1. **What is the JDBC?**

Java Database Connectivity (**JDBC**) is a standard Java API to interact with relational databases form Java. **JDBC** has set of classes and interfaces which can use from Java application and talk to database without learning RDBMS details and using Database Specific JDBC Drivers.

**2. What are the new features added to JDBC 4.0?**

The major features added in JDBC 4.0 include :

* Auto-loading of JDBC driver class
* Connection management enhancements
* Support for RowId SQL type
* DataSet implementation of SQL using Annotations
* SQL exception handling enhancements
* SQL XML support

**3. Explain Basic Steps in writing a Java program using JDBC?**

JDBC makes the interaction with RDBMS simple and intuitive. When a Java application needs to access database:

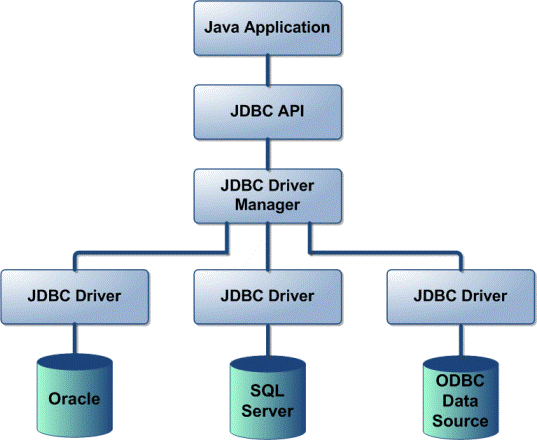
* Load the RDBMS specific JDBC driver because this driver actually communicates with the database (Incase of JDBC 4.0 this is automatically loaded).
* Open the connection to database which is then used to send SQL statements and get results back.
* Create JDBC Statement object. This object contains SQL query.
* Execute statement which returns resultset(s). ResultSet contains the tuples of database table as a result of SQL query.
* Process the result set.
* Close the connection.

**4. Exaplain the JDBC Architecture.**

The JDBC Architecture consists of two layers:

* The JDBC API, which provides the **application-to-JDBC Manager** connection.
* The JDBC Driver API, which supports the **JDBC Manager-to-Driver** Connection.

The JDBC API uses a driver manager and database-specific drivers to provide transparent connectivity to heterogeneous databases. The JDBC driver manager ensures that the correct driver is used to access each data source. The driver manager is capable of supporting multiple concurrent drivers connected to multiple heterogeneous databases. The location of the driver manager with respect to the JDBC drivers and the Java application is shown in Figure 1.



**Figure 1: JDBC Architecture**

**5. What are the main components of JDBC ?**

The life cycle of a servlet consists of the following phases:

* **DriverManager**: Manages a list of database drivers. Matches connection requests from the java application with the proper database driver using communication subprotocol. The first driver that recognizes a certain subprotocol under JDBC will be used to establish a database Connection.
* **Driver**: The database communications link, handling all communication with the database. Normally, once the driver is loaded, the developer need not call it explicitly.
* **Connection:** Interface with all methods for contacting a database. The connection object represents communication context, i.e., all communication with database is through connection object only.
* **Statement**: Encapsulates an SQL statement which is passed to the database to be parsed, compiled, planned and executed.
* **ResultSet**: The ResultSet represents set of rows retrieved due to query execution.

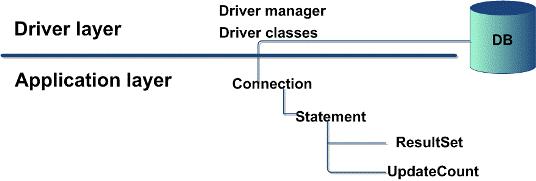
**6. How the JDBC application works?**

A JDBC application can be logically divided into two layers:

1. **Driver layer**

2. **Application layer**

* Driver layer consists of DriverManager class and the available JDBC drivers.
* The application begins with requesting the DriverManager for the connection.
* An appropriate driver is choosen and is used for establishing the connection. This connection is given to the application which falls under the application layer.
* The application uses this connection to create Statement kind of objects, through which SQL commands are sent to backend and obtain the results.



**Figure 2: JDBC Application**

|  |
| --- |
|  |

**7. How do I load a database driver with JDBC 4.0 / Java 6?**

Provided the JAR file containing the driver is properly configured, just place the JAR file in the classpath. Java developers **NO** longer need to explicitly load JDBC drivers using code like Class.forName() to register a JDBC driver.The DriverManager class takes care of this by automatically locating a suitable driver when the DriverManager.getConnection() method is called. This feature is backward-compatible, so no changes are needed to the existing JDBC code.

**8. What is JDBC Driver interface?**

The JDBC Driver interface provides vendor-specific implementations of the abstract classes provided by the JDBC API. Each vendor driver must provide implementations of

Connection,

Statement,

PreparedStatement,

CallableStatement,

ResultSet and Driver.

**9. What does the connection object represents?**

The connection object represents communication context, i.e., all communication with database is through connection object only.

**10. What is Statement?**

Statement acts like a vehicle through which SQL commands can be sent. Through the connection object we create statement kind of objects.  
Through the connection object we create statement kind of objects.

Statement stmt = conn.createStatement();

This method returns object which implements statement interface.

|  |
| --- |
|  |

**11. What is PreparedStatement?**

A prepared statement is an SQL statement that is precompiled by the database. Through precompilation, prepared statements improve the performance of SQL commands that are executed multiple times (given that the database supports prepared statements). Once compiled, prepared statements can be customized prior to each execution by altering predefined SQL parameters.

PreparedStatement pstmt = conn.prepareStatement("UPDATE EMPLOYEES SET SALARY = ? WHERE ID = ?");

pstmt.setBigDecimal(1, 153833.00);

pstmt.setInt(2, 110592);

*Here:*conn*is an instance of the Connection class and*"**?**"*represents parameters.These parameters must be specified before execution.*

|  |  |
| --- | --- |
| **Statement** | **PreparedStatement** |
| A standard Statement is used to create a Java representation of a literal SQL statement and execute it on the database. | A PreparedStatement is a precompiled statement.  This means that when the PreparedStatement is executed, the RDBMS can  just run the PreparedStatement SQL statement without having to compile it first. |
| Statement has to verify its metadata against the database every time. | While a prepared statement has to verify its metadata against the  database only once. |
| If you want to execute the SQL statement once go for STATEMENT | If you want to execute a single SQL statement multiple number of times,  then go for PREPAREDSTATEMENT. PreparedStatement objects can be  reused with passing different values to the queries. |

**12. What is the difference between a Statement and a PreparedStatement?**

**13 . What are callable statements ?**

Callable statements are used from JDBC application to invoke stored procedures and functions.

**14. How to call a stored procedure from JDBC ?**

PL/SQL stored procedures are called from within JDBC programs by means of the prepareCall() method of the Connection object created. A call to this method takes variable bind parameters as input parameters as well as output variables and creates an object instance of the CallableStatement class.

The following line of code illustrates this:

CallableStatement stproc\_stmt = conn.prepareCall("{call procname(?,?,?)}");

Here conn is an instance of the Connection class.

**15. What are types of JDBC drivers?**

There are four types of drivers defined by JDBC as follows:

* **Type 1: JDBC/ODBC**—These require an ODBC (Open Database Connectivity) driver for the database to be installed. This type of driver works by translating the submitted queries into equivalent ODBC queries and forwards them via native API calls directly to the ODBC driver. It provides no host redirection capability.
* **Type2: Native API (partly-Java driver)**—This type of driver uses a vendor-specific driver or database API to interact with the database. An example of such an API is Oracle OCI (Oracle Call Interface). It also provides no host redirection.
* **Type 3: Open Protocol-Net**—This is not vendor specific and works by forwarding database requests to a remote database source using a net server component. How the net server component accesses the database is transparent to the client. The client driver communicates with the net server using a database-independent protocol and the net server translates this protocol into database calls. This type of driver can access any database.
* **Type 4: Proprietary Protocol-Net(pure Java driver)**—This has a same configuration as a type 3 driver but uses a wire protocol specific to a particular vendor and hence can access only that vendor's database. Again this is all transparent to the client.

**Note:** *Type 4 JDBC driver is most preferred kind of approach in JDBC.*

**16. Which type of JDBC driver is the fastest one?**

JDBC Net pure Java driver (Type IV) is the fastest driver because it converts the JDBC calls into vendor specific protocol calls and it directly interacts with the database.

**17. Does the JDBC-ODBC Bridge support multiple concurrent open statements per connection?**

No. You can open only one Statement object per connection when you are using the JDBC-ODBC Bridge.  
**18. Which is the right type of driver to use and when?**

* Type I driver is handy for prototyping
* Type III driver adds security, caching, and connection control
* Type III and Type IV drivers need no pre-installation

Note: *Preferred by 9 out of 10 Java developers: Type IV*. To learn more about JDBC drivers.

**19. What are the standard isolation levels defined by JDBC?**

The values are defined in the class java.sql.Connection and are:

* TRANSACTION\_NONE
* TRANSACTION\_READ\_COMMITTED
* TRANSACTION\_READ\_UNCOMMITTED
* TRANSACTION\_REPEATABLE\_READ
* TRANSACTION\_SERIALIZABLE

Any given database may not support all of these levels.

**20. What is resultset ?**

The ResultSet represents set of rows retrieved due to query execution.

ResultSet rs = stmt.executeQuery(sqlQuery);

**21. What are the types of resultsets?**

The values are defined in the class java.sql.Connection and are:

* TYPE\_FORWARD\_ONLY specifies that a resultset is not scrollable, that is, rows within it can be advanced only in the forward direction.
* TYPE\_SCROLL\_INSENSITIVE specifies that a resultset is scrollable in either direction but is insensitive to changes committed by other transactions or other statements in the same transaction.
* TYPE\_SCROLL\_SENSITIVE specifies that a resultset is scrollable in either direction and is affected by changes committed by other transactions or statements within the same transaction.

***Note****:*A TYPE\_FORWARD\_ONLY*resultset is always insensitive.*

|  |  |  |  |
| --- | --- | --- | --- |
| **TYPE\_SCROLL\_INSENSITIVE** | | **TYPE\_SCROLL\_SENSITIVE** | |
| An insensitive  resultset is like the snapshot of the data in the database when query was executed. | A sensitive resultset does NOT represent a snapshot of data,  rather it contains points to those rows which satisfy the  query condition. | |
| After we get the resultset the changes made to data are not visible through the resultset, and hence they are known as insensitive. | After we obtain the resultset if the data is modified then  such modifications are visible through resultset. | | |
| Performance not effected with insensitive. | Since a trip is made for every ‘**get’** operation, the  performance drastically get affected. | | |

**22. What’s the difference between TYPE\_SCROLL\_INSENSITIVE and TYPE\_SCROLL\_SENSITIVE?**

**22. What is rowset?**

A RowSet is an object that encapsulates a set of rows from either Java Database Connectivity (JDBC) result sets or t

abular data sources like a file or spreadsheet. RowSets support component-based development models like JavaBeans, with a standard set of properties and an event notification mechanism.

**24. What are the different types  of RowSet ?**

There are two types of RowSet are there. They are:

* **Connected**- A connected RowSet object connects to the database once and remains connected until the application terminates.
* **Disconnected -** A disconnected RowSet object connects to the database, executes a query to retrieve the data from the database and then closes the connection. A program may change the data in a disconnected RowSet while it is disconnected. Modified data can be updated in the database after a disconnected RowSet reestablishes the connection with the database.

**25 . What is the need of BatchUpdates?**

The BatchUpdates feature allows us to group SQL statements together and send to database server in one single trip.

**26. What is a DataSource?**

A DataSource object is the representation of a data source in the Java programming language. In basic terms,

* A DataSource is a facility for storing data.
* DataSource can be referenced by JNDI.
* Data Source may point to RDBMS, file System , any DBMS etc..

**27. What are the advantages of DataSource?**

The few advantages of data source are :

* An application does not need to hardcode driver information, as it does with the DriverManager.
* The DataSource implementations can easily change the properties of data sources. *For example*: There is no need to modify the application code when making changes to the database details.
* The DataSource facility allows developers to implement a DataSource class to take advantage of features like connection pooling and distributed transactions.

**28. What is connection pooling? What is the main advantage of using connection pooling?**

A connection pool is a mechanism to reuse connections created. Connection pooling can increase performance dramatically by reusing connections rather than creating a new physical connection each time a connection is requested..

1. [What is JDBC API and when do we use it?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#jdbc-overview)
2. [What are different types of JDBC Drivers?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#jdbc-driver-types)
3. [How does JDBC API helps us in achieving loose coupling between Java Program and JDBC Drivers API?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#jdbc-reflection)
4. [What is JDBC Connection? Explain steps to get Database connection in a simple java program.](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#jdbc-connection)
5. [What is the use of JDBC DriverManager class?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#jdbc-DriverManager)
6. [How to get the Database server details in java program?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#jdbc-DatabaseMetaData)
7. [What is JDBC Statement?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#Statement)
8. [What is the difference between execute, executeQuery, executeUpdate?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#execute-executeQuery-executeUpdate)
9. [What is JDBC PreparedStatement?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#PreparedStatement)
10. [How to set NULL values in JDBC PreparedStatement?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#set-null-values)
11. [What is the use of getGeneratedKeys() method in Statement?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#generated-keys)
12. [What are the benefits of PreparedStatement over Statement?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#Statement-vs-PreparedStatement)
13. [What is the limitation of PreparedStatement and how to overcome it?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#PreparedStatement-IN-clause)
14. [What is JDBC ResultSet?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#ResultSet)
15. [What are different types of ResultSet?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#ResultSet-Types)
16. [What is the use of setFetchSize() and setMaxRows() methods in Statement?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#fetchSize-maxRows)
17. [How to use JDBC API to call Stored Procedures?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#CallableStatement-Stored-Procedure)
18. [What is JDBC Batch Processing and what are it’s benefits?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#Batch-Processing)
19. [What is JDBC Transaction Management and why do we need it?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#Transaction-Management)
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21. [What is JDBC Savepoint? How to use it?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#Savepoint)
22. [What is JDBC DataSource and what are it’s benefits?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#DataSource-Benefits)
23. [How to achieve JDBC Connection Pooling using JDBC DataSource and JNDI in Apache Tomcat Server?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#Connection-Pool-Tomcat)
24. [What is Apache DBCP API?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#apache-dbcp)
25. [What is JDBC Connection isolation levels?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#connection-isolation-levels)
26. [What is JDBC RowSet? What are different types of RowSet?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#RowSet-Types)
27. [What is the different between ResultSet and RowSet?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#ResultSet-vs-RowSet)
28. [What are common JDBC Exceptions?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#SQL-Exceptions)
29. [What is CLOB and BLOB datatypes in JDBC?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#CLOB-BLOB)
30. [What is “dirty read” in JDBC? Which isolation level prevents dirty read?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#dirty-read-isolation)
31. [What is 2 phase commit?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#2-phase-commit)
32. [What are the different types of locking in JDBC?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#locking-types)
33. [What do you understand by DDL and DML statements?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#DDL-DML-statements)
34. [What is difference between java.util.Date and java.sql.Date?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#java.util.Date-vs-java.sql.Date)
35. [How to insert an image or raw data into database?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#insert-binary-data)
36. [What is phantom read and which isolation level prevents it?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#phantom-read-isolation)
37. [What is SQL Warning? How to retrieve SQL warnings in the JDBC program?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#SQL-Warnings)
38. [How to invoke Oracle Stored Procedure with Database Objects as IN/OUT?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#Oracle-STRUCT)
39. [When do we get java.sql.SQLException: No suitable driver found?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#No-suitable-driver-found-exception)
40. [What are JDBC Best Practices?](http://www.journaldev.com/2529/jdbc-interview-questions-and-answers#jdbc-best-practices)

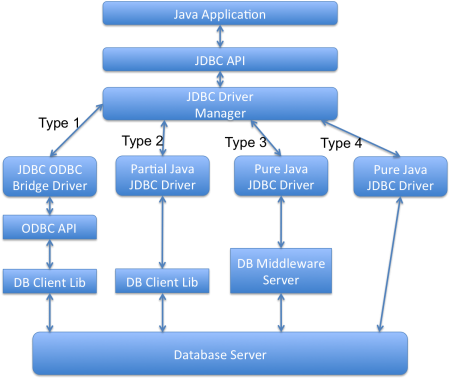
### What is JDBC API and when do we use it?

**Java DataBase Connectivity** API allows us to work with relational databases. JDBC API interfaces and classes are part of java.sql and javax.sql package. We can use JDBC API to get the database connection, run SQL queries and stored procedures in the database server and process the results.

JDBC API is written in a way to allow loose coupling between our Java program and actual JDBC drivers that makes our life easier in switching from one database to another database servers easily.

### What are different types of JDBC Drivers?

There are four types of JDBC drivers. Any java program that works with database has two parts, first part is the JDBC API and second part is the driver that does the actual work.

[](http://1988780851.rsc.cdn77.org/wp-content/uploads/2014/01/JDBC-Drivers.png)

* 1. **JDBC-ODBC Bridge plus ODBC Driver (Type 1)**: It uses ODBC driver to connect to database. We should have ODBC drivers installed to connect to database, that’s why this driver is almost obsolete.
  2. **Native API partly Java technology-enabled driver (Type 2)**: This driver converts JDBC class to the client API for the database servers. We should have database client API installed. Because of extra dependency on database client API drivers, this is also not preferred driver.
  3. **Pure Java Driver for Database Middleware (Type 3)**: This driver sends the JDBC calls to a middleware server that can connect to different type of databases. We should have a middleware server installed to work with this driver. This adds to extra network calls and slow performance and thats why not widely used JDBC driver.
  4. **Direct-to-Database Pure Java Driver (Type 4)**: This driver converts the JDBC calls to the network protocol understood by the database server. This solution is simple and suitable for database connectivity over the network. However for this solution, we should use database specific drivers, for example OJDBC jars by Oracle for Oracle DB and MySQL Connector/J for MySQL databases.

### How does JDBC API helps us in achieving loose coupling between Java Program and JDBC Drivers API?

JDBC API uses [Java Reflection API](http://www.journaldev.com/1789/java-reflection-tutorial-for-classes-methods-fields-constructors-annotations-and-much-more) to achieve loose coupling between java programs and JDBC Drivers. If you look at a simple JDBC example, you will notice that all the programming is done in terms of JDBC API and Driver comes in picture only when it’s loaded through reflection using Class.forName() method.

I think this is one of the best example of using Reflection in core java classes to make sure that our application doesn’t work directly with Drivers API and that makes it very easy to move from one database to another. Please read more at [JDBC Example](http://www.journaldev.com/2471/jdbc-example-tutorial-drivers-connection-statement-resultset).

### What is JDBC Connection? Explain steps to get Database connection in a simple java program.

JDBC Connection is like a Session created with the database server. You can also think Connection is like a [Socket connection](http://www.journaldev.com/741/java-socket-server-client-read-write-example) from the database server.

Creating a JDBC Connection is very easy and requires two steps:

* 1. Register and Load the Driver: Using Class.forName(), Driver class is registered to the DriverManager and loaded in the memory.
  2. Use DriverManager to get the Connection object: We get connection object from DriverManager.getConnection() by passing Database URL String, username and password as argument.

|  |  |
| --- | --- |
| 1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16 | Connection con = null;  try{      // load the Driver Class      Class.forName("com.mysql.jdbc.Driver");        // create the connection now      con = DriverManager.getConnection("jdbc:mysql://localhost:3306/UserDB",                      "pankaj",                      "pankaj123");      }catch (SQLException e) {              System.out.println("Check database is UP and configs are correct");              e.printStackTrace();      }catch (ClassNotFoundException e) {              System.out.println("Please include JDBC MySQL jar in classpath");              e.printStackTrace();      } |

### What is the use of JDBC DriverManager class?

JDBC DriverManager is the factory class through which we get the Database Connection object. When we load the JDBC Driver class, it registers itself to the DriverManager, you can look up the JDBC Driver classes source code to check this.

Then when we call DriverManager.getConnection() method by passing the database configuration details, DriverManager uses the registered drivers to get the Connection and return it to the caller program.

### How to get the Database server details in java program?

We can use DatabaseMetaData object to get the database server details. When the database connection is created successfully, we can get the meta data object by calling getMetaData() method. There are so many methods in DatabaseMetaData that we can use to get the database product name, it’s version and configuration details.

|  |  |
| --- | --- |
| 1  2 | DatabaseMetaData metaData = con.getMetaData();  String dbProduct = metaData.getDatabaseProductName(); |

### What is JDBC Statement?

JDBC API Statement is used to execute SQL queries in the database. We can create the Statement object by calling Connection getStatement() method. We can use Statement to execute static SQL queries by passing query through different execute methods such as execute(), executeQuery(), executeUpdate() etc.

Since the query is generated in the java program, if the user input is not properly validated it can lead to SQL injection issue, more details can be found at [SQL Injection Example](http://www.journaldev.com/2489/jdbc-statement-vs-preparedstatement-sql-injection-example).

By default, only one ResultSet object per Statement object can be open at the same time. Therefore, if we want to work with multiple ResultSet objects, then each must have been generated by different Statement objects. All execute() methods in the Statement interface implicitly close a statment’s current ResultSet object if an open one exists.

### What is the difference between execute, executeQuery, executeUpdate?

Statement execute(String query) is used to execute any SQL query and it returns TRUE if the result is an ResultSet such as running Select queries. The output is FALSE when there is no ResultSet object such as running Insert or Update queries. We can use getResultSet() to get the ResultSet and getUpdateCount()method to retrieve the update count.

Statement executeQuery(String query) is used to execute Select queries and returns the ResultSet. ResultSet returned is never null even if there are no records matching the query. When executing select queries we should use executeQuery method so that if someone tries to execute insert/update statement it will throw java.sql.SQLException with message “executeQuery method can not be used for update”.

Statement executeUpdate(String query) is used to execute Insert/Update/Delete (DML) statements or DDL statements that returns nothing. The output is int and equals to the row count for SQL Data Manipulation Language (DML) statements. For DDL statements, the output is 0.

You should use execute() method only when you are not sure about the type of statement else use executeQuery or executeUpdate method.

### What is JDBC PreparedStatement?

JDBC PreparedStatement object represents a precompiled SQL statement. We can use it’s setter method to set the variables for the query.

Since PreparedStatement is precompiled, it can then be used to efficiently execute this statement multiple times. PreparedStatement is better choice that Statement because it automatically escapes the special characters and avoid SQL injection attacks.

### How to set NULL values in JDBC PreparedStatement?

We can use PreparedStatement setNull() method to bind the null variable to a parameter. The setNull method takes index and SQL Types as argument, for example  
ps.setNull(10, java.sql.Types.INTEGER);.

### What is the use of getGeneratedKeys() method in Statement?

Sometimes a table can have auto generated keys used to insert the unique column value for primary key. We can use Statement getGeneratedKeys() method to get the value of this auto generated key.

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### What are the benefits of PreparedStatement over Statement?

Some of the benefits of PreparedStatement over Statement are:

* + PreparedStatement helps us in preventing SQL injection attacks because it automatically escapes the special characters.
  + PreparedStatement allows us to execute dynamic queries with parameter inputs.
  + PreparedStatement is faster than Statement. It becomes more visible when we reuse the PreparedStatement or use it’s batch processing methods for executing multiple queries.
  + PreparedStatement helps us in writing object Oriented code with setter methods whereas with Statement we have to use String Concatenation to create the query. If there are multiple parameters to set, writing Query using String concatenation looks very ugly and error prone.

### What is the limitation of PreparedStatement and how to overcome it?

One of the limitations of PreparedStatement is that we can’t use it directly with IN clause statements. Some of the alternative approaches to use PreparedStatement with IN clause are;

* + **Execute Single Queries** – very slow performance and not recommended
  + **Using Stored Procedure** – Database specific and hence not suitable for multiple database applications.
  + **Creating PreparedStatement Query dynamically** – Good approach but looses the benefit of cached PreparedStatement.
  + **Using NULL in PreparedStatement Query** – A good approach when you know the maximum number of variables inputs, can be extended to allow unlimited parameters by executing in parts.

A more detailed analysis can be found at [JDBC PreparedStatement IN clause alternatives](http://www.journaldev.com/2521/jdbc-preparedstatement-in-clause-alternative-approaches).

### What is JDBC ResultSet?

JDBC ResultSet is like a table of data representing a database result set, which is usually generated by executing a statement that queries the database.

ResultSet object maintains a cursor pointing to its current row of data. Initially the cursor is positioned before the first row. The next() method moves the cursor to the next row. If there are no more rows, next() method returns false and it can be used in a while loop to iterate through the result set.

A default ResultSet object is not updatable and has a cursor that moves forward only. Thus, you can iterate through it only once and only from the first row to the last row. It is possible to produce ResultSet objects that are scrollable and/or updatable using below syntax.

|  |  |
| --- | --- |
| 1  2 | Statement stmt = con.createStatement(ResultSet.TYPE\_SCROLL\_INSENSITIVE,                                     ResultSet.CONCUR\_UPDATABLE); |

A ResultSet object is automatically closed when the Statement object that generated it is closed, re-executed, or used to retrieve the next result from a sequence of multiple results.

We can use ResultSet getter method with column name or index number starting from 1 to retrieve the column data.

### What are different types of ResultSet?

There are different types of ResultSet objects that we can get based on the user input while creating the Statement. If you will look into the Connection methods, you will see that createStatement() and prepareStatement() method are overloaded to provide ResultSet type and concurrency as input argument.

There are three types of ResultSet object.

* 1. **ResultSet.TYPE\_FORWARD\_ONLY**: This is the default type and cursor can only move forward in the result set.
  2. **ResultSet.TYPE\_SCROLL\_INSENSITIVE**: The cursor can move forward and backward, and the result set is not sensitive to changes made by others to the database after the result set was created.
  3. **ResultSet.TYPE\_SCROLL\_SENSITIVE**: The cursor can move forward and backward, and the result set is sensitive to changes made by others to the database after the result set was created.

Based on the concurrency there are two types of ResultSet object.

* 1. **ResultSet.CONCUR\_READ\_ONLY**: The result set is read only, this is the default concurrency type.
  2. **ResultSet.CONCUR\_UPDATABLE**: We can use ResultSet update method to update the rows data.

### What is the use of setFetchSize() and setMaxRows() methods in Statement?

We can use setMaxRows(int i) method to limit the number of rows that the database returns from the query. You can achieve the same thing using SQL query itself. For example in MySQL we can use LIMIT clause to set the max rows that will be returned by the query.

Understanding **fetchSize** can be tricky, for that you should know how Statement and ResultSet works. When we execute a query in the database, the result is obtained and maintained in the database cache and ResultSet is returned. ResultSet is the cursor that has the reference to the result in the database.

Let’s say we have a query that returns 100 rows and we have set fetchSize to 10, so in every database trip JDBC driver will fetch only 10 rows and hence there will be 10 trips to fetch all the rows. Setting optimal fetchSize is helpful when you need a lot of processing time for each row and number of rows in the result is huge.

We can set fetchSize through Statement object but it can be overridden through ResultSet object setFetchSize() method.

### How to use JDBC API to call Stored Procedures?

Stored Procedures are group of SQL queries that are compiled in the database and can be executed from JDBC API. JDBC CallableStatement can be used to execute stored procedures in the database. The syntax to initialize CallableStatement is;

|  |  |
| --- | --- |
| 1  2  3  4  5  6  7  8  9  10  11 | CallableStatement stmt = con.prepareCall("{call insertEmployee(?,?,?,?,?,?)}");  stmt.setInt(1, id);  stmt.setString(2, name);  stmt.setString(3, role);  stmt.setString(4, city);  stmt.setString(5, country);    //register the OUT parameter before calling the stored procedure  stmt.registerOutParameter(6, java.sql.Types.VARCHAR);    stmt.executeUpdate(); |

1. We need to register the OUT parameters before executing the CallableStatement. More details about this can be found at [JDBC CallableStatement Example](http://www.journaldev.com/2502/jdbc-callablestatement-stored-procedure-in-out-oracle-struct-cursor-example-tutorial).

### What is JDBC Batch Processing and what are it’s benefits?

Sometimes we need to run bulk queries of similar kind for a database, for example loading data from CSV files to relational database tables. As we know that we have option to use Statement or PreparedStatement to execute queries. Apart from that JDBC API provides Batch Processing feature through which we can execute bulk of queries in one go for a database.

JDBC API supports batch processing through Statement and PreparedStatement addBatch() andexecuteBatch() methods.

Batch Processing is faster than executing one statement at a time because the number of database calls are less, read more at [JDBC Batch Processing Example](http://www.journaldev.com/2494/jdbc-batch-processing-example-tutorial-with-insert-statements).

### What is JDBC Transaction Management and why do we need it?

By default when we create a database connection, it runs in auto-commit mode. It means that whenever we execute a query and it’s completed, the commit is fired automatically. So every SQL query we fire is a transaction and if we are running some DML or DDL queries, the changes are getting saved into database after every SQL statement finishes.

Sometimes we want a group of SQL queries to be part of a transaction so that we can commit them when all the queries runs fine and if we get any exception, we have a choice of rollback all the queries executed as part of the transaction.

JDBC API provide method setAutoCommit(boolean flag) through which we can disable the auto commit feature of the connection. We should disable auto commit only when it’s required because the transaction will not be committed unless we call the commit() method on connection. Database servers uses table locks to achieve transaction management and it’s resource intensive process. So we should commit the transaction as soon as we are done with it. Read more with example program at[JDBC Transaction Management Example](http://www.journaldev.com/2483/jdbc-transaction-management-and-savepoint-example-tutorial).

### How to rollback a JDBC transaction?

We can use Connection object rollback() method to rollback the transaction. It will rollback all the changes made by the transaction and release any database locks currently held by this Connection object.

### What is JDBC Savepoint? How to use it?

Sometimes a transaction can be group of multiple statements and we would like to rollback to a particular point in the transaction. JDBC Savepoint helps us in creating checkpoints in a transaction and we can rollback to that particular checkpoint.

Any savepoint created for a transaction is automatically released and become invalid when the transaction is committed, or when the entire transaction is rolled back. Rolling a transaction back to a savepoint automatically releases and makes invalid any other savepoints that were created after the savepoint in question. Read more at [JDBC Savepoint Example](http://www.journaldev.com/2483/jdbc-transaction-management-and-savepoint-example-tutorial).

### What is JDBC DataSource and what are it’s benefits?

JDBC DataSource is the interface defined in javax.sql package and it is more powerful that DriverManager for database connections. We can use DataSource to create the database connection and Driver implementation classes does the actual work for getting connection. Apart from getting Database connection, DataSource provides some additional features such as:

* + Caching of PreparedStatement for faster processing
  + Connection timeout settings
  + Logging features
  + ResultSet maximum size threshold
  + Connection Pooling in servlet container using JNDI support

Read more about DataSource at [JDBC DataSource Example](http://www.journaldev.com/2509/jdbc-datasource-example-oracle-mysql-and-apache-dbcp-tutorial).

### How to achieve JDBC Connection Pooling using JDBC DataSource and JNDI in Apache Tomcat Server?

For web applications deployed in a servlet container, creating JDBC connection pool is very easy and involve only few steps.

* + Creating JDBC JNDI resource in the container configuration files, usually server.xml or context.xml. For example

|  |  |
| --- | --- |
| server.xml | |
| 1  2  3  4  5  6  7  8  9  10  11  12  13 | <Resource name="jdbc/MyDB"        global="jdbc/MyDB"        auth="Container"        type="javax.sql.DataSource"        driverClassName="com.mysql.jdbc.Driver"        url="jdbc:mysql://localhost:3306/UserDB"        username="pankaj"        password="pankaj123"          maxActive="100"        maxIdle="20"        minIdle="5"        maxWait="10000"/> |
| context.xml | |
| 1  2  3  4 | <ResourceLink name="jdbc/MyLocalDB"                  global="jdbc/MyDB"                  auth="Container"                  type="javax.sql.DataSource" /> |

* + In web application, using InitialContext to look up the JNDI resource configured in the first step and then get the connection.

|  |  |
| --- | --- |
| 1  2 | Context ctx = new InitialContext();  DataSource ds = (DataSource) ctx.lookup("java:/comp/env/jdbc/MyLocalDB"); |

* + For a complete example, read [Tomcat DataSource JNDI Example](http://www.journaldev.com/2513/tomcat-datasource-jndi-example-for-servlet-web-application).

### What is Apache DBCP API?

If you use DataSource to get the Database connection, usually the code to get the connection is tightly coupled with the Driver specific DataSource implementation. Also most of the code is boiler-plate code except the choice of the DataSource implementation class.

Apache DBCP helps us in getting rid of these issues by providing DataSource implementation that works as an abstraction layer between our program and different JDBC drivers. Apache DBCP library depends on Commons Pool library, so make sure they both are in the build path.

For a complete example, read [Apache DBCP Example](http://www.journaldev.com/2509/jdbc-datasource-example-oracle-mysql-and-apache-dbcp-tutorial).

### What is JDBC Connection isolation levels?

When we use JDBC Transactions for data integrity, DBMS uses locks to block access by others to the data being accessed by the transaction. DBMS uses locks to prevent Dirty Read, Non-Repeatable Reads and Phantom-Read issue.

JDBC transaction isolation level is used by DBMS to use the locking mechanism, we can get the isolation level information through Connection getTransactionIsolation() method and set it with setTransactionIsolation() method.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Isolation Level | Transaction | Dirty Read | Non-Repeatable Read | Phantom Read |
| TRANSACTION\_NONE | Not Supported | Not Applicable | Not Applicable | Not Applicable |
| TRANSACTION\_READ\_COMMITTED | Supported | Prevented | Allowed | Allowed |
| TRANSACTION\_READ\_UNCOMMITTED | Supported | Allowed | Allowed | Allowed |
| TRANSACTION\_REPEATABLE\_READ | Supported | Prevented | Prevented | Allowed |
| TRANSACTION\_SERIALIZABLE | Supported | Prevented | Prevented | Prevented |

### What is JDBC RowSet? What are different types of RowSet?

JDBC RowSet holds tabular data in more flexible ways that ResultSet. All RowSet objects are derived from ResultSet, so they have all the capabilities of ResultSet with some additional features. RowSet interface is defined in javax.sql package.

Some additional features provided by RowSet are:

* + Functions as Java Beans with properties and their getter-setter methods. RowSet uses JavaBeans event model and they can send notifications to any registered component for events such as cursor movement, update/insert/delete of a row and change to RowSet contents.
  + RowSet objects are scrollable and updatable by default, so if DBMS doesn’t support scrollable or updatable ResultSet, we can use RowSet to get these features.

RowSet are broadly divided into two types:

* + **Connected RowSet Objects** – These objects are connected to database and are most similar to ResultSet object. JDBC API provides only one connected RowSet object javax.sql.rowset.JdbcRowSetand it’s standard implementation class is com.sun.rowset.JdbcRowSetImpl
  + **Disconnected RowSet Objects** – These RowSet objects are not required to connected to a database, so they are more lightweight and serializable. They are suitable for sending data over a network. There are four types of disconnected RowSet implementations.
    - CachedRowSet – They can get the connection and execute a query and read the ResultSet data to populate the RowSet data. We can manipulate and update data while it is disconnected and reconnect to database and write the changes.
    - WebRowSet derived from CachedRowSet – They can read and write XML document.
    - JoinRowSet derived from WebRowSet – They can form SQL JOIN without having to connect to a data source.
    - FilteredRowSet derived from WebRowSet – We can apply filtering criteria so that only selected data is visible.

### What is the different between ResultSet and RowSet?

RowSet objects are derived from ResultSet, so they have all the features of ResultSet with some additional features. One of the huge benefit of RowSet is that they can be disconnected and that makes it lightweight and easy to transfer over a network.

Whether to use ResultSet or RowSet depends on your requirements but if you are planning to use ResultSet for longer duration, then a disconnected RowSet is better choice to free database resources.

### What are common JDBC Exceptions?

Some of the common JDBC Exceptions are:

* + java.sql.SQLException – This is the base exception class for JDBC exceptions.
  + java.sql.BatchUpdateException – This exception is thrown when Batch operation fails, but it depends on the JDBC driver whether they throw this exception or the base SQLException.
  + java.sql.SQLWarning – For warning messages in SQL operations.
  + java.sql.DataTruncation – when a data values is unexpectedly truncated for reasons other than its having exceeded MaxFieldSize.

### What is CLOB and BLOB datatypes in JDBC?

1. Character Large OBjects (CLOBs) are character string made up of single-byte characters with an associated code page. This data type is appropriate for storing text-oriented information where the amount of information can grow beyond the limits of a regular VARCHAR data type (upper limit of 32K bytes).

Binary Large OBjects (BLOBs) are binary string made up of bytes with no associated code page. This data type can store binary data larger than VARBINARY (32K limit). This data type is good for storing image, voice, graphical, and other types of business or application-specific data.

### What is “dirty read” in JDBC? Which isolation level prevents dirty read?

When we work with transactions, there is a chance that a row is updated and at the same time other query can read the updated value. This results in a dirty read because the updated value is not permanent yet, the transaction that has updated the row can rollback to previous value resulting in invalid data.

Dirty Read is prevented by isolation levels TRANSACTION\_READ\_COMMITTED, TRANSACTION\_REPEATABLE\_READ and TRANSACTION\_SERIALIZABLE.

### What is 2 phase commit?

When we work in distributed systems where multiple databases are involved, we are required to use 2 phase commit protocol. 2 phase commit protocol is an atomic commitment protocol for distributed systems. In the first phase, transaction manager sends commit-request to all the transaction resources. If all the transaction resources are OK, then transaction manager commits the transaction changes for all the resources. If any of the transaction resource responds as Abort, then the transaction manager can rollback all the transaction changes.

### What are the different types of locking in JDBC?

On a broad level, there are two types of locking mechanism to prevent data corruption because of more than one user working with the same data.

* + Optimistic Locking – Locking the record only when update is taking place
  + Pessimistic Locking – Locking the record from the select to read, update and commit phase.

Apart from that some DBMS systems provide locking mechanism to lock single row, table or database.

### What do you understand by DDL and DML statements?

Data Definition Language (DDL) statements are used to define the database schema. Create, Alter, Drop, Truncate, Rename statements comes under DDL statements and usually they don’t return any result.

Data Manipulation Language (DML) statements are used to manipulate data in the database schema. Select, Insert, Update, Delete, Call etc are example of DML statements.

### What is difference between java.util.Date and java.sql.Date?

java.util.Date contains information about the date and time whereas java.sql.Date contains information only about the date, it doesn’t have time information. So if you have to keep time information in the database, it is advisable to use Timestamp or DateTime fields.

### How to insert an image or raw data into database?

We can use BLOB to insert image or raw binary data into database.

### What is phantom read and which isolation level prevents it?

A phantom read is the situation where a transaction executes a query multiple times and get different data. Suppose a transaction is executing a query to get data based on a condition and then another transaction inserts a row that matches the condition. Now when same transaction will execute the query again, a new row will be part of the result set. This new row is referred as Phantom Row and this situation is termed as Phantom Read.

Phantom read can be prevented only with TRANSACTION\_SERIALIZABLE isolation level.

### What is SQL Warning? How to retrieve SQL warnings in the JDBC program?

SQLWarning is the subclass of SQLException and we can retrieve it by calling getWarnings() method on Connection, Statement, and ResultSet objects. SQL Warnings doesn’t stops the execution of the script but alerts the user about the warning.

### How to invoke Oracle Stored Procedure with Database Objects as IN/OUT?

If Oracle Stored Procedure has IN/OUT parameters as DB Objects then we need to create an Object array of the same size in the program and then use it to create Oracle STRUCT object. Then we can set this STRUCT object for the database object by calling setSTRUCT() method and work with it.

### When do we get java.sql.SQLException: No suitable driver found?

You get No suitable driver found exception when the SQL URL String is not properly formatted. You can get this exception in both simple java application using DriverManager or with JNDI resource using DataSource. The exception stack trace looks like below.

|  |  |
| --- | --- |
| 1  2  3  4  5  6  7  8  9  10  11  12  13 | org.apache.tomcat.dbcp.dbcp.SQLNestedException: Cannot create JDBC driver of class 'com.mysql.jdbc.Driver' for connect URL ''jdbc:mysql://localhost:3306/UserDB'      at org.apache.tomcat.dbcp.dbcp.BasicDataSource.createConnectionFactory(BasicDataSource.java:1452)      at org.apache.tomcat.dbcp.dbcp.BasicDataSource.createDataSource(BasicDataSource.java:1371)      at org.apache.tomcat.dbcp.dbcp.BasicDataSource.getConnection(BasicDataSource.java:1044)      java.sql.SQLException: No suitable driver found for 'jdbc:mysql://localhost:3306/UserDB      at java.sql.DriverManager.getConnection(DriverManager.java:604)      at java.sql.DriverManager.getConnection(DriverManager.java:221)      at com.journaldev.jdbc.DBConnection.getConnection(DBConnection.java:24)      at com.journaldev.jdbc.DBConnectionTest.main(DBConnectionTest.java:15)  Exception in thread "main" java.lang.NullPointerException      at com.journaldev.jdbc.DBConnectionTest.main(DBConnectionTest.java:16) |

While debugging this exception, just check the URL getting printed in the logs, as in above logs the URL String is ‘jdbc:mysql://localhost:3306/UserDB whereas it should be jdbc:mysql://localhost:3306/UserDB.

### What are JDBC Best Practices?

Some of the JDBC Best Practices are:

* + Database resources are heavy, so make sure you close it as soon as you are done with it. Connection, Statement, ResultSet and all other JDBC objects have close() method defined to close them.
  + Always close the result set, statement and connection explicitly in the code, because if you are working in connection pooling environment, the connection might be returned to the pool leaving open result sets and statement objects resulting in resource leak.
  + Close the resources in the finally block to make sure they are closed even in case of exception scenarios.
  + Use batch processing for bulk operations of similar kind.
  + Always use PreparedStatement over Statement to avoid SQL Injection and get pre-compilation and caching benefits of PreparedStatement.
  + If you are retrieving bulk data into result set, setting an optimal value for fetchSize helps in getting good performance.
  + The database server might not support all isolation levels, so check it before assuming.
  + More strict isolation levels result in slow performance, so make sure you have optimal isolation level set for your database connections.
  + If you are creating database connections in a web application, try to use JDBC DataSource resources using JNDI context for re-using the connections.
  + Try to use disconnected RowSet when you need to work with ResultSet for a long time.