Java jdbc tutorial point pdf

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I presume that you have some knowledge on Relational Databases and the SQL language. Otherwise, read "Introduction to Relational Database and SQL". Setting-up MySQL In this article, I shall describe the MySQL Relational Database Management System. For other database systems, read "Other Databases". Install MySQL (Read "How to Set Up MySQL and Get Started"). I shall assume that the MySQL server is running on the default TCP port number 3306. On MySQL, instead of using the "mysql" command-line client program provided, you can write your own client programs (in Java or other languages) to access the MySQL server. Your client programs shall connect to the database server at the given IP address and TCP port number, issue the SQL commands, and process the results received. Install JDK and Programming Editor Before you proceed, I shall assume that you are familiar with Java Programming and have installed the followings: Create a Directory to Keep all your Works I shall assume that you have created a directory called "c:\myWebProject" (for Windows) or "~/myWebProject" (for macOS) in your earlier exercises. Do it otherwise. This step is important; otherwise, you will be out-of-sync with this article and may not be able to find your files later. Install MySQL JDBC Driver (IMPORTANT - Don't MISS This Step!) You need to install an appropriate JDBC (Java Database Connectivity) driver to run your Java database programs. The MySQL's JDBC driver is called "MySQL Connector/J" and is available at MySQL mother site. Setup Database We have to set up a database before embarking on our database programming. We shall call our database "ebookshop" which contains a table called "books", with 5 columns, as below: Database: ebookshop Table: books +-------+----------+-------+--------+------+ | id | title | author | price | qty | | (INT) | (VARCHAR(50)) | (VARCHAR(50)) | (FLOAT) | (INT) | +-------+----------+-------+--------+------+ | 1001 | Java for dummies | Tan Ah Teck | 11.11 | 11 | | 1002 | More Java for dummies | Tan Ah Teck | 22.22 | 22 | | 1003 | More Java for more dummies | Mohammad Ali | 33.33 | 33 | | 1004 | A Cup of Java | Kumar | 44.44 | 44 | | 1005 | A Teaspoon of Java | Kevin Jones | 55.55 | 55 | +-------+----------+-------+--------+------+ Start MySQL Server: Start the MySQL server and verify the server's TCP port number from the console messages. I shall assume that MySQL server is running on the default port number of 3306. c: cd \myWebProject\mysql\bin mysqld --console Start a MySQL client: I shall also assume that there is an authorized user called "myuser" with password "xxxx". c: cd \myWebProject\mysql\bin mysql -u myuser -p cd /usr/local/mysql/bin ./mysql -u myuser -p Run the following SQL statements to create our test database and table. create database if not exists ebookshop; use ebookshop; drop table if exists books; create table books (id int, title varchar(50), author varchar(50), price float, qty int, primary key (id)); insert into books values (1001, 'Java for dummies', 'Tan Ah Teck', 11.11, 11); insert into books values (1002, 'More Java for dummies', 'Tan Ah Teck', 22.22, 22); insert into books values (1003, 'More Java for more dummies', 'Mohammad Ali', 33.33, 33); insert into books values (1004, 'A Cup of Java', 'Kumar', 44.44, 44); insert into books values (1005, 'A Teaspoon of Java', 'Kevin Jones', 55.55, 55); select * from books; Introduction to JDBC Programming by Examples A JDBC program comprises the following FIVE steps: STEP 1: Allocate a Connection object, for connecting to the database server. STEP 2: Allocate a Statement object, under the Connection created earlier, for holding a SQL command. STEP 3: Write a SQL query and execute the query, via the Statement and Connection created. STEP 4: Process the query result. STEP 5: Close the Statement and Connection to free up the resources. We shall illustrate Java Database programming by the following examples. Example 1: SQL SELECT Try out the following JDBC program, which issues an SQL SELECT to MySQL. Save the program as "JdbcSelectTest.java" in your project directory "c:\myWebProject" (Windows) or "~/myWebProject" (macOS). 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 import java.sql.*; public class JdbcSelectTest { public static void main(String[] args) { try (Connection conn = DriverManager.getConnection("jdbc:mysql://localhost:3306/ebookshop?allowPublicKeyRetrieval=true&useSSL=false&serverTimezone=UTC", "myuser", "xxxx"); Statement stmt = conn.createStatement();) { String strSelect = "select title, price, qty from books"; System.out.println("The SQL statement is: " + strSelect + ""); ResultSet rset = stmt.executeQuery(strSelect); System.out.println("The records selected are:"); int rowCount = 0; while(rset.next()) { String title = rset.getString("title"); double price = rset.getDouble("price"); int qty = rset.getInt("qty"); System.out.println(title + ", " + price + ", " + qty); ++rowCount; } System.out.println("Total number of records = " + rowCount); } catch(SQLException ex) { ex.printStackTrace(); } } } Compile: To compile the program: c: cd \myWebProject javac JdbcSelectTest.java cd ~/myWebProject javac JdbcSelectTest.java Run: It is rather difficult to run the program, as you need to include the MySQL JDBC Driver in the classpath (via -cp option) as follows. Replace {xx} with your installation number. c: cd \myWebProject java -cp .;C:\myWebProject\mysql-connector-java-8.0.{xx}\mysql-connector-java-8.0.{xx}.jar JdbcSelectTest cd ~/myWebProject java -cp .:$HOME/myWebProject/mysql-connector-java-8.0.{xx}/mysql-connector-java-8.0.{xx}.jar JdbcSelectTest You should COPY and SAVE this command to a scratch pad, so that you don't need to type this super-long command again and again. The -cp includes two paths separated by a ";" (Windows) or ":" (macOS). The "." denotes the current directory (to locate the JdbcSelectTest) followed by the full-path filename of the MySQL JDBC Driver JAR-file (that I asked you to take note earlier). (Skip Unless...) Read "Common Errors in JDBC Programming on MySQL". (For Eclipse IDE User) If you use Eclipse IDE, check my Eclipse article on how to add an external JAR file into an Eclipse project. Dissecting the Program The JDBC operations are carried out through the "Connection", "Statement" and "ResultSet" objects (defined in package java.sql). However, you need not know the details, but merely the public methods defined in the API (Application Program Interface). You also need not re-invent the wheels by creating these classes yourself (which will take you many years?!). "Re-using" software component is a main strength of OOP. Notice that there is little programming involved in using JDBC programming. You only have to specify the database-URL, write the SQL query, and process the query result. The rest of the codes are kind of "standard JDBC program template". Again, this is because the wheels have been invented. In Line 7, we allocate a Connection object (called conn) via DriverManager.getConnection(database-url, db-user, password). The Java program uses a so-called database-URL to connect to the server: For MySQL: Connection conn = DriverManager.getConnection("jdbc:mysql://localhost:{port}/{database-name}", "{user}", "{password}"); Connection conn = DriverManager.getConnection("jdbc:mysql://localhost:3306/ebookshop", "myuser", "xxxx"); The database-url is in the form of "jdbc:mysql://{host}:{port}/{database-name}", with protocol jdbc and sub-protocol mysql. The port specifies the MySQL server's TCP port number; user/password is an authorized MySQL user. In our example, "localhost" (with special IP address of 127.0.0.1) is the hostname for local loop-back; "3306" is the server's TCP port number, and ebookshop is the database name. Others: Read "Other Databases". In Line 13, we allocate a Statement object (called stmt) inside the Connection created in the previous step via conn.createStatement(). In Line 16, we write a SQL SELECT command string (called strSelect). To execute the SQL command, we invoke method stmt.executeQuery(strSelect). It returns the query result in a ResultSet object (called rset). The ResultSet models the returned table, which can be access via a row cursor. The cursor is initially positioned before the first row in the ResultSet. The method rset.next() moves the cursor to the first row. You can then use rset.getXxx(columnName) to retrieve the value of the column for that row, where Xxx corresponds to the type of the column, such as int, float, double and String. The while-loop issue rset.next() repeatedly to move the cursor to the next row, and processes row-by-row. The rset.next() returns false at the last row of the ResultSet, which terminates the while-loop. You could use rset.getString(columnName) to retrieve all types (int, double, etc). For maximum portability, ResultSet columns within each row should be read in left-to-right order, and each column should be read only once via the getXxx() methods. Issue getXxx() to a cell more than once may trigger a strange error. In this example, we use JDK 7's new feature called try-with-resources, which automatically closes all the opened resources in the try-clause, in our case, the Connection and Statement objects. Exercises: Modify the above program to issue the following SELECT statements and display all the columns retrieved. Make sure that you modify the ResultSet processing to process only the columns retrieved (otherwise, you will get a "Column not found" error). SELECT * FROM books SELECT title, author, price, qty FROM books WHERE author = 'Tan Ah Teck' OR price >= 30 ORDER BY price DESC, id ASC Example 2: SQL UPDATE To execute a SQL UPDATE, you have to invoke the method executeUpdate() of the Statement object, which returns an int indicating the number of records affected (Line 19). Recall that for SELECT, we use executeQuery(), which returns a ResultSet object modeling the returned table (Line 25). SQL UPDATE|INSERT|DELETE does not return a table, but an int indicating the number of records affected. Save the program as "JdbcUpdateTest.java" in your project directory "c:\myWebProject" (Windows) or "~/myWebProject" (macOS). 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 import java.sql.*; public class JdbcUpdateTest { public static void main(String[] args) { try (Connection conn = DriverManager.getConnection("jdbc:mysql://localhost:3306/ebookshop?allowPublicKeyRetrieval=true&useSSL=false&serverTimezone=UTC", "myuser", "xxxx"); Statement stmt = conn.createStatement();) { String strUpdate = "update books set price = price*1.07, qty = qty+1 where id = 1001"; System.out.println("The SQL statement is: " + strUpdate + ""); int countUpdated = stmt.executeUpdate(strUpdate); System.out.println(countUpdated + " records affected."); String strSelect = "select * from books where id = 1001"; System.out.println("The SQL statement is: " + strSelect + ""); ResultSet rset = stmt.executeQuery(strSelect); while(rset.next()) { System.out.println(rset.getInt("id") + ", " + rset.getString("author") + ", " + rset.getString("title") + ", " + rset.getDouble("price") + ", " + rset.getInt("qty")); } } catch(SQLException ex) { ex.printStackTrace(); } } } See the previous example on how to compile and run this program! Point to this Java file "JdbcUpdateTest"! Exercises: Modify your Java program to issue the following SQL statements: Increase the price by 50% for "A Cup of Java". Set the qty to 0 for "A Teaspoon of Java". Example 3: SQL INSERT and DELETE Similarly, use the executeUpdate() to execute 'INSERT INTO' and 'DELETE FROM' (Line 20, 26, 34, 40). The method returns an int indicating the number of records affected. Save the program as "JdbcInsertTest.java" in your project directory "c:\myWebProject" (Windows) or "~/myWebProject" (macOS). 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 import java.sql.*; public class JdbcInsertTest { public static void main(String[] args) { try (Connection conn = DriverManager.getConnection("jdbc:mysql://localhost:3306/ebookshop?allowPublicKeyRetrieval=true&useSSL=false&serverTimezone=UTC", "myuser", "xxxx"); Statement stmt = conn.createStatement();) { String sqlDelete = "delete from books where id >= 3000 and id < 4000"; System.out.println("The SQL statement is: " + sqlDelete + ""); int countDeleted = stmt.executeUpdate(sqlDelete); System.out.println(countDeleted + " records deleted."); String sqlInsert = "insert into books values (3001, 'Gone Fishing', 'Kumar', 11.11, 11)"; System.out.println("The SQL statement is: " + sqlInsert + ""); int countInserted = stmt.executeUpdate(sqlInsert); System.out.println(countInserted + " records inserted."); sqlInsert = "insert into books values " + "(3002, 'Gone Fishing 2', 'Kumar', 22.22, 22)," + "(3003, 'Gone Fishing 3', 'Kumar', 33.33, 33)"; System.out.println("The SQL statement is: " + sqlInsert + ""); countInserted = stmt.executeUpdate(sqlInsert); System.out.println(countInserted + " records inserted."); sqlInsert = "insert into books (id, title, author) values (3004, 'Fishing 101', 'Kumar')"; System.out.println("The SQL statement is: " + sqlInsert + ""); countInserted = stmt.executeUpdate(sqlInsert); System.out.println(countInserted + " records inserted."); String strSelect = "select * from books"; System.out.println("The SQL statement is: " + strSelect + ""); ResultSet rset = stmt.executeQuery(strSelect); while(rset.next()) { System.out.println(rset.getInt("id") + ", " + rset.getString("author") + ", " + rset.getString("title") + ", " + rset.getDouble("price") + ", " + rset.getInt("qty")); } } catch(SQLException ex) { ex.printStackTrace(); } } } See the previous example on how to compile and run this program! Point to this Java file "JdbcInsertTest"! Notes: You cannot insert two records with the same primary key (i.e., id) value. Hence, we issue a DELETE before INSERT new record. In this way, you can re-run the program. If you insert a partial record, the missing columns will be set to their default values. Exercise: Modify your Java program to issue the following SQL statements: Delete all books with id > 8000; and insert: (8001, 'Java ABC', 'Kevin Jones', 15.55, 55) and (8002, 'Java XYZ', 'Kevin Jones', 25.55, 55); JDBC Cycle (Skip Unless...) How to Debug? SYMPTOM: Can compile the JDBC program but Runtime Error ERROR MESSAGE: (Windows) No suitable driver found (macOS/Linux) NullPointerException PROBABLE CAUSES: MySQL JDBC Driver Connector/J was NOT (properly) installed. POSSIBLE SOLUTION: 1. Read "2.3 Install MySQL JDBC Driver" again, again and again... 2. You need to include MySQL JDBC driver via "cp" option to run your JDBC program: > java -cp .;path-to\mysql-connector-java-x.x.xx.jar JdbcClassName 3. For Tomcat, you may copy the driver JAR-file into Tomcat's "lib" directory. SYMPTOM: Can compile the JDBC program but Runtime Error ERROR MESSAGE: com.mysql.jdbc.exceptions.jdbc4.CommunicationsException: Communications link failure PROBABLE CAUSES: 1. MySQL Server is NOT started, or 2. The program was connecting to a wrong TCP port number or wrong hostname (or IP address) in your database-URL jdbc:mysql://localhost:port/databaseName. POSSIBLE SOLUTION: 1. Make sure that server has been started. Note down the server's port number from the server's console. 2. Check the database-URL's hostname and port number: jdbc:mysql://localhost:port/databaseName 3. Run a MySQL client, issue command "status" to confirm the server's TCP port number. 4. Run a mysql client, use "mysql -u root -p --port=xxxx" to specify the port number to confirm the server's port number. SYMPTOM: Can compile the JDBC program but Runtime Error ERROR MESSAGE: java.sql.SQLException: Access denied for user 'username'@'localhost' (using password: YES) PROBABLE CAUSES: Wrong username or password in statement: DriverManager.getConnection(databaseURL, username, password). POSSIBLE SOLUTION: Obvious! SYMPTOM: Can compile the JDBC program but Runtime Error ERROR MESSAGE: java.sql.SQLNonTransientConnectionException: Public Key Retrieval is not allowed POSSIBLE SOLUTION: 1. Check you userid and password by logging in thru mysql command-line client 2. Add allowPublicKeyRetrieval=true and/or useSSL=false to Connnection's URL, e.g., jdbc:mysql://localhost:3306/ebookshop?allowPublicKeyRetrieval=true&useSSL=false&serverTimezone=UTC SYMPTOM: Can compile the JDBC program but Runtime Error ERROR MESSAGE: com.mysql.jdbc.exceptions.jdbc4.MySQLSyntaxErrorException: Unknown database 'xxxx' PROBABLE CAUSES: DriverManager.getConnection("jdbc:mysql://localhost:8888/xxxx", userid, password) specifies a database that does not exist in the server. POSSIBLE SOLUTION: Create the database using a client, before running the Java program. SYMPTOM: Can compile the JDBC program but Runtime Error ERROR MESSAGE: com.mysql.jdbc.exceptions.jdbc4.MySQLSyntaxErrorException: Table 'xxxx.xxxx' doesn't exist PROBABLE CAUSES: The SQL statement references a non-existence table. POSSIBLE SOLUTION: Check your SQL statement and the database tables. SYMPTOM: Can compile the JDBC program but Runtime Error ERROR MESSAGE: java.sql.SQLException: Column 'xxx' not found. PROBABLE CAUSES: The method ResultSet.getXxx(columnName) cannot locate the requested columnName in the ResultSet. POSSIBLE SOLUTION: Make sure that the column 'xxx' is included in the SELECT statement, so that it is included in the ResultSet. SYMPTOM: Can compile the JDBC program but Runtime Error ERROR MESSAGE: com.mysql.jdbc.exceptions.jdbc4.MySQLSyntaxErrorException: You have an error in your SQL syntax; check the manual that corresponds to your MySQL server version for the right syntax to use near .... at line x PROBABLE CAUSES: Syntax error in your SQL statement. POSSIBLE SOLUTION: Obvious! REFERENCES & RESOURCES Latest version tested: Latest version tested: JDK 17.0.1, MySQL 8.0.28, Connector/J 8.0.28, Windows 10, macOS 11. Ubuntu 18.04(LTS) Last modified: February, 2022

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