

# Oracle/C++ Application Programming

C++ Call Interface Programmer's Guide

<https://docs.oracle.com/database/121/LNCP/relational.htm#LNCP003>

# Agenda

- Connecting to a Database
- Executing SQL DDL and DML Statements
- Types of SQL Statements in the OCCI Environment
- Executing SQL Queries
- Committing a Transaction
- Handling Exceptions

# Connecting to a Database

# Creating and Terminating an Environment

- All OCCI processing takes place inside the Environment class.
- An OCCI environment provides application modes and user-specified memory management functions.
- To create an OCCI environment

```
Environment *env = Environment::createEnvironment();
```
- createxxx() methods are used to create OCCI objects such as
  - connections
  - Statements
- At the end of your program, you need to terminate the OCCI environment:

```
Environment::terminateEnvironment(env);
```

# Opening and Closing a Connection

- The *Environment* class is the factory class for creating *Connection* objects.
- Before creating a connection, you need to create the environment.
- Use an environment instance to create a connection:

```
Environment *env = Environment::createEnvironment();  
Connection *conn = env->createConnection("username", "password ", "Connection String");
```
- You must terminate a connection at the end of the session.

```
env->terminateConnection(conn);  
Environment::terminateEnvironment(env);
```

# Creating a Database Connection

```
1  #include <iostream>
2  #include <occi.h>
3
4  using oracle::occi::Environment;
5  using oracle::occi::Connection;
6  using namespace oracle::occi;
7  using namespace std;
8
9  int main(void)
10 {
11     /* OCCI Variables */
12     Environment* env = nullptr;
13     Connection* conn = nullptr;
14     /* Used Variables */
15     string str;
16     string user = "username";
17     string pass = "password";
18     string constr = "myoracle12c.senecacollege.ca:1521/oracle12c";
19     try {
20         env = Environment::createEnvironment(Environment::DEFAULT);
21         conn = env->createConnection(user, pass, constr);
22         cout << "Connection is Successful!" << endl;
23         env->terminateConnection(conn);
24         Environment::terminateEnvironment(env);
25     }
26     catch (SQLException& sqlExcp) {
27         cout << sqlExcp.getErrorCode() << ": " << sqlExcp.getMessage();
28     }
29     return 0;
30 }
```

# Executing SQL DDL and DML Statements

# Creating a Statement Object

- The *Statement* class is used to execute SQL commands.
- To create a statement objects:

```
Statement *stmt = conn->createStatement();
```



# Execute SQL Commands

- After creating the statement object, the following methods can be called to execute SQL commands:
  - `execute()`
    - executes all nonspecific statement types
  - `executeUpdate()`
    - executes DML and DDL statements
  - `executeArrayUpdate()`
    - executes multiple DML statements
  - `executeQuery()`
    - executes a query
- To create a table in a database:

```
stmt->executeUpdate("CREATE TABLE student  
(s_id NUMBER(4), name VARCHAR2(40))");
```
- To insert values into a table

```
stmt->executeUpdate("INSERT INTO student  
VALUES(10, 'Sarah Stone')");
```

# executeUpdate()

- The *executeUpdate()* executes a SQL INSERT, UPDATE, DELETE, and a DDL statements CREATE/ALTER.
- It returns the number of rows affected by the SQL statement execution.

# Terminating a Statement Object

- Terminate and deallocate a *Statement* object using the following statement:
  - `terminateStatement()`
- See the following code that closes a statement object `stmt`:

```
Connection::conn->terminateStatement (Statement *stmt);
```

# executeUpdate() – Create a Table

```
try {  
    env = Environment::createEnvironment(Environment::DEFAULT);  
    conn = env->createConnection(user, pass, constr);  
  
    stmt = conn->createStatement("CREATE TABLE student (s_id NUMBER(4), name VARCHAR2(40))");  
    stmt->executeUpdate();  
  
    cout << "Table Created successfully." << endl;  
  
    conn->terminateStatement(stmt);  
    env->terminateConnection(conn);  
    Environment::terminateEnvironment(env);  
}  
catch (SQLException& sqlExcp) {  
    cout << "error";  
    cout << sqlExcp.getErrorCode() << ": " << sqlExcp.getMessage();  
}
```

# executeUpdate() – Drop a Table

```
try {  
    env = Environment::createEnvironment(Environment::DEFAULT);  
    conn = env->createConnection(user, pass, constr);  
  
    stmt = conn->createStatement("drop table student");  
    stmt->executeUpdate();  
  
    cout << "Table deleted successfully." << endl;  
  
    conn->terminateStatement(stmt);  
    env->terminateConnection(conn);  
    Environment::terminateEnvironment(env);  
}  
catch (SQLException& sqlExcp) {  
    cout << "error";  
    cout << sqlExcp.getErrorCode() << ": " << sqlExcp.getMessage();  
}
```

# createStatement - Example

```
stmt = conn->createStatement("CREATE TABLE student (s_id NUMBER(4), name VARCHAR2(40))");  
stmt->executeUpdate();
```

or

```
stmt = conn->createStatement();  
stmt->executeUpdate("CREATE TABLE student (s_id NUMBER(4), name VARCHAR2(40))");
```

# Types of SQL Statements in the OCCI Environment

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# Types of SQL Statements

- There are three types of SQL statements in OCI.
  - Standard Statements
    - use SQL commands with specified values
  - Parameterized Statements
    - have parameters, or bind variables
  - Callable Statements
    - call stored PL/SQL procedures and functions



# Standard Statements

- In standard statements, the values are explicitly specified.
- See the following example:
  - To create a table in a database:

```
stmt->executeUpdate("CREATE TABLE student  
(s_id NUMBER(4), name VARCHAR2(40))");
```

- To insert values into a table

```
stmt->executeUpdate("INSERT INTO student  
VALUES(10, 'Sarah Stone')");
```

# Standard Insert Statement

```
try {  
    env = Environment::createEnvironment(Environment::DEFAULT);  
    conn = env->createConnection(user, pass, constr);  
  
    stmt = conn->createStatement("INSERT INTO student VALUES (10, 'Sarah Stone')");  
    stmt->executeUpdate();  
  
    cout << "Row Inserted successfully." << endl;  
  
    conn->terminateStatement(stmt);  
    env->terminateConnection(conn);  
    Environment::terminateEnvironment(env);  
}  
catch (SQLException& sqlExcp) {  
    cout << "error";  
    cout << sqlExcp.getErrorCode() << ": " << sqlExcp.getMessage();  
}
```

# Parameterized Statements

- A statement can be executed with different values using parameters as placeholders for the input values.
  - The *setxxx()* is used to specify parameters.
  - *XXX* stands for the type of the parameter.

- See the following example:

```
setSQL("INSERT INTO student VALUES (:1,:2) ");
```

- You first need to specify the statement using the *setSQL()* method.

```
stmt->setInt(1, 1003); // value for first parameter
```

```
stmt->setString(2, "Nick Shine"); // value for second parameter
```

```
stmt->executeUpdate(); // execute statement
```

```
...
```

```
stmt->setInt(1, 1004); // value for first parameter
```

```
stmt->setString(2, "Adam Sandler"); // value for second parameter
```

```
stmt->executeUpdate(); // execute statement
```

# setSQL()

- The setSQL() method is used to reuse a statement object to store and execute a SQL statement multiple times.

```
setSQL("INSERT INTO student VALUES (:1,:2) ");
```

- The getSQL() method can be called to the content of the current statement.
- To reset a statement object, call setSQL() method with the new SQL statement.

```
stmt->setSQL("SELECT * FROM inventories WHERE quantity < :1");
```

# Parameterized Insert Statement

```
try {  
  
    env = Environment::createEnvironment(Environment::DEFAULT);  
    conn = env->createConnection(user, pass, constr);  
  
    stmt = conn->createStatement();  
    stmt->setSQL("INSERT INTO student VALUES (:1,:2) ");  
    // insert one row  
    stmt->setInt(1, 1003); // value for first parameter  
    stmt->setString(2, "Nick Shine"); // value for second parameter  
    stmt->executeUpdate();  
  
    cout << "First Student Inserted Successfully." << endl;  
  
    //insert another row  
    stmt->setInt(1, 1004); // value for first parameter  
    stmt->setString(2, "Adam Sandler"); // value for second parameter  
    stmt->executeUpdate();  
  
    cout << "Second Student Inserted Successfully." << endl;  
  
    conn->terminateStatement(stmt);  
    env->terminateConnection(conn);  
    Environment::terminateEnvironment(env);  
}
```

# Reset Statement Objects

The method `setSQL()` can be used to reset a statement object to be used for a different SQL statement.

```
try {  
  
    env = Environment::createEnvironment(Environment::DEFAULT);  
    conn = env->createConnection(user, pass, constr);  
  
    stmt = conn->createStatement();  
    stmt->setSQL("INSERT INTO student VALUES (:1,:2) ");  
    // insert one row  
    stmt->setInt(1, 1005); // value for first parameter  
    stmt->setString(2, "Tim Black"); // value for second parameter  
    stmt->executeUpdate();  
  
    cout << "Student Inserted Successfully." << endl;  
  
    //reset the statement  
    stmt->setSQL("DELETE FROM student WHERE s_id = :1");  
    stmt->setInt(1, 1004); // value for first parameter  
    stmt->executeUpdate();  
  
    cout << "Student Deleted Successfully." << endl;  
  
    conn->terminateStatement(stmt);  
    env->terminateConnection(conn);  
    Environment::terminateEnvironment(env);  
}
```

# Callable Statements

- PL/SQL stored procedures are procedures stored on a database server which can be called inside a database or by an application.

- First define the statement to be executed:

```
stmt->setSQL("BEGIN countStudents(:1, :2); END:");
```

- The above command will call the *countStudents* stored procedure that has two parameters.
- First parameter is an *IN* parameter. It gets the value of PGM (program). The stored procedure will then find the number of students in the “CPA” program.

```
stmt->setString(1, "CPA");
```

- The second parameter is an *OUT* parameter. It stored the number of students in the “CPA” program and the values will be returned to the caller.

```
int count; // this variable stores the returning value from the  
countStudent() procedure
```

```
stmt->registerOutParam(2, Type::OCIINT, sizeof(count));  
// specify type and size of the second (OUT) parameter
```

- And finally, execute the statement to call and execute the stored procedure.

```
stmt->executeUpdate(); // call the procedure
```

- Now, save the returning value of the OUT parameter in the count variable.

```
count = stmt->getInt(2);
```

# Executing SQL Queries

- An application fetch information from a database by executing SQL queries.
- You can execute a query and store a result into a result set object.
- See the following example:

```
ResultSet *rs = stmt->executeQuery("SELECT * FROM student");
```

- The result of the above query is stored in *rs*.

```
cout << "The CPA program has:" << endl;
```

```
while (rs->next())
```

```
{
```

```
int count = rs->getInt(1); // get the first column as int
```

```
string name = rs->getString(2); // get the second column as string
```

```
cout << count << " " << students << endl;
```

```
}
```

- You can perform operations on data in the result set.
- The `next()` method is used to fetch the next row.
- The `getXXX()` is used to fetch the value of a column.



# ResultSet Class

- A ResultSet provides access to the result of a query.
- It provides a cursor pointing to the current row.
- The cursor initially is pointing to the position before the first row.
- The *next()* method moves the cursor to the next row.
- The *getxxx()* method is used to fetch the value of a column.

```
ResultSet::getxxx()
```

```
while (rs->next())
```

```
{
```

```
int count = rs->getInt(1); // get the first column as int
```

```
string name = rs->getString(2); // get the second column as string
```

```
cout << count << " " << students << endl;
```

```
}
```

# Query with Variables

- Variables can be used to specify values in the WHERE clause of a SQL query.
- We want to find students with gpa 3.2:

```
stmt->setSQL("SELECT * FROM student WHERE gpa >= :1");  
float gpa = 3.2;  
stmt->setFloat(1, gpa); // set the parameter  
ResultSet *rs = stmt->executeQuery();  
cout << "The students with GPA 3.2:" << endl;  
while (rs->next())  
    cout << rs->getInt(1) << " " << rs->getString(2) << endl;
```

# Standard SQL Query

```
try {  
  
    env = Environment::createEnvironment(Environment::DEFAULT);  
    conn = env->createConnection(user, pass, constr);  
  
    Statement* stmt = conn->createStatement("SELECT * FROM student");  
    ResultSet* rs = stmt->executeQuery();  
  
    if (!rs->next()) {  
        // if the result set is empty  
        cout << "ResultSet is empty." << endl;  
    }  
    else {  
        // if the result set is not empty  
        do {  
            cout << "Student ID: " << rs->getInt(1) << " Student Name: " << rs->getString(2) << endl;  
        } while (rs->next()); //if there is more rows, iterate  
    }  
  
    conn->terminateStatement(stmt);  
    env->terminateConnection(conn);  
    Environment::terminateEnvironment(env);  
}
```

# SQL Query with Parameters

```
try {  
  
    env = Environment::createEnvironment(Environment::DEFAULT);  
    conn = env->createConnection(user, pass, constr);  
  
    Statement* stmt = conn->createStatement("SELECT * FROM student WHERE s_id = :1");  
    stmt->setInt(1,1004);  
    ResultSet* rs = stmt->executeQuery();  
  
    if (!rs->next()) {  
        // if the result set is empty  
        cout << "ResultSet is empty." << endl;  
    }  
    else {  
        // if the result set is not empty  
        do {  
            cout << "Student ID: " << rs->getInt(1) << " Student Name: " << rs->getString(2) << endl;  
        } while (rs->next()); //if there is more rows, iterate  
    }  
}
```

# getXXX() Methods

Method	Description
getDate()	Return the value of a parameter as a Date object
getDouble()	Return the value of a parameter as a C++ double.
getFloat()	Return the value of a parameter as a C++ float.
getInt()	Return the value of a parameter as a C++ int.
getNumber()	Return the value of a parameter as a Number object.
getString()	Return the value of the parameter as a string.

# isNull() Method

- Checks whether the parameter is null.

```
Statement* stmt = conn->createStatement("SELECT * FROM student WHERE s_id = :1");
stmt->setInt(1,1005);
ResultSet* rs = stmt->executeQuery();

if (!rs->next()) {
    // if the result set is empty
    cout << "ResultSet is empty." << endl;
}
else {
    // if the result set is not empty
    do {
        if (!rs->isNull(2)) //if the column name is not null
        {
            cout << "Student ID: " << rs->getInt(1) << " Student Name: " << rs->getString(2) << endl;
        } else
        {
            cout << "Student ID: " << rs->getInt(1) << " Student Name: " << "Unknown" << endl;
        }
    } while (rs->next()); //if there is more rows, iterate
}
```

# setXXX() Methods

Method	Description
setDate()	Set a parameter to a Date value.
setDouble()	Set a parameter to a C++ double value.
setFloat()	Set a parameter to a C++ float value.
setInt()	Set a parameter to a C++ int value.
setNull()	Set a parameter to SQL null.
setNumber()	Set a parameter to a Number value.
setString()	Set a parameter to an string value.

# Transactions

- Changes by DDL statements become permanent after committing the transaction or reversed by rollback.
- Commit and Rollback commands can be execute when using `executeUpdate()`.
  - `Connection::commit()`
  - `Connection::rollback()`
- To make changes of DML statements permanent immediately, execute the following command:  
`Statement::setAutoCommit (TRUE) ;`
- To set the auto commit off:  
`Statement::setAutoCommit (FALSE) ;`



# Handling Exceptions

- OCCI methods generates exceptions of type *SQLException* if they are unsuccessful.
  - The *SQLException* class contains Oracle specific error numbers and messages.
  - The error message can be obtained by the *exception::what()* or *getMessage()* method.
  - The *getErrorCode()* returns the Oracle error code.
- See the following examples:

```
catch (exception &excp)
{
    cerr << excp.what() <<
    endl;
}
```

```
catch (SQLException &sqlExcp)
{
    cerr <<sqlExcp.getErrorCode << ": " <<
    sqlExcp.getErrorMessage() << endl;
}
catch (exception &excp)
{
    cerr << excp.what() << endl;
}
```