REAL-TIME CHAT APPLICATION

A Project Based Learning Report Submitted in partial fulfilment of the requirements for the award of the degree

of

Bachelor of Technology

in The Department of

AOOP WITH 23CS2103E

Submitted by

2310030188 : Jashwanth Reddy

2310030163 : Abhinav Reddy

2310030421 : D. Guru charan

Under the guidance of

MR. Sashidhar Sir

Department of Electronics and Communication Engineering

Koneru Lakshmaiah Education Foundation, Aziz Nagar

Aziz Nagar – 500075 (Optional)

NOV - 2023.

What is a Real-Time Chat Application?

A **Real-Time Chat Application** allows users to **send and receive messages instantly**, **without** needing to refresh the page or manually reload anything.

The keyword is **"Real-Time"** — as soon as **one user** sends a message, it **immediately appears** on **everyone else's screen** connected to the chat.

This happens through **live server connections** using technologies like **WebSockets**, **Socket.IO**, **Pusher**, **Firebase**, etc.

Uses / Purposes of a Real-Time Chat Application

✅ **Instant Communication**

- Quickly talk with friends, coworkers, customers, etc., without waiting.

✅ **Customer Support Chat**

- Websites use real-time chats to help customers immediately (like "Live Chat" on shopping websites).

✅ **Collaboration Tools**

- Apps like Slack and Microsoft Teams use real-time chat for fast team discussions.

✅ **Gaming**

- Multiplayer games use real-time chat for players to coordinate strategies.

✅ **Social Media**

- Platforms like Facebook Messenger and Instagram DMs enable real-time messaging.

✅ **Live Events / Streams**

- YouTube Live and Twitch chats provide real-time communication during events.

✅ **Online Learning**

- Students and teachers interact instantly during online classes.

✅ **Telemedicine**

- Doctors and patients can communicate immediately through chat.

Why is Real-Time Important?

- **Speed:** No waiting for page reloads.
- **Engagement:** Keeps users active and interested.
- **Collaboration:** Teams and communities can work or discuss faster.
- **Better User Experience:** Feels modern, smooth, and alive.

Real-World Examples of Real-Time Chat Applications

Application	Purpose
WhatsApp	Personal communication
Slack	Team collaboration
Discord	Communities + gaming
Facebook Messenger	Social networking

Frontend

Frontend is the part of a website, web application, or mobile app that the **user directly interacts with**.

It’s **everything you see** on the screen:

- The **buttons** you click
- The **forms** you fill out
- The **chat messages** you read
- The **animations**, **colors**, **fonts**, and **layouts**

Basically, **frontend** is about **design** + **functionality** that happens **on the user's device** (browser, phone, etc.).

The **frontend** is what users interact with. It handles:

- Displaying chat messages instantly
- Sending user messages
- Showing online users
- Notifications for new messages

- **Visual Layout**: How the page looks — placement of text, images, buttons.
- **User Interaction**: What happens when you click a button? Scroll a page? Type a message?
- **Responsiveness**: How the app adjusts when you use it on different devices (phone, tablet, desktop).
- **Animations/Effects**: Smooth transitions, loading animations, popups, modals.

Frontend Components Example:

- Login/Register Screen
- Chat Room UI (messages + input box)
- User List Sidebar (showing who’s online)
- Notifications for new messages

Technologies Used in Frontend

Technology	Purpose	Examples
HTML	Structure of the webpage	Headings, paragraphs, links
CSS	Styling (colors, layouts, fonts)	Buttons, backgrounds
JavaScript	Making things interactive	Sliders, forms, alerts
Frontend Frameworks	Build complex apps faster	React.js, Vue.js, Angular
State Management	Manage app data across pages/screens	Redux, Context API

WebSockets	Real-time updates (for chat apps)	Instant messaging

-

Code :

```
package com.chatapp.gui;
import client.ChatClient; // Ensure this import matches your ChatClient package
import com.chatapp.db.Message; // If you use Message objects
import com.chatapp.db.MessageDAO; // If you use MessageDAO
import javafx.application.Application;
import javafx.application.Platform;
import javafx.collections.FXCollections;
import javafx.collections.ObservableList;
import javafx.geometry.Insets;
import javafx.scene.Scene;
import javafx.scene.control.*;
import javafx.scene.layout.*;
import javafx.stage.Stage;
import java.time.LocalDateTime;
import java.time.format.DateTimeFormatter;
import java.util.Arrays; // Import Arrays
import java.util.List;
import java.util.stream.Collectors;
public class ChatAppUI extends Application {
    // --- UI Components ---
    private TextArea chatArea;
    private TextField inputField;
    private Button sendButton;
    private ListView<String> userListView;
    private RadioButton privateRadioButton;
    private RadioButton groupRadioButton;
    private ToggleGroup messageTypeGroup;
    private BorderPane root; // Main layout pane
    // --- State & Networking ---
    private String currentUsername; // Store the logged-in username
    private ChatClient chatClient;
    private MessageDAO messageDAO; // Optional: For loading/saving message history
    // Observable list to hold user names for the ListView
    private final ObservableList<String> userList = FXCollections.observableArrayList();
    // --- Constructors ---
    /**
     * Primary constructor used by LoginRegisterApp.
     * @param username The username of the logged-in user.
     */
    public ChatAppUI(String username) {
        if (username == null || username.trim().isEmpty()) {
            throw new IllegalArgumentException("Username cannot be null or empty when creating ChatAppUI.");
        }
        this.currentUsername = username;
        this.messageDAO = new MessageDAO(); // Initialize DAO (if needed)
        System.out.println("ChatAppUI initialized for user: " + this.currentUsername);
    }
    /**
     * Default constructor (Needed for some JavaFX scenarios, but not the main entry point).
     */
    public ChatAppUI() {
        System.err.println("Warning: ChatAppUI created using default constructor. User context might be missing.");
    }
    // --- JavaFX Application Start Method ---
    @Override
    public void start(Stage stage) {
        System.out.println("ChatAppUI start() method called.");
        // 1. Check if user is logged in (essential)
        if (this.currentUsername == null || this.currentUsername.trim().isEmpty()) {
            System.err.println("ChatAppUI cannot start: Username not provided.");
            showError("Fatal Error: User not logged in. Please restart via Login Screen.");
            Platform.runLater(stage::close);
            return;
        }
        stage.setTitle("ChatApp - Logged in as: " + this.currentUsername);
        // 2. Initialize UI Components
        initializeUIComponents();
        // 3. Setup Layout
        setupLayout();
        // 4. Connect to Server & Start Listening (CRITICAL STEP)
        if (!connectToServer()) {
            Platform.runLater(stage::close);
            return;
        }
        // 5. Load Initial Data (Optional History/Users)
        loadInitialChatHistory();
        // 6. Create Scene and Load CSS
        Scene scene = new Scene(root, 750, 550); // Create scene BEFORE loading CSS
        // --- START: Debugging CSS Loading ---
        try {
            System.out.println("--- CSS Loading Debug ---");
            // Test loading login-styles.css (which worked before)
            java.net.URL loginCssUrlRelative = getClass().getResource("login-styles.css");
            System.out.println("Relative path ('login-styles.css'): " + loginCssUrlRelative);
            java.net.URL loginCssUrlAbsolute = getClass().getClassLoader().getResource("com/chatapp/gui/login-
styles.css");
            System.out.println("Absolute path ('login-styles.css'): " + loginCssUrlAbsolute);
            // Test loading
```

Backend

The **Backend** is the **behind-the-scenes brain** of any website or app.
It’s what happens **on the server**, not the screen.

If the **Frontend** is what the **user sees**,
then the **Backend** is what the **system does**.

It handles:

- Logic
- Databases
- Authentication
- Security
- Real-time events
- Communication with the frontend

Users don’t see it, but it powers everything.

The **backend** handles:

- Authenticating users
- Handling WebSocket connections
- Broadcasting messages
- Storing messages in a database
- Fetching old messages

Technologies commonly used:

Tool / Language	Role	Examples
Node.js	JavaScript runtime on server	Express.js, Socket.IO
Python	Backend language	Django, Flask
PHP	Server-side scripting	Laravel, WordPress
Java	Enterprise-level backend	Spring Boot
Databases	Stores app data	MongoDB, MySQL, PostgreSQL
APIs (REST/GraphQL)	Interface to frontend	`/api/users`, `/messages`
WebSockets	Real-time connection	For live chat, notifications
Authentication	Security features	JWT, OAuth2, bcrypt

Code :

```
t thread pool terminated gracefully."); }
        } catch (InterruptedException ie) { System.err.println("SERVER: Shutdown interrupted.");
clientExecutor.shutdownNow(); Thread.currentThread().interrupt(); }
```

```
        System.out.println(" SERVER: Shutdown complete.");
    }
    // --- Client Management ---
    protected void addClientHandler(ClientHandler handler) {
        if (handler != null && handler.getUsername() != null) { if (clientHandlers.add(handler))
{ System.out.println("SERVER: Client handler added for: " + handler.getUsername() + ". Total clients: " +
clientHandlers.size()); broadcastUserListUpdate(); } }
        else { System.err.println("SERVER ERROR: Attempted to add invalid handler."); }
    }
    protected void removeClientHandler(ClientHandler handler) {
        if (handler != null) { if (clientHandlers.remove(handler)) { String username = handler.getUsername();
System.out.println("SERVER: Client handler removed for: " + (username != null ? username : "[unknown]") + ".
Total clients: " + clientHandlers.size()); broadcastUserListUpdate(); } }
    }
    protected synchronized boolean isUsernameTaken(String username) {
        if (username == null || username.trim().isEmpty()) return true;
        String trimmedUsername = username.trim();
        return clientHandlers.stream().anyMatch(h -> trimmedUsername.equalsIgnoreCase(h.getUsername()));
    }
    protected String getUsernamesString() { return
clientHandlers.stream().map(ClientHandler::getUsername).filter(Objects::nonNull).sorted(String.CASE_INSENSI
TIVE_ORDER).collect(Collectors.joining(",")); }
    // --- Messaging ---
    public void broadcast(String message, ClientHandler sender) {
        String senderName = (sender != null && sender.getUsername() != null) ? sender.getUsername() :
"[SERVER]";
        System.out.println("SERVER: Entering broadcast method. Sender: " + senderName + ". Message: " +
message); System.out.println("SERVER: Broadcasting to " + clientHandlers.size() + " total handlers (excluding
sender if applicable).");
       int count = 0;
       for (ClientHandler client : clientHandlers) { if (client != sender) { String recipientName = (client != null &&
client.getUsername() != null) ? client.getUsername() : "[unknown]"; System.out.println("SERVER: Broadcasting
message to handler: " + recipientName); client.sendMessage(message); count++; } }
       System.out.println("SERVER: Finished broadcast loop. Sent to " + count + " recipient(s) for message from "
+ senderName);
    }
    public void sendPrivateMessage(String message, String recipientUsername, ClientHandler sender) {
       String senderName = (sender != null && sender.getUsername() != null) ? sender.getUsername() :
"[SERVER]";
       System.out.println("SERVER: Entering sendPrivateMessage method. From " + senderName + " to '" +
recipientUsername + "'");
       Optional<ClientHandler> recipient = clientHandlers.stream().filter(client ->
recipientUsername.equalsIgnoreCase(client.getUsername())).findFirst();
       if (recipient.isPresent()) { ClientHandler recipientHandler = recipient.get(); System.out.println("SERVER:
Found recipient handler for PM: " + recipientHandler.getUsername() + ". Sending message: " + message);
recipientHandler.sendMessage(message); }
       else { System.out.println("SERVER: Recipient '" + recipientUsername + "' not found for private message
from " + senderName); if (sender != null) { sender.sendMessage("ERROR:Server:User '" + recipientUsername +
"' is not online or does not exist."); } }
    }
     public void broadcastUserListUpdate() { String userListString = getUsernamesString(); String
userListMessage = "UPDATE_USERS:" + userListString + ":"; System.out.println("SERVER: Broadcasting user
list update: " + userListMessage); clientHandlers.forEach(client -> client.sendMessage(userListMessage)); }
    // --- FIX: Added public getter for the running state ---
    /**
     * Checks if the server is currently marked as running.
     * @return true if the server is running, false otherwise.
     */
    public boolean isRunning() {
return this.running; // Safely return the value of the private volatile field
    }
    // --- End Fix ---
    // --- Main ---
    public static void main(String[] args) {
        int port = 1237; // Default port from your log
        if (args.length > 0) { /* ... port parsing ... */ }
        ChatServer server = new ChatServer(port);
        Runtime.getRuntime().addShutdownHook(new Thread(() -> { System.out.println("SERVER: Shutdown hook
triggered."); server.shutdown(); }, "ServerShutdownHook"));
        server.start();
    }
} // End of ChatServer class
```

Database

The **database** stores:

- User profiles (username, email, password hash)
- Chat messages (message text, sender, timestamp, room)

Common choices:

- MongoDB (document-based, flexible)
- PostgreSQL, MySQL (relational databases)
- Redis (for fast real-time data like sessions)

MongoDB Schema Example:

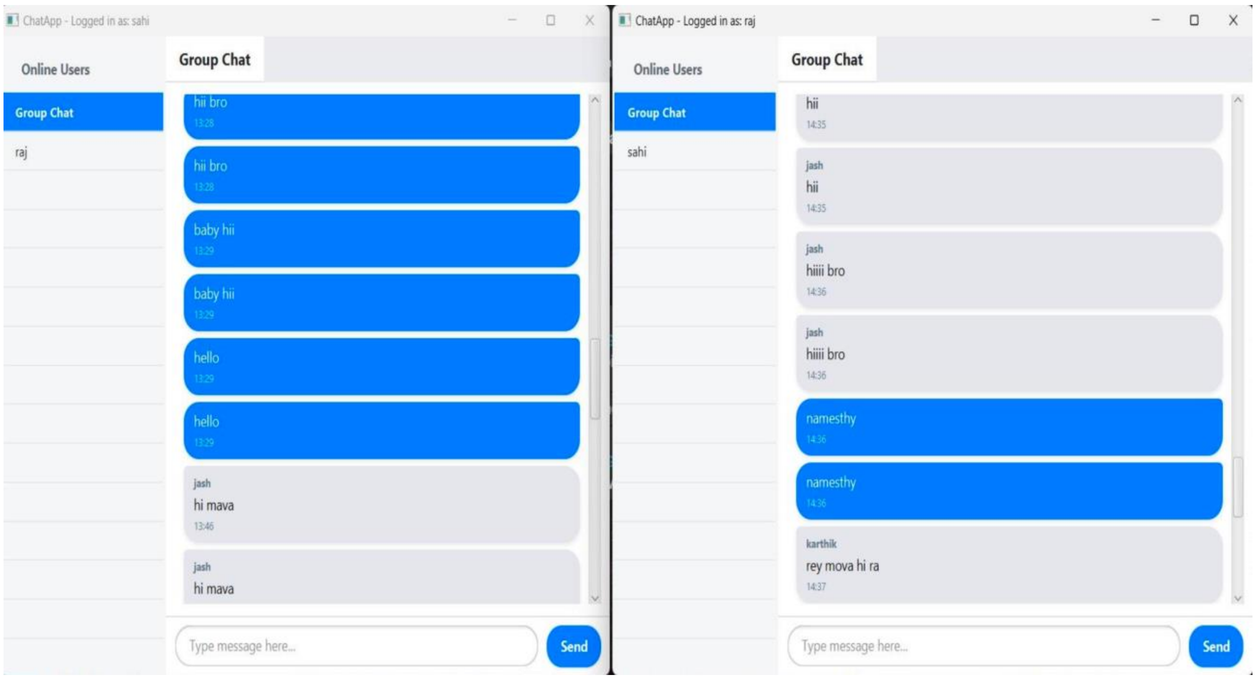
Full Example Flow

Scenario: User A sends a message to a chat room.

1. **Frontend**:
   - User A types "Hello everyone!" and clicks **Send**.
   - The frontend triggers a `socket.emit('chat message', messageData)`.
2. **Backend**:
   - Server listens with `socket.on('chat message')`.
   - Server saves the message to MongoDB.
   - Server broadcasts the message to all connected clients.
3. **Frontend** (on all clients):
   - All clients receive the event and update their chat screens instantly.
4. **Database**:

- Messages are stored securely so no data is lost.
- New users can fetch old messages when they join.

This how the login page looks and works:



hii bro
13:28

hii bro
13:28

baby hii
13:29

baby hii
13:29

hello
13:29

hello
13:29

jash
hi mava
13:46

jash
hi mava

hii
14:35

jash
hii
14:35

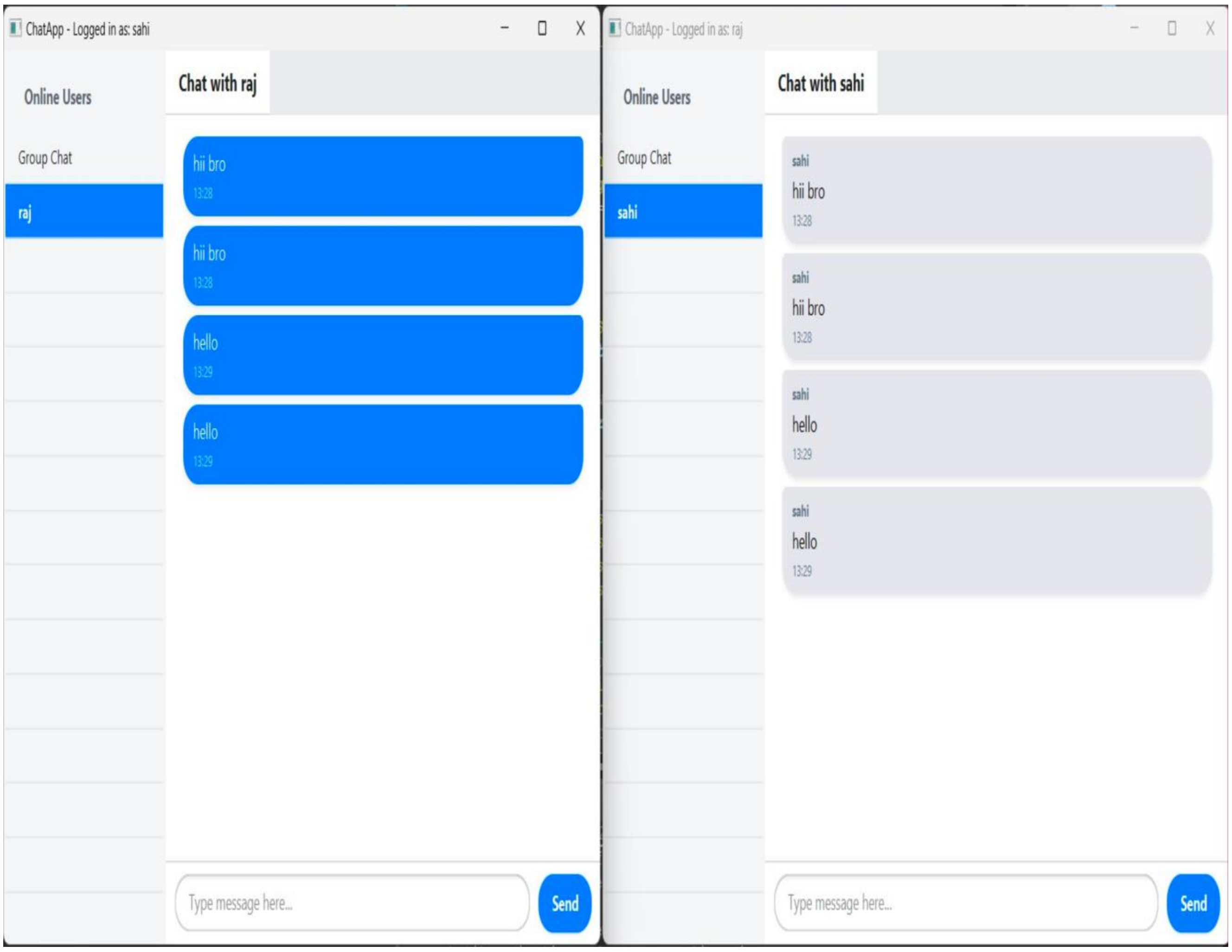
jash
hiiii bro
14:36

jash
hiiii bro
14:36

namesthy
14:36

namesthy
14:36

karthik
rey mova hi ra
14:37



hii bro
13:28

hii bro
13:28

hello
13:29

hello
13:29

sahi
hii bro
13:28

sahi
hii bro
13:28

sahi
hello
13:29

sahi
hello
13:29

Code:

```
package com.chatapp.gui;
import javafx.application.Application;
import javafx.fxml.FXMLLoader;
import javafx.scene.Parent;
import javafx.scene.Scene;
import javafx.stage.Stage;
import javafx.scene.control.Alert; // Import Alert
import java.io.IOException;
import java.net.URL;
/**
 * Main application class. Sets up the initial stage and loads the
 * login/register screen from FXML.
 */
public class LoginRegisterApp extends Application {
    @Override
    public void start(Stage primaryStage) {
        try {
            // --- Load the FXML file ---
            // Define the path relative to the current class's package
        String fxmlPath = "login-register.fxml";
        URL fxmlUrl = getClass().getResource(fxmlPath);
        // Check if the FXML file was found
        if (fxmlUrl == null) {
            System.err.println("CRITICAL ERROR: Cannot find FXML file at path: " + fxmlPath);
            System.err.println("Ensure '" + fxmlPath + "' is in the same package as LoginRegisterApp.java " +
                               "or check your build configuration (e.g., Maven/Gradle resource handling).");
            // Fallback attempt using ClassLoader (requires full path from classpath root)
            String absolutePath = "com/chatapp/gui/" + fxmlPath;
            System.err.println("Attempting fallback load via ClassLoader: " + absolutePath);
            fxmlUrl = getClass().getClassLoader().getResource(absolutePath);
            if (fxmlUrl == null) {
                // Throw an exception if still not found
                throw new IOException("FXML file '" + fxmlPath + "' not found via getResource() or ClassLoader().");
            } else {
                System.out.println("Loaded FXML via ClassLoader path successfully.");
            }
        } else {
            System.out.println("Loading FXML using getResource() from: " + fxmlUrl);
        }
        // Load the FXML hierarchy
        FXMLLoader loader = new FXMLLoader(fxmlUrl);
        Parent root = loader.load(); // Loads the VBox defined in FXML
        // --- Create the Scene ---
        // The size might be determined by the FXML's prefWidth/prefHeight,
        // or you can set it explicitly here if needed.
        Scene scene = new Scene(root);
        // --- Load the CSS ---
        String cssPath = "login-styles.css";
        URL cssUrl = getClass().getResource(cssPath); // Try relative path first
         if (cssUrl == null) {
            cssUrl = getClass().getClassLoader().getResource("com/chatapp/gui/" + cssPath); // Fallback
         }
        if (cssUrl != null) {
            scene.getStylesheets().add(cssUrl.toExternalForm());
            System.out.println("Login CSS loaded successfully from: " + cssUrl);
        } else {
            // Log a warning if CSS is missing, but don't stop the app
            System.err.println("Warning: Could not load CSS file 'login-styles.css'. UI might lack styling.");
        }
        // --- Configure and Show the Stage ---
        primaryStage.setTitle("ChatApp - Login / Register");
        primaryStage.setScene(scene);
        primaryStage.setResizable(false); // Login window is typically not resizable
        primaryStage.show();
    } catch (IOException e) {
        // Handle errors loading FXML (critical)
        System.err.println("Failed to load application UI (FXML): " + e.getMessage());
        e.printStackTrace();
        // Show a user-friendly error dialog
        showErrorDialog("Application Load Error",
                        "Failed to load the application interface.",
                        "Could not load the main screen (login-register.fxml).\n" +
                        "Please check the application files and installation.\nError: " + e.getMessage());
    } catch (Exception e) {
        // Catch any other unexpected errors during startup
```

The Successful JavaFX console output from Eclipse IDE, showing the startup logs for a Chat Application project.

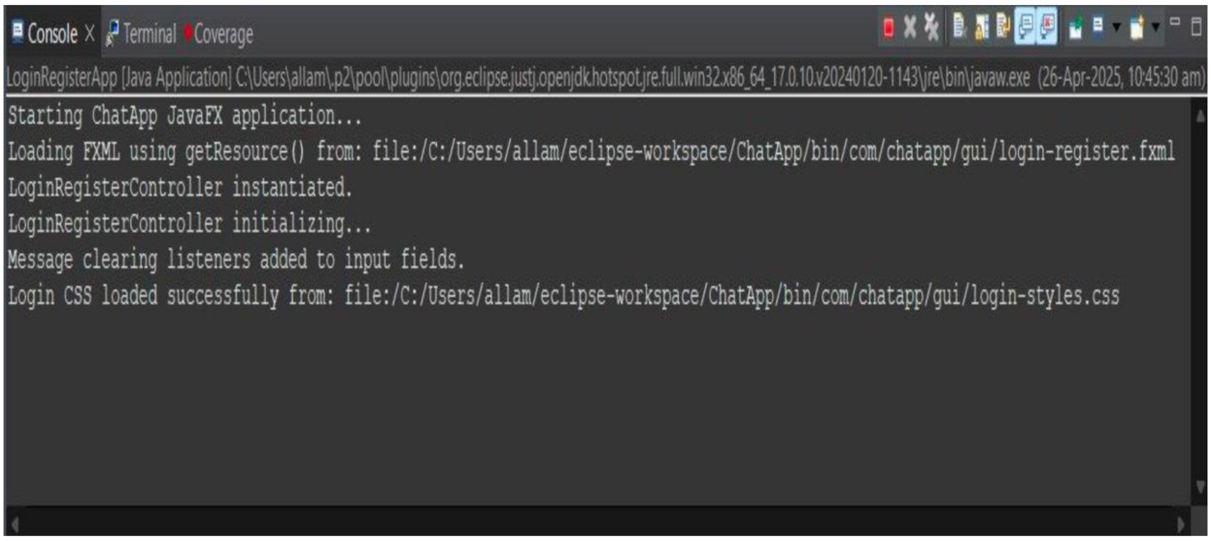
steps:

You are starting a JavaFX Chat Application.

It is loading a Login/Register screen designed in FXML.

The logic behind that screen is handled by LoginRegisterController.

The screen's styling (colors, fonts, etc.) is loaded through a CSS file.



```
LoginRegisterApp [Java Application] C:\Users\allam\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.10.v20240120-1143\jre\bin\javaw.exe  (26-Apr-2025, 10:45:30 am)
Starting ChatApp JavaFX application...
Loading FXML using getResource() from: file:/C:/Users/allam/eclipse-workspace/ChatApp/bin/com/chatapp/gui/login-register.fxml
LoginRegisterController instantiated.
LoginRegisterController initializing...
Message clearing listeners added to input fields.
Login CSS loaded successfully from: file:/C:/Users/allam/eclipse-workspace/ChatApp/bin/com/chatapp/gui/login-styles.css
```

REFERENCES

React Documentation – ***React – A JavaScript library for building user interfaces*****.** **https://reactjs.org**

Node.js Documentation – ***Node.js® is a JavaScript runtime built on Chrome's V8 JavaScript engine*****.**

https://nodejs.org

Express.js Guide – ***Fast, unopinionated, minimalist web framework for Node.js*****.** **https://expressjs.com**

MongoDB Documentation – ***The Developer Data Platform*****.**
https://www.mongodb.com/docs