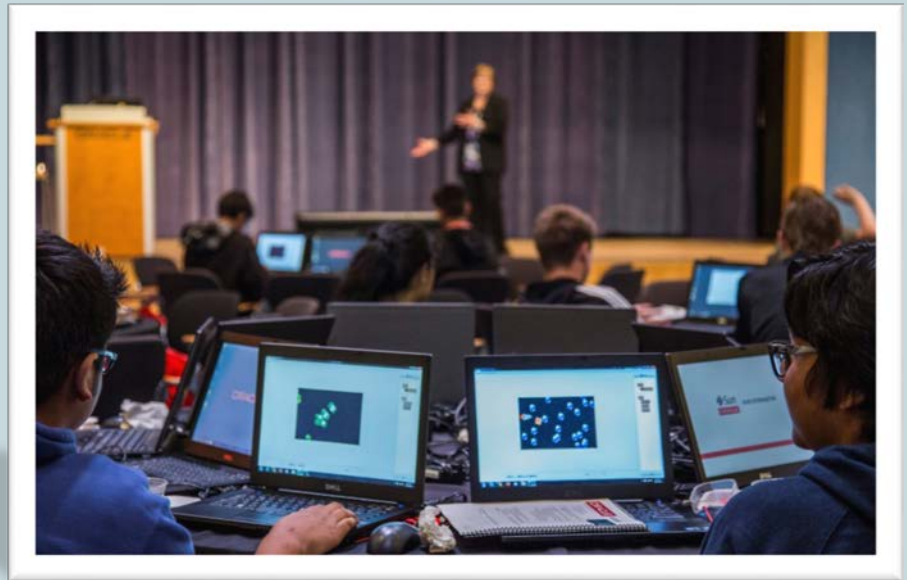




Database Programming with PL/SQL

8-1 Creating Procedures



Objectives

This lesson covers the following objectives:

- Differentiate between anonymous blocks and subprograms
- Identify the benefits of subprograms
- Define a stored procedure
- Create a procedure
- Describe how a stored procedure is invoked
- List the development steps for creating a procedure
- Create a nested subprogram in the declarative section of a procedure

Purpose

- There are times that you want to give a set of steps a name.
- For example, if you're told to take notes, you know that this means you need to get out a piece of paper and a pencil and prepare to write.
- So far you have learned to write and execute anonymous PL/SQL blocks (blocks that do not have a name associated with them).

Purpose

- Next you will learn how to create, execute, and manage two types of PL/SQL subprograms that are named and stored in the database, resulting in several benefits such as shareability, better security, and faster performance.
- Two types of subprograms:
 - Functions
 - Procedures



Differences Between Anonymous Blocks and Subprograms

- As the word “anonymous” indicates, anonymous blocks are unnamed executable PL/SQL blocks.
- Because they are unnamed, they can neither be reused nor stored in the database for later use.
- While you can store anonymous blocks on your PC, the database is not aware of them, so no one else can share them.
- Procedures and functions are PL/SQL blocks that are named, and they are also known as subprograms.

Differences Between Anonymous Blocks and Subprograms

- These subprograms are compiled and stored in the database.
- The block structure of the subprograms is similar to the structure of anonymous blocks.
- While subprograms can be explicitly shared, the default is to make them private to the owner's schema.
- Later subprograms become the building blocks of packages and triggers.

Differences Between Anonymous Blocks and Subprograms

- Anonymous blocks

```
DECLARE    (Optional)
    Variables, cursors, etc.;
BEGIN      (Mandatory)
    SQL and PL/SQL statements;
EXCEPTION (Optional)
    WHEN exception-handling actions;
END;       (Mandatory)
```

- Subprograms (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)
```


Differences Between Anonymous Blocks and Subprograms

- The alternative to an anonymous block is a named block. How the block is named depends on what you are creating.
- You can create :
 - a named procedure (does not return values except as out parameters)
 - a function (must return a single value not including out parameters)
 - a package (groups functions and procedures together)
 - a trigger

Differences Between Anonymous Blocks and Subprograms

- The keyword DECLARE is replaced by CREATE PROCEDURE procedure-name IS | AS.
- In anonymous blocks, DECLARE states, "this is the start of a block."
- Because CREATE PROCEDURE states, "this is the start of a subprogram," we do not need (and must not use) DECLARE.



Differences Between Anonymous Blocks and Subprograms

Anonymous Blocks	Subprograms
Unnamed PL/SQL blocks	Named PL/SQL blocks
Compiled on every execution	Compiled only once, when created
Not stored in the database	Stored in the database
Cannot be invoked by other applications	They are 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

Differences Between Anonymous Blocks and Subprograms

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Benefits of Subprograms

- Procedures and functions have many benefits due to the modularizing of the code:
 - Easy maintenance: Modifications need only be done once to improve multiple applications and minimize testing.
 - Code reuse: Subprograms are located in one place.
- When compiled and validated, they can be used and reused in any number of applications.



Benefits of Subprograms

- Improved data security: Indirect access to database objects is permitted by the granting of security privileges on the subprograms.
- By default, subprograms run with the privileges of the subprogram owner, not the privileges of the user.
- Data integrity: Related actions can be grouped into a block and are performed together (“Statement Processed”) or not at all.



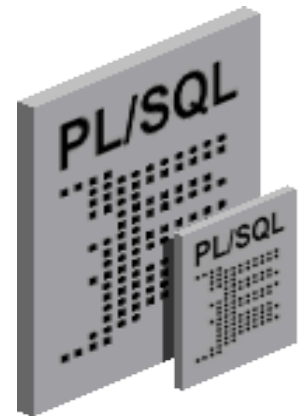


Benefits of Subprograms

- Improved performance: You can reuse compiled PL/SQL code that is stored in the shared SQL area cache of the server.
- Subsequent calls to the subprogram avoid compiling the code again.
- Also, many users can share a single copy of the subprogram code in memory.
- Improved code clarity: By using appropriate names and conventions to describe the action of the routines, you can reduce the need for comments, and enhance the clarity of the code.

Procedures and Functions : Similarities

- Are named PL/SQL blocks
- Are called PL/SQL subprograms
- Have block structures similar to anonymous blocks:
 - Optional parameters
 - Optional declarative section (but the DECLARE keyword changes to IS or AS)
 - Mandatory executable section
 - Optional section to handle exceptions
- Procedures and functions can both return data as OUT and IN OUT parameters.



Procedures and Functions : Differences

- A function MUST return a value using the RETURN statement.
- A procedure can only return a value using an OUT or an IN OUT parameter.
- The return statement in a function returns control to the calling program and returns the results of the function.
- The return statement within a procedure is optional. It returns control to the calling program before all of the procedure's code has been executed.
- Functions can be called from SQL, procedures cannot.
- Functions are considered expressions, procedures are not.

What Is a Procedure?

- A procedure is a named PL/SQL block that can accept parameters.
- Generally, you use a procedure to perform an action (sometimes called a “side-effect”).
- A procedure is compiled and stored in the database as a schema object.
 - Shows up in `USER_OBJECTS` as an object type of `PROCEDURE`
 - More details in `USER_PROCEEDURES`
 - Detailed PL/SQL code in `USER_SOURCE`

Syntax for Creating Procedures

- Parameters are optional
- Mode defaults to IN
- Datatype can be either explicit (for example, VARCHAR2) or implicit with %TYPE
- Body is the same as an anonymous block

```
CREATE [OR REPLACE] PROCEDURE procedure_name
    [(parameter1 [mode1] datatype1,
      parameter2 [mode2] datatype2,
      . . .)]
IS|AS
procedure_body;
```

Syntax for Creating Procedures

- Use CREATE PROCEDURE followed by the name, optional parameters, and keyword IS or AS.
- Add the OR REPLACE option to overwrite an existing procedure.
- Write a PL/SQL block containing local variables, a BEGIN, and an END (or END procedure_name).

```
CREATE [OR REPLACE] PROCEDURE procedure_name
  [(parameter1 [mode] datatype1,
    parameter2 [mode] datatype2, ...)]
IS|AS
  [local_variable_declarations; ...]
BEGIN
  -- actions;
END [procedure_name];
```



PL/SQL Block

Procedure: Example

- In the following example, the add_dept procedure inserts a new department with the department_id 280 and department_name ST-Curriculum.
- The procedure declares two variables, v_dept_id and v_dept_name, in the declarative section.

```
CREATE OR REPLACE PROCEDURE add_dept IS
  v_dept_id    dept.department_id%TYPE;
  v_dept_name  dept.department_name%TYPE;
BEGIN
  v_dept_id    := 280;
  v_dept_name  := 'ST-Curriculum';
  INSERT INTO dept(department_id, department_name)
    VALUES(v_dept_id, v_dept_name);
  DBMS_OUTPUT.PUT_LINE('Inserted ' || SQL%ROWCOUNT || ' row.');
```

```
END;
```

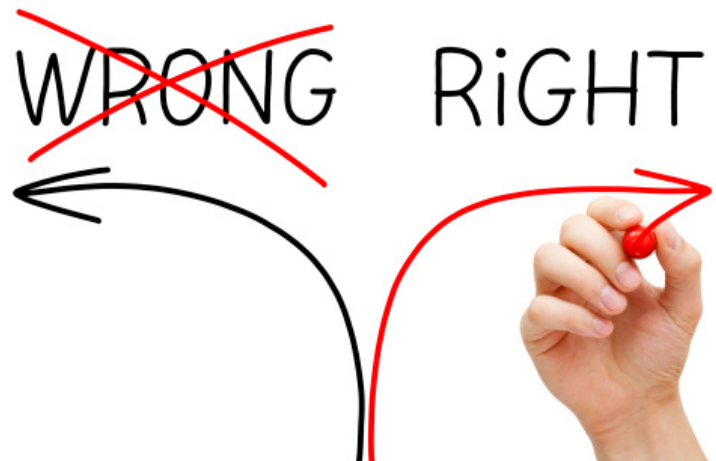
Procedure: Example

- The declarative section of a procedure starts immediately after the procedure declaration and does not begin with the keyword DECLARE.
- This procedure uses the SQL%ROWCOUNT cursor attribute to check if the row was successfully inserted. SQL%ROWCOUNT should return 1 in this case.

```
CREATE OR REPLACE PROCEDURE add_dept IS
    v_dept_id      dept.department_id%TYPE;
    v_dept_name     dept.department_name%TYPE;
BEGIN
    v_dept_id      := 280;
    v_dept_name    := 'ST-Curriculum';
    INSERT INTO dept(department_id, department_name)
        VALUES(v_dept_id, v_dept_name);
    DBMS_OUTPUT.PUT_LINE('Inserted ' || SQL%ROWCOUNT || ' row. ');
END;
```

Invoking Procedures

- You can invoke (execute) a procedure from:
 - An anonymous block
 - Another procedure
 - A calling application
- Note: You cannot invoke a procedure from inside a SQL statement such as SELECT.



Invoking the Procedure from Application Express

- To invoke (execute) a procedure in Oracle Application Express, write and run a small anonymous block that invokes the procedure.
- For example:

```
BEGIN
    add_dept;
END;

SELECT department_id, department_name FROM dept WHERE department_id=280;
```

- The select statement at the end confirms that the row was successfully inserted.

Correcting Errors in CREATE PROCEDURE Statements

- If compilation errors exist, Application Express displays them in the output portion of the SQL Commands window.
- You must edit the source code to make corrections.
- When a subprogram is CREATED, the source code is stored in the database even if compilation errors occurred.



Correcting Errors in CREATE PROCEDURE Statements

- After you have corrected the error in the code, you need to recreate the procedure.
- There are two ways to do this:
 - Use a CREATE OR REPLACE PROCEDURE statement to overwrite the existing code (most common).
 - DROP the procedure first and then execute the CREATE PROCEDURE statement (less common).



Saving Your Work

- Once a procedure has been created successfully, you should save its definition in case you need to modify the code later.

```
CREATE OR REPLACE PROCEDURE add_dept IS
  v_dept_id    dept.department_id%TYPE;
  v_dept_name  dept.department_name%TYPE;
BEGIN
  v_dept_id := 280;
  v_dept_name := 'ST-Curriculum';
  INSERT INTO dept(department_id, department_name)
    VALUES(v_dept_id, v_dept_name);
  DBMS_OUTPUT.PUT_LINE('Inserted ' || SQL%ROWCOUNT || ' row');
END;
```

Results

Explain

Describe

Saved SQL

History

Procedure created.

Saving Your Work

- In the Application Express SQL Commands window, click the SAVE button, then enter a name and optional description for your code.
- You can view and reload your code later by clicking on the Saved SQL button in the SQL Commands window.

Local Subprograms

- When one procedure invokes another procedure, we would normally create them separately, but we can create them together as a single procedure if we like.

```
CREATE OR REPLACE PROCEDURE subproc  
    ...  
END subproc;
```

```
CREATE OR REPLACE PROCEDURE mainproc  
    ...  
IS BEGIN  
    ...  
    subproc(...);  
    ...  
END mainproc;
```

Local Subprograms

- All the code is now in one place, and is easier to read and maintain.
- The nested subprogram's scope is limited to the procedure within which it is defined; SUBPROC can be invoked from MAINPROC, but from nowhere else.

```
CREATE OR REPLACE PROCEDURE mainproc
...
IS
  PROCEDURE subproc (...) IS BEGIN
    ...
  END subproc;
BEGIN
  ...
  subproc(...);
  ...
END mainproc;
```

Local Subprograms

- Every time an employee is deleted, we need to insert a row into a logging table.
- The nested procedure LOG_EMP is called a Local Subprogram.

```
CREATE OR REPLACE PROCEDURE delete_emp
  (p_emp_id IN employees.employee_id%TYPE)
IS
  PROCEDURE log_emp (p_emp IN employees.employee_id%TYPE)
  IS BEGIN
    INSERT INTO logging_table VALUES(p_emp, ...);
  END log_emp;
BEGIN
  DELETE FROM employees
    WHERE employee_id = p_emp_id;
  log_emp(p_emp_id);
END delete_emp;
```

Alternative Tools for Developing Procedures

- If you end up writing PL/SQL procedures for a living, there are other free tools that can make this process easier.
- For instance, Oracle tools, such as SQL Developer and JDeveloper assist you by:
 - Color-coding commands vs variables vs constants
 - Highlighting matched and mismatched (parentheses)
 - Displaying errors more graphically

Alternative Tools for Developing Procedures

- Enhancing code with standard indentations and capitalization
- Completing commands when typing
- Completing column names from tables

Alternative Tools for Developing Procedures

To develop a stored procedure when not using Oracle Application Express, perform the following steps:

- 1. Write the code to create a procedure in an editor or a word processor, and then save it as a SQL script file (typically with a .sql extension).
- 2. Load the code into one of the development tools such as iSQL*Plus or SQL Developer.
- 3. Create the procedure in the database. The CREATE PROCEDURE statement compiles and stores source code and the compiled m-code in the database. If compilation errors exist, then the m-code is not stored and you must edit the source code to make corrections.

Alternative Tools for Developing Procedures

To develop a stored procedure when not using Oracle Application Express, perform the following steps:

- 4. After successful compilation, execute the procedure to perform the desired action. Use the EXECUTE command from iSQL*Plus or an anonymous PL/SQL block from environments that support PL/SQL.



Terminology

Key terms used in this lesson included:

- Anonymous blocks
- IS or AS
- Procedures
- Subprograms

Summary

In this lesson, you should have learned how to:

- Differentiate between anonymous blocks and subprograms
- Identify the benefits of subprograms
- Define a stored procedure
- Create a procedure
- Describe how a stored procedure is invoked
- List the development steps for creating a procedure
- Create a nested subprogram in the declarative section of a procedure

