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# Visulgorithm: Easy Conceptualization of Data Structures and Algorithms

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**ABSTRACT**: There are various Data Structure Algorithms that we use to find solutions to standard problems and to obtain an insight into how efficient it is to use each one of them. However, these algorithms can be complex and difficult to understand, differentiate and select an efficient algorithm. As a solution to this, visualizing these algorithms will aid in understanding them.

The working of various algorithms like path finding algorithms, tree based algorithms, sorting algorithms and searching algorithms can be demonstrated using examples to understand what happens at each stage in the processing of the algorithm. This system is very useful for Educational purposes to demonstrate while teaching and can also be used by researchers and coders to find the best algorithm to solve their problems. In recent time path finding algorithms are also used by Space rovers to navigate on foreign planets, they can be visualized to select the best path. The System uses Express Framework (Node JS), HTML, CSS, JavaScript and JQuery to create attractive visual animations which make the visualization more attractive and easy to understand.

**KEYWORDS**: Data Structure Algorithms, Visualization, Animation

## I. INTRODUCTION

The idea is to develop a web-based tool to visualize various Data Structure Algorithms using JSAV (JavaScript Algorithm Visualization Library) to capture the dynamics of algorithm execution in terms of transformation of data objects involved in turn allowing to differentiate between algorithms and choosing the most efficient one.

### A. MOTIVATION

This section summarizes the difficulties learners face while studying Data Structure Algorithms that served as a motivation for this project Study of Data Structure Algorithms is a crucial part of Computer Engineering. While surely being an essential subject in the coursework, it is also one of the toughest to understand and implement in labs.In order to be a good programmer it is important to be able to recognize and use the most efficient algorithm for a given problem statement. arises in this stage because evaluation of time complexities and step wise operation of each algorithm can be compared but is complex and the differences are not apparent through the theoretical pen and paper method of comparison. The problem faced by learners can be resolved by improvising on the teaching techniques and thereby aiding learners to understand better by visualization of the dynamics of each algorithm and comparing them, at each step, with other algorithms in real time for a given problem statement.

With the use of JSAV (JavaScript Algorithm Visualization Library) visual representation of the dynamics of an algorithm along with different levels of user interaction can be achieved and allows us to integrate audio-visuals to online learning content. Visualization of the algorithms ultimately contributes to better understanding of the subject by making the learning experience more comprehensive and interactive for the students.

### B. OBJECTIVES

- To visualize various algorithms related to various data structures to make it easy to understand complex algorithms
- To make it easier to differentiate algorithms and also select the best algorithm for the problem
- Deepen your understanding of various data structure algorithms

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## II. LITERATURE SURVEY

- ALGORITHM VISUALIZER AND CODING PLATFORM FOR REMOTE CLASSROOM LEARNING (ANIKET B. GHANDGE,BHAGYASHREE P. UDHANE ,HRITHIK R. YADAV,2021)[1]

  This paper was based on an application developed for students and teachers , to help in learning related to various Data Structure Algorithms.AlgoAssist provides complete animation of common Data Structure Algorithm along with a coding playground for getting hands-on practice. Also the student module contains a dashboard for continuous assessment of their performance. For various Data Structure Algorithm techniques each visualization has a set of buttons to carry out operations which consist of a play button to begin visualization, a pause button to pause the visualization, a reset array, a slider to manipulate the rate of the visualization and a code hint toggle button to view the leader-board and spot their modern role in the leader-board to get encouraged and feature a healthful opposition with the peers.

  The teacher module allows teachers to enroll students, view students' performance along with giving them assignments and evaluation processes. The application aims to connect students and teachers in one place and make the Data Structure Algorithm learning process quick and easy. Also the application has security features to avoid cheating.This paper gives a clear idea about building an visualizing application and the features it can include but it lacks a few major Data Structure Algorithms which are mainly Graph and Tree Based which can be added to further benefit the learning process.

- ALGORITHM VISUALIZATION: THE STATE OF THE FIELD (CLIFFORD A. SHAFFER,MATTHEW L. COOPER,ALEXANDER JOEL D.,MONIKA AKBAR,2016)[3]

  This paper includes the history of Algorithm Visualizers and the tools used. In addition to many hundreds of individual AVs created over the years, there have also been many systems created to support AV development. A significant amount of research has been devoted to understanding the pedagogical effectiveness of AVs.

  Algorithms and data structures form one cornerstone of an undergraduate computer science education. A technique for improving instruction in this critical area is to include algorithm and data structure visualizations and animations (hereafter referred to as "algorithm visualizations" or "AVs") into the curricu- lum. AVs have a long history in computer science education, dating from the 1981 video "Sorting out Sorting" by Ronald Baeker and the BALSA system [Brown and Sedgewick 1984]. Since then, hundreds of AVs have been imple- mented and provided free to educators, and scores of papers have been written about them [AlgoViz.org 2010]. Good AVs bring algorithms to life by graphi- cally representing their various states and animating the transitions between those states. They illustrate data structures in natural, abstract ways instead of focusing on memory addresses and function calls.

  A number of AV development systems have become well known within the CS educational community. We can divide their history into two parts: what came before the rise of Sun's Java programming language and widespread uptake of content delivered via the Internet, and what came after. See Saraiya [2002] and Wiggins [1998] for a more complete treatment of older or presently inaccessible systems. From this paper we understand that since the widespread use of Java, development seems to have moved away from AV authoring toolkits, and towards suites of "canned" AVs. PreJava systems often came packaged with pregenerated AVs, but allowed educators and even students the freedom to implement other AVs in a scripting language or by annotating a real program. Today's systems are frequently distributed as collections of AVs not tied to any operating system or environment.

## III. PROBLEM DEFINITION

To Visualize Various Data Structure Algorithms using JSAV (JavaScript Algorithm Visualization Library) and capture the dynamics of algorithm execution in terms of transformation of data objects involved which in turn allows to differentiate between algorithms and choose the most efficient one.

## IV. REQUIREMENT SPECIFICATION

**Functional Requirements**

1. Path Finding Algorithm :
   Visualize various algorithms to find the shortest path.
   Create Maze like Patterns to visualize the working of various path finding algorithms .
2. Tree Based Algorithm :

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Visualize working of various types of tree algorithms.
Insert , Delete Search a Node in a given tree.

3. Sorting Algorithm :
   Visualize working of various Sorting Algorithms.
   Visualizing the passes and traversal through animation.

**Non-Functional Requirements**

1. Usability : Very user-friendly and easy to use interface.
2. Availability : Available for use as long as a compatible browser and proper internet connectivity is used.
3. Reliability : System can visualize all possible test cases for all algorithms.
4. Performance : System quickly responds to user actions , carrying out the algorithm visualization without the user having to face any delay .

**Hardware Requirements**

i5 8th Gen RAM – 4GB

**Software Requirements**

Visual Studio Code
Express Framework including Node , HTML , CSS ,JavaScript , JQuery

## V. PROPOSED ARCHITECTURE

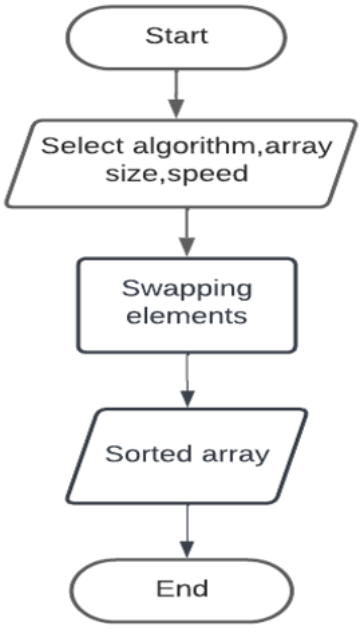


Fig 1 Block Diagram of Sorting Algorithm

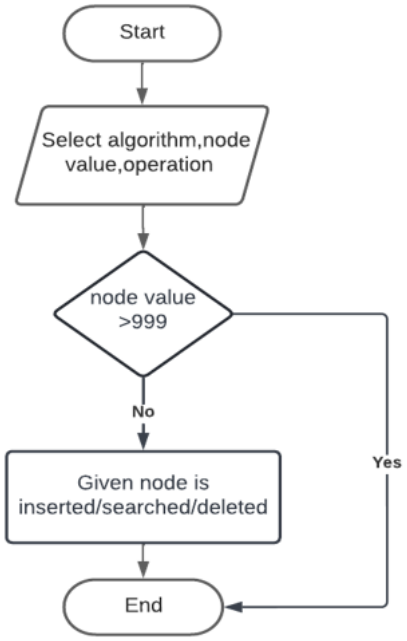


Fig.2. Block Diagram of Tree Based Algorithm

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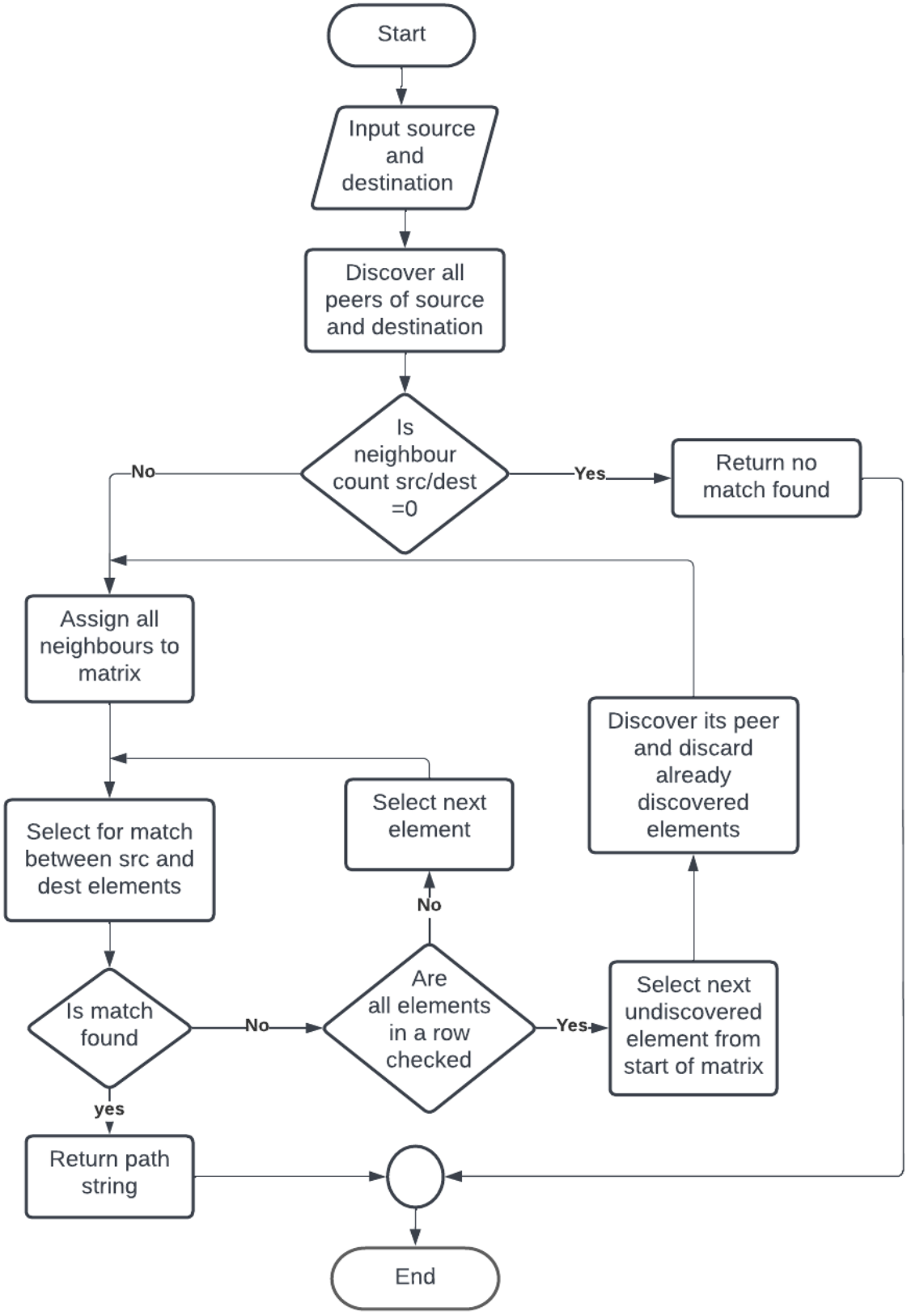


Fig.3. Block Diagram of Path Finding Algorithm

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## VI. METHODOLOGY

The user chooses among the following algorithms for the visualization:

1.Sorting Algorithms
2. Path Finding Algorithms
3. Tree Based Algorithm

The inputs for the selected algorithm are provided by the user to the system. The process of visualization starts by pressing the start button. Now, the system processes the selected Data structure algorithm and provides colorful visualization through animation like resizing/sorting of the bars in required order, coloring of the boxes and movement of nodes. The Buttons Pause and Resume are used to suspend and resume the process of visualization. This is a useful tool for all types of learners/scholars to easily understand the algorithm's implicit sequences.

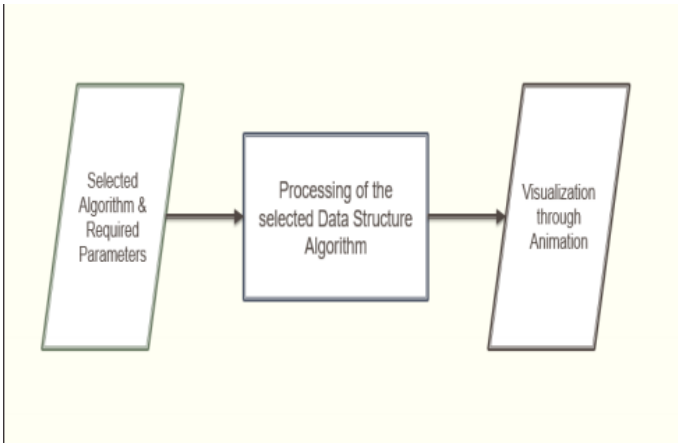


Fig. 4. Methodology of the System

## VII. OVERVIEW OF PROJECT MODULES

The project includes 3 modules. Following is the list of modules:

1. **Sorting Algorithms**: In this module, a new array can be generated. The user can choose the size of the array(insert size range here) and also the speed of the sorting. The various sorting algorithms available are Merge sort,Heap sort, Quick sort, Bubble sort and then by clicking on the Sort Button, the sorting can be started. For visual presentation the randomly generated numbers in the array are displayed via vertical or sticks of different heights or lengths, which need to be rearranged according to their sizes. Hence for the dataset the screen is divided in each pixel which is taken as an element in an array and then the array is shuffled using the shuffle(array) function.

2. **Path finding Algorithm**: Here, the display screen is divided into grids(1*1cm). The user is expected to input the source and destination. Then the user should select any one A* algorithm, Djikstra's algorithm, Bi-directional algorithm . The user can see the visited nodes/grids which are colored in light blue and purple color. The unvisited nodes remain in white color and finally the shortest path between the source and destination is highlighted using the yellow color. You can also add one bomb which makes that node to be mandatorily visited before reaching the destination. The system will also include a feature to create Mazes and solve them using various algorithms.

3. **Tree-based algorithm**: The user can insert,delete as well as search a node . The feature of replaying the animation of recent operations is also available.

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## VIII. USER INTERFACE

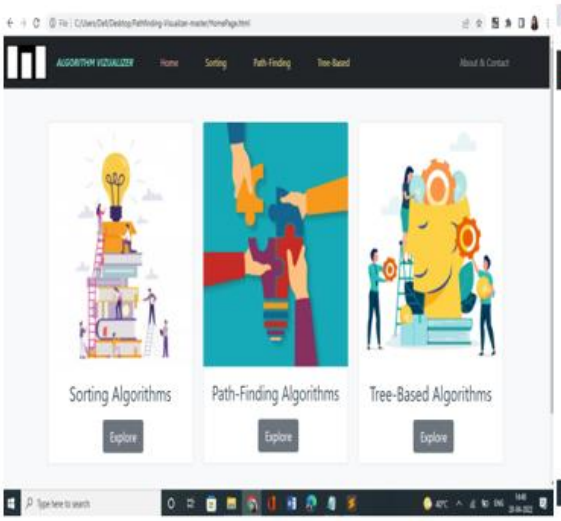


Fig. 5. Home Page

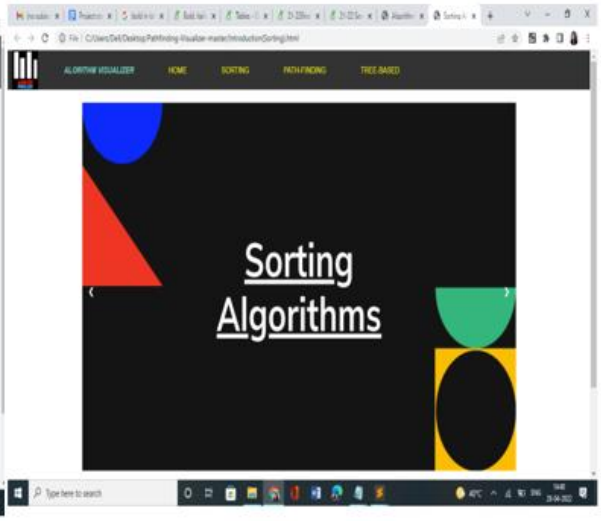


Fig.6. GUI of Sorting Algorithm

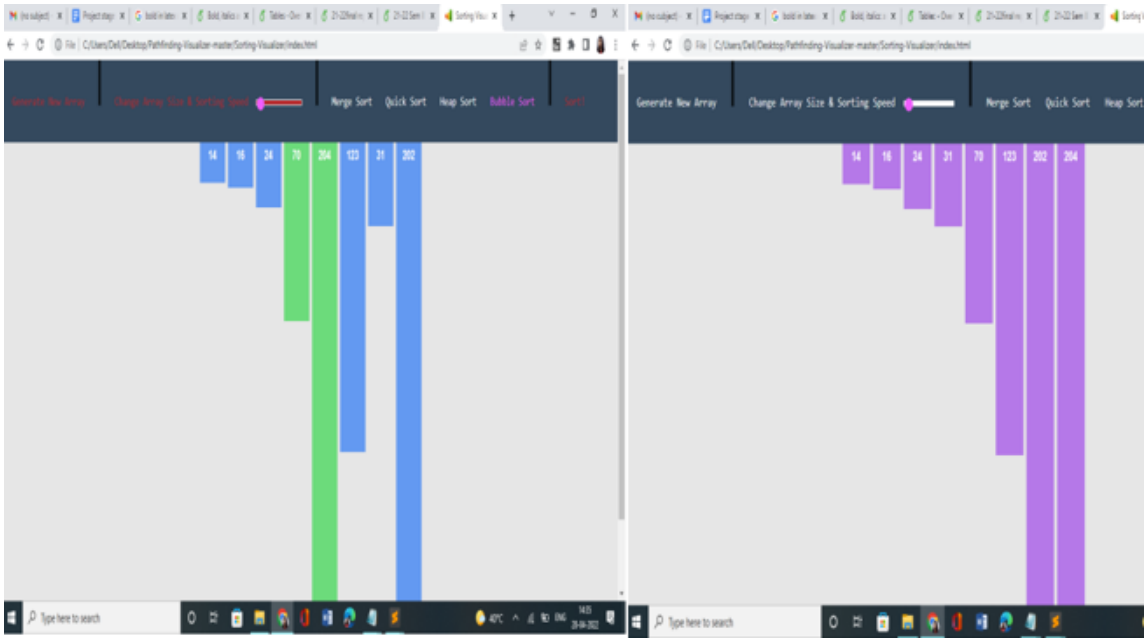


Fig.7. Sorting Algorithms

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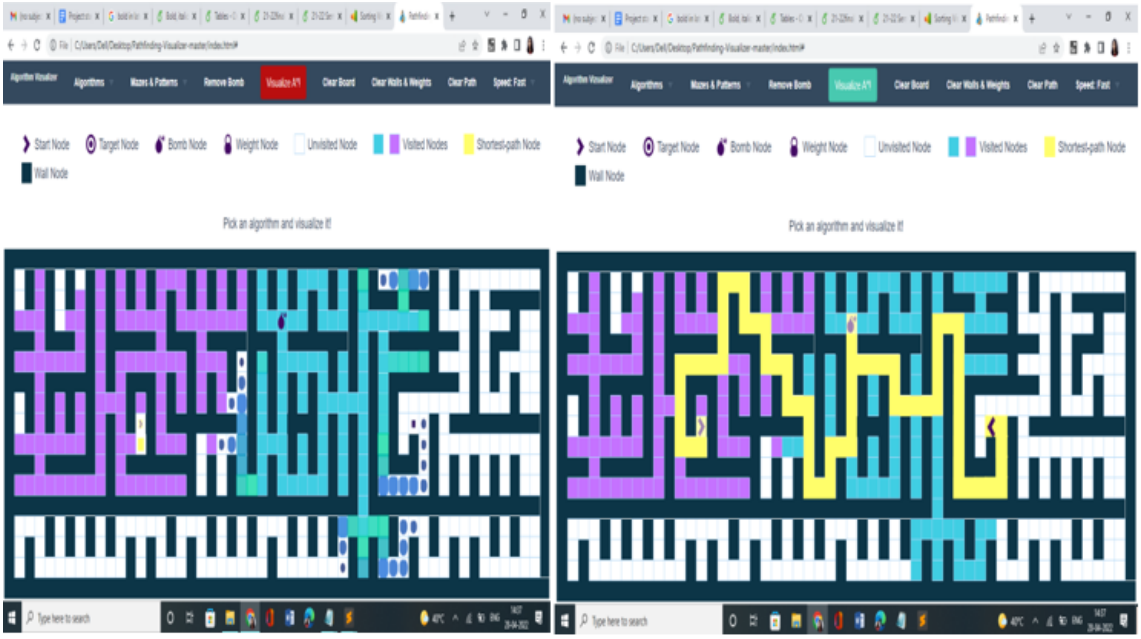


Fig.9. GUI of Path Finding Algorithm

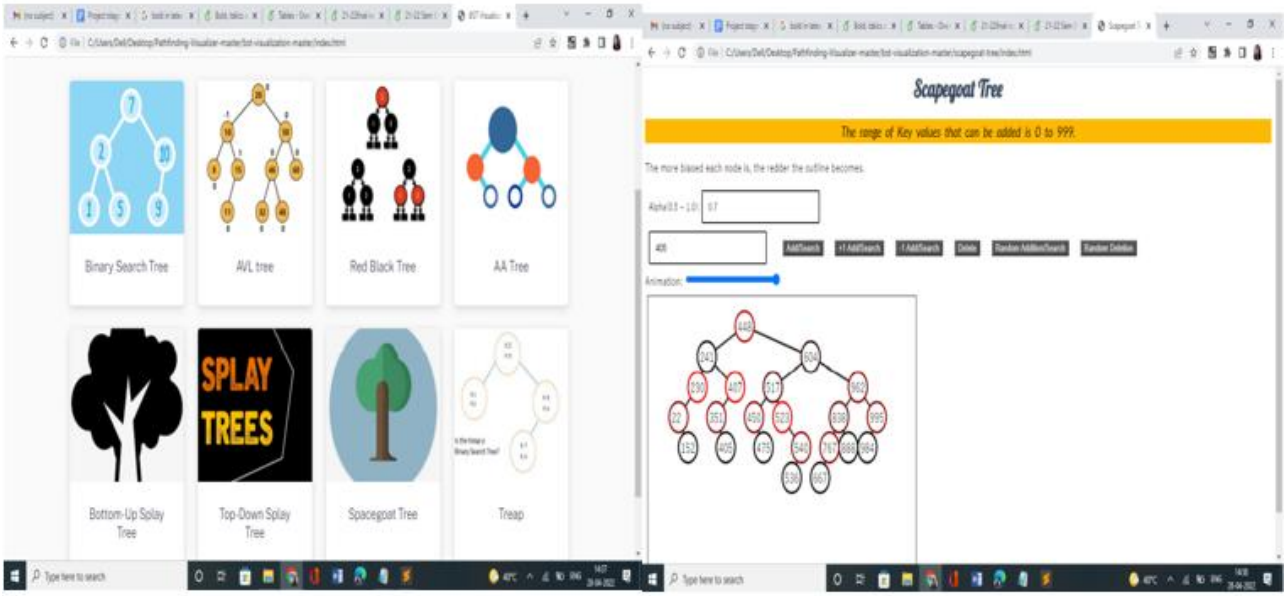


Fig.10. GUI Tree Base Algorithm

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## IX. CONCLUSION

According to our findings, algorithm visualization can be seen as a valuable tool used in addition to standard ways of education in the field of computer science and even as well as for non-technical branches for their better understanding. The proposed system provides the complete animation of a common Data Structure Algorithm. We aim to decrease the fear in the minds of students regarding Data Structure Algorithm and make it fun and engaging.

## X. FUTURE WORK

In the future we can attempt to visualize algorithms according to problem statements and also add learning Modules to test the learning of students. Still many more algorithms can be added like algorithms for Data Structures like Linked List and Queue. Then you can also try to visualize machine learning algorithms to help AI and ML enthusiasts.

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