Implementation of Advanced SQL Using Java Server Pages as Frontend

Nur Atikah Arbain[1], Abdul Razak Hussain[2], Norhayati Harum[3], Mohd Sanusi Azmi[4]

nur.atikah@utem.edu.my[1], razak@utem.edu.my[2], norharyati@utem.edu.my[3], sanusi@utem.edu.my[4]

[1,2,3,4]Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka, Malaysia

Abstract

In web-based applications, communication between web (frontend) and database (backend) is crucial as it is not only used to store and retrieve data but also to perform other processes either at the frontend or backend. However, the process that is performed at frontend could lead to data leak due to weak security. Therefore, this paper presents the idea by storing all process including prepared statements of Create, Retrieve, Update and Delete (CRUD) and calculations into database using PL/SQL programming language (Oracle) where web based of Java Server Pages (JSP) is used as a frontend. The framework of Model View Controller (MVC) is applied as the guideline to handle the development of web based. Besides events advanced SQL such as stored procedures, functions and trigger event are implemented where they are used to commit the operation of CRUD. As the output, all operation of CRUD, calculation, error handling (exception handlers) is committed and process at backend while frontend is used only to display data and send input from user. As conclusion, the transaction data between web and database can be secured as well as all processes are performed in the database.

Keywords:
PL/SQL, CRUD, Java Server Pages, Stored Procedure, and Model View Controller

Introduction

In the present knowledge world, the influence of technology brings big impact in daily life where most people use the internet to communicate with each other. Based on Fu (2016), the web-based application plays a vital role in presenting webpage and acts as information representation. Communication between front-end and back-end web development is crucial as it is used to obtain user information from database based on user request. Besides that, the communication between front-end and back-end does not only focus on obtaining user information but also to perform other processes such as calculation where the result will be displayed in reports form. However, the process that is performed at front-end web could lead to data leak due to weak security. Mostly, front-end web focuses on providing interfaces that might contain several forms and reports for the user. Thus, any processes such as CREATE, RETRIEVE, UPDATE and DELETE are not advised to be performed at front-end web development in order to avoid manipulation data by user. In this paper, it aims to propose of implementing the advanced SQL statements where CREATE, RETRIEVE, UPDATE and DELETE (CRUD) operations are stored in STORED PROCEDURE while FUNCTION and TRIGGER are employed to perform other task such as calculation, checking login process and generate unique ID. As the output, all operations will be processed at back-end web while MVC is employed to manage and control the input and output from user request from front-end web development.

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Literature Review

In web-based applications, front-end and back-end web development is important in technology nowadays as they are used to manage the user request from front-end web and send it to the client's browser. The MVC framework is known as Model-View-Controller and is often used by developers to manage and control data between front-end and back-end web development. Based on Singh (2020), MVC contains three layers (Model-View-Controller) that is presenting as an architectural pattern that usually employed in web-based applications. In work of Xu & Liao (2021), the MVC framework is employed where SQL Server 2012 is used as the database. Unlike to work of Zmaranda et al. (2020), the MVC framework is employed where Azure database is used. In both works, SQL is used known as standard programming language for database. The Structured Query Language is an acronym for SQL which is a standard language used in many databases such as Oracle, Microsoft SQL Server, MySQL, and NoSQL. The Procedure Language (PL) is often used to integrate with SQL in background applications (Bonteanu et al., 2023; González-Aparicio et al., 2016; Seser et al., 2022). Based on Myalapalli & Ravi Teja (2015), PL/SQL programming language is employed to communicate with underlying database and most commercial transaction scripts are written using PL/SQL code.

Based on Seser et al. (2022), there are two stages for prepared statement execution namely preparation and execution. In a preparation stage a statement template is transmitted to the database server for syntax check, parsing, compiling and internal resource allocation (Seser et al., 2022). In work of Văduva & Vălean (2021), the low code is used as the motivation to propose new framework which use less code in order to build fast and efficient complex applications. In related study by Saisanguansat & Jeatrakul (2017), PL/SQL is employed to manipulate the data of CRUD operation and possible to use PL/SQL to optimize the database system performance by applying PL/SQL optimization technique. Therefore, this study intends to implement the usability of advanced SQL where PL/SQL code is employed to perform the tasks of CRUD by implements STORED PROCDEURE, FUNCTIONS and TRIGGER. In this paper, preliminary studies for implementation of advanced SQL are presented where Java Server Pages (JSP) is used as the front-end web and MVC framework is applied to manage and handle the process between front-end and back-end web development.
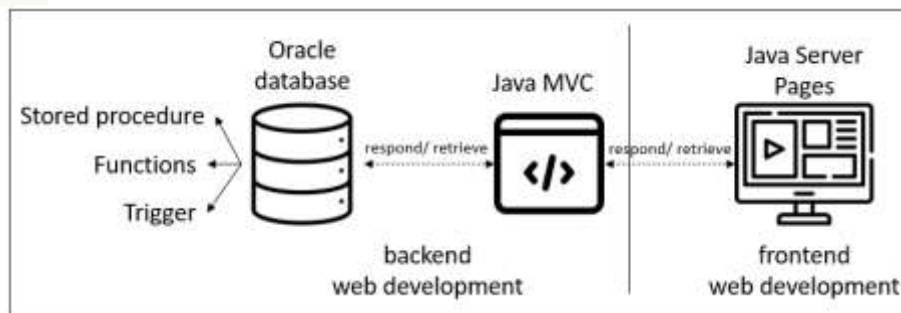
Research Methods

Figure 1. Overview of Process Between Frontend and Backend Web Development

Figure *1* shows the overview of process between frontend and backend web development. As front-end web development, Java Server Pages (JSP) are used to design the user interfaces using combination of HTML, XML and Java code. In web server, JSP pages are executed, and the output is transmitted to client's web browser. The MVC framework and Oracle database are executed at the backend process of web development. The processes of backend web development are described as follows:
1.   Model-View-Controller Framework (MVC)

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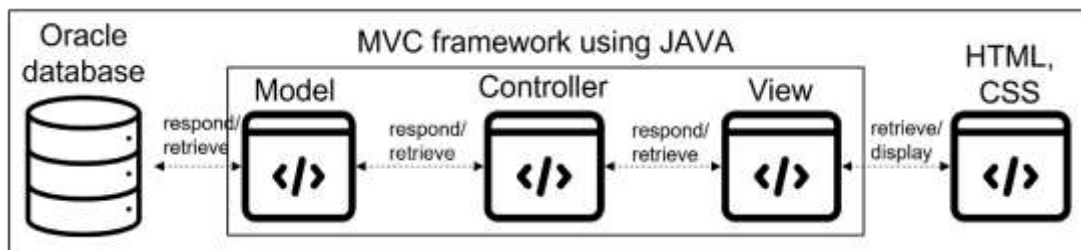Norhayati Harum, and Mohd Sanusi Azmi

Figure 2. MVC Framework Process

The MVC framework uses Java code which performs to control the processes in separate ways. The MVC framework is divided into three layers namely Model, View, and Controller. Based on Figure 2, the View layer focuses to transmit to and retrieve information from user by communicating through web server. From View layer, the information will transmit and retrieve via Controller layer which focuses to perform all logic operation that users had requested for actions. The Controller layer also acts as a bridge to communicate between View layer and Model layer. The Model layer focuses on managing the information and communicating to the database.

2. Stored procedure

In Oracle, the stored procedure is also known as PL/SQL procedure that is used to receive some input or none in the form of parameters and performs some of tasks that may or not to return the value. The PL/SQL stored procedure is created to perform specific tasks. In this paper, PL/SQL stored procedure is applied to store and perform the tasks such as Create, Update, Retrieve, Delete (CRUD) and calculations.

3. Functions

The Oracle function is a standalone function that is used to create function statements or a call specification of task. By using function statement, a return value is must compared to stored procedures that may or not return some values. In this paper, function statement is employed to perform checking process that focus task during login process.

4. Trigger

The trigger is employed to create a unique identification (ID) for each of tables where database object of sequence is applied to generate a unique number.

Results and Discussion

1. Preparation

The environmental setup is built to perform the transmitting process between front-end and back-end web development using JSP, MVC and Oracle database. The description of environmental setup is shown in **Table 1**.

No	Hardware	Software
1	Windows 11th Gen Intel(R) Core (TM) i5-11300H @ 3.10GHz 3.11 GHz	Eclipse IDE (Integrated Development Environment)
2	Random Access Memory (RAM): 12GB	Java Development Kit (JDK) version 18
3		Database Oracle XE 11g

No	Hardware	Software

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1	Windows 11th Gen Intel(R) Core (TM) i5-11300H @ 3.10GHz 3.11 GHz	Eclipse IDE (Integrated Development Environment)	**Table 1.**
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3		Database Oracle XE 11g	

Description of Environmental Setup

2.   Implementation Phase

For front-end web development, JSP pages are developed as user interfaces that contain several forms and reports. The form is used to capture user information. Examples of forms are registration and login. Whilst reports are used to display the data information that the user had requested and mostly reports are displayed in table form. Figure 3 shows the example of navigation design for simple user interfaces.
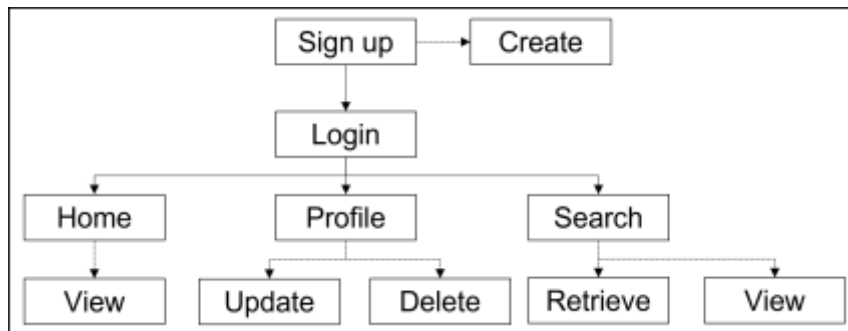

Figure 3. Navigation Design for Simple Interfaces

Based on Figure 3, there are five interfaces are created namely Sign up, Login, Home, Profile and Search. Each interface's design contains a different process either it can view, create, retrieve, update, or delete. The process of create, retrieve, update, and delete are stored into stored procedure where return value is provided either in status form or based on user request. The function statement is applied to execute the task for login process where checking username and password is performed, and a return value is in status form.

a.   Stored procedure

```
create or replace PROCEDURE insert_user
(ic_org IN VARCHAR2, password IN VARCHAR2, name IN VARCHAR2, address IN VARCHAR2,
telephone IN VARCHAR2, email IN VARCHAR2, organizer IN VARCHAR2, status OUT NUMBER)
AS
BEGIN
INSERT INTO organizer(org_name,org_address,org_telephone,org_email,org_dateRegister,
password,org_ic,organizername)
VALUES(name,address,telephone,email,sysdate,password,ic_org,organizer);
status := 3;
END;
```

Figure 4. Example of Stored Procedure Statement for INSERT Statement

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Based on Figure 4, the PROCEDURE statement of CREATE AND REPLACE PROCEDURE is applied to execute the task of INSERT statement for user information. The PROCEDURE statement is applied to store the INSERT statement inside the PROCEDURE statement and as a result the procedure will return the status in number format which will be used to determine the status info will be displayed to user.

b.   Functions

```
create or replace function check_userlogin (no in varchar2, pass in varchar2)
    return number
is
  users_result number := 0;
begin

select count(*) into users_result from organizer where org_id = no and password = pass;

end;
```

Figure 5. Example of Function Statement

Based on Figure 5, the FUNCTION statement of CREATE AND REPLACE FUNCTION is applied to execute the task of checking user login based on their username and password in the database. The task of SELECT statement based on COUNT function is performed to obtain the return value based on number of rows. As the result, return value is in number format where default value is 0 which shows the status is wrong username or password while return value other than 0 will show the status is success and user can login the system.

c.   Trigger

```
create or replace TRIGGER users_BI
BEFORE INSERT ON users
FOR EACH ROW
BEGIN
SELECT usersSeq.nextval INTO :new.users_ID FROM DUAL;
:new.users_ID := 'U'||:new.users_ID;
END;
```

Figure 6. Example of Trigger Statement for BEFORE INSERT Event

Based on Figure 6, the TRIGGER block of CREATE AND REPLACE is applied to execute the specified task. Similarly, as stored procedure, TRIGGER can be invoked automatically whenever a specific event occurs. In Figure 6, a BEFORE INSERT trigger is fired before the INSERT statement on USERS table is performed. The task of SELECT statement will be performed for each row where unique ID is created before it can be inserted into selected table in the database.

3.   Testing Phase

For the testing phase, there are two approaches employed namely White Box and Black Box. The summary of testing phase is shown in Table 2.

Table 2. Summary of Testing Phase

Modules	White Box	Black Box	
	Unit Testing	Unit Integration Testing	System Testing

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Sign up	✓	✓	✓
Login	✓	✓	✓
Home	✓	✓	✓
Profile	✓	✓	✓
Search	✓	✓	✓

All tests (testing phase) are only applied to test the usability of system after implementing the advanced SQL statements (stored procedure, functions, trigger) and MVC framework. It also tests the effectiveness of communication and transmitting data between front-end and back-end web development by using MVC framework. Based on Table 2, the two testing phase approaches have been applied. For White Box approach, Unit Testing is performed for five modules (interfaces). In Unit Testing, each data entry in each of modules is tested. The expected error message will be prompted if data entry has wrong input or blank. Compared to the Black box approach, there are two tests namely Unit Integration Testing and System Testing. These tests are applied to test the navigation process of modules and dialogue sequence shifting from module to another module.

Conclusions

This paper presents the implementation of advanced SQL using JSP as front-end where preliminary studies have been conducted to test the usability of PL/SQL code to invoke and execute the query statements in database. Besides that, the MVC framework is also applied in order to manage and control the input and output between front-end and back-end web development. Based on the result and discussion, the testing phase is also conducted in order to test the usability of system and it had shown that the implementation of advanced SQL is possible and effective way to store the process of CRUD and secure as well as all processes are performed in the database.

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