4

Interacting with the Oracle Server

Objectives

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

- **Determine 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**

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Lesson Aim

In this lesson, you learn to embed standard SQL `SELECT`, `INSERT`, `UPDATE`, `DELETE`, and `MERGE` statements in PL/SQL blocks. You learn how to include data definition language (DDL) and transaction control statements in PL/SQL. You learn the need for cursors and differentiate between the two types of cursors. The lesson also presents the various SQL cursor attributes that can be used with implicit cursors.

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.**

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SQL Statements in PL/SQL

In a PL/SQL block, you use SQL statements to retrieve and modify data from the database table. PL/SQL supports data manipulation language (DML) and transaction control commands. You can use DML commands to modify the data in a database table. However, remember the following points while using DML statements and transaction control commands in PL/SQL blocks:

- The keyword `END` signals the end of a PL/SQL block, not the end of a transaction. Just as a block can span multiple transactions, a transaction can span multiple blocks.
- PL/SQL does not directly support data definition language (DDL) statements, such as `CREATE TABLE`, `ALTER TABLE`, or `DROP TABLE`. PL/SQL supports early binding; as a result, compilation time is greater than execution time. If applications have to create database objects at run time by passing values, then early binding cannot happen in such cases. DDL statements cannot be directly executed. These statements are dynamic SQL statements. Dynamic SQL statements are built as character strings at run time and can contain placeholders for parameters. Therefore, you can use dynamic SQL to execute your DDL statements in PL/SQL. Use the `EXECUTE IMMEDIATE` statement, which takes the SQL statement as an argument to execute your DDL statement. The `EXECUTE IMMEDIATE` statement parses and executes a dynamic SQL statement.

SQL Statements in PL/SQL (continued)

Consider the following example:

```
BEGIN
CREATE TABLE My_emp_table AS SELECT * FROM employees;
END;
/
```

The example uses a DDL statement directly in the block. When you execute the block, you see the following error:

```
create table My_table as select * from table_name; * ERROR
at line 5:
ORA-06550: line 5, column 1:
PLS-00103: Encountered the symbol "CREATE" when expecting
one of the following:
…
```

Use the `EXECUTE IMMEDIATE` statement to avoid the error:

```
BEGIN
EXECUTE IMMEDIATE 'CREATE TABLE My_emp_table AS SELECT *
FROM employees';
END;
/
```

- PL/SQL does not support data control language (DCL) statements such as `GRANT` or `REVOKE`. You can use `EXECUTE IMMEDIATE` statement to execute them.
- You use transaction control statements to make the changes to the database permanent or to discard them. `COMMIT`, `ROLLBACK`, and `SAVEPOINT` are three main transactional control statements that are used. `COMMIT` is used to make the database changes permanent. `ROLLBACK` is for discarding any changes that were made to the database after the last `COMMIT`. `SAVEPOINT` is used to mark an intermediate point in transaction processing. The transaction control commands are valid in PL/SQL and therefore can be directly used in the executable section of a PL/SQL block.

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];
```

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SELECT Statements in PL/SQL

Use the SELECT statement to retrieve data from the database.

select_list	List of at least one column; can include SQL expressions, row functions, or group functions
variable_name	Scalar variable that holds the retrieved value
record_name	PL/SQL record that holds the retrieved values
table	Specifies the database table name
condition	Is composed of column names, expressions, constants, and comparison operators, including PL/SQL variables and constants

Guidelines for Retrieving Data in PL/SQL

- Terminate each SQL statement with a semicolon (;).
- Every value retrieved must be stored in a variable using the INTO clause.
- The WHERE clause is optional and can be used to specify input variables, constants, literals, and PL/SQL expressions. However, when you use the INTO clause, you should fetch only one row; using the WHERE clause is required in such cases.

`SELECT` Statements in PL/SQL (continued)

- Specify the same number of variables in the `INTO` clause as the number of database columns in the `SELECT` clause. Be sure that they correspond positionally and that their data types are compatible.
- Use group functions, such as `SUM`, in a SQL statement, because group functions apply to groups of rows in a table.

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;
/
```

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SELECT Statements in PL/SQL (continued)

INTO Clause

The INTO clause is mandatory and occurs between the SELECT and FROM clauses. It is used to specify the names of variables that hold the values that SQL returns from the SELECT clause. You must specify one variable for each item selected, and the order of the variables must correspond with the items selected.

Use the INTO clause to populate either PL/SQL variables or host variables.

Queries Must Return Only One Row

SELECT statements within a PL/SQL block fall into the ANSI classification of embedded SQL, for which the following rule applies: queries must return only one row. A query that returns more than one row or no row generates an error.

PL/SQL manages these errors by raising standard exceptions, which you can handle in the exception section of the block with the NO_DATA_FOUND and TOO_MANY_ROWS exceptions. Include a WHERE condition in the SQL statement so that the statement returns a single row. You learn about exception handling later in the course.

`SELECT` Statements in PL/SQL (continued)

How to Retrieve Multiple Rows from a Table and Operate on the Data

A `SELECT` statement with the `INTO` clause can retrieve only one row at a time. If your requirement is to retrieve multiple rows and operate on the data, you can make use of explicit cursors. You learn about cursors later in this lesson.

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;
/
```

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Retrieving Data in PL/SQL

In the example in the slide, the variables `emp_hiredate` and `emp_salary` are declared in the declarative section of the PL/SQL block. In the executable section, the values of the columns `hire_date` and `salary` for the employee with the `employee_id` 100 are retrieved from the `employees` table; they are stored in the `emp_hiredate` and `emp_salary` variables, respectively. Observe how the `INTO` clause, along with the `SELECT` statement, retrieves the database column values into the PL/SQL variables.

Note: The `SELECT` statement retrieves `hire_date` and then `salary`. The variables in the `INTO` clause must thus be in the same order. For example, if you exchange `emp_hiredate` and `emp_salary` in the statement in the slide, the statement results in an error.

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;
/
```

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Retrieving Data in PL/SQL (continued)

In the example in the slide, the `sum_sal` and `deptno` variables are declared in the declarative section of the PL/SQL block. In the executable section, the total salary for the employees in the department with the `department_id` 60 is computed using the SQL aggregate function `SUM`. The calculated total salary is assigned to the `sum_sal` variable.

Note: Group functions cannot be used in PL/SQL syntax. They are used in SQL statements within a PL/SQL block as shown in the example. You cannot use them as follows:

```
sum_sal := SUM(employees.salary);
```

The output of the PL/SQL block in the slide is the following:

```
The sum of salary is 28800
PL/SQL procedure successfully completed.
```

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
```

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Naming Conventions

In potentially ambiguous SQL statements, the names of database columns take precedence over the names of local variables.

The example shown in the slide is defined as follows: Retrieve the hire date and today's date from the `employees` table for `employee_id` 176. This example raises an unhandled run-time exception because in the `WHERE` clause, the PL/SQL variable names are the same as the database column names in the `employees` table.

The following `DELETE` statement removes all employees from the `employees` table where the last name is not null (not just "King") because the Oracle server assumes that both occurrences of `last_name` in the `WHERE` clause refer to the database column:

```
DECLARE
   last_name VARCHAR2(25) := 'King';
BEGIN
   DELETE FROM employees WHERE last_name = last_name;
. . .
```

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.**

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Naming Conventions (continued)

Avoid ambiguity in the `WHERE` clause by adhering to a naming convention that distinguishes database column names from PL/SQL variable names.

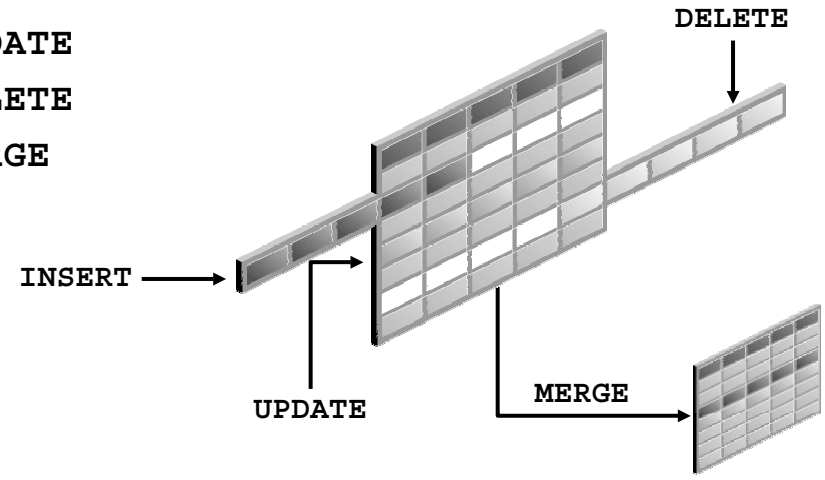
- Database columns and identifiers should have distinct names.
- Syntax errors can arise because PL/SQL checks the database first for a column in the table.

Note: There is no possibility for ambiguity in the `SELECT` clause because any identifier in the `SELECT` clause must be a database column name. There is no possibility for ambiguity in the `INTO` clause because identifiers in the `INTO` clause must be PL/SQL variables. There is the possibility of confusion only in the `WHERE` clause.

Manipulating Data Using PL/SQL

Make changes to database tables by using DML commands:

- **INSERT**
- **UPDATE**
- **DELETE**
- **MERGE**



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Manipulating Data Using PL/SQL

You manipulate data in the database by using the DML commands. You can issue the DML commands `INSERT`, `UPDATE`, `DELETE` and `MERGE` without restriction in PL/SQL. Row locks (and table locks) are released by including `COMMIT` or `ROLLBACK` statements in the PL/SQL code.

- The `INSERT` statement adds new rows to the table.
- The `UPDATE` statement modifies existing rows in the table.
- The `DELETE` statement removes rows from the table.
- The `MERGE` statement selects rows from one table to update or insert into another table. The decision whether to update or insert into the target table is based on a condition in the `ON` clause.

Note: `MERGE` is a deterministic statement. That is, you cannot update the same row of the target table multiple times in the same `MERGE` statement. You must have `INSERT` and `UPDATE` object privileges in the target table and the `SELECT` privilege on the source table.

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;
/
```

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Inserting Data

In the example in the slide, an `INSERT` statement is used within a PL/SQL block to insert a record into the `employees` table. While using the `INSERT` command in a PL/SQL block, you can:

- Use SQL functions, such as `USER` and `SYSDATE`
- Generate primary key values by using existing database sequences
- Derive values in the PL/SQL block

Note: The data in the `employees` table needs to remain unchanged. Inserting, updating, and deleting are thus not allowed on this table.

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;
/
```

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Updating Data

There may be ambiguity in the `SET` clause of the `UPDATE` statement because, although the identifier on the left of the assignment operator is always a database column, the identifier on the right can be either a database column or a PL/SQL variable. Recall that if column names and identifier names are identical in the `WHERE` clause, the Oracle server looks to the database first for the name.

Remember that the `WHERE` clause is used to determine which rows are affected. If no rows are modified, no error occurs (unlike the `SELECT` statement in PL/SQL).

Note: PL/SQL variable assignments always use `:=`, and SQL column assignments always use `=`.

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;
/
```

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Deleting Data

The `DELETE` statement removes unwanted rows from a table. If the `WHERE` clause is not used, all the rows in a table can be removed if there are no integrity constraints.

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 = c.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;
/
```

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Merging Rows

The `MERGE` statement inserts or updates rows in one table by using data from another table. Each row is inserted or updated in the target table depending on an equijoin condition.

The example shown matches the `employee_id` in the `COPY_EMP` table to the `employee_id` in the `employees` table. If a match is found, the row is updated to match the row in the `employees` table. If the row is not found, it is inserted into the `copy_emp` table.

The complete example for using `MERGE` in a PL/SQL block is shown on the next notes page.

Merging Rows (continued)

```
DECLARE
    empno EMPLOYEES.EMPLOYEE_ID%TYPE := 100;
BEGIN
MERGE INTO copy_emp c
     USING employees e
     ON (e.employee_id = c.empno)
   WHEN MATCHED THEN
     UPDATE SET
       c.first_name     = e.first_name,
       c.last_name      = e.last_name,
       c.email          = e.email,
       c.phone_number   = e.phone_number,
       c.hire_date      = e.hire_date,
       c.job_id         = e.job_id,
       c.salary         = e.salary,
       c.commission_pct = e.commission_pct,
       c.manager_id     = e.manager_id,
       c.department_id  = e.department_id
   WHEN NOT MATCHED THEN
     INSERT VALUES(e.employee_id,  e.first_name, e.last_name,
          e.email, e.phone_number, e.hire_date, e.job_id,
          e.salary, e.commission_pct, e.manager_id,
          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: Created and managed internally by the Oracle server to process SQL statements**
  - **Explicit: Explicitly declared by the programmer**

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SQL Cursor

You have already learned that you can include SQL statements that return a single row in a PL/SQL block. The data retrieved by the SQL statement should be held in variables using the `INTO` clause.

Where Does Oracle Process SQL Statements?

The Oracle server allocates a private memory area called the *context area* for processing SQL statements. The SQL statement is parsed and processed in this area. Information required for processing and information retrieved after processing is all stored in this area. You have no control over this area because it is internally managed by the Oracle server.

A cursor is a pointer to the context area. However, this cursor is an implicit cursor and is automatically managed by the Oracle server. When the executable block issues a SQL statement, PL/SQL creates an implicit cursor.

There are two types of cursors:

- **Implicit:** Implicit cursors are created and managed by the Oracle server. You do not have access to them. The Oracle server creates such a cursor when it has to execute a SQL statement.

SQL Cursor (continued)

- **Explicit:** As a programmer you may want to retrieve multiple rows from a database table, have a pointer to each row that is retrieved, and work on the rows one at a time. In such cases, you can declare cursors explicitly depending on your business requirements. Cursors that are declared by programmers are called *explicit cursors*. You declare these cursors in the declarative section of a PL/SQL block. Remember that you can also declare variables and exceptions in the declarative section.

SQL Cursor Attributes for Implicit Cursors

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

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

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SQL Cursor Attributes for Implicit Cursors

SQL cursor attributes enable you to evaluate what happened when an implicit cursor was last used. Use these attributes in PL/SQL statements but not in SQL statements.

You can test the attributes `SQL%ROWCOUNT`, `SQL%FOUND`, and `SQL%NOTFOUND` in the executable section of a block to gather information after the appropriate DML command. PL/SQL does not return an error if a DML statement does not affect rows in the underlying table. However, if a `SELECT` statement does not retrieve any rows, PL/SQL returns an exception.

Observe that the attributes are prefixed with SQL. These cursor attributes are used with implicit cursors that are automatically created by PL/SQL and for which you do not know the names. Therefore, you use SQL instead of the cursor name.

The `SQL%NOTFOUND` attribute is opposite to `SQL%FOUND`. This attribute may be used as the exit condition in a loop. It is useful in `UPDATE` and `DELETE` statements when no rows are changed because exceptions are not returned in these cases.

You learn about explicit cursor attributes later in the course.

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
```

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SQL Cursor Attributes for Implicit Cursors (continued)

The example in the slide deletes a row with `employee_id` 176 from the `employees` table. Using the `SQL%ROWCOUNT` attribute, you can print the number of 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**

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Summary

The DML commands and transaction control statements can be used in PL/SQL programs without restriction. However, the DDL commands cannot be used directly.

A `SELECT` statement in PL/SQL block can return only one row. It is mandatory to use the `INTO` clause to hold the values retrieved by the `SELECT` statement.

A cursor is a pointer to the memory area. There are two types of cursors. Implicit cursors are created and managed internally by the Oracle server to execute SQL statements. You can use SQL cursor attributes with these cursors to determine the outcome of the SQL statement. Explicit cursors are declared by programmers.

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**

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Practice 4

Note: It is recommended to use *i*SQL*Plus for this practice.

1. Create a PL/SQL block that selects the maximum department ID in the `departments` table and stores it in the `max_deptno` variable. Display the maximum department ID.
   a. Declare a variable `max_deptno` of type `NUMBER` in the declarative section.
   b. Start the executable section with the keyword `BEGIN` and include a `SELECT` statement to retrieve the maximum `department_id` from the `departments` table.
   c. Display `max_deptno` and end the executable block.
   d. Execute and save your script as `lab_04_01_soln.sql`. Sample output is
   ```
   The maximum department_id is : 270
   PL/SQL procedure successfully completed.
   ```

2. Modify the PL/SQL block you created in exercise 1 to insert a new department into the `departments` table.
   a. Load the script `lab_04_01_soln.sql`. Declare two variables:
   `dept_name` of type `departments.department_name`.
   Bind variable `dept_id` of type `NUMBER`.
   Assign 'Education' to `dept_name` in the declarative section.
   b. You have already retrieved the current maximum department number from the `departments` table. Add 10 to it and assign the result to `dept_id`.
   c. Include an `INSERT` statement to insert data into the `department_name`, `department_id`, and `location_id` columns of the `departments` table. Use values in `dept_name`, `dept_id` for `department_name`, `department_id` and use NULL for `location_id`.
   d. Use the SQL attribute `SQL%ROWCOUNT` to display the number of rows that are affected.
   e. Execute a select statement to check if the new department is inserted. You can terminate the PL/SQL block with "/" and include the `SELECT` statement in your script.
   f. Execute and save your script as `lab_04_02_soln.sql`. Sample output is
   ```
   The maximum department_id is : 270
   SQL%ROWCOUNT gives 1
   PL/SQL procedure successfully completed.
   ```

DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
280	Education		

Practice 4 (continued)

3. In exercise 2, you have set `location_id` to null. Create a PL/SQL block that updates the `location_id` to 3000 for the new department. Use the bind variable `dept_id` to update the row.
   Note: Skip step a if you have not started a new *i*SQL*Plus session for this practice.
   a. If you have started a new *i*SQL*Plus session, delete the department that you have added to the `departments` table and execute the script `lab_04_02_soln.sql`.
   b. Start the executable block with the keyword `BEGIN`. Include the `UPDATE` statement to set the `location_id` to 3000 for the new department. Use the bind variable `dept_id` in your `UPDATE` statement.
   c. End the executable block with the keyword `END`. Terminate the PL/SQL block with "/" and include a `SELECT` statement to display the department that you updated.
   d. Finally, include a `DELETE` statement to delete the department that you added.
   e. Execute and save your script as `lab_04_03_soln.sql`. Sample output is shown below.

   PL/SQL procedure successfully completed.

DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
280	Education		3000

   1 row deleted.

4. Load the script `lab_03_05b.sql` to the *i*SQL*Plus workspace.
   a. Observe that the code has nested blocks. You will see the declarative section of the outer block. a. Look for the comment "INCLUDE EXECUTABLE SECTION OF OUTER BLOCK HERE" and start an executable section
   b. Include a single `SELECT` statement, which retrieves the `employee_id` of the employee working in the 'Human Resources' department. Use the `INTO` clause to store the retrieved value in the variable `emp_authorization`.
   c. Save your script as `lab_04_04_soln.sql`.