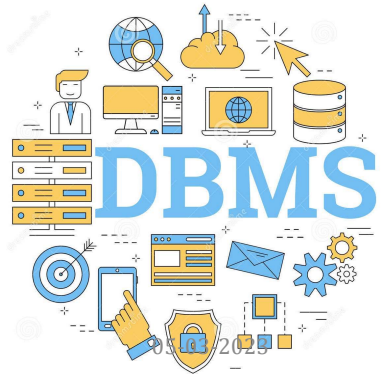
Unit I – Relational Model

Relational Data Model - keys, referential integrity and foreign keys, Relational Algebra - SQL fundamentals- Introduction, data definition in SQL, table, key and foreign key definitions, update behaviors-Intermediate SQL- **Advanced SQL features** -**Embedded SQL- Dynamic SQL,** CASE Studies- Oracle: Database Design and Querying Tools; SQL Variations and Extensions



Accessing SQL from a Programming Language

A database programmer must have access to a general-purpose programming language for at least two reasons

- Not all queries can be expressed in SQL, since SQL does not provide the full expressive power of a general-purpose language.
- Non-declarative actions -such as printing a report, interacting with a user, or sending the results of a query to a graphical user interface -- cannot be done from within SQL.

Accessing SQL from a Programming Language (Cont.)

There are two approaches to accessing SQL from a general-purpose programming language

- A general-purpose program -- can connect to and communicate with a database server using a **collection of functions**
- **Embedded SQL** -- provides a means by which a program can interact with a database server.
  - The SQL statements are translated at compile time into function calls.
  - At runtime, these function calls connect to the database using an API that provides dynamic SQL facilities.

Java Database Connectivity

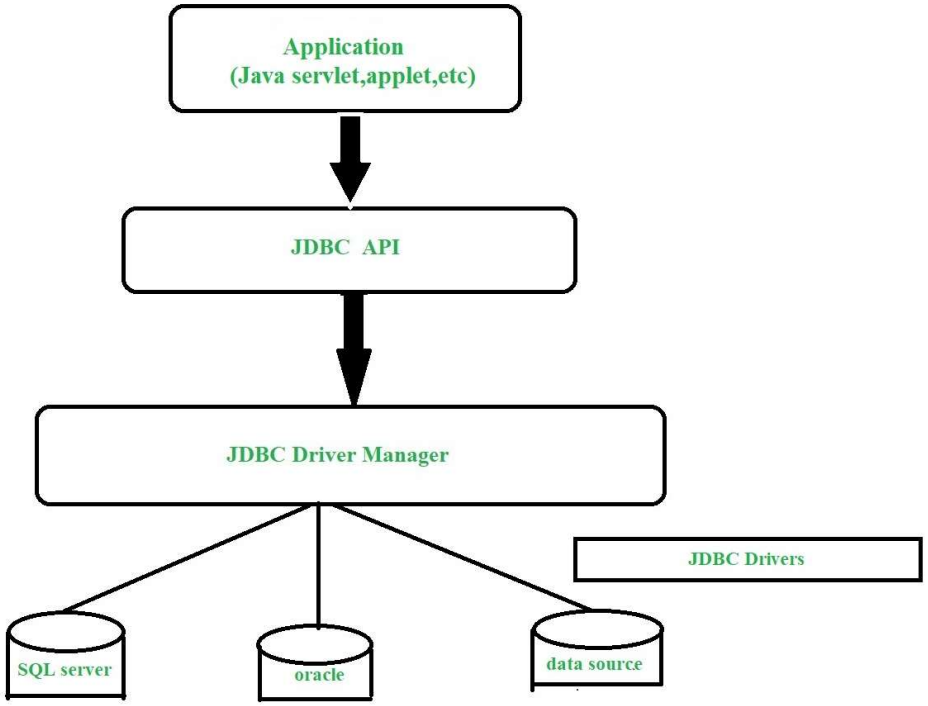
- JDBC or Java Database Connectivity is a Java API to connect and execute the query with the database.
- Specification from Sun Microsystems
- *The* **classes and interfaces** *of JDBC* allow the *application to send* requests *made by users to the specified database.*

Purpose of JDBC

- **Interacting with a database** requires efficient database connectivity, which can be achieved by using the **ODBC(Open database connectivity) driver**
- Driver is used with JDBC to interact or communicate with various kinds of databases such as **Oracle, MS Access, Mysql, and SQL server database**.

1. Java Applications
2. Java Applets
3. Java Servlets
4. Java ServerPages (JSPs)
5. Enterprise JavaBeans (EJBs).

Architecture



Components of JDBC

1. **JDBC API:** It provides various methods and interfaces for easy communication with the database. - **java.sql.*;**
2. **JDBC Driver manager:** It **loads a database-specific driver in an application** to establish a connection with a database.
3. **JDBC Test suite:** It is used to test the operation(such as insertion, deletion, updation) being performed by JDBC Drivers.
4. **JDBC-ODBC Bridge Drivers**: It connects database drivers to the database. This bridge translates the **JDBC method call to the ODBC function call.**

Components of JDBC

- **Driver Manager** – This class manages a list of database drivers. Matches connection requests from the java application with the proper database driver using communication sub protocol.
- **Driver** – This interface handles the communications with the database server.
- **Connection** – This interface with all methods for contacting a database.
- **Statement** – You use objects created from this interface to submit the SQL statements to the database.
- **ResultSet** – These objects hold data retrieved from a database after you execute an SQL query using Statement objects.
- **SQLException -** –This class handles any errors that occur in a database application.

JDBC Drivers

There are 4 types of JDBC drivers:

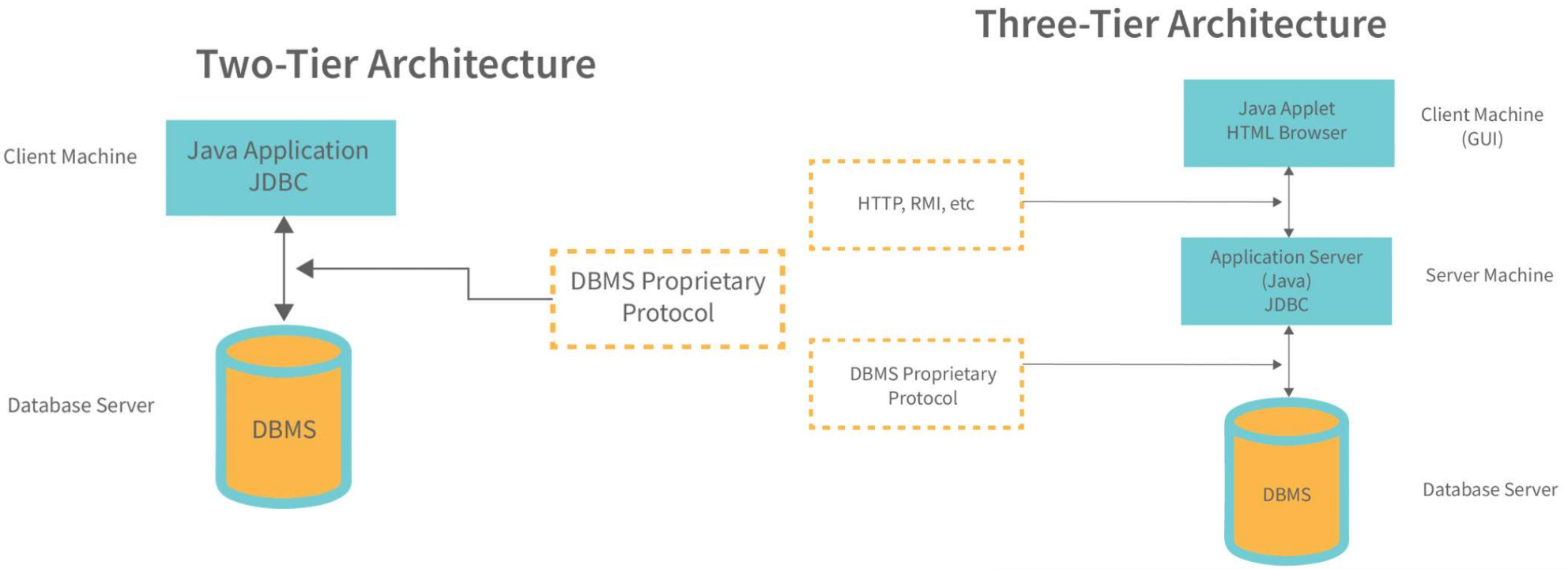
1.Type-1 driver or JDBC-ODBC bridge driver

2.Type-2 driver or Native-API driver

3.Type-3 driver or Network Protocol driver

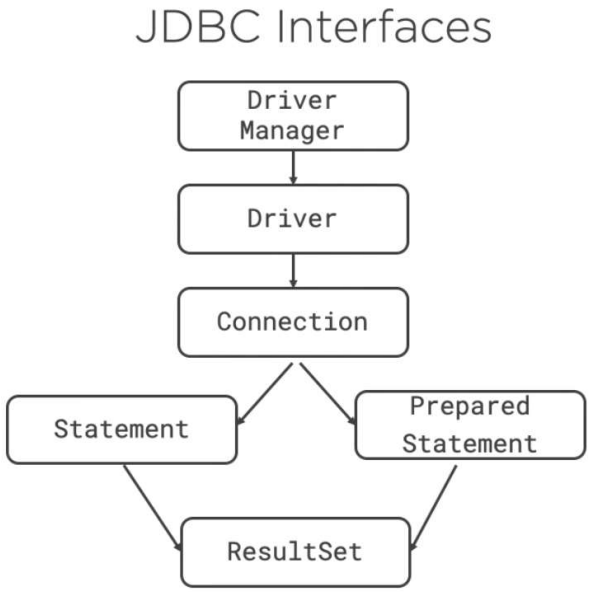
4.Type-4 driver or Thin driver

Types of JDBC Architecture(2-tier and 3-tier)



Interfaces of JDBC API

- Driver interface
- Connection interface
- Statement interface
- PreparedStatement interface
- CallableStatement interface
- ResultSet interface
- ResultSetMetaData interface
- DatabaseMetaData interface
- RowSet interface



Popular Classes in JDBC API

- DriverManager class
- Blob class - Binary
- Clob class - Character
- Types class

```
public static void JDBCexample(String dbid, String userid, String passwd)
 {
   try {
       Class.forName ("oracle.jdbc.driver.OracleDriver");
       Connection conn = DriverManager.getConnection(
            "jdbc:oracle:thin:@db.yale.edu:2000:univdb", userid, passwd);
      Statement stmt = conn.createStatement();
        ... Do Actual Work ....
      stmt.close();
      conn.close();
   }
   catch (SQLException sqle) {
      System.out.println("SQLException : " + sqle);
   }
}
```

NOTE: Class.forName is not required from JDBC 4 onwards.

Simple Application

```
package com.sa.jdbc;

import java.sql.*;

public class JDBCDemo {

   public static void main(String args[])
      throws SQLException, ClassNotFoundException
   {
      String driverClassName
         = "sun.jdbc.odbc.JdbcOdbcDriver";
      String url = "jdbc:odbc:XE";
      String username = "scott";
      String password = "tiger";
      String query
         = "insert into students values(109, 'bhatt')";
```

```
// Load driver class
      Class.forName(driverClassName);

      // Obtain a connection
      Connection con = DriverManager.getConnection(
         url, username, password);

      // Obtain a statement
      Statement st = con.createStatement();

      // Execute the query
      int count = st.executeUpdate(query);
      System.out.println(
         "number of rows affected by this query= "
         + count);

      // Closing the connection as per the
      // requirement with connection is completed
      con.close();
   }
}
```

Update to database

```
try {
     stmt.executeUpdate(
         "insert into instructor values('77987', 'Kim', 'Physics', 98000)");
  } catch (SQLException sqle)
  {
     System.out.println("Could not insert tuple. " + sqle);
  }
```

Execute query and fetch and print results

```
ResultSet rset = stmt.executeQuery("select dept_name, avg (salary) from
instructor group by dept_name");
while (rset.next()) {
    System.out.println(rset.getString("dept_name") + " " +  rset.getFloat(2));
}
```

Embedded SQL

- The SQL standard defines embeddings of SQL in a variety of programming languages such as C, C++, Java, Fortran, and PL/1,
- The basic form of these languages follows that of the System R embedding of SQL into PL/1.
- **EXEC SQL** statement is used in the host language to identify embedded SQL request to the preprocessor

EXEC SQL <embedded SQL statement >;

Note: this varies by language:

- **In some languages, like COBOL, the semicolon is replaced with END-EXEC**
- **In Java embedding uses # SQL { .... };**

Embedded SQL (Cont.)

- Before executing any SQL statements, the program must first connect to the database. This is done using:

  EXEC-SQL connect to *server* user *user-name* using *password*;

  Here, *server* identifies the server to which a connection is to be established.

- Variables used as above must be declared within DECLARE section,

  EXEC-SQL BEGIN DECLARE SECTION}

  int *credit-amount* ;

  EXEC-SQL END DECLARE SECTION;

Embedded SQL (Cont.)

- To write an embedded SQL query, we use the

  declare *c* **cursor for <SQL query>**

- Example:

```
EXEC SQL
declare c cursor for
select ID, name
from student
where tot_cred > :credit_amount
END_EXEC
```

Embedded SQL (Cont.)

- The **open** statement EXEC SQL **open** *c* ;

  This statement causes the database system to execute the query and to save the results within a temporary relation. The query uses the value of the host-language variable *credit-amount* at the time the **open** statement is executed.

- The fetch statement causes the values of one tuple in the query result to be placed on host language variables.

  EXEC SQL **fetch** *c* **into** :*si, :sn* END_EXEC

  Repeated calls to fetch get successive tuples in the query result

Embedded SQL (Cont.)

- The **close** statement causes the database system to delete the temporary relation that holds the result of the query.

EXEC SQL **close** *c* ;

Note: above details vary with language. For example, the Java embedding defines Java iterators to step through result tuples.

Updates Through Embedded SQL

- Embedded SQL expressions for database modification (**update**, **insert**, and **delete**)
- Can update tuples fetched by cursor by declaring that the cursor is for update

```
EXEC SQL
  declare c cursor for
  select *
  from instructor
  where dept_name = 'Music'
  for update
```

```
update instructor
    set salary = salary + 1000
    where current of c
```

Updates Through Embedded SQL

- Theniterate through the tuples by performing **fetch** operations on the cursor (as illustrated earlier), and after fetching each tuple we execute the following code:

Difference between Embedded and Dynamic SQL

- **Static or Embedded** SQL are SQL statements in an application that do not change at runtime and, therefore, can be hard-coded into the application.
- **Dynamic** SQL is SQL statements that are constructed at runtime; for example, the application may allow users to enter their own queries.

Functions and Procedure

- The function program has a block of code that performs some specific tasks or functions.
- Particular set of instructions or commands along known as a procedure.

Function

```
CREATE [OR REPLACE] FUNCTION function_name
[(parameter_name  type [, ...])]
// this statement  is must for functions
RETURN return_datatype
{IS | AS}
BEGIN
  // program code
[EXCEPTION
 exception_section;
END [function_name];
```

```
create function MultiplyNumbers(@int1 as int,@int2 as int)
As
BEGIN
Return (@int1 * @int2)
end
```

Procedure

```
CREATE or REPLACE PROCEDURE name(parameters)
IS
variables;
BEGIN
//statements;
END;
```

```
CREATE or REPLACE PROCEDURE INC_SAL(eno IN NUMBER, up_sal OUT NUMBER)
IS
BEGIN
UPDATE emp_table SET salary = salary+1000 WHERE emp_no = eno;
COMMIT;
SELECT sal INTO up_sal FROM emp_table WHERE emp_no = eno;
END;
```

Trigger

- A trigger is a stored procedure in database which automatically invokes whenever a special event in the database occurs.
- For example, a trigger can be invoked when a row is inserted into a specified table or when certain table columns are being updated.

Trigger Syntax

```
create trigger [trigger_name]
[before | after]
{insert | update | delete}
on [table_name]
[for each row]
[trigger_body]
```

Trigger Example

```
mysql> desc Student;
+-------+-------------+------+-----+---------+----------------+
| Field | Type        | Null | Key | Default | Extra          |
+-------+-------------+------+-----+---------+----------------+
| tid   | int(4)      | NO   | PRI | NULL    | auto_increment |
| name  | varchar(30) | YES  |     | NULL    |                |
| subj1 | int(2)      | YES  |     | NULL    |                |
| subj2 | int(2)      | YES  |     | NULL    |                |
| subj3 | int(2)      | YES  |     | NULL    |                |
| total | int(3)      | YES  |     | NULL    |                |
| per   | int(3)      | YES  |     | NULL    |                |
+-------+-------------+------+-----+---------+----------------+
7 rows in set (0.00 sec)
```

Trigger Example

```
create trigger stud_marks
before
INSERT
on Student
for each row
set Student.total = Student.subj1 + Student.subj2 +
Student.subj3, Student.per = Student.total * 60 / 100;
```

Trigger Example

```
mysql> insert into Student values(0, "ABCDE", 20, 20, 20, 0, 0);
Query OK, 1 row affected (0.09 sec)

mysql> select * from Student;
+-----+-------+-------+-------+-------+-------+------+
| tid | name  | subj1 | subj2 | subj3 | total | per  |
+-----+-------+-------+-------+-------+-------+------+
| 100 | ABCDE |    20 |    20 |    20 |    60 |   36 |
+-----+-------+-------+-------+-------+-------+------+
1 row in set (0.00 sec)
```


Thank You!