# Database Connectivity ODBC, JDBC and SQLJ

CS2312

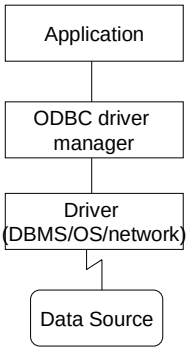
## What is ODBC?

- ODBC is (Open Database Connectivity):
- A standard or open application programming interface (API) for accessing a database.
- SQL Access Group, chiefly Microsoft, in 1992
- By using ODBC statements in a program, you can access files in a number of different databases, including Access, dBase, DB2, Excel, and Text.
- It allows programs to use SQL requests that will access databases without having to know the proprietary interfaces to the databases.
- ODBC handles the SQL request and converts it into a request the individual database system understands.

## More on ODBC

- You need:
  - the ODBC software, and
  - a separate module or *driver* for each database to be accessed. Library that is dynamically connected to the application.
- Driver masks the heterogeneity of DBMS operating system and network protocol.
- E.g. (Sybase, Windows/NT, Novell driver)

## ODBC Architecture




## What is JDBC?

- JDBC is: Java Database Connectivity
  - is a Java API for connecting programs written in Java to the data in relational databases.
  - consists of a set of classes and interfaces written in the Java programming language.
  - provides a standard API for tool/database developers and makes it possible to write database applications using a pure Java API.
  - The standard defined by Sun Microsystems, allowing individual providers to implement and extend the standard with their own JDBC drivers.
- JDBC:
  - establishes a connection with a database
  - sends SQL statements
  - processes the results.

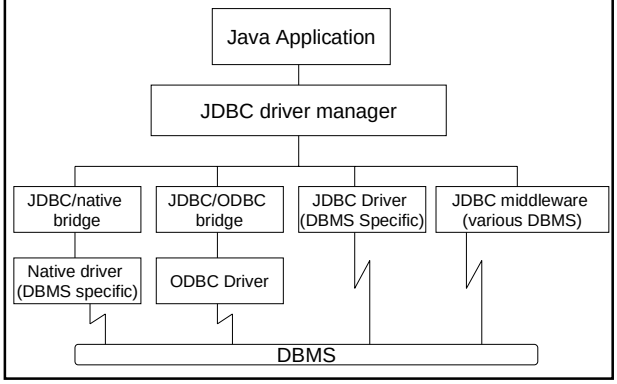
## JDBC vs ODBC

- ODBC is used between applications
- JDBC is used by Java programmers to connect to databases
- With a small "bridge" program, you can use the JDBC interface to access ODBC-accessible databases.
- JDBC allows SQL-based database access for EJB persistence and for direct manipulation from CORBA, DJB or other server objects

## JDBC API

- The JDBC API supports both two-tier and three-tier models for database access.
- Two-tier model -- a Java applet or application interacts directly with the database.
- Three-tier model -- introduces a middle-level server for execution of business logic:
  - the middle tier to maintain control over data access.
  - the user can employ an easy-to-use higher-level API which is translated by the middle tier into the appropriate low-level calls.

## JDBC Architectures




## The JDBC Steps

1. Importing Packages
2. Registering the JDBC Drivers
3. Opening a Connection to a Database
4. Creating a Statement Object
5. Executing a Query and Returning a Result Set Object
6. Processing the Result Set
7. Closing the Result Set and Statement Objects
8. Closing the Connection

## 1: Importing Packages

```
//
// Program name: LecExample_1a.java
// Purpose: Basic selection using prepared
  statement
//

  //Import packages
  import java.sql.*;  //JDBC packages
  import java.math.*;
  import java.io.*;
  import oracle.jdbc.driver.*;
```

## 2: Registering JDBC Drivers

```
class LecExample_1a {

public static void main (String args [])
  throws SQLException {

// Load Oracle driver
DriverManager.registerDriver (new
  oracle.jdbc.driver.OracleDriver());
```

## 3: Opening connection to a Database

```
//Prompt user for username and password
  String user;
  String password;

  user     = readEntry("username: ");
  password = readEntry("password: ");

// Connect to the local database
  Connection conn =
  DriverManager.getConnection
  ("jdbc:oracle:thin:@aardvark:1526:teach
  ", user, password);
```

## 4. Creating a Statement Object

```
// Query the hotels table for resort =
  'palma nova'
// Please notice the essential trim
PreparedStatement pstmt =
  conn.prepareStatement ("SELECT
  hotelname, rating FROM hotels WHERE
  trim(resort) = ?");
pstmt.setString(1, "palma nova");
```

## 5. Executing a Query, Returning a Result Set Object & 6. Processing the Result Set

```
ResultSet rset = pstmt.executeQuery ();

// Print query results
  while (rset.next ())
    System.out.println (rset.getString
(1)+" "+ rset.getString(2));
```

## 7. Closing the Result Set and Statement Objects 8. Closing the Connection

```
// close the result set, statement, and the
  connection
      rset.close();
      pstmt.close();
      conn.close();
  }
```

## Mapping Data Types

- There are data types specified to SQL that need to be mapped to Java data types if the user expects Java to be able to handle them.
- Conversion falls into three categories:
  - SQL type to Java direct equivalents

    SQL INTEGER direct equivalent of Java int data type.
  - SQL type can be converted to a Java equivalent.

    SQL CHAR, VARCHAR, and LONGVARCHAR can all be converted to the Java String data type.
  - SQL data type is unique and requires a special Java data class object to be created specifically for their SQL equivalent.

    SQL DATE converted to the Java Date object that is defined in java.Date especially for this purpose.

## What is SQLJ?

- SQLJ is a set of programming extensions that allow a programmer using the Java programming language to embed statements that provide SQL database requests.
- SQLJ is similar to existing extensions for SQL that are provided for C, FORTRAN, and other programming languages.
- IBM, Oracle, and several other companies are proposed SQLJ as a standard and as a simpler and easier-to-use alternative to JDBC.

## SQLJ Specifications

- The SQLJ specifications are in several parts:
  - SQLJ: Embedded SQL...Specifications for embedding SQL statements in Java methods.
  - SQLJ: SQL Routines...Specifications for calling Java static methods as SQL stored procedures and user-defined functions.
  - SQLJ: SQL Types...Specifications for using Java classes as SQL user-defined data types.

## SQLJ Example

`#sql { … } ;`

SQL can span multiple lines

Java host expressions in SQL statement

throws `java.sql.SQLException`

```
String bug = “spider”;
#sql {
  INSERT INTO bugs (name, numLegs)
    VALUES (:bug, :(getNumLegs(bug)))
};
```

## JDBC Example

```
PreparedStatement pstm =
  conn.createStatement
  (“INSERT INTO bugs (name, numLegs)
  VALUES (?, ?)”);
  pstmt.setString(1,bug);
  pstmt.setInt(2,getNumLegs(bug));
  pstmt.executeUpdate();
  pstmt.close();
```

JDBC needs:

- explicit statement handles
- explicit `setXxx` binds
- explicit connection

## SQLJ vs JDBC comparison

| | SQLJ | JDBC |
|---|---|---|
| SQL statements | static | dynamic |
| Strong typing | yes | no |
| Checking | static | runtime only |
| Syntax | concise | API |
| Standard | ANSI | Sun |
| Portable | yes | yes |
| Object support | yes* | yes* |

## Use SQLJ to write your program when

- you want to be able to check your program for errors at translation-time rather than at run-time.
- you want to write an application that you can deploy to another database. Using SQLJ, you can customize the static SQL for that database at deployment-time.
- you are working with a database that contains compiled SQL. You will want to use SQLJ because you cannot compile SQL statements in a JDBC program.

## Use JDBC to write your program when

- your program uses dynamic SQL. For example, you have a program that builds queries on-the-fly or has an interactive component.
- you do not want to have a SQLJ layer during deployment or development. For example, you might want to download only the JDBC Thin driver and not the SQLJ runtime libraries to minimize download time over a slow link.

## SQLJ static and non-static SQL

- The standard covers only *static SQL* operations
  - those that are predefined and do not change in real-time as a user runs the application
  - of course the data values that are transmitted can change dynamically!
- Oracle SQLJ offers extensions to support *dynamic SQL* operations
  - those that are *not* predefined, where the operations *themselves* can change in real-time.
- It is possible to use dynamic SQL operations through JDBC code or PL/SQL code within a SQLJ application.
- Typical applications contain much more static SQL than dynamic SQL.

## Java and SQLJ versus PL/SQL I

- Java and PL/SQL are complementary.
- Suited for different kinds of applications.

- PL/SQL is better for SQL-intensive applications.
  - Optimized for SQL, and so SQL operations are faster in PL/SQL than in Java.
  - Uses SQL datatypes directly, while Java applications must convert between SQL datatypes and Java types.
- Java, is better for logic-intensive applications.
  - Superior programming model.
  - Java's more general type system is better suited than PL/SQL for component-oriented applications.

## Interoperability: SQLJ and PL/SQL

- PL/SQL programs
  - transparently call Java stored procedures, enabling you to build component-based Enterprise JavaBeans and CORBA applications.
  - have transparent access to a wide variety of existing Java class libraries through trivial PL/SQL call specifications.

- Java programs
  - call PL/SQL stored procedures and anonymous blocks through JDBC or SQLJ.
  - SQLJ provides syntax for calling stored procedures and functions from within a SQLJ statement, and also supports embedded PL/SQL anonymous blocks within a SQLJ statement.

## Further Information

- http://www.whatis.com/odbc.htm
- http://www.whatis.com/jdbc.htm
- http://www.whatis.com/sqlj.htm

- Local online JDBC Oracle manual pages

## Additional material

## ReadEntry method for completeness

```
 //  Method:  readEntry
 //  Purpose: to read a string from the user and return it
 //  Input:   The prompt string
 //  Output:  User entry

 static String readEntry (String prompt)
  {
    try{
      StringBuffer buffer = new StringBuffer ();
      System.out.print (prompt);
      System.out.flush ();
      int c = System.in.read ();
      while (c != '\n' && c != -1){
    buffer.append ((char)c);
    c = System.in.read ();
      }
      return buffer.toString ().trim ();
    }
    catch (IOException e){
      return "";
    }
  }
}
```