JDBC Insights

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SESSION TOPICS

- Introduction to Database and JDBC
- Usage of SQLite and H2 Databases
- SQL CRUD Process – Create Read Update Delete
- Usage of log4j – Logging Framework
- JDBC Connection Pool using HikariCP
- Concepts to JPA with Spring JPA
- Introduction to Database Trigger
- Usage of Google Guava Cache for Static Data
- Q & A

JDBC Insights

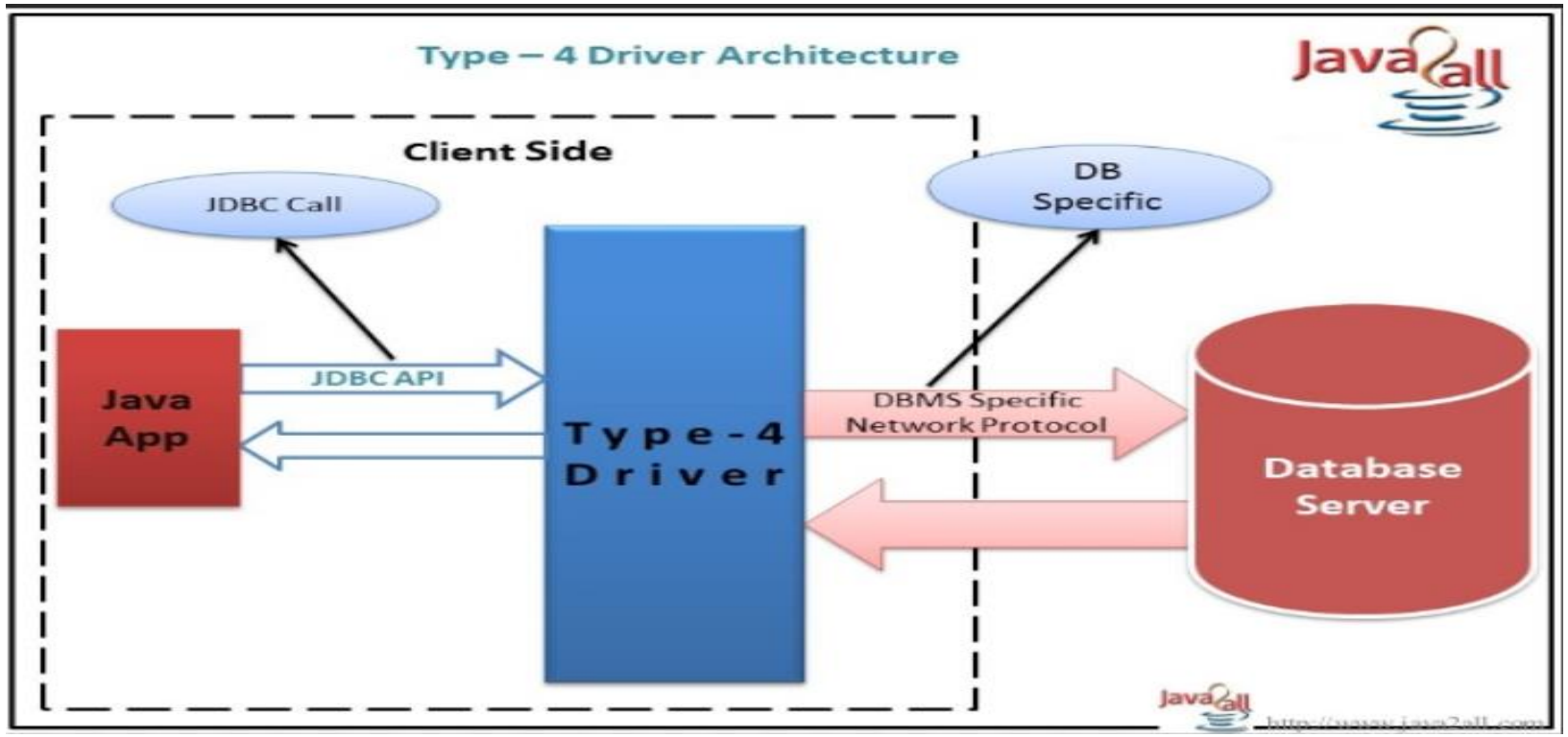
- JDBC

  JDBC stands for Java DataBase Connectivity. JDBC is a Java API to connect and execute database queries. JDBC API uses JDBC drivers to connect with database. Each vendor will have their own JDBC Drivers for Client Exchange of Data.

- What is an API

  API (Application Programming Interface) is a service that describes on features of a product or software for communications. It represents on how client can exchange data.

- Popular Database(s)
  - Oracle, Informix, MySQL, Microsoft SQL Server, H2, SQLite .....



What is Database and Table

- **Database**

  A database is an organized collection of table(s). Each table is collection of column(s). Table data can then be easily queried or manipulated using SQL Statements over JDBC API.

- Table

  Data is logically organized in a row-and-column format similar to a spreadsheet. Each row represents a unique record, and each column represents a field in the record.
  e.g.

  Excel File is a Database, and Each Sheet is a Table.

customer_id	fname	lname	open_dt	addr_ln_1	addr_ln_2	addr_ln_3	city_nm	state_cd	ctry_cd	zip_cd
1	John	Smith	2020-11-01	1, W Wilmington Street			Phoenix	AZ	US	85260
2	Tom	Moody	2020-11-02	1, E Hillery Way			New York	NY	US	89553
3	George	Glen	2020-11-03	1, N Wilford Garden			Scottsdale	AZ	US	83456
4	Kevin	Spacey	2020-11-04	1, E Glen Way			Glendale	AZ	US	85263
5	Tracy	Guest	2020-11-05	85, Tai Seng Drive	Ang Ko Moi		Singapore	SG	SG	34560

state_id	state_cd	state_nm
1	AZ	Arizona
2	CA	California
3	NY	New York
4	SG	Singapore

ctry_id	ctry_cd	ctry_nm
1	IN	India
2	US	United States of America
3	SG	Singapore

Query

SELECT

Manipulation

INSERT
UPDATE
DELETE

Q & A

Cycle

The JDBC classes are contained in Java package **java.sql** and **javax.sql**.

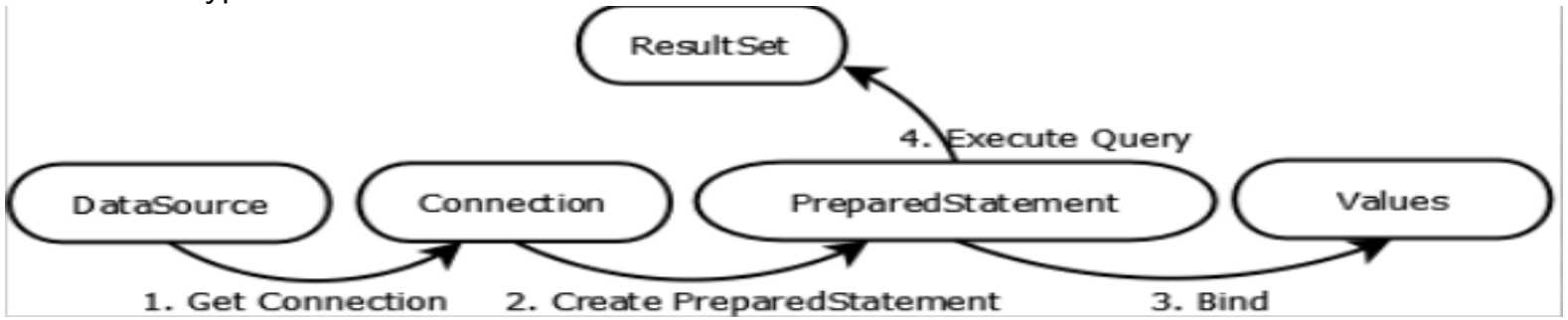
The **java.sql** package contains classes and interfaces for **JDBC API**.

- Driver interface
- Connection interface
- PreparedStatement interface
- ResultSet interface

JDBC connections support creating and executing statements. Data manipulation statements such as *CREATE, INSERT, UPDATE and DELETE*, or query statements like *SELECT*.

Statement – the statement is sent to the database server each and every time.
PreparedStatement – the statement is cached and then the execution path is pre-determined on the database server allowing it to be executed multiple times in an efficient manner.
CallableStatement – used for executing stored procedures on the database.
Update statements such as INSERT, UPDATE and DELETE return an update count that indicates how many rows were affected in the database. These statements do not return any other information.

Query statements return a JDBC row result set. The row result set is used to iterate data rows. Individual columns in a row are retrieved either by name or by column number. There may be any number of rows in the result set. Row Result has meta information about column name and associated types



Data Types

- Char
- Decimal
- Varchar
- NVarchar
- Datetime
- Date
- Boolean
- Integer
- Text

https://www.sqlite.org/datatype3.html

How to Create Database in SQLite

- **Install SQLite** from https://sqlite.org/download.html
- Assuming Database to be Created in D:\WebService\Project\JdbcExample\database
- SQLite e.g. is Installed in **D:\SQLite-330**

Create Database

D:\> cd D:\WebService\Project\JdbcExample\database\
D:\> \sqlite\sqlite-330\sqlite3 ***customer.db***
This will create a BLANK Database ***customer-sqlite.db***

SQLite version 3.33.0 2020-08-14 13:23:32
Enter ".help" for usage hints.

```
sqlite> CREATE TABLE customer (
          [customer_id] INTEGER PRIMARY KEY AUTOINCREMENT NOT NULL,
          [ctry_cd] [char](2) NOT NULL,
          [customer_name] [text] NOT NULL,
          [phone_no] [varchar](18) NOT NULL,
          [phone_type] [varchar](12) NOT NULL,
          [email_ad] [varchar](65) NOT NULL,
          [customer_guid] [uniqueidentifier] NOT NULL,
          [init_insert_ts] [datetime] NOT NULL,
          [last_mdfy_ts] [datetime] NOT NULL,
          [last_mdfy_user] [varchar](65) NOT NULL,
          [last_mdfy_prog] [varchar](65) NOT NULL
);
sqlite>SELECT * FROM customer;
This is to ensure table is created and you can select though no records
sqlite>.schema TO List Schema
sqlite>.quit
```

Q & A

JDBC Action

- Register Driver Class

When a Java application needs a database connection, one of the `DriverManager.getConnection()` methods is used to create a JDBC connection.

The URL depends on particular database and JDBC driver.
It will always begin with the "jdbc:“ which is the protocol, but the rest is up to the Vendor specific.

```
Connection conn = DriverManager.getConnection(JDBC_URL, DB_USER, DB_PASSWORD);
```

e.g.
`jdbc:sqlserver://localhost:1433;databaseName=testdb;integratedSecurity=true;`

`jdbc:sqlserver://[serverName[instanceName][:portNumber]][;property=value[;property=value]]`

serverName: Host name or the IP address of the machine on which database server is running.
instanceName: Name of the instance to connect to on a serverName. If this parameter is not specified, the default instance is used.

portNumber: The default port number for connecting to SQL server is 1433. In case this parameter is missing, the default port is used as per database vendor. For Sqlite, there is no user / password or port as it is running off local host pointing to directory.

property=value: This parameter specifies one or more additional connection properties. To see the properties specific to the database server, you need to google vendor specifics

Connection & Finally Close

```
/**
 * Get Connection
 *
 * @return
 * @throws SQLException
 */
public Connection getConnection() throws SQLException {
    System.out.println("---Connecting to Db...");
    Connection conn = DriverManager.getConnection(JDBC_URL, DB_USER,
    DB_PASSWORD);
    return conn;
}
```

```
/**
 * Close Connection
 *
 * @param conn
 * @throws SQLException
 */
public void close(Connection conn) throws SQLException {
    System.out.println("---Closing Db Connection...");
    conn.close();
}
```

CRUD Process –
C(reate)
R(read)
U(pdate)
D(elete)

Create

```
/**
 * Get Connection
 */
conn = SimpleDbManager.getConnection(autoCommit);
String sql = " INSERT INTO customer (ctry_cd, customer_name, phone_no,
phone_type, email_ad, customer_guid, "
+ " last_mdfy_user, last_mdfy_prog, init_insert_ts, last_mdfy_ts) "
+ " VALUES (?, ?, ?, ?, ?, ?, ?, ?, CURRENT_TIMESTAMP, CURRENT_TIMESTAMP)
";
/**
 * Prepare Statement
 */
pstmt = conn.prepareStatement(sql);
/**
 * Set Values for INSERT
 */
pstmt.setString(1, customer.getCtry_cd());
pstmt.setString(2, customer.getCustomer_name());
pstmt.setString(3, customer.getPhone_no());
pstmt.setString(4, customer.getPhone_type());
pstmt.setString(5, customer.getEmail_ad());
pstmt.setString(6, customer.getCustomer_guid());

pstmt.setString(7, customer.getLast_mdfy_user());
pstmt.setString(8, customer.getLast_mdfy_prog());

int rowsUpdated = pstmt.executeUpdate();
success = rowsUpdated > 0;
```

CRUD Process –
C(reate)
R(read)
U(pdate)
D(elete)

Read

```
/**
 * Get Connection
 */
conn = SimpleDbManager.getConnection(autoCommit);
String sql = " SELECT customer_id, ctry_cd, customer_name, email_ad, phone_no,
customer_guid "
+ " FROM customer WHERE email_ad = ? ";
/**
 * Prepare Statement
 */
pstmt = conn.prepareStatement(sql);
pstmt.setString(1, emailAd);
/**
 * Get Result Set
 */
rs = pstmt.executeQuery();

Customer customer = null;
while (rs.next()) {
      customer = new Customer();
      success = true;

      customer.setCustomer_id(rs.getLong("customer_id"));
      customer.setCtry_cd(rs.getString("ctry_cd"));
      customer.setCustomer_name(rs.getString("customer_name"));
      customer.setEmail_ad(rs.getString("email_ad"));
      /**
       * You can also use Query Column Number - Not Recommended though
       */
      customer.setCustomer_guid(rs.getString(5));

      System.out.println(customer);
}
```

CRUD Process - Update

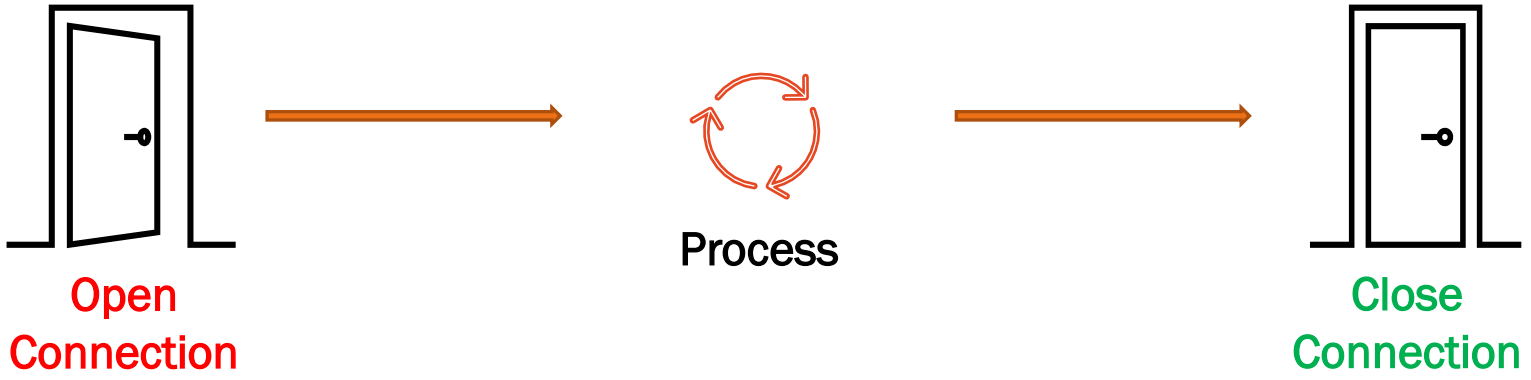
```
/**
 * Get Connection
 */
Connection conn = SimpleDbManager.getConnection();
String sql = " UPDATE customer SET phone_no = ?, last_mdfy_ts =
CURRENT_TIMESTAMP WHERE email_ad = ? ";
/**
 * Prepare Statement
 */
PreparedStatement pstmt = conn.prepareStatement(sql);
/**
 * Set Value for Delete
 */
pstmt.setString(1, phoneNo);
pstmt.setString(2, emailAd);

int rowsUpdated = pstmt.executeUpdate();
success = rowsUpdated > 0;
```

CRUD Process - Delete

```
/**
 * Get Connection
 */
Connection conn = SimpleDbManager.getConnection();
String sql = " DELETE FROM customer WHERE email_ad = ? ";
/**
 * Prepare Statement
 */
PreparedStatement pstmt = conn.prepareStatement(sql);
/**
 * Set Value for Delete
 */
pstmt.setString(1, emailAd);
int rowsUpdated = pstmt.executeUpdate();
success = rowsUpdated > 0;
```

REMEMBER

To CLOSE Resources
Finally



Any resources opened for database should be CLOSED WITHOUT FAIL

e.g.

- ResultSet
- PreparedStatement
- Connection
- DataSource

```
try {
      if (rs != null) {
            rs.close();
      }
      if (pstmt != null) {
            pstmt.close();
      }
      if (conn != null) {
            conn.close();
      }
} catch (SQLException e) {
      e.printStackTrace();
}
```

Q & A

Database Transaction

A **database transaction** symbolizes a unit of work performed within a database management system against a data set(s) and treated in a logical work. A transaction generally represents change to data table(s) like *UPDATE* and/or *DELETE* and/or *INSERT*.

In a database management system, a transaction is a single unit of logic or work, sometimes made up of multiple operations. e.g: Transfer from one bank account to another: the complete transaction requires subtracting the amount to be transferred from one account and adding that same amount to the other.

Example

```
boolean success = false;
Boolean autoCommit = false; // Commit on Demand
Connection conn = SimpleDbManager.getConnect(autoCommit);
/**
 * Add Customer
 */
success = add(conn, customer);
if(success) {
     /**
      * Update Customer
      */
      success = update(conn, "test@somewhere.com", "1-800-CALL-HELP");
}
if (success) {
     System.out.println("Commit Transaction...");
     conn.commit()
} else {
     System.out.println("Rollback Transaction...");
     conn.rollback();
}
conn.close();
```

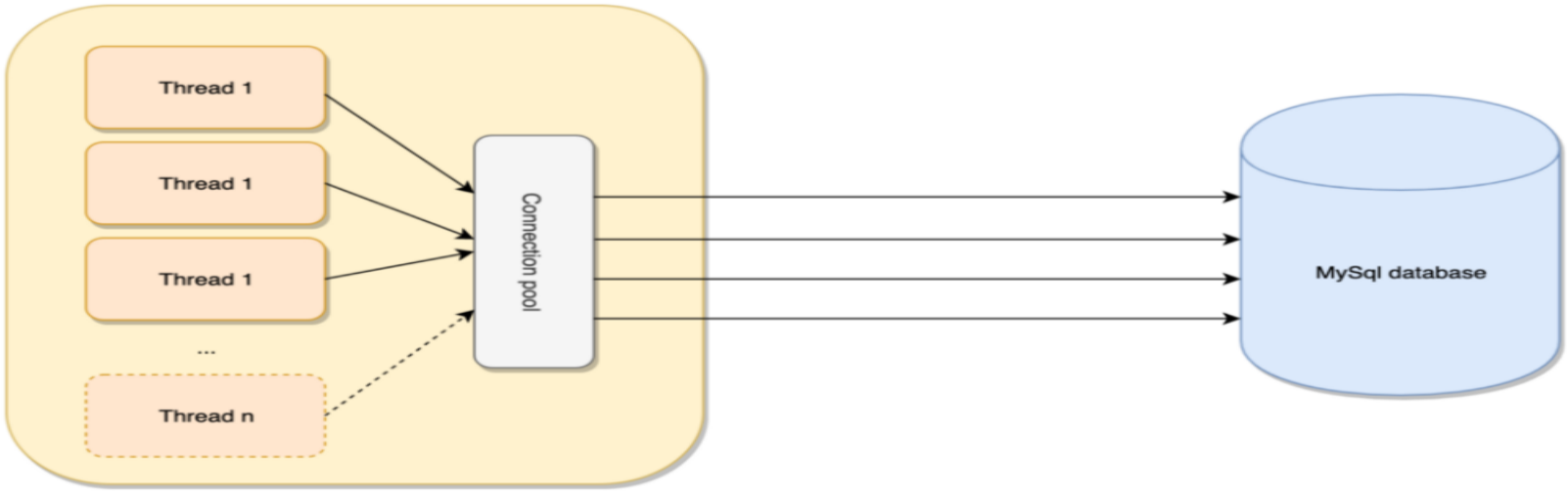
Database Connection Pool

Traditional Database Connection Trip

1. Opening a connection to the database using the database driver
2. Opening a TCP socket for reading/writing data
3. Reading / writing data over the socket
4. Closing the connection
5. Closing the socket

A **connection pool** is a cache of **database connection** objects. The objects represent physical **database connections** that can be used by an application to **connect** to a **database**. At run time, the application requests a **connection** from the **pool**.

Implementing a database connection container, which allows us to reuse a number of existing connections, we can effectively save the cost of performing a huge number of expensive database trips, hence boosting the overall performance of our database-driven applications.



DB connection pooling

Database Connection Pool using HikariCP

```
private static HikariConfig hcfg = new HikariConfig();
private static HikariDataSource hds = null;

static {
	logger.info("BEGIN - Creating Connection Pool...");
	try {
		InputStream is = new FileInputStream(new File(DB_H2_PROP_FILE));
		Properties props = new Properties();
		props.load(is);

		hcfg.setPoolName(props.getProperty("jdbc.poolName"));

		hcfg.setJdbcUrl(props.getProperty("jdbc.url"));
		hcfg.setUsername(props.getProperty("jdbc.username"));
		hcfg.setPassword(props.getProperty("jdbc.password"));

		hcfg.setMaximumPoolSize(Integer.parseInt(props.getProperty("jdbc.maxPoolSize")));
		hcfg.setMinimumIdle(Integer.parseInt(props.getProperty("jdbc.initialSize")));
		hcfg.setAutoCommit(false);
		hcfg.setDriverClassName(props.getProperty("jdbc.driverClassName"));

		hcfg.addDataSourceProperty("cachePrepStmts", "true");
		hcfg.addDataSourceProperty("prepStmtCacheSize", "10");
		hcfg.addDataSourceProperty("prepStmtCacheSqlLimit", "128");

		hds = new HikariDataSource(hcfg);
		logger.info("Created DataSource: " + hds);
	} catch (Exception e) {
		e.printStackTrace();
	} finally {
		logger.info("END - Creating Connection Pool DataSource: " + hds);
	}
}

public static HikariDataSource getDataSource() {
	return hds;
}
```

Popular Connection Pool Frameworks

- Apache Commons DBCP
- HikariCP – Most Preferred for Light Weight and Fast
- C3PO

Q & A

Object Relational Mapping using Apache DbUtils

Traditional Approach

```
String sql = " SELECT customer_id, ctry_cd, email_ad, phone_no,
customer_guid FROM customer WHERE email_ad = ? ";
/**
 * Prepare Statement
 */
PreparedStatement pstmt = conn.prepareStatement(sql);
pstmt.setString(1, emailAd);
/**
 * Get Result Set
 */
ResultSet rs = pstmt.executeQuery();

Customer customer = null;
while (rs.next()) {
     customer = new Customer();

     customer.setCustomer_id(rs.getLong("customer_id"));
     customer.setCtry_cd(rs.getString("ctry_cd"));
     customer.setEmail_ad(rs.getString("email_ad"));
     customer.setCustomer_guid(rs.getString(“customer_guid"));

     System.out.println(customer);
}
```

Object Relational Mapping using Apache DbUtils

Object Mapping Approach using Apache DbUtils

```
String sql = " SELECT * FROM customer WHERE email_ad = ? ";
/**
 * Handler Bean for ResultSet
 */
BeanListHandler<Customer> beanListHandler = new
BeanListHandler<>(Customer.class);
/**
 * Fetch Data
 */
List<Customer> customers = new QueryRunner().query(conn,
sql, beanListHandler, new Object[] { emailAd });
for (Customer customer : customers) {
    System.out.println(customer);
}
```

Introduction to JPA (Java Persistence API)

The Java Persistence API (JPA) is a Java specification for accessing, persisting, and managing data between Java Entity Classes and a Relational Database.

JPA allows POJO (Plain Old Java Objects) to be easily persisted.

A JavaBean is a POJO that is serializable, has a no-argument constructor, and allows access to properties using getter and setter methods that follow a simple naming convention.

In our example: ***Customer.java / Country.java*** is a POJO which can be converted to Entity Class for Object Relational Map.

Entity Bean

```
@Entity
@Table(name = "country")
/**
    Using Lombok which is a java library tool which is used to minimize/remove the
    boilerplate code. @Data will generate Constructor, Getter / Setter / toString() by
    Default
*/
@Data
public class Country implements Serializable {

    private static final long serialVersionUID = 9120997940945205046L;

    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    private Long country_id;

    private String ctry_cd;
    private String ctry_nm;

    @Temporal(TemporalType.TIMESTAMP)
    private Date last_mdfy_ts;

    private String last_mdfy_prog;
    private String last_mdfy_user;
}
```

Query Entity
Country, Customer
Using JPA with
Spring Boot

Sample Methods

```
/**
 * Find by Country Code
 *
 * @param ctry_cd
 * @return
 */
@Query(" SELECT o FROM Country o WHERE o.ctry_cd = ?1 ")
@Cacheable("country")
Country findByCtryCd(@Param("ctry_cd") String ctry_cd);

/**
 * Find All
 *
 * @return
 */
@Query(" SELECT o FROM Country o ORDER By o.ctry_cd ")
List<Country> findAll();

/**
 * Find Customer by Email
 *
 * @param email_ad
 * @return
 */
@Query(" SELECT o FROM Customer o WHERE o.email_ad = ?1 ")
List<Customer> findByEmail(@Param("email_ad") String email_ad);
```

Traditional
JDBC Transaction

```java
import java.sql.Connection;

Connection connection = dataSource.getConnection(); // (1)

try (connection) {
    connection.setAutoCommit(false); // (2)
    // execute some SQL statements...
    connection.commit(); // (3)

} catch (SQLException e) {
    connection.rollback(); // (4)
}
```

Spring JPA Transaction
using Annotations

```
@Transactional(propagation = Propagation.REQUIRES_NEW, readOnly = false,
rollbackFor = { Exception.class })
public synchronized boolean persist(Customer customer,
     CustomerAddress customerAddress) throws RuntimeException, Exception {
     boolean success = false;
     try {
          customer = customerRepository.saveAndFlush(customer);
          customerAddress =
customerAddressRepository.saveAndFlush(customerAddress);
          if (customerAddress != null) {
               updateCustomerLastMdfyTs(customer);
               success = true;
          }
     } catch (Exception e) {
          e.printStackTrace();
     }
     return success;
}

@Transactional(propagation = Propagation.MANDATORY, readOnly = false, rollbackFor
= { Exception.class })
private boolean updateCustomerLastMdfyTs(Customer customer) {
     customer.setLast_mdfy_ts(new Date());
     customer.setLast_mdfy_prog(CLAZZ);
     /**
       * Update
        */
     customerRepository.save(customer);
     return true;
}
```

Introduction to Triggers

A **database trigger** is procedural code that is automatically executed in response to certain events on a particular table or view in a **database**. The **trigger** is mostly used for maintaining the integrity of the information on the **database**.

Trigger Types

- INSERT
- UPDATE
- DELETE

Trigger can be BEFORE or AFTER Trigger Type

Trigger Action can be either Execute an SQL(s) or Stored Procedure (SPL)

UPDATE Trigger Example

```
CREATE TABLE customer_audit (
    [customer_audit_id] INTEGER PRIMARY KEY AUTOINCREMENT NOT NULL,
          [customer_id] INTEGER NOT NULL,
          [ctry_cd] [char](2) NOT NULL,
          [customer_name] [text] NOT NULL,
          [phone_no] [varchar](18) NOT NULL,
          [phone_type] [varchar](12) NOT NULL,
          [email_ad] [varchar](65) NOT NULL,
          [customer_guid] [uniqueidentifier] NOT NULL,
          [init_insert_ts] [datetime] NOT NULL,
          [last_mdfy_ts] [datetime] NOT NULL,
          [last_mdfy_user] [varchar](65) NOT NULL,
          [last_mdfy_prog] [varchar](65) NOT NULL
);

CREATE TRIGGER update_customer BEFORE UPDATE ON customer
  BEGIN
    INSERT INTO customer_audit (customer_id, customer_id, ctry_cd,
          customer_name, phone_no, phone_type, email_ad, customer_guid,
          init_insert_ts, last_mdfy_ts, last_mdfy_user, last_mdfy_prog)
    VALUES (old.customer_id, old.customer_id, old.ctry_cd,
          old.customer_name, old.phone_no, old.phone_type, old.email_ad,
          old.customer_guid, old.init_insert_ts, old.last_mdfy_ts,
          old.last_mdfy_user, old.last_mdfy_prog);
  END;
```

DELETE Trigger Example

```
CREATE TRIGGER delete_customer BEFORE DELETE ON customer
  BEGIN
    INSERT INTO customer_audit (customer_id, customer_id, ctry_cd,
         customer_name, phone_no, phone_type, email_ad, customer_guid,
         init_insert_ts, last_mdfy_ts, last_mdfy_user, last_mdfy_prog)
    VALUES (old.customer_id, old.customer_id, old.ctry_cd,
         old.customer_name, old.phone_no, old.phone_type, old.email_ad,
         old.customer_guid, old.init_insert_ts, old.last_mdfy_ts,
         old.last_mdfy_user, old.last_mdfy_prog);
  END;
```

Q & A

Project Tools & Technologies

- **Java 1.8.x**
- **Eclipse** IDE - https://www.eclipse.org/
- **Apache Maven** as Build Tool - https://maven.apache.org
- **GitHub** – Source Control Management - https://github.com
- **DBVisualizer** – Database tool - https://dbvis.com
- **SQLite** - https://sqlite.org/
- **H2** - http://www.h2database.com/html/main.html
- **Apache DbUtils** – https://commons.apache.org/proper/commons-dbutils/index.html
- **Lombok** - Automate BoilerPlate Code - https://projectlombok.org/

References

- Project Source - https://github.com/newfound-systems/JdbcExample
- Build Tool Maven - https://maven.apache.org/
- Log4J Tutorials - https://mkyong.com/logging/apache-log4j-2-tutorials/
- SQLite - https://sqlite.org/
- SQLite Tutorials - https://www.tutorialspoint.com/sqlite/index.htm
- SQLite Trigger - https://www.sqlitetutorial.net/sqlite-trigger/
- JDBC Wiki - https://en.wikipedia.org/wiki/Java_Database_Connectivity
- Spring Boot - https://spring.io/projects/spring-boot
- Spring Boot with JPA - https://www.javatpoint.com/spring-boot-jpa

Thank You

Stay and Keep Safe

Project is posted in github

https://github.com/newfound-systems

https://github.com/newfound-systems/JdbcExample