# 9

# Creating Stored Procedures and Functions

ORACLE

# 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**

ORACLE

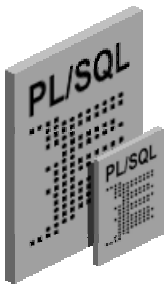


### Lesson Aim

You have learned about anonymous blocks. This lesson introduces you to named blocks, which are also called *subprograms*. Procedures and functions are PL/SQL subprograms. In the lesson, you learn to differentiate between anonymous blocks and subprograms.

# 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**




ORACLE



## Procedures and Functions

Until this point, anonymous blocks are the only examples of PL/SQL code covered in this course. As the name indicates, *anonymous* blocks are unnamed executable PL/SQL blocks. Because they are unnamed, they can be neither reused nor stored for later use.

Procedures and functions are named PL/SQL blocks. They are also known as subprograms. These subprograms are compiled and stored in the database. The block structure of the subprograms is similar to the structure of anonymous blocks. Subprograms can be declared not only at the schema level but also within any other PL/SQL block. A subprogram contains the following sections:

**Declarative section:** Subprograms can have an optional declarative section. However, unlike anonymous blocks, the declarative section of a subprogram does not start with the keyword `DECLARE`. The optional declarative section follows the keyword `IS` or `AS` in the subprogram declaration.

**Executable section:** This is the mandatory section of the subprogram, which contains the implementation of the business logic. Looking at the code in this section, you can easily determine the business functionality of the subprogram. This section begins and ends with the keywords `BEGIN` and `END`, respectively.

**Exception section:** This is an optional section that is included to handle exceptions.

# Differences Between Anonymous Blocks and Subprograms

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

ORACLE



### Differences Between Anonymous Blocks and Subprograms

The table in the slide not only shows the differences between anonymous blocks and subprograms, but also highlights the general benefits of subprograms.

Anonymous blocks are not persistent database objects. They are compiled and executed only once. They are not stored in the database for reuse. If you want to reuse, you must rerun the script that creates the anonymous block, which causes recompilation and execution. Procedures and functions are compiled and stored in the database in a compiled form. They are recompiled only when they are modified. Because they are stored in the database, any application can make use of these subprograms based on appropriate permissions. The calling application can pass parameters to the procedures if the procedure is designed to accept parameters. Similarly, a calling application can retrieve a value if it invokes a function or a procedure.

# Procedure: Syntax

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







### Procedure: Syntax

The slide shows the syntax for creating procedures. In the syntax:

| | |
|---|---|
| *procedure_name* | Is the name of the procedure to be created |
| *argument* | Is the name given to the procedure parameter. Every argument is associated with a mode and data type. You can have any number of arguments separated by commas. |
| *mode* | Mode of argument:<br>`IN` (default)<br>`OUT`<br>`IN OUT` |
| *datatype* | Is the data type of the associated parameter. The data type of parameters cannot have explicit size; instead, use `%TYPE`. |
| *Procedure_body* | Is the PL/SQL block that makes up the code |

The argument list is optional in a procedure declaration. You learn about procedures in detail in the course titled *Oracle Database 10g: Develop PL/SQL Program Units*.

# 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;
/
```

ORACLE





### Procedure: Example

Examine the code in the slide. The `add_dept` procedure inserts a new department with department ID `280` and department name `ST-Curriculum`. The procedure declares two variables, `dept_id` and `dept_name`, in the declarative section. The declarative section of a procedure starts immediately after the procedure declaration and does not begin with the keyword `DECLARE`. The procedure uses the implicit cursor attribute or the `SQL%ROWCOUNT` SQL attribute to verify whether the row was successfully inserted. `SQL%ROWCOUNT` should return `1` in this case.

**Note:** When you create any object (such as a table, procedure, function, and so on), the entries are made to the `user_objects` table. When the code in the slide is executed successfully, you can check the `user_objects` table by issuing the following command:

```
SELECT object_name,object_type FROM user_objects;
```

| | |
|---|---|
| ADD_DEPT | PROCEDURE |
| DEPT | TABLE |

## Procedure: Example (continued)

The source of the procedure is stored in the `user_source` table. You can check the source for the procedure by issuing the following command:

```
SELECT * FROM  user_source WHERE name='ADD_DEPT';
```

| NAME | TYPE | LINE | TEXT |
|---|---|---|---|
| ADD_DEPT | PROCEDURE | 1 | PROCEDURE add_dept IS |
| ADD_DEPT | PROCEDURE | 2 | dept_id dept.department_id%TYPE; |
| ADD_DEPT | PROCEDURE | 3 | dept_name dept.department_name%TYPE; |
| ADD_DEPT | PROCEDURE | 4 | BEGIN |
| ADD_DEPT | PROCEDURE | 5 | dept_id:=280; |
| ADD_DEPT | PROCEDURE | 6 | dept_name:='ST-Curriculum'; |
| ADD_DEPT | PROCEDURE | 7 | INSERT INTO dept(department_id,department_name) |
| ADD_DEPT | PROCEDURE | 8 | VALUES(dept_id,dept_name); |
| ADD_DEPT | PROCEDURE | 9 | DBMS_OUTPUT.PUT_LINE(' Inserted '\|\| SQL%ROWCOUNT \|\|' row '); |
| ADD_DEPT | PROCEDURE | 10 | END; |
| ADD_DEPT | PROCEDURE | 11 | |

# 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 |

ORACLE



### Invoking the Procedure

The slide shows how to invoke a procedure from an anonymous block. You have to include the call to the procedure in the executable section of the anonymous block. Similarly, you can invoke the procedure from any application, such as a forms application, Java application and so on. The select statement in the code checks to see if the row was successfully inserted.

You can also invoke a procedure with the SQL statement `CALL <procedure_name>`.

# Function: Syntax

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

ORACLE





### Function: Syntax

The slide shows the syntax for creating a function. In the syntax:

| | |
|---|---|
| *function_name* | Is the name of the function to be created |
| *argument* | Is the name given to the function parameter (Every argument is associated with a mode and data type. You can have any number or arguments separated by a comma. You pass the argument when you invoke the function.) |
| *mode* | Is the type of parameter (Only `IN` parameters should be declared.) |
| *datatype* | Is the data type of the associated parameter |
| `RETURN` *datatype* | Is the data type of the value returned by the function |
| *function_body* | Is the PL/SQL block that makes up the function code |

The argument list is optional in function declaration. The difference between a procedure and a function is that a function must return a value to the calling program. Therefore, the syntax contains *return_type*, which specifies the data type of the value that the function returns. A procedure may return a value via an `OUT` or `IN OUT` parameter.

# 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;
/
```

ORACLE



## Function: Example

The `check_sal` function is written to determine whether the salary of a particular employee is greater than or less than the average salary of all employees working in the same department. The function returns `TRUE` if the salary of the employee is greater than the average salary of employees in the department; if not, it returns `FALSE`. The function returns `NULL` if a `NO_DATA_FOUND` exception is thrown.

Note that the function checks for the employee with the employee ID 205. The function is hard-coded to check for this employee ID only. If you want to check for any other employees, you must modify the function itself. You can solve this problem by declaring the function so that it accepts an argument. You can then pass the employee ID as parameter.

# 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.
```

ORACLE



## Invoking the Function

You include the call to the function in the executable section of the anonymous block. The function is invoked as a part of a statement. Remember that the `check_sal` function returns `Boolean` or `NULL`. Thus the call to the function is included as the conditional expression for the `IF` block.

**Note:** You can use the `DESCRIBE` command to check the arguments and return type of the function, as in the following example:

```
DESCRIBE check_sal;
```

## Passing a 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 ...
...
```

ORACLE



### Passing a Parameter to the Function

Remember that the function was hard-coded to check the salary of the employee with the employee ID 205. The code shown in the slide removes that constraint because it is re-written to accept the employee number as a parameter. You can now pass different employee numbers and check for the employee's salary.

You learn more about functions in the course titled *Oracle Database 10g: Develop PL/SQL Program Units*.

## 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;
/
```

PUT THE SCREENSHOT OF OUTPUT HERE ORACLE



### Invoking the Function with a Parameter

The code in the slide invokes the function twice by passing parameters. The output of the code is as follows:

```
Checking for employee with id 205
Salary > average
Checking for employee with id 70
The function returned NULL due to exception
PL/SQL procedure successfully completed.
```

# 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**

ORACLE



## Summary

You can use anonymous blocks to design any functionality in PL/SQL. However, the major constraint with anonymous blocks is that they are not stored and therefore cannot be reused.

Instead of creating anonymous blocks, you can create PL/SQL subprograms. Procedures and functions are called subprograms, which are named PL/SQL blocks. Subprograms express reusable logic by virtue of parameterization. The structure of a procedure or a function is similar to the structure of an anonymous block. These subprograms are stored in the database and are therefore reusable.

# 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**

ORACLE

## Practice 9

1. In *i*SQL*Plus, load the script `lab_02_04_soln.sql` that you created for question 4 of practice 2.
   a. Modify the script to convert the anonymous block to a procedure called `greet`.
   b. Execute the script to create the procedure.
   c. Save your script as `lab_09_01_soln.sql`.
   d. Click the Clear button to clear the workspace.
   e. Create and execute an anonymous block to invoke the procedure `greet`. Sample output is shown below.

      ```
      Hello World
      TODAY IS : 20-JAN-04
      TOMORROW IS : 21-JAN-04
      PL/SQL procedure successfully completed.
      ```

2. Load the script `lab_09_01_soln.sql`.
   a. Drop the procedure `greet` by issuing the following command:
      ```
      DROP PROCEDURE greet
      ```
   b. Modify the procedure to accept an argument of type `VARCHAR2`. Call the argument `name`.
   c. Print Hello <*name*> instead of printing Hello World.
   d. Save your script as `lab_09_02_soln.sql`.
   e. Execute the script to create the procedure.
   f. Create and execute an anonymous block to invoke the procedure `greet` with a parameter. Sample output is shown below.

      ```
      Hello Neema
      TODAY IS : 20-JAN-04
      TOMORROW IS : 21-JAN-04
      PL/SQL procedure successfully completed.
      ```