Assignment 2: Milestone-1

CS346: Software Engineering Laboratory

Assignment-2 Report

Group 8B Task:

Develop an Interactive Learning Software to teach students fundamental concepts of "Data Structures" using some graphics to make learning more interesting.

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1 Problem

Teaching essential principles of data structures can be difficult due to their abstract nature and complexity. Traditional teaching approaches may not always be interesting to students as they do not accommodate varied learning styles, resulting in gaps in comprehension.

This problem can be addressed by an interactive solution where students can visualize the data structures in a simpler manner and by using a step-wise approach.

1.1 Problem Statement

Build a software application designed to educate students on the fundamental concepts of "Data Structures" through interactive learning modules, visuals, and quizzes to improve comprehension and engagement. Basic topics like Searching, Sorting, Arrays, Stacks, Queues, Linked Lists, and so on must be covered, along with any other topics that may be required.

1.2 Goal and Motivation

The goal is to develop a user-friendly software solution that provides organized learning modules on a variety of data structures and algorithms. To make learning easier, the program should include step-by-step explanations, visual aids, and interactive aspects. Quizzes and assessments should be used to test students' understanding and encourage learning.

Ultimately, the aim is to improve students' knowledge of data structures and problem-solving skills in programming.

2 Software Requirements

The software should facilitate the understanding of Data Structures and Algorithms through step-by-step explanations, visualizations, and quizzes. It must accomplish the following requirements:

- User should be able to choose between Data Structures and Algorithms.
- User should be given the option of further refining his/her choices by selecting specific algorithms or data structure topics.
- Every topic or algorithm should have detailed explanation, interactive visualization and should conclude with quizzes.
- The interactive explanation should be enhanced by allowing the user to give input depending on the topic.

Meeting these requirements will allow the user to learn the topics effectively, ensuring a comprehensive understanding of Data Structures and Algorithms.

3 Incremental Model

In this project, the incremental model is applied to develop the educational software in a systematic and iterative manner. Here's how it's used:

- **Incremental Content Development:** The project is divided into increments, focusing on specific topics or functionalities related to data structures and algorithms. This modularity helps write and understand the code better.
- **Gradual Feature Addition:** New features are added with each increment based on stakeholder deadlines, usage and priorities.
- **Early Delivery of Value:** Users benefit from the product early on, even if it's not fully complete, as each increment delivers usable functionality.
- **Flexibility and Adaptability:** The incremental approach allows for changes to requirements and design to be accommodated in future increments.
- **Parallel Development:** Different increments can be developed in parallel, speeding up progress and utilization of resources.

4 Detailed Pathway of the Solution

To facilitate the understanding of fundamental concepts in Data Structures and Algorithms, the software will provide step-by-step explanations, incorporate graphics to create visualisations, which will help in enhancing user's learning experience, and include small quizzes to test knowledge.

4.1 Forms at each level

The software will consist of various forms organized into hierarchical levels to guide the user through the learning process effectively.

4.1.1 User Authentication (Level 0)

This form serves as the entry point of the software. The user has to log in to the software. If the user is has an account, he/she can enter the username and password. Given the password is correct, it leads to a successful authentication. If the user doesn't have an account, he/she can sign up and create an account. Username and password are required for creating an account. Once the account is created, the user is requested to log in to the software.

4.1.2 Main Menu (Level 1)

At this level, users are presented with the option to choose between different learning areas, namely Algorithms and Data Structures. The user interface prompts the user with a question,

"What do you want to learn today?" and offers two options:

Algorithms: Choosing this option, the user is directed to further refine their choice by selecting either searching or sorting algorithms.

Data Structures: Choosing this option leads the user to explore various data structure topics such as arrays, linked lists, stacks, and queues.

On selecting a button(either Data structure or algorithm), the further options will appear as buttons or menu below the respective button clicked by the user. It allows users to navigate to their desired learning area.

4.1.3 Selection of Specific Topics (Level 2)

Once the user has chosen a learning area in Level 0, they are prompted to select a specific topic within that area. The available choices vary depending on the initial selection.

Algorithms:

- Searching Algorithms: User can choose between Linear Search and Binary Search.
- Sorting Algorithms: User can choose between Bubble Sort, Insertion Sort, and Merge Sort.

Data Structures:

- Arrays: Users are presented with the option to create an array of a specified size and learn about memory allocation.
- Linked Lists: Topics covered here include traversal, insertion, deletion, and searching within linked lists.
- Stacks: Users can explore stack operations such as top, push, pop and clear.
- Queues: This option provides insights into queue operations like front, rear, enqueue, and dequeue.

4.1.4 In-depth Explanation and Quiz (Level 3 or Leaf)

At this level, users delve deeper into the selected algorithm or data structure. They receive comprehensive explanation, visualizations, and examples to enhance their understanding. Additionally, a multiple-choice quiz is also provided at the end of each topic to assess comprehension.

4.2 Data Flow Diagram (DFD)

The below DFD offers a graphical representation of how information moves through the various components and modules of the software. Through this analysis, we aim to provide a comprehensive understanding of the software's architecture and functionality, laying the groundwork

for its successful development

4.2.1 Level 0

Level 0 Data Flow Diagram is also called a Context Diagram. It's a basic overview of the whole system or process being analyzed or modeled. It's designed to be an at-a-glance view, showing the system as a single high-level process, with its relationship to external entities. It should be easily understood by a wide audience, including stakeholders, business analysts, data analysts and developers.

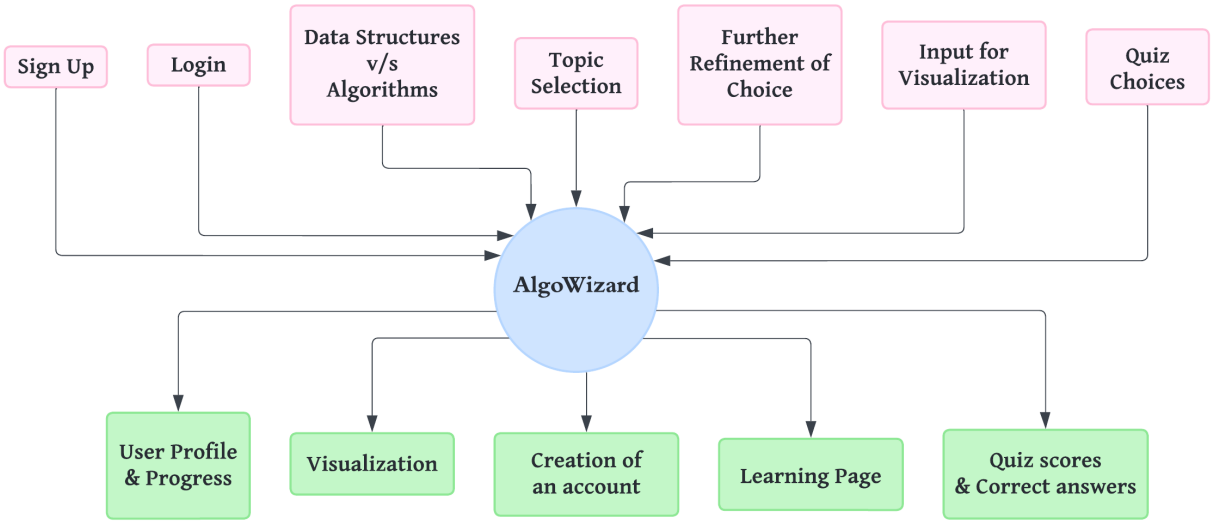

Figure 1: Level 0 DFD

4.2.2 Level 1

Level 1 Data Flow Diagram provides a more detailed breakout of pieces of the Context Level Diagram. The main functions carried out by the system are highlighted. The high-level process of the Context Diagram is divided into its subprocesses.

In the Level 1 DFD given below, it can be observed that there are 8 main modules which are, Login, Sign Up/ New User, Main Menu, Further Section in Data Structures and Algorithms, Learning Page, Quiz and Profile.

Moreover, there are two databases. The first database is the User Database which contains the details of the user i.e username, password, progress in each topic etc. The second database is the Quiz Database which contains the quiz questions for all the topics.

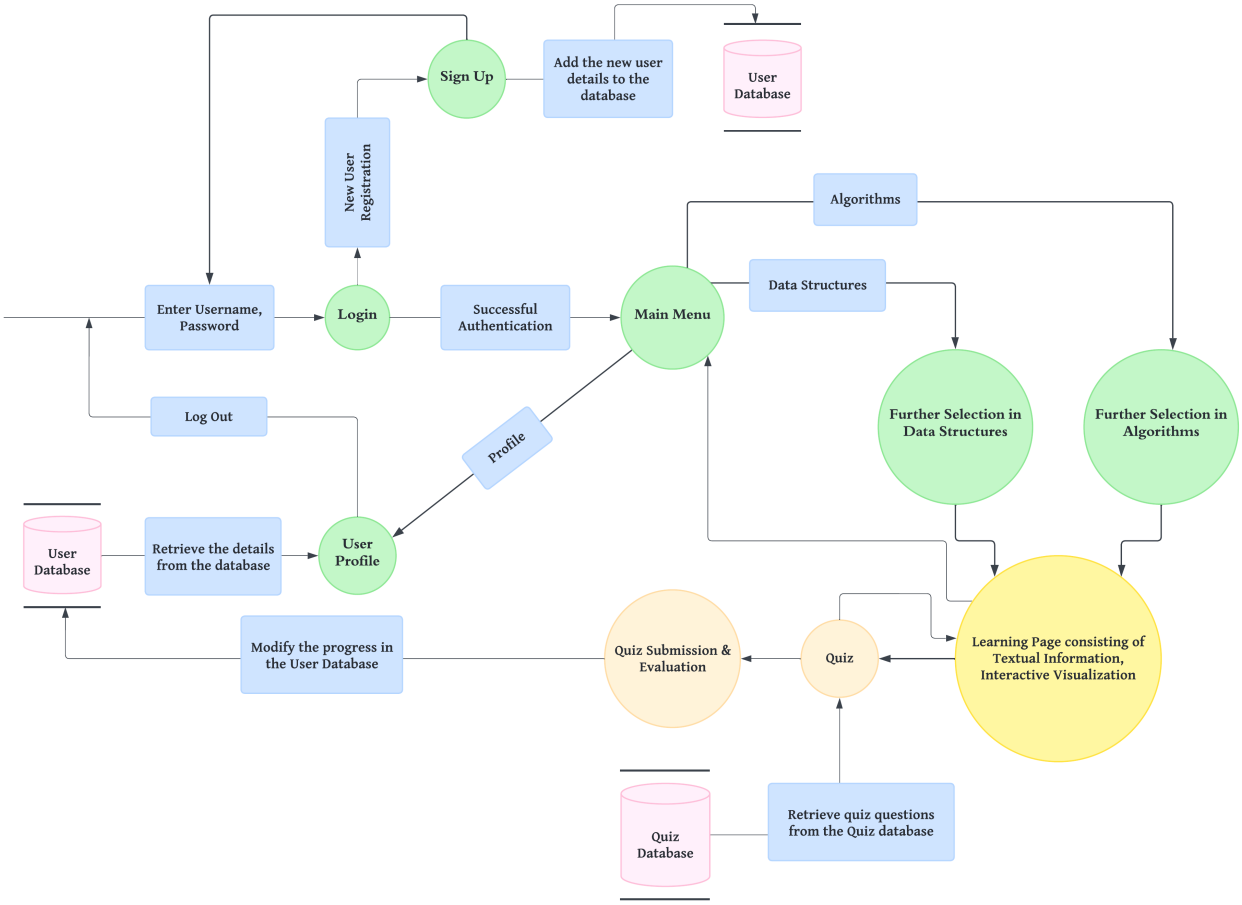

Figure 2: Level 1 DFD

4.2.3 Level 2

DFD Level 2 then goes one step deeper into parts of Level 1. It may require more text to reach the necessary level of detail about the system's functioning.

In this level, we give details about inputs and outputs as well as the process of each module. We even look into the flow of one module to another for every module in the data flow diagram.

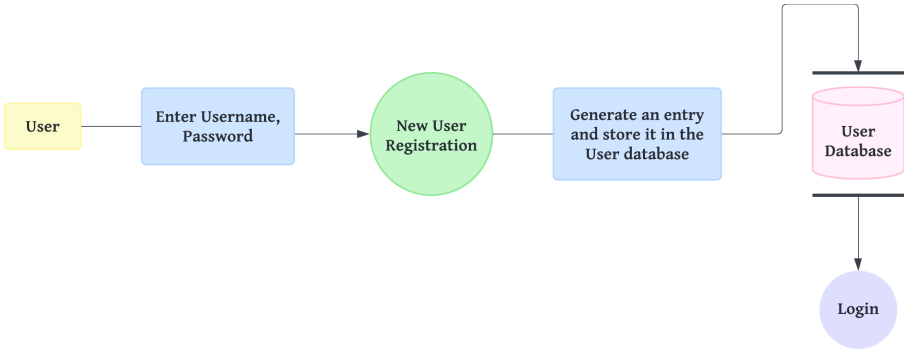

Figure 3: Sign Up Module

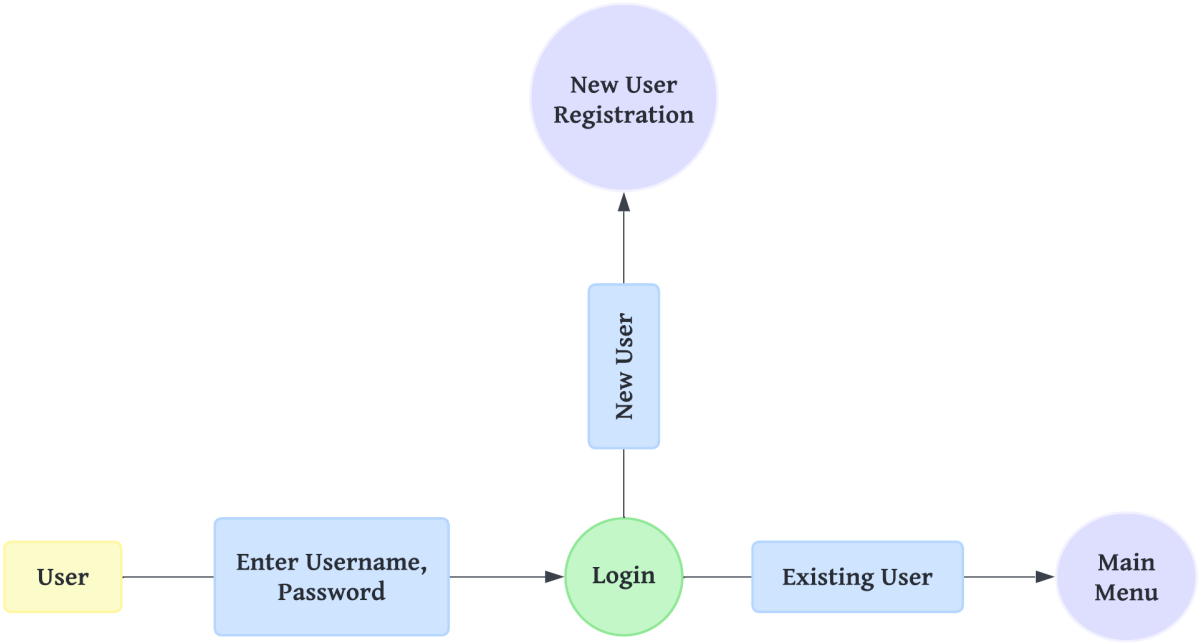

Figure 4: Login Module

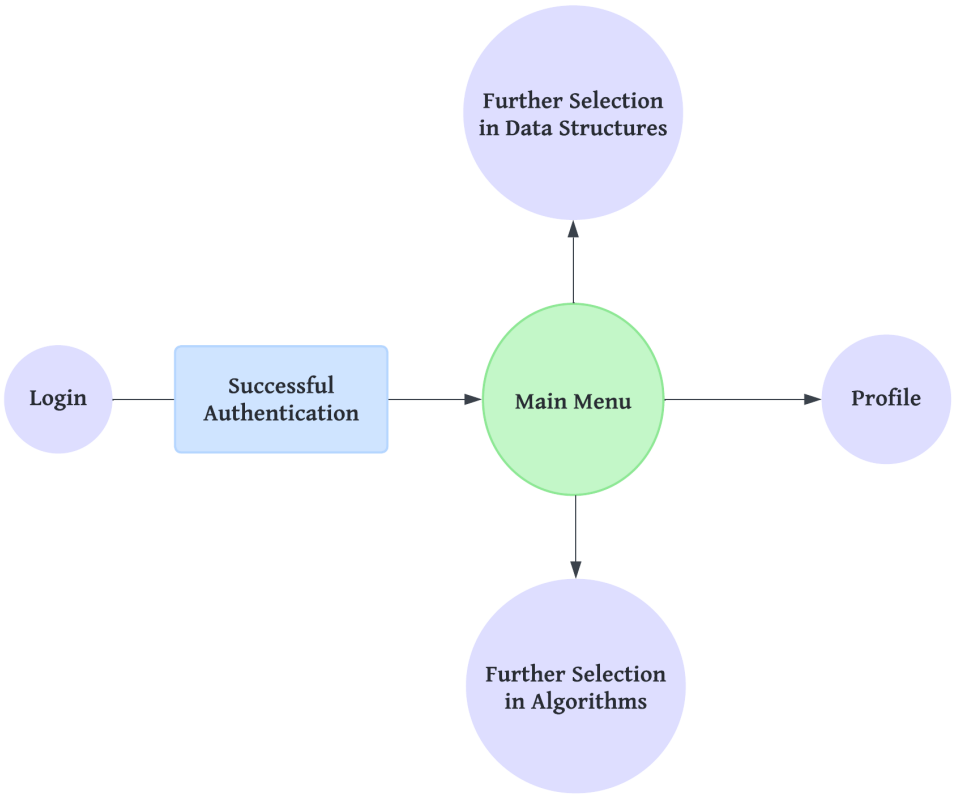

Figure 5: Main Menu Module

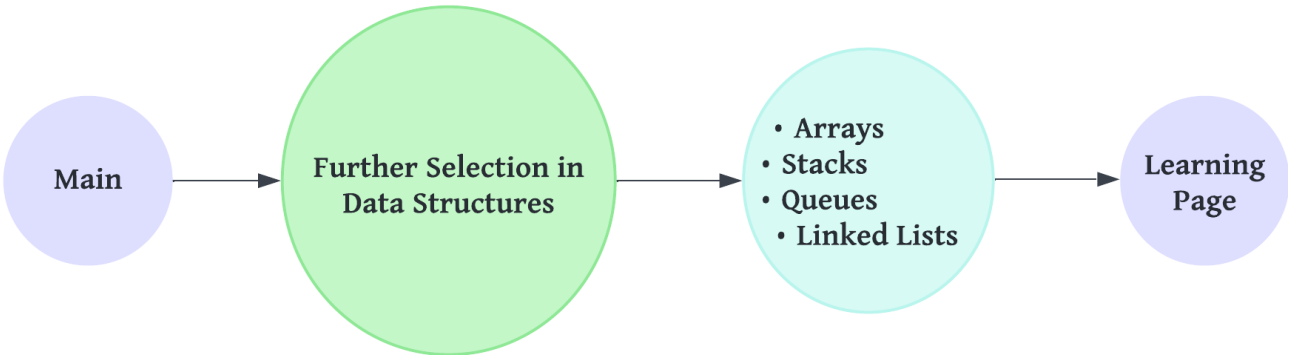

Figure 6: Further Selection in Data Structures Module

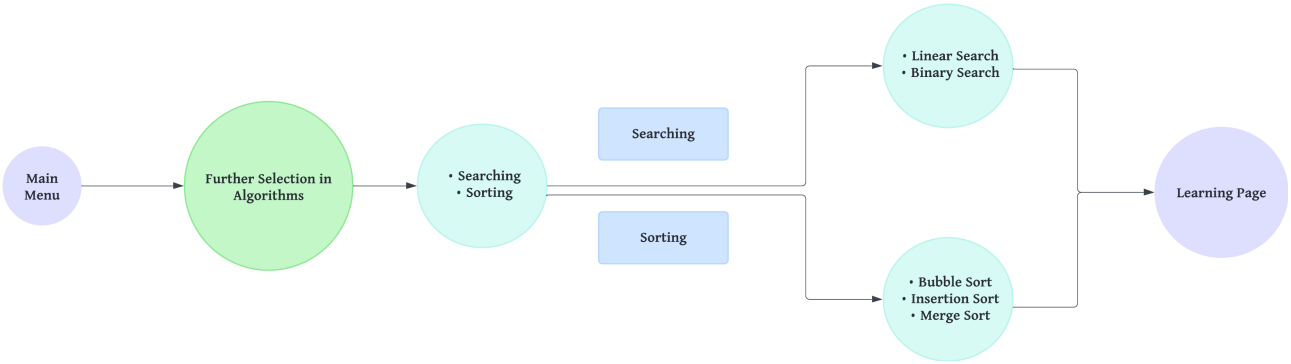

Figure 7: Further Selection in Algorithm Module

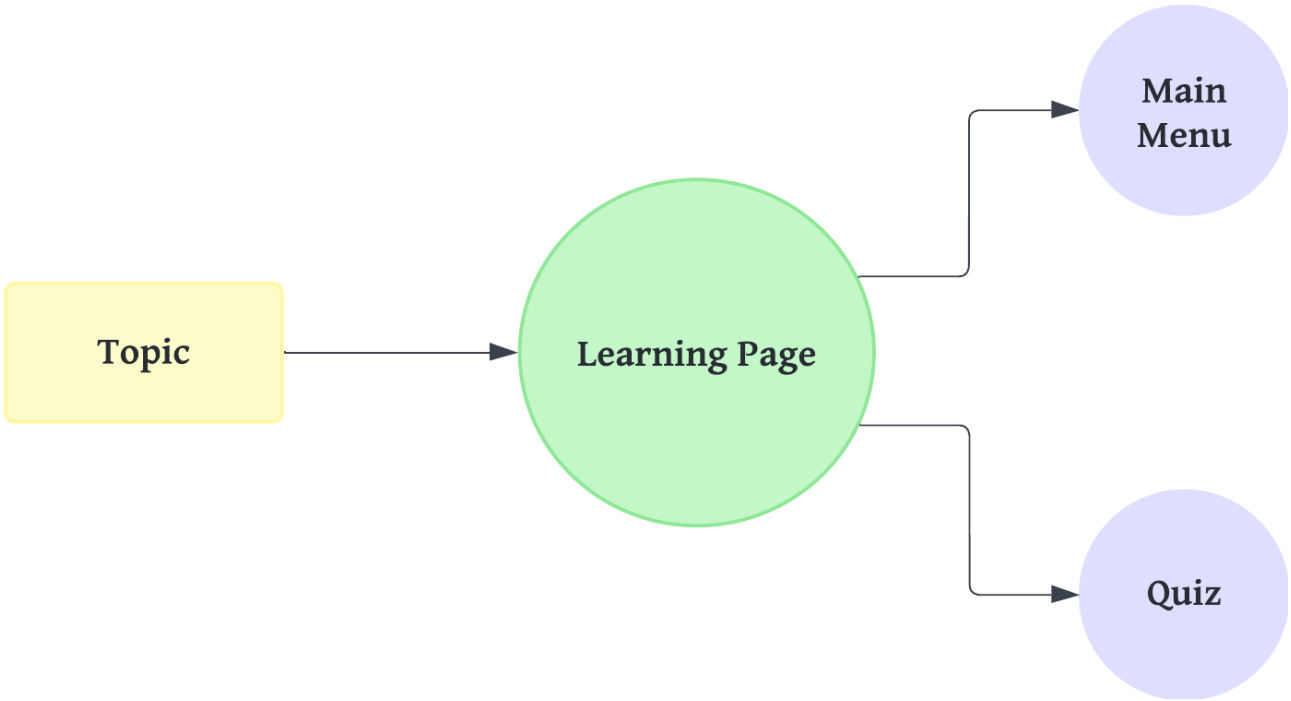

Figure 8: Learning Page Module

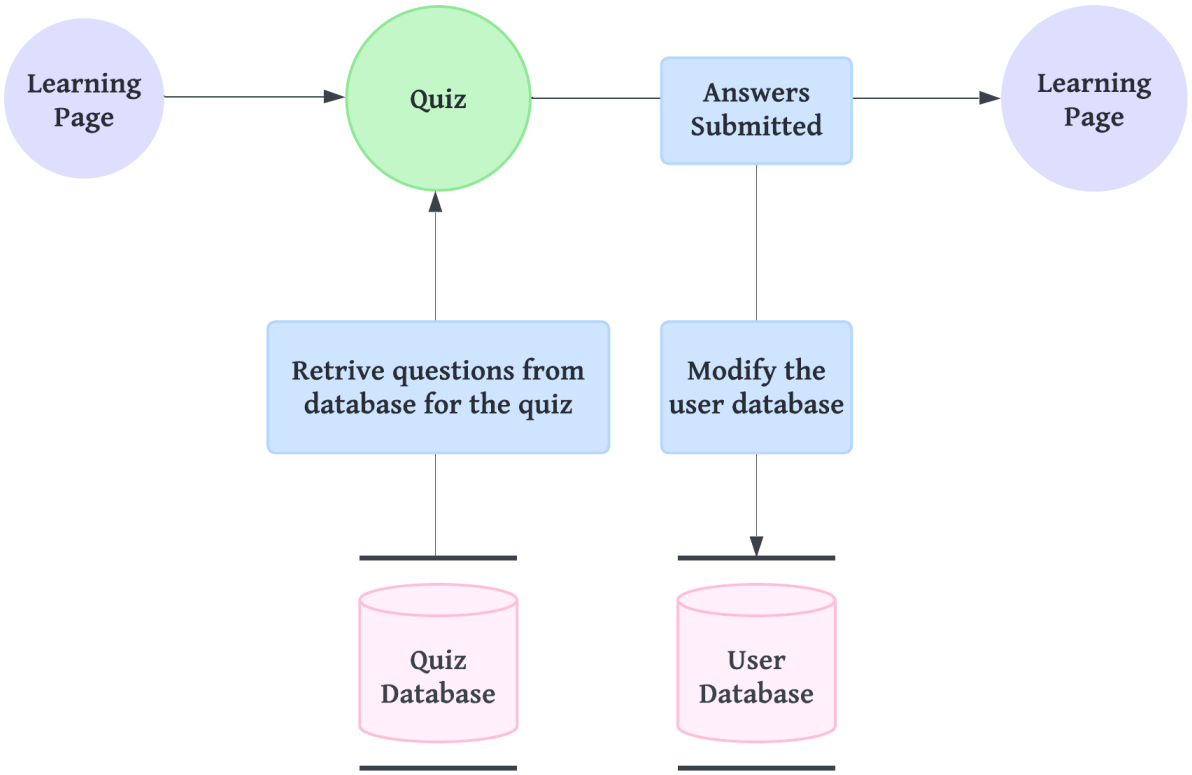

Figure 9: Quiz Module

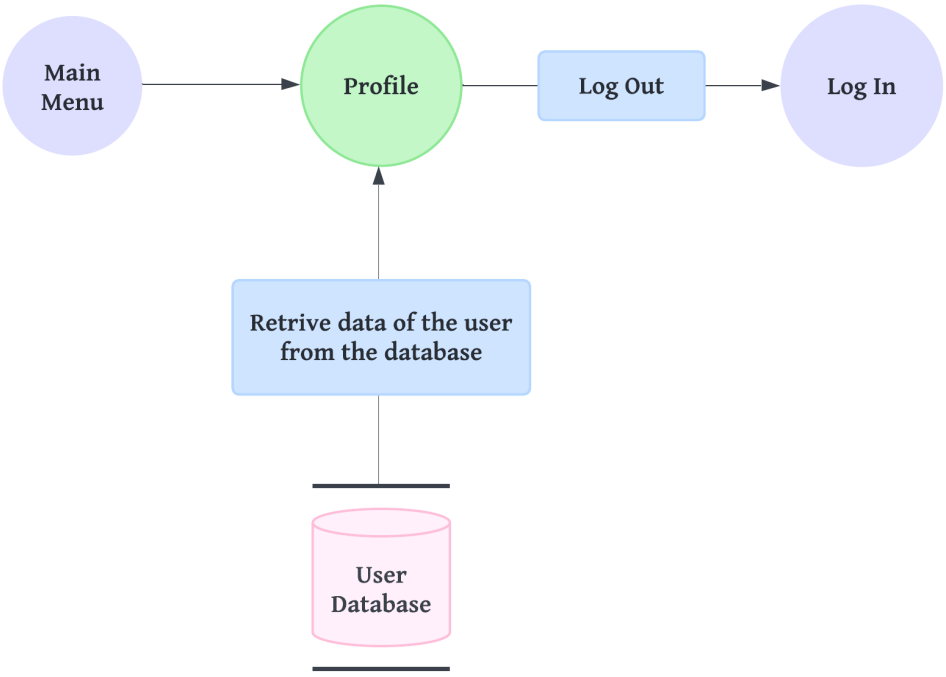

Figure 10: Profile Module

4.3 Basic Interface

A basic interface has been designed with the following:

- **Home Page:** The software is named "AlgoWizard". This page is the home page of the entire software. Upon clicking the "Get Started" button, the user will be taken to the Login Page.

Figure 11: Home Page

- **Login Page:** The user has to login to the software with username and password. If the user is new to the software, he/she can create an accound by clicking on "Sign up".

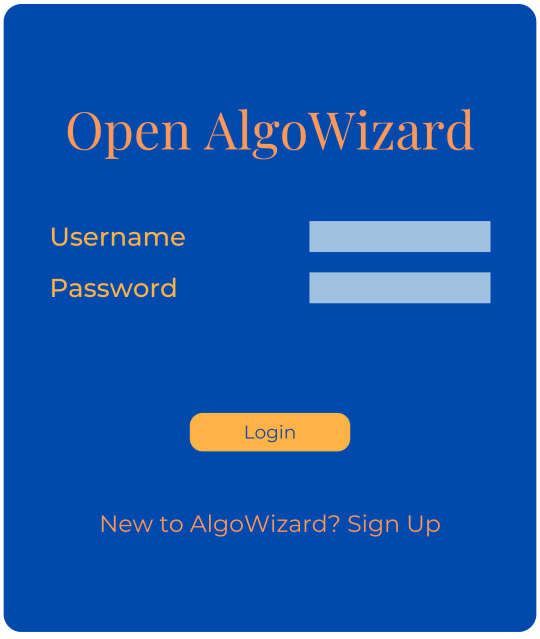

Figure 12: Login Page

- **Sign Up Page:** A new user can create an account in the software by setting up a username and password. If the user has an existing account, he/she can be redirected to the login page by clicking on the "Login" button.

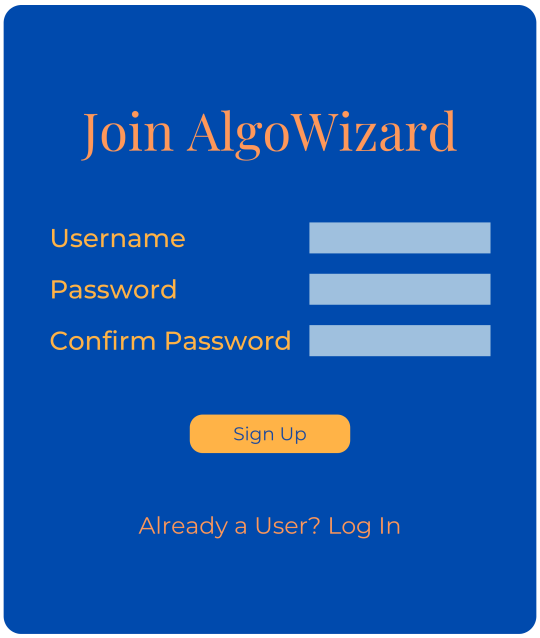

Figure 13: Sign Up Page

- **Main Menu:** The main menu is the starting point of the software after successful authentication. This is where the user lands upon authenticating. It gives the user two options i.e Data Structures and Algorithm. User can choose any one of them.

Figure 14: Main Menu Page

- **Sub Menu:** In the main menu, upon choosing an option, the text vanishes and it is replaced by the various topics available in the chosen option. This is the sub menu where the user is given further options to choose.

  The figure below shows the interface upon clicking on both Data Structures and Algorithms.

Figure 15: Sub Menu Page

- **Specific Topic Selection:** This interface shows up in the event of the user choosing 'Searching' or 'Sorting'. The software offers explanations of several kinds of 'Searching' and 'Sorting'. Thus, this interface is provided to allow the user to choose a specific kind of 'Searching' or 'Sorting'.

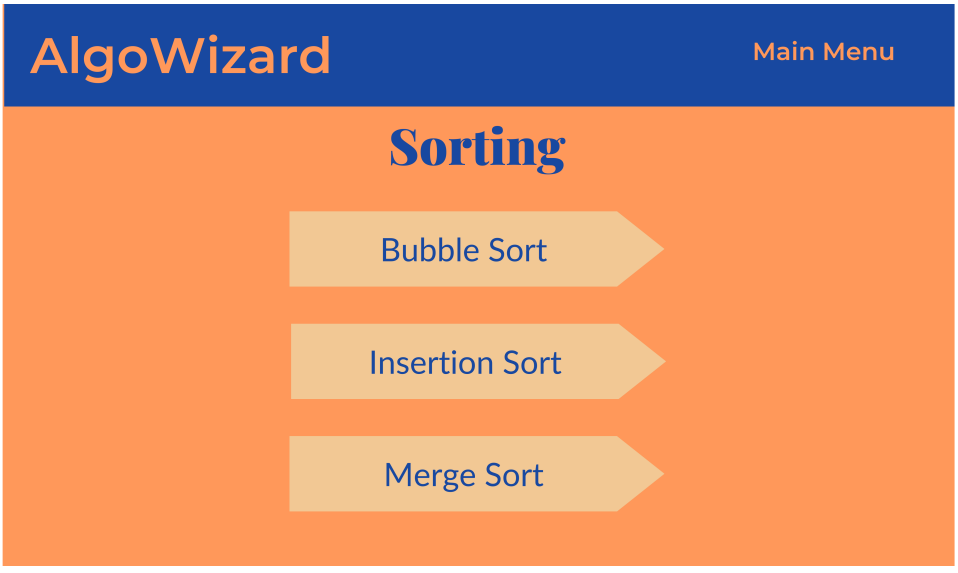

Figure 16: Specific Topic Selection in Sorting

- **Learning Page:** This can also be called the 'Leaf' of the software as this is the last page and there are no further pages that originate from this one. The learning page is where the explanation and visualization of the chosen topic are provided. Along with them, quizzes are also present at the end of the page to measure the level of understanding of the topic.

  This page can be sub-divided in to four parts

  – **Header:** This section has a button "Main Menu" which upon clicked takes the user to the Main Menu Page.

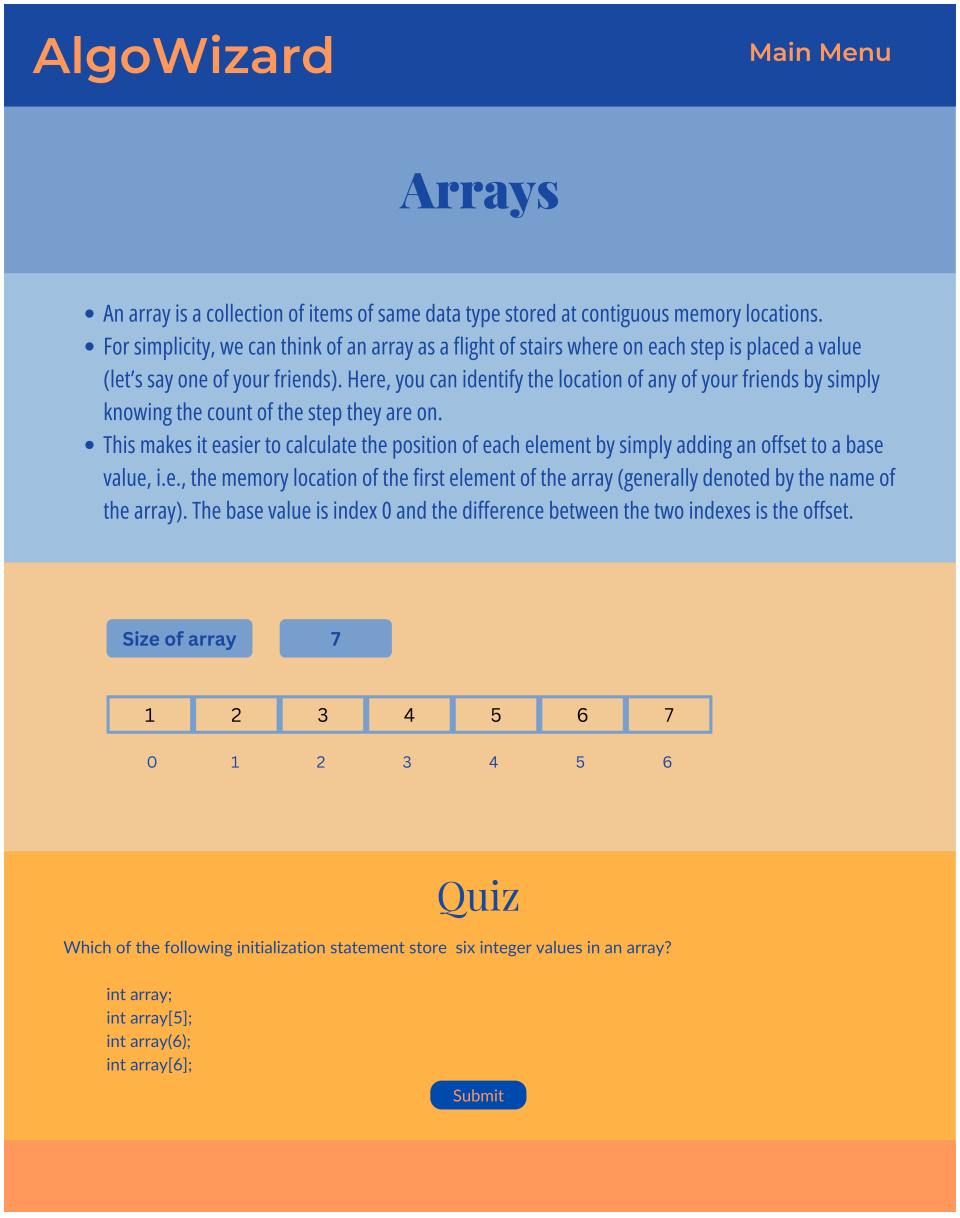

Figure 17: Learning Page of Arrays

  – **Explanation:** This is the textual explanation of the topic in discussion. It gives all the necessary information in simple language and also explains how to utilize the

visualization provided.

- **Visualization:** This is the interactive visualization of the topic in discussion. For instance, in case of Arrays, there will be a text-box to take in the size of the array and when the size is entered, a row containing the entered size of boxes shows up and the user can enter the elements in the array generated.
- **Quiz:** This contains some multiple choice questions which the user can answer and after answering, he/she can check their score by submitting the selected options. Correct and incorrect options will be informed.

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- **User Profile:** The user can see his/her profile where the details of the user along with the progress in each topic can be seen. There is also an option to log out of the software in the Profile Page.

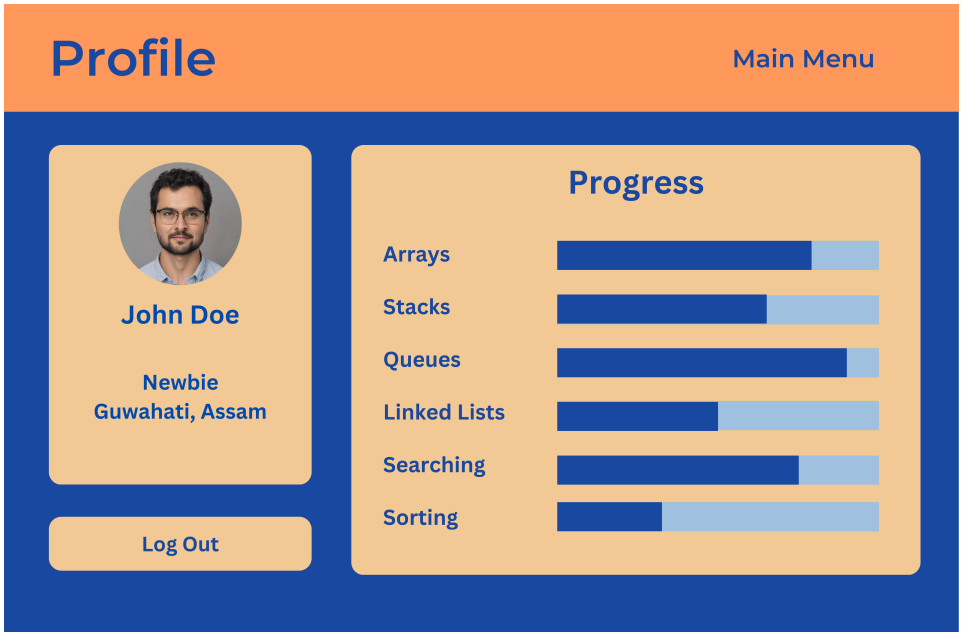

Figure 18: Profile Page

5 Further Improvements

The following section outlines proposed enhancements and future plans for the software designed to teach fundamental concepts of data structures. These additions aim to broaden the scope of topics covered, improve user engagement and interaction, and provide a better user learning experience.

- **More topics for learning**
  - Expand content to cover additional data structures and algorithms.
  - Include topics such as graphs, trees, heaps, tries, hash tables, etc with existing structure.

  - Provide detailed explanations, visualizations, and interactive quizzes for each new topic.

- **Features for Likes and Comments**
  - Introduce features like likes and comments to encourage user engagement.
  - Enable users to provide feedback, ask questions, and share insights.
  - Utilize feedback to identify popular content and improve the software.
- **Timed coding contests**
  - Introduce timed coding contests to enhance user engagement.
  - Structure challenges with coding problems related to data structures and algorithms.

6 Conclusion

By covering key topics through interactive learning modules, visuals, and quizzes, this software offers a dynamic and engaging learning experience. Furthermore, the addition of quizzes ensures that students can assess their understanding of the material in real-time, facilitating continuous learning and skill development.

Through its design, we aim to stimulate curiosity, encourage critical thinking, and facilitate continuous learning.
