Oracle Database: SQL Fundamentals I

Student Guide - Volume I

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ORACLE

Authors

Supriya Ananth

Salome Clement

Brian Pottle

Technical Contributors and Reviewers

Diganta Choudhury

Bryan Roberts

Kimseong Loh

Laszlo Czinkoczki

Brent Dayley

Nancy Greenberg

Manish Pawar

Clair Bennett

Zarko Cesljas

Yanti Chang

Gerlinde Frenzen

Helen Robertson

Joel Goodman

Pedro Neves

Hilda Simon

Editor

Raj Kumar

Graphic Designer

Satish Bettegowda

Publishers

Sujatha Nagendra

Joseph Fernandez

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1 Introduction

Lesson Objectives

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

- Define the goals of the course
- List the features of Oracle Database 11*g*
- Discuss the theoretical and physical aspects of a relational database
- Describe Oracle server's implementation of RDBMS and object relational database management system (ORDBMS)
- Identify the development environments that can be used for this course
- Describe the database and schema used in this course

In this lesson, you gain an understanding of the relational database management system (RDBMS) and the object relational database management system (ORDBMS). You are also introduced to Oracle SQL Developer and SQL*Plus as development environments used for executing SQL statements, and for formatting and reporting purposes.

Lesson Agenda

- Course objectives, agenda, and appendixes used in the course
- Overview of Oracle Database 11*g* and related products
- Overview of relational database management concepts and terminologies
- Introduction to SQL and its development environments
- The `HR` schema and the tables used in this course
- Oracle Database 11*g* documentation and additional resources

Course Objectives

After completing this course, you should be able to:

- Identify the major components of Oracle Database
- Retrieve row and column data from tables with the `SELECT` statement
- Create reports of sorted and restricted data
- Employ SQL functions to generate and retrieve customized data
- Run complex queries to retrieve data from multiple tables
- Run data manipulation language (DML) statements to update data in Oracle Database
- Run data definition language (DDL) statements to create and manage schema objects

This course offers you an introduction to the Oracle Database technology. In this class, 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
  - Retrieving Data Using the SQL `SELECT` Statement
  - Restricting and Sorting Data
  - Using Single-Row Functions to Customize Output
  - Using Conversion Functions and Conditional Expressions
- Day 2:
  - Reporting Aggregated Data Using the Group Functions
  - Displaying Data from Multiple Tables Using Joins
  - Using Subqueries to Solve Queries
  - Using the Set Operators

Course Agenda

- Day 3:
  - Manipulating Data
  - Using DDL Statements to Create and Manage Tables
  - Creating Other Schema Objects

Appendices and Practices Used in the Course

- Appendix A: Table Descriptions
- Appendix B: Using SQL Developer
- Appendix C: Using SQL*Plus
- Appendix D: Using JDeveloper
- Appendix E: Oracle Join Syntax
- Activity Guide
  - Practices and Solutions
  - Additional Practices and Solutions

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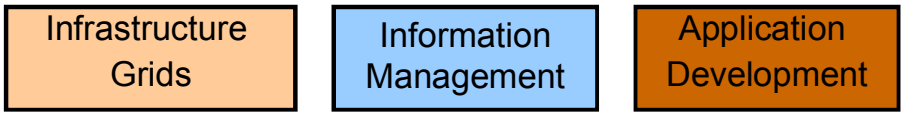
Oracle Database 11*g*: Focus Areas



Oracle Database 11*g* offers extensive features across the following focus areas:

- **Infrastructure Grids:** The Infrastructure Grid technology of Oracle enables pooling of low-cost servers and storage to form systems that deliver the highest quality of service in terms of manageability, high availability, and performance. Oracle Database 11*g* consolidates and extends the benefits of grid computing. Apart from taking full advantage of grid computing, Oracle Database 11*g* has unique change assurance features to manage changes in a controlled and cost effective manner.
- **Information Management:** Oracle Database 11*g* extends the existing information management capabilities in content management, information integration, and information life-cycle management areas. Oracle provides content management of advanced data types such as Extensible Markup Language (XML), text, spatial, multimedia, medical imaging, and semantic technologies.
- **Application Development:** Oracle Database 11*g* has capabilities to use and manage all the major application development environments such as PL/SQL, Java/JDBC, .NET and Windows, PHP, SQL Developer, and Application Express.

Oracle Database 11*g*

Manageability

High availability

Performance

Security

Information integration

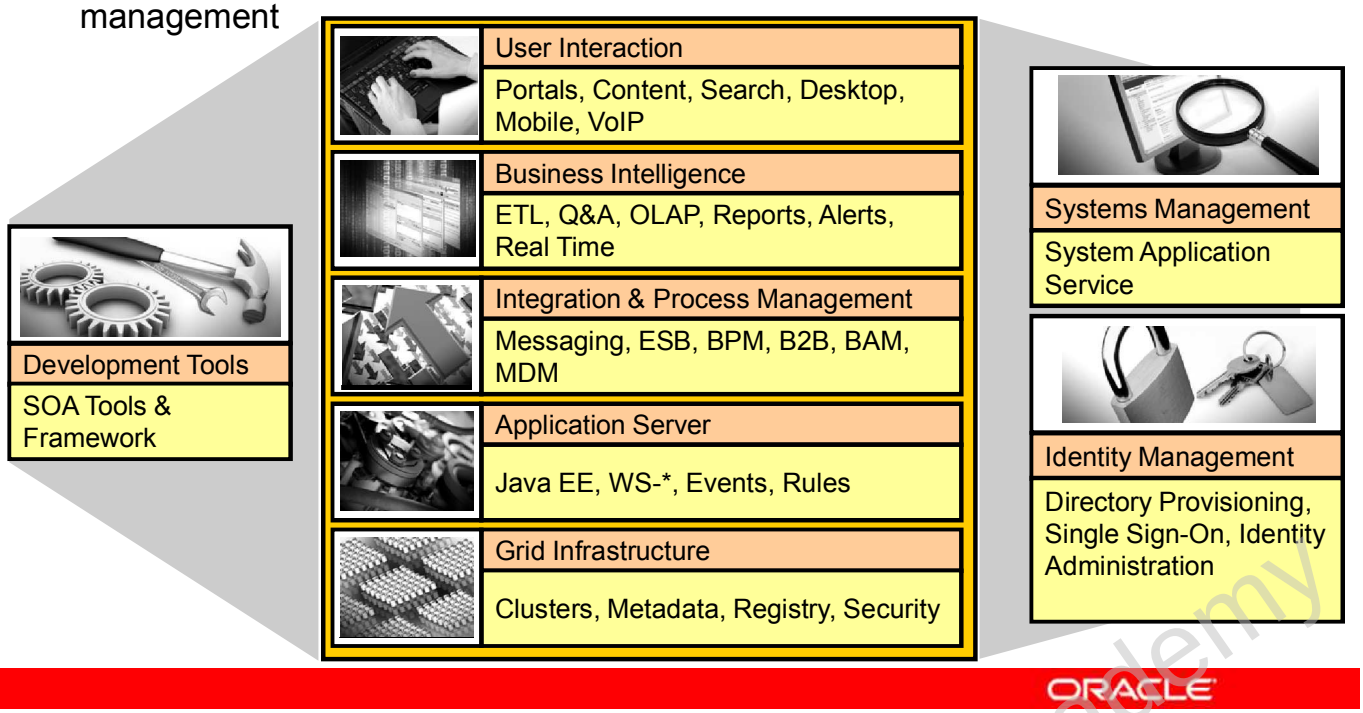
Organizations need to support multiple terabytes of information for users who demand fast and secure access to business applications round the clock. The database systems must be reliable and must be able to recover quickly in the event of any kind of failure. Oracle Database 11*g* is designed along the following feature areas to help organizations manage infrastructure grids easily and deliver high-quality service:

- **Manageability:** By using some of the change assurance, management automation, and fault diagnostics features, the database administrators (DBAs) can increase their productivity, reduce costs, minimize errors, and maximize quality of service. Some of the useful features that promote better management are Database Replay facility, the SQL Performance Analyzer, and the Automatic SQL Tuning facility.
- **High availability:** By using the high availability features, you can reduce the risk of down time and data loss. These features improve online operations and enable faster database upgrades.

- **Performance:** By using capabilities such as SecureFiles, compression for online transaction processing (OLTP), Real Application Clusters (RAC) optimizations, Result Caches, and so on, you can greatly improve the performance of your database. Oracle Database 11*g* enables organizations to manage large, scalable, transactional, and data warehousing systems that deliver fast data access using low-cost modular storage.
- **Security:** Oracle Database 11*g* helps organizations protect their information with unique secure configurations, data encryption and masking, and sophisticated auditing capabilities. It delivers a secure and scalable platform for reliable and fast access to all types of information by using the industry-standard interfaces.
- **Information integration:** Oracle Database 11*g* has many features to better integrate data throughout the enterprise. It also supports advanced information life-cycle management capabilities. This helps you manage the changing data in your database.

Oracle Fusion Middleware

Portfolio of leading, standards-based, and customer-proven software products that spans a range of tools and services from Java EE and developer tools, through integration services, business intelligence, collaboration, and content management



Oracle Fusion Middleware is a comprehensive and well-integrated family of products that offers complete support for development, deployment, and management of Service-Oriented Architecture (SOA). SOA facilitates the development of modular business services that can be easily integrated and reused, thereby reducing development and maintenance costs, and providing higher quality of services. Oracle Fusion Middleware's pluggable architecture enables you to leverage your investments in any existing application, system, or technology. Its unbreakable core technology minimizes the disruption caused by planned or unplanned outages.

Some of the products from the Oracle Fusion Middleware family include:

- **Enterprise Application Server:** Application Server
- **Integration and Process Management:** BPEL Process Manager, Oracle Business Process Analysis Suite
- **Development Tools:** Oracle Application Development Framework, JDeveloper, SOA Suite
- **Business Intelligence:** Oracle Business Activity Monitoring, Oracle Data Integrator
- **Systems Management:** Enterprise Manager
- **Identity Management:** Oracle Identity Management
- **Content Management:** Oracle Content Database Suite
- **User Interaction:** Portal, WebCenter

Oracle Enterprise Manager Grid Control

- Efficient Oracle Fusion Middleware management
- Simplifying application and infrastructure life-cycle management
- Improved database administration and application management capabilities

ORACLE

Spanning applications, middleware, and database management, Oracle Enterprise Manager Grid Control delivers integrated enterprise management for Oracle and non-Oracle systems.

Oracle Enterprise Manager Grid Control features advanced Oracle Fusion Middleware management capabilities for the services that business applications rely upon, including SOA, Business Activity Monitoring, and Identity Management.

- **Wide-ranging management functionality** is available for your applications including service-level management, application performance management, configuration management, and change automation
- **Built-in grid automation capabilities** means that information technology responds proactively to fluctuating demand and implements new services more quickly so that businesses can thrive.
- **In-depth diagnostics and readily available remediation** can be applied across a range of applications including custom-built applications, Oracle E-Business Suite, PeopleSoft, Siebel, Oracle Fusion Middleware, Oracle Database, and underlying infrastructure
- **Extensive life cycle management capabilities** extend grid computing by providing solutions for the entire application and infrastructure life cycle, including test, stage, and production through operations. It has simplified patch management with synchronized patching, additional operating system support, and conflict detection features.

Oracle BI Publisher

- Provides a central architecture for authoring, managing, and delivering information in secure and multiple formats
- Reduces complexity and time to develop, test, and deploy all kinds of reports
  - Financial Reports, Invoices, Sales or Purchase orders, XML, and EDI/EFT(eText documents)
- Enables flexible customizations
  - For example, a Microsoft Word document report can be generated in multiple formats, such as PDF, HTML, Excel, RTF, and so on.

Oracle BI Publisher is the enterprise reporting solution from Oracle. Oracle BI Publisher offers the most efficient and scalable reporting solution available for complex, distributed environments.

Oracle BI Publisher reduces the high costs associated with the development, customization, and maintenance of business documents, while increasing the efficiency of reports management. By using a set of familiar desktop tools, users can create and maintain their own report formats based on data queries created by the IT staff or developers.

Oracle BI Publisher report formats can be designed using Microsoft Word or Adobe Acrobat—tools that most users are already familiar with. Oracle BI Publisher also enables you to bring in data from multiple data sources into a single output document. You can deliver reports via printer, email, or fax. You can publish your report to a portal. You can even allow users to collaboratively edit and manage reports on the Web-based Distributed Authoring and Versioning (WebDav) Web servers.

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Relational and Object Relational Database Management Systems

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

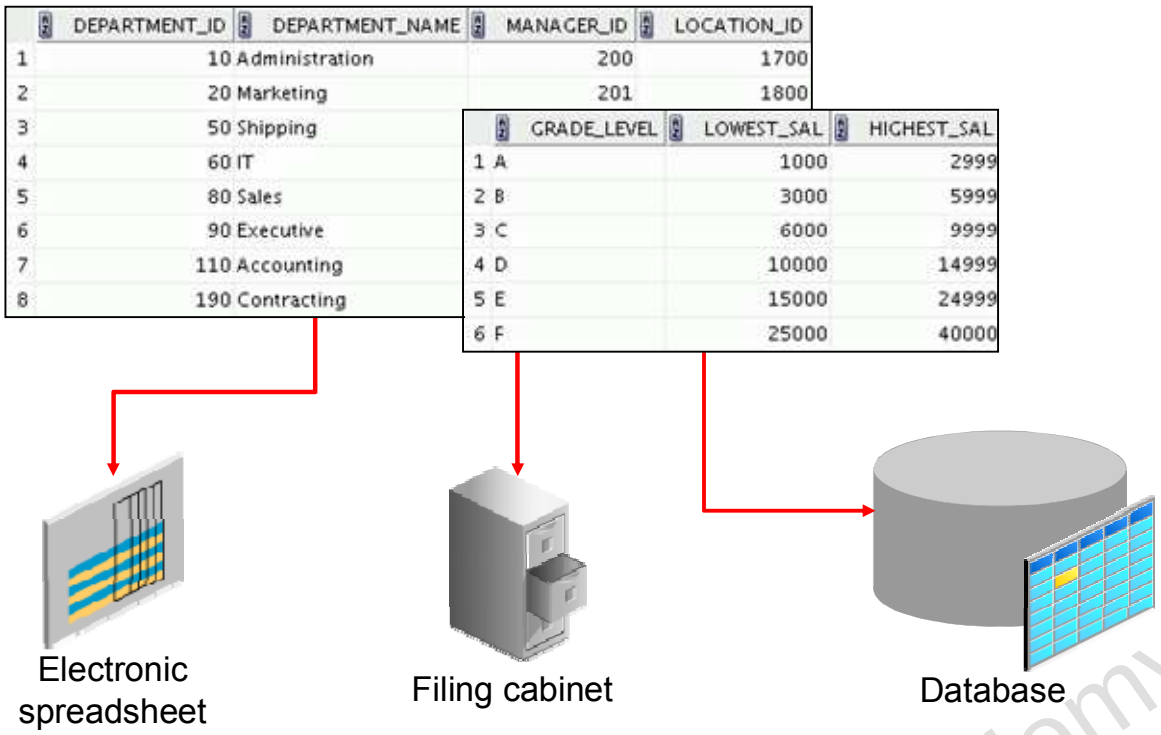
The Oracle server supports both the relational and the object relational database models.

The Oracle server extends the data-modeling capabilities to support an object relational database model that provides object-oriented programming, complex data types, complex business objects, and full compatibility with the relational world.

It includes several features for improved performance and functionality of the OLTP applications, such as better sharing of run-time data structures, larger buffer caches, and deferrable constraints. Data warehouse applications benefit from enhancements such as parallel execution of insert, update, and delete operations; partitioning; and parallel-aware query optimization. The Oracle model supports client/server and Web-based applications that are distributed and multitiered.

For more information about the relational and object relational model, refer to *Oracle Database Concepts for 10g or 11g database*.

Data Storage on Different Media



Every organization has some information needs. A library keeps a list of members, books, due dates, and fines. A company needs to save information about its employees, departments, and salaries. These pieces of information are called *data*.

Organizations can store data in various media and in different formats, such as a hard copy document in a filing cabinet, or data stored in electronic spreadsheets, or in databases.

A *database* is an organized collection of information.

To manage databases, you need a database management system (DBMS). A DBMS is a program that stores, retrieves, and modifies data in databases on request. There are four main types of databases: *hierarchical*, *network*, *relational*, and (most recently) *object relational*.

Relational Database Concept

- Dr. E. F. Codd proposed the relational model for database systems in 1970.
- It is the basis for the relational database management system (RDBMS).
- The relational model consists of the following:
  - Collection of objects or relations
  - Set of operators to act on the relations
  - Data integrity for accuracy and consistency

The principles of the relational model were first outlined by Dr. E. F. Codd in a June 1970 paper titled *A Relational Model of Data for Large Shared Data Banks*. In this paper, Dr. Codd proposed the relational model for database systems.

The common models used at that time were hierarchical and network, or even simple flat-file data structures. Relational database management systems (RDBMS) soon became very popular, especially for their ease of use and flexibility in structure. In addition, a number of innovative vendors, such as Oracle, supplemented the RDBMS with a suite of powerful, application development and user-interface products, thereby providing a total solution.

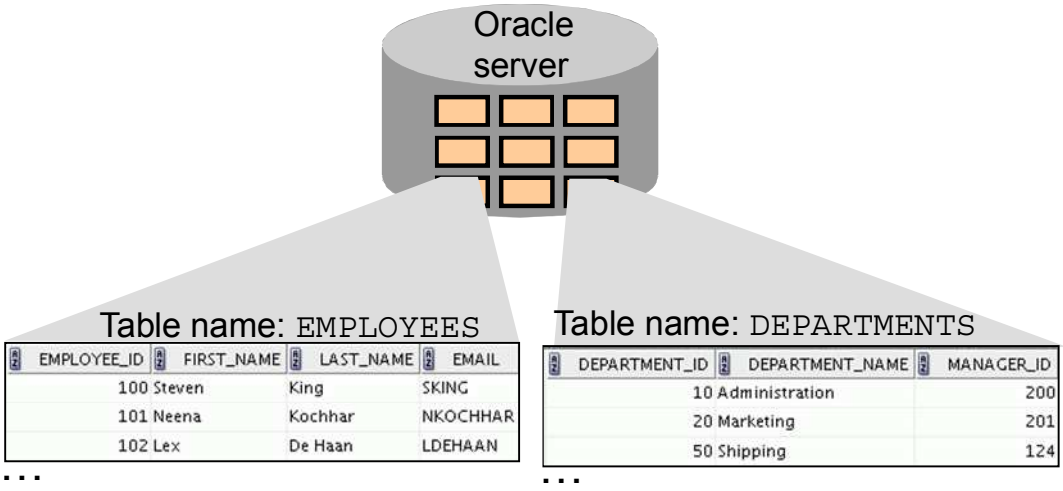
Components of the Relational Model

- Collections of objects or relations that store the data
- A set of operators that can act on the relations to produce other relations
- Data integrity for accuracy and consistency

For more information, refer to *An Introduction to Database Systems, Eighth Edition* (Addison-Wesley: 2004), written by Chris Date.

Definition of a Relational Database

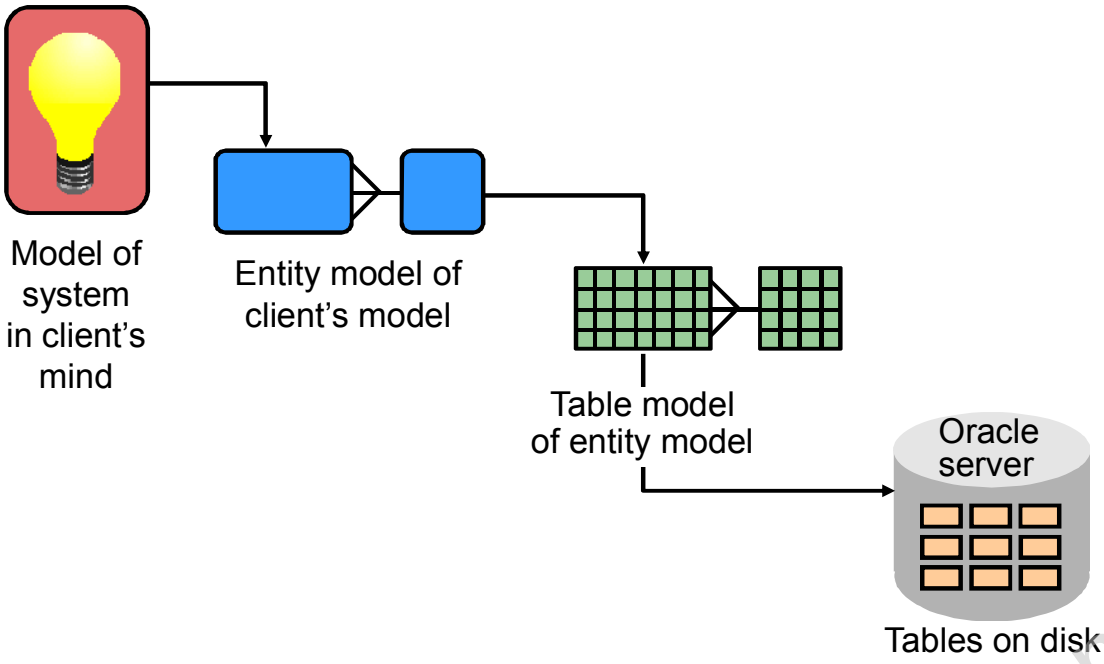
A relational database is a collection of relations or two-dimensional tables controlled by the Oracle server.



A relational database uses relations or two-dimensional tables to store information.

For example, you might want to store information about all the employees in your company. In a relational database, you create several tables to store different pieces of information about your employees, such as an employee table, a department table, and a salary table.

Data Models



Models are the cornerstone of design. Engineers build a model of a car to work out any details before putting it into production. In the same manner, system designers develop models to explore ideas and improve the understanding of database design.

Purpose of Models

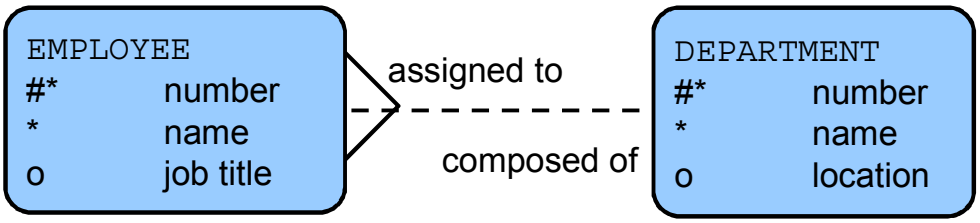
Models help to communicate the concepts that are in people's minds. They can be used to do the following:

- Communicate
- Categorize
- Describe
- Specify
- Investigate
- Evolve
- Analyze
- Imitate

The objective is to produce a model that fits a multitude of these uses, can be understood by an end user, and contains sufficient detail for a developer to build a database system.

Entity Relationship Model

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



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

In an effective system, data is divided into discrete categories or entities. An entity relationship (ER) model is an illustration of the various entities in a business and the relationships among them. An ER model is derived from business specifications or narratives and built during the analysis phase of the system development life cycle. ER models separate the information required by a business from the activities performed within the business. Although businesses can change their activities, the type of information tends to remain constant. Therefore, the data structures also tend to be constant.

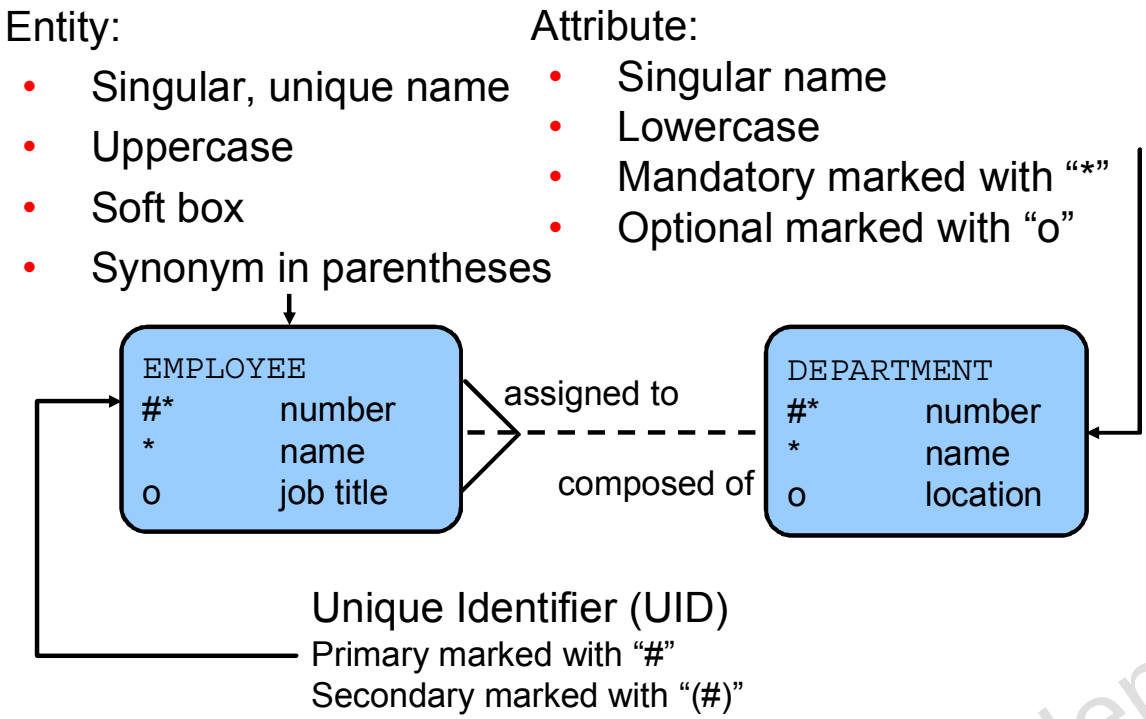
Benefits of ER Modeling:

- Documents information for the organization in a clear, precise format
- Provides a clear picture of the scope of the information requirement
- Provides an easily understood pictorial map for database design
- Offers an effective framework for integrating multiple applications

Key Components

- **Entity:** An aspect of significance about which information must be known. Examples are departments, employees, and orders.
- **Attribute:** Something that describes or qualifies an entity. For example, for the employee entity, the attributes would be the employee number, name, job title, hire date, department number, and so on. Each of the attributes is either required or optional. This state is called *optionality*.
- **Relationship:** A named association between entities showing optionality and degree. Examples are employees and departments, and orders and items.

Entity Relationship Modeling Conventions



Entities

To represent an entity in a model, use the following conventions:

- Singular, unique entity name
- Entity name in uppercase
- Soft box
- Optional synonym names in uppercase within parentheses: ( )

Attributes

To represent an attribute in a model, use the following conventions:

- Singular name in lowercase
- Asterisk (*) tag for mandatory attributes (that is, values that *must* be known)
- Letter "o" tag for optional attributes (that is, values that *may* be known)

Relationships

Symbol	Description
Dashed line	Optional element indicating “maybe”
Solid line	Mandatory element indicating “must be”
Crow’s foot	Degree element indicating “one or more”
Single line	Degree element indicating “one and only one”

Each direction of the relationship contains:

- **A label:** For example, *taught by* or *assigned to*
- **An optionality:** Either *must be* or *maybe*
- **A degree:** Either *one and only one* or *one or more*

Note: The term *cardinality* is a synonym for the term *degree*.

Each source entity {may be | must be} in relation {one and only one | one or more} with the destination entity.

Note: The convention is to read clockwise.

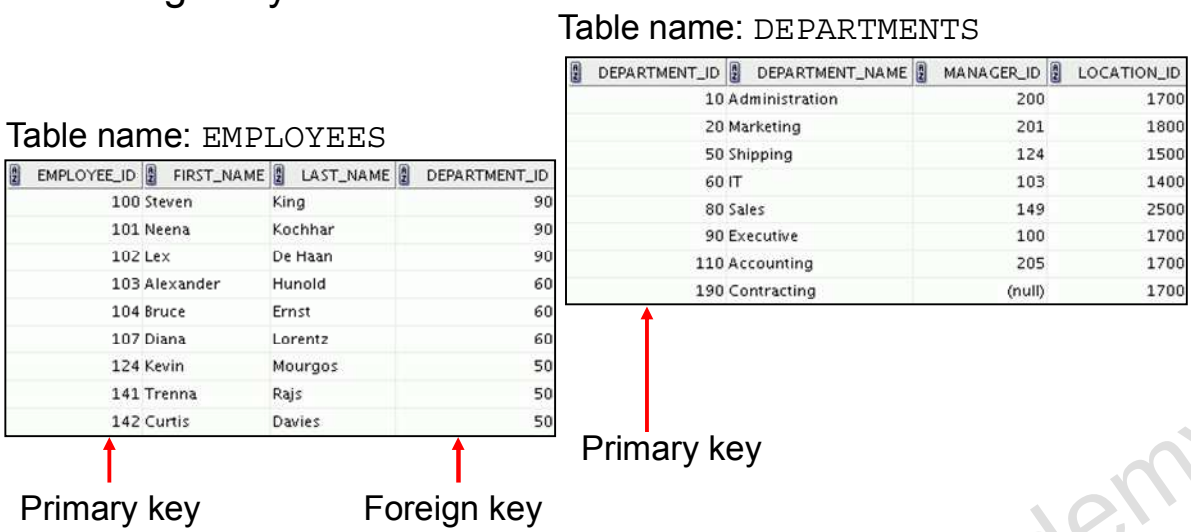
Unique Identifiers

A unique identifier (UID) is any combination of attributes or relationships, or both, that serves to distinguish occurrences of an entity. Each entity occurrence must be uniquely identifiable.

- Tag each attribute that is part of the UID with a hash sign “#”.
- Tag secondary UIDs with a hash sign in parentheses (#).

Relating Multiple Tables

- Each row of data in a table can be uniquely identified by a primary key.
- You can logically relate data from multiple tables using foreign keys.



Each table contains data that describes exactly one entity. For example, the EMPLOYEES table contains information about employees. Categories of data are listed across the top of each table, and individual cases are listed below. By using a table format, you can readily visualize, understand, and use information.

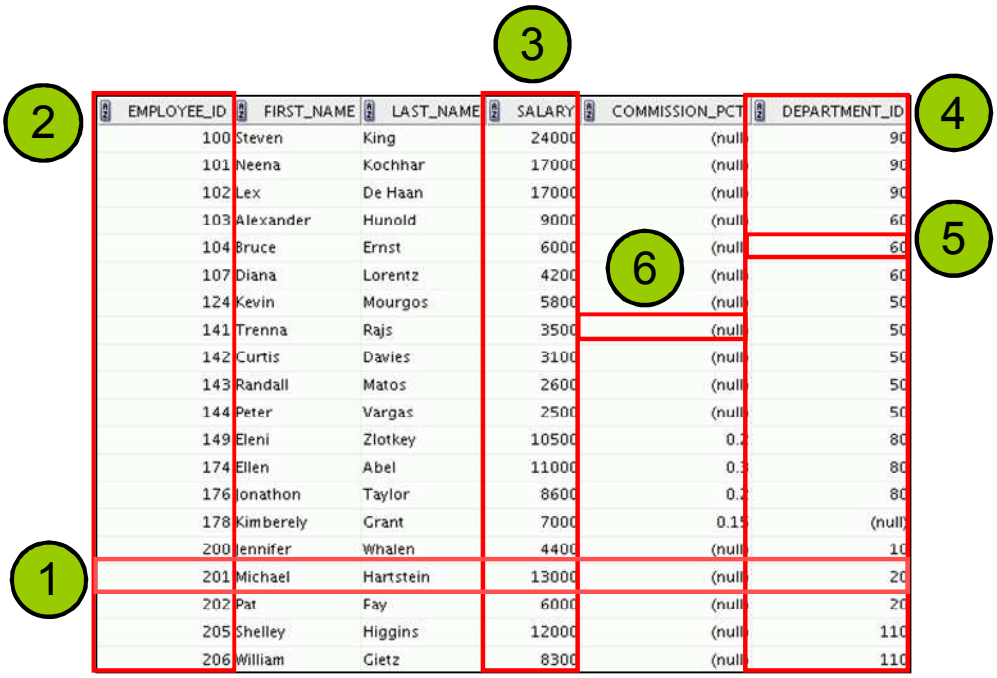
Because data about different entities is stored in different tables, you may need to combine two or more tables to answer a particular question. For example, you may want to know the location of the department where an employee works. In this scenario, you need information from the EMPLOYEES table (which contains data about employees) and the DEPARTMENTS table (which contains information about departments). With an RDBMS, you can relate the data in one table to the data in another by using the foreign keys. A foreign key is a column (or a set of columns) that refers to a primary key in the same table or another table.

You can use the ability to relate data in one table to data in another to organize information in separate, manageable units. Employee data can be kept logically distinct from the department data by storing it in a separate table.

Guidelines for Primary Keys and Foreign Keys

- You cannot use duplicate values in a primary key.
- Primary keys generally cannot be changed.
- Foreign keys are based on data values and are purely logical (not physical) pointers.
- A foreign key value must match an existing primary key value or unique key value; otherwise, it must be null.
- A foreign key must reference either a primary key or a unique key column.

Relational Database Terminology



A relational database can contain one or many tables. A *table* is the basic storage structure of an RDBMS. A table holds all the data necessary about something in the real world, such as employees, invoices, or customers.

The slide shows the contents of the `EMPLOYEES` *table* or *relation*. The numbers indicate the following:

1. A single *row* (or *tuple*) representing all the data required for a particular employee. Each row in a table should be identified by a primary key, which permits no duplicate rows. The order of rows is insignificant; specify the row order when the data is retrieved.
2. A *column* or attribute containing the employee number. The employee number identifies a *unique* employee in the `EMPLOYEES` table. In this example, the employee number column is designated as the *primary key*. A primary key must contain a value and the value must be unique.
3. A column that is not a key value. A column represents one kind of data in a table; in this example, the data is the salaries of all the employees. Column order is insignificant when storing data; specify the column order when the data is retrieved.

4. A column containing the department number, which is also a *foreign key*. A foreign key is a column that defines how tables relate to each other. A foreign key refers to a primary key or a unique key in the same table or in another table. In the example, `DEPARTMENT_ID` uniquely identifies a department in the `DEPARTMENTS` table.
5. A *field* can be found at the intersection of a row and a column. There can be only one value in it.
6. A field may have no value in it. This is called a null value. In the `EMPLOYEES` table, only those employees who have the role of sales representative have a value in the `COMMISSION_PCT` (commission) field.

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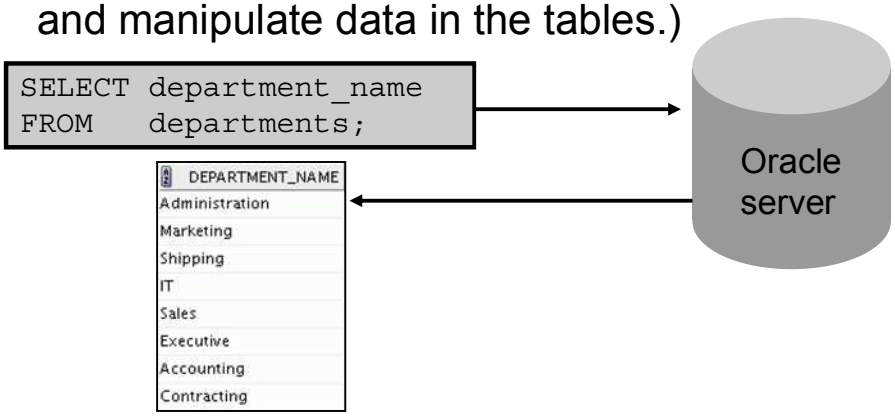
Using SQL to Query Your Database

Structured query language (SQL) is:

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



In a relational database, you do not specify the access route to the tables, and you do not need to know how the data is arranged physically.

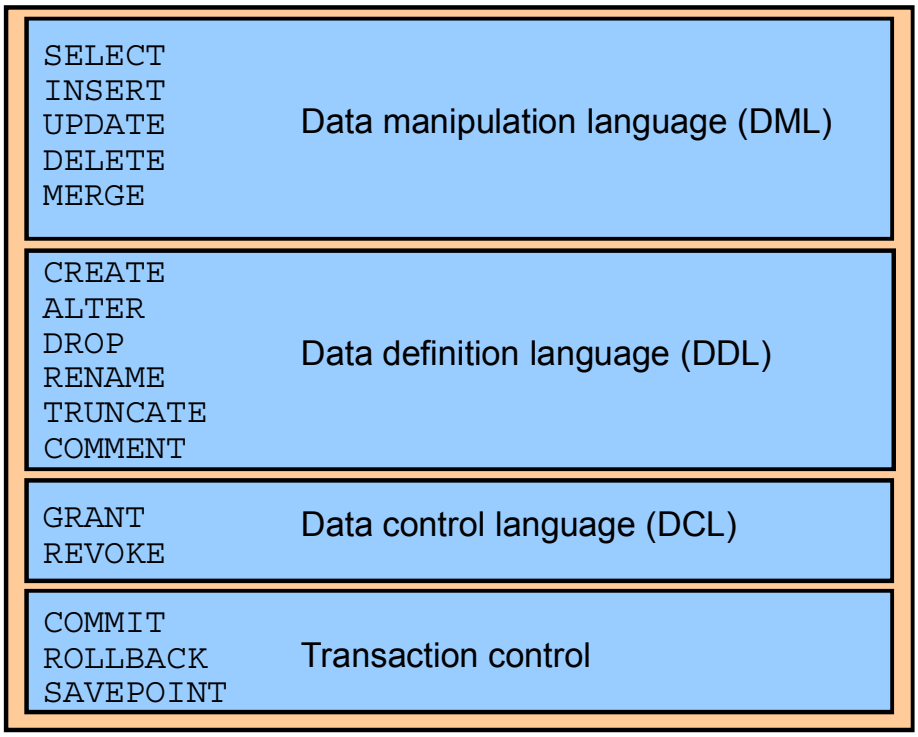
To access the database, you execute a structured query language (SQL) statement, which is the American National Standards Institute (ANSI) standard language for operating relational databases. SQL is a set of statements with which all programs and users access data in an Oracle Database. Application programs and Oracle tools often allow users access to the database without using SQL directly, but these applications, in turn, must use SQL when executing the user's request.

SQL provides statements for a variety of tasks, including:

- Querying data
- Inserting, updating, and deleting rows in a table
- Creating, replacing, altering, and dropping objects
- Controlling access to the database and its objects
- Guaranteeing database consistency and integrity

SQL unifies all of the preceding tasks in one consistent language and enables you to work with data at a logical level.

SQL Statements Used in the Course



SQL Statements

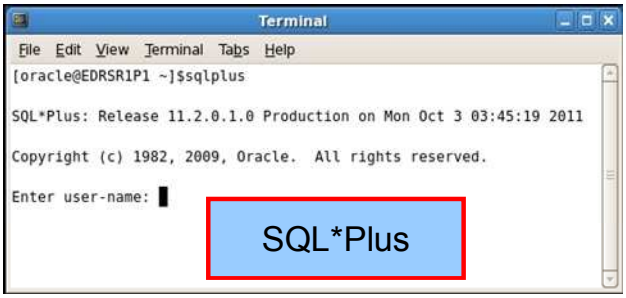
SQL statements supported by Oracle comply with industry standards. Oracle Corporation ensures future compliance with evolving standards by actively involving key personnel in SQL standards committees. The industry-accepted committees are ANSI and International Standards Organization (ISO). Both ANSI and ISO have accepted SQL as the standard language for relational databases.

Statement	Description
SELECT INSERT UPDATE DELETE MERGE	Retrieves data from the database, enters new rows, changes existing rows, and removes unwanted rows from tables in the database, respectively. Collectively known as *data manipulation language* (DML)
CREATE ALTER DROP RENAME TRUNCATE COMMENT	Sets up, changes, and removes data structures from tables. Collectively known as *data definition language* (DDL)
GRANT REVOKE	Provides or removes access rights to both the Oracle Database and the structures within it
COMMIT ROLLBACK SAVEPOINT	Manages the changes made by DML statements. Changes to the data can be grouped together into logical transactions

Development Environments for SQL

There are two development environments for this course:

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



SQL Developer

This course is developed using Oracle SQL Developer as the tool for running the SQL statements discussed in the examples in the lessons and the practices. SQL Developer version 3.1 is the default tool for this class.

SQL*Plus

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

Note

- See Appendix B for information about using SQL Developer, including simple instructions on installation process.
- See Appendix C for information about using SQL*Plus.

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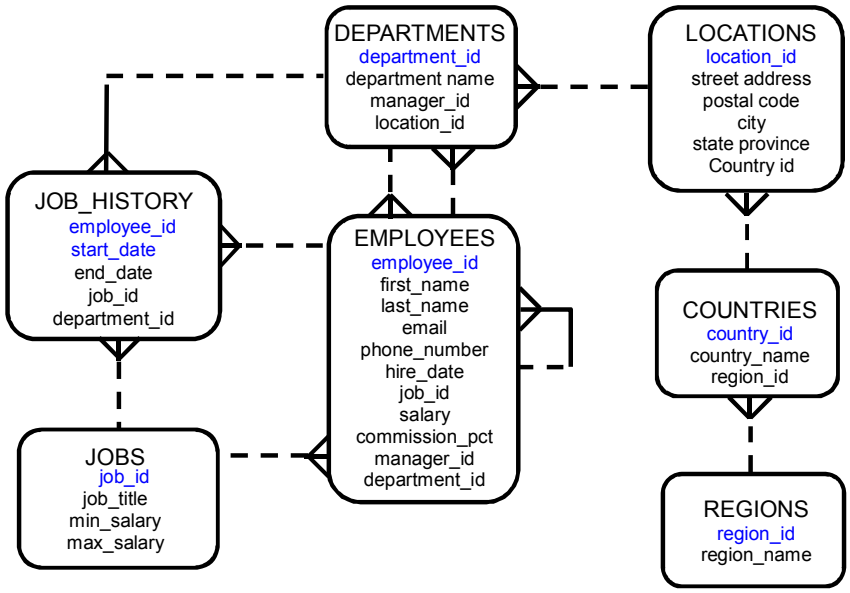
Human Resources (HR) Schema



Human Resources (HR) Schema Description

The Human Resources (HR) schema is a part of the Oracle Sample Schemas that can be installed in an Oracle Database. The practice sessions in this course use data from the HR schema.

Table Descriptions

- REGIONS contains rows that represent a region such as America, Asia, and so on.
- COUNTRIES contains rows for countries, each of which is associated with a region.
- LOCATIONS contains the specific address of a specific office, warehouse, or production site of a company in a particular country.
- DEPARTMENTS shows details about the departments in which the employees work. Each department may have a relationship representing the department manager in the EMPLOYEES table.
- EMPLOYEES contains details about each employee working for a department. Some employees may not be assigned to any department.
- JOBS contains the job types that can be held by each employee.
- JOB_HISTORY contains the job history of the employees. If an employee changes departments within a job or changes jobs within a department, a new row is inserted into this table with the earlier job information of the employee.

Tables Used in the Course

EMPLOYEES

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	SALARY	COMMISSION_PCT	DEPARTMENT_ID	EMAIL	PHONE_NUMBER	HIRE_DATE
100	Steven	King	24000	(null)	90	SKING	515.123.4567	17-JUN-87
101	Neena	Kochhar	17000	(null)	90	NKOCHHAR	515.123.4568	21-SEP-89
102	Lex	De Haan	17000	(null)	90	LDEHAAN	515.123.4569	13-JAN-93
103	Alexander	Hunold	9000	(null)	60	AHUNOLD	590.423.4567	03-JAN-90
104	Bruce	Ernst	6000	(null)	60	BERNST	590.423.4568	21-MAY-91
107	Diana	Lorentz	4200	(null)	60	DLORENTZ	590.423.5567	07-FEB-99
124	Kevin	Mourgos	5800	(null)	50	KMOURGOS	650.123.5234	16-NOV-99
141	Trenna	Rajs	3500	(null)	50	TRAJS	650.121.8009	17-OCT-95
142	Curtis	Davies	3100	(null)	50	CDAVIES	650.121.2994	29-JAN-97
143	Randall	Matos	2600	(null)	50	RMATOS	650.121.2874	15-MAR-98
144	Peter	Vargas	2500	(null)	50	PVARGAS	650.121.2004	09-JUL-98
149	Eleni	Zlotkey	10500	0.2	80	EZLOTKEY	011.44.1344.429018	29-JAN-00
174	Ellen	Abel	11000	0.3	80	EABEL	011.44.1644.429267	11-MAY-96
176	Jonathon	Taylor	8600	0.2	80	JTAYLOR	011.44.1644.429265	24-MAR-98
178	Kimberely	Grant	7000	0.15	(null)	KGRANT	011.44.1644.429263	24-MAY-99
200	Jennifer	Whalen	4400	(null)	10	JWHALEN	515.123.4444	17-SEP-87
201	Michael	Hartstein	13000	(null)	20	MHARTSTE	515.123.5555	17-FEB-96
202	Pat	Fay	6000	(null)	20	PFAY	603.123.6666	17-AUG-97
205	Shelley	Higgins	12000	(null)	110	SHIGGINS	515.123.8080	07-JUN-94
206	William	Gietz	8300	(null)	110	WGIETZ	515.123.8181	07-JUN-94

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

JOB_GRADES

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

DEPARTMENTS

The following main tables are used in this course:

- EMPLOYEES table: Gives details of all the employees
- DEPARTMENTS table: Gives details of all the departments
- JOB_GRADES table: Gives details of salaries for various grades

Apart from these tables, you will also use the other tables listed in the previous slide such as the LOCATIONS and the JOB_HISTORY table.

Note: The structure and data for all the tables are provided in Appendix A.

Lesson Agenda

- Course objectives, course agenda, and appendixes used in this course
- Overview of Oracle Database 11*g* and related products
- Overview of relational database management concepts and terminologies
- Introduction to SQL and its development environments
- The `HR` schema and the tables used in this course
- Oracle Database 11*g* documentation and additional resources

Oracle Database Documentation

- Oracle Database New Features Guide
- Oracle Database Reference
- Oracle Database SQL Language Reference
- Oracle Database Concepts
- Oracle Database SQL Developer User's Guide

Navigate to http://www.oracle.com/pls/db102/homepage to access the Oracle Database 10*g* documentation library.

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

Additional Resources

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

- *Oracle Database 11g: New Features eStudies*
- *Oracle Learning Library:*
  - http://www.oracle.com/goto/oll

Summary

In this lesson, you should have learned that:

- Oracle Database 11*g* extends:
  - The benefits of infrastructure grids
  - The existing information management capabilities
  - The capabilities to use the major application development environments such as PL/SQL, OracleJava/JDBC, .NET, XML, and so on
- The database is based on ORDBMS
- Relational databases are composed of relations, managed by relational operations, and governed by data integrity constraints
- With the Oracle server, you can store and manage information by using SQL

Relational database management systems are composed of objects or relations. They are managed by operations and governed by data integrity constraints.

Oracle Corporation produces products and services to meet your RDBMS needs. The main products are the following:

- Oracle Database with which you store and manage information by using SQL
- Oracle Fusion Middleware with which you develop, deploy, and manage modular business services that can be integrated and reused
- Oracle Enterprise Manager Grid Control, which you use to manage and automate administrative tasks across sets of systems in a grid environment

SQL

The Oracle server supports ANSI-standard SQL and contains extensions. SQL is the language that is used to communicate with the server to access, manipulate, and control data.

Practice 1: Overview

This practice covers the following topics:

- Starting Oracle SQL Developer
- Creating a new database connection
- Browsing the `HR` tables

In this practice, you perform the following:

- Start Oracle SQL Developer and create a new connection to the `ora1` account.
- Use Oracle SQL Developer to examine data objects in the ora1 account. The `ora1` account contains the `HR` schema tables.

Note the following location for the lab files:

/home/oracle/labs/sql1/labs

If you are asked to save any lab files, save them in this location.

In any practice, there may be exercises that are prefaced with the phrases “If you have time” or “If you want an extra challenge.” Work on these exercises only if you have completed all other exercises within the allocated time and would like a further challenge to your skills.

Perform the practices slowly and precisely. You can experiment with saving and running command files. If you have any questions at any time, ask your instructor.

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

2

Retrieving Data Using the SQL SELECT Statement

Objectives

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

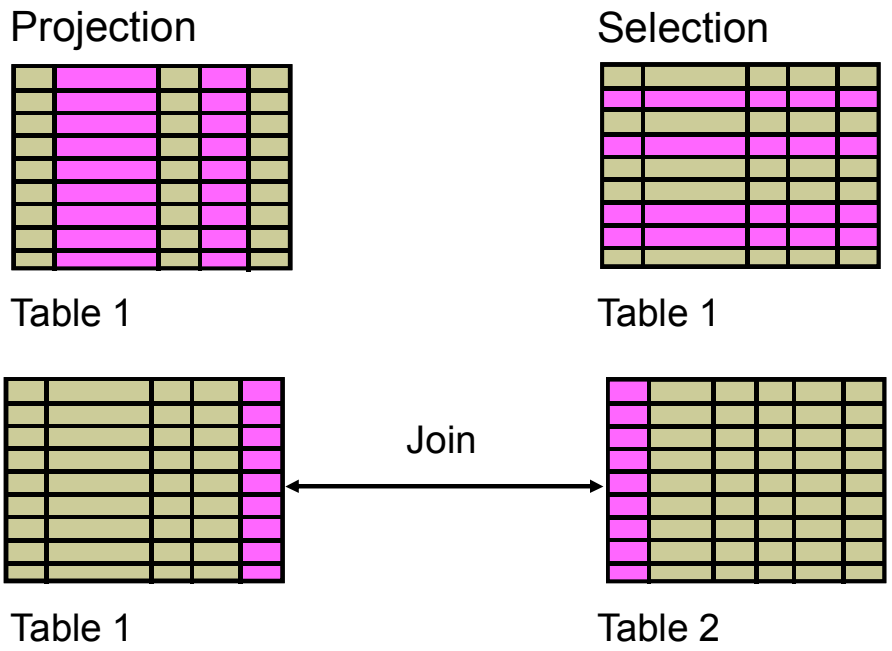
- List the capabilities of SQL `SELECT` statements
- Execute a basic `SELECT` statement

To extract data from the database, you need to use the SQL `SELECT` statement. However, you may need to restrict the columns that are displayed. This lesson describes the `SELECT` statement that is needed to perform these actions. Further, you may want to create `SELECT` statements that can be used more than once.

Lesson Agenda

- Basic `SELECT` statement
- Arithmetic expressions and `NULL` values in the `SELECT` statement
- Column aliases
- Use of concatenation operator, literal character strings, alternative quote operator, and the `DISTINCT` keyword
- `DESCRIBE` command

Capabilities of SQL SELECT Statements



A SELECT statement retrieves information from the database. With a SELECT statement, you can do the following:

- **Projection:** Selects the columns in a table that are returned by a query. Selects a few or as many of the columns as required.
- **Selection:** Selects the rows in a table that are returned by a query. Various criteria can be used to restrict the rows that are retrieved.
- **Joins:** Brings together data that is stored in different tables by specifying the link between them. SQL joins are covered in more detail in the lesson titled “Displaying Data from Multiple Tables Using Joins.”

Basic SELECT Statement

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

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

In its simplest form, a SELECT statement must include the following:

- A SELECT clause, which specifies the columns to be displayed
- A FROM clause, which identifies the table containing the columns that are listed in the SELECT clause

In the syntax:

SELECT	Is a list of one or more columns
*	Selects all columns
DISTINCT	Suppresses duplicates
column|expression	Selects the named column or the expression
alias	Gives different headings to the selected columns
FROM *table*	Specifies the table containing the columns

Note: Throughout this course, the words *keyword*, *clause*, and *statement* are used as follows:

- A *keyword* refers to an individual SQL element—for example, SELECT and FROM are keywords.
- A *clause* is a part of a SQL statement—for example, SELECT employee_id, last_name, and so on.
- A *statement* is a combination of two or more clauses—for example, SELECT * FROM employees.

Selecting All Columns

```
SELECT *
FROM   departments;
```

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

You can display all columns of data in a table by following the `SELECT` keyword with an asterisk (`*`). In the example in the slide, the `DEPARTMENTS` table contains four columns: `DEPARTMENT_ID`, `DEPARTMENT_NAME`, `MANAGER_ID`, and `LOCATION_ID`. The table contains eight rows, one for each department.

You can also display all columns in the table by listing them after the `SELECT` keyword. For example, the following SQL statement (like the example in the slide) displays all columns and all rows of the `DEPARTMENTS` table:

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

Note: In SQL Developer, you can enter your SQL statement in a SQL Worksheet and click the "Execute Statement" icon or press [F9] to execute the statement. The output displayed on the Results tabbed page appears as shown in the slide.

Selecting Specific Columns

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

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

You can use the `SELECT` statement to display specific columns of the table by specifying the column names, separated by commas. The example in the slide displays all the department numbers and location numbers from the `DEPARTMENTS` table.

In the `SELECT` clause, specify the columns that you want in the order in which you want them to appear in the output. For example, to display location before department number (from left to right), you use the following statement:

```
SELECT location_id, department_id
FROM   departments 7
```

	LOCATION_ID	DEPARTMENT_ID
1	1700	10
2	1800	20
3	1500	50
4	1400	60

. . .

Writing SQL Statements

- SQL statements are not case sensitive.
- SQL statements can be entered on one or more lines.
- Keywords cannot be abbreviated or split across lines.
- Clauses are usually placed on separate lines.
- Indents are used to enhance readability.
- In SQL Developer, SQL statements can be optionally terminated by a semicolon (;). Semicolons are required when you execute multiple SQL statements.
- In SQL*Plus, you are required to end each SQL statement with a semicolon (;).

Writing SQL Statements

By using the following simple rules and guidelines, you can construct valid statements that are both easy to read and edit:

- SQL statements are not case sensitive (unless indicated).
- SQL statements can be entered on one or many lines.
- Keywords cannot be split across lines or abbreviated.
- Clauses are usually placed on separate lines for readability and ease of editing.
- Indents should be used to make code more readable.
- Keywords typically are entered in uppercase; all other words, such as table names and columns names are entered in lowercase.

Executing SQL Statements

In SQL Developer, click the Run Script icon or press [F5] to run the command or commands in the SQL Worksheet. You can also click the Execute Statement icon or press [F9] to run a SQL statement in the SQL Worksheet. The Execute Statement icon executes the statement at the mouse pointer in the Enter SQL Statement box while the Run Script icon executes all the statements in the Enter SQL Statement box. The Execute Statement icon displays the output of the query on the Results tabbed page, whereas the Run Script icon emulates the SQL*Plus display and shows the output on the Script Output tabbed page.

In SQL*Plus, terminate the SQL statement with a semicolon, and then press [Enter] to run the command.

Column Heading Defaults

- SQL Developer:
  - Default heading alignment: Left-aligned
  - Default heading display: Uppercase
- SQL*Plus:
  - Character and Date column headings are left-aligned.
  - Number column headings are right-aligned.
  - Default heading display: Uppercase

In SQL Developer, column headings are displayed in uppercase and are left-aligned.

```
SELECT last_name, hire_date, salary
FROM   employees;
```

	LAST_NAME	HIRE_DATE	SALARY
1	King	17-JUN-87	24000
2	Kochhar	21-SEP-89	17000
3	De Haan	13-JAN-93	17000
4	Hunold	03-JAN-90	9000
5	Ernst	21-MAY-91	6000
6	Lorentz	07-FEB-99	4200
7	Mourgos	16-NOV-99	5800
8	Rajs	17-OCT-95	3500
9	Davies	29-JAN-97	3100

...

You can override the column heading display with an alias. Column aliases are covered later in this lesson.

Lesson Agenda

- Basic `SELECT` statement
- Arithmetic expressions and `NULL` values in the `SELECT` statement
- Column Aliases
- Use of concatenation operator, literal character strings, alternative quote operator, and the `DISTINCT` keyword
- `DESCRIBE` command

Arithmetic Expressions

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

Operator	Description
+	Add
-	Subtract
*	Multiply
/	Divide

You may need to modify the way in which data is displayed, or you may want to perform calculations, or look at what-if scenarios. All these are possible using arithmetic expressions. An arithmetic expression can contain column names, constant numeric values, and the arithmetic operators.

Arithmetic Operators

The slide lists the arithmetic operators that are available in SQL. You can use arithmetic operators in any clause of a SQL statement (except the `FROM` clause).

Note: With the `DATE` and `TIMESTAMP` data types, you can use the addition and subtraction operators only.

Using Arithmetic Operators

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

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

...

The example in the slide uses the addition operator to calculate a salary increase of $300 for all employees. The slide also displays a `SALARY+300` column in the output.

Note that the resultant calculated column, `SALARY+300`, is not a new column in the `EMPLOYEES` table; it is for display only. By default, the name of a new column comes from the calculation that generated it—in this case, `salary+300`.

Note: The Oracle server ignores blank spaces before and after the arithmetic operator.

Operator Precedence

If an arithmetic expression contains more than one operator, multiplication and division are evaluated first. If operators in an expression are of the same priority, evaluation is done from left to right.

You can use parentheses to force the expression that is enclosed by the parentheses to be evaluated first.

Rules of Precedence

- Multiplication and division occur before addition and subtraction.
- Operators of the same priority are evaluated from left to right.
- Parentheses are used to override the default precedence or to clarify the statement.

Operator Precedence

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

1

	LAST_NAME	SALARY	12*SALARY+100
1	King	24000	288100
2	Kochhar	17000	204100
3	De Haan	17000	204100
4	Hunold	9000	108100

...

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

2

	LAST_NAME	SALARY	12*(SALARY+100)
1	King	24000	289200
2	Kochhar	17000	205200
3	De Haan	17000	205200
4	Hunold	9000	109200

...

The first example in the slide displays the last name, salary, and annual compensation of employees. It calculates the annual compensation by multiplying the monthly salary with 12, plus a one-time bonus of $100. Note that multiplication is performed before addition.

Note: Use parentheses to reinforce the standard order of precedence and to improve clarity. For example, the expression in the slide can be written as `(12*salary)+100` with no change in the result.

Using Parentheses

You can override the rules of precedence by using parentheses to specify the desired order in which the operators are to be executed.

The second example in the slide displays the last name, salary, and annual compensation of employees. It calculates the annual compensation as follows: adding a monthly bonus of $100 to the monthly salary, and then multiplying that subtotal with 12. Because of the parentheses, addition takes priority over multiplication.

Defining a Null Value

- Null is a value that is unavailable, unassigned, unknown, or inapplicable.
- Null is not the same as zero or a blank space.

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

	LAST_NAME	JOB_ID	SALARY	COMMISSION_PCT
1	King	AD_PRES	24000	(null)
2	Kochhar	AD_VP	17000	(null)
3	De Haan	AD_VP	17000	(null)
...				
17	Hartstein	MK_MAN	13000	(null)
18	Fay	MK_REP	6000	(null)
19	Higgins	AC_MGR	12000	(null)
20	Gietz	AC_ACCOUNT	8300	(null)

If a row lacks a data value for a particular column, that value is said to be *null* or to contain a null.

Null is a value that is unavailable, unassigned, unknown, or inapplicable. Null is not the same as zero or a blank space. Zero is a number and blank space is a character.

Columns of any data type can contain nulls. However, some constraints (`NOT NULL` and `PRIMARY KEY`) prevent nulls from being used in the column.

In the `COMMISSION_PCT` column in the `EMPLOYEES` table, notice that only a sales manager or sales representative can earn a commission. Other employees are not entitled to earn commissions. A null represents that fact.

Note: By default, SQL Developer uses the literal, (null), to identify null values. However, you can set it to something more relevant to you. To do so, select Preferences from the Tools menu. In the Preferences dialog box, expand the Database node. Click Advanced Parameters and on the right pane, for the “Display Null value As,” enter the appropriate value.

Null Values in Arithmetic Expressions

Arithmetic expressions containing a null value evaluate to null.

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

	LAST_NAME	12*SALARY*COMMISSION_PCT
1	King	(null)
2	Kochhar	(null)
3	De Haan	(null)
4	Hunold	(null)

...

16	Whalen	(null)
17	Hartstein	(null)
18	Fay	(null)
19	Higgins	(null)
20	Gietz	(null)

If any column value in an arithmetic expression is null, the result is null. For example, if you attempt to perform division by zero, you get an error. However, if you divide a number by null, the result is a null or unknown.

In the example in the slide, employee Whalen does not get any commission. Because the `COMMISSION_PCT` column in the arithmetic expression is null, the result is null.

For more information, see the section on "Basic Elements of Oracle SQL" in *Oracle Database SQL Language Reference* for 10*g* or 11*g* database.

Lesson Agenda

- Basic SELECT statement
- Arithmetic expressions and NULL values in the SELECT statement
- Column aliases
- Use of concatenation operator, literal character strings, alternative quote operator, and the DISTINCT keyword
- DESCRIBE command

Defining a Column Alias

A column alias:

- Renames a column heading
- Is useful with calculations
- Immediately follows the column name (There can also be the optional `AS` keyword between the column name and the alias.)
- Requires double quotation marks if it contains spaces or special characters, or if it is case-sensitive

When displaying the result of a query, SQL Developer normally uses the name of the selected column as the column heading. This heading may not be descriptive and, therefore, may be difficult to understand. You can change a column heading by using a column alias.

Specify the alias after the column in the `SELECT` list using blank space as a separator. By default, alias headings appear in uppercase. If the alias contains spaces or special characters (such as # or $), or if it is case-sensitive, enclose the alias in double quotation marks (“ “).

Using Column Aliases

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

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

...

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

	Name	Annual Salary
1	King	288000
2	Kochhar	204000
3	De Haan	204000
4	Hunold	108000

...

The first example displays the names and the commission percentages of all the employees. Note that the optional `AS` keyword has been used before the column alias name. The result of the query is the same whether the `AS` keyword is used or not. Also, note that the SQL statement has the column aliases, `name` and `comm`, in lowercase, whereas the result of the query displays the column headings in uppercase. As mentioned in the preceding slide, column headings appear in uppercase by default.

The second example displays the last names and annual salaries of all the employees. Because `Annual Salary` contains a space, it has been enclosed in double quotation marks. Note that the column heading in the output is exactly the same as the column alias.

Lesson Agenda

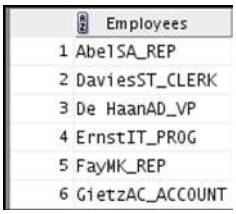
- Basic SELECT Statement
- Arithmetic Expressions and NULL values in SELECT statement
- Column Aliases
- Use of concatenation operator, literal character strings, alternative quote operator, and the DISTINCT keyword
- DESCRIBE command

Concatenation Operator

A concatenation operator:

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

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



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

...

You can link columns to other columns, arithmetic expressions, or constant values to create a character expression by using the concatenation operator (||). Columns on either side of the operator are combined to make a single output column.

In the example, `LAST_NAME` and `JOB_ID` are concatenated, and given the alias `Employees`. Note that the last name of the employee and the job code are combined to make a single output column.

The `AS` keyword before the alias name makes the `SELECT` clause easier to read.

Null Values with the Concatenation Operator

If you concatenate a null value with a character string, the result is a character string. `LAST_NAME || NULL` results in `LAST_NAME`.

Note: You can also concatenate date expressions with other expressions or columns.

Literal Character Strings

- A literal is a character, a number, or a date that is included in the `SELECT` statement.
- Date and character literal values must be enclosed within single quotation marks.
- Each character string is output once for each row returned.

A literal is a character, a number, or a date that is included in the `SELECT` list. It is not a column name or a column alias. It is printed for each row returned. Literal strings of free-format text can be included in the query result and are treated the same as a column in the `SELECT` list.

The date and character literals *must* be enclosed within single quotation marks (`''`); number literals need not be enclosed in a similar manner.

Using Literal Character Strings

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

	Employee Details
1	Abel is a SA_REP
2	Davies is a ST_CLERK
3	De Haan is a AD_VP
4	Ernst is a IT_PROG
5	Fay is a MK_REP
6	Gietz is a AC_ACCOUNT
7	Grant is a SA_REP
8	Hartstein is a MK_MAN
9	Higgins is a AC_MGR
10	Hunold is a IT_PROG
11	King is a AD_PRES

. . .

The example in the slide displays the last names and job codes of all employees. The column has the heading Employee Details. Note the spaces between the single quotation marks in the SELECT statement. The spaces improve the readability of the output.

In the following example, the last name and salary for each employee are concatenated with a literal, to give the returned rows more meaning:

```
SELECT last_name ||': 1 Month salary = '||salary Monthly
FROM   employees;
```

	MONTHLY
1	King: 1 Month salary = 24000
2	Kochhar: 1 Month salary = 17000
3	De Haan: 1 Month salary = 17000
4	Hunold: 1 Month salary = 9000
5	Ernst: 1 Month salary = 6000
6	Lorentz: 1 Month salary = 4200
7	Mourgos: 1 Month salary = 5800

. . .

Alternative Quote (q) Operator

- Specify your own quotation mark delimiter.
- Select any delimiter.
- Increase readability and usability.

```
SELECT department_name || q'[ Department's Manager Id: ]'
       || manager_id
       AS "Department and Manager"
FROM departments;
```

	Department and Manager
1	Administration Department's Manager Id: 200
2	Marketing Department's Manager Id: 201
3	Shipping Department's Manager Id: 124
4	IT Department's Manager Id: 103
5	Sales Department's Manager Id: 149
6	Executive Department's Manager Id: 100
7	Accounting Department's Manager Id: 205
8	Contracting Department's Manager Id:

Many SQL statements use character literals in expressions or conditions. If the literal itself contains a single quotation mark, you can use the quote (q) operator and select your own quotation mark delimiter.

You can choose any convenient delimiter, single-byte or multibyte, or any of the following character pairs: [ ], { }, ( ), or < >.

In the example shown, the string contains a single quotation mark, which is normally interpreted as a delimiter of a character string. By using the q operator, however, brackets [ ] are used as the quotation mark delimiters. The string between the brackets delimiters is interpreted as a literal character string.

Duplicate Rows

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

1

```
SELECT department_id
FROM   employees;
```

	DEPARTMENT_ID
1	90
2	90
3	90
4	60
5	60
6	60
7	50
8	50

...

2

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

	DEPARTMENT_ID
1	(null)
2	90
3	20
4	110
5	50
6	80
7	60
8	10

Unless you indicate otherwise, SQL displays the results of a query without eliminating the duplicate rows. The first example in the slide displays all the department numbers from the EMPLOYEES table. Note that the department numbers are repeated.

To eliminate duplicate rows in the result, include the DISTINCT keyword in the SELECT clause immediately after the SELECT keyword. In the second example in the slide, the EMPLOYEES table actually contains 20 rows, but there are only seven unique department numbers in the table.

You can specify multiple columns after the DISTINCT qualifier. The DISTINCT qualifier affects all the selected columns, and the result is every distinct combination of the columns.

```
SELECT  DISTINCT department_id, job_id
FROM    employees;
```

	DEPARTMENT_ID	JOB_ID
1	110	AC_ACCOUNT
2	90	AD_VP
3	50	ST_CLERK

...

Note: You may also specify the keyword UNIQUE, which is a synonym for the keyword DISTINCT.

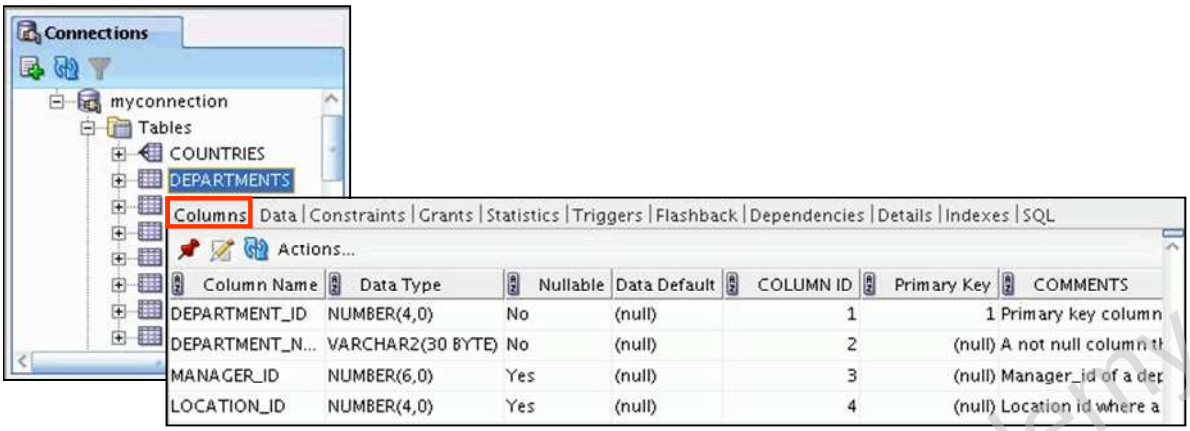
Lesson Agenda

- Basic `SELECT` statement
- Arithmetic expressions and `NULL` values in the `SELECT` statement
- Column aliases
- Use of concatenation operator, literal character strings, alternative quote operator, and the `DISTINCT` keyword
- `DESCRIBE` command

Displaying the Table Structure

- Use the `DESCRIBE` command to display the structure of a table.
- Or, select the table in the Connections tree and use the Columns tab to view the table structure.

```
DESC[RIBE] tablename
```



You can display the structure of a table by using the `DESCRIBE` command. The command displays the column names and the data types, and it shows you whether a column *must* contain data (that is, whether the column has a `NOT NULL` constraint).

In the syntax, *`table name`* is the name of any existing table, view, or synonym that is accessible to the user.

Using the SQL Developer GUI interface, you can select the table in the Connections tree and use the Columns tab to view the table structure.

Note: `DESCRIBE` is a SQL *PLUS command supported by SQL Developer. It is abbreviated as `DESC`.

Using the DESCRIBE Command

```
DESCRIBE employees
```

```
DESCRIBE Employees
Name           Null     Type
-------------- -------- ------------
EMPLOYEE_ID    NOT NULL NUMBER(6)
FIRST_NAME              VARCHAR2(20)
LAST_NAME      NOT NULL VARCHAR2(25)
EMAIL          NOT NULL VARCHAR2(25)
PHONE_NUMBER            VARCHAR2(20)
HIRE_DATE      NOT NULL DATE
JOB_ID         NOT NULL VARCHAR2(10)
SALARY                  NUMBER(8,2)
COMMISSION_PCT          NUMBER(2,2)
MANAGER_ID              NUMBER(6)
DEPARTMENT_ID           NUMBER(4)
```


The example in the slide displays information about the structure of the EMPLOYEES table using the DESCRIBE command.

In the resulting display, *Null* indicates that the values for this column may be unknown. NOT NULL indicates that a column must contain data. *Type* displays the data type for a column.

The data types are described in the following table:

Data Type	Description
NUMBER(*p*,*s*)	Number value having a maximum number of digits *p*, with *s* digits to the right of the decimal point
VARCHAR2(*s*)	Variable-length character value of maximum size *s*
DATE	Date and time value between January 1, 4712 B.C. and December 31, A.D. 9999

Quiz

Identify the two SELECT statements that execute successfully.

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

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

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

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


Answer: b, c

Summary

In this lesson, you should have learned how to:

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

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


In this lesson, you should have learned how to retrieve data from a database table with the `SELECT` statement.

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

In the syntax:

`SELECT`	Is a list of one or more columns
`*`	Selects all columns
`DISTINCT`	Suppresses duplicates
`column|expression`	Selects the named column or the expression
`alias`	Gives different headings to the selected columns
`FROM` *`table`*	Specifies the table containing the columns

Practice 2: Overview

This practice covers the following topics:

- Selecting all data from different tables
- Describing the structure of tables
- Performing arithmetic calculations and specifying column names

In this practice, you write simple `SELECT` queries. The queries cover most of the `SELECT` clauses and operations that you learned in this lesson.

3

Restricting and Sorting Data

Objectives

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

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

When retrieving data from the database, you may need to do the following:

- Restrict the rows of data that are displayed
- Specify the order in which the rows are displayed

This lesson explains the SQL statements that you use to perform the actions listed above.

Lesson Agenda

- Limiting rows with:
  - The `WHERE` clause
  - The comparison operators using `=`, `<=`, `BETWEEN`, `IN`, `LIKE`, and `NULL` conditions
  - Logical conditions using `AND`, `OR`, and `NOT` operators
- Rules of precedence for operators in an expression
- Sorting rows using the `ORDER BY` clause
- Substitution variables
- `DEFINE` and `VERIFY` commands

Limiting Rows Using a Selection

EMPLOYEES

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

...

"retrieve all employees in department 90"

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

In the example in the slide, assume that you want to display all the employees in department 90. The rows with a value of 90 in the `DEPARTMENT_ID` column are the only ones that are returned. This method of restriction is the basis of the `WHERE` clause in SQL.

Limiting the Rows That Are Selected

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

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

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

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. If the condition is true, the row meeting the condition is returned.

In the syntax:

`WHERE`	Restricts the query to rows that meet a condition
`logical expression`	Is composed of column names, constants, and a comparison operator. It specifies a combination of one or more expressions and Boolean operators, and returns a value of `TRUE`, `FALSE`, or `UNKNOWN`.

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

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

Using the WHERE Clause

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

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

In the example, the SELECT statement retrieves the employee ID, last name, job ID, and department number of all employees who are in department 90.

Note: You cannot use column alias in the WHERE clause.

Character Strings and Dates

- Character strings and date values are enclosed with single quotation marks.
- Character values are case-sensitive and date values are format-sensitive.
- The default date display format is DD-MON-RR.

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

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

Character strings and dates in the WHERE clause must be enclosed with single quotation marks (''). Number constants, however, need not be enclosed with single quotation marks.

All character searches are case-sensitive. In the following example, no rows are returned because the EMPLOYEES table stores all the last names in mixed case:

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

Oracle databases store dates in an internal numeric format, representing the century, year, month, day, hours, minutes, and seconds. The default date display is in the DD-MON-RR format.

Note: For details about the RR format and about changing the default date format, see the lesson titled "Using Single-Row Functions to Customize Output." Also, you learn about the use of single-row functions such as UPPER and LOWER to override the case sensitivity in the same lesson.

Comparison Operators

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

Comparison operators are used in conditions that compare one expression with another value or expression. They are used in the `WHERE` clause in the following format:

Syntax

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

Example

```
... WHERE hire_date = '01-JAN-95'
... WHERE salary >= 6000
... WHERE last_name = 'Smith'
```

Remember, an alias cannot be used in the `WHERE` clause.

Note: The symbols `!=` and `^=` can also represent the *not equal* to condition

Using Comparison Operators

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

	LAST_NAME	SALARY
1	Matos	2600
2	Vargas	2500

In the example, the `SELECT` statement retrieves the last name and salary from the `EMPLOYEES` table for any employee whose salary is less than or equal to $3,000. Note that there is an explicit value supplied to the `WHERE` clause. The explicit value of `3000` is compared to the salary value in the `SALARY` column of the `EMPLOYEES` table.

Range Conditions Using the BETWEEN Operator

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

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

Lower limit Upper limit

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

You can display rows based on a range of values using the BETWEEN operator. The range that you specify contains a lower limit and an upper limit.

The SELECT statement in the slide returns rows from the EMPLOYEES table for any employee whose salary is between $2,500 and $3,500.
Values that are specified with the BETWEEN operator are inclusive. However, you must specify the lower limit first.

You can also use the BETWEEN operator on character values:

```
SELECT last_name
FROM   employees
WHERE  last_name BETWEEN 'King' AND 'Smith
```

	LAST_NAME
1	King
2	Kochhar
3	Lorentz
4	Matos
5	Mourgos
6	Rajs

Membership Condition Using the IN Operator

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

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

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

To test for values in a specified set of values, use the IN operator. The condition defined using the IN operator is also known as the *membership condition*.

The slide example displays employee numbers, last names, salaries, and manager's employee numbers for all the employees whose manager's employee number is 100, 101, or 201.

Note: The set of values can be specified in any random order—for example, (201,100,101).

The IN operator can be used with any data type. The following example returns a row from the EMPLOYEES table, for any employee whose last name is included in the list of names in the WHERE clause:

```
SELECT employee_id, manager_id, department_id
FROM   employees
WHERE  last_name IN ('Hartstein', 'Vargas');
```

If characters or dates are used in a list, they must be enclosed with single quotation marks ('').

Note: The IN operator is internally evaluated by the Oracle server as a set of OR conditions, such as a=value1 or a=value2 or a=value3. Therefore, using the IN operator has no performance benefits and is used only for logical simplicity.

Pattern Matching Using the LIKE Operator

- Use the LIKE operator to perform wildcard searches of valid search string values.
- Search conditions can contain either literal characters or numbers:
  - % denotes zero or many characters.
  - _ denotes one character.

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


You may not always know the exact value to search for. You can select rows that match a character pattern by using the LIKE operator. The character pattern–matching operation is referred to as a *wildcard* search. Two symbols can be used to construct the search string.

Symbol	Description
%	Represents any sequence of zero or more characters
_	Represents any single character

The SELECT statement in the slide returns the first name from the EMPLOYEES table for any employee whose first name begins with the letter "S." Note the uppercase "S." Consequently, names beginning with a lowercase "s" are not returned.

The LIKE operator can be used as a shortcut for some BETWEEN comparisons. The following example displays the last names and hire dates of all employees who joined between January, 1995 and December, 1995:

```
SELECT last_name, hire_date
FROM   employees
WHERE  hire_date LIKE '%95';
```

Combining Wildcard Characters

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

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

	LAST_NAME
1	Kochhar
2	Lorentz
3	Mourgos

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

The % and _ symbols can be used in any combination with literal characters. The example in the slide displays the names of all employees whose last names have the letter “o” as the second character.

ESCAPE Identifier

When you need to have an exact match for the actual % and _ characters, use the ESCAPE identifier. This option specifies what the escape character is. If you want to search for strings that contain SA_, you can use the following SQL statement:

```
SELECT employee_id, last_name, job_id
FROM   employees WHERE  job_id LIKE '%SA\_%' ESCAPE '\';
```

	EMPLOYEE_ID	LAST_NAME	JOB_ID
1	149	Zlotkey	SA_MAN
2	174	Abel	SA_REP
3	176	Taylor	SA_REP
4	178	Grant	SA_REP

The ESCAPE identifier identifies the backslash (\) as the escape character. In the SQL statement, the escape character precedes the underscore (_). This causes the Oracle server to interpret the underscore literally.

Using the NULL Conditions

Test for nulls with the IS NULL operator.

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

	LAST_NAME	MANAGER_ID
1	King	(null)

The NULL conditions include the IS NULL condition and the IS NOT NULL condition.

The IS NULL condition tests for nulls. A null value means that the value is unavailable, unassigned, unknown, or inapplicable. Therefore, you cannot test with =, because a null cannot be equal or unequal to any value. The example in the slide retrieves the last names and managers of all employees who do not have a manager.

Here is another example: To display the last name, job ID, and commission for all employees who are *not* entitled to receive a commission, use the following SQL statement:

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

	LAST_NAME	JOB_ID	COMMISSION_PCT
1	King	AD_PRES	(null)
2	Kochhar	AD_VP	(null)
3	De Haan	AD_VP	(null)
4	Hunold	IT_PROG	(null)
5	Ernst	IT_PROG	(null)
6	Lorentz	IT_PROG	(null)

. . .

Defining Conditions Using the Logical Operators

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

A logical condition combines the result of two component conditions to produce a single result based on those conditions or it inverts the result of a single condition. A row is returned only if the overall result of the condition is true.

Three logical operators are available in SQL:

- AND
- OR
- NOT

All the examples so far have specified only one condition in the WHERE clause. You can use several conditions in a single WHERE clause using the AND and OR operators.

Using the AND Operator

AND requires both the component conditions to be true:

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

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

In the example, both the component conditions must be true for any record to be selected. Therefore, only those employees who have a job title that contains the string 'MAN' *and* earn $10,000 or more are selected.

All character searches are case-sensitive, that is, no rows are returned if 'MAN' is not uppercase. Further, character strings must be enclosed with quotation marks.

AND Truth Table

The following table shows the results of combining two expressions with AND:

AND	TRUE	FALSE	NULL
TRUE	TRUE	FALSE	NULL
FALSE	FALSE	FALSE	FALSE
NULL	NULL	FALSE	NULL

Using the OR Operator

OR requires either component condition to be true:

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

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

In the example, either component condition can be true for any record to be selected. Therefore, any employee who has a job ID that contains the string 'MAN' *or* earns $10,000 or more is selected.

OR Truth Table

The following table shows the results of combining two expressions with OR:

OR	TRUE	FALSE	NULL
TRUE	TRUE	TRUE	TRUE
FALSE	TRUE	FALSE	NULL
NULL	TRUE	NULL	NULL

Using the NOT Operator

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

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

The example in the slide displays the last name and job ID of all employees whose job ID *is not* IT_PROG, ST_CLERK, or SA_REP.

NOT Truth Table

The following table shows the result of applying the NOT operator to a condition:

NOT	TRUE	FALSE	NULL
	FALSE	TRUE	NULL

Note: The NOT operator can also be used with other SQL operators, such as BETWEEN, LIKE, and NULL.

```
... WHERE  job_id     NOT  IN ('AC_ACCOUNT', 'AD_VP')
... WHERE  salary     NOT  BETWEEN  10000 AND  15000
... WHERE  last_name  NOT  LIKE '%A%'
... WHERE  commission_pct  IS   NOT  NULL
```

Lesson Agenda

- Limiting rows with:
  - The `WHERE` clause
  - The comparison conditions using `=`, `<=`, `BETWEEN`, `IN`, `LIKE`, and `NULL` operators
  - Logical conditions using `AND`, `OR`, and `NOT` operators
- Rules of precedence for operators in an expression
- Sorting rows using the `ORDER BY` clause
- Substitution variables
- `DEFINE` and `VERIFY` commands

Rules of Precedence

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

You can use parentheses to override rules of precedence.

The rules of precedence determine the order in which expressions are evaluated and calculated. The table in the slide lists the default order of precedence. However, you can override the default order by using parentheses around the expressions that you want to calculate first.

Rules of Precedence

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

1

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

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

2

	LAST_NAME	JOB_ID	SALARY
1	King	AD_PRES	24000

ORACLE

1. **Precedence of the AND Operator: Example**

   In this example, there are two conditions:

   - The first condition is that the job ID is `AD_PRES` *and* the salary is greater than $15,000.
   - The second condition is that the job ID is `SA_REP`.

   Therefore, the `SELECT` statement reads as follows:

   "Select the row if an employee is a president *and* earns more than $15,000, *or* if the employee is a sales representative."

2. **Using Parentheses: Example**

   In this example, there are two conditions:

   - The first condition is that the job ID is `AD_PRES` *or* `SA_REP`.
   - The second condition is that the salary is greater than $15,000.

   Therefore, the `SELECT` statement reads as follows:

   "Select the row if an employee is a president *or* a sales representative, *and* if the employee earns more than $15,000."

Lesson Agenda

- Limiting rows with:
  - The `WHERE` clause
  - The comparison conditions using `=`, `<=`, `BETWEEN`, `IN`, `LIKE`, and `NULL` operators
  - Logical conditions using `AND`, `OR`, and `NOT` operators
- Rules of precedence for operators in an expression
- Sorting rows using the `ORDER BY` clause
- Substitution variables
- `DEFINE` and `VERIFY` commands

Using the ORDER BY Clause

- Sort the 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

...

The order of rows that are returned in a query result is undefined. The ORDER BY clause can be used to sort the rows. However, if you use the ORDER BY clause, it must be the last clause of the SQL statement. Further, 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.

Note: Use the keywords NULLS FIRST or NULLS LAST to specify whether returned rows containing null values should appear first or last in the ordering sequence.

Sorting

- Sorting in descending order:

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

1

- Sorting by column alias:

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

2

The default sort order is ascending:

- Numeric values are displayed with the lowest values first (for example, 1 to 999).
- Date values are displayed with the earliest value first (for example, 01-JAN-92 before 01-JAN-95).
- Character values are displayed in the alphabetical order (for example, “A” first and “Z” last).
- Null values are displayed last for ascending sequences and first for descending sequences.
- You can also sort by a column that is not in the `SELECT` list.

Examples

1. To reverse the order in which the rows are displayed, specify the `DESC` keyword after the column name in the `ORDER BY` clause. The example in the slide sorts the result by the most recently hired employee.
2. You can also use a column alias in the `ORDER BY` clause. The slide example sorts the data by annual salary.

Note: The `DESC` keyword used here for sorting in descending order should not be confused with the `DESC` keyword used to describe table structures.

Sorting

- Sorting by using the column's numeric position:

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

3

- Sorting by multiple columns:

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

4

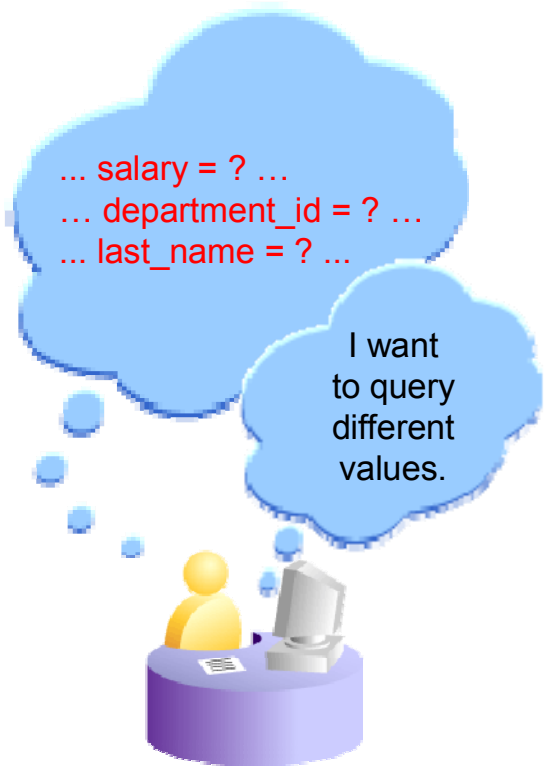
Examples

3. You can sort query results by specifying the numeric position of the column in the `SELECT` clause. The example in the slide sorts the result by the `department_id` as this column is at the third position in the `SELECT` clause.
4. You can sort query results by more than one column. The sort limit is the number of columns in the given table. In the `ORDER BY` clause, specify the columns and separate the column names using commas. If you want to reverse the order of a column, specify `DESC` after its name. The result of the query example shown in the slide is sorted by department_id in ascending order and also by salary in descending order.

Lesson Agenda

- Limiting rows with:
  - The WHERE clause
  - The comparison conditions using =, <=, BETWEEN, IN, LIKE, and NULL operators
  - Logical conditions using AND, OR, and NOT operators
- Rules of precedence for operators in an expression
- Sorting rows using the ORDER BY clause
- Substitution variables
- DEFINE and VERIFY commands

Substitution Variables



So far, all the SQL statements were executed with predetermined columns, conditions, and their values. Suppose that you want a query that lists the employees with various jobs and not just those whose `job_ID` is `SA_REP`. You can edit the `WHERE` clause to provide a different value each time you run the command, but there is also an easier way.

By using a substitution variable in place of the exact values in the `WHERE` clause, you can run the same query for different values.

You can create reports that prompt users to supply their own values to restrict the range of data returned, by using substitution variables. You can embed *substitution variables* in a command file or in a single SQL statement. A variable can be thought of as a container in which values are temporarily stored. When the statement is run, the stored value is substituted.

Substitution Variables

- Use substitution variables to:
  - Temporarily store values with single-ampersand (&) and double-ampersand (&&) substitution
- Use substitution variables to supplement the following:
  - WHERE conditions
  - ORDER BY clauses
  - Column expressions
  - Table names
  - Entire SELECT statements

You can use single-ampersand (&) substitution variables to temporarily store values.

You can also predefine variables by using the DEFINE command. DEFINE creates and assigns a value to a variable.

Restricted Ranges of Data: Examples

- Reporting figures only for the current quarter or specified date range
- Reporting on data relevant only to the user requesting the report
- Displaying personnel only within a given department

Other Interactive Effects

Interactive effects are not restricted to direct user interaction with the WHERE clause. The same principles can also be used to achieve other goals, such as:

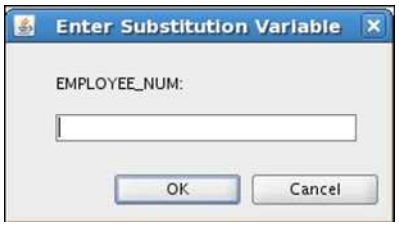
- Obtaining input values from a file rather than from a person
- Passing values from one SQL statement to another

Note: Both SQL Developer and SQL* Plus support substitution variables and the DEFINE/UNDEFINE commands. Neither SQL Developer nor SQL* Plus support validation checks (except for data type) on user input. If used in scripts that are deployed to users, substitution variables can be subverted for SQL injection attacks.

Using the Single-Ampersand Substitution Variable

Use a variable prefixed with an ampersand (&) to prompt the user for a value:

```
SELECT employee_id, last_name, salary, department_id
FROM   employees
WHERE  employee_id = &employee_num ;
```



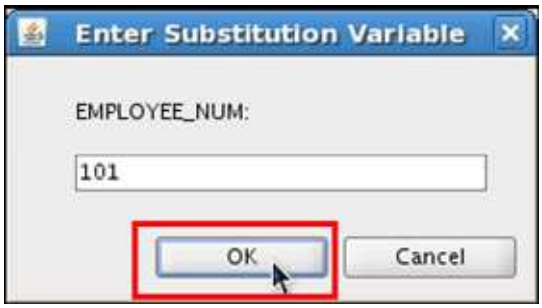
When running a report, users often want to restrict the data that is returned dynamically. SQL*Plus or SQL Developer provides this flexibility with user variables. Use an ampersand (&) to identify each variable in your SQL statement. However, you do not need to define the value of each variable.

Notation	Description
&user_variable	Indicates a variable in a SQL statement; if the variable does not exist, SQL*Plus or SQL Developer prompts the user for a value (the new variable is discarded after it is used.)

The example in the slide creates a SQL Developer substitution variable for an employee number. When the statement is executed, SQL Developer prompts the user for an employee number and then displays the employee number, last name, salary, and department number for that employee.

With the single ampersand, the user is prompted every time the command is executed if the variable does not exist.

Using the Single-Ampersand Substitution Variable



	EMPLOYEE_ID	LAST_NAME	SALARY	DEPARTMENT_ID
1	101	Kochhar	17000	90

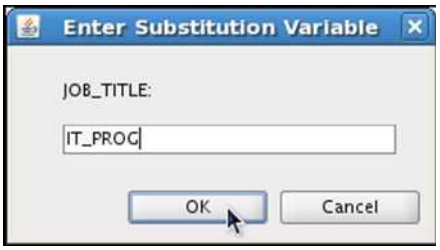
When SQL Developer detects that the SQL statement contains an ampersand, you are prompted to enter a value for the substitution variable that is named in the SQL statement.

After you enter a value and click the OK button, the results are displayed in the Results tab of your SQL Developer session.

Character and Date Values with Substitution Variables

Use single quotation marks for date and character values:

```
SELECT last_name, department_id, salary*12
FROM   employees
WHERE  job_id = '&job_title' ;
```



	LAST_NAME	DEPARTMENT_ID	SALARY*12
1	Hunold	60	108000
2	Ernst	60	72000
3	Lorentz	60	50400

In a `WHERE` clause, date and character values must be enclosed with single quotation marks. The same rule applies to the substitution variables.

Enclose the variable with single quotation marks within the SQL statement itself.

The slide shows a query to retrieve the employee names, department numbers, and annual salaries of all employees based on the job title value of the SQL Developer substitution variable.

Specifying Column Names, Expressions, and Text

```
SELECT employee_id, last_name, job_id,&column_name
FROM   employees
WHERE  &condition
ORDER BY &order_column ;
```

You can use the substitution variables not only in the `WHERE` clause of a SQL statement, but also as substitution for column names, expressions, or text.

Example

The example in the slide displays the employee number, last name, job title, and any other column that is specified by the user at run time, from the `EMPLOYEES` table. For each substitution variable in the `SELECT` statement, you are prompted to enter a value, and then click OK to proceed.

If you do not enter a value for the substitution variable, you get an error when you execute the preceding statement.

Note: A substitution variable can be used anywhere in the `SELECT` statement, except as the first word entered at the command prompt.

Using the Double-Ampersand Substitution Variable

Use double ampersand (&&) if you want to reuse the variable value without prompting the user each time:

```
SELECT   employee_id, last_name, job_id, &&column_name
FROM     employees
ORDER BY &column_name ;
```

	EMPLOYEE_ID	LAST_NAME	JOB_ID	DEPARTMENT_ID
1	200	Whalen	AD_ASST	10
2	201	Hartstein	MK_MAN	20
3	202	Fay	MK_REP	20

...

You can use the double-ampersand (&&) substitution variable if you want to reuse the variable value without prompting the user each time. The user sees the prompt for the value only once. In the example in the slide, the user is asked to give the value for the variable, column_name, only once. The value that is supplied by the user (department_id) is used for both display and ordering of data. If you run the query again, you will not be prompted for the value of the variable.

SQL Developer stores the value that is supplied by using the DEFINE command; it uses it again whenever you reference the variable name. After a user variable is in place, you need to use the UNDEFINE command to delete it:

```
UNDEFINE column_name;
```

Double-ampersand can also be used with the ACCEPT command. The ACCEPT command reads a line of input and stores it in a given user variable.

Example

```
ACCEPT col_name PROMPT 'Please specify the column name:'

SELECT &&col_name
FROM employees
ORDER BY &col_name;
```

Lesson Agenda

- Limiting rows with:
  - The `WHERE` clause
  - The comparison conditions using `=`, `<=`, `BETWEEN`, `IN`, `LIKE`, and `NULL` operators
  - Logical conditions using `AND`, `OR`, and `NOT` operators
- Rules of precedence for operators in an expression
- Sorting rows using the `ORDER BY` clause
- Substitution variables
- `DEFINE` and `VERIFY` commands

Using the DEFINE Command

- Use the DEFINE command to create and assign a value to a variable.
- Use the UNDEFINE command to remove a variable.

```
DEFINE employee_num = 200

SELECT employee_id, last_name, salary, department_id
FROM   employees
WHERE  employee_id = &employee_num ;

UNDEFINE employee_num
```


The example shown creates a substitution variable for an employee number by using the DEFINE command. At run time, this displays the employee number, name, salary, and department number for that employee.

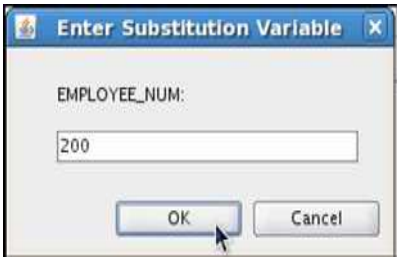
Because the variable is created using the SQL Developer DEFINE command, the user is not prompted to enter a value for the employee number. Instead, the defined variable value is automatically substituted in the SELECT statement.

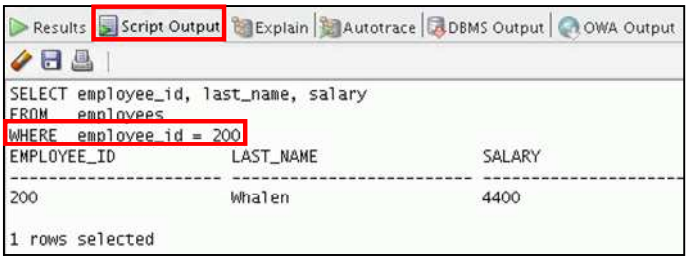
The EMPLOYEE_NUM substitution variable is present in the session until the user undefines it or exits the SQL Developer session.

Using the VERIFY Command

Use the VERIFY command to toggle the display of the substitution variable, both before and after SQL Developer replaces substitution variables with values:

```
SET VERIFY ON
SELECT employee_id, last_name, salary
FROM   employees
WHERE  employee_id = &employee_num;
```





To confirm the changes in the SQL statement, use the VERIFY command. Setting SET VERIFY ON forces SQL Developer to display the text of a command after it replaces substitution variables with values. To see the VERIFY output, you should use the Run Script (F5) icon in the SQL Worksheet. SQL Developer displays the text of a command after it replaces substitution variables with values, in the Script Output tab as shown in the slide.

The example in the slide displays the new value of the EMPLOYEE_ID column in the SQL statement followed by the output.

SQL*Plus System Variables

SQL*Plus uses various system variables that control the working environment. One of the variables is VERIFY. To obtain a complete list of all the system variables, you can issue the SHOW ALL command on the SQL*Plus command prompt.

Quiz

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

a. `>=`
b. `IS NULL`
c. `!=`
d. `IS LIKE`
e. `IN BETWEEN`
f. `<>`

Answer: a, b, c, f

Summary

In this lesson, you should have learned how to:

- Use the WHERE clause to restrict rows of output:
  - Use the comparison conditions
  - Use the BETWEEN, IN, LIKE, and NULL operators
  - Apply the logical AND, OR, and NOT operators
- Use the ORDER BY clause to sort rows of output:

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

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

In this lesson, you should have learned about restricting and sorting rows that are returned by the SELECT statement. You should also have learned how to implement various operators and conditions.

By using the substitution variables, you can add flexibility to your SQL statements. This enables the queries to prompt for the filter condition for the rows during run time.

Practice 3: Overview

This practice covers the following topics:

- Selecting data and changing the order of the rows that are displayed
- Restricting rows by using the `WHERE` clause
- Sorting rows by using the `ORDER BY` clause
- Using substitution variables to add flexibility to your SQL `SELECT` statements

In this practice, you build more reports, including statements that use the `WHERE` clause and the `ORDER BY` clause. You make the SQL statements more reusable and generic by including the ampersand substitution.

4

Using Single-Row Functions to Customize Output

Objectives

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

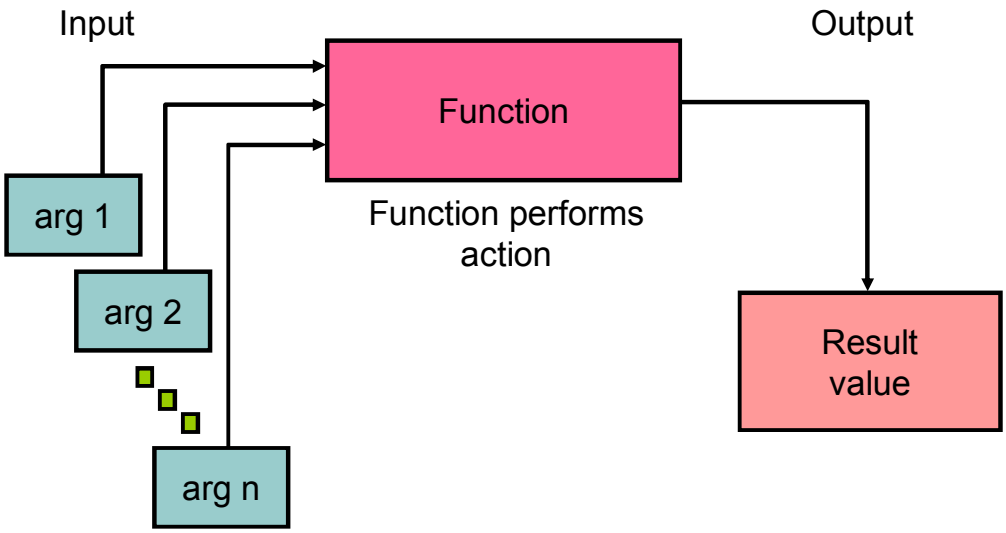
- Describe the various types of functions available in SQL
- Use the character, number, and date functions in `SELECT` statements

Functions make the basic query block more powerful, and they are used to manipulate data values. This is the first of two lessons that explore functions. It focuses on single-row character, number, and date functions.

Lesson Agenda

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

SQL Functions



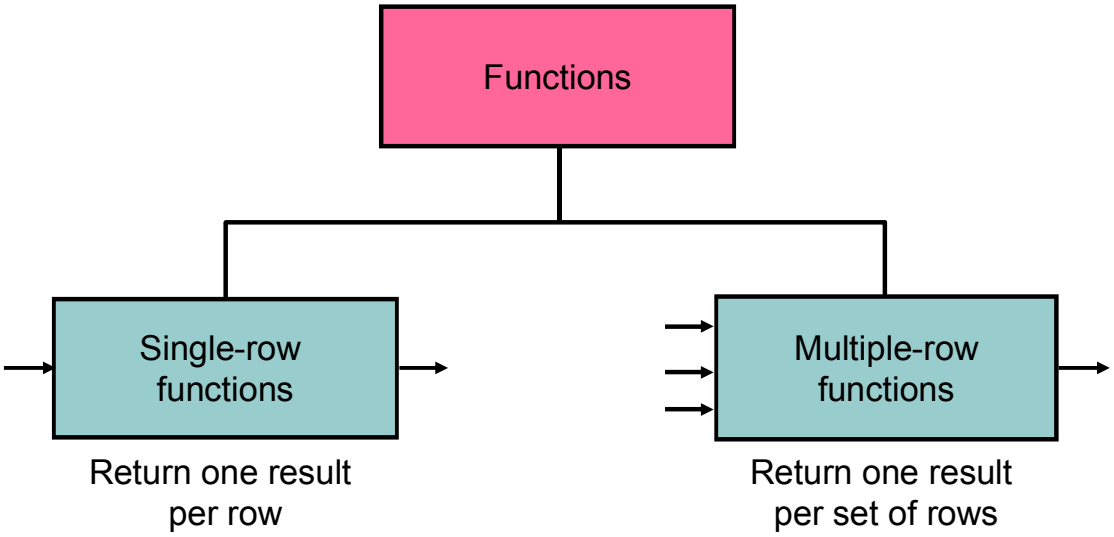
Functions are a very powerful feature of SQL. They can be used to do the following:

- Perform calculations on data
- Modify individual data items
- Manipulate output for groups of rows
- Format dates and numbers for display
- Convert column data types

SQL functions sometimes take arguments and always return a value.

Note: If you want to know whether a function is a SQL:2003 compliant function, refer to the "Oracle Compliance to Core SQL:2003" section in *Oracle Database SQL Language Reference* for 10*g* or 11*g* database.

Two Types 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. This lesson covers the following functions:

- Character
- Number
- Date
- Conversion
- General

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* (covered in the lesson titled "Reporting Aggregated Data Using the Group Functions").

Note: For more information and a complete list of available functions and their syntax, see the "Functions" section in *Oracle Database SQL Language Reference* for 10*g* or 11*g* database.

Single-Row Functions

Single-row functions:

- Manipulate data items
- Accept arguments and return one value
- Act on each row that is returned
- Return one result per row
- May modify the data type
- Can be nested
- Accept arguments that can be a column or an expression

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


Single-row functions are used to manipulate data items. They accept one or more arguments and return one value for each row that is returned by the query. An argument can be one of the following:

- User-supplied constant
- Variable value
- Column name
- Expression

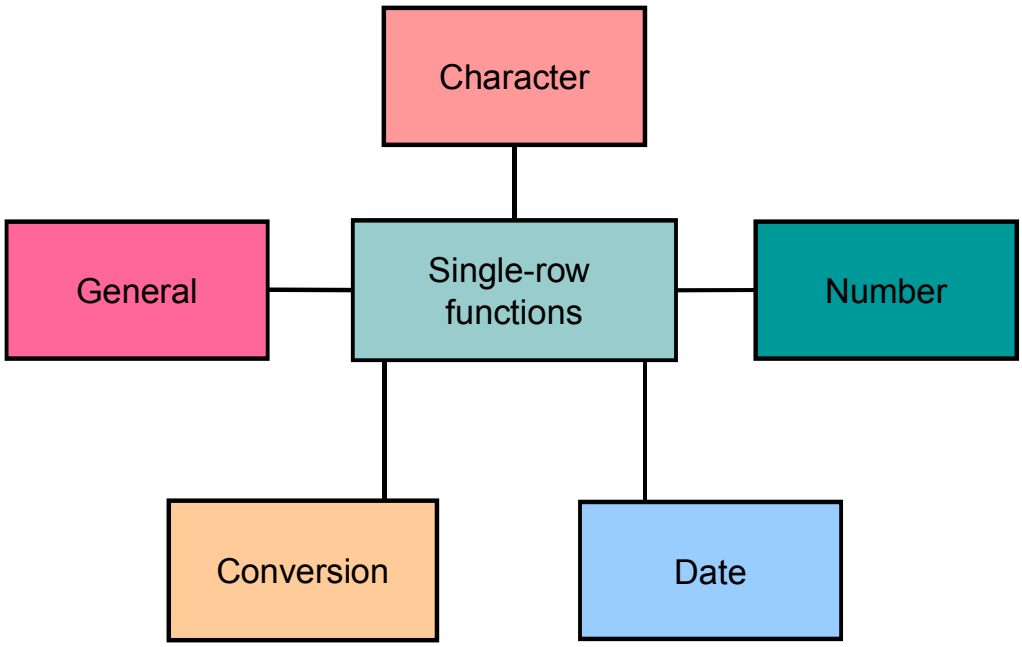
Features of single-row functions include:

- Acting on each row that is returned in the query
- Returning one result per row
- Possibly returning a data value of a different type than the one that is referenced
- Possibly expecting one or more arguments
- Can be used in `SELECT`, `WHERE`, and `ORDER BY` clauses; can be nested

In the syntax:

function_name	Is the name of the function
arg1, arg2	Is any argument to be used by the function. This can be represented by a column name or expression.

Single-Row Functions



This lesson covers the following 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.)

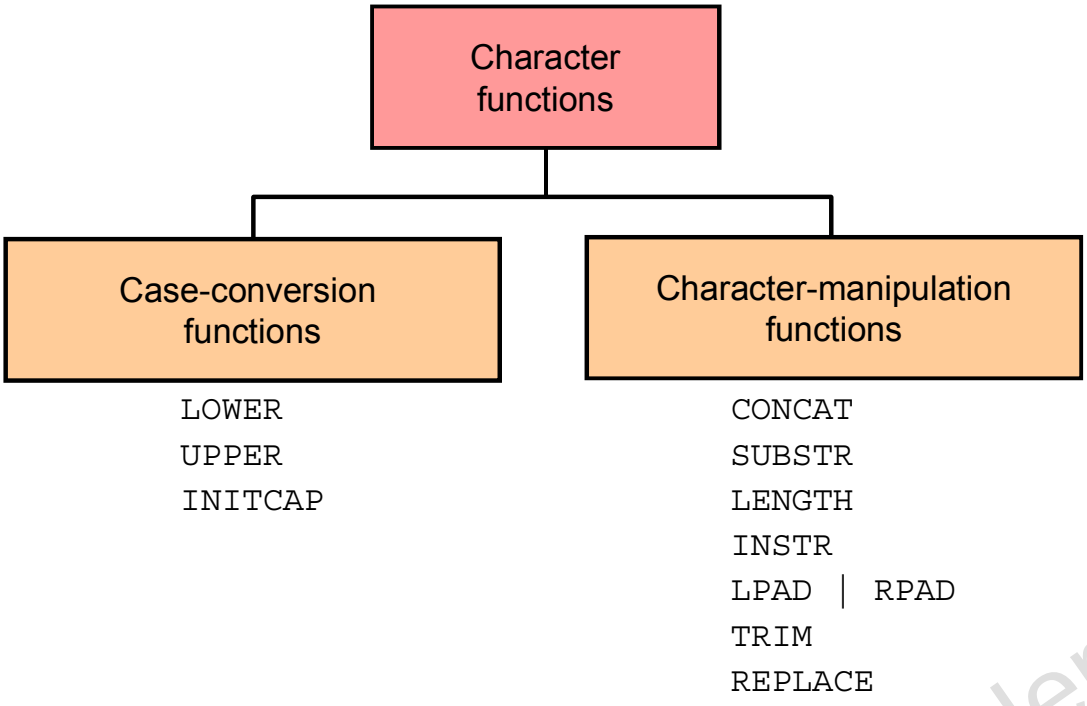
The following single-row functions are discussed in the lesson titled “Using Conversion Functions and Conditional Expressions”:

- **Conversion functions:** Convert a value from one data type to another
- **General functions:**
  - `NVL`
  - `NVL2`
  - `NULLIF`
  - `COALESCE`
  - `CASE`
  - `DECODE`

Lesson Agenda

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

Character Functions



Single-row character functions accept character data as input and can return both character and numeric values. Character functions can be divided into the following:

- Case-conversion functions
- Character-manipulation functions

Function	Purpose
LOWER(*column|expression*)	Converts alpha character values to lowercase
UPPER(*column|expression*)	Converts alpha character values to uppercase
INITCAP(*column|expression*)	Converts alpha character values to uppercase for the first letter of each word; all other letters in lowercase
CONCAT(*column1|expression1, column2|expression2*)	Concatenates the first character value to the second character value; equivalent to concatenation operator (||)
SUBSTR(*column|expression,m[,n]*)	Returns specified characters from character value starting at character position *m, n* characters long (If *m* is negative, the count starts from the end of the character value. If *n* is omitted, all characters to the end of the string are returned.)

Note: The functions discussed in this lesson are only some of the available functions.

Function	Purpose
LENGTH(*column*|*expression*)	Returns the number of characters in the expression
INSTR(*column*|*expression*, *'string', [,m], [n]*)	Returns the numeric position of a named string. Optionally, you can provide a position *m* to start searching, and the occurrence *n* of the string. *m* and *n* default to 1, meaning start the search at the beginning of the string and report the first occurrence.
LPAD(*column*|*expression*, *n*, '*string*') RPAD(*column*|*expression*, *n*, '*string*')	Returns an expression left-padded to length of *n* characters with a character expression. Returns an expression right-padded to length of *n* characters with a character expression.
TRIM(*leading*|*trailing*|*both*, *trim_character FROM trim_source*)	Enables you to trim leading or trailing characters (or both) from a character string. If *trim_character* or *trim_source* is a character literal, you must enclose it in single quotation marks. This is a feature that is available in Oracle8*i* and later versions.
REPLACE(*text*, *search_string*, *replacement_string*)	Searches a text expression for a character string and, if found, replaces it with a specified replacement string

Note: Some of the functions that are fully or partially SQL:2003 compliant are:

- UPPER
- LOWER
- TRIM
- LENGTH
- SUBSTR
- INSTR

For more information, refer to the "Oracle Compliance to Core SQL:2003" section in *Oracle Database SQL Language Reference* for 10*g* or 11*g* database.

Case-Conversion Functions

These functions convert the case for character strings:

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

LOWER, UPPER, and INITCAP are the three case-conversion functions.

- LOWER: Converts mixed-case or uppercase character strings to lowercase
- UPPER: Converts mixed-case or lowercase character strings to uppercase
- INITCAP: Converts the first letter of each word to uppercase and the remaining letters to lowercase

```
SELECT 'The job id for '||UPPER(last_name)||' is '
 ||LOWER(job_id) AS "EMPLOYEE DETAILS"
FROM   employees;
```

	EMPLOYEE DETAILS
1	The job id for ABEL is sa_rep
2	The job id for DAVIES is st_clerk
3	The job id for DE HAAN is ad_vp
4	The job id for ERNST is it_prog
5	The job id for FAY is mk_rep
6	The job id for GIETZ is ac_account

. . .

Using Case-Conversion Functions

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

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

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

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
1	205	Higgins	110

The slide example displays the employee number, name, and department number of employee Higgins.

The `WHERE` clause of the first SQL statement specifies the employee name as `higgins`. Because all the data in the `EMPLOYEES` table is stored in proper case, the name `higgins` does not find a match in the table, and no rows are selected.

The `WHERE` clause of the second SQL statement specifies that the employee name in the `EMPLOYEES` table is compared to `higgins`, converting the `LAST_NAME` column to lowercase for comparison purposes. Because both names are now lowercase, a match is found and one row is selected. The `WHERE` clause can be rewritten in the following manner to produce the same result:

```
...WHERE last_name = 'Higgins'
```

The name in the output appears as it was stored in the database. To display the name in uppercase, use the `UPPER` function in the `SELECT` statement.

```
SELECT employee_id, UPPER(last_name), department_id
FROM   employees
WHERE  INITCAP(last_name) = 'Higgins
```

Character-Manipulation Functions

These functions manipulate character strings:

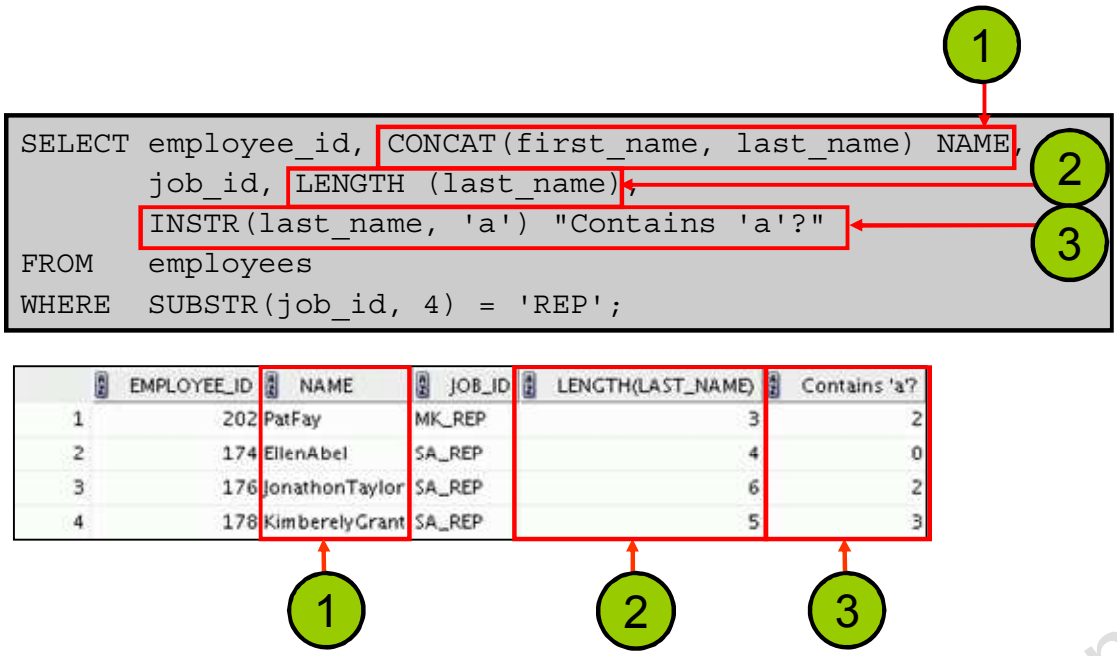
Function	Result
CONCAT('Hello', 'World')	HelloWorld
SUBSTR('HelloWorld',1,5)	Hello
LENGTH('HelloWorld')	10
INSTR('HelloWorld', 'W')	6
LPAD(salary,10,'*')	*****24000
RPAD(salary, 10, '*')	24000*****
REPLACE ('JACK and JUE','J','BL')	BLACK and BLUE
TRIM('H' FROM 'HelloWorld')	elloWorld

CONCAT, SUBSTR, LENGTH, INSTR, LPAD, RPAD, and TRIM are the character-manipulation functions that are covered in this lesson.

- CONCAT: Joins values together (You are limited to using two parameters with CONCAT.)
- SUBSTR: Extracts a string of determined length
- LENGTH: Shows the length of a string as a numeric value
- INSTR: Finds the numeric position of a named character
- LPAD: Returns an expression left-padded to the length of *n* characters with a character expression
- RPAD: Returns an expression right-padded to the length of *n* characters with a character expression
- TRIM: Trims leading or trailing characters (or both) from a character string (If *trim_character* or *trim_source* is a character literal, you must enclose it within single quotation marks.)

Note: You can use functions such as UPPER and LOWER with ampersand substitution. For example, use UPPER('&job_title') so that the user does not have to enter the job title in a specific case.

Using the Character-Manipulation Functions



The example in the slide displays employee first names and last names joined together, the length of the employee last name, and the numeric position of the letter “a” in the employee last name for all employees who have the string, `REP`, contained in the job ID starting at the fourth position of the job ID.

Example

Modify the SQL statement in the slide to display the data for those employees whose last names end with the letter “n.”

```
SELECT employee_id, CONCAT(first_name, last_name) NAME,
LENGTH (last_name), INSTR(last_name, 'a') "Contains 'a'?"
FROM   employees
WHERE  SUBSTR(last_name, -1, 1) = 'n
```

	EMPLOYEE_ID	NAME	LENGTH(LAST_NAME)	Contains 'a'?
1	102	LexDe Haan	7	5
2	200	JenniferWhalen	6	3
3	201	MichaelHartstein	9	2

Lesson Agenda

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

Numeric Functions

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

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

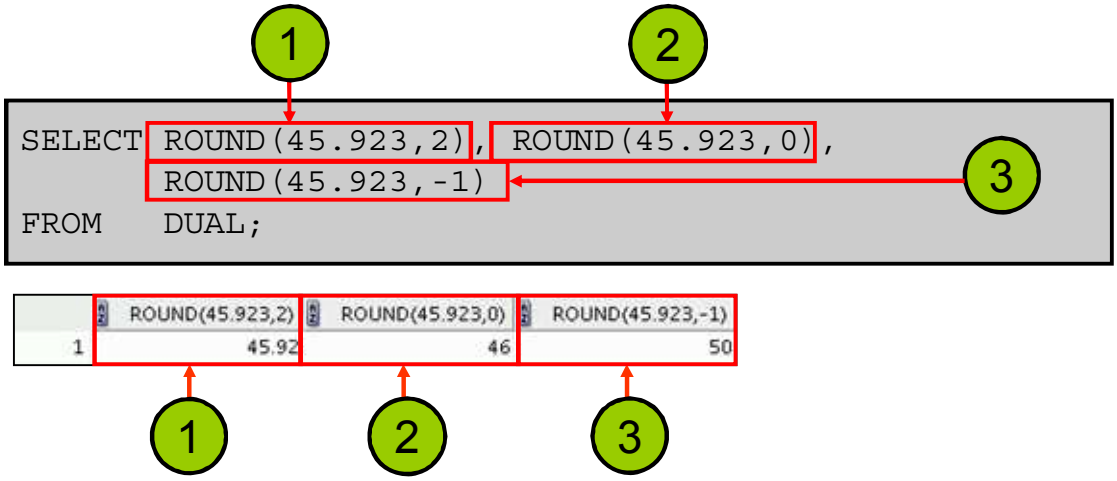
Numeric functions accept numeric input and return numeric values. This section describes some of the numeric functions.

Function	Purpose
ROUND(*column*|*expression*, *n*)	Rounds the column, expression, or value to *n* decimal places or, if *n* is omitted, no decimal places (If *n* is negative, numbers to the left of decimal point are rounded.
TRUNC(*column*|*expression*, *n*)	Truncates the column, expression, or value to *n* decimal places or, if *n* is omitted, *n* defaults to zero
MOD(*m*,*n*)	Returns the remainder of *m* divided by *n*

Note: This list contains only some of the available numeric functions.

For more information, see the "Numeric Functions" section in *Oracle Database SQL Language Reference* for 10*g* or 11*g* database.

Using the ROUND Function



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

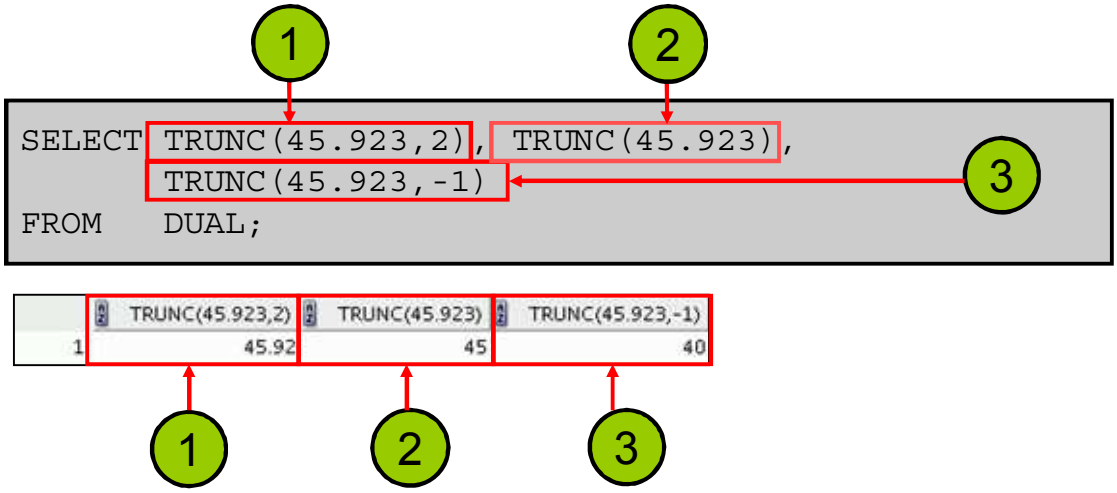
The ROUND function rounds the column, expression, or value to *n* decimal places. If the second argument is 0 or is missing, the value is rounded to zero decimal places. If the second argument is 2, the value is rounded to two decimal places. Conversely, if the second argument is –2, the value is rounded to two decimal places to the left (rounded to the nearest unit of 100).

The ROUND function can also be used with date functions. You will see examples later in this lesson.

DUAL Table

The DUAL table is owned by the user SYS and can be accessed by all users. It contains one column, DUMMY, and one row with the value X. The DUAL table is useful when you want to return a value only once (for example, the value of a constant, pseudocolumn, or expression that is not derived from a table with user data). The DUAL table is generally used for completeness of the SELECT clause syntax, because both SELECT and FROM clauses are mandatory, and several calculations do not need to select from the actual tables.

Using the TRUNC Function



The TRUNC function truncates the column, expression, or value to *n* decimal places.

The TRUNC function works with arguments similar to those of the ROUND function. If the second argument is 0 or is missing, the value is truncated to zero decimal places. If the second argument is 2, the value is truncated to two decimal places. Conversely, if the second argument is –2, the value is truncated to two decimal places to the left. If the second argument is –1, the value is truncated to one decimal place to the left.

Like the ROUND function, the TRUNC function can be used with date functions.

Using the MOD Function

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

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

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

The MOD function finds the remainder of the first argument divided by the second argument. The slide example calculates the remainder of the salary after dividing it by 5,000 for all employees whose job ID is SA_REP.

Note: The MOD function is often used to determine whether a value is odd or even. The MOD function is also the Oracle hash function.

Lesson Agenda

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

Working with Dates

- The Oracle Database stores dates in an internal numeric format: century, year, month, day, hours, minutes, and seconds.
- The default date display format is DD-MON-RR.
  - Enables you to store 21st-century dates in the 20th century by specifying only the last two digits of the year
  - Enables you to store 20th-century dates in the 21st century in the same way

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

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

The Oracle Database stores dates in an internal numeric format, representing the century, year, month, day, hours, minutes, and seconds.

The default display and input format for any date is DD-MON-RR. Valid Oracle dates are between January 1, 4712 B.C., and December 31, 9999 A.D.

In the example in the slide, the `HIRE_DATE` column output is displayed in the default format DD-MON-RR. However, dates are not stored in the database in this format. All the components of the date and time are stored. So, although a `HIRE_DATE` such as 17-JUN-87 is displayed as day, month, and year, there is also *time* and *century* information associated with the date. The complete data might be June 17, 1987, 5:10:43 PM.

RR Date Format

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

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

The RR date format is similar to the YY element, but you can use it to specify different centuries. Use the RR date format element instead of YY so that the century of the return value varies according to the specified two-digit year and the last two digits of the current year. The table in the slide summarizes the behavior of the RR element.

Current Year	Given Date	Interpreted (RR)	Interpreted (YY)
1994	27-OCT-95	1995	1995
1994	27-OCT-17	2017	1917
2001	27-OCT-17	2017	2017
2048	27-OCT-52	1952	2052
2051	27-OCT-47	2147	2047

Note the values shown in the last two rows of the above table. As we approach the middle of the century, then the RR behavior is probably not what you want.

This data is stored internally as follows:

CENTURY	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
19	87	06	17	17	10	43

Centuries and the Year 2000

When a record with a date column is inserted into a table, the *century* information is picked up from the `SYSDATE` function. However, when the date column is displayed on the screen, the century component is not displayed (by default).

The `DATE` data type uses 2 bytes for the year information, one for century and one for year. The century value is always included, whether or not it is specified or displayed. In this case, `RR` determines the default value for century on `INSERT`.

Using the SYSDATE Function

SYSDATE is a function that returns:

- Date
- Time

```
SELECT sysdate
FROM   dual;
```

SYSDATE is a date function that returns the current database server date and time. You can use SYSDATE just as you would use any other column name. For example, you can display the current date by selecting SYSDATE from a table. It is customary to select SYSDATE from a public table called DUAL.

Note: SYSDATE returns the current date and time set for the operating system on which the database resides. Therefore, if you are in a place in Australia and connected to a remote database in a location in the United States (U.S.), the sysdate function will return the U.S. date and time. In that case, you can use the CURRENT_DATE function that returns the current date in the session time zone.

The CURRENT_DATE function and other related time zone functions are discussed in detail in *Oracle Database: SQL Fundamentals II*.

Arithmetic with Dates

- Add to or subtract a number from a date for a resultant date value.
- Subtract two dates to find the number of days between those dates.
- Add hours to a date by dividing the number of hours by 24.

Because the database stores dates as numbers, you can perform calculations using arithmetic operators such as addition and subtraction. You can add and subtract number constants as well as dates.

You can perform the following operations:

Operation	Result	Description
date + number	Date	Adds a number of days to a date
date – number	Date	Subtracts a number of days from a date
date – date	Number of days	Subtracts one date from another
date + number/24	Date	Adds a number of hours to a date

Using Arithmetic Operators with Dates

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

	LAST_NAME	WEEKS
1	King	1147.102432208994708994708994708994708995
2	Kochhar	1028.959575066137566137566137566137566138
3	De Haan	856.102432208994708994708994708994708995

The example in the slide displays the last name and the number of weeks employed for all employees in department 90. It subtracts the date on which the employee was hired from the current date (`SYSDATE`) and divides the result by 7 to calculate the number of weeks that a worker has been employed.

Note: `SYSDATE` is a SQL function that returns the current date and time. Your results may differ depending on the date and time set for the operating system of your local database when you run the SQL query.

If a more current date is subtracted from an older date, the difference is a negative number.

Lesson Agenda

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

Date-Manipulation Functions

Function	Result
MONTHS_BETWEEN	Number of months between two dates
ADD_MONTHS	Add calendar months to date
NEXT_DAY	Next day of the date specified
LAST_DAY	Last day of the month
ROUND	Round date
TRUNC	Truncate date

Date functions operate on Oracle dates. All date functions return a value of the DATE data type except MONTHS_BETWEEN, which returns a numeric value.

- MONTHS_BETWEEN(*date1, date2*): Finds the number of months between *date1* and *date2*. The result can be positive or negative. If *date1* is later than *date2*, the result is positive; if *date1* is earlier than *date2*, the result is negative. The noninteger part of the result represents a portion of the month.
- ADD_MONTHS(*date, n*): Adds *n* number of calendar months to *date*. The value of *n* must be an integer and can be negative.
- NEXT_DAY(*date, 'char'*): Finds the date of the next specified day of the week (*'char'*) following *date*. The value of *char* may be a number representing a day or a character string.
- LAST_DAY(*date*): Finds the date of the last day of the month that contains *date*

The above list is a subset of the available date functions. ROUND and TRUNC number functions can also be used to manipulate the date values as shown below:

- ROUND(*date*[,*'fmt'*]): Returns *date* rounded to the unit that is specified by the format model *fmt*. If the format model *fmt* is omitted, *date* is rounded to the nearest day.
- TRUNC(*date*[, *'fmt'*]): Returns *date* with the time portion of the day truncated to the unit that is specified by the format model *fmt*. If the format model *fmt* is omitted, *date* is truncated to the nearest day.

The format models are covered in detail in the lesson titled “Using Conversion Functions and Conditional Expressions.”

Using Date Functions

Function	Result
MONTHS_BETWEEN ('01-SEP-95','11-JAN-94')	19.6774194
ADD_MONTHS ('31-JAN-96',1)	'29-FEB-96'
NEXT_DAY ('01-SEP-95','FRIDAY')	'08-SEP-95'
LAST_DAY ('01-FEB-95')	'28-FEB-95'

In the example in the slide, the ADD_MONTHS function adds one month to the supplied date value "31-JAN-96" and returns "29-FEB-96." The function recognizes the year 1996 as the leap year and, therefore, returns the last day of the February month. If you change the input date value to "31-JAN-95," the function returns "28-FEB-95."

For example, display the employee number, hire date, number of months employed, six-month review date, first Friday after hire date, and the last day of the hire month for all employees who have been employed for fewer than 150 months.

```
SELECT employee_id, hire_date, MONTHS_BETWEEN (SYSDATE, hire_date)
TENURE, ADD_MONTHS (hire_date, 6) REVIEW,  NEXT_DAY (hire_date,
'FRIDAY'), LAST_DAY(hire_date)
FROM employees WHERE  MONTHS_BETWEEN (SYSDATE, hire_date) < 150;
```

	EMPLOYEE_ID	HIRE_DATE	TENURE	REVIEW	NEXT_DA...	LAST_DAY...
1	202	17-AUG-97	141.79757989...	17-FEB-98	22-AUG-97	31-AUG-97
2	107	07-FEB-99	124.12016054...	07-AUG-99	12-FEB-99	28-FEB-99
3	124	16-NOV-99	114.82983796...	16-MAY-00	19-NOV-99	30-NOV-99
4	142	29-JAN-97	148.41048312...	29-JUL-97	31-JAN-97	31-JAN-97
5	143	15-MAR-98	134.86209602...	15-SEP-98	20-MAR-98	31-MAR-98
6	144	09-JUL-98	131.05564441...	09-JAN-99	10-JUL-98	31-JUL-98
7	149	29-JAN-00	112.41048312...	29-JUL-00	04-FEB-00	31-JAN-00
8	176	24-MAR-98	134.57177344...	24-SEP-98	27-MAR-98	31-MAR-98
9	178	24-MAY-99	120.57177344...	24-NOV-99	28-MAY-99	31-MAY-99

Using ROUND and TRUNC Functions with Dates

Assume SYSDATE = '25-JUL-03':

Function	Result
ROUND(SYSDATE,'MONTH')	01-AUG-03
ROUND(SYSDATE ,'YEAR')	01-JAN-04
TRUNC(SYSDATE ,'MONTH')	01-JUL-03
TRUNC(SYSDATE ,'YEAR')	01-JAN-03

The ROUND and TRUNC functions can be used for number and date values. When used with dates, these functions round or truncate to the specified format model. Therefore, you can round dates to the nearest year or month. If the format model is month, dates 1-15 result in the first day of the current month. Dates 16-31 result in the first day of the next month. If the format model is year, months 1-6 result in January 1 of the current year. Months 7-12 result in January 1 of the next year.

Example

Compare the hire dates for all employees who started in 1997. Display the employee number, hire date, and starting month using the ROUND and TRUNC functions.

```
SELECT employee_id, hire_date,
 ROUND(hire_date, 'MONTH'), TRUNC(hire_date, 'MONTH')
FROM   employees
WHERE  hire_date LIKE '%97
```

	EMPLOYEE_ID	HIRE_DATE	ROUND(HIRE_DATE,'MONTH')	TRUNC(HIRE_DATE,'MONTH')
1	202	17-AUG-97	01-SEP-97	01-AUG-97
2	142	29-JAN-97	01-FEB-97	01-JAN-97

Quiz

Which four of the following statements are true about single-row functions?

a. Manipulate data items
b. Accept arguments and return one value per argument
c. Act on each row that is returned
d. Return one result per set of rows
e. May not modify the data type
f. Can be nested
g. Accept arguments that can be a column or an expression

Answer: a, c, f, g

Summary

In this lesson, you should have learned how to:

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

Single-row functions can be nested to any level. Single-row functions can manipulate the following:

- **Character data:** LOWER, UPPER, INITCAP, CONCAT, SUBSTR, INSTR, LENGTH
- **Number data:** ROUND, TRUNC, MOD
- **Date values:** SYSDATE, MONTHS_BETWEEN, ADD_MONTHS, NEXT_DAY, LAST_DAY

Remember the following:

- Date values can also use arithmetic operators.
- ROUND and TRUNC functions can also be used with date values.

SYSDATE and DUAL

SYSDATE is a date function that returns the current date and time. It is customary to select SYSDATE from a single-row public table called DUAL

Practice 4: Overview

This practice covers the following topics:

- Writing a query that displays the current date
- Creating queries that require the use of numeric, character, and date functions
- Performing calculations of years and months of service for an employee

This practice provides a variety of exercises using different functions that are available for character, number, and date data types.

5

Using Conversion Functions and Conditional Expressions

Objectives

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

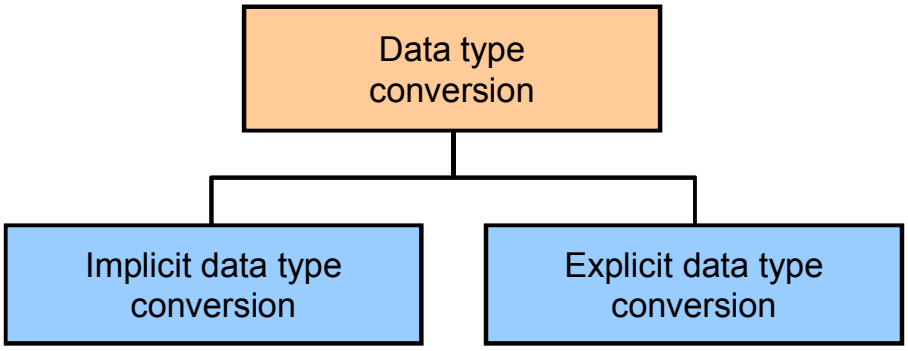
- Describe the various types of conversion functions that are available in SQL
- Use the `TO_CHAR`, `TO_NUMBER`, and `TO_DATE` conversion functions
- Apply conditional expressions in a `SELECT` statement

This lesson focuses on functions that convert data from one type to another (for example, conversion from character data to numeric data) and discusses the conditional expressions in SQL `SELECT` statements.

Lesson Agenda

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

Conversion Functions



In addition to Oracle data types, columns of tables in an Oracle Database can be defined by using the American National Standards Institute (ANSI), DB2, and SQL/DS data types. However, the Oracle server internally converts such data types to Oracle data types.

In some cases, the Oracle server receives data of one data type where it expects data of a different data type. When this happens, the Oracle server can automatically convert the data to the expected data type. This data type conversion can be done *implicitly* by the Oracle server or *explicitly* by the user.

Implicit data type conversions work according to the rules explained in the following slides.

Explicit data type conversions are performed by using the conversion functions. Conversion functions convert a value from one data type to another. Generally, the form of the function names follows the convention *data type* TO *data type*. The first data type is the input data type and the second data type is the output.

Note: Although implicit data type conversion is available, it is recommended that you do the explicit data type conversion to ensure the reliability of your SQL statements.

Implicit Data Type Conversion

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

From	To
VARCHAR2 or CHAR	NUMBER
VARCHAR2 or CHAR	DATE

Oracle server can automatically perform data type conversion in an expression. For example, the expression `hire_date > '01-JAN-90'` results in the implicit conversion from the string `'01-JAN-90'` to a date. Therefore, a `VARCHAR2` or `CHAR` value can be implicitly converted to a number or date data type in an expression.

Implicit Data Type Conversion

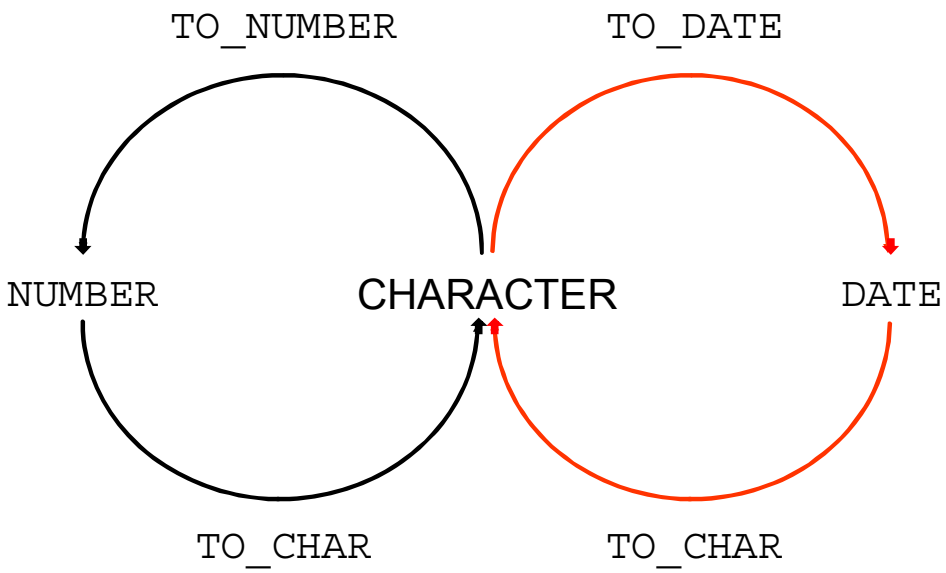
For expression evaluation, the Oracle server can automatically convert the following:

From	To
NUMBER	VARCHAR2 or CHAR
DATE	VARCHAR2 or CHAR

In general, the Oracle server uses the rule for expressions when a data type conversion is needed. For example, the expression `grade = 2` results in the implicit conversion of the number `2` to the string "2" because grade is a `CHAR(2)` column.

Note: `CHAR` to `NUMBER` conversions succeed only if the character string represents a valid number.

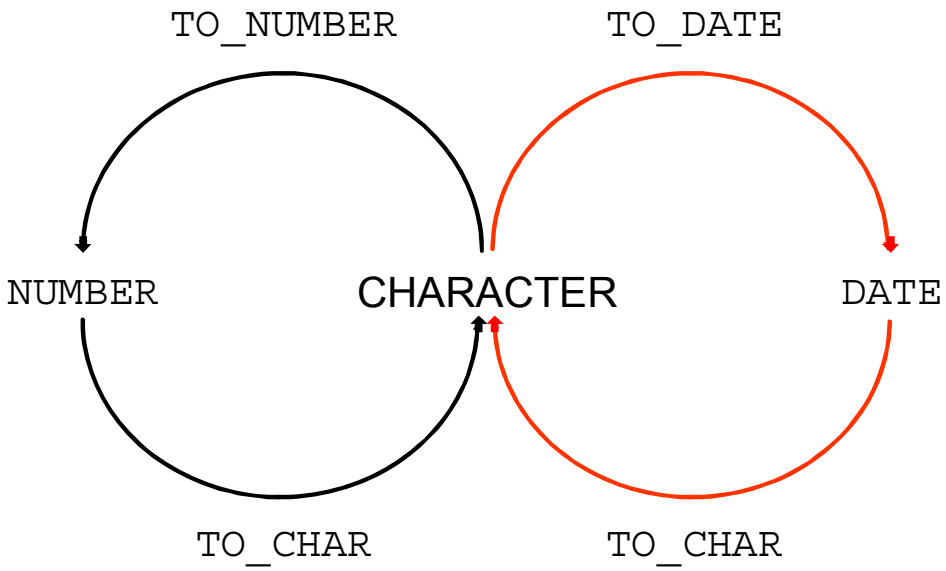
Explicit Data Type Conversion



SQL provides three functions to convert a value from one data type to another:

Function	Purpose
`TO_CHAR(`*number*`|`*date*`,[ `*fmt*`], [`*nlsparams*`])`	Converts a number or date value to a `VARCHAR2` character string with the format model *`fmt`* **Number conversion:** The `nlsparams` parameter specifies the following characters, which are returned by number format elements: • Decimal character • Group separator • Local currency symbol • International currency symbol If `nlsparams` or any other parameter is omitted, this function uses the default parameter values for the session.

Explicit Data Type Conversion



Function	Purpose
TO_CHAR(*number*|*date*,[*fmt*], [*nlsparams*])	**Date conversion:** The nlsparams parameter specifies the language in which the month and day names, and abbreviations are returned. If this parameter is omitted, this function uses the default date languages for the session.
TO_NUMBER(*char*,*[fmt]*, *[nlsparams]*)	Converts a character string containing digits to a number in the format specified by the optional format model *fmt*. The nlsparams parameter has the same purpose in this function as in the TO_CHAR function for number conversion.
TO_DATE(*char*,[*fmt*],[*nlsparams*])	Converts a character string representing a date to a date value according to *fmt* that is specified. If *fmt* is omitted, the format is DD-MON-YY. The nlsparams parameter has the same purpose in this function as in the TO_CHAR function for date conversion.

Note: The list of functions mentioned in this lesson includes only some of the available conversion functions.

For more information, see the “Conversion Functions” section in *Oracle Database SQL Language Reference* for 10*g* or 11*g* database.

Lesson Agenda

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

Using the TO_CHAR Function with Dates

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

The format model:

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

TO_CHAR converts a datetime data type to a value of VARCHAR2 data type in the format specified by the *format_model*. A format model is a character literal that describes the format of datetime stored in a character string. For example, the datetime format model for the string '11-Nov-1999' is 'DD-Mon-YYYY'. You can use the TO_CHAR function to convert a date from its default format to the one that you specify.

Guidelines

- The format model must be enclosed with single quotation marks and is case-sensitive.
- The format model can include any valid date format element. But be sure to separate the date value from the format model with a comma.
- The names of days and months in the output are automatically padded with blanks.
- To remove padded blanks or to suppress leading zeros, use the fill mode *fm* element.

```
SELECT employee_id, TO_CHAR(hire_date, 'MM/YY') Month_Hired
FROM   employees
WHERE  last_name = 'Higgins';
```

	EMPLOYEE_ID	MONTH_HIRED
1	205	06/94

Elements of the Date Format Model

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

Element	Description
SCC or CC	Century; server prefixes B.C. date with -
Years in dates YYYY or SYYYY	Year; server prefixes B.C. date with -
YYY or YY or Y	Last three, two, or one digit of the year
Y,YYY	Year with comma in this position
IYYY, IYY, IY, I	Four-, three-, two-, or one-digit year based on the ISO standard
SYEAR or YEAR	Year spelled out; server prefixes B.C. date with -
BC or AD	Indicates B.C. or A.D. year
B.C. or A.D.	Indicates B.C. or A.D. year using periods
Q	Quarter of year
MM	Month: two-digit value
MONTH	Name of the month padded with blanks to a length of nine characters
MON	Name of the month, three-letter abbreviation
RM	Roman numeral month
WW or W	Week of the year or month
DDD or DD or D	Day of the year, month, or week
DAY	Name of the day padded with blanks to a length of nine characters
DY	Name of the day; three-letter abbreviation
J	Julian day; the number of days since December 31, 4713 B.C.
IW	Weeks in the year from ISO standard (1 to 53)

Elements of the Date Format Model

- Time elements format the time portion of the date:

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

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

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

- Number suffixes spell out numbers:

`ddspth`	`fourteenth`

Use the formats that are listed in the following tables to display time information and literals, and to change numerals to spelled numbers.

Element	Description
AM or PM	Meridian indicator
A.M. or P.M.	Meridian indicator with periods
HH or HH12	12 hour format
HH24	24 hour format
MI	Minute (0–59)
SS	Second (0–59)
SSSSS	Seconds past midnight (0–86399)

Other Formats

Element	Description
/ . ,	Punctuation is reproduced in the result.
“of the”	Quoted string is reproduced in the result.

Specifying Suffixes to Influence Number Display

Element	Description
TH	Ordinal number (for example, DDTH for 4TH)
SP	Spelled-out number (for example, DDSP for FOUR)
SPTH or THSP	Spelled-out ordinal numbers (for example, DDSPTH for FOURTH)

Using the TO_CHAR Function with Dates

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

	LAST_NAME	HIREDATE
1	Whalen	17 September 1987
2	Hartstein	17 February 1996
3	Fay	17 August 1997
4	Higgins	7 June 1994
5	Gietz	7 June 1994
6	King	17 June 1987
7	Kochhar	21 September 1989
8	De Haan	13 January 1993
9	Hunold	3 January 1990
10	Ernst	21 May 1991

...

The SQL statement in the slide displays the last names and hire dates for all the employees. The hire date appears as 17 June 1987.

Example

Modify the example in the slide to display the dates in a format that appears as “Seventeenth of June 1987 12:00:00 AM.”

```
SELECT  last_name,
 TO_CHAR(hire_date,
       'fmDdspth "of" Month YYYY fmHH:MI:SS AM')
 HIREDATE
FROM    employees;
```

	LAST_NAME	HIREDATE
1	Whalen	Seventeenth of September 1987 12:00:00 AM
2	Hartstein	Seventeenth of February 1996 12:00:00 AM

...

Notice that the month follows the format model specified; in other words, the first letter is capitalized and the rest are in lowercase.

Using the TO_CHAR Function with Numbers

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

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

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

When working with number values, such as character strings, you should convert those numbers to the character data type using the TO_CHAR function, which translates a value of NUMBER data type to VARCHAR2 data type. This technique is especially useful with concatenation.

Number Format Elements

If you are converting a number to the character data type, you can use the following format elements:

Element	Description	Example	Result
9	Numeric position (number of 9s determine display width)	999999	1234
0	Display leading zeros	099999	001234
$	Floating dollar sign	$999999	$1234
L	Floating local currency symbol	L999999	FF1234
D	Returns the decimal character in the specified position. The default is a period (.).	9999D99	1234.00
.	Decimal point in position specified	999999.99	1234.00
G	Returns the group separator in the specified position. You can specify multiple group separators in a number format model.	9G999	1,234
,	Comma in position specified	999,999	1,234
MI	Minus signs to right (negative values)	999999MI	1234-
PR	Parenthesize negative numbers	999999PR	<1234>
EEEE	Scientific notation (format must specify four Es)	99.999EEEE	1.234E+03
U	Returns in the specified position the “Euro” (or other) dual currency	U9999	€1234
V	Multiply by 10 *n* times (*n* = number of 9s after V)	9999V99	123400
S	Returns the negative or positive value	S9999	-1234 or +1234
B	Display zero values as blank, not 0	B9999.99	1234.00

Using the TO_CHAR Function with Numbers

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

	SALARY
1	$6,000.00

- The Oracle server displays a string of number signs (#) in place of a whole number whose digits exceed the number of digits provided in the format model.
- The Oracle server rounds the stored decimal value to the number of decimal places provided in the format model.

Using the TO_NUMBER and TO_DATE Functions

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

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

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

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

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

You may want to convert a character string to either a number or a date. To accomplish this task, use the TO_NUMBER or TO_DATE functions. The format model that you select is based on the previously demonstrated format elements.

The fx modifier specifies the exact match for the character argument and date format model of a TO_DATE function:

- Punctuation and quoted text in the character argument must exactly match (except for case) the corresponding parts of the format model.
- The character argument cannot have extra blanks. Without fx, the Oracle server ignores extra blanks.
- Numeric data in the character argument must have the same number of digits as the corresponding element in the format model. Without fx, the numbers in the character argument can omit leading zeros.

Example

Display the name and hire date for all employees who started on May 24, 1999. There are two spaces after the month *May* and before the number *24* in the following example. Because the `fx` modifier is used, an exact match is required and the spaces after the word *May* are not recognized:

```
SELECT last_name, hire_date
FROM   employees
WHERE  hire_date = TO_DATE('May  24, 1999', 'fxMonth DD, YYYY');
```

The resulting error output looks like this:

```
ORA-01858: a non-numeric character was found where a numeric was expected
01858. 00000 - "a non-numeric character was found where a numeric was expected"
*Cause:    The input data to be converted using a date format model was
           incorrect.  The input data did not contain a number where a number was
           required by the format model.
*Action:   Fix the input data or the date format model to make sure the
           elements match in number and type.  Then retry the operation.
```

To see the output, correct the query by deleting the extra space between 'May' and '24'.

```
SELECT last_name, hire_date
FROM   employees
WHERE  hire_date = TO_DATE('May 24, 1999', 'fxMonth DD, YYYY');
```

	LAST_NAME	HIRE_DATE
1	Grant	24-MAY-99

Using the TO_CHAR and TO_DATE Function with the RR Date Format

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

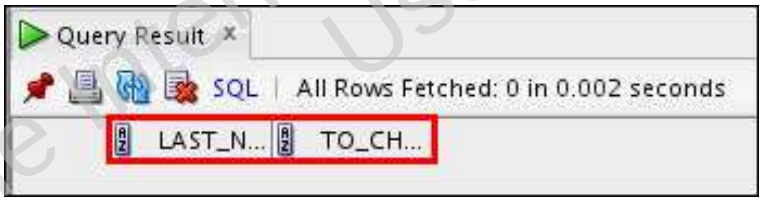
```
SELECT last_name, TO_CHAR(hire_date, 'DD-Mon-YYYY')
FROM  employees
WHERE hire_date < TO_DATE('01-Jan-90','DD-Mon-RR');
```

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

To find employees who were hired before 1990, the RR format can be used. Because the current year is greater than 1999, the RR format interprets the year portion of the date from 1950 to 1999.

Alternatively, the following command, results in no rows being selected because the YY format interprets the year portion of the date in the current century (2090).

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



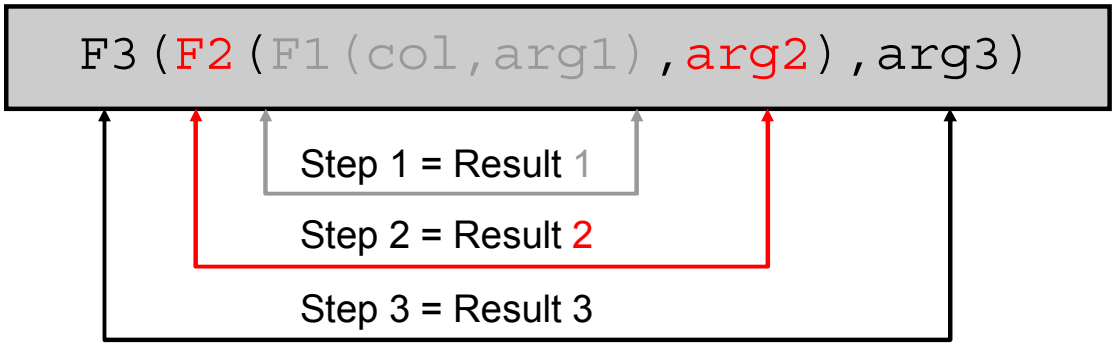
Notice that no rows are retrieved from the above query.

Lesson Agenda

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

Nesting Functions

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



Single-row functions can be nested to any depth. Nested functions are evaluated from the innermost level to the outermost level. Some examples follow to show you the flexibility of these functions.

Nesting Functions: Example 1

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

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

The example in the slide displays the last names of employees in department 60. The evaluation of the SQL statement involves three steps:

1. The inner function retrieves the first eight characters of the last name.
   ```
   Result1 = SUBSTR (LAST_NAME, 1, 8)
   ```
2. The outer function concatenates the result with _US.
   ```
   Result2 = CONCAT(Result1, '_US')
   ```
3. The outermost function converts the results to uppercase.

The entire expression becomes the column heading because no column alias was given.

Example

Display the date of the next Friday that is six months from the hire date. The resulting date should appear as Friday, August 13th, 1999. Order the results by hire date.

```
SELECT   TO_CHAR(NEXT_DAY(ADD_MONTHS
         (hire_date, 6), 'FRIDAY'),
         'fmDay, Month ddth, YYYY')
         "Next 6 Month Review"
FROM      employees
ORDER BY  hire_date;
```

Nesting Functions: Example 2

```
SELECT   TO_CHAR(ROUND((salary/7), 2),'99G999D99',
         'NLS_NUMERIC_CHARACTERS = '',.'' ')
         "Formatted Salary"
FROM employees;
```

	Formatted Salary
1	628,57
2	1.857,14
3	857,14
4	1.714,29
5	1.185,71
6	3.428,57

...

The example in the slide displays the salaries of employees divided by 7 and rounded to two decimals. The result is then formatted to display the salary in Danish notation. That is, comma is used for decimal point and a period for thousands.

First, the inner `ROUND` function is executed to round off the value of salary divided by 7 to two decimal places. The `TO_CHAR` function is then used to format the result of the `ROUND` function.

Note: D and G specified in the `TO_CHAR` function parameter are number format elements. D returns a decimal character in the specified position. G is used as a group separator.

The NLS_NUMERIC_CHARACTERS function shown in the example above is used to identify the characters to use for the decimal and thousands separators. In this example, it is specifying to use the ',' as the decimal separator and the '.' for the thousands separator. Without using the NLS_NUMERIC_CHARACTERS function, these separators would default to values that are set at the database level.

Lesson Agenda

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

General Functions

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

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

These functions work with any data type and pertain to the use of null values in the expression list.

Function	Description
`NVL`	Converts a null value to an actual value
`NVL2`	If `expr1` is not null, `NVL2` returns `expr2`. If `expr1` is null, `NVL2` returns `expr3`. The argument `expr1` can have any data type.
`NULLIF`	Compares two expressions and returns null if they are equal; returns the first expression if they are not equal
`COALESCE`	Returns the first non-null expression in the expression list

Note: For more information about the hundreds of functions available, see the “Functions” section in *Oracle Database SQL Language Reference* for 10*g* or 11*g* database.

NVL Function

Converts a null value to an actual value:

- Data types that can be used are date, character, and number.
- Data types must match:
  - NVL(commission_pct,0)
  - NVL(hire_date,'01-JAN-97')
  - NVL(job_id,'No Job Yet')

To convert a null value to an actual value, use the NVL function.

Syntax

NVL (*expr1*, *expr2*)

In the syntax:

- *expr1* is the source value or expression that may contain a null
- *expr2* is the target value for converting the null

You can use the NVL function with any data type, but the return value is always the same as the data type of *expr1*.

NVL Conversions for Various Data Types

Data Type	Conversion Example
NUMBER	NVL(*number_column*,9)
DATE	NVL(*date_column*, '01-JAN-95')
CHAR or VARCHAR2	NVL(*character_column*, 'Unavailable')

Using the NVL Function

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

	LAST_NAME	SALARY	NVL(COMMISSION_PCT,0)	AN_SAL
1	Whalen	4400	0	52800
2	Hartstein	13000	0	156000
3	Fay	6000	0	72000
4	Higgins	12000	0	144000
5	Gietz	8300	0	99600
6	King	24000	0	288000
7	Kochhar	17000	0	204000
8	De Haan	17000	0	204000
9	Hunold	9000	0	108000
10	Ernst	6000	0	72000

...

To calculate the annual compensation of all employees, you need to multiply the monthly salary by 12 and then add the commission percentage to the result:

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

	LAST_NAME	SALARY	COMMISSION_PCT	AN_SAL
1	Whalen	4400	(null)	(null)

...

16	Vargas	2500	(null)	(null)
17	Zlotkey	10500	0.2	151200
18	Abel	11000	0.3	171600
19	Taylor	8600	0.2	123840
20	Grant	7000	0.15	96600

Notice that the annual compensation is calculated for only those employees who earn a commission. If any column value in an expression is null, the result is null. To calculate values for all employees, you must convert the null value to a number before applying the arithmetic operator. In the example in the slide, the NVL function is used to convert null values to zero.

Using the NVL2 Function

```
SELECT last_name,  salary, commission_pct,
       NVL2(commission_pct,
            'SAL+COMM', 'SAL') income
FROM   employees WHERE department_id IN (50, 80);
```

1 2

	LAST_NAME	SALARY	COMMISSION_PCT	INCOME
1	Mourgos	5800	(null)	SAL
2	Rajs	3500	(null)	SAL
3	Davies	3100	(null)	SAL
4	Matos	2600	(null)	SAL
5	Vargas	2500	(null)	SAL
6	Zlotkey	10500	0.2	SAL+COMM
7	Abel	11000	0.3	SAL+COMM
8	Taylor	8600	0.2	SAL+COMM

1 2

The NVL2 function examines the first expression. If the first expression is not null, the NVL2 function returns the second expression. If the first expression is null, the third expression is returned.

Syntax

```
NVL2(expr1, expr2, expr3)
```

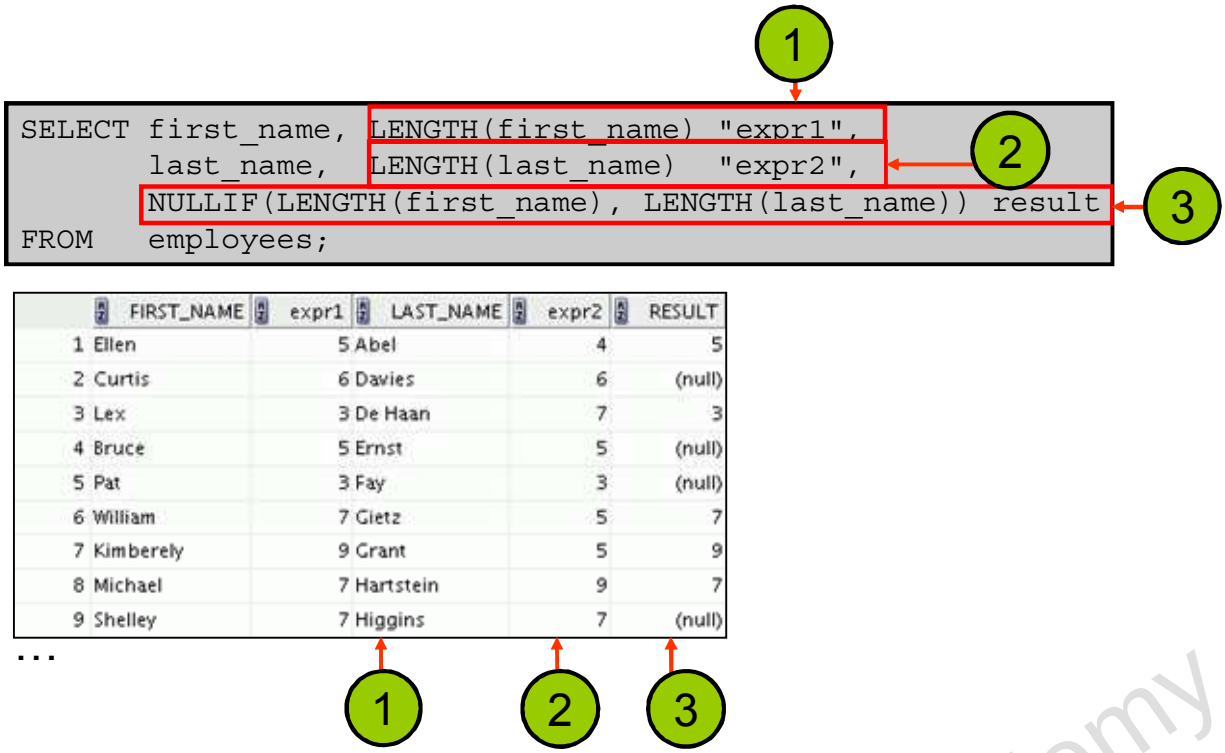
In the syntax:

- *expr1* is the source value or expression that may contain a null
- *expr2* is the value that is returned if *expr1* is not null
- *expr3* is the value that is returned if *expr1* is null

In the example shown in the slide, the COMMISSION_PCT column is examined. If a value is detected, the text literal value of SAL+COMM is returned. If the COMMISSION_PCT column contains a null value, the text literal value of SAL is returned.

Note: The argument *expr1* can have any data type. The arguments *expr2* and *expr3* can have any data types except LONG.

Using the NULLIF Function



The NULLIF function compares two expressions.

Syntax

```
NULLIF (expr1, expr2)
```

In the syntax:

- NULLIF compares *expr1* and *expr2*. If they are equal, the function returns null. If they are not, the function returns *expr1*. However, you cannot specify the literal NULL for *expr1*.

In the example shown in the slide, the length of the first name in the EMPLOYEES table is compared to the length of the last name in the EMPLOYEES table. When the lengths of the names are equal, a null value is displayed. When the lengths of the names are not equal, the length of the first name is displayed.

Using the COALESCE Function

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

The COALESCE function returns the first non-null expression in the list.

Syntax

```
COALESCE (expr1, expr2, ... exprn)
```

In the syntax:

- *expr1* returns this expression if it is not null
- *expr2* returns this expression if the first expression is null and this expression is not null
- *exprn* returns this expression if the preceding expressions are null

Note that all expressions must be of the same data type.

Using the COALESCE Function

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

	LAST_NAME	EMPLOYEE_ID	COALESCE(TO_CHAR(COMMISSI...
1	Whalen	200	101
2	Hartstein	201	100
3	Fay	202	201
4	Higgins	205	101
5	Gietz	206	205
6	King	100	No commission and no manager

...

17	Zlotkey	149	.2
18	Abel	174	.3
19	Taylor	176	.2
20	Grant	178	.15

In the example shown in the slide, if the `manager_id` value is not null, it is displayed. If the `manager_id` value is null, the `commission_pct` is displayed. If the `manager_id` and `commission_pct` values are null, “No commission and no manager” is displayed. Note that `TO_CHAR` function is applied so that all expressions are of the same data type.

Example

For the employees who do not get any commission, your organization wants to give a salary increment of $2,000 and for employees who get commission, the query should compute the new salary that is equal to the existing salary added to the commission amount.

```
SELECT last_name, salary, commission_pct,
 COALESCE((salary+(commission_pct*salary)), salary+2000, salary)
  "New Salary"
FROM   employees;
```

Note: Examine the output. For employees who do not get any commission, the New Salary column shows the salary incremented by $2,000 and for employees who get commission, the New Salary column shows the computed commission amount added to the salary.

	LAST_NAME	SALARY	COMMISSION_PCT	New Salary
1	Whalen	4400	(null)	6400
2	Hartstein	13000	(null)	15000
3	Fay	6000	(null)	8000
4	Higgins	12000	(null)	14000
5	Gietz	8300	(null)	10300
6	King	24000	(null)	26000

. . .

17	Zlotkey	10500	0.2	12600
18	Abel	11000	0.3	14300
19	Taylor	8600	0.2	10320
20	Grant	7000	0.15	8050

Lesson Agenda

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

Conditional Expressions

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

The two methods that are used to implement conditional processing (IF-THEN-ELSE logic) in a SQL statement are the CASE expression and the DECODE function.

Note: The CASE expression complies with the ANSI SQL. The DECODE function is specific to Oracle syntax.

CASE Expression

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

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


CASE expressions allow you to use the IF-THEN-ELSE logic in SQL statements without having to invoke procedures.

In a simple CASE expression, the Oracle server searches for the first WHEN ... THEN pair for which expr is equal to comparison_expr and returns return_expr. If none of the WHEN ... THEN pairs meet this condition, and if an ELSE clause exists, the Oracle server returns else_expr. Otherwise, the Oracle server returns a null. You cannot specify the literal NULL for all the return_exprs and the else_expr.

The expressions expr and comparison_expr must be of the same data type, which can be CHAR, VARCHAR2, NCHAR, or NVARCHAR2, NUMBER, BINARY_FLOAT, or BINARY_DOUBLE or must all have a numeric datatype. All of the return values (return_expr) must be of the same data type.

If all expressions have a numeric datatype, then Oracle determines the argument with the highest numeric precedence, implicitly converts the remaining arguments to that datatype, and returns that datatype.

Using the CASE Expression

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

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

	LAST_NAME	JOB_ID	SALARY	REVISED_SALARY
1	Whalen	AD_ASST	4400	4400
...				
9	Hunold	IT_PROG	9000	9900
10	Ernst	IT_PROG	6000	6600
11	Lorentz	IT_PROG	4200	4620
12	Mourgos	ST_MAN	5800	5800
13	Rajs	ST_CLERK	3500	4025
14	Davies	ST_CLERK	3100	3565
...				
19	Taylor	SA_REP	8600	10320
20	Grant	SA_REP	7000	8400

In the SQL statement in the slide, the value of JOB_ID is decoded. If JOB_ID is IT_PROG, the salary increase is 10%; if JOB_ID is ST_CLERK, the salary increase is 15%; if JOB_ID is SA_REP, the salary increase is 20%. For all other job roles, there is no increase in salary.

The same statement can be written with the DECODE function.

The following code is an example of the searched CASE expression. In a searched CASE expression, the search occurs from left to right until an occurrence of the listed condition is found, and then it returns the return expression. If no condition is found to be true, and if an ELSE clause exists, the return expression in the ELSE clause is returned; otherwise, a NULL is returned.

```
SELECT last_name,salary,
(CASE WHEN salary<5000 THEN 'Low'
      WHEN salary<10000 THEN 'Medium'
      WHEN salary<20000 THEN 'Good'
      ELSE 'Excellent'
END) qualified_salary
FROM employees;
```

DECODE Function

Facilitates conditional inquiries by doing the work of a CASE expression or an IF-THEN-ELSE statement:

```
DECODE(col|expression, search1, result1
                      [, search2, result2,...,]
                      [, default])
```


The DECODE function decodes an expression in a way similar to the IF-THEN-ELSE logic that is used in various languages. The DECODE function decodes *expression* after comparing it to each *search* value. If the expression is the same as *search*, *result* is returned.

If the default value is omitted, a null value is returned where a search value does not match any of the result values.

Using the DECODE Function

```
SELECT last_name, job_id, salary,
       DECODE(job_id, 'IT_PROG',  1.10*salary,
                      'ST_CLERK', 1.15*salary,
                      'SA_REP',   1.20*salary,
              salary)
       REVISED_SALARY
FROM   employees;
```

	LAST_NAME	JOB_ID	SALARY	REVISED_SALARY
...				
10	Ernst	IT_PROG	6000	6600
11	Lorentz	IT_PROG	4200	4620
12	Mourgos	ST_MAN	5800	5800
13	Rajs	ST_CLERK	3500	4025
...				
19	Taylor	SA_REP	8600	10320
20	Grant	SA_REP	7000	8400

In the SQL statement in the slide, the value of JOB_ID is tested. If JOB_ID is IT_PROG, the salary increase is 10%; if JOB_ID is ST_CLERK, the salary increase is 15%; if JOB_ID is SA_REP, the salary increase is 20%. For all other job roles, there is no increase in salary.

The same statement can be expressed in pseudocode as an IF-THEN-ELSE statement:

```
IF job_id = 'IT_PROG'     THEN  salary = salary*1.10
IF job_id = 'ST_CLERK'    THEN  salary = salary*1.15
IF job_id = 'SA_REP'      THEN  salary = salary*1.20
ELSE salary = salary
```

Using the DECODE Function

Display the applicable tax rate for each employee in department 80:

```
SELECT last_name, salary,
       DECODE (TRUNC(salary/2000, 0),
                         0, 0.00,
                         1, 0.09,
                         2, 0.20,
                         3, 0.30,
                         4, 0.40,
                         5, 0.42,
                         6, 0.44,
                            0.45) TAX_RATE
FROM   employees
WHERE  department_id = 80;
```


This slide shows another example using the DECODE function. In this example, you determine the tax rate for each employee in department 80 based on the monthly salary. The tax rates are as follows:

Monthly Salary Range	***Tax Rate***
$0.00–1,999.99	00%
$2,000.00–3,999.99	09%
$4,000.00–5,999.99	20%
$6,000.00–7,999.99	30%
$8,000.00–9,999.99	40%
$10,000.00–11,999.99	42%
$12,200.00–13,999.99	44%
$14,000.00 or greater	45%

	LAST_NAME	SALARY	TAX_RATE
1	Zlotkey	10500	0.42
2	Abel	11000	0.42
3	Taylor	8600	0.4

Quiz

The `TO_NUMBER` function converts either character strings or date values to a number in the format specified by the optional format model.

a. True
b. False

Answer: b

Summary

In this lesson, you should have learned how to:

- Alter date formats for display using functions
- Convert column data types using functions
- Use `NVL` functions
- Use `IF-THEN-ELSE` logic and other conditional expressions in a `SELECT` statement

Remember the following:

- Conversion functions can convert character, date, and numeric values: `TO_CHAR`, `TO_DATE`, `TO_NUMBER`
- There are several functions that pertain to nulls, including `NVL`, `NVL2`, `NULLIF`, and `COALESCE`.
- The `IF-THEN-ELSE` logic can be applied within a SQL statement by using the `CASE` expression or the `DECODE` function.

Practice 5: Overview

This practice covers the following topics:

- Creating queries that use `TO_CHAR`, `TO_DATE`, and other `DATE` functions
- Creating queries that use conditional expressions such as `DECODE` and `CASE`

This practice provides a variety of exercises using `TO_CHAR` and `TO_DATE` functions, and conditional expressions such as `DECODE` and `CASE`. Remember that for nested functions, the results are evaluated from the innermost function to the outermost function.

6

Reporting Aggregated Data Using the Group Functions

Objectives

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

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

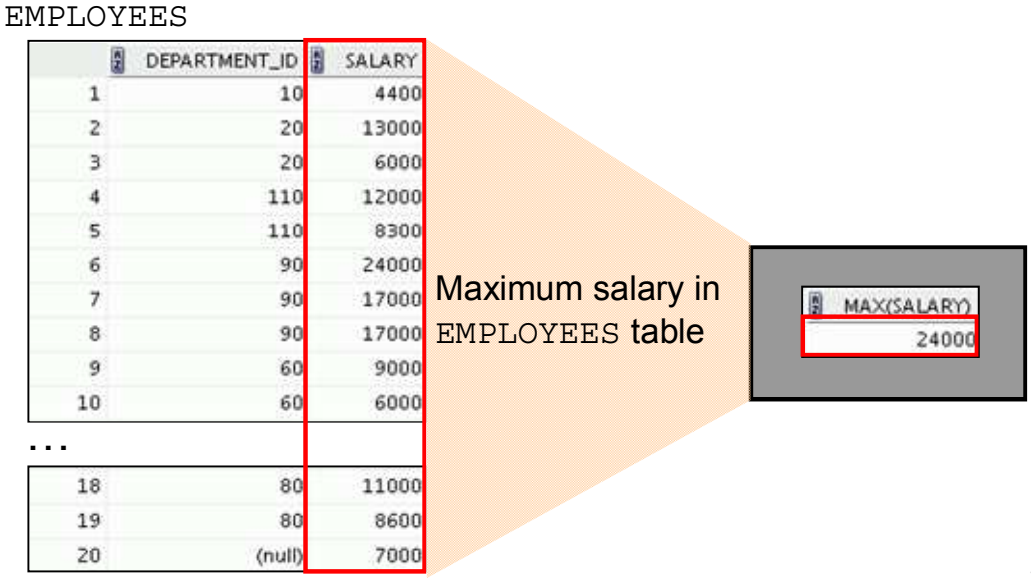
This lesson further addresses functions. It focuses on obtaining summary information (such as averages) for groups of rows. It discusses how to group rows in a table into smaller sets and how to specify search criteria for groups of rows.

Lesson Agenda

- Group functions:
  - Types and syntax
  - Use `AVG`, `SUM`, `MIN`, `MAX`, `COUNT`
  - Use the `DISTINCT` keyword within group functions
  - `NULL` values in a group function
- Grouping rows:
  - `GROUP BY` clause
  - `HAVING` clause
- Nesting group functions

What Are Group Functions?

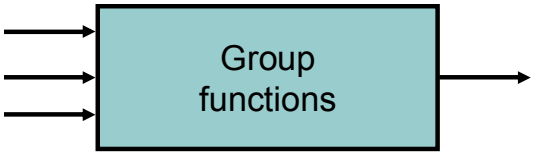
Group functions operate on sets of rows to give one result per group.



Unlike single-row functions, group functions operate on sets of rows to give one result per group. These sets may comprise the entire table or the table split into groups.

Types of Group Functions

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



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

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

Group Functions: Syntax

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


The group function is placed after the SELECT keyword. You may have multiple group functions separated by commas.

Syntax:

group_function([DISTINCT|ALL] *expr*)

Guidelines for using the group functions:

- DISTINCT makes the function consider only nonduplicate values; ALL makes it consider every value, including duplicates. The default is ALL and, therefore, does not need to be specified.
- The data types for the functions with an expr argument may be CHAR, VARCHAR2, NUMBER, or DATE.
- All group functions ignore null values. To substitute a value for null values, use the NVL, NVL2, COALESCE, CASE, or DECODE functions.

Using the AVG and SUM Functions

You can use AVG and SUM for numeric data.

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

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

You can use the AVG, SUM, MIN, and MAX functions against the columns that can store numeric data. The example in the slide displays the average, highest, lowest, and sum of monthly salaries for all sales representatives.

Using the MIN and MAX Functions

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

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

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

You can use the MAX and MIN functions for numeric, character, and date data types. The example in the slide displays the most junior and most senior employees.

The following example displays the employee last name that is first and the employee last name that is last in an alphabetic list of all employees:

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

	MIN(LAST_NAME)	MAX(LAST_NAME)
1	Abel	Zlotkey

Note: The AVG, SUM, VARIANCE, and STDDEV functions can be used only with numeric data types. MAX and MIN cannot be used with LOB or LONG data types.

Using the COUNT Function

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

1
```
SELECT COUNT(*)
FROM   employees
WHERE  department_id = 50;
```

	COUNT(*)
1	5

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

2
```
SELECT COUNT(commission_pct)
FROM   employees
WHERE  department_id = 50;
```

	COUNT(COMMISSION_PCT)
1	0

The COUNT function has three formats:

- COUNT(*)
- COUNT(*expr*)
- COUNT(DISTINCT *expr*)

COUNT(*) returns the number of rows in a table that satisfy the criteria of the SELECT statement, including duplicate rows and rows containing null values in any of the columns. If a WHERE clause is included in the SELECT statement, COUNT(*) returns the number of rows that satisfy the condition in the WHERE clause.

In contrast, COUNT(*expr*) returns the number of non-null values that are in the column identified by *expr*.

COUNT(DISTINCT *expr*) returns the number of unique, non-null values that are in the column identified by *expr*.

Examples

1. The example in the slide displays the number of employees in department 50.
2. The example in the slide displays the number of employees in department 50 who can earn a commission.

Using the DISTINCT Keyword

- COUNT(DISTINCT *expr*) returns the number of distinct non-null values of *expr*.
- To display the number of distinct department values in the EMPLOYEES table:

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

	COUNT(DISTINCTDEPARTMENT_ID)
1	7

Use the DISTINCT keyword to suppress the counting of any duplicate values in a column.

The example in the slide displays the number of distinct department values that are in the EMPLOYEES table.

Group Functions and Null Values

Group functions ignore null values in the column:

1

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

	AVG(COMMISSION_PCT)
1	0.2125

The NVL function forces group functions to include null values:

2

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

	AVG(NVL(COMMISSION_PCT,0))
1	0.0425

All group functions ignore null values in the column.

However, the NVL function forces group functions to include null values.

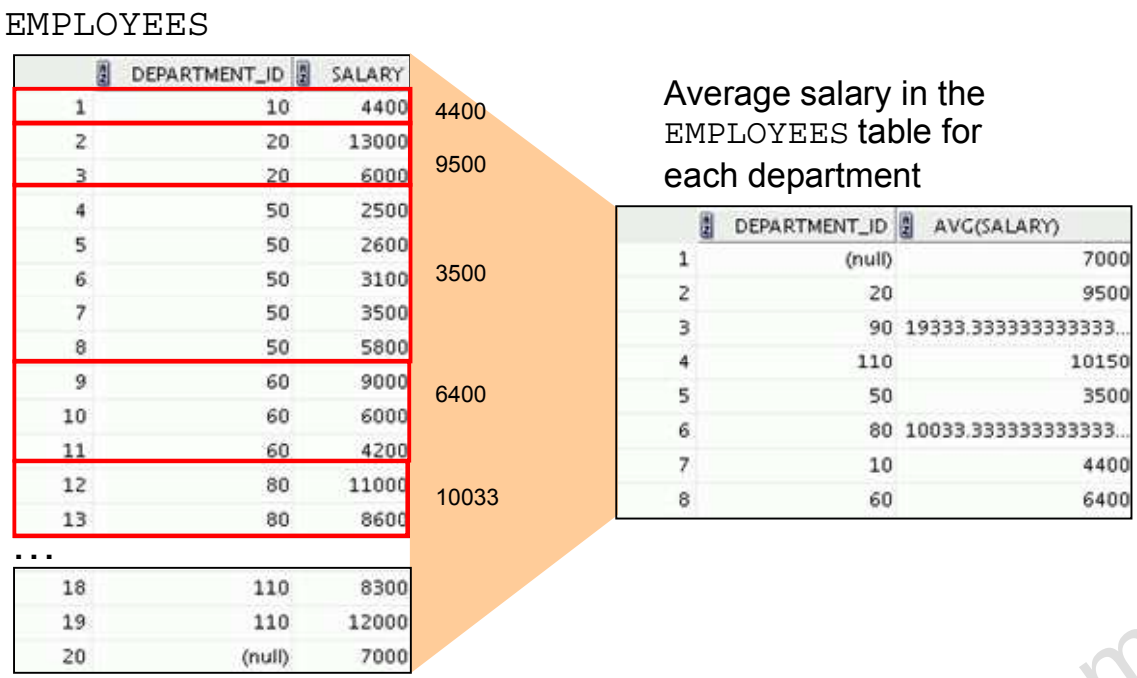
Examples

1. The average is calculated based on *only* those rows in the table in which a valid value is stored in the COMMISSION_PCT column. The average is calculated as the total commission that is paid to all employees divided by the number of employees receiving a commission (four).
2. The average is calculated based on *all* rows in the table, regardless of whether null values are stored in the COMMISSION_PCT column. The average is calculated as the total commission that is paid to all employees divided by the total number of employees in the company (20).

Lesson Agenda

- Group functions:
  - Types and syntax
  - Use `AVG`, `SUM`, `MIN`, `MAX`, `COUNT`
  - Use `DISTINCT` keyword within group functions
  - `NULL` values in a group function
- Grouping rows:
  - `GROUP BY` clause
  - `HAVING` clause
- Nesting group functions

Creating Groups of Data



Until this point in the discussion, all group functions have treated the table as one large group of information. At times, however, you need to divide the table of information into smaller groups. This can be done by using the `GROUP BY` clause.

Creating Groups of Data: GROUP BY Clause Syntax

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

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


You can use the GROUP BY clause to divide the rows in a table into groups. You can then use the group functions to return summary information for each group.

In the syntax:

group_by_expression	Specifies the columns whose values determine the basis for grouping rows

Guidelines

- If you include a group function in a SELECT clause, you cannot select individual column as well, *unless* the individual column appears in the GROUP BY clause. You receive an error message if you fail to include the column list in the GROUP BY clause.
- Using a WHERE clause, you can exclude rows before dividing them into groups.
- You can substitute *column* by an Expression in the SELECT statement.
- You must include the *columns* in the GROUP BY clause.
- You cannot use a column alias in the GROUP BY clause.

Using the GROUP BY Clause

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

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

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

When using the GROUP BY clause, make sure that all columns in the SELECT list that are not group functions are included in the GROUP BY clause. The example in the slide displays the department number and the average salary for each department. Here is how this SELECT statement, containing a GROUP BY clause, is evaluated:

- The SELECT clause specifies the columns to be retrieved, as follows:
  - Department number column in the EMPLOYEES table
  - The average of all salaries in the group that you specified in the GROUP BY clause
- The FROM clause specifies the tables that the database must access: the EMPLOYEES table.
- The WHERE clause specifies the rows to be retrieved. Because there is no WHERE clause, all rows are retrieved by default.
- The GROUP BY clause specifies how the rows should be grouped. The rows are grouped by department number, so the AVG function that is applied to the salary column calculates the average salary for each department.

Note: To order the query results in ascending or descending order, include the ORDER BY clause in the query.

Using the GROUP BY Clause

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

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

	AVG(SALARY)
1	7000
2	9500
3	19333.333333333333333333...
4	10150
5	3500
6	10033.333333333333333333...
7	4400
8	6400

The GROUP BY column does not have to be in the SELECT clause. For example, the SELECT statement in the slide displays the average salaries for each department without displaying the respective department numbers. Without the department numbers, however, the results do not look meaningful.

You can also use the group function in the ORDER BY clause:

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

	DEPARTMENT_ID	AVG(SALARY)
1	50	3500
2	10	4400
3	60	6400
...		
7	110	10150
8	90	19333.333333333333333333333333333333333

Grouping by More Than One Column

EMPLOYEES

	DEPARTMENT_ID	JOB_ID	SALARY
1	10	AD_ASST	4400
2	20	MK_MAN	13000
3	20	MK_REP	6000
4	50	ST_CLERK	2500
5	50	ST_CLERK	2600
6	50	ST_CLERK	3100
7	50	ST_CLERK	3500
8	50	ST_MAN	5800
9	60	IT_PROG	9000
10	60	IT_PROG	6000
11	60	IT_PROG	4200
12	80	SA_REP	11000
13	80	SA_REP	8600
14	80	SA_MAN	10500
...			
19	110	AC_MGR	12000
20	(null)	SA_REP	7000

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

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

Sometimes, you need to see results for groups within groups. The slide shows a report that displays the total salary that is paid to each job title in each department.

The EMPLOYEES table is grouped first by the department number, and then by the job title within that grouping. For example, the four stock clerks in department 50 are grouped together, and a single result (total salary) is produced for all stock clerks in the group.

The following SELECT statement returns the result shown in the slide:

```
SELECT   department_id, job_id, sum(salary)
FROM     employees
GROUP BY department_id, job_id
ORDER BY job_id;
```

Using the GROUP BY Clause on Multiple Columns

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

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

You can return summary results for groups and subgroups by listing multiple GROUP BY columns. The GROUP BY clause groups rows but does not guarantee the order of the result set. To order the groupings, use the ORDER BY clause.
In the example in the slide, the SELECT statement that contains a GROUP BY clause is evaluated as follows:

- The SELECT clause specifies the column to be retrieved:
  - Department ID in the EMPLOYEES table
  - Job ID in the EMPLOYEES table
  - The sum of all salaries in the group that you specified in the GROUP BY clause
- The FROM clause specifies the tables that the database must access: the EMPLOYEES table.
- The WHERE clause reduces the result set to those rows where department ID is greater than 40.
- The GROUP BY clause specifies how you must group the resulting rows:
  - First, the rows are grouped by the department ID.
  - Second, the rows are grouped by job ID in the department ID groups.
- The ORDER BY clause sorts the results by department ID.

Note: The SUM function is applied to the salary column for all job IDs in the result set in each department ID group. Also, note that the SA_REP row is not returned. The department ID for this row is NULL and, therefore, does not meet the WHERE condition.

Illegal Queries Using Group Functions

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

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

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

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

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

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

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

Whenever you use a mixture of individual items (DEPARTMENT_ID) and group functions (COUNT) in the same SELECT statement, you must include a GROUP BY clause that specifies the individual items (in this case, DEPARTMENT_ID). If the GROUP BY clause is missing, the error message "not a single-group group function" appears and an asterisk (*) points to the offending column. You can correct the error in the first example in the slide by adding the GROUP BY clause:

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

Any column or expression in the SELECT list that is not an aggregate function must be in the GROUP BY clause. In the second example in the slide, job_id is neither in the GROUP BY clause nor is it being used by a group function, so there is a "not a GROUP BY expression" error. You can correct the error in the second slide example by adding job_id in the GROUP BY clause.

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

Illegal Queries Using Group Functions

- You cannot use the `WHERE` clause to restrict groups.
- You use the `HAVING` clause to restrict groups.
- You cannot use group functions in the `WHERE` clause.

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

```
ORA-00934: group function is not allowed here
00934. 00000 - "group function is not allowed here"
*Cause:
*Action:
Error at Line: 3 Column: 9
```

Cannot use the `WHERE` clause to restrict groups

The `WHERE` clause cannot be used to restrict groups. The `SELECT` statement in the example in the slide results in an error because it uses the `WHERE` clause to restrict the display of the average salaries of those departments that have an average salary greater than $8,000.

However, you can correct the error in the example by using the `HAVING` clause to restrict groups:

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

	DEPARTMENT_ID	AVG(SALARY)
1	20	9500
2	90	19333.3333333333...
3	110	10150
4	80	10033.3333333333...

Restricting Group Results

EMPLOYEES

	DEPARTMENT_ID	SALARY
1	10	4400
2	20	13000
3	20	6000
4	50	2500
5	50	2600
6	50	3100
7	50	3500
8	50	5800
9	60	9000
10	60	6000
11	60	4200
12	80	11000
13	80	8600
...		
18	110	8300
19	110	12000
20	(null)	7000

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

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

You use the `HAVING` clause to restrict groups in the same way that you use the `WHERE` clause to restrict the rows that you select. To find the maximum salary in each of the departments that have a maximum salary greater than $10,000, you need to do the following:

1. Find the average salary for each department by grouping by department number.
2. Restrict the groups to those departments with a maximum salary greater than $10,000.

Restricting Group Results with the HAVING Clause

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

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

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


You use the HAVING clause to specify the groups that are to be displayed, thus further restricting the groups on the basis of aggregate information.

In the syntax, *group_condition* restricts the groups of rows returned to those groups for which the specified condition is true.

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

1. Rows are grouped.
2. The group function is applied to the group.
3. The groups that match the criteria in the HAVING clause are displayed.

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. Groups are formed and group functions are calculated before the HAVING clause is applied to the groups in the SELECT list.

Note: The WHERE clause restricts rows, whereas the HAVING clause restricts groups.

Using the HAVING Clause

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

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

The example in the slide displays the department numbers and maximum salaries for those departments with a maximum salary greater than $10,000.

You can use the GROUP BY clause without using a group function in the SELECT list. If you restrict rows based on the result of a group function, you must have a GROUP BY clause as well as the HAVING clause.

The following example displays the department numbers and average salaries for those departments with a maximum salary greater than $10,000:

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

	DEPARTMENT_ID	AVG(SALARY)
1	20	9500
2	90	19333.333333333...
3	110	10150
4	80	10033.333333333...

Using the HAVING Clause

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

	JOB_ID	PAYROLL
1	IT_PROG	19200
2	AD_PRES	24000
3	AD_VP	34000

The example in the slide displays the job ID and total monthly salary for each job that has a total payroll exceeding $13,000. The example excludes sales representatives and sorts the list by the total monthly salary.

Lesson Agenda

- Group functions:
  - Types and syntax
  - Use `AVG`, `SUM`, `MIN`, `MAX`, `COUNT`
  - Use `DISTINCT` keyword within group functions
  - `NULL` values in a group function
- Grouping rows:
  - `GROUP BY` clause
  - `HAVING` clause
- Nesting group functions

Nesting Group Functions

Display the maximum average salary:

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

	MAX(AVG(SALARY))
1	19333.3333333333333333333333333333333333

Group functions can be nested to a depth of two functions. The example in the slide calculates the average salary for each `department_id` and then displays the maximum average salary.

Note that `GROUP BY` clause is mandatory when nesting group functions.

Quiz

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

a. You cannot use a column alias in the `GROUP BY` clause.
b. The `GROUP BY` column must be in the `SELECT` clause.
c. By using a `WHERE` clause, you can exclude rows before dividing them into groups.
d. The `GROUP BY` clause groups rows and ensures order of the result set.
e. If you include a group function in a `SELECT` clause, you must include a `GROUP BY` clause.

Answer: a, c

Summary

In this lesson, you should have learned how to:

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

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


There are several group functions available in SQL, such as AVG, COUNT, MAX, MIN, SUM, STDDEV, and VARIANCE.

You can create subgroups by using the GROUP BY clause. Further, groups can be restricted using the HAVING clause.

Place the HAVING and GROUP BY clauses after the WHERE clause in a statement. The order of the GROUP BY and HAVING clauses following the WHERE clause is not important. You can have either the GROUP BY clause or the HAVING clause first as long as they follow the WHERE clause. Place the ORDER BY clause at the end.

The Oracle server evaluates the clauses in the following order:

1. If the statement contains a WHERE clause, the server establishes the candidate rows.
2. The server identifies the groups that are specified in the GROUP BY clause.
3. The HAVING clause further restricts result groups that do not meet the group criteria in the HAVING clause.

Note: For a complete list of the group functions, see *Oracle Database SQL Language Reference* for 10*g* or 11*g* database.

Practice 6: Overview

This practice covers the following topics:

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

In this practice, you learn to use group functions and select groups of data.

7

Displaying Data from Multiple Tables Using Joins

Objectives

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

- Write `SELECT` statements to access data from more than one table using equijoins and nonequijoins
- Join a table to itself by using a self-join
- View data that generally does not meet a join condition by using `OUTER` joins
- Generate a Cartesian product of all rows from two or more tables

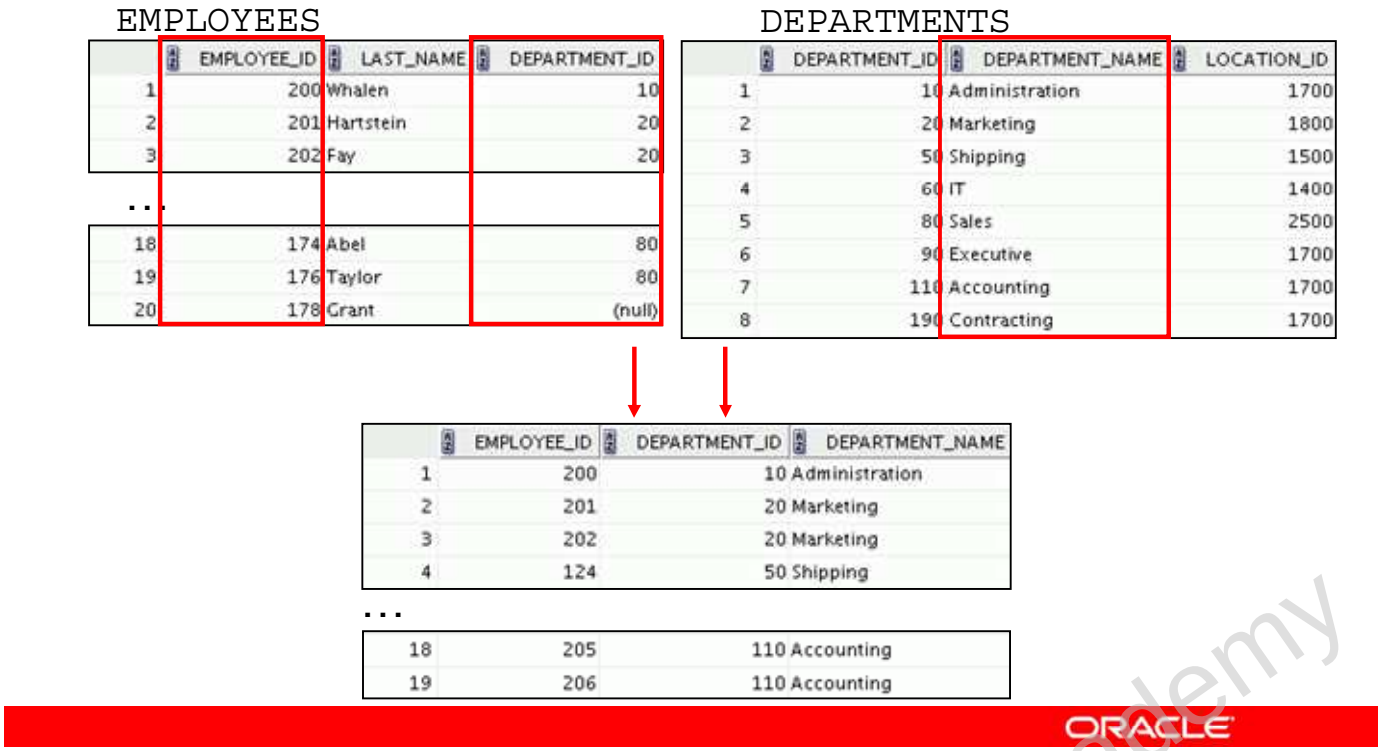
This lesson explains how to obtain data from more than one table. A *join* is used to view information from multiple tables. Therefore, you can *join* tables together to view information from more than one table.

Note: Information about joins is found in the "SQL Queries and Subqueries: Joins" section in *Oracle Database SQL Language Reference* for 10*g* or 11*g* database.

Lesson Agenda

- Types of JOINS and its syntax
- Natural join
- Join with the USING Clause
- Join with the ON Clause
- Self-join
- Nonequijoins
- OUTER join:
  - LEFT OUTER join
  - RIGHT OUTER join
  - FULL OUTER join
- Cartesian product
  - Cross join

Obtaining Data from Multiple Tables



Sometimes you need to use data from more than one table. In the example in the slide, the report displays data from two separate tables:

- Employee IDs exist in the `EMPLOYEES` table.
- Department IDs exist in both the `EMPLOYEES` and `DEPARTMENTS` tables.
- Department names exist in the `DEPARTMENTS` table.

To produce the report, you need to link the `EMPLOYEES` and `DEPARTMENTS` tables, and access data from both of them.

Types of Joins

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

- Natural join with the `NATURAL JOIN` clause
- Join with the `USING` Clause
- Join with the `ON` Clause
- `OUTER` joins:
  - `LEFT OUTER JOIN`
  - `RIGHT OUTER JOIN`
  - `FULL OUTER JOIN`
- Cross joins

To join tables, you can use a join syntax that is compliant with the SQL:1999 standard.

Note

- Before the Oracle9*i* release, the join syntax was different from the American National Standards Institute (ANSI) standards. The SQL:1999–compliant join syntax does not offer any performance benefits over the Oracle-proprietary join syntax that existed in the prior releases. For detailed information about the proprietary join syntax, see Appendix E: Oracle Join Syntax.
- The following slide discusses the SQL:1999 join syntax.

Joining Tables Using SQL:1999 Syntax

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

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


In the syntax:

- `table1.column` denotes the table and the column from which data is retrieved
- `NATURAL JOIN` joins two tables based on the same column name
- `JOIN table2 USING column_name` performs an equijoin based on the column name
- `JOIN table2 ON table1.column_name = table2.column_name` performs an equijoin based on the condition in the `ON` clause
- `LEFT/RIGHT/FULL OUTER` is used to perform `OUTER` joins
- `CROSS JOIN` returns a Cartesian product from the two tables

For more information, see the section titled "`SELECT`" in *Oracle Database SQL Language Reference* for 10*g* or 11*g* database.

Qualifying Ambiguous Column Names

- Use table prefixes to qualify column names that are in multiple tables.
- Use table prefixes to improve performance.
- Instead of full table name prefixes, use table aliases.
- Table alias gives a table a shorter name:
  - Keeps SQL code smaller, uses less memory
- Use column aliases to distinguish columns that have identical names, but reside in different tables.

When joining two or more tables, you need to qualify the names of the columns with the table name to avoid ambiguity. Without the table prefixes, the `DEPARTMENT_ID` column in the `SELECT` list could be from either the `DEPARTMENTS` table or the `EMPLOYEES` table. It is necessary to add the table prefix to execute your query. If there are no common column names between the two tables, there is no need to qualify the columns. However, using the table prefix improves performance, because you tell the Oracle server exactly where to find the columns.

However, qualifying column names with table names can be time consuming, particularly if the table names are lengthy. Instead, you can use *table aliases*. Just as a column alias gives a column another name, a table alias gives a table another name. Table aliases help to keep SQL code smaller, therefore, using less memory.

The table name is specified in full, followed by a space, and then the table alias. For example, the `EMPLOYEES` table can be given an alias of `e`, and the `DEPARTMENTS` table an alias of `d`.

Guidelines

- Table aliases can be up to 30 characters in length, but shorter aliases are better than longer ones.
- If a table alias is used for a particular table name in the `FROM` clause, that table alias must be substituted for the table name throughout the `SELECT` statement.
- Table aliases should be meaningful.
- The table alias is valid for only the current `SELECT` statement.

Lesson Agenda

- Types of JOINS and its syntax
- Natural join
- Join with the USING Clause
- Join with the ON Clause
- Self-join
- Nonequijoins
- OUTER join:
  - LEFT OUTER join
  - RIGHT OUTER join
  - FULL OUTER join
- Cartesian product
  - Cross join

Creating Natural Joins

- The `NATURAL JOIN` clause is based on all the columns in the two tables that have the same name.
- It selects rows from the two tables that have equal values in all matched columns.
- If the columns having the same names have different data types, an error is returned.

You can join tables automatically based on the columns in the two tables that have matching data types and names. You do this by using the `NATURAL JOIN` keywords.

Note: The join can happen on only those columns that have the same names and data types in both tables. If the columns have the same name but different data types, the `NATURAL JOIN` syntax causes an error.

Retrieving Records with Natural Joins

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

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

In the example in the slide, the `LOCATIONS` table is joined to the `DEPARTMENT` table by the `LOCATION_ID` column, which is the only column of the same name in both tables. If other common columns were present, the join would have used them all.

Natural Joins with a `WHERE` Clause

Additional restrictions on a natural join are implemented by using a `WHERE` clause. The following example limits the rows of output to those with a department ID equal to 20 or 50:

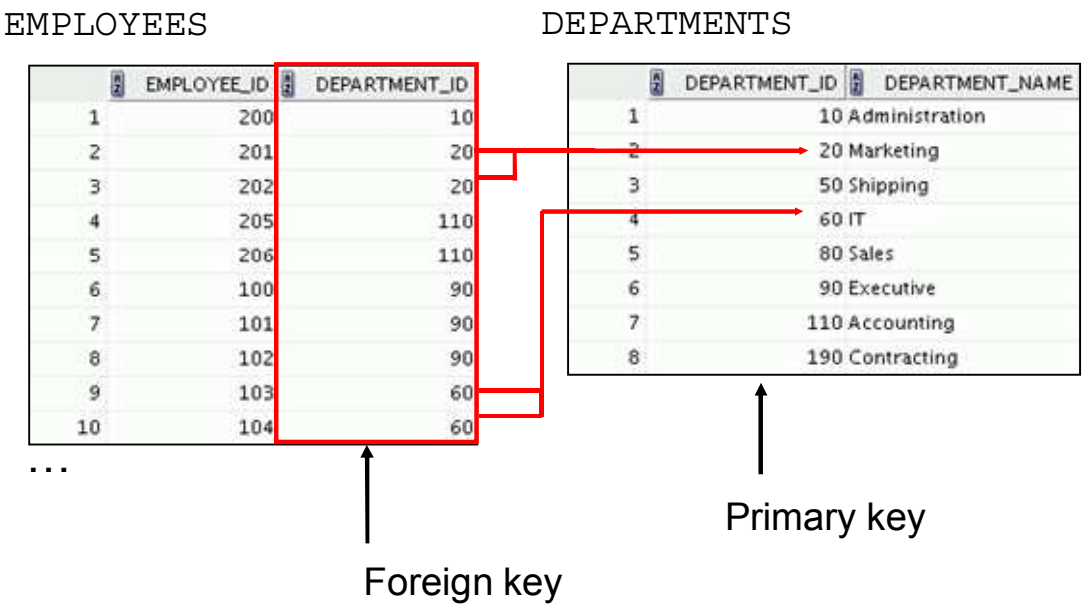
```
SELECT  department_id, department_name,
        location_id, city
FROM    departments
NATURAL JOIN locations
WHERE   department_id IN (20, 50);
```

Creating Joins with the USING Clause

- If several columns have the same names but the data types do not match, use the USING clause to specify the columns for the equijoin.
- Use the USING clause to match only one column when more than one column matches.
- The NATURAL JOIN and USING clauses are mutually exclusive.

Natural joins use all columns with matching names and data types to join the tables. The USING clause can be used to specify only those columns that should be used for an equijoin.

Joining Column Names



To determine an employee's department name, you compare the value in the DEPARTMENT_ID column in the EMPLOYEES table with the DEPARTMENT_ID values in the DEPARTMENTS table. The relationship between the EMPLOYEES and DEPARTMENTS tables is an *equijoin*; that is, values in the DEPARTMENT_ID column in both the tables must be equal. Frequently, this type of join involves primary and foreign key complements.

Note: Equijoins are also called *simple joins* or *inner joins*.

Retrieving Records with the USING Clause

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

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

...

18	206	Gietz	1700	110
19	205	Higgins	1700	110

In the example in the slide, the DEPARTMENT_ID columns in the EMPLOYEES and DEPARTMENTS tables are joined and thus the LOCATION_ID of the department where an employee works is shown.

Using Table Aliases with the USING Clause

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

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

```
ORA-25154: column part of USING clause cannot have qualifier
25154. 00000 - "column part of USING clause cannot have qualifier"
*Cause:    Columns that are used for a named-join (either a NATURAL join
           or a join with a USING clause) cannot have an explicit qualifier.
*Action:   Remove the qualifier.
Error at Line: 4 Column: 6
```


When joining with the USING clause, you cannot qualify a column that is used in the USING clause itself. Furthermore, if that column is used anywhere in the SQL statement, you cannot alias it. For example, in the query mentioned in the slide, you should not alias the location_id column in the WHERE clause because the column is used in the USING clause.

The columns that are referenced in the USING clause should not have a qualifier (table name or alias) anywhere in the SQL statement. For example, the following statement is valid:

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

The columns that are common in both the tables, but not used in the USING clause, must be prefixed with a table alias; otherwise, you get the “column ambiguously defined” error.

In the following statement, manager_id is present in both the employees and departments table; if manager_id is not prefixed with a table alias, it gives a “column ambiguously defined” error.

The following statement is valid:

```
SELECT first_name, d.department_name, d.manager_id
FROM   employees e JOIN departments d USING (department_id)
WHERE  department_id = 50;
```

Creating Joins with the ON Clause

- The join condition for the natural join is basically an equijoin of all columns with the same name.
- Use the ON clause to specify arbitrary conditions or specify columns to join.
- The join condition is separated from other search conditions.
- The ON clause makes code easy to understand.

Use the ON clause to specify a join condition. With this, you can specify join conditions separate from any search or filter conditions in the WHERE clause.

Retrieving Records with the ON Clause

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

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_ID_1	LOCATION_ID
1	200	Whalen	10	10	1700
2	201	Hartstein	20	20	1800
3	202	Fay	20	20	1800
4	144	Vargas	50	50	1500
5	143	Matos	50	50	1500
6	142	Davies	50	50	1500
7	141	Rajs	50	50	1500
8	124	Mourgos	50	50	1500
9	103	Hunold	60	60	1400
10	104	Ernst	60	60	1400
11	107	Lorentz	60	60	1400

...

In this example, the DEPARTMENT_ID columns in the EMPLOYEES and DEPARTMENTS table are joined using the ON clause. Wherever a department ID in the EMPLOYEES table equals a department ID in the DEPARTMENTS table, the row is returned. The table alias is necessary to qualify the matching column_names.

You can also use the ON clause to join columns that have different names. The parenthesis around the joined columns, as in the example in the slide, (e.department_id = d.department_id) is optional. So, even ON e.department_id = d.department_id will work.

Note: When you use the Execute Statement icon to run the query, SQL Developer suffixes a '_1' to differentiate between the two department_ids.

Creating Three-Way Joins with the ON Clause

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

	EMPLOYEE_ID	CITY	DEPARTMENT_NAME
1	100	Seattle	Executive
2	101	Seattle	Executive
3	102	Seattle	Executive
4	103	Southlake	IT
5	104	Southlake	IT
6	107	Southlake	IT
7	124	South San Francisco	Shipping
8	141	South San Francisco	Shipping
9	142	South San Francisco	Shipping

...

A three-way join is a join of three tables. In SQL:1999–compliant syntax, joins are performed from left to right. So, the first join to be performed is `EMPLOYEES JOIN DEPARTMENTS`. The first join condition can reference columns in `EMPLOYEES` and `DEPARTMENTS` but cannot reference columns in `LOCATIONS`. The second join condition can reference columns from all three tables.

Note: The code example in the slide can also be accomplished with the `USING` clause:

```
SELECT e.employee_id, l.city, d.department_name
FROM employees e
JOIN departments d
USING (department_id)
JOIN locations l
USING (location_id);
```

Applying Additional Conditions to a Join

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

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

Or

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


You can apply additional conditions to the join.

The example shown performs a join on the EMPLOYEES and DEPARTMENTS tables and, in addition, displays only employees who have a manager ID of 149. To add additional conditions to the ON clause, you can add AND clauses. Alternatively, you can use a WHERE clause to apply additional conditions.

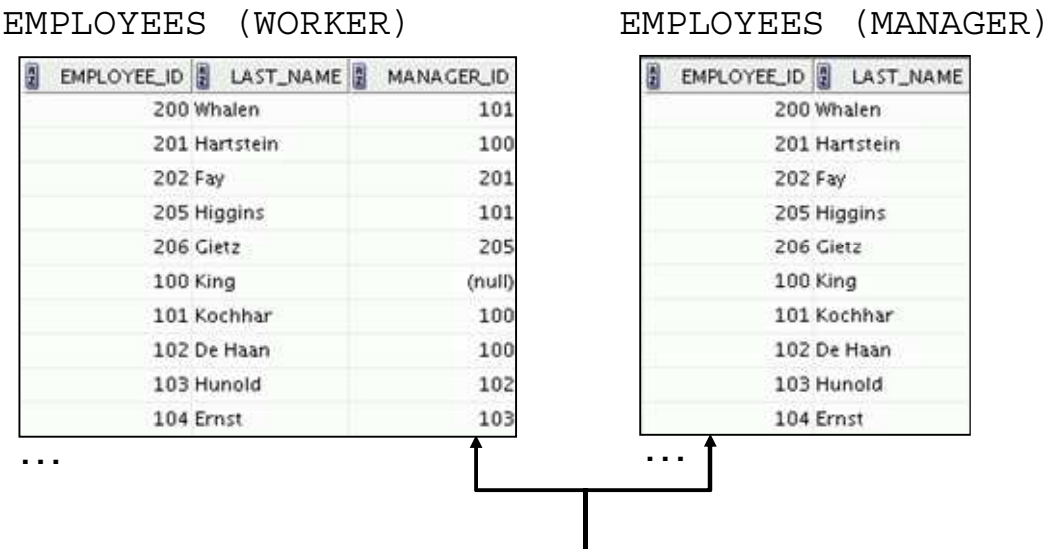
Both the queries produce the same output

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_ID_1	LOCATION_ID
1	174	Abel	80	80	2500
2	176	Taylor	80	80	2500

Lesson Agenda

- Types of JOINS and its syntax
- Natural join
- Join with the USING Clause
- Join with the ON Clause
- Self-join
- Nonequijoins
- OUTER join:
  - LEFT OUTER join
  - RIGHT OUTER join
  - FULL OUTER join
- Cartesian product
  - Cross join

Joining a Table to Itself



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

Sometimes you need to join a table to itself. To find the name of each employee's manager, you need to join the EMPLOYEES table to itself, or perform a self-join. For example, to find the name of Ernst's manager, you need to:

- Find Ernst in the EMPLOYEES table by looking at the LAST_NAME column
- Find the manager number for Ernst by looking at the MANAGER_ID column. Ernst's manager number is 103.
- Find the name of the manager with EMPLOYEE_ID 103 by looking at the LAST_NAME column. Hunold's employee number is 103, so Hunold is Ernst's manager.

In this process, you look in the table twice. The first time you look in the table to find Ernst in the LAST_NAME column and the MANAGER_ID value of 103. The second time you look in the EMPLOYEE_ID column to find 103 and the LAST_NAME column to find Hunold.

Self-Joins Using the ON Clause

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

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

...

The ON clause can also be used to join columns that have different names, within the same table or in a different table.

The example shown is a self-join of the EMPLOYEES table, based on the EMPLOYEE_ID and MANAGER_ID columns.

Note: The parenthesis around the joined columns as in the example in the slide, (e.manager_id = m.employee_id) is **optional**. So, even ON e.manager_id = m.employee_id will work.

Lesson Agenda

- Types of JOINS and its syntax
- Natural join
- Join with the USING Clause
- Join with the ON Clause
- Self-join
- Nonequijoins
- OUTER join:
  - LEFT OUTER join
  - RIGHT OUTER join
  - FULL OUTER join
- Cartesian product
  - Cross join

Nonequijoins

EMPLOYEES

	LAST_NAME	SALARY
1	Whalen	4400
2	Hartstein	13000
3	Fay	6000
4	Higgins	12000
5	Gietz	8300
6	King	24000
7	Kochhar	17000
8	De Haan	17000
9	Hunold	9000
10	Ernst	6000
...		
19	Taylor	8600
20	Grant	7000

JOB_GRADES

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

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

A nonequijoin is a join condition containing something other than an equality operator.

The relationship between the EMPLOYEES table and the JOB_GRADES table is an example of a nonequijoin. The SALARY column in the EMPLOYEES table ranges between the values in the LOWEST_SAL and HIGHEST_SAL columns of the JOB_GRADES table. Therefore, each employee can be graded based on their salary. The relationship is obtained using an operator other than the equality (=) operator.

Retrieving Records with Nonequijoins

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

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

...

The example in the slide creates a nonequijoin to evaluate an employee's salary grade. The salary must be *between* any pair of the low and high salary ranges.

It is important to note that all employees appear exactly once when this query is executed. No employee is repeated in the list. There are two reasons for this:

- None of the rows in the `JOB_GRADES` table contain grades that overlap. That is, the salary value for an employee can lie only between the low salary and high salary values of one of the rows in the salary grade table.
- All of the employees' salaries lie within the limits provided by the job grade table. That is, no employee earns less than the lowest value contained in the `LOWEST_SAL` column or more than the highest value contained in the `HIGHEST_SAL` column.

Note: Other conditions (such as `<=` and `>=`) can be used, but `BETWEEN` is the simplest. Remember to specify the low value first and the high value last when using the `BETWEEN` condition. The Oracle server translates the `BETWEEN` condition to a pair of `AND` conditions. Therefore, using `BETWEEN` has no performance benefits, but should be used only for logical simplicity.

Table aliases have been specified in the slide example for performance reasons, not because of possible ambiguity.

Lesson Agenda

- Types of JOINS and its syntax
- Natural join
- Join with the USING Clause
- Join with the ON Clause
- Self-join
- Nonequijoins
- OUTER join:
  - LEFT OUTER join
  - RIGHT OUTER join
  - FULL OUTER join
- Cartesian product
  - Cross join

Returning Records with No Direct Match Using OUTER Joins

DEPARTMENTS

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

There are no employees in department 190.

Equijoin with EMPLOYEES

	DEPARTMENT_ID	LAST_NAME
1	10	Whalen
2	20	Hartstein
3	20	Fay
4	110	Higgins
5	110	Gietz
6	90	King
7	90	Kochhar
8	90	De Haan
9	60	Hunold
10	60	Ernst
...		
18	80	Abel
19	80	Taylor

Employee “Grant” has not been assigned a department ID.

If a row does not satisfy a join condition, the row does not appear in the query result.

In the slide example, a simple equijoin condition is used on the EMPLOYEES and DEPARTMENTS tables to return the result on the right. The result set does not contain the following:

- Department ID 190, because there are no employees with that department ID recorded in the EMPLOYEES table
- The employee with the last name of Grant, because this employee has not been assigned a department ID

To return the department record that does not have any employees, or employees that do not have an assigned department, you can use an OUTER join.

INNER Versus OUTER Joins

- In SQL:1999, the join of two tables returning only matched rows is called an INNER join.
- A join between two tables that returns the results of the INNER join as well as the unmatched rows from the left (or right) table is called a left (or right) OUTER join.
- A join between two tables that returns the results of an INNER join as well as the results of a left and right join is a full OUTER join.

Joining tables with the NATURAL JOIN, USING, or ON clauses results in an INNER join. Any unmatched rows are not displayed in the output. To return the unmatched rows, you can use an OUTER join. An OUTER join returns all rows that satisfy the join condition and also returns some or all of those rows from one table for which no rows from the other table satisfy the join condition.

There are three types of OUTER joins:

- LEFT OUTER
- RIGHT OUTER
- FULL OUTER

LEFT OUTER JOIN

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

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

...

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

This query retrieves all the rows in the EMPLOYEES table, which is the left table, even if there is no match in the DEPARTMENTS table.

RIGHT OUTER JOIN

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

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

...

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

This query retrieves all the rows in the DEPARTMENTS table, which is the table at the right, even if there is no match in the EMPLOYEES table.

FULL OUTER JOIN

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

	LAST_NAME	DEPARTMENT_ID	DEPARTMENT_NAME
1	Whalen	10	Administration
2	Hartstein	20	Marketing
3	Fay	20	Marketing
4	Higgins	110	Accounting
...			
17	Zlotkey	80	Sales
18	Abel	80	Sales
19	Taylor	80	Sales
20	Grant	(null)	(null)
21	(null)	190	Contracting

This query retrieves all rows in the EMPLOYEES table, even if there is no match in the DEPARTMENTS table. It also retrieves all rows in the DEPARTMENTS table, even if there is no match in the EMPLOYEES table.

Lesson Agenda

- Types of JOINS and its syntax
- Natural join
- Join with the USING Clause
- Join with the ON Clause
- Self-join
- Nonequijoins
- OUTER join:
  - LEFT OUTER join
  - RIGHT OUTER join
  - FULL OUTER join
- Cartesian product
  - Cross join

Cartesian Products

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

When a join condition is invalid or omitted completely, the result is a *Cartesian product*, in which all combinations of rows are displayed. All rows in the first table are joined to all rows in the second table.

A Cartesian product tends to generate a large number of rows and the result is rarely useful. You should, therefore, always include a valid join condition unless you have a specific need to combine all rows from all tables.

Cartesian products are useful for some tests when you need to generate a large number of rows to simulate a reasonable amount of data.

Generating a Cartesian Product

EMPLOYEES (20 rows)

	EMPLOYEE_ID	LAST_NAME	DEPARTMENT_ID
1	200	Whalen	10
2	201	Hartstein	20
3	202	Fay	20
4	205	Higgins	110
...			
19	176	Taylor	80
20	178	Grant	(null)

DEPARTMENTS (8 rows)

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

Cartesian product:
20 x 8 = 160 rows

	EMPLOYEE_ID	DEPARTMENT_ID	LOCATION_ID
1	200	10	1700
2	201	20	1700
...			
21	200	10	1800
22	201	20	1800
...			
159	176	80	1700
160	178	(null)	1700

A Cartesian product is generated if a join condition is omitted. The example in the slide displays the employee last name and the department name from the EMPLOYEES and DEPARTMENTS tables. Because no join condition was specified, all rows (20 rows) from the EMPLOYEES table are joined with all rows (8 rows) in the DEPARTMENTS table, thereby generating 160 rows in the output.

Creating Cross Joins

- The `CROSS JOIN` clause produces the cross-product of two tables.
- This is also called a Cartesian product between the two tables.

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

	LAST_NAME	DEPARTMENT_NAME
1	Abel	Administration
2	Davies	Administration
3	De Haan	Administration
4	Ernst	Administration
5	Fay	Administration
...		
158	Vargas	Contracting
159	Whalen	Contracting
160	Zlotkey	Contracting

The example in the slide produces a Cartesian product of the `EMPLOYEES` and `DEPARTMENTS` tables.

The `CROSS JOIN` technique can be applied to many situations usefully. For example, to return total labor cost by office by month, even if month X has no labor cost, you can do a cross join of Offices with a table of all Months.

It is a good practice to explicitly state `CROSS JOIN` in your `SELECT` when you intend to create a Cartesian product. Therefore, it is very clear that you intend for this to happen and it is not the result of missing joins.

Quiz

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

a. Equijoins
b. Nonequijoins
c. Left `OUTER` join
d. Right `OUTER` join
e. Full `OUTER` join
f. Self joins
g. Natural joins
h. Cartesian products

Answer: a, b, c, d, f, h

Summary

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

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

There are multiple ways to join tables.

Types of Joins

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

Cartesian Products

A Cartesian product results in the display of all combinations of rows. This is done by either omitting the `WHERE` clause or specifying the `CROSS JOIN` clause.

Table Aliases

- Table aliases speed up database access.
- Table aliases can help to keep SQL code smaller by conserving memory.
- Table aliases are sometimes mandatory to avoid column ambiguity.

Practice 7: Overview

This practice covers the following topics:

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

This practice is intended to give you experience in extracting data from more than one table using the SQL:1999–compliant joins.

8

Using Subqueries to Solve Queries

Objectives

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

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

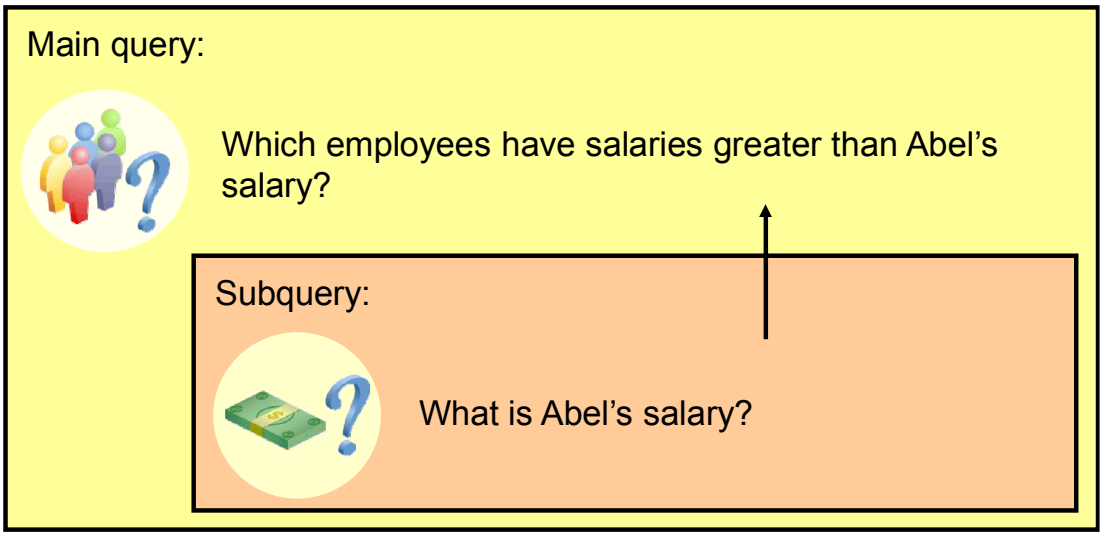
In this lesson, you learn about the more advanced features of the `SELECT` statement. You can write subqueries in the `WHERE` clause of another SQL statement to obtain values based on an unknown conditional value. This lesson also covers single-row subqueries and multiple-row subqueries.

Lesson Agenda

- Subquery: Types, syntax, and guidelines
- Single-row subqueries:
  - Group functions in a subquery
  - `HAVING` clause with subqueries
- Multiple-row subqueries
  - Use `ALL` or `ANY` operator.
- Using the `EXISTS` operator
- Null values in a subquery

Using a Subquery to Solve a Problem

Who has a salary greater than Abel's?



Suppose you want to write a query to find out who earns a salary greater than Abel's salary.

To solve this problem, you need *two* queries: one to find how much Abel earns, and a second query to find who earns more than that amount.

You can solve this problem by combining the two queries, placing one query *inside* the other query.

The inner query (or *subquery*) returns a value that is used by the outer query (or *main query*). Using a subquery is equivalent to performing two sequential queries and using the result of the first query as the search value in the second query.

Subquery Syntax

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

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

A subquery is a `SELECT` statement that is embedded in the clause of another `SELECT` statement. You can build powerful statements out of simple ones by using subqueries. They can be very useful when you need to select rows from a table with a condition that depends on the data in the table itself.

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

- `WHERE` clause
- `HAVING` clause
- `FROM` clause

In the syntax:

`operator` includes a comparison condition such as `>`, `=`, or `IN`

Note: Comparison conditions fall into two classes: single-row operators (`>`, `=`, `>=`, `<`, `<>`, `<=`) and multiple-row operators (`IN`, `ANY`, `ALL`, `EXISTS`).

The subquery is often referred to as a nested `SELECT`, sub-`SELECT`, or inner `SELECT` statement. The subquery generally executes first, and its output is used to complete the query condition for the main (or outer) query.

Using a Subquery

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

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

In the slide, the inner query determines the salary of employee Abel. The outer query takes the result of the inner query and uses this result to display all the employees who earn more than employee Abel.

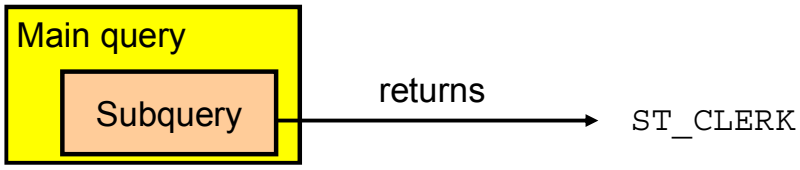
Rules for Using Subqueries

- Enclose subqueries in parentheses.
- Place subqueries on the right side of the comparison condition for readability. (However, the subquery can appear on either side of the comparison operator.)
- Use single-row operators with single-row subqueries and multiple-row operators with multiple-row subqueries.

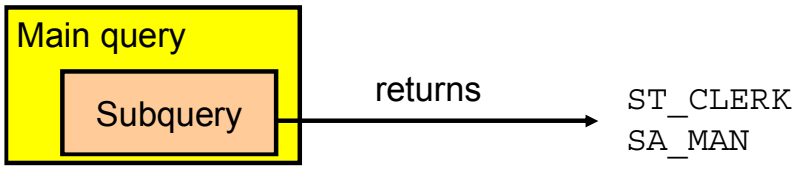
- A subquery must be enclosed in parentheses.
- Place the subquery on the right side of the comparison condition for readability. However, the subquery can appear on either side of the comparison operator.
- Two classes of comparison conditions are used in subqueries: single-row operators and multiple-row operators.

Types of Subqueries

- Single-row subquery



- Multiple-row subquery



- **Single-row subqueries:** Queries that return only one row from the inner `SELECT` statement
- **Multiple-row subqueries:** Queries that return more than one row from the inner `SELECT` statement

Note: There are also multiple-column subqueries, which are queries that return more than one column from the inner `SELECT` statement. These are covered in the *Oracle Database: SQL Fundamentals II* course.

Lesson Agenda

- Subquery: Types, syntax, and guidelines
- Single-row subqueries:
  - Group functions in a subquery
  - `HAVING` clause with subqueries
- Multiple-row subqueries
  - Use `ALL` or `ANY` operator
- Using the `EXISTS` operator
- Null values in a subquery

Single-Row Subqueries

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

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

A single-row subquery is one that returns one row from the inner `SELECT` statement. This type of subquery uses a single-row operator. The slide gives a list of single-row operators.

Example

Display the employees whose job ID is the same as that of employee 141:

```
SELECT last_name, job_id
FROM   employees
WHERE  job_id =
                (SELECT job_id
                 FROM   employees
                 WHERE  employee_id = 141);
```

	LAST_NAME	JOB_ID
1	Rajs	ST_CLERK
2	Davies	ST_CLERK
3	Matos	ST_CLERK
4	Vargas	ST_CLERK

Executing Single-Row Subqueries

```
SELECT last_name, job_id, salary
FROM   employees
WHERE  job_id =                    SA_REP
               (SELECT job_id
                FROM   employees
                WHERE  last_name = 'Taylor')
AND    salary >                    8600
               (SELECT salary
                FROM   employees
                WHERE  last_name = 'Taylor');
```

	LAST_NAME	JOB_ID	SALARY
1	Abel	SA_REP	11000

A `SELECT` statement can be considered as a query block. The example in the slide displays employees who do the same job as “Taylor,” but earn more salary than him.

The example consists of three query blocks: the outer query and two inner queries. The inner query blocks are executed first, producing the query results `SA_REP` and `8600`, respectively. The outer query block is then processed and uses the values that were returned by the inner queries to complete its search conditions.

Both inner queries return single values (`SA_REP` and `8600`, respectively), so this SQL statement is called a single-row subquery.

Note: The outer and inner queries can get data from different tables.

Using Group Functions in a Subquery

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

2500

	LAST_NAME	JOB_ID	SALARY
1	Vargas	ST_CLERK	2500

You can display data from a main query by using a group function in a subquery to return a single row. The subquery is in parentheses and is placed after the comparison condition.

The example in the slide displays the employee last name, job ID, and salary of all employees whose salary is equal to the minimum salary. The `MIN` group function returns a single value (`2500`) to the outer query.

HAVING Clause with Subqueries

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

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

	DEPARTMENT_ID	MIN(SALARY)
1	(null)	7000
2	20	6000
3	90	17000
4	110	8300
5	80	8600
6	10	4400
7	60	4200

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You can use subqueries not only in the WHERE clause, but also in the HAVING clause. The Oracle server executes the subquery and the results are returned into the HAVING clause of the main query.

The SQL statement in the slide displays all the departments that have a minimum salary greater than that of department 50.

Example

Find the job with the lowest average salary.

```
SELECT   job_id, AVG(salary)
FROM     employees
GROUP BY job_id
HAVING   AVG(salary) = (SELECT   MIN(AVG(salary))
                        FROM     employees
                        GROUP BY job_id);
```

	JOB_ID	AVG(SALARY)
1	ST_CLERK	2925

What Is Wrong with This Statement?

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

```
ORA-01427: single-row subquery returns more than one row
01427. 00000 - "single-row subquery returns more than one row"
*Cause:
*Action:
```

Single-row operator with multiple-row subquery

A common error with subqueries occurs when more than one row is returned for a single-row subquery.

In the SQL statement in the slide, the subquery contains a `GROUP BY` clause, which implies that the subquery will return multiple rows, one for each group that it finds. In this case, the results of the subquery are `4400`, `6000`, `2500`, `4200`, `7000`, `17000`, and `8300`.

The outer query takes those results and uses them in its `WHERE` clause. The `WHERE` clause contains an equal (`=`) operator, a single-row comparison operator that expects only one value. The `=` operator cannot accept more than one value from the subquery and, therefore, generates the error.

To correct this error, change the `=` operator to `IN`.

No Rows Returned by the Inner Query

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

Subquery returns no rows because there is no employee named “Haas.”

Another common problem with subqueries occurs when no rows are returned by the inner query.

In the SQL statement in the slide, the subquery contains a `WHERE` clause. Presumably, the intention is to find the employee whose name is Haas. The statement is correct, but selects no rows when executed because there is no employee named Haas. Therefore, the subquery returns no rows.

The outer query takes the results of the subquery (null) and uses these results in its `WHERE` clause. The outer query finds no employee with a job ID equal to null, and so returns no rows. If a job existed with a value of null, the row is not returned because comparison of two null values yields a null; therefore, the `WHERE` condition is not true.

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Multiple-Row Subqueries

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

Operator	Meaning
IN	Equal to any member in the list
ANY	Must be preceded by =, !=, >, <, <=, >=. Returns TRUE if at least one element exists in the result-set of the Subquery for which the relation is TRUE.
ALL	Must be preceded by =, !=, >, <, <=, >=. Returns TRUE if the relation is TRUE for all elements in the result set of the Subquery.

Subqueries that return more than one row are called multiple-row subqueries. You use a multiple-row operator, instead of a single-row operator, with a multiple-row subquery. The multiple-row operator expects one or more values:

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

Example

Find the employees who earn the same salary as the minimum salary for each department.

The inner query is executed first, producing a query result. The main query block is then processed and uses the values that were returned by the inner query to complete its search condition. In fact, the main query appears to the Oracle server as follows:

```
SELECT last_name, salary, department_id
FROM   employees
WHERE  salary IN (2500, 4200, 4400, 6000, 7000, 8300,
       8600, 17000);
```

Using the ANY Operator in Multiple-Row Subqueries

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

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

...

9	206	Gietz	AC_ACCOUNT	8300
10	176	Taylor	SA_REP	8600

The ANY operator (and its synonym, the SOME operator) compares a value to *each* value returned by a subquery. The slide example displays employees who are not IT programmers and whose salary is less than that of any IT programmer. The maximum salary that a programmer earns is $9,000.

- <ANY means less than the maximum.
- >ANY means more than the minimum.
- =ANY is equivalent to IN.

Using the ALL Operator in Multiple-Row Subqueries

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

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

The ALL operator compares a value to *every* value returned by a subquery. The example in the slide displays employees whose salary is less than the salary of all employees with a job ID of IT_PROG and whose job is not IT_PROG.

>ALL means more than the maximum and <ALL means less than the minimum.

The NOT operator can be used with IN, ANY, and ALL operators.

Using the EXISTS Operator

```
SELECT employee_id,salary,last_name FROM employees M
WHERE EXISTS
(SELECT employee_id FROM employees W
 WHERE (W.manager_id=M.employee_id) AND W.salary > 10000);
```

	EMPLOYEE_ID	SALARY	LAST_NAME
1	100	24000	King
2	149	10500	Zlotkey
3	101	17000	Kochhar

```
SELECT * FROM departments
WHERE NOT EXISTS
(SELECT * FROM employees
 WHERE employees.department_id=departments.department_id);
```

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	190	Contracting	(null)	1700

The EXISTS operator is used in queries where the query result depends on whether or not certain rows exist in a table. It evaluates to TRUE if the subquery returns at least one row.

The first example in the slide displays managers in the EMPLOYEES table who earns a salary more than 10000.For each row in EMPLOYEES table, the condition is checked whether there exists a manager_id who earns a salary more than 10000.

The second example in the slide displays departments that have no employees. For each row in the DEPARTMENTS table, the condition is checked whether there exists a row in the EMPLOYEES table that has the same department ID. In case no such row exists, the condition is satisfied for the row under consideration and it is selected. If there exists a corresponding row in the EMPLOYEES table, the row is not selected.

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Null Values in a Subquery

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

Subquery returns no rows because one of the values returned by a subquery is Null.

The SQL statement in the slide attempts to display all the employees who do not have any subordinates. Logically, this SQL statement should have returned 12 rows. However, the SQL statement does not return any rows. One of the values returned by the inner query is a null value and, therefore, the entire query returns no rows.

The reason is that all conditions that compare a null value result in a null. So whenever null values are likely to be part of the results set of a subquery, do not use the `NOT IN` operator. The `NOT IN` operator is equivalent to `<> ALL`.

Notice that the null value as part of the results set of a subquery is not a problem if you use the `IN` operator. The `IN` operator is equivalent to `=ANY`. For example, to display the employees who have subordinates, use the following SQL statement:

```
SELECT emp.last_name
FROM   employees emp
WHERE  emp.employee_id  IN
                          (SELECT mgr.manager_id
                           FROM   employees mgr);
```

Alternatively, a `WHERE` clause can be included in the subquery to display all employees who do not have any subordinates:

```
SELECT last_name FROM employees
WHERE  employee_id NOT IN
                        (SELECT manager_id
                         FROM   employees
                         WHERE  manager_id IS NOT NULL);
```

Quiz

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

a. True
b. False

Answer: a

Summary

In this lesson, you should have learned how to:

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

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


In this lesson, you should have learned how to use subqueries. A subquery is a `SELECT` statement that is embedded in the clause of another SQL statement. Subqueries are useful when a query is based on a search criterion with unknown intermediate values.

Subqueries have the following characteristics:

- Can pass one row of data to a main statement that contains a single-row operator, such as =, <>, >, >=, <, or <=
- Can pass multiple rows of data to a main statement that contains a multiple-row operator, such as `IN`
- Are processed first by the Oracle server, after which the `WHERE` or `HAVING` clause uses the results
- Can contain group functions

Practice 8: Overview

This practice covers the following topics:

- Creating subqueries to query values based on unknown criteria
- Using subqueries to find out the values that exist in one set of data and not in another

In this practice, you write complex queries using nested `SELECT` statements.

For practice questions, you may want to create the inner query first. Make sure that it runs and produces the data that you anticipate before you code the outer query.