Oracle Database 12*c*: SQL Workshop I

Student Guide – Volume I

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2 Retrieving Data Using the SQL SELECT Statement

3 Restricting and Sorting Data

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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 12*c*
- Describe the salient features of Oracle Cloud
- 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). 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 12*c* and related products
- Overview of relational database management concepts and terminologies
- Introduction to SQL and its development environments
- Human Resource (`HR`) Schema and the tables used in the course
- Oracle database 12*c* SQL 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
- Day 2:
  - Using Conversion Functions and Conditional Expressions
  - Reporting Aggregated Data Using the Group Functions
  - Displaying Data from Multiple Tables Using Joins
  - Using Subqueries to Solve Queries

Course Agenda

- Day 3:
  - Using the Set Operators
  - Managing Tables Using DML Statements
  - Introduction to Data Definition Language

Appendixes and Practices Used in the Course

- Appendix A: Table Descriptions
- Appendix B: Using SQL Developer
- Appendix C: Using SQL*Plus
- Appendix D: Commonly Used SQL Commands
- Activity Guide
  - Practices and Solutions
  - Additional Practices and Solutions

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Oracle Database 12*c*: Focus Areas

ORACLE DATABASE 12*c*

Infrastructure Grids

Information Management

Application Development

Oracle Cloud

Oracle Database 12*c* 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 12*c* 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 12*c* extends the existing information management capabilities in content management, information integration, and information lifecycle 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 12*c* 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 Cloud:** The Oracle Cloud is an enterprise cloud for business. It provides an integrated collection of application and platform cloud services that are based on best-in-class products and open Java and SQL standards.

Oracle Database 12*c*

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DATABASE

Manageability
High Availability
Performance
Security
Information Integration

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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 12*c* 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, the Automatic SQL Tuning facility, and Real-Time Database Operations Monitoring.

  Enterprise Manager Database Express 12*c* is a web-based tool for managing Oracle databases. Enterprise Manager Database Express greatly simplifies database performance diagnostics by consolidating the relevant database performance screens into a consolidated view called Database Performance Hub. DBAs get a single, consolidated view of the current real-time and historical view of the database performance across multiple dimensions such as database load, monitored SQL and PL/SQL, and Active Session History (ASH) on a single page for the selected time period.

- **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 12*c* enables organizations to manage large, scalable, transactional, and data warehousing systems that deliver fast data access using low-cost modular storage.
- **Security:** Oracle Database 12*c* 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 12*c* has many features to better integrate data throughout the enterprise. It also supports advanced information lifecycle 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:

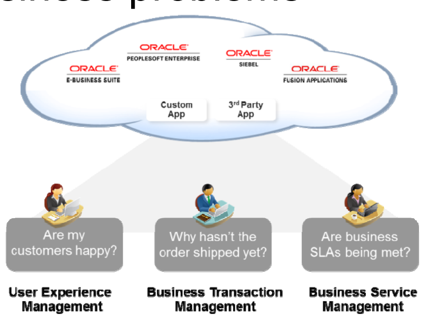
- **Application Server:** Java EE, web services
- **SOA and Process Management:** BPEL Process Manager, SOA Governance
- **Development Tools:** Oracle Application Development Framework, JDeveloper, SOA Suite
- **Business Intelligence:** Oracle Business Activity Monitoring, Oracle Data Integrator
- **Enterprise Management:** Enterprise Manager
- **Identity Management:** Oracle Identity Management
- **Content Management:** Oracle Content Database Suite
- **User Interaction:** Portal, Rich Internet Apps

Oracle Enterprise Manager Cloud Control

- Create and manage a complete set of cloud services.
- Manage all phases of cloud life cycle.
- Manage the entire cloud stack
- Monitor the health of all components
- Identify, understand, and resolve business problems

Complete life cycle

Complete stack



Complete integration

Self-Service IT | Simple and Automated | Business-Driven

Enterprise Manager Cloud Control is a management tool that provides monitoring and management capabilities for Oracle and non-Oracle components. It is a complete, integrated, and business-driven cloud management solution in a single product, which is referred to as "Total Cloud Control."

Using Enterprise Manager Cloud Control, you can:

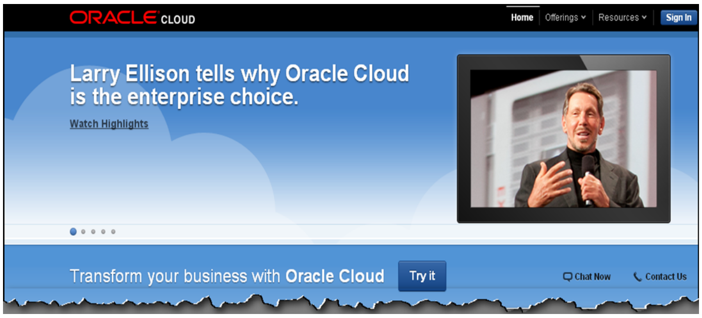
- Create and manage a complete set of cloud services, including: Infrastructure-as-a-service, Database-as-a-service, Platform-as-a-service, and others
- Manage all phases of cloud life cycle
- Manage the entire cloud stack: From application to disk, including engineered systems (Exa series) and with integrated support capabilities
- Monitor the health of all components, the hosts that they run on, and the key business processes that they support
- Identify, understand, and resolve business problems through the unified and correlated management of User Experience, Business Transactions, and Business Services across all your packaged and custom applications

Oracle Cloud

The Oracle Cloud is an enterprise cloud for business. It consists of many different services that share some common characteristics:

- On-demand self-service
- Resource pooling
- Rapid elasticity
- Measured service
- Broad network access

www.cloud.oracle.com



The Oracle Cloud is an enterprise cloud for business. It provides an integrated collection of application and platform cloud services that are based on best-in-class products and open Java and SQL standards. The top two benefits of cloud computing are speed and cost.

As a result, the applications and databases deployed in the Oracle Cloud are portable and you can easily move them to or from a private cloud or on-premise environment.

- All Cloud Services can be provisioned through a self-service interface. Users can get their Cloud Services delivered on an integrated development and deployment platform with tools to rapidly extend and create new services.
- Oracle Cloud services are built on Oracle Exalogic Elastic Cloud and Oracle Exadata Database Machine, together offering a platform that delivers extreme performance, redundancy, and scalability.

The following are five essential characteristics of Oracle Cloud services:

- **On-demand self-service:** Provisioning, monitoring, and management control
- **Resource pooling:** Implies sharing and a level of abstraction between consumers and services
- **Rapid elasticity:** Ability to quickly scale up or down as needed
- **Measured service:** Metering utilization for either internal chargeback (private cloud) or external billing (public cloud)
- **Broad network access:** Access through a browser on any networked device

Oracle Cloud Services

Oracle Cloud provides three types of services:

- Software as a Service (SaaS)
- Platform as a Service (PaaS)
- Infrastructure as a Service (IaaS)

SaaS generally refers to applications that are delivered to end users over the Internet. Oracle CRM On Demand is an example of a SaaS offering that provides both multitenant as well as single-tenant options, depending on the customer's preferences.

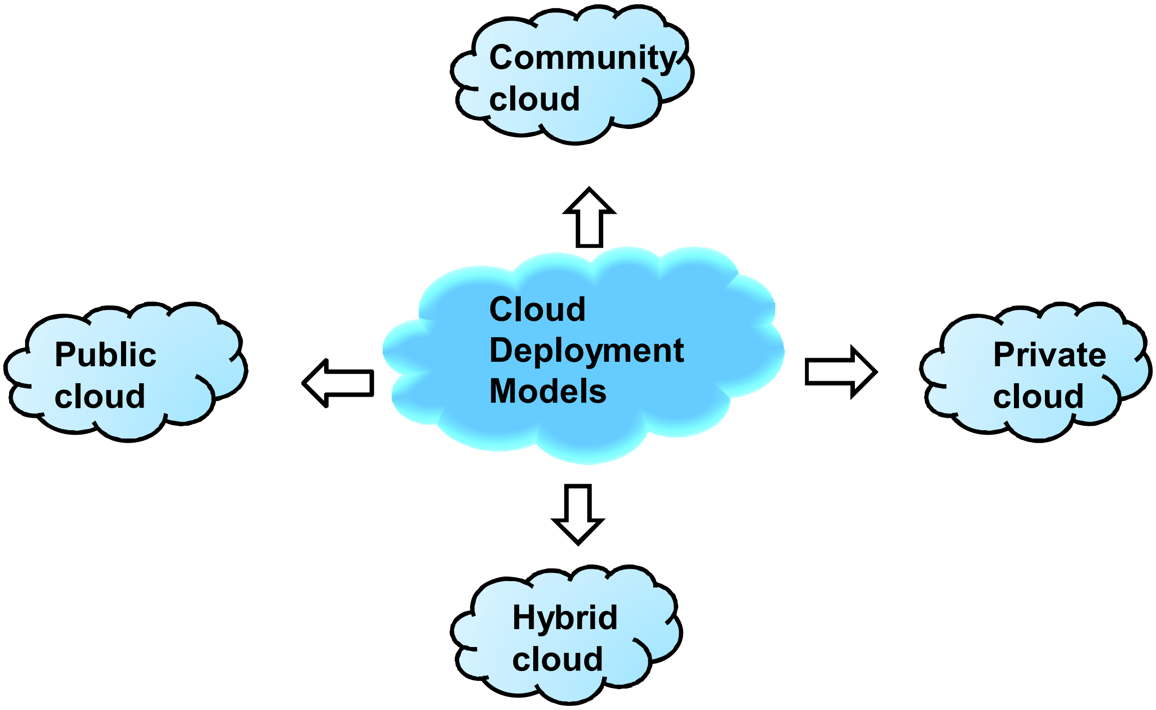
PaaS generally refers to an application development and deployment platform delivered as a service to developers, enabling them to quickly build and deploy a SaaS application to end users. The platform typically includes databases, middleware, and development tools, all delivered as a service via the Internet

IaaS refers to computing hardware (servers, storage, and network) delivered as a service. This service typically includes the associated software as well as operating systems, virtualization, clustering, and so on. Examples of IaaS in the public cloud include Amazon's Elastic Compute Cloud (EC2) and Simple Storage Service (S3).

The database cloud is built within an enterprise's private cloud environment, as a PaaS model. The database cloud provides on-demand access to database services in a self-service, elastically scalable, and metered manner. The database cloud offers compelling advantages in cost, quality of service, and agility. You can deploy a database within a virtual machine in an IaaS platform.

You can rapidly deploy Database clouds on Oracle Exadata which is a pre-integrated and optimized hardware platform that supports both OLTP and DW workloads.

Cloud Deployment Models



- **Private cloud:** A single organization uses a private cloud, which it typically controls, manages, and hosts in private data centers. However, the organization can also outsource hosting and operation to a third-party service provider. Amazon's Virtual Private Cloud is an example of a private cloud in an external provider setting.
- **Public cloud:** Multiple organizations (tenants) uses private cloud on a shared basis, hosted and managed by a third-party service provider. Example: Amazon Elastic Compute Cloud (EC2), IBM's Blue Cloud, Sun Cloud, Google AppEngine, and so on
- **Community cloud:** A group of related organizations, who want to make use of a common cloud computing environment, uses the community cloud. It is managed by the participating organizations or by a third-party managed service provider. It is hosted internally or externally. For example, A community might consist of the different branches of the military, all the universities in a given region, or all the suppliers to a large manufacturer.
- **Hybrid cloud:** A single organization that wants to adopt both private and public clouds for a single application uses the hybrid cloud. A third model, the hybrid cloud, is maintained by both internal and external providers. For example, an organization might use a public cloud service, such as Amazon Simple Storage Service (Amazon S3) for archived data but continue to maintain in-house (private cloud) storage for operational customer data.

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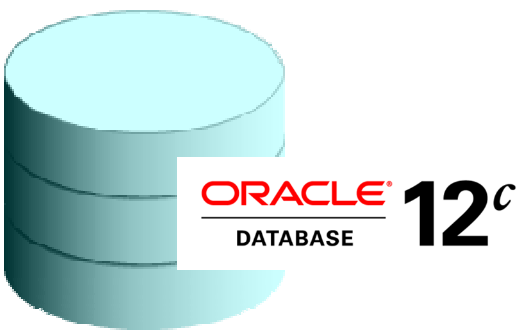
Relational and Object Relational Database Management Systems

- 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.

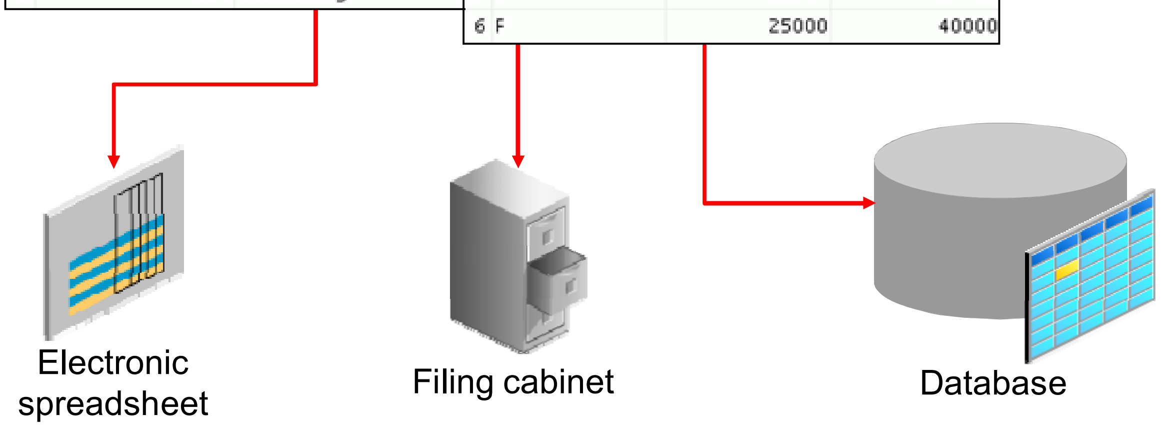
It includes several features for improved performance and functionality of the OLTP applications, such as better sharing of runtime data structures, larger buffer caches, and deferrable constraints. Data warehouse applications benefit from enhancements such as parallel execution of insert, update, and 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 12*c *Database*.

Data Storage on Different Media

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	200	1700
2	20	Marketing	201	1800
3	50	Shipping		
4	60	IT		
5	80	Sales		
6	90	Executive		
7	110	Accounting		
8	190	Contracting		

	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



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

Definition of a Relational Database

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

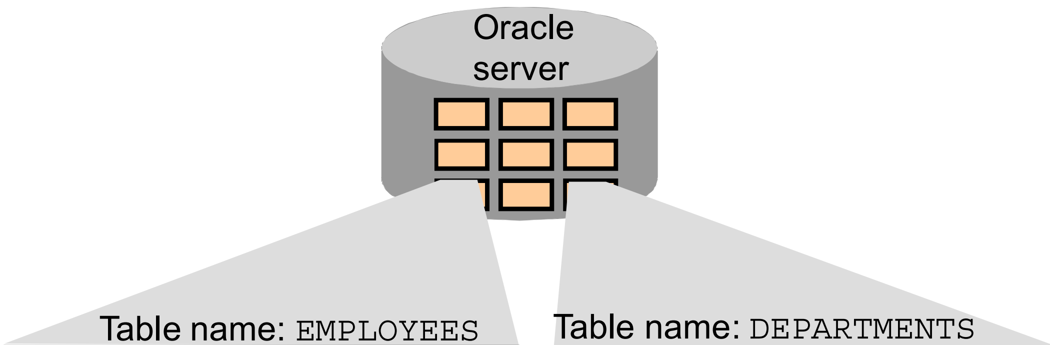


Table name: `EMPLOYEES`

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

. . .

Table name: `DEPARTMENTS`

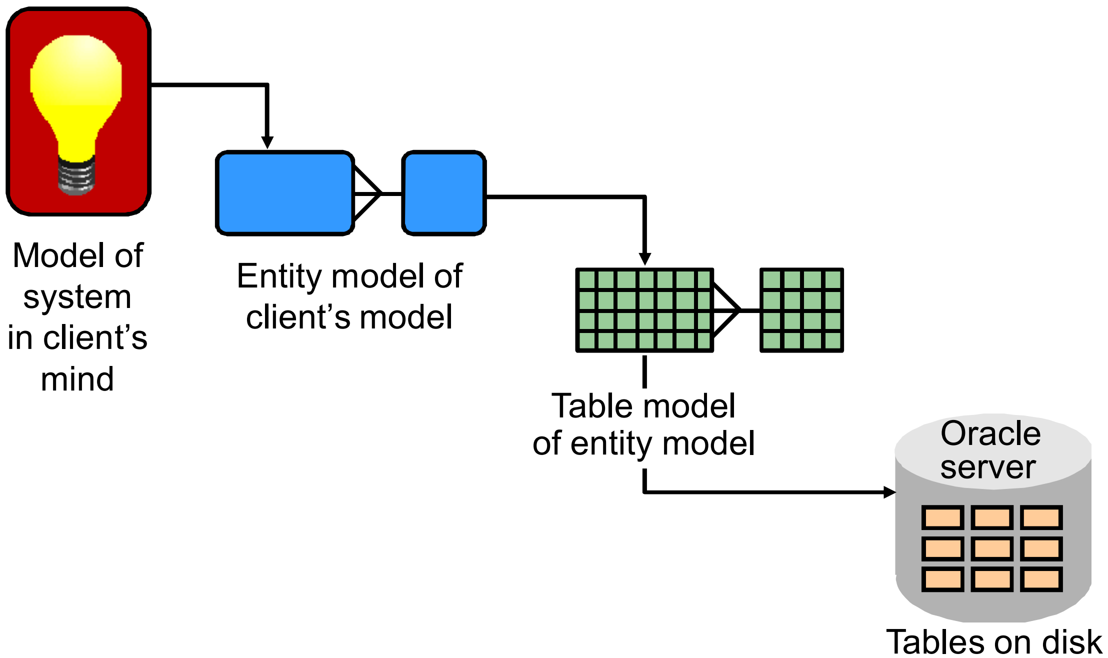
DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID
10	Administration	200
20	Marketing	201
50	Shipping	124

. . .

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

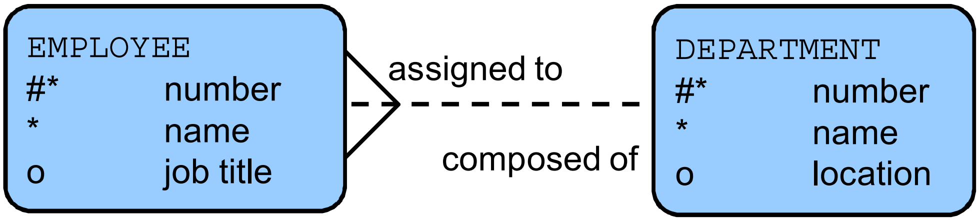
Models help to communicate the concepts that are in people's minds. They can be used to do the following:

- 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

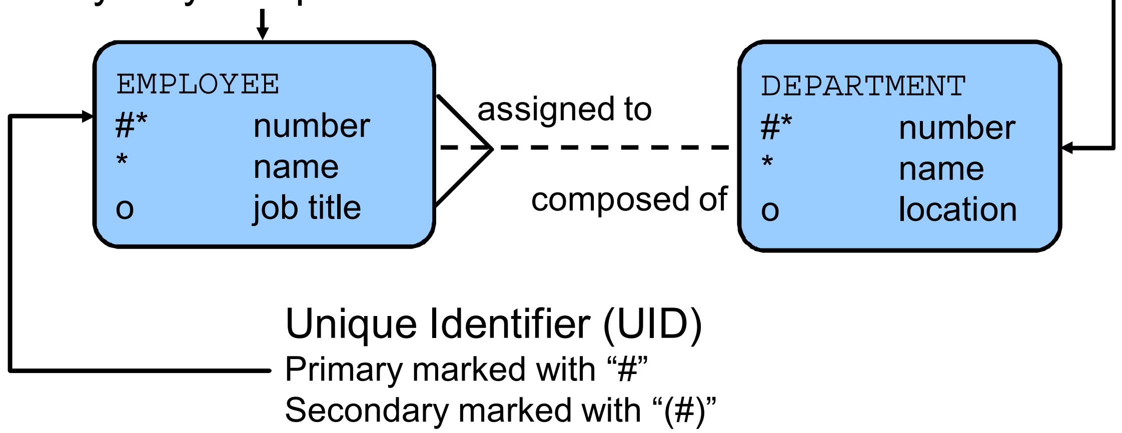
Key Components

- **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

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

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



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

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*

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"

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.

Table name: `DEPARTMENTS`

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

Primary key

Table name: `EMPLOYEES`

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	DEPARTMENT_ID
100	Steven	King	90
101	Neena	Kochhar	90
102	Lex	De Haan	90
103	Alexander	Hunold	60
104	Bruce	Ernst	60
107	Diana	Lorentz	60
124	Kevin	Mourgos	50
141	Trenna	Rajs	50
142	Curtis	Davies	50

Primary key Foreign key

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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 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

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

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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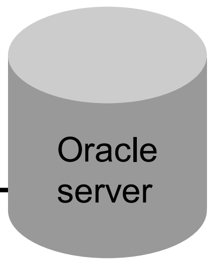
Using SQL to Query Your Database

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 tables.)

```
SELECT department_name
FROM   departments;
```



DEPARTMENT_NAME
Administration
Marketing
Shipping
IT
Sales
Executive
Accounting
Contracting

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 also compliant to ISO Standard (SQL 1999).

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

`SELECT`
`INSERT`
`UPDATE`
`DELETE`
`MERGE`
	Data manipulation language (DML)

`CREATE`
`ALTER`
`DROP`
`RENAME`
`TRUNCATE`
`COMMENT`
	Data definition language (DDL)

`GRANT` `REVOKE`	Data control language (DCL)

`COMMIT`
`ROLLBACK`
`SAVEPOINT`
	Transaction control

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)

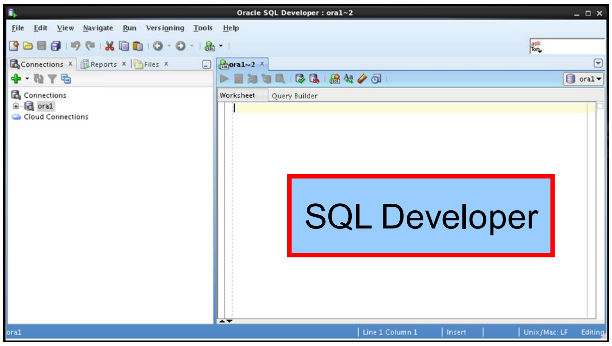
`GRANT` `REVOKE`	Provides or removes access rights to both the Oracle Database and the structures within it

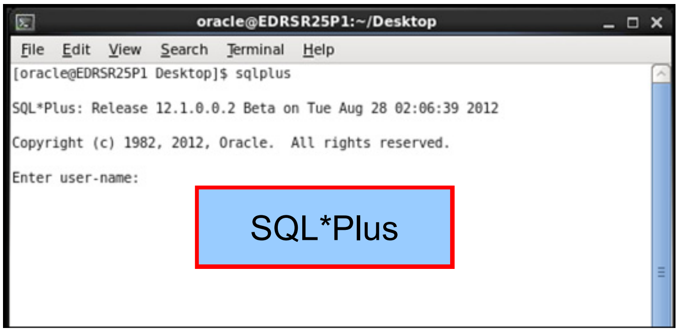
`COMMIT`
`ROLLBACK`
`SAVEPOINT`
	Manages the changes made by DML statements. Changes to the data can be grouped together into logical transactions

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 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.

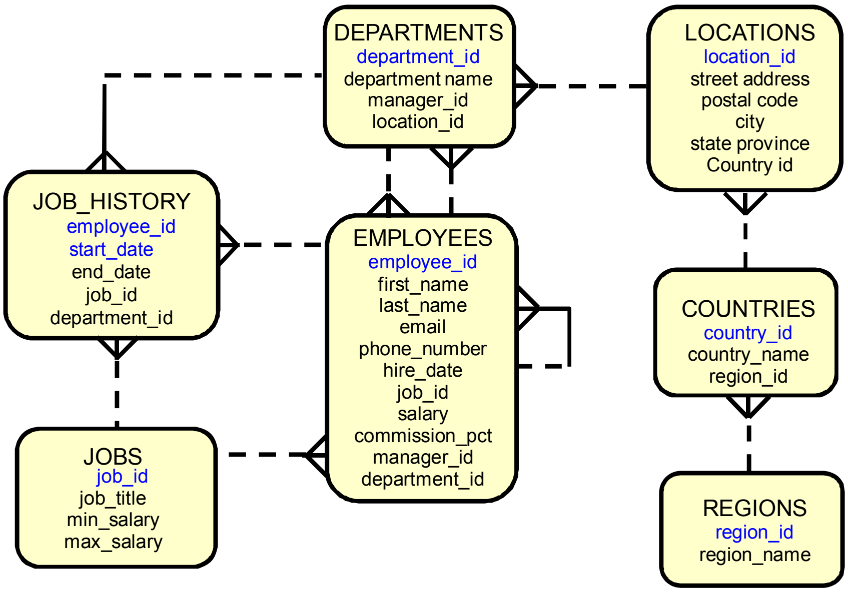
Notes

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

Lesson Agenda

- Course objectives, agenda, and appendixes used in the course
- Overview of Oracle Database 12*c* and related products
- Overview of relational database management concepts and terminologies
- Introduction to SQL and its development environments
- Human Resource (`HR`) Schema and the tables used in this course
- Oracle database 12*c* SQL Documentation and Additional Resources

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	EMAIL	PHONE_NUMBER	HIRE_DATE	JOB_ID	SALARY
1	100	Steven	King	SKING	515.123.4567	17-JUN-03	AD_PRES	24000
2	101	Neena	Kochhar	NKOCHHAR	515.123.4568	21-SEP-05	AD_VP	17000
3	102	Lex	De Haan	LDEHAAN	515.123.4569	13-JAN-01	AD_VP	17000
4	103	Alexander	Hunold	AHUNOLD	590.423.4567	03-JAN-06	AC_MGR	12008
5	104	Bruce	Ernst	BERNST	590.423.4568	21-MAY-07	IT_PROG	6000
6	107	Diana	Lorentz	DLORENTZ	590.423.5567	07-FEB-07	IT_PROG	4200
7	124	Kevin	Mourgos	KMOURGOS	650.123.5234	16-NOV-07	ST_MAN	5800
8	141	Trenna	Rajs	TRAJS	650.121.8009	17-OCT-03	ST_CLERK	3500
9	142	Curtis	Davies	CDAVIES	650.121.2994	29-JAN-05	ST_CLERK	3100
10	143	Randall	Matos	RMATOS	650.121.2874	15-MAR-06	ST_CLERK	2600
11	144	Peter	Vargas	PVARGAS	650.121.2004	09-JUL-06	ST_CLERK	2500
12	149	Eleni	Zlotkey	EZLOTKEY	011.44.1344.429018	29-JAN-08	SA_MAN	10500
13	174	Ellen	Abel	EABEL	011.44.1644.429267	11-MAY-04	SA_REP	11000
14	176	Jonathon	Taylor	JTAYLOR	011.44.1644.429265	24-MAR-06	SA_REP	8600
15	178	Kimberely	Grant	KGRANT	011.44.1644.429263	24-MAY-07	SA_REP	7000
16	200	Jennifer	Whalen	JWHALEN	515.123.4444	17-SEP-03	AD_ASST	4400
17	201	Michael	Hartstein	MHARTSTE	515.123.5555	17-FEB-04	MK_MAN	13000
18	202	Pat	Fay	PFAY	603.123.6666	17-AUG-05	MK_REP	6000
19	205	Shelley	Higgins	SHIGGINS	515.123.8080	07-JUN-02	AC_MGR	12008
20	206	William	Gietz	WGIETZ	515.123.8181	07-JUN-02	AC_ACCOUNT	8300

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

JOB_GRADES

	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

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, agenda, and appendixes used in the course
- Overview of Oracle Database 12*c* and related products
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- Oracle database 12*c* SQL Documentation and Additional Resources

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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://st-doc.us.oracle.com/12/121/index.htm to access the Oracle Database 12*c* documentation library.

Additional Resources

For additional information about Oracle Database 12*c*, refer to the following:

- *Oracle Database 12c: New Features eStudies*
- *Oracle Learning Library:*
  – http://www.oracle.com/goto/oll
- *Oracle Cloud:*
  – http://cloud.oracle.com
- Access the online SQL Developer Home Page, which is available at:
  – http://www.oracle.com/technology/products/database/sql_developer/index.html
- Access the SQL Developer tutorial, which is available online at:
  – http://download.oracle.com/oll/tutorials/SQLDeveloper/index.htm

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Summary

In this lesson, you should have learned:

- The goals of the course
- Features of Oracle Database 12*c*
- The salient features of Oracle Cloud
- The theoretical and physical aspects of a relational database
- Oracle server's implementation of RDBMS and object relational database management system (ORDBMS)
- The development environments that can be used for this course
- About the database and schema used in this course

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

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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.

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

- Capabilities of SQL `SELECT` statements
- 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

Basic `SELECT` Statement

```
SELECT   *|{[DISTINCT] column [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 6
```

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 (;).

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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 cursor 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;
```

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

Lesson Agenda

- Capabilities of SQL `SELECT` statements
- 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.

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

...

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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)

...

12	Zlotkey	SA_MAN	10500	0.2
13	Abel	SA_REP	11000	0.3
14	Taylor	SA_REP	8600	0.2
15	Grant	SA_REP	7000	0.15

...

18	Fay	MK_REP	6000	(null)
19	Higgins	AC_MGR	12008	(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.

Columns with NULL value can be selected in a SELECT query and can be the part of an arithmetic expression. Any arithmetic expression using NULL values results into NULL.

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 slide example, notice that only a sales manager or sales representative can earn a commission in the COMMISSION_PCT column of the EMPLOYEES table. 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)

...

12	Zlotkey	25200
13	Abel	39600
14	Taylor	20640
15	Grant	12600

...

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

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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 King 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 12*c* database.

Lesson Agenda

- Capabilities of SQL `SELECT` statements
- 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 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

- Capabilities of SQL `SELECT` statements
- 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
7	GrantSA_REP
8	HartsteinMK_MAN

...

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`.

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;
```

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;
```

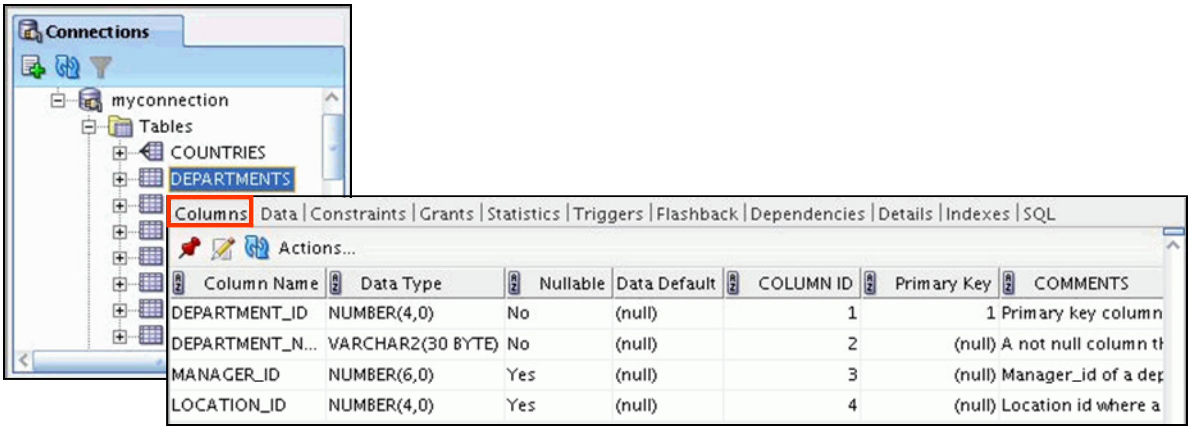
Lesson Agenda

- Capabilities of SQL `SELECT` statements
- 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 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 `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;
```

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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

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 in the slide.

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
- SQL row limiting clause in a query
- Substitution variables
- DEFINE and VERIFY commands

Limiting Rows by 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 Rows That Are Selected

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

```
SELECT   *|{[DISTINCT] column [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 `KNOWN`.

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 within 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' ;
```

	LAST_NAME	JOB_ID	DEPARTMENT_ID
1	Whalen	AD_ASST	10

```
SELECT last_name
FROM   employees
WHERE  hire_date = '17-OCT-03' ;
```

	LAST_NAME
1	Rajs

Character strings and dates in the `WHERE` clause must be enclosed within single quotation marks (`''`). Number constants, however, need not be enclosed within 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-05'
... 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 first example in the slide, 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.

In the second code example, the `SELECT` statement retrieves all rows where the last name is either Ernst or Abel. Because * is used in the `SELECT` statement, all fields from the employees table would appear in the result set.

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 'Whalen 10
```

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	12008	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 example in the slide 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 within single quotation marks (`''`).

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 more characters.
  - `_` denotes one character.

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

	FIRST_NAME
1	Shelley
2	Steven

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, 2005 and December, 2005:

```
SELECT last_name, hire_date
FROM   employees
WHERE  hire_date LIKE '%05';
```

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.

When you need to have an exact match for the actual `%` and _ characters, use the `ESCAPE` identifier.

Using 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_name and manager_id 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;
```

. . .

Defining Conditions Using 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 results of two or more 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 within 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	12008

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 both 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

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
- SQL row limiting clause in a query
- 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 operator
8	`AND` logical operator
9	`OR` logical operator

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, department_id, salary
FROM   employees
WHERE  department_id = 60
OR     department_id = 80
AND    salary > 10000;
```

1

	LAST_NAME	DEPARTMENT_ID	SALARY
1	Hunold	60	9000
2	Ernst	60	6000
3	Lorentz	60	4200
4	Zlotkey	80	10500
5	Abel	80	11000

```
SELECT last_name, department_id, salary
FROM   employees
WHERE  (department_id = 60
OR     department_id = 80)
AND    salary > 10000;
```

2

	LAST_NAME	DEPARTMENT_ID	SALARY
1	Zlotkey	80	10500
2	Abel	80	11000

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

   In this example, there are two conditions:

   - The first condition is that the department `ID` is `80` *and* the salary is greater than $10,000.
   - The second condition is that the department `ID` is `60`.

   Therefore, the `SELECT` statement reads as follows:

   "Select the row if an employee's department ID is 80 *and* earns more than $10,000, *or* if the employee's department ID is 60."

2. **Using Parentheses: Example**

   In this example, there are two conditions:

   - The first condition is that the department `ID` is 80 *or* 60.
   - The second condition is that the salary is greater than $10,000.

   Therefore, the `SELECT` statement reads as follows:

   "Select the row if an employee's department ID is 80 *or* 60, *and* if the employee earns more than $10,000."

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
- SQL row limiting clause in a query
- 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

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

	LAST_NAME	JOB_ID	DEPARTMENT_ID	HIRE_DATE
1	De Haan	AD_VP	90	13-JAN-01
2	Gietz	AC_ACCOUNT	110	07-JUN-02
3	Higgins	AC_MGR	110	07-JUN-02
4	King	AD_PRES	90	17-JUN-03
5	Whalen	AD_ASST	10	17-SEP-03
6	Rajs	ST_CLERK	50	17-OCT-03

...

The order of rows that are returned in a query result is undefined. The ORDER BY clause can be used to sort the rows. You can specify an expression, an alias, or a column position as the sort condition. You can specify multiple expressions in the *order_by_clause*. Oracle Database first sorts rows based on their values for the first expression. Rows with the same value for the first expression are then sorted based on their values for the second expression, and so on.

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.

Sorting

- Sorting in descending order:

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

1

- Sorting by column alias:

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

2

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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 department_id.
2. You can also use a column alias in the `ORDER BY` clause. The slide example sorts the data by annual salary.

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 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;
```

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Examples

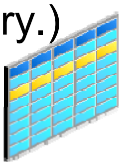
3. You can sort query results by specifying the numeric position of the column in the `SELECT` clause. The example in the slide sorts the result by the `department_id` as this column is at the third position in the `SELECT` clause.
4. You can sort query results by more than one column. You list the columns (or `SELECT` list column sequence numbers) in the `ORDER BY` clause, delimited by commas. The results are ordered by the first column, then the second, and so on for as many columns as the `ORDER BY` clause includes. If you want any results sorted in descending order, your `ORDER BY` clause must use the `DESC` keyword directly after the name or the number of the relevant column. 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
- SQL row limiting clause in a query
- Substitution variables
- `DEFINE` and `VERIFY` commands

SQL Row Limiting Clause

- You can use the `row_limiting_clause` to limit the rows that are returned by a query.
- You can use this clause to implement Top-N reporting.
- You can specify the number of rows or percentage of rows to return with the `FETCH FIRST` keyword.
- You can use the `OFFSET` keyword to specify that the returned rows begin with a row after the first row of the full result set.
- The `WITH TIES` keyword includes additional rows with the same ordering keys as the last row of the row-limited result set. (You must specify `ORDER BY` in the query.)



In Oracle Database 12*c* Release 1, SQL `SELECT` syntax has been enhanced to allow a `row_limiting_clause`, which limits the number of rows that are returned in the result set. The `row_limiting_clause` provides both easy-to-understand syntax and expressive power. Limiting the number or rows returned can be valuable for reporting, analysis, data browsing, and other tasks. Queries that order data and then limit row output are widely used and are often referred to as Top-N queries. Top-N queries sort their result set and then return only the first n rows.

You can specify the number of rows or percentage of rows to return with the `FETCH FIRST` keywords. You can use the `OFFSET` keyword to specify that the returned rows begin with a row after the first row of the full result set. The `WITH TIES` keywords includes rows with the same ordering keys as the last row of the row-limited result set (you must specify the `ORDER BY` clause with the `WITH TIES` clause in the query). `FETCH FIRST` and `OFFSET` keywords simplify syntax and comply with the ANSI SQL standard.

There are certain limitations of the SQL row limiting clause:

- You cannot specify this clause with the `for_update_clause`.
- You cannot specify this clause in the subquery of a `DELETE` or `UPDATE` statement.
- If you specify this clause, then the select list cannot contain the sequence pseudocolumns `CURRVAL` or `NEXTVAL`.

Using SQL Row Limiting Clause in a Query

You specify the `row_limiting_clause` in the SQL `SELECT` statement by placing it after the `ORDER BY` clause.

Syntax:

```
SELECT …
   FROM …
 [ WHERE …  ]
 [ ORDER BY …  ]
 [OFFSET offset { ROW | ROWS }]
[FETCH { FIRST | NEXT } [{ row_count | percent PERCENT
}] { ROW | ROWS }
  { ONLY | WITH TIES }]
```


You specify the `row_limiting_clause` in the SQL `SELECT` statement by placing it after the `ORDER BY` clause. Note that an `ORDER BY` clause is required if you want to sort the rows for consistency.

- `OFFSET`: Use this clause to specify the number of rows to skip before row limiting begins. The value for offset must be a number. If you specify a negative number, offset is treated as 0. If you specify `NULL` or a number greater than or equal to the number of rows that are returned by the query, 0 rows are returned.
- `ROW` | `ROWS`: Use these keywords interchangeably. They are provided for semantic clarity.
- `FETCH`: Use this clause to specify the number of rows or percentage of rows to return.
- `FIRST` | `NEXT`: Use these keywords interchangeably. They are provided for semantic clarity.
- `row_count` | *percent* `PERCENT`: Use `row_count` to specify the number of rows to return. Use *percent* `PERCENT` to specify the percentage of the total number of selected rows to return. The value for percent must be a number.
- `ONLY` | `WITH TIES`: Specify `ONLY` to return exactly the specified number of rows or percentage of rows. Specify `WITH TIES` to return additional rows with the same sort key as the last row fetched. If you specify `WITH TIES`, then you must specify the `order_by_clause`. If you do not specify the `order_by_clause`, then no additional rows will be returned.

SQL Row Limiting Clause: Example

```
SELECT employee_id, first_name
FROM employees
ORDER BY employee_id
FETCH FIRST 5 ROWS ONLY;
```

	EMPLOYEE_ID	FIRST_NAME
1	100	Steven
2	101	Neena
3	102	Lex
4	103	Alexander
5	104	Bruce

```
SELECT employee_id, first_name
FROM employees
ORDER BY employee_id
OFFSET 5 ROWS FETCH NEXT 5 ROWS ONLY;
```

	EMPLOYEE_ID	FIRST_NAME
1	107	Diana
2	124	Kevin
3	141	Trenna
4	142	Curtis
5	143	Randall

The first code example returns the five employees with the lowest `employee_id`.

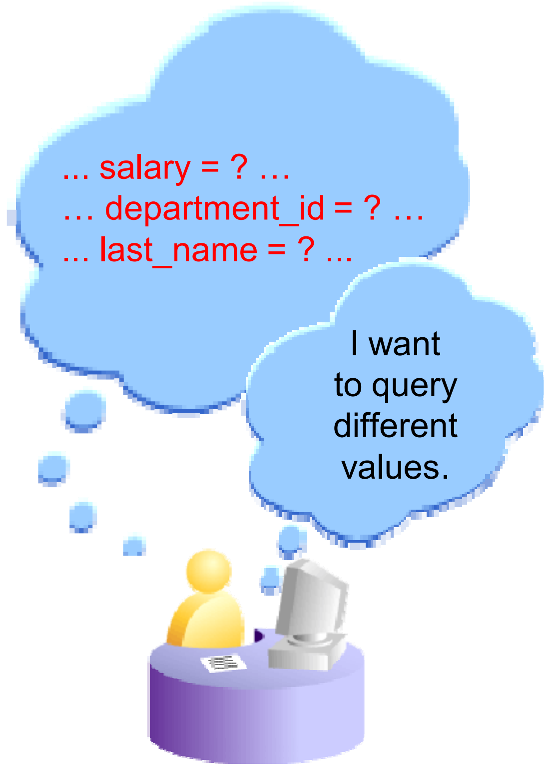
The second code example returns the five employees with the next set of lowest `employee_id`.

Note: If `employee_id` is assigned sequentially by the date when the employee joined the organization, these examples give us the top 5 employees and then employees 6-10, all in terms of seniority.

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
- SQL row limiting clause in a query
- 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:

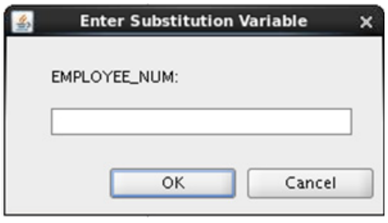
- Obtaining input values from a file rather than from a person
- Passing values from one SQL statement to another

Note: Both SQL Developer and SQL* Plus support substitution variables and the `DEFINE/UNDEFINE` commands.

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 ;
```



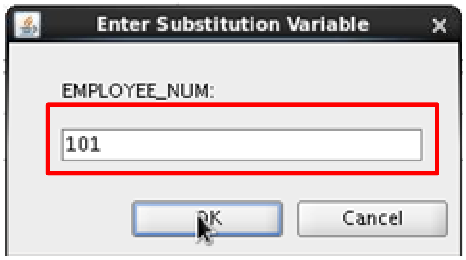
When running a report, users often want to restrict the data that is returned dynamically. SQL*Plus or SQL Developer provides this flexibility with user variables. Use an ampersand (&) to identify each variable in your SQL statement. However, you do not need to define the value of each variable.

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

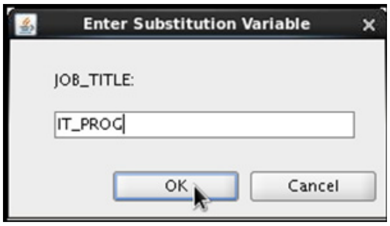
When SQL Developer detects that the SQL statement contains an ampersand, you are prompted to enter a value for the substitution variable that is named in the SQL statement.

After you enter a value and click the OK button, the results are displayed.

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

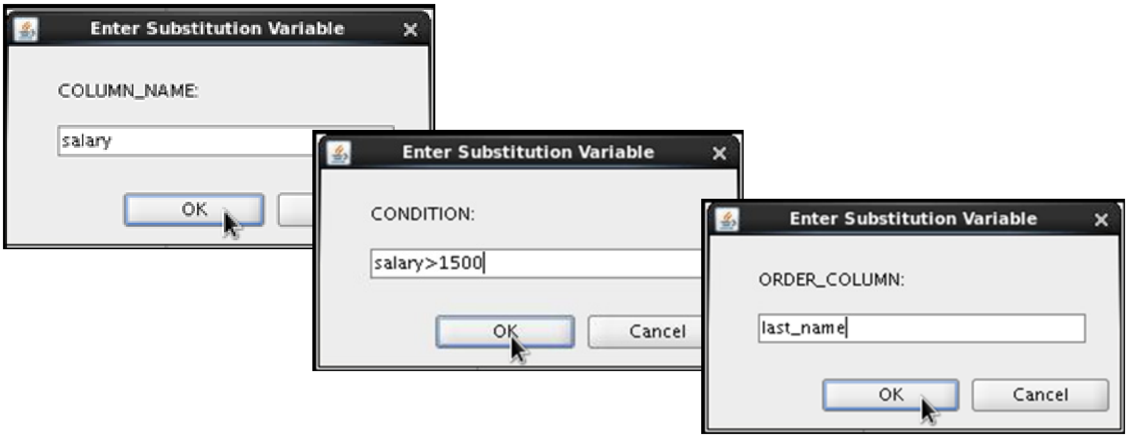
In a `WHERE` clause, date and character values must be enclosed within single quotation marks. The same rule applies to the substitution variables.

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.

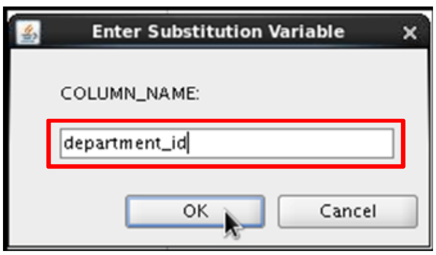
If you do not enter a value for the substitution variable, you get an error when you execute the preceding statement.

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

. . .

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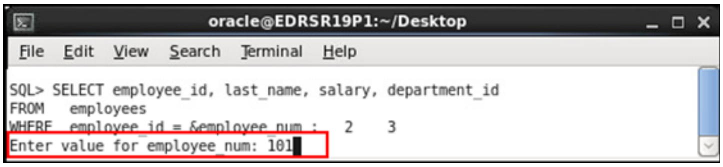
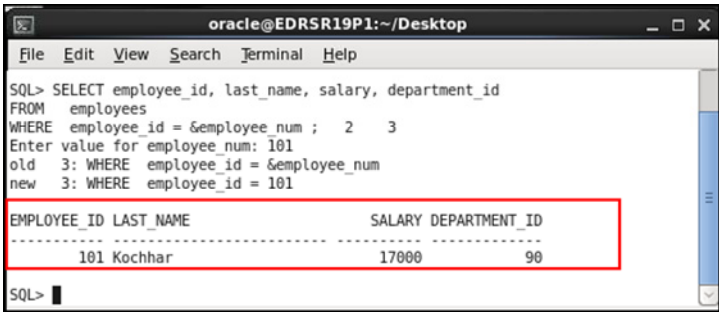
You can use the double-ampersand (`&&`) substitution variable if you want to reuse the variable value without prompting the user each time. The user sees the prompt for the value only once. In the example in the slide, the user is asked to give the value for the variable, `column_name`, only once. The 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;
```

Using the Ampersand Substitution Variable in SQL*Plus





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

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
- SQL row limiting clause in a query
- 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
```

	EMPLOYEE_ID	LAST_NAME	SALARY	DEPARTMENT_ID
1	200	Whalen	4400	10

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.

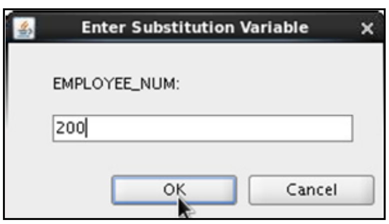
Because the variable is created using the SQL Developer DEFINE command, the user is not prompted to enter a value for the employee number. Instead, the defined variable value is automatically substituted in the SELECT statement.

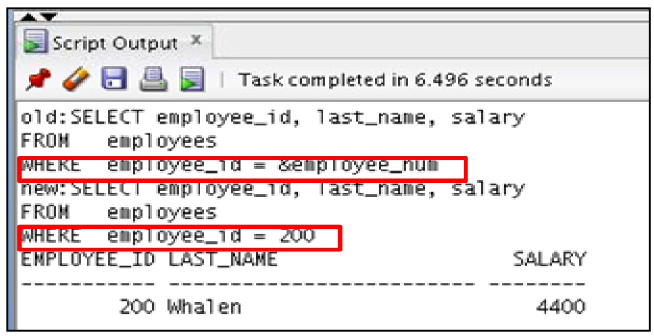
The EMPLOYEE_NUM substitution variable is present in the session until the user undefines it or exits the SQL Developer session.

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:

- 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

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:

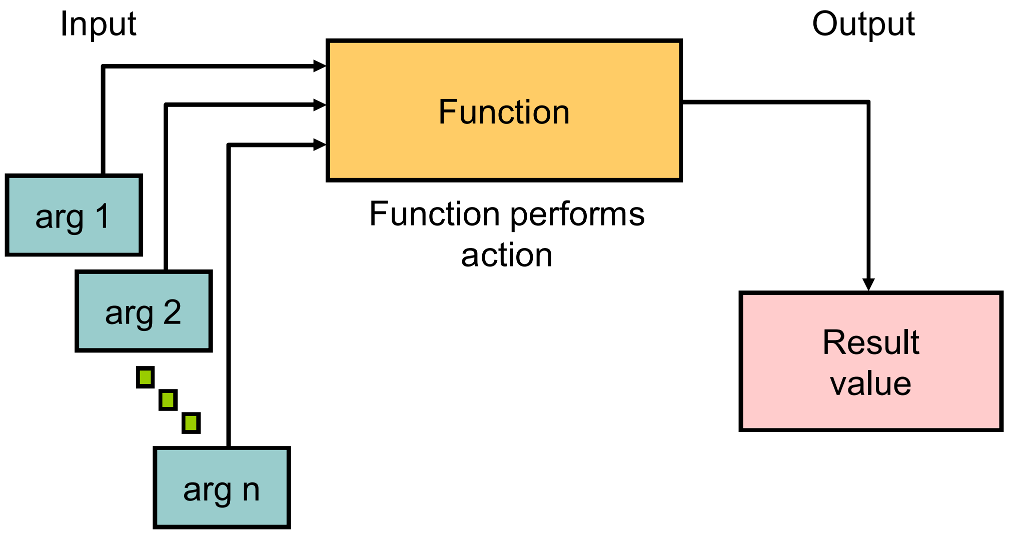
- Describe the various types of functions available in SQL
- Use the character, number, and date functions in `SELECT` statements

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
- Nesting functions
- Number functions
- Working with dates
- Date functions

SQL Functions

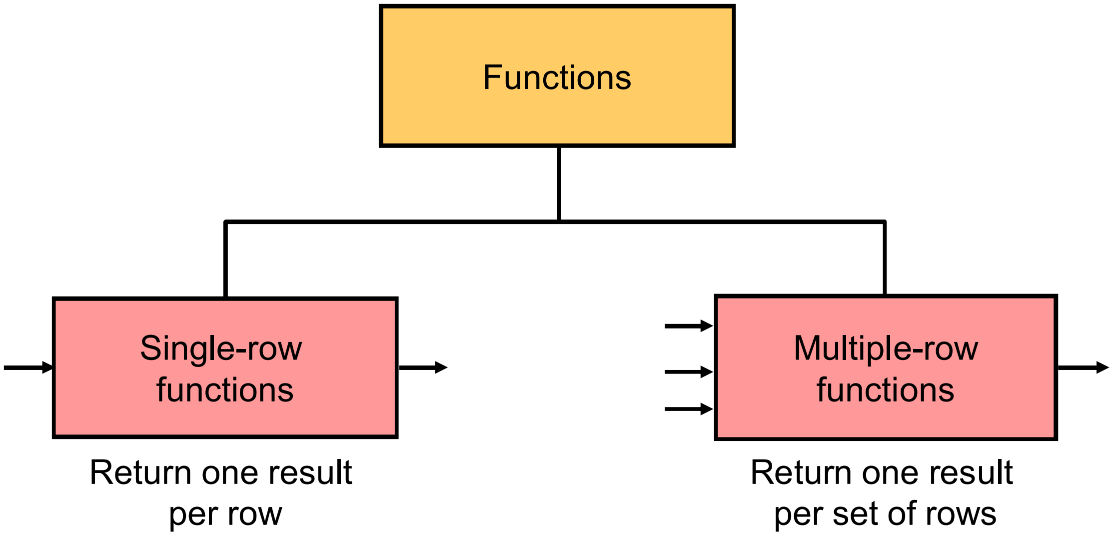


Functions are a very powerful feature of SQL. They can be used to do the following:

- 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.

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

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 12*c* 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:

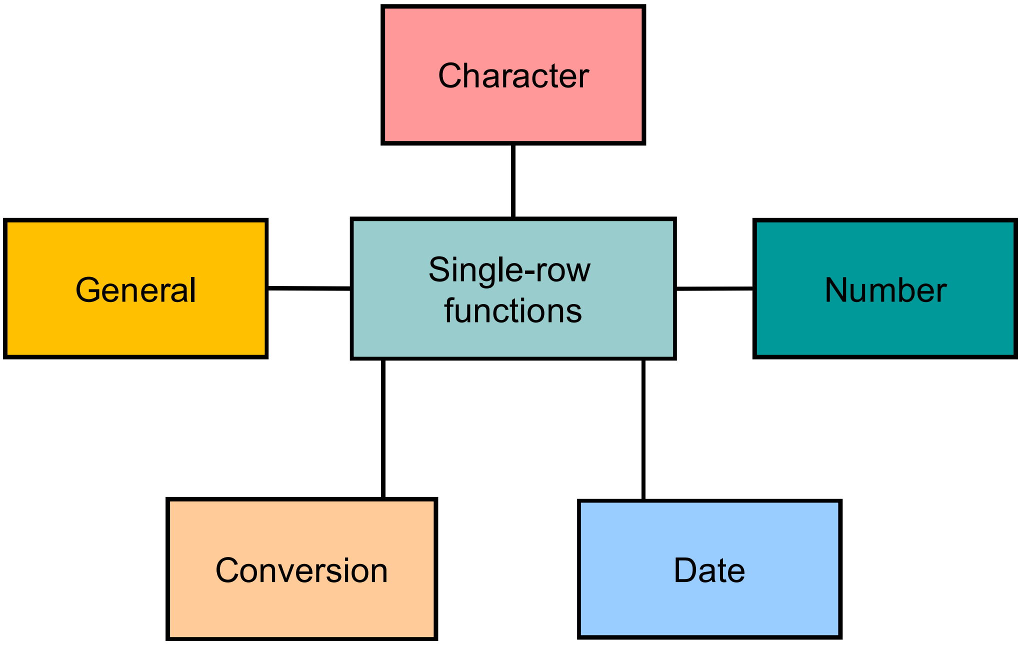
- Acting on each row that is returned in the query
- Returning one result per row
- Possibly returning a data value of a different type than the one that is referenced
- Possibly expecting one or more arguments
- Can be used in `SELECT`, `WHERE`, and `ORDER BY` clauses; can be nested

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

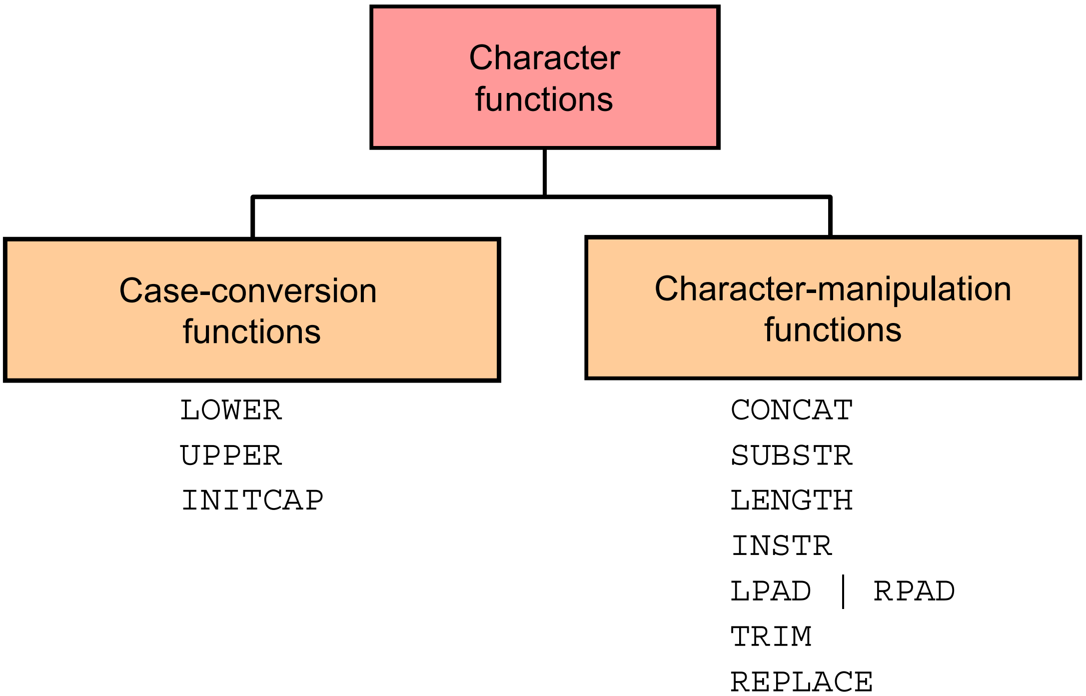
The following single-row functions are discussed in the lesson titled "Using Conversion Functions and Conditional Expressions":

- **Conversion functions:** Convert a value from one data type to another
- **General functions:** These functions take any data type and can also handle NULLs.

Lesson Agenda

- Single-row SQL functions
- Character functions
- Nesting 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.
REPLACE(*text*, *search_string*, *replacement_string*)	Searches a text expression for a character string and, if found, replaces it with a specified replacement string

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;
```

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(last_name,12,'-')`	`*****24000`
`RPAD(first_name, 12, '-')`	`24000*****`

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`CONCAT`, `SUBSTR`, `LENGTH`, `INSTR`, `LPAD`, and `RPAD` 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

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 Character-Manipulation Functions

1

```
SELECT CONCAT(CONCAT(last_name, '''s job category is '), job_id)
"Job" FROM   employees
WHERE  SUBSTR(job_id, 4) = 'REP';
```

	Job
1	Abel's job category is SA_REP
2	Fay's job category is MK_REP
3	Grant's job category is SA_REP
4	Taylor's job category is SA_REP

2

```
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

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The first example in the slide displays employee last names and job IDs joined together 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`.

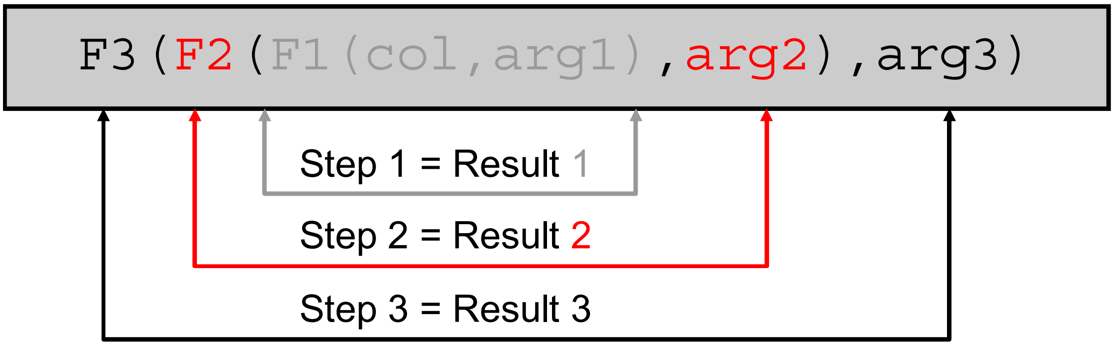
The second SQL statement in the slide displays the data for those employees whose last names end with the letter "n."

Lesson Agenda

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

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

```
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.

Lesson Agenda

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

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Numeric Functions

- `ROUND`: Rounds value to a specified decimal
- `TRUNC`: Truncates value to a specified decimal
- `CEIL`: Returns the smallest whole number greater than or equal to a specified number
- `FLOOR`: Returns the largest whole number equal to or less than a specified number
- `MOD`: Returns remainder of division

Function	Result
`ROUND(45.926, 2)`	`45.93`
`TRUNC(45.926, 2)`	`45.92`
`CEIL (2.83)`	`3`
`FLOOR (2.83)`	`2`
`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 12*c* database.

Using the ROUND Function

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

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

DUAL is a 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).

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

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

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

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.

Using the MOD Function

Display the employee records where the employee_id is an even number.

```
SELECT employee_id as "Even Numbers", last_name
FROM employees
WHERE MOD(employee_id,2) = 0;
```

	Even Numbers	LAST_NAME
1	174	Abel
2	142	Davies
3	102	De Haan
4	104	Ernst
5	202	Fay
6	206	Gietz
7	178	Grant
8	100	King
9	124	Mourgos
10	176	Taylor
11	144	Vargas
12	200	Whalen

The MOD function finds the remainder of the first argument divided by the second argument. The slide example displays employee records where the employee_id is an even number.

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

Lesson Agenda

- Single-row SQL functions
- Character functions
- Nesting 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-2008';
```

	LAST_NAME	HIRE_DATE
1	King	17-JUN-03
2	Kochhar	21-SEP-05

…

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-03 is displayed as day, month, and year, there is also *time* and *century* information associated with the date. The complete date might be June 17, 2003, 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 preceding table.

This data is stored internally as follows:

CENTURY	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
19	03	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
1	24-AUG-12

`SYSDATE` is a date function that returns the system date. You can use `SYSDATE` just as you would use any other column name. For example, you can display the system 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.

Using the `CURRENT_DATE` and `CURRENT_TIMESTAMP` Functions

- `CURRENT_DATE` returns the current date from the user session.

```
SELECT SESSIONTIMEZONE, CURRENT_DATE FROM DUAL;
```

	SESSIONTIMEZONE	CURRENT_DATE
1	Etc/Universal	26-MAY-14

- `CURRENT_TIMESTAMP` returns the current date and time from the user session.

```
SELECT SESSIONTIMEZONE, CURRENT_TIMESTAMP FROM DUAL;
```

	SESSIONTIMEZONE	CURRENT_TIMESTAMP
1	Etc/Universal	26-MAY-14 12.25.34.401622000 AM ETC/UNIVERSAL

The `CURRENT_DATE` and `CURRENT_TIMESTAMP` functions return the current date and current time stamp, respectively.

Note: The `SESSIONTIMEZONE` function returns the value of the current session's time zone. The return type is a time zone offset (a character type in the format `'[+|-]TZH:TZM'`) or a time zone region name, depending on how the user specified the session time zone value in the most recent `ALTER SESSION` statement. The example in the slide shows that the session time zone is offset to UTC by –5 hours. Observe that the database time zone is different from the current session's time zone.

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	478.871917989417989417989417989417989418
2	Kochhar	360.729060846560846560846560846560846561
3	De Haan	605.300489417989417989417989417989417989

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.

Lesson Agenda

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

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Date-Manipulation Functions

Function	Result
MONTHS_BETWEEN	Number of months between two dates
ADD_MONTHS	Add calendar months to date
NEXT_DAY	Week 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 preceding 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-05','11-JAN-04')`	`19.6774194`
`ADD_MONTHS ('31-JAN-04',1)`	`'29-FEB-04'`
`NEXT_DAY ('01-SEP-05','FRIDAY')`	`'08-SEP-05'`
`LAST_DAY ('01-FEB-05')`	`'28-FEB-05'`

In the example in the slide, the `ADD_MONTHS` function adds one month to the supplied date value "31-JAN-04" and returns "29-FEB-04." The function recognizes the year 2004 as the leap year and, therefore, returns the last day of the February month. If you change the input date value to "31-JAN-05," the function returns "28-FEB-05."

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;
```

Using ROUND and TRUNC Functions with Dates

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 2004. 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 '%04
```

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. Never modifies 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:
- Use the various types of functions available in SQL
- Use the character, number, and date functions in `SELECT` statements

Practice 4: Overview

This practice covers the following topics:

- Writing a query that displays the `SYSDATE`
- 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:

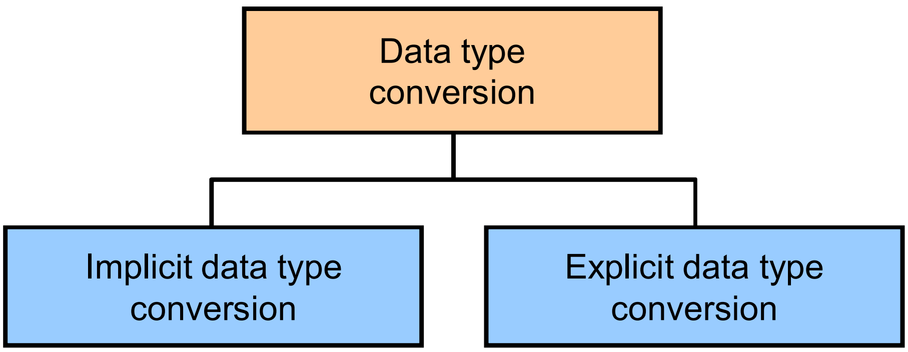
- Describe the various types of conversion functions that are available in SQL
- Use the `TO_CHAR`, `TO_NUMBER`, and `TO_DATE` conversion functions
- Apply conditional expressions in a `SELECT` statement

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
- General functions:
  - `NVL`
  - `NVL2`
  - `NULLIF`
  - `COALESCE`
- Conditional expressions:
  - `CASE`
  - Searched `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.

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

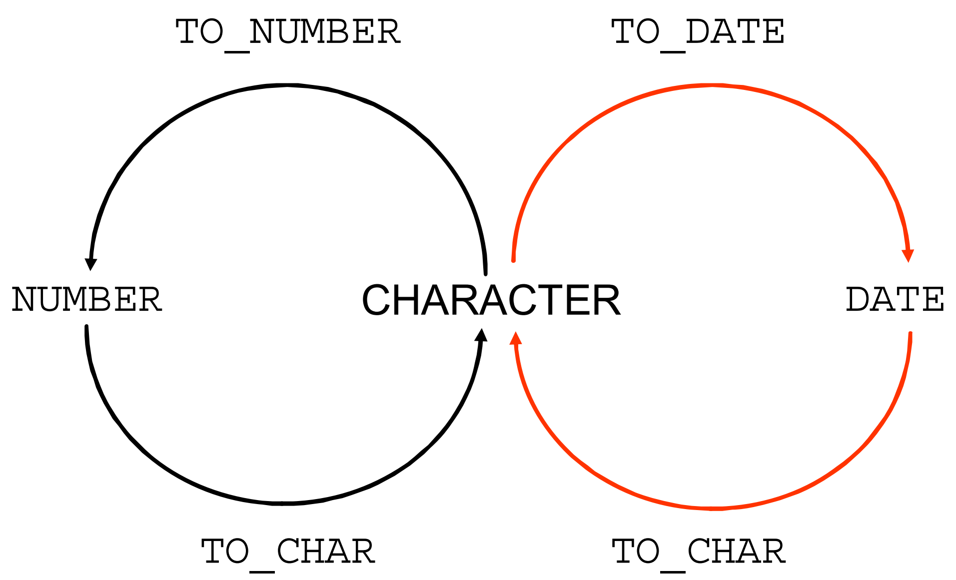
Implicit Data Type Conversion

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 `job_id = 2` results in the implicit conversion of the number `2` to the string "2" because `job_id` is a `VARCHAR(2)` column.

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.

Function	Purpose
`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 12*c* database.

Lesson Agenda

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

Using the `TO_CHAR` Function with Dates

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

The format model:

- Must be enclosed within 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-2000'` 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 within 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';
```

Elements of the Date Format Model

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

Elements of the Date Format Model

- Time elements format the time portion of the date:

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

- Add character strings by enclosing them within 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	King	17 June 2003
2	Kochhar	21 September 2005
3	De Haan	13 January 2001
4	Hunold	3 January 2006
5	Ernst	21 May 2007
6	Lorentz	7 February 2007
7	Mourgos	16 November 2007
8	Rajs	17 October 2003

...

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The SQL statement in the slide displays the last names and hire dates for all the employees. The hire date appears as 17 June 2003.

Example

Modify the example in the slide to display the dates in a format that appears as “Seventeenth of June 2003 12:00:00 AM.”

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

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, 2007. 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, 2007', '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, 2007', 'fxMonth DD, YYYY');
```

Using TO_CHAR and TO_DATE Functions 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	Popp	03-Feb-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 preceding query.

Lesson Agenda

- Implicit and explicit data type conversion
- `TO_CHAR`, `TO_DATE`, `TO_NUMBER` functions
- General functions:
  - `NVL`
  - `NVL2`
  - `NULLIF`
  - `COALESCE`
- Conditional expressions:
  - `CASE`
  - Searched `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 12*c* 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	King	24000	0	288000
2	Kochhar	17000	0	204000
3	De Haan	17000	0	204000
4	Hunold	9000	0	108000
5	Ernst	6000	0	72000
6	Lorentz	4200	0	50400
7	Mourgos	5800	0	69600
8	Rajs	3500	0	42000
9	Davies	3100	0	37200
10	Matos	2600	0	31200

...

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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;
```

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);
```

	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

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 be any data type, but *`expr2`* and *`expr3`* should be the same data type.

Using the NULLIF Function

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

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

...

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

	LAST_NAME	SALARY	COMMISSION_PCT	New Salary
1	King	24000	(null)	26000
2	Kochhar	17000	(null)	19000
3	De Haan	17000	(null)	19000
4	Hunold	9000	(null)	11000
5	Ernst	6000	(null)	8000
6	Lorentz	4200	(null)	6200
7	Mourgos	5800	(null)	7800
8	Rajs	3500	(null)	5500
9	Davies	3100	(null)	5100
10	Matos	2600	(null)	4600
11	Vargas	2500	(null)	4500
12	Zlotkey	10500	0.2	12600
13	Abel	11000	0.3	14300
14	Taylor	8600	0.2	10320
15	Grant	7000	0.15	8050
16	Whalen	4400	(null)	6400
17	Hartstein	13000	(null)	15000
18	Fay	6000	(null)	8000
19	Higgins	12008	(null)	14008
20	Gietz	8300	(null)	10300

In the example shown in the slide, 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.

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.

Lesson Agenda

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

Conditional Expressions

- Provide the use of the `IF-THEN-ELSE` logic within a SQL statement
- Use the following methods:
  - `CASE` expression
  - Searched `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 data type. All of the return values (return_expr) must be of the same data type.

Using the CASE Expression

```
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	King	AD_PRES	24000	24000
...				
4	Hunold	IT_PROG	9000	9900
5	Ernst	IT_PROG	6000	6600
6	Lorentz	IT_PROG	4200	4620
7	Mourgos	ST_MAN	5800	5800
8	Rajs	ST_CLERK	3500	4025
9	Davies	ST_CLERK	3100	3565
10	Matos	ST_CLERK	2600	2990
11	Vargas	ST_CLERK	2500	2875
...				
13	Abel	SA_REP	11000	13200
14	Taylor	SA_REP	8600	10320
15	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.

Searched `CASE` Expression

```
CASE
   WHEN condition1 THEN use_expression1
   WHEN condition2 THEN use_expression2
   WHEN condition3 THEN use_expression3
   ELSE default_use_expression
END
```

```
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;
```


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. The searched `CASE` evaluates the conditions independently under each of the `WHEN` options.

The difference between the `CASE` expression and the searched `CASE` expression is that in a searched `CASE` expression, you specify a condition or predicate instead of a *`comparison_expression`* after the `WHEN` keyword.

For both simple and searched `CASE` expressions, all of the *`return_exprs`* must either have the same data type `CHAR`, `VARCHAR2`, `NCHAR`, or `NVARCHAR2`, `NUMBER`, `BINARY_FLOAT`, or `BINARY_DOUBLE` or must all have a numeric data type.

The code in the slide is an example of the searched `CASE` expression.

`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
...				
4	Hunold	IT_PROG	9000	9900
5	Ernst	IT_PROG	6000	6600
6	Lorentz	IT_PROG	4200	4620
7	Mourgos	ST_MAN	5800	5800
8	Rajs	ST_CLERK	3500	4025
9	Davies	ST_CLERK	3100	3565
10	Matos	ST_CLERK	2600	2990
11	Vargas	ST_CLERK	2500	2875
12	Zlotkey	SA_MAN	10500	10500
...				
13	Abel	SA_REP	11000	13200
14	Taylor	SA_REP	8600	10320
15	Grant	SA_REP	7000	8400

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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%

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, searched CASE, 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 CASE, searched CASE, and DECODE

This practice provides a variety of exercises using the TO_CHAR and TO_DATE functions, and conditional expressions such as CASE, searched CASE, and DECODE.

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

Group Functions

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

`EMPLOYEES`

	DEPARTMENT_ID	SALARY
1	10	4400
2	20	13000
3	20	6000
4	110	12000
5	110	8300
6	90	24000
7	90	17000
8	90	17000
9	60	9000
10	60	6000
...		
18	80	11000
19	80	8600
20	(null)	7000

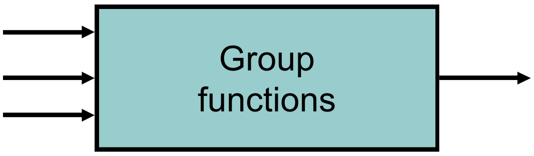
Maximum salary in `EMPLOYEES` table

MAX(SALARY)
24000

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 that is split into groups.

Types of Group Functions

- AVG
- COUNT
- MAX
- MIN
- SUM
- LISTAGG
- STDDEV
- 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
`COUNT`	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
`LISTAGG`	Orders data within each group specified in the `ORDER BY` clause and then concatenates the values of the measure column
`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

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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	13-JAN-01	29-JAN-08

ORACLE

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;
```

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

`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

4400

9500

3500

6400

10033

Average salary in the `EMPLOYEES` table for each department

	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

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* with 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	90	19333.3333333333333333333333333333333333
3	20	9500
4	110	10154
5	50	3500
6	80	10033.3333333333333333333333333333333333
7	60	6400
8	10	4400

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	19333.333333333333333333333333333333333
3	9500
4	10154
5	3500
6	10033.333333333333333333333333333333333
7	6400
8	4400

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);
```

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	12008
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	12008

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;
```

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	90	24000
2	20	13000
3	110	12008
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;
```

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	19333.33333333333333333333333333333333333

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, AVG, LISTAGG, STDDEV, and VARIANCE
- 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, LISTAGG, 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 12*c* database.

Practice 6: Overview

This practice covers the following topics:

- Writing queries that use 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

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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 12*c* database.

Lesson Agenda

- Types of `JOINS` and their 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

EMPLOYEES

	EMPLOYEE_ID	FIRST_NAME	LAST_NAME	JOB_ID
1	100	Steven	King	AD_PRES
2	101	Neena	Kochhar	AD_VP
3	102	Lex	De Haan	AD_VP
4	103	Alexander	Hunold	IT_PROG
5	104	Bruce	Ernst	IT_PROG
6	105	David	Austin	IT_PROG
7	106	Valli	Pataballa	IT_PROG
8	107	Diana	Lorentz	IT_PROG
9	108	Nancy	Greenberg	FI_MGR
10	109	Daniel	Faviet	FI_ACCOUNT

JOBS

	JOB_ID	JOB_TITLE
1	AD_PRES	President
2	AD_VP	Administration Vice President
3	AD_ASST	Administration Assistant
4	FI_MGR	Finance Manager
5	FI_ACCOUNT	Accountant
6	AC_MGR	Accounting Manager
7	AC_ACCOUNT	Public Accountant
8	SA_MAN	Sales Manager
9	SA_REP	Sales Representative

	EMPLOYEE_ID	JOB_ID	JOB_TITLE
1	206	AC_ACCOUNT	Public Accountant
2	205	AC_MGR	Accounting Manager
3	200	AD_ASST	Administration Assistant
4	100	AD_PRES	President
5	101	AD_VP	Administration Vice President
6	102	AD_VP	Administration Vice President
7	109	FI_ACCOUNT	Accountant

. . .

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:

- Employees IDs exist in the EMPLOYEES table.
- Job IDs exist in both the EMPLOYEES and JOBS tables.
- Job title exist in the JOBS table.

To produce the report, you need to link the EMPLOYEES and JOBS 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

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To join tables, you can use a join syntax that is compliant with the SQL:1999 standard.

Note

- Before the Oracle9*i* release, the Oracle 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.
- 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 12*c* database.

Lesson Agenda

- Types of `JOINS` and their 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 that have the same name in two tables.
- 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.

```
SELECT * FROM table1 NATURAL JOIN table2;
```


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 employee_id, first_name, job_id, job_title
from employees NATURAL JOIN jobs;
```

	EMPLOYEE_ID	FIRST_NAME	JOB_ID	JOB_TITLE
1	100	Steven	AD_PRES	President
2	101	Neena	AD_VP	Administration Vice President
3	102	Lex	AD_VP	Administration Vice President
4	103	Alexander	IT_PROG	Programmer
5	104	Bruce	IT_PROG	Programmer
6	105	David	IT_PROG	Programmer
7	106	Valli	IT_PROG	Programmer
8	107	Diana	IT_PROG	Programmer
9	108	Nancy	FI_MGR	Finance Manager
10	109	Daniel	FI_ACCOUNT	Accountant
11	110	John	FI_ACCOUNT	Accountant

…

In the example in the slide, the JOBS table is joined to the EMPLOYEES table by the JOB_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.

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

EMPLOYEES

	EMPLOYEE_ID	DEPARTMENT_ID
1	200	10
2	201	20
3	202	20
4	205	110
5	206	110
6	100	90
7	101	90
8	102	90
9	103	60
10	104	60

...

Foreign key

DEPARTMENTS

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

Primary key

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.

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.

Qualifying Ambiguous Column Names

- Use table prefixes to qualify column names that are in multiple tables.
- Use table prefixes to increase the speed of parsing of the statement.
- 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.

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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 increases the speed of parsing of the statement, 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.

Using Table Aliases with the `USING` Clause

- Do not qualify a column that is used in the `NATURAL` join or a join with a `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, e.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	124	Mourgos	50	50	1500
5	144	Vargas	50	50	1500
6	143	Matos	50	50	1500
7	142	Davies	50	50	1500
8	141	Rajs	50	50	1500
9	107	Lorentz	60	60	1400
10	104	Ernst	60	60	1400
11	103	Hunold	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 parentheses 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

```
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. Here, 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 ;
```

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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.

Lesson Agenda

- Types of `JOINS` and their 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

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Joining a Table to Itself

EMPLOYEES (WORKER)

EMPLOYEE_ID	LAST_NAME	MANAGER_ID
200	Whalen	101
201	Hartstein	100
202	Fay	201
205	Higgins	101
206	Gietz	205
100	King	(null)
101	Kochhar	100
102	De Haan	100
103	Hunold	102
104	Ernst	103

...

EMPLOYEES (MANAGER)

EMPLOYEE_ID	LAST_NAME
200	Whalen
201	Hartstein
202	Fay
205	Higgins
206	Gietz
100	King
101	Kochhar
102	De Haan
103	Hunold
104	Ernst

...

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
8	Kochhar	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.

Lesson Agenda

- Types of `JOINS` and their 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

. . .

	LAST_NAME	SALARY
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.

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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 their 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

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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.

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

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

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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

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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	King	90	Executive
2	Kochhar	90	Executive
3	De Haan	90	Executive
4	Hunold	60	IT

...

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

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 their 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

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Cartesian Products

- Cartesian product is a join of every row of one table to every row of another table.
- A Cartesian product generates a large number of rows and the result is rarely useful.

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

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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

- A `CROSS JOIN` is a `JOIN` operation that produces the Cartesian product of two tables.
- To create a Cartesian product, specify the `CROSS JOIN` in your `SELECT` statement.

```
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

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The example in the slide produces a Cartesian product of the `EMPLOYEES` and `DEPARTMENTS` tables.

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

If you join a table to itself, what kind of join are you using?

a. Nonequijoin
b. Left OUTER join
c. Right OUTER join
d. Full OUTER join
e. Self-join
f. Natural join
g. Cartesian products

Answer: e

Summary

In this lesson, you should have learned how to :

- 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

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.
- They can help to keep SQL code smaller by conserving memory.
- They 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, multiple-row, multiple-column subqueries

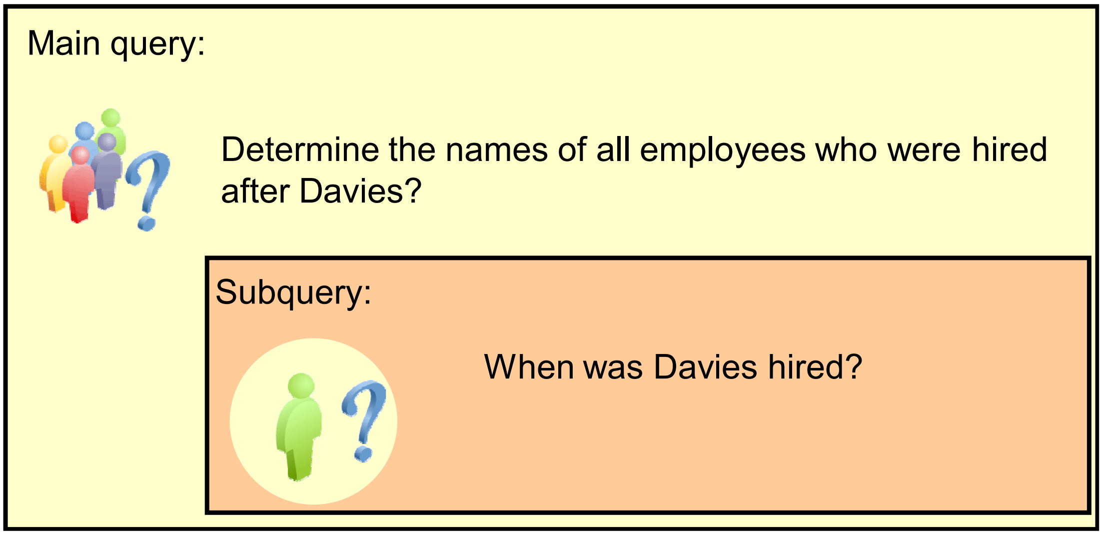
In this lesson, you learn about the more advanced features of the `SELECT` statement. You can write subqueries in the `WHERE` clause of another SQL statement to obtain values based on an unknown conditional value. This lesson also covers single-row subqueries, multiple-row subqueries, and multiple-column subqueries.

Lesson Agenda

- Subquery: Types, syntax, and guidelines
- Single-row subqueries:
  – Group functions in a subquery
  – `HAVING` clause with subqueries
- Multiple-row subqueries
  – Using `ALL` or `ANY` operator
- Multiple-column subqueries
- Null values in a subquery

Using a Subquery to Solve a Problem

Who is hired after Davies?



Suppose you want to write a query to find out the names of all employees who were hired after Davies?

To solve this problem, you need *two* queries: one query to find when Davies was hired, and a second query to find who were hired after Davies.

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*). The execution plan of the query depends on the optimizer’s decision on the structure of the subquery.

Subquery Syntax

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

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


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`

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, hire_date
FROM   employees                29-JAN-05
WHERE  hire_date > (SELECT hire_date
                    FROM   employees
                    WHERE  last_name = 'Davies');
```


In the slide, the inner query determines the hire date of the employee Davies. The outer query takes the result of the inner query and uses this result to display all the employees who were hired after Davies.

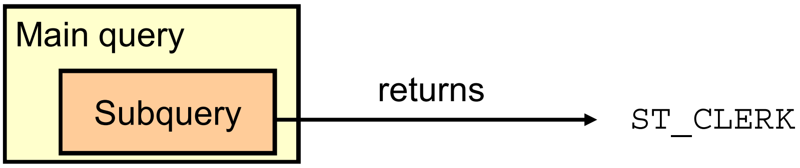
Rules and Guidelines for Using Subqueries

- Enclose subqueries in parentheses.
- Place subqueries on the right side of the comparison condition for readability. (However, the subquery can appear on either side of the comparison operator.)
- Use single-row operators with single-row subqueries and multiple-row operators with multiple-row subqueries.

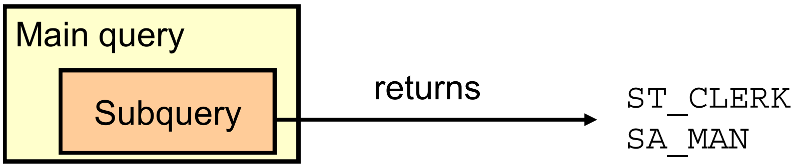
- A subquery must be enclosed in parentheses.
- Place the subquery on the right side of the comparison condition for readability. However, the subquery can appear on either side of the comparison operator.
- Two classes of comparison conditions are used in subqueries: single-row operators and multiple-row operators.

Types of Subqueries

- Single-row subquery



- Multiple-row subquery



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- **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 Workshop II* course.

Lesson Agenda

- Subquery: Types, syntax, and guidelines
- Single-row subqueries:
  - Group functions in a subquery
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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 =                    2500
                 (SELECT MIN(salary)
                  FROM   employees);
```

	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) >
                        (SELECT MIN(salary)
                         FROM   employees
                         WHERE  department_id = 30);
```

2500

	DEPARTMENT_ID	MIN(SALARY)
1	100	6900
2	(null)	7000
3	90	17000
4	20	6000
5	70	10000
6	110	8300
7	80	6100
8	40	6500
9	60	4200
10	10	4400

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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 30.

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);
```

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.

Lesson Agenda

- Subquery: Types, syntax, and guidelines
- Single-row subqueries:
  - Group functions in a subquery
  - `HAVING` clause with subqueries
- Multiple-row subqueries
  - Use `IN`, `ALL`, or `ANY`
- Multiple-column subqueries
- Null values in a subquery

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

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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.

Multiple-Column Subqueries

- A multiple-column subquery returns more than one column to the outer query.
- Column comparisons in multiple column comparisons can be pairwise or nonpairwise.
- A multiple-column subquery can also be used in the `FROM` clause of a `SELECT` statement.

A multiple-column subquery returns more than one column to the outer query and can be listed in the outer query's `FROM`, `WHERE`, or `HAVING` clause.

If you want to compare two or more columns, you must write a compound `WHERE` clause using logical operators. Multiple-column subqueries enable you to combine duplicate `WHERE` conditions into a single `WHERE` clause.

`IN` operator is used to check a value within a set of values. The list of values may come from the results returned by a subquery.

Syntax:

```
SELECT column, column, ...
FROM table
WHERE (column, column, ...) IN
                              (SELECT column, column, ...
                               FROM table
                               WHERE condition);
```

Multiple-Column Subquery: Example

Display all the employees with the lowest salary in each department

```
SELECT first_name, department_id, salary
FROM employees
WHERE (salary, department_id) IN
       (SELECT min(salary), department_id
        FROM employees
        GROUP BY department_id)
ORDER BY department_id;
```

	FIRST_NAME	DEPARTMENT_ID	SALARY
1	Jennifer	10	4400
2	Pat	20	6000
3	Peter	50	2500
4	Diana	60	4200
5	Jonathon	80	8600
6	Neena	90	17000
7	Lex	90	17000
8	William	110	8300

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The example in the slide is that of a multiple-column subquery because the subquery returns more than one column.

The inner query is executed first, and it returns the lowest `salary` and `department_id` for each department. The main query block is then processed and uses the values that were returned by the inner query to complete its search condition.

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- Subquery: Types, syntax, and guidelines
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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.

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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:

- Define subqueries
- Identify the types of problems that the subqueries can solve
- Write single-row, multiple-row, multiple-column subqueries

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.