互联网应用开发技术

Web Application Development

第8课 WEB后端-访问关系型数据库

Episode Eight

Access to RDBMS With JDBC

Web Application Development

陈昊鹏

chen-hp@sjtu.edu.cn

Overview

- Access Database via JDBC Reading
  - JDBC Specification
  - DriverManager vs. DataSource
  - Statements
  - RowSet vs. ResultSet
- Pros and Cons of
  - JDBC Reading and ORM

JDBC Specification

- The JDBC™ API provides
  - programmatic access to relational data from the Java™ programming language.
- The JDBC API is part of the Java platform
  - which includes the Java™ Standard Edition (Java SE™) and the Java™ Enterprise Edition (Java EE™).
- The JDBC 3.0 API is divided into two packages:
  - `java.sql` and `javax.sql`.
  - Both packages are included in the J2SE and J2EE platforms.

JDBC Overview

- Establishing Connection
  - The JDBC API defines the `Connection` interface to represent a connection to an underlying data source.
    - `DriverManager` or `Datasource`

- Executing SQL Statements and Manipulating Results
  - `DatabaseMetadata`
  - `Statement`, `PreparedStatement`, and `CallableStatement`.
  - `ResultSet` and `RowSet`

Establishing Connection

- To obtain a connection, the application may interact with either:
  - the `DriverManager` class working with one or more Driver implementations

    OR
  - a `DataSource` implementation

Establishing Connection

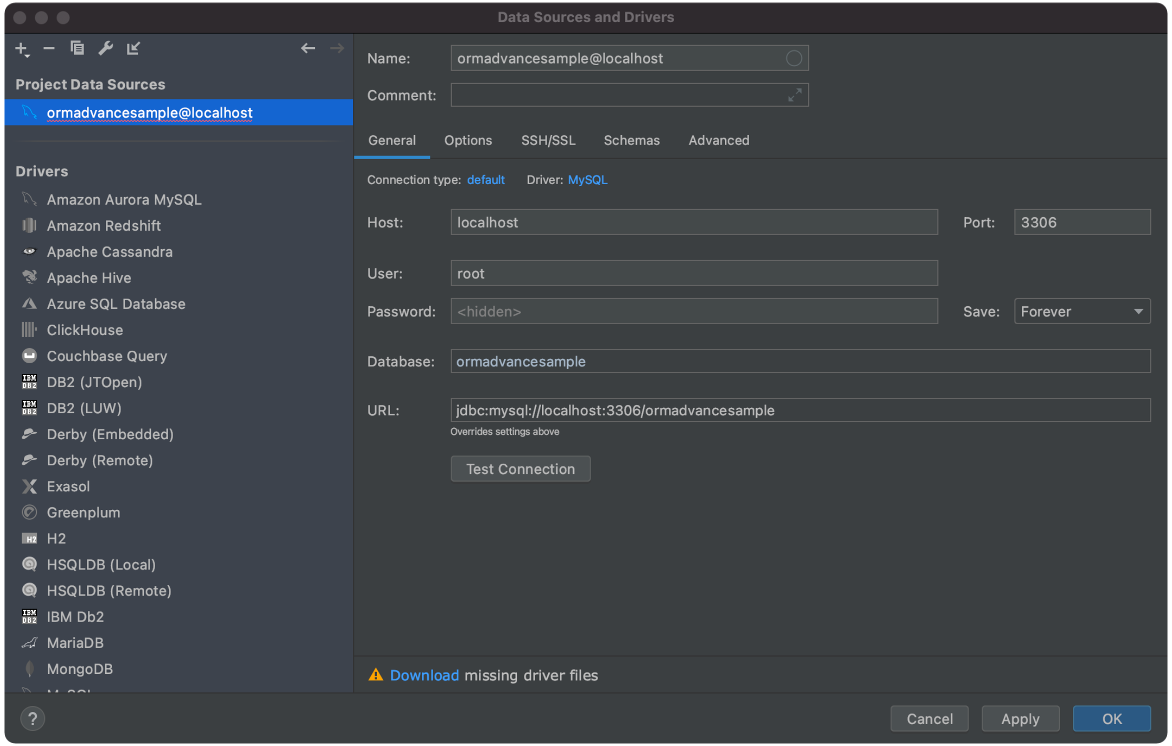
- DriverManager
  - registerDriver and getConnection

```
package sample;

import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.SQLException;

public class AccessDB {

      public static void main(String[] args) throws
                                        ClassNotFoundException, SQLException
      {
                  Class.forName("com.mysql.jdbc.Driver");

                  String url = "jdbc:mysql://localhost:3306";
                  String user = "root";
                  String passwd = "12345678";

                  Connection con = DriverManager.getConnection(url, user, passwd);
                  System.out.println(con.getTransactionIsolation());
      }

}
```

Establishing Connection

REliable, INtelligent & Scalable Systems

- Necessary Configuration



Name: ormadvancesample@localhost
Comment:

Connection type: default Driver: MySQL

Host: localhost Port: 3306
User: root
Password: <hidden> Save: Forever
Database: ormadvancesample
URL: jdbc:mysql://localhost:3306/ormadvancesample
Overrides settings above

Download missing driver files

ormadvancesample@localhost

Amazon Aurora MySQL
Amazon Redshift
Apache Cassandra
Apache Hive
Azure SQL Database
ClickHouse
Couchbase Query
DB2 (JTOpen)
DB2 (LUW)
Derby (Embedded)
Derby (Remote)
Exasol
Greenplum
H2
HSQLDB (Local)
HSQLDB (Remote)
IBM Db2
MariaDB
MongoDB

Establishing Connection

- `DataSource`
  - A logical name is mapped to a `DataSource` object via a naming service that uses the Java Naming and Directory Interface ™ (JNDI).

Property Name	Type	Description
databaseName	String	name of a particular database on a server
dataSourceName	String	a data source name
description	String	description of this data source
networkProtocol	String	network protocol used to communicate with the server
password	String	a database password
portNumber	int	port number where a server is listening for requests
roleName	String	the initial SQL rolename
serverName	String	database server name
user	String	user’s account name

Establishing Connection

- DataSource
  - A logical name is mapped to a DataSource object via a naming service that uses the Java Naming and Directory Interface TM (JNDI).

```
package sample;
import java.sql.SQLException;
import javax.naming.Context;
import javax.naming.InitialContext;
import javax.naming.NamingException;
import com.mysql.jdbc.jdbc2.optional.MysqlDataSource;
public class Server {
      public static void main(String[] args) throws ClassNotFoundException,
                                                   SQLException, NamingException
      {
                 MysqlDataSource ds = new MysqlDataSource();
                 ds.setServerName("localhost");
                 ds.setPortNumber(3306);
                 ds.setUser("root");
                 ds.setPassword("12345678");

                 Context namingContext = new InitialContext();
                 namingContext.bind("rmi://localhost:1099/datasource", ds);
      }
}
```

Establishing Connection

- DataSource
  - A logical name is mapped to a DataSource object via a naming service that uses the Java Naming and Directory Interface TM (JNDI).

```
package sample;
import java.rmi.RemoteException;
import java.sql.Connection;
import java.sql.SQLException;
import javax.naming.Context;
import javax.naming.InitialContext;
import javax.naming.NamingException;
import com.mysql.jdbc.jdbc2.optional.MysqlDataSource;

public class Client {
   public static void main(String[] args) throws
              NamingException, RemoteException, SQLException
   {
      Context namingContext = new InitialContext();
      String url = "rmi://localhost:1099/datasource";
      MysqlDataSource ds = (MysqlDataSource) namingContext.lookup(url);
      Connection con = ds.getConnection("root","12345678");
      System.out.println(con.getTransactionIsolation());
   }
}
```

Establishing Connection

- Necessary Configuration
- Run the rmiregistry
  - `rmiregistry`
- Run the `Server`
- Run the `Client`

Statements

- Statement
  - defines methods for executing SQL statements that do not contain parameter markers
- PreparedStatement
  - adds methods for setting input parameters
- CallableStatement
  - adds methods for retrieving output parameter values returned from stored procedures

Statement

```java
// get a connection from the DataSource object ds
Connection con = ds.getConnection(user, passwd);

// create two instances of Statement
Statement stmt1 = con.createStatement();
Statement stmt2 = con.createStatement();

// Setting ResultSet Characteristics
Statement stmt = con.createStatement(
          ResultSet.TYPE_SCROLL_INSENSITIVE,
          ResultSet.CONCUR_UPDATABLE,
          ResultSet.HOLD_CURSORS_OVER_COMMIT);
```

Statement

```
// Executing Statement and  return ResultSet
ResultSet rs = stmt.executeQuery(
    "select id, username, password, email from tbl_user");
while (rs.next()){
    ...
}

// Returning an Update Count
Statement stmt = con.createStatement();
int rows = stmt.executeUpdate(" update tbl_user
    set username = 'ADMIN' " + "where id = 1");
if (rows > 0) {
    ...
}
```

Statement

REliable, INtelligent & Scalable Systems

```
// Using execute method
String sql;
...
Statement stmt = conn.createStatement();
boolean b = stmt.execute(sql);
if (b == true) {
     // b is true if a ResultSet is returned
    ResultSet rs;
    rs = stmt.getResultSet();
    while (rs.next()) {
             ...
    }
    rs.close();
}
else {
    // b is false if a UpdateCount is returned
    int rows = stmt.getUpdateCount();
     if (rows > 0) {
             ...
    }
}
stmt.close();
conn.close();
```

PreparedStatement

```
// Creating a PreparedStatement
PreparedStatement ps = con.prepareStatement("INSERT
INTO
   tbl_user (id, username, password, email)
   VALUES (?, ?, ?, ?)");
// Setting Parameters
ps.setInt(1, 3);
ps.setString(2, "Guest");
ps.setString(3, "guest");
ps.setString(4, "haha@163.com");
ps.execute();
```

PreparedStatement

```
// ParameterMetaData
PreparedStatement pstmt = con.prepareStatement(
   "SELECT * FROM tbl_user WHERE id = ?
                                 and username = ?");
pstmt.setInt(1, 3);
pstmt.setString(2, "Guest");
pstmt.execute();
ParameterMetaData pmd = pstmt.getParameterMetaData();
int number = pmd.getParameterCount();
```

PreparedStatement

```
// ResultSetMetaData
ResultSetMetaData rsmd = pstmt.getMetaData();
int colCount = rsmd.getColumnCount();
int colType;
String colLabel;
for (int i = 1; i <= colCount; i++) {
    colType = rsmd.getColumnType(i);
    colLabel = rsmd.getColumnLabel(i);
    System.out.println(colType + ":" + colLabel);
}
```

CallableStatement

```
CREATE DEFINER=`root`@`localhost`
   PROCEDURE `insert_user`(
         in id int,
         inout username varchar(20),
         in password varchar(20),
         in email varchar(20))
BEGIN
   insert tbl_user (id,username,password,email)
         Values(id,username,password,email);
   select username from tbl_user where id = id;
END
```

CallableStatement

```
CallableStatement cstmt =
   con.prepareCall("{CALL insert_user(?, ?, ?, ?)}");
cstmt.registerOutParameter(2, java.sql.Types.INTEGER);
cstmt.setInt(1, 4);
cstmt.setString(2, "Host");
cstmt.setString(3, "Host");
cstmt.setString(4, "Host@sjtu.edu.cn");

cstmt.execute();

// Retrieve OUT parameters
String username = cstmt.getNString(2);
System.out.println(username);
```

Manipulate result

- `ResultSet`
  - Types
  1. TYPE_FORWARD_ONLY
  2. TYPE_SCROLL_INSENSITIVE
  3. TYPE_SCROLL_SENSITIVE

  - Concurrency
  1. CONCUR_READ_ONLY
  2. CONCUR_UPDATABLE

  - Holdability
  1. HOLD_CURSORS_OVER_COMMIT
  2. CLOSE_CURSORS_AT_COMMIT

Manipulate result

- ResultSet

```
Statement stmt = conn.createStatement();
ResultSet rs = stmt.executeQuery(“select author, title, isbn"
                               +"from booklist”);

next()              beforeFirst()
previous()          afterLast()
first()             relative(int rows)
last()              absolute(int row)

int colIdx = rs.findColumn(“ISBN”);

ResultSetMetaData rsmd = rs.getMetaData();
int colType [] = new int[rsmd.getColumnCount()];
for (int idx = 0, int col = 1; idx < colType.length;
     idx++, col++)
    colType[idx] = rsmd.getColumnType(col);
```

Manipulate result

REliable, INtelligent & Scalable Systems

- ResultSet

```
// Update a row: two-phase process
Statement stmt =
conn.createStatement(ResultSet.TYPE_FORWARD_ONLY,
                ResultSet.CONCUR_UPDATABLE);
ResultSet rs = stmt.executeQuery(“select author from
                booklist " + "where isbn = 140185852”);
rs.next();
rs.updateString(“author”, “Zamyatin, Evgenii Ivanovich”);
rs.updateRow();

// Delete a row
rs.absolute(4);
rs.deleteRow();
```

Manipulate result

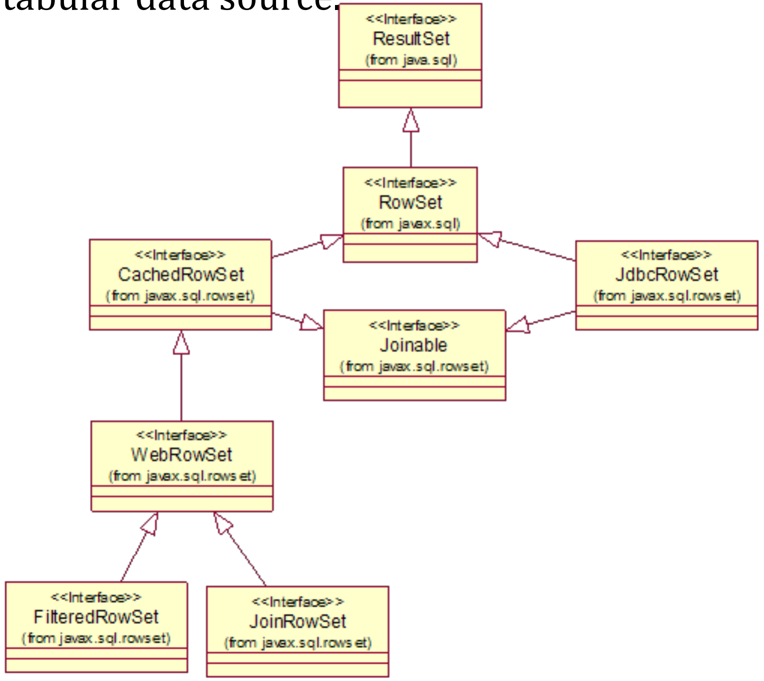
REliable, INtelligent & Scalable Systems

- ResultSet

```
// Insert a row: three steps
// select all the columns from the table booklist
ResultSet rs = stmt.executeQuery(“select author, title,
                             isbn " + "from booklist”);
rs.moveToInsertRow();
// set values for each column
rs.updateString(1, “Huxley, Aldous”);
rs.updateString(2, “Doors of Perception and Heaven and
                Hell”);
rs.updateLong(3, 60900075);
// insert the row
rs.insertRow();
// move the cursor back to its position in the result set
rs.moveToCurrentRow();
```

Manipulate result

- RowSet
  - A `javax.sql.RowSet` object encapsulates a set of rows that have been retrieved from a tabular data source.
  - JdbcRowSet - online
  - CachedRowSet
    - WebRowSet
    - FilteredRowSet
    - JoinRowSet



Manipulate result

REliable, INtelligent & Scalable Systems

- RowSet
  - JdbcRowSet – online

```
public class AccessDB {
    private JdbcRowSet rowset;
    public AccessDB(String url, String user, String pwd)
                              throws SQLException {
        RowSetFactory rowSetFactory =
                RowSetProvider.newFactory();
        JdbcRowSet rowset =
                rowSetFactory.createJdbcRowSet();
        rowset.setUrl(
                "jdbc:mysql://localhost:3306/sample_one");
        rowset.setUsername("root");
        rowset.setPassword(“12345678");
        rowset.setCommand("SELECT * FROM tbl_user");
        rowset.execute();
    }
```

Manipulate result

- RowSet
  - JdbcRowSet – online

```
public List<User> get() throws SQLException {
    List<User> records = new ArrayList<>();
    rowset.beforeFirst();
    while (rowset.next()) {
        User record = new User();
        record.setId(rowset.getLong(1));
        record.setUsername(rowset.getString(2));
        record.setPassword(rowset.getString(3));
        record.setEmail(rowset.getString(4));
        records.add(record);
    }
    return records;
}
```

Manipulate result

- RowSet
  - JdbcRowSet – online

```
public void add(User user) throws SQLException {
    rowset.moveToInsertRow();
    rowset.updateInt(1, (int)user.getId());
    rowset.updateString(2, user.getUsername());
    rowset.updateString(3, user.getPassword());
    rowset.updateString(4, user.getEmail());
    rowset.insertRow();
}
```

Manipulate result

- RowSet
  - JdbcRowSet – online

```
public class User {

    private long id;
    private String username;
    private String password;
    private String email;

    public long getId(){return this.id;}
    public String getUsername(){return this.username;}
    public String getPassword(){return this.password;}
    public String getEmail(){return this.email;}

    public void setId(long id) {this.id = id;}
    public void setUsername(String username) {this.username = username;}
    public void setPassword(String password) {this.password = password;}
    public void setEmail(String email) {this.email = email;}
}
```

Manipulate result

- RowSet
  - JdbcRowSet – online

```
public static void main(String[] args) throws SQLException {
        AccessDB ad = new AccessDB(url,user,pwd);

        List<User> records = ad.get();
        Iterator<User> it = records.iterator();
        while(it.hasNext()){
                User use = it.next();
                ……
        }

        User usertoadd = new User();
        usertoadd.setId(10);
        ……
        ad.add(usertoadd);

        records = ad.get();
        it = records.iterator();
        while(it.hasNext()){
                User use = it.next();
                ……
        }
}
```

Manipulate result

REliable, INtelligent & Scalable Systems

- RowSet
  - CachedRowSet

```
RowSetFactory rowSetFactory =
        RowSetProvider.newFactory();
rowset = rowSetFactory.createCachedRowSet();
```

  - WebRowSet

```
RowSetFactory rowSetFactory =
        RowSetProvider.newFactory();
rowset = rowSetFactory.createWebRowSet();
rowset.execute();
rowset.writeXml(System.out);
```

Manipulate result

- RowSet
  - FilteredRowSet

```
RowSetFactory rowSetFactory =
             RowSetProvider.newFactory();
rowset =  rowSetFactory.createFilteredRowSet();
Range range = new Range();
rowset.setFilter(range);
```

Manipulate result

- RowSet
  - FilteredRowSet

```
class Range implements Predicate {

    public boolean evaluate(RowSet rs) {
        try {
            if (rs.getInt(1) > 1) {
                return true;
            }
        } catch (SQLException e) {
            // do nothing
        }
        return false;
    }

    public boolean evaluate(Object value, int column) throws SQLException {
        return false;
    }

    public boolean evaluate(Object value, String columnName)
            throws SQLException {
        return false;
    }
}
```

Manipulate result

- RowSet
  - Rowsets can generate three different types of events:

  1. Cursor movement events
  2. Row change events
  3. Rowset change events

  - To add a listener to Rowset

```
Listener listener = new Listener();
rowset.addRowSetListener(listener);
```

Manipulate result

- RowSet
  - RowSetListener:

```
public class Listener implements RowSetListener {

    @Override
    public void cursorMoved(RowSetEvent arg0) {
        System.out.println("The cursor is moved");
    }

    @Override
    public void rowChanged(RowSetEvent arg0) {
        System.out.println("A row is changed");
    }

    @Override
    public void rowSetChanged(RowSetEvent arg0) {
        System.out.println("The rowset is changed");
    }

}
```

Pros & Cons of JDBC reading

- JDBC reading
  - Advantages:
    - Good performance, especially for accessing massive data
    - Take advantage of various functions provided by DBMS
    - Use stored procedures to implement complex logics
  - Disadvantages:
    - Coupling with DBMS
    - Coupling with data structure
    - Programming is complicate
  - How to avoid the disadvantages?

References

- JDBC™ 3.0 Specification Final Release,
  - Jon Ellis & Linda Ho with Maydene Fisher
- JNDI ™ 1.2.1 Javadoc,
  - http://java.sun.com/products/jndi/1.2/javadoc/

- *Web开发技术*
- *Web Application Development*

Thank You!