National University of Computer & Emerging Sciences, Karachi
Computer Science Department
Spring 2022, Lab Manual - 10

Course Code: SL3001	**Course: Software Construction and Development**
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Lab # 10

Introduction to MySQL

MySQL is a widely used, free and open-source relational database management system (RDBMS). It is ideal for both small and large applications.

Let's go through some basic operations for MySQL. We will later use this table to perform CRUD operations using your application on Eclipse.

CREATE DATABASE

The CREATE DATABASE statement is used to create a new SQL database. (You can also use the command CREATE SCHEMA)

```
CREATE DATABASE `lab10 ` ;
```

CREATE TABLE

The CREATE TABLE statement is used to create a new table in a database. It follows the following format:

```
CREATE TABLE table_name (
   column1 datatype,
   column2 datatype,
   column3 datatype,
  ....
);
```

Create the following table:

```
CREATE TABLE `person` (
 `id` INT NOT NULL,
`name` VARCHAR(45) NULL,
`address` VARCHAR(45) NULL,
PRIMARY KEY (`id`)
);
```

INSERT INTO

The INSERT INTO statement is used to insert new records in a table. You have to specify both the column names and the values to be inserted:

INSERT INTO *table_name* (*column1*, *column2*, *column3*, ...)
VALUES (*value1*, *value2*, *value3*, ...);

NOTE: you must surround string insides single quotations ('), however, you can enter numbers directly.

Now insert the following rows into your table:

INSERT INTO \`person\` (\`id\`, \`name\`, \`address\`) VALUES ('10', 'Sophia', 'Manchester');

INSERT INTO \`person\` (\`id\`, \`name\`, \`address\`) VALUES ('11', 'William', 'Washington');

INSERT INTO \`person\` (\`id\`, \`name\`, \`address\`) VALUES ('12', 'Alex', 'Boise');

INSERT INTO \`person\` (\`id\`, \`name\`, \`address\`) VALUES ('13', 'Amelia', 'London');

SELECT

The SELECT statement is used to select data from a database. Syntax:

SELECT * FROM *table_name*;

Try viewing your table with the statement:

SELECT * from \`person\`;

WHERE, AND, OR & NOT

The WHERE clause is used to filter records. It can be combined with AND, OR, and NOT operators.

SELECT *column1*, *column2, ...*
FROM *table_name*
WHERE *condition1* **AND** *condition2* **OR** *condition3 ...*;

SELECT *column1*, *column2, ...*
FROM *table_name*
WHERE NOT *condition*;

ORDER BY

The ORDER BY keyword is used to sort the result-set in ascending or descending order.

SELECT *column1*, *column2, ...*
FROM *table_name*
ORDER BY *column1, column2, ...* ASC|DESC;

Try sorting by name on your table.

SELECT * from `person` order by `name` desc;

UPDATE & SET

The UPDATE statement is used to modify the existing records in a table. SET is a keyword that is used along with the UPDATE statement in order to set the new values. It has the following syntax:

UPDATE *table_name*
SET *column1* = *value1*, *column2* = *value2*, ...
WHERE *condition*;

NOTE: If you omit the WHERE clause, all records in the table will be updated!

DELETE

The DELETE statement is used to delete existing records in a table.

DELETE FROM *table_name* WHERE *condition*;

NOTE: If you omit the WHERE clause, all records in the table will be deleted!

LIMIT

The LIMIT clause is used to specify the number of records to return. It is useful on large tables with thousands of records. Returning a large number of records can impact performance.

SELECT *column_name(s)*
FROM *table_name*
WHERE *condition*
LIMIT *number*;

Try it for your own table to return the top two records in the table:

SELECT * FROM `person`
LIMIT 2;

MIN() & MAX()

The MIN() function returns the smallest value of the selected column. Syntax:

SELECT MIN(*column_name*)
FROM *table_name*
WHERE *condition*;

The MAX() function returns the largest value of the selected column. Syntax:

SELECT MAX(*column_name*)
FROM *table_name*
WHERE *condition*;

COUNT, AVG & SUM

The COUNT() function returns the number of rows that matches a specified criterion. Syntax:

SELECT COUNT(*column_name*)
FROM *table_name*
WHERE *condition*;

The AVG() function returns the average value of a numeric column. Syntax:

SELECT AVG(*column_name*)
FROM *table_name*
WHERE *condition*;

The SUM() function returns the total sum of a numeric column. Syntax:

SELECT SUM(*column_name*)
FROM *table_name*
WHERE *condition*;

NOTE: Please explore rest of the things on your own! We have covered the very basics here.

You can download MySQL from here: https://dev.mysql.com/downloads/windows/installer/8.0.html

The mysql connector jar file would be present in **C:\Program Files (x86)\MySQL\Connector J 8.0** if you installed it with default settings.

JDBC

Java Database Connectivity (JDBC) is an application programming interface (API) for the Java programming language, which defines how a client may access a database. It is a Java-based data access technology used for Java to database connectivity and it is part of the Java Standard Edition platform and given by Oracle corporation. It provides methods to query and update data in a database and is oriented toward relational databases.

JDBC technology allows us to use the Java programming language to exploit “Write Once, Run Anywhere” capabilities for applications that require access to enterprise data. With a JDBC technology-enabled driver, we can connect all corporate data even in a heterogeneous environment.

For each database, we need a separate JDBC driver. If we want to work with Oracle database then arrange Oracle JDBC driver, for MySQL database arrange MySQL JDBC driver/connector, and for PostgreSQL arrange PostgreSQL JDBC driver.

JDBC Basic components are:

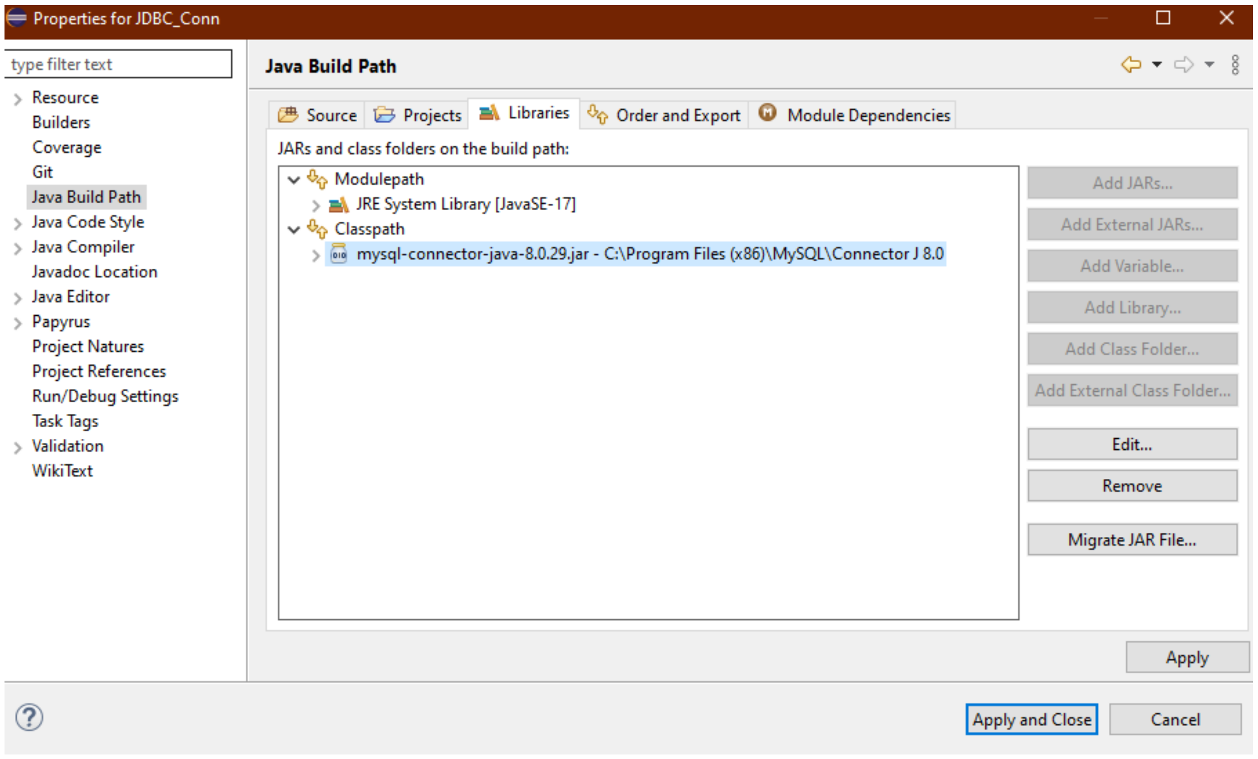
1. **Driver**: It works as a translator which converts Java-specific call to database call and database-specific call to Java call.
2. **Connection**: From Java application to reach database some network connection is required, that network socket is nothing but a connection.
3. **Statement**: It is used to send the SQL queries to the database.
4. **ResultSet**: It holds the result of the SQL query.

JDBC features:

1. It is a standalone API. It is database-independent technologies. JDBC program written for one database can be used for any database.
2. It supports WORA (write once and run anywhere). Most JDBC drivers are written in Java only so it can be used on any platform.
3. Using JDBC we can easily perform CRUD operations. C=> Create, R=> Retrieve, U=> Update, D=> Delete.
4. JDBC technology is open-source so most of the vendors developed their product based on JDBC.

Using JDBC with Eclipse:

1. Open Eclipse => chose your workspace => File => New => Other => Search for “Java Project” => Next => Enter project name (Example: MySQLDBConnection) => Finish
2. Now, open the properties of the project. For this you can use shortcut key:- select project then Alt + Enter (Or) Right click on the Project => Properties
3. In the Java Build path, in the Libraries Section => Classpath => Click on “Add External Jars” => Select *mysql-connector-java-<version>.jar* => Apply => Apply and close



JARs and class folders on the build path:

```
Modulepath
  JRE System Library [JavaSE-17]
Classpath
  mysql-connector-java-8.0.29.jar - C:\Program Files (x86)\MySQL\Connector J 8.0
```

4. In the Project Explorer, in that Java Project, in the “Referenced Libraries” section, You can see that *mysql-connector-java-<version>.jar* is available. Eclipse IDE will use it while compilation and execution process.
5. In the Java project => Right-click on “src” => New => Class => ClassName => Finish. Use a reasonable class name, like: *ConnectionTest, Conn_Class, etc.*
6. Now we need some details of the JDBC driver to develop our program.
   a. JDBC Driver Class Name:: ***com.mysql.cj.jdbc.Driver***
   b. URL for local MySQL:: **jdbc:mysql:///<logical-database-name>**
      NOTE: You can view the name of the database by using **“show databases”** command
   c. Username: ***<username-of-MySQL-database>***
   d. Password: ***<password-of-MySQL-database>***
7. Write the following program to test your connection:

```
import java.sql.Connection;
import java.sql.DriverManager;

public class Conn_class {

	public static void main(String[] args) throws Exception{
		// see note at bottom
		Class.forName("com.mysql.cj.jdbc.Driver");

		// variables for connection
		final String url = "jdbc:mysql:///test";
```

```
          final String user = "root";
          final String password = "yourpassword";

          // establish the connection
          Connection   con   =   DriverManager.getConnection(url,   user,
password);

          // display status message
          if (con == null) {
            System.out.println("JDBC connection is not established");
            return;

          } else {
            System.out.println("Congratulations,   JDBC   connection   is
established successfully.\n");

          }

          //Remember to close the JDBC connection
          con.close();

      }

}
```

NOTE: When you are using JDBC outside of an application server, the **DriverManager** class manages the establishment of connections.
Specify to the **DriverManager** which JDBC drivers to try to make Connections with. The easiest way to do this is to use **Class.forName()** on the class that implements the **java.sql.Driver** interface. With **MySQL Connector/J**, the name of this class is **com.mysql.jdbc.Driver**. With this method, you could use an external configuration file to supply the driver class name and driver parameters to use when connecting to a database.

8. Now let make a class (for example: SelectTest) in which we can try fetching the information from the database.

```
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.ResultSet;
import java.sql.SQLException;
import java.sql.Statement;

public class SelectTest {

      public static void main(String[] args) throws SQLException {
            // variables
            final String url = "jdbc:mysql:///test";
            final String user = "root";
            final String password = "yourpassword";

            // establish the connection
            Connection  con  =  DriverManager.getConnection(url,  user, 
password);

            // create JDBC statement object
            Statement st = con.createStatement();

            // prepare SQL query
            String query = "SELECT ID, NAME, ADDRESS FROM PERSON";

            // send and execute SQL query in Database software
            ResultSet rs = st.executeQuery(query);

            // process the ResultSet object
            boolean flag = false;
            while (rs.next()) {
               flag = true;
               System.out.println(rs.getInt(1) + " " + rs.getString(2) + 
                        " " + rs.getString(3));
            }

            if (flag == true) {
               System.out.println("\nRecords retrieved and displayed");
            } else {
               System.out.println("Record not found");
            }

            // close JDBC objects
            rs.close();
            st.close();
            con.close();
      }

}
```

9. Now let’s see how we can insert a record. Create a new class (for example: InsertTest)

```java
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.SQLException;
import java.sql.Statement;
import java.util.Scanner;

public class InsertTest {
      // values specific to each database
      private static final String URL = "jdbc:mysql:///test";
      private static final String USERNAME = "root";
      private static final String PASSWORD = "YourPassword";

      public static void main(String[] args) {
            // declare variables
           Scanner scan = null;
           int sno = 0;
           String sname = null, sadd = null;
           float avg = 0.0f;
           String query = null;
           Connection con = null;
           Statement st = null;
           int count = 0;

           try {
               // create Scanner class object
               scan = new Scanner(System.in);

               // read input
               if(scan != null) {
                  System.out.print("Enter student number: ");
                  sno = scan.nextInt();
            System.out.print("Enter student name: ");
            sname = scan.next();
            System.out.print("Enter student address: ");
            sadd = scan.next();
         }
         // prepare SQL query
         query = "INSERT INTO PERSON VALUES ("
                 + sno + ", " + "\'" + sname +"\' ,"
                 +"\'"+ sadd + "\') ";

         // establish the connection
         con = DriverManager.getConnection(
                     URL, USERNAME, PASSWORD);

         // create JDBC statement object
         if(con != null) {
            st = con.createStatement();
         }
         // execute the SQL query
         if(st != null) {
            count = st.executeUpdate(query);
         }
         // display result
         System.out.println(count + " record inserted.");

      } catch(SQLException se) {
         se.printStackTrace();
      } catch(Exception e) {
         e.printStackTrace();
      } // try-catch block end
     finally {
```

```
                // close JDBC objects
                try {
                   if(st != null) st.close();
                } catch(SQLException se) {
                   se.printStackTrace();
                }
                try {
                   if(con != null) con.close();
                } catch(SQLException se) {
                   se.printStackTrace();
                }
                try {
                   if(scan != null) scan.close();
                } catch(Exception e) {
                   e.printStackTrace();
                }
             }//finally block end
      }
}
```

TYPES OF STATEMENTS

Statement:

It is the object of a JDBC driver software supplied Java class that implements java.sql.Statement(I). It is also called as Simple Statement because it is used with simple SQL statements without parameters. We have seen how to use these in our previous examples.

PreparedStatement object:

It is the object of a JDBC driver software supplied Java class that implements java.sql.PreparedStatement(I). It is extended from java.sql.Statement(I), and it is used for precompiling SQL statements that might contain input parameters.

CallableStatment object:

It is the object of a JDBC driver software supplied Java class that implements java.sql.CallableStatement(I). It is also extended from java.sql.Statement(I), and it is used to execute stored procedures that may contain both input and output parameters.

How to Write a Program that uses Prepared Statements:

1. Prepare SQL query with positional parameter/place holder/place resolver (?)
   ```
   String query = "INSERT INTO PERSON VALUES(?,?,?)";
   ```
2. Send SQL query to Database software. Make that SQL query as pre-compiled SQL query in database software and get **PreparedStatement** object representing the SQL query.
   ```
   PreparedStatement ps = con.prepareStatement(query);
   ```
3. Set input values to pre-compiled SQL query parameters(?) using setXxx(-) methods.
   ```
   ps.setInt(1,1001); // ID

   ps.setString(2, “Abeeha Sattar”); // product name

   ps.setString(3, “My Address”); // price of product
   ```
4. Execute the pre-compiled SQL query in database software
   ```
   int result = ps.executeUpdate();
   ```
5. Process the result:
   ```
   if(result == 0)
         System.out.println("Not inserted");
   else
         System.out.println("record inserted");
   ```
6. Execute the above pre-compiled SQL query for multiple times either with same or difference values (repeat 3 to 5 steps)
7. Close the JDBC objects.
   ```
   ps.close();
   con.close();
   ```

Example for Insert Prepared Statement:

```
import java.sql.Connection;

import java.sql.DriverManager;

import java.sql.PreparedStatement;

import java.sql.SQLException;

import java.util.Scanner;


public class PreparedInsert {

      // SQL query

      private static final String INSERT_PERSON_QUERY = "INSERT INTO PERSON
VALUES(?,?,?)";

      private static final String URL = "jdbc:mysql:///test";

      private static final String USERNAME = "root";
```

```
      private static final String PASSWORD = "YourPassword";

      public static void main(String[] args) {
            // declare variables
          Scanner scan = null;
          int noRec = 0, sid = 0;
          String name = null, address = null;
          Connection con = null;
          PreparedStatement ps = null;
          int result = 0;

          try {
               // read input
               scan = new Scanner(System.in);
               if(scan != null) {
                  System.out.print("Enter the number of records that you want
to insert: ");
                  noRec = scan.nextInt();
               }

               // establish the connection
               con = DriverManager.getConnection(URL, USERNAME, PASSWORD);

               // compile SQL query and
               // store it in PreparedStatemet object
               if(con != null)
                  ps = con.prepareStatement(INSERT_PERSON_QUERY);

               // read multiple set of inputs from end-user
               // set input values and execute the query
               if(scan != null && ps != null) {
```

```
               for(int i=0; i < noRec; i++) {

                  // read inputs
                  System.out.println("\nEnter Record-"+ (i+1) +
                                  " details, ");
                  System.out.print("ID: ");
                  sid = scan.nextInt();
                  System.out.print("Name: ");
                  name = scan.next();
                  System.out.print("Address: ");
                  address = scan.next();

                  // set input values to query parameters
                  ps.setInt(1, sid);
                  ps.setString(2, name);
                  ps.setString(3, address);

                  // execute the query
                  result = ps.executeUpdate();
              }
           }

           // process the result
           if(result == 0)
               System.out.println("\nRecords not inserted");
           else
               System.out.println("\nRecords inserted"+
                                        " successfully");

        } catch(SQLException se) {
           se.printStackTrace();
```

```
            } catch(Exception e) {
               e.printStackTrace();
            } // end of try-catch block
      }

}
```

Example for Update Prepared Statement:

```
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.PreparedStatement;
import java.sql.SQLException;
import java.util.Scanner;

public class PreparedUpdate {
      // SQL query
      private static final String UPDATE_PERSON_QUERY =
                "UPDATE PERSON SET NAME = ?, ADDRESS = ?"
                + "WHERE ID = ? ";
      private static final String URL = "jdbc:mysql:///test";
      private static final String USERNAME = "root";
      private static final String PASSWORD = "YourPassword";

      public static void main(String[] args) {
            // declare variables
            Scanner scan = null;
            int id = 0;
            String name = null;
            String address = null;
            Connection con = null;
            PreparedStatement ps = null;
            int result = 0;

            try {
              //read input
              scan = new Scanner(System.in);
              if(scan != null) {
                    System.out.println("Enter the existing person ID to 
update: ");
                    id = scan.nextInt();
                    System.out.println("Enter new details,");
                    System.out.print("Name of the person: ");
                    name = scan.next();
                    System.out.print("Address: ");
                    address = scan.next();
              }
              // establish the connection
              con = DriverManager.getConnection(URL, USERNAME, PASSWORD);

              // compile SQL query and
                // store it in PreparedStatemet object
                if(con != null)
                   ps = con.prepareStatement(UPDATE_PERSON_QUERY);

                // set input values and execute query
                if(ps != null) {
                    // set input values to query parameters
                    ps.setString(1, name);
                    ps.setString(2, address);
                    ps.setInt(3, id);
                    // execute the query
                    result = ps.executeUpdate();
                }

                // process the result
                if(result == 0)
                  System.out.println("Records not updated");
                else
                  System.out.println("Records updated successfully");

            } catch(SQLException se) {
                se.printStackTrace();
            } catch(Exception e) {
               e.printStackTrace();
            } // end of try-catch block
            finally {
                // close JDBC objects
                try {
                   if(ps != null) ps.close();
                } catch(SQLException se) {
                   se.printStackTrace();
                }
                try {
                   if(con != null) con.close();
                } catch(SQLException se) {
                   se.printStackTrace();
                }
                try {
                   if(scan != null) scan.close();
                } catch(Exception e) {
                   e.printStackTrace();
                }
            } // end of finally block
      }
}
```

Example for Select and Display Record using Prepared Statement

```
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.PreparedStatement;
import java.sql.ResultSet;
import java.sql.SQLException;
import java.util.Scanner;

public class PreparedSelect {
      // SQL query
      private static final String SELECT_PERSON_QUERY =
              "SELECT NAME, ADDRESS FROM PERSON"+
              " WHERE ID = ?";
      private static final String URL = "jdbc:mysql:///test";
      private static final String USERNAME = "root";
      private static final String PASSWORD = "YourPassword";

      public static void main(String[] args) {
             // declare variables
            Scanner scan = null;
            int id = 0;
            Connection con = null;
            PreparedStatement ps = null;
            ResultSet rs = null;
            boolean flag = false;
            try {
```

```
            // read input
             scan = new Scanner(System.in);
             if(scan != null) {
                System.out.print("Enter person ID: ");
                id = scan.nextInt();
             }

             // establish the connection
             con = DriverManager.getConnection(URL, USERNAME, PASSWORD);

             // compile SQL query and
               // store it in PreparedStatemet object
               if(con != null)
               ps = con.prepareStatement(SELECT_PERSON_QUERY);

               // set input value to query parameter
               if(ps != null)
                  ps.setInt(1, id);
               // execute the query
               if(ps != null)
                  rs = ps.executeQuery();
               // process the result
               if(rs != null) {
                 while(rs.next()) {
                    flag = true;
                    System.out.println(""
                       + rs.getString("NAME") +" "
                       + rs.getString("ADDRESS"));
                 }
               }
```

```
                if(flag)
                    System.out.println("Records fetched & displayed");
                else
                    System.out.println("Records not found");
            } catch(SQLException se) {
                se.printStackTrace();
            } catch(Exception e) {
               e.printStackTrace();
            } // end of try-catch block
            finally {
                // close JDBC objects
                try {
                   if(ps != null) ps.close();
                } catch(SQLException se) {
                   se.printStackTrace();
                }
                try {
                   if(con != null) con.close();
                } catch(SQLException se) {
                   se.printStackTrace();
                }
                try {
                   if(scan != null) scan.close();
                } catch(Exception e) {
                   e.printStackTrace();
                }
            } //end if finally block
      }
}
```