Principles and Techniques of DBMS 4
DB Access II

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Overview

- Access Database via JDBC Reading
  - RowSet vs. ResultSet
- Basics of ORM
- Pros and Cons of
  - JDBC/ODBC Reading and ORM

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

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- 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

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- 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

- 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

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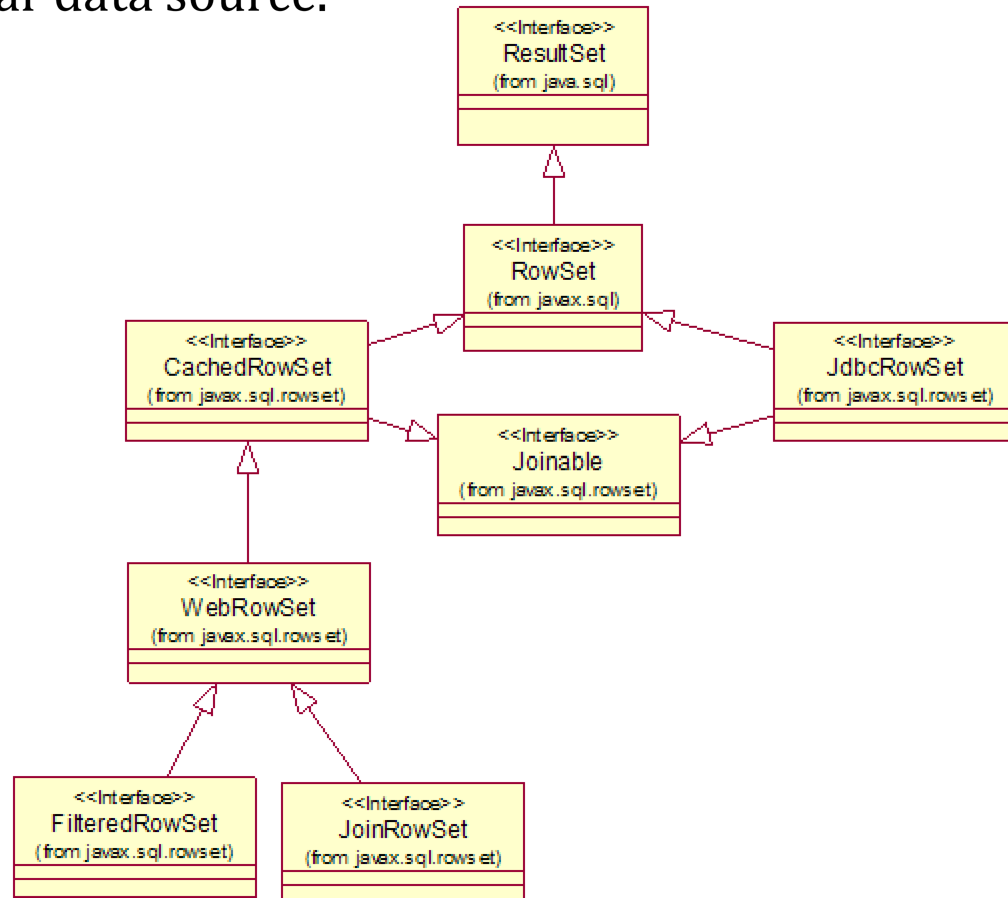
- RowSet
  - A `javax.sql.RowSet` object encapsulates a set of rows that have been retrieved from a tabular data source.
  - JdbcRowSet - online
  - CachedRowSet
    - WebRowSet
    - FilteredRowSet
    - JoinRowSet



Manipulate result

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- 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

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- 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

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- 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

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- 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

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- 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

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- RowSet
  - FilteredRowSet

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

Manipulate result

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- 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

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- 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

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- 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");
    }

}
```

ODBC Specification

- ODBC is a specification for a database API.
  - This API is independent of any one DBMS or operating system; although this manual uses C, the ODBC API is language-independent.
- The functions in the ODBC API are implemented by developers of DBMS-specific drivers.
  - Applications call the functions in these drivers to access data in a DBMS-independent manner.
  - A Driver Manager manages communication between applications and drivers.
- It is important to understand that ODBC is designed to expose database capabilities, not supplement them.

ODBC Architecture

- The ODBC architecture has four components:
  - **Application** Performs processing and calls ODBC functions to submit SQL statements and retrieve results.
  - **Driver Manager** Loads and unloads drivers on behalf of an application. Processes ODBC function calls or passes them to a driver.
  - **Driver** Processes ODBC function calls, submits SQL requests to a specific data source, and returns results to the application. If necessary, the driver modifies an application's request so that the request conforms to syntax supported by the associated DBMS.
  - **Data Source** Consists of the data the user wants to access and its associated operating system, DBMS, and network platform (if any) used to access the DBMS.

Basic ODBC Application Steps

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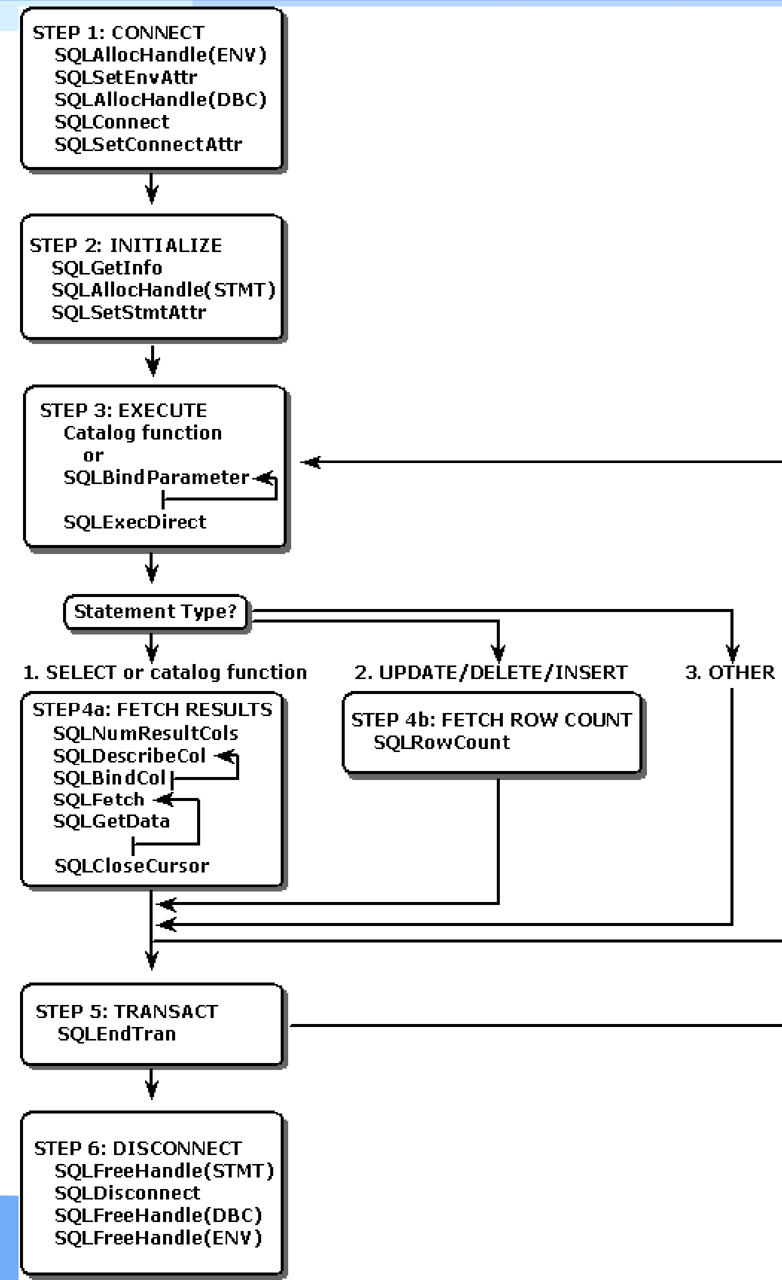
- Step 1: Connect to the Data Source
- Step 2: Initialize the Application
- Step 3: Build and Execute an SQL Statement
- Step 4a: Fetch the Results
- Step 4b: Fetch the Row Count
- Step 5: Commit the Transaction
- Step 6: Disconnect from the Data Source



Access DB with ODBC

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```
string MyConString = "DRIVER={MySQL ODBC 3.51 Driver};" +
                              "SERVER=localhost;" + "DATABASE=inv;" +
                              "UID=root;" + "PASSWORD=831025;" + "OPTION=3";
OdbcConnection MyConnection = new OdbcConnection(MyConString);
MyConnection.Open();

string query = "insert into test values( 'hello', 'lucas', 'liu')";
OdbcCommand cmd = new OdbcCommand(query, MyConnection);

try{
  cmd.ExecuteNonQuery();
}
catch(Exception ex){
  Console.WriteLine("record duplicate.");
}finally{
  cmd.Dispose();
}
```

Access DB with ODBC

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```
string tmp1 = null;
string tmp2 = null;
string tmp3 = null;
query = "select * from test ";
OdbcCommand cmd2 = new OdbcCommand(query, MyConnection);
OdbcDataReader reader = cmd2.ExecuteReader();

while (reader.Read())
{
      tmp1 = reader[0].ToString();
      tmp2 = reader[1].ToString();
      tmp3 = reader[2].ToString();
}

OdbcDataAdapter oda = new OdbcDataAdapter("select * from customer ", MyConnection);
DataSet ds = new DataSet();

oda.Fill(ds, "employee");
DataGridView dgv = new DataGridView();
dgv.DataSource = ds.Tables["employee"];
MyConnection.Close();
```

Pros & Cons of JDBC/ODBC reading

- JDBC/ODBC 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?

O/R Mapping

- Working with both Object-Oriented software and Relational Databases can be
  - cumbersome and time consuming.
- Development costs are significantly higher due to
  - a paradigm mismatch between how data is represented in objects versus relational databases.
- The term Object/Relational Mapping refers to
  - the technique of mapping data from an object model representation to a relational data model representation (and visa versa)

Hibernate – first class

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- User.class

```
public class User {
    private Long id;

    private String username;
    private String password;
    private String email;

    public User() {}

    public Long getId() {  return id; }
    public void setId(Long id) {  this.id = id;  }

    public String getUsername() {  return username;  }
    public void setUsername(String username) {  this.username = username;  }

    public String getPassword() {  return password;  }
    public void setPassword(String password) {  this.password = password;  }

    public String getEmail() {  return email;  }
    public void setEmail(String email) { this.email = email; }

}
```

Hibernate – mapping

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- User.hbm.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE hibernate-mapping PUBLIC
        "-//Hibernate/Hibernate Mapping DTD 3.0//EN"
        "http://www.hibernate.org/dtd/hibernate-mapping-3.0.dtd">

<hibernate-mapping package="sample">

    <class name="User" table="tbl_user">
        <id name="id" column="id">
            <generator class="native"/>
        </id>
        <property name="username" />
        <property name="password"/>
        <property name="email"/>
    </class>

</hibernate-mapping>
```

Hibernate – configuration

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- hibernate.cfg.xml

```
<hibernate-configuration>
    <session-factory>
        <property name="connection.driver_class">
                com.mysql.jdbc.Driver
        </property>
        <property name="connection.url">
                jdbc:mysql://localhost:3306/sample_one
        </property>
        <property name="connection.username">root</property>
        <property name="connection.password">12345678</property>
        <property name="connection.pool_size">1</property>
        <property name="dialect">
                org.hibernate.dialect.MySQL5Dialect
        </property>
        <property name="current_session_context_class">thread</property>
```

Hibernate – configuration

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```
        <property name="cache.provider_class">
                org.hibernate.cache.internal.NoCacheProvider
        </property>

        <!-- Echo all executed SQL to stdout -->
        <property name="show_sql">true</property>

        <!-- Drop and re-create the database schema on startup -->
        <property name="hbm2ddl.auto">update</property>
        <mapping resource="sample/User.hbm.xml"/>
    </session-factory>
</hibernate-configuration>
```

Helper class

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```
public class HibernateUtil {
    private static final SessionFactory sessionFactory = buildSessionFactory();
    private static SessionFactory buildSessionFactory() {
        try {
            // Create the SessionFactory from hibernate.cfg.xml
            return new Configuration().configure().buildSessionFactory(); }
        catch (Throwable ex) {
                      // Make sure you log the exception, as it might be
            System.err.println("Initial SessionFactory creation failed." + ex);
                      throw new ExceptionInInitializerError(ex);
        }
    }
    public static SessionFactory getSessionFactory() {
        return sessionFactory;
    }
}
```

Servlet

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```
public class UserManagerServlet extends HttpServlet {
    private static final long serialVersionUID = 1L;
    public UserManagerServlet() {
        super();
    }

    protected void doGet(HttpServletRequest request, HttpServletResponse response)
                     throws ServletException, IOException {
         try {
                 HibernateUtil.getSessionFactory().
                         getCurrentSession().beginTransaction();
                 PrintWriter out = response.getWriter();
                 out.println("<html><head><title>
                                 User Manager</title></head><body>");
                 listUser(out);

                 out.println("</body></html>");
                 out.flush();
                 out.close();
                 HibernateUtil.getSessionFactory().
                         getCurrentSession().getTransaction().commit();
        }
```

Servlet

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```
        catch (Exception ex) {
            HibernateUtil.getSessionFactory()
                .getCurrentSession().getTransaction().rollback();
            if ( ServletException.class.isInstance( ex ) ) {
                throw ( ServletException ) ex;
            }
            else {
                throw new ServletException( ex );
            }
        }
}
```

Servlet


```
private void listUser(PrintWriter out) {
   List result = HibernateUtil.getSessionFactory()
           .getCurrentSession().createCriteria(User.class).list();
   if (result.size() > 0) {
       out.println("<h2>Users in database:</h2>");
       out.println("<table border='1'>");
       out.println("<tr>");
       out.println("<th>id</th>");
       out.println("<th>Username</th>");
       out.println("<th>Password</th>");
       out.println("<th>email</th>");
       out.println("</tr>");
       Iterator it = result.iterator();
       while (it.hasNext()) {
           User user = (User) it.next();
           out.println("<tr>");
           out.println("<td>" + user.getId() + "</td>");
           out.println("<td>" + user.getUsername() + "</td>");
           out.println("<td>" + user.getPassword() + "</td>");
           out.println("<td>" + user.getEmail() + "</td>");
           out.println("</tr>");
       }
       out.println("</table>");
   }
}
```

Pros and Cons of ORM

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- ORM
  - Advantages:
    - Independent of DBMS
    - Independent of data structure
    - OOP
  - Disadvantages:
    - Impact on performance
    - Can NOT utilize the extra functions in addition to standard functions defined in specification.
    - Mapping between O and R maybe complex.
    - Can NOT invoke stored procedures.

Which one is better ?

- JDBC/ODBC reading or ORM?
  - Requirements Driven
  - Requirement 1:
    - To list all records about courses selection of a certain semester.
    - It could be a big records set with over 150,000 records selected from millions of records
  - Requirement 2:
    - To get the average age of all undergraduate students
  - Requirement3:
    - To ensure that the database could be moved from ORACLE to DB2

Project

- To develop a Book Store with PHP
  - jQuery UI
  - MySQL DB
  - Apache HTTP Server
  - To implement the CRUD of book, order and user.
  - You can design the structure of book, order and user tables as your will.

References

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Thank You!