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ALGORITHM VISUALIZATION

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ABSTRACT

Data structures prove to be an effective way of performing various operations related to data management including storing and arranging data along with its retrieval so that the data can be easily used and manipulated in the future as the need arises. There are various algorithms for various operations of data management. Often it becomes confusing to differentiate and remember algorithms performing similar tasks. Understanding the concepts and the flow of the algorithm, why iterations are necessary at certain times can be really demanding and stressful especially for a beginner who is not familiar with its terminologies. Here comes the need for visualization. Algorithm Visualization can aid better to learn data structures. These tools for visualizing algorithms demonstrate how the algorithm works in a visually appealing manner so that the data structure's implementation can be understood easily. When we learn a concept after visualizing it, we form its conceptual model in our mind which stays permanently thus making learning effective and fun. This forms a clear understanding of the underlying mechanics behind some confusing data structures thus building the foundation for the concepts of advanced methodologies and implementations. To make the process more interactive, we are presenting animated algorithm visualizations.

Keywords: Data Structure, Algorithm Visualizer.

I. INTRODUCTION

The rapidly developing technologies have influenced education greatly. Especially the pandemic has locked us inside our homes, everything starting from education to employment has gone digital. From traditional classrooms to digital classrooms, everything has evolved. Nowadays, various instructional websites offering online courses have grown dramatically. Web-based courses have become the new trend. Instructional websites dedicated to Algorithms on Data Structures can be easily found by using Search Engines. Data Structures and algorithms are basic concepts. But many students complain it being difficult to remember the various algorithms in data structures since abstract thinking is required in order to comprehend it and grasp the concept. One way for improving instruction in this area is to include algorithm and data structure visualizations in the form of animations. A visualization tool of data structures like arrays, stacks, queues, linked lists, trees and graphs is necessary for students to experiment with thus, allowing students to see the actual process of an element being inserted into or deleted from different data structures, how a tree is traversed in different orders (pre-order, in-order, post-order, level-order) etc. Good Algorithmic Visualizers have the capability to bring algorithms to life by illustrating data structures in natural, abstract ways and animating their various states. We are presenting a data structure visualization tool designed to animate standard manipulations of several common data structures. The platform is intended for use by students to thorough themselves with the subject as well as instructors who wish to enhance their lectures with an animated interface.

II. LITERATURE SURVEY

We surveyed papers aimed to examine the effect of instruction using this method in which students constructed visualizations on their programming achievement and their attitudes toward computer programming, exploring how such tools support their learning enquiring their self-reported experiences in the course where visualizations related to sorting were constructed. The resulting serial of key frames featuring major data structure transformation are available for review and analysis. All these combines to fill the gap between the abstract data representation and a dynamic learning-by coding process. It has been observed that Algorithm Visualisation (AV) tools help learners to learn the actual working of algorithms and data structures. Most of

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them cover basic data structure algorithms like sequential data structures such as arrays, stacks, queues, linked lists, sorting and searching algorithms. Some of the algorithm visualizers are in the format of packages that allow students or instructors to implement independently in any scripting language. Visualizations that can be directly accessed from web pages will naturally get more attention from potential users, since they do not have to go through the additional step of downloading and unpacking a visualization system. Most of the visualization platforms that we have encountered either does not have a user-friendly interface, or are a bit complicated to understand. Mostly these platforms lack interactive multimedia. The user does not actively play any role in the majority of existing platforms, being mere observers with no control over input values or the pace of observing the animations.

III. METHODOLOGY

The implementation of algorithms in a visually appealing animated format is developed using the various available animation libraries in JavaScript. A user friendly and interactive website is created to which all the algorithm visualization models are exported. A backend database connectivity is also given to the system to keep a record of the existing users and new ones along with providing them the feature of tracking their progress in their respective accounts. Some of the general animation controls implemented in the system are – Skip back/forward, Step back/forward, Play/Pause, Change canvas size.

IV. PROBLEM DEFINITION

The most proven method to learn any algorithm is visualizing them. Especially for subjects like Data Structures, where algorithms form its basis, it is not practical to memorize them theoretically without comprehending them practically. It becomes quite confusing and tedious to visualize them on our own since abstract thinking plays a crucial role in forming its conceptual model in our mind. Thus, a need for a tool for visualizing the data structure algorithms interactively so that the student can experiment and learn as need arises.

V. PROPOSED SOLUTION

Seeing them in action would be an effective way to understand the complex data structures. The proposed system has various interactive animations for a variety of algorithms. Our visualization tool is written in JavaScript using the HTML5 canvas element, and it can be accessed via any modern browser. The visualizations are meant to be fairly self- explanatory. Our proposed system can be used to enhance the traditional classroom education and textbook for Data Structures and Basic Geometric Algorithms courses.

VI. AIM & OBJECTIVES

When we learn various algorithms whether it be from data structures or any basic geometry, most of the tools explain them without providing any details about how they are actually represented and their behaviour in a real program. This results in the students knowing only how the data structures work theoretically and may not be able to use them practically for solving a programming or any other task which in turn further enlarges the gap between students' theoretical and practical ability, adversely affecting the students' problem-solving skill. The main objective of this visualization platform is to provide a means for learning the concepts requiring abstract thinking in a more effective as well as enjoyable way which will engage the learners and drive away any boredom. The purpose is to build a user friendly interface where the students can experiment and learn data structures. A system providing visualizations for some basic geometric algorithms and widely used data structures such as array, stack, queue, tree, heap, graph, etc. along with the animation of common operations associated with the data structures, such as inserting an element into and deleting an element from array, stack, and queue. The main aim is to mitigate the gap between students' theoretical and practical ability related to data structures via this platform to provide a systematic approach for learning and conceptualizing implementation of data structures. JavaScript will be used for creating animated implementations of algorithms which will be given a database connectivity. Thus, our main objective is to help the analysis of concepts of basic algorithms to those eager to learn.

VII. PROPOSED SYSTEM

Here in the proposed system, the user can select whichever model or algorithm he/she wants to study. On its selection according to the algorithm, a graph or its visual representation will be generated. On starting the animation, a systematic and detailed animation will be shown so as to how the algorithm works for a better

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understanding. The animation speed can be controlled according to the user's pace. After learning, the user can also test their knowledge by trying to predict the working before playing the animation.

VIII. ALGORITHM AND PROCESS DESIGN

1. Graph Generation Algorithm: In order for the system to provide a better educational experience and to give users the ability to test themselves on the same algorithm multiple times, it is necessary to use randomly generated graphs. It changes the values and randomly generates different graphs every time the user refreshes the tab.

2. Basic Data Structure Algorithms like arrays, linked lists, stacks, queues, sorting algorithms, searching algorithms, graph algorithms, geometric algorithms.

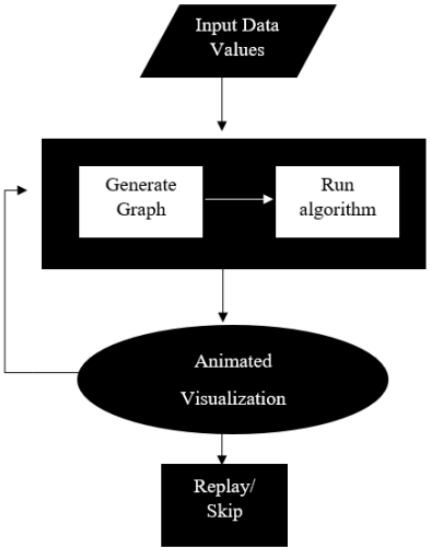

Fig 1: Algorithm

Use Case Diagram and Activity Diagram

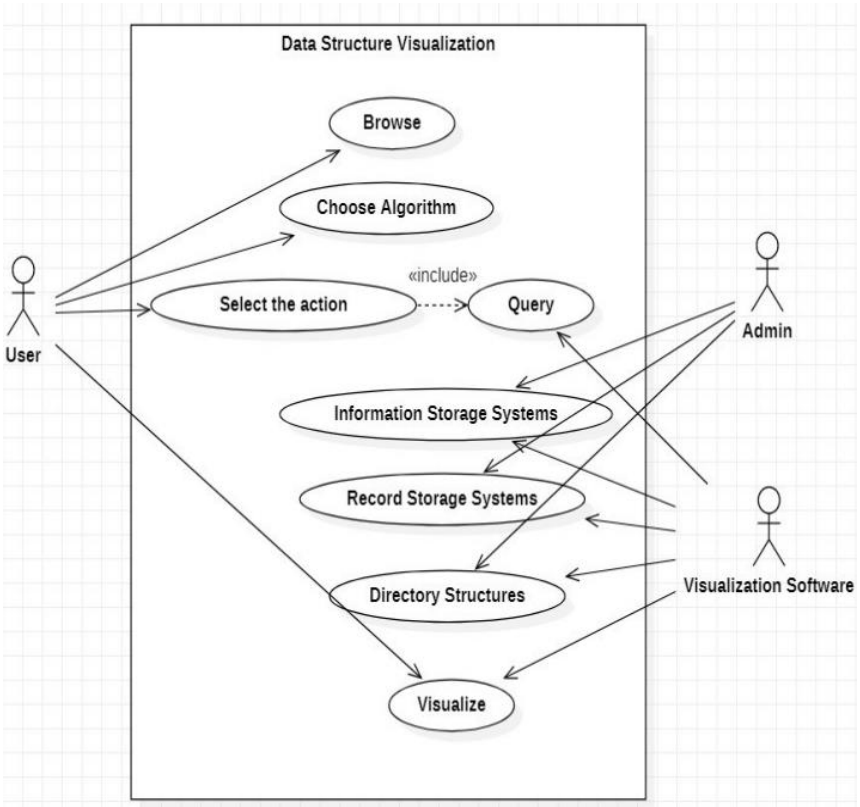

Fig 2: Use Case Diagram

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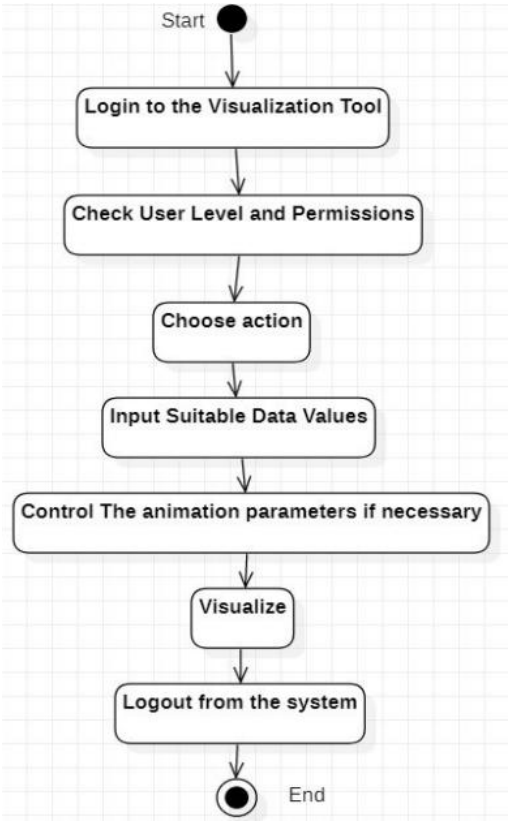

Fig 3: Activity Diagram for User

IX. RESULTS

The user can sign up themselves to access the algorithms and can also give suggestions to make any amendments if necessary.

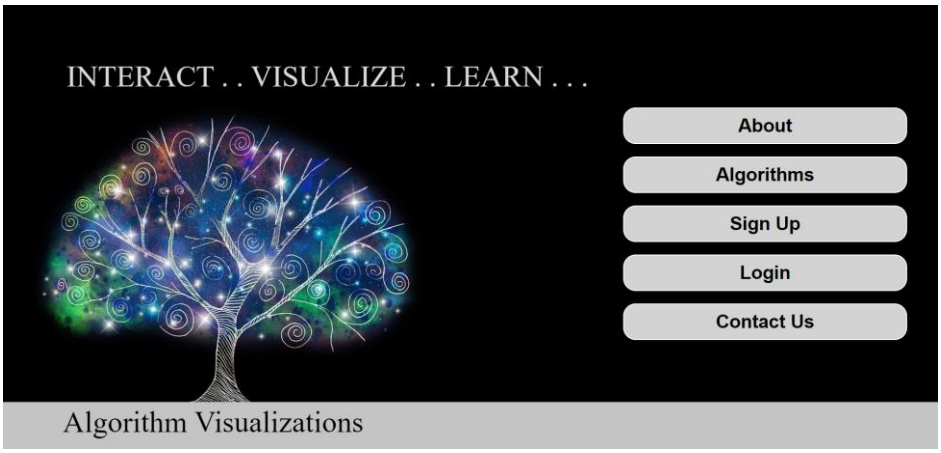

Fig 4: Home Page

Fig 5: About Page

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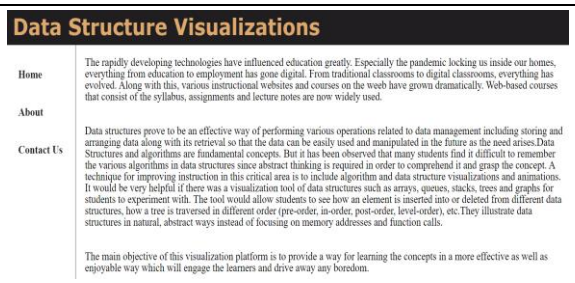

Fig 6: Contact Us Page

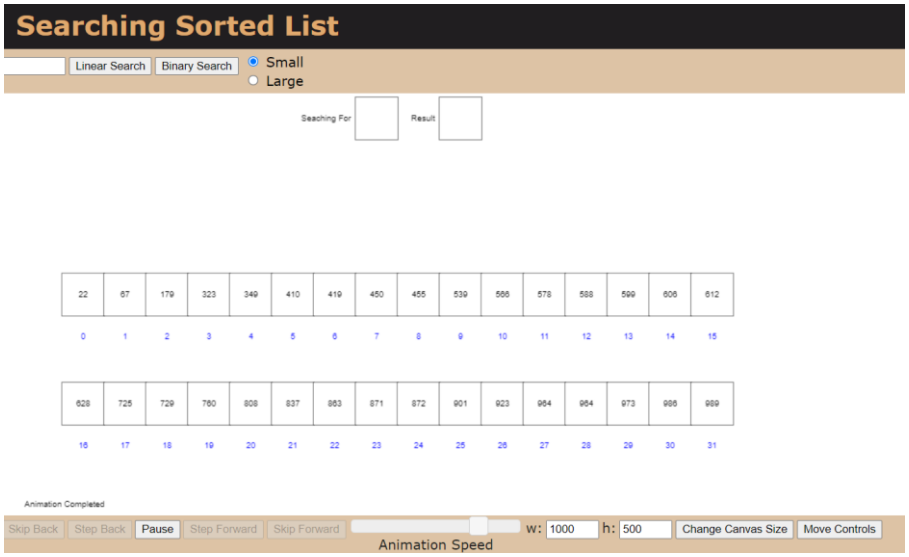

Fig 7: Algorithm Visualizations

X. CONCLUSION

Some features implemented include a feedback system enabling the user to contact us if there exist any queries or even suggestions. While learning from the visualizations the learner can input their own data and see the outcome animated. So, they can experiment with various self-generated examples. They can also control the animation speed along with the options of rewinding, fast forwarding or skipping a particular iteration. Some of the general animation controls implemented in the system are - Skip Back/Forward, Step back/forward, Play/Pause Toggle, Animation Speed (in the form of slider) & Change Canvas Size (to change the width / height of the display area).

XI. FUTURE SCOPE

A visualization tool for visualizing some basic geometric algorithms along with data structure algorithms and operations associated with them has been presented. This tool provides an easy way to play and learn data structure concepts with its user-friendly and self-explanatory interface. In this system, only some commonly used and basic algorithms are implemented like arrays, queues, stacks, linked lists, linear and binary search tree, various sorting methods etc. Its scope can be extended by implementing more complex algorithms in the software. It can also be categorized for a more systematic interface. Developing and implementing a mechanism for the software package to recognize the user- defined observable data structures, and leave the implementation to the user is yet another way to extend its current scope, allowing users to use their own observable data structures, thus adding more flexibility to the software.

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