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Module Code: **PUSL3122**	Module Name: **HCI, Computer Graphic and Visualisation**
Coursework Title: **Coursework report**	
Deadline Date: **09/05/2025**	Member of staff responsible for coursework: **Dr. Taimur Bakhshi**
Programme: **BSc (Hons) Software Engineering - Plymouth**	

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Signed on behalf of the group: Chamod 09/05/2025

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Acknowledgement

We would like to express our sincere gratitude to Dr. Taimur Bakhshi, Module Leader for PUSL3122, for his invaluable guidance, support, and constructive feedback throughout the development of this project. His insights on human-computer interaction principles, usability testing methods, and interface design played a crucial role in shaping the direction and quality of our work.

We are also thankful to the teaching staff and peers who provided feedback during the prototyping and evaluation stages, as well as the participants who volunteered their time for user testing. Their contributions significantly enhanced the effectiveness and usability of the final application.

We appreciate the collaborative effort of all group members who remained committed and proactive throughout the project, ensuring a successful outcome.

Abstract

This report documents the end-to-end development of a desktop application designed for a furniture design company to support in-store customer consultations. The goal was to create an intuitive and interactive platform allowing designers to input room parameters, assemble furniture layouts using 2D components, apply customizations, and visualize the final setup in 3D. Following an agile methodology, the team employed HCI principles and user-centered design practices to ensure the application meets practical retail needs.

The project involved thorough requirement gathering through interviews, surveys, and focus groups, which informed the functional design. User personas, storyboards, and low- and high-fidelity prototypes were created to guide interface development. Java Swing and JavaFX were used to implement the user interface and 3D visualization, with usability playing a central role in all design decisions.

Formative user testing was carried out with a sample group of target users, and their feedback was captured through direct observation, think-aloud sessions, and usability questionnaires. Results indicated strong satisfaction with the interface and the 3D preview feature, while also highlighting improvement areas such as enhanced tooltips and real-time 3D rotation.

The report concludes with recommendations for iterative improvements and highlights the potential of the tool to streamline the furniture design experience in retail environments. Supporting materials, including the GitHub source code and a video demonstration, are accessible via the links provided.

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1. Introduction

1.1 Overview of the Report

This report presents the design, development, and evaluation of a desktop-based interior design application tailored for a furniture design company. The application enables store designers to create customized room layouts using 2D shapes, apply color schemes, and visualize the layout in both 2D and 3D formats. Its core functionality includes the ability to scale, shade, and adjust color for various elements, helping customers see how furniture items such as tables and chairs would look in their rooms before making purchasing decisions.

The primary aim of this report is to document the entire Human-Computer Interaction (HCI) process followed throughout the software development lifecycle from gathering user requirements to testing and evaluating the final product. It details the rationale behind design decisions, the prototyping stages, and usability testing conducted to ensure that the application meets user expectations effectively. The report also reflects on feedback received during evaluation and how it guided improvements in the final implementation.

GitHub repository Link : https://github.com/chamod4915/PUSL3122_HCI

Demonstration YouTube video Link : https://youtu.be/XyjZozIutKo?si=L-xyUmC24VjQX9Hm

2. Background

2.1 Project Scenario

Modern furniture retailers face increasing demand for personalized design experiences. Customers often struggle to visualize how specific furniture items will look in their rooms, especially when considering varying dimensions, color palettes, and layout constraints. To address this challenge, our project provides a software-based solution enabling designers to create customized interior layouts for customers in real time. This offers a more engaging and informed shopping experience, reducing uncertainty and enhancing decision-making.

2.2 Application Purpose and Features

The purpose of this desktop application is to empower in-store designers to develop and present room designs tailored to individual customer preferences. Key features include the ability to input room dimensions, define room shapes, select color schemes, and assemble furniture using 2D shapes. The application then renders a 3D visualization of the layout, allowing users to evaluate how the furniture fits and appears within the room. Users can also scale objects, apply shading, modify colors, and save or edit designs.

From a technical standpoint, the application leverages Java with Swing for the user interface, integrated 2D/3D rendering libraries for visualization, and object-oriented design principles to manage design components effectively.

2.3 Target Users

The primary users are furniture store designers who assist customers during in-store visits. By enabling them to quickly generate personalized, visual mockups, the application helps bridge the gap between imagination and reality making the buying process more interactive, efficient, and confidence-driven for both the designer and the customer.

3. Gathering Data

3.1 Requirements Gathering Methods

To develop a user-centered application that aligns with the needs of in-store furniture designers, we employed multiple data-gathering techniques. These included semi-structured interviews, a short survey distributed via Google Forms, and an informal focus group session with five participants comprising furniture designers and showroom staff. These methods were selected to obtain both qualitative insights and quantitative validation of functional expectations.

Example questions asked during interviews and surveys

- "What tools do you currently use when planning room designs for customers?"
- "What challenges do you face when helping customers visualize furniture in a space?"
- "How important are 3D visuals in influencing purchasing decisions?"
- "Would features like color customization or scaling be useful in your workflow?"

These questions aim to uncover pain points, desired features, and workflow habits.

3.2 Data Analysis

The data collected was analyzed using a combination of thematic analysis for qualitative responses and frequency analysis for survey results. Interview transcripts were reviewed manually and coded into categories such as "visualization," "customization," and "workflow speed." Survey responses were exported to Excel for summarization and charting.

Common User Requirements Identified

Requirement	Frequency	Category
3D visualization of furniture	9/10	Visualization
Easy color customization	8/10	Customization
Ability to scale objects to room size	7/10	Functionality
Save and edit previous designs	6/10	Productivity
Simple and intuitive interface	5/10	Usability

4. Design

4.1 Requirements Documentation

The application's requirements were divided into functional and non-functional categories. These were derived from data gathered during interviews and surveys.

Summary of Requirements

Type	Requirement Description
Functional	Designers can input room dimensions and select room shapes
Functional	Add and arrange furniture objects using 2D shapes
Functional	Visualize the layout in 3D
Functional	Apply scaling, colors, and shading to objects
Functional	Save, edit, or delete design projects
Non-Functional	User-friendly interface with minimal learning curve
Non-Functional	Fast rendering performance for 2D and 3D views
Non-Functional	Data persistence and design recovery support

4.2 User Personas and User Stories

Persona 1 : Mr. Samantha - Furniture Retailer

User Story

- As a furniture retailer, I want to showcase my product catalog in a virtual environment, allowing customers to interact with furniture designs before purchasing.
- As a furniture retailer, I need a platform that supports customization options so customers can personalize their furniture choices.
- As a furniture retailer, I want insights into customer preferences and interactions with different furniture designs to inform product development and marketing strategies.

Figure 1 : User Persona

4.3 Storyboard

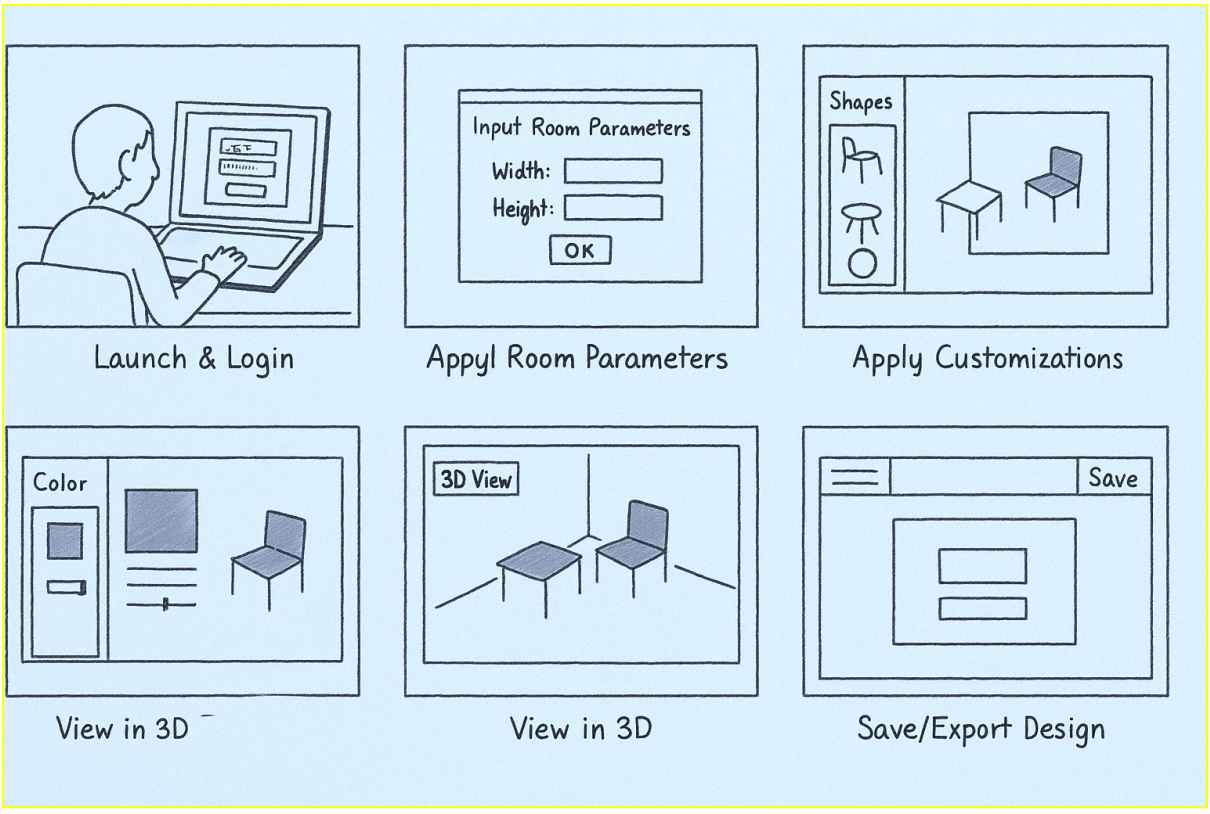

Figure 2 : Story Board

4.4 Prototypes

Low-Fidelity Prototype

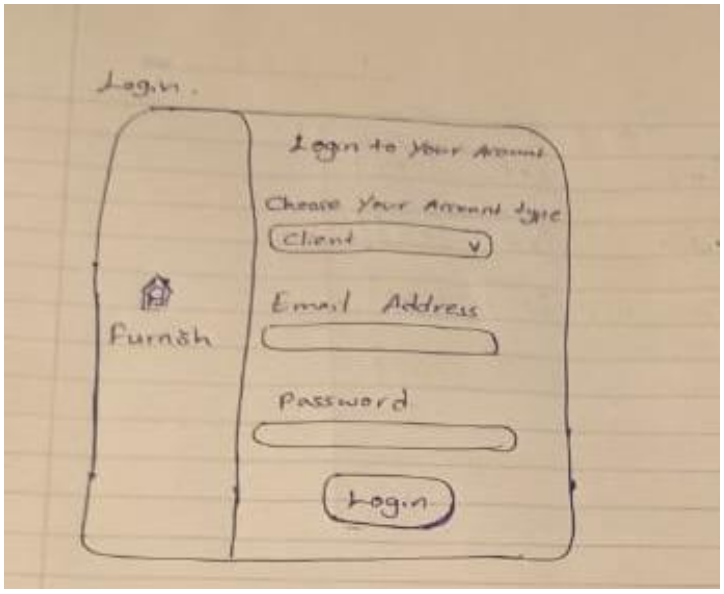

Figure 3 : Login

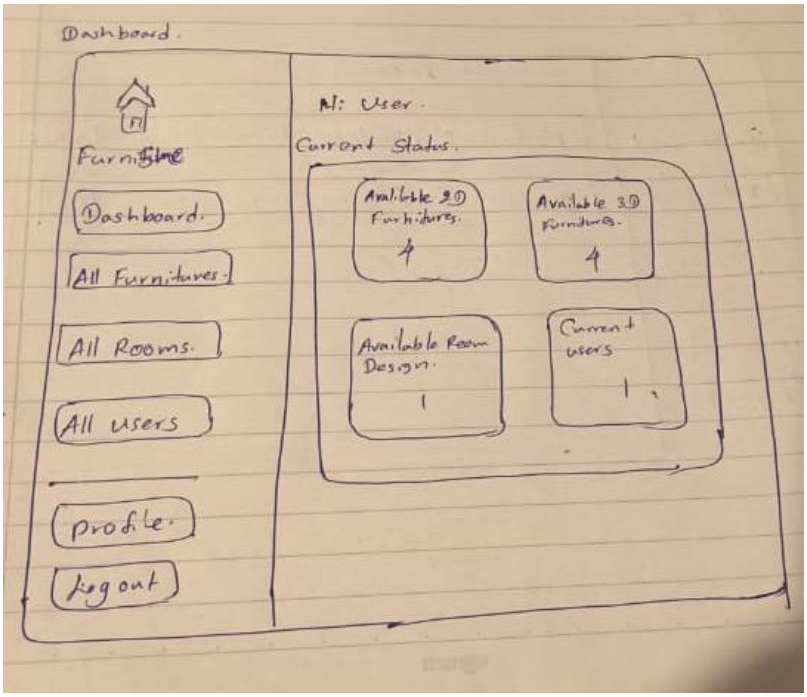

Figure 4 : Dashboard

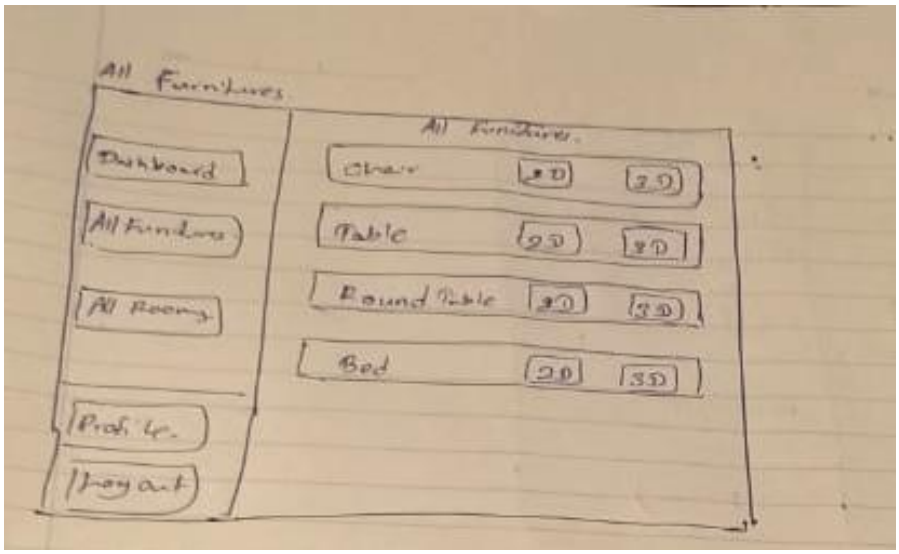

Figure 5 : All Furniture

Figure 6 : All rooms

High-Fidelity Prototype

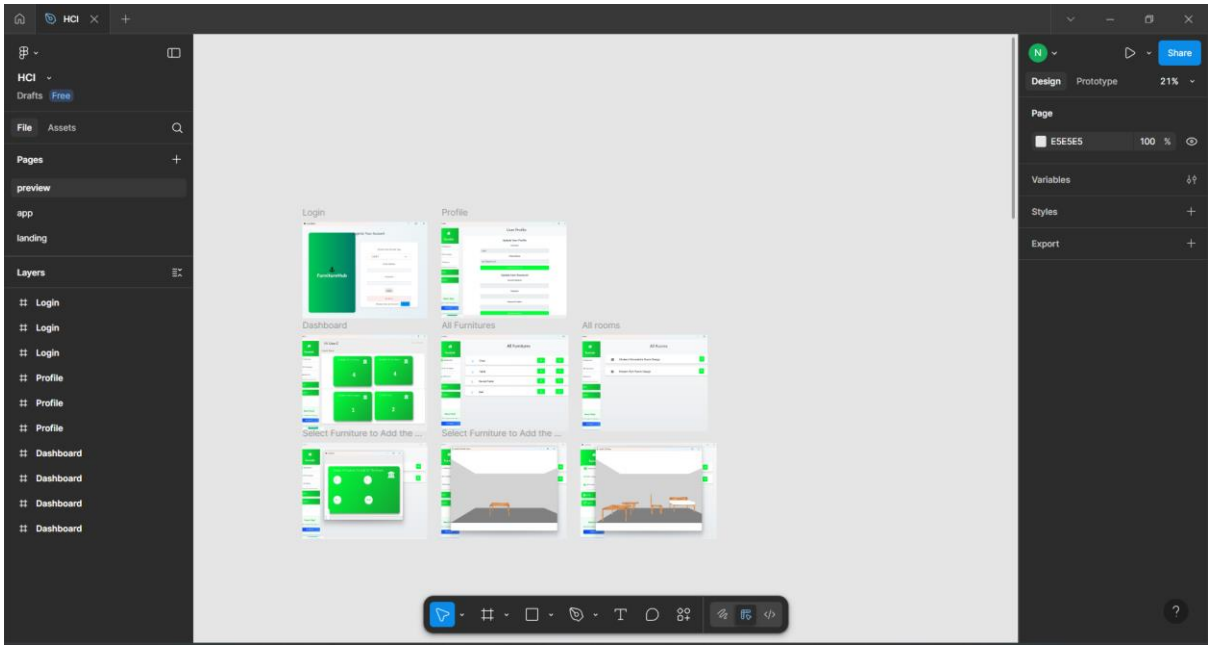

Figure 7： High fidelity Phototype

5. Implementation

5.1 Technology Stack

The application was developed using Java Swing for the frontend interface and JavaFX for enhanced 3D rendering capabilities. The backend logic, including room and furniture object management, was also implemented in Java, with object-oriented programming principles for maintainability. No external database was used, as designs are saved locally using file-based serialization. For rendering 3D views, we integrated the JavaFX 3D API. Git was used for version control and collaboration, with regular commitments documented on GitHub.

- **Frontend**

  Java Swing (UI), JavaFX (3D rendering)

- **Backend**

  Java (OOP design)

- **Storage**

  Local file-based serialization

- **Tools**

  IntelliJ IDEA, Git, Figma (for design)

5.2 Key Screens and Features

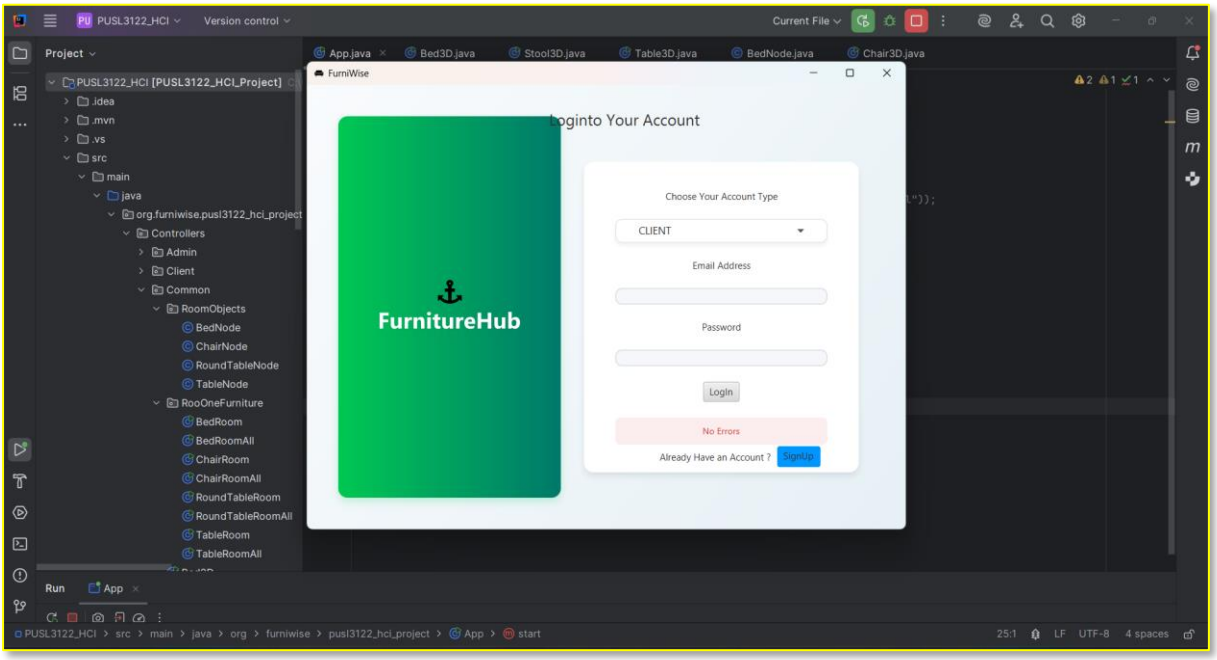

Figure 8 : Login Page

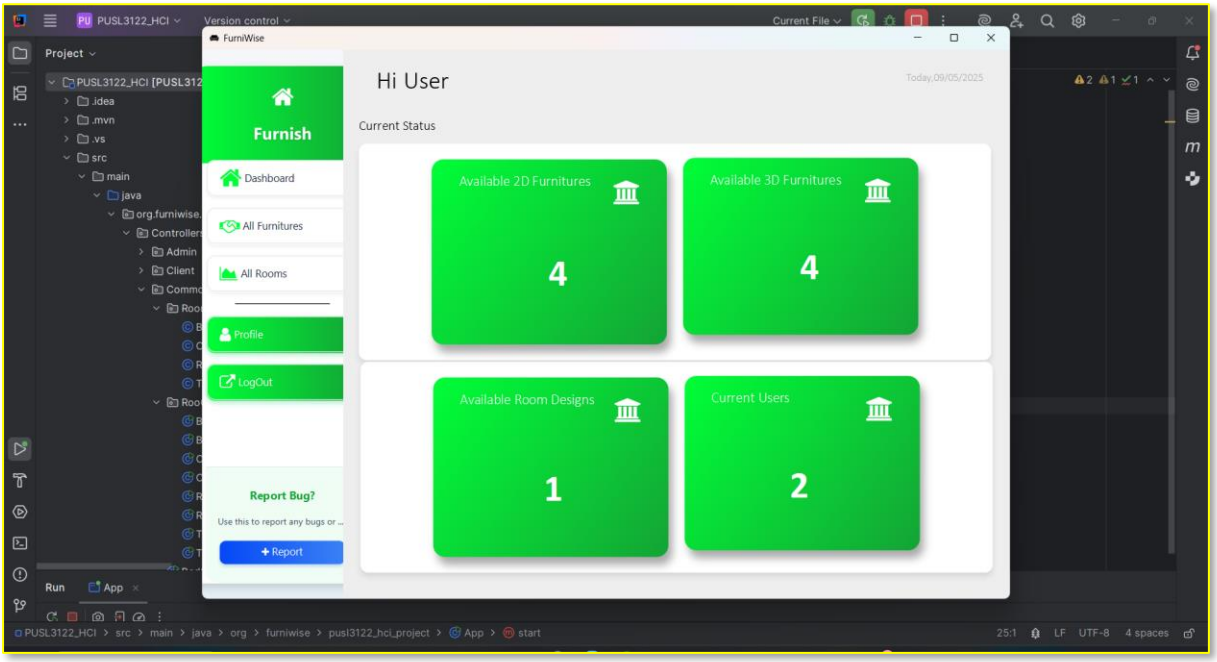

Figure 9 : Dashboard

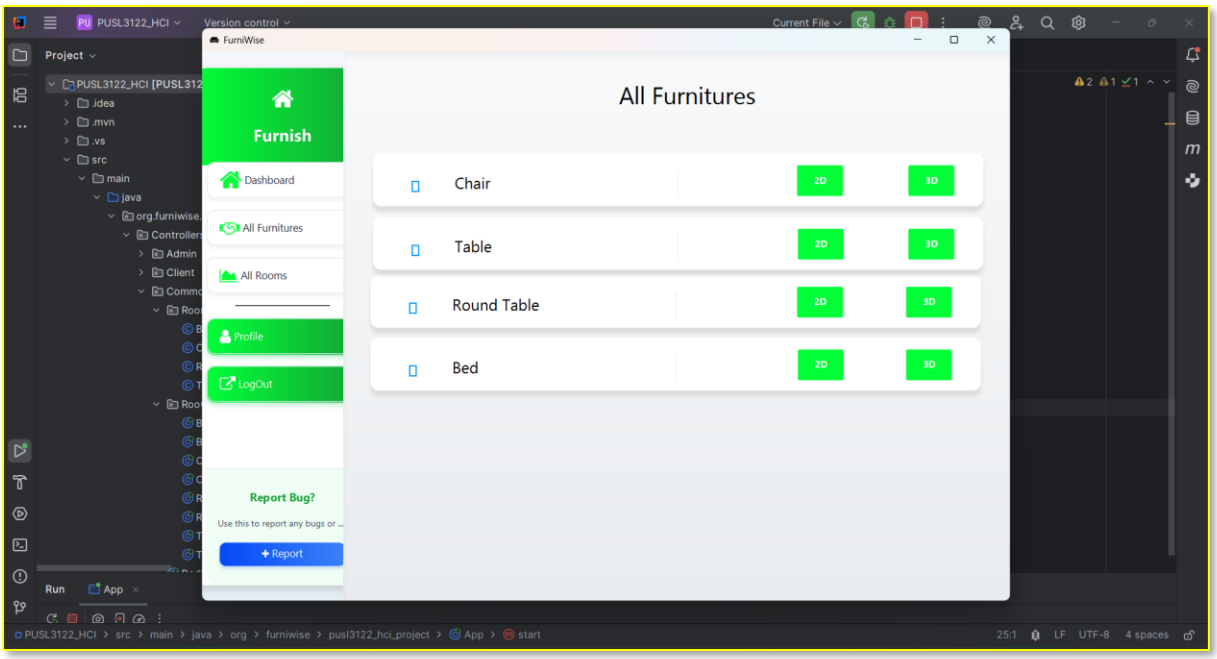

Figure 10 : All furniture pages

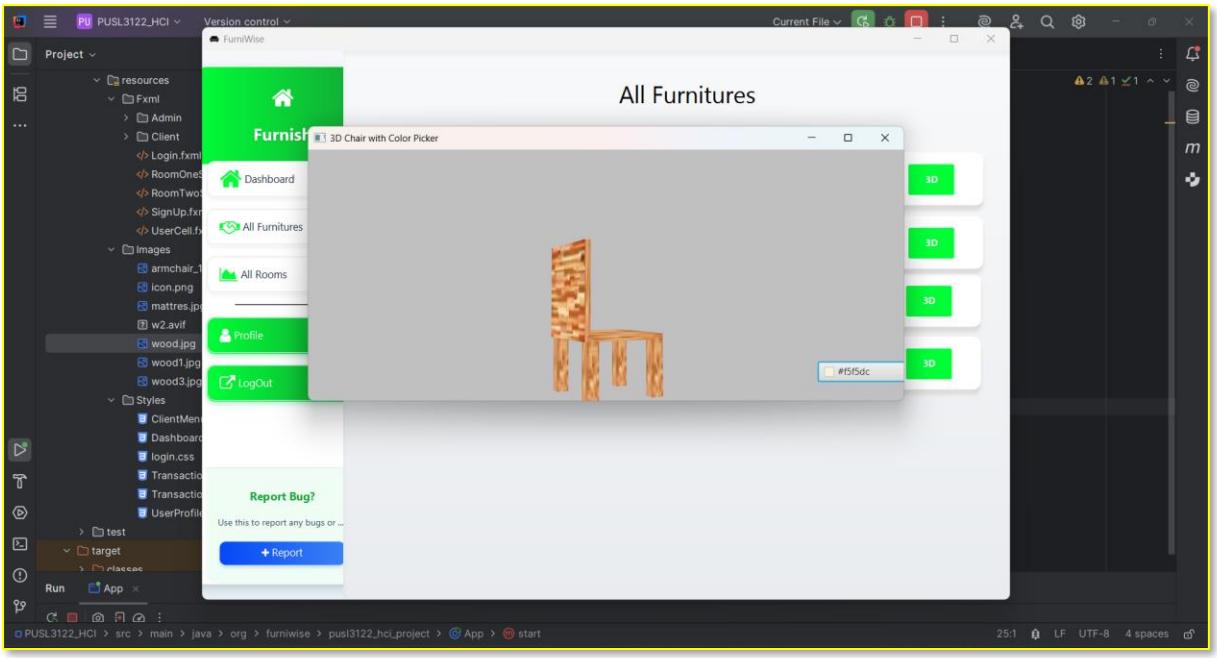

Figure 11 : 3D furniture

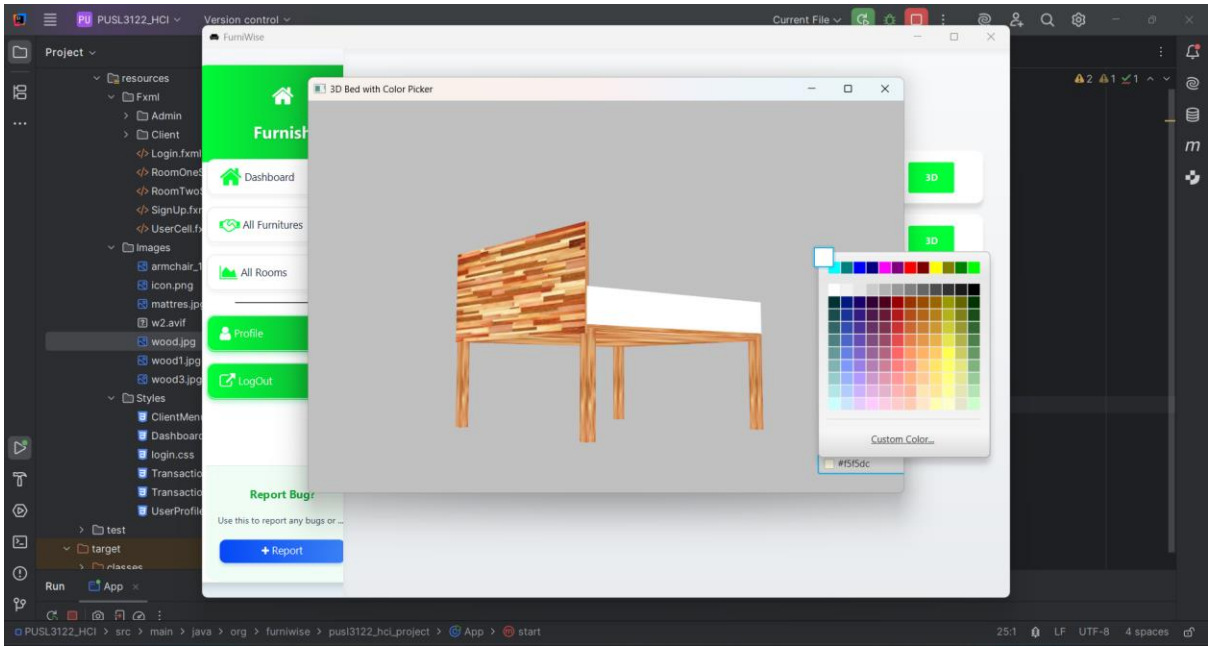

Figure 12 : 3D furniture change color

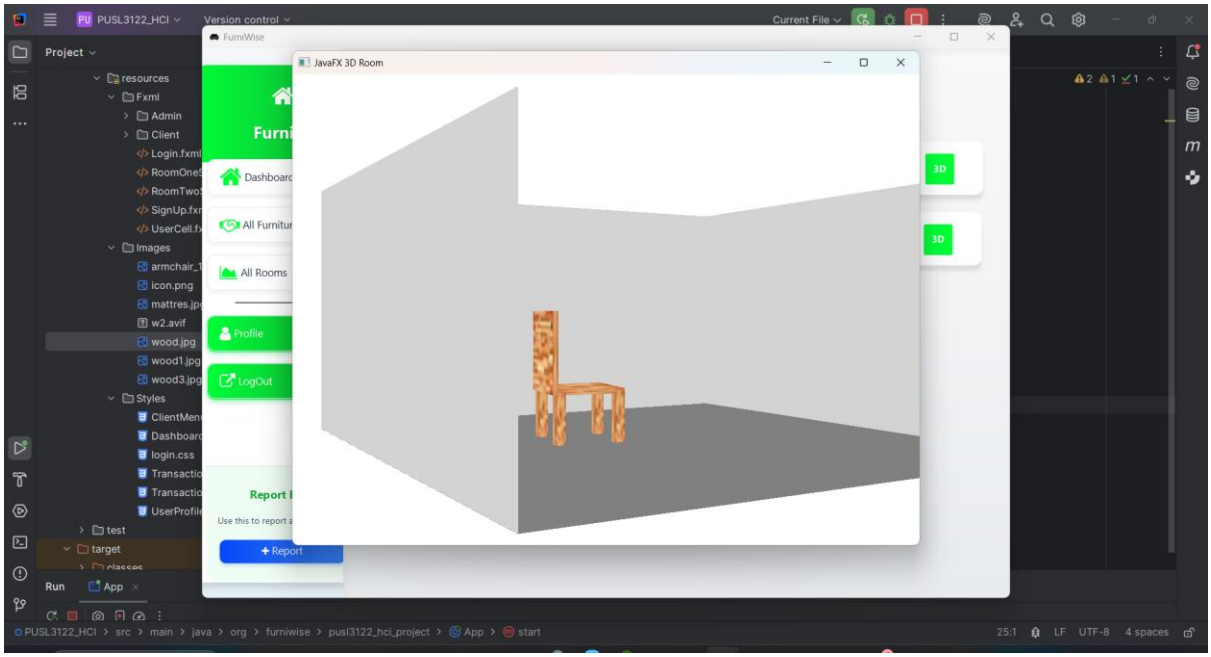

Figure 13 : Side view of the 3D room with chair

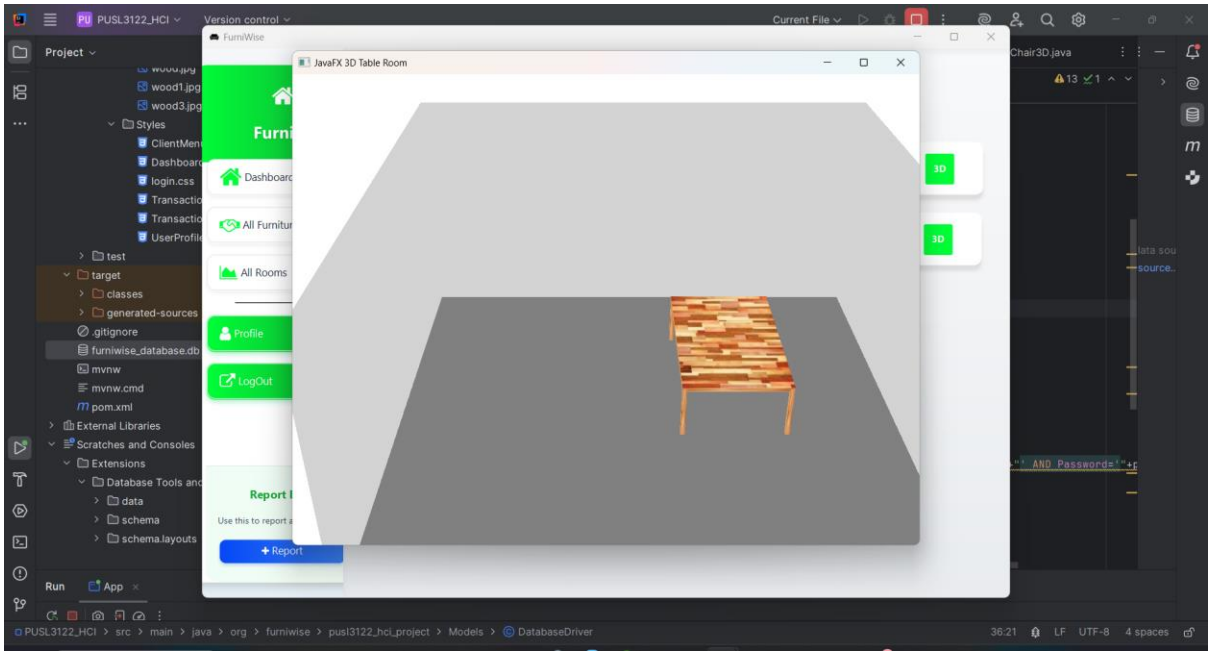

Figure 14 : top view of the 3D room with table

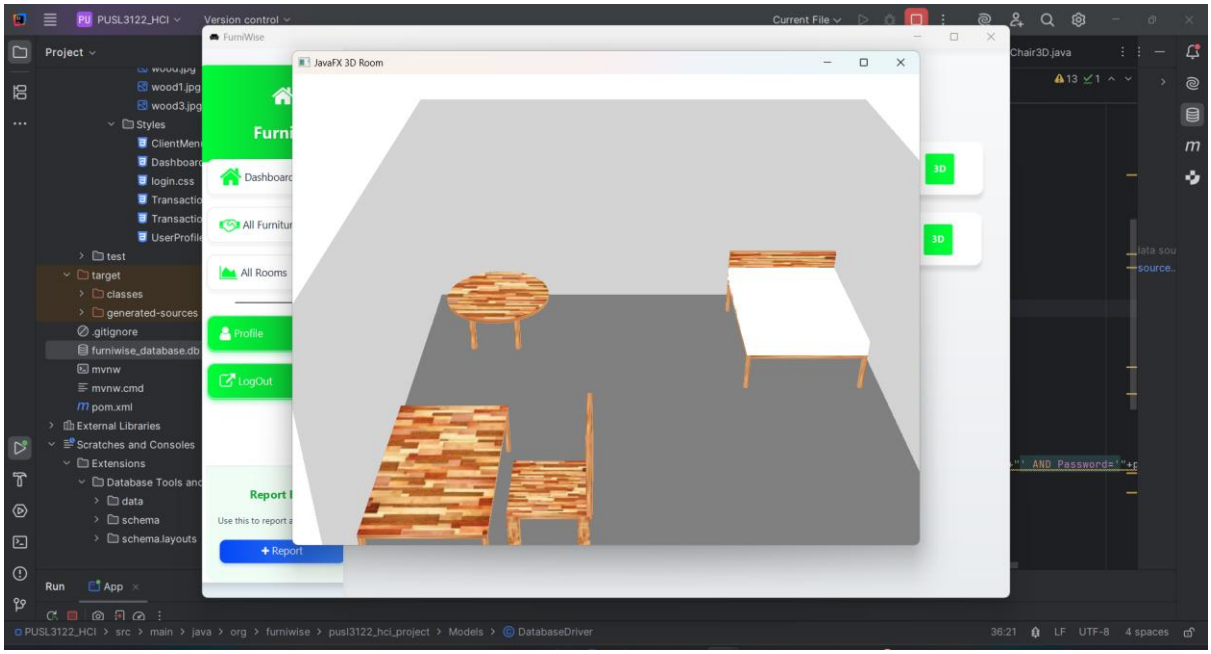

Figure 15 : furniture with room 3D top view

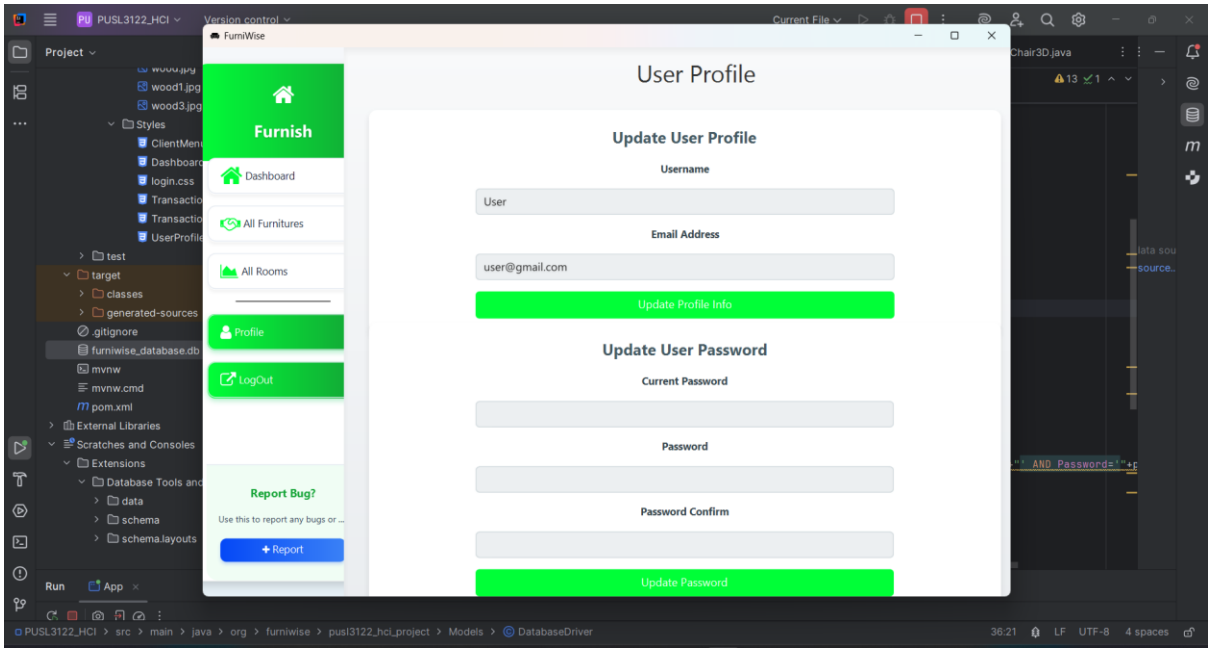

Figure 16 : Profile Page

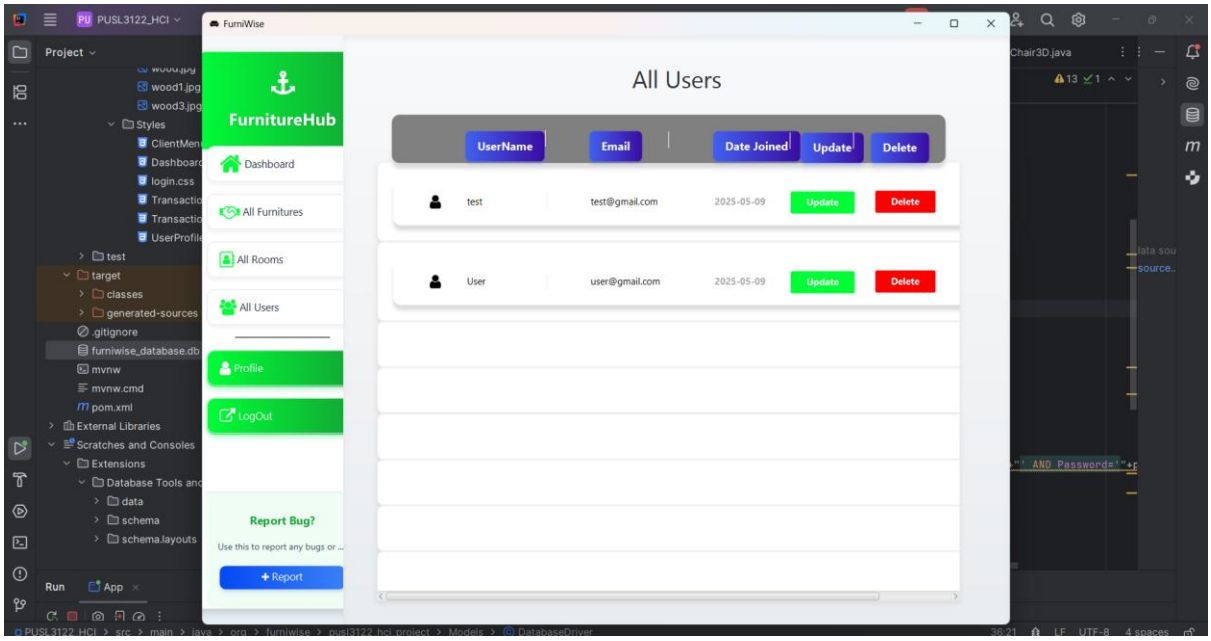

Figure 17 : All users (can view only admin)

5.3 Implementation Notes

One of the main challenges was integrating JavaFX 3D with the existing Swing UI. This was solved by embedding the JavaFX components into a JFXPanel, allowing both technologies to coexist. Performance optimization was also a concern, especially during 3D rendering of multiple objects. We addressed this by limiting polygon complexity and optimizing the rendering loop.

Another challenge was implementing dynamic scaling and rotation for furniture objects. This was achieved using transformation matrices and JavaFX's built-in rotation and scale classes.

Integrated Figma export assets to guide UI layout replication, ensuring consistency between design and implementation. Though no external APIs or AI models were used in this version, the architecture is modular enough to support future integration.

6. Evaluation

6.1 Evaluation Methodology

To assess the usability, functionality, and overall user satisfaction of the application, a comprehensive formative usability evaluation was conducted. We adopted a mixed-method approach, combining task-based observational testing, heuristic evaluation, and a System Usability Scale (SUS) questionnaire for quantitative scoring. Additionally, we utilized the think-aloud protocol to capture real-time user feedback.

Five participants were involved in the evaluation: three experienced furniture designers and two assistant showroom consultants. Participants were selected based on their familiarity with in-store design workflows and customer-facing design tools. Each session lasted approximately 30–40 minutes and was conducted in a controlled environment using the final high-fidelity version of the application.

6.2 Execution of Evaluation

Each participant was asked to complete a set of structured tasks that reflected real-world use cases

1. Log in and create a new design project
2. Input room dimensions and select shape
3. Add furniture items and modify their scale and colors
4. Preview the design in 3D
5. Save and then reopen the design for further editing

Participants were encouraged to think aloud as they interacted with the app, describing their thoughts, confusions, or expectations. Observers recorded behavioral cues and usability issues. Upon completing the tasks, participants filled out a SUS questionnaire and an open-ended feedback form.

6.3 Results and Analysis

Feedback showed a generally positive reception. Users found the interface clean and easy to navigate. The drag-and-drop functionality and color picker were particularly praised. Minor confusion arose around the 3D toggle placement and lack of tooltips.

User Satisfaction (SUS Scores from 5 Users)

Feature Tested	Average Rating (/10)
Ease of Use	8.4
Visual Design	8.8
3D View Functionality	9.2
Color Customization	9.0
Task Completion Speed	7.6

Common Qualitative Feedback

- "The app is visually appealing and easy to use."
- "Would be great to have real-time rotation in 3D mode."
- "Tooltips could help first-time users."
- "Nice flow, but the login screen could use autofill."

Overall, SUS score: 82, placing the application in the 'Good' usability bracket according to industry standards.

6.4 Improvement Areas

Based on the evaluation outcomes, the following improvements are proposed

- Interactive tooltips and an optional onboarding walkthrough for first-time users
- Enhanced 3D interaction, including rotation with drag gestures
- Undo/redo functionality to ease editing workflows
- Flexible export options (PDF, PNG) for sharing or printing designs
- Persistent user sessions to avoid frequent logins

Implementing these suggestions will not only improve the overall user experience but also increase the application's professionalism and client-readiness in real retail environments.

7. Summary

7.1 Recap of Each Section

This report introduced the design and development of a desktop-based interior design application tailored for in-store furniture designers. The introduction outlined the purpose of the report and provided access to the GitHub repository and YouTube demo. The background explained the scenario of helping customers visualize room designs using furniture and highlighted the app's role in improving that experience.

In data gathering, we used interviews, surveys, and a focus group to define user needs and prioritize requirements. The design section documented functional goals, user personas, storyboards, and prototypes, aligning all stages with HCI best practices. The implementation showcased the chosen tech stack, code architecture, and key UI screens, while the evaluation demonstrated that the app achieved high usability scores, supported by both qualitative feedback and SUS metrics.

7.2 Key Takeaways

This project emphasized the value of iterative, user-focused design in real-world software development. Applying usability testing and visual feedback loops significantly improved the application's effectiveness and user experience. Key challenges, such as integrating 3D rendering and scaling features, were successfully addressed through agile development and team collaboration. Looking ahead, planned improvements such as enhanced 3D interaction and export options will further refine the application for professional retail use.

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