9

Creating Procedures

Objectives

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

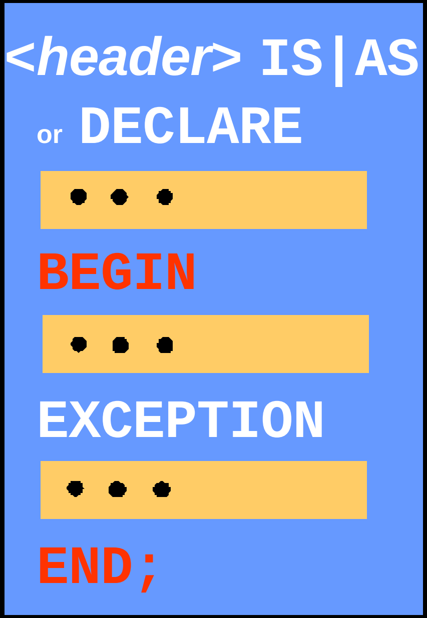
- Distinguish anonymous PL/SQL blocks from named PL/SQL blocks (subprograms)
- Describe subprograms
- List the benefits of using subprograms
- List the different environments from which subprograms can be invoked

Objectives

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

- Describe PL/SQL blocks and subprograms
- Describe the uses of procedures
- Create procedures
- Differentiate between formal and actual parameters
- List the features of different parameter modes
- Create procedures with parameters
- Invoke a procedure
- Handle exceptions in procedures
- Remove a procedure

PL/SQL Program Constructs



```
<header> IS|AS
  or DECLARE
  • • •
BEGIN
  • • •
EXCEPTION
  • • •
END;
```

Tools Constructs
Anonymous blocks
Application procedures or functions
Application packages
Application triggers
Object types

Database Server Constructs
Anonymous blocks
Stored procedures or functions
Stored packages
Database triggers
Object types

Overview of Subprograms

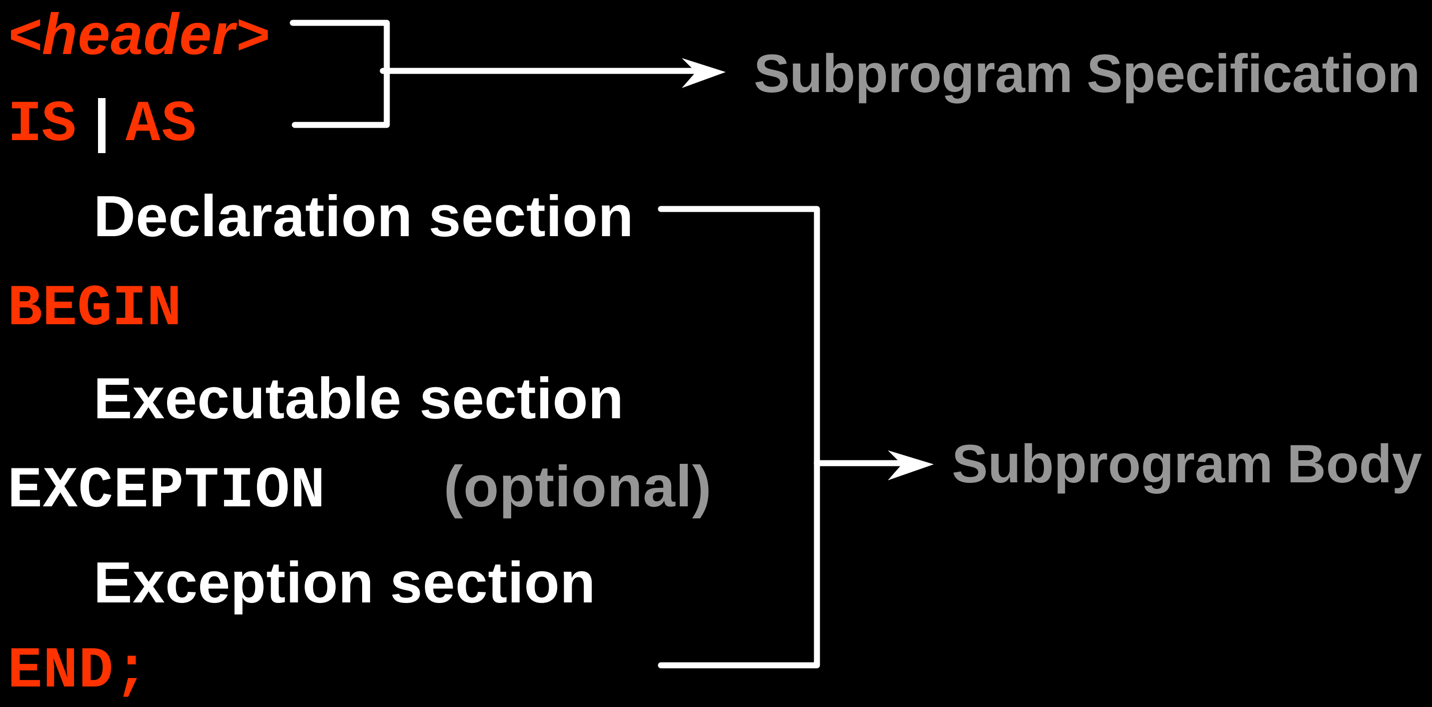
A subprogram:

- Is a named PL/SQL block that can accept parameters and be invoked from a calling environment
- Is of two types:
  - A procedure that performs an action
  - A function that computes a value
- Is based on standard PL/SQL block structure
- Provides modularity, reusability, extensibility, and maintainability
- Provides easy maintenance, improved data security and integrity, improved performance, and improved code clarity

Block Structure for Anonymous PL/SQL Blocks

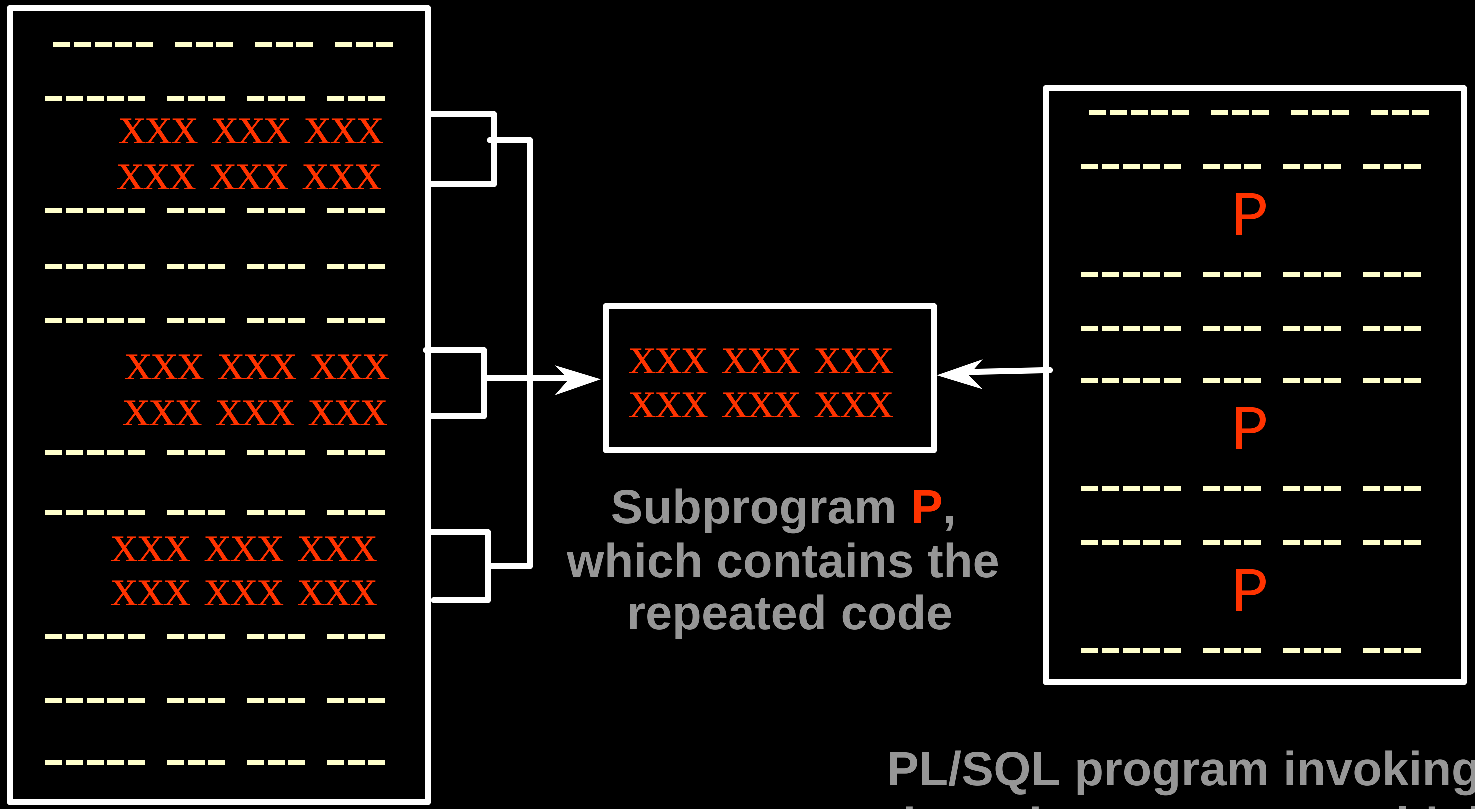
```
DECLARE    (optional)
           Declare PL/SQL objects to be used
           within this block
BEGIN      (mandatory)
           Define the executable statements
EXCEPTION  (optional)
           Define the actions that take place if
           an error or exception arises
END;       (mandatory)
```

Block Structure for PL/SQL Subprograms



```
<header>
IS | AS
    Declaration section
BEGIN
    Executable section
EXCEPTION     (optional)
    Exception section
END;
```

PL/SQL Subprograms



Subprogram **P**, which contains the repeated code

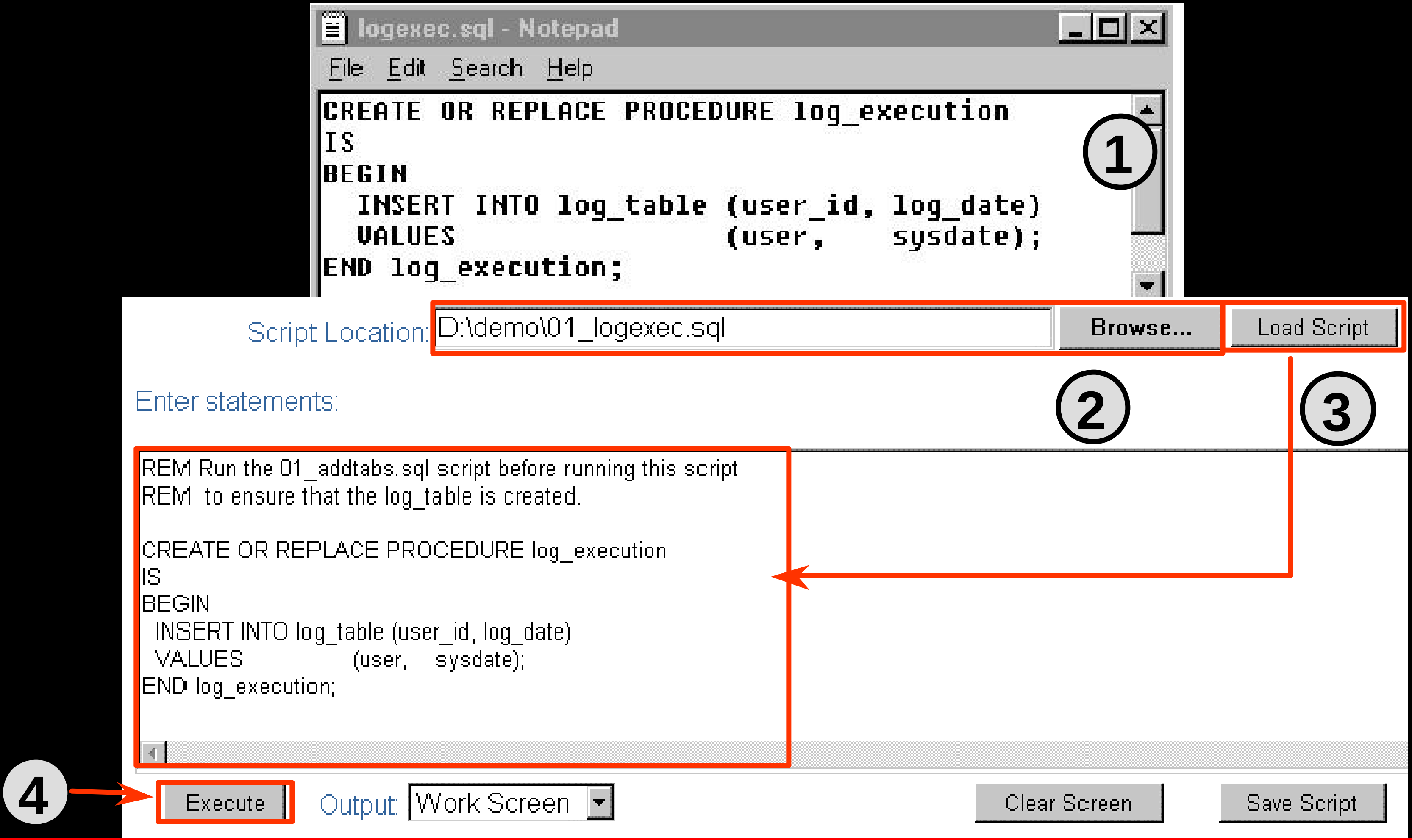
Code repeated more than once in a PL/SQL program

PL/SQL program invoking the subprogram at multiple locations

Benefits of Subprograms

- Easy maintenance
- Improved data security and integrity
- Improved performance
- Improved code clarity

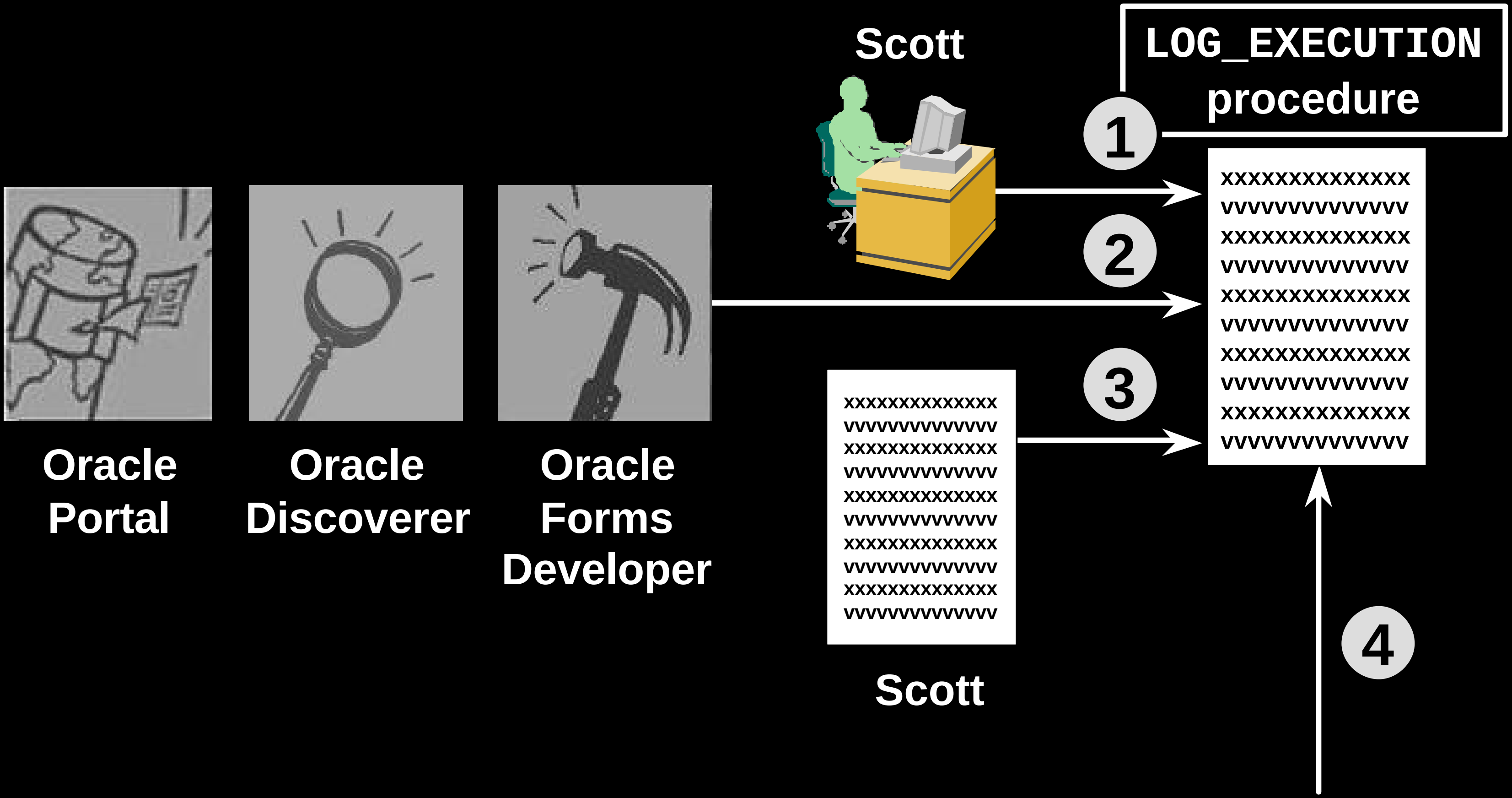
Developing Subprograms by Using *i*SQL*Plus



```
CREATE OR REPLACE PROCEDURE log_execution
IS
BEGIN
  INSERT INTO log_table (user_id, log_date)
  VALUES                (user,    sysdate);
END log_execution;
```

```
REM Run the 01_addtabs.sql script before running this script
REM  to ensure that the log_table is created.

CREATE OR REPLACE PROCEDURE log_execution
IS
BEGIN
  INSERT INTO log_table (user_id, log_date)
  VALUES                (user,    sysdate);
END log_execution;
```

Invoking Stored Procedures and Functions



What Is a Procedure?

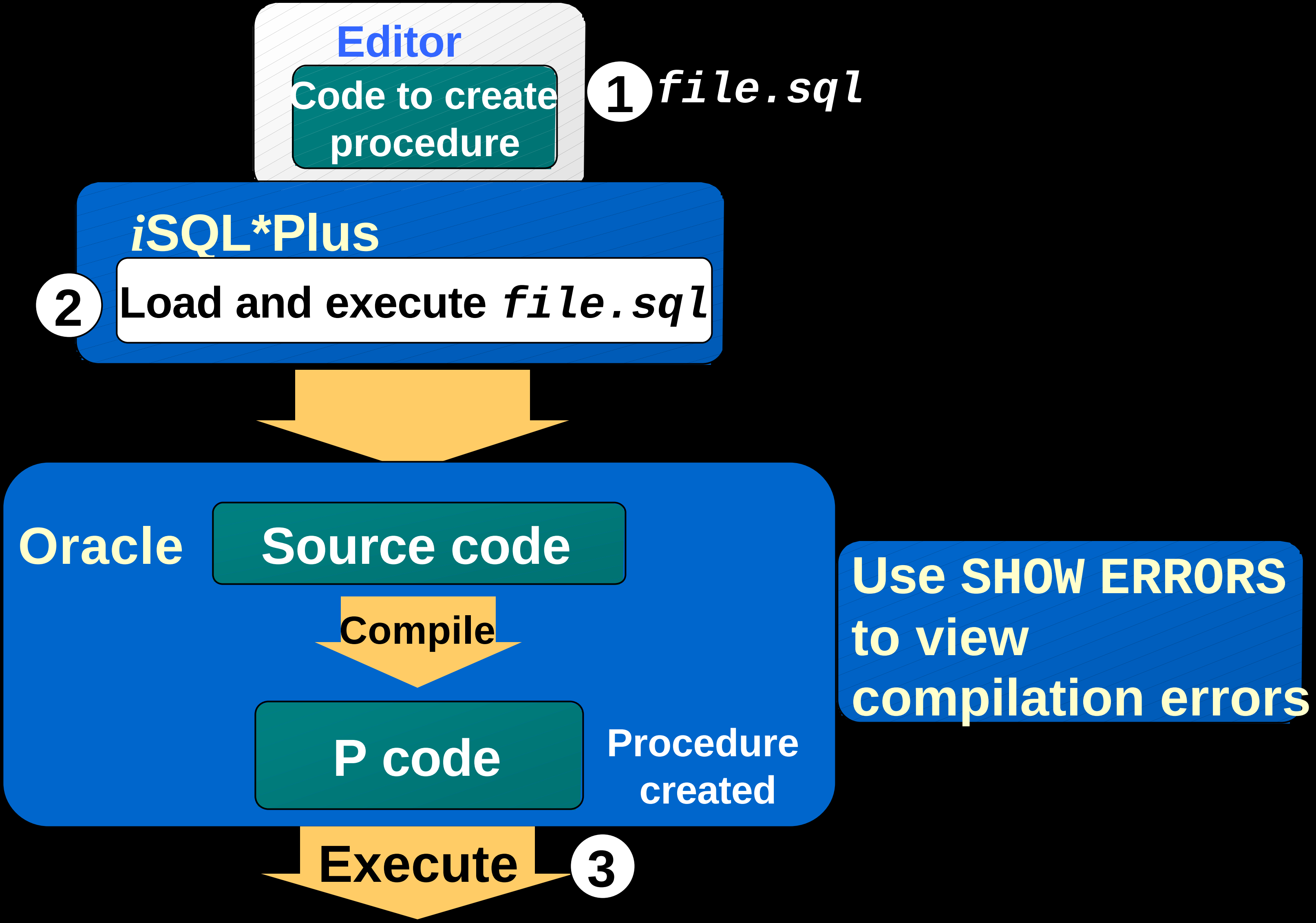
- A procedure is a type of subprogram that performs an action.
- A procedure can be stored in the database, as a schema object, for repeated execution.

Syntax for Creating Procedures

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

- The REPLACE option indicates that if the procedure exists, it will be dropped and replaced with the new version created by the statement.
- PL/SQL block starts with either `BEGIN` or the declaration of local variables and ends with either END or END *procedure_name.*

Developing Procedures



Formal Versus Actual Parameters

- Formal parameters: variables declared in the parameter list of a subprogram specification

  Example:

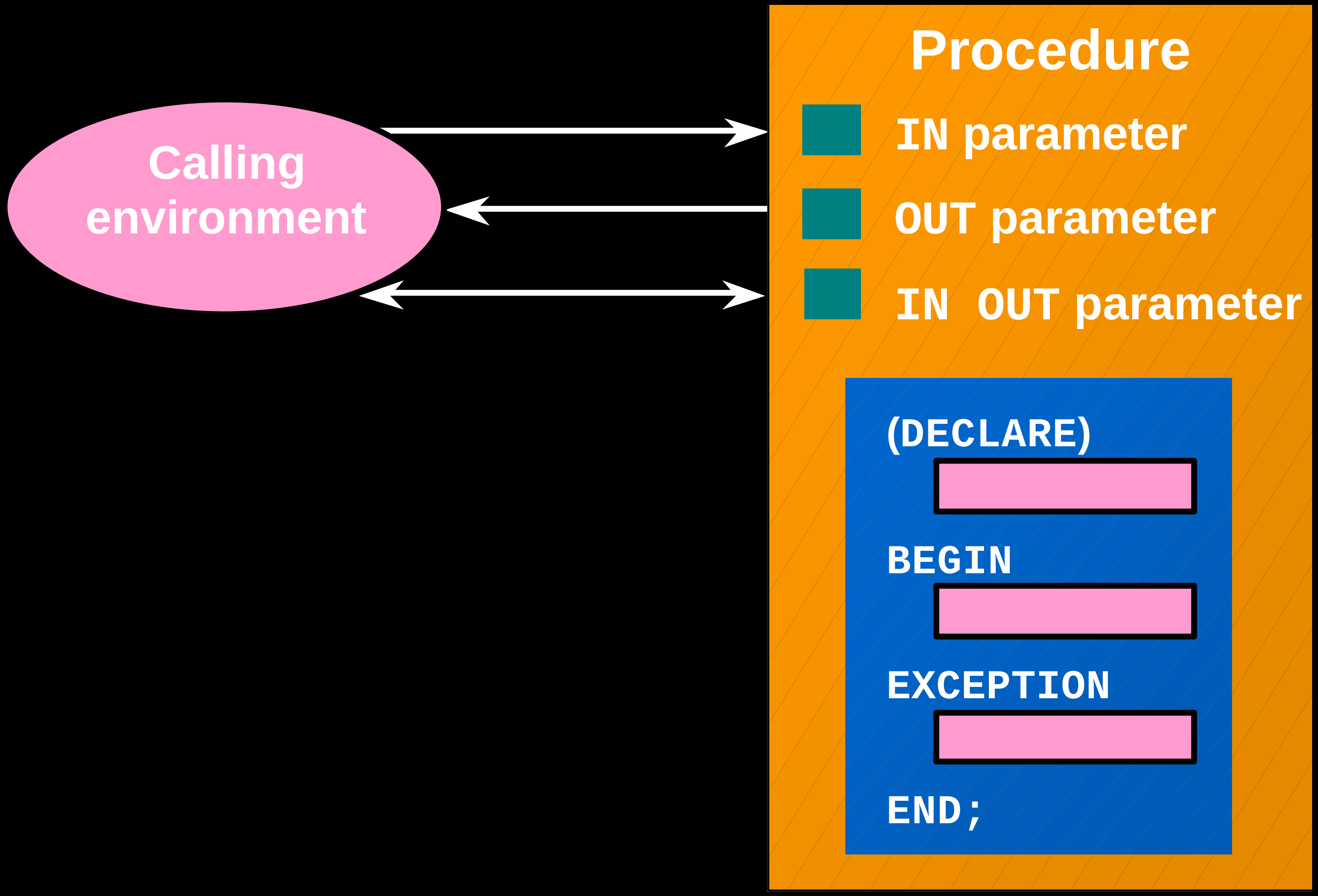
```
CREATE PROCEDURE raise_sal(p_id NUMBER, p_amount NUMBER)
...
END raise_sal;
```

- Actual parameters: variables or expressions referenced in the parameter list of a subprogram call

  Example:

```
raise_sal(v_id, 2000)
```

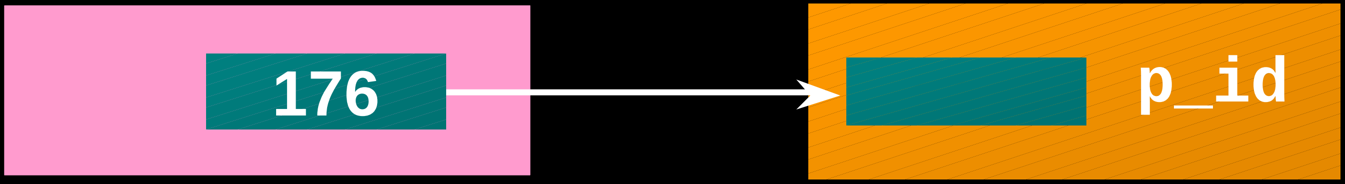
Procedural Parameter Modes



Creating Procedures with Parameters

IN	OUT	IN OUT
Default mode	Must be specified	Must be specified
Value is passed into subprogram	Returned to calling environment	Passed into subprogram; returned to calling environment
Formal parameter acts as a constant	Uninitialized variable	Initialized variable
Actual parameter can be a literal, expression, constant, or initialized variable	Must be a variable	Must be a variable
Can be assigned a default value	Cannot be assigned a default value	Cannot be assigned a default value

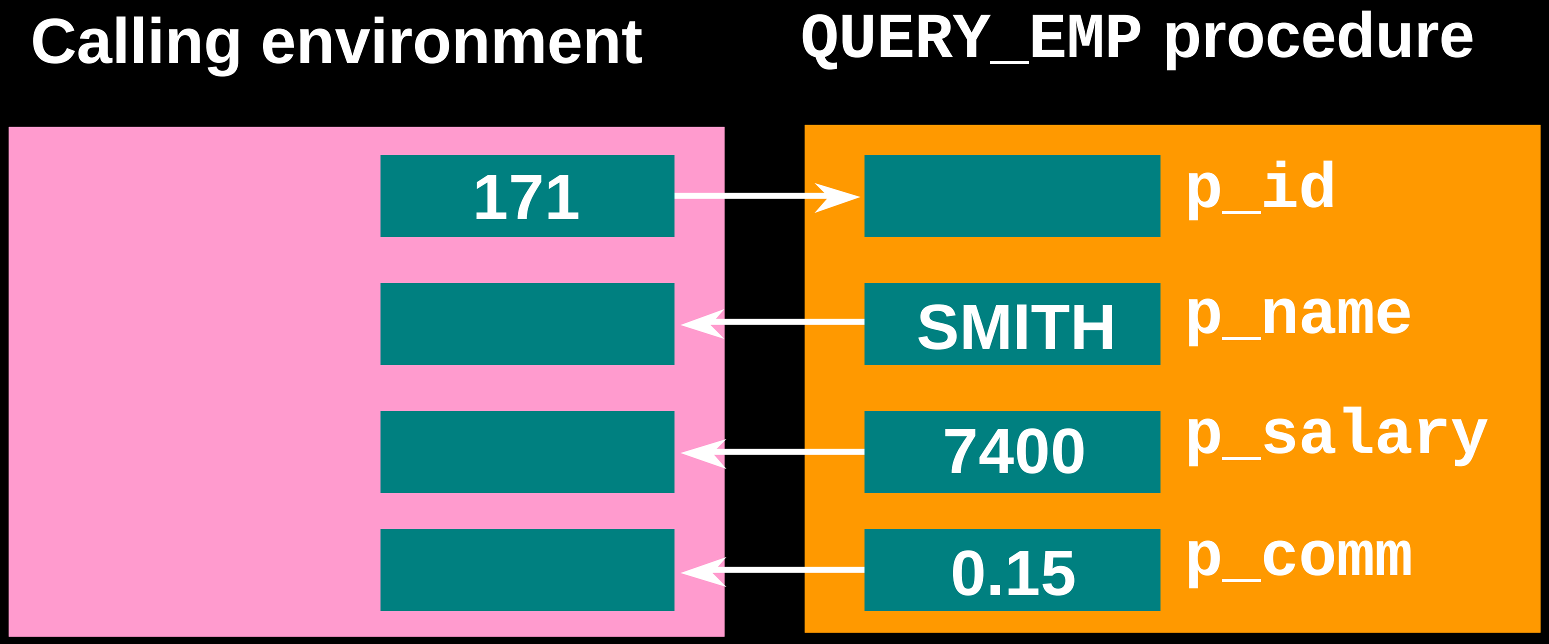
IN Parameters: Example



```
CREATE OR REPLACE PROCEDURE raise_salary
  (p_id IN employees.employee_id%TYPE)
IS
BEGIN
  UPDATE employees
  SET    salary = salary * 1.10
  WHERE  employee_id = p_id;
END raise_salary;
/
```

```
Procedure created.
```

OUT Parameters: Example



OUT Parameters: Example

emp_query.sql

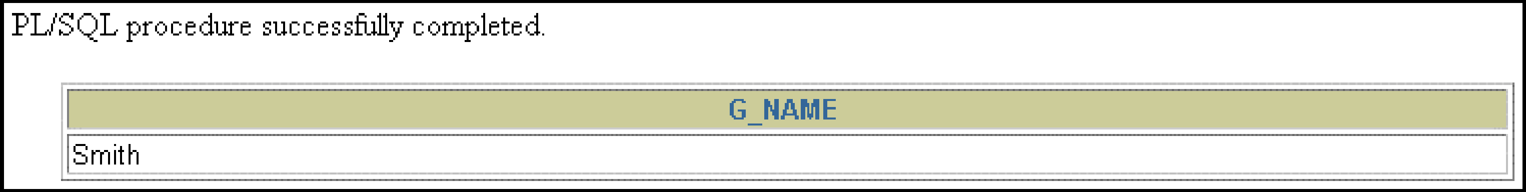
```
CREATE OR REPLACE PROCEDURE query_emp
  (p_id       IN   employees.employee_id%TYPE,
   p_name     OUT  employees.last_name%TYPE,
   p_salary   OUT  employees.salary%TYPE,
   p_comm     OUT  employees.commission_pct%TYPE)
IS
BEGIN
  SELECT   last_name, salary, commission_pct
   INTO    p_name, p_salary, p_comm
   FROM    employees
   WHERE   employee_id = p_id;
END query_emp;
/
```

```
Procedure created.
```

Viewing OUT Parameters

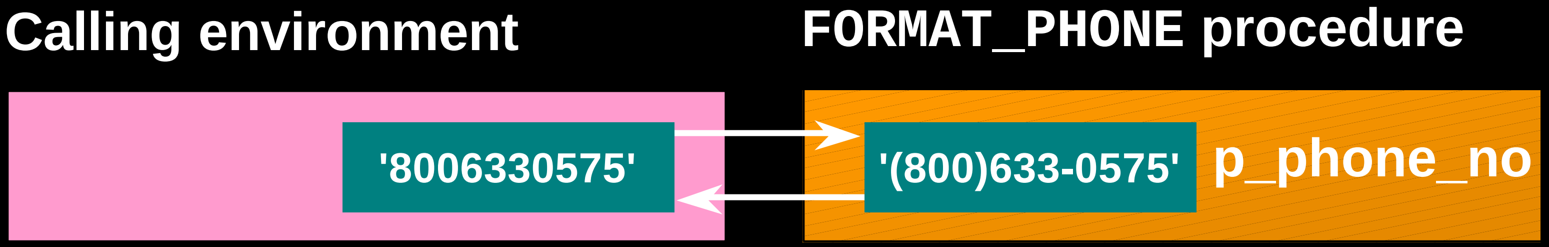
- Load and run the `emp_query.sql` script file to create the `QUERY_EMP` procedure.
- Declare host variables, execute the `QUERY_EMP` procedure, and print the value of the global `G_NAME` variable.

```
VARIABLE g_name     VARCHAR2(25)
VARIABLE g_sal      NUMBER
VARIABLE g_comm     NUMBER

EXECUTE query_emp(171, :g_name, :g_sal, :g_comm)

PRINT g_name
```



```
PL/SQL procedure successfully completed.

G_NAME
Smith
```

IN OUT Parameters

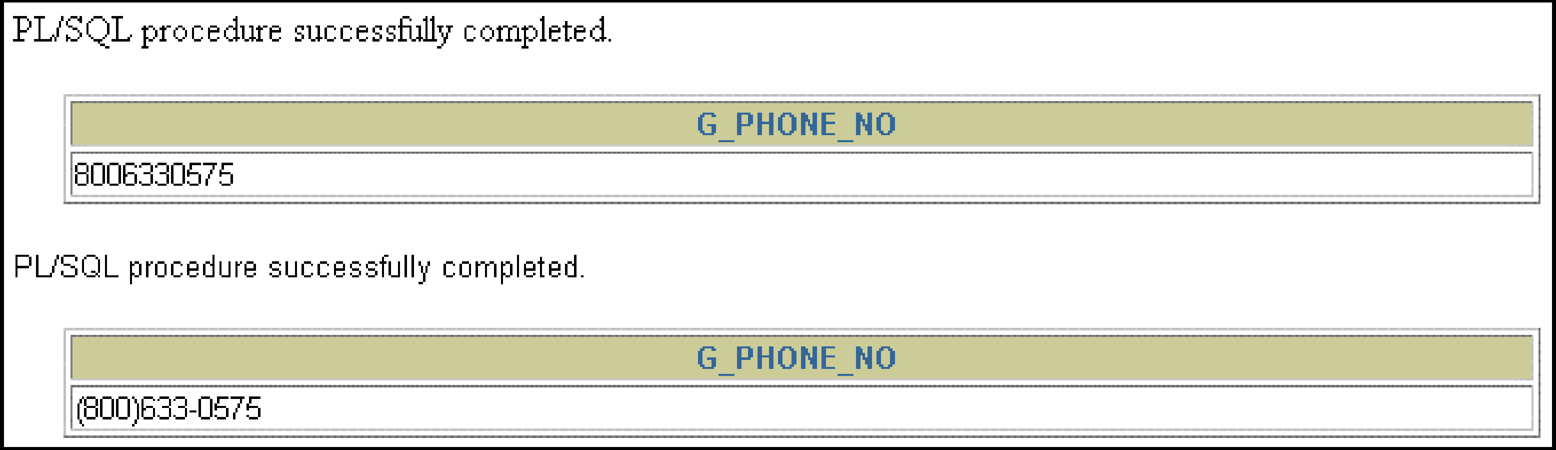


```
CREATE OR REPLACE PROCEDURE format_phone
  (p_phone_no IN OUT VARCHAR2)
IS
BEGIN
  p_phone_no := '(' || SUBSTR(p_phone_no,1,3) ||
                ')' || SUBSTR(p_phone_no,4,3) ||
                '-' || SUBSTR(p_phone_no,7);
END format_phone;
/
```

```
Procedure created.
```

Viewing IN OUT Parameters

```
VARIABLE g_phone_no VARCHAR2(15)
BEGIN
  :g_phone_no := '8006330575';
END;
/
PRINT g_phone_no
EXECUTE format_phone (:g_phone_no)
PRINT g_phone_no
```



```
PL/SQL procedure successfully completed.

                         G_PHONE_NO
8006330575

PL/SQL procedure successfully completed.

                         G_PHONE_NO
(800)633-0575
```

Methods for Passing Parameters

- Positional: List actual parameters in the same order as formal parameters.
- Named: List actual parameters in arbitrary order by associating each with its corresponding formal parameter.
- Combination: List some of the actual parameters as positional and some as named.

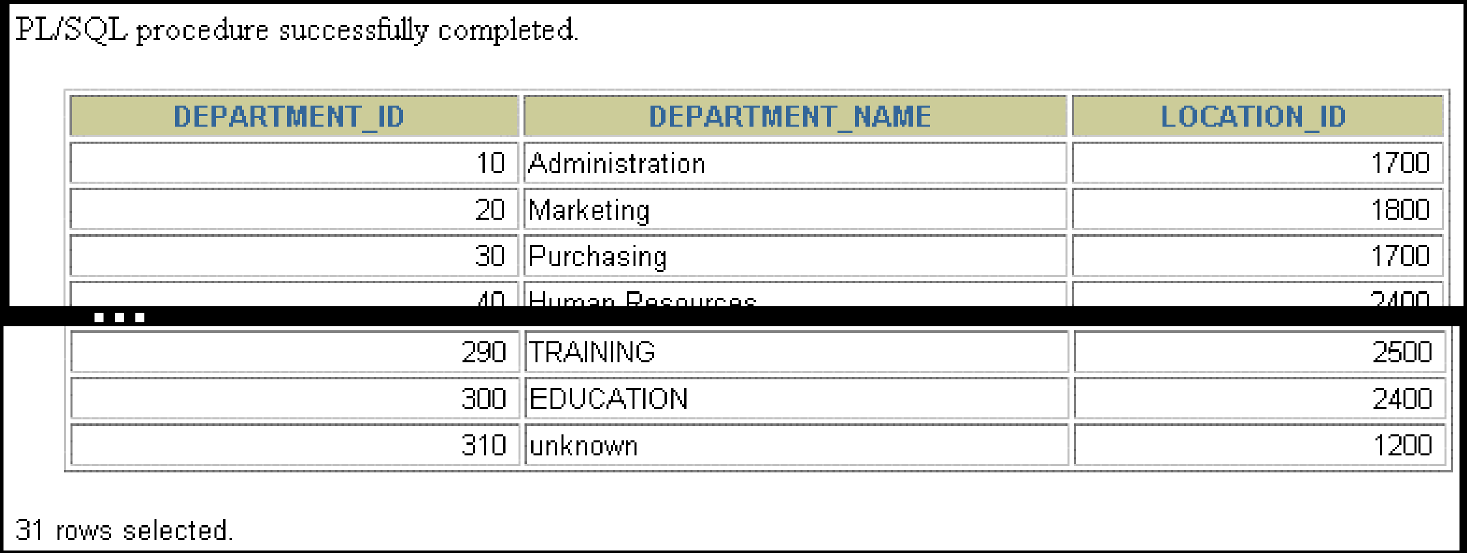
DEFAULT Option for Parameters

```
CREATE OR REPLACE PROCEDURE add_dept
  (p_name  IN departments.department_name%TYPE
                               DEFAULT 'unknown',
   p_loc   IN departments.location_id%TYPE
                               DEFAULT 1700)
IS
BEGIN
  INSERT INTO departments(department_id,
            department_name, location_id)
  VALUES (departments_seq.NEXTVAL, p_name, p_loc);
END add_dept;
/
```

```
Procedure created.
```

Examples of Passing Parameters

```
BEGIN
  add_dept;
  add_dept ('TRAINING', 2500);
  add_dept ( p_loc => 2400, p_name =>'EDUCATION');
  add_dept ( p_loc => 1200) ;
END;
/
SELECT department_id, department_name, location_id
FROM departments;
```



PL/SQL procedure successfully completed.

DEPARTMENT_ID	DEPARTMENT_NAME	LOCATION_ID
10	Administration	1700
20	Marketing	1800
30	Purchasing	1700
40	Human Resources	2400
…		
290	TRAINING	2500
300	EDUCATION	2400
310	unknown	1200

31 rows selected.

Declaring Subprograms

leave_emp2.sql

```
CREATE OR REPLACE PROCEDURE leave_emp2
  (p_id  IN  employees.employee_id%TYPE)
IS
  PROCEDURE log_exec
  IS
  BEGIN
    INSERT INTO log_table (user_id, log_date)
    VALUES (USER, SYSDATE);
  END log_exec;
BEGIN
  DELETE FROM employees
  WHERE employee_id = p_id;
  log_exec;
END leave_emp2;
/
```

Invoking a Procedure from an Anonymous PL/SQL Block

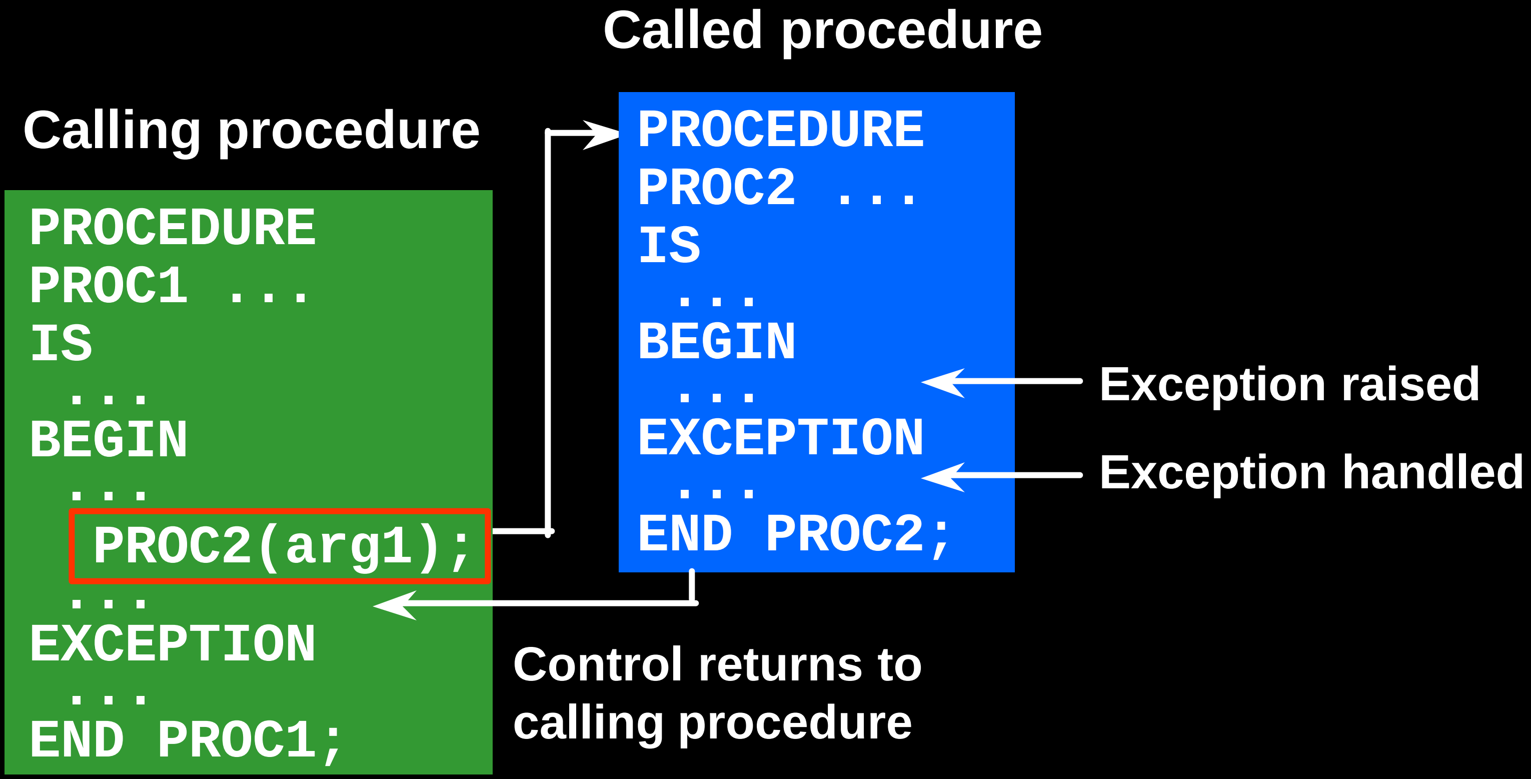
```
DECLARE
  v_id NUMBER := 163;
BEGIN
  raise_salary(v_id);     --invoke procedure
  COMMIT;
...
END;
```

Invoking a Procedure from Another Procedure

process_emps.sql

```
CREATE OR REPLACE PROCEDURE process_emps
IS
   CURSOR emp_cursor IS
    SELECT employee_id
    FROM   employees;
BEGIN
   FOR emp_rec IN emp_cursor
   LOOP
    raise_salary(emp_rec.employee_id);
   END LOOP;
   COMMIT;
END process_emps;
/
```

Handled Exceptions



```
PROCEDURE
PROC1 ...
IS
  ...
BEGIN
  ...
    PROC2(arg1);
  ...
EXCEPTION
  ...
END PROC1;
```

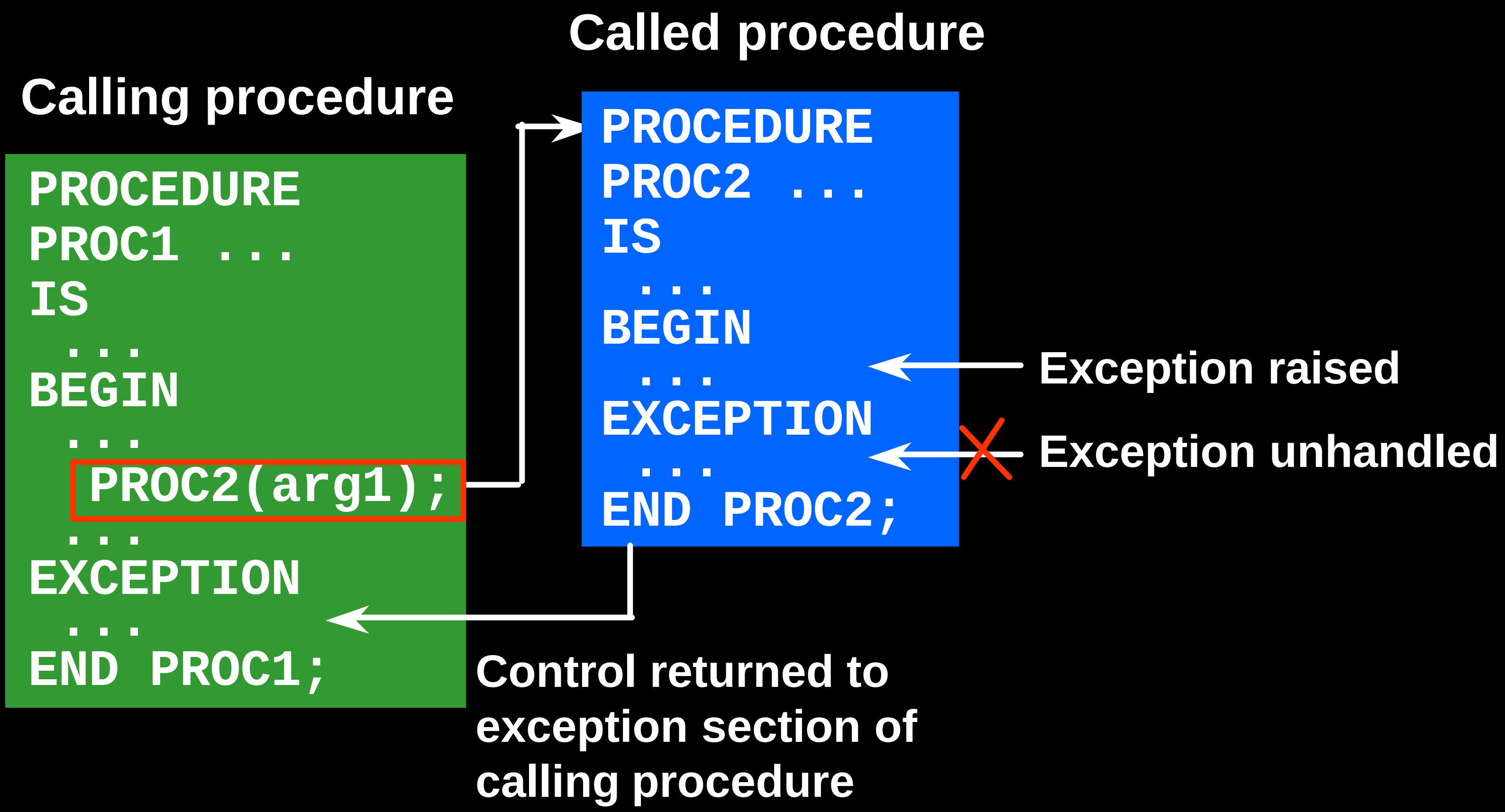
```
PROCEDURE
PROC2 ...
IS
  ...
BEGIN
  ...
EXCEPTION
  ...
END PROC2;
```

Handled Exceptions

```
CREATE PROCEDURE p2_ins_dept(p_locid NUMBER) IS
 v_did NUMBER(4);
BEGIN
 DBMS_OUTPUT.PUT_LINE('Procedure p2_ins_dept started');
 INSERT INTO departments VALUES (5, 'Dept 5', 145, p_locid);
 SELECT department_id INTO v_did FROM employees
  WHERE employee_id = 999;
END;
```

```
CREATE PROCEDURE p1_ins_loc(p_lid NUMBER, p_city VARCHAR2)
IS
 v_city VARCHAR2(30); v_dname VARCHAR2(30);
BEGIN
 DBMS_OUTPUT.PUT_LINE('Main Procedure p1_ins_loc');
 INSERT INTO locations (location_id, city) VALUES (p_lid, p_city);
 SELECT city INTO v_city FROM locations WHERE location_id = p_lid;
 DBMS_OUTPUT.PUT_LINE('Inserted city '||v_city);
 DBMS_OUTPUT.PUT_LINE('Invoking the procedure p2_ins_dept ...');
 p2_ins_dept(p_lid);
EXCEPTION
  WHEN NO_DATA_FOUND THEN
   DBMS_OUTPUT.PUT_LINE('No such dept/loc for any employee');
END;
```

Unhandled Exceptions



```
PROCEDURE
PROC1 ...
IS
  ...
BEGIN
  ...
   PROC2(arg1);
  ...
EXCEPTION
  ...
END PROC1;
```

```
PROCEDURE
PROC2 ...
IS
  ...
BEGIN
  ...
EXCEPTION
  ...
END PROC2;
```

Unhandled Exceptions

```
CREATE PROCEDURE p2_noexcep(p_locid NUMBER) IS
 v_did NUMBER(4);
BEGIN
 DBMS_OUTPUT.PUT_LINE('Procedure p2_noexcep started');
 INSERT INTO departments VALUES (6, 'Dept 6', 145, p_locid);
 SELECT department_id INTO v_did FROM employees
  WHERE employee_id = 999;
END;
```

```
CREATE PROCEDURE p1_noexcep(p_lid NUMBER, p_city VARCHAR2)
IS
 v_city VARCHAR2(30); v_dname VARCHAR2(30);
BEGIN
 DBMS_OUTPUT.PUT_LINE(' Main Procedure p1_noexcep');
 INSERT INTO locations (location_id, city) VALUES (p_lid, p_city);
 SELECT city INTO v_city FROM locations WHERE location_id = p_lid;
 DBMS_OUTPUT.PUT_LINE('Inserted new city '||v_city);
 DBMS_OUTPUT.PUT_LINE('Invoking the procedure p2_noexcep ...');
 p2_noexcep(p_lid);
END;
```

Removing Procedures

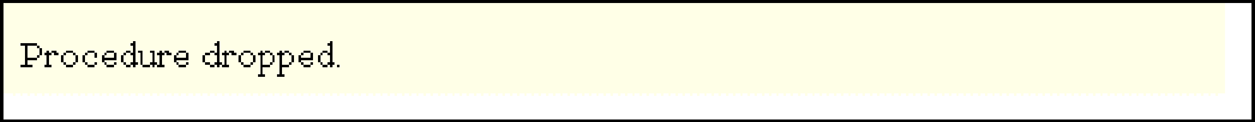
Drop a procedure stored in the database.

Syntax:

```
DROP PROCEDURE procedure_name
```

Example:

```
DROP PROCEDURE raise_salary;
```



```
Procedure dropped.
```

Summary

In this lesson, you should have learned that:

- A procedure is a subprogram that performs an action.
- You create procedures by using the `CREATE PROCEDURE` command.
- You can compile and save a procedure in the database.
- Parameters are used to pass data from the calling environment to the procedure.
- There are three parameter modes: `IN`, `OUT`, and `IN OUT`.

Summary

- Local subprograms are programs that are defined within the declaration section of another program.
- Procedures can be invoked from any tool or language that supports PL/SQL.
- You should be aware of the effect of handled and unhandled exceptions on transactions and calling procedures.
- You can remove procedures from the database by using the `DROP PROCEDURE` command.
- Procedures can serve as building blocks for an application.

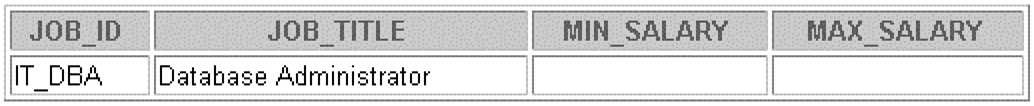
Practice 9

Note: You can find table descriptions and sample data in Appendix D “Table Descriptions and Data.”

Save your subprograms as `.sql` files, using the `Save Script` button.

Remember to set the `SERVEROUTPUT ON` if you set it off previously.

1. Create and invoke the `ADD_JOB` procedure and consider the results.
   a. Create a procedure called `ADD_JOB` to insert a new job into the `JOBS` table. Provide the ID and title of the job, using two parameters.
   b. Compile the code, and invoke the procedure with `IT_DBA` as job ID and `Database Administrator` as job title. Query the `JOBS` table to view the results.



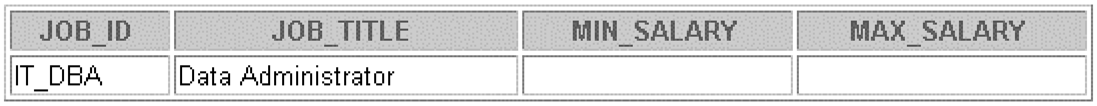
JOB_ID	JOB_TITLE	MIN_SALARY	MAX_SALARY
IT_DBA	Database Administrator		

   c. Invoke your procedure again, passing a job ID of `ST_MAN` and a job title of `Stock Manager`. What happens and why?

   ____

   ____

2. Create a procedure called `UPD_JOB` to modify a job in the `JOBS` table.
   a. Create a procedure called `UPD_JOB` to update the job title. Provide the job ID and a new title, using two parameters. Include the necessary exception handling if no update occurs.
   b. Compile the code; invoke the procedure to change the job title of the job ID `IT_DBA` to `Data Administrator`. Query the `JOBS` table to view the results.



JOB_ID	JOB_TITLE	MIN_SALARY	MAX_SALARY
IT_DBA	Data Administrator		

   Also check the exception handling by trying to update a job that does not exist (you can use job ID `IT_WEB` and job title `Web Master`).

3. Create a procedure called `DEL_JOB` to delete a job from the `JOBS` table.
   a. Create a procedure called `DEL_JOB` to delete a job. Include the necessary exception handling if no job is deleted.
   b. Compile the code; invoke the procedure using job ID `IT_DBA`. Query the `JOBS` table to view the results.

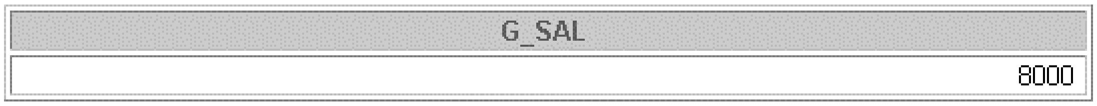
```
no rows selected
```

   Also, check the exception handling by trying to delete a job that does not exist (use job ID `IT_WEB`). You should get the message you used in the exception-handling section of the procedure as output.

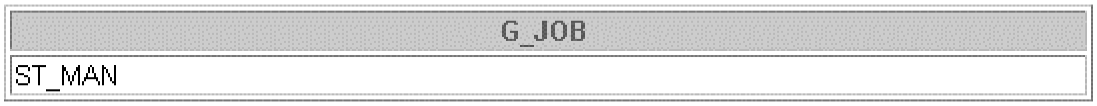
Practice 9 (continued)

4. Create a procedure called `QUERY_EMP` to query the `EMPLOYEES` table, retrieving the salary and job ID for an employee when provided with the employee ID.
   a. Create a procedure that returns a value from the `SALARY` and `JOB_ID` columns for a specified employee ID.

      Use host variables for the two `OUT` parameters salary and job ID.
   b. Compile the code, invoke the procedure to display the salary and job ID for employee ID 120.



```
G_SAL
 8000
```



```
G_JOB
ST_MAN
```

   c. Invoke the procedure again, passing an `EMPLOYEE_ID` of 300. What happens and why?