PL/SQL Fundamentals

Student Guide

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Contents

Preface

Profile

Before You Begin This Course

Before you begin this course, you should be familiar with data processing concepts and techniques. The required prerequisite is an introductory SQL course, and an advanced SQL course is suggested.

How This Course Is Organized

PL/SQL Fundamentals is an instructor-led course featuring lectures and hands-on exercises. Online demonstrations and written practice sessions reinforce the concepts and skills introduced.

Related Publications

Oracle Publications

Title	Part Number
PL/SQL User's Guide and Reference, Release 8.1.5	A67842-01
Oracle8i SQL Reference Manual, Release 8.1.5	A67779-01
*SQL*Plus User's Guide and Reference, Release 8.1.5*	A66736-01
Oracle8i Server Application Developer's Guide	A68003-01

Additional Publications

- System release bulletins
- Installation and user's guides
- *read.me* files
- International Oracle User's Group (IOUG) articles
- *Oracle Magazine*

Typographic Conventions

What follows are two lists of typographical conventions used specifically within text or within code.

Typographic Conventions Within Text

Convention	Object or Term	Example
Uppercase	Commands, functions, column names, table names, PL/SQL objects, schemas	Use the SELECT command to view information stored in the LAST_NAME column of the EMP table.
Lowercase, italic	Filenames, syntax variables, usernames, passwords	**where:** *role* is the name of the role to be created.
Initial cap	Trigger and button names	Assign a When-Validate-Item trigger to the ORD block. Choose Cancel.
Italic	Books, names of courses and manuals, and emphasized words or phrases	For more information on the subject see *Oracle Server SQL Language Reference Manual* Do *not* save changes to the database.
Quotation marks	Lesson module titles referenced within a course	This subject is covered in Lesson 3, "Working with Objects."

Typographic Conventions Within Code

Convention	Object or Term	Example
Uppercase	Commands, functions	`SQL> SELECT userid` `  2 FROM emp;`
Lowercase, italic	Syntax variables	`SQL> CREATE ROLE role;`

Initial cap	Forms triggers	`Form module: ORD`
		`Trigger level: S_ITEM.QUANTITY item`
		`Trigger name: When-Validate-Item`
		`. . .`

Lowercase	Column names, table names, filenames, PL/SQL objects	`. . .`
		`OG_ACTIVATE_LAYER`
		`(OG_GET_LAYER ('prod_pie_layer'))`
		`. . .`
		`SQL> SELECT last_name`
		`  2 FROM emp;`

Bold	Text that must be entered by a user	`SQLDBA> DROP USER scott` `  2> IDENTIFIED BY tiger;`

Overview of PL/SQL

Course Objectives

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

- Describe the purpose of PL/SQL
- Describe the use of PL/SQL for the developer as well as the DBA
- Explain the benefits of PL/SQL

Aim

In this course, you will be introduced to PL/SQL and you will learn what PL/SQL is and where it can be used.

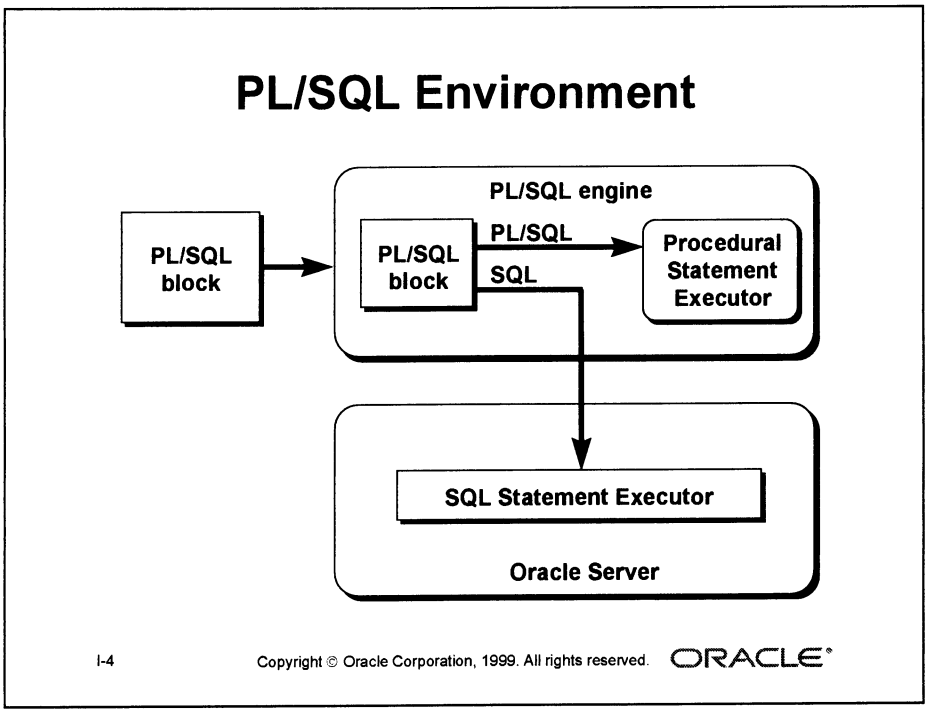
About PL/SQL

- PL/SQL is an extension to SQL with design features of programming languages.
- Data manipulation and query statements of SQL are included within procedural units of code.

About PL/SQL

Procedural Language/SQL (PL/SQL) is Oracle Corporation's procedural language extension to SQL, the standard data access language for relational databases. PL/SQL offers modern software engineering features such as data encapsulation, exception handling, information hiding, and object orientation, and so brings state-of-the-art programming to the Oracle Server and Toolset.

PL/SQL incorporates many of the advanced features made in programming languages designed during the 1970s and 1980s. It allows the data manipulation and query statements of SQL to be included in block-structured and procedural units of code, making PL/SQL a powerful transaction processing language. With PL/SQL, you can use SQL statements to finesse Oracle data and PL/SQL control statements to process the data.



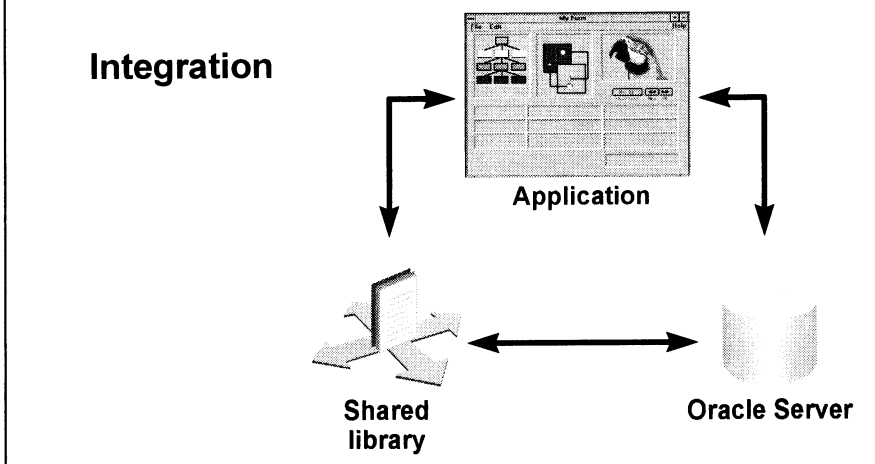
PL/SQL Engine and the Oracle Server

PL/SQL is not an Oracle product in its own right; it is a technology employed by the Oracle Server and by certain Oracle tools. Blocks of PL/SQL are passed to and processed by a PL/SQL engine, which may reside within the tool or within the Oracle Server. The engine used depends on where the PL/SQL is being invoked.

When you submit PL/SQL blocks from a Pro* program, user-exit, SQL*Plus, or Server Manager, the PL/SQL engine in the Oracle Server processes them. It separates out the SQL statements and sends them individually to the SQL statements executor.

A single transfer is required to send the block from the application to the Oracle Server, thus improving performance, especially in a client-server network. PL/SQL code can also be stored in the Oracle Server as subprograms that can be referenced by any number of applications connected to the database.

Benefits of PL/SQL



Integration

PL/SQL plays a central role to both the Oracle Server (through stored procedures, stored functions, database triggers, and packages) and Oracle development tools (through Oracle Developer component triggers).

Oracle Developer applications make use of shared libraries that hold code (procedures and functions) and can be accessed locally or remotely. Oracle Developer consists of Oracle Forms, Oracle Reports, and Oracle Graphics.

SQL datatypes can also be used in PL/SQL. Combined with the direct access that SQL provides, these shared datatypes integrate PL/SQL with the Oracle Server data dictionary. PL/SQL bridges the gap between convenient access to database technology and the need for procedural programming capabilities.

PL/SQL in Oracle Tools

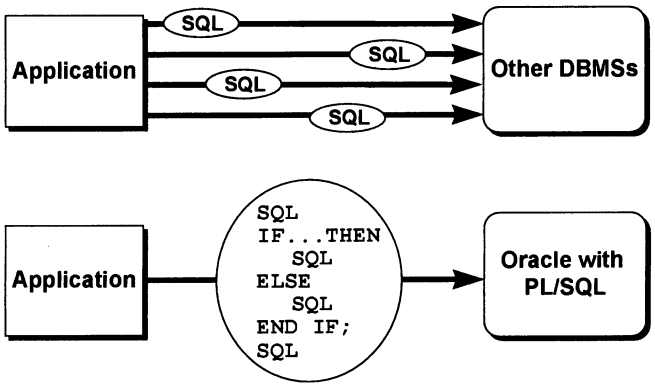
Many Oracle tools, including Oracle Developer, have their own PL/SQL engine, which is independent of the engine present in the Oracle Server.

The engine filters out SQL statements and sends them individually to the SQL statement executor in the Oracle Server. It processes the remaining procedural statements in the procedural statement executor, which is in the PL/SQL engine.

The procedural statement executor processes data that is local to the application (that is already inside the client environment, rather than the database). This reduces work sent to the Oracle Server and the number of memory cursors required.

Benefits of PL/SQL

Improve performance



Improved Performance

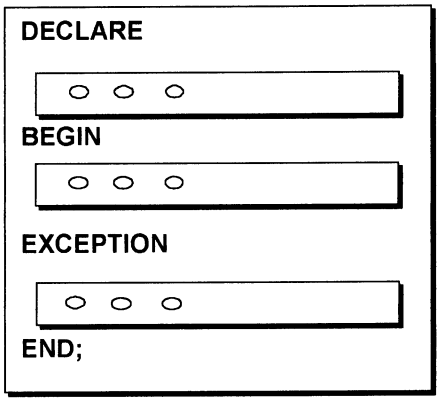
PL/SQL can improve the performance of an application. The benefits differ depending on the execution environment.

- PL/SQL can be used to group SQL statements together within a single block and to send the entire block to the server in a single call, thereby reducing networking traffic. Without PL/SQL, the SQL statements would be sent to the Oracle Server one at a time. Each SQL statement results in another call to the Oracle Server and higher performance overhead. In a networked environment, the overhead can become significant. As the slide illustrates, if your application is SQL intensive, you can use PL/SQL blocks and subprograms to group SQL statements before sending them to the Oracle Server for execution.
- PL/SQL can also cooperate with Oracle Server application development tools such as Oracle Developer Forms and Reports. By adding procedural processing power to these tools, PL/SQL boosts performance.

Note: Procedures and functions declared as part of a Developer application are distinct from those stored in the database, although their general structure is the same. Stored subprograms are database objects and are stored in the data dictionary. They can be accessed by any number of applications, including Developer applications.

Benefits of PL/SQL

Modularize program development



Benefits of PL/SQL

You can take advantage of the procedural capabilities of PL/SQL, which are not available in SQL.

PL/SQL Block Structure

Every unit of PL/SQL comprises one or more blocks. These blocks can be entirely separate or nested one within another. The basic units (procedures, functions, and anonymous blocks) that make up a PL/SQL program are logical blocks, which can contain any number of nested subblocks. Therefore, one block can represent a small part of another block, which in turn can be part of the whole unit of code.

Modularized Program Development

- Group logically related statements within blocks.
- Nest subblocks inside larger blocks to build powerful programs.
- Break down a complex problem into a set of manageable, well-defined, logical modules and implement the modules with blocks.
- Place reusable PL/SQL code in libraries to be shared between Oracle Developer applications or store it in an Oracle Server to make it accessible to any application that can interact with an Oracle database.

Benefits of PL/SQL

- It is portable.
- You can declare identifiers.

Portability

- Because PL/SQL is native to the Oracle Server, you can move programs to any host environment (operating system or platform) that supports the Oracle Server and PL/SQL. In other words, PL/SQL programs can run anywhere the Oracle Server can run; you do not need to tailor them to each new environment.
- You can also move code between the Oracle Server and your application. You can write portable program packages and create libraries that can be reused in different environments.

Identifiers

- Declare variables, cursors, constants, and exceptions and then use them in SQL and procedural statements.
- Declare variables belonging to scalar, reference, composite, and large object (LOB) datatypes.
- Declare variables dynamically based on the data structure of tables and columns in the database.

Benefits of PL/SQL

- You can program with procedural language control structures.
- It can handle errors.

Procedural Language Control Structures

- Execute a sequence of statements conditionally
- Execute a sequence of statements iteratively in a loop
- Process individually the rows returned by a multiple-row query with an explicit cursor

Errors

- Process Oracle Server errors with exception-handling routines
- Declare user-defined error conditions and process them with exception-handling routines

Summary

- PL/SQL is an extension to SQL.
- Blocks of PL/SQL code are passed to and processed by a PL/SQL engine.
- Benefits of PL/SQL:
  - Integration
  - Improved performance
  - Portability
  - Modularity of program development

Summary

PL/SQL is a language that has programming features that serve as an extension to SQL. It provides control-of-flow constructs and lets you declare and use variables. PL/SQL applications can run on any platform and operating system on which Oracle runs.

Declaring Variables

(IDENTIFIERS)

Objectives

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

- **Recognize the basic PL/SQL block and its sections**
- **Describe the significance of variables in PL/SQL**
- **Declare PL/SQL variables**
- **Execute a PL/SQL block**

Lesson Aim

This lesson presents the basic rules and structure for writing and executing PL/SQL blocks of code. It also shows you how to declare variables and assign datatypes to them.

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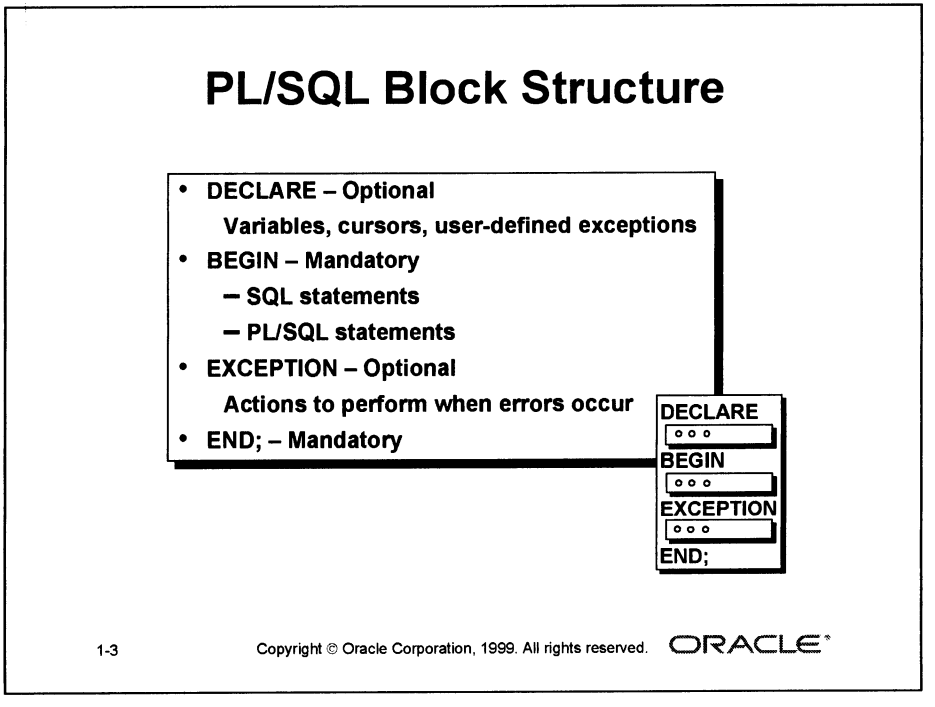
SET SERVEROUTPUT ON



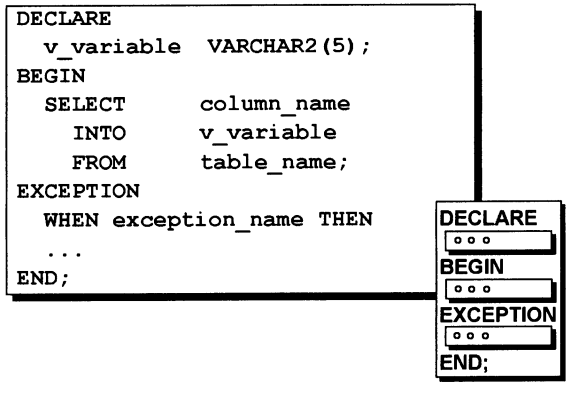
PL/SQL Block Structure

PL/SQL is a block-structured language, meaning that programs can be divided into logical blocks. A PL/SQL block consists of up to three sections: declarative (optional), executable (required), and exception handling (optional). Only BEGIN and END keywords are required. You can declare variables locally to the block that uses them. Error conditions (known as *exceptions*) can be handled specifically in the block to which they apply. You can store and change values within a PL/SQL block by declaring and referencing variables and other identifiers.

The following table describes the three block sections:

Section	Description	Inclusion
Declarative	Contains all variables, constants, cursors, and user-defined exceptions that are referenced in the executable and declarative sections	Optional
Executable	Contains SQL statements to manipulate data in the database and PL/SQL statements to manipulate data in the block	Mandatory
Exception handling	Specifies the actions to perform when errors and abnormal conditions arise in the executable section	Optional

PL/SQL Block Structure



Executing Statements and PL/SQL Blocks from SQL*Plus

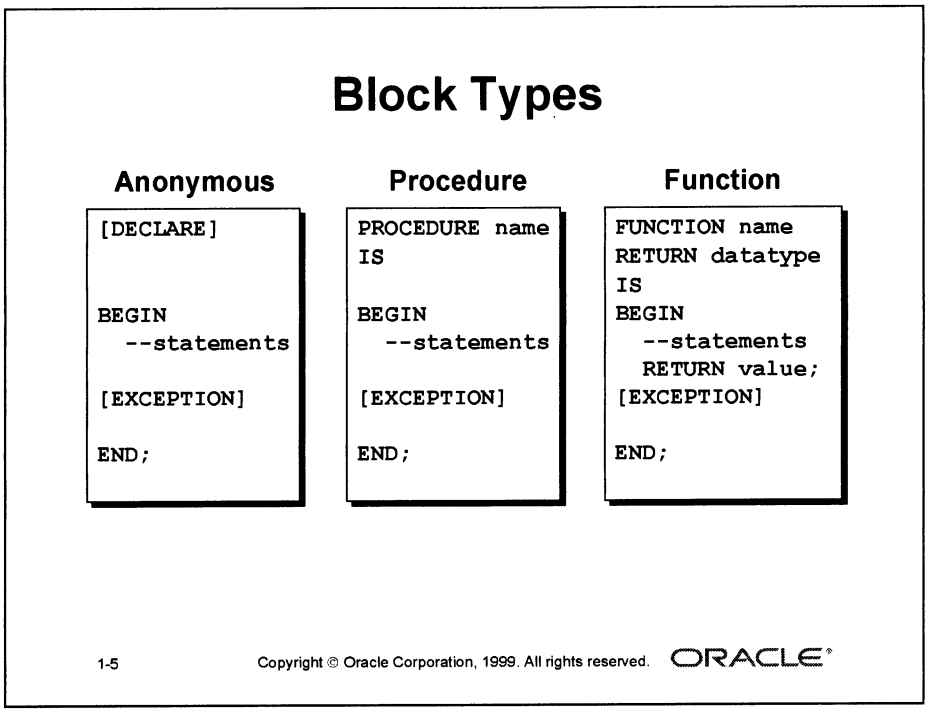
- Place a semicolon (;) at the end of a SQL statement or PL/SQL control statement.
- Use a slash (/) to run the anonymous PL/SQL block in the SQL*Plus buffer. When the block is executed successfully, without unhandled errors or compile errors, the message output should be as follows:

```
PL/SQL procedure successfully completed
```

- Place a period (.) to close a SQL*Plus buffer. A PL/SQL block is treated as one continuous statement in the buffer, and the semicolons within the block do not close or run the buffer.

Note: In PL/SQL, an error is called an *exception.*

Section keywords DECLARE, BEGIN, and EXCEPTION are not followed by semicolons. However, END and all other PL/SQL statements do require a semicolon to terminate the statement. You can string statements together on the same line, but this method is not recommended for clarity or editing.



Block Types

Every unit of PL/SQL comprises one or more blocks. These blocks can be entirely separate or nested one within another. The basic units (procedures and functions, also known as *subprograms*, and anonymous blocks) that make up a PL/SQL program are logical blocks, which can contain any number of nested subblocks. Therefore, one block can represent a small part of another block, which in turn can be part of the whole unit of code. Of the two types of PL/SQL constructs available, anonymous blocks and subprograms, only anonymous blocks are covered in this course.

Anonymous Blocks

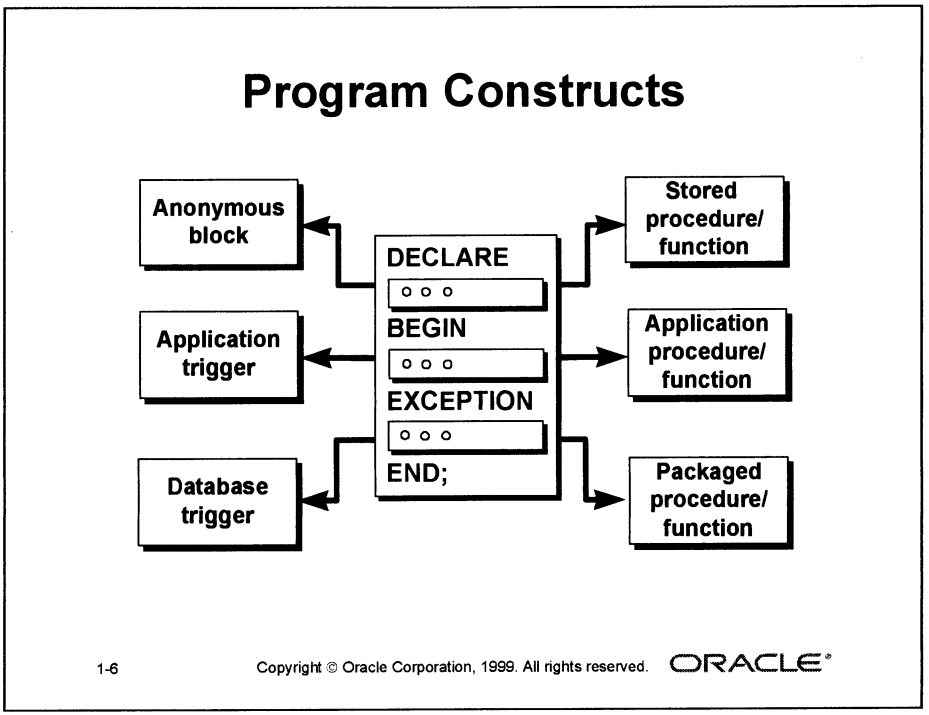
Anonymous blocks are unnamed blocks. They are declared at the point in an application where they are to be executed and are passed to the PL/SQL engine for execution at runtime. You can embed an anonymous block within a precompiler program and within SQL*Plus or Server Manager. Triggers in Oracle Developer components consist of such blocks.

Subprograms

Subprograms are named PL/SQL blocks that can take parameters and can be invoked. You can declare them either as procedures or as functions. Generally you use a procedure to perform an action and a function to compute a value.

You can store subprograms at the server or application level. Using Oracle Developer components (Forms, Reports, and Graphics), you can declare procedures and functions as part of the application (a form or report) and call them from other procedures, functions, and triggers (see next page) within the same application whenever necessary.

Note: A function is similar to a procedure, except that a function *must* return a value. Procedures and functions are covered in the next PL/SQL course.

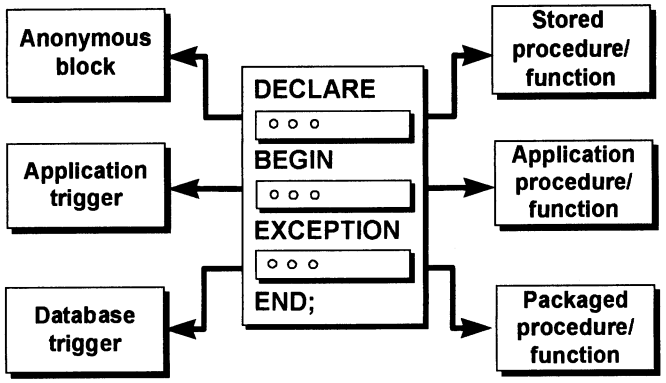


Program Constructs

The following table outlines a variety of different PL/SQL program constructs that use the basic PL/SQL block. They are available based on the environment in which they are executed.

Program Construct	Description	Availability
Anonymous block	Unnamed PL/SQL block that is embedded within an application or is issued interactively	All PL/SQL environments
Stored procedure or function	Named PL/SQL block stored in the Oracle Server that can accept parameters and can be invoked repeatedly by name	Oracle Server
Application procedure or function	Named PL/SQL block stored in an Oracle Developer application or shared library that can accept parameters and can be invoked repeatedly by name	Oracle Developer components—for example, Forms
Package	Named PL/SQL module that groups related procedures, functions, and identifiers	Oracle Server and Oracle Developer components—for example, Forms

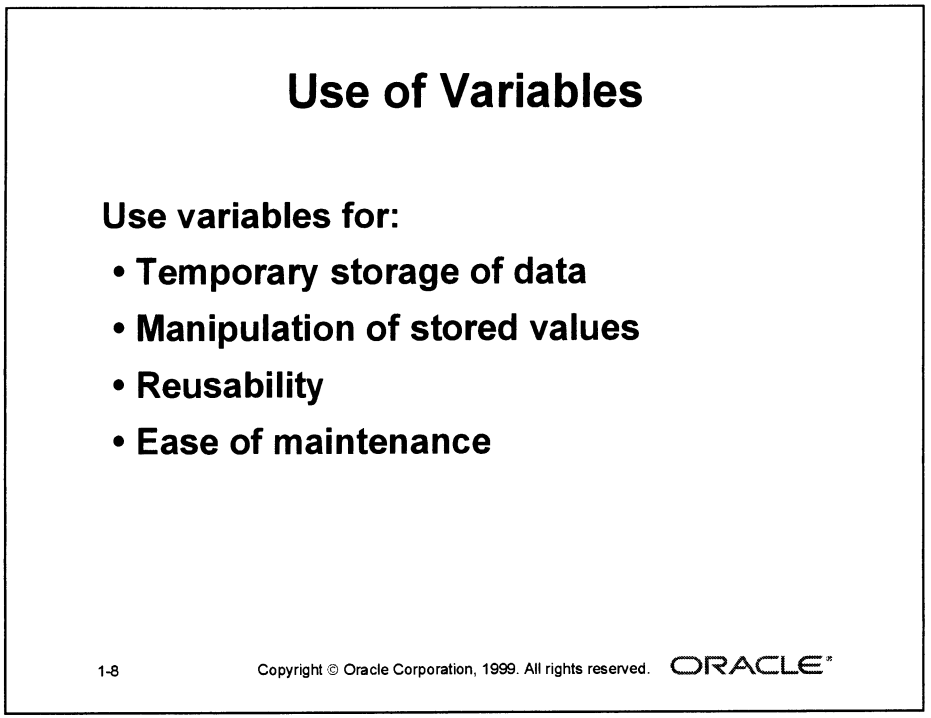
Program Constructs



1-7 ORACLE

Program Constructs (continued)

Program Construct	Description	Availability
Database trigger	PL/SQL block that is associated with a database table and is fired automatically when triggered by DML statements	Oracle Server
Application trigger	PL/SQL block that is associated with an application event and is fired automatically	Oracle Developer components—for example, Forms



Use of Variables

With PL/SQL you can declare variables and then use them in SQL and procedural statements anywhere an expression can be used.

- Temporary storage of data

  Data can be temporarily stored in one or more variables for use when validating data input for processing later in the data flow process.

- Manipulation of stored values

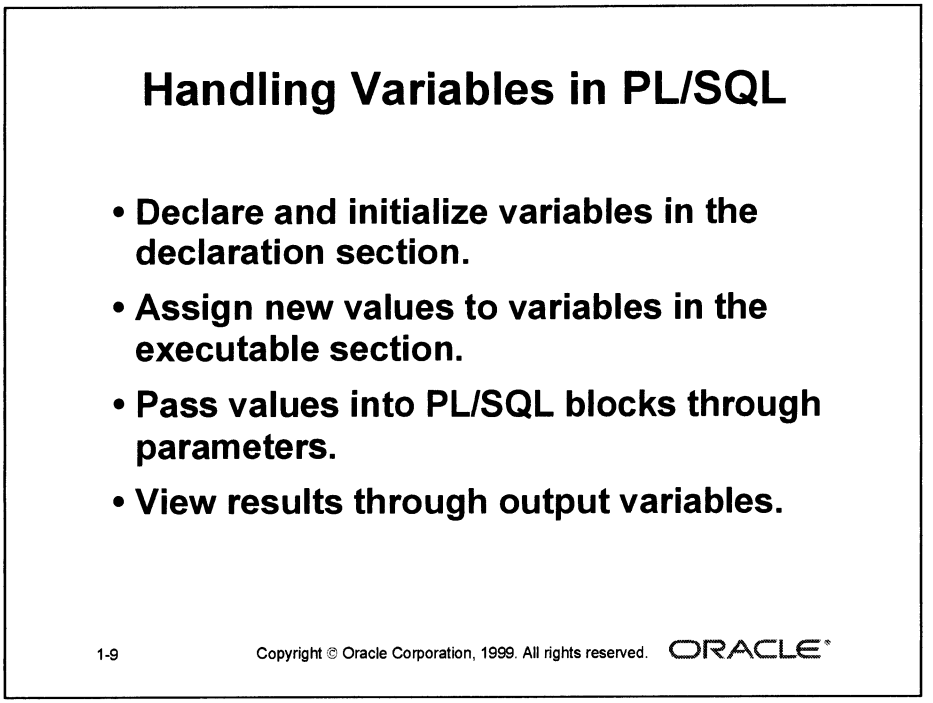
  Variables can be used for calculations and other data manipulations without accessing the database.

- Reusability

  Once declared, variables can be used repeatedly in an application simply by referencing them in other statements, including other declarative statements.

- Ease of maintenance

  When using %TYPE and %ROWTYPE (more information on %ROWTYPE is covered in a subsequent lesson), you declare variables, basing the declarations on the definitions of database columns. PL/SQL variables or cursor variables previously declared in the current scope may also use the %TYPE and %ROWTYPE attributes as datatype specifiers. If an underlying definition changes, the variable declaration changes accordingly at runtime. This provides data independence, reduces maintenance costs, and allows programs to adapt as the database changes to meet new business needs.



Handling Variables in PL/SQL

- Declare and initialize variables in the declaration section.

  You can declare variables in the declarative part of any PL/SQL block, subprogram, or package. Declarations allocate storage space for a value, specify its datatype, and name the storage location so that you can reference it. Declarations can also assign an initial value and impose the NOT NULL constraint.
- Assign new values to variables in the executable section.
  - The existing value of the variable is replaced with a new one.
  - Forward references are not allowed. You must declare a variable before referencing it in other statements, including other declarative statements.
- Pass values into PL/SQL subprograms through parameters.

  There are three parameter modes, IN (the default), OUT, and IN OUT. You use the IN parameter to pass values to the subprogram being called. You use the OUT parameter to return values to the caller of a subprogram. And you use the IN OUT parameter to pass initial values to the subprogram being called and to return updated values to the caller. IN and OUT subprogram parameters are covered in the another course.
- View the results from a PL/SQL block through output variables.

  You can use reference variables for input or output in SQL data manipulation statements.

Types of Variables

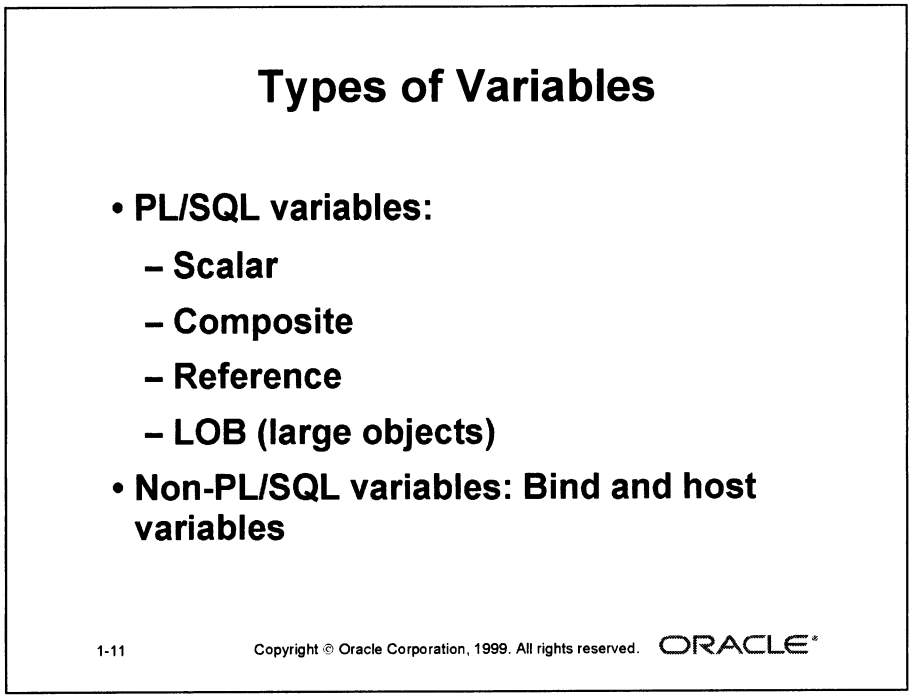
- **PL/SQL variables:**
  - **Scalar**
  - **Composite**
  - **Reference**
  - **LOB (large objects)**
- **Non-PL/SQL variables: Bind and host variables**

All PL/SQL variables have a datatype, which specifies a storage format, constraints, and valid range of values. PL/SQL supports four datatype categories—scalar, composite, reference, and LOB (large object)—that you can use for declaring variables, constants, and pointers.

- Scalar datatypes hold a single value. The main datatypes are those that correspond to column types in Oracle Server tables; PL/SQL also supports Boolean variables.
- Composite datatypes such as records allow groups of fields to be defined and manipulated in PL/SQL blocks. Composite datatypes are only briefly mentioned in this course.
- Reference datatypes hold values, called *pointers*, that designate other program items. Reference datatypes are not covered in this course.
- LOB datatypes hold values, called *locators*, that specify the location of large objects (graphic images for example) that are stored out of line. LOB datatypes are only briefly mentioned in this course.

Non-PL/SQL variables include host language variables declared in precompiler programs, screen fields in Forms applications, and SQL*Plus host variables.

For more information on LOBs, see *PL/SQL User's Guide and Reference*, Release 8, "Fundamentals."

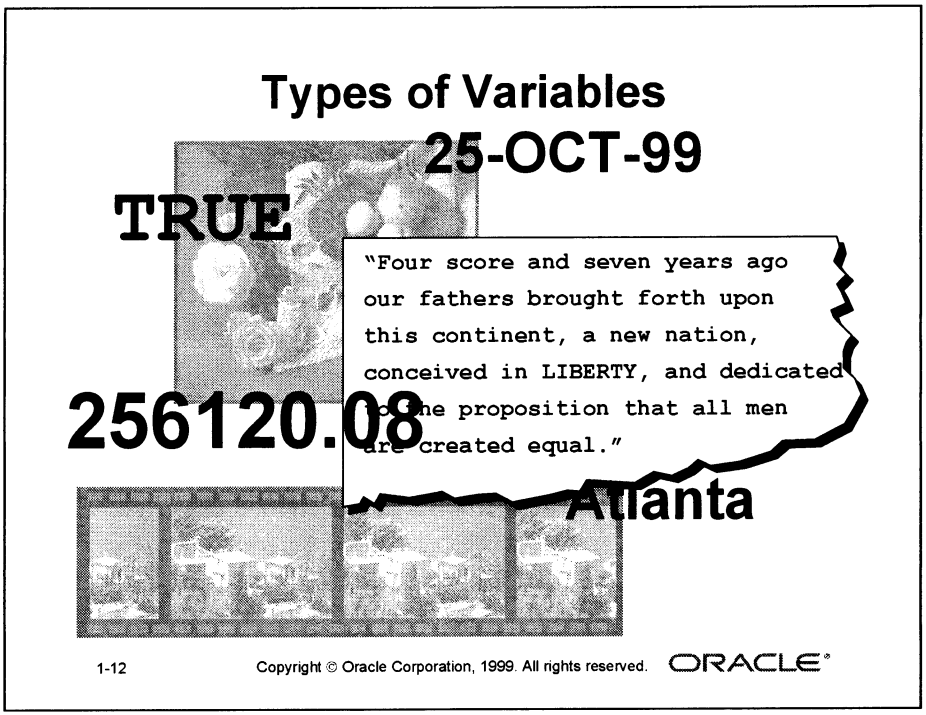


Using SQL*Plus Variables Within PL/SQL Blocks

PL/SQL does not have input/output capability of its own. You must rely on the environment in which PL/SQL is executing for passing values into and out of a PL/SQL block.

In the SQL*Plus environment, SQL*Plus substitution variables allow portions of command syntax to be stored and then edited into the command before it is run. Substitution variables are variables that you can use to pass runtime values, number or character, into a PL/SQL block. You can reference them within a PL/SQL block with a preceding ampersand in the same manner as you reference SQL*Plus substitution variables in a SQL statement. The text values are substituted into the PL/SQL block before the PL/SQL block is executed. Therefore you cannot substitute different values for the substitution variables by using a loop. Only one value will replace the substitution variable.

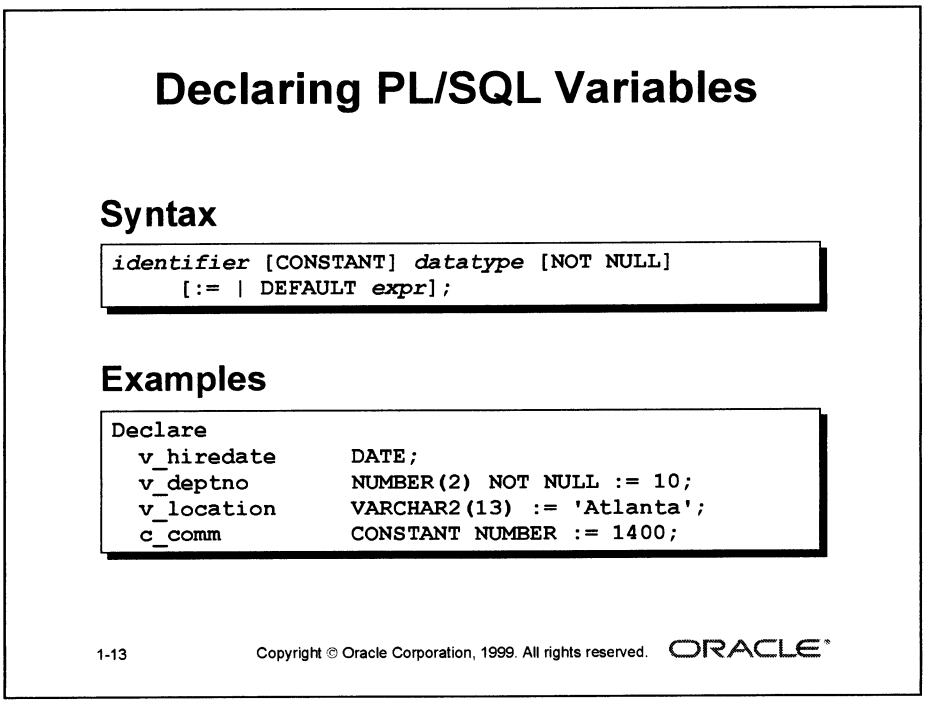
SQL*Plus host (or "bind") variables can be used to pass runtime values out of the PL/SQL block back to the SQL*Plus environment. You can reference them in a PL/SQL block with a preceding colon. Bind variables are discussed in further detail later in this lesson.



Types of Variables

The slide illustrates the following variable datatypes:

- TRUE represents a Boolean value.
- 25-OCT-99 represents a DATE.
- The photograph represents a BLOB.
- The text of a speech represents a LONG RAW.
- 256120.08 represents a NUMBER datatype with precision and scale.
- The movie represents a BFILE.
- The city name represents a VARCHAR2.



Declaring PL/SQL Variables

You need to declare all PL/SQL identifiers in the declaration section before referencing them in the PL/SQL block. You have the option to assign an initial value. You do not need to assign a value to a variable in order to declare it. If you refer to other variables in a declaration, you must be sure to declare them separately in a previous statement.

In the syntax:

identifier	is the name of the variable
CONSTANT	constrains the variable so that its value cannot change; constants must be initialized
datatype	is a scalar, composite, reference, or LOB datatype (This course covers only scalar and composite datatypes.)
NOT NULL	constrains the variable so that it must contain a value (NOT NULL variables must be initialized.)
expr	is any PL/SQL expression that can be a literal, another variable, or an expression involving operators and functions

Declaring PL/SQL Variables

Guidelines

- Follow naming conventions.
- Initialize variables designated as NOT NULL and CONSTANT.
- Initialize identifiers by using the assignment operator (:=) or the DEFAULT reserved word.
- Declare at most one identifier per line.

Guidelines

The assigned expression can be a literal, another variable, or an expression involving operators and functions.

- Name the identifier according to the same rules used for SQL objects.
- You can use naming conventions—for example, *v_name* to represent a variable and *c_name* to represent a constant variable.
- Initialize the variable to an expression with the assignment operator (:=) or, equivalently, with the DEFAULT reserved word. If you do not assign an initial value, the new variable contains NULL by default until you assign it later.
- If you use the NOT NULL constraint, you must assign a value.
- Declaring only one identifier per line makes code more easily read and maintained.
- In constant declarations, the keyword CONSTANT must precede the type specifier. The following declaration names a constant of NUMBER subtype REAL and assigns the value of 50000 to the constant. A constant must be initialized in its declaration; otherwise, you get a compilation error when the declaration is elaborated (compiled).

```
v_sal      CONSTANT REAL := 50000.00;
```

Naming Rules

- Two variables can have the same name, provided they are in different blocks.
- The variable name (identifier) should not be the same as the name of table columns used in the block.

```
DECLARE
  empno  NUMBER(4);
BEGIN
  SELECT    empno
  INTO      empno
  FROM      emp
  WHERE     ename = 'SMITH';
END;
```

Adopt a naming convention for PL/SQL identifiers: for example, v_empno

1-15 ORACLE

Naming Rules

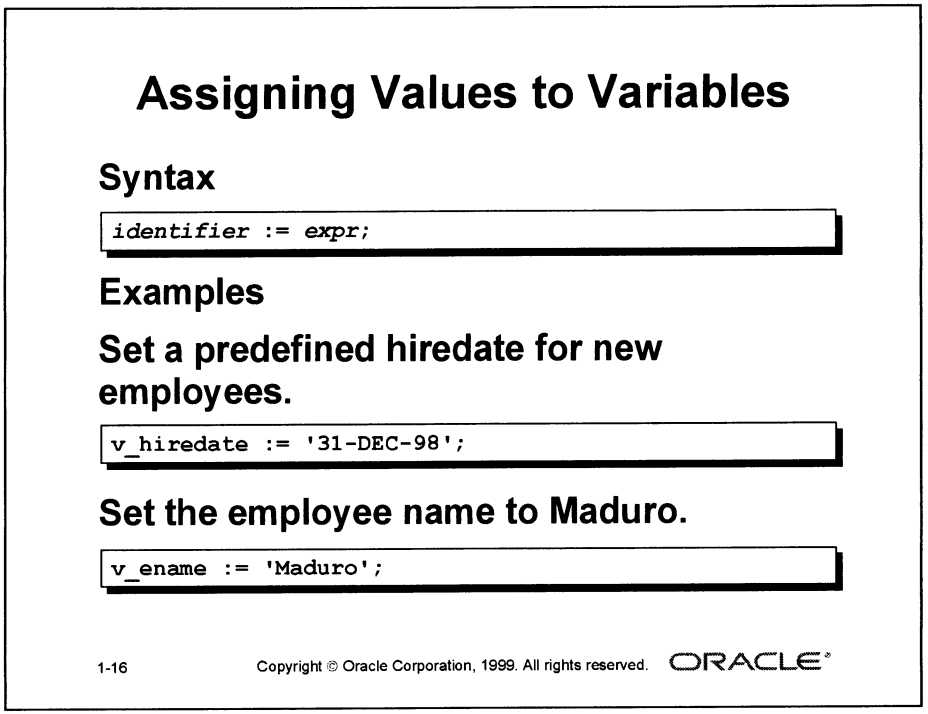
Two objects can have the same name, provided that they are defined in different blocks. Where they coexist, only the object declared in the current block can be used.

You should not choose the same name (identifier) for a variable as the name of table columns used in the block. If PL/SQL variables occur in SQL statements and have the same name as a column, the Oracle Server assumes that it is the column that is being referenced. Although the example code in the slide works, code written using the same name for a database table and variable name is not easy to read or maintain.

Consider adopting a naming convention for various objects such as the following example. Using v_ as a prefix representing *variable* and g_ representing *global* variable avoids naming conflicts with database objects.

```
DECLARE
   v_hiredate          date;
   g_deptno            number(2) NOT NULL := 10;
BEGIN
...
```

Note: Identifiers must not be longer than 30 characters. The first character must be a letter; the remaining characters can be letters, numbers, or special symbols.



Assigning Values to Variables

To assign or reassign a value to a variable, you write a PL/SQL assignment statement. You must explicitly name the variable to receive the new value to the left of the assignment operator (:=).

In the syntax:

identifier	is the name of the scalar variable
expr	can be a variable, literal, or function call, but *not* a database column

The variable value assignment examples are defined as follows:

- Set the identifier v_hiredate to a value of 31-DEC-98.
- Store the name "Maduro" in the v_ename identifier.

Another way to assign values to variables is to select or fetch database values into it. The following example, computes a 10% bonus when you select the salary of an employee:

```
SQL> SELECT     sal * 0.10
  2 INTO        v_bonus
  3 FROM        emp
  4 WHERE       empno = 7369;
```

Then you can use the variable v_*bonus* in another computation or insert its value into a database table.

Note: To assign a value into a variable from the database, use a SELECT or FETCH statement.

Variable Initialization and Keywords

Using:

- Assignment operator (:=)
- DEFAULT keyword
- NOT NULL constraint

Variables are initialized every time a block or subprogram is entered. By default, variables are initialized to NULL. Unless you expressly initialize a variable, its value is undefined.

- Use the assignment operator (:=) for variables that have no typical value.

```
v_hiredate := '15-SEP-1999'
```

Note: This assignment is possible only in Oracle8*i*. Lower versions may require the usage of the TO_DATE function.

Because the default date format set in the Oracle Server can differ from database to database, you may want to assign date values in a generic manner, as in the previous example.

- DEFAULT: You can use the DEFAULT keyword instead of the assignment operator to initialize variables. Use DEFAULT for variables that have a typical value.

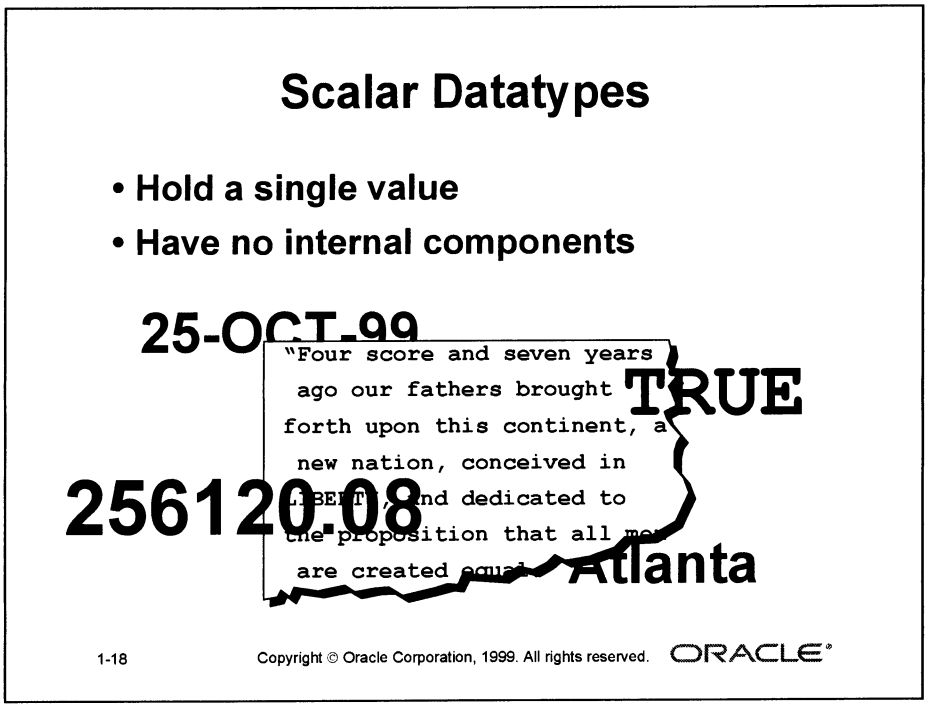
```
g_mgr          NUMBER(4) DEFAULT 7839;
```

- NOT NULL: Impose the NOT NULL constraint when the variable must contain a value.

  You cannot assign nulls to a variable defined as NOT NULL. The NOT NULL constraint must be followed by an initialization clause.

```
v_location  VARCHAR2(13) NOT NULL := 'CHICAGO';
```

Note: String literals must be enclosed in single quotation marks—for example, 'Hello, world'. If there is a single quotation mark in the string, write a single quotation mark twice—for example, to insert a value FISHERMAN'S DRIVE, the string would be 'FISHERMAN''S DRIVE'.



Scalar Datatypes

A scalar datatype holds a single value and has no internal components. Scalar datatypes can be classified into four categories: number, character, date, and Boolean. Character and number datatypes have subtypes that associate a base type to a constraint. For example, INTEGER and POSITIVE are subtypes of the NUMBER base type.

For more information and the complete list of scalar datatypes, see *PL/SQL User's Guide and Reference, Release 8*, "Fundamentals."

Base Scalar Datatypes

- VARCHAR2 (*maximum_length*)
- NUMBER [(*precision, scale*)]
- DATE
- CHAR [(*maximum_length*)]
- LONG
- LONG RAW
- BOOLEAN
- BINARY_INTEGER
- PLS_INTEGER

Base Scalar Datatypes

Data Type	Description
VARCHAR2 (*maximum_length*)	Base type for variable-length character data up to 32,767 bytes. There is no default size for VARCHAR2 variables and constants.
NUMBER [(*precision, scale*)]	Base type for fixed and floating-point numbers.
DATE	Base type for dates and times. DATE values include the time of day in seconds since midnight. The range for dates is between 4712 B.C. and 9999 A.D.
CHAR [(*maximum_length*)]	Base type for fixed-length character data up to 32,767 bytes. If you do not specify a *maximum_length*, the default length is set to 1.
LONG	Base type for variable-length character data up to 32,760 bytes. The maximum width of a LONG database column is 2,147,483,647 bytes.

Base Scalar Datatypes

- VARCHAR2 (*maximum_length*)
- NUMBER [(*precision, scale*)]
- DATE
- CHAR [(*maximum_length*)]
- LONG
- LONG RAW
- BOOLEAN
- BINARY_INTEGER
- PLS_INTEGER

Base Scalar Datatypes (continued)

Data type	Description
LONG RAW	Base type for binary data and byte strings up to 32,760 bytes. LONG RAW data is not interpreted by PL/SQL.
BOOLEAN	Base type that stores one of three possible values used for logical calculations: TRUE, FALSE, or NULL.
BINARY_INTEGER	Base type for integers between -2,147,483,647 and 2,147,483,647.
PLS_INTEGER	Base type for signed integers between -2,147,483,647 and 2,147,483,647. PLS_INTEGER values require less storage and are faster than NUMBER and BINARY_INTEGER values.

Note: The LONG datatype is similar to VARCHAR2, except that the maximum length of a LONG value is 32,760 bytes. Therefore, values longer than 32,760 bytes cannot be selected from a LONG database column into a LONG PL/SQL variable.

Scalar Variable Declarations

Examples

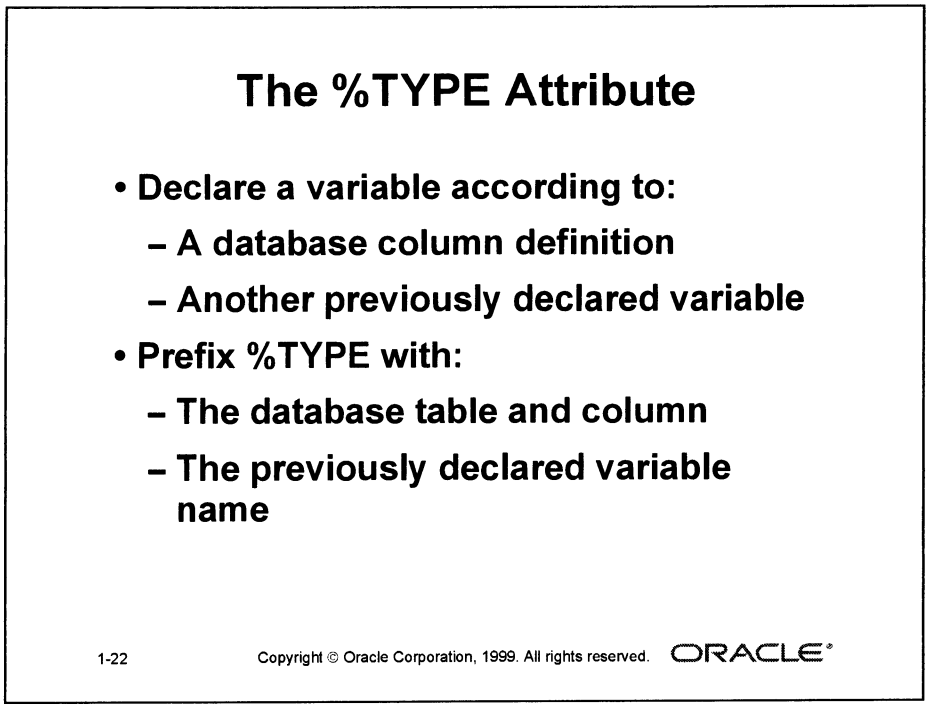
```
v_job          VARCHAR2(9);
v_count        BINARY_INTEGER := 0;
v_total_sal    NUMBER(9,2) := 0;
v_orderdate    DATE := SYSDATE + 7;
c_tax_rate     CONSTANT NUMBER(3,2) := 8.25;
v_valid        BOOLEAN NOT NULL := TRUE;
```

1-21 ORACLE

Declaring Scalar Variables

The examples of variable declaration shown on the slide are defined as follows:

- v_job: Declared variable to store an employee job title.
- v_count: Declared variable to count the iterations of a loop and initialize the variable to 0.
- v_total_sal: Declared variable to accumulate the total salary for a department and initialize the variable to 0.
- v_orderdate: Declared variable to store the ship date of an order and initialize the variable to one week from today.
- c_tax_rate: Declared a constant variable for the tax rate, which never changes throughout the PL/SQL block.
- v_valid: Declared flag to indicate whether a piece of data is valid or invalid and initialize the variable to TRUE.

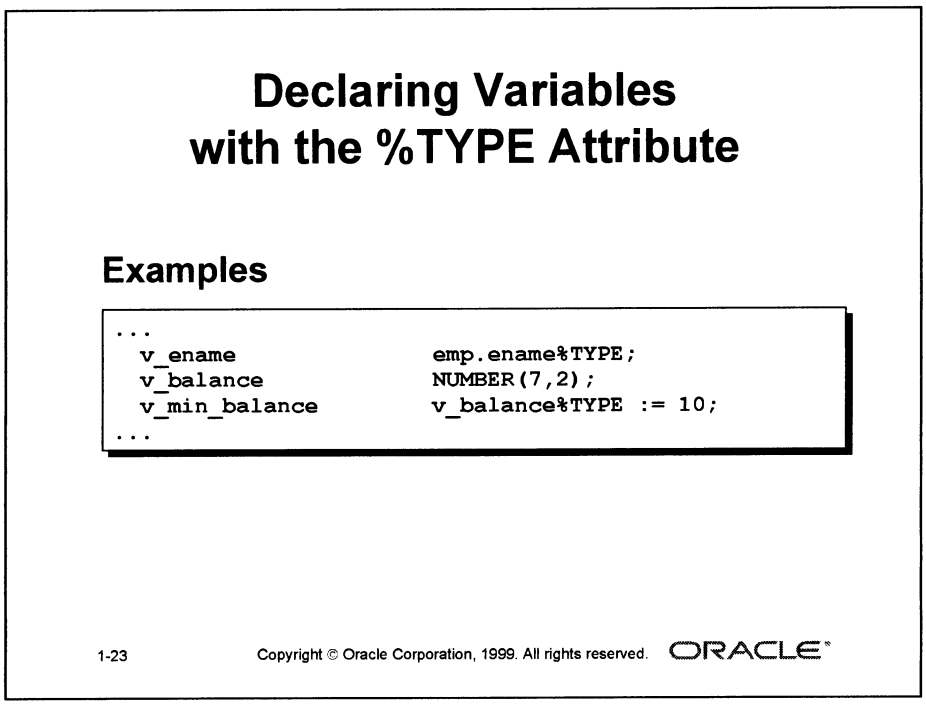


The %TYPE Attribute

When you declare PL/SQL variables to hold column values, you must ensure that the variable is of the correct datatype and precision. If it is not, a PL/SQL error will occur during execution.

Rather than hard coding the datatype and precision of a variable, you can use the %TYPE attribute to declare a variable according to another previously declared variable or database column. The %TYPE attribute is most often used when the value stored in the variable will be derived from a table in the database or if the variable is destined to be written to. To use the attribute in place of the datatype required in the variable declaration, prefix it with the database table and column name. If referring to a previously declared variable, prefix the variable name to the attribute.

PL/SQL determines the datatype and size of the variable when the block is compiled, so it is always compatible with the column used to populate it. This is a definite advantage for writing and maintaining code, because there is no need to be concerned with column datatype changes made at the database level. You can also declare a variable according to another previously declared variable by prefixing the variable name to the attribute.



Declaring Variables with the %TYPE Attribute

Declare variables to store the name of an employee.

```
...
v_ename                 emp.ename%TYPE;
...
```

Declare variables to store the balance of a bank account, as well as the minimum balance, which starts out as 10.

```
...
v_balance               NUMBER(7,2);
v_min_balance           v_balance%TYPE := 10;
...
```

A NOT NULL column constraint does not apply to variables declared using %TYPE. Therefore, if you declare a variable using the %TYPE attribute using a database column defined as NOT NULL, you can assign the NULL value to the variable.

Declaring Boolean Variables

- Only the values TRUE, FALSE, and NULL can be assigned to a Boolean variable.
- The variables are connected by the logical operators AND, OR, and NOT.
- The variables always yield TRUE, FALSE, or NULL.
- Arithmetic, character, and date expressions can be used to return a Boolean value.

Declaring Boolean Variables

With PL/SQL you can compare variables in both SQL and procedural statements. These comparisons, called *Boolean expressions*, consist of simple or complex expressions separated by relational operators. In a SQL statement, you can use Boolean expressions to specify the rows in a table that are affected by the statement. In a procedural statement, Boolean expressions are the basis for conditional control.

NULL stands for a missing, inapplicable, or unknown value.

Examples

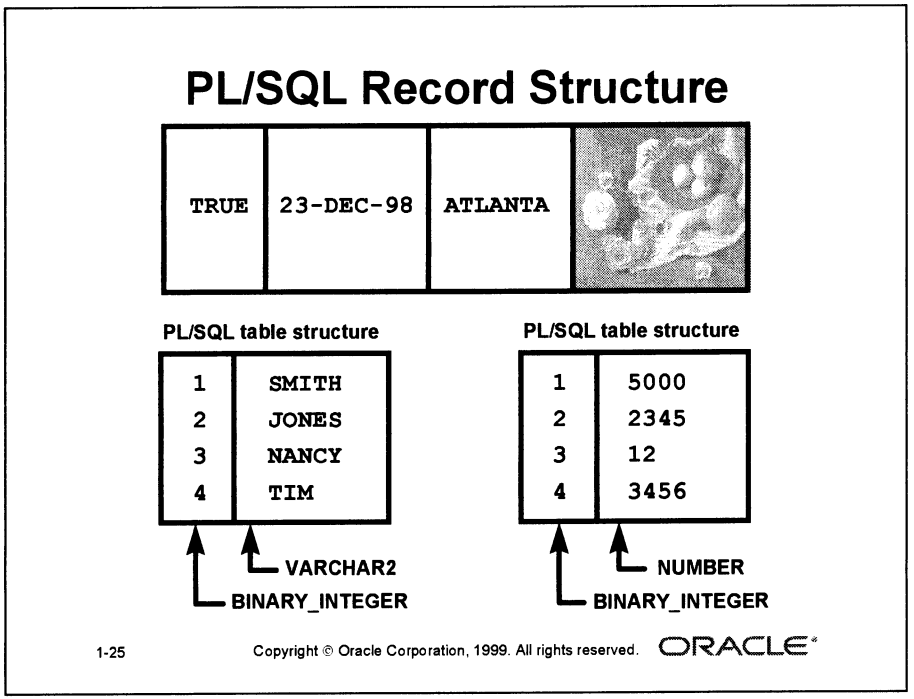
```
v_sal1 := 50000;
v_sal2 := 60000;
```

The following expression yields TRUE:

```
v_sal1 < v_sal2
```

Declare and initialize a Boolean variable:

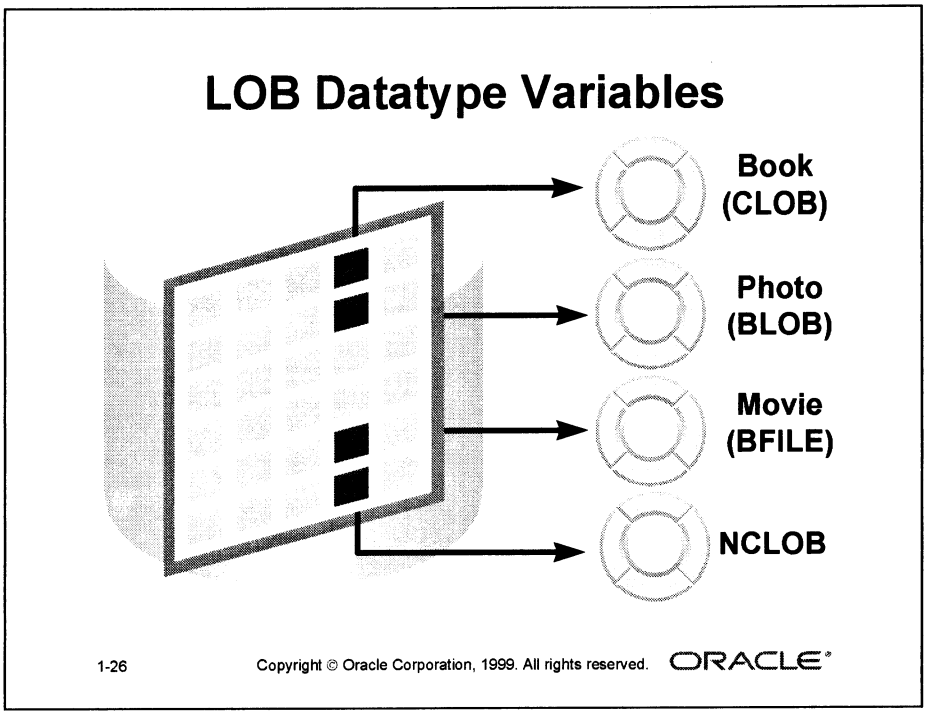
```
v_comm_sal BOOLEAN := (v_sal1 < v_sal2);
```



Composite Datatypes

Composite datatypes (also known as *collections*) are TABLE, RECORD, NESTED TABLE, and VARRAY. You use the RECORD datatype to treat related but dissimilar data as a logical unit. You use the TABLE datatype to reference and manipulate collections of data as a whole object. Both RECORD and TABLE datatypes are covered in detail in a subsequent lesson. The NESTED TABLE and VARRAY datatypes are not covered in this course.

For more information, see *PL/SQL User's Guide and Reference*, Release 8, "Collections and Records."

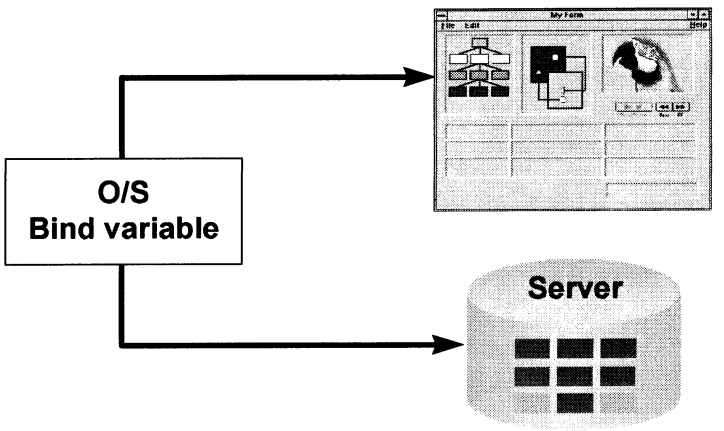


LOB Datatype Variables

With the LOB (large object) Oracle8 datatypes you can store blocks of unstructured data (such as text, graphic images, video clips, and sound wave forms) up to 4 gigabytes in size. LOB datatypes allow efficient, random, piecewise access to the data and can be attributes of an object type. LOBs also support random access to data.

- The CLOB (character large object) datatype is used to store large blocks of single-byte character data in the database.
- The BLOB (binary large object) datatype is used to store large binary objects in the database in line (inside the row) or out of line (outside the row).
- The BFILE (binary file) datatype is used to store large binary objects in operating system files outside the database.
- The NCLOB (national language character large object) datatype is used to store large blocks of single-byte or fixed-width multibyte NCHAR data in the database, in line or out of line.

Bind Variables



1-27 ORACLE

Bind Variables

A bind variable is a variable that you declare in a host environment and then use to pass runtime values, either number or character, into or out of one or more PL/SQL programs, which can use it as they would use any other variable. You can reference variables declared in the host or calling environment in PL/SQL statements, unless the statement is in a procedure, function, or package. This includes host language variables declared in precompiler programs, screen fields in Oracle Developer Forms applications, and SQL*Plus bind variables.

Creating Bind Variables

To declare a bind variable in the SQL*Plus environment, you use the command VARIABLE. For example, you declare a variable of type NUMBER and VARCHAR2 as follows:

```
VARIABLE return_code NUMBER
VARIABLE return_msg VARCHAR2(30)
```

Both SQL and SQL*Plus can reference the bind variable, and SQL*Plus can display its value.

Displaying Bind Variables

To display the current value of bind variables in the SQL*Plus environment, you use the command PRINT. However, PRINT cannot be used inside a PL/SQL block as a SQL*Plus command. The following example illustrates a PRINT command:

```
SQL> VARIABLE g_n NUMBER
...
SQL> PRINT g_n
```

Referencing Non-PL/SQL Variables

Store the annual salary into a SQL*Plus host variable.

```
:g_monthly_sal := v_sal / 12;
```

- Reference non-PL/SQL variables as host variables.
- Prefix the references with a colon (:).

Assigning Values to Variables

To reference host variables, you must prefix the references with a colon (:) to distinguish them from declared PL/SQL variables.

Example

This example computes the monthly salary, based upon the annual salary supplied by the user. This script contains both SQL*Plus commands as well as a complete PL/SQL block.

```
VARIABLE   g_monthly_sal  NUMBER
ACCEPT     p_annual_sal PROMPT 'Please enter the annual salary: '

DECLARE
  v_sal    NUMBER(9,2) := &p_annual_sal;
BEGIN
  :g_monthly_sal := v_sal/12;
END;
/

PRINT      g_monthly_sal
```

DBMS_OUTPUT.PUT_LINE

- An Oracle-supplied packaged procedure
- An alternative for displaying data from a PL/SQL block
- Must be enabled in SQL*Plus with SET SERVEROUTPUT ON

Another Option

You have seen that you can declare a host variable, reference it in a PL/SQL block, and then display its contents in SQL*Plus using the PRINT command. Another option for displaying information from a PL/SQL block is *DBMS_OUTPUT.PUT_LINE*. DBMS_OUTPUT is an Oracle-supplied package, and PUT_LINE is a procedure within that package.

Within a PL/SQL block, reference DBMS_OUTPUT.PUT_LINE and, in parentheses, the information you want to print to the screen. The package must first be enabled in your SQL*Plus session. To do this, execute the SQL*Plus command *SET SERVEROUTPUT ON*.

Example

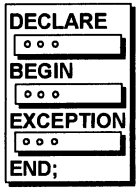
This script computes the monthly salary and prints it to the screen, using DBMS_OUTPUT.PUT_LINE.

```
SET SERVEROUTPUT ON
ACCEPT    p_annual_sal PROMPT 'Please enter the annual salary: '

DECLARE
  v_sal   NUMBER(9,2) := &p_annual_sal;
BEGIN
  v_sal := v_sal/12;
  DBMS_OUTPUT.PUT_LINE ('The monthly salary is ' || TO_CHAR(v_sal));
END;
/
```

Summary

- PL/SQL blocks are composed of the following sections:
  - Declarative (optional)
  - Executable (required)
  - Exception handling (optional)
- A PL/SQL block can be an anonymous block, procedure, or function.



Summary

A PL/SQL block is the basic, unnamed unit of a PL/SQL program. It consists of a set of SQL or PL/SQL statements and it performs a single logical function. The declarative part is the first part of a PL/SQL block and is used for declaring objects such as variables, constants, cursors, and definitions of error situations called exceptions. The executable part is the mandatory part of a PL/SQL block and contains SQL and PL/SQL statements for querying and manipulating data. The exception-handling part is embedded inside the executable part of a block and is placed at the end of the executable part.

An anonymous PL/SQL block is the basic, unnamed unit of a PL/SQL program. Procedures and functions can be compiled separately and stored permanently in an Oracle database, ready to be executed.

Summary

- PL/SQL identifiers:
  - Are defined in the declarative section
  - Can be of scalar, composite, reference, or LOB datatype
  - Can be based on the structure of another variable or database object
  - Can be initialized

Summary (continued)

All PL/SQL datatypes are scalar, composite, reference or LOB type. Scalar datatypes do not have any components within them, while composite datatypes have other datatypes within them. PL/SQL variables are declared and initialized in the decalrative section.

Practice Overview

- Determining validity of declarations
- Developing a simple PL/SQL block

Practice Overview

This practice reinforces the basics of PL/SQL learned in this lesson, including datatypes, legal definitions of identifiers, and validation of expressions. You put all these elements together to create a simple PL/SQL block.

Paper-Based Questions

Questions 1 and 2 are paper-based questions.

Practice 1

1. Evaluate each of the following declarations. Determine which of them are *not* legal and explain why.

   a.
   ```
   DECLARE
     v_id              NUMBER(4);
   ```

   b.
   ```
   DECLARE
     v_x, v_y, v_z     VARCHAR2(10);
   ```
   Not valid

   c.
   ```
   DECLARE
     v_birthdate       DATE NOT NULL;
   ```

   d.
   ```
   DECLARE
     v_in_stock        BOOLEAN := 1;
   ```

Practice 1 (continued)

2. In each of the following assignments, determine the datatype of the resulting expression.

   a. `v_days_to_go := v_due_date - SYSDATE;`

   b. `v_sender := USER || ': ' || TO_CHAR(v_dept_no);`

   c. `v_sum := $100,000 + $250,000;`

   d. `v_flag := TRUE;`

   e. `v_n1 := v_n2 > (2 * v_n3);`

   f. `v_value := NULL;`

3. Create an anonymous block to output the phrase "My PL/SQL Block Works" to the screen.

```
G_MESSAGE
-----------------------
My PL/SQL Block Works
```

Practice 1 (continued)

If you have time, complete the following exercise:

4. Create a block that declares two variables. Assign the value of these PL/SQL variables to SQL*Plus host variables and print the results of the PL/SQL variables to the screen. Execute your PL/SQL block. Save your PL/SQL block to a file named `p1q4.sql`.

```
V_CHAR Character (variable length)
V_NUM  Number
```

Assign values to these variables as follows:

```
Variable Value
-------- -------------------------------------
V_CHAR   The literal '42 is the answer'
V_NUM    The first two characters from V_CHAR
```

```
G_CHAR
----------------------
42 is the answer

    G_NUM
---------
       42
```

2

Writing Executable Statements

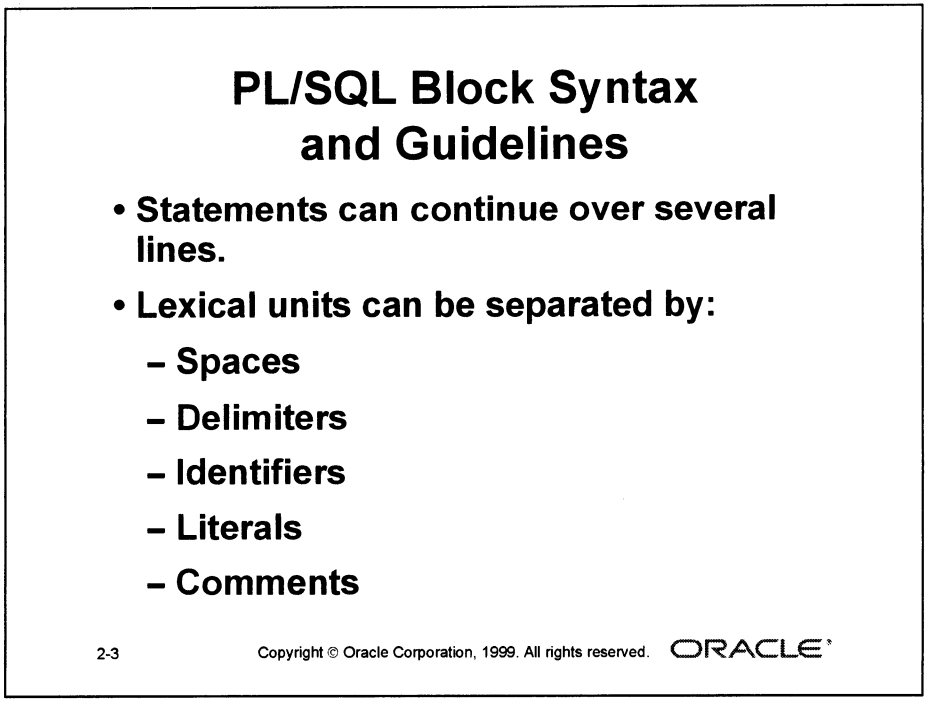
Objectives

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

- Recognize the significance of the executable section
- Write statements in the executable section
- Describe the rules of nested blocks
- Execute and test a PL/SQL block
- Use coding conventions

Lesson Aim

In this lesson, you will learn how to write executable code in the PL/SQL block. You will also learn the rules for nesting PL/SQL blocks of code, as well as how to execute and test their PL/SQL code.



PL/SQL Block Syntax and Guidelines

Because PL/SQL is an extension of SQL, the general syntax rules that apply to SQL also apply to the PL/SQL language.

- Lexical units (for example, identifiers and literals) can be separated by one or more spaces or other delimiters that cannot be confused as being part of the lexical unit. You cannot embed spaces in lexical units except for string literals and comments.
- Statements can be split across lines, but keywords must not be split.

Delimiters

Delimiters are simple or compound symbols that have special meaning to PL/SQL.

Simple Symbols **Compound Symbols**

Symbol	Meaning	Symbol	Meaning
+	Addition operator	<>	Relational operator
-	Subtraction/negation operator	!=	Relational operator
*	Multiplication operator	||	Concatenation operator
/	Division operator	--	Single line comment indicator
=	Relational operator	/*	Beginning comment delimiter
@	Remote access indicator	*/	Ending comment delimiter
;	Statement terminator	:=	Assignment operator

For more information, see *PL/SQL User's Guide and Reference*, Release 8, "Fundamentals."

PL/SQL Block Syntax and Guidelines

Identifiers

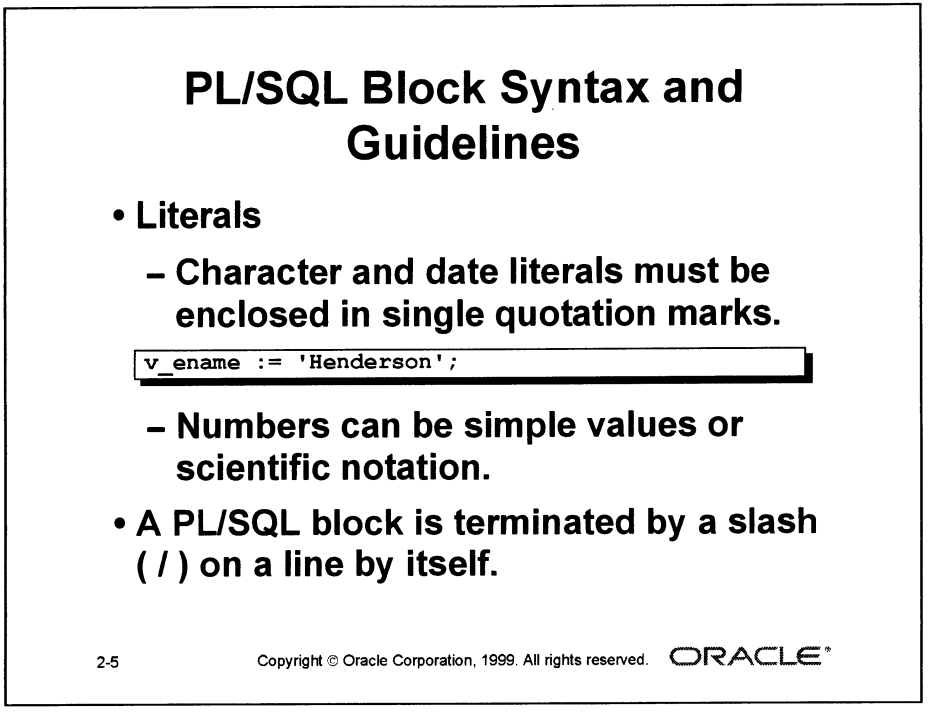
- Can contain up to 30 characters
- Cannot contain reserved words unless enclosed in double quotation marks
- Must begin with an alphabetic character
- Should not have the same name as a database table column name

Identifiers

Identifiers are used to name PL/SQL program items and units, which include constants, variables, exceptions, cursors, cursor variables, subprograms, and packages.

- Identifiers can contain up to 30 characters, but they must start with an alphabetic character.
- Do not choose the same name for the identifier as the name of columns in a table used in the block. If PL/SQL identifiers are in the same SQL statements and have the same name as a column, then Oracle assumes that it is the column that is being referenced.
- Reserved words cannot be used as identifiers unless they are enclosed in double quotation marks (for example, "SELECT").
- Reserved words should be written in uppercase to promote readability.

For a complete list of reserved words, see *PL/SQL User's Guide and Reference*, Release 8, "Appendix F."



Literals

- A literal is an explicit numeric, character, string, or Boolean value not represented by an identifier.
  - Character literals include all the printable characters in the PL/SQL character set: letters, numerals, spaces, and special symbols.
  - Numeric literals can be represented either by a simple value (for example, -32.5) or by scientific notation (for example, 2E5, meaning 2* (10 to the power of 5) = 200000).
- A PL/SQL block is terminated by a slash (/) on a line by itself.

Commenting Code

- **Prefix single-line comments with two dashes (--).**
- **Place multi-line comments between the symbols /* and */.**

Example

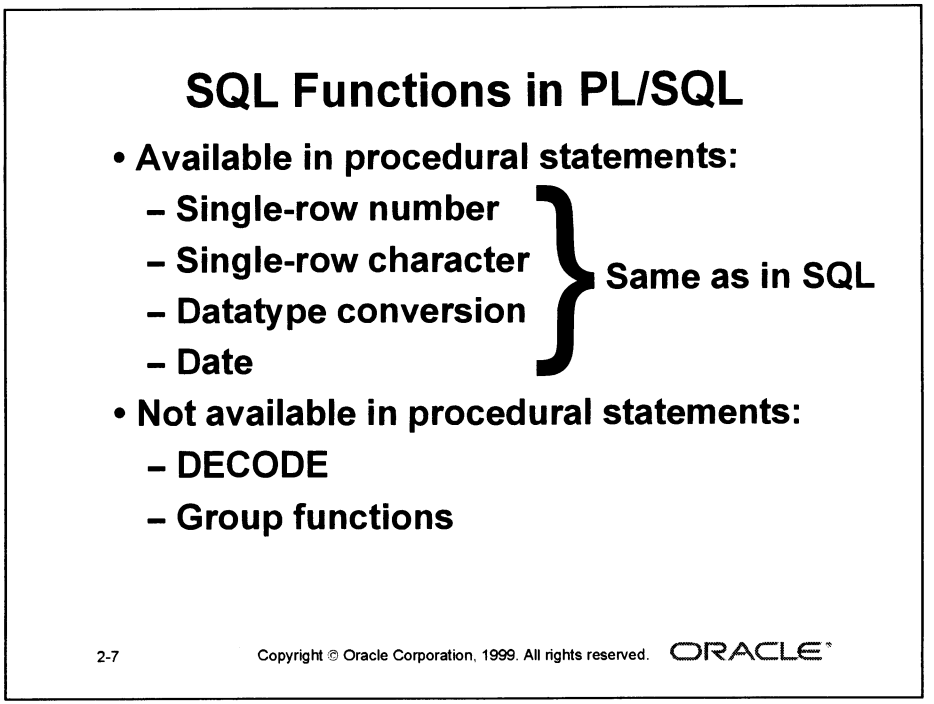
```
...
  v_sal NUMBER (9,2);
BEGIN
  /* Compute the annual salary based on the
     monthly salary input from the user */
  v_sal := &p_monthly_sal * 12;
END; -- This is the end of the block
```


Commenting Code

Comment code to document each phase and to assist with debugging. Comment the PL/SQL code with two dashes (--) if the comment is on a single line, or enclose the comment between the symbols /* and */ if the comment spans several lines. Comments are strictly informational and do not enforce any conditions or behavior on behavioral logic or data. Well-placed comments are extremely valuable for code readability and future code maintenance.

Example

In the example on the slide, the line enclosed within /* and */ is the comment that explains the code that follows it.



SQL Functions in PL/SQL

Most of the functions available in SQL are also valid in PL/SQL expressions:

- Single-row number functions
- Single-row character functions
- Datatype conversion functions
- Date functions
- GREATEST, LEAST
- Miscellaneous functions

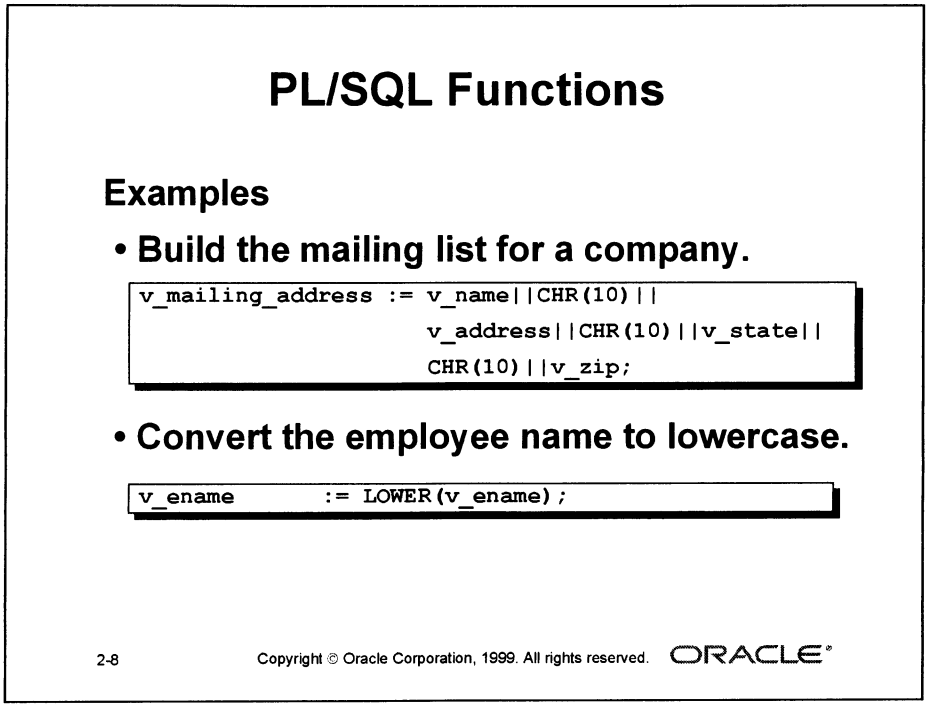
The following functions are not available in procedural statements:

- DECODE.
- Group functions: AVG, MIN, MAX, COUNT, SUM, STDDEV, and VARIANCE. Group functions apply to groups of rows in a table and therefore are available only in SQL statements in a PL/SQL block.

Example

Compute the sum of all numbers stored in the NUMBER_TABLE PL/SQL table. *This example produces a compilation error.*

```
v_total     := SUM(number_table);
```



PL/SQL Functions

PL/SQL provides many powerful functions to help you manipulate data. These built-in functions fall into the following categories:

- Error reporting
- Number
- Character
- Conversion
- Date
- Miscellaneous

The function examples in the slide are defined as follows:

- Build the mailing address for a company.
- Convert the name to lowercase.

CHR is the SQL function that converts an ASCII code to its corresponding character; 10 is the code for a line feed.

For more information, see *PL/SQL User's Guide and Reference*, Release 8, "Fundamentals."

Datatype Conversion

- Convert data to comparable datatypes.
- Mixed datatypes can result in an error and affect performance.
- Conversion functions:
  - TO_CHAR
  - TO_DATE
  - TO_NUMBER

```
DECLARE
   v_date VARCHAR2(15);
BEGIN
   SELECT TO_CHAR(hiredate,
                  'MON. DD, YYYY')
   INTO   v_date
   FROM   emp
   WHERE  empno = 7839;
END;
```


Datatype Conversion

PL/SQL attempts to convert datatypes dynamically if they are mixed in a statement. For example, if you assign a NUMBER value to a CHAR variable, then PL/SQL dynamically translates the number into a character representation, so that it can be stored in the CHAR variable. The reverse situation also applies, providing that the character expression represents a numeric value.

Providing that they are compatible, you can also assign characters to DATE variables and vice versa.

Within an expression, you should make sure that datatypes are the same. If mixed datatypes occur in an expression, you should use the appropriate conversion function to convert the data.

Syntax

```
TO_CHAR (value, fmt)

TO_DATE (value, fmt)

TO_NUMBER (value, fmt)
```

where:	*value*	is a character string, number, or date
	fmt	is the format model used to convert value

Datatype Conversion

This statement produces a compilation error if the variable v_date is declared as datatype DATE.

```
v_date := 'January 13, 1998';
```

To correct the error, use the TO_DATE conversion function.

```
v_date := TO_DATE ('January 13, 1998',
                   'Month DD, YYYY');
```


Datatype Conversion

The conversion examples in the slide are defined as follows:

- Store a character string representing a date in a variable declared of datatype DATE. *This code causes a syntax error.*
- To correct the error, convert the string to a date with the TO_DATE conversion function.

PL/SQL attempts conversion if possible, but the success depends on the operations being performed. It is good programming practice to explicitly perform datatype conversions, because they can favorably affect performance and remain valid even with a change in software versions.

Nested Blocks and Variable Scope

- Statements can be nested wherever an executable statement is allowed.
- A nested block becomes a statement.
- An exception section can contain nested blocks.
- The scope of an object is the region of the program that can refer to the object.

2-11 ORACLE

Nested Blocks

One of the advantages that PL/SQL has over SQL is the ability to nest statements. You can nest blocks wherever an executable statement is allowed, thus making the nested block a statement. Therefore, you can break down the executable part of a block into smaller blocks. The exception section can also contain nested blocks.

Variable Scope

The scope of an object is the region of the program that can refer to the object. You can reference the declared variable within the executable section.

Nested Blocks and Variable Scope

An identifier is visible in the regions in which you can reference the unqualified identifier:

- **A block can look up to the enclosing block.**
- **A block cannot look down to enclosed blocks.**

Identifiers

An identifier is visible in the block in which it is declared and in all nested subblocks, procedures, and functions. If the block does not find the identifier declared locally, it looks *up* to the declarative section of the enclosing (or parent) blocks. The block never looks *down* to enclosed (or child) blocks or sideways to sibling blocks.

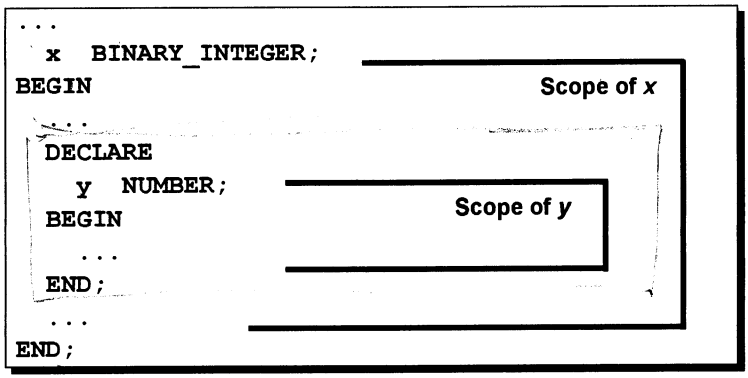
Scope applies to all declared objects, including variables, cursors, user-defined exceptions, and constants.

Note: Qualify an identifier by using the block label prefix.

For more information on block labels, see *PL/SQL User's Guide and Reference,* Release 8, "Fundamentals."

Nested Blocks and Variable Scope

Example



Nested Blocks and Variable Scope

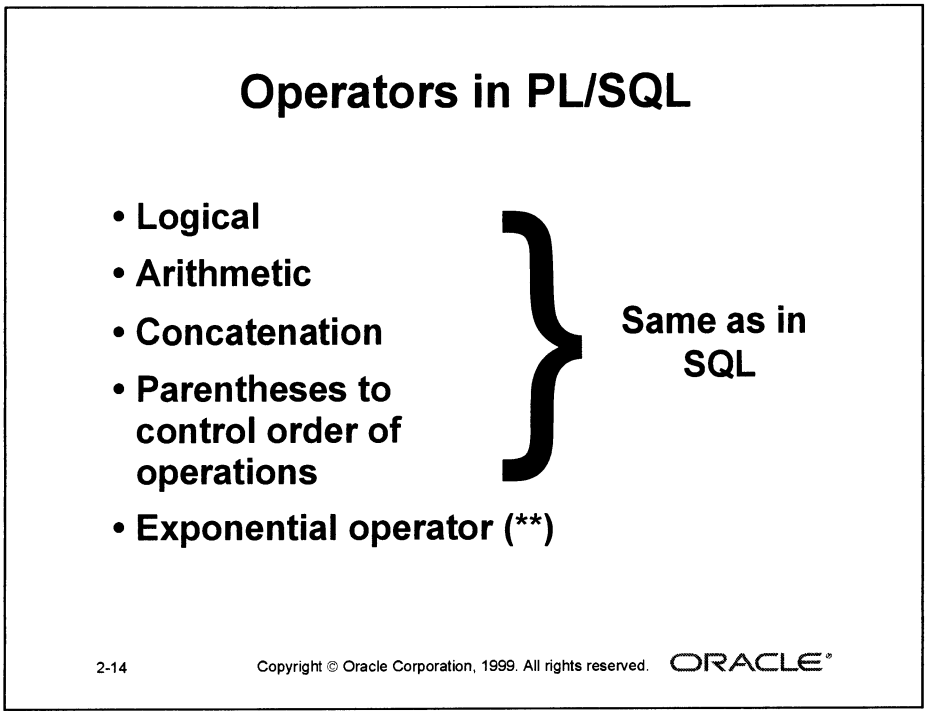
In the nested block shown on the slide, the variable named *y* can reference the variable named *x*. Variable *x*, however, cannot reference variable *y*. If the variable named *y* in the nested block is given the same name as the variable named *x* in the outer block its value is valid only for the duration of the nested block.

Scope

The scope of an identifier is that region of a program unit (block, subprogram, or package) from which you can reference the identifier.

Visibility

An identifier is visible only in the regions from which you can reference the identifier using an unqualified name.



Order of Operations

The operations within an expression are done in a particular order depending on their precedence (priority). The following table shows the default order of operations from top to bottom:

Operator	Operation
**, NOT	Exponentiation, logical negation
+, -	Identity, negation
*, /	Multiplication, division
+, -, ||	Addition, subtraction, concatenation
=, !=, <, >, <=, >=, IS NULL, LIKE, BETWEEN, IN	Comparison
AND	Conjunction
OR	Inclusion

Note: It is not necessary to use parentheses with Boolean expressions, but it does make the text easier to read.

For more information on operators, see *PL/SQL User's Guide and Reference*, Release 8, "Fundamentals."

Operators in PL/SQL

Examples

- **Increment the counter for a loop.**

```
v_count        := v_count + 1;
```

- **Set the value of a Boolean flag.**

```
v_equal        := (v_n1 = v_n2);
```

- **Validate an employee number if it contains a value.**

```
v_valid        := (v_empno IS NOT NULL);
```

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Operators in PL/SQL

When working with nulls, you can avoid some common mistakes by keeping in mind the following rules:

- Comparisons involving nulls always yield NULL.
- Applying the logical operator NOT to a null yields NULL.
- In conditional control statements, if the condition yields NULL, its associated sequence of statements is not executed.

Using Bind Variables

To reference a bind variable in PL/SQL, you must prefix its name with a colon (:).

Example

```
VARIABLE      g_salary NUMBER
DECLARE
   v_sal      emp.sal%TYPE;
BEGIN
   SELECT     sal
   INTO       v_sal
   FROM       emp
   WHERE      empno = 7369;
  :g_salary   := v_sal;
END;
/
```


Printing Bind Variables

In SQL*Plus you can display the value of the bind variable using the PRINT command.

```
SQL>  PRINT g_salary

G_SALARY
--------
     800
```

Programming Guidelines

Make code maintenance easier by:

- **Documenting code with comments**
- **Developing a case convention for the code**
- **Developing naming conventions for identifiers and other objects**
- **Enhancing readability by indenting**

Programming Guidelines

Follow these programming guidelines to produce clear code and reduce maintenance when developing a PL/SQL block.

Code Conventions

The following table gives guidelines for writing code in uppercase or lowercase to help you to distinguish keywords from named objects.

Category	Case Convention	Examples
SQL statements	Uppercase	SELECT, INSERT
PL/SQL keywords	Uppercase	DECLARE, BEGIN, IF
Datatypes	Uppercase	VARCHAR2, BOOLEAN
Identifiers and parameters	Lowercase	v_sal, emp_cursor, g_sal, p_empno
Database tables and columns	Lowercase	emp, orderdate, deptno

Code Naming Conventions

Avoid ambiguity:

- The names of local variables and formal parameters take precedence over the names of database tables.
- The names of columns take precedence over the names of local variables.

Code Naming Conventions

The following table shows a set of prefixes and suffixes to distinguish identifiers from other identifiers, from database objects, and from other named objects.

Identifier	Naming Convention	Example
Variable	v_*name*	v_sal
Constant	c_*name*	c_company_name
Cursor	*name*_cursor	emp_cursor
Exception	e_*name*	e_too_many
Table type	*name*_table_type	amount_table_type
Table	*name*_table	order_total_table
Record type	*name*_record_type	emp_record_type
Record	*name*_record	customer_record
SQL*Plus substitution variable (also referred to as substitution parameter)	p_*name*	p_sal
SQL*Plus global variable (also referred to as host or bind variable)	g_*name*	g_year_sal

Indenting Code

For clarity, indent each level of code.

Example

```
BEGIN
  IF x=0 THEN
     y:=1;
  END IF;
END;
```

```
DECLARE
  v_deptno        NUMBER(2);
  v_location      VARCHAR2(13);
BEGIN
  SELECT  deptno,
          loc
  INTO    v_deptno,
          v_location
  FROM    dept
  WHERE   dname = 'SALES';
...
END;
```


Indenting Code

For clarity, and to enhance readability, indent each level of code. To show structure, you can divide lines using carriage returns and indent lines using spaces or tabs. Compare the following IF statements for readability:

```
IF x>y THEN v_max:=x;ELSE v_max:=y;END IF;
```

```
IF x > y THEN
   v_max := x;
ELSE
   v_max := y;
END IF;
```

Determining Variable Scope

Class Exercise

```
...
DECLARE
V_SAL          NUMBER(7,2) := 60000;
V_COMM         NUMBER(7,2) := V_SAL * .20;
V_MESSAGE      VARCHAR2(255) := ' eligible for commission';
BEGIN ...
```

```
DECLARE
  V_SAL              NUMBER(7,2) := 50000;
  V_COMM             NUMBER(7,2) := 0;
  V_TOTAL_COMP       NUMBER(7,2) := V_SAL + V_COMM;
BEGIN ...
  V_MESSAGE := 'CLERK not'||V_MESSAGE;
END;
```

```
   V_MESSAGE := 'SALESMAN'||V_MESSAGE;
END;
```

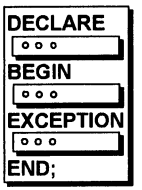

Class Exercise

Evaluate the PL/SQL block on the slide. Determine each of the following values according to the rules of scoping:

1. The value of V_MESSAGE in the subblock.
2. The value of V_TOTAL_COMP in the main block.
3. The value of V_COMM in the subblock.
4. The value of V_COMM in the main block.
5. The value of V_MESSAGE in the main block.

Summary

- PL/SQL block structure: Nesting blocks and scoping rules
- PL/SQL programming:
  - Functions
  - Datatype conversions
  - Operators
  - Bind variables
  - Conventions and guidelines



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Summary

A block can have any number of nested blocks defined within its executable part. Blocks defined within a block are called sub-blocks. You can nest blocks only in executable part of a block.

PL/SQL provides many powerful functions to help you manipulate data. Conversion functions convert a value from one datatype to another. Generally, the form of the function names follows the convention *datatype* TO *datatype*. The first datatype is the input datatype. The second datatype is the output datatype.

Comparison operators compare one expression to another. The result is always true, false, or null. Typically, you use comparison operators in conditional control statements and in the WHERE clause of SQL data manipulation statements. The relational operators allow you to compare arbitrarily complex expressions.

Variables declared in SQL*Plus are called bind variables. To reference these variables in PL/SQL programs, they should be preceded by a colon.

Practice Overview

- Reviewing scoping and nesting rules
- Developing and testing PL/SQL blocks

Practice Overview

This practice reinforces the basics of PL/SQL presented in the lesson, including the rules for nesting PL/SQL blocks of code as well as how to execute and test their PL/SQL code.

Paper-Based Questions

Questions 1 and 2 are paper-based questions.

Practice 2

PL/SQL Block

```
DECLARE
  v_weightNUMBER(3) := 600;
  v_message           VARCHAR2(255) := 'Product 10012';
BEGIN
                      /* SUB-BLOCK */
    DECLARE
      v_weight          NUMBER(3) := 1;
      v_message         VARCHAR2(255) := 'Product 11001';
      v_new_locn        VARCHAR2(50) := 'Europe';
    BEGIN
      v_weight := v_weight + 1;
      v_new_locn := 'Western ' || v_new_locn;
    END;

  v_weight := v_weight + 1;
  v_message := v_message || ' is in stock';
  v_new_locn           := 'Western ' || v_new_locn;
END;
```

1. Evaluate the PL/SQL block above and determine the datatype and value of each of the following variables according to the rules of scoping.
   a. The value of V_WEIGHT in the subblock is:

   b. The value of V_NEW_LOCN in the subblock is:

   c. The value of V_WEIGHT in the main block is:

   d. The value of V_MESSAGE in the main block is:

   e. The value of V_NEW_LOCN in the main block is:

Practice 2 (continued)

Scope Example

```
DECLARE
  v_customer          VARCHAR2(50) := 'Womansport';
  v_credit_rating     VARCHAR2(50) := 'EXCELLENT';
BEGIN
  DECLARE
    v_customer   NUMBER(7) := 201;
    v_name   VARCHAR2(25) := 'Unisports';
  BEGIN
   v_customer      v_name   v_credit_rating
  END;

   v_customer      v_name   v_credit_rating
END;
```

2. Suppose you embed a subblock within a block, as shown above. You declare two variables, V_CUSTOMER and V_CREDIT_RATING, in the main block. You also declare two variables, V_CUSTOMER and V_NAME, in the subblock. Determine the values and datatypes for each of the following cases.
   a. The value of V_CUSTOMER in the subblock is:

   b. The value of V_NAME in the subblock is:

   c. The value of V_CREDIT_RATING in the subblock is:

   d. The value of V_CUSTOMER in the main block is:

   e. The value of V_NAME in the main block is:

   f. The value of V_CREDIT_RATING in the main block is:

Practice 2 (continued)

3. Create and execute a PL/SQL block that accepts two numbers through SQL*Plus substitution variables. The first number should be divided by the second number and have the second number added to the result. The result should be stored in a PL/SQL variable and printed on the screen, or the result should be written to a SQL*Plus variable and printed to the screen.

   a. When a PL/SQL variable is used:

```
Please enter the first number: 2
Please enter the second number: 4
4.5
PL/SQL procedure successfully completed.
```

   b. When a SQL*Plus variable is used:

```
Please enter the first number: 2
Please enter the second number: 4

PL/SQL procedure successfully completed.

  G_RESULT
  --------
       4.5
```

4. Build a PL/SQL block that computes the total compensation for one year. The annual salary and the annual bonus percentage are passed to the PL/SQL block through SQL*Plus substitution variables, and the bonus needs to be converted from a whole number to a decimal (for example, 15 to .15). If the salary is null, set it to zero before computing the total compensation. Execute the PL/SQL block. *Reminder:* Use the NVL function to handle null values.

   Note: To test the NVL function, type NULL at the prompt; pressing |Return| results in a missing expression error.

```
Please enter the salary amount: 50000
Please enter the bonus percentage: 10

PL/SQL procedure successfully completed.

G_TOTAL
-------
  55000
```

3

Interacting with the Oracle Server

Objectives

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

- **Write a successful SELECT statement in PL/SQL**
- **Declare the datatype and size of a PL/SQL variable dynamically**
- **Write DML statements in PL/SQL**
- **Control transactions in PL/SQL**
- **Determine the outcome of SQL DML statements**

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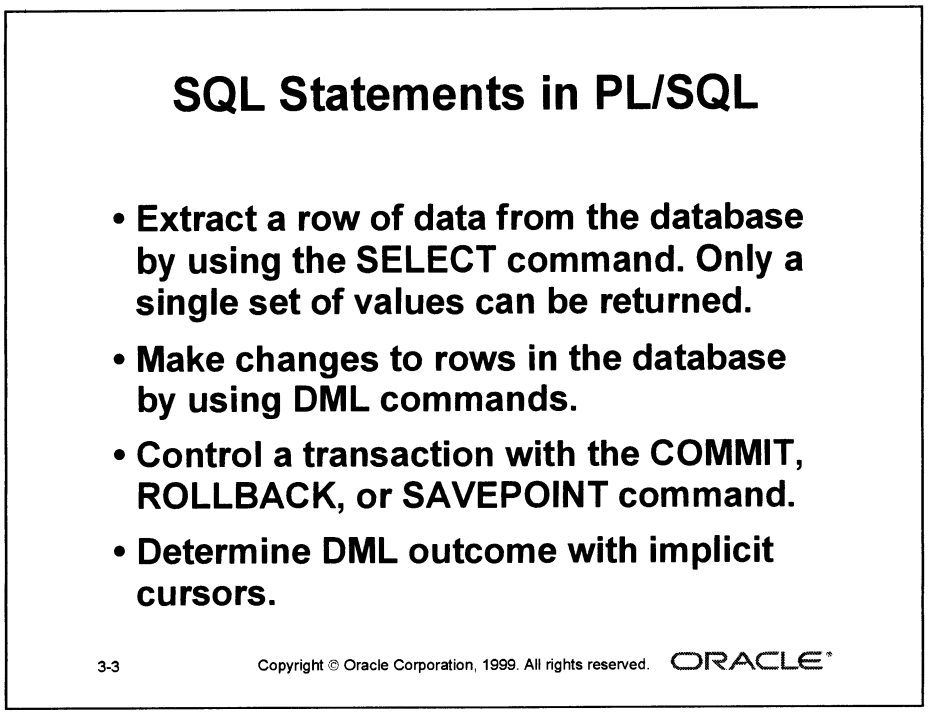
Lesson Aim

In this lesson, you will learn to embed standard SQL SELECT, INSERT, UPDATE, and DELETE statements in PL/SQL blocks. You will also learn how to control transactions and determine the outcome of SQL DML statements in PL/SQL.



Overview

When you need to extract information from or apply changes to the database, you must use SQL. PL/SQL supports full data manipulation language and transaction control commands within SQL. You can use SELECT statements to populate variables with values queried from a row in a table. Your DML (data manipulation) commands can process multiple rows.

Comparing SQL and PL/SQL Statement Types

- A PL/SQL block is not a transaction unit. Commits, savepoints, and rollbacks are independent of blocks, but you can issue these commands within a block.
- PL/SQL does not support data definition language (DDL), such as CREATE TABLE, ALTER TABLE, or DROP TABLE.
- PL/SQL does not support data control language (DCL), such as GRANT or REVOKE.

For more information about the DBMS_SQL package, see *Oracle8 Server Application Developer's Guide*, Release 8.

SELECT Statements in PL/SQL

Retrieve data from the database with SELECT.

Syntax

```
SELECT select_list
INTO    {variable_name[, variable_name]...
        | record_name}
FROM    table
WHERE   condition;
```


Retrieving Data Using PL/SQL

Use the SELECT statement to retrieve data from the database.

In the syntax:

select_list	is a list of at least one column and can include SQL expressions, row functions, or group functions
variable_name	is the scalar variable to hold the retrieved value
record_name	is the PL/SQL RECORD to hold the retrieved values
table	specifies the database table name
condition	is composed of column names, expressions, constants, and comparison operators, including PL/SQL variables and constants

Take advantage of the full range of Oracle Server syntax for the SELECT statement.

Remember that host variables must be prefixed with a colon.

SELECT Statements in PL/SQL

The INTO clause is required.

Example

```
DECLARE
  v_deptno    NUMBER(2);
  v_loc       VARCHAR2(15);
BEGIN
  SELECT      deptno, loc
  INTO        v_deptno, v_loc
  FROM        dept
  WHERE       dname = 'SALES';
...
END;
```


INTO Clause

The INTO clause is mandatory and occurs between the SELECT and FROM clauses. It is used to specify the names of variables to hold the values that SQL returns from the SELECT clause. You must give one variable for each item selected, and their order must correspond to the items selected.

You use the INTO clause to populate either PL/SQL variables or host variables.

Queries Must Return One and Only One Row

SELECT statements within a PL/SQL block fall into the ANSI classification of Embedded SQL, for which the following rule applies: queries must return one and only one row. More than one row or no row generates an error.

PL/SQL deals with these errors by raising standard exceptions, which you can trap in the exception section of the block with the NO_DATA_FOUND and TOO_MANY_ROWS exceptions (exception handling is covered in a subsequent lesson). You should code SELECT statements to return a single row.

Retrieving Data in PL/SQL

Retrieve the order date and the ship date for the specified order.

Example

```
DECLARE
  v_orderdate   ord.orderdate%TYPE;
  v_shipdate    ord.shipdate%TYPE;
BEGIN
  SELECT   orderdate, shipdate
  INTO     v_orderdate, v_shipdate
  FROM     ord
  WHERE    id = 620;
      ...
END;
```


Guidelines

Follow these guidelines to retrieve data in PL/SQL:

- Terminate each SQL statement with a semicolon (;).
- The INTO clause is required for the SELECT statement when it is embedded in PL/SQL.
- The WHERE clause is optional and can be used to specify input variables, constants, literals, or PL/SQL expressions.
- Specify the same number of output variables in the INTO clause as database columns in the SELECT clause. Be sure that they correspond positionally and that their datatypes are compatible.

Retrieving Data in PL/SQL

Return the sum of the salaries for all employees in the specified department.

Example

```
DECLARE
  v_sum_sal    emp.sal%TYPE;
  v_deptno     NUMBER NOT NULL := 10;
BEGIN
  SELECT       SUM(sal)  -- group function
  INTO         v_sum_sal
  FROM         emp
  WHERE        deptno = v_deptno;
END;
```


Guidelines (continued)

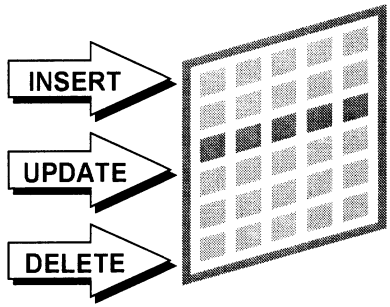
- To ensure that the datatypes of the identifiers match the datatypes of the columns, use the %TYPE attribute. The datatype and number of variables in the INTO clause match those in the SELECT list.
- Use group functions, such as SUM, in a SQL statement, because group functions apply to groups of rows in a table.

Note: Group functions cannot be used in PL/SQL syntax. They are used in SQL statements within a PL/SQL block.

Manipulating Data Using PL/SQL

Make changes to database tables by using DML commands:

- INSERT
- UPDATE
- DELETE



Manipulating Data Using PL/SQL

You manipulate data in the database by using the DML (data manipulation) commands. You can issue the DML commands INSERT, UPDATE, and DELETE without restriction in PL/SQL. Including COMMIT or ROLLBACK statements in the PL/SQL code releases row locks (and table locks).

- The INSERT statement adds new rows of data to the table.
- The UPDATE statement modifies existing rows in the table.
- The DELETE statement removes unwanted rows from the table.

Inserting Data

Add new employee information to the emp table.

Example

```
BEGIN
    INSERT INTO   emp(empno, ename, job, deptno)
    VALUES        (empno_sequence.NEXTVAL, 'HARDING',
                  'CLERK', 10);
END;
```

3-9 ORACLE

Inserting Data

- Use SQL functions, such as USER and SYSDATE.
- Generate primary key values by using database sequences.
- Derive values in the PL/SQL block.
- Add column default values.

Note: There is no possibility for ambiguity with identifiers and column names in the INSERT statement. Any identifier in the INSERT clause must be a database column name.

Updating Data

Increase the salary of all employees in the emp table who are Analysts.

Example

```
DECLARE
  v_sal_increase   emp.sal%TYPE := 2000;
BEGIN
  UPDATE      emp
  SET         sal = sal + v_sal_increase
  WHERE       job = 'ANALYST';
END;
```


Updating and Deleting Data

There may be ambiguity in the SET clause of the UPDATE statement because although the identifier on the left of the assignment operator is always a database column, the identifier on the right can be either a database column or a PL/SQL variable.

Remember that the WHERE clause is used to determine which rows are affected. If no rows are modified, no error occurs, unlike the SELECT statement in PL/SQL.

Note: PL/SQL variable assignments always use := and SQL column assignments always use =. Recall that if column names and identifier names are identical in the WHERE clause, the Oracle Server looks to the database first for the name.

Deleting Data

Delete rows that belong to department 10 from the emp table.

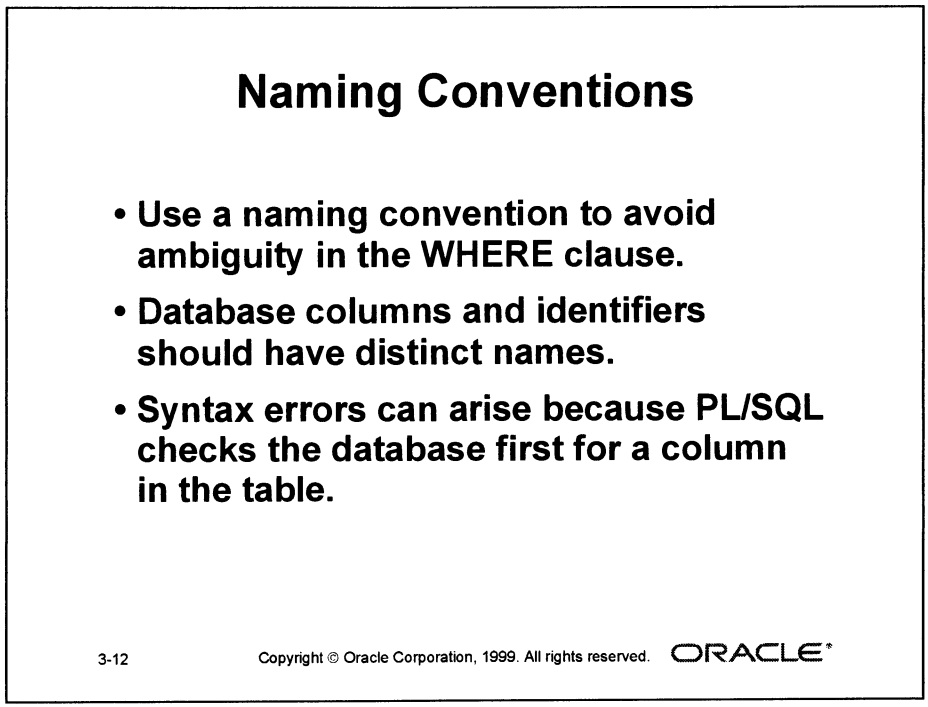
Example

```
DECLARE
  v_deptno    emp.deptno%TYPE := 10;
BEGIN
  DELETE FROM    emp
  WHERE          deptno = v_deptno;
END;
```


Deleting Data

Delete a specified order.

```
DECLARE
  v_ordid   ord.ordid%TYPE := 605;
BEGIN
  DELETE FROM  item
    WHERE      ordid = v_ordid;
END;
```



Naming Conventions

Avoid ambiguity in the WHERE clause by adhering to a naming convention that distinguishes database column names from PL/SQL variable names.

- Database columns and identifiers should have distinct names.
- Syntax errors can arise because PL/SQL checks the database first for a column in the table.

Naming Conventions

```
DECLARE
  orderdate  ord.orderdate%TYPE;
  shipdate   ord.shipdate%TYPE;
  ordid      ord.ordid%TYPE := 601;
BEGIN
  SELECT     orderdate, shipdate
  INTO       orderdate, shipdate
  FROM       ord
  WHERE      ordid = ordid;
END;
SQL> /
DECLARE
*
ERROR at line 1:
ORA-01422: exact fetch returns more than requested
number of rows
ORA-06512: at line 6
```


Naming Conventions (continued)

The example shown on the slide is defined as follows: Retrieve the date ordered and the date shipped from the ord table for order number 601. This example raises an unhandled runtime exception.

PL/SQL checks whether an identifier is a column in the database; if not, it is assumed to be a PL/SQL identifier.

Note: There is no possibility for ambiguity in the SELECT clause because any identifier in the SELECT clause must be a database column name. There is no possibility for ambiguity in the INTO clause because identifiers in the INTO clause must be PL/SQL variables. Only in the WHERE clause is there the possibility of confusion.

More information on TOO_MANY_ROWS and other exceptions are covered in a subsequent lesson.

COMMIT and ROLLBACK Statements

- **Initiate a transaction with the first DML command to follow a COMMIT or ROLLBACK.**
- **Use COMMIT and ROLLBACK SQL statements to terminate a transaction explicitly.**

Controlling Transactions

You control the logic of transactions with COMMIT and ROLLBACK SQL statements, rendering some groups of database changes permanent while discarding others. As with Oracle Server, DML transactions start at the first command to follow a COMMIT or ROLLBACK and end on the next successful COMMIT or ROLLBACK. These actions may occur within a PL/SQL block or as a result of events in the host environment (for example, ending a SQL*Plus session automatically commits the pending transaction). To mark an intermediate point in the transaction processing, use SAVEPOINT.

Syntax

```
COMMIT [WORK];

SAVEPOINT savepoint_name;

ROLLBACK [WORK];

ROLLBACK [WORK] TO [SAVEPOINT] savepoint_name;
```

where: WORK is for compliance with ANSI standards

Note: The transaction control commands are all valid within PL/SQL, although the host environment may place some restriction on their use.

You can also include explicit locking commands (such as LOCK TABLE and SELECT ... FOR UPDATE) in a block (a subsequent lesson will cover more information on the FOR UPDATE command). They stay in effect until the end of the transaction. Also, one PL/SQL block does not necessarily imply one transaction.

SQL Cursor

- A cursor is a private SQL work area.
- There are two types of cursors:
  - Implicit cursors
  - Explicit cursors
- The Oracle Server uses implicit cursors to parse and execute your SQL statements.
- Explicit cursors are explicitly declared by the programmer.

SQL Cursor

Whenever you issue a SQL statement, the Oracle Server opens an area of memory in which the command is parsed and executed. This area is called a *cursor*.

When the executable part of a block issues a SQL statement, PL/SQL creates an implicit cursor, which has the SQL identifier. PL/SQL manages this cursor automatically. The programmer explicitly declares and names an explicit cursor. There are four attributes available in PL/SQL that can be applied to cursors.

Note: More information about explicit cursors is covered in a subsequent lesson.

For more information, see *PL/SQL User's Guide and Reference*, Release 8, "Interaction with Oracle."

SQL Cursor Attributes

Using SQL cursor attributes, you can test the outcome of your SQL statements.

SQL%ROWCOUNT	Number of rows affected by the most recent SQL statement (an integer value)
SQL%FOUND	Boolean attribute that evaluates to TRUE if the most recent SQL statement affects one or more rows
SQL%NOTFOUND	Boolean attribute that evaluates to TRUE if the most recent SQL statement does not affect any rows
SQL%ISOPEN	Always evaluates to FALSE because PL/SQL closes implicit cursors immediately after they are executed

SQL Cursor Attributes

SQL cursor attributes allow you to evaluate what happened when the implicit cursor was last used. You use these attributes in PL/SQL statements such as functions. You cannot use them in SQL statements.

You can use the attributes SQL%ROWCOUNT, SQL%FOUND, SQL%NOTFOUND, and SQL%ISOPEN in the exception section of a block to gather information about the execution of a data manipulation statement. PL/SQL does not consider a DML statement that affects no rows to have failed, unlike the SELECT statement, which returns an exception.

SQL Cursor Attributes

Delete rows that have the specified order number from the ITEM table. Print the number of rows deleted.

Example

```
VARIABLE rows_deleted VARCHAR2(30)
DECLARE
  v_ordid  NUMBER := 605;
BEGIN
  DELETE FROM  item
  WHERE        ordid = v_ordid;
  :rows_deleted := (SQL%ROWCOUNT ||
                       ' rows deleted.');
END;
/
PRINT rows_deleted
```


SQL Cursor Attributes (continued)

The example shown on the slide is defined as follows: Delete the rows from the ord table for order number 605. Using the SQL%ROWCOUNT, you print the number of rows deleted.

Summary

- Embed SQL in the PL/SQL block:
  SELECT, INSERT, UPDATE, DELETE
- Embed transaction control statements in a PL/SQL block:
  COMMIT, ROLLBACK, SAVEPOINT

Summary

The DML commands INSERT, UPDATE and DELETE can be used in PL/SQL programs without any restriction. The COMMIT statement ends the current transaction and makes permanent any changes made during that transaction. The ROLLBACK statement ends the current transaction and undoes any changes made during that transaction. SAVEPOINT names and marks the current point in the processing of a transaction. Used with the ROLLBACK TO statement, savepoints let you undo parts of a transaction instead of the whole transaction.

Summary

- There are two cursor types: implicit and explicit.
- Implicit cursor attributes verify the outcome of DML statements:
  - SQL%ROWCOUNT
  - SQL%FOUND
  - SQL%NOTFOUND
  - SQL%ISOPEN
- Explicit cursors are defined by the programmer.

Summary (continued)

An implicit cursor is declared by PL/SQL for each SQL data manipulation statement. PL/SQL provides four attributes for each cursor. These attributes provide you with useful information about the operations that are performed with cursors. Explicit cursors are defined by the programmer.

Practice Overview

- Creating a PL/SQL block to select data from a table
- Creating a PL/SQL block to insert data into a table
- Creating a PL/SQL block to update data in a table
- Creating a PL/SQL block to delete a record from a table

Practice Overview

In this practice, you create procedures to select, input, update, and delete information in a table, using basic SQL query and DML statements within a PL/SQL block.

Practice 3

1. Create a PL/SQL block that selects the maximum department number in the DEPT table and stores it in a SQL*Plus variable. Print the results to the screen. Save your PL/SQL block to a file named `p3q1.sql`.

```
G_MAX_DEPTNO
------------
          40
```

2. Modify the PL/SQL block you created in exercise 1 to insert a new department into the DEPT table. Save your PL/SQL block to a file named `p3q2.sql`.
   a. Rather than printing the department number retrieved from exercise 1, add 10 to it and use it as the department number for the new department.
   b. Use a SQL*Plus substitution variable for the department name.
   c. Leave the location null for now.
   d. Execute the PL/SQL block.

```
Please enter the department name: EDUCATION

PL/SQL procedure successfully completed.
```

   e. Display the new department that you created.

```
DEPTNO DNAME      LOC
------ ---------- -----
    50 EDUCATION
```

3. Create a PL/SQL block that updates the location for an existing department. Save your PL/SQL block to a file named `p3q3.sql`.
   a. Use a SQL*Plus substitution variable for the department number.
   b. Use a SQL*Plus substitution variable for the department location.
   c. Test the PL/SQL block.

```
Please enter the department number: 50
Please enter the department location: HOUSTON

PL/SQL procedure successfully completed.
```

Practice 3 (continued)

d. Display the department number, department name, and location for the updated department.

```
DEPTNO DNAME          LOC
------ --------- ---------------
    50 EDUCATION HOUSTON
```

e. Display the department that you updated.

4. Create a PL/SQL block that deletes the department created in exercise 2. Save your PL/SQL block to a file named `p3q4.sql`.

   a. Use a SQL*Plus substitution variable for the department number.

   b. Print to the screen the number of rows affected.

   c. Test the PL/SQL block.

```
Please enter the department number: 50
PL/SQL procedure successfully completed.

G_RESULT
-------------------------------------------------------------
1 row(s) deleted.
```

   d. What happens if you enter a department number that does not exist?

```
Please enter the department number: 99
PL/SQL procedure successfully completed.

G_RESULT
-------------------------------------------------------------
0 row(s) deleted.
```

   e. Confirm that the department has been deleted.

```
no rows selected
```

Writing Control Structures

Objectives

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

- Identify the uses and types of control structures
- Construct an IF statement
- Construct and identify different loop statements
- Use logic tables
- Control block flow using nested loops and labels

Lesson Aim

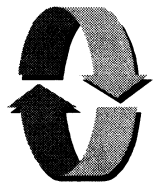
In this lesson, you will learn about conditional control within the PL/SQL block by using IF statements and loops.

Controlling PL/SQL Flow of Execution

You can change the logical flow of statements using conditional IF statements and loop control structures.

Conditional IF statements:

- **IF-THEN-END IF**
- **IF-THEN-ELSE-END IF**
- **IF-THEN-ELSIF-END IF**



You can change the logical flow of statements within the PL/SQL block with a number of *control structures*. This lesson addresses two types of PL/SQL control structures: conditional constructs with the IF statement and LOOP control structures (covered later in this lesson).

There are three forms of IF statements:

- IF-THEN-END IF
- IF-THEN-ELSE-END IF
- IF-THEN-ELSIF-END IF

IF Statements

Syntax

```
IF condition THEN
  statements;
[ELSIF condition THEN
  statements;]
[ELSE
  statements;]
END IF;
```

Simple IF statement:

Set the manager ID to 22 if the employee name is Osborne.

```
IF v_ename = 'OSBORNE' THEN
  v_mgr := 22;
END IF;
```


IF Statements

The structure of the PL/SQL IF statement is similar to the structure of IF statements in other procedural languages. It allows PL/SQL to perform actions selectively based on conditions.

In the syntax:

condition	is a Boolean variable or expression (TRUE, FALSE, or NULL) (It is associated with a sequence of statements, which is executed only if the expression yields TRUE.)
THEN	is a clause that associates the Boolean expression that precedes it with the sequence of statements that follows it
statements	can be one or more PL/SQL or SQL statements (They may include further IF statements containing several nested IFs, ELSEs, and ELSIFs.)
ELSIF	is a keyword that introduces a Boolean expression (If the first condition yields FALSE or NULL then the ELSIF keyword introduces additional conditions.)
ELSE	is a keyword that if control reaches it, the sequence of statements that follows it is executed

Simple IF Statements

Set the job title to Salesman, the department number to 35, and the commission to 20% of the current salary if the last name is Miller.

Example

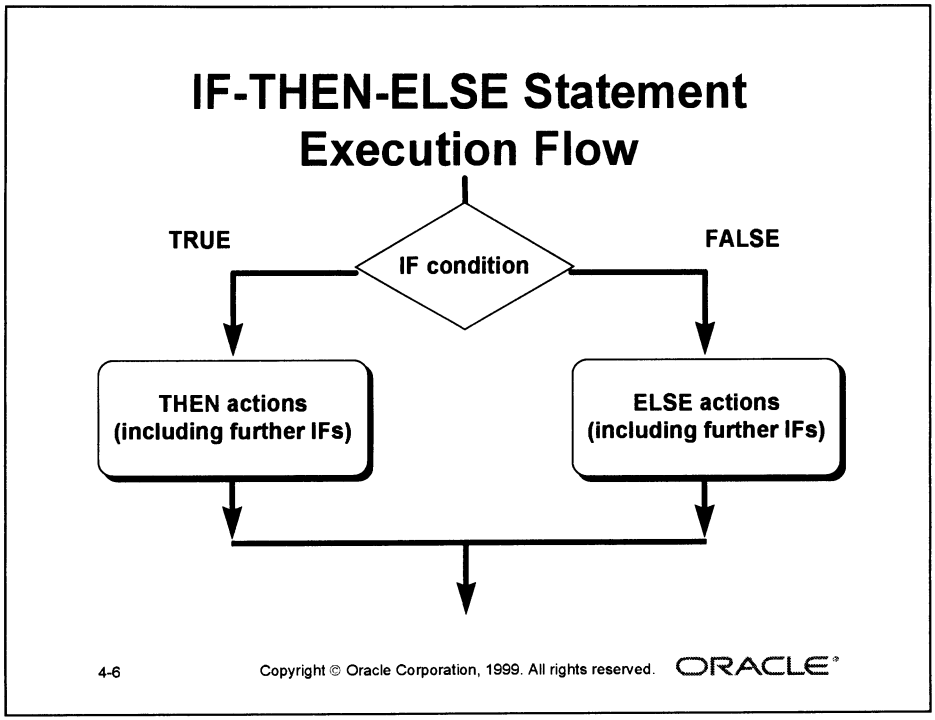
```
. . .
IF v_ename       = 'MILLER' THEN
   v_job         := 'SALESMAN';
   v_deptno      := 35;
   v_new_comm    := sal * 0.20;
END IF;
. . .
```


Simple IF Statements

In the example on the slide, PL/SQL performs these three actions (setting the v_job, v_deptno, and v_new_comm variables) only if the condition is TRUE. If the condition is FALSE or NULL, PL/SQL ignores them. In either case, control resumes at the next statement in the program following END IF.

Guidelines

- You can perform actions selectively based on conditions being met.
- When writing code, remember the spelling of the keywords:
  - ELSIF is one word.
  - END IF is two words.
- If the controlling Boolean condition is TRUE, the associated sequence of statements is executed; if the controlling Boolean condition is FALSE or NULL, the associated sequence of statements is passed over. Any number of ELSIF clauses is permitted.
- There can be at most one ELSE clause.
- Indent the conditionally executed statements for clarity.



IF-THEN-ELSE Statement Execution Flow

If the condition is FALSE or NULL, you can use the ELSE clause to carry out other actions. As with the simple IF statement, control resumes in the program from the END IF. For example:

```
IF condition1 THEN
  statement1;
ELSE
  statement2;
END IF;
```

Nested IF Statements

Either set of actions of the result of the first IF statement can include further IF statements before specific actions are performed. The THEN and ELSE clauses can include IF statements. Each nested IF statement must be terminated with a corresponding END IF.

```
IF condition1 THEN
  statement1;
ELSE
  IF condition2 THEN
    statement2;
  END IF;
END IF;
```

IF-THEN-ELSE Statements

Set a flag for orders where there are fewer than five days between order date and ship date.

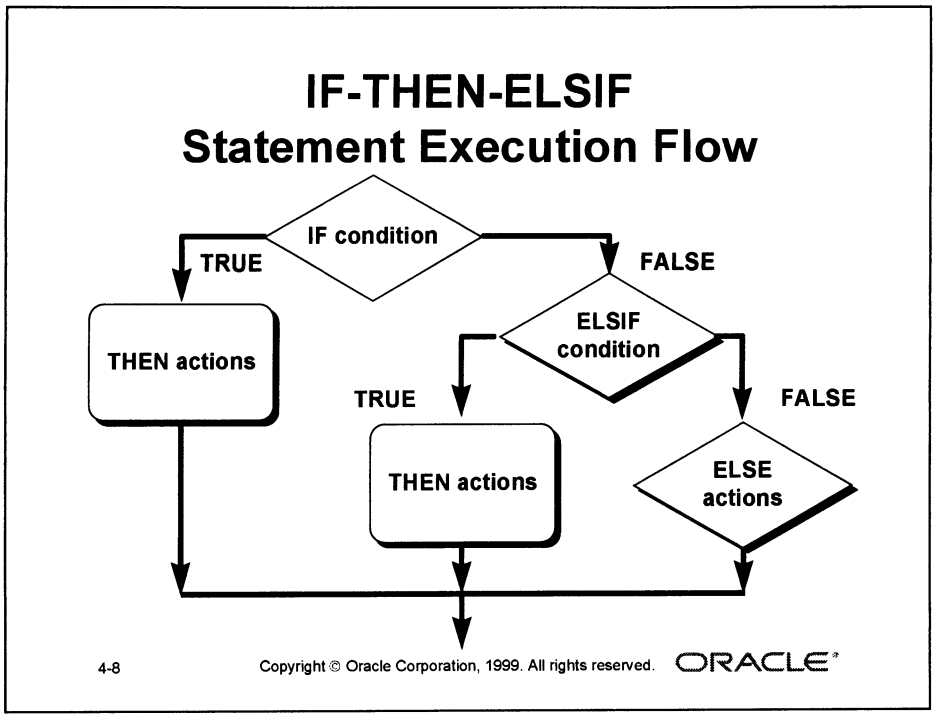
Example

```
...
IF v_shipdate - v_orderdate < 5 THEN
  v_ship_flag := 'Acceptable';
ELSE
  v_ship_flag := 'Unacceptable';
END IF;
...
```


Example

Set the job to Manager if the employee name is King. If the employee name is other than King, set the job to Clerk.

```
IF v_ename  = 'KING' THEN
   v_job    := 'MANAGER';
ELSE
   v_job := 'CLERK';
END IF;
```



IF-THEN-ELSIF Statement Execution Flow

Determine an employee's bonus based upon the employee's department.

```
...
IF v_deptno = 10 THEN
  v_comm := 5000;
ELSIF v_deptno = 20 THEN
  v_comm := 7500;
ELSE
  v_comm := 2000;
END IF;
...
```

In the example, the variable v_comm will be used to update the COMM column in the EMP table and v_deptno represents an employee's department number.

IF-THEN-ELSIF Statements

For a given value, calculate a percentage of that value based on a condition.

Example

```
. . .
IF    v_start > 100 THEN
      v_start := 2 * v_start;
ELSIF v_start >= 50 THEN
      v_start := .5 * v_start;
ELSE
      v_start := .1 * v_start;
END IF;
. . .
```


IF-THEN-ELSIF Statements

When possible, use the ELSIF clause instead of nesting IF statements. The code is easier to read and understand, and the logic is clearly identified. If the action in the ELSE clause consists purely of another IF statement, it is more convenient to use the ELSIF clause. This makes the code clearer by removing the need for nested END IFs at the end of each further set of conditions and actions.

Example

```
IF condition1 THEN
  statement1;
ELSIF condition2 THEN
  statement2;
ELSIF condition3 THEN
  statement3;
END IF;
```

The example IF-THEN-ELSIF statement above is further defined as follows:

For a given value, calculate a percentage of the original value. If the value is more than 100, then the calculated value is two times the starting value. If the value is between 50 and 100, then the calculated value is 50% of the starting value. If the entered value is less than 50, then the calculated value is 10% of the starting value.

Note: Any arithmetic expression containing null values evaluates to null.

Building Logical Conditions

- You can handle null values with the IS NULL operator.
- Any arithmetic expression containing a null value evaluates to NULL.
- Concatenated expressions with null values treat null values as an empty string.

Building Logical Conditions

You can build a simple Boolean condition by combining number, character, or date expressions with a comparison operator. In general, handle null values with the IS NULL operator.

Null in Expressions and Comparisons

- The IS NULL condition evaluates to TRUE only if the variable it is checking is NULL.
- Any expression containing a null value evaluates to NULL, with the exception of a concatenated expression, which treats the null value as an empty string.

Examples

Both these expressions evaluate to NULL if v_sal is NULL.

```
v_sal > 1000

v_sal * 1.1
```

In the next example the string does not evaluate to NULL if v_string is NULL.

```
'PL'||v_string||'SQL'
```

Logic Tables

Build a simple Boolean condition with a comparison operator.

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

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

NOT	
TRUE	FALSE
FALSE	TRUE
NULL	NULL

Boolean Conditions with Logical Operators

You can build a complex Boolean condition by combining simple Boolean conditions with the logical operators AND, OR, and NOT. In the logic tables shown in the slide, FALSE takes precedence on an AND condition and TRUE takes precedence in an OR condition. AND returns TRUE only if both of its operands are TRUE. OR returns FALSE only if both of its operands are FALSE. NULL AND TRUE always evaluate to NULL because it is not known if the second operand evaluates to TRUE or not.

Note: The negation of NULL (NOT NULL) results in a null value because null values are indeterminate.

Boolean Conditions

What is the value of V_FLAG in each case?

```
v_flag := v_reorder_flag AND v_available_flag;
```

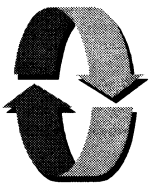
V_REORDER_FLAG	V_AVAILABLE_FLAG	V_FLAG
TRUE	TRUE	TRUE
TRUE	FALSE	FALSE
NULL	TRUE	NULL
NULL	FALSE	FALSE

Building Logical Conditions

The AND logic table can help you evaluate the possibilities for the Boolean condition on the slide.

Iterative Control: LOOP Statements

- Loops repeat a statement or sequence of statements multiple times.
- There are three loop types:
  - Basic loop
  - FOR loop
  - WHILE loop



Iterative Control: LOOP Statements

PL/SQL provides a number of facilities to structure loops to repeat a statement or sequence of statements multiple times.

Looping constructs are the second type of control structure:

- Basic loop to provide repetitive actions without overall conditions
- FOR loops to provide iterative control of actions based on a count
- WHILE loops to provide iterative control of actions based on a condition
- EXIT statement to terminate loops

For more information, see *PL/SQL User's Guide and Reference*, Release 8, "Control Structures."

Note: Another type of FOR LOOP, cursor FOR LOOP, is discussed in a subsequent lesson.

Basic Loop

Syntax

```
LOOP                                    -- delimiter
  statement1;                           -- statements
  . . .
  EXIT [WHEN condition];                -- EXIT statement
END LOOP;                               -- delimiter
```

```
where:   condition          is a Boolean variable or
                            expression (TRUE, FALSE,
                            or NULL);
```


Basic Loop

The simplest form of LOOP statement is the basic (or infinite) loop, which encloses a sequence of statements between the keywords LOOP and END LOOP. Each time the flow of execution reaches the END LOOP statement, control is returned to the corresponding LOOP statement above it. A basic loop allows execution of its statement at least once, even if the condition is already met upon entering the loop. Without the EXIT statement, the loop would be infinite.

The EXIT Statement

You can terminate a loop using the EXIT statement. Control passes to the next statement after the END LOOP statement. You can issue EXIT either as an action within an IF statement or as a standalone statement within the loop. The EXIT statement must be placed inside a loop. In the latter case, you can attach a WHEN clause to allow conditional termination of the loop. When the EXIT statement is encountered, the condition in the WHEN clause is evaluated. If the condition yields TRUE, the loop ends and control passes to the next statement after the loop. A basic loop can contain multiple EXIT statements.

Basic Loop

Example

```
DECLARE
  v_ordid     item.ordid%TYPE := 601;
  v_counter   NUMBER(2) := 1;
BEGIN
  LOOP
    INSERT INTO item(ordid, itemid)
      VALUES(v_ordid, v_counter);
    v_counter := v_counter + 1;
    EXIT WHEN v_counter > 10;
  END LOOP;
END;
```


Basic Loop (continued)

The basic loop example shown on the slide is defined as follows: Insert the first 10 new line items for order number 601.

Note: A basic loop allows execution of its statements at least once, even if the condition has been met upon entering the loop, provided the condition is placed in the loop such that it is not checked until after these statements. However, if the exit condition is placed at the top of the loop, before any of the other executable statements, and that condition is true, the loop will be exited and the statements never executed.

FOR Loop

Syntax

```
FOR counter in [REVERSE]
    lower_bound..upper_bound LOOP
  statement1;
  statement2;
  . . .
END LOOP;
```

- **Use a FOR loop to shortcut the test for the number of iterations.**
- **Do not declare the counter; it is declared implicitly.**

FOR Loop

FOR loops have the same general structure as the basic loop. In addition, they have a control statement at the front of the LOOP keyword to determine the number of iterations that PL/SQL performs.

In the syntax:

counter	is an implicitly declared integer whose value automatically increases or decreases (decreases if the REVERSE keyword is used) by 1 on each iteration of the loop until the upper or lower bound is reached
REVERSE	causes the counter to decrement with each iteration from the upper bound to the lower bound (Note that the lower bound is still referenced first.)
lower_bound	specifies the lower bound for the range of counter values
upper_bound	specifies the upper bound for the range of counter values

Do not declare the counter; it is declared implicitly as an integer.

Note: The sequence of statements is executed each time the counter is incremented, as determined by the two bounds. The lower bound and upper bound of the loop range can be literals, variables, or expressions, but must evaluate to integers. If the lower bound of the loop range evaluates to a larger integer than the upper bound, the sequence of statements will not be executed.

For example, statement1 is executed only once:

```
FOR i IN 3..3 LOOP statement1; END LOOP;
```

FOR Loop

Guidelines

- Reference the counter within the loop only; it is undefined outside the loop.
- Use an expression to reference the existing value of a counter.
- Do *not* reference the counter as the target of an assignment.

FOR Loop (continued)

Note: The lower and upper bounds of a LOOP statement do not need to be numeric literals. They can be expressions that convert to numeric values.

Example

```
DECLARE
  v_lower   NUMBER := 1;
  v_upper   NUMBER := 100;
BEGIN
  FOR i IN v_lower..v_upper LOOP
  ...
  END LOOP;
END;
```

FOR Loop

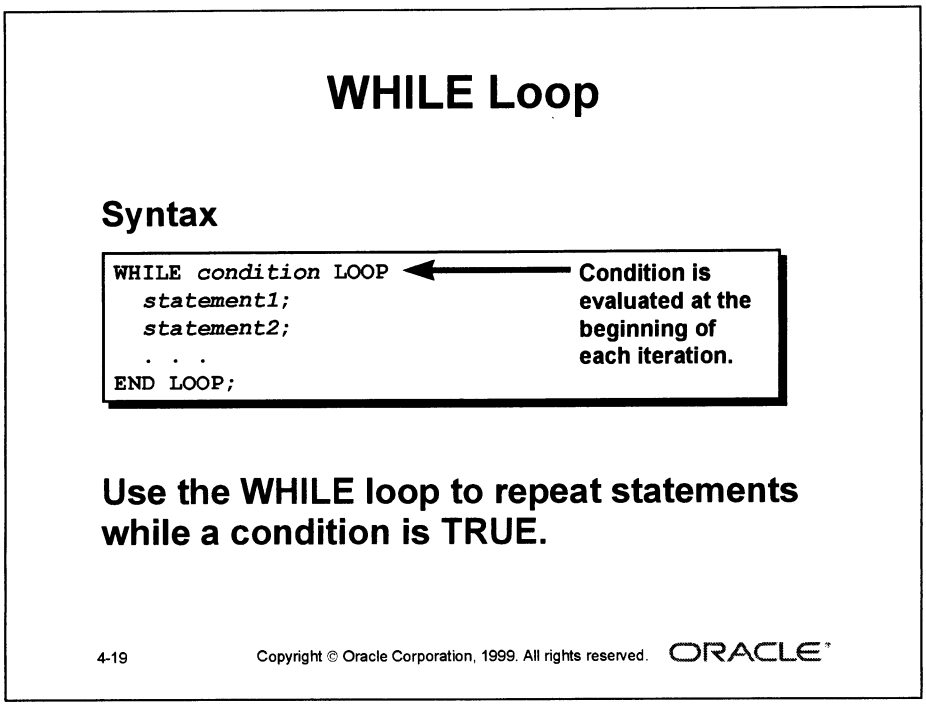
Insert the first 10 new line items for order number 601.

Example

```
DECLARE
  v_ordid     item.ordid%TYPE := 601;
BEGIN
  FOR i IN 1..10 LOOP
    INSERT INTO item(ordid, itemid)
      VALUES(v_ordid, i);
  END LOOP;
END;
```


For Loop

The example shown on the slide is defined as follows: Insert the first 10 new line items for order number 601. This is done using a FOR loop.



WHILE Loop

You can use the WHILE loop to repeat a sequence of statements until the controlling condition is no longer TRUE. The condition is evaluated at the start of each iteration. The loop terminates when the condition is FALSE. If the condition is FALSE at the start of the loop, then no further iterations are performed.

In the syntax:

condition	is a Boolean variable or expression (TRUE, FALSE, or NULL)
statement	can be one or more PL/SQL or SQL statements

If the variables involved in the conditions do not change during the body of the loop, then the condition remains TRUE and the loop does not terminate.

Note: If the condition yields NULL, the loop is bypassed and control passes to the next statement.

WHILE Loop

Example

```
ACCEPT p_new_order PROMPT 'Enter the order number: '
ACCEPT p_items -
  PROMPT 'Enter the number of items in this order: '
DECLARE
v_count     NUMBER(2) := 1;
BEGIN
  WHILE v_count <= &p_items LOOP
    INSERT INTO item (ordid, itemid)
    VALUES (&p_new_order, v_count);
    v_count := v_count + 1;
  END LOOP;
  COMMIT;
END;
/
```


WHILE Loop (continued)

In the example on the slide, line items are being added to the ITEM table for a specified order. The user is prompted for the order number (p_new_order) and the number of items in this order (p_items). With each iteration through the WHILE loop, a counter (v_count) is incremented. If the number of iterations is less than or equal to the number of items for this order, the code within the loop is executed and a row is inserted into the ITEM table. Once the counter exceeds the number of items for this order, the condition controlling the loop evaluates to false and the loop is terminated.

Nested Loops and Labels

- Nest loops to multiple levels.
- Use labels to distinguish between blocks and loops.
- Exit the outer loop with the EXIT statement referencing the label.

Nested Loops and Labels

You can nest loops to multiple levels. You can nest FOR, WHILE, and basic loops within one another. The termination of a nested loop does not terminate the enclosing loop unless an exception was raised. However, you can label loops and exit the outer loop with the EXIT statement.

Label names follow the same rules as other identifiers. A label is placed before a statement, either on the same line or on a separate line. Label loops by placing the label before the word LOOP within label delimiters (*<<label>>*).

If the loop is labeled, the label name can optionally be included after the END LOOP statement for clarity.

Nested Loops and Labels

```
...
BEGIN
  <<Outer_loop>>
  LOOP
    v_counter := v_counter+1;
  EXIT WHEN v_counter>10;
    <<Inner_loop>>
    LOOP
      ...
      EXIT Outer_loop WHEN total_done = 'YES';
      -- Leave both loops
      EXIT WHEN inner_done = 'YES';
      -- Leave inner loop only
      ...
    END LOOP Inner_loop;
    ...
  END LOOP Outer_loop;
END;
```


Nested Loops and Labels

In the example on the slide, there are two loops. The outer loop is identified by the label, <<Outer_Loop>> and the inner loop is identified by the label <<Inner_Loop>>. loops by placing the label before the word LOOP within label delimiters (<<*label*>>). The inner loop is nested within the outer loop. The label names are included after the END LOOP statement for clarity.

Summary

Change the logical flow of statements by using control structures.

- **Conditional (IF statement)**
- **Loops:**
  - **Basic loop**
  - **FOR loop**
  - **WHILE loop**
  - **EXIT statement**

Summary

A conditional control construct checks for the validity of a condition and accordingly performs a corresponding action. You use the IF construct to perform a conditional execution of statements.

An iterative control construct executes a sequence of statements repeatedly, as long as a specified condition holds TRUE. You use the various loop constructs to perform iterative operations.

Practice Overview

- Performing conditional actions using the IF statement
- Performing iterative steps using the loop structure

Practice Overview

In this practice, you create PL/SQL blocks that incorporate loops and conditional control structures.

Practice 4

1. Run the script `lab4_1.sql` to create the MESSAGES table. Write a PL/SQL block to insert numbers into the MESSAGES table.
   a. Insert the numbers 1 to 10, excluding 6 and 8.
   b. Commit before the end of the block.
   c. Select from the MESSAGES table to verify that your PL/SQL block worked.

```
RESULTS
---------
1
2
3
4
5
7
9
10
```

2. Create a PL/SQL block that computes the commission amount for a given employee based on the employee's salary.
   a. Run the script `lab4_2.sql` to insert a new employee into the EMP table.
   Note: The employee will have a NULL salary.
   b. Accept the employee number as user input with a SQL*Plus substitution variable.
   c. If the employee's salary is less than $1,000, set the commission amount for the employee to 10% of the salary.
   d. If the employee's salary is between $1,000 and $1,500, set the commission amount for the employee to 15% of the salary.
   e. If the employee's salary exceeds $1,500, set the commission amount for the employee to 20% of the salary.
   f. If the employee's salary is NULL, set the commission amount for the employee to 0.
   g. Commit.
   h. Test the PL/SQL block for each case using the following test cases, and check each updated commission.

Employee Number	Salary	Resulting Commission
7369	800	80
7934	1300	195
7499	1600	320
8000	NULL	0

Practice 4 (continued)

```
EMPNO ENAME      SAL       COMM
----- ------ ----- ---------
 8000 DOE                    0
 7499 ALLEN    1600        320
 7934 MILLER   1300        195
 7369 SMITH     800         80
```

If you have time, complete the following exercises:

3. Modify the `p1q4.sql` file to insert the text "Number is odd" or "Number is even," depending on whether the value is odd or even, into the MESSAGES table. Query the MESSAGES table to determine if your PL/SQL block worked.

```
RESULTS
---------------
Number is even
```

4. Add a new column called STARS, of datatype VARCHAR2 and length 50, to the EMP table for storing asterisk (*).
5. Create a PL/SQL block that rewards an employee by appending an asterisk in the STARS column for every $100 of the employee's salary. Save your PL/SQL block to a file called `p4q5.sql`.
   a. Accept the employee ID as user input with a SQL*Plus substitution variable.
   b. Initialize a variable that will contain a string of asterisks.
   c. Append an asterisk to the string for every $100 of the salary amount. For example, if the employee has a salary amount of $800, the string of asterisks should contain eight asterisks. If the employee has a salary amount of $1250, the string of asterisks should contain 13 asterisks.
   d. Update the STARS column for the employee with the string of asterisks.
   e. Commit.
   f. Test the block for employees who have no salary and for an employee who has a salary.

```
Please enter the employee number: 7934
  PL/SQL procedure successfully completed.
  Please enter the employee number: 8000
  PL/SQL procedure successfully completed.

  EMPNO     SAL STARS
  ----- ------ ----------------
   8000
   7934   1300 *************
```

5

Working with Composite Datatypes

Objectives

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

- **Create user-defined PL/SQL records**
- **Create a record with the %ROWTYPE attribute**
- **Create a PL/SQL table**
- **Create a PL/SQL table of records**
- **Describe the difference between records, tables, and tables of records**

Lesson Aim

In this lesson, you will learn more about composite datatypes and their uses.

Composite Datatypes

- Types:
  - PL/SQL RECORDS
  - PL/SQL TABLES
- Contain internal components
- Are reusable

5-3 ORACLE

RECORDS and TABLES

Like scalar variables, composite variables have a datatype also. Composite datatypes (also known as *collections*) are RECORD, TABLE, Nested TABLE, and VARRAY. You use the RECORD datatype to treat related but dissimilar data as a logical unit. You use the TABLE datatype to reference and manipulate collections of data as a whole object. The Nested TABLE and VARRAY datatypes are not covered in this course.

A record is a group of related data items stored in fields, each with its own name and datatype. A table contains a column and a primary key to give you array-like access to rows. Once defined, tables and records can be reused.

For more information, see *PL/SQL User's Guide and Reference*, Release 8, "Collections and Records."

PL/SQL Records

- Must contain one or more components of any scalar, RECORD, or PL/SQL TABLE datatype, called fields
- Are similar in structure to records in a 3GL
- Are not the same as rows in a database table
- Treat a collection of fields as a logical unit
- Are convenient for fetching a row of data from a table for processing

PL/SQL Records

A *record* is a group of related data items stored in *fields*, each with its own name and datatype. For example, suppose you have different kinds of data about an employee, such as name, salary, hire date, and so on. This data is dissimilar in type but logically related. A record that contains such fields as the name, salary, and hire date of an employee lets you treat the data as a logical unit. When you declare a record type for these fields, they can be manipulated as a unit.

- Each record defined can have as many fields as necessary.
- Records can be assigned initial values and can be defined as NOT NULL.
- Fields without initial values are initialized to NULL.
- The DEFAULT keyword can also be used when defining fields.
- You can define RECORD types and declare user-defined records in the declarative part of any block, subprogram, or package.
- You can declare and reference nested records. A record can be the component of another record.

Creating a PL/SQL Record

Syntax

```
TYPE type_name IS RECORD
     (field_declaration[, field_declaration]…);
identifier    type_name;
```

Where *field_declaration* is

```
field_name {field_type | variable%TYPE
           | table.column%TYPE | table%ROWTYPE}
           [[NOT NULL] {:= | DEFAULT} expr]
```

5-5 ORACLE

Defining and Declaring a PL/SQL Record

To create a record, you define a RECORD type and then declare records of that type.

In the syntax:

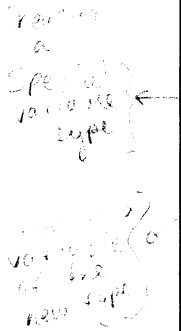
type_name	is the name of the RECORD type (This identifier is used to declare records.)
field_name	is the name of a field within the record
field_type	is the datatype of the field (It represents any PL/SQL datatype except REF CURSOR. You can use the %TYPE and %ROWTYPE attributes.)
expr	is the *field_type* or an initial value

The NOT NULL constraint prevents the assigning of nulls to those fields. Be sure to initialize NOT NULL fields.

Creating a PL/SQL Record

Declare variables to store the name, job, and salary of a new employee.

Example



```
...
TYPE emp_record_type IS RECORD
   (ename       VARCHAR2(10),
    job         VARCHAR2(9),
    sal         NUMBER(7,2));
emp_record      emp_record_type;
...
```


ORACLE

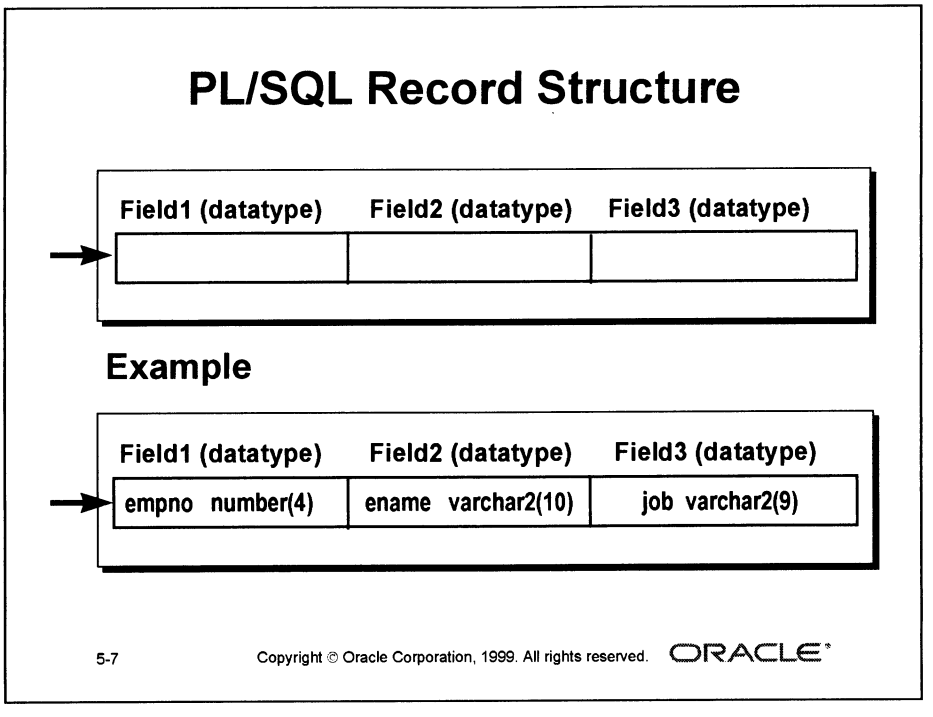
Creating a PL/SQL Record

Field declarations are like variable declarations. Each field has a unique name and a specific datatype. There are no predefined datatypes for PL/SQL records, as there are for scalar variables. Therefore, you must create the datatype first and then declare an identifier using that datatype.

The following example shows that you can use the %TYPE attribute to specify a field datatype:

```
DECLARE
  TYPE emp_record_type IS RECORD
    (empno      NUMBER(4) NOT NULL := 100,
     ename      emp.ename%TYPE,
     job        emp.job%TYPE);
  emp_record  emp_record_type;
...
```

Note: You can add the NOT NULL constraint to any field declaration to prevent the assigning of nulls to that field. Remember, fields declared as NOT NULL must be initialized.



Referencing and Initializing Records

Fields in a record are accessed by name. To reference or initialize an individual field, you use dot notation and the following syntax:

```
record_name.field_name
```

For example, you reference field *job* in record *emp_record* as follows:

```
emp_record.job ...
```

You can then assign a value to the record field as follows:

```
emp_record.job := 'CLERK';
```

In a block or subprogram, user-defined records are instantiated when you enter the block or subprogram and cease to exist when you exit the block or subprogram.

Assigning Values to Records

You can assign a list of common values to a record by using the SELECT or FETCH statement. Make sure that the column names appear in the same order as the fields in your record. You can also assign one record to another if they have the same datatype. A user-defined record and a %ROWTYPE record *never* have the same datatype.

The %ROWTYPE Attribute

A variable to hold an entire line

- Declare a variable according to a collection of columns in a database table or view.
- Prefix %ROWTYPE with the database table.
- Fields in the record take their names and datatypes from the columns of the table or view.

Declaring Records with the %ROWTYPE Attribute

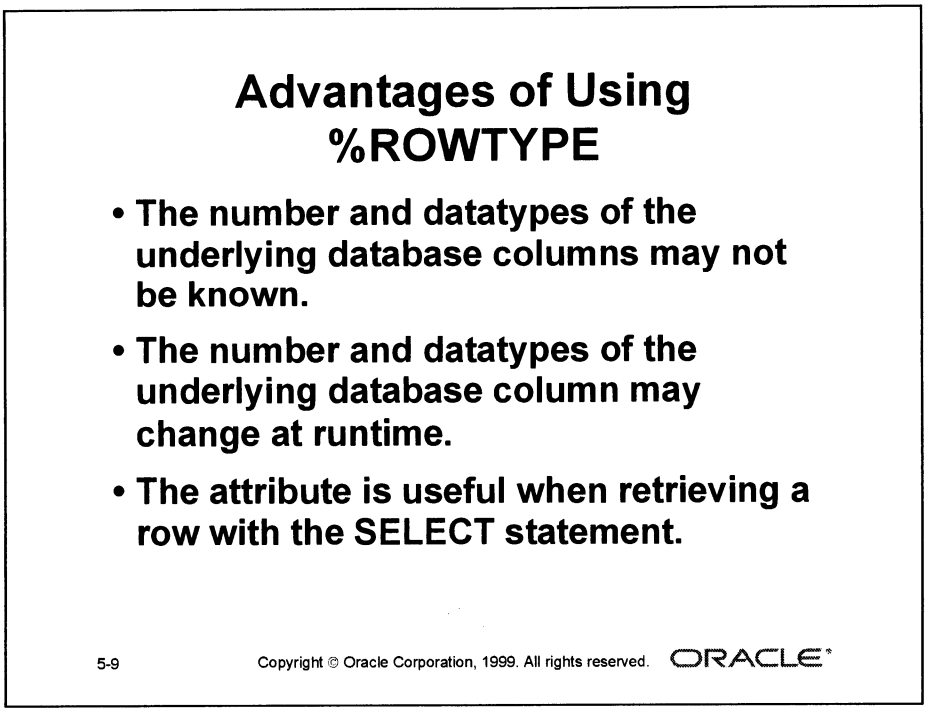
To declare a record based on a collection of columns in a database table or view, you use the %ROWTYPE attribute. The fields in the record take their names and datatypes from the columns of the table or view. The record can also store an entire row of data fetched from a cursor or cursor variable.

In the following example, a record is declared using %ROWTYPE as a datatype specifier.

```
DECLARE
   emp_record        emp%ROWTYPE;
...
```

The record, *emp_record*, will have a structure consisting of the following fields, each representing a column in the EMP table. **Note:** This is not code, but simply the structure of the composite variable.

```
(empno       NUMBER(4),
 ename       VARCHAR2(10),
 job         VARCHAR2(9),
 mgr         NUMBER(4),
 hiredate    DATE,
 sal         NUMBER(7,2),
 comm        NUMBER(7,2),
 deptno      NUMBER(2))
```



Declaring Records with the %ROWTYPE Attribute (continued)

Syntax

```
DECLARE
   identifier       reference%ROWTYPE;
```

where: *identifier* is the name chosen for the record as a whole

reference is the name of the table, view, cursor, or cursor variable on which the record is to be based (You must make sure that this reference is valid when you declare the record that is, the table or view must exist.)

To reference an individual field, you use dot notation and the following syntax:

```
record_name.field_name
```

For example, you reference field *comm* in record *emp_record* as follows:

```
emp_record.comm
```

You can then assign a value to the record field as follows:

```
emp_record.comm := 750;
```

The %ROWTYPE Attribute

Examples

Declare a variable to store the same information about a department as it is stored in the DEPT table.

```
dept_record    dept%ROWTYPE;
```

Declare a variable to store the same information about an employee as it is stored in the EMP table.

```
emp_record     emp%ROWTYPE;
```

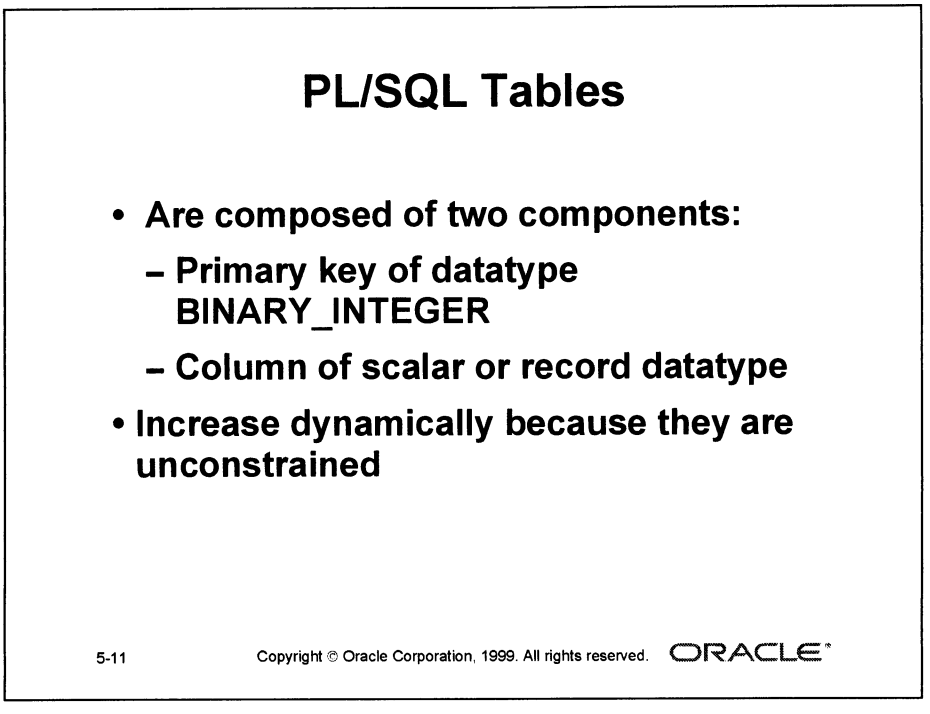

Examples

The first declaration on the slide creates a record with the same field names and field datatypes as a row in the DEPT table. The fields are DEPTNO, DNAME, and LOCATION.

The second declaration creates a record with the same field names and field datatypes as a row in the EMP table. The fields are EMPNO, ENAME, JOB, MGR, HIREDATE, SAL, COMM, and DEPTNO.

In the following example, an employee is retiring. Information about this employee is added to a table holding information about retired employees. The user supplies the employee's number.

```
DECLARE
 emp_rec     emp%ROWTYPE;
BEGIN
 SELECT * INTO emp_rec
 FROM   emp
 WHERE  empno = &employee_number;
 INSERT INTO retired_emps(empno, ename, job, mgr, hiredate,
 leavedate, sal, comm, deptno)
 VALUES (emp_rec.empno, emp_rec.ename, emp_rec.job, emp_rec.mgr,
 emp_rec.hiredate, SYSDATE, emp_rec.sal, emp_rec.comm,
 emp_rec.deptno);
 COMMIT;
END;
```



PL/SQL Tables

Objects of type TABLE are called PL/SQL tables. They are modeled as (but not the same as) database tables. PL/SQL tables use a primary key to give you array-like access to rows.

A PL/SQL table:

- Is similar to an array
- Must contain two components:
  - A primary key of datatype BINARY_INTEGER that indexes the PL/SQL TABLE
  - A column of a scalar or record datatype, which stores the PL/SQL TABLE elements
- Can increase dynamically because it is unconstrained

Creating a PL/SQL Table

Syntax

```
TYPE type_name IS TABLE OF
     {column_type | variable%TYPE
     | table.column%TYPE} [NOT NULL]
     [INDEX BY BINARY_INTEGER];
identifier   type_name;
```

Declare a PL/SQL table to store names.

Example

```
...
TYPE ename_table_type IS TABLE OF emp.ename%TYPE
  INDEX BY BINARY_INTEGER;
ename_table ename_table_type;
...
```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Creating a PL/SQL Table

There are two steps involved in creating a PL/SQL table.

1. Declare a TABLE datatype.
2. Declare a variable of that datatype.

In the syntax:

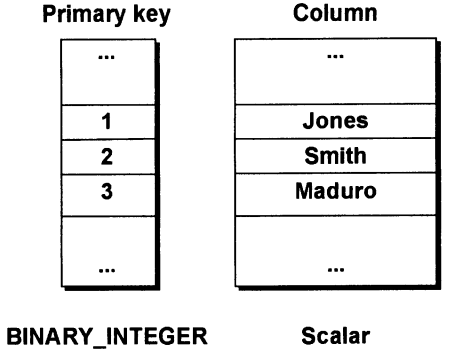
type_name	is the name of the TABLE type (It is a type specifier used in subsequent declarations of PL/SQL tables.)
column_type	is any scalar (not composite) datatype such as VARCHAR2, DATE, or NUMBER (You can use the %TYPE attribute to provide the column datatype.)
identifier	is the name of the identifier that represents an entire PL/SQL table

The NOT NULL constraint prevents nulls from being assigned to the PL/ SQL TABLE of that type. Do not initialize the PL/SQL TABLE.

Declare a PL/SQL table to store dates.

```
DECLARE
  TYPE date_table_type IS TABLE OF DATE
  INDEX BY BINARY_INTEGER;
  date_table  date_table_type;
```

PL/SQL Table Structure



PL/SQL Table Structure

Like the size of a database table, the size of a PL/SQL table is unconstrained. That is, the number of rows in a PL/SQL table can increase dynamically, so your PL/SQL table grows as new rows are added.

PL/SQL tables can have one column and a primary key, neither of which can be named. The column can belong to any scalar or record datatype, but the primary key must belong to type BINARY_INTEGER. You cannot initialize a PL/SQL table in its declaration.

Creating a PL/SQL Table

```
DECLARE
  TYPE ename_table_type IS TABLE OF emp.ename%TYPE
    INDEX BY BINARY_INTEGER;
  TYPE hiredate_table_type IS TABLE OF DATE
    INDEX BY BINARY_INTEGER;
  ename_table     ename_table_type;
  hiredate_table  hiredate_table_type;
BEGIN
  ename_table(1) := 'CAMERON';
  hiredate_table(8) := SYSDATE + 7;
  IF ename_table.EXISTS(1) THEN
    INSERT INTO ...
  ...
END;
```


Creating a PL/SQL Table

There are no predefined datatypes for PL/SQL tables, as there are for scalar variables. Therefore you must create the datatype first and then declare an identifier using that datatype.

Referencing a PL/SQL Table

Syntax

```
pl/sql_table_name(primary_key_value)
```

where: *primary_key_value* belongs to type BINARY_INTEGER.

Reference the third row in a PL/SQL table ename_table.

```
ename_table(3) ...
```

The magnitude range of a BINARY_INTEGER is –2147483647 ... 2147483647, so the primary key value can be negative. Indexing need not start with 1.

Note: The *table*.EXISTS(i) statement returns TRUE if at least one row with index *i* is returned. Use the EXISTS statement to prevent an error that is raised in reference to a non-existing table element.

Using PL/SQL Table Methods

The following methods make PL/SQL tables easier to use:

- EXISTS
- COUNT
- FIRST and LAST
- PRIOR
- NEXT
- EXTEND
- TRIM
- DELETE

5-15 ORACLE

A PL/SQL Table method is a built-in procedure or function that operates on tables and is called using dot notation. The methods noted with an asterisk below are available for PL/SQL version 8 tables only.

Syntax

```
table_name.method_name[ (parameters) ]
```

Method	Description
EXISTS(*n*)	Returns TRUE if the *n*th element in a PL/SQL table exists.
COUNT	Returns the number of elements that a PL/SQL table currently contains.
FIRST LAST	Returns the first and last (smallest and largest) index numbers in a PL/SQL table. Returns NULL if the PL/SQL table is empty.
PRIOR(*n*)	Returns the index number that precedes index *n* in a PL/SQL table.
NEXT(*n*)	Returns the index number that succeeds index *n* in a PL/SQL table.
EXTEND(*n*, *i*)*	Increases the size of a PL/SQL table. EXTEND appends one null element to a PL/SQL table. EXTEND(*n*) appends *n* null elements to a PL/SQL table. EXTEND(*n*, *i*) appends *n* copies of the *i*th element to a PL/SQL table.
TRIM*	TRIM removes one element from the end of a PL/SQL table. TRIM(*n*) removes *n* elements from the end of a PL/SQL table.
DELETE	DELETE removes all elements from a PL/SQL table. DELETE(*n*) removes the *n*th element from a PL/SQL table. DELETE(*m*, *n*) removes all elements in the range *m* ... *n* from a PL/SQL table.

PL/SQL Table of Records

- Define a TABLE variable with a permitted PL/SQL datatype.
- Declare a PL/SQL variable to hold department information.

Example

```
DECLARE
  TYPE dept_table_type IS TABLE OF dept%ROWTYPE
    INDEX BY BINARY_INTEGER;
  dept_table dept_table_type;
  -- Each element of dept_table is a record
```


PL/SQL Table of Records

Because only one table definition is needed to hold information about all of the fields of a database table, the table of records greatly increases the functionality of PL/SQL tables.

Referencing a Table of Records

In the example given on the slide, you can refer to fields in the dept_table record because each element of this table is a record.

Syntax

```
table(index).field
```

Example

```
dept_table(15).loc := 'Atlanta';
```

LOC represents a field in DEPT_TABLE.

Note: You can use the %ROWTYPE attribute to declare a record that represents a row in a database table. The difference between the %ROWTYPE attribute and the composite datatype RECORD is that RECORD allows you to specify the datatypes of fields in the record or to declare fields of your own.

Example of PL/SQL Table of Records

```
DECLARE
  TYPE e_table_type IS TABLE OF emp.Ename%Type
  INDEX BY BINARY_INTEGER;
  e_tab e_table_type;
BEGIN
  e_tab(1) := 'SMITH';
  UPDATE emp
  SET sal = 1.1 * sal
  WHERE Ename = e_tab(1);
  COMMIT;
END;
/
```


Example PL/SQL Table of Records

The example on the slide declares a PL/SQL table e_table_type. Using this PL/SQL table, another table, e_tab, is declared. In the executable section of the PL/SQL block, the e_tab table is used to update the salary of the employee, Smith.

Summary

- Define and reference PL/SQL variables of composite datatypes:
  - PL/SQL records
  - PL/SQL tables
  - PL/SQL table of records
- Define a PL/SQL record by using the %ROWTYPE attribute.

Summary

A PL/SQL record is a collection of individual fields that represent a row in the table. They are unique and each row has its own name and datatype. The record as a whole does not have any value. By using records you can group the data into one structure and then manipulate this structure into one entity or logical unit. This helps to reduce coding, and keeps the code easier to maintain and understand.

Like PL/SQL records, the table is another composite datatype. PL/SQL tables are objects of type TABLE and look similar to database tables but with slight difference. PL/SQL tables use a primary key to give you array like access to row. The size of a PL/SQL table is unconstrained. PL/SQL table can have one column and a primary key, neither of which can be named. The column can have any datatype, but the primary key must be of the type BINARY_INTEGER.

A PL/SQL table of records enhances the functionality of PL/SQL tables, since only one table definition is required to hold information about all the fields.

The %ROWTYPE is used to declare a compound variable whose type is the same as that of a row of a database table.

Practice Overview

- Declaring PL/SQL tables
- Processing data by using PL/SQL tables
- Declaring a PL/SQL record
- Processing data by using a PL/SQL record

Practice Overview

In this practice, you define, create, and use PL/SQL tables and a PL/SQL record.

Practice 5

1. Create a PL/SQL block to retrieve the name of each department from the DEPT table and print each department name to the screen, incorporating a PL/SQL table.
   a. Declare a PL/SQL table, MY_DEPT_TABLE, to temporarily store the name of the departments.
   b. Using a loop, retrieve the name of all departments currently in the DEPT table and store them in the PL/SQL table. Each department number is a multiple of 10.
   c. Using another loop, retrieve the department names from the PL/SQL table and print them to the screen, using DBMS_OUTPUT.PUT_LINE.

```
SQL> START p5_1
ACCOUNTING
RESEARCH
SALES
OPERATIONS

PL/SQL procedure successfully completed.
```

2. Write a PL/SQL block to print information about a given order.
   a. Declare a PL/SQL record based on the structure of the ORD table.
   b. Use a SQL*Plus substitution variable to retrieve all information about a specific order and store that information into the PL/SQL record.
   c. Use DBMS_OUTPUT. PUT_LINE to print selected information about the order.

```
SQL> START p5_2
Please enter an order number: 614
Order 614 was placed on 01-FEB-87 and shipped on 05-FEB-87 for a
total of  $23,940.00

PL/SQL procedure successfully completed.
```

Practice 5 (continued)

If you have time, complete the following exercise.

3. Modify the block you created in practice 1 to retrieve all information about each department from the DEPT table and print the information to the screen, incorporating a PL/SQL table of records.
   a. Declare a PL/SQL table, MY_DEPT_TABLE, to temporarily store the number, name, and location of all the departments.
   b. Using a loop, retrieve all department information currently in the DEPT table and store it in the PL/SQL table. Each department number is a multiple of 10.
   c. Using another loop, retrieve the department information from the PL/SQL table and print it to the screen, using DBMS_OUTPUT.PUT_LINE.

```
SQL> START p5_3
Dept. 10, ACCOUNTING is located in NEW YORK
Dept. 20, RESEARCH is located in DALLAS
Dept. 30, SALES is located in CHICAGO
Dept. 40, OPERATIONS is located in BOSTON

PL/SQL procedure successfully completed.
```

6

Writing Explicit Cursors

Objectives

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

- **Distinguish between an implicit and an explicit cursor**
- **Use a PL/SQL record variable**
- **Write a cursor FOR loop**

Lesson Aim

In this lesson, you will learn the differences between implicit and explicit cursors. You will also learn when and why to use an explicit cursor.

You may need to use a multiple-row SELECT statement in PL/SQL to process many rows. To accomplish this, you declare and control explicit cursors, which are used in loops, including the cursor FOR loop.

About Cursors

Every SQL statement executed by the Oracle Server has an individual cursor associated with it:

- **Implicit cursors: Declared for all DML and PL/SQL SELECT statements**
- **Explicit cursors: Declared and named by the programmer**

Implicit and Explicit Cursors

The Oracle Server uses work areas called *private SQL areas* to execute SQL statements and to store processing information. You can use PL/SQL cursors to name a private SQL area and access its stored information. The cursor directs all phases of processing.

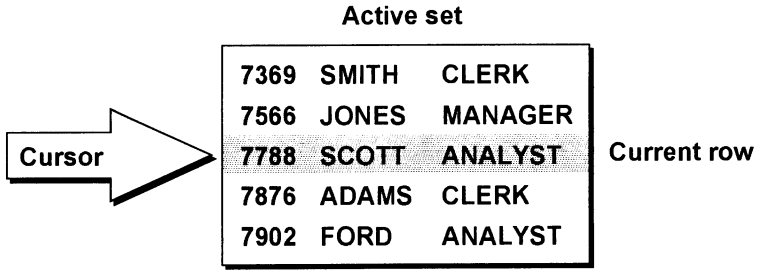
Cursor Type	Description
Implicit	Implicit cursors are declared by PL/SQL implicitly for all DML and PL/SQL SELECT statements, including queries that return only one row.
Explicit	For queries that return more than one row. Explicit cursors are declared and named by the programmer and manipulated through specific statements in the block's executable actions.

Implicit Cursors

The Oracle Server implicitly opens a cursor to process each SQL statement not associated with an explicitly declared cursor. PL/SQL lets you refer to the most recent implicit cursor as the *SQL* cursor.

You cannot use the OPEN, FETCH, and CLOSE statements to control the SQL cursor, but you can use cursor attributes to get information about the most recently executed SQL statement.

Explicit Cursor Functions



Explicit Cursors

Use explicit cursors to individually process each row returned by a multiple-row SELECT statement.

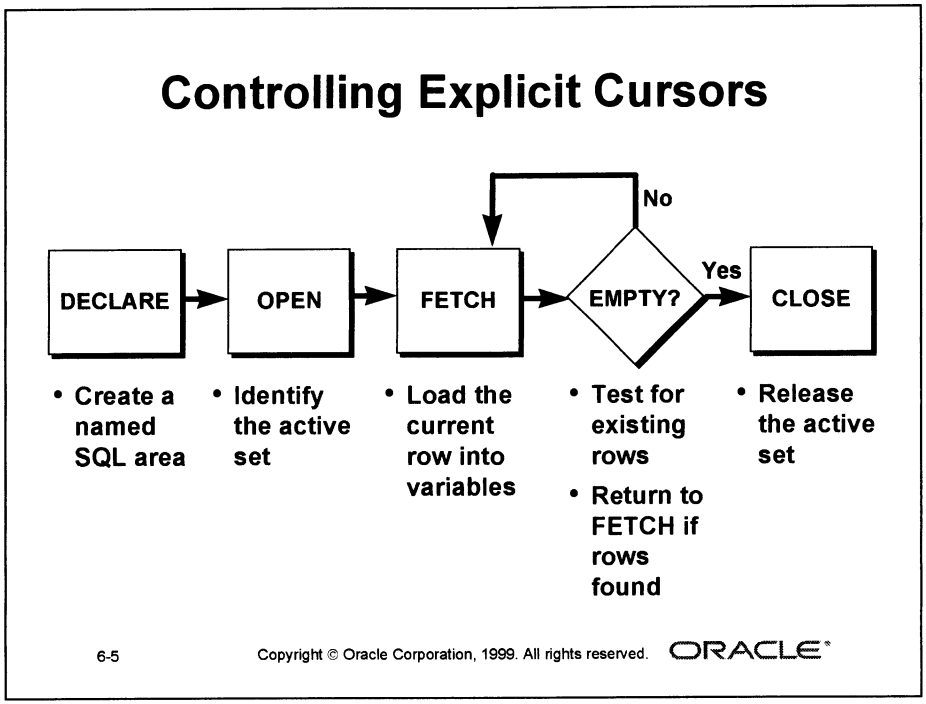
The set of rows returned by a multiple-row query is called the *active set.* Its size is the number of rows that meet your search criteria. The diagram on the slide shows how an explicit cursor "points" to the *current row* in the active set. This allows your program to process the rows one at a time.

A PL/SQL program opens a cursor, processes rows returned by a query, and then closes the cursor. The cursor marks the current position in the active set.

Explicit cursor functions:

- Can process beyond the first row returned by the query, row by row
- Keep track of which row is currently being processed
- Allow the programmer to manually control them in the PL/SQL block

Note: The fetch for an implicit cursor is an array fetch, and the existence of a second row still raises the TOO_MANY_ROWS exception. Furthermore, you can use explicit cursors to perform multiple fetches and to re-execute parsed queries in the work area.



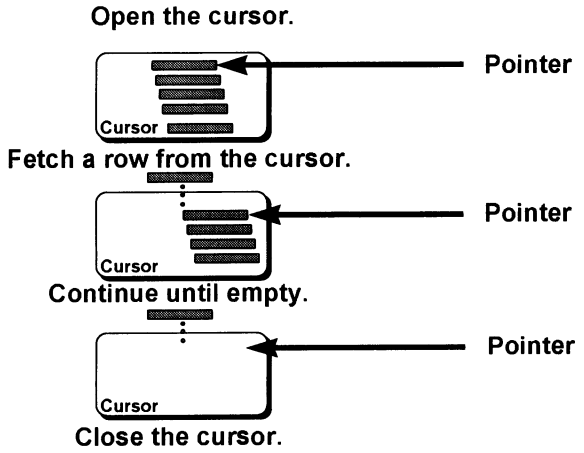
Explicit Cursors (continued)

Now that you have a conceptual understanding of cursors, review the steps to use them. The syntax for each step can be found on the following pages.

Controlling Explicit Cursors Using Four Commands

1. Declare the cursor by naming it and defining the structure of the query to be performed within it.
2. Open the cursor. The OPEN statement executes the query and binds any variables that are referenced. Rows identified by the query are called the *active set* and are now available for fetching.
3. Fetch data from the cursor. In the flow diagram shown on the slide, after each fetch you test the cursor for any existing row. If there are no more rows to process, then you need to close the cursor.
4. Close the cursor. The CLOSE statement releases the active set of rows. It is now possible to reopen the cursor to establish a fresh active set.

Controlling Explicit Cursors



Explicit Cursors (continued)

You use the OPEN, FETCH, and CLOSE statements to control a cursor. The OPEN statement executes the query associated with the cursor, identifies the active set, and positions the cursor (pointer) before the first row. The FETCH statement retrieves the current row and advances the cursor to the next row. When the last row has been processed, the CLOSE statement disables the cursor.

Declaring the Cursor

Syntax

```
CURSOR cursor_name IS
     select_statement;
```

- **Do not include the INTO clause in the cursor declaration.**
- **If processing rows in a specific sequence is required, use the ORDER BY clause in the query.**

Explicit Cursor Declaration

Use the CURSOR statement to declare an explicit cursor. You can reference variables within the query, but you must declare them before the CURSOR statement.

In the syntax:

cursor_name	is a PL/SQL identifier
select_statement	is a SELECT statement without an INTO clause

Note: Do not include the INTO clause in the cursor declaration because it appears later in the FETCH statement.

Declaring the Cursor

Example

```
DECLARE
  CURSOR emp_cursor IS
    SELECT empno, ename
    FROM   emp;

  CURSOR dept_cursor IS
    SELECT *
    FROM   dept
    WHERE  deptno = 10;
BEGIN
  ...
```


Explicit Cursor Declaration (continued)

Retrieve the employees one by one.

```
DECLARE
  v_empno             emp.empno%TYPE;
  v_ename             emp.ename%TYPE;
  CURSOR emp_cursor IS
    SELECT empno, ename
    FROM   emp;
BEGIN
...
```

Note: You can reference variables in the query, but you must declare them before the CURSOR statement.

Opening the Cursor

Syntax

```
OPEN  cursor_name;
```

- **Open the cursor to execute the query and identify the active set.**
- **If the query returns no rows, no exception is raised.**
- **Use cursor attributes to test the outcome after a fetch.**

OPEN Statement

Open the cursor to execute the query and identify the active set, which consists of all rows that meet the query search criteria. The cursor now points to the first row in the active set.

In the syntax:

cursor_name is the name of the previously declared cursor

OPEN is an executable statement that performs the following operations:

1. Dynamically allocates memory for a context area that eventually contains crucial processing information.
2. Parses the SELECT statement.
3. Binds the input variables—that is, sets the value for the input variables by obtaining their memory addresses.
4. Identifies the active set—that is, the set of rows that satisfy the search criteria. Rows in the active set are not retrieved into variables when the OPEN statement is executed. Rather, the FETCH statement retrieves the rows.
5. Positions the pointer just before the first row in the active set.

Note: If the query returns no rows when the cursor is opened, PL/SQL does not raise an exception. However, you can test the status of the cursor after a fetch.

For cursors declared using the FOR UPDATE clause, the OPEN statement also locks those rows. The FOR UPDATE clause is discussed in a later lesson.

Fetching Data from the Cursor

Syntax

```
FETCH cursor_name INTO [variable1, variable2, ...]
                       | record_name];
```

- **Retrieve the current row values into variables.**
- **Include the same number of variables.**
- **Match each variable to correspond to the columns positionally.**
- **Test to see if the cursor contains rows.**

FETCH Statement

The FETCH statement retrieves the rows in the active set one at a time. After each fetch, the cursor advances to the next row in the active set.

In the syntax:

cursor_name	is the name of the previously declared cursor
variable	is an output variable to store the results
record_name	is the name of the record in which the retrieved data is stored (The record variable can be declared using the %ROWTYPE attribute.)

Guidelines:

- Include the same number of variables in the INTO clause of the FETCH statement as columns in the SELECT statement, and be sure that the datatypes are compatible.
- Match each variable to correspond to the columns positionally.
- Alternatively, define a record for the cursor and reference the record in the FETCH INTO clause.
- Test to see if the cursor contains rows. If a fetch acquires no values, there are no rows left to process in the active set and no error is recorded.

Note: The FETCH statement performs the following operations:

1. Advances the pointer to the next row in the active set.
2. Reads the data for the current row into the output PL/SQL variables.

Fetching Data from the Cursor

Examples

```
FETCH emp_cursor INTO v_empno, v_ename;
```

```
...
OPEN defined_cursor;
LOOP
  FETCH defined_cursor INTO defined_variables
  EXIT WHEN ...;
  ...
    -- Process the retrieved data
  ...
END;
```


FETCH Statement (continued)

You use the FETCH statement to retrieve the current row values into output variables. After the fetch, you can manipulate the variables by further statements. For each column value returned by the query associated with the cursor, there must be a corresponding variable in the INTO list. Also, their datatypes must be compatible.

Retrieve the first 10 employees one by one.

```
DECLARE
  v_empno             emp.empno%TYPE;
  v_ename             emp.ename%TYPE;
  CURSOR emp_cursor IS
    SELECT empno, ename
    FROM   emp;
BEGIN
  OPEN emp_cursor;
  FOR i IN 1..10 LOOP
    FETCH emp_cursor INTO v_empno, v_ename;
    ...
  END LOOP;
END ;
```

Closing the Cursor

Syntax

```
CLOSE     cursor_name;
```

- Close the cursor after completing the processing of the rows.
- Reopen the cursor, if required.
- Do not attempt to fetch data from a cursor once it has been closed.

CLOSE Statement

The CLOSE statement disables the cursor, and the active set becomes undefined. Close the cursor after completing the processing of the SELECT statement. This step allows the cursor to be reopened, if required. Therefore, you can establish an active set several times.

In the syntax:

cursor_name is the name of the previously declared cursor.

Do not attempt to fetch data from a cursor once it has been closed, or the INVALID_CURSOR exception will be raised.

Note: The CLOSE statement releases the context area.
Although it is possible to terminate the PL/SQL block without closing cursors, you should get into the habit of closing any cursor that you declare explicitly in order to free up resources.
There is a maximum limit to the number of open cursors per user, which is determined by the OPEN_CURSORS parameter in the database parameter field. OPEN_CURSORS = 50 by default.

```
...
  FOR i IN 1..10 LOOP
    FETCH emp_cursor INTO v_empno, v_ename;
    ...
  END LOOP;
  CLOSE emp_cursor;
END;
```

Explicit Cursor Attributes

Obtain status information about a cursor.

Attribute	Type	Description
%ISOPEN	Boolean	Evaluates to TRUE if the cursor is open
%NOTFOUND	Boolean	Evaluates to TRUE if the most recent fetch does not return a row
%FOUND	Boolean	Evaluates to TRUE if the most recent fetch returns a row; complement of %NOTFOUND
%ROWCOUNT	Number	Evaluates to the total number of rows returned so far

Explicit Cursor Attributes

As with implicit cursors, there are four attributes for obtaining status information about a cursor. When appended to the cursor variable name, these attributes return useful information about the execution of a data manipulation statement.

Note: You cannot reference cursor attributes directly in a SQL statement.

Controlling Multiple Fetches

- Process several rows from an explicit cursor using a loop.
- Fetch a row with each iteration.
- Use the %NOTFOUND attribute to write a test for an unsuccessful fetch.
- Use explicit cursor attributes to test the success of each fetch.

Controlling Multiple Fetches from Explicit Cursors

To process several rows from an explicit cursor, you typically define a loop to perform a fetch on each iteration. Eventually all rows in the active set are processed, and an unsuccessful fetch sets the %NOTFOUND attribute to TRUE. Use the explicit cursor attributes to test the success of each fetch before any further references are made to the cursor. If you omit an exit criterion, an infinite loop results.

For more information, see *PL/SQL User's Guide and Reference*, Release 8, "Interaction With Oracle."

The %ISOPEN Attribute

- Fetch rows only when the cursor is open.
- Use the %ISOPEN cursor attribute before performing a fetch to test whether the cursor is open.

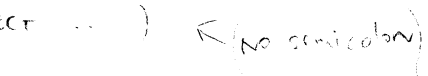
Example

```
IF NOT emp_cursor%ISOPEN THEN
   OPEN emp_cursor;
END IF;
LOOP
  FETCH emp_cursor...
```


Explicit Cursor Attributes

- You can fetch rows only when the cursor is open. Use the %ISOPEN cursor attribute to determine whether the cursor is open, if necessary.
- Fetch rows in a loop. Use cursor attributes to determine when to exit the loop.
- Use the %ROWCOUNT cursor attribute to retrieve an exact number of rows, fetch the rows in a numeric FOR loop, or fetch the rows in a simple loop and determine when to exit the loop.

Note: %ISOPEN returns the status of the cursor: TRUE if open and FALSE if not. It is not usually necessary to inspect %ISOPEN.

FOR emp_rec IN (SELECT ...)  (No semicolon)

LOOP ...

The %NOTFOUND and %ROWCOUNT Attributes

- Use the %ROWCOUNT cursor attribute to retrieve an exact number of rows.
- Use the %NOTFOUND cursor attribute to determine when to exit the loop.

Example

Retrieve the first 10 employees one by one.

```
DECLARE
  v_empno  emp.empno%TYPE;
  v_ename  emp.ename%TYPE;
  CURSOR emp_cursor IS
    SELECT empno, ename
    FROM   emp;
BEGIN
  OPEN emp_cursor;
  LOOP
    FETCH emp_cursor INTO v_empno, v_ename;
    EXIT WHEN emp_cursor%ROWCOUNT > 10 OR emp_cursor%NOTFOUND;
    ...
  END LOOP;
  CLOSE emp_cursor;
END ;
```

Note: Before the first fetch, %NOTFOUND evaluates to NULL. So if FETCH never executes successfully, the loop is never exited. That is because the EXIT WHEN statement executes only if its WHEN condition is true. To be safe, you might want to use the following EXIT statement:

```
EXIT WHEN emp_cursor%NOTFOUND OR emp_cursor%NOTFOUND IS NULL;
```

If using %ROWCOUNT, add a test for no rows in the cursor by using the %NOTFOUND attribute, because the row count is not incremented if the fetch does not retrieve any rows.

Cursors and Records

Process the rows of the active set conveniently by fetching values into a PL/SQL RECORD.

Example

```
DECLARE
  CURSOR emp_cursor IS
    SELECT  empno, ename
    FROM    emp;
  emp_record   emp_cursor%ROWTYPE;
BEGIN
  OPEN emp_cursor;
  LOOP
    FETCH emp_cursor INTO emp_record;
  ...
```


Cursors and Records

You have already seen that you can define records to use the structure of columns in a table. You can also define a record based on the selected list of columns in an explicit cursor. This is convenient for processing the rows of the active set, because you can simply fetch into the record. Therefore, the values of the row are loaded directly into the corresponding fields of the record.

Example

Use a cursor to retrieve employee numbers and names and populate a temporary database table with this information.

```
DECLARE
  CURSOR emp_cursor IS
    SELECT empno, ename
    FROM   emp;
  emp_record emp_cursor%ROWTYPE;
BEGIN
  OPEN emp_cursor;
  LOOP
    FETCH emp_cursor INTO emp_record;
    EXIT WHEN emp_cursor%NOTFOUND;
    INSERT INTO temp_list (empid, empname)
    VALUES (emp_record.empno, emp_record.ename);
  END LOOP;
  COMMIT;
  CLOSE emp_cursor;
END ;
```

Cursor FOR Loops

Syntax

```
FOR record_name IN cursor_name LOOP
  statement1;
  statement2;
  . . .
END LOOP;
```

- **The cursor FOR loop is a shortcut to process explicit cursors.**
- **Implicit open, fetch, and close occur.**
- **The record is implicitly declared.**

Cursor FOR Loops

A cursor FOR loop processes rows in an explicit cursor. It is a shortcut because the cursor is opened, rows are fetched once for each iteration in the loop, and the cursor is closed automatically when all rows have been processed. The loop itself is terminated automatically at the end of the iteration where the last row was fetched.

In the syntax:

record_name	is the name of the implicitly declared record
cursor_name	is a PL/SQL identifier for the previously declared cursor

Guidelines

- Do not declare the record that controls the loop. Its scope is only in the loop.
- Test the cursor attributes during the loop, if required.
- Supply the parameters for a cursor, if required, in parentheses following the cursor name in the FOR statement. More information on cursor parameters is covered in a subsequent lesson.
- Do not use a cursor FOR loop when the cursor operations must be handled manually.

Note: You can define a query at the start of the loop itself. The query expression is called a SELECT substatement, and the cursor is internal to the FOR loop. Because the cursor is not declared with a name, you cannot test its attributes.

Cursor FOR Loops

Retrieve employees one by one until no more are left.

Example

```
DECLARE
  CURSOR emp_cursor IS
    SELECT ename, deptno
    FROM   emp;
BEGIN
  FOR emp_record IN emp_cursor LOOP
        -- implicit open and implicit fetch occur
    IF emp_record.deptno = 30 THEN
      ...
  END LOOP; -- implicit close occurs
END;
```


Example

Retrieve employees one by one and print out a list of those employees currently working in the Sales department. The example from the slide is completed below.

```
SET SERVEROUTPUT ON
DECLARE
  CURSOR emp_cursor IS
    SELECT ename, deptno
    FROM   emp;
BEGIN
  FOR emp_record IN emp_cursor LOOP
        --implicit open and implicit fetch occur
    IF emp_record.deptno = 30 THEN
       DBMS_OUTPUT.PUT_LINE ('Employee ' || emp_record.ename
                             || ' works in the Sales Dept. ');
    END IF;
  END LOOP;   --implicit close occurs
END ;
/
```

Cursor FOR Loops Using Subqueries

No need to declare the cursor.

Example

```
BEGIN
  FOR emp_record IN (SELECT ename, deptno
                     FROM   emp) LOOP
        -- implicit open and implicit fetch occur
    IF emp_record.deptno = 30 THEN
      ...
  END LOOP; -- implicit close occurs
END;
```


Cursor FOR Loops Using Subqueries

You do not need to declare a cursor because PL/SQL lets you substitute a subquery. This example does the same thing as the one on the previous page. It is complete code for the slide above.

```
SET SERVEROUTPUT ON
BEGIN
  FOR emp_record IN (SELECT ename, deptno
                     FROM   emp) LOOP
        --implicit open and implicit fetch occur
    IF emp_record.deptno = 30 THEN
       DBMS_OUTPUT.PUT_LINE ('Employee ' || emp_record.ename
                             || ' works in the Sales Dept. ');
    END IF;
  END LOOP;   --implicit close occurs
END ;
/
```

Summary

- Cursor types:
  - Implicit cursors: Used for all DML statements and single-row queries.
  - Explicit cursors: Used for queries of zero, one, or more rows.
- You can manipulate explicit cursors.
- You can evaluate the cursor status by using cursor attributes.
- You can use cursor FOR loops.

Summary

An implicit cursor is declared by PL/SQL for each SQL data manipulation statement. PL/SQL lets you refer to the most recent implicit cursor as the SQL cursor. PL/SQL provides four attributes for each cursor. These attributes provide you with useful information about the operations that are performed with cursors. you can use the cursor attribute by appending it to the name of an explicit cursor. You may use these attributes only in PL/SQL statements.

PL/SQL allows you to process rows returned by a multi-row query. To individually process a row in a set of one or more rows returned by a query, you can declare an explicit cursor.

Example

Retrieve the first 5 line items for an order one by one. As each product is processed for the order, calculate the new total for the order and print it to the screen.

```
SET SERVEROUTPUT ON
ACCEPT p_ordid PROMPT 'Please enter the order number: '

DECLARE
  v_prodid   item.prodid%TYPE;
  v_item_total    NUMBER (11,2);
  v_order_total NUMBER (11,2) := 0;
  CURSOR item_cursor IS
     SELECT  prodid, actualprice * qty
     FROM    item
     WHERE   ordid = &p_ordid;
BEGIN
  OPEN item_cursor;
  LOOP
     FETCH item_cursor INTO v_prodid, v_item_total;
     EXIT WHEN item_cursor%ROWCOUNT > 5 OR
         item_cursor%NOTFOUND;
     v_order_total := v_order_total + v_item_total;
     DBMS_OUTPUT.PUT_LINE ('Product number ' || TO_CHAR (v_prodid) ||
         ' brings this order to a total of ' ||
         TO_CHAR (v_order_total, '$999,999.99'));
  END LOOP;
  CLOSE item_cursor;
END;
/
```

Practice Overview

- Declaring and using explicit cursors to query rows of a table
- Using a cursor FOR loop
- Applying cursor attributes to test the cursor status

6-23 ORACLE

Practice Overview

This practice applies your knowledge of cursors to process a number of rows from a table and populate another table with the results using a cursor FOR loop.

Practice 6

1. Run the script `lab6_1.sql` to create a new table for storing employees and their salaries.

```
SQL> CREATE TABLE     top_dogs
  2  (name           VARCHAR2(25),
  3   salary         NUMBER(11,2));
```

2. Create a PL/SQL block that determines the top employees with respect to salaries.
   a. Accept a number *n* as user input with a SQL*Plus substitution parameter.
   b. In a loop, get the last names and salaries of the top *n* people with respect to salary in the EMP table.
   c. Store the names and salaries in the TOP_DOGS table.
   d. Assume that no two employees have the same salary.
   e. Test a variety of special cases, such as $n = 0$ or where *n* is greater than the number of employees in the EMP table. Empty the TOP_DOGS table after each test.

```
Please enter the number of top money makers: 5
NAME        SALARY

----------- ------
KING          5000
FORD          3000
SCOTT         3000
JONES         2975
BLAKE         2850
```

3. Consider the case where several employees have the same salary. If one person is listed, then all people who have the same salary should also be listed.
   a. For example, if the user enters a value of 2 for *n*, then King, Ford, and Scott should be displayed. (These employees are tied for second highest salary.)
   b. If the user enters a value of 3, then King, Ford, Scott, and Jones should be displayed.
   c. Delete all rows from TOP_DOGS and test the practice.

```
Please enter the number of top money makers: 2
NAME         SALARY
------------ ------
KING           5000
FORD           3000
SCOTT          3000
```

Practice 6 (continued)

```
Please enter the number of top money makers: 3
NAME         SALARY
------------ ------
KING           5000
FORD           3000
SCOTT          3000
JONES          2975
```

7

Advanced Explicit Cursor Concepts

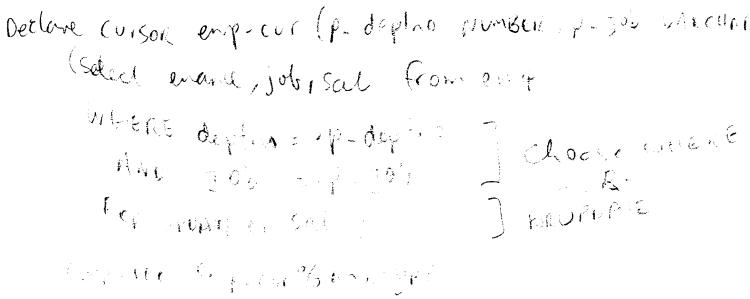
Objectives

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

- **Write a cursor that uses parameters**
- **Determine when a FOR UPDATE clause in a cursor is required**
- **Determine when to use the WHERE CURRENT OF clause**
- **Write a cursor that uses a subquery**

Lesson Aim

In this lesson, you will learn more about writing explicit cursors, specifically about writing cursors that use parameters.



Cursors with Parameters

Syntax

```
CURSOR cursor_name
  [(parameter_name datatype, ...)]
IS
  select_statement;
```

- **Pass parameter values to a cursor when the cursor is opened and the query is executed.**
- **Open an explicit cursor several times with a different active set each time.**

Cursors with Parameters

Parameters allow values to be passed to a cursor when it is opened and to be used in the query when it executes. This means that you can open and close an explicit cursor several times in a block, returning a different active set on each occasion.

Each formal parameter in the cursor declaration must have a corresponding actual parameter in the OPEN statement. Parameter datatypes are the same as those for scalar variables, but you do not give them sizes. The parameter names are for references in the query expression of the cursor.

In the syntax:

cursor_name	is a PL/SQL identifier for the previously declared cursor
parameter_name	is the name of a parameter (Parameter stands for the following syntax.)

```
cursor_parameter_name  [IN]  datatype  [{:= | DEFAULT} expr]
```

datatype	is a scalar datatype of the parameter
select_statement	is a SELECT statement without the INTO clause

When the cursor is opened, you pass values to each of the parameters positionally. You can pass values from PL/SQL or host variables as well as from literals.

Note: The parameter notation does not offer greater functionality; it simply allows you to specify input values easily and clearly. This is particularly useful when the same cursor is referenced repeatedly.

Cursors with Parameters

Pass the department number and job title to the WHERE clause.

Example

```
DECLARE
  CURSOR emp_cursor
  (p_deptno NUMBER, p_job VARCHAR2) IS
    SELECT    empno, ename
    FROM      emp
    WHERE     deptno = p_deptno
     AND      job = p_job;
BEGIN
  OPEN emp_cursor(10, 'CLERK');
...
```


Parameter datatypes are the same as those for scalar variables, but you do not give them sizes. The parameter names are for references in the cursor's query.

In the following example, two variables and a cursor are declared. The cursor is defined with two parameters.

```
DECLARE
   v_emp_job             emp.job%TYPE := 'CLERK';
   v_ename               emp.ename%TYPE;
   CURSOR emp_cursor(p_deptno NUMBER, p_job VARCHAR2) is
      SELECT ...
```

Either of the following statements opens the cursor:

```
OPEN emp_cursor(10, v_emp_job);
OPEN emp_cursor(20, 'ANALYST');
```

You can pass parameters to the cursor used in a cursor FOR loop:

```
DECLARE
   CURSOR emp_cursor(p_deptno NUMBER, p_job VARCHAR2) is
      SELECT ...
BEGIN
   FOR emp_record IN emp_cursor(10, 'ANALYST') LOOP ...
```

The FOR UPDATE Clause

Syntax

```
SELECT ...
FROM          ...
FOR UPDATE [OF column_reference][NOWAIT];
```

- **Explicit locking lets you deny access for the duration of a transaction.**
- **Lock the rows *before* the update or delete.**

The FOR UPDATE Clause

You may want to lock rows before you update or delete rows. Add the FOR UPDATE clause in the cursor query to lock the affected rows when the cursor is opened. Because the Oracle Server releases locks at the end of the transaction, you should not commit across fetches from an explicit cursor if FOR UPDATE is used.

In the syntax:

column_reference	is a column in the table against which the query is performed (A list of columns may also be used.)
NOWAIT	returns an Oracle error if the rows are locked by another session

The FOR UPDATE clause is the last clause in a select statement, even after the ORDER BY, if one exists.

When querying multiple tables, you can use the FOR UPDATE clause to confine row locking to particular tables. Rows in a table are locked only if the FOR UPDATE clause refers to a column in that table.

Exclusive row locks are taken on the rows in the active set before the OPEN returns when the FOR UPDATE clause is used.

The FOR UPDATE Clause

Retrieve the employees who work in department 30.

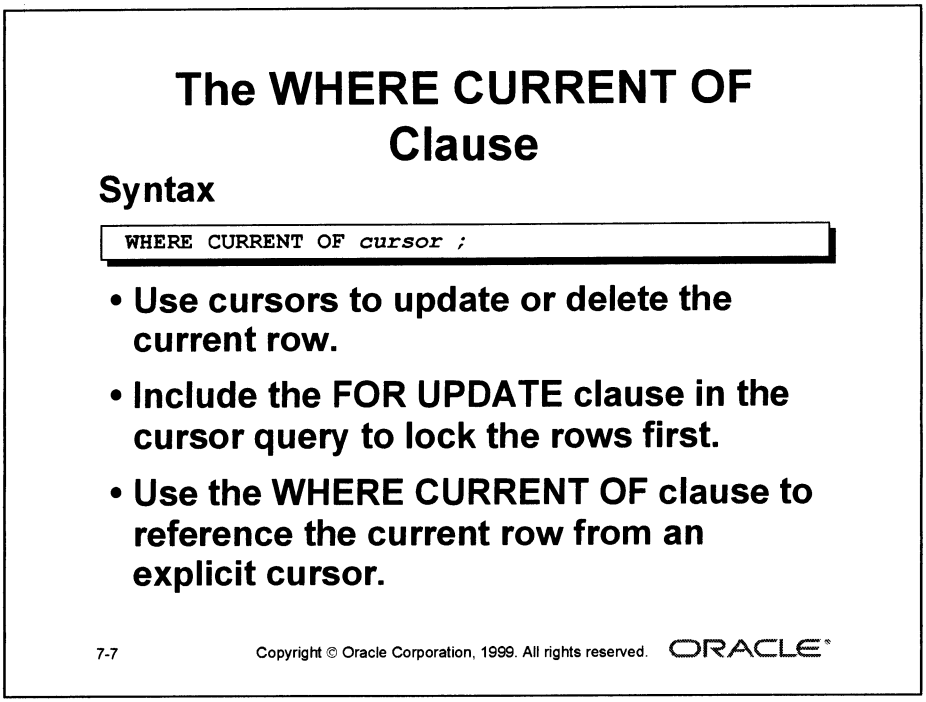
Example

```
DECLARE
  CURSOR emp_cursor IS
    SELECT empno, ename, sal
    FROM   emp
    WHERE  deptno = 30
    FOR UPDATE OF sal NOWAIT;
```


The FOR UPDATE Clause

Note: If the Oracle Server cannot acquire the locks on the rows it needs in a SELECT FOR UPDATE, it waits indefinitely. You can use the NOWAIT clause in the SELECT FOR UPDATE statement and test for the error code that returns because of failure to acquire the locks in a loop. Therefore, you can retry opening the cursor *n* times before terminating the PL/SQL block. If you have a large table, you can achieve better performance by using the LOCK TABLE statement to lock all rows in the table. However, when using LOCK TABLE, you cannot use the WHERE CURRENT OF clause and must use the notation WHERE *column = identifier*.

It is not mandatory that the FOR UPDATE OF clause refers to a column, but it is recommended for better readability and maintenance.



The WHERE CURRENT OF Clause

When referencing the current row from an explicit cursor, use the WHERE CURRENT OF clause. This allows you to apply updates and deletes to the row currently being addressed, without the need to explicitly reference ROWID. You must include the FOR UPDATE clause in the cursor query so that the rows are locked on OPEN.

In the syntax:

cursor	is the name of a declared cursor (The cursor must have been declared with the FOR UPDATE clause.)

The WHERE CURRENT OF Clause

Example

```
DECLARE
  CURSOR sal_cursor IS
    SELECT    sal
    FROM      emp
    WHERE     deptno = 30
    FOR UPDATE OF sal NOWAIT;
BEGIN
  FOR emp_record IN sal_cursor LOOP
    UPDATE    emp
    SET       sal = emp_record.sal * 1.10
    WHERE CURRENT OF sal_cursor;
  END LOOP;
  COMMIT;
END;
```


The WHERE CURRENT OF Clause (continued)

You can update rows based on criteria from a cursor.

Additionally, you can write your DELETE or UPDATE statement to contain the WHERE CURRENT OF *cursor_name* clause to refer to the latest row processed by the FETCH statement. When you use this clause, the cursor you reference must exist and must contain the FOR UPDATE clause in the cursor query; otherwise, you will receive an error. This clause allows you to apply updates and deletes to the currently addressed row without the need to explicitly reference the ROWID pseudo-column.

Example

The slide example loops through each employee in department 30, raising each salary by 10%. The WHERE CURRENT OF clause in the UPDATE statement refers to the currently fetched record.

Cursors with Subqueries

Example

```
DECLARE
  CURSOR my_cursor IS
    SELECT t1.deptno, t1.dname, t2.STAFF
    FROM   dept t1, (SELECT deptno,
                            count(*) STAFF
                    FROM   emp
                    GROUP BY deptno) t2
    WHERE  t1.deptno = t2.deptno
    AND    t2.STAFF >= 5;
```


Subqueries

A subquery is a query (usually enclosed by parentheses) that appears within another SQL data manipulation statement. When evaluated, the subquery provides a value or set of values to the statement.

Subqueries are often used in the WHERE clause of a select statement. They can also be used in the FROM clause, creating a temporary data source for that query. In this example, the subquery creates a data source consisting of department numbers and employee head count in each department (known as the alias STAFF). A table alias, t2, refers to this temporary data source in the FROM clause. When this cursor is opened, the active set will contain the department number, department name, and employee head count for those departments that have a head count greater than or equal to 5.

A subquery or correlated subquery can be used.

Summary

- You can return different active sets using cursors with parameters.
- You can define cursors with subqueries and correlated subqueries.
- You can manipulate explicit cursors with commands:
  - FOR UPDATE Clause
  - WHERE CURRENT OF Clause

7-10 ORACLE®

Summary

An explicit cursor can take parameters. In a query, you can specify a cursor parameter wherever a constant can appear. An advantage of using parameters is that you can decide the active set at run time. PL/SQL provides a method to modify the rows that have been retrieved by the cursor, The method consists of two parts. The FOR UPDATE clause in the cursor declaration and the WHERE CURRENT OF clause in an UPDATE or DELETE statement.

Practice Overview

- Declaring and using explicit cursors with parameters
- Using a cursor FOR UPDATE

Practice Overview

This practice applies your knowledge of cursors with parameters to process a number of rows from multiple tables.

Practice 7

1. Use a cursor to retrieve the department number and the department name from the dept table. Pass the department number to another cursor to retrieve from the emp table the details of employee name, job, hiredate, and salary of all the employees who work in that department.

```
Department Number : 10  Department Name : ACCOUNTING

KING    PRESIDENT   17-NOV-81   5000
CLARK    MANAGER   09-JUN-81   2450
MILLER    CLERK   23-JAN-82   1300

Department Number : 20  Department Name : RESEARCH

JONES    MANAGER   02-APR-81   2975
FORD    ANALYST   03-DEC-81   3000
SMITH    CLERK   17-DEC-80   800
SCOTT    ANALYST   09-DEC-82   3000
ADAMS    CLERK   12-JAN-83   1100

Department Number : 30  Department Name : SALES

BLAKE    MANAGER   01-MAY-81   2850
MARTIN    SALESMAN   28-SEP-81   1250
ALLEN    SALESMAN   20-FEB-81   1600
TURNER    SALESMAN   08-SEP-81   1500
JAMES    CLERK   03-DEC-81   950
WARD    SALESMAN   22-FEB-81   1250

Department Number : 40  Department Name : OPERATIONS
```

2. Modify `p4q5.sql` to incorporate the FOR UPDATE and WHERE CURRENT OF functionality in cursor processing.

```
EMPNO     SAL STARS
----- ------ ----------------------
 8000
 7900     950 **********
 7844    1500 ***************
```

Handling Exceptions

Objectives

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

- **Define PL/SQL exceptions**
- **Recognize unhandled exceptions**
- **List and use different types of PL/SQL exception handlers**
- **Trap unanticipated errors**
- **Describe the effect of exception propagation in nested blocks**
- **Customize PL/SQL exception messages**

Lesson Aim

In this lesson, you will learn what PL/SQL exceptions are and how to deal with them using predefined, non-predefined, and user-defined exception handlers.

Handling Exceptions with PL/SQL

- What is an exception?
  Identifier in PL/SQL that is raised during execution
- How is it raised?
  - An Oracle error occurs.
  - You raise it explicitly.
- How do you handle it?
  - Trap it with a handler.
  - Propagate it to the calling environment.

8-3 ORACLE

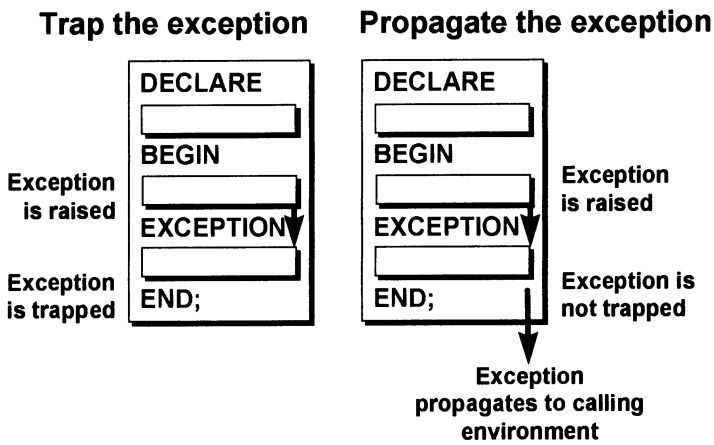
Overview

An exception is an identifier in PL/SQL, raised during the execution of a block that terminates its main body of actions. A block always terminates when PL/SQL raises an exception, but you specify an exception handler to perform final actions.

Two Methods for Raising an Exception

- An Oracle error occurs and the associated exception is raised automatically. For example, if the error ORA-01403 occurs when no rows are retrieved from the database in a SELECT statement, then PL/SQL raises the exception NO_DATA_FOUND.
- You raise an exception explicitly by issuing the RAISE statement within the block. The exception being raised may be either user defined or predefined.

Handling Exceptions

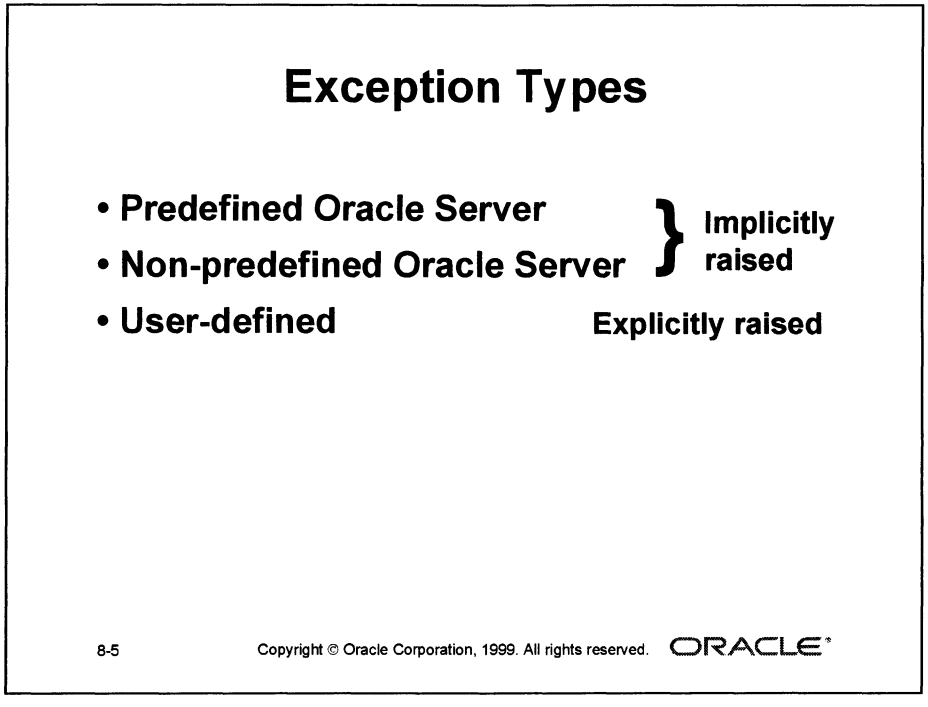


Trapping an Exception

If the exception is raised in the executable section of the block, processing branches to the corresponding exception handler in the exception section of the block. If PL/SQL successfully handles the exception, then the exception does not propagate to the enclosing block or environment. The PL/SQL block terminates successfully.

Propagating an Exception

If the exception is raised in the executable section of the block and there is no corresponding exception handler, the PL/SQL block terminates with failure and the exception is propagated to the calling environment.

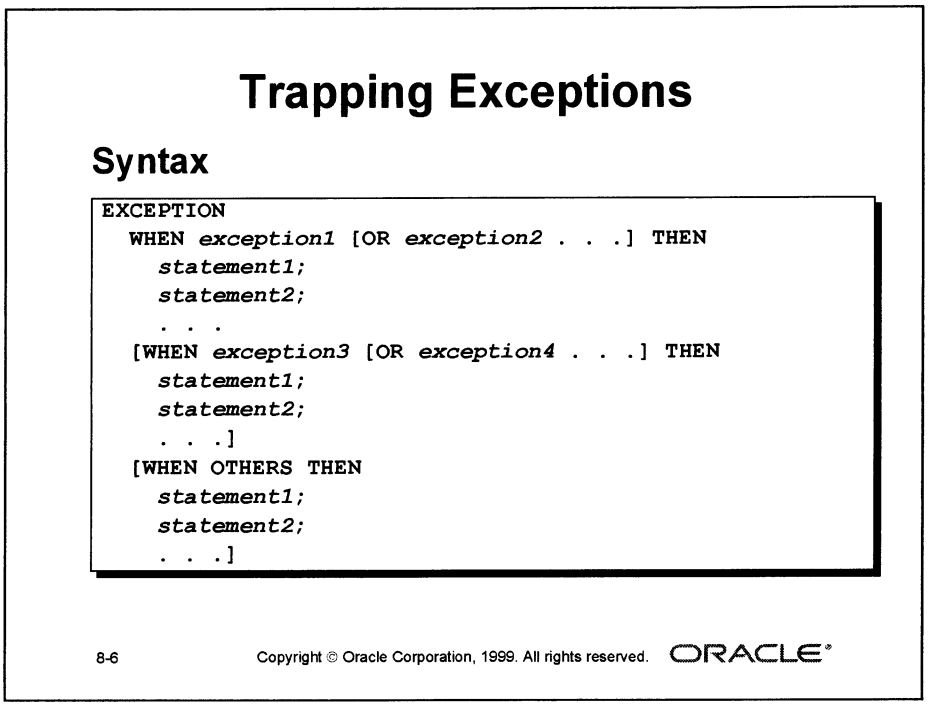


Exception Types

You can program for exceptions to avoid disruption at runtime. There are three types of exceptions.

Exception	Description	Directions for Handling
Predefined Oracle Server error	One of approximately 20 errors that occur most often in PL/SQL code	Do not declare and allow the Oracle Server to raise them implicitly
Non-predefined Oracle Server error	Any other standard Oracle Server error	Declare within the declarative section and allow the Oracle Server to raise them implicitly
User-defined error	A condition that the developer determines is abnormal.	Declare within the declarative section *and* raise explicitly

Note: Some application tools with client-side PL/SQL, such as Oracle Developer Forms, have their own exceptions.



Trapping Exceptions

You can trap any error by including a corresponding routine within the exception handling section of the PL/SQL block. Each handler consists of a WHEN clause, which specifies an exception, followed by a sequence of statements to be executed when that exception is raised.

In the syntax:

exception	is the standard name of a predefined exception or the name of a user-defined exception declared within the declarative section
statement	is one or more PL/SQL or SQL statements
OTHERS	is an optional exception-handling clause that traps unspecified exceptions

WHEN OTHERS Exception Handler

The exception-handling section traps only those exceptions specified; any other exceptions are not trapped unless you use the OTHERS exception handler. This traps any exception not yet handled. For this reason, OTHERS is the last exception handler defined.

The OTHERS handler traps *all* exceptions not already trapped. Some Oracle tools have their own predefined exceptions that you can raise to cause events in the application. OTHERS also traps these exceptions.

Trapping Exceptions Guidelines

- **WHEN OTHERS is the last clause.**
- **EXCEPTION keyword starts exception-handling section.**
- **Several exception handlers are allowed.**
- **Only one handler is processed before leaving the block.**

Guidelines

- Begin the exception-handling section of the block with the keyword EXCEPTION.
- Define several exception handlers, each with its own set of actions, for the block.
- When an exception occurs, PL/SQL processes *only one* handler before leaving the block.
- Place the OTHERS clause after all other exception-handling clauses.
- You can have at most one OTHERS clause.
- Exceptions cannot appear in assignment statements or SQL statements.

Trapping Predefined Oracle Server Errors

- Reference the standard name in the exception-handling routine.
- Sample predefined exceptions:
  - NO_DATA_FOUND
  - TOO_MANY_ROWS
  - INVALID_CURSOR
  - ZERO_DIVIDE
  - DUP_VAL_ON_INDEX

8-8 ORACLE®

Trapping Predefined Oracle Server Errors

Trap a predefined Oracle Server error by referencing its standard name within the corresponding exception-handling routine.

For a complete list of predefined exceptions, see *PL/SQL User's Guide and Reference*, Release 8, "Error Handling."

Note: PL/SQL declares predefined exceptions in the STANDARD package.
It is a good idea to always consider the NO_DATA_FOUND and TOO_MANY_ROWS exceptions, which are the most common.

Predefined Exceptions

Exception Name	Oracle Server Error Number	Description
ACCESS_INTO_NULL	ORA-06530	Attempted to assign values to the attributes of an uninitialized object
COLLECTION_IS_NULL	ORA-06531	Attempted to apply collection methods other than EXISTS to an uninitialized nested table or varray
CURSOR_ALREADY_OPEN	ORA-06511	Attempted to open an already open cursor
DUP_VAL_ON_INDEX	ORA-00001	Attempted to insert a duplicate value
INVALID_CURSOR	ORA-01001	Illegal cursor operation occurred
INVALID_NUMBER	ORA-01722	Conversion of character string to number fails
LOGIN_DENIED	ORA-01017	Logging on to Oracle with an invalid username or password
NO_DATA_FOUND	ORA-01403	Single row SELECT returned no data
NOT_LOGGED_ON	ORA-01012	PL/SQL program issues a database call without being connected to Oracle
PROGRAM_ERROR	ORA-06501	PL/SQL has an internal problem
ROWTYPE_MISMATCH	ORA-06504	Host cursor variable and PL/SQL cursor variable involved in an assignment have incompatible return types
STORAGE_ERROR	ORA-06500	PL/SQL ran out of memory or memory is corrupted
SUBSCRIPT_BEYOND_COUNT	ORA-06533	Referenced a nested table or varray element using an index number larger than the number of elements in the collection
SUBSCRIPT_OUTSIDE_LIMIT	ORA-06532	Referenced a nested table or varray element using an index number that is outside the legal range (−1 for example)
TIMEOUT_ON_RESOURCE	ORA-00051	Time-out occurred while Oracle is waiting for a resource
TOO_MANY_ROWS	ORA-01422	Single-row SELECT returned more than one row
VALUE_ERROR	ORA-06502	Arithmetic, conversion, truncation, or size-constraint error occurred
ZERO_DIVIDE	ORA-01476	Attempted to divide by zero

Predefined Exception

Syntax

```
BEGIN
EXCEPTION
  WHEN NO_DATA_FOUND THEN
    statement1;
    statement2;
  WHEN TOO_MANY_ROWS THEN
    statement1;
  WHEN OTHERS THEN
    statement1;
    statement2;
    statement3;
END;
```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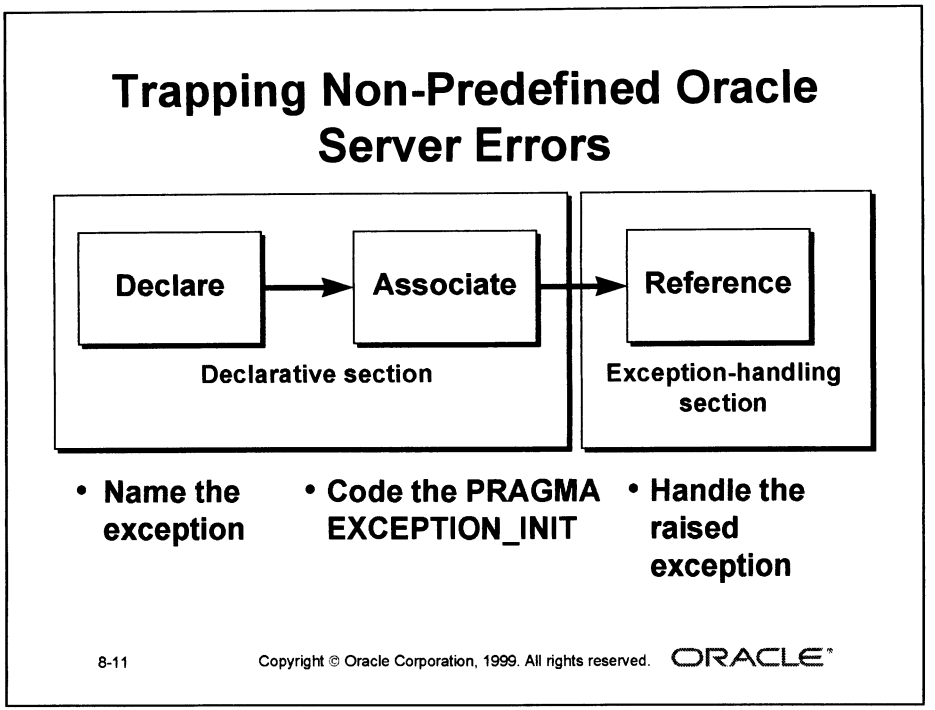
Trapping Predefined Oracle Server Exceptions

Only one exception is raised and handled at any time.



Trapping Non-Predefined Oracle Server Errors

You trap a non-predefined Oracle Server error by declaring it first, or by using the OTHERS handler. The declared exception is raised implicitly. In PL/SQL, the pragma EXCEPTION_INIT tells the compiler to associate an exception name with an Oracle error number. That allows you to refer to any internal exception by name and to write a specific handler for it.

Note: PRAGMA (also called *pseudoinstructions*) is the keyword that signifies that the statement is a compiler directive, which is not processed when the PL/SQL block is executed. Rather, it directs the PL/SQL compiler to interpret all occurrences of the exception name within the block as the associated Oracle Server error number.

Non-Predefined Error

Trap for Oracle Server error number –2292, an integrity constraint violation.

```
DECLARE
  e_emps_remaining    EXCEPTION;                    (1)
  PRAGMA EXCEPTION_INIT (                           (2)
             e_emps_remaining, -2292);
  v_deptno     dept.deptno%TYPE := &p_deptno;
BEGIN
  DELETE FROM dept
  WHERE        deptno = v_deptno;
  COMMIT;
EXCEPTION
  WHEN e_emps_remaining THEN                        (3)
   DBMS_OUTPUT.PUT_LINE ('Cannot remove dept ' ||
   TO_CHAR(v_deptno) || '.  Employees exist. ');
END;
```


Trapping a Non-Predefined Oracle Server Exception

1. Declare the name for the exception within the declarative section.

   Syntax

   ```
   exception EXCEPTION;
   ```

   where: *exception* is the name of the exception.

2. Associate the declared exception with the standard Oracle Server error number using the PRAGMA EXCEPTION_INIT statement.

   Syntax

   ```
   PRAGMA EXCEPTION_INIT(exception, error_number);
   ```

   where: *exception* is the previously declared exception.
   error_number is a standard Oracle Server error number.

3. Reference the declared exception within the corresponding exception-handling routine.

Example

If there are employees in a department, print a message to the user that the department cannot be removed.

For more information, see *Oracle Server Messages*, Release 8.

Functions for Trapping Exceptions

- **SQLCODE**
  Returns the numeric value for the error code
- **SQLERRM**
  Returns the message associated with the error number

Error Trapping Functions

When an exception occurs, you can identify the associated error code or error message by using two functions. Based on the values of the code or message, you can decide what subsequent action to take based on the error.

SQLCODE returns the number of the Oracle error for internal exceptions. You can pass an error number to SQLERRM, which then returns the message associated with the error number.

Function	Description
SQLCODE	Returns the numeric value for the error code (You can assign it to a NUMBER variable.)
SQLERRM	Returns character data containing the message associated with the error number

Example SQLCODE Values

SQLCODE Value	Description
0	No exception encountered
1	User-defined exception
+100	NO_DATA_FOUND exception
negative number	Another Oracle Server error number

Functions for Trapping Exceptions

Example

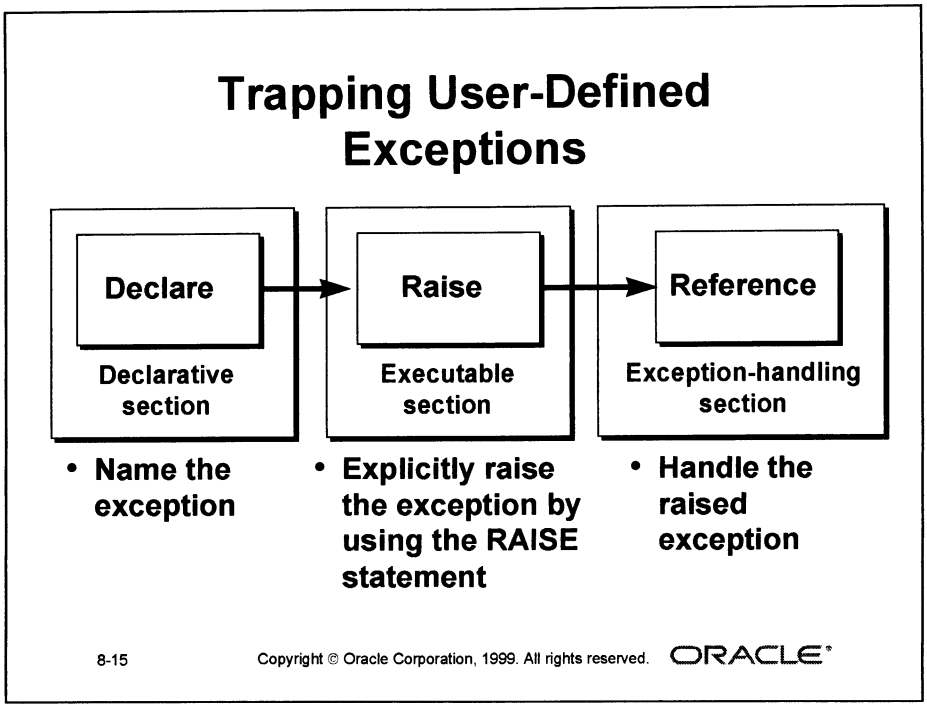
```
DECLARE
  v_error_code      NUMBER;
  v_error_message   VARCHAR2(255);
BEGIN
...
EXCEPTION
...
  WHEN OTHERS THEN
    ROLLBACK;
    v_error_code := SQLCODE ;
    v_error_message := SQLERRM ;
    INSERT INTO errors VALUES(v_error_code,
                              v_error_message);
END;
```

Error-Trapping Functions

When an exception is trapped in the WHEN OTHERS exception handler, you can use a set of generic functions to identify those errors.

The example on the slide illustrates the values of SQLCODE and SQLERRM being assigned to variables and then those variables being used in a SQL statement.

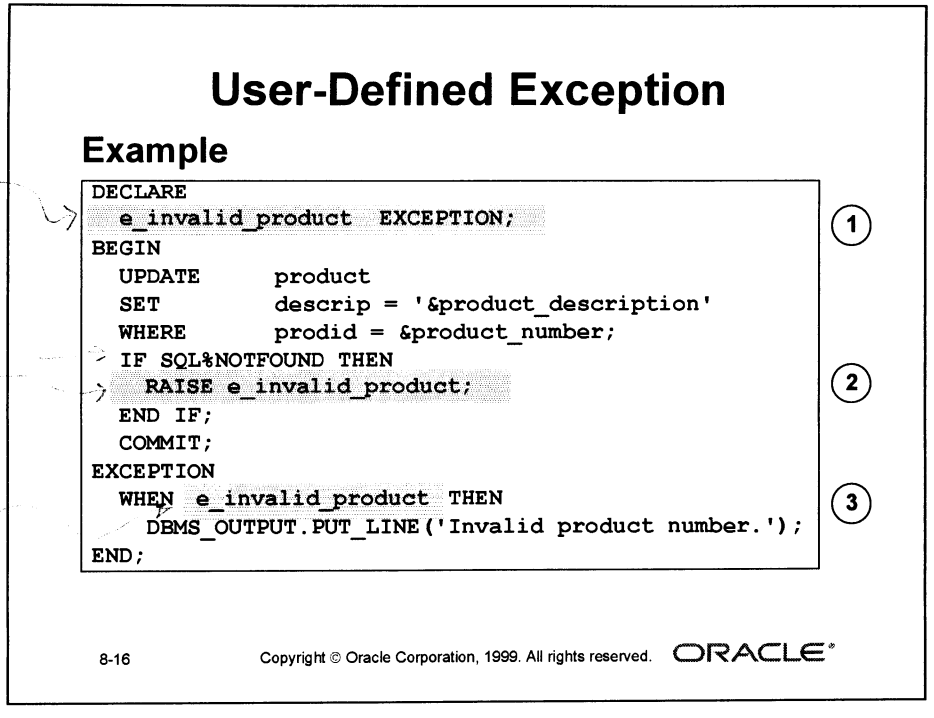
Truncate the value of SQLERRM to a known length before attempting to write it to a variable.



Trapping User-Defined Exceptions

PL/SQL lets you define your own exceptions. User-defined PL/SQL exceptions must be:

- Declared in the declare section of a PL/SQL block
- Raised explicitly with RAISE statements



Trapping User-Defined Exceptions (continued)

You trap a user-defined exception by declaring it and raising it explicitly.

1. Declare the name for the user-defined exception within the declarative section.

   Syntax

   ```
   exception EXCEPTION;
   ```

   where: *exception* is the name of the exception

2. Use the RAISE statement to raise the exception explicitly within the executable section.

   Syntax

   ```
   RAISE exception;
   ```

   where: *exception* is the previously declared exception

3. Reference the declared exception within the corresponding exception handling routine.

Example

This block updates the description of a product. The user supplies the product number and the new description. If the user enters a product number that does not exist, no rows will be updated in the PRODUCT table. Raise an exception and print a message to the user alerting them that an invalid product number was entered.

Note: Use the RAISE statement by itself within an exception handler to raise the same exception back to the calling environment.

Calling Environments

SQL*Plus	Displays error number and message to screen
Procedure Builder	Displays error number and message to screen
Oracle Developer Forms	Accesses error number and message in a trigger by means of the ERROR_CODE and ERROR_TEXT packaged functions
Precompiler application	Accesses exception number through the SQLCA data structure
An enclosing PL/SQL block	Traps exception in exception-handling routine of enclosing block

Propagating Exceptions

Instead of trapping an exception within the PL/SQL block, propagate the exception to allow the calling environment to handle it. Each calling environment has its own way of displaying and accessing errors.

Propagating Exceptions

Subblocks can handle an exception or pass the exception to the enclosing block.

```
DECLARE
  . . .
  e_no_rows       exception;
  e_integrity     exception;
  PRAGMA EXCEPTION_INIT (e_integrity, -2292);
BEGIN
  FOR c_record IN emp_cursor LOOP
    BEGIN
      SELECT ...
      UPDATE ...
      IF SQL%NOTFOUND THEN
        RAISE e_no_rows;
      END IF;
    EXCEPTION
      WHEN e_integrity THEN ...
      WHEN e_no_rows THEN ...
    END;
END LOOP;
EXCEPTION
  WHEN NO_DATA_FOUND THEN . . .
  WHEN TOO_MANY_ROWS THEN . . .
END;
```


Propagating an Exception in a Subblock

When a subblock handles an exception, it terminates normally, and control resumes in the enclosing block immediately after the subblock END statement.

However, if PL/SQL raises an exception and the current block does not have a handler for that exception, the exception propagates in successive enclosing blocks until it finds a handler. If none of these blocks handle the exception, an unhandled exception in the host environment results.

When the exception propagates to an enclosing block, the remaining executable actions in that block are bypassed.

One advantage of this behavior is that you can enclose statements that require their own exclusive error handling in their own block, while leaving more general exception handling to the enclosing block.

RAISE_APPLICATION_ERROR Procedure

Syntax

```
raise_application_error (error_number,
                         message[, {TRUE | FALSE}]);
```

- A procedure that lets you issue user-defined error messages from stored subprograms
- Called only from an executing stored subprogram

RAISE_APPLICATION_ERROR Procedure

Use the RAISE_APPLICATION_ERROR procedure to communicate a predefined exception interactively by returning a nonstandard error code and error message. With RAISE_APPLICATION_ERROR, you can report errors to your application and avoid returning unhandled exceptions.

In the syntax:

error_number	is a user specified number for the exception between –20000 and –20999.
message	is the user-specified message for the exception. It is a character string up to 2,048 bytes long.
TRUE | FALSE	is an optional Boolean parameter (If TRUE, the error is placed on the stack of previous errors. If FALSE, the default, the error replaces all previous errors.)

Example

```
...
EXCEPTION
  WHEN NO_DATA_FOUND THEN
    RAISE_APPLICATION_ERROR (-20201,
          'Manager is not a valid employee.');
END;
```

Site-specific special e.g.

RAISE_APPLICATION_ERROR Procedure

- Used in two different places:
  - Executable section
  - Exception section
- Returns error conditions to the user in a manner consistent with other Oracle Server errors

Example

```
...
DELETE FROM emp
WHERE  mgr = v_mgr;
IF SQL%NOTFOUND THEN
  RAISE_APPLICATION_ERROR(-20202,'This is not a valid manager');
END IF;
...
```

Summary

- Exception types:
  - Predefined Oracle Server error
  - Non-predefined Oracle Server error
  - User-defined error
- Exception trapping
- Exception handling:
  - Trap the exception within the PL/SQL block.
  - Propagate the exception.

Summary

PL/SQL implements error handling via exceptions and exception handlers. Predefined exceptions are error conditions that are defined by Oracle server. Non-Predefined exceptions are any other standard Oracle Server error. Exceptions that are specific to your application or ones that you can anticipate while creating the application are user-defined exceptions.

Once an error has occurred, (an exception has been raised) the control is transferred to the exception handling part of the PL/SQL block. If an associated exception is there in the exception-handling part, the code specified with the exception handler is executed. If an associated exception handler is not found in the current block and the current block is nested, the control will propagate to outer block, if any. If an exception handler is not found in the outer block(s) too, PL/SQL reports an error.

Practice Overview

- Handling named exceptions
- Creating and invoking user-defined exceptions

Practice Overview

In this practice, you create exception handlers for specific situations.

Practice 8

1. Write a PL/SQL block to select the name of the employee with a given salary value.
   a. If the salary entered returns more than one row, handle the exception with an appropriate exception handler and insert into the MESSAGES table the message "More than one employee with a salary of *<salary>*."
   b. If the salary entered does not return any rows, handle the exception with an appropriate exception handler and insert into the MESSAGES table the message "No employee with a salary of *<salary>*."
   c. If the salary entered returns only one row, insert into the MESSAGES table the employee's name and the salary amount.
   d. Handle any other exception with an appropriate exception handler and insert into the MESSAGES table the message "Some other error occurred."
   e. Test the block for a variety of test cases.

```
RESULTS
-----------------------------------------
SMITH - 800
More than one employee with a salary of 3000
No employee with a salary of 6000
```

2. Modify `p3q3.sql` to add an exception handler.
   a. Write an exception handler for the error to pass a message to the user that the specified department does not exist.
   b. Execute the PL/SQL block by entering a department that does not exist.

```
Please enter the department number: 50
Please enter the department location: HOUSTON
PL/SQL procedure successfully completed.

G_MESSAGE
-------------------------------------
Department 50 is an invalid department
```

3. Write a PL/SQL block that prints the number of employees who make plus or minus $100 of the salary value entered.
   a. If there is no employee within that salary range, print a message to the user indicating that is the case. Use an exception for this case.
   b. If there are one or more employees within that range, the message should indicate how many employees are in that salary range.
   c. Handle any other exception with an appropriate exception handler. The message should indicate that some other error occurred.

Practice 8 (continued)

```
Please enter the salary: 800
PL/SQL procedure successfully completed.

G_MESSAGE
-------------------------------------------------------
There is/are 1 employee(s) with a salary between 700 and 900

Please enter the salary: 3000
PL/SQL procedure successfully completed.

G_MESSAGE
-------------------------------------------------------
There is/are 3 employee(s) with a salary between 2900 and 3100

Please enter the salary: 6000
PL/SQL procedure successfully completed.

G_MESSAGE
-----------------------------------------------
There is no employee salary between 5900 and 6100
```

A

Practice Solutions

Practice 1 Solutions

1. Evaluate each of the following declarations. Determine which of them are *not* legal and explain why.

   a.
   ```
   DECLARE
     v_id            NUMBER(4);
   ```
   Legal

   b.
   ```
   DECLARE
     v_x, v_y, v_z  VARCHAR2(10);
   ```
   Illegal because only one identifier per declaration is allowed

   c.
   ```
   DECLARE
     v_birthdate    DATE NOT NULL;
   ```
   Illegal because the NOT NULL variable must be initialized

   d.
   ```
   DECLARE
     v_in_stock     BOOLEAN := 1;
   ```
   Illegal because 1 is not a Boolean expression

Practice 1 Solutions (continued)

2. In each of the following assignments, determine the datatype of the resulting expression.

   a. `v_days_to_go := v_due_date - SYSDATE;`

      Number

   b. `v_sender := USER || ': ' || TO_CHAR(v_dept_no);`

      Character string

   c. `v_sum := $100,000 + $250,000;`

      Illegal; PL/SQL cannot convert special symbols from VARCHAR2 to NUMBER

   d. `v_flag := TRUE;`

      Boolean

   e. `v_n1 := v_n2 > (2 * v_n3);`

      Boolean

   f. `v_value := NULL;`

      Any scalar datatype

3. Create an anonymous block to output the phrase "My PL/SQL Block Works" to the screen.

```
VARIABLE g_message VARCHAR2(30)
BEGIN
  :g_message := 'My PL/SQL Block Works';
END;
/
PRINT g_message
SQL> START p1q3.sql

G_MESSAGE
--------------------------------------------------
My PL/SQL Block Works
```

Practice 1 Solutions (continued)

If you have time, complete the following exercise:

4. Create a block that declares two variables. Assign the value of these PL/SQL variables to SQL*Plus host variables and print the results of the PL/SQL variables to the screen. Execute your PL/SQL block. Save your PL/SQL block to a file named `p1q4.sql`.

   V_CHAR Character (variable length)

   V_NUM Number

   Assign values to these variables as follows:

   ```
   Variable        Value
   ---------- ---------------------------------------

   V_CHAR     The literal '42 is the answer'
   V_NUM      The first two characters from V_CHAR
   ```

   ```
   VARIABLE g_char VARCHAR2(30)
   VARIABLE g_num  NUMBER
   DECLARE
     v_char VARCHAR2(30);
     v_num  NUMBER(11,2);
   BEGIN
     v_char := '42 is the answer';
     v_num  := TO_NUMBER(SUBSTR(v_char,1,2));
     :g_char := v_char;
     :g_num  := v_num;
   END;
   /
   PRINT g_char
   PRINT g_num
   SQL> START p1q4.sql


   G_CHAR
   ----------------------
   42 is the answer

       G_NUM
   ---------
          42
   ```

Practice 2 Solutions

```
PL/SQL Block
 DECLARE
   v_weight   NUMBER(3) := 600;
   v_message  VARCHAR2(255) := 'Product 10012';
 BEGIN
                  /*SUBBLOCK*/
     DECLARE
       v_weight   NUMBER(3) := 1;
       v_message  VARCHAR2(255) := 'Product 11001'
       v_new_locn VARCHAR2(50) := 'Europe';
     BEGIN
       v_weight := v_weight + 1;
       v_new_locn := 'Western ' || v_new_locn;
     END;

   v_weight := v_weight + 1;
   v_message := v_message || ' is in stock';
   v_new_locn := 'Western ' || v_new_locn;

 END;
```

Practice 2 Solutions (continued)

1. Evaluate the PL/SQL block on the previous page and determine the datatype and value of each of the following variables according to the rules of scoping.
   a. The value of V_WEIGHT in the subblock is:

      "2" and the datatype is NUMBER.

   b. The value of V_NEW_LOCN in the subblock is:

      "Western Europe" and the datatype is VARCHAR2.

   c. The value of V_WEIGHT in the main block is:

      "601" and the datatype is NUMBER.

   d. The value of V_MESSAGE in the main block is:

      "Product 10012 is in stock" and the datatype is VARCHAR2.

   e. The value of V_NEW_LOCN in the main block is:

      Illegal because v_new_locn is not visible outside the subblock.

Practice 2 Solutions (continued)

Scope Example

```
DECLARE
  v_customer         VARCHAR2(50) := 'Womansport';
  v_credit_rating    VARCHAR2(50) := 'EXCELLENT';
BEGIN
  DECLARE
    v_customer  NUMBER(7) := 201;
    v_name VARCHAR2(25) := 'Unisports';
  BEGIN
   v_customer      v_name  v_credit_rating
  END;

 v_customer       v_name  v_credit_rating

END;
```

Practice 2 Solutions (continued)

2. Suppose you embed a subblock within a block, as shown on the previous page. You declare two variables, V_CUSTOMER and V_CREDIT_RATING, in the main block. You also declare two variables, V_CUSTOMER and V_NAME, in the subblock. Determine the values and datatypes for each of the following cases.

   a. The value of V_CUSTOMER in the subblock is:

      "201" and the datatype is NUMBER.

   b. The value of V_NAME in the subblock is:

      "Unisports" and the datatype is VARCHAR2.

   c. The value of V_CREDIT_RATING in the subblock is:

      "EXCELLENT" and the datatype is VARCHAR2.

   d. The value of V_CUSTOMER in the main block is:

      "Womansport" and the datatype is VARCHAR2.

   e. The value of V_NAME in the main block is:

      V_NAME is not visible in the main block and you would see an error.

   f. The value of V_CREDIT_RATING in the main block is:

      "EXCELLENT" and the datatype is VARCHAR2.

Practice 2 Solutions (continued)

3. Create and execute a PL/SQL block that accepts two numbers through SQL*Plus substitution variables. The first number should be divided by the second number and have the second number added to the result. The result should be stored in a PL/SQL variable and printed on the screen, or the result should be written to a SQL*Plus variable and printed to the screen.

   a. When a PL/SQL variable is used:

```
SET ECHO OFF
SET VERIFY OFF
SET SERVEROUTPUT ON
ACCEPT p_num1 PROMPT 'Please enter the first number: '
ACCEPT p_num2 PROMPT 'Please enter the second number: '
DECLARE
     v_num1    NUMBER(9,2) := &p_num1;
     v_num2    NUMBER(9,2) := &p_num2;
     v_result  NUMBER(9,2) ;
BEGIN
     v_result :=  (v_num1/v_num2) + v_num2;
     /* Printing the PL/SQL variable */
     DBMS_OUTPUT.PUT_LINE (v_result);
END;
/
SET SERVEROUTPUT OFF
SET VERIFY ON
SET ECHO ON
```

Note: Solution continued on next page.

Practice 2 Solutions (continued)

b. When a SQL*Plus variable is used:

```
SET ECHO OFF
SET VERIFY OFF
VARIABLE g_result NUMBER
ACCEPT p_num1 PROMPT 'Please enter the first number:
ACCEPT p_num2 PROMPT 'Please enter the second number:
DECLARE
     v_num1    NUMBER(9,2) := &p_num1;
     v_num2    NUMBER(9,2) := &p_num2;
BEGIN
     :g_result := (v_num1/v_num2) + v_num2;
END;
/
PRINT g_result /* Printing the SQL*Plus variable */
SET VERIFY ON
SET ECHO ON
```

Practice 2 Solutions (continued)

4. Build a PL/SQL block that computes the total compensation for one year. The annual salary and the annual bonus percentage are passed to the PL/SQL block through SQL*Plus substitution variables, and the bonus needs to be converted from a whole number to a decimal (for example, 15 to .15). If the salary is null, set it to zero before computing the total compensation. Execute the PL/SQL block. *Reminder*: Use the NVL function to handle null values.

   Note: To test the NVL function, type NULL at the prompt; pressing |Return| results in a missing expression error.

   a. When a PL/SQL variable is used:

```
SET VERIFY OFF
VARIABLE g_total NUMBER
ACCEPT p_salary PROMPT 'Please enter the salary amount: '
ACCEPT p_bonus PROMPT 'Please enter the bonus percentage: '
DECLARE
  v_salary NUMBER := &p_salary;
  v_bonus  NUMBER := &p_bonus;
BEGIN
  :g_total := NVL(v_salary, 0) * (1 + NVL(v_bonus, 0) / 100);
END;
/
PRINT g_total
SET VERIFY ON
SQL> START p2q4.sql
```

   b. When a SQL*Plus variable is used:

```
SET VERIFY OFF
SET SERVEROUTPUT ON
ACCEPT p_salary PROMPT 'Please enter the salary amount: '
ACCEPT p_bonus PROMPT 'Please enter the bonus percentage: '
DECLARE
  v_salary NUMBER := &p_salary;
  v_bonus  NUMBER := &p_bonus;
BEGIN
  dbms_output.put_line(TO_CHAR(NVL(v_salary, 0) *
                    (1 + NVL(v_bonus, 0) / 100)));
END;
/
SET VERIFY ON
SET SERVEROUTPUT OFF
```

Practice 3 Solutions

1. Create a PL/SQL block that selects the maximum department number in the DEPT table and stores it in a SQL*Plus variable. Print the results to the screen. Save your PL/SQL block to a file named `p3q1.sql`.

```
VARIABLE g_max_deptno NUMBER
DECLARE
  v_max_deptno  NUMBER;
BEGIN
  SELECT     MAX(deptno)
  INTO       v_max_deptno
  FROM       dept;
  :g_max_deptno := v_max_deptno;
END;
/
PRINT g_max_deptno
SQL> START p3q1.sql

DECLARE
  v_max_deptno  NUMBER;
BEGIN
  SELECT     MAX(deptno)
  INTO       v_max_deptno
  FROM       dept;
  dbms_output.put_line(TO_CHAR(v_max_deptno));
END;
/
```

2. Modify the PL/SQL block you created in exercise 1 to insert a new row into the DEPT table. Save your PL/SQL block to a file named `p3q2.sql`.
   a. Rather than printing the department number retrieved from exercise 1, and add 10 to that number and use it as the department number for the new department.
   b. Use a SQL*Plus substitution parameter for the department name.
   c. Leave the location null for now.

```
SET ECHO OFF
SET VERIFY OFF
ACCEPT p_dept_name PROMPT 'Please enter the department name: '
DECLARE
  v_max_deptno  dept.deptno%TYPE;
BEGIN
  SELECT   MAX(deptno)+10
  INTO     v_max_deptno
  FROM     dept;
  INSERT INTO dept (deptno, dname, loc)
  VALUES   (v_max_deptno, '&p_dept_name', NULL);
  COMMIT;
END;
/
SET ECHO ON
SET VERIFY ON
```

d. Execute the PL/SQL block.

```
SQL> START p3q2.sql
```

e. Display the new department that you created.

```
SELECT *
FROM   dept
WHERE  deptno = :g_max_deptno + 10;
```

3. Create a PL/SQL block that updates the location for an existing department. Save your PL/SQL block to a file named `p3q3.sql`.

   a. Use a SQL*Plus substitution parameter for the department number.

   b. Use a SQL*Plus substitution parameter for the department location.

   c. Test the PL/SQL block.

   d. Display the department number, department name, and location for the updated department.

```
SET VERIFY OFF
ACCEPT p_deptno PROMPT 'Please enter the department number: '
ACCEPT p_loc PROMPT 'Please enter the department location: '
BEGIN
  UPDATE dept
  SET loc = '&p_loc'
  WHERE deptno = &p_deptno;
COMMIT;
END;
/
SET VERIFY ON
SQL> START p3q3.sql
```

e. Display the department that you updated.

```
SQL> SELECT*
  2  FROM  dept
  3  WHERE deptno = &p_deptno;
```

4. Create a PL/SQL block that deletes the department created in exercise 2. Save your PL/SQL block to a file named `p3q4.sql`.

   a. Use a SQL*Plus substitution parameter for the department number.

   b. Print to the screen the number of rows affected.

   c. Test the PL/SQL block.

```
SET VERIFY OFF
VARIABLE g_result VARCHAR2(40)
ACCEPT p_deptno PROMPT 'Please enter the department number: '
DECLARE
  v_result NUMBER(2);
BEGIN
  DELETE
  FROM     dept
  WHERE    deptno = &p_deptno;
  v_result := SQL%ROWCOUNT;
  :g_result := (TO_CHAR(v_result) || ' row(s) deleted.');
  COMMIT;
END;
/
PRINT g_result
SET VERIFY ON
SQL> START p3q4.sql

ACCEPT p_deptno PROMPT 'Please enter the department number: '
DECLARE
  v_result NUMBER(2);
BEGIN
  DELETE
  FROM     dept
  WHERE    deptno = &p_deptno;
  v_result := SQL%ROWCOUNT;
  dbms_output.put_line(TO_CHAR(v_result)||
   ' row(s) deleted.');
  COMMIT;
END;
/
```

Practice 3 Solutions (continued)

d. What happens if you enter a department number that does not exist?

If the operator enters a department number that does not exist, the PL/SQL block finishes successfully because this does not constitute an exception.

e. Confirm that the department has been deleted.

```
SQL> SELECT *
  2   FROM  dept
  3   WHERE deptno = 50;
```

Practice 4 Solutions

1. Run the script `lab4_1.sql` to create the MESSAGES table. Write a PL/SQL block to insert numbers into the MESSAGES table.

```
CREATE TABLE messages (results VARCHAR2 (60))
/
```

   a. Insert the numbers 1 to 10, excluding 6 and 8.

   b. Commit before the end of the block.

```
BEGIN
FOR i IN 1..10 LOOP
  IF i = 6 or i = 8 THEN
    null;
  ELSE
INSERT INTO messages(results)
VALUES (i);
  END IF;
  COMMIT;
END LOOP;
END;
/
```

   c. Select from the MESSAGES table to verify that your PL/SQL block worked.

```
SQL> SELECT  *
  2  FROM    messages;
```

2. Create a PL/SQL block that computes the commission amount for a given employee based on the employee's salary.

   a. Run the script `lab4_2.sql` to insert a new employee into the EMP table.
   Note: The employee will have a NULL salary.

```
SQL> START lab4_2.sql
```

   b. Accept the employee number as user input with a SQL*Plus substitution variable.

   c. If the employee's salary is less than $1,000, set the commission amount for the employee to 10% of the salary.

   d. If the employee's salary is between $1,000 and $1,500, set the commission amount for the employee to 15% of the salary.

   e. If the employee's salary exceeds $1,500, set the commission amount for the employee to 20% of the salary.

   f. If the employee's salary is NULL, set the commission amount for the employee to 0.

   g. Commit.

```
ACCEPT p_empno PROMPT 'Please enter employee number: '
DECLARE
  v_empno         emp.empno%TYPE := &p_empno;
  v_sal           emp.sal%TYPE;
  v_comm               emp.comm%TYPE;
BEGIN
  SELECT sal
  INTO v_sal
  FROM emp
  WHERE empno = v_empno;
  IF v_sal < 1000 THEN
    v_comm := .10;
   ELSIF v_sal BETWEEN 1000 and 1500 THEN
    v_comm := .15;
  ELSIF v_sal > 1500 THEN
    v_comm := .20;
  ELSE
    v_comm := 0;
END IF;
  UPDATE emp
  SET comm = NVL(sal,0) * v_comm
  WHERE empno = v_empno;
COMMIT;
END;
/
```

h. Test the PL/SQL block for each case using the following test cases, and check each updated commission.

Employee Number	Salary	Resulting Commission
7369	800	80
7934	1300	195
7499	1600	320
8000	NULL	0

```
SQL> SELECT      empno, sal, comm
  2  FROM        emp
  3  WHERE       empno IN (7369, 7934,7499, 8000)
  4  ORDER BY    comm;
```

If you have time, complete the following exercises:

3. Modify the `p1q4.sql` file to insert the text "Number is odd" or "Number is even," depending on whether the value is odd or even, into the MESSAGES table. Query the MESSAGES table to determine if your PL/SQL block worked.

```
DECLARE
  v_char VARCHAR2(30);
  v_num  NUMBER(11,2);
BEGIN
  v_char := '42 is the answer';
  v_num  := TO_NUMBER(SUBSTR(v_char,1,2));
  IF mod(v_num, 2) = 0 THEN
    INSERT INTO messages (results)
    VALUES ('Number is even');
  ELSE
    INSERT INTO messages (results)
    VALUES ('Number is odd');
  END IF;
END;
/
SQL> SELECT *
  2  FROM messages;
```

4. Add a new column, STARS of datatype VARCHAR2 and length 50 to the EMP table for storing asterisk (*).

```
SQL> ALTER TABLE emp
  2  ADD stars   VARCHAR2(50);
```

5. Create a PL/SQL block that rewards an employee by appending an asterisk in the STARS column for every $100 of the employee's salary. Save your PL/SQL block to a file called `p4q5.sql`.
   a. Accept the employee ID as user input with a SQL*Plus substitution variable.
   b. Initialize a variable that will contain a string of asterisks.
   c. Append an asterisk to the string for every $100 of the salary amount. For example, if the employee has a salary amount of $800, the string of asterisks should contain eight asterisks. If the employee has a salary amount of $1250, the string of asterisks should contain 13 asterisks.
   d. Update the STARS column for the employee with the string of asterisks.

e. Commit.

f. Test the block for employees who have no salary and for an employee who has a salary.

```
SET VERIFY OFF
ACCEPT p_empno PROMPT 'Please enter the employee number: '
DECLARE
  v_empno    emp.empno%TYPE := &p_empno;
  v_asterisk emp.stars%TYPE := NULL;
  v_sal      emp.sal%TYPE;
BEGIN
  SELECT NVL(ROUND(sal/100), 0)
  INTO v_sal
  FROM emp
  WHERE empno = v_empno;
  FOR i IN 1..v_sal LOOP
    v_asterisk := v_asterisk ||'*';
  END LOOP;
  UPDATE emp
  SET stars = v_asterisk
  WHERE empno = v_empno;
  COMMIT;
END;
/
SET VERIFY ON
SQL> START p4q5.sql
SQL> SELECT empno, sal, stars
  2  FROM   emp
  3  WHERE  empno IN (7934, 8000);
```

Practice 5 Solutions

1. Create a PL/SQL block to retrieve the name of each department from the DEPT table and print each department name to the screen, incorporating a PL/SQL table.
   a. Declare a PL/SQL table, MY_DEPT_TABLE, to temporarily store the name of the departments.
   b. Using a loop, retrieve the name of all departments currently in the DEPT table and store them in the PL/SQL table. Each department number is a multiple of 10.
   c. Using another loop, retrieve the department names from the PL/SQL table and print them to the screen, using DBMS_OUTPUT.PUT_LINE.

```
SET SERVEROUTPUT ON
DECLARE
  TYPE dept_table_type is table of dept.dname%TYPE
  INDEX BY BINARY_INTEGER;
  my_dept_table dept_table_type;
  v_count       NUMBER (2);
BEGIN
  SELECT COUNT(*)
  INTO  v_count
  FROM  dept;
  FOR i IN 1..v_count LOOP
    SELECT dname
    INTO my_dept_table(i)
    FROM dept
    WHERE deptno = i*10;
  END LOOP;
  FOR i IN 1..v_count  LOOP
        DBMS_OUTPUT.PUT_LINE (my_dept_table(i));
  END LOOP;
END;
/
```

2. Write a PL/SQL block to print information about a given order.
   a. Declare a PL/SQL record based on the structure of the ORD table.
   b. Use a SQL*Plus substitution variable to retrieve all information about a specific order and store that information into the PL/SQL record.
   c. Use DBMS_OUTPUT. PUT_LINE and print selected information about the order.

```
SET SERVEROUTPUT ON
SET VERIFY OFF
ACCEPT p_ordid PROMPT 'Please enter an order number: '
DECLARE
 ord_record     ord%ROWTYPE;
BEGIN
SELECT*
INTO   ord_record
FROM   ord
WHERE ordid = &p_ordid;
DBMS_OUTPUT.PUT_LINE ('Order ' || TO_CHAR(ord_record.ordid)
|| ' was placed on ' || TO_CHAR(ord_record.orderdate)
 || ' and shipped on ' || TO_CHAR(ord_record.shipdate) ||
 ' for a total of ' ||
 TO_CHAR(ord_record.total,'$99,999.99'));
END;
/
```

If you have time, complete the following exercise.

3. Modify the block you created in practice 1 to retrieve all information about each department from the DEPT table and print the information to the screen, incorporating a PL/SQL table of records.
   a. Declare a PL/SQL table, MY_DEPT_TABLE, to temporarily store the number, name, and location of all the departments.
   b. Using a loop, retrieve all department information currently in the DEPT table and store it in the PL/SQL table. Each department number is a multiple of 10.
   c. Using another loop, retrieve the department information from the PL/SQL table and print it to the screen, using DBMS_OUTPUT.PUT_LINE.

Practice 5 Solutions (continued)

```
SET SERVEROUTPUT ON
DECLARE
   TYPE dept_table_type is table of dept%ROWTYPE
   INDEX BY BINARY_INTEGER;
   my_dept_table dept_table_type;
   v_count       NUMBER (2);
BEGIN
  SELECT COUNT(*)
  INTO   v_count
  FROM   dept;
  FOR i IN 1..v_count
  LOOP
    SELECT *
    INTO my_dept_table(i)
    FROM dept
    WHERE deptno = i*10;
  END LOOP;
  FOR i IN 1..v_count
  LOOP
    DBMS_OUTPUT.PUT_LINE ('Dept. ' || my_dept_table(i).deptno ||
    || my_dept_table(i).dname || ' is located in ' ||
       my_dept_table(i).loc);
  END LOOP;
END;
/
```

Practice 6 Solutions

1. Run the script `lab6_1.sql` to create a new table for storing employees and salaries.

```
SQL> CREATE TABLE top_dogs
  2   (name          VARCHAR2(25),
  3    salary        NUMBER(11,2));
```

2. Create a PL/SQL block that determines the top employees with respect to salaries.
   a. Accept a number *n* as user input with a SQL*Plus substitution parameter.
   b. In a loop, get the last names and salaries of the top *n* people with respect to salary in the EMP table.
   c. Store the names and salaries in the TOP_DOGS table.
   d. Assume that no two employees have the same salary.
   e. Test a variety of special cases, such as $n = 0$ or where *n* is greater than the number of employees in the EMP table. Empty the TOP_DOGS table after each test.

```
DELETE FROM top_dogs;

SET ECHO OFF

ACCEPT p_num -
PROMPT 'Please enter the number of top money makers: '
DECLARE
  v_num          NUMBER(3) := &p_num;
  v_ename        emp.ename%TYPE;
  v_sal          emp.sal%TYPE;
  CURSOR         emp_cursor IS
    SELECT       ename, sal
    FROM         emp
    WHERE        sal IS NOT NULL
    ORDER BY     sal DESC;
BEGIN
OPEN emp_cursor;
FETCH emp_cursor INTO v_ename, v_sal;
WHILE emp_cursor%ROWCOUNT <= v_num AND
      emp_cursor%FOUND LOOP
  INSERT INTO top_dogs (name, salary)
  VALUES (v_ename, v_sal);
   FETCH emp_cursor INTO v_ename, v_sal;
END LOOP;
CLOSE emp_cursor;
COMMIT;
END;
/
SELECT * FROM top_dogs;
SET ECHO ON
```

Practice 6 Solutions (continued)

3. Consider the case where several employees have the same salary. If one person is listed, then all people who have the same salary should also be listed.
   a. For example, if the user enters a value of 2 for *n*, then King, Ford, and Scott should be displayed. (These employees are tied for second highest salary.)
   b. If the user enters a value of 3, then King, Ford, Scott, and Jones should be displayed.
   c. Delete all rows from TOP_DOGS and test the practice.

```
DELETE FROM top_dogs;
ACCEPT p_num PROMPT 'Please enter the number of top money makers:
DECLARE
  v_num           NUMBER(3) := &p_num;
  v_ename         emp.ename%TYPE;
  v_current_sal       emp.sal%TYPE;
  v_last_sal      emp.sal%TYPE;
  CURSOR  emp_cursor IS
  SELECT     ename, sal
  FROM            emp
  WHERE      sal IS NOT NULL
  ORDER BY        sal DESC;
BEGIN
 OPEN emp_cursor;
  FETCH emp_cursor INTO v_ename, v_current_sal;
  WHILE emp_cursor%ROWCOUNT <= v_num AND emp_cursor%FOUND LOOP
  INSERT INTO top_dogs (name, salary)
  VALUES (v_ename, v_current_sal);
  v_last_sal := v_current_sal;
  FETCH emp_cursor INTO v_ename, v_current_sal;
  IF v_last_sal = v_current_sal THEN
    v_num := v_num + 1;
  END IF;
  END LOOP;
  CLOSE emp_cursor;
  COMMIT;
END;
/
SELECT * FROM top_dogs;
```

Practice 7 Solutions

1. Use a cursor to retrieve the department number and the department name from the dept table. Pass the department number to another cursor to retrieve from the emp table the details of employee name, job, hiredate, and salary of all the employees who work in that department.

```
SET SERVEROUTPUT ON
 DECLARE
     CURSOR dept_cursor IS
     SELECT deptno,dname
     FROM dept
     ORDER BY    deptno;
     CURSOR emp_cursor(v_deptno NUMBER) IS
     SELECT ename,job,hiredate,sal
     FROM emp
     WHERE    deptno = v_deptno;
     v_current_deptno  dept.deptno%TYPE;
     v_current_dname dept.dname%TYPE;
     v_ename emp.ename%TYPE;
     v_job emp.job%TYPE;
     v_mgr emp.mgr%TYPE;
     v_hiredate emp.hiredate%TYPE;
     v_sal emp.sal%TYPE;
     v_line  varchar2(100);
BEGIN
     v_line := '                                                  ';
     OPEN dept_cursor;
     LOOP
       FETCH dept_cursor INTO
       v_current_deptno,v_current_dname;
       EXIT WHEN dept_cursor%NOTFOUND;
       DBMS_OUTPUT.PUT_LINE ('Department Number : ' ||
       v_current_deptno ||  '  Department Name : ' ||
       v_current_dname);
      DBMS_OUTPUT.PUT_LINE(v_line);
      IF emp_cursor%ISOPEN THEN
          CLOSE emp_cursor;
      END IF;
```

Note: Solution continued on next page.

Practice 7 Solutions (continued)

```
OPEN emp_cursor (v_current_deptno);
     LOOP
       FETCH emp_cursor INTO  v_ename,v_job,v_hiredate,v_sal;
       EXIT WHEN emp_cursor%NOTFOUND;
       DBMS_OUTPUT.PUT_LINE (v_ename || '    ' ||  v_job || '
      ||  v_hiredate || '   ' ||  v_sal);
     END LOOP;
    IF emp_cursor%ISOPEN THEN
          CLOSE emp_cursor;
   END IF;
   DBMS_OUTPUT.PUT_LINE(v_line);
   END LOOP;
   IF emp_cursor%ISOPEN THEN
     CLOSE emp_cursor;
  END IF;
  CLOSE dept_cursor;
  END;
 /
SET SERVEROUTPUT OFF
```

Practice 7 Solutions (continued)

2. Modify `p4q5.sql` to incorporate the FOR UPDATE and WHERE CURRENT OF functionality in cursor processing.

```
SET VERIFY OFF
ACCEPT p_empno PROMPT 'Please enter the employee number:
DECLARE
  v_empno    emp.empno%TYPE := &p_empno;
  v_asterisk emp.stars%TYPE := NULL;
  CURSOR emp_cursor IS
    SELECT  empno, NVL(ROUND(sal/100), 0) sal
    FROM         emp
    WHERE   empno = v_empno
    FOR UPDATE;
BEGIN
  FOR emp_record IN emp_cursor LOOP
    FOR i IN 1..emp_record.sal LOOP
      v_asterisk := v_asterisk ||'*';
    END LOOP;
  UPDATE emp
  SET stars = v_asterisk
  WHERE CURRENT OF emp_cursor;
 v_asterisk := NULL;
  END LOOP;
COMMIT;
END;
/
SET VERIFY ON
SQL> START p7q2.sql
SQL> SELECT empno, sal, stars
  2  FROM   emp
  3  WHERE  empno IN (7844, 7900, 8000);
```

Practice 8 Solutions

1. Write a PL/SQL block to select the name of the employee with a given salary value.
   a. If the salary entered returns more than one row, handle the exception with an appropriate exception handler and insert into the MESSAGES table the message "More than one employee with a salary of *<salary>*."
   b. If the salary entered does not return any rows, handle the exception with an appropriate exception handler and insert into the MESSAGES table the message "No employee with a salary of *<salary>*."
   c. If the salary entered returns only one row, insert into the MESSAGES table the employee's name and the salary amount.
   d. Handle any other exception with an appropriate exception handler and insert into the MESSAGES table the message "Some other error occurred."
   e. Test the block for a variety of test cases.

```
SET VERIFY OFF
ACCEPT p_sal PROMPT 'Please enter the salary value: '
DECLARE
  v_ename  emp.ename%TYPE;
  v_sal    emp.sal%TYPE := &p_sal;
BEGIN
  SELECT   ename
  INTO     v_ename
  FROM     emp
  WHERE         sal = v_sal;
  INSERT INTO messages (results)
  VALUES (v_ename || ' - ' || v_sal);
EXCEPTION
  WHEN no_data_found THEN
    INSERT INTO messages (results)
    VALUES ('No employee with a salary of '|| TO_CHAR(v_sal));
  WHEN too_many_rows THEN
    INSERT INTO messages (results)
    VALUES ('More than one employee with a salary of '||
             TO_CHAR(v_sal));
  WHEN others THEN
    INSERT INTO messages (results)
    VALUES ('Some other error occurred.');
END;
/
SET VERIFY ON
SQL> START p8q1.sql
SQL> START p8q1.sql
SQL> START p8q1.sql
```

Practice 8 Solutions (continued)

2. Modify `p3q3.sql` to add an exception handler.
   a. Write an exception handler for the error to pass a message to the user that the specified department does not exist.
   b. Execute the PL/SQL block by entering a department that does not exist.

```
SET VERIFY OFF
VARIABLE g_message VARCHAR2(40)
ACCEPT p_deptno PROMPT 'Please enter the department number:
ACCEPT p_loc PROMPT 'Please enter the department location:
DECLARE
  e_invalid_dept    EXCEPTION;
  v_deptno      dept.deptno%TYPE := &p_deptno;
BEGIN
  UPDATE dept
  SET loc = '&p_loc'
  WHERE deptno = v_deptno;
  IF SQL%NOTFOUND THEN
    raise e_invalid_dept;
  END IF;
  COMMIT;
EXCEPTION
  WHEN e_invalid_dept THEN
    :g_message := 'Department '|| TO_CHAR(v_deptno) ||
                  ' is an invalid department';
END;
/
SET VERIFY ON
PRINT g_message
SQL> START p8q2.sql
```

Practice 8 Solutions (continued)

```
SET VERIFY OFF
ACCEPT p_deptno PROMPT 'Please enter the department number: '
ACCEPT p_loc PROMPT 'Please enter the department location: '
DECLARE
  e_invalid_dept EXCEPTION;
  v_deptno       dept.deptno%TYPE := &p_deptno;
BEGIN
  UPDATE dept
  SET loc = '&p_loc'
  WHERE deptno = v_deptno;
  IF SQL%NOTFOUND THEN
    raise e_invalid_dept;
  END IF;
  COMMIT;

EXCEPTION
  WHEN e_invalid_dept THEN
    dbms_output.put_line('Department '|| TO_CHAR(v_deptno) ||
                  ' is an invalid department');
END;
/
SET VERIFY ON
```

Practice 8 Solutions (continued)

3. Write a PL/SQL block that prints the number of employees who make plus or minus $100 of the salary value entered.
   a. If there is no employee within that salary range, print a message to the user indicating that is the case. Use an exception for this case.
   b. If there are one or more employees within that range, the message should indicate how many employees are in that salary range.
   c. Handle any other exception with an appropriate exception handler. The message should indicate that some other error occurred.

```
VARIABLE g_message VARCHAR2(100)
SET VERIFY OFF
ACCEPT p_sal PROMPT 'Please enter the salary: '
DECLARE
  v_sal              emp.sal%TYPE := &p_sal;
  v_low_sal               emp.sal%TYPE := v_sal - 100;
  v_high_sal         emp.sal%TYPE := v_sal + 100;
  v_no_emp      NUMBER(7);
  e_no_emp_returned EXCEPTION;
  e_more_than_one_emp    EXCEPTION;
BEGIN
  SELECT    count(ename)
  INTO      v_no_emp
  FROM      emp
  WHERE     sal between v_low_sal and v_high_sal;
  IF v_no_emp  = 0 THEN
    RAISE e_no_emp_returned;
  ELSIF v_no_emp > 0 THEN
    RAISE e_more_than_one_emp;
  END IF;
EXCEPTION
  WHEN e_no_emp_returned THEN
    :g_message := 'There is no employee salary between '||
                  TO_CHAR(v_low_sal) || ' and '||
                      TO_CHAR(v_high_sal);
  WHEN e_more_than_one_emp THEN
    :g_message := 'There is/are '|| TO_CHAR(v_no_emp) ||
                  ' employee(s) with a salary between '||
                TO_CHAR(v_low_sal) || ' and '||
                TO_CHAR(v_high_sal);
END;
/
SET VERIFY ON
PRINT g_message
SQL> START p8q3.sql
```

Practice 8 Solutions (continued)

```
SET VERIFY OFF
ACCEPT p_sal PROMPT 'Please enter the salary: '
DECLARE
  v_sal           emp.sal%TYPE := &p_sal;
  v_low_sal       emp.sal%TYPE := v_sal - 100;
  v_high_sal      emp.sal%TYPE := v_sal + 100;
  v_no_emp        NUMBER(7);
  e_no_emp_returned   EXCEPTION;
  e_more_than_one_emp EXCEPTION;
BEGIN
  SELECT     count(ename)
  INTO       v_no_emp
  FROM       emp
  WHERE      sal between v_low_sal and v_high_sal;
  IF v_no_emp  = 0 THEN
    RAISE e_no_emp_returned;
  ELSIF v_no_emp > 0 THEN
    RAISE e_more_than_one_emp;
  END IF;
EXCEPTION
  WHEN e_no_emp_returned THEN
    dbms_output.put_line('There is no employee salary
                  between '|| TO_CHAR(v_low_sal) || ' and '||
                  TO_CHAR(v_high_sal));
  WHEN e_more_than_one_emp THEN
    dbms_output.put_line('There is/are '|| TO_CHAR(v_no_emp) ||
                   ' employee(s) with a salary between '||
                  TO_CHAR(v_low_sal) || ' and '||
                  TO_CHAR(v_high_sal));
  WHEN others THEN
    dbms_output.put_line('Some other error occurred.');
END;
/
SET VERIFY ON
```

B

Table Descriptions and Data

EMP Table

```
SQL> DESCRIBE emp
```

```
Name                                      Null?    Type
----------------------------------------- -------- ----
EMPNO                                     NOT NULL NUMBER(4)
ENAME                                              VARCHAR2(10)
JOB                                                VARCHAR2(9)
MGR                                                NUMBER(4)
HIREDATE                                           DATE
SAL                                                NUMBER(7,2)
COMM                                               NUMBER(7,2)
DEPTNO                                    NOT NULL NUMBER(2)
```

```
SQL> SELECT * FROM emp;
```

EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	COMM	DEPTNO
7839	KING	PRESIDENT		17-NOV-81	5000		10
7698	BLAKE	MANAGER	7839	01-MAY-81	2850		30
7782	CLARK	MANAGER	7839	09-JUN-81	2450		10
7566	JONES	MANAGER	7839	02-APR-81	2975		20
7654	MARTIN	SALESMAN	7698	28-SEP-81	1250	1400	30
7499	ALLEN	SALESMAN	7698	20-FEB-81	1600	300	30
7844	TURNER	SALESMAN	7698	08-SEP-81	1500	0	30
7900	JAMES	CLERK	7698	03-DEC-81	950		30
7521	WARD	SALESMAN	7698	22-FEB-81	1250	500	30
7902	FORD	ANALYST	7566	03-DEC-81	3000		20
7369	SMITH	CLERK	7902	17-DEC-80	800		20
7788	SCOTT	ANALYST	7566	09-DEC-82	3000		20
7876	ADAMS	CLERK	7788	12-JAN-83	1100		20
7934	MILLER	CLERK	7782	23-JAN-82	1300		10

DEPT Table

```
SQL> DESCRIBE dept
```

```
Name                           Null?    Type
------------------------------ -------- ----
DEPTNO                         NOT NULL NUMBER(2)
DNAME                                   VARCHAR2(14)
LOC                                     VARCHAR2(13)
```

```
SQL> SELECT * FROM dept;
```

```
    DEPTNO DNAME          LOC
---------- -------------- -------------
        10 ACCOUNTING     NEW YORK
        20 RESEARCH       DALLAS
        30 SALES          CHICAGO
        40 OPERATIONS     BOSTON
```

SALGRADE Table

```
SQL> DESCRIBE salgrade

Name                            Null?    Type
------------------------------- -------- ----
GRADE                                    NUMBER
LOSAL                                    NUMBER
HISAL                                    NUMBER

SQL> SELECT * FROM salgrade;

    GRADE      LOSAL      HISAL
--------- ---------- ---------
        1        700       1200
        2       1201       1400
        3       1401       2000
        4       2001       3000
        5       3001       9999
```

ORD Table

```
SQL> DESCRIBE ord
```

```
Name                           Null?    Type
------------------------------ -------- ----
ORDID                          NOT NULL NUMBER(4)
ORDERDATE                               DATE
COMMPLAN                                VARCHAR2(1)
CUSTID                         NOT NULL NUMBER(6)
SHIPDATE                                DATE
TOTAL                                   NUMBER(8,2)
```

```
SQL> SELECT * FROM ord;
```

ORDID	ORDERDATE	C	CUSTID	SHIPDATE	TOTAL
610	07-JAN-87	A	101	08-JAN-87	101.4
611	11-JAN-87	B	102	11-JAN-87	45
612	15-JAN-87	C	104	20-JAN-87	5860
601	01-MAY-86	A	106	30-MAY-86	2.4
602	05-JUN-86	B	102	20-JUN-86	56
604	15-JUN-86	A	106	30-JUN-86	698
605	14-JUL-86	A	106	30-JUL-86	8324
606	14-JUL-86	A	100	30-JUL-86	3.4
609	01-AUG-86	B	100	15-AUG-86	97.5
607	18-JUL-86	C	104	18-JUL-86	5.6
608	25-JUL-86	C	104	25-JUL-86	35.2
603	05-JUN-86		102	05-JUN-86	224
620	12-MAR-87		100	12-MAR-87	4450
613	01-FEB-87		108	01-FEB-87	6400
614	01-FEB-87		102	05-FEB-87	23940
616	03-FEB-87		103	10-FEB-87	764
619	22-FEB-87		104	04-FEB-87	1260
617	05-FEB-87		105	03-MAR-87	46370
615	01-FEB-87		107	06-FEB-87	710
618	15-FEB-87	A	102	06-MAR-87	3510.5
621	15-MAR-87	A	100	01-JAN-87	730

PRODUCT Table

```
SQL> DESCRIBE product

Name                           Null?    Type
------------------------------ -------- ----
PRODID                         NOT NULL NUMBER(6)
DESCRIP                                 VARCHAR2(30)

SQL> SELECT * FROM product;

   PRODID DESCRIP
--------- ------------------------------
   100860 ACE TENNIS RACKET I
   100861 ACE TENNIS RACKET II
   100870 ACE TENNIS BALLS-3 PACK
   100871 ACE TENNIS BALLS-6 PACK
   100890 ACE TENNIS NET
   101860 SP TENNIS RACKET
   101863 SP JUNIOR RACKET
   102130 RH: "GUIDE TO TENNIS"
   200376 SB ENERGY BAR-6 PACK
   200380 SB VITA SNACK-6 PACK
```

ITEM Table

```
SQL> DESCRIBE item
```

```
 Name                           Null?    Type
------------------------------- -------- ----
ORDID                           NOT NULL NUMBER(4)
ITEMID                          NOT NULL NUMBER(4)
PRODID                                   NUMBER(6)
ACTUALPRICE                              NUMBER(8,2)
QTY                                      NUMBER(8)
ITEMTOT                                  NUMBER(8,2)
```

```
SQL> SELECT * FROM item;
```

ORDID	ITEMID	PRODID	ACTUALPRICE	QTY	ITEMTOT
610	3	100890	58	1	58
611	1	100861	45	1	45
612	1	100860	30	100	3000
601	1	200376	2.4	1	2.4
602	1	100870	2.8	20	56
604	1	100890	58	3	174
604	2	100861	42	2	84
604	3	100860	44	10	440
603	2	100860	56	4	224
610	1	100860	35	1	35
610	2	100870	2.8	3	8.4
613	4	200376	2.2	200	440
614	1	100860	35	444	15540
614	2	100870	2.8	1000	2800
612	2	100861	40.5	20	810
612	3	101863	10	150	1500
620	1	100860	35	10	350
620	2	200376	2.4	1000	2400
620	3	102130	3.4	500	1700
613	1	100871	5.6	100	560
613	2	101860	24	200	4800
613	3	200380	4	150	600
619	3	102130	3.4	100	340
617	1	100860	35	50	1750
617	2	100861	45	100	4500
614	3	100871	5.6	1000	5600

Continued on next page

ITEM Table (continued)

ORDID	ITEMID	PRODID	ACTUALPRICE	QTY	ITEMTOT
616	1	100861	45	10	450
616	2	100870	2.8	50	140
616	3	100890	58	2	116
616	4	102130	3.4	10	34
616	5	200376	2.4	10	24
619	1	200380	4	100	400
619	2	200376	2.4	100	240
615	1	100861	45	4	180
607	1	100871	5.6	1	5.6
615	2	100870	2.8	100	280
617	3	100870	2.8	500	1400
617	4	100871	5.6	500	2800
617	5	100890	58	500	29000
617	6	101860	24	100	2400
617	7	101863	12.5	200	2500
617	8	102130	3.4	100	340
617	9	200376	2.4	200	480
617	10	200380	4	300	1200
609	2	100870	2.5	5	12.5
609	3	100890	50	1	50
618	1	100860	35	23	805
618	2	100861	45.11	50	2255.5
618	3	100870	45	10	450
621	1	100861	45	10	450
621	2	100870	2.8	100	280
615	3	100871	5	50	250
608	1	101860	24	1	24
608	2	100871	5.6	2	11.2
609	1	100861	35	1	35
606	1	102130	3.4	1	3.4
605	1	100861	45	100	4500
605	2	100870	2.8	500	1400
605	3	100890	58	5	290
605	4	101860	24	50	1200
605	5	101863	9	100	900
605	6	102130	3.4	10	34
612	4	100871	5.5	100	550
619	4	100871	5.6	50	280

CUSTOMER Table

```
SQL> DESCRIBE customer

 Name                           Null?    Type
 ------------------------------ -------- ----
 CUSTID                         NOT NULL NUMBER(6)
 NAME                                    VARCHAR2(45)
 ADDRESS                                 VARCHAR2(40)
 CITY                                    VARCHAR2(30)
 STATE                                   VARCHAR2(2)
 ZIP                                     VARCHAR2(9)
 AREA                                    NUMBER(3)
 PHONE                                   VARCHAR2(9)
 REPID                          NOT NULL NUMBER(4)
 CREDITLIMIT                             NUMBER(9,2)
 COMMENTS                                LONG
```

CUSTOMER Table (continued)

```
SQL> SELECT * FROM customer;
```

CUSTID	NAME	ADDRESS
100	JOCKSPORTS	345 VIEWRIDGE
101	TKB SPORT SHOP	490 BOLI RD.
102	VOLLYRITE	9722 HAMILTON
103	JUST TENNIS	HILLVIEW MALL
104	EVERY MOUNTAIN	574 SURRY RD.
105	K + T SPORTS	3476 EL PASEO
106	SHAPE UP	908 SEQUOIA
107	WOMENS SPORTS	VALCO VILLAGE
108	NORTH WOODS HEALTH AND FITNESS SUPPLY CENTER	98 LONE PINE WAY

CITY	ST	ZIP	AREA	PHONE	REPID	CREDITLIMIT
BELMONT	CA	96711	415	598-6609	7844	5000
REDWOOD CITY	CA	94061	415	368-1223	7521	10000
BURLINGAME	CA	95133	415	644-3341	7654	7000
BURLINGAME	CA	97544	415	677-9312	7521	3000
CUPERTINO	CA	93301	408	996-2323	7499	10000
SANTA CLARA	CA	91003	408	376-9966	7844	5000
PALO ALTO	CA	94301	415	364-9777	7521	6000
SUNNYVALE	CA	93301	408	967-4398	7499	10000
HIBBING	MN	55649	612	566-9123	7844	8000

COMMENTS
Very friendly people to work with -- sales rep likes to be called Mike.
Rep called 5/8 about change in order - contact shipping.
Company doing heavy promotion beginning 10/89. Prepare for large orders during orders during winter
Contact rep about new line of tennis rackets.
Customer with high market share (23%) due to aggressive advertising.
Tends to order large amounts of merchandise at once. Accounting is considering raising their credit limit
Support intensive. Orders small amounts (< 800) of merchandise at a time.
First sporting goods store geared exclusively towards women. Unusual promotional style

PRICE Table

```
SQL> DESCRIBE price

Name                                      Null?    Type
----------------------------------------- -------- ----
PRODID                                    NOT NULL NUMBER(6)
STDPRICE                                           NUMBER(8,2)
MINPRICE                                           NUMBER(8,2)
STARTDATE                                          DATE
ENDDATE                                            DATE

SQL> SELECT * FROM price;

   PRODID  STDPRICE  MINPRICE STARTDATE ENDDATE
--------- --------- --------- --------- ---------
   100871       4.8       3.2 01-JAN-85 01-DEC-85
   100890        58      46.4 01-JAN-85
   100890        54      40.5 01-JUN-84 31-MAY-84
   100860        35        28 01-JUN-86
   100860        32      25.6 01-JAN-86 31-MAY-86
   100860        30        24 01-JAN-85 31-DEC-85
   100861        45        36 01-JUN-86
   100861        42      33.6 01-JAN-86 31-MAY-86
   100861        39      31.2 01-JAN-85 31-DEC-85
   100870       2.8       2.4 01-JAN-86
   100870       2.4       1.9 01-JAN-85 01-DEC-85
   100871       5.6       4.8 01-JAN-86
   101860        24        18 15-FEB-85
   101863      12.5       9.4 15-FEB-85
   102130       3.4       2.8 18-AUG-85
   200376       2.4      1.75 15-NOV-86
   200380         4       3.2 15-NOV-86
```

Index

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