPING SETS Statements	Equivalent GROUP BY Statements
GROUP BY GROUPING SETS(a, b, c)	GROUP BY a UNION ALL GROUP BY b UNION ALL GROUP BY c
GROUP BY GROUPING SETS(a, b, (b, c)) (The GROUPING SETS expression has a composite column.)	GROUP BY a UNION ALL GROUP BY b UNION ALL GROUP BY b, c
GROUP BY GROUPING SETS((a, b, c))	GROUP BY a, b, c
GROUP BY GROUPING SETS(a, (b), ())	GROUP BY a UNION ALL GROUP BY b UNION ALL GROUP BY ()
GROUP BY GROUPING SETS (a, ROLLUP(b, c)) (The GROUPING SETS expression has a composite column.)	GROUP BY a UNION ALL GROUP BY ROLLUP(b, c)

Composite Columns: Example

```
SELECT  department_id, job_id, manager_id,
        SUM(salary)
FROM    employees
GROUP BY ROLLUP( department_id, (job_id, manager_id));
```

	DEPARTMENT_ID	JOB_ID	MANAGER_ID	SUM(SALARY)
1	(null)	SA_REP	149	7000
2	(null)	(null)	(null)	7000
3	10	AD_ASST	101	4400
4	10	(null)	(null)	4400
5	20	MK_MAN	100	13000
6	20	MK_REP	201	6000
7	20	(null)	(null)	19000

...

	DEPARTMENT_ID	JOB_ID	MANAGER_ID	SUM(SALARY)
40	100	FL_MGR	101	12000
41	100	FL_ACCOUNT	108	39600
42	100	(null)	(null)	51600
43	110	AC_MGR	101	12000
44	110	AC_ACCOUNT	205	8300
45	110	(null)	(null)	20300
46	(null)	(null)	(null)	691400

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Composite Columns: Example

Consider the example:

```
SELECT department_id, job_id, manager_id, SUM(salary)
FROM    employees
GROUP BY ROLLUP( department_id, job_id, manager_id);
```

This query results in the Oracle server computing the following groupings:

- (job_id, manager_id)
- (department_id, job_id, manager_id)
- (department_id)
- Grand total

If you are interested only in specific groups, you cannot limit the calculation to those groupings without using composite columns. With composite columns, this is possible by treating JOB_ID and MANAGER_ID columns as a single unit while rolling up. Columns enclosed in parentheses are treated as a unit while computing ROLLUP and CUBE. This is illustrated in the example in the slide. By enclosing the JOB_ID and MANAGER_ID columns in parentheses, you indicate to the Oracle server to treat JOB_ID and MANAGER_ID as a single unit—that is, a composite column.

Composite Columns: Example (continued)

The example in the slide computes the following groupings:

- (department_id, job_id, manager_id)
- (department_id)
- ()

The example in the slide displays the following:

- Total salary for every job and manager (labeled 1)
- Total salary for every department, job, and manager (labeled 2)
- Total salary for every department (labeled 3)
- Grand total (labeled 4)

The example in the slide can also be written as:

```
SELECT department_id, job_id, manager_id, SUM(salary)
FROM   employees
GROUP   BY department_id, job_id, manager_id
UNION   ALL
SELECT   department_id, TO_CHAR(NULL), TO_NUMBER(NULL),
        SUM(salary)
FROM     employees
GROUP BY department_id
UNION ALL
SELECT   TO_NUMBER(NULL), TO_CHAR(NULL), TO_NUMBER(NULL),
        SUM(salary)
FROM     employees
GROUP BY ( );
```

In the absence of an optimizer that looks across query blocks to generate the execution plan, the preceding query would need three scans of the base table, EMPLOYEES. This could be very inefficient. Therefore, the use of composite columns is recommended.

Concatenated Groupings

- Concatenated groupings offer a concise way to generate useful combinations of groupings.
- To specify concatenated grouping sets, you separate multiple grouping sets, ROLLUP and CUBE operations with commas so that the Oracle server combines them into a single GROUP BY clause.
- The result is a cross-product of groupings from each GROUPING SET.

```
GROUP BY GROUPING SETS(a, b), GROUPING SETS(c, d)
```

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Concatenated Groupings

Concatenated groupings offer a concise way to generate useful combinations of groupings. The concatenated groupings are specified by listing multiple grouping sets, CUBEs, and ROLLUPS, and separating them with commas. The following is an example of concatenated grouping sets:

```
GROUP BY GROUPING SETS(a, b), GROUPING SETS(c, d)
```

This SQL example defines the following groupings:

```
(a, c), (a, d), (b, c), (b, d)
```

Concatenation of grouping sets is very helpful for these reasons:

- **Ease of query development:** You need not manually enumerate all groupings.
- **Use by applications:** SQL generated by online analytical processing (OLAP) applications often involves concatenation of grouping sets, with each GROUPING SET defining groupings needed for a dimension.

Concatenated Groupings: Example

```
SELECT department_id, job_id, manager_id,
       SUM(salary)
FROM   employees
GROUP BY department_id,
       ROLLUP(job_id),
       CUBE(manager_id);
```

	DEPARTMENT_ID	JOB_ID	MANAGER_ID	SUM(SALARY)
1	(null)	SA_REP	149	7000
2		10 AD_ASST	101	4400
3		20 MK_MAN	100	13000
4		20 MK_REP	201	6000
...				
1	90	AD_VP	100	34000
	90	AD_PRES	(null)	24000
...				
	(null)	SA_REP	(null)	7000
	10	AD_ASST	(null)	4400
...				
2	110	(null)	101	12000
	110	(null)	205	8300
	110	(null)	(null)	20300

Concatenated Groupings: Example

The example in the slide results in the following groupings:

- (department_id, job_id,) (1)
- (department_id, manager_id) (2)
- (department_id) (3)

The total salary for each of these groups is calculated.

The following is another example of a concatenated grouping.

```
SELECT department_id, job_id, manager_id, SUM(salary) totalsal
FROM employees
WHERE department_id < 60
GROUP BY GROUPING SETS (department_id),
GROUPING SETS (job_id, manager_id);
```


Summary

In this appendix, you should have learned how to use the:

- ROLLUP operation to produce subtotal values
- CUBE operation to produce cross-tabulation values
- GROUPING function to identify the row values created by ROLLUP or CUBE
- GROUPING SETS syntax to define multiple groupings in the same query
- GROUP BY clause to combine expressions in various ways:
 - Composite columns
 - Concatenated grouping sets

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Summary

- ROLLUP and CUBE are extensions of the GROUP BY clause.
- ROLLUP is used to display subtotal and grand total values.
- CUBE is used to display cross-tabulation values.
- The GROUPING function enables you to determine whether a row is an aggregate produced by a CUBE or ROLLUP operator.
- With the GROUPING SETS syntax, you can define multiple groupings in the same query. GROUP BY computes all the groupings specified and combines them with UNION ALL.
- Within the GROUP BY clause, you can combine expressions in various ways:
 - To specify composite columns, you group columns within parentheses so that the Oracle server treats them as a unit while computing ROLLUP or CUBE operations.
 - To specify concatenated grouping sets, you separate multiple grouping sets, ROLLUP, and CUBE operations with commas so that the Oracle server combines them into a single GROUP BY clause. The result is a cross-product of groupings from each grouping set.

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Hierarchical Retrieval

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Objectives

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

- Interpret the concept of a hierarchical query
- Create a tree-structured report
- Format hierarchical data
- Exclude branches from the tree structure

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Objectives

In this appendix, you learn how to use hierarchical queries to create tree-structured reports.

Sample Data from the EMPLOYEES Table

	EMPLOYEE_ID	LAST_NAME	JOB_ID	MANAGER_ID
1	100	King	AD_PRES	(null)
2	101	Kochhar	AD_VP	100
3	102	De Haan	AD_VP	100
4	103	Hunold	IT_PROG	102
5	104	Ernst	IT_PROG	103
6	107	Lorentz	IT_PROG	103

...

16	200	Whalen	AD_ASST	101
17	201	Hartstein	MK_MAN	100
18	202	Fay	MK_REP	201
19	205	Higgins	AC_MGR	101
20	206	Gietz	AC_ACCOUNT	205

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Sample Data from the EMPLOYEES Table

Using hierarchical queries, you can retrieve data based on a natural hierarchical relationship between the rows in a table. A relational database does not store records in a hierarchical way. However, where a hierarchical relationship exists between the rows of a single table, a process called *tree walking* enables the hierarchy to be constructed. A hierarchical query is a method of reporting, with the branches of a tree in a specific order.

Imagine a family tree with the eldest members of the family found close to the base or trunk of the tree and the youngest members representing branches of the tree. Branches can have their own branches, and so on.

A hierarchical query is possible when a relationship exists between rows in a table. For example, in the slide, you see that Kochhar, De Haan, and Hartstein report to MANAGER_ID 100, which is King's EMPLOYEE_ID.

Note: Hierarchical trees are used in various fields such as human genealogy (family trees), livestock (breeding purposes), corporate management (management hierarchies), manufacturing (product assembly), evolutionary research (species development), and scientific research.

Natural Tree Structure

```
graph TD; King["King  
EMPLOYEE_ID = 100 (Parent)"] --- Line1; Line1 --- Kochhar; Line1 --- DeHaan["De Haan"]; Line1 --- Mourgos; Line1 --- Zlotkey; Line1 --- Hartstein; Kochhar --- Whalen; Kochhar --- Higgins; Higgins --- Gietz; DeHaan --- Hunold; Hunold --- Ernst; Hunold --- Lorentz; Mourgos --- Rajs; Mourgos --- Davies; Mourgos --- Matos; Mourgos --- Vargas; Zlotkey --- Abel; Zlotkey --- Taylor; Zlotkey --- Grant; Hartstein --- Fay;
```

EMPLOYEE_ID = 100 (Parent)

King

MANAGER_ID = 100 (Child)

Kochhar

De Haan

Mourgos

Zlotkey

Hartstein

Whalen

Higgins

Hunold

Rajs

Davies

Matos

Vargas

Gietz

Ernst

Lorentz

Abel

Taylor

Grant

Fay

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The EMPLOYEES table has a tree structure representing the management reporting line. The hierarchy can be created by looking at the relationship between equivalent values in the EMPLOYEE_ID and MANAGER_ID columns. This relationship can be exploited by joining the table to itself. The MANAGER_ID column contains the employee number of the employee's manager.

- The direction in which the hierarchy is walked
- The starting point inside the hierarchy

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Hierarchical Queries

```
SELECT [LEVEL], column, expr...  
FROM   table  
[WHERE condition(s)]  
[START WITH condition(s)]  
[CONNECT BY PRIOR condition(s)] ;
```

condition:

```
expr comparison_operator expr
```

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Keywords and Clauses

Hierarchical queries can be identified by the presence of the CONNECT BY and START WITH clauses.

In the syntax:

SELECT	Is the standard SELECT clause
LEVEL	For each row returned by a hierarchical query, the LEVEL pseudocolumn returns 1 for a root row, 2 for a child of a root, and so on.
FROM <i>table</i>	Specifies the table, view, or snapshot containing the columns. You can select from only one table.
WHERE	Restricts the rows returned by the query without affecting other rows of the hierarchy
<i>condition</i>	Is a comparison with expressions
START WITH	Specifies the root rows of the hierarchy (where to start). This clause is required for a true hierarchical query.
CONNECT BY	Specifies the columns in which the relationship between parent and child PRIOR rows exist. This clause is required for a hierarchical query.

Walking the Tree

Starting Point

- Specifies the condition that must be met
- Accepts any valid condition

```
START WITH column1 = value
```

Using the EMPLOYEES table, start with the employee whose last name is Kochhar.

```
...START WITH last_name = 'Kochhar'
```

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Walking the Tree

The row or rows to be used as the root of the tree are determined by the START WITH clause. The START WITH clause can contain any valid condition.

Examples

Using the EMPLOYEES table, start with King, the president of the company.

```
... START WITH manager_id IS NULL
```

Using the EMPLOYEES table, start with employee Kochhar. A START WITH condition can contain a subquery.

```
... START WITH employee_id = (SELECT employee_id
                                FROM   employees
                                WHERE  last_name = 'Kochhar')
```

If the START WITH clause is omitted, the tree walk is started with all the rows in the table as root rows.

Note: The CONNECT BY and START WITH clauses are not American National Standards Institute (ANSI) SQL standard.

Walking the Tree

CONNECT BY PRIOR *column1* = *column2*

Walk from the top down, using the `EMPLOYEES` table.

```
... CONNECT BY PRIOR employee_id = manager_id
```

Direction

Top down \longrightarrow Column1 = Parent Key
 Column2 = Child Key

Bottom up \longrightarrow Column1 = Child Key
Column2 = Parent Key

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Walking the Tree (continued)

The direction of the query is determined by the `CONNECT BY PRIOR` column placement. For top-down, the `PRIOR` operator refers to the parent row. For bottom-up, the `PRIOR` operator refers to the child row. To find the child rows of a parent row, the Oracle server evaluates the `PRIOR` expression for the parent row and the other expressions for each row in the table. Rows for which the condition is true are the child rows of the parent. The Oracle server always selects child rows by evaluating the `CONNECT BY` condition with respect to a current parent row.

Examples

Walk from the top down using the EMPLOYEES table. Define a hierarchical relationship in which the EMPLOYEE_ID value of the parent row is equal to the MANAGER_ID value of the child row:

```
... CONNECT BY PRIOR employee_id = manager_id
```

Walk from the bottom up using the EMPLOYEES table:

```
... CONNECT BY PRIOR manager_id = employee_id
```

The PRIOR operator does not necessarily need to be coded immediately following CONNECT BY. Thus, the following CONNECT BY PRIOR clause gives the same result as the one in the preceding example:

```
... CONNECT BY employee_id = PRIOR manager_id
```

Note: The CONNECT BY clause cannot contain a subquery.

Walking the Tree: From the Bottom Up

```
SELECT employee_id, last_name, job_id, manager_id
FROM employees
START WITH employee_id = 101
CONNECT BY PRIOR manager_id = employee_id ;
```

	EMPLOYEE_ID	LAST_NAME	JOB_ID	MANAGER_ID
1	101	Kochhar	AD_VP	100
2	100	King	AD_PRES	(null)

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Walking the Tree: From the Bottom Up

The example in the slide displays a list of managers starting with the employee whose employee ID is 101.

Walking the Tree: From the Top Down

```
SELECT last_name||' reports to '||  
PRIOR last_name "Walk Top Down"  
FROM employees  
START WITH last_name = 'King'  
CONNECT BY PRIOR employee_id = manager_id ;
```

Walk Top Down
1 King reports to
2 King reports to
3 Kochhar reports to King
4 Greenberg reports to Kochhar
5 Faviet reports to Greenberg

...

105 Grant reports to Zlotkey
106 Johnson reports to Zlotkey
107 Hartstein reports to King
108 Fay reports to Hartstein

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Walking the Tree: From the Top Down

Walking from the top down, display the names of the employees and their manager. Use employee King as the starting point. Print only one column.

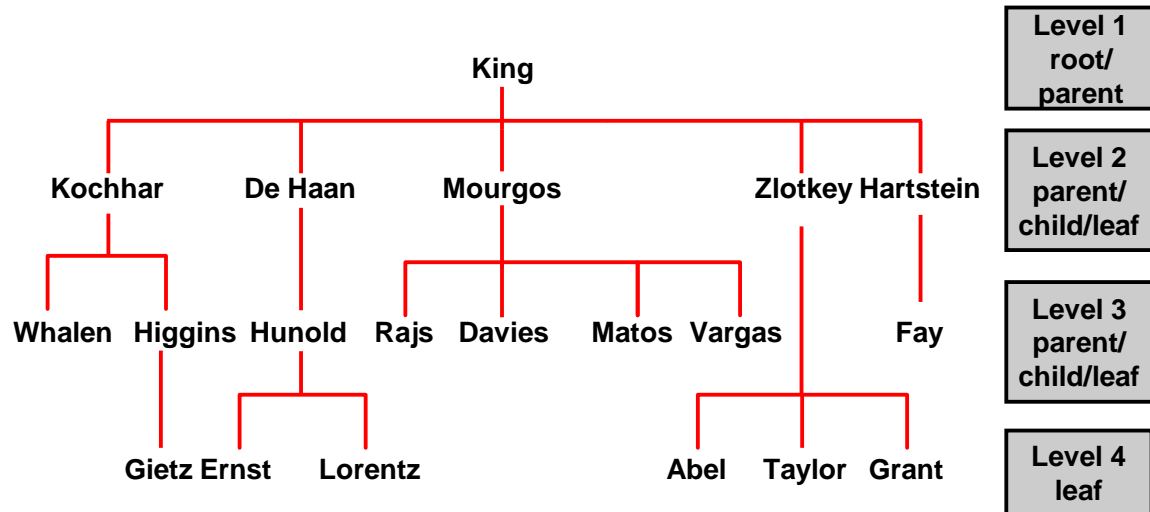
Example

In the following example, EMPLOYEE_ID values are evaluated for the parent row and MANAGER_ID and SALARY values are evaluated for the child rows. The PRIOR operator applies only to the EMPLOYEE_ID value.

```
... CONNECT BY PRIOR employee_id = manager_id  
                AND salary > 15000;
```

To qualify as a child row, a row must have a MANAGER_ID value equal to the EMPLOYEE_ID value of the parent row and must have a SALARY value greater than \$15,000.

Ranking Rows with the LEVEL Pseudocolumn



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Ranking Rows with the LEVEL Pseudocolumn

You can explicitly show the rank or level of a row in the hierarchy by using the LEVEL pseudocolumn. This will make your report more readable. The forks where one or more branches split away from a larger branch are called nodes, and the very end of a branch is called a leaf or leaf node. The graphic in the slide shows the nodes of the inverted tree with their LEVEL values. For example, employee Higgins is a parent and a child, whereas employee Davies is a child and a leaf.

LEVEL Pseudocolumn

Value	Level for Top Down	Level for Bottom up
1	A root node	A root node
2	A child of a root node	The parent of a root node
3	A child of a child, and so on	A parent of a parent, and so on

In the slide, King is the root or parent (LEVEL = 1). Kochhar, De Haan, Mourgos, Zlotkey, Hartstein, Higgins, and Hunold are children and also parents (LEVEL = 2). Whalen, Rajs, Davies, Matos, Vargas, Gietz, Ernst, Lorentz, Abel, Taylor, Grant, and Fay are children and leaves (LEVEL = 3 and LEVEL = 4).

Note: A *root node* is the highest node within an inverted tree. A *child node* is any nonroot node. A parent node is any node that has children. A leaf node is any node without children. The number of levels returned by a hierarchical query may be limited by available user memory.

Formatting Hierarchical Reports Using LEVEL and LPAD

Create a report displaying company management levels, beginning with the highest level and indenting each of the following levels.

```
COLUMN org_chart FORMAT A12
SELECT LPAD(last_name, LENGTH(last_name)+(LEVEL*2)-2, '_')
       AS org_chart
FROM   employees
START WITH first_name='Steven' AND last_name='King'
CONNECT BY PRIOR employee_id=manager_id
```

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Formatting Hierarchical Reports Using LEVEL and LPAD

The nodes in a tree are assigned level numbers from the root. Use the LPAD function in conjunction with the LEVEL pseudocolumn to display a hierarchical report as an indented tree.

In the example in the slide:

- `LPAD(char1, n [, char2])` returns *char1*, left-padded to length *n* with the sequence of characters in *char2*. The argument *n* is the total length of the return value as it is displayed on your terminal screen.
- `LPAD(last_name, LENGTH(last_name)+(LEVEL*2)-2, '_')` defines the display format
- *char1* is the LAST_NAME, *n* the total length of the return value, is length of the LAST_NAME + (LEVEL*2) - 2, and *char2* is '_'

That is, this tells SQL to take the LAST_NAME and left-pad it with the '_' character until the length of the resultant string is equal to the value determined by `LENGTH(last_name) + (LEVEL*2) - 2`.

For King, LEVEL = 1. Therefore, $(2 * 1) - 2 = 2 - 2 = 0$. So King does not get padded with any '_' character and is displayed in column 1.

For Kochhar, LEVEL = 2. Therefore, $(2 * 2) - 2 = 4 - 2 = 2$. So Kochhar gets padded with 2 '_' characters and is displayed indented.

The rest of the records in the EMPLOYEES table are displayed similarly.

Formatting Hierarchical Reports Using LEVEL and LPAD (continued)

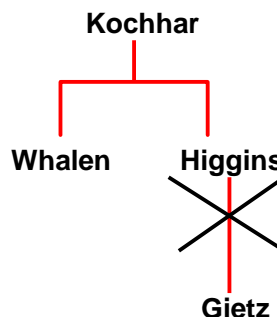
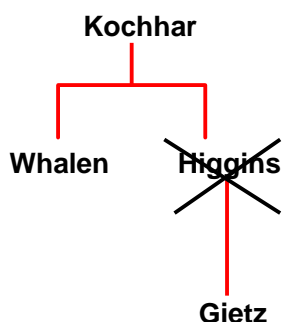
 ORG_CHART
1 King
2 __Kochhar
3 ____Greenberg
4 _____Faviet
5 _____Chen
6 _____Sciarra
7 _____Urman
8 _____Popp
9 _____Whalen
10 ____Mavris
11 ____Baer
12 ____Higgins
13 _____Gietz
14 __De Haan
15 ____Hunold
16 _____Ernst
17 _____Austin

Pruning Branches

Use the WHERE clause
to eliminate a node.

Use the CONNECT BY clause
to eliminate a branch.

```
WHERE last_name != 'Higgins'
CONNECT BY PRIOR
employee_id = manager_id
AND last_name != 'Higgins'
```



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Pruning Branches

You can use the WHERE and CONNECT BY clauses to prune the tree (that is, to control which nodes or rows are displayed). The predicate you use acts as a Boolean condition.

Examples

Starting at the root, walk from the top down, and eliminate employee Higgins in the result, but process the child rows.

```
SELECT department_id, employee_id, last_name, job_id, salary
FROM employees
WHERE last_name != 'Higgins'
START WITH manager_id IS NULL
CONNECT BY PRIOR employee_id = manager_id;
```

Starting at the root, walk from the top down, and eliminate employee Higgins and all child rows.

```
SELECT department_id, employee_id, last_name, job_id, salary
FROM employees
START WITH manager_id IS NULL
CONNECT BY PRIOR employee_id = manager_id
AND last_name != 'Higgins';
```

Summary

In this appendix, you should have learned that you can:

- Use hierarchical queries to view a hierarchical relationship between rows in a table
- Specify the direction and starting point of the query
- Eliminate nodes or branches by pruning

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Summary

You can use hierarchical queries to retrieve data based on a natural hierarchical relationship between rows in a table. The `LEVEL` pseudocolumn counts how far down a hierarchical tree you have traveled. You can specify the direction of the query using the `CONNECT BY PRIOR` clause. You can specify the starting point using the `START WITH` clause. You can use the `WHERE` and `CONNECT BY` clauses to prune the tree branches.

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Writing Advanced Scripts

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Objectives

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

- Describe the type of problems that are solved by using SQL to generate SQL
- Write a script that generates a script of `DROP TABLE` statements
- Write a script that generates a script of `INSERT INTO` statements

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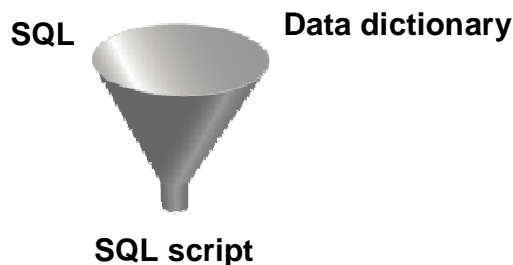
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Objectives

In this appendix, you learn how to write a SQL script to generate a SQL script.

Using SQL to Generate SQL

- SQL can be used to generate scripts in SQL.
- The data dictionary is:
 - A collection of tables and views that contain database information
 - Created and maintained by the Oracle server



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Using SQL to Generate SQL

SQL can be a powerful tool to generate other SQL statements. In most cases, this involves writing a script file. You can use SQL from SQL to:

- Avoid repetitive coding
- Access information from the data dictionary
- Drop or re-create database objects
- Generate dynamic predicates that contain run-time parameters

The examples used in this appendix involve selecting information from the data dictionary. The data dictionary is a collection of tables and views that contain information about the database. This collection is created and maintained by the Oracle server. All data dictionary tables are owned by the SYS user. Information stored in the data dictionary includes names of Oracle server users, privileges granted to users, database object names, table constraints, and audit information. There are four categories of data dictionary views. Each category has a distinct prefix that reflects its intended use.

Prefix	Description
USER_	Contains details of objects owned by the user
ALL_	Contains details of objects to which the user has been granted access rights, in addition to objects owned by the user
DBA_	Contains details of users with DBA privileges to access any object in the database
V\$_	Stores information about database server performance and locking; available only to the DBA

Creating a Basic Script

```
SELECT 'CREATE TABLE ' || table_name ||  
      '_test ' || 'AS SELECT * FROM '  
      || table_name || ' WHERE 1=2;'  
      AS "Create Table Script"  
FROM   user_tables;
```

Create Table Script

```
1 CREATE TABLE REGIONS_test AS SELECT * FROM REGIONS WHERE 1=2;  
2 CREATE TABLE LOCATIONS_test AS SELECT * FROM LOCATIONS WHERE 1=2;  
3 CREATE TABLE DEPARTMENTS_test AS SELECT * FROM DEPARTMENTS WHERE 1=2;  
4 CREATE TABLE JOBS_test AS SELECT * FROM JOBS WHERE 1=2;  
5 CREATE TABLE EMPLOYEES_test AS SELECT * FROM EMPLOYEES WHERE 1=2;  
6 CREATE TABLE JOB_HISTORY_test AS SELECT * FROM JOB_HISTORY WHERE 1=2;
```

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A Basic Script

The example in the slide produces a report with CREATE TABLE statements from every table you own. Each CREATE TABLE statement produced in the report includes the syntax to create a table using the table name with a suffix of _test and having only the structure of the corresponding existing table. The old table name is obtained from the TABLE_NAME column of the data dictionary view USER_TABLES.

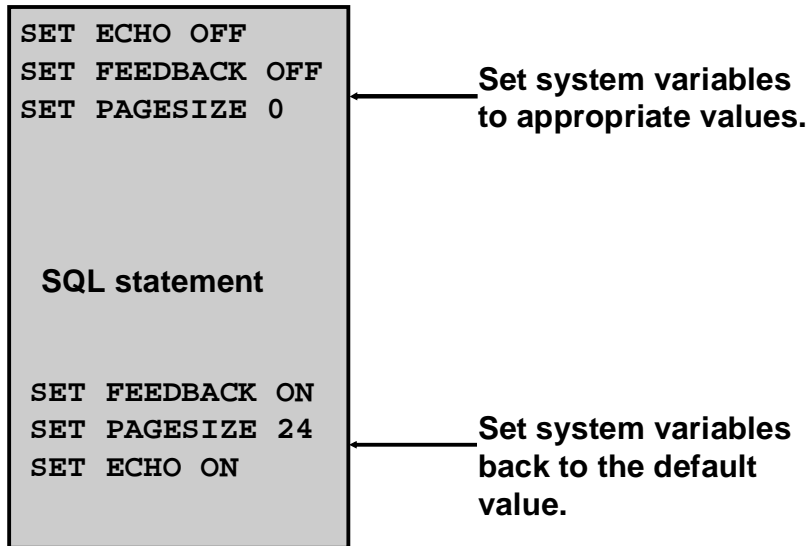
The next step is to enhance the report to automate the process.

Note: You can query the data dictionary tables to view various database objects that you own.

The data dictionary views frequently used include:

- USER_TABLES: Displays description of the user's own tables
- USER_OBJECTS: Displays all the objects owned by the user
- USER_TAB_PRIVS_MADE: Displays all grants on objects owned by the user
- USER_COL_PRIVS_MADE: Displays all grants on columns of objects owned by the user

Controlling the Environment



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Controlling the Environment

To execute the SQL statements that are generated, you must capture them in a file that can then be run. You must also plan to clean up the output that is generated and make sure that you suppress elements such as headings, feedback messages, top titles, and so on. In SQL Developer, you can save these statements to a script. To save the contents of the Enter SQL Statement box, click the Save icon or use the **File > Save** menu item. Alternatively, you can right-click in the Enter SQL Statement box and select the Save File option from the drop-down menu.

Note: Some of the SQL*Plus statements are not supported by SQL Worksheet. For the complete list of SQL*Plus statements that are supported, and not supported by SQL Worksheet, refer to the topic titled *SQL*Plus Statements Supported and Not Supported in SQL Worksheet* in the SQL Developer online Help.

The Complete Picture

```
SET ECHO OFF
SET FEEDBACK OFF
SET PAGESIZE 0

SELECT 'DROP TABLE ' || object_name || ';'
FROM   user_objects
WHERE  object_type = 'TABLE'
/

SET FEEDBACK ON
SET PAGESIZE 24
SET ECHO ON
```

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The Complete Picture

The output of the command in the slide is saved into a file called `dropem.sql` in SQL Developer. To save the output into a file in SQL Developer, you use the Save File option under the Script Output pane. The `dropem.sql` file contains the following data. This file can now be started from SQL Developer by locating the script file, loading it, and executing it.

	'DROPTABLE' OBJECT_NAME ';'
1	DROP TABLE REGIONS;
2	DROP TABLE COUNTRIES;
3	DROP TABLE LOCATIONS;
4	DROP TABLE DEPARTMENTS;
5	DROP TABLE JOBS;
6	DROP TABLE EMPLOYEES;
7	DROP TABLE JOB_HISTORY;
8	DROP TABLE JOB_GRADES;

Dumping the Contents of a Table to a File

```
SET HEADING OFF ECHO OFF FEEDBACK OFF
SET PAGESIZE 0

SELECT
  'INSERT INTO departments_test VALUES
  (' || department_id || ', ' || department_name ||
  ', ' || location_id || ');'
  AS "Insert Statements Script"
FROM   departments
/

SET PAGESIZE 24
SET HEADING ON ECHO ON FEEDBACK ON
```

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Dumping Table Contents to a File

Sometimes, it is useful to have the values for the rows of a table in a text file in the format of an INSERT INTO VALUES statement. This script can be run to populate the table in case the table has been dropped accidentally.

The example in the slide produces INSERT statements for the DEPARTMENTS_TEST table, captured in the data.sql file using the Save File option in SQL Developer.

The contents of the data.sql script file are as follows:

```
INSERT INTO departments_test VALUES
  (10, 'Administration', 1700);
INSERT INTO departments_test VALUES
  (20, 'Marketing', 1800);
INSERT INTO departments_test VALUES
  (50, 'Shipping', 1500);
INSERT INTO departments_test VALUES
  (60, 'IT', 1400);
...
```

Dumping the Contents of a Table to a File

Source	Result
<code>'''X'''</code>	<code>'X'</code>
<code>'''</code>	<code>'</code>
<code>''' department_name '''</code>	<code>'Administration'</code>
<code>''' , '''</code>	<code>' , '</code>
<code>'''); '</code>	<code>'); '</code>

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Dumping Table Contents to a File (continued)

You may have noticed the large number of single quotation marks in the previous slide. A set of four single quotation marks produces one single quotation mark in the final statement. Also remember that character and date values must be enclosed within quotation marks.

Within a string, to display one quotation mark, you need to prefix it with another single quotation mark. For example, in the fifth example in the slide, the surrounding quotation marks are for the entire string. The second quotation mark acts as a prefix to display the third quotation mark. Thus, the result is a single quotation mark followed by the parenthesis, followed by the semicolon.

Generating a Dynamic Predicate

```
COLUMN my_col NEW_VALUE dyn_where_clause

SELECT DECODE('&deptno', null,
DECODE ('&hiredate', null, ' ',
'WHERE hire_date=TO_DATE('' || '&hiredate'', 'DD-MON-YYYY'')),
DECODE ('&hiredate', null,
'WHERE department_id = ' || '&deptno',
'WHERE department_id = ' || '&deptno' ||
' AND hire_date = TO_DATE('' || '&hiredate'', 'DD-MON-YYYY''))
AS my_col FROM dual;
```

```
SELECT last_name FROM employees &dyn_where_clause;
```

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Generating a Dynamic Predicate

The example in the slide generates a `SELECT` statement that retrieves data of all employees in a department who were hired on a specific day. The script generates the `WHERE` clause dynamically.

Note: After the user variable is in place, you must use the `UNDEFINE` command to delete it.

The first `SELECT` statement prompts you to enter the department number. If you do not enter any department number, the department number is treated as null by the `DECODE` function, and the user is then prompted for the hire date. If you do not enter any hire date, the hire date is treated as null by the `DECODE` function and the dynamic `WHERE` clause that is generated is also a null, which causes the second `SELECT` statement to retrieve all the rows from the `EMPLOYEES` table.

Note: The `NEW_V[ALUE]` variable specifies a variable to hold a column value. You can reference the variable in `TTITLE` commands. Use `NEW_VALUE` to display column values or the date in the top title. You must include the column in a `BREAK` command with the `SKIP PAGE` action. The variable name cannot contain a pound sign (`#`). `NEW_VALUE` is useful for master/detail reports in which there is a new master record for each page.

Generating a Dynamic Predicate (continued)

Note: Here, the hire date must be entered in the DD-MON-YYYY format.

The SELECT statement in the slide can be interpreted as follows:

```
IF (<<deptno>> is not entered) THEN
  IF (<<hiredate>> is not entered) THEN
    return empty string
  ELSE
    return the string 'WHERE hire_date =
TO_DATE('<<hiredate>>', 'DD-MON-YYYY')'
ELSE
  IF (<<hiredate>> is not entered) THEN
    return the string 'WHERE department_id =
<<deptno>> entered'
  ELSE
    return the string 'WHERE department_id =
<<deptno>> entered
AND hire_date =
TO_DATE(' <<hiredate>>', 'DD-MON-YYYY')'
END IF
```

The returned string becomes the value of the DYN_WHERE_CLAUSE variable, which will be used in the second SELECT statement.

Note: Use SQL*Plus for these examples.

When the first example in the slide is executed, the user is prompted for the values for DEPTNO and HIREDATE:

Enter value for deptno: 10

Enter value for hiredate: 17-SEP-1987

The following value for MY_COL is generated:

```
MY_COL
-----
WHERE department_id = 10 AND hire_date = TO_DATE('27-SEP-1987','DD-MON-YYYY')
```

When the second example in the slide is executed, the following output is generated:

```
LAST_NAME
-----
Whalen
```

Summary

In this appendix, you should have learned that:

- You can write a SQL script to generate another SQL script
- Script files often use the data dictionary
- You can capture the output in a file

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Summary

SQL can be used to generate SQL scripts. These scripts can be used to avoid repetitive coding, drop or re-create objects, get help from the data dictionary, and generate dynamic predicates that contain run-time parameters.

Oracle Database Architectural Components



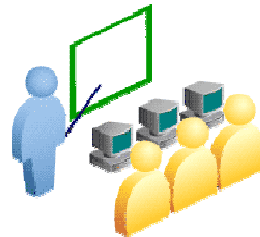
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Objectives

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

- List the major database architectural components
- Describe the background processes
- Explain the memory structures
- Correlate the logical and physical storage structures



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Objectives

This appendix provides an overview of the Oracle Database architecture. You learn about the physical and logical structures and various components of Oracle Database and their functions.

Oracle Database Architecture: Overview

The Oracle Relational Database Management System (RDBMS) is a database management system that provides an open, comprehensive, integrated approach to information management.



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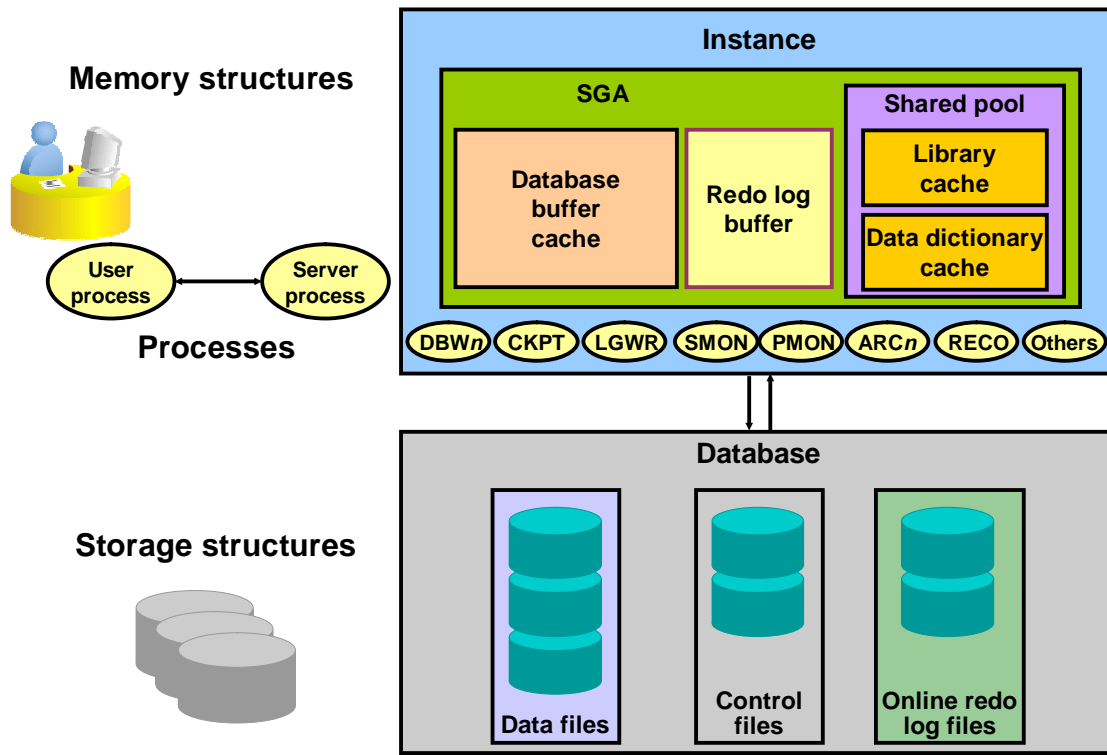
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Oracle Database Architecture: Overview

A database is a collection of data treated as a unit. The purpose of a database is to store and retrieve related information.

An Oracle database reliably manages a large amount of data in a multiuser environment so that many users can concurrently access the same data. This is accomplished while delivering high performance. At the same time, it prevents unauthorized access and provides efficient solutions for failure recovery.

Oracle Database Server Structures



Oracle Database Server Structures

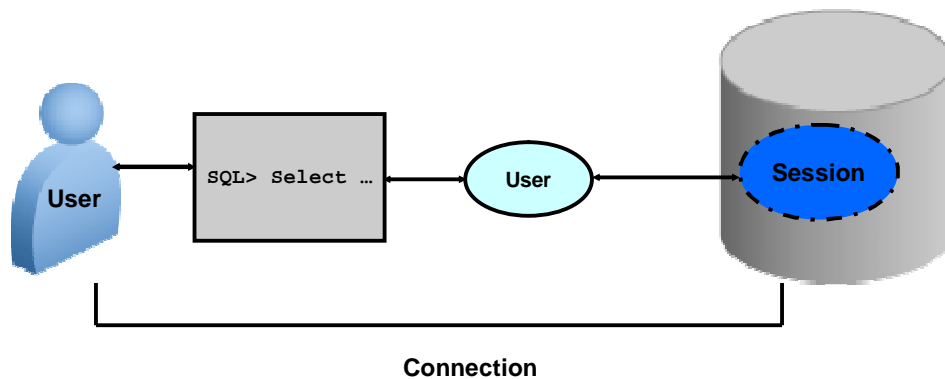
The Oracle Database consists of two main components—the instance and the database.

- The instance consists of the System Global Area (SGA), which is a collection of memory structures, and the background processes that perform tasks within the database. Every time an instance is started, the SGA is allocated and the background processes are started.
- The database consists of both physical structures and logical structures. Because the physical and logical structures are separate, the physical storage of data can be managed without affecting access to logical storage structures. The physical storage structures include:
 - The control files where the database configuration is stored
 - The redo log files that have information required for database recovery
 - The data files where all data is stored

An Oracle instance uses memory structures and processes to manage and access the database storage structures. All memory structures exist in the main memory of the computers that constitute the database server. Processes are jobs that work in the memory of these computers. A process is defined as a “thread of control” or a mechanism in an operating system that can run a series of steps.

Connecting to the Database

- Connection: Communication pathway between a user process and a database instance
- Session: A specific connection of a user to a database instance through a user process



Connecting to the Database

To access information in the database, the user needs to connect to the database using a tool (such as SQL*Plus). After the user establishes connection, a session is created for the user. Connection and session are closely related to user process but are very different in meaning.

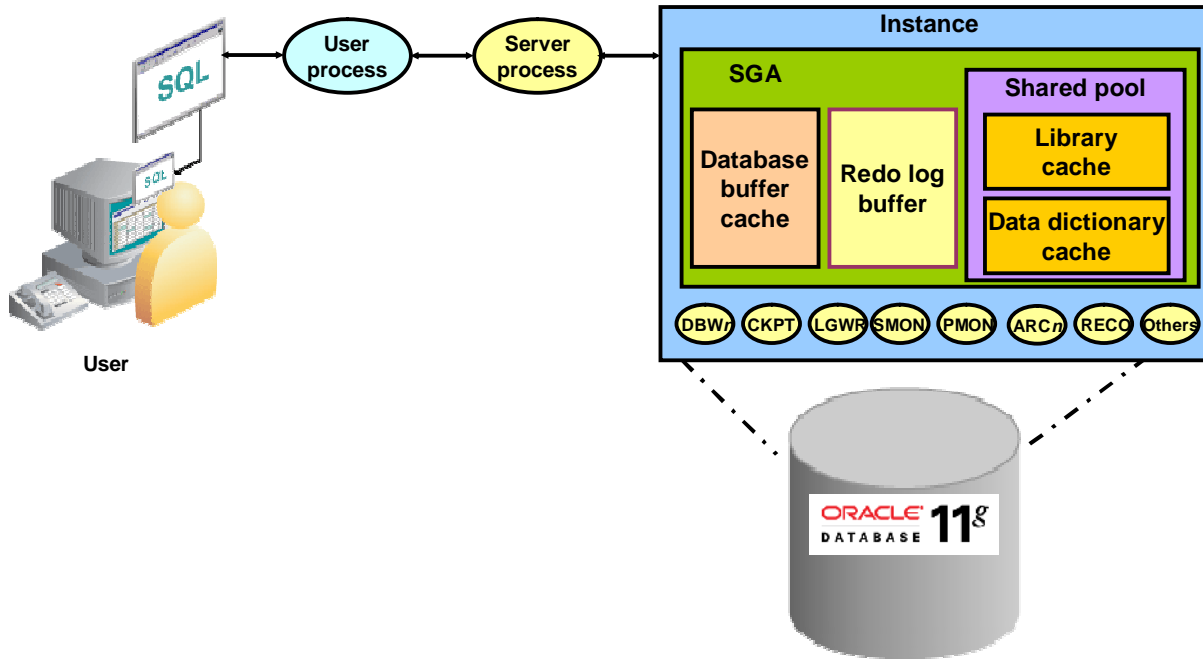
A connection is a communication pathway between a user process and an Oracle Database instance. A communication pathway is established using available interprocess communication mechanisms or network software (when different computers run the database application and Oracle Database, and communicate through a network).

A session represents the state of a current user login to the database instance. For example, when a user starts SQL*Plus, the user must provide a valid username and password, and then a session is established for that user. A session lasts from the time the user connects until the time the user disconnects or exits the database application.

In the case of a dedicated connection, the session is serviced by a permanent dedicated process. In the case of a shared connection, the session is serviced by an available server process selected from a pool, either by the middle tier or by Oracle shared server architecture.

Multiple sessions can be created and exist concurrently for a single Oracle Database user using the same username, but through different applications, or multiple invocations of the same application.

Interacting with an Oracle Database



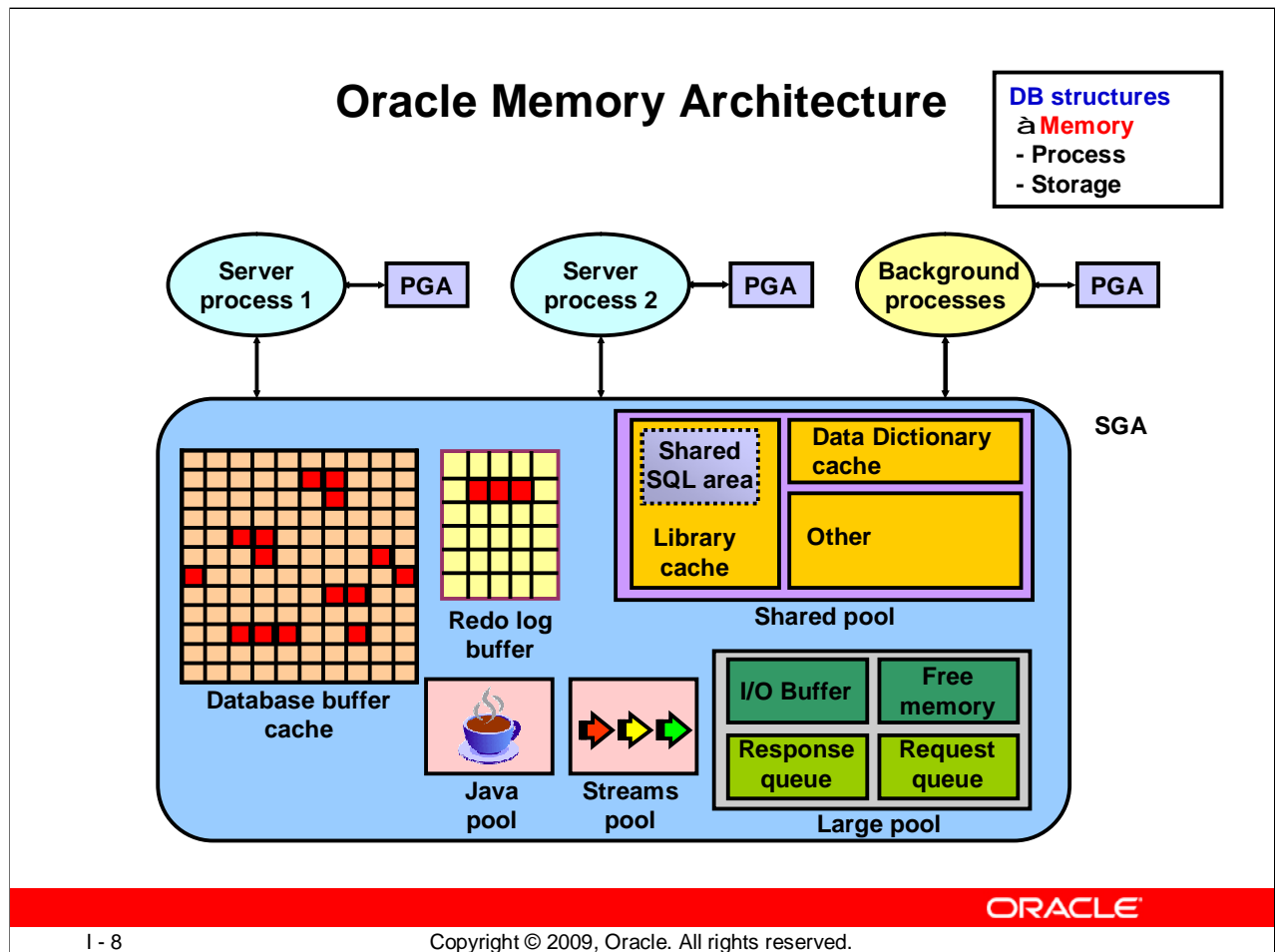
Interacting with an Oracle Database

The following example describes Oracle Database operations at the most basic level. It illustrates an Oracle Database configuration where the user and associated server process are on separate computers, connected through a network.

1. An instance has started on a node where Oracle Database is installed, often called the host or database server.
2. A user starts an application spawning a user process. The application attempts to establish a connection to the server. (The connection may be local, client server, or a three-tier connection from a middle tier.)
3. The server runs a listener that has the appropriate Oracle Net Services handler. The server detects the connection request from the application and creates a dedicated server process on behalf of the user process.
4. The user runs a DML-type SQL statement and commits the transaction. For example, the user changes the address of a customer in a table and commits the change.
5. The server process receives the statement and checks the shared pool (an SGA component) for any shared SQL area that contains a similar SQL statement. If a shared SQL area is found, the server process checks the user's access privileges to the requested data, and the existing shared SQL area is used to process the statement. If not, a new shared SQL area is allocated for the statement, so it can be parsed and processed.

Interacting with an Oracle Database (continued)

6. The server process retrieves any necessary data values, either from the actual data file (in which the table is stored) or those cached in the SGA.
7. The server process modifies data in the SGA. Because the transaction is committed, the log writer process (LGWR) immediately records the transaction in the redo log file. The database writer process (DBWn) writes modified blocks permanently to disk when doing so is efficient.
8. If the transaction is successful, the server process sends a message across the network to the application. If it is not successful, an error message is transmitted.
9. Throughout this entire procedure, the other background processes run, watching for conditions that require intervention. In addition, the database server manages other users' transactions and prevents contention between transactions that request the same data.



Oracle Memory Structures

Oracle Database creates and uses memory structures for various purposes. For example, memory stores program code being run, data shared among users, and private data areas for each connected user.

Two basic memory structures are associated with an instance:

- The System Global Area (SGA) is a group of shared memory structures, known as SGA components, that contain data and control information for one Oracle Database instance. The SGA is shared by all server and background processes. Examples of data stored in the SGA include cached data blocks and shared SQL areas.
- The Program Global Areas (PGA) are memory regions that contain data and control information for a server or background process. A PGA is nonshared memory created by Oracle Database when a server or background process is started. Access to the PGA is exclusive to the server process. Each server process and background process has its own PGA.

Oracle Memory Structures (continued)

The SGA is the memory area that contains data and control information for the instance. The SGA includes the following data structures:

- **Database buffer cache:** Caches blocks of data retrieved from the database
- **Redo Log buffer:** Caches redo information (used for instance recovery) until it can be written to the physical redo log files stored on the disk
- **Shared pool:** Caches various constructs that can be shared among users
- **Large pool:** Is an optional area that provides large memory allocations for certain large processes, such as Oracle backup and recovery operations, and input/output (I/O) server processes
- **Java pool:** Is used for all session-specific Java code and data within the Java Virtual Machine (JVM)
- **Streams pool:** Is used by Oracle Streams to store information required by capture and apply

When you start the instance by using Enterprise Manager or SQL*Plus, the amount of memory allocated for the SGA is displayed.

With the dynamic SGA infrastructure, the size of the database buffer cache, the shared pool, the large pool, the Java pool, and the Streams pool changes without shutting down the instance.

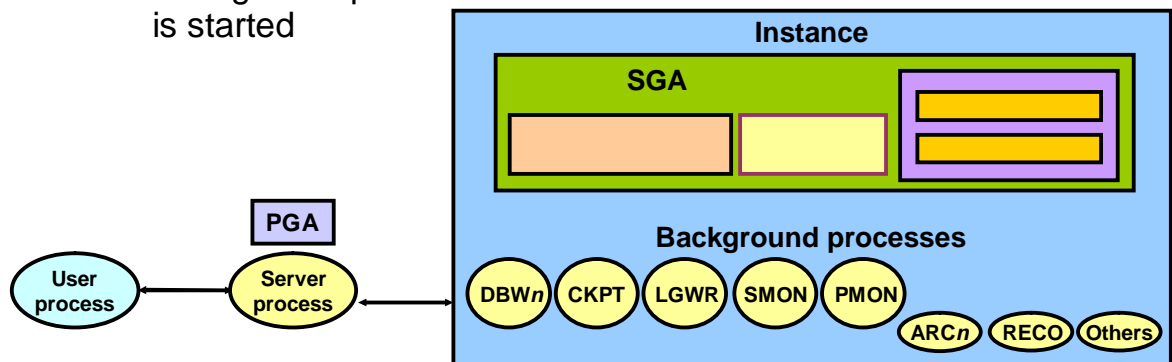
Oracle Database uses initialization parameters to create and configure memory structures. For example, the `SGA_TARGET` parameter specifies the total size of the SGA components. If you set `SGA_TARGET` to 0, Automatic Shared Memory Management is disabled.

Process Architecture

DB structures

- Memory
- à **Process**
- Storage

- User process:
 - Is started when a database user or a batch process connects to the Oracle Database
- Database processes:
 - Server process: Connects to the Oracle instance and is started when a user establishes a session
 - Background processes: Are started when an Oracle instance is started



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Process Architecture

The processes in an Oracle Database server can be categorized into two major groups:

- User processes that run the application or Oracle tool code
- Oracle Database processes that run the Oracle database server code. These include server processes and background processes.

When a user runs an application program or an Oracle tool such as SQL*Plus, Oracle Database creates a *user process* to run the user's application. The Oracle Database also creates a *server process* to execute the commands issued by the user process. In addition, the Oracle server also has a set of *background processes* for an instance that interact with each other and with the operating system to manage the memory structures and asynchronously perform I/O to write data to disk, and perform other required tasks.

The process structure varies for different Oracle Database configurations, depending on the operating system and the choice of Oracle Database options. The code for connected users can be configured as a dedicated server or a shared server.

- With dedicated server, for each user, the database application is run by a user process, which is served by a dedicated server process that executes Oracle database server code.
- A shared server eliminates the need for a dedicated server process for each connection. A dispatcher directs multiple incoming network session requests to a pool of shared server processes. A shared server process serves any client request.

Process Architecture (continued)

Server Processes

Oracle Database creates server processes to handle the requests of user processes connected to the instance. In some situations when the application and Oracle Database operate on the same computer, it is possible to combine the user process and the corresponding server process into a single process to reduce system overhead. However, when the application and Oracle Database operate on different computers, a user process always communicates with Oracle Database through a separate server process.

Server processes created on behalf of each user's application can perform one or more of the following:

- Parse and run SQL statements issued through the application.
- Read necessary data blocks from data files on disk into the shared database buffers of the SGA, if the blocks are not already present in the SGA.
- Return results in such a way that the application can process the information.

Background Processes

To maximize performance and accommodate many users, a multiprocess Oracle Database system uses some additional Oracle Database processes called background processes. An Oracle Database instance can have many background processes.

The following background processes are required for a successful startup of the database instance:

- Database writer (DBW n)
- Log writer (LGWR)
- Checkpoint (CKPT)
- System monitor (SMON)
- Process monitor (PMON)

The following background processes are a few examples of optional background processes that can be started if required:

- Recoverer (RECO)
- Job queue
- Archiver (ARC n)
- Queue monitor (QMN n)

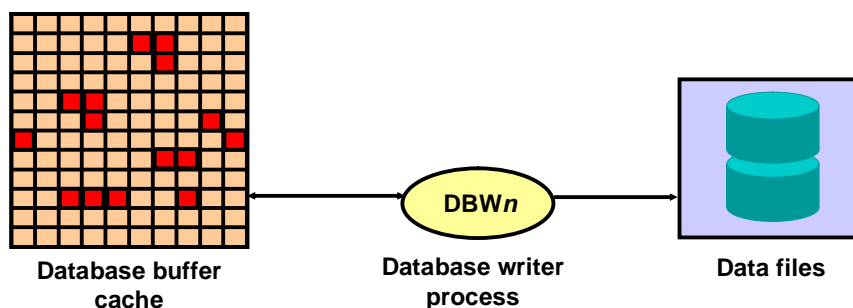
Other background processes may be found in more advanced configurations such as Real Application Clusters (RAC). See the V\$BGPROCESS view for more information about the background processes.

On many operating systems, background processes are created automatically when an instance is started.

Database Writer Process

Writes modified (dirty) buffers in the database buffer cache to disk:

- Asynchronously while performing other processing
- Periodically to advance the checkpoint



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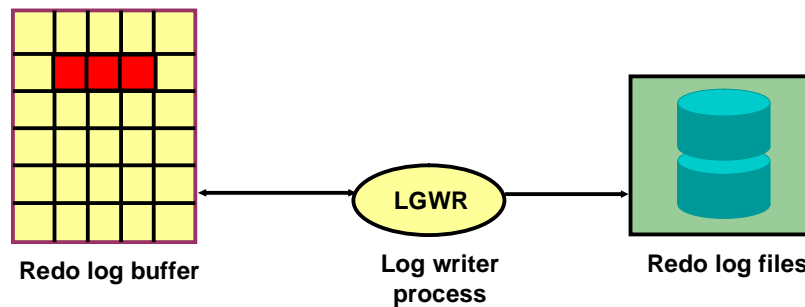
Database Writer Process

The database writer (DBW_n) process writes the contents of buffers to data files. The DBW_n processes are responsible for writing modified (dirty) buffers in the database buffer cache to disk. Although one database writer process (DBW0) is adequate for most systems, you can configure additional processes (DBW1 through DBW9 and DBWa through DBWj) to improve write performance if your system modifies data heavily. These additional DBW_n processes are not useful on uniprocessor systems.

When a buffer in the database buffer cache is modified, it is marked “dirty” and is added to the LRUW list of dirty buffers that is kept in system change number (SCN) order, thereby matching the order of Redo corresponding to these changed buffers that is written to the Redo logs. When the number of available buffers in the buffer cache falls below an internal threshold such that server processes find it difficult to obtain available buffers, DBW_n writes dirty buffers to the data files in the order that they were modified by following the order of the LRUW list.

Log Writer Process

- Writes the redo log buffer to a redo log file on disk
- LGWR writes:
 - A process commits a transaction
 - When the redo log buffer is one-third full
 - Before a DBWn process writes modified buffers to disk



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Log Writer Process

The log writer (LGWR) process is responsible for redo log buffer management by writing the redo log buffer entries to a redo log file on disk. LGWR writes all redo entries that have been copied into the buffer since the last time it wrote.

The redo log buffer is a circular buffer. When LGWR writes redo entries from the redo log buffer to a redo log file, server processes can then copy new entries over the entries in the redo log buffer that have been written to disk. LGWR normally writes fast enough to ensure that space is always available in the buffer for new entries, even when access to the redo log is heavy.

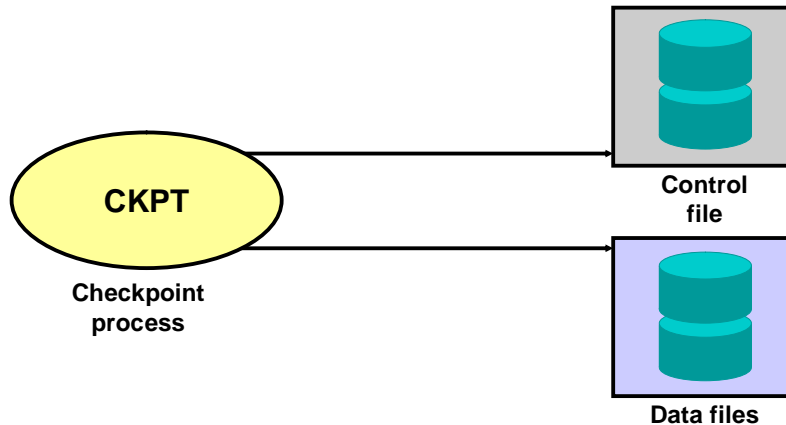
LGWR writes one contiguous portion of the buffer to disk. LGWR writes:

- When a user process commits a transaction
- When the redo log buffer is one-third full
- Before a DBWn process writes modified buffers to disk, if necessary

Checkpoint Process

Records checkpoint information in:

- The control file
- Each datafile header



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Checkpoint Process

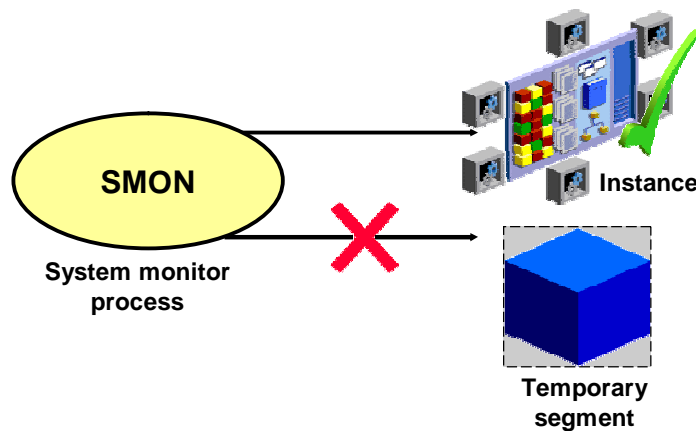
A checkpoint is a data structure that defines an SCN in the redo thread of a database. Checkpoints are recorded in the control file and each data file header, and are a crucial element of recovery.

When a checkpoint occurs, Oracle Database must update the headers of all data files to record the details of the checkpoint. This is done by the CKPT process. The CKPT process does not write blocks to disk; DBWR always performs that work. The SCNs recorded in the file headers guarantee that all the changes made to database blocks before that SCN have been written to disk.

The statistic DBWR checkpoints displayed by the `SYSTEM_STATISTICS` monitor in Oracle Enterprise Manager indicate the number of checkpoint requests completed.

System Monitor Process

- Performs recovery at instance startup
- Cleans up unused temporary segments



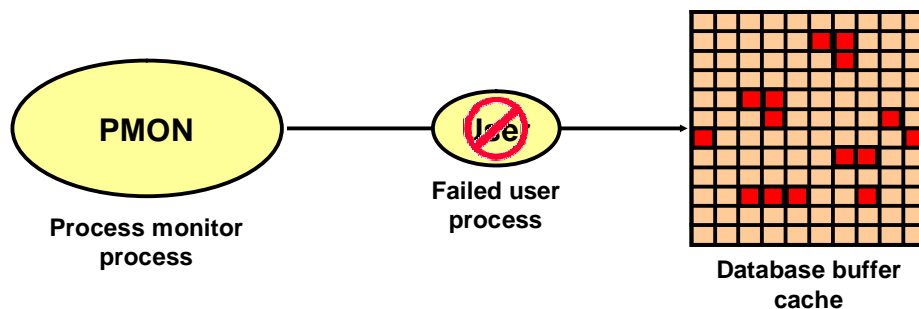
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System Monitor Process

The system monitor (SMON) process performs recovery, if necessary, at instance startup. SMON is also responsible for cleaning up temporary segments that are no longer in use. If any terminated transactions were skipped during instance recovery because of file-read or offline errors, SMON recovers them when the tablespace or file is brought back online. SMON checks regularly to see whether it is needed. Other processes can call SMON if they detect a need for it.

Process Monitor Process

- Performs process recovery when a user process fails:
 - Cleans up the database buffer cache
 - Frees resources used by the user process
- Monitors sessions for idle session timeout
- Dynamically registers database services with listeners



Process Monitor Process

The process monitor (PMON) performs process recovery when a user process fails. PMON is responsible for cleaning up the database buffer cache and freeing resources that the user process was using. For example, it resets the status of the active transaction table, releases locks, and removes the process ID from the list of active processes.

PMON periodically checks the status of dispatcher and server processes, and restarts any that have stopped running (but not any that Oracle Database has terminated intentionally). PMON also registers information about the instance and dispatcher processes with the network listener.

Like SMON, PMON checks regularly to see whether it is needed and can be called if another process detects the need for it.

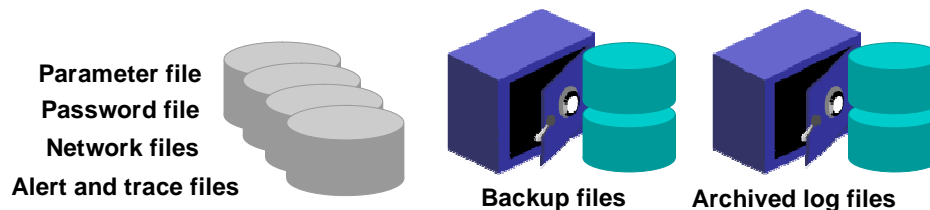
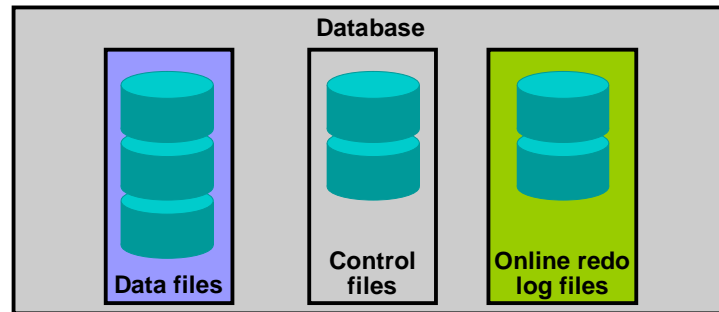
Oracle Database Storage Architecture

DB structures

- Memory

- Process

à **Storage**



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Oracle Database Storage Architecture

The files that constitute an Oracle database are organized into the following:

- **Control files:** Contain data about the database itself (that is, physical database structure information). These files are critical to the database. Without them, you cannot open data files to access the data within the database.
- **Data files:** Contain the user or application data of the database, as well as metadata and the data dictionary
- **Online redo log files:** Allow for instance recovery of the database. If the database server crashes and does not lose any data files, the instance can recover the database with the information in these files.

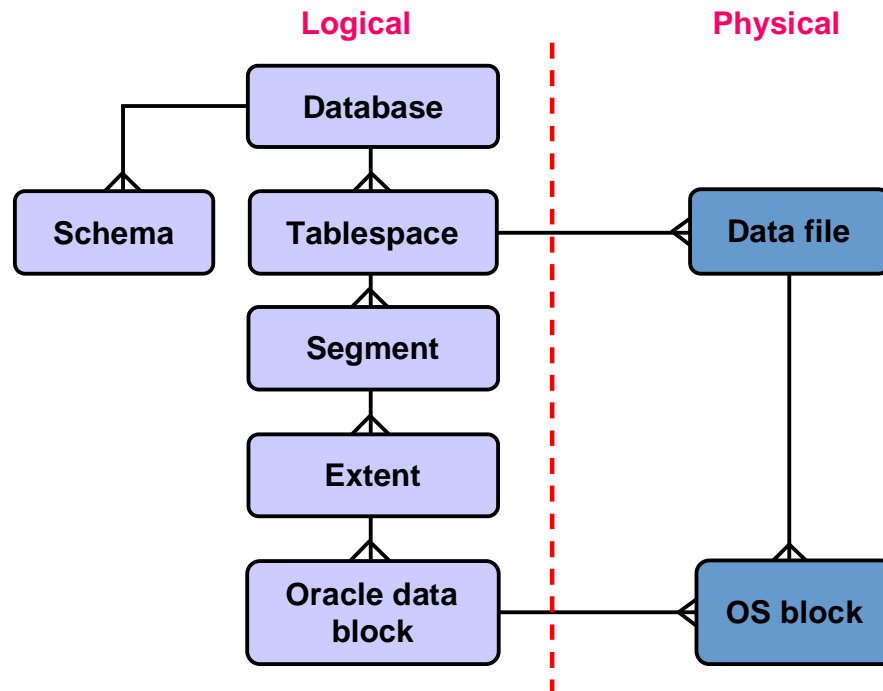
The following additional files are important to the successful running of the database:

- **Backup files:** Are used for database recovery. You typically restore a backup file when a media failure or user error has damaged or deleted the original file.
- **Archived log files:** Contain an ongoing history of the data changes (redo) that are generated by the instance. Using these files and a backup of the database, you can recover a lost data file. That is, archive logs enable the recovery of restored data files.
- **Parameter file:** Is used to define how the instance is configured when it starts up
- **Password file:** Allows `sysdba`/`sysoper`/`sysasm` to connect remotely to the database and perform administrative tasks

Oracle Database Storage Architecture (continued)

- **Network files:** Are used for starting the database listener and store information required for user connections
- **Trace files:** Each server and background process can write to an associated trace file. When an internal error is detected by a process, the process dumps information about the error to its trace file. Some of the information written to a trace file is intended for the database administrator, whereas other information is for Oracle Support Services.
- **Alert log files:** These are special trace entries. The alert log of a database is a chronological log of messages and errors. Each instance has one alert log file. Oracle recommends that you review this alert log periodically.

Logical and Physical Database Structures



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Logical and Physical Database Structures

An Oracle database has logical and physical storage structures.

Tablespaces

A database is divided into logical storage units called tablespaces, which group related logical structures together. For example, tablespaces commonly group all of an application's objects to simplify some administrative operations. You may have a tablespace for application data and an additional one for application indexes.

Databases, Tablespaces, and Data Files

The relationship among databases, tablespaces, and data files is illustrated in the slide. Each database is logically divided into one or more tablespaces. One or more data files are explicitly created for each tablespace to physically store the data of all logical structures in a tablespace. If it is a TEMPORARY tablespace, instead of a data file, the tablespace has a temporary file.

Logical and Physical Database Structures (continued)

Schemas

A schema is a collection of database objects that are owned by a database user. Schema objects are the logical structures that directly refer to the database's data. Schema objects include such structures as tables, views, sequences, stored procedures, synonyms, indexes, clusters, and database links. In general, schema objects include everything that your application creates in the database.

Data Blocks

At the finest level of granularity, an Oracle database's data is stored in data blocks. One data block corresponds to a specific number of bytes of physical database space on the disk. A data block size is specified for each tablespace when it is created. A database uses and allocates free database space in Oracle data blocks.

Extents

The next level of logical database space is called an extent. An extent is a specific number of contiguous data blocks (obtained in a single allocation) that are used to store specific type of information.

Segments

The level of logical database storage above an extent is called a segment. A segment is a set of extents allocated for a certain logical structure. For example, the different types of segments include:

- **Data segments:** Each nonclustered, non-indexed-organized table has a data segment with the exception of external tables, global temporary tables, and partitioned tables, where each table has one or more segments. All of the table's data is stored in the extents of its data segment. For a partitioned table, each partition has a data segment. Each cluster has a data segment. The data of every table in the cluster is stored in the cluster's data segment.
- **Index segments:** Each index has an index segment that stores all of its data. For a partitioned index, each partition has an index segment.
- **Undo segments:** One UNDO tablespace is created per database instance that contains numerous undo segments to temporarily store *undo* information. The information in an undo segment is used to generate read-consistent database information and, during database recovery, to roll back uncommitted transactions for users.
- **Temporary segments:** Temporary segments are created by the Oracle Database when a SQL statement needs a temporary work area to complete execution. When the statement finishes execution, the temporary segment's extents are returned to the instance for future use. Specify a default temporary tablespace for every user or a default temporary tablespace, which is used databasewide.

The Oracle Database dynamically allocates space. When the existing extents of a segment are full, additional extents are added. Because extents are allocated as needed, the extents of a segment may or may not be contiguous on the disk.

Processing a SQL Statement

- Connect to an instance using:
 - The user process
 - The server process
- The Oracle server components that are used depend on the type of SQL statement:
 - Queries return rows.
 - Data manipulation language (DML) statements log changes.
 - Commit ensures transaction recovery.
- Some Oracle server components do not participate in SQL statement processing.

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Processing a SQL Statement

Not all the components of an Oracle instance are used to process SQL statements. The user and server processes are used to connect a user to an Oracle instance. These processes are not part of the Oracle instance, but are required to process a SQL statement.

Some of the background processes, SGA structures, and database files are used to process SQL statements. Depending on the type of SQL statement, different components are used:

- Queries require additional processing to return rows to the user.
- DML statements require additional processing to log the changes made to the data.
- Commit processing ensures that the modified data in a transaction can be recovered.

Some required background processes do not directly participate in processing a SQL statement, but are used to improve performance and to recover the database. For example, the optional Archiver background process, ARC*n*, is used to ensure that a production database can be recovered.

Processing a Query

- Parse:
 - Search for an identical statement.
 - Check the syntax, object names, and privileges.
 - Lock the objects used during parse.
 - Create and store the execution plan.
- Execute: Identify the rows selected.
- Fetch: Return the rows to the user process.

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Processing a Query

Queries are different from other types of SQL statements because, if successful, they return data as results. Other statements simply return success or failure, whereas a query can return one row or thousands of rows.

There are three main stages in the processing of a query:

- Parse
- Execute
- Fetch

During the *parse* stage, the SQL statement is passed from the user process to the server process, and a parsed representation of the SQL statement is loaded into a shared SQL area.

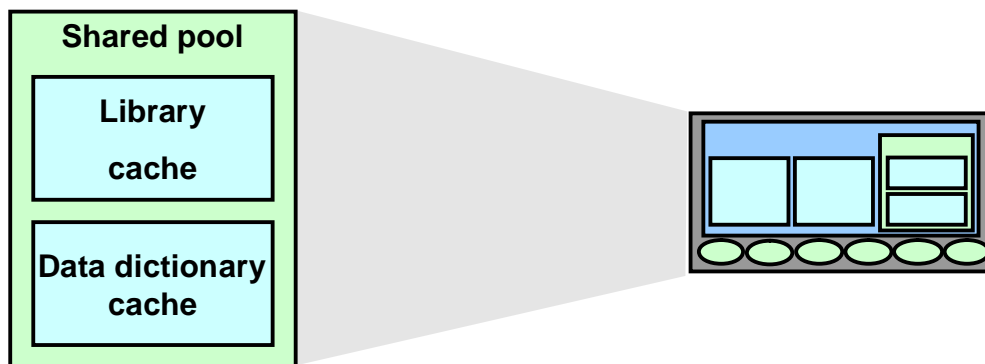
During parse, the server process performs the following functions:

- Searches for an existing copy of the SQL statement in the shared pool
- Validates the SQL statement by checking its syntax
- Performs data dictionary lookups to validate table and column definitions

The execute stage executes the statement using the best optimizer approach and the fetch retrieves the rows back to the user.

Shared Pool

- The library cache contains the SQL statement text, parsed code, and execution plan.
- The data dictionary cache contains table, column, and other object definitions and privileges.
- The shared pool is sized by `SHARED_POOL_SIZE`.



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Shared Pool

During the parse stage, the server process uses the area in the SGA known as the shared pool to compile the SQL statement. The shared pool has two primary components:

- Library cache
- Data dictionary cache

Library Cache

The library cache stores information about the most recently used SQL statements in a memory structure called a shared SQL area. The shared SQL area contains:

- The text of the SQL statement
- The parse tree, which is a compiled version of the statement
- The execution plan, with steps to be taken when executing the statement

The optimizer is the function in the Oracle server that determines the optimal execution plan.

If a SQL statement is reexecuted and a shared SQL area already contains the execution plan for the statement, the server process does not need to parse the statement. The library cache improves the performance of applications that reuse SQL statements by reducing parse time and memory requirements. If the SQL statement is not reused, it is eventually aged out of the library cache.

Shared Pool (continued)

Data Dictionary Cache

The data dictionary cache, also known as the dictionary cache or row cache, is a collection of the most recently used definitions in the database. It includes information about database files, tables, indexes, columns, users, privileges, and other database objects.

During the parse phase, the server process looks for the information in the dictionary cache to resolve the object names specified in the SQL statement and to validate the access privileges. If necessary, the server process initiates the loading of this information from the data files.

Sizing the Shared Pool

The size of the shared pool is specified by the `SHARED_POOL_SIZE` initialization parameter.

Database Buffer Cache

- The database buffer cache stores the most recently used blocks.
- The size of a buffer is based on `DB_BLOCK_SIZE`.
- The number of buffers is defined by `DB_BLOCK_BUFFERS`.



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Database Buffer Cache

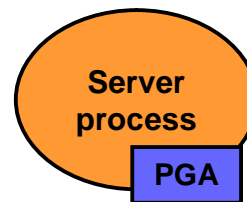
When a query is processed, the server process looks in the database buffer cache for any blocks it needs. If the block is not found in the database buffer cache, the server process reads the block from the data file and places a copy in the buffer cache. Because subsequent requests for the same block may find the block in memory, the requests may not require physical reads. The Oracle server uses a least recently used algorithm to age out buffers that have not been accessed recently to make room for new blocks in the buffer cache.

Sizing the Database Buffer Cache

The size of each buffer in the buffer cache is equal to the size of an Oracle block, and it is specified by the `DB_BLOCK_SIZE` parameter. The number of buffers is equal to the value of the `DB_BLOCK_BUFFERS` parameter.

Program Global Area (PGA)

- Is not shared
- Is writable only by the server process
- Contains:
 - Sort area
 - Session information
 - Cursor state
 - Stack space



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Program Global Area (PGA)

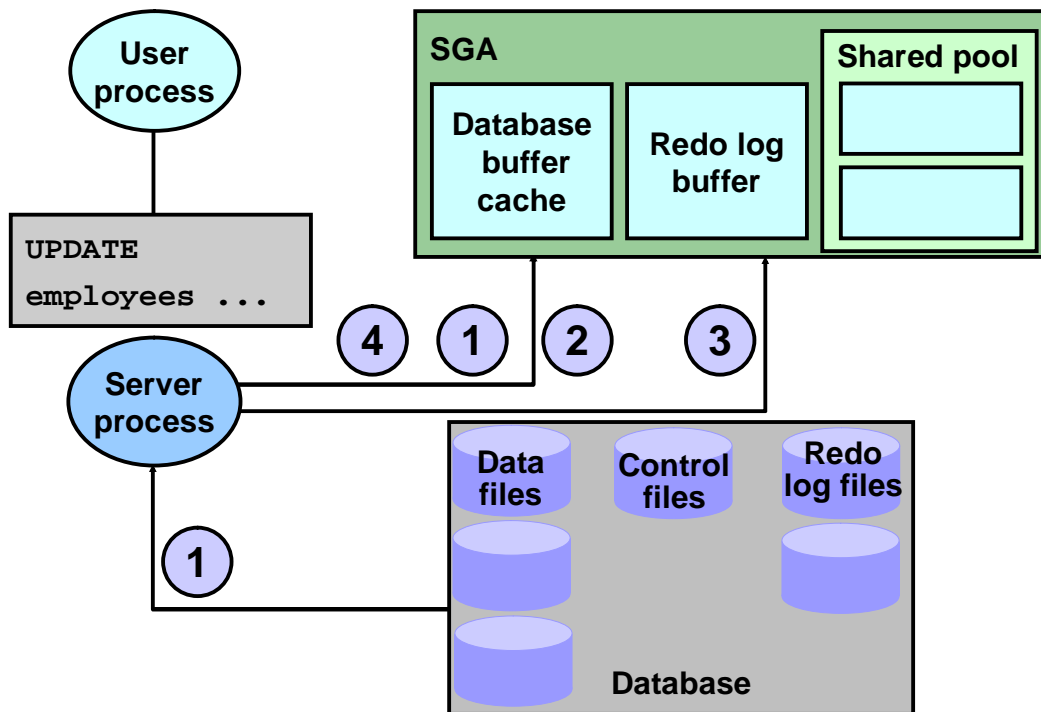
A Program Global Area (PGA) is a memory region that contains data and control information for a server process. It is a nonshared memory created by Oracle when a server process is started. Access to it is exclusive to that server process, and is read and written only by the Oracle server code acting on behalf of it. The PGA memory allocated by each server process attached to an Oracle instance is referred to as the aggregated PGA memory allocated by the instance.

In a dedicated server configuration, the PGA of the server includes the following components:

- **Sort area:** Is used for any sorts that may be required to process the SQL statement
- **Session information:** Includes user privileges and performance statistics for the session
- **Cursor state:** Indicates the stage in the processing of the SQL statements that are currently used by the session
- **Stack space:** Contains other session variables

The PGA is allocated when a process is created, and deallocated when the process is terminated.

Processing a DML Statement



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Processing a DML Statement

A data manipulation language (DML) statement requires only two phases of processing:

- Parse is the same as the parse phase used for processing a query.
- Execute requires additional processing to make data changes.

DML Execute Phase

To execute a DML statement:

- If the data and rollback blocks are not already in the buffer cache, the server process reads them from the data files into the buffer cache
- The server process places locks on the rows that are to be modified
- In the redo log buffer, the server process records the changes to be made to the rollback and data blocks
- The rollback block changes record the values of the data before it is modified. The rollback block is used to store the “before image” of the data, so that the DML statements can be rolled back if necessary.
- The data block changes record the new values of the data

Processing a DML Statement (continued)

The server process records the “before image” to the rollback block and updates the data block. Both of these changes are done in the database buffer cache. Any changed blocks in the buffer cache are marked as dirty buffers (that is, buffers that are not the same as the corresponding blocks on the disk).

The processing of a DELETE or INSERT command uses similar steps. The “before image” for a DELETE contains the column values in the deleted row, and the “before image” of an INSERT contains the row location information.

Because the changes made to the blocks are only recorded in memory structures and are not written immediately to disk, a computer failure that causes the loss of the SGA can also lose these changes.

Redo Log Buffer

- Has its size defined by `LOG_BUFFER`
- Records changes made through the instance
- Is used sequentially
- Is a circular buffer



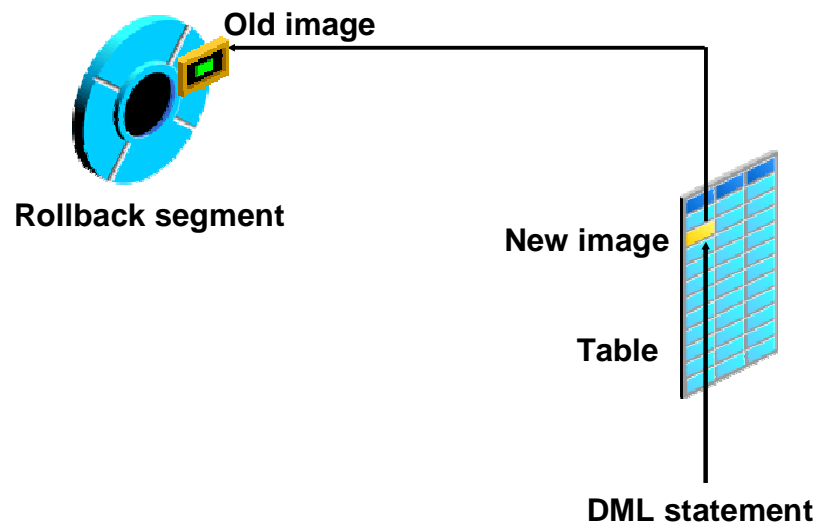
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Redo Log Buffer

The server process records most of the changes made to data file blocks in the redo log buffer, which is a part of the SGA. The redo log buffer has the following characteristics:

- Its size in bytes is defined by the `LOG_BUFFER` parameter.
- It records the block that is changed, the location of the change, and the new value in a redo entry. A redo entry makes no distinction between the types of block that is changed; it only records which bytes are changed in the block.
- The redo log buffer is used sequentially, and changes made by one transaction may be interleaved with changes made by other transactions.
- It is a circular buffer that is reused after it is filled, but only after all the old redo entries are recorded in the redo log files.

Rollback Segment



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Rollback Segment

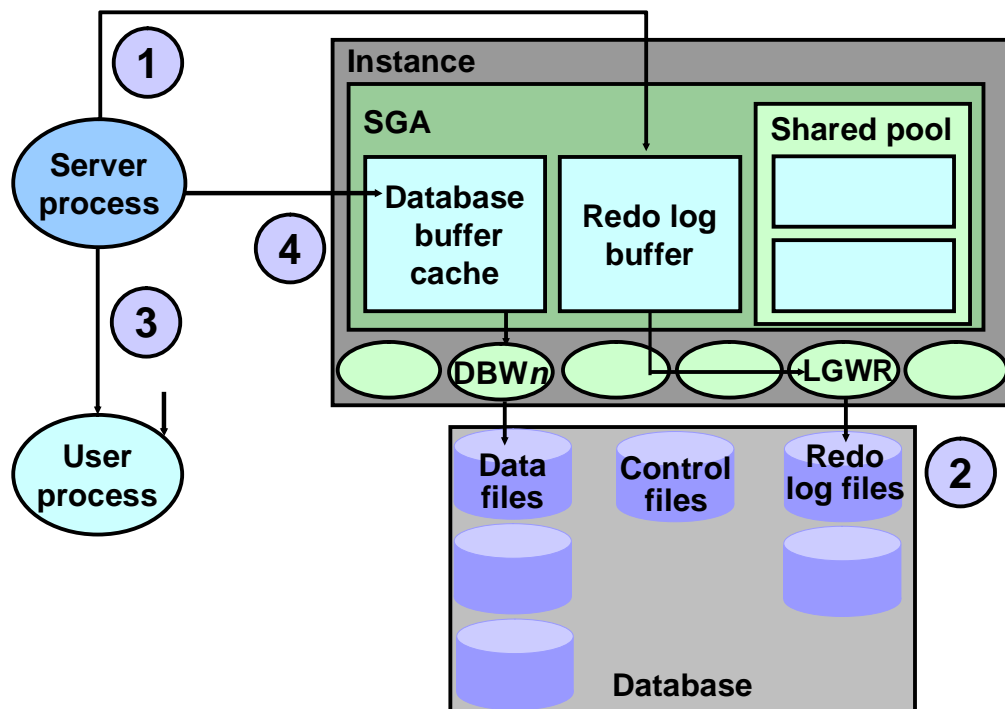
Before making a change, the server process saves the old data value in a rollback segment. This “before image” is used to:

- Undo the changes if the transaction is rolled back
- Provide read consistency by ensuring that other transactions do not see uncommitted changes made by the DML statement
- Recover the database to a consistent state in case of failures

Rollback segments, such as tables and indexes, exist in data files, and rollback blocks are brought into the database buffer cache as required. Rollback segments are created by the DBA.

Changes to rollback segments are recorded in the redo log buffer.

COMMIT Processing



COMMIT Processing

The Oracle server uses a fast COMMIT mechanism that guarantees that the committed changes can be recovered in case of instance failure.

System Change Number

Whenever a transaction commits, the Oracle server assigns a commit SCN to the transaction. The SCN is monotonically incremented and is unique within the database. It is used by the Oracle server as an internal time stamp to synchronize data and to provide read consistency when data is retrieved from the data files. Using the SCN enables the Oracle server to perform consistency checks without depending on the date and time of the operating system.

Steps in Processing COMMITs

When a COMMIT is issued, the following steps are performed:

1. The server process places a commit record, along with the SCN, in the redo log buffer.
2. LGWR performs a contiguous write of all the redo log buffer entries up to and including the commit record to the redo log files. After this point, the Oracle server can guarantee that the changes will not be lost even if there is an instance failure.

COMMIT Processing (continued)

3. The user is informed that the COMMIT is complete.
4. The server process records information to indicate that the transaction is complete and that resource locks can be released.

Flushing of the dirty buffers to the data file is performed independently by DBW0 and can occur either before or after the commit.

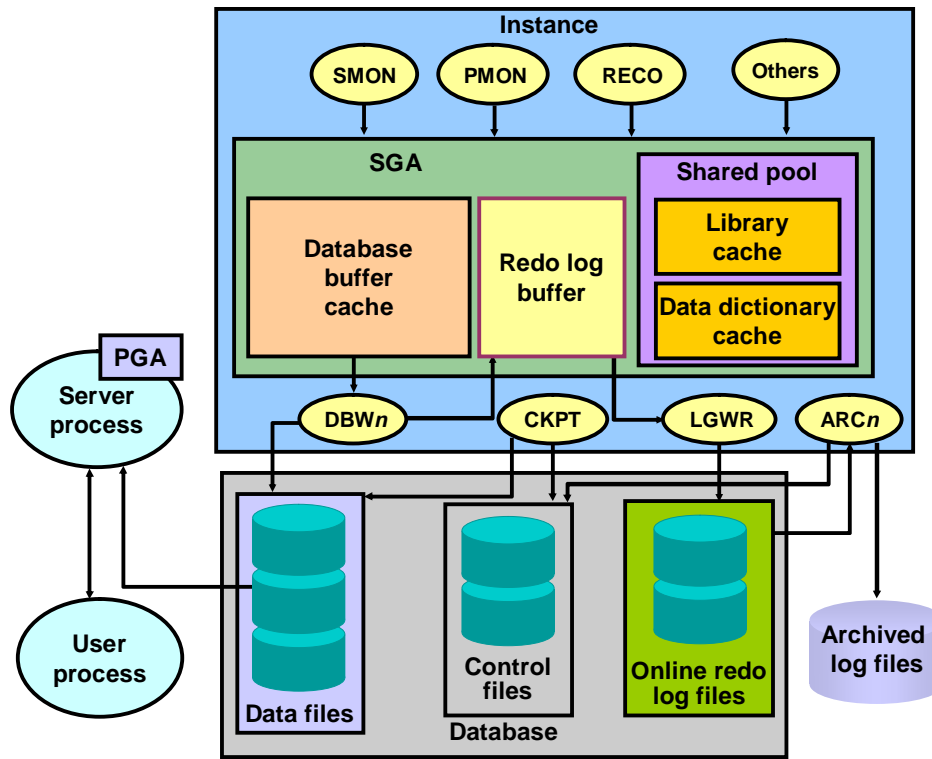
Advantages of the Fast COMMIT

The fast COMMIT mechanism ensures data recovery by writing changes to the redo log buffer instead of the data files. It has the following advantages:

- Sequential writes to the log files are faster than writing to different blocks in the data file.
- Only the minimal information that is necessary to record changes is written to the log files; writing to the data files would require whole blocks of data to be written.
- If multiple transactions request to commit at the same time, the instance piggybacks redo log records into a single write.
- Unless the redo log buffer is particularly full, only one synchronous write is required per transaction. If piggybacking occurs, there can be less than one synchronous write per transaction.
- Because the redo log buffer may be flushed before the COMMIT, the size of the transaction does not affect the amount of time needed for an actual COMMIT operation.

Note: Rolling back a transaction does not trigger LGWR to write to disk. The Oracle server always rolls back uncommitted changes when recovering from failures. If there is a failure after a rollback, before the rollback entries are recorded on disk, the absence of a commit record is sufficient to ensure that the changes made by the transaction are rolled back.

Summary of the Oracle Database Architecture



Summary of the Oracle Database Architecture

An Oracle database comprises an instance and its associated database:

- An instance comprises the SGA and the background processes
 - **SGA:** Database buffer cache, redo log buffer, shared pool, and so on
 - **Background processes:** SMON, PMON, DBWn, CKPT, LGWR, and so on
- A database comprises storage structures:
 - **Logical:** Tablespaces, schemas, segments, extents, and Oracle block
 - **Physical:** Data files, control files, redo log files

When a user accesses the Oracle database through an application, a server process communicates with the instance on behalf of the user process.

