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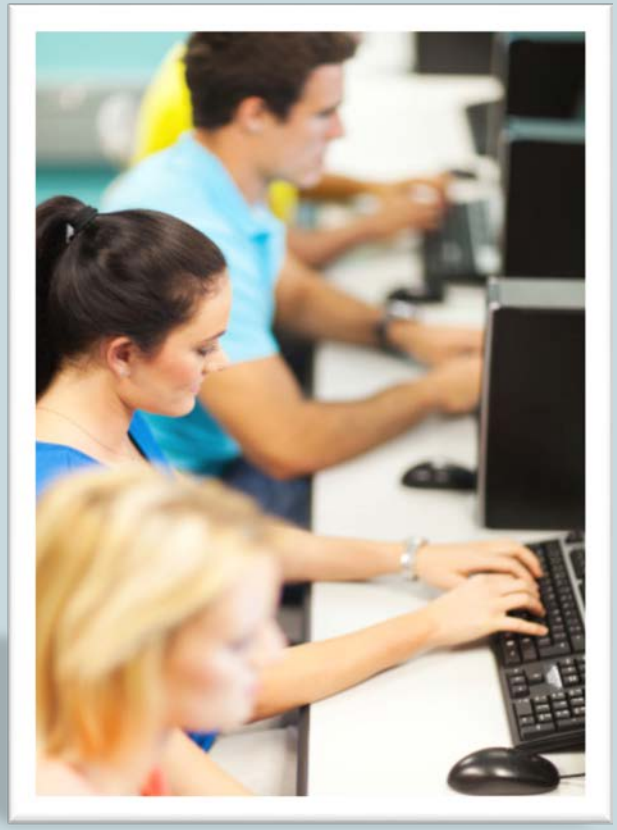
Database Programming with PL/SQL

9-1
Creating Functions



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Objectives

This lesson covers the following objectives:

- Define a stored function
- Create a PL/SQL block containing a function
- List ways in which a function can be invoked
- Create a PL/SQL block that invokes a function that has parameters
- List the development steps for creating a function
- Describe the differences between procedures and functions

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Purpose

- In this lesson, you learn how to create and invoke functions.
- A function is a named subprogram that must return exactly one value and must be called as part of a SQL or PL/SQL expression.
- Functions are an integral part of modular code.
- They are stored in the database as schema objects for repeated execution.
- Functions promote reusability and maintainability.

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What Is a Stored Function?

- A function is a named PL/SQL block (subprogram) that can accept optional IN parameters and must return exactly one value.
- Functions must be called as part of a SQL or PL/SQL expression.
- In SQL expressions, a function must obey specific rules to control side effects.
- Avoid the following within functions:
  - Any kind of DML or DDL
  - COMMIT or ROLLBACK
  - Altering global variables

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What Is a Stored Function?

- Certain return types (Boolean, for example) prevent a function from being called as part of a SELECT.
- In PL/SQL expressions, the function identifier acts like a variable whose value depends on the parameters passed to it.
- A function must have a RETURN clause in the header and at least one RETURN statement in the executable section.

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Syntax for Creating Functions

- The header for a function is like a PROCEDURE header with two differences:
  - The parameter mode should only be IN.
  - The RETURN clause is used instead of OUT mode.

```
CREATE [OR REPLACE] FUNCTION function_name
 [(parameter1 [mode1] datatype1, ...)]
RETURN datatype IS|AS
 [local_variable_declarations; …]
BEGIN
  -- actions;
  RETURN expression;
END [function_name];
```


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Syntax for Creating Functions

- A function must return a single value.
- You must provide a RETURN statement to return a value with a data type that is consistent with the function declaration type.
- You create new functions using the CREATE [OR REPLACE] FUNCTION statement which can declare a list of parameters, must return exactly one value, and must define the actions to be performed by the PL/SQL block.

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Stored Function With a Parameter: Example

- Create the function:

```
CREATE OR REPLACE FUNCTION get_sal
 (p_id IN employees.employee_id%TYPE)
  RETURN NUMBER IS
  v_sal employees.salary%TYPE := 0;
BEGIN
  SELECT salary
    INTO  v_sal
    FROM  employees
    WHERE employee_id = p_id;
  RETURN v_sal;
END get_sal;
```

- Invoke the function as an expression or as a parameter value:

```
... v_salary := get_sal(100);
```


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Using RETURN

- You can use RETURN from the executable section and/or from the EXCEPTION section.
- Create the function:

```
CREATE OR REPLACE FUNCTION get_sal
 (p_id IN employees.employee_id%TYPE) RETURN NUMBER IS
  v_sal employees.salary%TYPE := 0;
BEGIN
  SELECT salary INTO v_sal
    FROM employees WHERE employee_id = p_id;
  RETURN v_sal;
EXCEPTION
  WHEN NO_DATA_FOUND THEN RETURN NULL;
END get_sal;
```

- Invoke the function as an expression with a bad parameter:

```
... v_salary := get_sal(999);
```


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Ways to Invoke (or Execute) Functions With Parameters

- Functions can be invoked in the following ways:
- As part of PL/SQL expressions – use a local variable in an anonymous block to hold the returned value from a function.
- As a parameter to another subprogram – pass functions between subprograms.
- As an expression in a SQL statement – invoke a function as any other single-row function in a SQL statement.

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Invoking a Function as Part of a PL/SQL Expression

- When invoking a function as part of a PL/SQL expression, you can use a local variable to store the returned result.
- In this example, v_sal is the local variable in an anonymous block that stores the results returned from the get_sal function.

```
DECLARE v_sal employees.salary%type;
BEGIN
  v_sal := get_sal(100); ...
END;
```


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Invoking a Function as a Parameter in Another Subprogram

- You can also invoke a function as a parameter to another subprogram.
- In this example, the get_sal function with all its arguments is nested in the parameter required by the DBMS_OUTPUT.PUT_LINE procedure.

```
...DBMS_OUTPUT.PUT_LINE(get_sal(100));
```

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Invoking a Function as an Expression in a SQL Statement

- You can also invoke a function as an expression in a SQL statement.
- The following example shows how you can use a function as a single-row function in a SQL statement.

```
SELECT job_id, get_sal(employee_id) FROM employees;
```

- Note: The restrictions that apply to functions when used in a SQL statement are discussed in the next lesson.
- If functions are designed thoughtfully, they can be powerful constructs.

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Invoking a Function as an Expression in a SQL Statement

- In SQL expressions, a function must obey specific rules to control side effects. So, for example, if you want to call a stored function from a SELECT statement, the stored function is not allowed to perform any DML statements before the RETURN statement in that function.
- When a function is used in a SQL statement, it executes once for each row processed by the statement, just like Oracle-defined, single-row functions such as UPPER, LOWER, ROUND, and so on.
- As functions return a value when they are invoked, the call to them must have a mechanism to receive the value returned by the function

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Invoking a Function as an Expression in a SQL Statement - Example

- If you need a function to verify the validity of a department number for an employee, you might develop the following function:

```
CREATE OR REPLACE FUNCTION valid_dept
    (p_dept_no departments.department_id%TYPE)
RETURN BOOLEAN IS v_valid VARCHAR2(1);
BEGIN
  SELECT 'x‘ INTO v_valid
    FROM departments
    WHERE department_id = p_dept_no;
  RETURN(true);
EXCEPTION
  WHEN NO_DATA_FOUND THEN RETURN(false);
  WHEN OTHERS THEN NULL;
END;
```


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Invoking a Function as an Expression in a SQL Statement - Example

- This function cannot be called from a SQL statement, as it returns a non-sql datatype (BOOLEAN), but it can be called from another PL/SQL program, like this:

```
BEGIN      …

IF valid_dept(v_departmentid) THEN
  -- this was a valid department, so we'll do this
     part of the code, e.g. an insert into employees

ELSE
  -- valid_dept returned a false, so we are not
     doing the insert

END IF;

…

END;
```


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Invoking Functions Without Parameters

- Most functions have parameters, but not all.
- For example, the system functions USER and SYSDATE have no parameters.
- Invoke as part of a PL/SQL expression, using a local variable to obtain the result

```
DECLARE v_today DATE;
BEGIN
  v_today := SYSDATE; ...
END;
```


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Invoking Functions Without Parameters

- Use as a parameter to another subprogram

```
...DBMS_OUTPUT.PUT_LINE(USER);
```

- Use in a SQL statement (subject to restrictions)

```
SELECT job_id, SYSDATE-hire_date FROM employees;
```

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Benefits and Restrictions That Apply to Functions

Benefits	Restrictions
Try things quickly: Functions allow you to temporarily display a value in a new format: a different case, annually vs. monthly (times 12), concatenated, or with substrings.	PL/SQL types do not completely overlap with SQL types. What is fine for PL/SQL (for example, `BOOLEAN`, `RECORD`) might be invalid for a `SELECT`.
Extend functionality: Add new features, such as spell checking and parsing.	PL/SQL sizes are not the same as SQL sizes. For instance, a PL/SQL `VARCHAR2` variable can be up to 32 KB, whereas a SQL `VARCHAR2` column can be only up to 4 KB.

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Syntax Differences Between Procedures and Functions

- Procedures

```
CREATE [OR REPLACE] PROCEDURE name [parameters] IS|AS (Mandatory)
  Variables, cursors, etc. (Optional)
BEGIN          (Mandatory)
  SQL and PL/SQL statements;
EXCEPTION      (Optional)
  WHEN exception-handling actions;
END [name];      (Mandatory)
```

- Functions

```
CREATE [OR REPLACE] FUNCTION name [parameters] (Mandatory)
  RETURN datatype IS|AS         (Mandatory)
  Variables, cursors, etc. (Optional)
BEGIN          (Mandatory)
  SQL and PL/SQL statements;
  RETURN ...; (One Mandatory, more optional)
EXCEPTION      (Optional)
  WHEN exception-handling actions;
END [name];      (Mandatory)
```


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Differences/Similarities Between Procedures and Functions

Procedures	Functions
Execute as a PL/SQL statement	Invoked as part of an expression
Do not contain RETURN clause in the header	Must contain a RETURN clause in the header
May return values (if any) in output parameters (not required)	Must return a single value
May contain a RETURN statement without a value	Must contain at least one RETURN statement

- Both can have zero or more IN parameters that can be passed from the calling environment.
- Both have the standard block structure including exception handling.

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Differences Between Procedures and Functions

Procedures:

- You create a procedure to store a series of actions for later execution.
- A procedure does not have to return a value.
- A procedure can call a function to assist with its actions.
- Note: A procedure containing a single OUT parameter might be better rewritten as a function returning the value.

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Differences Between Procedures and Functions

Functions:

- You create a function when you want to compute a value that must be returned to the calling environment.
- Functions return only a single value, and the value is returned through a RETURN statement.
- The functions used in SQL statements cannot use OUT or IN OUT modes.
- Although a function using OUT can be invoked from a PL/SQL procedure or anonymous block, it cannot be used in SQL statements.

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Terminology

Key terms used in this lesson included:

- Stored function

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Summary

In this lesson, you should have learned how to:

- Define a stored function
- Create a PL/SQL block containing a function
- List ways in which a function can be invoked
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