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# Oracle Database 10g: PL/SQL Fundamentals

Electronic Presentation

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**ORACLE®**

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# I Introduction

# Objectives

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

- **Describe the objectives of the course**
- **Describe the course agenda**
- **Identify the database tables used in the course**
- **Identify the Oracle products that help you design a complete business solution**

# Course Objectives

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

- **Appreciate that PL/SQL provides programming extensions to SQL**
- **Write PL/SQL code to interface with the database**
- **Design PL/SQL program units that execute efficiently**
- **Use PL/SQL programming constructs and conditional control statements**
- **Handle run-time errors**
- **Describe stored procedures and functions**

# **Course Agenda**

**Lessons that are to be covered on day 1:**

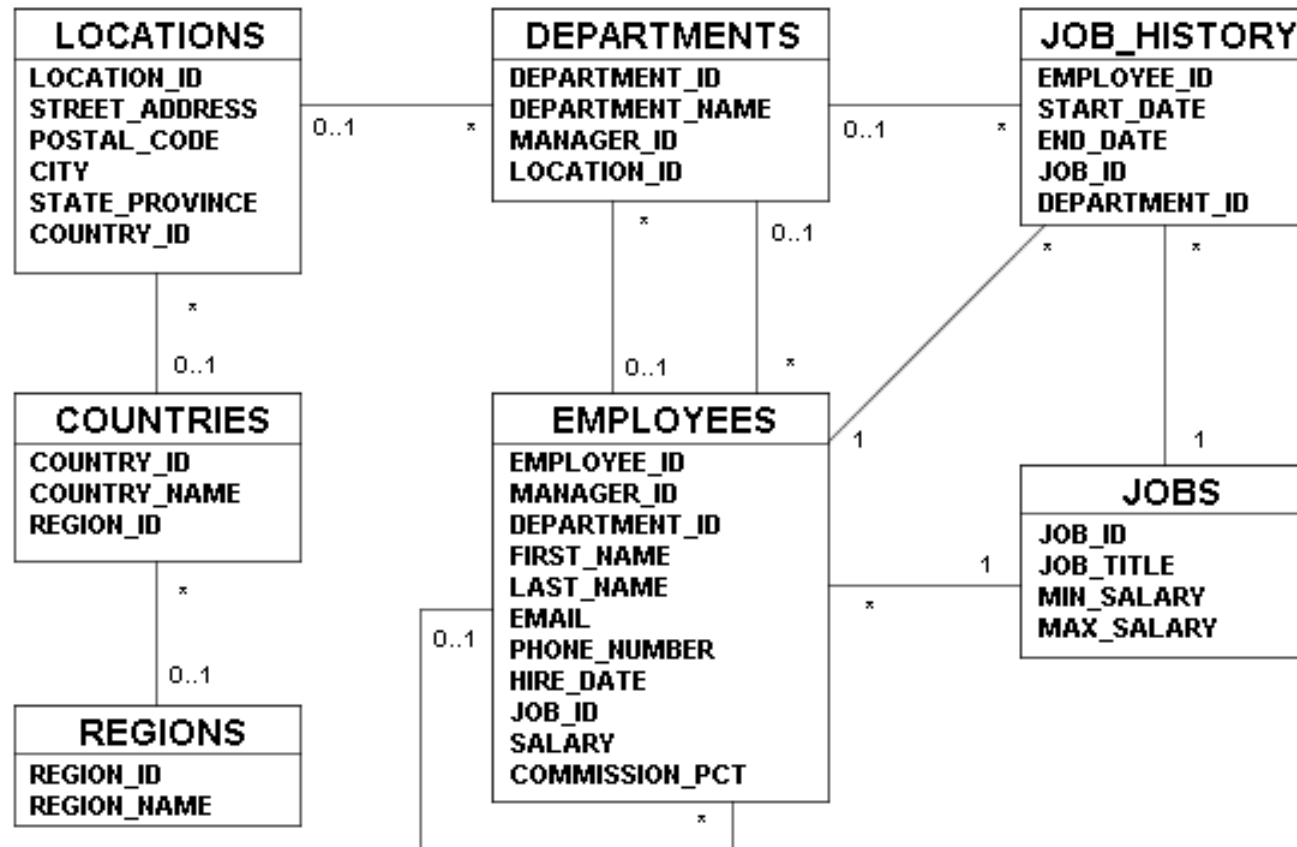
- I. Introduction**
  - 1. Introduction to PL/SQL**
  - 2. Declaring PL/SQL Variables**
  - 3. Creating the Executable Section**
  - 4. Interacting with the Oracle Database Server**
  - 5. Writing Control Structures**

# Course Agenda

**Lessons that are to be covered on day 2:**

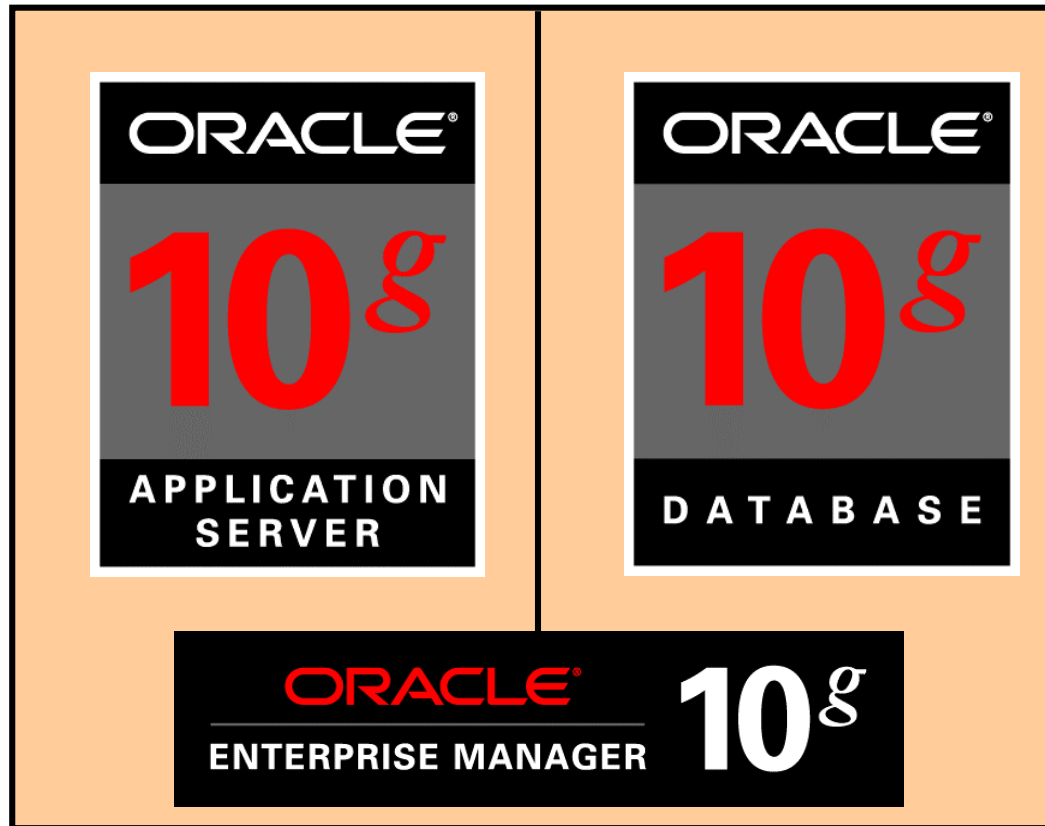
- 6. Working with Composite Data Types**
- 7. Using Explicit Cursors**
- 8. Including Exception Handling**
- 9. Creating Stored Procedures and Functions**

# The Human Resources (hr) Data Set

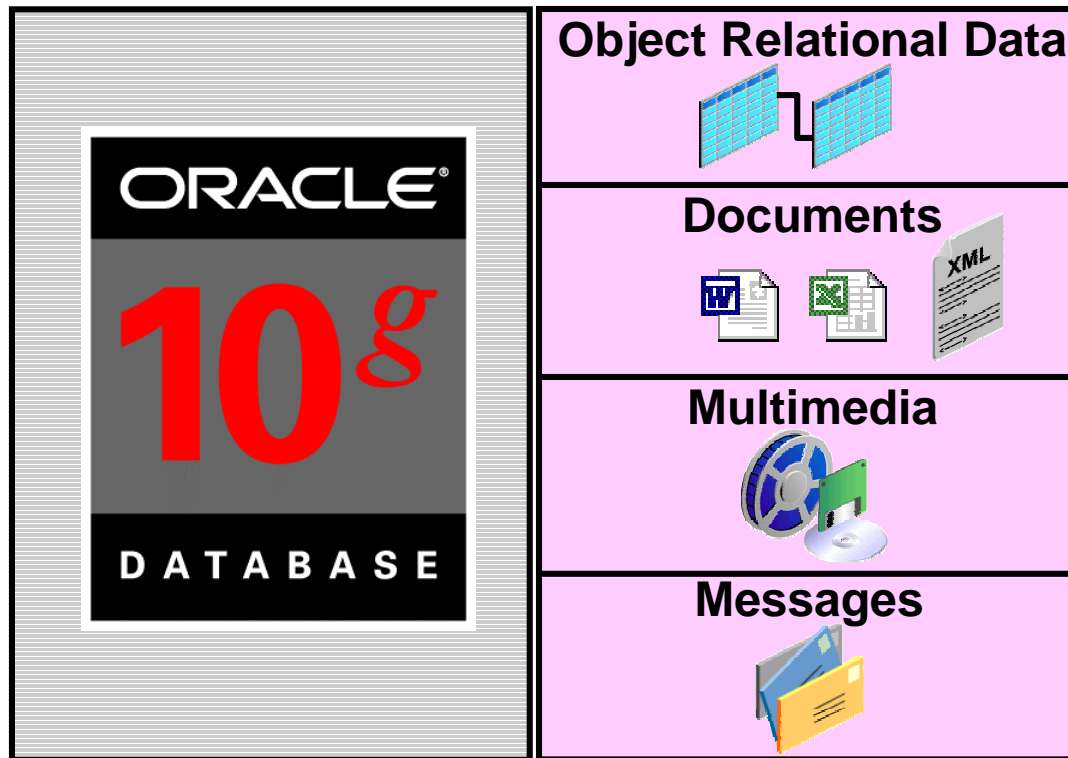




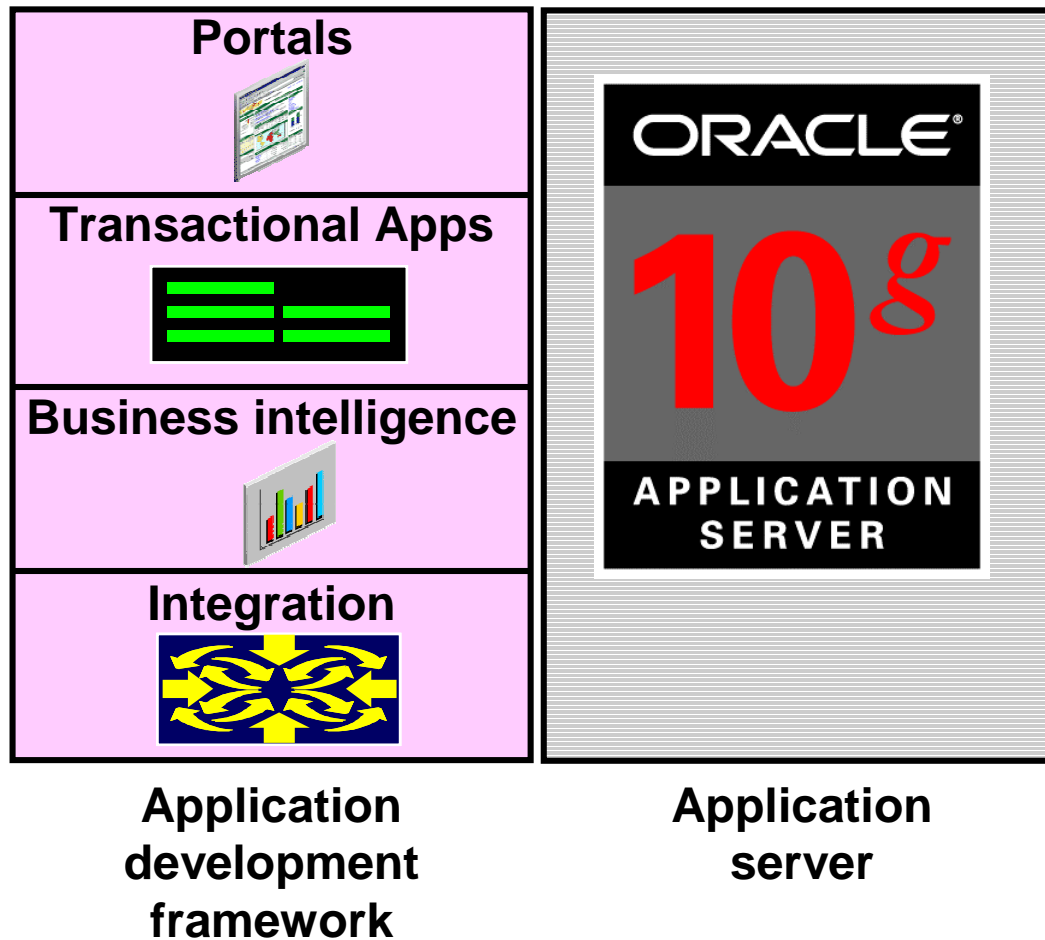
# Oracle10g



# Oracle Database 10g



# Oracle Application Server 10g

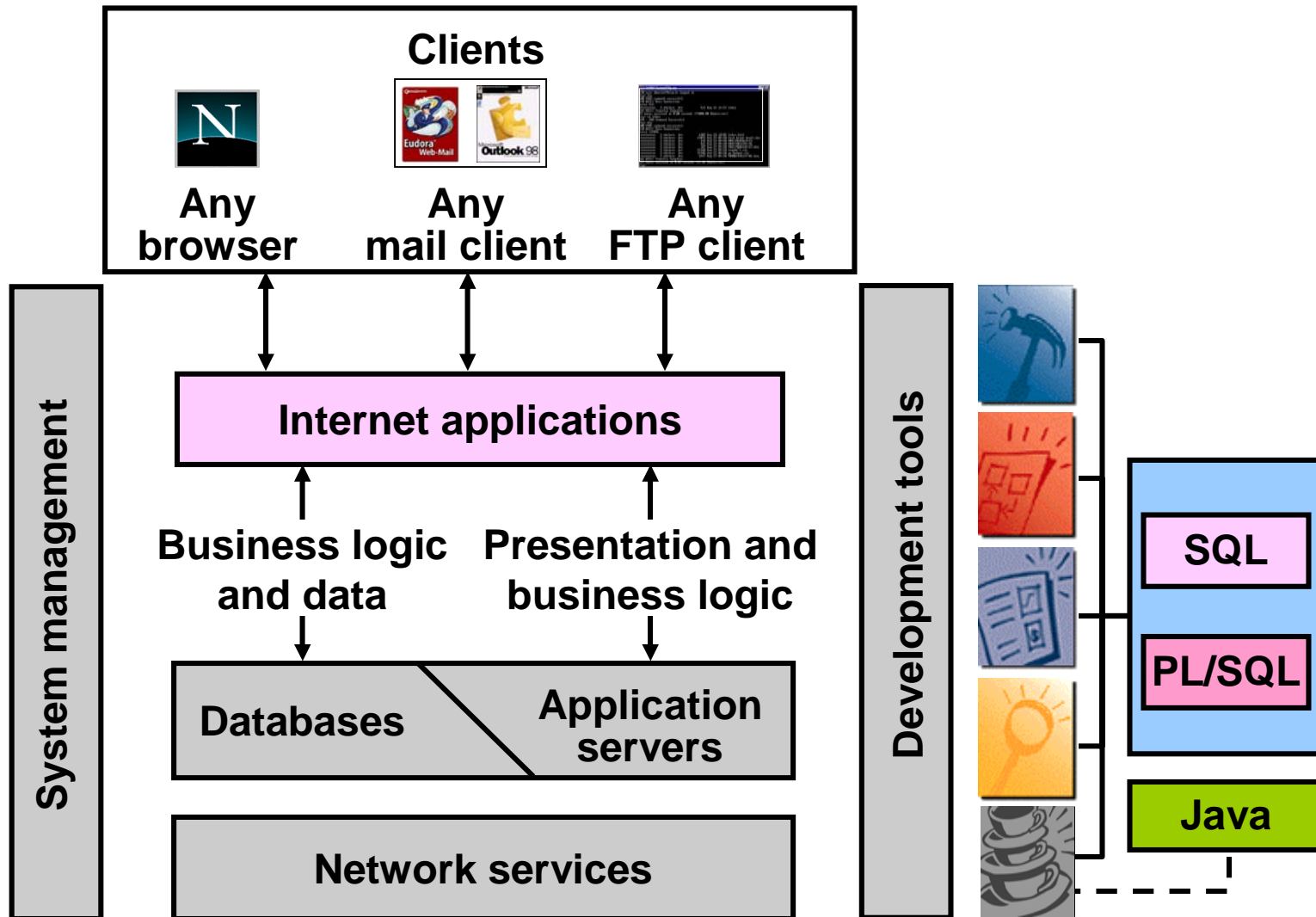


# Oracle Enterprise Manager 10g Grid Control

- Software provisioning
- Application service-level monitoring



# Oracle Internet Platform



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# Summary

**In this lesson, you should have learned how to:**

- **Describe the course objectives and course agenda**
- **Identify the tables and their relationships in the hr schema**
- **Identify the various products in the Oracle 10g grid infrastructure that enable you to develop a complete business solution**

# 1

## Introduction to PL/SQL

# Objectives

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

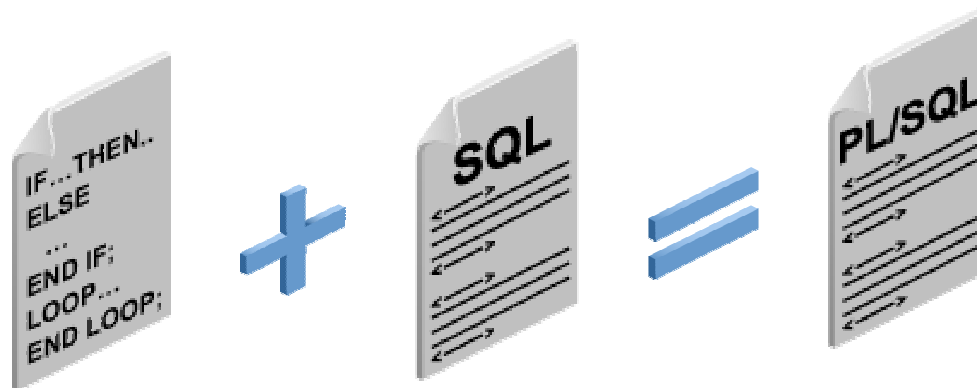
- **Explain the need for PL/SQL**
- **Explain the benefits of PL/SQL**
- **Identify the different types of PL/SQL blocks**
- **Use *iSQL\*Plus* as a development environment for PL/SQL**
- **Output messages in PL/SQL**



# What Is PL/SQL?

## PL/SQL:

- Stands for **Procedural Language extension to SQL**
- Is Oracle Corporation's standard data access language for relational databases
- Seamlessly integrates procedural constructs with SQL

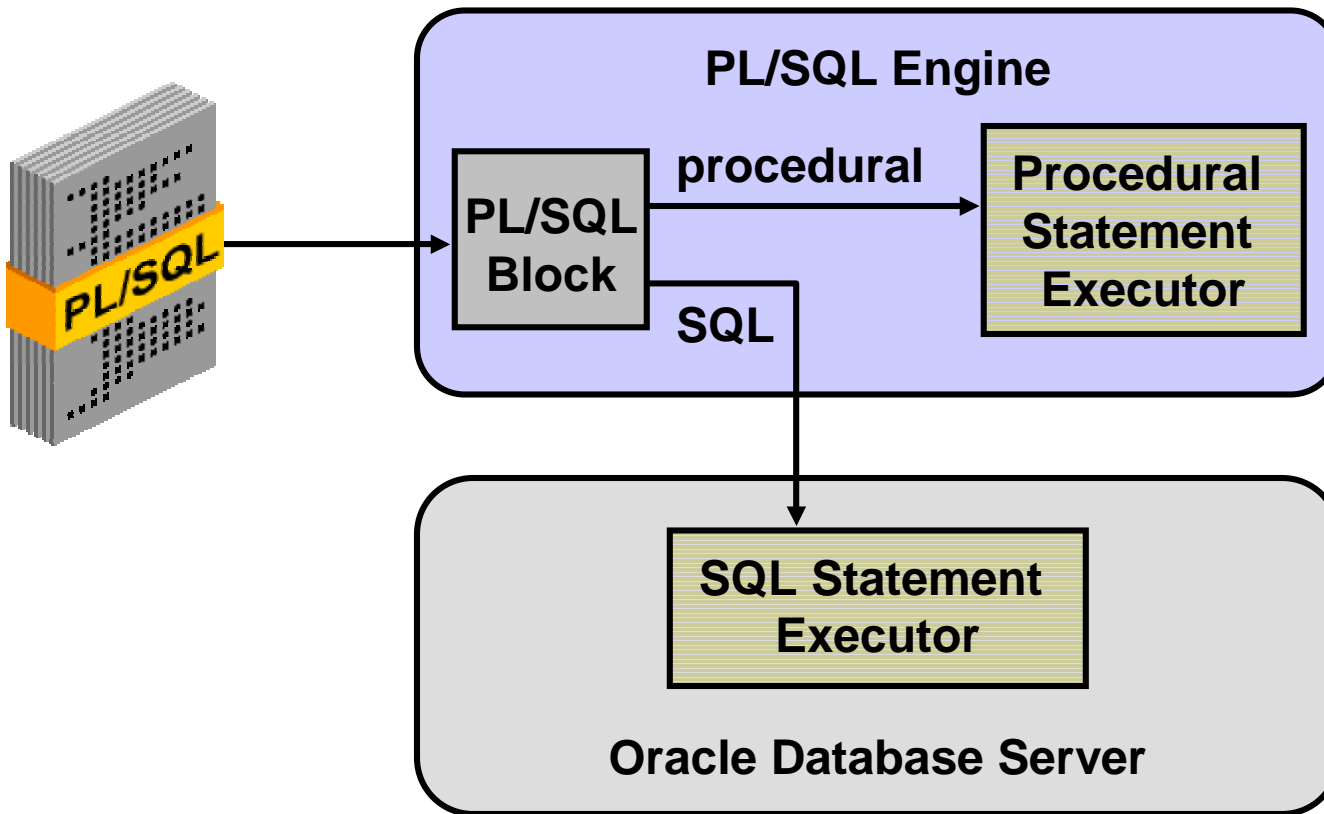


# About PL/SQL

## PL/SQL:

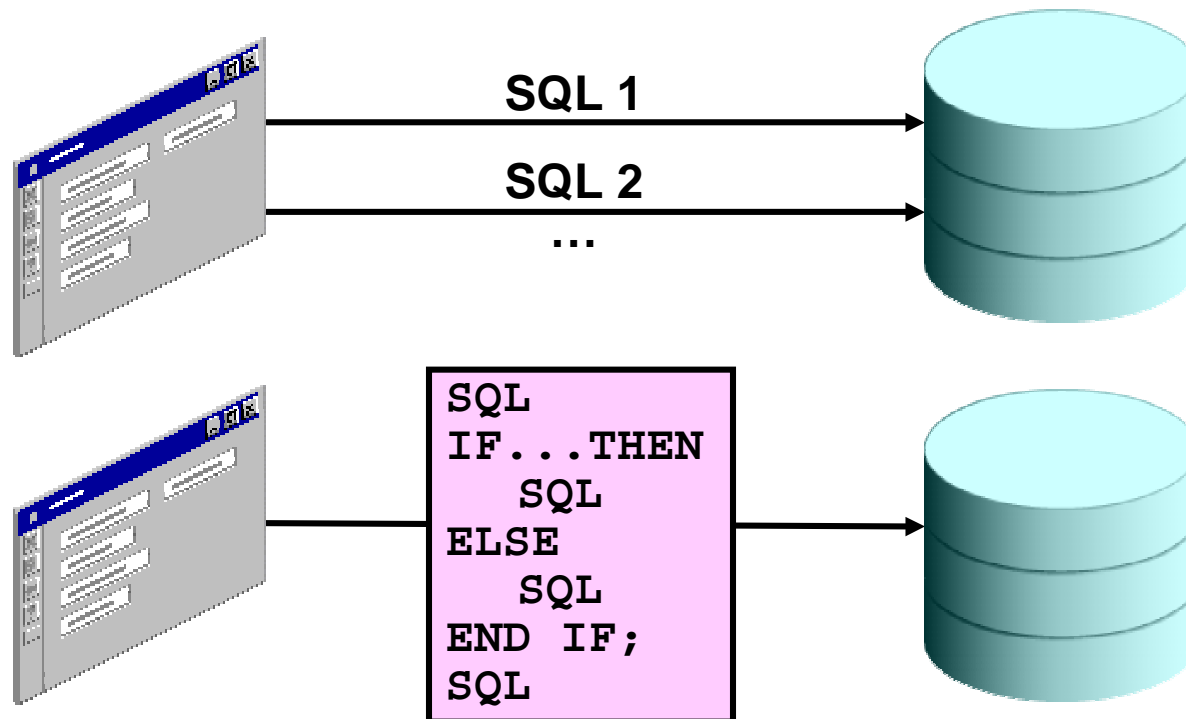
- **Provides a block structure for executable units of code. Maintenance of code is made easier with such a well-defined structure.**
- **Provides procedural constructs such as:**
  - **Variables, constants, and types**
  - **Control structures such as conditional statements and loops**
  - **Reusable program units that are written once and executed many times**

# PL/SQL Environment



# Benefits of PL/SQL

- Integration of procedural constructs with SQL
- Improved performance



# Benefits of PL/SQL

- **Modularized program development**
- **Integration with Oracle tools**
- **Portability**
- **Exception handling**

# PL/SQL Block Structure

**DECLARE (Optional)**

**Variables, cursors, user-defined exceptions**

**BEGIN (Mandatory)**

- SQL statements
- PL/SQL statements

**EXCEPTION (Optional)**

**Actions to perform  
when errors occur**

**END; (Mandatory)**



# Block Types

## Anonymous

```
[DECLARE]

BEGIN
    -- statements

[EXCEPTION]

END;
```

## Procedure

```
PROCEDURE name
IS

BEGIN
    -- statements

[EXCEPTION]

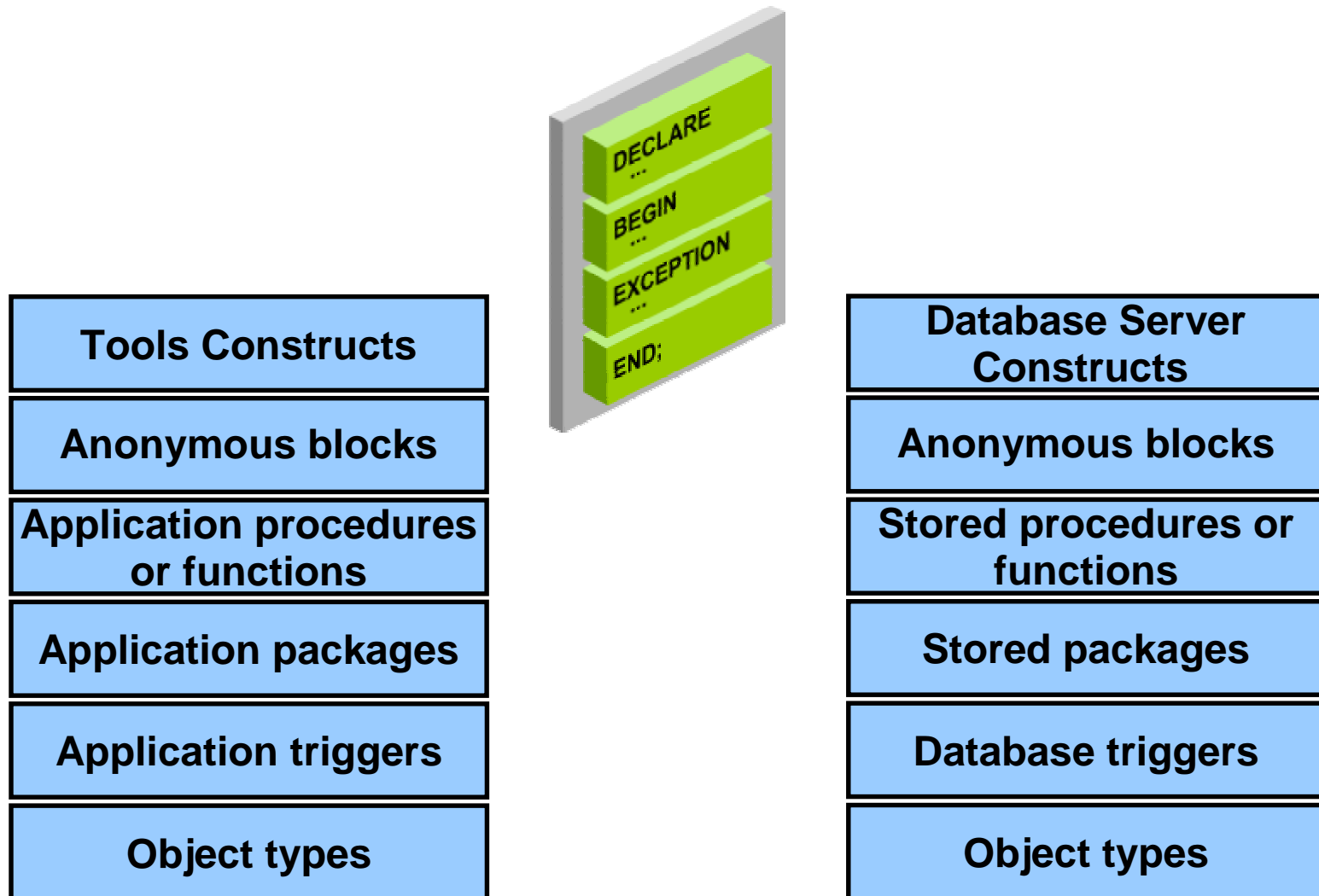
END;
```

## Function

```
FUNCTION name
RETURN datatype
IS
BEGIN
    -- statements
    RETURN value;
[EXCEPTION]

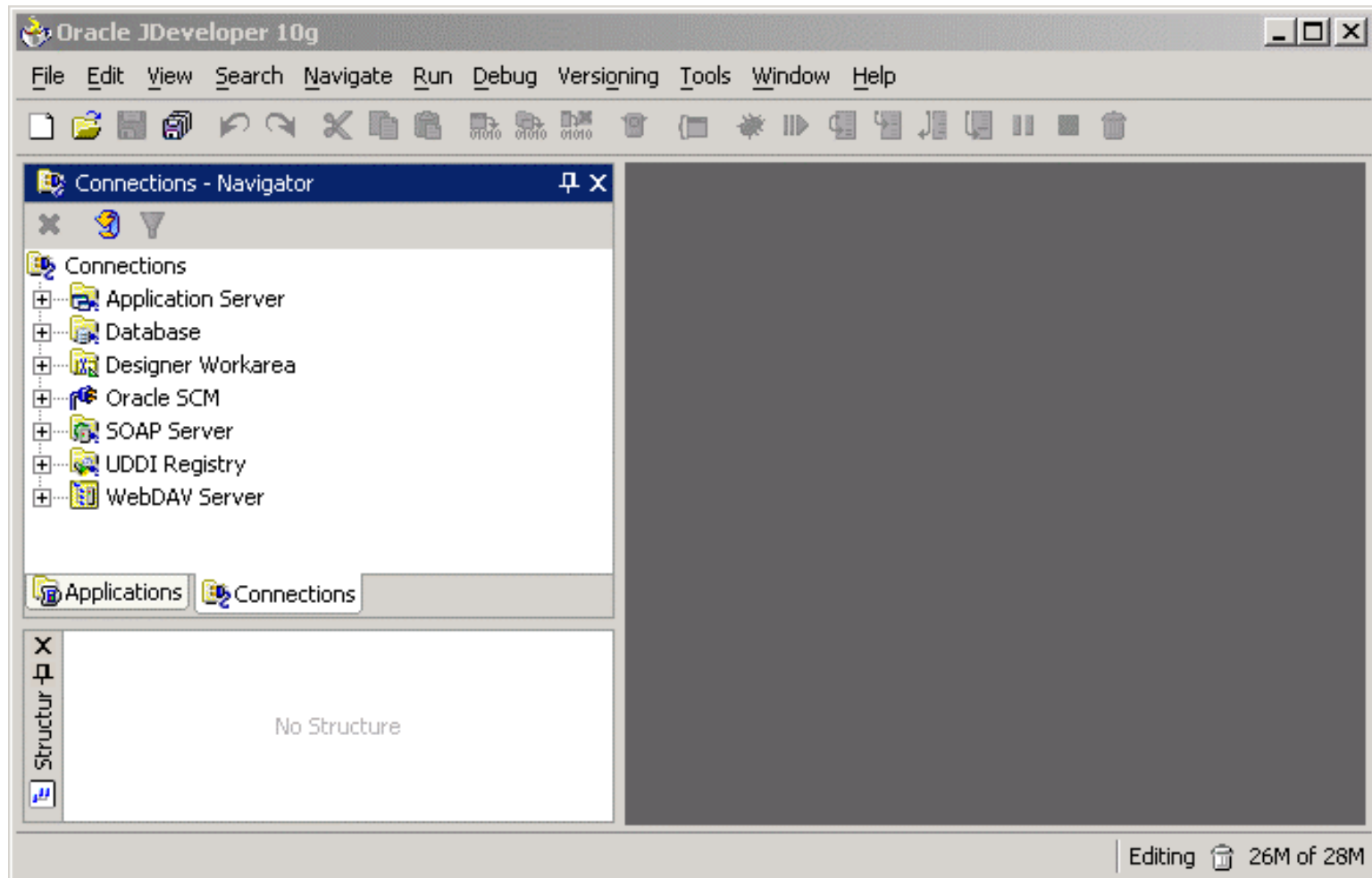
END;
```

# Program Constructs



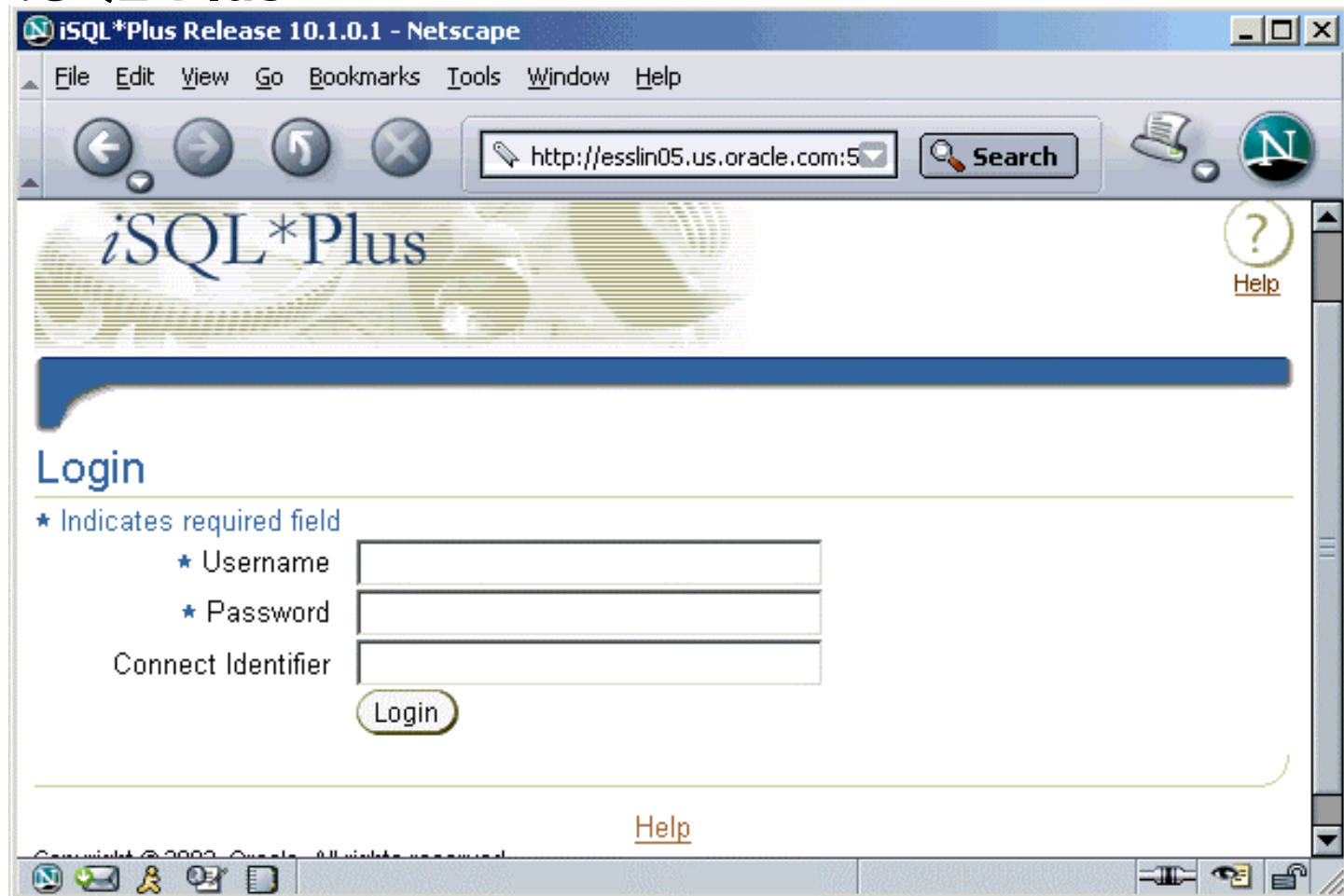


# PL/SQL Programming Environments

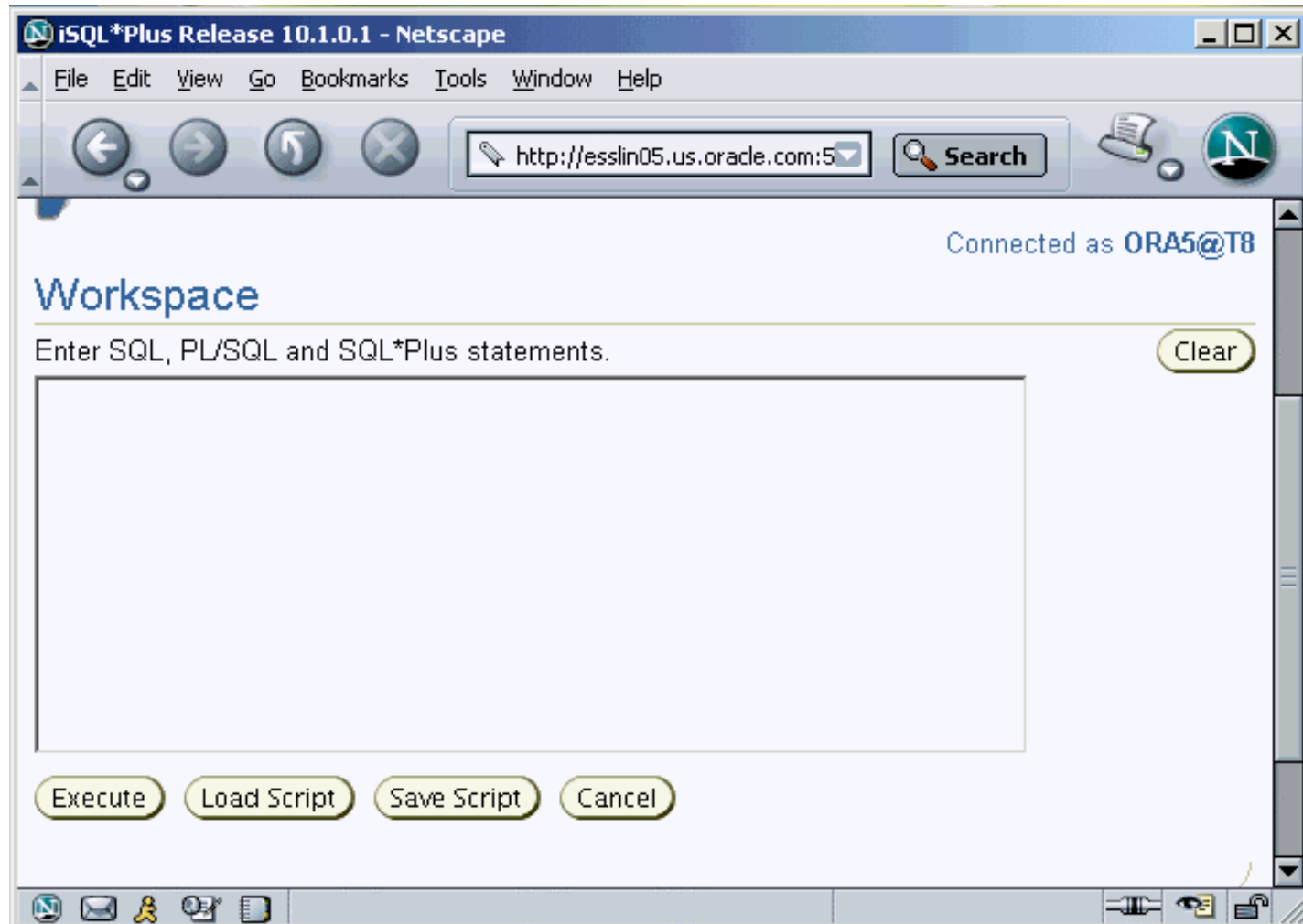


# PL/SQL Programming Environments

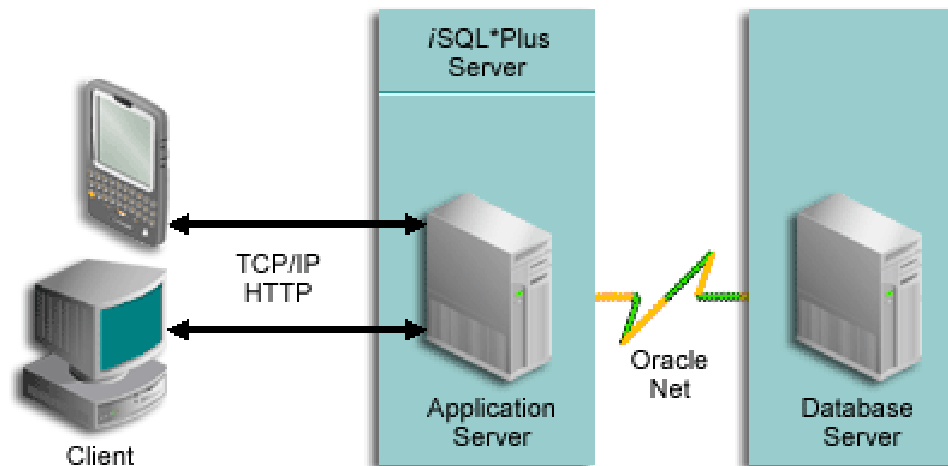
## iSQL\*Plus



# PL/SQL Programming Environments



# *i*SQL\*Plus Architecture



# Create an Anonymous Block

Type the anonymous block in the *iSQL\*Plus* workspace:

## Workspace

Enter SQL, PL/SQL and SQL\*Plus statements.

```
DECLARE
f_name VARCHAR(20);

BEGIN
SELECT first_name INTO f_name FROM employees WHERE
employee_id=100;
END;
```

Execute

Load Script

Save Script

Cancel

# Execute an Anonymous Block

**Click the Execute button to execute the anonymous block:**

## Workspace

Enter SQL, PL/SQL and SQL\*Plus statements.

```
DECLARE  
f_name VARCHAR(20);  
  
BEGIN  
SELECT first_name INTO f_name FROM employees WHERE  
employee_id=100;  
END;
```

Execute

Load Script

Save Script

Cancel

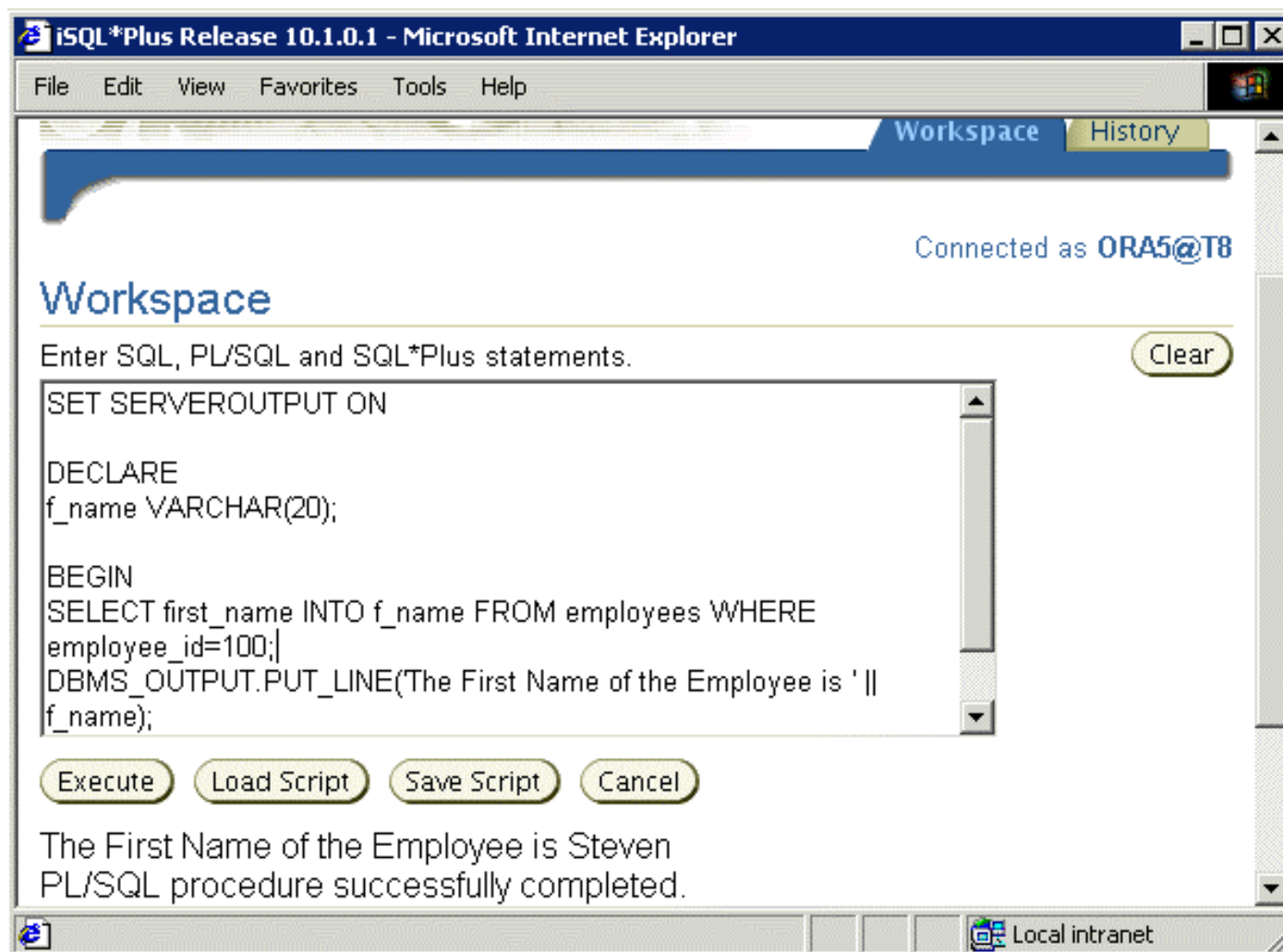
PL\SQL procedure successfully completed.

# Test the Output of a PL/SQL Block

- Enable output in *iSQL\*Plus* with the command  
`SET SERVEROUTPUT ON`
- Use a predefined Oracle package and its procedure:
  - `DBMS_OUTPUT.PUT_LINE`

```
SET SERVEROUTPUT ON
...
DBMS_OUTPUT.PUT_LINE(' The First Name of the
Employee is ' || f_name);
...
```

# Test the Output of a PL/SQL Block





# Summary

**In this lesson, you should have learned how to:**

- **Integrate SQL statements with PL/SQL program constructs**
- **Identify the benefits of PL/SQL**
- **Differentiate different PL/SQL block types**
- **Use *iSQL\*Plus* as the programming environment for PL/SQL**
- **Output messages in PL/SQL**

# Practice 1: Overview

**This practice covers the following topics:**

- **Identifying which PL/SQL blocks execute successfully**
- **Creating and executing a simple PL/SQL block**



# **Declaring PL/SQL Variables**

# Objectives

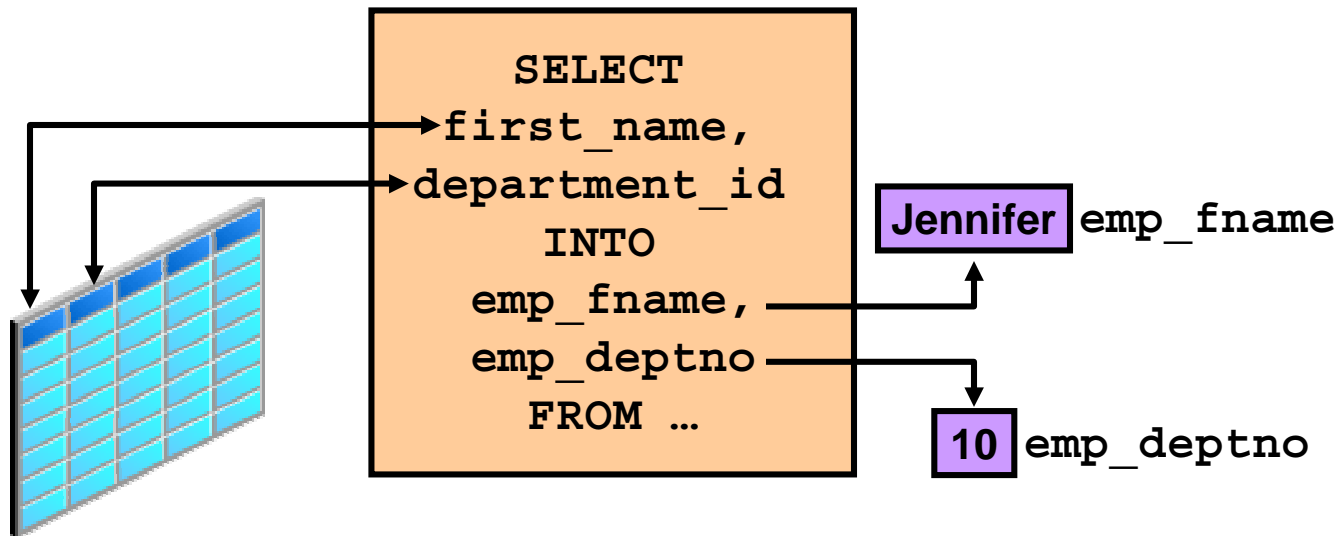
**After completing this lesson, you should be able to do the following:**

- **Identify valid and invalid identifiers**
- **List the uses of variables**
- **Declare and initialize variables**
- **List and describe various data types**
- **Identify the benefits of using %TYPE attribute**
- **Declare, use, and print bind variables**

# Use of Variables

Variables can be used for:

- Temporary storage of data
- Manipulation of stored values
- Reusability



# Identifiers

**Identifiers are used for:**

- **Naming a variable**
- **Providing a convention for variable names:**
  - **Must start with a letter**
  - **Can include letters or numbers**
  - **Can include special characters such as dollar sign, underscore, and pound sign**
  - **Must limit the length to 30 characters**
  - **Must not be reserved words**



# Handling Variables in PL/SQL

**Variables are:**

- **Declared and initialized in the declarative section**
- **Used and assigned new values in the executable section**
- **Passed as parameters to PL/SQL subprograms**
- **Used to hold the output of a PL/SQL subprogram**

# Declaring and Initializing PL/SQL Variables

## Syntax:

```
identifier [CONSTANT] datatype [NOT NULL]  
      [:= | DEFAULT expr];
```

## Examples:

```
DECLARE  
    emp_hiredate    DATE;  
    emp_deptno      NUMBER(2) NOT NULL := 10;  
    location        VARCHAR2(13) := 'Atlanta';  
    c_comm          CONSTANT NUMBER := 1400;
```



# Declaring and Initializing PL/SQL Variables

1

```
SET SERVEROUTPUT ON
DECLARE
    Myname VARCHAR2(20);
BEGIN
    DBMS_OUTPUT.PUT_LINE('My name is: ' || Myname);
    Myname := 'John';
    DBMS_OUTPUT.PUT_LINE('My name is: ' || Myname);
END;
/
```

2

```
SET SERVEROUTPUT ON
DECLARE
    Myname VARCHAR2(20) := 'John';
BEGIN
    Myname := 'Steven';
    DBMS_OUTPUT.PUT_LINE('My name is: ' || Myname);
END;
/
```

# Delimiters in String Literals

```
SET SERVEROUTPUT ON
DECLARE
    event VARCHAR2(15);
BEGIN
    event := q'!Father's day!';
    DBMS_OUTPUT.PUT_LINE('3rd Sunday in June is :
    ' || event);
    event := q'[Mother's day]';
    DBMS_OUTPUT.PUT_LINE('2nd Sunday in May is :
    ' || event);
END;
/
```

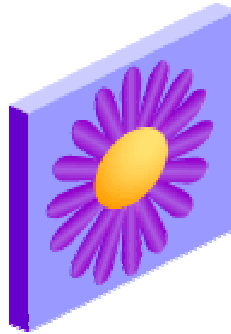
3rd Sunday in June is : Father's day  
2nd Sunday in May is : Mother's day  
PL/SQL procedure successfully completed.

# Types of Variables

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

# Types of Variables

TRUE



25-JAN-01

The soul of the lazy man desires, and has nothing; but the soul of the diligent shall be made rich.

256120.08



Atlanta

# Guidelines for Declaring and Initializing PL/SQL Variables

- Follow naming conventions.
- Use meaningful names for variables.
- Initialize variables designated as `NOT NULL` and `CONSTANT`.
- Initialize variables with the assignment operator (`:=`) or the `DEFAULT` keyword:

```
Myname VARCHAR2 (20) := 'John' ;
```

```
Myname VARCHAR2 (20) DEFAULT 'John' ;
```

- Declare one identifier per line for better readability and code maintenance.

# Guidelines for Declaring PL/SQL Variables

- Avoid using column names as identifiers.

```
DECLARE
    employee_id  NUMBER(6);
BEGIN
    SELECT      employee_id
    INTO        employee_id
    FROM        employees
    WHERE       last_name = 'Kochhar';
END;
/
```

- Use the NOT NULL constraint when the variable must hold a value.

# Scalar Data Types

- Hold a single value
- Have no internal components

TRUE

25-JAN-01

The soul of the lazy man  
desires, and has nothing;  
but the soul of the diligent  
shall be made rich.

256120.08

Atlanta

# Base Scalar Data Types

- `CHAR [(maximum_length)]`
- `VARCHAR2 (maximum_length)`
- `LONG`
- `LONG RAW`
- `NUMBER [(precision, scale)]`
- `BINARY_INTEGER`
- `PLS_INTEGER`
- `BOOLEAN`
- `BINARY_FLOAT`
- `BINARY_DOUBLE`



# Base Scalar Data Types

- **DATE**
- **TIMESTAMP**
- **TIMESTAMP WITH TIME ZONE**
- **TIMESTAMP WITH LOCAL TIME ZONE**
- **INTERVAL YEAR TO MONTH**
- **INTERVAL DAY TO SECOND**

# **BINARY\_FLOAT and BINARY\_DOUBLE**

- **Represent floating point numbers in IEEE (Institute of Electrical and Electronics Engineers) 754 format**
- **Offer better interoperability and operational speed**
- **Store values beyond the values that the data type NUMBER can store**
- **Offer benefits of closed arithmetic operations and transparent rounding**

# Declaring Scalar Variables

## Examples:

```
DECLARE
  emp_job          VARCHAR2(9);
  count_loop       BINARY_INTEGER := 0;
  dept_total_sal   NUMBER(9,2) := 0;
  orderdate        DATE := SYSDATE + 7;
  c_tax_rate       CONSTANT NUMBER(3,2) := 8.25;
  valid            BOOLEAN NOT NULL := TRUE;
  ...
```

# The %TYPE Attribute

## The %TYPE attribute

- Is used to declare a variable according to:
  - A database column definition
  - Another declared variable
- Is prefixed with:
  - The database table and column
  - The name of the declared variable

# Declaring Variables with the %TYPE Attribute

## Syntax:

```
identifier       table.column_name%TYPE;
```

## Examples:

```
...  
  emp_lname       employees.last_name%TYPE;  
  balance        NUMBER(7,2);  
  min_balance     balance%TYPE := 1000;  
...
```

# Declaring Boolean Variables

- Only the values **TRUE**, **FALSE**, and **NULL** can be assigned to a Boolean variable.
- Conditional expressions use logical operators **AND**, **OR**, and unary operator **NOT** to check the variable values.
- The variables always yield **TRUE**, **FALSE**, or **NULL**.
- Arithmetic, character, and date expressions can be used to return a Boolean value.

# Bind Variables

**Bind variables are:**

- **Created in the environment**
- **Also called host variables**
- **Created with the `VARIABLE` keyword**
- **Used in SQL statements and PL/SQL blocks**
- **Accessed even after the PL/SQL block is executed**
- **Referenced with a preceding colon**

# Printing Bind Variables

## Example:

```
VARIABLE emp_salary NUMBER
BEGIN
    SELECT salary INTO :emp_salary
    FROM employees WHERE employee_id = 178;
END;
/
PRINT emp_salary
SELECT first_name, last_name FROM employees
WHERE salary=:emp_salary;
```



# Printing Bind Variables

## Example:


```
VARIABLE emp_salary NUMBER
SET AUTOPRINT ON
BEGIN
    SELECT salary INTO :emp_salary
    FROM employees WHERE employee_id = 178;
END;
/
```

# Substitution Variables

- Are used to get user input at run time
- Are referenced within a PL/SQL block with a preceding ampersand
- Are used to avoid hard coding values that can be obtained at run time

```
VARIABLE emp_salary NUMBER
SET AUTOPRINT ON
DECLARE
    empno NUMBER(6) := &empno;
BEGIN
    SELECT salary INTO :emp_salary
    FROM employees WHERE employee_id = empno;
END;
/
```

# Substitution Variables

 **Input Required**

Enter value for empno:

Cancel Continue

Cancel Continue

1

old 2: empno NUMBER(6):=&empno;  
new 2: empno NUMBER(6):=100;  
PL/SQL procedure successfully completed.

2

EMP_SALARY	
	24000

PL/SQL procedure successfully completed.

3

EMP_SALARY	
	24000

# Prompt for Substitution Variables

```
SET VERIFY OFF
VARIABLE emp_salary NUMBER
ACCEPT empno PROMPT 'Please enter a valid employee
number: '
SET AUTOPRINT ON
DECLARE
    empno NUMBER(6) := &empno;
BEGIN
    SELECT salary INTO :emp_salary FROM employees
    WHERE employee_id = empno;
END;
/
```

 Input Required

Cancel

Continue

Please enter a valid employee number:

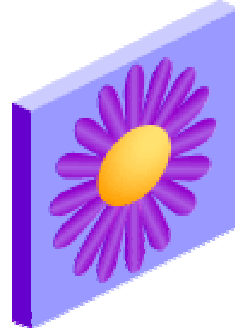
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# Using DEFINE for User Variable

## Example:

```
SET VERIFY OFF
DEFINE lname= Urman
DECLARE
    fname VARCHAR2(25);
BEGIN
    SELECT first_name INTO fname FROM employees
    WHERE last_name='&lname';
END;
/
```

# Composite Data Types

TRUE	23-DEC-98	ATLANTA	
------	-----------	---------	---

PL/SQL table structure

1	SMITH
2	JONES
3	NANCY
4	TIM

↑  
PLS\_INTEGER

↑  
VARCHAR2

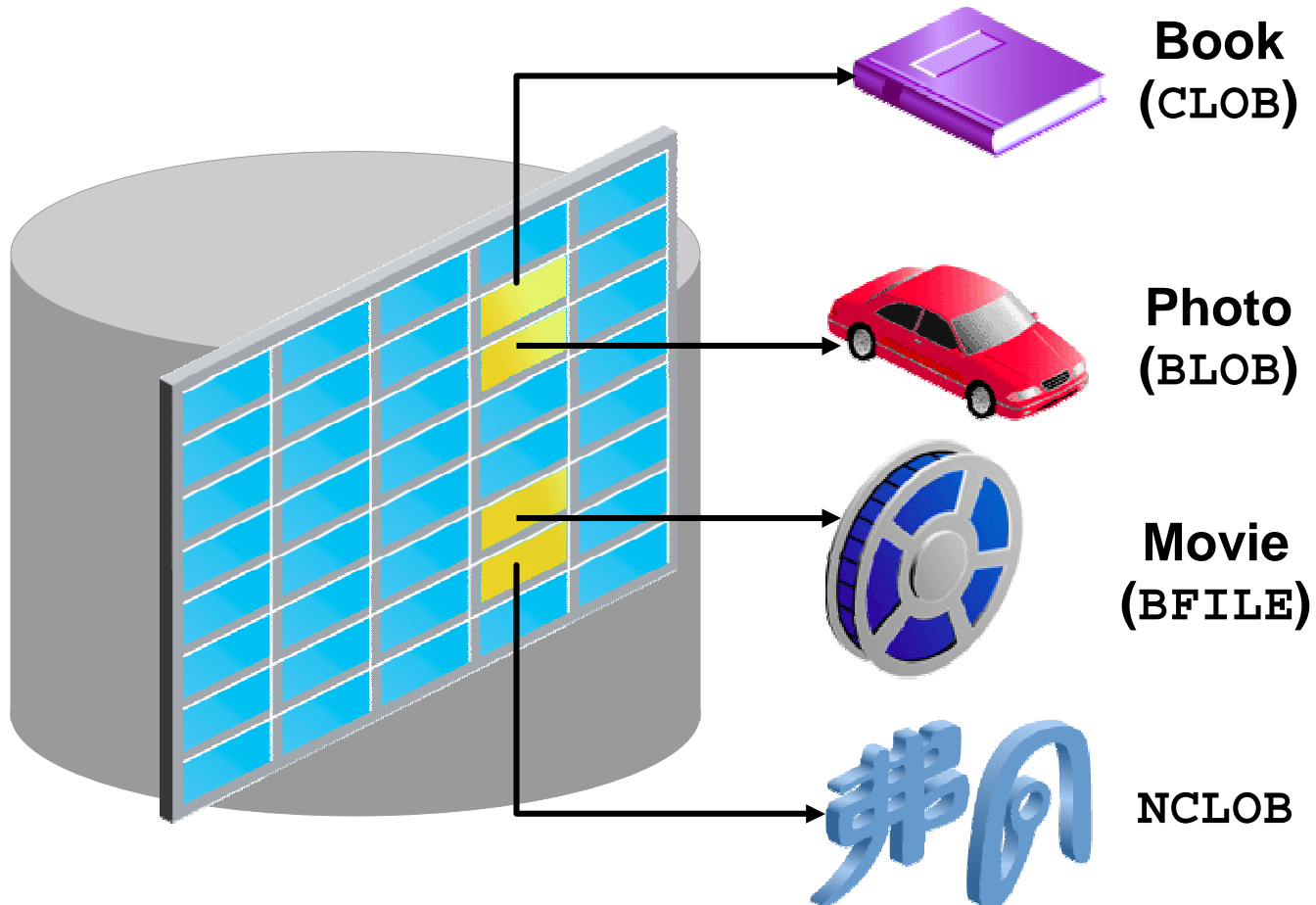
PL/SQL table structure

1	5000
2	2345
3	12
4	3456

↑  
PLS\_INTEGER

↑  
NUMBER

# LOB Data Type Variables



# Summary

**In this lesson, you should have learned how to:**

- **Identify valid and invalid identifiers**
- **Declare variables in the declarative section of a PL/SQL block**
- **Initialize variables and utilize them in the executable section**
- **Differentiate between scalar and composite data types**
- **Use the %TYPE attribute**
- **Make use of bind variables**



# Practice 2: Overview

**This practice covers the following topics:**

- **Determining valid identifiers**
- **Determining valid variable declarations**
- **Declaring variables within an anonymous block**
- **Using the `%TYPE` attribute to declare variables**
- **Declaring and printing a bind variable**
- **Executing a PL/SQL block**



# Writing Executable Statements

# Objectives

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

- **Identify lexical units in a PL/SQL block**
- **Use built-in SQL functions in PL/SQL**
- **Describe when implicit conversions take place and when explicit conversions have to be dealt with**
- **Write nested blocks and qualify variables with labels**
- **Write readable code with appropriate indentations**

# Lexical Units in a PL/SQL Block

## Lexical units:

- Are building blocks of any PL/SQL block
- Are sequences of characters including letters, digits, tabs, spaces, returns, and symbols
- Can be classified as:
  - Identifiers
  - Delimiters
  - Literals
  - Comments

# PL/SQL Block Syntax and Guidelines

- **Literals:**
  - Character and date literals must be enclosed in single quotation marks.  

```
name := 'Henderson';
```
  - Numbers can be simple values or scientific notation.
- **Statements can continue over several lines.**

# Commenting Code

- Prefix single-line comments with two dashes (--).
- Place multiple-line comments between the symbols “/\*” and “\*/”.

## Example:

```
DECLARE
...
annual_sal NUMBER (9,2);
BEGIN      -- Begin the executable section

/* Compute the annual salary based on the
   monthly salary input from the user */
annual_sal := monthly_sal * 12;
END;      -- This is the end of the block
/
```

# SQL Functions in PL/SQL

- **Available in procedural statements:**
  - Single-row number
  - Single-row character
  - Data type conversion
  - Date
  - Timestamp
  - GREATEST and LEAST
  - Miscellaneous functions
- **Not available in procedural statements:**
  - DECODE
  - Group functions

# SQL Functions in PL/SQL: Examples

- **Get the length of a string:**

```
desc_size INTEGER(5);  
prod_description VARCHAR2(70):='You can use this  
product with your radios for higher frequency';  
  
-- get the length of the string in prod_description  
desc_size:= LENGTH(prod_description);
```

- **Convert the employee name to lowercase:**

```
emp_name:= LOWER(emp_name);
```



# Data Type Conversion

- **Convert data to comparable data types**
- **Are of two types:**
  - **Implicit conversions**
  - **Explicit conversions**

## **Some conversion functions:**

- **TO\_CHAR**
- **TO\_DATE**
- **TO\_NUMBER**
- **TO\_TIMESTAMP**

# Data Type Conversion

1

```
date_of_joining DATE:= '02-Feb-2000';
```

2

```
date_of_joining DATE:= 'February 02,2000';
```

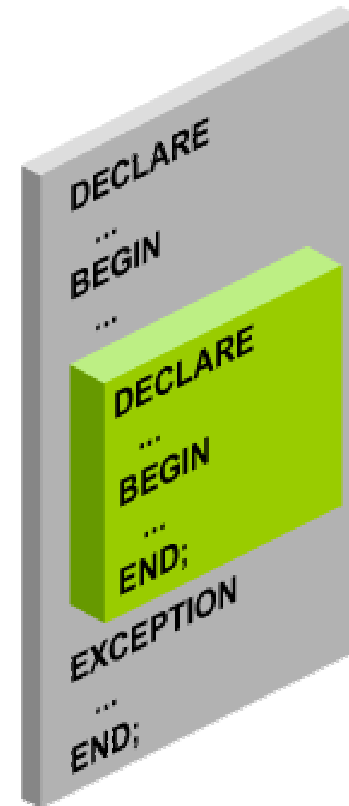
3

```
date_of_joining DATE:= TO_DATE('February  
02,2000','Month DD, YYYY');
```

# Nested Blocks

PL/SQL blocks can be nested.

- An executable section (`BEGIN ... END`) can contain nested blocks.
- An exception section can contain nested blocks.



# Nested Blocks

## Example:

```
DECLARE
  outer_variable VARCHAR2(20):='GLOBAL VARIABLE';
BEGIN
  DECLARE
    inner_variable VARCHAR2(20):='LOCAL VARIABLE';
  BEGIN
    DBMS_OUTPUT.PUT_LINE(inner_variable);
    DBMS_OUTPUT.PUT_LINE(outer_variable);
  END;
  DBMS_OUTPUT.PUT_LINE(outer_variable);
END;
/
```

# Variable Scope and Visibility

```
DECLARE
  father_name VARCHAR2(20):='Patrick';
  date_of_birth DATE:='20-Apr-1972';
BEGIN
  DECLARE
    child_name VARCHAR2(20):='Mike';
    date_of_birth DATE:='12-Dec-2002';
  BEGIN
    DBMS_OUTPUT.PUT_LINE('Father's Name: ' || father_name);
    DBMS_OUTPUT.PUT_LINE('Date of Birth: ' || date_of_birth);
    DBMS_OUTPUT.PUT_LINE('Child's Name: ' || child_name);
  END;
  DBMS_OUTPUT.PUT_LINE('Date of Birth: ' || date_of_birth);
END;
/
```

# Qualify an Identifier

```
<<outer>>
DECLARE
  father_name VARCHAR2(20):='Patrick';
  date_of_birth DATE:='20-Apr-1972';
BEGIN
  DECLARE
    child_name VARCHAR2(20):='Mike';
    date_of_birth DATE:='12-Dec-2002';
  BEGIN
    DBMS_OUTPUT.PUT_LINE('Father's Name: ' || father_name);
    DBMS_OUTPUT.PUT_LINE('Date of Birth: '
                          || outer.date_of_birth);
    DBMS_OUTPUT.PUT_LINE('Child's Name: ' || child_name);
    DBMS_OUTPUT.PUT_LINE('Date of Birth: ' || date_of_birth);
  END;
END;
/-
```

# Determining Variable Scope

```
<<outer>>
DECLARE
  sal      NUMBER(7,2) := 60000;
  comm     NUMBER(7,2) := sal * 0.20;
  message  VARCHAR2(255) := ' eligible for commission';
BEGIN
  DECLARE
    sal      NUMBER(7,2) := 50000;
    comm     NUMBER(7,2) := 0;
    total_comp NUMBER(7,2) := sal + comm;
  BEGIN
    message := 'CLERK not' || message;
    outer.comm := sal * 0.30;
  END;
  message := 'SALESMAN' || message;
END;
/
```

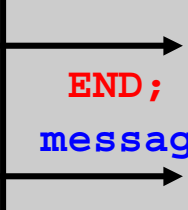



Diagram illustrating variable scope in PL/SQL:

- 1 points to the line: `outer.comm := sal * 0.30;` (This line is inside the inner `BEGIN` block, demonstrating access to the outer block's `comm` variable).
- 2 points to the line: `message := 'SALESMAN' || message;` (This line is outside the inner `BEGIN` block, demonstrating access to the outer block's `message` variable).

# Operators in PL/SQL

- Logical
  - Arithmetic
  - Concatenation
  - Parentheses to control order of operations
  - Exponential operator (\*\*)
- 
- Same as in SQL



# Operators in PL/SQL

## Examples:

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

```
loop_count := loop_count + 1;
```

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

```
good_sal := sal BETWEEN 50000 AND 150000;
```

- **Validate whether an employee number contains a value.**

```
valid := (empno IS NOT NULL);
```

# 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**

# Indenting Code

For clarity, indent each level of code.

Example:

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

```
DECLARE
  deptno          NUMBER(4);
  location_id     NUMBER(4);
BEGIN
  SELECT  department_id,
          location_id
  INTO    deptno,
          location_id
  FROM    departments
  WHERE   department_name
          = 'Sales';

  ...
END;
/
```

# Summary

**In this lesson, you should have learned how to:**

- **Use built-in SQL functions in PL/SQL**
- **Write nested blocks to break logically related functionalities**
- **Decide when you should perform explicit conversions**
- **Qualify variables in nested blocks**

# Practice 3: Overview

**This practice covers the following topics:**

- **Reviewing scoping and nesting rules**
- **Writing and testing PL/SQL blocks**



# **Interacting with the Oracle Server**

# Objectives

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

- **Decide which SQL statements can be directly included in a PL/SQL executable block**
- **Manipulate data with DML statements in PL/SQL**
- **Use transaction control statements in PL/SQL**
- **Make use of the INTO clause to hold the values returned by a SQL statement**
- **Differentiate between implicit cursors and explicit cursors**
- **Use SQL cursor attributes**

# SQL Statements in PL/SQL

- **Retrieve a row from the database by using the `SELECT` command.**
- **Make changes to rows in the database by using `DML` commands.**
- **Control a transaction with the `COMMIT`, `ROLLBACK`, or `SAVEPOINT` command.**



# SELECT Statements in PL/SQL

Retrieve data from the database with a `SELECT` statement.

Syntax:

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

# SELECT Statements in PL/SQL

- The INTO clause is required.
- Queries must return only one row.

## Example:

```
SET SERVEROUTPUT ON
DECLARE
  fname VARCHAR2(25);
BEGIN
  SELECT first_name INTO fname
  FROM employees WHERE employee_id=200;
  DBMS_OUTPUT.PUT_LINE(' First Name is : ' || fname);
END;
/
```

# Retrieving Data in PL/SQL

Retrieve the `hire_date` and the `salary` for the specified employee.

**Example:**

```
DECLARE
  emp_hiredate    employees.hire_date%TYPE;
  emp_salary      employees.salary%TYPE;
BEGIN
  SELECT    hire_date, salary
  INTO      emp_hiredate, emp_salary
  FROM      employees
  WHERE     employee_id = 100;
END;
/
```

# Retrieving Data in PL/SQL

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

**Example:**

```
SET SERVEROUTPUT ON
DECLARE
    sum_sal    NUMBER(10,2);
    deptno     NUMBER NOT NULL := 60;
BEGIN
    SELECT  SUM(salary)  -- group function
    INTO    sum_sal FROM employees
    WHERE   department_id = deptno;
    DBMS_OUTPUT.PUT_LINE ('The sum of salary is '
        || sum_sal);
END;
/
```

# Naming Conventions

```
DECLARE
  hire_date      employees.hire_date%TYPE;
  sysdate        hire_date%TYPE;
  employee_id     employees.employee_id%TYPE := 176;
BEGIN
  SELECT          hire_date, sysdate
  INTO            hire_date, sysdate
  FROM            employees
  WHERE           employee_id = employee_id;
END;
/
```

DECLARE

\*

ERROR at line 1:

ORA-01422: exact fetch returns more than requested number of rows

ORA-06512: at line 6

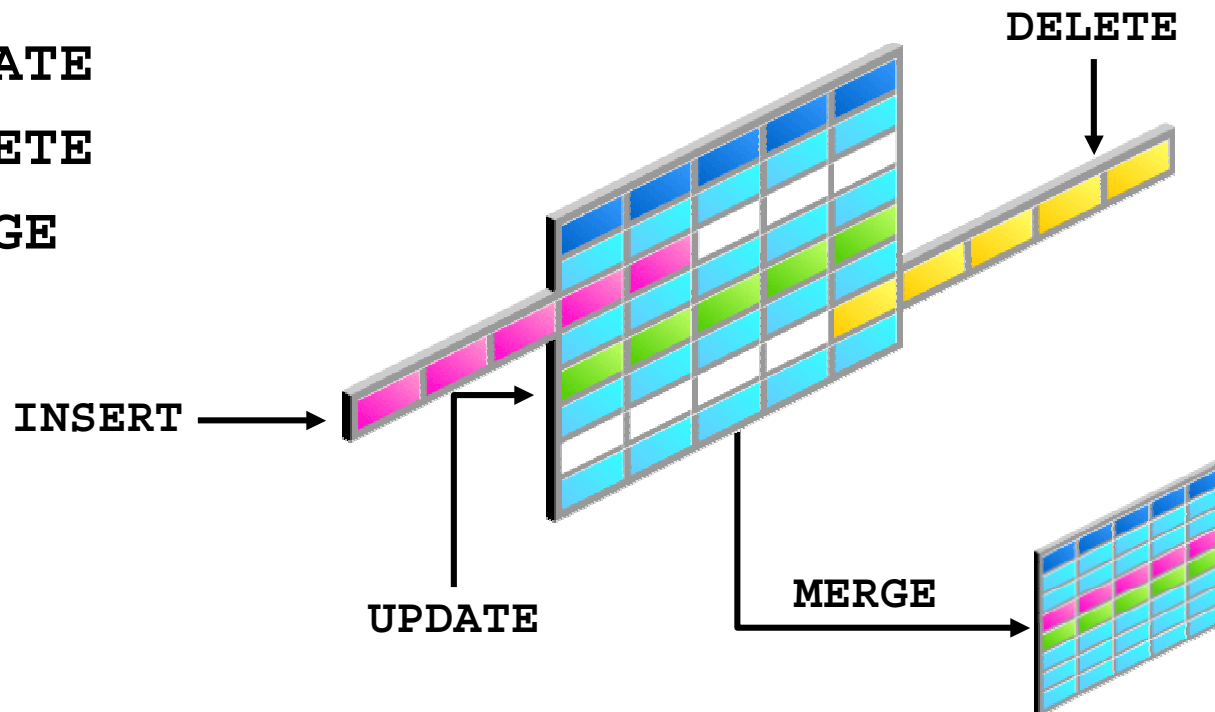
# Naming Conventions

- Use a naming convention to avoid ambiguity in the **WHERE** clause.
- Avoid using database column names as identifiers.
- Syntax errors can arise because PL/SQL checks the database first for a column in the table.
- The names of local variables and formal parameters take precedence over the names of database *tables*.
- The names of database table *columns* take precedence over the names of local variables.

# Manipulating Data Using PL/SQL

Make changes to database tables by using DML commands:

- INSERT
- UPDATE
- DELETE
- MERGE



# Inserting Data

Add new employee information to the **EMPLOYEES** table.

**Example:**

```
BEGIN
  INSERT INTO employees
    (employee_id, first_name, last_name, email,
     hire_date, job_id, salary)
    VALUES (employees_seq.NEXTVAL, 'Ruth', 'Cores',
            'RCORES',sysdate, 'AD_ASST', 4000);
END;
/
```



# Updating Data

**Increase the salary of all employees who are stock clerks.**

**Example:**

```
DECLARE
    sal_increase    employees.salary%TYPE := 800;
BEGIN
    UPDATE          employees
    SET              salary = salary + sal_increase
    WHERE            job_id = 'ST_CLERK';
END;
/
```

# Deleting Data

**Delete rows that belong to department 10 from the employees table.**

**Example:**

```
DECLARE
    deptno    employees.department_id%TYPE := 10;
BEGIN
    DELETE FROM    employees
    WHERE    department_id = deptno;
END;
/
```

# Merging Rows

**Insert or update rows in the `copy_emp` table to match the `employees` table.**

```
DECLARE
    empno employees.employee_id%TYPE := 100;
BEGIN
MERGE INTO copy_emp c
    USING employees e
    ON (e.employee_id = empno)
    WHEN MATCHED THEN
        UPDATE SET
            c.first_name      = e.first_name,
            c.last_name       = e.last_name,
            c.email           = e.email,
            . . .
    WHEN NOT MATCHED THEN
        INSERT VALUES(e.employee_id, e.first_name, e.last_name,
            . . ., e.department_id);
END;
/
```

# SQL Cursor

- **A cursor is a pointer to the private memory area allocated by the Oracle server.**
- **There are two types of cursors:**
  - **Implicit cursors: Created and managed internally by the Oracle server to process SQL statements**
  - **Explicit cursors: Explicitly declared by the programmer**

# SQL Cursor Attributes for Implicit Cursors

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

<b>SQL%FOUND</b>	<b>Boolean attribute that evaluates to TRUE if the most recent SQL statement returned at least one row.</b>
<b>SQL%NOTFOUND</b>	<b>Boolean attribute that evaluates to TRUE if the most recent SQL statement did not return even one row.</b>
<b>SQL%ROWCOUNT</b>	<b>An integer value that represents number of rows affected by the most recent SQL statement.</b>

# SQL Cursor Attributes for Implicit Cursors

**Delete rows that have the specified employee ID from the `employees` table. Print the number of rows deleted.**

**Example:**

```
VARIABLE rows_deleted VARCHAR2(30)
DECLARE
    empno employees.employee_id%TYPE := 176;
BEGIN
    DELETE FROM employees
    WHERE employee_id = empno;
    :rows_deleted := (SQL%ROWCOUNT ||
                     ' row deleted. ');
END;
/
PRINT rows_deleted
```

# Summary

**In this lesson, you should have learned how to:**

- **Embed DML statements, transaction control statements, and DDL statements in PL/SQL**
- **Use the `INTO` clause, which is mandatory for all `SELECT` statements in PL/SQL**
- **Differentiate between implicit cursors and explicit cursors**
- **Use SQL cursor attributes to determine the outcome of SQL statements**

# Practice 4: Overview

**This practice covers the following topics:**

- **Selecting data from a table**
- **Inserting data into a table**
- **Updating data in a table**
- **Deleting a record from a table**



# 5

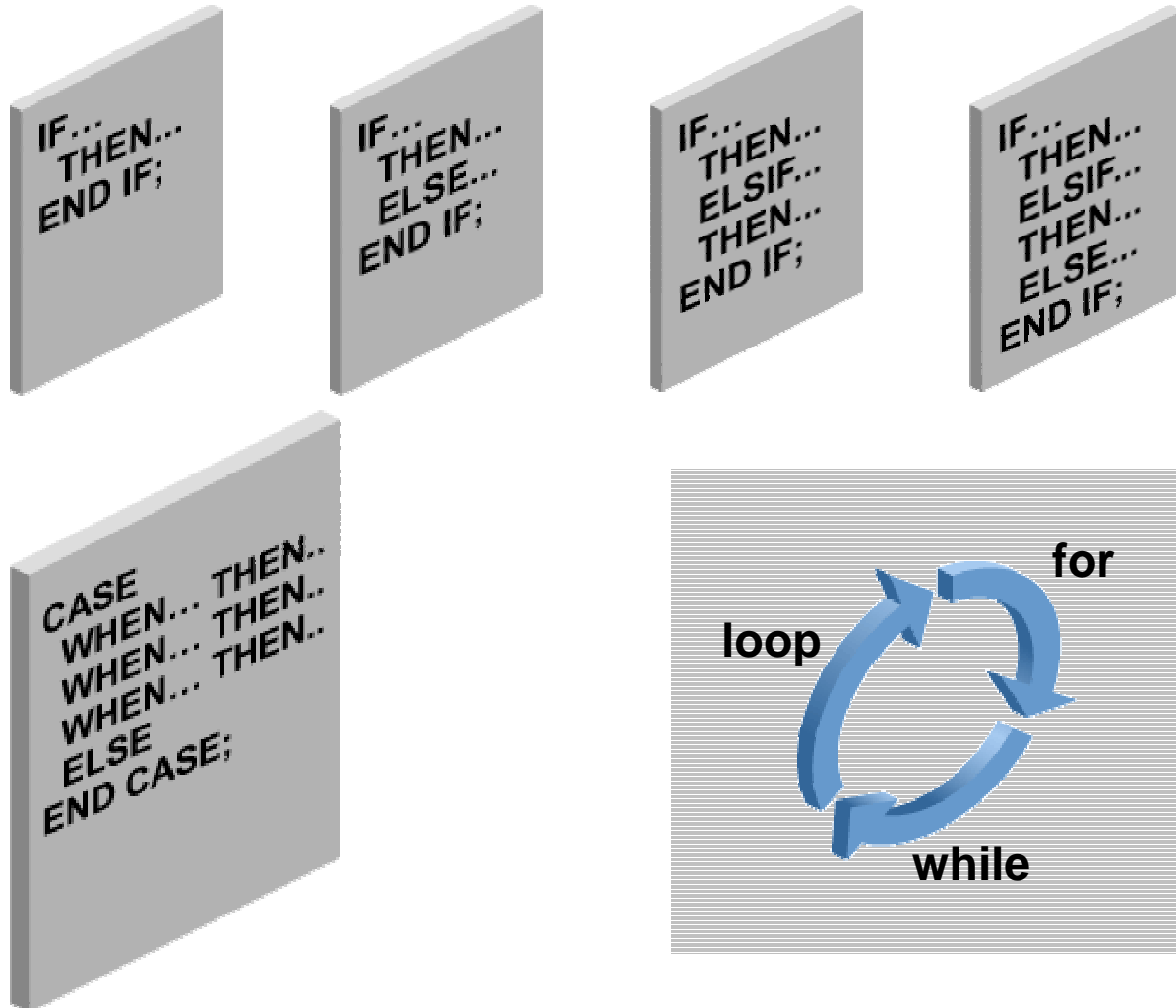
## Writing Control Structures

# 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**
- **Use `CASE` statements and `CASE` expressions**
- **Construct and identify different loop statements**
- **Make use of guidelines while using the conditional control structures**

# Controlling Flow of Execution



# IF Statements

## Syntax:

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

# Simple IF Statement

```
DECLARE
  myage number:=31;
BEGIN
  IF myage < 11
  THEN
    DBMS_OUTPUT.PUT_LINE(' I am a child ');
  END IF;
END;
/
```

PL/SQL procedure successfully completed.

# IF THEN ELSE Statement

```
SET SERVEROUTPUT ON
DECLARE
myage number:=31;
BEGIN
IF myage < 11
  THEN
    DBMS_OUTPUT.PUT_LINE(' I am a child ');
  ELSE
    DBMS_OUTPUT.PUT_LINE(' I am not a child ');
END IF;
END;
/
```

I am not a child  
PL/SQL procedure successfully completed.

# IF ELSIF ELSE Clause

```
DECLARE
myage number:=31;
BEGIN
IF myage < 11
THEN
    DBMS_OUTPUT.PUT_LINE(' I am a child ');
ELSIF myage < 20
THEN
    DBMS_OUTPUT.PUT_LINE(' I am young ');
ELSIF myage < 30
THEN
    DBMS_OUTPUT.PUT_LINE(' I am in my twenties');
ELSIF myage < 40
THEN
    DBMS_OUTPUT.PUT_LINE(' I am in my thirties');
ELSE
    DBMS_OUTPUT.PUT_LINE(' I am always young ');
END IF;
END;
/
```

I am in my thirties  
PL/SQL procedure successfully completed.

# NULL Values in IF Statements

```
DECLARE
myage number;
BEGIN
IF myage < 11
  THEN
    DBMS_OUTPUT.PUT_LINE(' I am a child ');
  ELSE
    DBMS_OUTPUT.PUT_LINE(' I am not a child ');
END IF;
END;
/
```

I am not a child  
PL/SQL procedure successfully completed.



# CASE Expressions

- A CASE expression selects a result and returns it.
- To select the result, the CASE expression uses expressions. The value returned by these expressions is used to select one of several alternatives.

```
CASE selector
  WHEN expression1 THEN result1
  WHEN expression2 THEN result2
  ...
  WHEN expressionN THEN resultN
[ELSE resultN+1]
END;
/
```

# CASE Expressions: Example

```
SET SERVEROUTPUT ON
SET VERIFY OFF
DECLARE
    grade CHAR(1) := UPPER('&grade');
    appraisal VARCHAR2(20);
BEGIN
    appraisal :=
        CASE grade
            WHEN 'A' THEN 'Excellent'
            WHEN 'B' THEN 'Very Good'
            WHEN 'C' THEN 'Good'
            ELSE 'No such grade'
        END;
    DBMS_OUTPUT.PUT_LINE ('Grade: ' || grade || '
                          Appraisal ' || appraisal);
END;
/
```

# Searched CASE Expressions

```
DECLARE
    grade CHAR(1) := UPPER('&grade');
    appraisal VARCHAR2(20);
BEGIN
    appraisal :=
        CASE
            WHEN grade = 'A' THEN 'Excellent'
            WHEN grade IN ('B','C') THEN 'Good'
            ELSE 'No such grade'
        END;
    DBMS_OUTPUT.PUT_LINE ('Grade: ' || grade || '
                          Appraisal ' || appraisal);
END;
/
```

# CASE Statement

```
DECLARE
    deptid NUMBER;
    deptname VARCHAR2(20);
    emps NUMBER;
    mngid NUMBER:= 108;
BEGIN
    CASE mngid
    WHEN 108 THEN
        SELECT department_id, department_name
        INTO deptid, deptname FROM departments
        WHERE manager_id=108;
        SELECT count(*) INTO emps FROM employees
        WHERE department_id=deptid;
    WHEN 200 THEN
        ...
    END CASE;
    DBMS_OUTPUT.PUT_LINE ('You are working in the ' || deptname |
    ' department. There are ' || emps || ' employees in this
    department');
END;
/
```

# Handling Nulls

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

- **Simple 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.**

# Logic Tables

Build a simple Boolean condition with a comparison operator.

AND	<i>TRUE</i>	<i>FALSE</i>	<i>NULL</i>	OR	<i>TRUE</i>	<i>FALSE</i>	<i>NULL</i>	NOT	
<i>TRUE</i>	TRUE	FALSE	NULL	<i>TRUE</i>	TRUE	TRUE	TRUE	<i>TRUE</i>	FALSE
<i>FALSE</i>	FALSE	FALSE	FALSE	<i>FALSE</i>	TRUE	FALSE	NULL	<i>FALSE</i>	TRUE
<i>NULL</i>	NULL	FALSE	NULL	<i>NULL</i>	TRUE	NULL	NULL	<i>NULL</i>	NULL

# Boolean Conditions

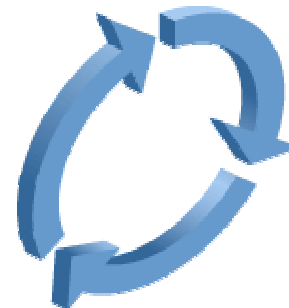
What is the value of `flag` in each case?

```
flag := reorder_flag AND available_flag;
```

REORDER_FLAG	AVAILABLE_FLAG	FLAG
TRUE	TRUE	?
TRUE	FALSE	?
NULL	TRUE	?
NULL	FALSE	?

# 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**





# Basic Loops

## Syntax:

```
LOOP
  statement1;
  . . .
  EXIT [WHEN condition];
END LOOP;
```

# Basic Loops

## Example:

```
DECLARE
  countryid      locations.country_id%TYPE := 'CA';
  loc_id         locations.location_id%TYPE;
  counter        NUMBER(2) := 1;
  new_city       locations.city%TYPE := 'Montreal';
BEGIN
  SELECT MAX(location_id) INTO loc_id FROM locations
  WHERE country_id = countryid;
  LOOP
    INSERT INTO locations(location_id, city, country_id)
    VALUES((loc_id + counter), new_city, countryid);
    counter := counter + 1;
    EXIT WHEN counter > 3;
  END LOOP;
END;
/
```

# WHILE Loops

## Syntax:

```
WHILE condition LOOP  
    statement1;  
    statement2;  
    . . .  
END LOOP;
```

**Use the WHILE loop to repeat statements while a condition is TRUE.**

# WHILE Loops

## Example:

```
DECLARE
  countryid    locations.country_id%TYPE := 'CA';
  loc_id       locations.location_id%TYPE;
  new_city     locations.city%TYPE := 'Montreal';
  counter      NUMBER := 1;
BEGIN
  SELECT MAX(location_id) INTO loc_id FROM locations
  WHERE country_id = countryid;
  WHILE counter <= 3 LOOP
    INSERT INTO locations(location_id, city, country_id)
    VALUES((loc_id + counter), new_city, countryid);
    counter := counter + 1;
  END LOOP;
END;
/
```

# FOR Loops

- Use a **FOR** loop to shortcut the test for the number of iterations.
- Do not declare the counter; it is declared implicitly.
- '**lower\_bound .. upper\_bound**' is required syntax.

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

# FOR Loops

## Example:

```
DECLARE
    countryid    locations.country_id%TYPE := 'CA';
    loc_id       locations.location_id%TYPE;
    new_city     locations.city%TYPE := 'Montreal';
BEGIN
    SELECT MAX(location_id) INTO loc_id
    FROM locations
    WHERE country_id = countryid;
    FOR i IN 1..3 LOOP
        INSERT INTO locations(location_id, city, country_id)
        VALUES((loc_id + i), new_city, countryid );
    END LOOP;
END;
/
```

# FOR Loops

## Guidelines

- **Reference the counter within the loop only; it is undefined outside the loop.**
- **Do not reference the counter as the target of an assignment.**
- **Neither loop bound should be NULL.**

# Guidelines While Using Loops

- Use the basic loop when the statements inside the loop must execute at least once.
- Use the `WHILE` loop if the condition has to be evaluated at the start of each iteration.
- Use a `FOR` loop if the number of iterations is known.



# 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 that references the label.

# Nested Loops and Labels

```
...  
BEGIN  
  <<Outer_loop>>  
  LOOP  
    counter := counter+1;  
    EXIT WHEN 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;  
/
```

# Summary

**In this lesson, you should have learned how to:  
Change the logical flow of statements by using the  
following control structures.**

- **Conditional (IF statement)**
- **CASE expressions and CASE statements**
- **Loops:**
  - **BASIC loop**
  - **FOR loop**
  - **WHILE loop**
- **EXIT statements**

# Practice 5: Overview

**This practice covers the following topics:**

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



# **Working with Composite Data Types**

# 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 an `INDEX BY table`**
- **Create an `INDEX BY table of records`**
- **Describe the difference between records, tables, and tables of records**

# Composite Data Types

- Can hold multiple values, unlike scalar types
- Are of two types:
  - PL/SQL records
  - PL/SQL collections

INDEX BY tables or associative arrays

Nested table

VARRAY

# Composite Data Types

- **Use PL/SQL records when you want to store values of different data types but only one occurrence at a time.**
- **Use PL/SQL collections when you want to store values of same data type.**



# PL/SQL Records

- **Must contain one or more components of any scalar, RECORD, or INDEX BY table data type, called fields**
- **Are similar to structures in most 3GL languages including C and C++**
- **Are user defined and can be a subset of a row in a table**
- **Treat a collection of fields as a logical unit**
- **Are convenient for fetching a row of data from a table for processing**

# Creating a PL/SQL Record

## Syntax:

1

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

2

```
identifier      type_name;
```

## *field\_declaration*:

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

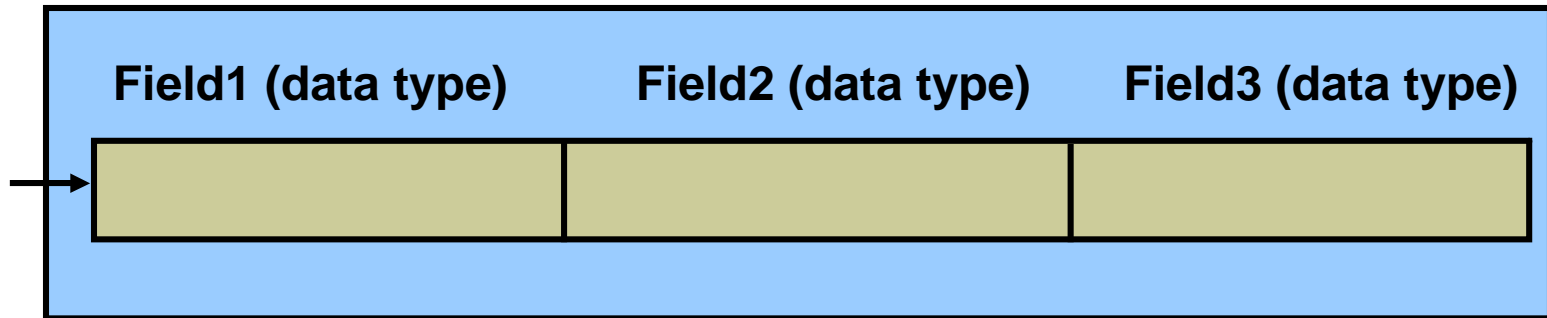
# Creating a PL/SQL Record

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

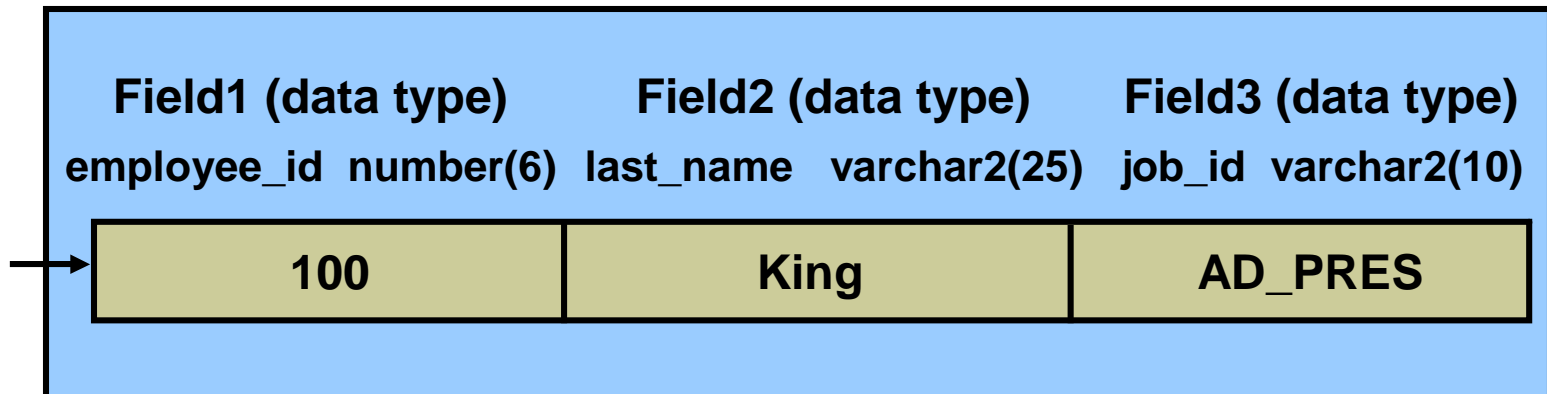
**Example:**

```
...  
    TYPE emp_record_type IS RECORD  
        (last_name    VARCHAR2(25),  
         job_id       VARCHAR2(10),  
         salary       NUMBER(8,2));  
    emp_record        emp_record_type;  
...
```

# PL/SQL Record Structure



## Example:



# The %ROWTYPE Attribute

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

## Syntax:

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

# Advantages of Using %ROWTYPE

- The number and data types of the underlying database columns need not be known.
- The number and data types of the underlying database column may change at run time.
- The attribute is useful when retrieving a row with the `SELECT *` statement.

# The %ROWTYPE Attribute

```
...  
DEFINE employee_number = 124  
DECLARE  
    emp_rec    employees%ROWTYPE;  
BEGIN  
    SELECT * INTO emp_rec FROM employees  
    WHERE  employee_id = &employee_number;  
    INSERT INTO retired_emps(empno, ename, job, mgr,  
    hiredate, leavedate, sal, comm, deptno)  
    VALUES (emp_rec.employee_id, emp_rec.last_name,  
    emp_rec.job_id, emp_rec.manager_id,  
    emp_rec.hire_date, SYSDATE, emp_rec.salary,  
    emp_rec.commission_pct, emp_rec.department_id);  
END;  
/
```

# Inserting a Record Using %ROWTYPE

```
...  
DEFINE employee_number = 124  
DECLARE  
    emp_rec  retired_emps%ROWTYPE;  
BEGIN  
    SELECT employee_id, last_name, job_id, manager_id,  
           hire_date, hire_date, salary, commission_pct,  
           department_id INTO emp_rec FROM employees  
    WHERE  employee_id = &employee_number;  
    INSERT INTO retired_emps VALUES emp_rec;  
END;  
/  
SELECT * FROM retired_emps;
```



# Updating a Row in a Table Using a Record

```
SET SERVEROUTPUT ON
SET VERIFY OFF
DEFINE employee_number = 124
DECLARE
    emp_rec retired_emps%ROWTYPE;
BEGIN
    SELECT * INTO emp_rec FROM retired_emps;
    emp_rec.leavedate:=SYSDATE;
    UPDATE retired_emps SET ROW = emp_rec WHERE
        empno=&employee_number;
END;
/
SELECT * FROM retired_emps;
```

# INDEX BY Tables or Associative Arrays

- **Are PL/SQL structures with two columns:**
  - **Primary key type integer or string**
  - **Column of scalar or record data type**
- **Are unconstrained in size. However the size depends on the values the key data type can hold.**

# Creating an INDEX BY Table

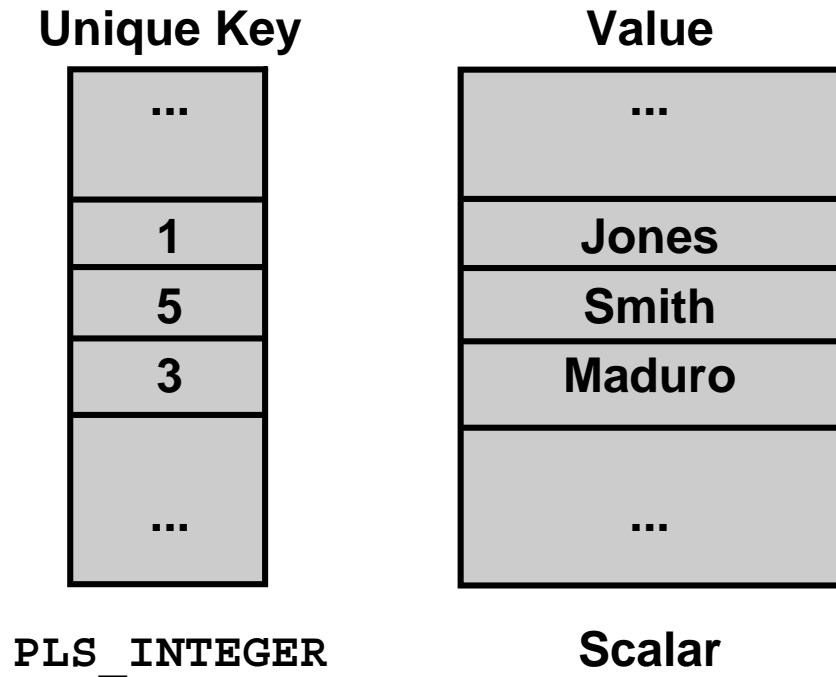
## Syntax:

```
TYPE type_name IS TABLE OF
    {column_type | variable%TYPE
    | table.column%TYPE} [NOT NULL]
    | table%ROWTYPE
    [INDEX BY PLS_INTEGER | BINARY_INTEGER
    | VARCHAR2(<size>)];
identifier    type_name;
```

**Declare an INDEX BY table to store the last names of employees.**

```
...
TYPE ename_table_type IS TABLE OF
    employees.last_name%TYPE
    INDEX BY PLS_INTEGER;
...
ename_table ename_table_type;
```

# INDEX BY Table Structure



# Creating an INDEX BY Table

```
DECLARE
  TYPE ename_table_type IS TABLE OF
    employees.last_name%TYPE
    INDEX BY PLS_INTEGER;
  TYPE hiredate_table_type IS TABLE OF DATE
    INDEX BY PLS_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;
/
```

# Using INDEX BY Table Methods

The following methods make INDEX BY tables easier to use:

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

# INDEX BY Table of Records

**Define an INDEX BY table variable to hold an entire row from a table.**

**Example:**

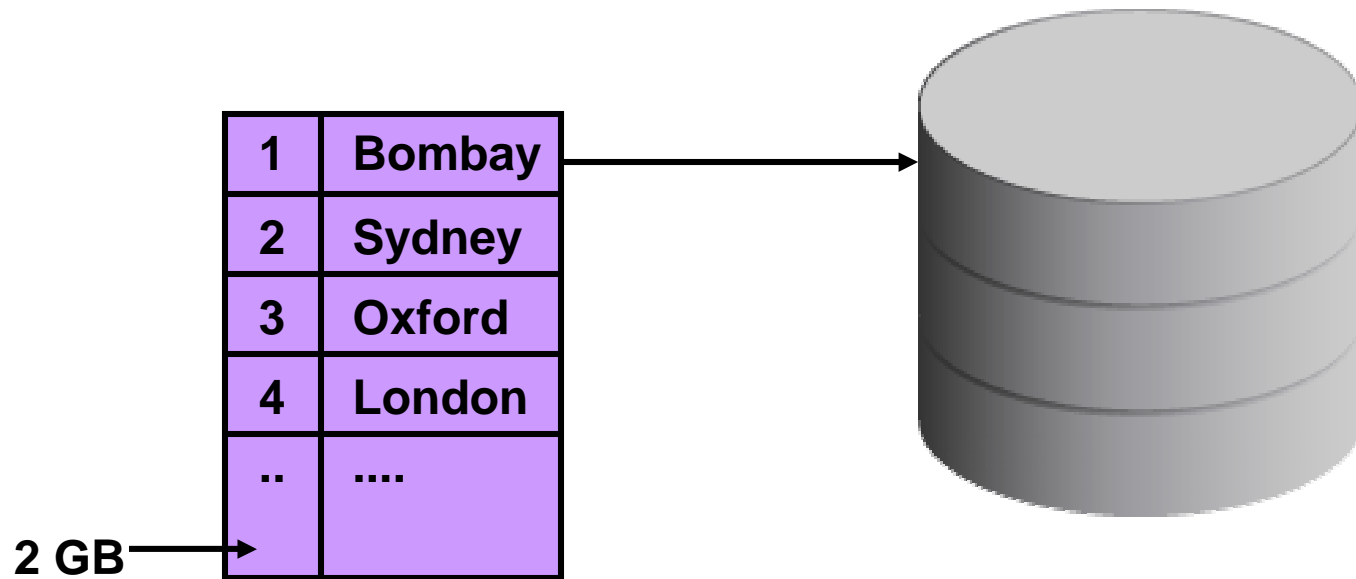
```
DECLARE
  TYPE dept_table_type IS TABLE OF
    departments%ROWTYPE
    INDEX BY PLS_INTEGER;
  dept_table dept_table_type;
  -- Each element of dept_table is a record
```

# Example of INDEX BY Table of Records

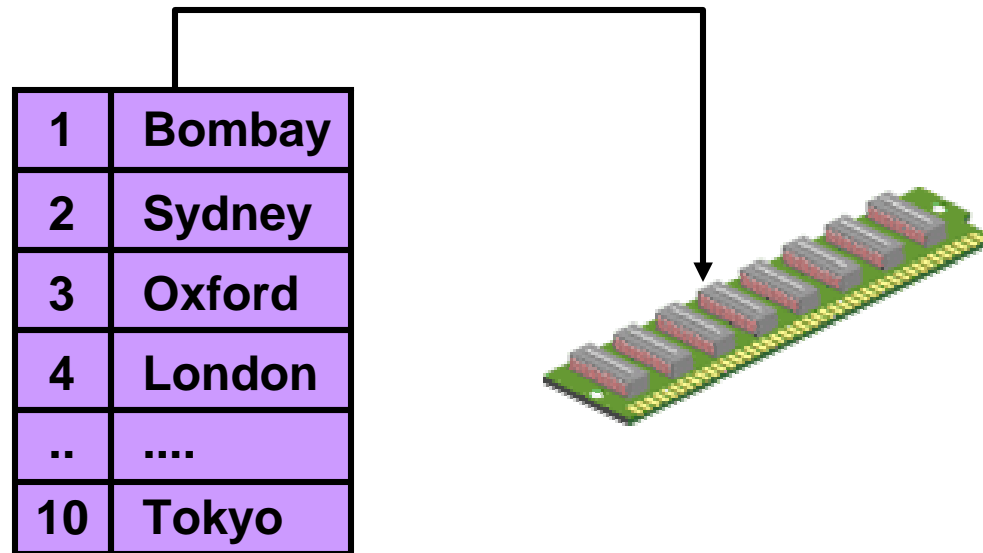
```
SET SERVEROUTPUT ON
DECLARE
    TYPE emp_table_type IS TABLE OF
        employees%ROWTYPE INDEX BY PLS_INTEGER;
    my_emp_table    emp_table_type;
    max_count       NUMBER(3) := 104;
BEGIN
    FOR i IN 100..max_count
    LOOP
        SELECT * INTO my_emp_table(i) FROM employees
        WHERE employee_id = i;
    END LOOP;
    FOR i IN my_emp_table.FIRST..my_emp_table.LAST
    LOOP
        DBMS_OUTPUT.PUT_LINE(my_emp_table(i).last_name);
    END LOOP;
END;
/
```



# Nested Tables



# VARRAY



# Summary

**In this lesson, you should have learned how to:**

- **Define and reference PL/SQL variables of composite data types:**
  - **PL/SQL records**
  - **INDEX BY tables**
  - **INDEX BY table of records**
- **Define a PL/SQL record by using the `%ROWTYPE` attribute**

# Practice 6: Overview

**This practice covers the following topics:**

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



# Using Explicit Cursors

# Objectives

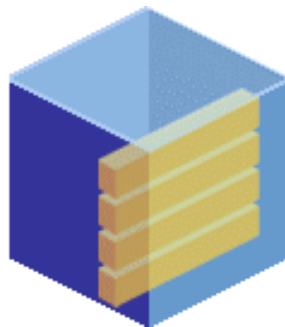
**After completing this lesson, you should be able to do the following:**

- **Distinguish between an implicit and an explicit cursor**
- **Discuss when and why to use an explicit cursor**
- **Declare and control explicit cursors**
- **Use simple loop and cursor `FOR` loop to fetch data**
- **Declare and use cursors with parameters**
- **Lock rows using the `FOR UPDATE` clause**
- **Reference the current row with the `WHERE CURRENT` clause**

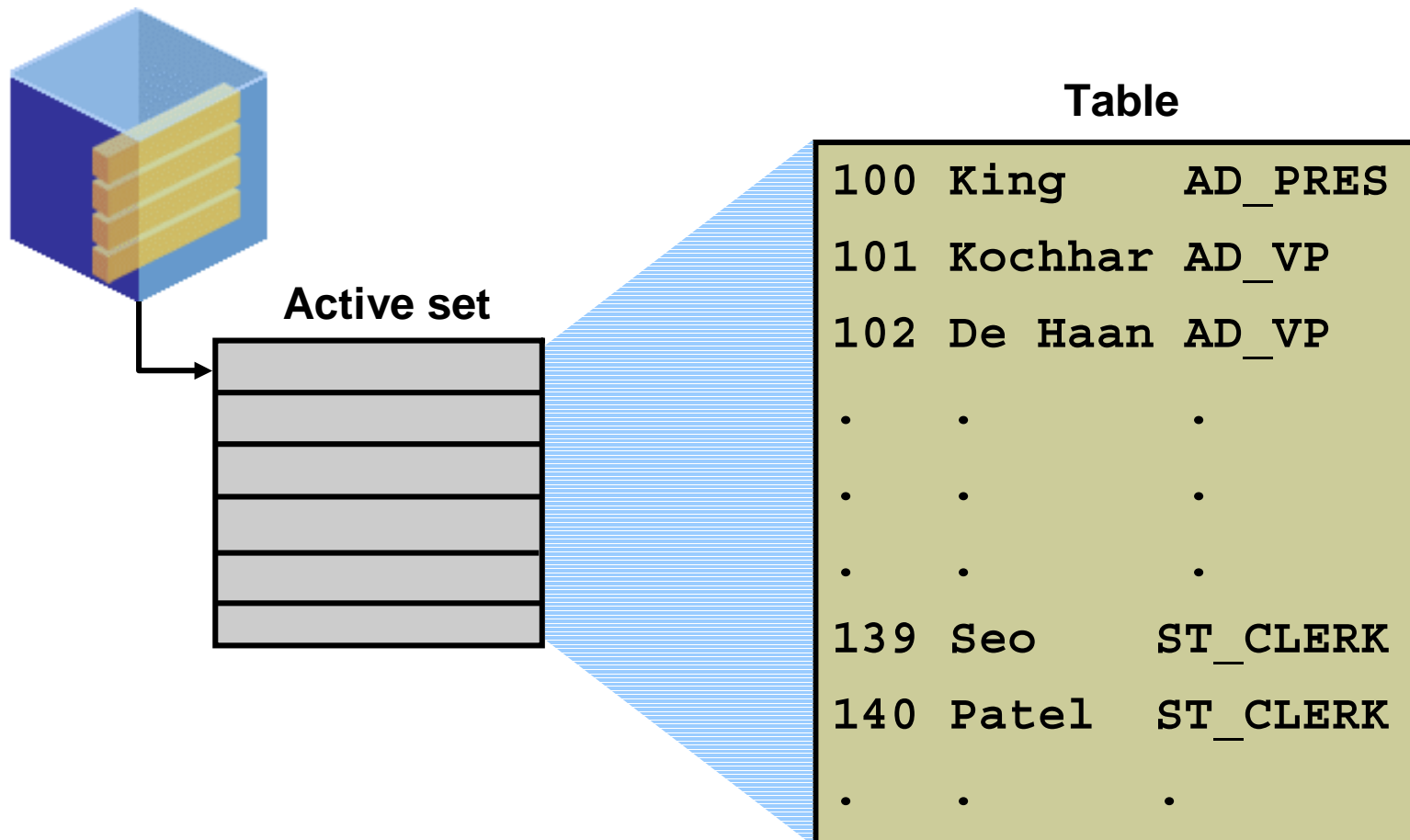
# About Cursors

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

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

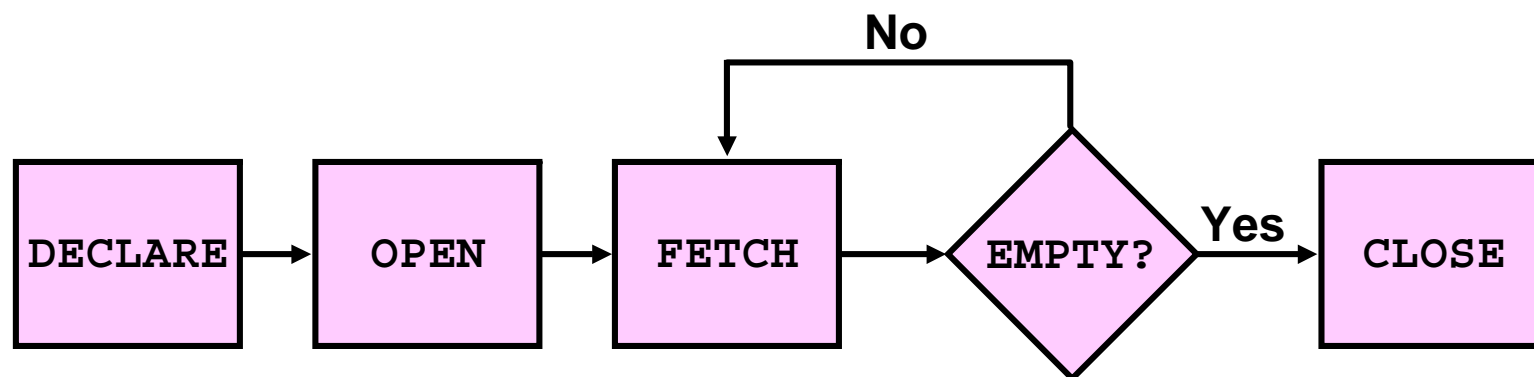


# Explicit Cursor Operations





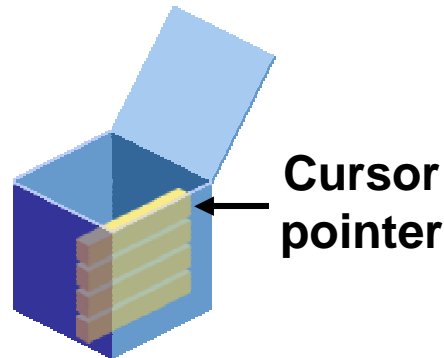
# Controlling Explicit Cursors



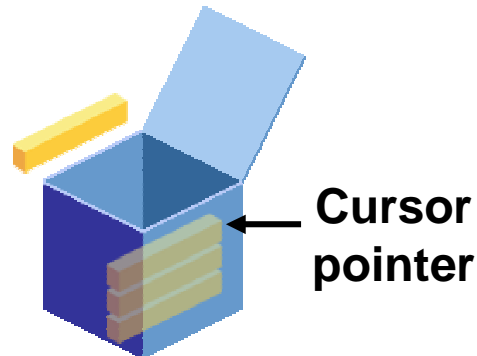
- Create a named SQL area
- Identify the active set
- Load the current row into variables
- Test for existing rows
- Release the active set
- Return to **FETCH** if rows are found

# Controlling Explicit Cursors

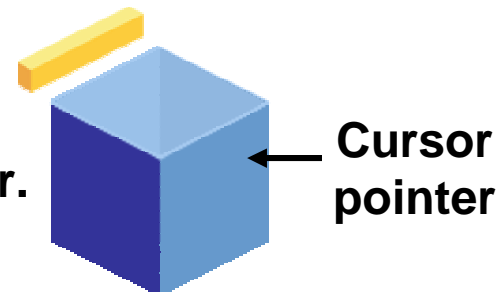
**1** Open the cursor.



**2** Fetch a row.



**3** Close the cursor.



# Declaring the Cursor

## Syntax:

```
CURSOR cursor_name IS  
    select_statement;
```

## Examples:

```
DECLARE  
    CURSOR emp_cursor IS  
        SELECT employee_id, last_name FROM employees  
        WHERE department_id = 30;
```

```
DECLARE  
    locid NUMBER := 1700;  
    CURSOR dept_cursor IS  
        SELECT * FROM departments  
        WHERE location_id = locid;  
    ...
```

# Opening the Cursor

```
DECLARE
  CURSOR emp_cursor IS
    SELECT employee_id, last_name FROM employees
    WHERE department_id =30;
  ...
BEGIN
  OPEN emp_cursor;
```

# Fetching Data from the Cursor

```
SET SERVEROUTPUT ON
DECLARE
    CURSOR emp_cursor IS
        SELECT employee_id, last_name FROM employees
        WHERE department_id =30;
    empno employees.employee_id%TYPE;
    lname employees.last_name%TYPE;
BEGIN
    OPEN emp_cursor;
    FETCH emp_cursor INTO empno, lname;
    DBMS_OUTPUT.PUT_LINE( empno || ' ' || lname);
    ...
END;
/
```

# Fetching Data from the Cursor

```
SET SERVEROUTPUT ON
DECLARE
  CURSOR emp_cursor IS
    SELECT employee_id, last_name FROM employees
    WHERE department_id = 30;
  empno employees.employee_id%TYPE;
  lname employees.last_name%TYPE;
BEGIN
  OPEN emp_cursor;
  LOOP
    FETCH emp_cursor INTO empno, lname;
    EXIT WHEN emp_cursor%NOTFOUND;
    DBMS_OUTPUT.PUT_LINE( empno || ' ' || lname);
  END LOOP;
  ...
END;
/
```

# Closing the Cursor

```
...  
  LOOP  
    FETCH emp_cursor INTO empno, lname;  
    EXIT WHEN emp_cursor%NOTFOUND;  
    DBMS_OUTPUT.PUT_LINE( empno || ' ' || lname);  
  END LOOP;  
  CLOSE emp_cursor;  
END;  
/
```

# Cursors and Records

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

```
DECLARE
  CURSOR emp_cursor IS
    SELECT employee_id, last_name FROM employees
    WHERE department_id =30;
  emp_record emp_cursor%ROWTYPE;
BEGIN
  OPEN emp_cursor;
  LOOP
    FETCH emp_cursor INTO emp_record;
    ...
```



# 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, exit, and close occur.
- The record is implicitly declared.

# Cursor FOR Loops

```
SET SERVEROUTPUT ON
DECLARE
  CURSOR emp_cursor IS
    SELECT employee_id, last_name FROM employees
    WHERE department_id =30;
BEGIN
  FOR emp_record IN emp_cursor
  LOOP
    DBMS_OUTPUT.PUT_LINE( emp_record.employee_id
      || ' ' || emp_record.last_name );
  END LOOP;
END;
/
```

# Explicit Cursor Attributes

**Obtain status information about a cursor.**

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

# 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...
```

# Example of %ROWCOUNT and %NOTFOUND

```
SET SERVEROUTPUT ON
DECLARE
    empno    employees.employee_id%TYPE;
    ename    employees.last_name%TYPE;
    CURSOR emp_cursor IS SELECT employee_id,
    last_name FROM employees;
BEGIN
    OPEN emp_cursor;
    LOOP
        FETCH emp_cursor INTO empno, ename;
        EXIT WHEN emp_cursor%ROWCOUNT > 10 OR
                emp_cursor%NOTFOUND;
        DBMS_OUTPUT.PUT_LINE (TO_CHAR (empno)
                                || ' ' || ename);
    END LOOP;
    CLOSE emp_cursor;
END ;
/
```

# Cursor FOR Loops Using Subqueries

No need to declare the cursor.

Example:

```
SET SERVEROUTPUT ON
BEGIN
  FOR emp_record IN (SELECT employee_id, last_name
                     FROM employees WHERE department_id =30)
  LOOP
    DBMS_OUTPUT.PUT_LINE( emp_record.employee_id || '
    ' || emp_record.last_name);
  END LOOP;
END;
/
```

# 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.

```
OPEN cursor_name (parameter_value, ....) ;
```

# Cursors with Parameters

```
SET SERVEROUTPUT ON
DECLARE
    CURSOR    emp_cursor (deptno NUMBER) IS
        SELECT employee_id, last_name
        FROM    employees
        WHERE   department_id = deptno;
    dept_id NUMBER;
    lname     VARCHAR2(15);
BEGIN
    OPEN emp_cursor (10);
    ...
    CLOSE emp_cursor;
    OPEN emp_cursor (20);
    ...
```



# The FOR UPDATE Clause

## Syntax:

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

- Use explicit locking to deny access to other sessions for the duration of a transaction.
- Lock the rows *before* the update or delete.

# The WHERE CURRENT OF Clause

## Syntax:

```
WHERE CURRENT OF cursor ;
```

- Use cursors to update or delete the current row.
- Include the FOR UPDATE clause in the cursor query to lock the rows first.
- Use the WHERE CURRENT OF clause to reference the current row from an explicit cursor.

```
UPDATE employees  
  SET    salary = ...  
  WHERE CURRENT OF emp_cursor;
```

# Cursors with Subqueries

## Example:

```
DECLARE
  CURSOR my_cursor IS
    SELECT t1.department_id, t1.department_name,
           t2.staff
    FROM   departments t1, (SELECT department_id,
                                   COUNT(*) AS STAFF
                           FROM employees
                           GROUP BY department_id) t2
    WHERE  t1.department_id = t2.department_id
    AND    t2.staff >= 3;

...
```

# Summary

**In this lesson, you should have learned how to:**

- **Distinguish cursor types:**
  - **Implicit cursors:** Used for all `DML` statements and single-row queries
  - **Explicit cursors:** Used for queries of zero, one, or more rows
- **Create and handle explicit cursors**
- **Use simple loops and cursor `FOR` loops to handle multiple rows in the cursors**
- **Evaluate the cursor status by using the cursor attributes**
- **Use the `FOR UPDATE` and `WHERE CURRENT OF` clauses to update or delete the current fetched row**

# Practice 7: Overview

**This practice covers the following topics:**

- **Declaring and using explicit cursors to query rows of a table**
- **Using a cursor `FOR` loop**
- **Applying cursor attributes to test the cursor status**
- **Declaring and using cursor with parameters**
- **Using the `FOR UPDATE` and `WHERE CURRENT OF` clauses**

# 8

## 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**

# Example

```
SET SERVEROUTPUT ON
DECLARE
  lname VARCHAR2(15);
BEGIN
  SELECT last_name INTO lname FROM employees WHERE
    first_name='John';
  DBMS_OUTPUT.PUT_LINE ('John''s last name is : '
    ||lname);
END;
/
```



# Example

```
SET SERVEROUTPUT ON
DECLARE
    lname VARCHAR2(15);
BEGIN
    SELECT last_name INTO lname FROM employees WHERE
    first_name='John';
    DBMS_OUTPUT.PUT_LINE ('John''s last name is : '
    ||lname);
EXCEPTION
    WHEN TOO_MANY_ROWS THEN
    DBMS_OUTPUT.PUT_LINE (' Your select statement
    retrieved multiple rows. Consider using a
    cursor.');
```

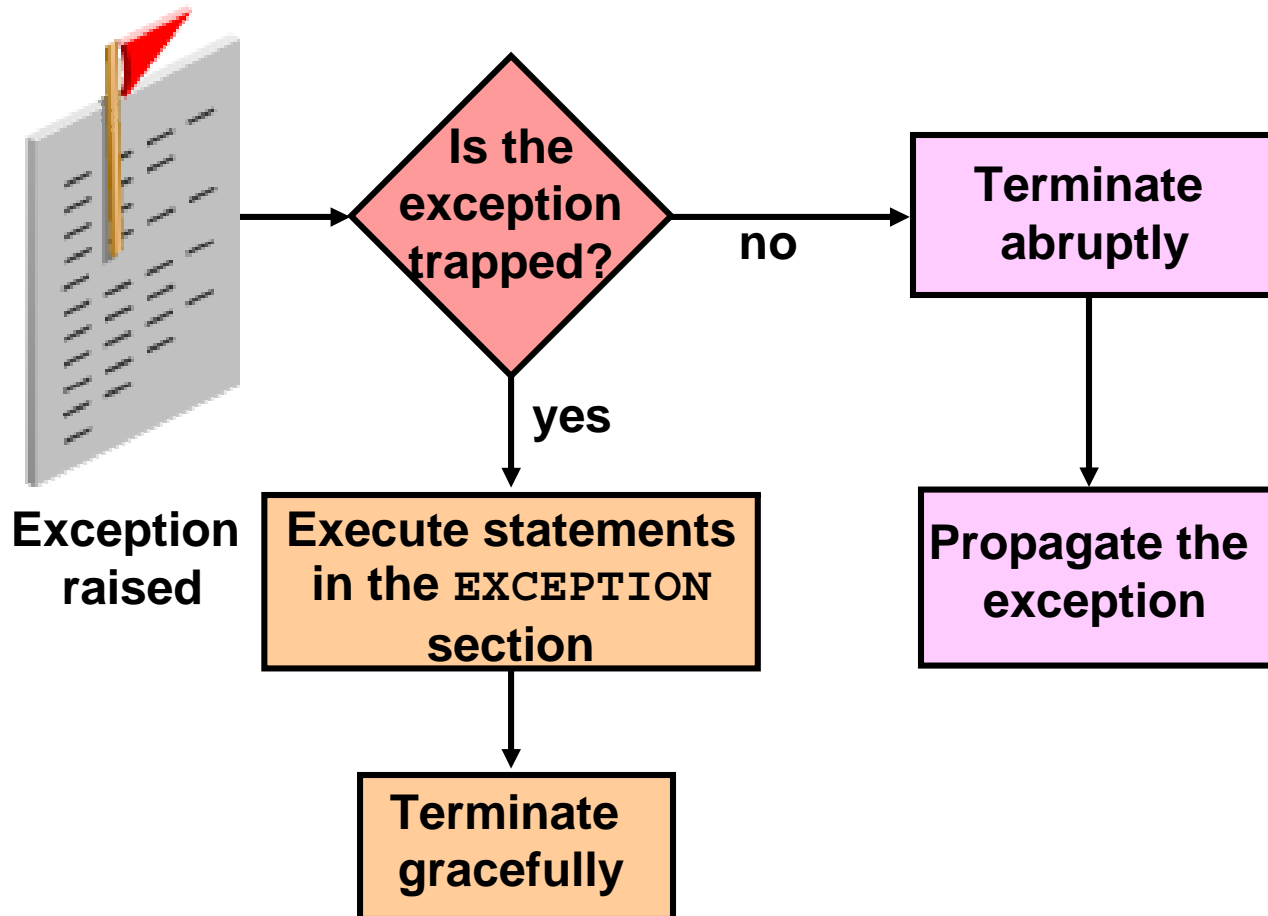
END;

/


# Handling Exceptions with PL/SQL

- **An exception is an error PL/SQL that is raised during program execution.**
- **An exception can be raised:**
  - Implicitly by the Oracle server
  - Explicitly by the program
- **An exception can be handled:**
  - By trapping it with a handler
  - By propagating it to the calling environment

# Handling Exceptions



# Exception Types

- **Predefined Oracle Server**
  - **Non-predefined Oracle Server**
- 
- Implicitly raised**
- 
- **User-defined**
- Explicitly raised**

# Trapping Exceptions

## Syntax:

```
EXCEPTION
  WHEN exception1 [OR exception2 . . .] THEN
    statement1;
    statement2;
    . . .
  [WHEN exception3 [OR exception4 . . .] THEN
    statement1;
    statement2;
    . . .]
  [WHEN OTHERS THEN
    statement1;
    statement2;
    . . .]
```

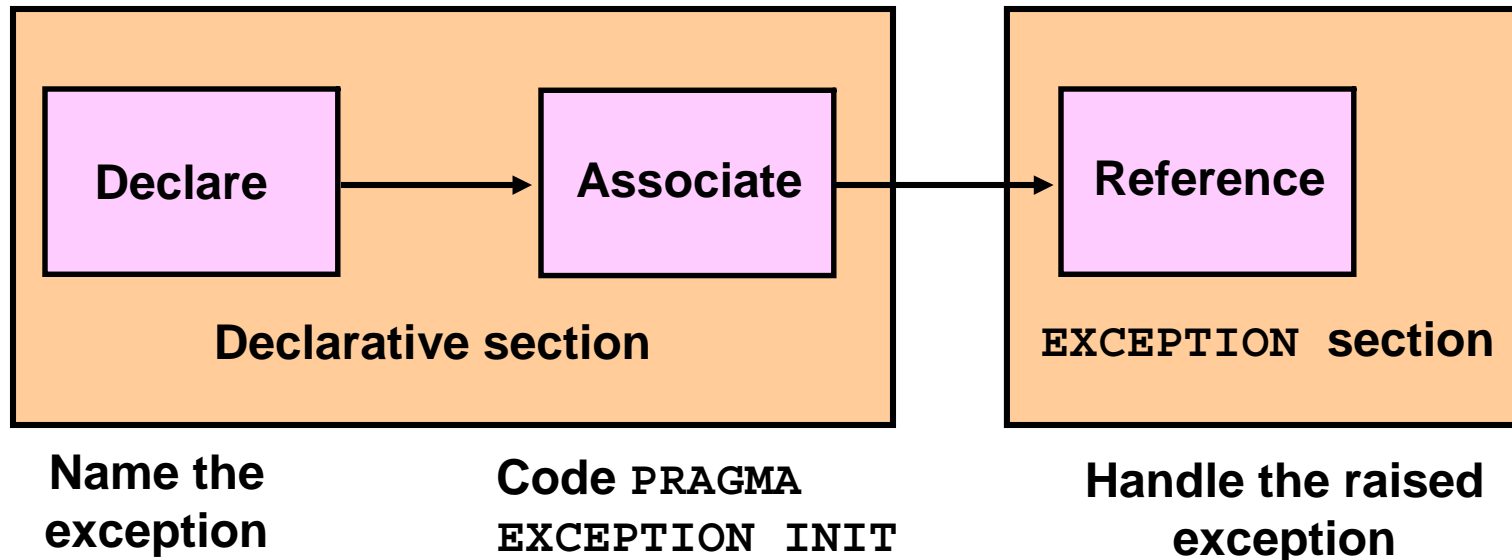
# Guidelines for Trapping Exceptions

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

# Trapping Predefined Oracle Server Errors

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

# Trapping Non-Predefined Oracle Server Errors





# Non-Predefined Error

Trap Oracle server error number -01400, cannot insert NULL.

```
SET SERVEROUTPUT ON
DECLARE
  insert_excep EXCEPTION;
  PRAGMA EXCEPTION_INIT
    (insert_excep, -01400);
BEGIN
  INSERT INTO departments
    (department_id, department_name) VALUES (280, NULL);
EXCEPTION
  WHEN insert_excep THEN
    DBMS_OUTPUT.PUT_LINE('INSERT OPERATION FAILED');
    DBMS_OUTPUT.PUT_LINE(SQLERRM);
END;
/
```

1

2

3

# Functions for Trapping Exceptions

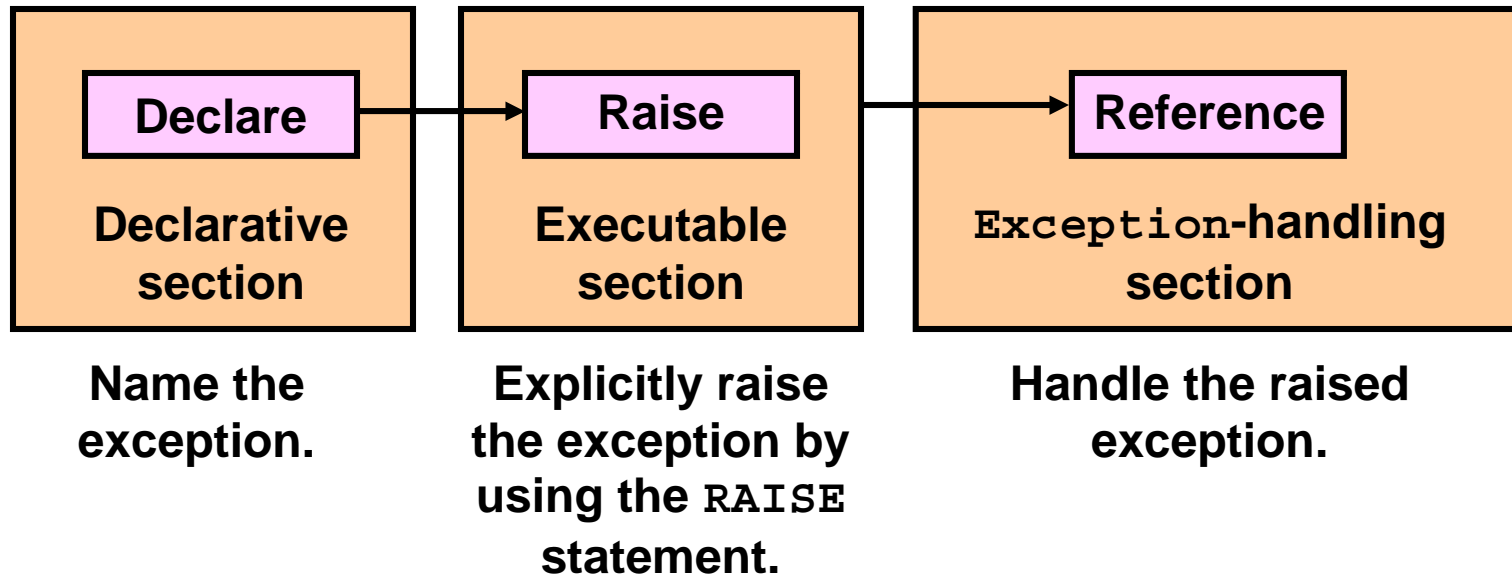
- **SQLCODE:** Returns the numeric value for the error code
- **SQLERRM:** Returns the message associated with the error number

# Functions for Trapping Exceptions

## Example:

```
DECLARE
    error_code      NUMBER;
    error_message    VARCHAR2(255);
BEGIN
    ...
EXCEPTION
    ...
    WHEN OTHERS THEN
        ROLLBACK;
        error_code := SQLCODE ;
        error_message := SQLERRM ;
        INSERT INTO errors (e_user, e_date, error_code,
            error_message) VALUES (USER,SYSDATE,error_code,
            error_message);
END;
/
```

# Trapping User-Defined Exceptions



# Trapping User-Defined Exceptions

```
...  
ACCEPT deptno PROMPT 'Please enter the department number:'  
ACCEPT name   PROMPT 'Please enter the department name:'  
DECLARE  
    invalid_department EXCEPTION; ← ①  
    name VARCHAR2(20) := '&name';  
    deptno NUMBER := &deptno;  
BEGIN  
    UPDATE departments  
    SET     department_name = name  
    WHERE   department_id = deptno;  
    IF SQL%NOTFOUND THEN  
        RAISE invalid_department; ← ②  
    END IF;  
    COMMIT;  
EXCEPTION  
    WHEN invalid_department THEN ← ③  
        DBMS_OUTPUT.PUT_LINE('No such department id.');
```

END;  
/

# Calling Environments

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

# Propagating Exceptions in a Subblock

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

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

# The RAISE\_APPLICATION\_ERROR Procedure

## Syntax:

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

- You can use this procedure to issue user-defined error messages from stored subprograms.
- You can report errors to your application and avoid returning unhandled exceptions.



# **The 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.**

# RAISE\_APPLICATION\_ERROR

## Executable section:

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

## Exception section:

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

END;

# Summary

**In this lesson, you should have learned how to:**

- **Define PL/SQL exceptions**
- **Add an `EXCEPTION` section to the PL/SQL block to deal with exceptions at run time**
- **Handle different types of exceptions:**
  - **Predefined exceptions**
  - **Non-predefined exceptions**
  - **User-defined exceptions**
- **Propagate exceptions in nested blocks and call applications**

# Practice 8: Overview

**This practice covers the following topics:**

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



# Creating Stored Procedures and Functions

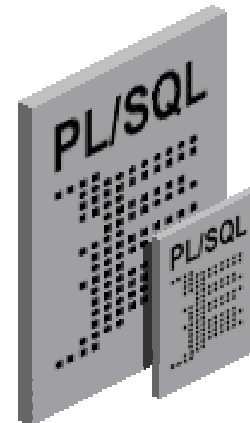
# Objectives

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

- **Differentiate between anonymous blocks and subprograms**
- **Create a simple procedure and invoke it from an anonymous block**
- **Create a simple function**
- **Create a simple function that accepts a parameter**
- **Differentiate between procedures and functions**

# Procedures and Functions

- Are named PL/SQL blocks
- Are called PL/SQL subprograms
- Have block structures similar to anonymous blocks:
  - Optional declarative section (without DECLARE keyword)
  - Mandatory executable section
  - Optional section to handle exceptions



# Differences Between Anonymous Blocks and Subprograms

<b>Anonymous Blocks</b>	<b>Subprograms</b>
<b>Unnamed PL/SQL blocks</b>	<b>Named PL/SQL blocks</b>
<b>Compiled every time</b>	<b>Compiled only once</b>
<b>Not stored in the database</b>	<b>Stored in the database</b>
<b>Cannot be invoked by other applications</b>	<b>They are named and therefore can be invoked by other applications</b>
<b>Do not return values</b>	<b>Subprograms called functions must return values</b>
<b>Cannot take parameters</b>	<b>Can take parameters</b>



# Procedure: Syntax

```
CREATE [OR REPLACE] PROCEDURE procedure_name
  [(argument1 [mode1] datatype1,
    argument2 [mode2] datatype2,
    . . .)]
IS|AS
procedure_body;
```

# Procedure: Example

```
...  
CREATE TABLE dept AS SELECT * FROM departments;  
CREATE PROCEDURE add_dept IS  
  dept_id dept.department_id%TYPE;  
  dept_name dept.department_name%TYPE;  
BEGIN  
  dept_id:=280;  
  dept_name:='ST-Curriculum';  
  INSERT INTO dept(department_id,department_name)  
  VALUES (dept_id,dept_name);  
  DBMS_OUTPUT.PUT_LINE(' Inserted ' ||  
    SQL%ROWCOUNT || ' row ');  
END;  
/
```

# Invoking the Procedure

```
BEGIN
  add_dept;
END;
/
SELECT department_id, department_name FROM
dept WHERE department_id=280;
```

Inserted 1 row  
PL/SQL procedure successfully completed.

DEPARTMENT_ID	DEPARTMENT_NAME
280	ST-Curriculum

# Function: Syntax

```
CREATE [OR REPLACE] FUNCTION function_name
  [(argument1 [mode1] datatype1,
    argument2 [mode2] datatype2,
    . . .)]
RETURN datatype
IS|AS
function_body;
```

# Function: Example

```
CREATE FUNCTION check_sal RETURN Boolean IS
  dept_id employees.department_id%TYPE;
  empno    employees.employee_id%TYPE;
  sal      employees.salary%TYPE;
  avg_sal  employees.salary%TYPE;
BEGIN
  empno:=205;
  SELECT salary,department_id INTO sal,dept_id
  FROM employees WHERE employee_id= empno;
  SELECT avg(salary) INTO avg_sal FROM employees
  WHERE department_id=dept_id;
  IF sal > avg_sal THEN
    RETURN TRUE;
  ELSE
    RETURN FALSE;
  END IF;
EXCEPTION
  WHEN NO_DATA_FOUND THEN
    RETURN NULL;
END;
/
```

# Invoking the Function

```
SET SERVEROUTPUT ON
BEGIN
  IF (check_sal IS NULL) THEN
    DBMS_OUTPUT.PUT_LINE('The function returned
      NULL due to exception');
  ELSIF (check_sal) THEN
    DBMS_OUTPUT.PUT_LINE('Salary > average');
  ELSE
    DBMS_OUTPUT.PUT_LINE('Salary < average');
  END IF;
END;
/
```

Salary > average  
PL/SQL procedure successfully completed.

# Passing Parameter to the Function

```
DROP FUNCTION check_sal;
/
CREATE FUNCTION check_sal(empno employees.employee_id%TYPE)
RETURN Boolean IS
    dept_id employees.department_id%TYPE;
    sal      employees.salary%TYPE;
    avg_sal  employees.salary%TYPE;
BEGIN
    SELECT salary,department_id INTO sal,dept_id
    FROM employees WHERE employee_id=empno;
    SELECT avg(salary) INTO avg_sal FROM employees
    WHERE department_id=dept_id;
    IF sal > avg_sal THEN
        RETURN TRUE;
    ELSE
        RETURN FALSE;
    END IF;
EXCEPTION ...
...
```

# Invoking the Function with a Parameter

```
BEGIN
DBMS_OUTPUT.PUT_LINE('Checking for employee with id 205');
  IF (check_sal(205) IS NULL) THEN
    DBMS_OUTPUT.PUT_LINE('The function returned
      NULL due to exception');
  ELSIF (check_sal(205)) THEN
    DBMS_OUTPUT.PUT_LINE('Salary > average');
  ELSE
    DBMS_OUTPUT.PUT_LINE('Salary < average');
  END IF;
DBMS_OUTPUT.PUT_LINE('Checking for employee with id 70');
  IF (check_sal(70) IS NULL) THEN
    DBMS_OUTPUT.PUT_LINE('The function returned
      NULL due to exception');
  ELSIF (check_sal(70)) THEN
    ...
  END IF;
END;
/
```



# Summary

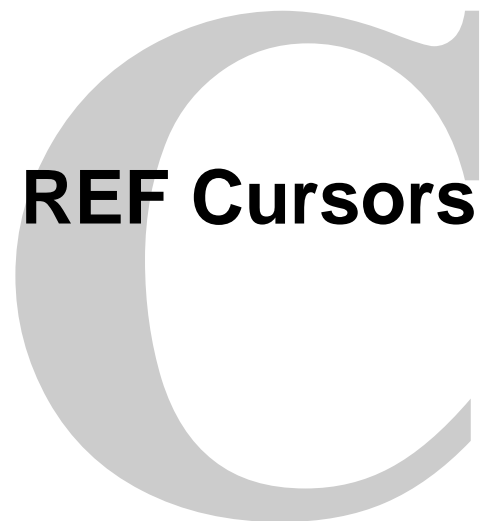
**In this lesson, you should have learned how to:**

- **Create a simple procedure**
- **Invoke the procedure from an anonymous block**
- **Create a simple function**
- **Create a simple function that accepts parameters**
- **Invoke the function from an anonymous block**

# Practice 9: Overview

**This practice covers the following topics:**

- **Converting an existing anonymous block to a procedure**
- **Modifying the procedure to accept a parameter**
- **Writing an anonymous block to invoke the procedure**



# Cursor Variables

- **Cursor variables are like C or Pascal pointers, which hold the memory location (address) of an item instead of the item itself.**
- **In PL/SQL, a pointer is declared as `REF X`, where `REF` is short for `REFERENCE` and `X` stands for a class of objects.**
- **A cursor variable has the data type `REF CURSOR`.**
- **A cursor is static, but a cursor variable is dynamic.**
- **Cursor variables give you more flexibility.**

# Why Use Cursor Variables?

- You can use cursor variables to pass query result sets between PL/SQL stored subprograms and various clients.
- PL/SQL can share a pointer to the query work area in which the result set is stored.
- You can pass the value of a cursor variable freely from one scope to another.
- You can reduce network traffic by having a PL/SQL block open (or close) several host cursor variables in a single round trip.

# Defining REF CURSOR Types

- **Define a REF CURSOR type.**

```
Define a REF CURSOR type  
TYPE ref_type_name IS REF CURSOR [RETURN  
return_type];
```

- **Declare a cursor variable of that type.**

```
ref_cv ref_type_name;
```

- **Example:**

```
DECLARE  
TYPE DeptCurTyp IS REF CURSOR RETURN  
departments%ROWTYPE;  
dept_cv DeptCurTyp;
```

# Using the OPEN-FOR, FETCH, and CLOSE Statements

- The **OPEN-FOR** statement associates a cursor variable with a multirow query, executes the query, identifies the result set, and positions the cursor to point to the first row of the result set.
- The **FETCH** statement returns a row from the result set of a multirow query, assigns the values of select-list items to corresponding variables or fields in the **INTO** clause, increments the count kept by **%ROWCOUNT**, and advances the cursor to the next row.
- The **CLOSE** statement disables a cursor variable.

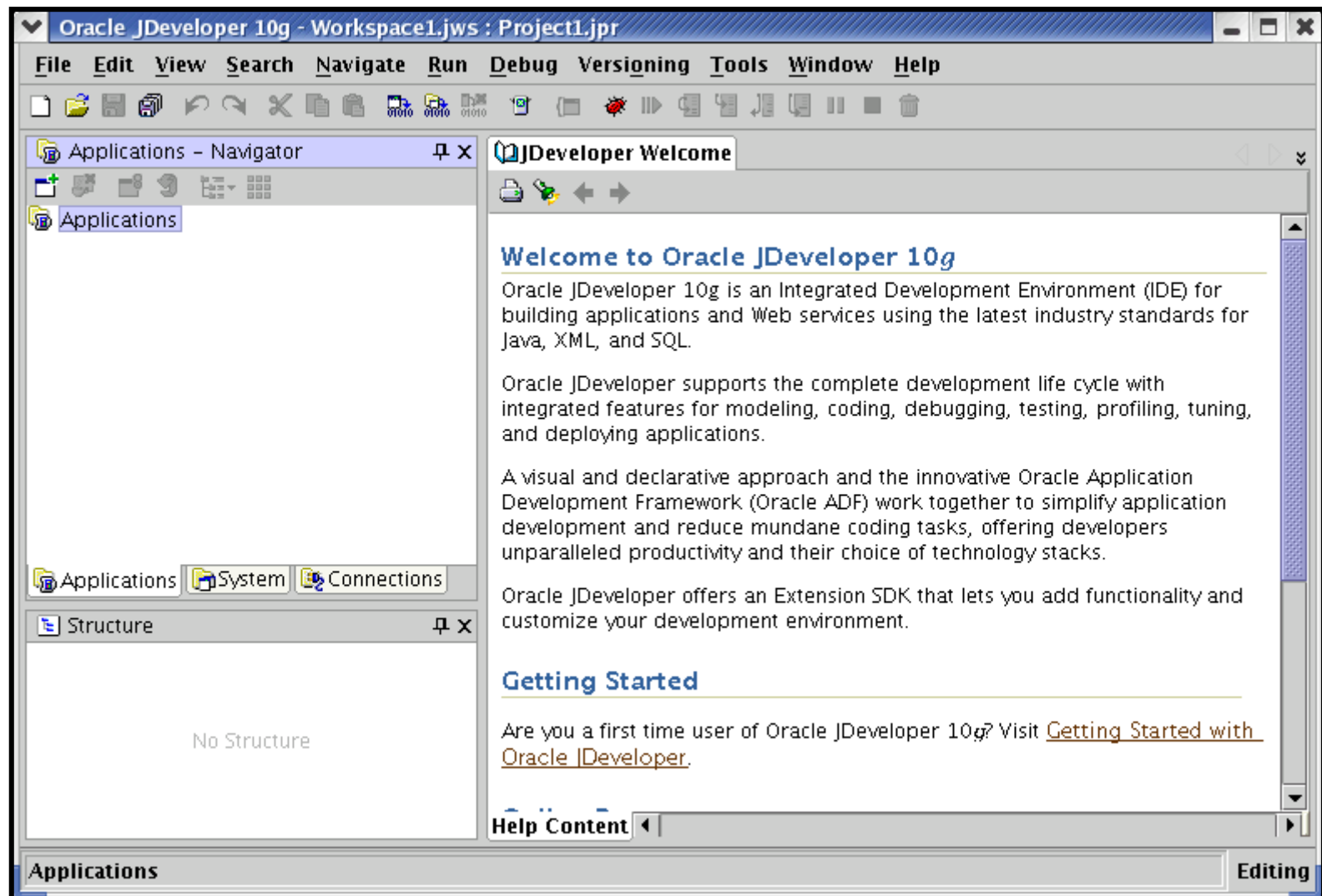
# An Example of Fetching

```
DECLARE
    TYPE EmpCurTyp IS REF CURSOR;
    emp_cv    EmpCurTyp;
    emp_rec   employees%ROWTYPE;
    sql_stmt  VARCHAR2(200);
    my_job    VARCHAR2(10) := 'ST_CLERK';
BEGIN
    sql_stmt := 'SELECT * FROM employees
                WHERE job_id = :j';
    OPEN emp_cv FOR sql_stmt USING my_job;
    LOOP
        FETCH emp_cv INTO emp_rec;
        EXIT WHEN emp_cv%NOTFOUND;
        -- process record
    END LOOP;
    CLOSE emp_cv;
END;
/
```

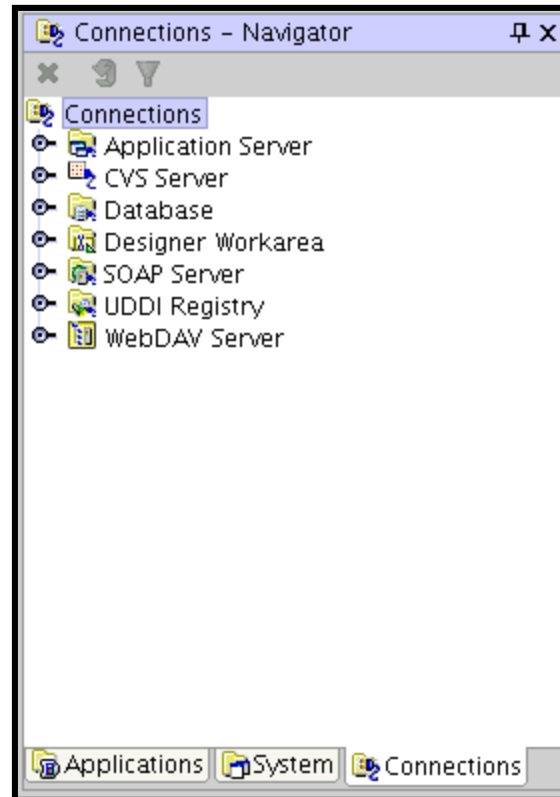




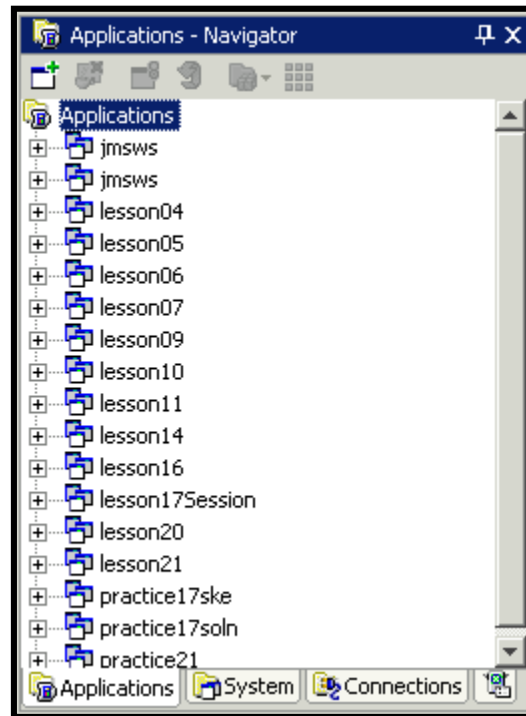
# JDeveloper



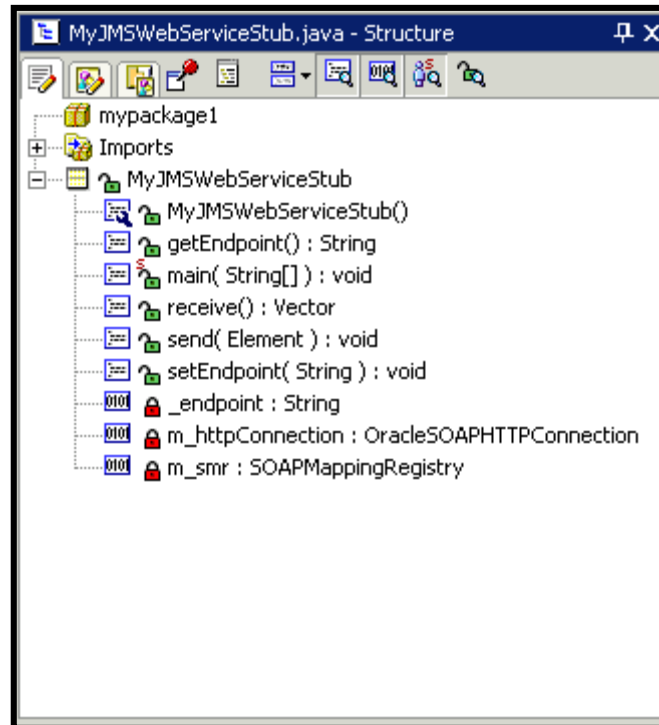
# Connection Navigator



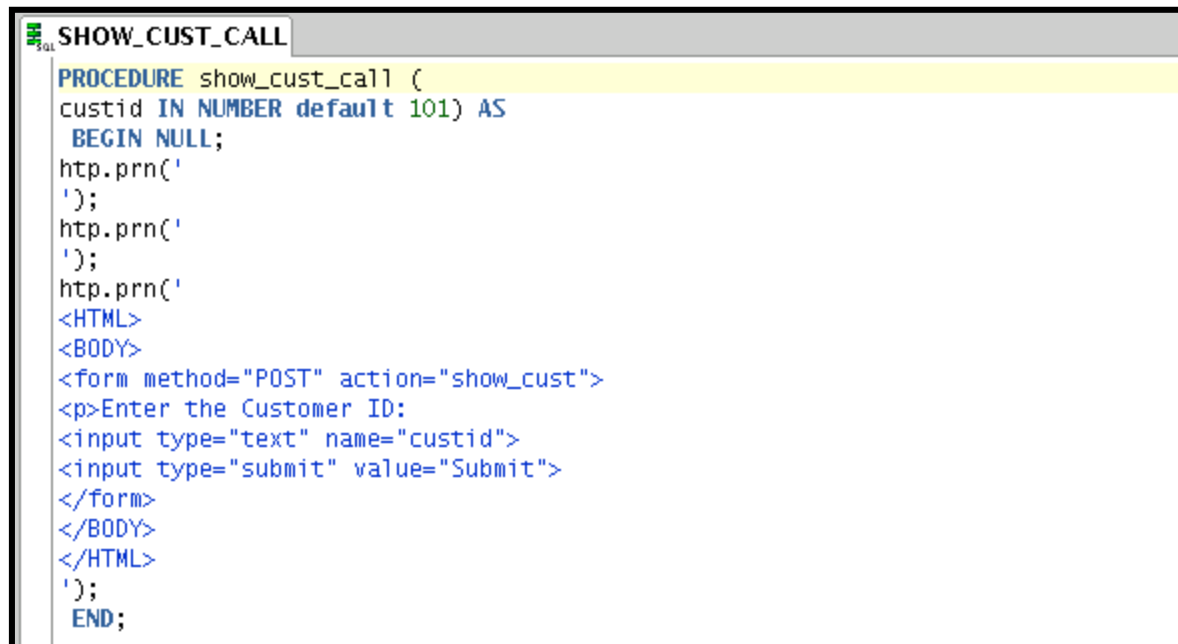
# Application Navigator



# Structure Window



# Editor Window

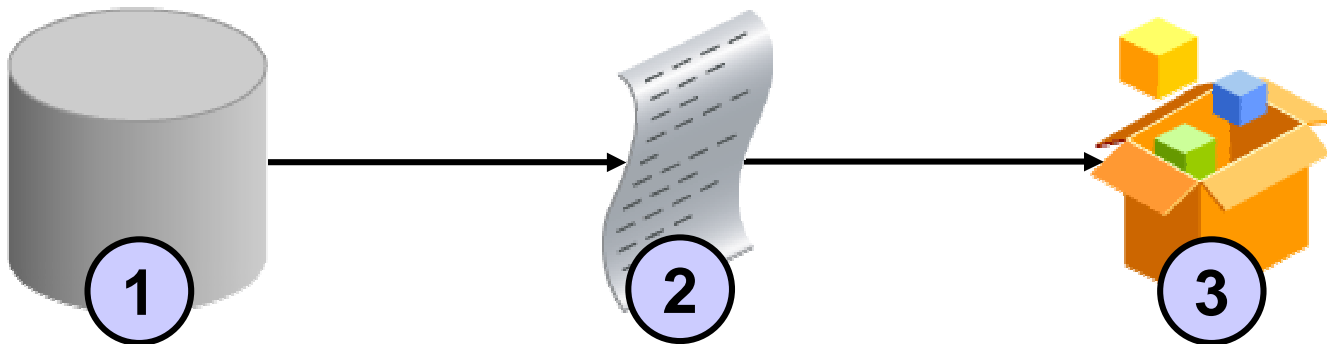
A screenshot of an Oracle SQL Developer editor window. The window has a title bar that says "SHOW\_CUST\_CALL". The main area contains a PL/SQL procedure named "show\_cust\_call". The procedure takes a parameter "custid" of type "NUMBER" with a default value of "101". The procedure body starts with "BEGIN NULL;" followed by three calls to "http.prn()" with single quote arguments. The third call is followed by an HTML form. The form has a method of "POST" and an action of "show\_cust". It contains a prompt "Enter the Customer ID:", a text input field with name "custid", and a submit button with value "Submit". The procedure ends with "END;".

```
PROCEDURE show_cust_call (  
  custid IN NUMBER default 101) AS  
  BEGIN NULL;  
  http.prn(''  
  ');  
  http.prn(''  
  ');  
  http.prn(''  
  <HTML>  
  <BODY>  
  <form method="POST" action="show_cust">  
  <p>Enter the Customer ID:  
  <input type="text" name="custid">  
  <input type="submit" value="Submit">  
  </form>  
  </BODY>  
  </HTML>  
  ');  
  END;
```

# Deploying Java Stored Procedures

**Before deploying Java stored procedures, perform the following steps:**

- 1. Create a database connection.**
- 2. Create a deployment profile.**
- 3. Deploy the objects.**



# Publishing Java to PL/SQL

```
FormatCreditCardNo.java  CCFORMAT

public class FormatCreditCardNo
{
    public static final void formatCard(String[] cardno)
    {
        int count=0, space=0;
        String oldcc=cardno[0];
        // System.out.println("Printing the card no initially "+oldcc);
        String[] newcc= {" "};
        while (count<16)
        {
            newcc[0]+= oldcc.charAt(count);
            space++;
            if (space ==4)
            { newcc[0]+= " "; space=0; }
            count++;
        }
        cardno[0]=newcc [0];
    }
}
```

```
FormatCreditCardNo.java  CCFORMAT

PROCEDURE ccformat (x IN OUT varchar2)
AS LANGUAGE JAVA
NAME 'FormatCreditCardNo.formatCard(java.lang.String[])';
```



# Creating Program Units

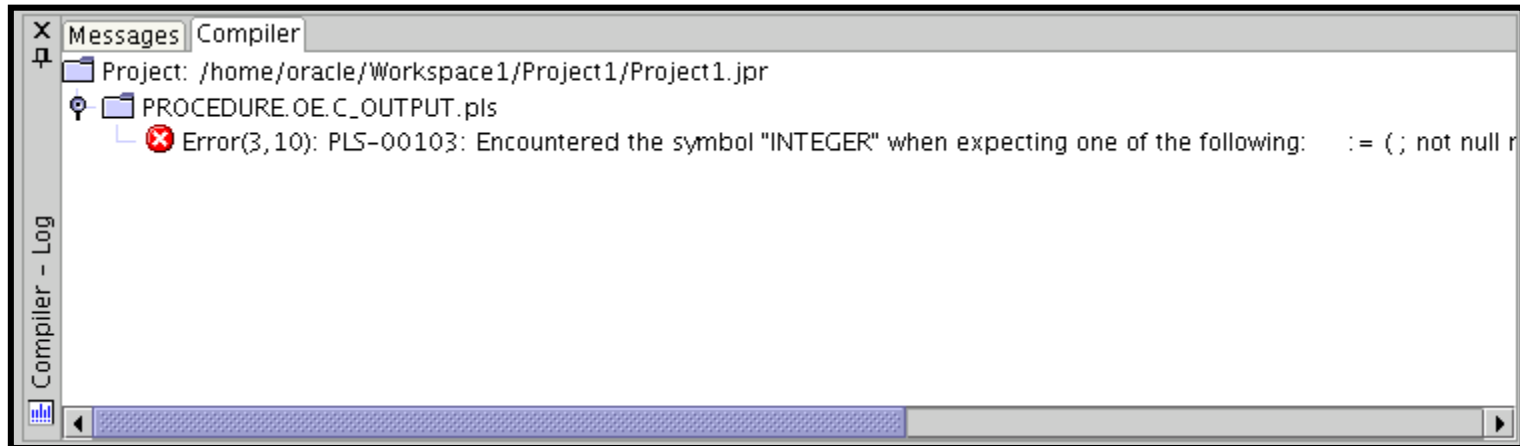


A screenshot of a SQL editor window. The title bar shows a small icon and the text "TEST\_JDEV". The editor area contains the following PL/SQL code:

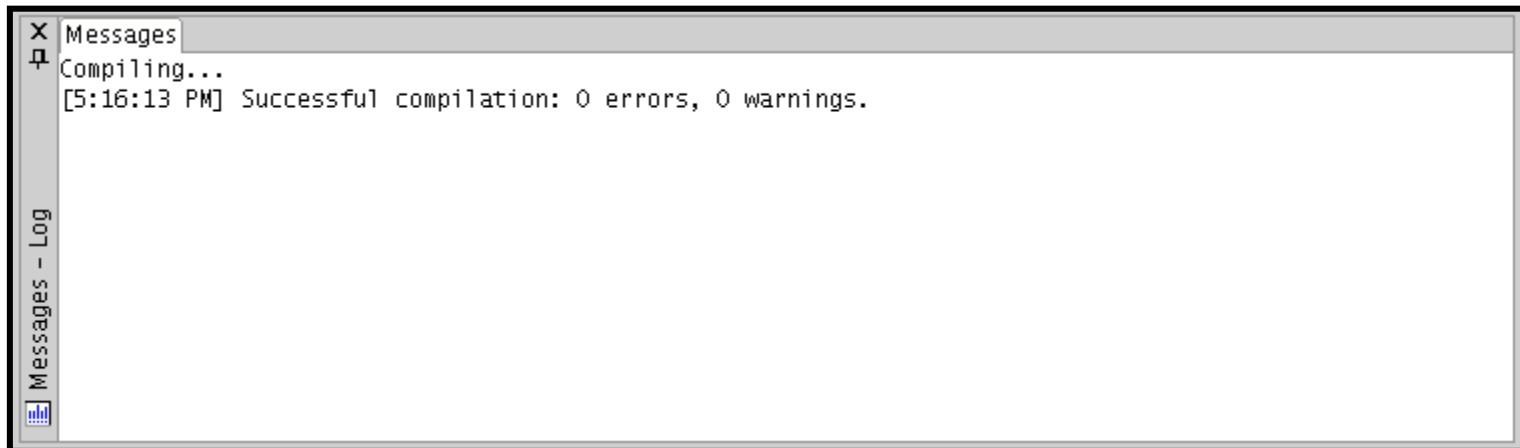
```
FUNCTION "TEST_JDEV" RETURN VARCHAR2
AS
BEGIN
    RETURN(' ');
END;
```

**Skeleton of the function**

# Compiling

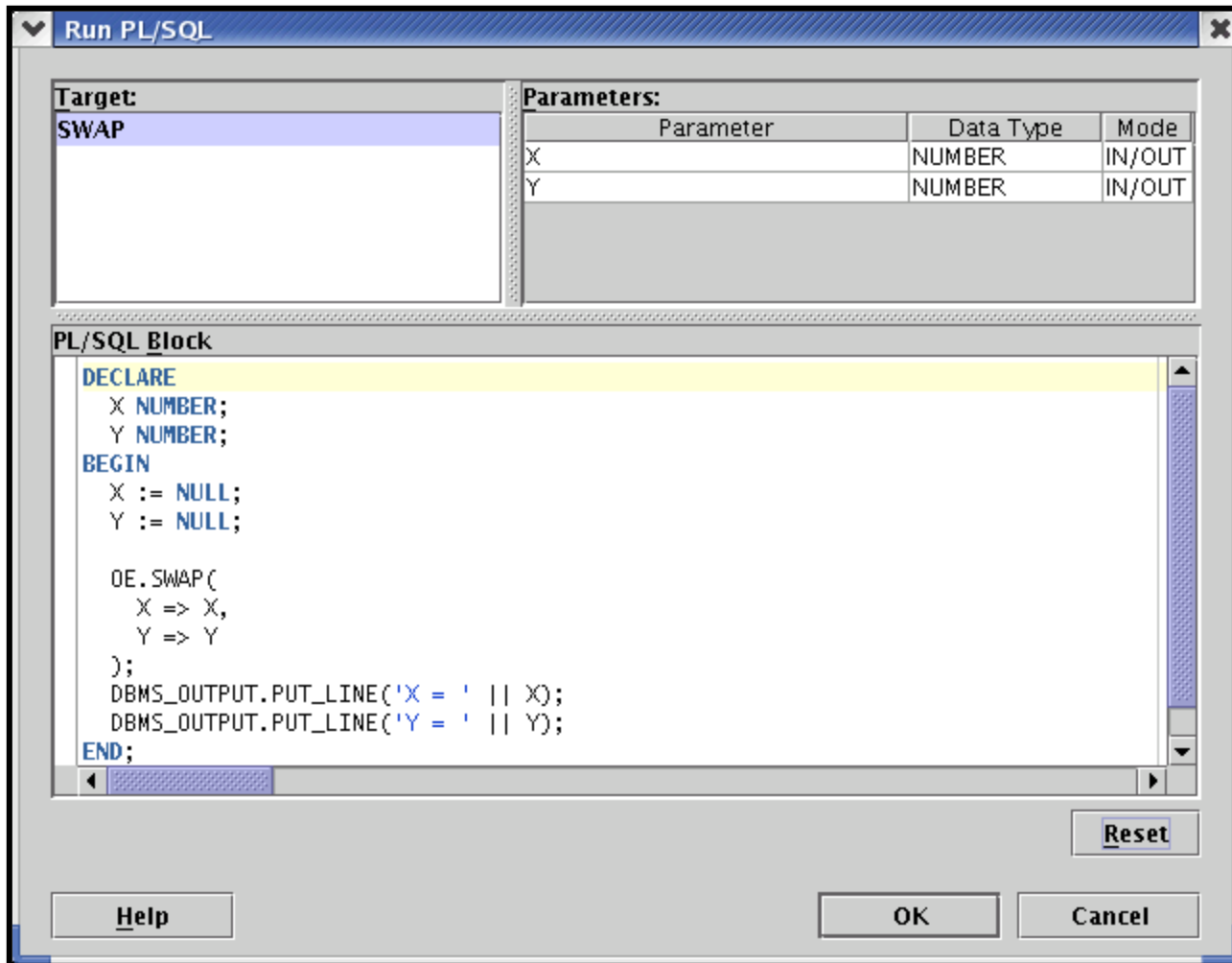


## Compilation with errors

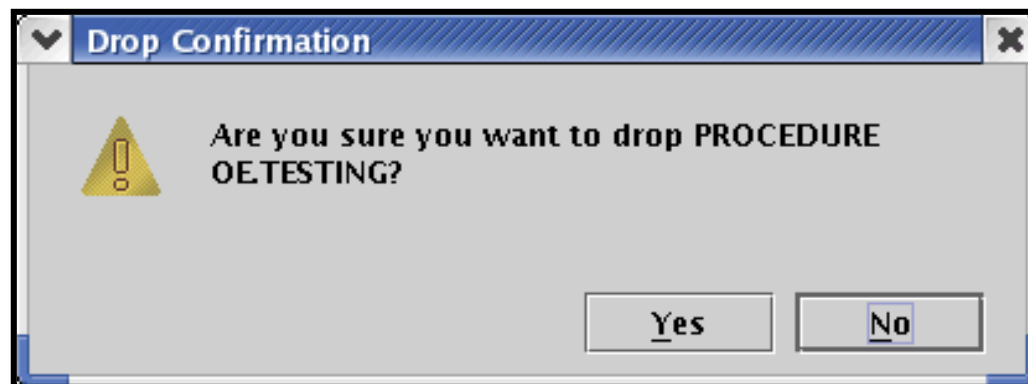


## Compilation without errors

# Running a Program Unit



# Dropping a Program Unit



# Debugging PL/SQL Programs

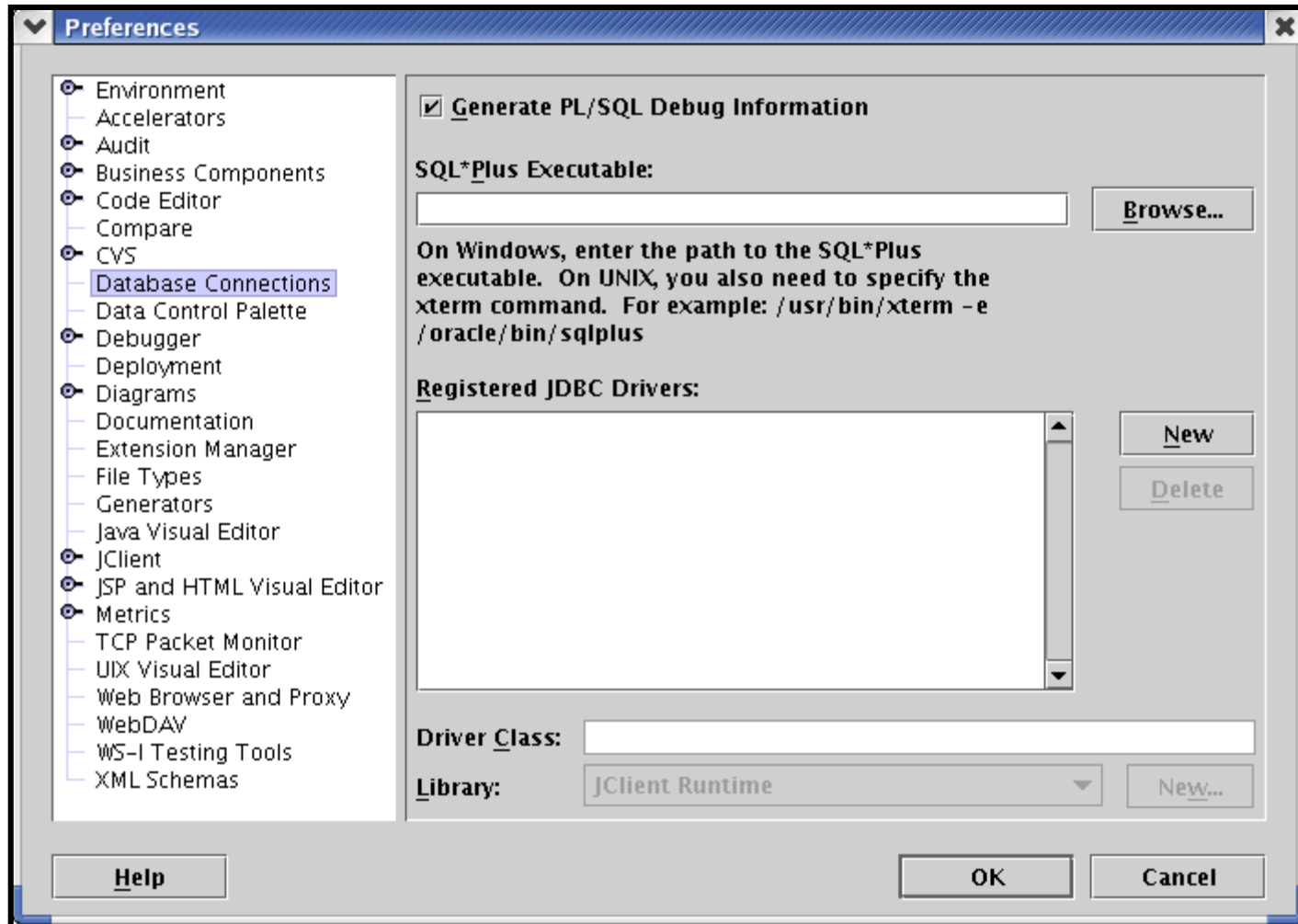
**JDeveloper support two types of debugging:**

- **Local**
- **Remote**

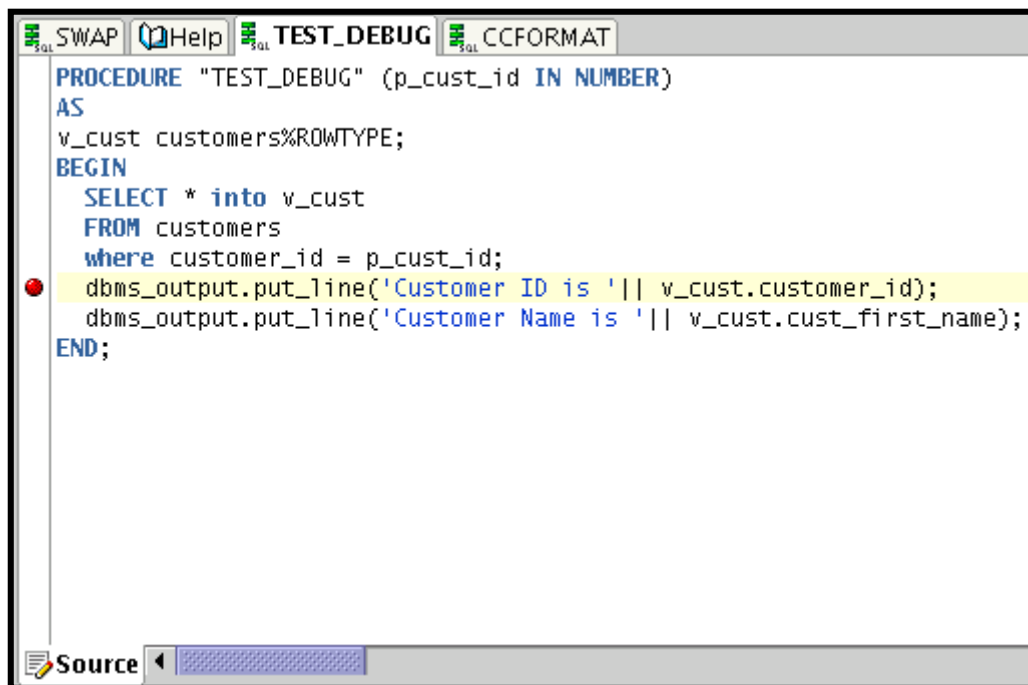
**You need the following privileges to perform PL/SQL debugging:**

- **DEBUG ANY PROCEDURE**
- **DEBUG CONNECT SESSION**

# Debugging PL/SQL Programs



# Setting Breakpoints



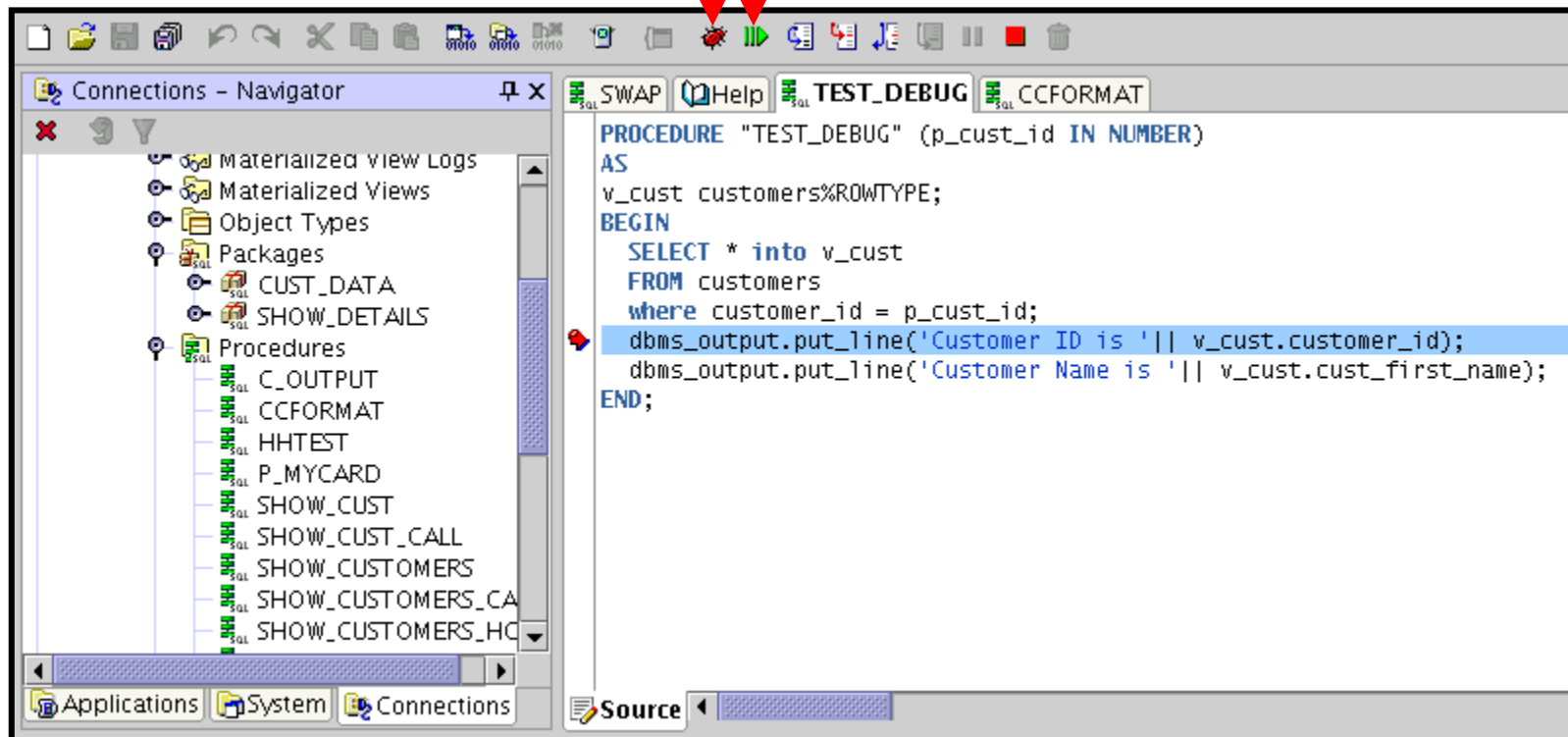
The screenshot shows a window titled "TEST\_DEBUG" with tabs for "SWAP", "Help", "TEST\_DEBUG", and "CCFORMAT". The code editor contains the following PL/SQL procedure:

```
PROCEDURE "TEST_DEBUG" (p_cust_id IN NUMBER)
AS
v_cust customers%ROWTYPE;
BEGIN
  SELECT * into v_cust
  FROM customers
  where customer_id = p_cust_id;
  dbms_output.put_line('Customer ID is ' || v_cust.customer_id);
  dbms_output.put_line('Customer Name is ' || v_cust.cust_first_name);
END;
```

A red circular breakpoint icon is positioned to the left of the line containing the first `dbms_output.put_line` statement. The line itself is highlighted in yellow. At the bottom of the window, there is a "Source" button and a scroll bar.

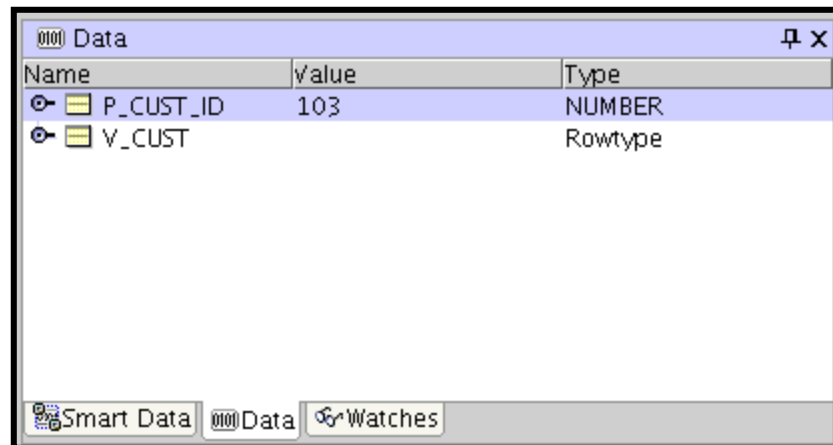
# Stepping Through Code

Debug    Resume



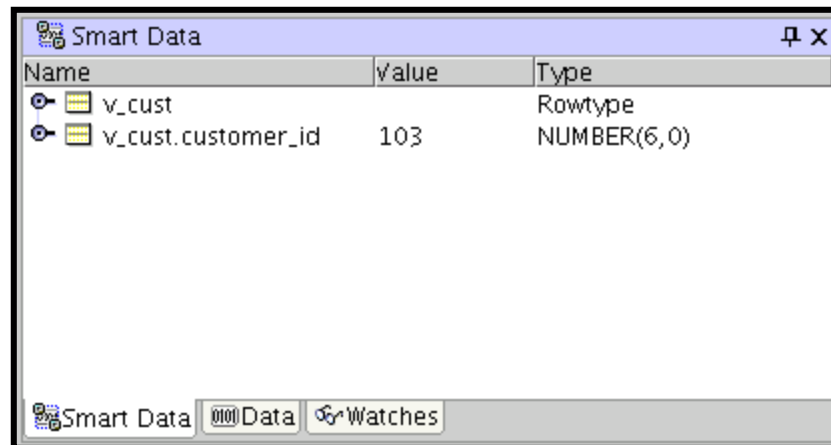


# Examining and Modifying Variables



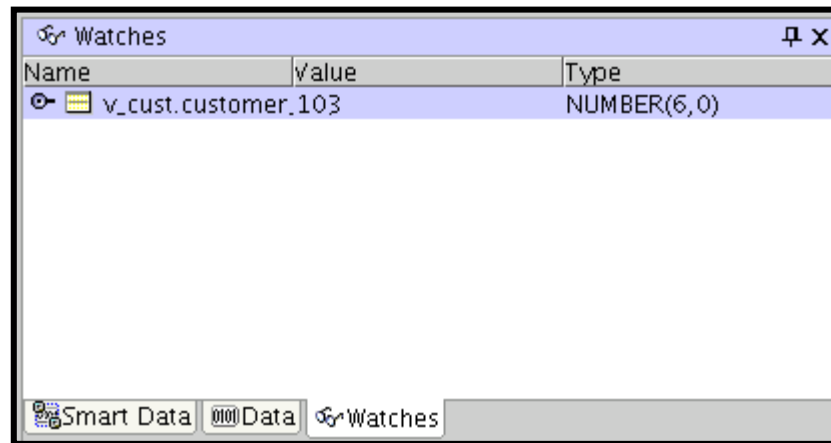
**Data window**

# Examining and Modifying Variables



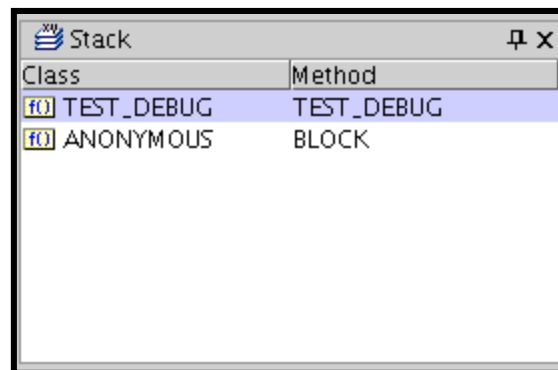
**Smart Data window**

# Examining and Modifying Variables



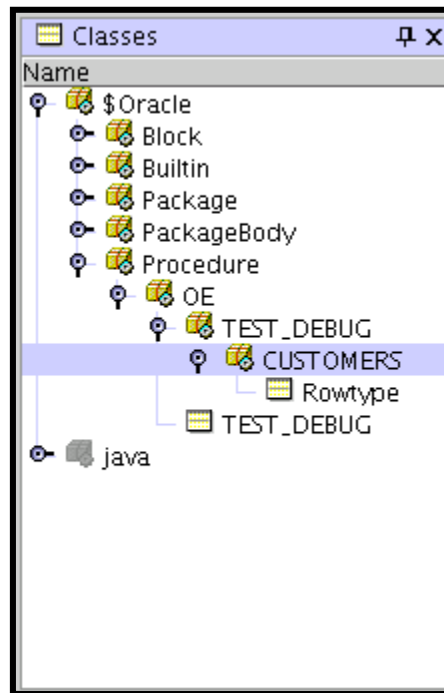
**Watches window**

# Examining and Modifying Variables



**Stack window**

# Examining and Modifying Variables



**Classes window**