

Lecture 50

JDBC - I



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OBJECT ORIENTED PROGRAMMING WITH JAVA

Java Database Connectivity – I

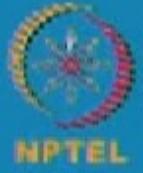
Debasis Samanta

Department of Computer Science & Engineering
Indian Institute of Technology Kharagpur





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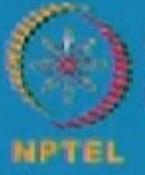




MySQL Basics



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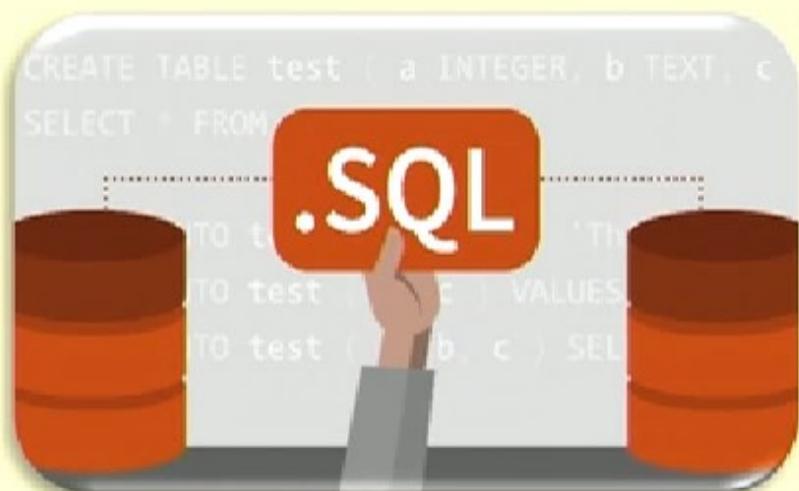
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Introduction to SQL

- SQL stands for *Structured Query Language*. It is a kind of language(mostly like English).
- SQL is undoubtedly the most popular and widely-used open source Database Management System (DBMS) language.
- It is simple to set up and use.
- SQL is mainly used to create a table, enter data into table, update records in a table and retrieving data from a table.



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Introduction to SQL

- SQL stands for *Structured Query Language*. It is a kind of language(mostly like English).
- SQL is undoubtedly **Note:**
Database Management
 - 1. SQL is not a programming language like C, C++, Java, etc.
 - 2. SQL is not case sensitive.
- It is simple to set up and use.
- SQL is mainly used to create a table, enter data into table, update records in a table and retrieving data from a table.



MySQL is one of the most popular **Database Management System (DBMS)**.

- MySQL is a database system used on the web.
- MySQL is a database system that runs on a server.
- MySQL is ideal for both small and large applications.
- MySQL is very fast, reliable, and easy to use.
- MySQL uses standard **SQL**.
- MySQL works on a number of platforms.
- MySQL is free to download and use.
- MySQL is developed, distributed, and supported by Oracle Corporation.
- MySQL is named after co-founder Monty Widenius's daughter: My





MySQL Setup



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Why install MySQL locally?

- Installing MySQL on a simple PC allows a user to safely create and test a web application without affecting the data or systems on the actual database management systems.
- Let's discuss the installation information for MySQL on Windows.



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All-in-One packages

There are some excellent all-in-one Windows distributions that contain Apache, PHP (Hypertext Pre-Processor), MySQL and other applications in a single installation file, e.g. XAMPP, WAMP Server, etc.



<https://www.apachefriends.org/download.html>

XAMPP for Windows



<http://www.wampserver.com/en/>

WAMP for Windows



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Manual installation : Download MySQL

1. Go to the link: dev.mysql.com/downloads/
2. Open MySQL Community Server
3. Download the “Without installer” (Archive) version.

Direct Link: <https://dev.mysql.com/get/Downloads/MySQL-8.0/mysql-8.0.13-winx64.zip>



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Manual installation : Extract files

- Let us install MySQL to C:mysql.
 - Extract the files in ZIP to C: drive.
 - Rename the folder mysql-x.x.xx-win32 to mysql.

Note:

- MySQL can be installed anywhere in your system.
- If you want a lightweight installation, you can remove every sub-folder except for bin, data, scripts and share.



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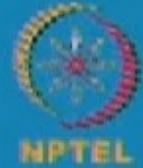


Manual installation : Move 'data' folder

- Place the **data** folder on another drive (or partition your drive) to make backups and re-installation easier.
 - For this purpose, create a folder, say **D://data/**.
 - Move the contents of **C://mysql/data** into it.
- Now, you have two folders, **C://mysql/data** and **D://data/**.
 - The original **C://mysql/data** folder can be removed now.



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Manual installation : File configuration

MySQL provides several configuration methods but, in general, it is easier to create a **my.ini** file in the **mysql** folder.

The simplest my.ini file is:

```
[mysqld]
# installation directory
basedir="C:\mysql\"

# data directory
datadir="D:\data\"
```

Note:

Remember to change these folder locations if you have installed MySQL or the data folder elsewhere.



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Manual installation : Test installation

- The MySQL server now should be started by running `C:mysql/bin/mysqld.exe`. Open a command box (Start > Run > cmd) and enter the following commands:

```
mysqld --console --initialize  
(Remember the password generated)
```

- This will start the MySQL server which listens for requests on localhost port `3306` with the random generated password. You can now start the MySQL command line tool and connect to the database.

Open another command box and enter and use the random password to login:

```
mysql -u root -p
```

Note: This will show a welcome message and the `mysql>` prompt.



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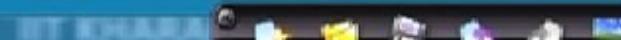


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Manual installation : Test installation

- Now we have to change the temporary password of root user to a new password using the following command in the command line mysql console

```
ALTER USER 'root'@'localhost' IDENTIFIED BY 'root';  
(Our new password for root user will be 'root')
```

- Now type EXIT to exit from the console and then restart the mysql console using the new root password using the following command:

```
mysql -u root -p
```

Note:

- This will show a welcome message and the mysql> prompt.
- Enter show databases; to view a list of the pre-defined databases, for example.



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Manual installation : Windows service

- The easiest way to start MySQL is to add it as a Windows service. From a command prompt, enter:

```
cd mysqlbin  
mysqld --install
```

Open the

1. Control Panel,
2. Administrative Tools, then
3. Services and
4. Double-click MySQL.
5. Set the Startup type to “Automatic” to ensure MySQL starts every time you boot your PC.

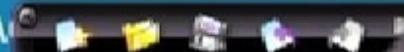


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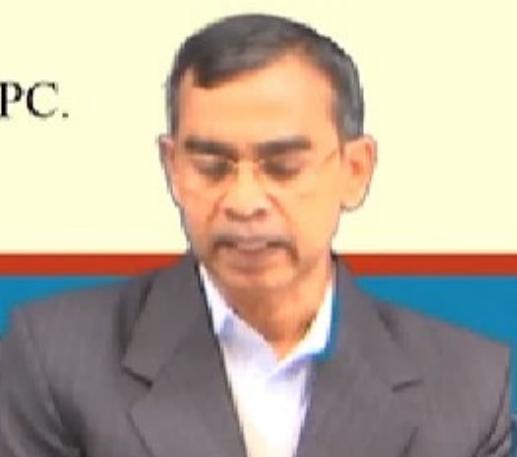
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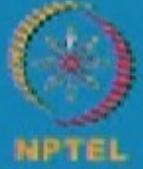




MySQL Statements



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Basic Statements

➤ DISPLAY DATABASES

```
show databases;
```

SHOW statement shows the databases already present.





Basic Statements

➤ DISPLAY DATABASES

```
show databases;
```

SHOW statement shows the databases already present.

➤ CREATE DATABASE

```
create database test;
```

CREATE statement is used to create a new database.

➤ SET CURRENT DATABASE (test)

```
use test;
```

USE is used to set the current working database.



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Statement : CREATE

To begin with, the table creation command requires the following details –

- Name of the table
- Name of the fields
- Definitions for each field

Syntax

```
CREATE TABLE table_name (
    column_name1 column_type1,
    column_name2 column_type2 ...);
```

➤ Create a table, say JavaCourse under test database

```
create table JavaCourse(
    Roll Integer primary key,
    Name Varchar(30),
    Marks Integer not null,
    Grade Varchar(2));
```



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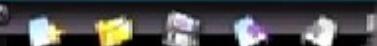


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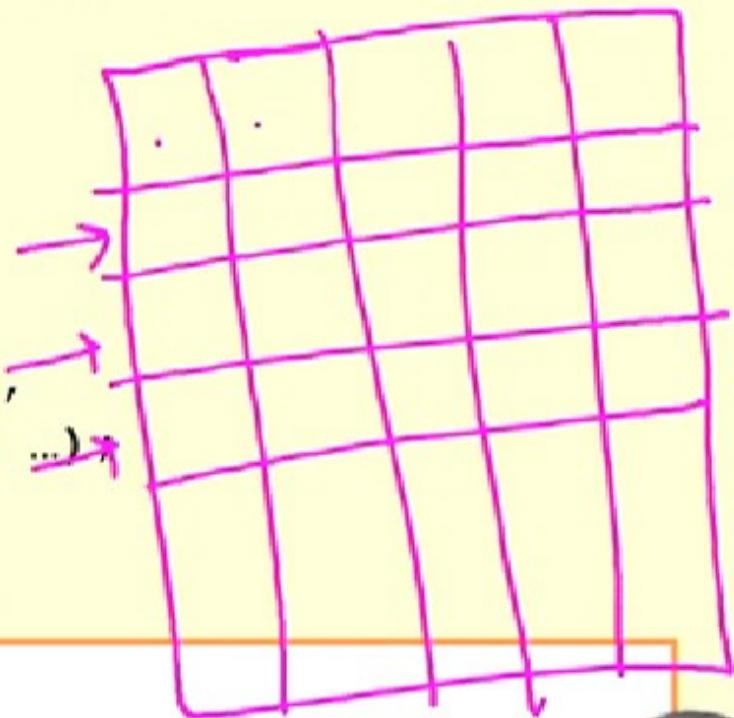
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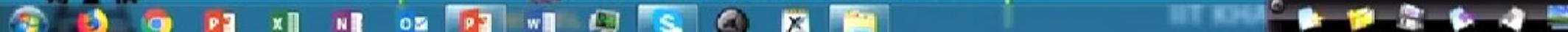
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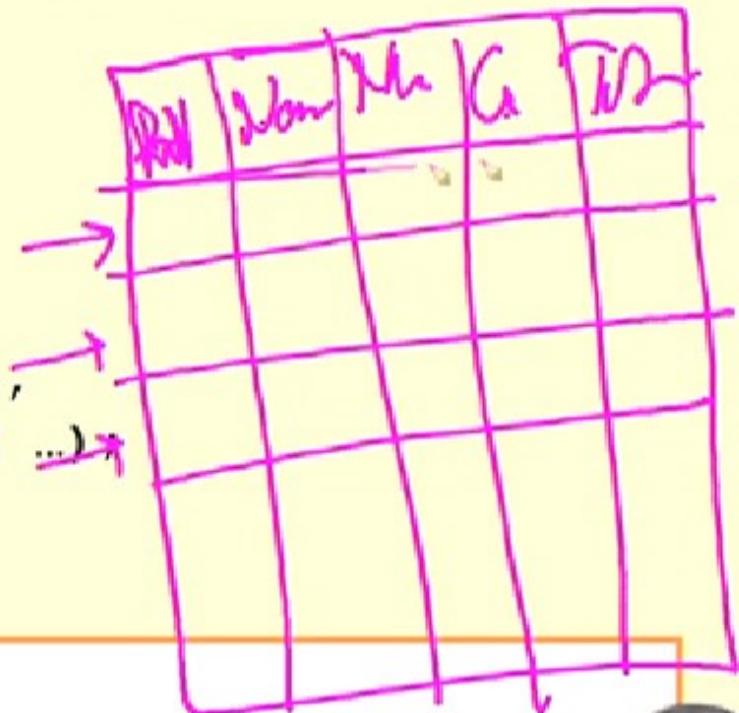
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Statement : DESC

In practice, you use the DESC statement which is a shorthand of the DESCRIBE statement. These statements are used to view the structure, datatype, keys and constraints used in a table.

Syntax

```
DESC table_name;
```

➤ Describe table 'JavaCourse'

```
desc JavaCourse;
```

Field	Type	Null	Key	Default
Roll	int(11)	NO	PRI	NULL
Name	varchar(30)	YES		NULL
Marks	int(11)	NO		NULL
Grade	varchar(2)	YES		NULL



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Syntax

DESC table name;

➤ Describe table 'JavaCourse'

desc JavaCourse;

Field	Type	Null	Key	Default
Roll	int(11)	NO	PRI	NULL
Name	varchar(30)	YES		NULL
Marks	int(11)	NO		NULL
Grade	varchar(2)	YES		NULL



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Statement : INSERT

You can insert data into the existing MySQL table by using the mysql> prompt or by using any script like PHP or any programming language using proper drivers using the **INSERT** statement.

Syntax

```
INSERT INTO table_name VALUES (Value1, Value2, ..., Value n);
```

➤ INSERT

```
insert into JavaCourse values (01,'Debasish', 75, 'A');
insert into JavaCourse values(02,'Nilanjan', 85, 'EX');
insert into JavaCourse values(03,'Tauheed', 65, 'B');
insert into JavaCourse values(04,'Priyabrata', 78, 'A')
```

Roll	Name	Marks	Grade
1	Debasish	75	A
2	Nilanjan	85	EX
3	Tauheed	65	B
4	Priyabrata	78	A



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```
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insert into JavaCourse values (02, 'Nilanjan', 85, 'EX');
insert into JavaCourse values (03, 'Tauheed', 65, 'B');
insert into JavaCourse values (04, 'Priyabrata', 78, 'A')
```

Roll	Name	Marks	Grade
1	Debasish	75	A
2	Nilanjan	85	EX
3	Tauheed	65	B
4	Priyabrata	78	A



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Statement : UPDATE

UPDATE statement is used to modify previously inserted data in a table.

Syntax

```
UPDATE table_name SET  
    ColName1=Value1,  
    ColName2=Value2,  
    ...  
    WHERE ColName1=Value1);
```

➤ UPDATE

```
update JavaCourse set Name='Debasis' where Name='Debasish';  
update JavaCourse set Marks=85, Grade='Ex' where Name='Debasis';
```

Roll	Name	Marks	Grade
1	Debasis	85	Ex
2	Nilanjan	85	EX
3	Tauheed	65	B
4	Priyabrata	78	A



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UPDATE statement is used to modify previously inserted data in a table.

Syntax

```
UPDATE "table_name" SET  
    ColName1=Value1,  
    ColName2=Value2,  
    ...  
    WHERE ColName1=Value1);
```

➤ UPDATE

```
update JavaCourse set Name='Debasis' where Name='Debasish';  
update JavaCourse set Marks=85, Grade='Ex' where Name='Debasis';
```

Roll	Name	Marks	Grade
1	Debasis	85	Ex
2	Nilanjan	85	EX
3	Tauheed		
4	Priyabrata		



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Statement : SELECT

SELECT statement is used to retrieve data from a table.

Syntax

```
SELECT <ColName1> <ColName2>...<ColNameP>
FROM table_name
WHERE <Condition>;
```



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Statement : SELECT

SELECT statement is used to retrieve data from a table.

Syntax

```
SELECT <ColName1> <ColName2>...<ColNameP>
FROM table_name
WHERE <Condition>;
```

Roll	Name	Marks	Grade
1	Debasis	85	Ex
2	Nilanjan	85	EX
3	Tauheed	65	B
4	Priyabrata	78	A

```
select * from JavaCourse;
```



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Statement : SELECT

SELECT statement is used to retrieve data from a table.

Syntax

```
SELECT <ColName1> <ColName2>...<ColNameP>
FROM table_name
WHERE <Condition>;
```



Roll	Name	Marks	Grade
1	Debasis	85	Ex
2	Nilanjan	85	EX
3	Tauheed	65	B
4	Priyabrata	78	A

name	roll
Debasis	1
Nilanjan	2
Tauheed	3
Priyabrata	4

✓
`select * from JavaCourse;`

`select name, roll from JavaCourse;`



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Statement : SELECT

SELECT statement is used to retrieve data from a table.

Syntax

```
SELECT <ColName1> <ColName2>...<ColNameP>
FROM table_name
WHERE <Condition>;
```

✓
select * from JavaCourse;

select name, roll from JavaCourse;

select * from JavaCourse where marks>80;

Roll	Name	Marks	Grade
1	Debasis	85	Ex
2	Nilanjan	85	EX
3	Tauheed	65	B
4	Priyabrata	78	A

Roll	Name	Marks	Grade
1	Debasis	85	Ex
2	Nilanjan	85	EX



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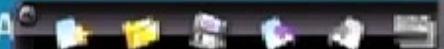


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Statement : SELECT

SELECT statement is used to retrieve data from a table.

Syntax

```
SELECT <ColName1> <ColName2>...<ColNameP>
FROM table_name
WHERE <Condition>;
```

```
✓ select * from JavaCourse;
select name, roll from JavaCourse;
select * from JavaCourse where marks>80;
select * from JavaCourse where name like '%jee%';
```

Roll	Name	Marks	Grade
1	Debasis	85	Ex
2	Nilanjan	85	EX
3	Tauheed	65	B
4	Priyabrata	78	A

Roll	Name	Marks	Grade
1	Debasis	85	Ex
2	Nilanjan	85	EX

name	roll
Debasis	1
Nilanjan	2
Tauheed	3
Priyabrata	4

Roll Name Marks Grade





Statement : SELECT

SELECT statement is used to retrieve data from a table.

Syntax

```
SELECT <ColName1> <ColName2>...<ColNameP>
FROM table_name
WHERE <Condition>;
```

```
select * from JavaCourse;

select name, roll from JavaCourse;

select * from JavaCourse where marks>80;

select * from JavaCourse where name like '%jee%';

select * from JavaCourse order by marks;
```

Roll	Name	Marks	Grade	name	roll
1	Debasis	85	Ex	Debasis	1
2	Nilanjan	85	EX	Nilanjan	2
3	Tauheed	65	B	Tauheed	3
4	Priyabrata	78	A	Priyabrata	4

✓

Roll	Name	Marks	Grade	Roll	Name	Marks	Grade
1	Debasis	85	Ex	1	Debasis	85	Ex
2	Nilanjan	85	EX	2	Nilanjan	85	EX

Roll	Name	Marks	Grade
3	Tauheed	65	B
4	Priyabrata	78	A
1	Debasis	85	Ex
2	Nilanjan	85	EX



Statement : DELETE

DELETE FROM statement is used to delete a record from any MySQL table.

Syntax

```
DELETE FROM table_name  
WHERE <Condition>;
```

- **DELETE**



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Statement : DELETE

DELETE FROM statement is used to delete a record from any MySQL table.

Syntax

```
DELETE FROM table_name  
WHERE <Condition>;
```

➤ DELETE

```
delete from JavaCourse where marks <66;
```

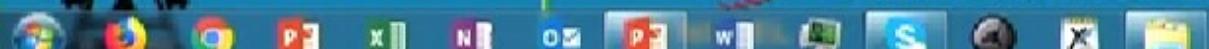
Roll	Name	Marks	Grade
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Statement : DELETE

DELETE FROM statement is used to delete a record from any MySQL table.

Syntax

```
DELETE FROM table_name  
WHERE <Condition>;
```

➤ DELETE

```
delete from JavaCourse where marks <66;
```

```
delete from JavaCourse;
```

Roll	Name	Marks	Grade
1	Debasis	85	Ex
2	Nilanjan	85	EX
4	Priyabrata	78	A

Roll	Name	Marks	Grade



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Statement : DROP

DROP TABLE statement is used to drop an existing MySQL table, but you need to be very careful while deleting any existing table because the data lost will not be recovered after deleting a table.

Syntax

```
DROP TABLE table_name;
```

➤ **DROP TABLE**

```
drop table JavaCourse;
```



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Questions to think...

- Can MySQL store unstructured data?
- How to take backup of MySQL data?



Lecture 51

JDBC - II



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Java Database Connectivity – II

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Department of Computer Science & Engineering
Indian Institute of Technology Kharagpur

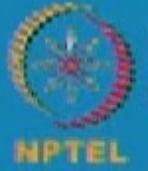




Concept of JDBC



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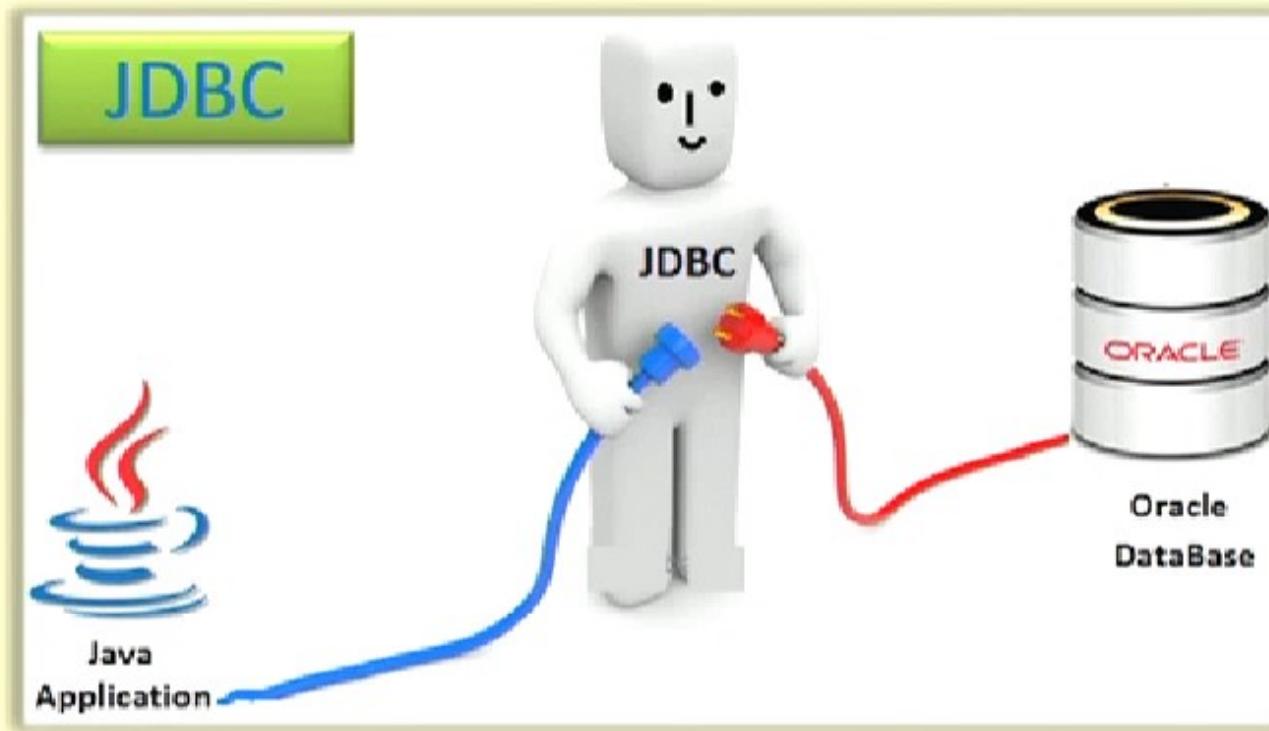
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JDBC: Java Database Connectivity

- JDBC is a standard Java API for handling database related activities.
- In Java, there is a package `java.sql` having number of classes for database related programming.
- It includes `java.sql.DriverManager` class and two interfaces `java.sql.Driver` and `java.sql.Connection`.



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JDBC: Characteristics

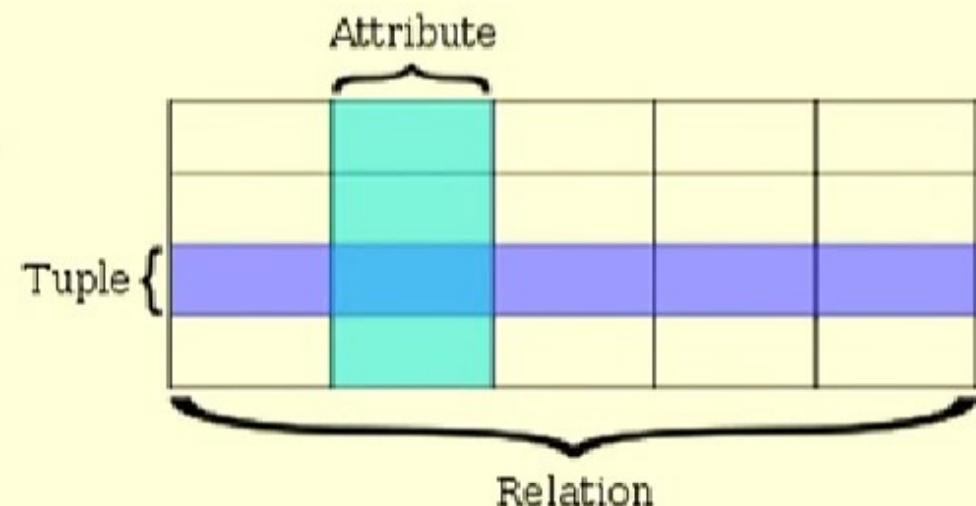
- JDBC is a SQL (Structured Query Language)-level API, which is very popular for RDBMS (Relational Database Management System).
- It is compatible with the most of the popular database management systems, namely OracleDB, MySQL, Sybase, Microsoft SQL, etc.
- It is simple and easy to implement.





Relational database

- A relational database is a database that allows for queries which typically use Structured Query Language (SQL) to store and retrieve data.
- A relational database stores information by means of tables. A table is referred to as a relation in the sense that it is a collection of objects of the same type (rows).
- Examples:
MS SQL Server, IBM DB2, Oracle, MySQL , etc.



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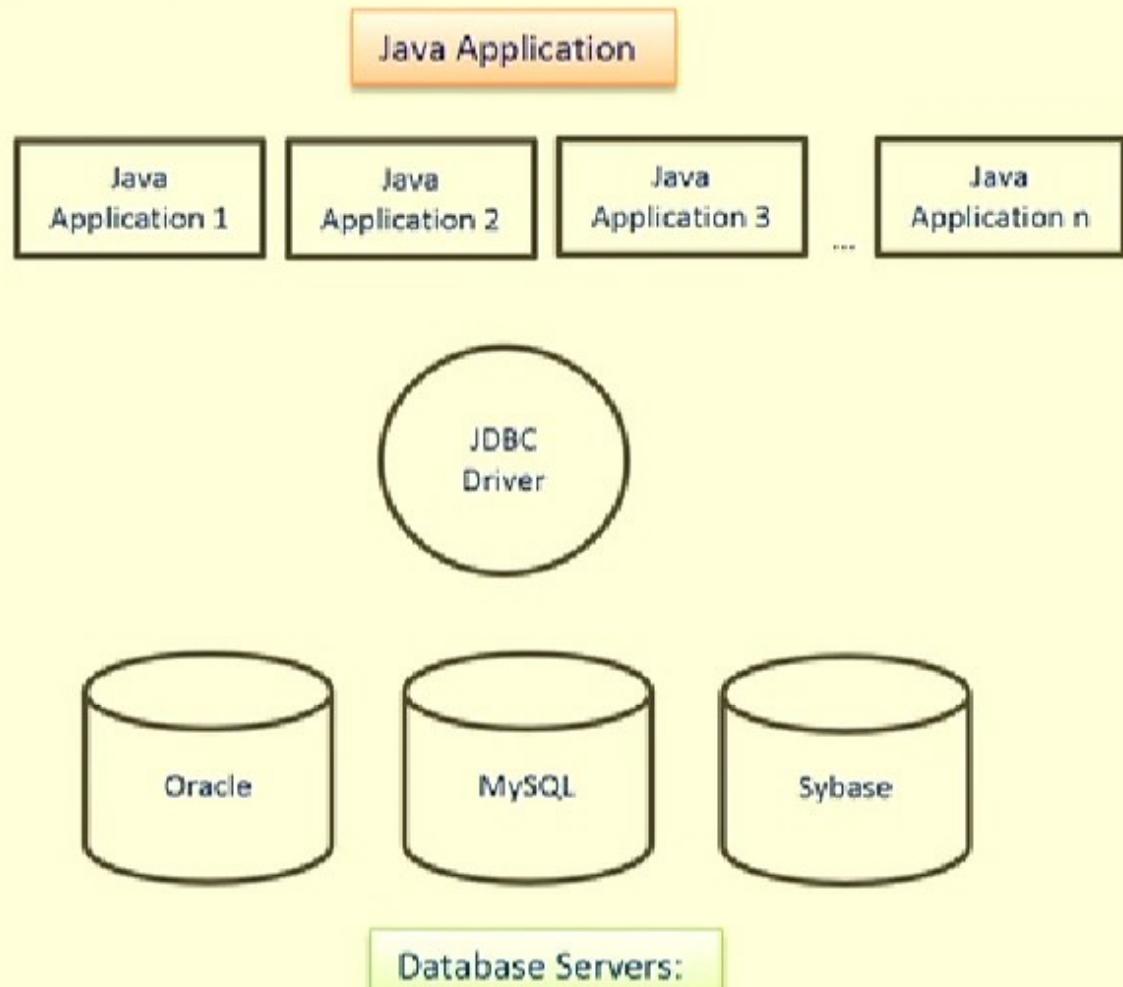
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JDBC: Characteristics



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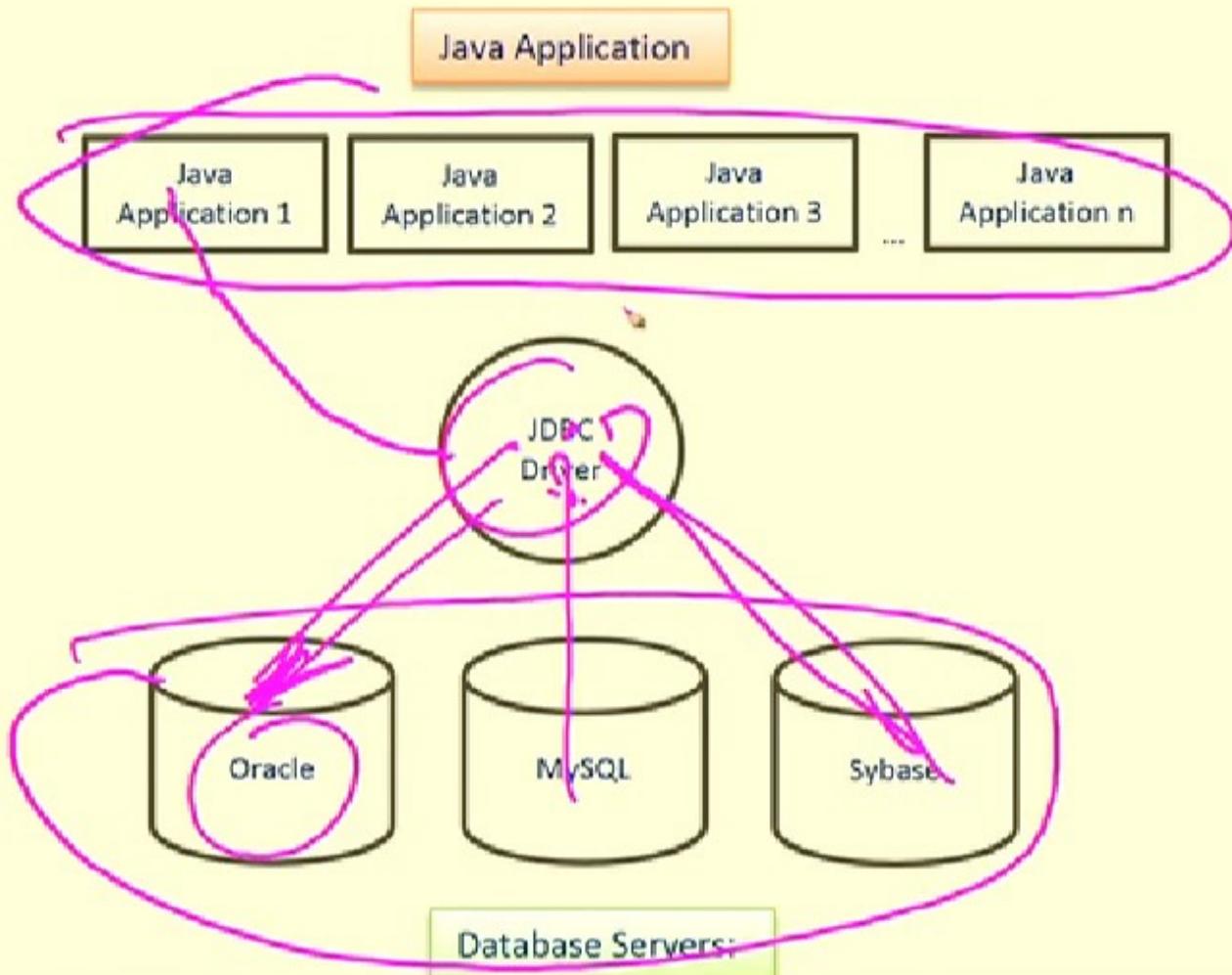


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JDBC: Characteristics



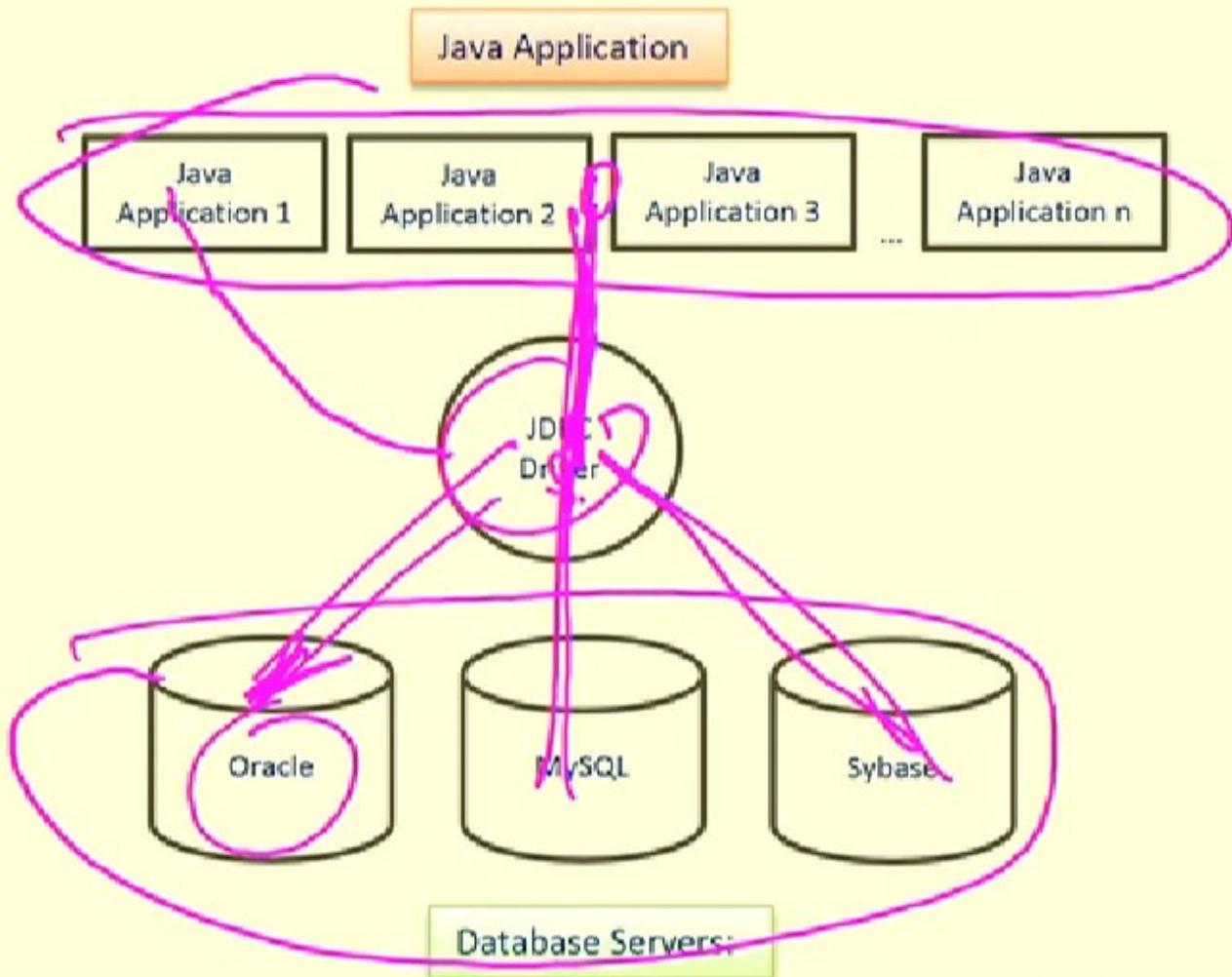
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JDBC: Characteristics



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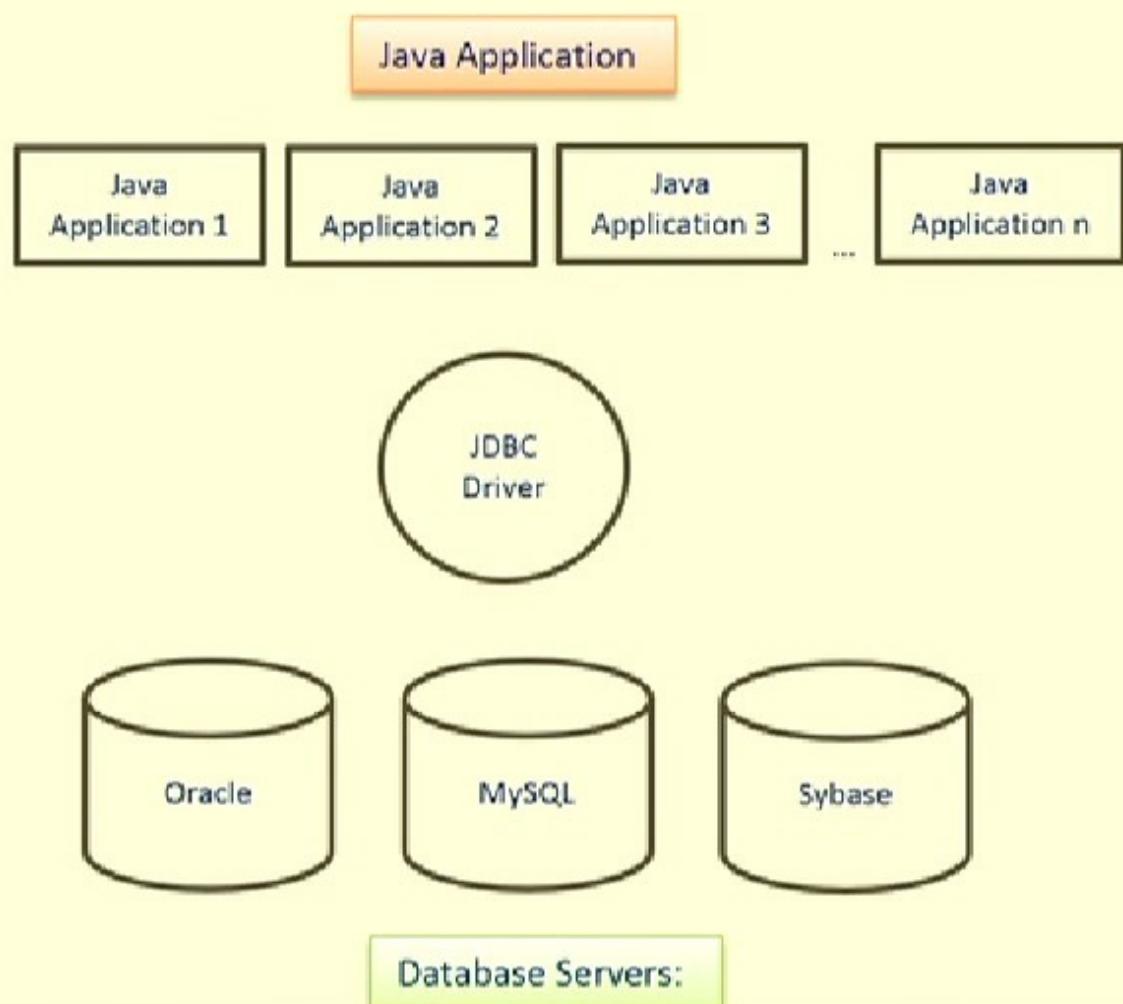
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JDBC: Characteristics



- In this course, we shall refer to JDBC to connect to MySQL database server.
- The approach is same to any other database.

Note:

- The **JDBC driver** for different database is different. But, as an end-user, we don't have to bother about their implementation.



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Why JDBC?

- Write once, run anywhere
 - Multiple client and server platforms.
- Object-relational mapping
 - Databases optimized for searching/indexing.
 - Objects optimized for engineering/flexibility.
- Network independence
 - Works across Internet Protocol.
- Database independence
 - Java can access any database vendor.



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JDBC: Structure

- JDBC is a SQL-level API. It means that the JDBC allows to construct SQL statements and embed them inside Java API calls.
- The JDBC API is an implementation to interact a particular database engine. This implementation is called JDBC Driver.



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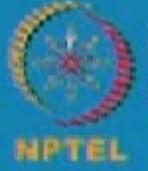




Types of JDBC Drivers



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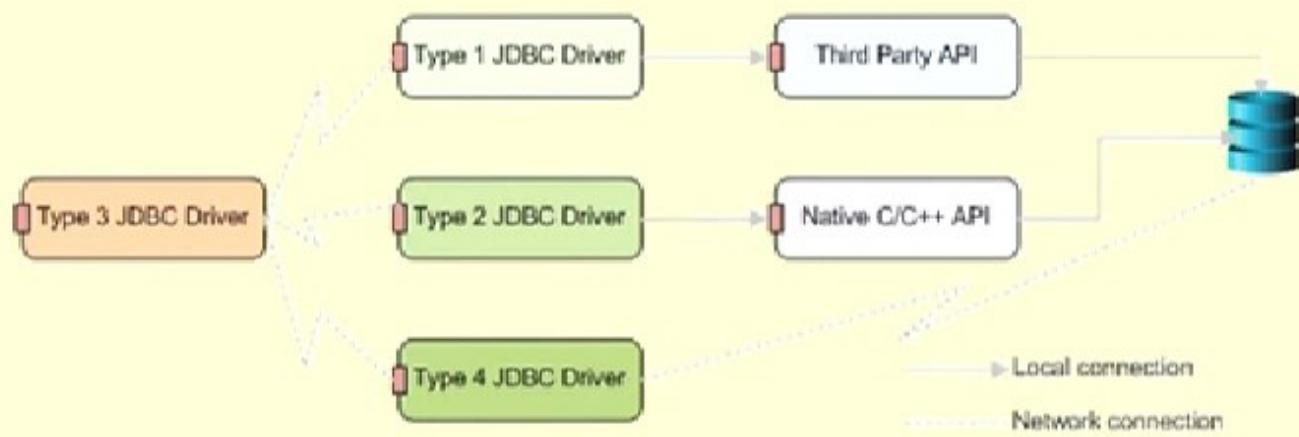
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JDBC: Types

JDBC Driver is a software component that enables Java application to interact with the database.



There are 4 types of JDBC drivers:

Type – 1 : JDBC-ODBC bridge driver

Type – 2 : Native-API driver (partially Java driver)

Type – 3 : Network Protocol driver (fully Java driver)

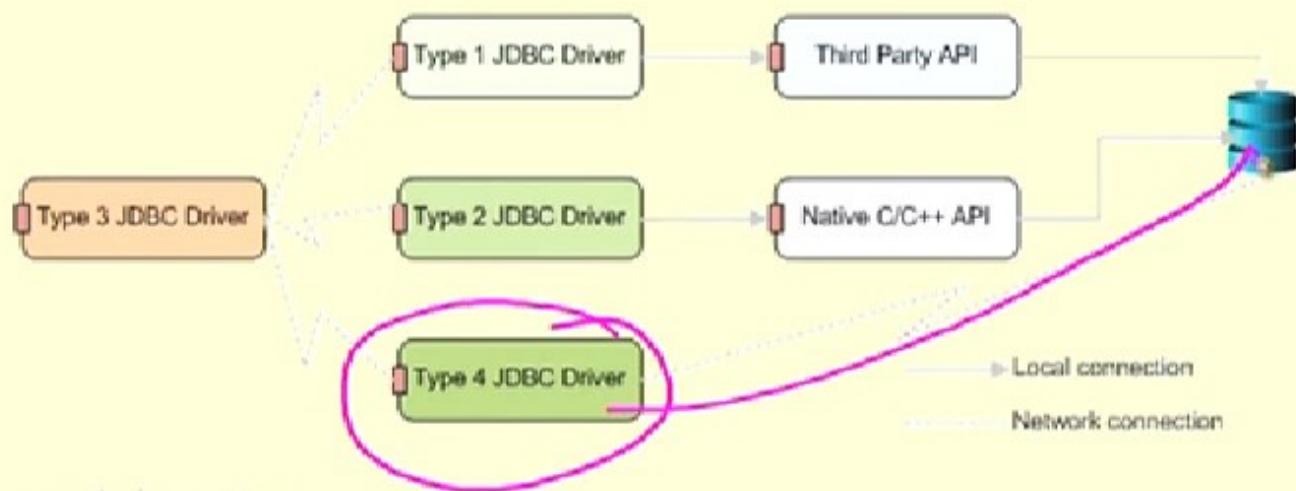
Type – 4 : Thin driver (fully Java driver)





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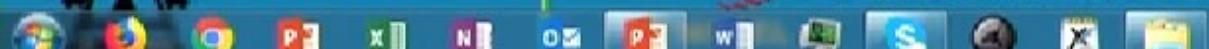
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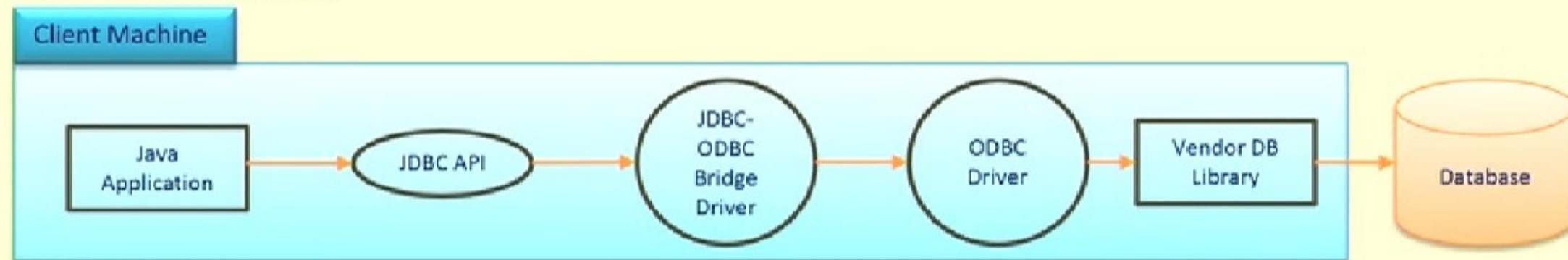




JDBC: Type 1 – JDBC-ODBC

Type – I : JDBC-ODBC bridge driver

The JDBC-ODBC bridge driver uses ODBC driver to connect to the database. The JDBC-ODBC bridge driver converts JDBC method calls into the ODBC function calls. This is now discouraged because of thin driver.



Note: Oracle does not support the JDBC-ODBC Bridge from Java 8. Oracle recommends that you use JDBC drivers provided by the vendor of your database instead of the JDBC-ODBC Bridge.





JDBC: Type 1 – JDBC-ODBC

Type – I : JDBC-ODBC bridge driver

Advantages:

1. Easy to use.
2. Can be easily connected to any database.

Disadvantages:

1. Performance degraded because JDBC method call is converted into the ODBC function calls.
2. The ODBC driver needs to be installed on the client machine.

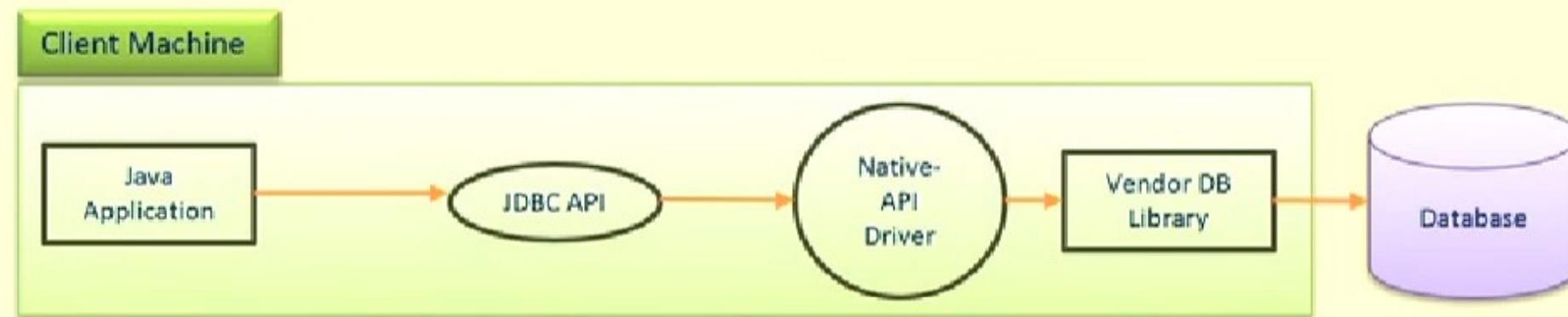




JDBC: Type 2 – Native-API

Type – II : Native-API driver (partially Java driver)

The native API driver uses the client-side libraries of the database. The driver converts JDBC method calls into native calls of the database API. It is not written entirely in java.



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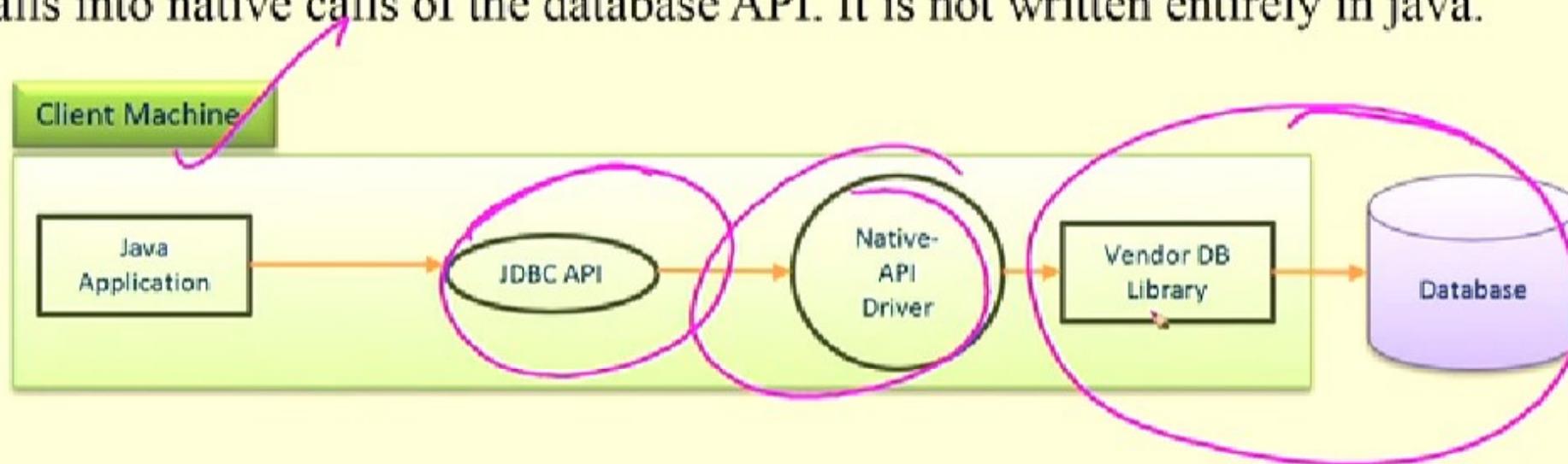




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JDBC: Type 2 – Native-API

Type – II : Native-API driver (partially Java driver)

Advantages:

1. Performance upgraded than JDBC-ODBC bridge driver.

Disadvantages:

1. The native driver needs to be installed on the each client machine.
2. The vendor client library needs to be installed on client machine.

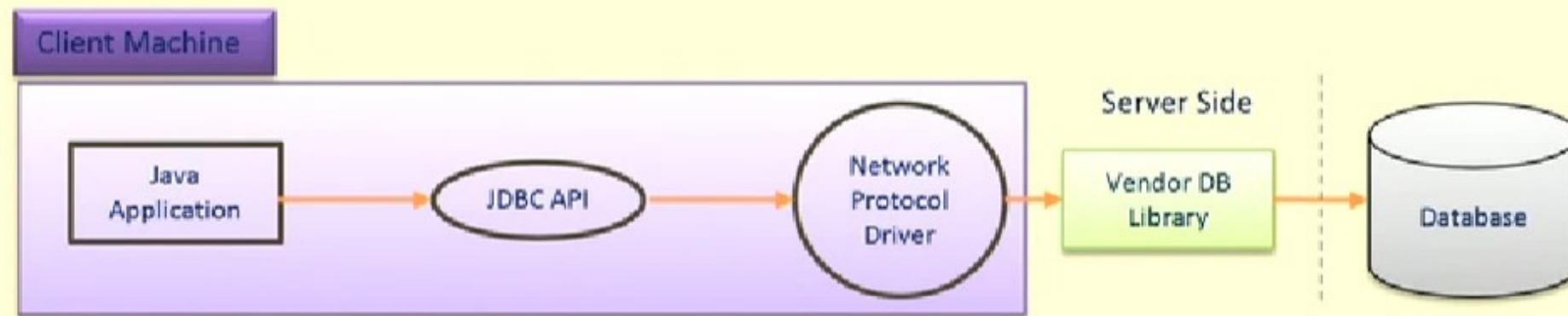




JDBC: Type 3 – Network Protocol

Type – III : Network Protocol driver (fully Java driver)

The network protocol driver uses middleware (application server) that converts JDBC calls directly or indirectly into the vendor-specific database protocol. It is fully written in java.

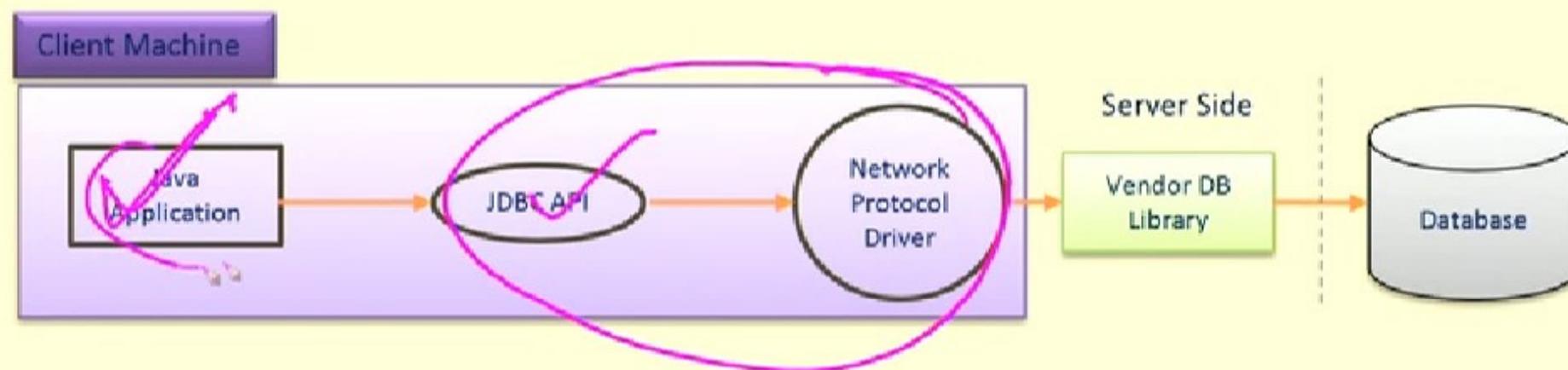




JDBC: Type 3 – Network Protocol

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JDBC: Type 3 – Network Protocol

Type – III : Network Protocol driver (fully Java driver)

Advantages:

1. No client side library is required because of application server that can perform many tasks like auditing, load balancing, logging etc.

Disadvantages:

1. Network support is required on client machine.
2. Requires database-specific coding to be done in the middle tier.
3. Maintenance of Network Protocol driver becomes costly because it requires database-specific coding to be done in the middle tier.



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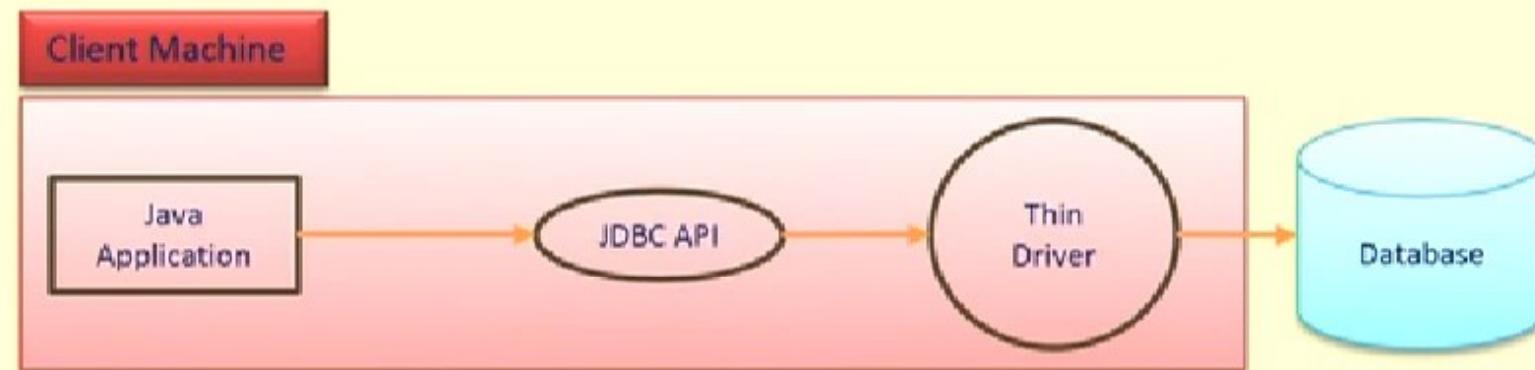




JDBC: Type 4 – Thin Driver

Type – IV : Thin driver (fully Java driver)

The thin driver converts JDBC calls directly into the vendor-specific database protocol. That is why it is known as thin driver. It is fully written in Java language.



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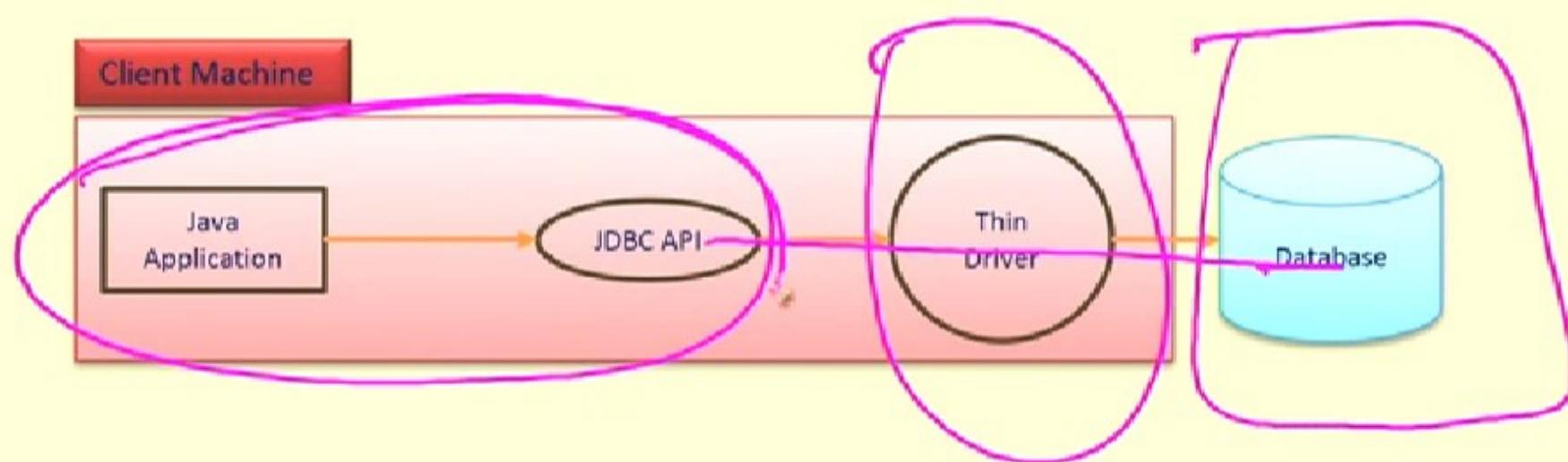
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JDBC: Type 4 – Thin Driver

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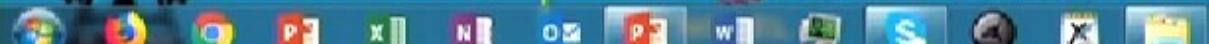
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JDBC: Type 4 – Thin Driver

Type – IV : Thin driver (fully Java driver)

Advantages:

1. Better performance than all other drivers.
2. No software is required at client side or server side.

Disadvantages:

1. Drivers depend on the database.

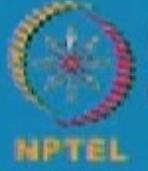




JDBC Architectures



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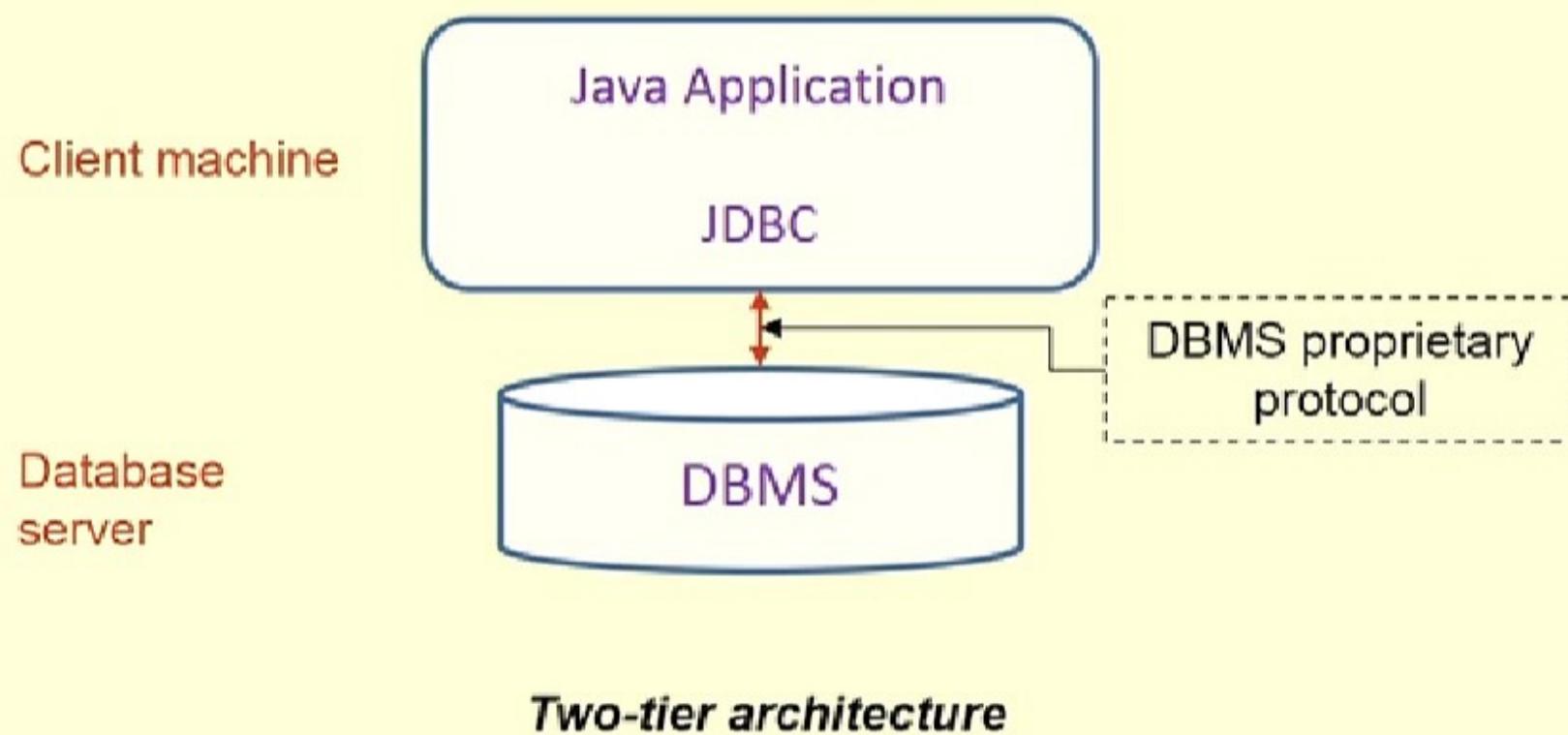
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JDBC Architecture : Two-tier



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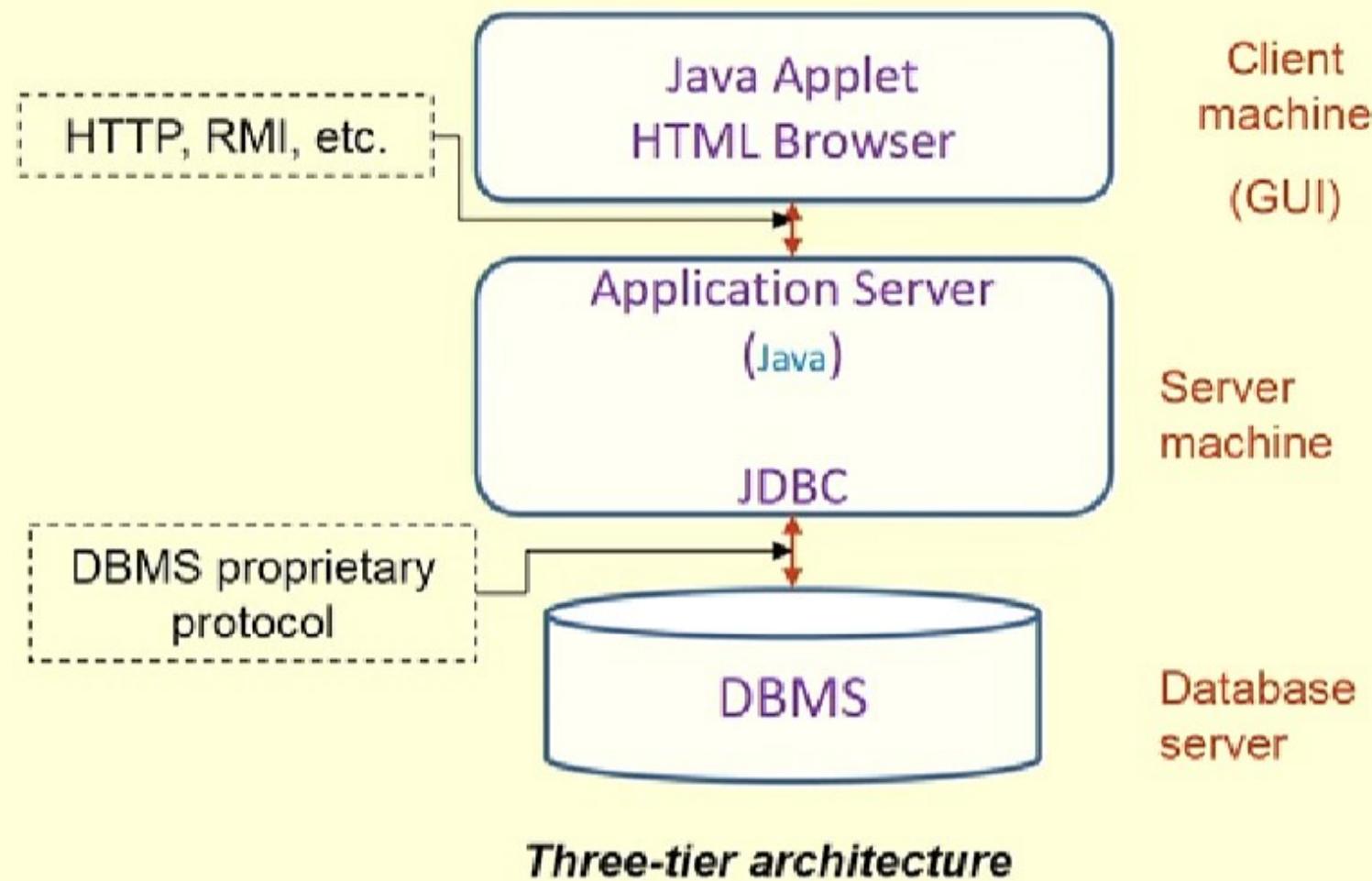
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JDBC Architecture : Three-tier



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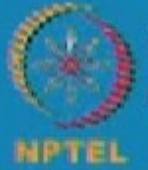




Inside JDBC



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JDBC steps



- Load a JDBC driver.
- Create connections.
- Connect to the data source.
- Execute SQL statement(s).
- Map the results to data structures.



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JDBC driver

- Acts as the gateway to a database.
- Not actually a Windows “*driver*”, it is just a .jar file.
- For MySQL JDBC driver:
[mysql-connector-java-8.0.12-bin.jar \(current\)](#)

MySQL Driver Link

<https://dev.mysql.com/downloads/connector/j/8.0.html>



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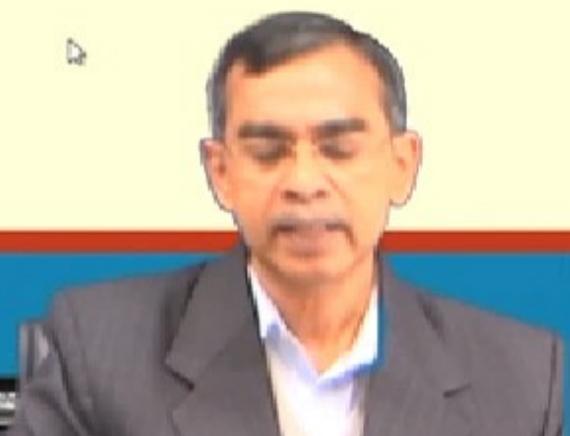
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JDBC driver installation

- Download the driver, extract .jar file and add its path into your \$CLASSPATH
- Linux: use command:
 - `export CLASSPATH=$CLASSPATH:<path to .jar file>:`
- Windows: Add the path of .jar file to system variable CLASSPATH

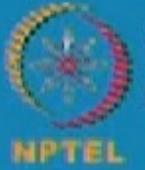




Connecting to Database



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Common JDBC components

Class/Interface	Description
DriverManager	This class manages a list of database drivers. Matches connection requests from the Java application with the proper database driver using communication sub protocol. The first driver that recognizes a certain sub-protocol under JDBC will be used to establish a database Connection.
Driver	This interface handles the communications with the database server. You will interact directly with Driver objects very rarely. Instead, you use DriverManager objects, which manage objects of this type. It also abstracts the details associated with working with Driver objects.
Connection	This 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	You use objects created from this interface to submit the SQL statements to the database. Some derived interfaces accept parameters in addition to executing stored procedures.
ResultSet	This class retrieves data from a database after you execute an SQL query using Statement objects. It acts as an iterator to allow you to move through its data.
SQLException	This class handles any errors that occur in a database application.





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Loading JDBC driver

- For MySql:

```
Class.forName ("com.mysql.cj.jdbc.Driver").newInstance();
```

- For Oracle:

```
Class.forName("oracle.jdbc.driver.OracleDriver").newInstance();
```

- For MS SQL Server :

```
Class.forName("com.microsoft.jdbc.sqlserver.SQLServerDriver").newInstance();
```



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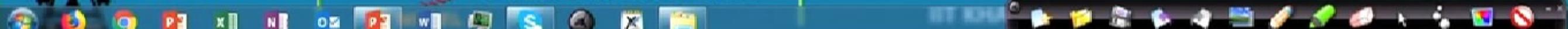
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Establishing connection

- Create a `Connection` object
- Use the `DriverManager` to grab a connection with the `getConnection()` method

```
Connection conn = null;
String userName = "guest";
String password = "guest";
String url = "jdbc:mysql://10.14.100.141/test";
conn = DriverManager.getConnection (url, userName, password);
```





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```

→ Name of driver



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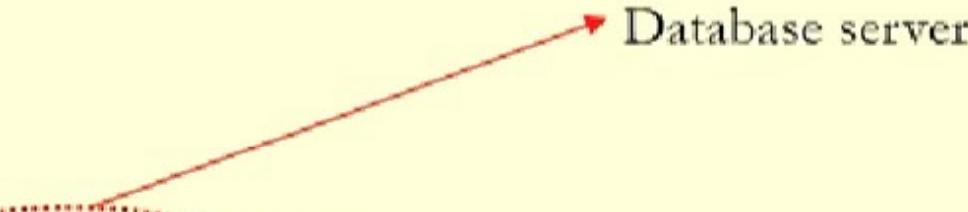




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Database server

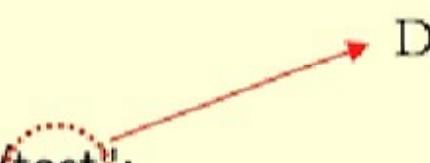




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Database name



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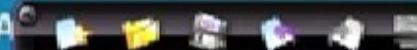


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Three types of statements

Types	Description
Statement	For executing a simple SQL statement
PreparedStatement	For executing a precompiled SQL statement
CallableStatement	For executing a database stored procedure



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Executing SQL statements

Create a statement object from the connection

```
Statement stmt = null;  
stmt = conn.createStatement();  
  
stmt.execute("show tables");  
stmt.execute("insert into JavaCourse values (01,'Debasis', 85, 'Ex')");
```





Executing SQL statements

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Statement stmt = null;  
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stmt.execute("insert into JavaCourse values (01, 'Debasis', 85, 'Ex')");
```





Useful methods in Statement class

Methods	Description
executeQuery ()	Executes SQL query and returns the data in a table (ResultSet) object. This method is used for SQL command that expects a return data from a database.
executeUpdate ()	Used to execute INSERT, UPDATE, DELETE, CREATE TABLE, DROP TABLE, ALTER TABLE Returns the number of rows that are affected in the database
execute ()	Generic method for executing simple statements, stored procedures, prepared statements. It can be used when the statement is either related to query or update. This method returns true (if query yields a row) otherwise returns false .
getMaxRows ()	Determines the number of rows a ResultSet can contain.





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PreparedStatement : An example

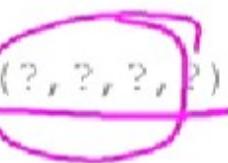
```
PreparedStatement pstmt = null;  
  
String QryString = "INSERT INTO JavaCourse (Roll,Name,Marks,Grade) VALUES (?,?,?,?)";  
pstmt = conn.prepareStatement(QryString);  
  
pstmt.setInt(1, 12);  
pstmt.setString(2, "ABC");  
pstmt.setInt(3, 64);  
pstmt.setString(4, "Ex");  
pstmt.executeUpdate();
```





PreparedStatement : An example

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PreparedStatement pstmt = null;  
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pstmt.setInt(3, 64);  
pstmt.setString(4, "Ex");  
pstmt.executeUpdate();
```





ResultSet

- A `ResultSet` provides access to a table of data generated by executing a Statement.
- Only one `ResultSet` per Statement can be open at once.
- The table rows are retrieved in sequence.
- A `ResultSet` maintains a cursor pointing to its current row of data.
- The `next()` method moves the cursor to the next row.
 - you can't rewind.



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Useful ResultSet methods

Methods	Description
<code>boolean next()</code>	<ul style="list-style-type: none">– attempts to move to the next row in ResultSet– the first call to next() positions cursor at the first row– returns false if there are no more rows
<code>Type getType(int columnIndex)</code>	<ul style="list-style-type: none">– returns the given field as the given type– fields indexed starting at 1 (not 0)
<code>Type getType(String columnName)</code>	<ul style="list-style-type: none">– same, but uses name of field– less efficient
<code>void close()</code>	<ul style="list-style-type: none">– disposes of the ResultSet– allows you to re-use the Statement that created it
<code>int findColumn(String columnName)</code>	<ul style="list-style-type: none">– looks up column index given column name





Matching with Java and SQL data types

<u>SQL type</u>	<u>Java class</u>	<u>ResultSet method</u>
BIT	Boolean	getBoolean()
CHAR	String	getString()
VARCHAR	String	getString()
DOUBLE	Double	getDouble()
FLOAT	Double	getDouble()
INTEGER	Integer	getInt()
REAL	Double	getFloat()
DATE	java.sql.Date	getDate()
TIME	java.sql.Time	getTime()
TIMESTAMP	java.sql.Timestamp	getTimestamp()



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VARCHAR	String	getString()
DOUBLE	Double	getDouble()
FLOAT	Double	getDouble()
INTEGER	Integer	getInt()
REAL	Double	getFloat()
DATE	java.sql.Date	getDate()
TIME	java.sql.Time	getTime()
TIMESTAMP	java.sql.Timestamp	getTimestamp()



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Map the results to data structures

```
ResultSet rs = null;  
String NameString, RollString, MarksString, GradeString;  
  
stmt.execute("SELECT * FROM JavaCourse");  
rs = stmt.getResultSet();  
  
while (rs.next()) {  
    NameString = rs.getString("Name");  
    RollString = rs.getString("Roll");  
    MarksString = rs.getString("Marks");  
    GradeString = rs.getString("Grade");  
}  
}
```



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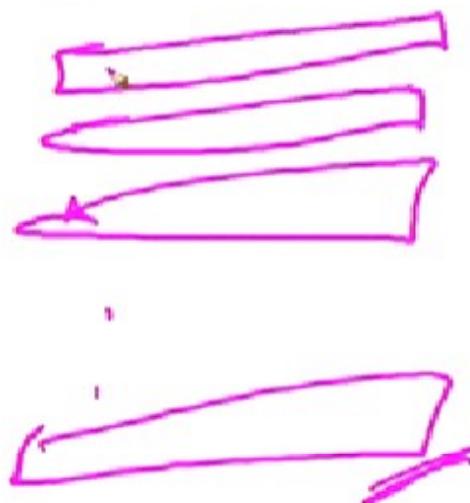
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Map the results to data structures

```
ResultSet rs = null;  
String NameString, RollString, MarksString, GradeString;  
  
stmt.execute("SELECT * FROM JavaCourse");  
rs = stmt.getResultSet();  
  
while (rs.next()) {  
    NameString = rs.getString("Name");  
    RollString = rs.getString("Roll");  
    MarksString = rs.getString("Marks");  
    GradeString = rs.getString("Grade");  
}
```



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JDBC exceptions

SQLException is an Exception class which provides information on database access errors.

```
try{
    ...
}

catch (SQLException ex){
    // handle any errors
    System.out.println("SQLException: " + ex.getMessage());
    System.out.println("SQLState: " + ex.getSQLState());
    System.out.println("VendorError: " + ex.getErrorCode());
}
```



Questions to think...

- Can we store and retrieve images using JDBC?
- What are the benefits of PreparedStatement over Statement?

