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Visual Rendering of Path Finding Algorithm

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Abstract: Algorithm visualization has been a high topic in Computer science education for years, but it did not make its way through Educational Institutions as the main educational tool. The field of Visualization is getting mature. Many Problems are getting solved Using Visualization. The present paper identifies two key circumstances that an algorithm visualization must fulfil to be successful: general availability of used software, and visualization of why an algorithm solves the problem rather than what it is doing. One possible method of "why" algorithm visualization is using algorithm unvarying rather than showing the data conversion only. Invariants are known in Program faultlessness. In order to make good choices, an understanding of the purpose and meaning of visualization is needed. Especially, the main goal of the thesis was to create a program that would serve as a tool for understanding how most known algorithms work. There was an attempt to make the best possible user experience. The demonstration software is made in a user-friendly and easy-to-use style. It mainly aims to simplify and deepen the understanding of algorithms operation. Within this paper, we discuss the possibility of enriching the standard methods of teaching algorithms, with the algorithm visualizations. To gain maximal benefit from learning you can try each sorting algorithm on your data. The study consisted of a demonstration and survey that asked the students questions that may show improvement when understanding algorithms.

Index: Path-finding, Algorithm, Visualization

I. INTRODUCTION

Algorithm is an integral part of computers and programming. It provides consistency in solving similar tasks with a predictable and desirable outcome. Among algorithms, search algorithms are regarded as the gateway to the world of algorithms in programming.

In this paper we want to give a contribution to the discussion on the status and possible directions of our field. Rather than to pinpoint specific topics and activities, our aim is to detect overall patterns, and to find a way to understand and qualify visualization in general. This is an ambitious and vague plan, although the basic ground for this is highly practical. Evident by their definition, they are used to search data set with similar properties. Visualization itself is an ambiguous term. It can refer to the research discipline, to a technology, to a specific technique, or to the visual result. If visualization is considered as a technology, i.e., as a collection of methods, techniques, and tools developed and applied to satisfy a need, then standard measures apply: Visualization has to be effective and efficient. In other words, visualization should do what it is supposed to do,

and has to do this using a minimal amount of resources. One immediate and obvious implication is that we cannot judge visualization on its own, but have to take into account the context in which it is used. There are various types of so algorithm search with their distinct implementations and strategies. They are often not as easy to understand and absorb. A possible contributing factor can be the lack of visualization of the process and steps each one takes to accomplish the task of searching. Thus, the objective of this thesis was to create a web application as a visualization tool for Algorithms like A-Star Algorithm, BFS, DFS, Dijkstra's Algorithm, etc. This web application also visualizes Minimum Spanning Tree using Prim's algorithm and Topological sorting using Kahn's algorithm.

Visualization of data makes it possible for researchers, analysts, engineers, and the audience i.e. users in general to obtain insight into these data in an efficient and effective way, thanks to the unique capabilities of the human visual system, which enables us to detect interesting features and patterns in short time. The result was a web application built using HTML, CSS, and JavaScript along with its libraries & frameworks The application UI was able to visualize the Algorithm process using animation. Many algorithm animations had appeared, mostly for simple problems like primary tree data structures and sorting. There were even attempts to robotize development of animated algorithms and algorithm visualization. Another guidance was to develop tools that would allow learners to prepare their own animations comfortably. An algorithm animation is usually enforced by running the algorithm slowly or in steps, and simply reorganize the visual portrayal of the data in the screen. A person who knows and understands the algorithm in question can see how the algorithm progresses, but a learner user just sees visual objects moving and changing their shapes and colours, but finding out why the movie runs in that way is usually too difficult for him or her. Visualization is the process of graphically or pictorially representing objects, concepts, or processes. Visualization is attention-grabbing, and generally more efficient than the verbal or numerical presentation of the same information or data in terms of understandability and user-friendliness. There are various trial & error-based approaches available but all of them lack the visuals of how an algorithm traces the path. In this project we plan to help the end-user visualise the path between two points and how it is implemented by the chosen algorithms, thus being able to pick the best one possible. By making it visual and dynamic i.e. letting users be in control of where the obstacles are placed and which algorithm is being visualised, we make learning and understanding the logic behind the code easy & faster than just reading it. Graphical representation of data helps in extracting, abstracting, and presenting meaningful, pertinent information from large volumes of complex data. Visual demonstrations and interactive visualization tools can be used effectively to convey complex ideas.

I.1 Background

If we use 1987 as the year where visualization started, our discipline celebrates this year its 36th anniversary. In the Netherlands, at this age a person is considered mature. Many things have changed since 1987. Graphics hardware developments are amazing, as well as the large amount of techniques that have been developed to visualize data in a variety of ways.

There are signals that there is a need to reconsider visualization. First of all, there seems to be a growing gap between the research community and its prospective users. Few, if no attendants at the IEEE Visualization conference are prospective users looking for new ways to visualize their data and solve their problems. Secondly, the community itself is getting both more specialized and critical, judging from my experience as paper co-chair for IEEE Visualization 2003 and 2004. In the early nineties, the field lay fallow, and it was relatively easy to come up with new ideas. The proceedings in the early nineties show a great diversity. Nowadays the field is getting more specialized, submitted work consists often of incremental results. This could signal that our field is getting mature. On the other hand, it is not always clear that these incremental contributions have merit, and reviewers are getting more and more critical. Thirdly, some big problems have

been solved more or less. For volume rendering of medical data sophisticated industrial packages that satisfy the needs of many users are available.

Algorithm Visualizer (also referred as algorithmic animation) uses dynamic graphics to see computation of a given algorithmic program. First makes an attempt to robustness of algorithms date to mid-80's (Brown, 1988; Brown and Sedgewick, 1985), and also the golden age of algorithmic visualization was around the year 2000, when outstanding software tools for a dynamic algorithmic visualization (e.g., the language Java and its graphic libraries) and sufficiently powerful hardware were already available on the market. It had been expected that algorithmic visualization would replace the way algorithms are taught.

Theoretical Background:

This section introduces the theoretical backgrounds of the various aspects that are part of the thesis in detail. The topics include algorithm, visualization with their definition, history, and scope.

Algorithm:

Algorithms can be defined as a set of steps to accomplish a given task. Its purpose is to make it easier to replicate doing the task again and be efficient and accurate to the same degree. The term 'Algorithm' is derived from the name of 9th-century Persian scientist, astronomer, and mathematician Abdullah Muhammad bin Musa al-Khwarizmi who is also regarded as 'The father of Algebra'.

Algorithms can be found everywhere in day-to-day life. The primitive form of algorithm began with calculating and at present, it is being used in complex study and operations such as artificial intelligence, computer processing, gaming, molecular biology, and various other scientific research areas. It can be as simple as steps to turn on and off a light switch to any complex mathematical or computational operations. It is used primarily for calculation, data processing, and automated reasoning. The importance of algorithms arises once quality and efficiency are key factors to be considered while accomplishing any task. The opposite of following an algorithmic process is performing the same task, each time in a unique manner. This introduces unreliability, inefficiency and increases time, energy, cost, and many other factors. Thus, the use of algorithms helps to eliminate these hurdles, brings consistency, efficiency, and quality which is visible as the result.

Algorithm is related to function and sometimes they are even used interchangeably but still, they are not the same. While an algorithm is a set of ideas or an abstract concept that elaborates on how to solve a problem, functions are the actual implementation of the algorithm which can be used to solve them. Hence, a function can be an implementation of a whole algorithm or a single or multiple steps of an algorithm.

Visualization:

Visualization is a visual representation of an idea, story, data, etc. On a simplified note, using a visual clue to describe a piece of information is also Visualization. The visualized information or entity doesn't need to be a real-life or physical object, it can an abstract idea such as feelings, concepts, imagination, or just a belief. Letters, numbers, statues, symbols, arts such as paintings, sketches, murals, digital graphics, movies, etc. are means of visualization that are used to convey an idea of information. Any information that is visualized pleasingly and informatively has a greater potential of communicating the core message much easier and faster.

II. LITERATURE SURVEY

1] **Paper Name**: THE VALUE OF VISUALIZATION

Author: Jarke J. van Wijk

The field of Visualization is getting mature. Many problems have been solved, and new directions are sought for. In order to make good choices, an understanding of the purpose and meaning of visualization is needed. Especially, it would be nice if we could assess what a good visualization is. In this paper an attempt is made to determine the value of visualization. A technological viewpoint is adopted, where the value of visualization is measured based on effectiveness and efficiency. An economic model of visualization is presented, and benefits and costs are established. Next, consequences for and limitations of visualization are discussed (including the use of alternative methods, high initial costs, subjectiveness, and the role of interaction), as well as examples of the use of the model for the judgement of existing classes of methods and understanding why they are or are not used in practice. Furthermore, two alternative views on visualization are presented and discussed: viewing visualization as an art or as a scientific discipline. Implications and future directions are identified.

2] **Paper Name**: SORTING ALGORITHM VISUALIZATION

Author: Bikram Karki

The goal and main objective of the thesis were to bring sorting algorithms and visualization together. The concept of sorting algorithm mostly expressed through codes and syntax was still abstract. Thus, this thesis was an attempt to eliminate that by creating a tool that can visualize the process and steps of sorting algorithms. Visualization is a form of expression; it can take numerous forms to convey the idea, yet it always provides a new outlook if it is implemented properly. This thesis report can be taken as a visualization of the objective and idea of the thesis in the form of report writing with letters, figures, and tables. This thesis project was successful in delivering the idea of visualization of sorting algorithm through a web application and providing a separate look into the algorithm apart from lines of code and syntaxes. Algorithms are an integral part of programming and computer science. Visualization is the means to communicate. Those abstract ideas of algorithms can attract more people to learn and understand them if they are visualized in more interactive ways.

3] **Paper Name**: ALGORITHMS VISUALIZER APPLICATION

Author: Aditya, Shipra Srivastava, Gulshan Gupta, Bilal Ibrahim, Jatin Kumar

Algorithm visualization has been high topic in CS education for years, but it did not make its way to university lecture halls as the main educational tool. The present paper identifies two key conditions that an algorithm visualization must satisfy to be successful: general availability of used software, and visualization of why an algorithm solves the problem rather than what it is doing. One possible method of "why" algorithm visualization is using algorithm invariants rather than showing the data transformations only. Invariants are known in Program Correctness Theory and Software Verification and many researchers believe that knowledge of invariants is essentially equivalent to understanding the algorithm. Algorithm invariant visualizing leads to codes that are computationally very demanding, and powerful software tools require downloading/installing compilers and/or runtime machines, which limits the scope of users.

4] **Paper Name**: VISUALIZATION OF ALGORITHMS

Author: Mykhailo Klunko

As the main goal of this bachelor thesis, there was created the teaching support application which visualizes the most known sorting algorithms. The application allows stepping forward and backward through each represented algorithm. User may run sorting on a random or custom array. During the demonstration run, the application visualizes pseudocode and current information about some variables. I tried to create high-quality software with a user-friendly and easy-to-use interface, which could be used by lecturers, tutors, and students. Possible next improvement of the applications is extension it by other algorithms. The first part of the thesis

text is more theoretical. It tells about algorithms in general and the algorithms represented in the application. The second part is focused on the application itself.

5] **Paper Name**: VISUALIZING SORTING ALGORITHMS

Author: Brian J. Faria

Through much time and effort, They have successfully created a working web based animation tool for visualizing the following sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, and Merge/Insertion Sort. Even with its memory overhead, it received overall positive feedback from the students who explored it. They are not surprised that there was not a significant difference in learning the material, which reflects what I found in my previous research. There remains, however, a strong mindset to research and create animations like these to improve learning in the classroom, which they agree with completely. Learning how to code a web platform was challenging.

III. NOTABLE ALGORITHMS FOR VISUALISING ALGORITHMS

1] **A* Algorithm**:

The A* search algorithm is generally regarded as the de facto standard in game pathfinding. It was first described in 1968 by Peter Hart, Nils Nilsson, and Bertram Raphael. For every node in the graph, A* maintains three values: f(x), g(x), and h(x). g(x) is the distance, or cost, from the initial node to the node currently being examined. h(x) is an estimate or heuristic distance from the node being examined to the target.

In pseudocode

Step1: Place the starting node in the OPEN list.

Step 2: Check if the OPEN list is empty or not, if the list is empty then return failure and stops.

Step 3: Select the node from the OPEN list which has the smallest value of evaluation function (g+h), if node n is goal node, then return success and stop, otherwise.

Step 4: Expand node n and generate all of its successors, and put n into the closed list. For each successor n', check whether n' is already in the OPEN or CLOSED list, if not then compute evaluation function for n' and place into Open list.

Step 5: Else if node n' is already in OPEN and CLOSED, then it should be attached to the back pointer which reflects the lowest g(n') value.

Step 6: Return to Step 2

2] **Breadth-First Search (BFS) Algorithm**:

Breadth-first search is a graph traversal algorithm that starts traversing the graph from root node and explores all the neighbouring nodes. Then, it selects the nearest node and explores all the unexplored nodes. The algorithm follows the same process for each of the nearest nodes until it finds the goal.

In pseudocode:

Step 1: SET STATUS = 1 (ready state) for each node in G

Step 2: Enqueue the starting node A and set its STATUS = 2 (waiting state)

Step 3: Repeat Steps 4 and 5 until QUEUE is empty

Step 4: Dequeue a node N. Process it and set its STATUS = 3 (processed state).

Step 5: Enqueue all the neighbours of N that are in the ready state (whose STATUS = 1) and set their STATUS = 2 (waiting state)

Step 6: EXIT

3] **Depth First Search (DFS) Algorithm**:

Depth-first search (DFS) algorithm starts with the initial node of the graph G and then goes deeper and deeper until we find the goal node or the node which has no children. The algorithm then backtracks from the dead-end towards the most recent node that is yet to be completely unexplored.

In pseudocode:

Step 1: SET STATUS = 1 (ready state) for each node in G

Step 2: Push the starting node A on the stack and set its STATUS = 2 (waiting for state)

Step 3: Repeat Steps 4 and 5 until STACK is empty

Step 4: Pop the top node N. Process it and set its STATUS = 3 (processed state)

Step 5: Push on the stack all the neighbours of N that are in the ready state (whose STATUS = 1) and set their STATUS = 2

Step 6: EXIT

4] **Dijkstra's (UCS)**:

Dijkstra's algorithm allows us to find the shortest path between any two vertices of a graph.

It differs from the minimum spanning tree because the shortest distance between two vertices might not include all the vertices of the graph.

Step 1: Mark the ending vertex with a distance of zero. Designate this vertex as current.

Step 2: Find all vertices leading to the current vertex. Calculate their distances to the end. Since we already know the distance the current vertex is from the end, this will just require adding the most recent edge. Don't record this distance if it is longer than a previously recorded distance.

Step 3: Mark the current vertex as visited. We will never look at this vertex again.

Step 4: Mark the vertex with the smallest distance as current, and repeat from step 2.

5] **Greedy Best First Search**:

Greedy best-first search algorithm always selects the path which appears best at that moment. It is the combination of depth-first search and breadth-first search algorithms. It uses the heuristic function and search.

Pseudo code:

Step 1: Place the starting node into the OPEN list.

Step 2: If the OPEN list is empty, Stop and return failure.

Step 3: Remove the node n, from the OPEN list which has the lowest value of h(n), and places it in the CLOSED list.

Step 4: Expand the node n, and generate the successors of node n.

Step 5: Check each successor of node n, and find whether any node is a goal node or not. If any successor node is goal node, then return success and terminate the search, else proceed to Step 6.

Step 6: For each successor node, algorithm checks for evaluation function f(n), and then check if the node has been in either OPEN or CLOSED list. If the node has not been in both lists, then add it to the OPEN list.

Step 7: Return to Step 2.

6] **Prim's Algorithm**:

Prim's algorithm is a greedy algorithm that starts from one vertex and continue to add the edges with the smallest weight until the goal is reached. The steps to implement the prim's algorithm are given as follows:

-First, we have to initialize an MST with the randomly chosen vertex.

-Now, we have to find all the edges that connect the tree in the above step with the new vertices. From the edges found, select the minimum edge and add it to the tree.

-Repeat step 2 until the minimum spanning tree is formed.

Pseudocode:

Step 1: Select a starting vertex

Step 2: Repeat Steps 3 and 4 until there are fringe vertices

Step 3: Select an edge 'e' connecting the tree vertex and fringe vertex that has minimum weight

Step 4: Add the selected edge and the vertex to the minimum spanning tree T

[END OF LOOP]

Step 5: EXIT

7] **Kahn's Algorithm**:

Topological sorting for **D**irected **A**cyclic **G**raph (DAG) is a linear ordering of vertices such that for every directed edge uv, vertex u comes before v in the ordering. Topological Sorting for a graph is not possible if the graph is not a DAG.

Pseudo code:

Step-1: Compute in-degree (number of incoming edges) for each of the vertex present in the DAG and initialize the count of visited nodes as 0.

Step-2: Pick all the vertices with in-degree as 0 and add them into a queue (Enqueue operation)

Step-3: Remove a vertex from the queue (Dequeue operation) and then.

8] **Minimum Spanning Tree**:

The minimum spanning tree is a spanning tree whose sum of the edges is minimum. Consider the below graph that contains the edge weight:

Pseudo code:

Step 1: Sort all edges in increasing order of their edge weights.

Step 2: Pick the smallest edge.

Step 3: Check if the new edge creates a cycle or loop in a spanning tree.

Step 4: If it doesn't form the cycle, then include that edge in MST. Otherwise, discard it.

Step 5: Repeat from step 2 until it includes |V| - 1 edges in MST.

9] **Topological Sorting**:

A topological sort or topological ordering of a directed graph is a linear ordering of its vertices in which u occurs before v in the ordering for every directed edge uv from vertex u to vertex v. For example, the graph's vertices could represent jobs to be completed, and the edges could reflect requirements that one work must be completed before another.

Pseudo code:

Step 1: We start from a vertex, we first print it, and then

Step 2: Recursively call DFS for its adjacent vertices.

10] **Bidirectional Algorithm**:

Bidirectional search is a graph search algorithm that finds a shortest path from an initial vertex to a goal vertex in a directed graph. It runs two simultaneous searches: one forward from the initial state, and one backward from the goal, stopping when the two meet.

Pseudo code:

Step 1: Say, A is the initial node and O is the goal node, and H is the intersection node.

Step 2: We will start searching simultaneously from start to goal node and backward from goal to start node.

Step 3: Whenever the forward search and backward search intersect at one node, then the searching stops.

IV. METHODOLOGY

Water Fall Model:

The waterfall model is the first modern approach to the (SDLC) software development life cycle model. The model describes the project development in multiple sequential phases. Each phase track progress of the project from multiple dimensions and the result of each phase act as input for the next phase.

Requirement analysis:

In the first phase of the waterfall model, all the business requirements and logic of the system are documented. The requirements are divided into two categories viz Functional requirements and Non-Functional requirements. Functional requirements define the system behavior while Non-functional requirements define how the system should behave. These requirements are gathered through the discussion of the end-users and/or clients and finally validated for the possibility of the implementation with given time and resources. The documented requirement serves as a guideline for the next phase.

System design:

In the second phase, all the collected requirements are taken into consideration to prepare documentation for the system and software design. In this phase, there are two types of design development High-Level Design (HLD) and Low-Level Design (LLD). HLD describes the properties of every module such as description, name, outline, functionality, relationship, identification of database table, and complete architecture diagram along with technical details. And LLD is more of a description of the functional logic of the modules, database table with the properties like type and size, complete interface details, handling errors, and input/output for every module.

Implementation:

In the third phase, the coding of the application begins according to the specification of the system design. The system is built using the chosen programming of language/s. The tasks are divided into multiple smaller units which are assigned to the developers. Along the way, the unit or the modules are integrated into larger functional components of the system as described in the previous phases. This is normally the longest-running phase-out of all the phases in the waterfall model.

Testing:
Testing is the fourth phase of the waterfall model. Once, the system is ready, it is deployed or hosted in a testing environment. The testing of the system is carried out to verify functional and non-functional requirements are met which is set by the customer during the requirement analysis phase. During the testing, the possible bugs and defects are tracked and reported back to the developers, and fixed. The system is tested multiple times and the process continues until the application is stable, bug-free as much as possible, and covers all the business requirements.

Deployment:
In this phase, the application is deployed or packaged for installation to the environment where the end-users can start using it. The system is monitored for any possible deployment issues

Maintenance:
After the deployment or release of the system, the end-users will start using it. During this phase, three major activities are performed Bug fixing, upgrade, and enhancement. Feedbacks are taken from the end user's experience and any bugs that are tracked will be fixed. It ensures the system is consistently performing as per the specification.

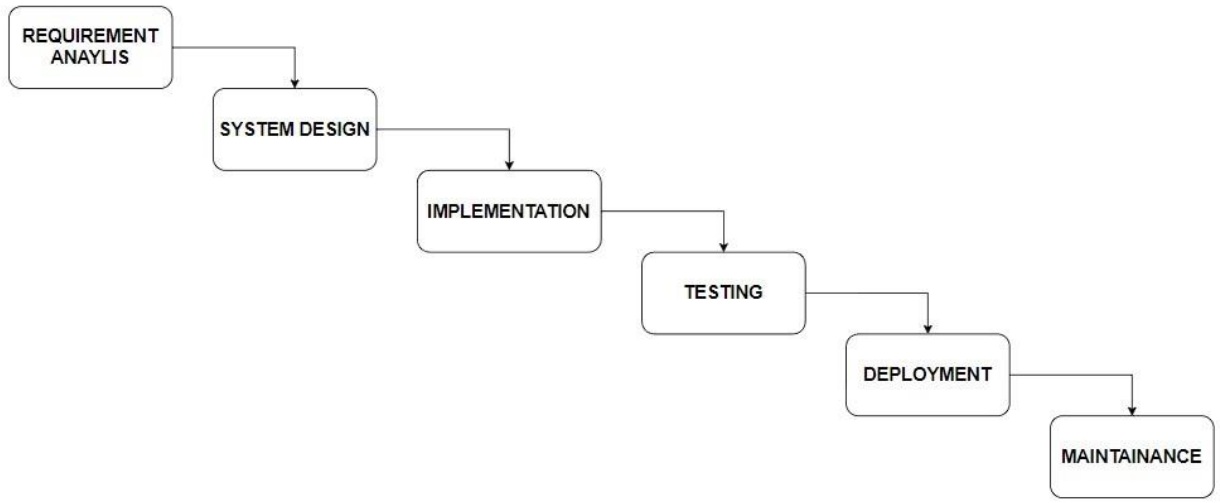


fig.: Waterfall Model

Proposed System:
The pathfinding algorithm visualizer is a tool that allows users to see the pathfinding algorithm in action. It shows the pathfinding algorithm step by step so that users can see how it works. The visualizer also allows users to see the path that the algorithm takes to find the goal. The visualizer has a simple interface that shows the grid and the two points that are being connected by the path. User can Adjust the position of two points as per their choice. The user can select the algorithm that they want to use, and the visualizer will step through the algorithm, showing the steps involved in finding the shortest path. The user can at which the algorithm is executed, and can understand the execution at any time. The pathfinding algorithm visualizer is a useful tool for learning about pathfinding algorithms. It is simple to use and has a number of features that make it useful for teaching. With the visualization of the algorithm, the code optimization can be easily done by the user of the algorithm and make the more efficient of complexity of algorithm

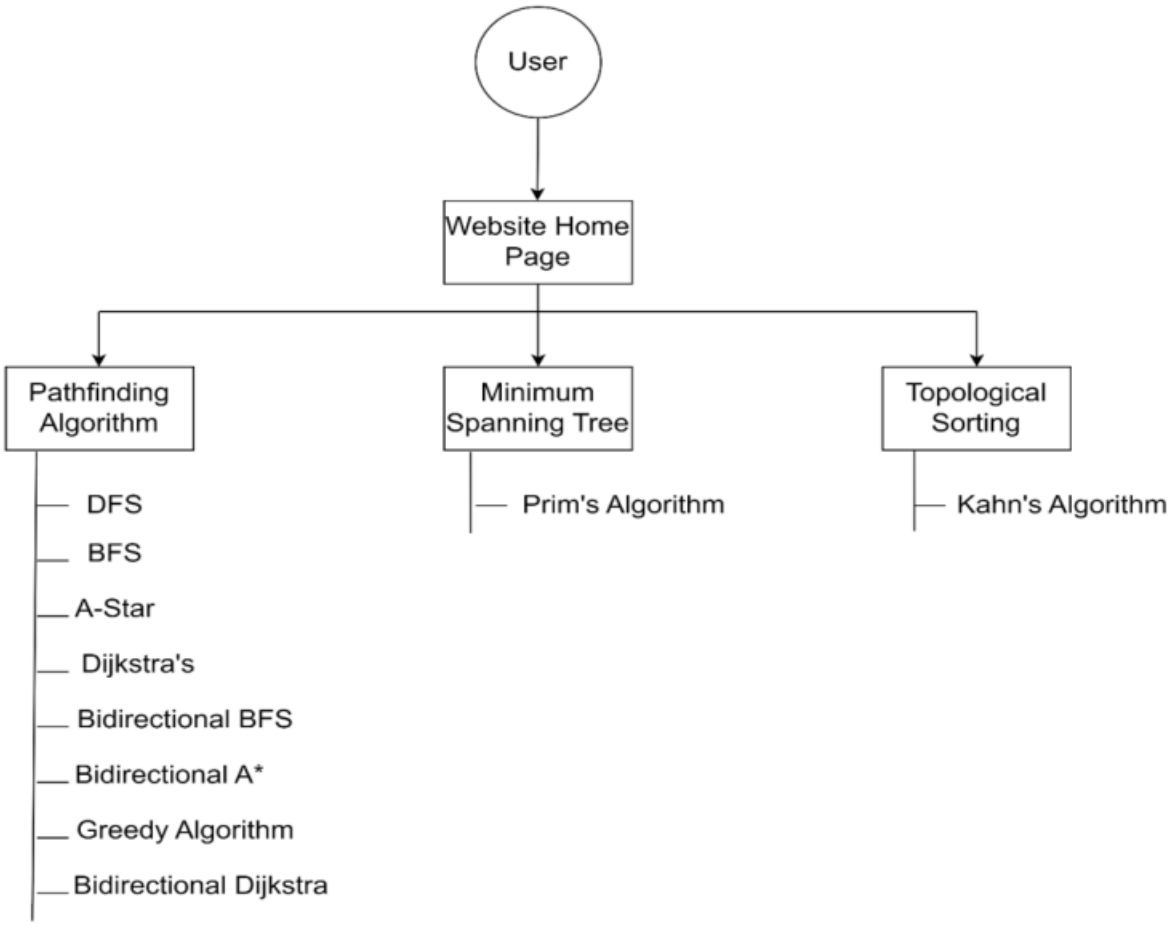


Fig 1. Proposed System

System Architecture:

For Proper visualisation we use graphical interface it helps user to visualize in easy way. we have used different colours to differentiate between the walls , nodes , Algorithms and unvisited node and shown as white . As we are able to see from the above model that the centre of attraction of our application is the user thus, we need to ensure great user experience (UX) which would enhance the overall impact of our application. Since we did not have much complex relationships to manage in our application, we decided to implement our app using some lightweight frameworks and scripting languages. Thus, JavaScript as the base language was an obvious choice owing to its lightweight nature and wide variety of framework options. We then went through most of the popular JavaScript frameworks. We tested each of them by trying to implement a sample page and came to a unanimous decision that Node.js was the best choice due to its features like reusability, easy testing and debugging, and component based approach. Now, the only thing left was to decide how to structure our application to maximize its effectiveness. For this we analysed a few existing designs over the internet and we finally decided on an architecture which has already been explained in the methodology section.

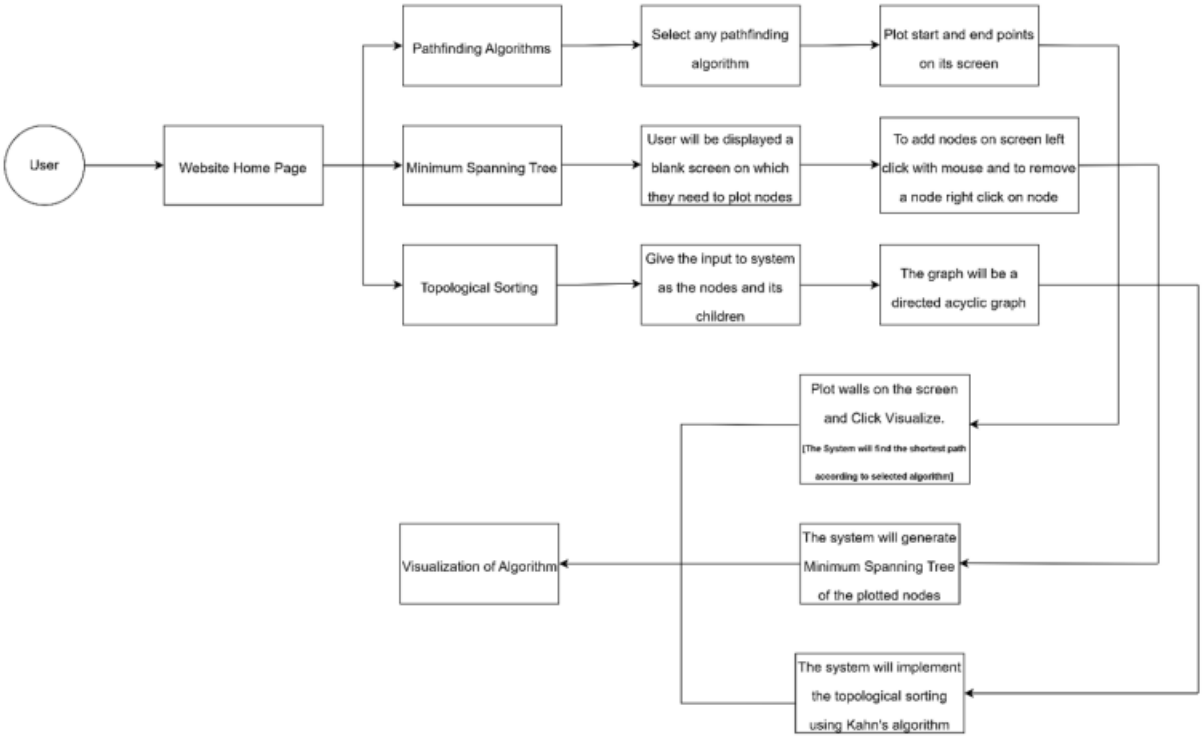
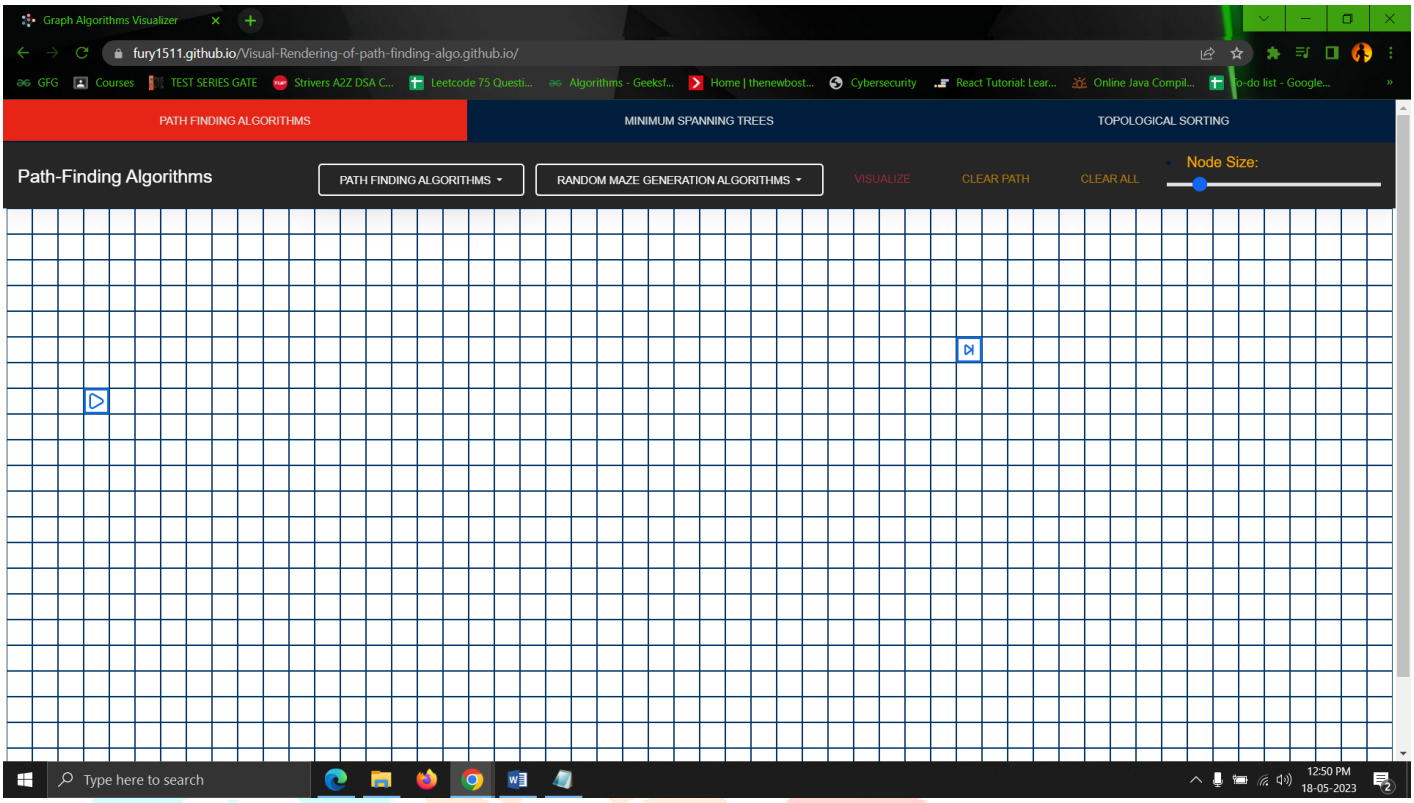


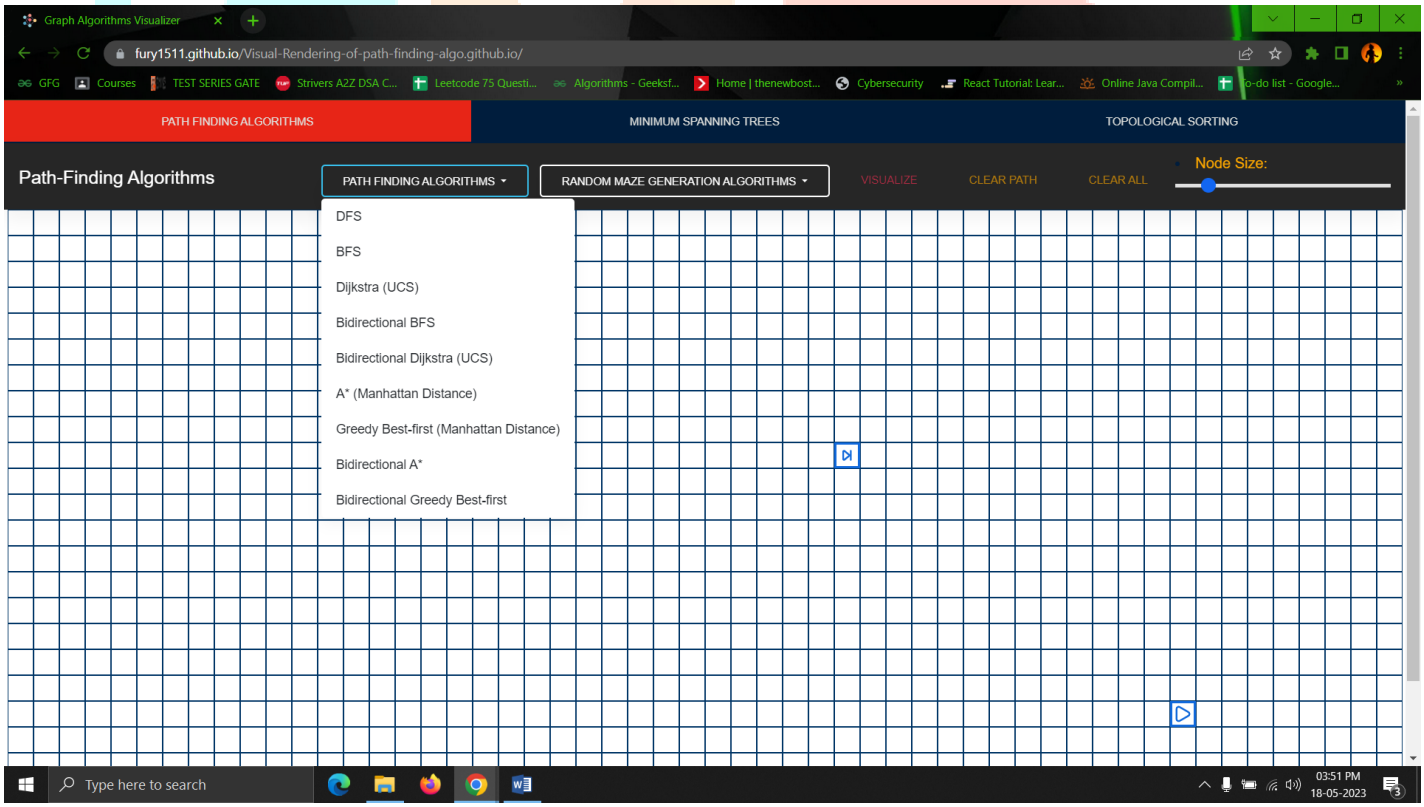
Fig 2: System Architecture

V. Results / Output

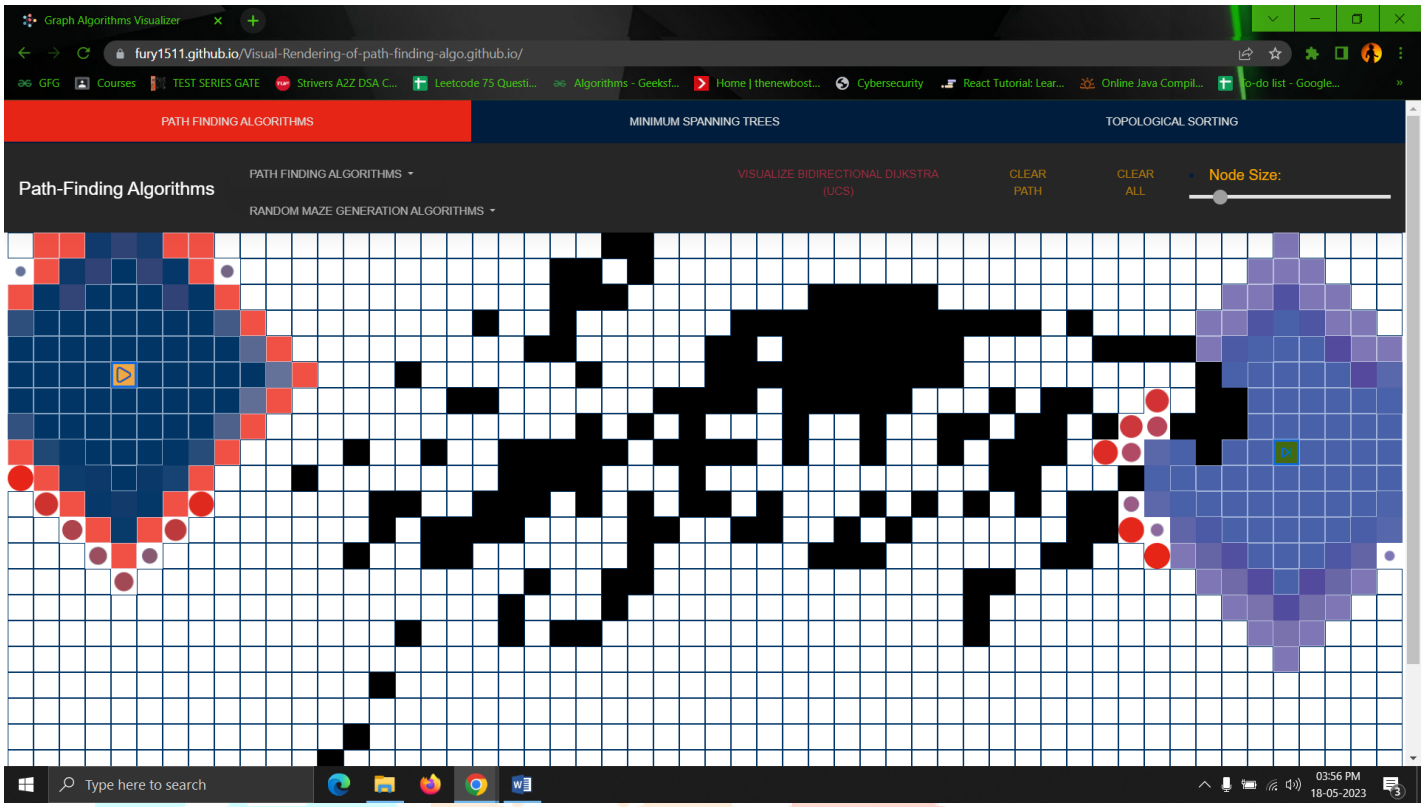
The GUI consists of various elements such as the navbar highlighting the various feature list which users can use to input data & get the relevant results. Here users can add two points, add obstacles as per need & run various. Algorithms to compare the faster one & see the most efficient algorithm amongst all. This current grid is basically a 2d array of objects. Here every object has properties such as a row, column, is start, is finish, is visited, is wall to form the grid, locate the points & traverse the grid from one point to another using the logic of the particular algorithm. It is designed to be simple & direct.



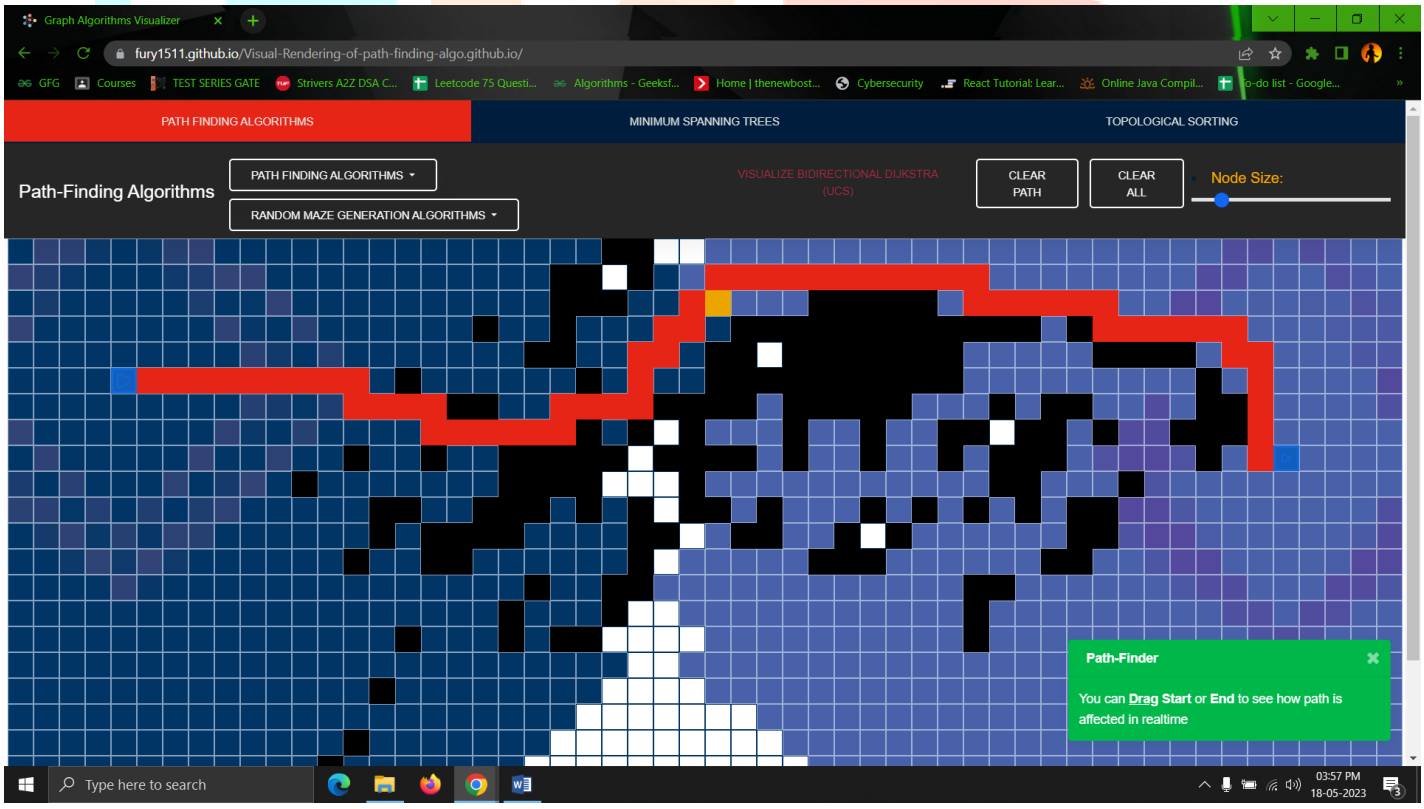
UI of pathfinding Algorithm



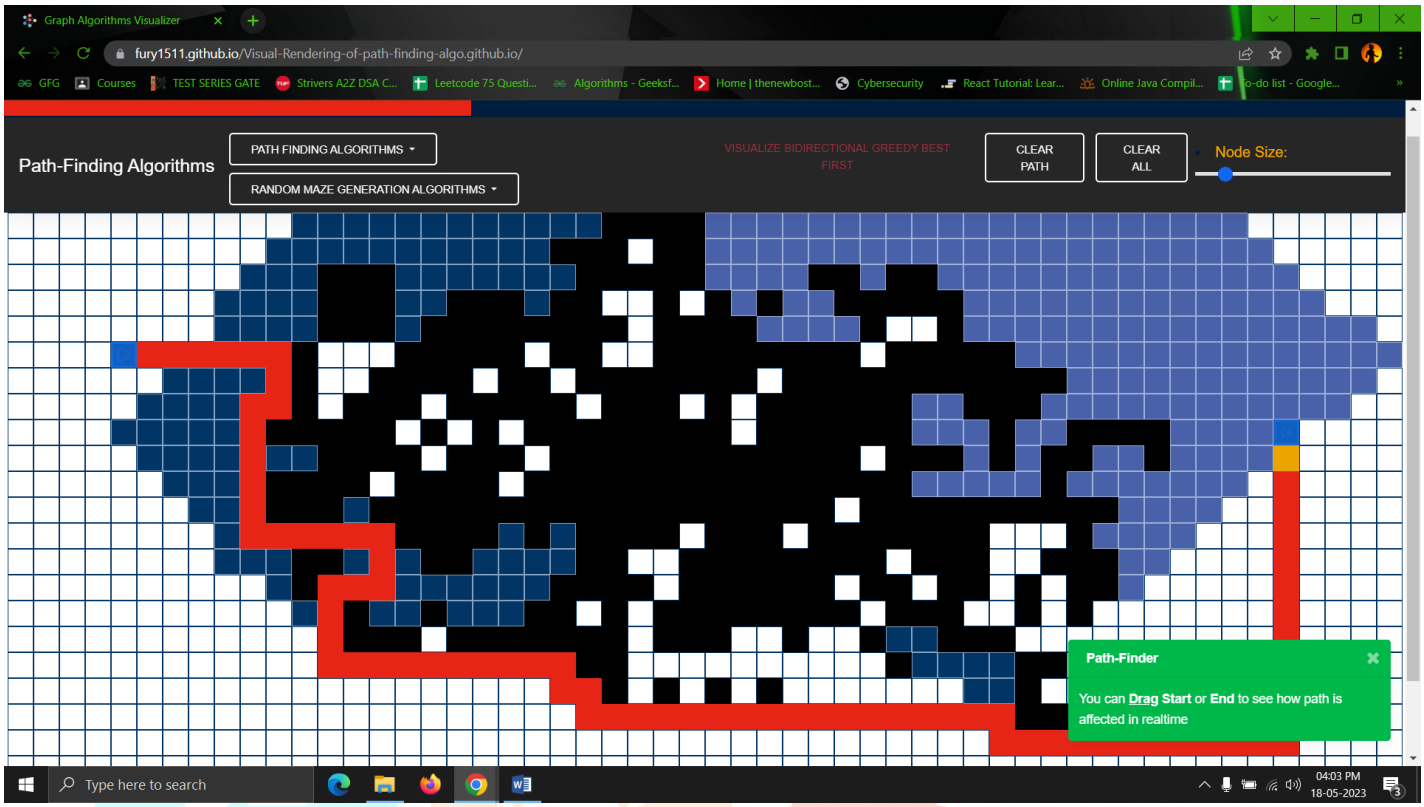
Algorithms Present in Pathfinding Algorithm



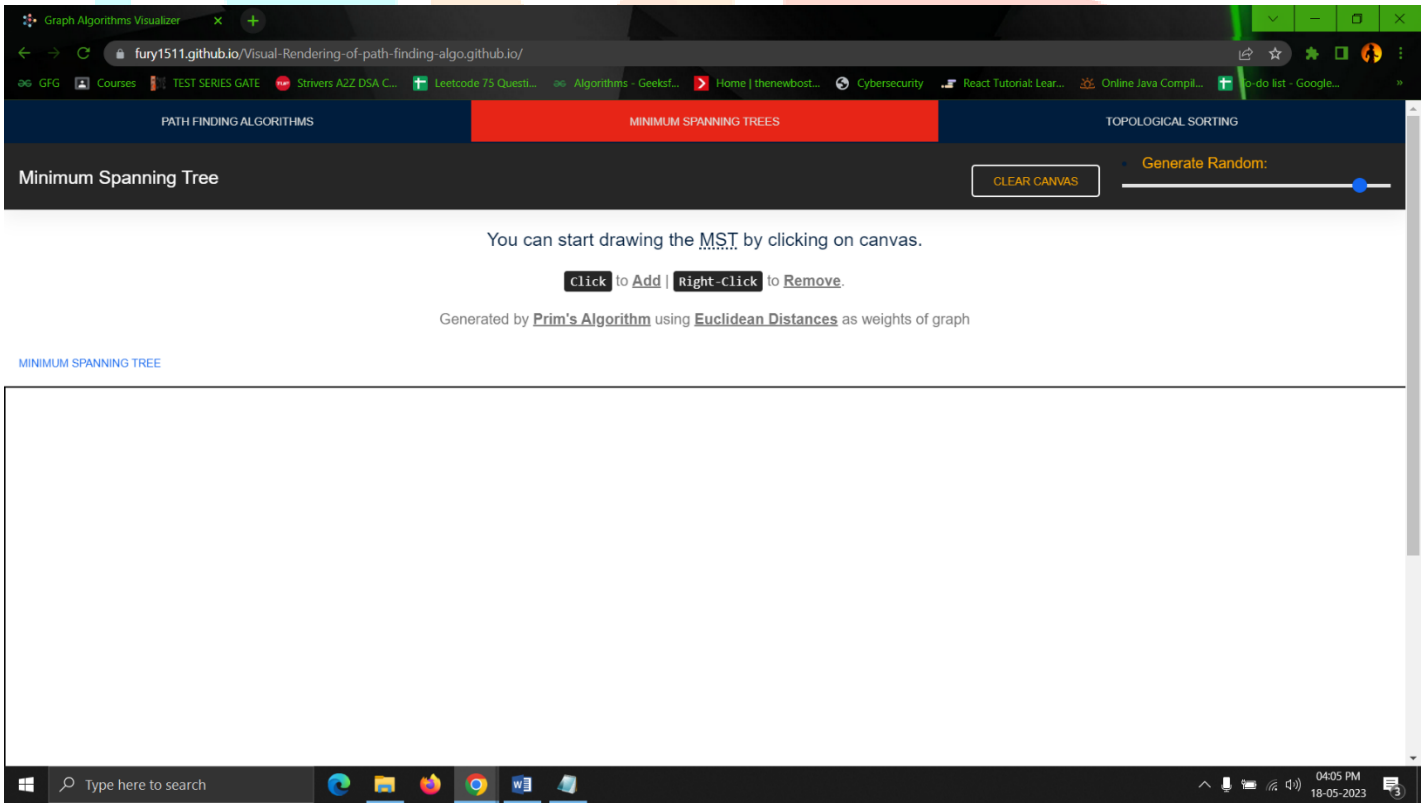
Working of Dijkstra Algorithm



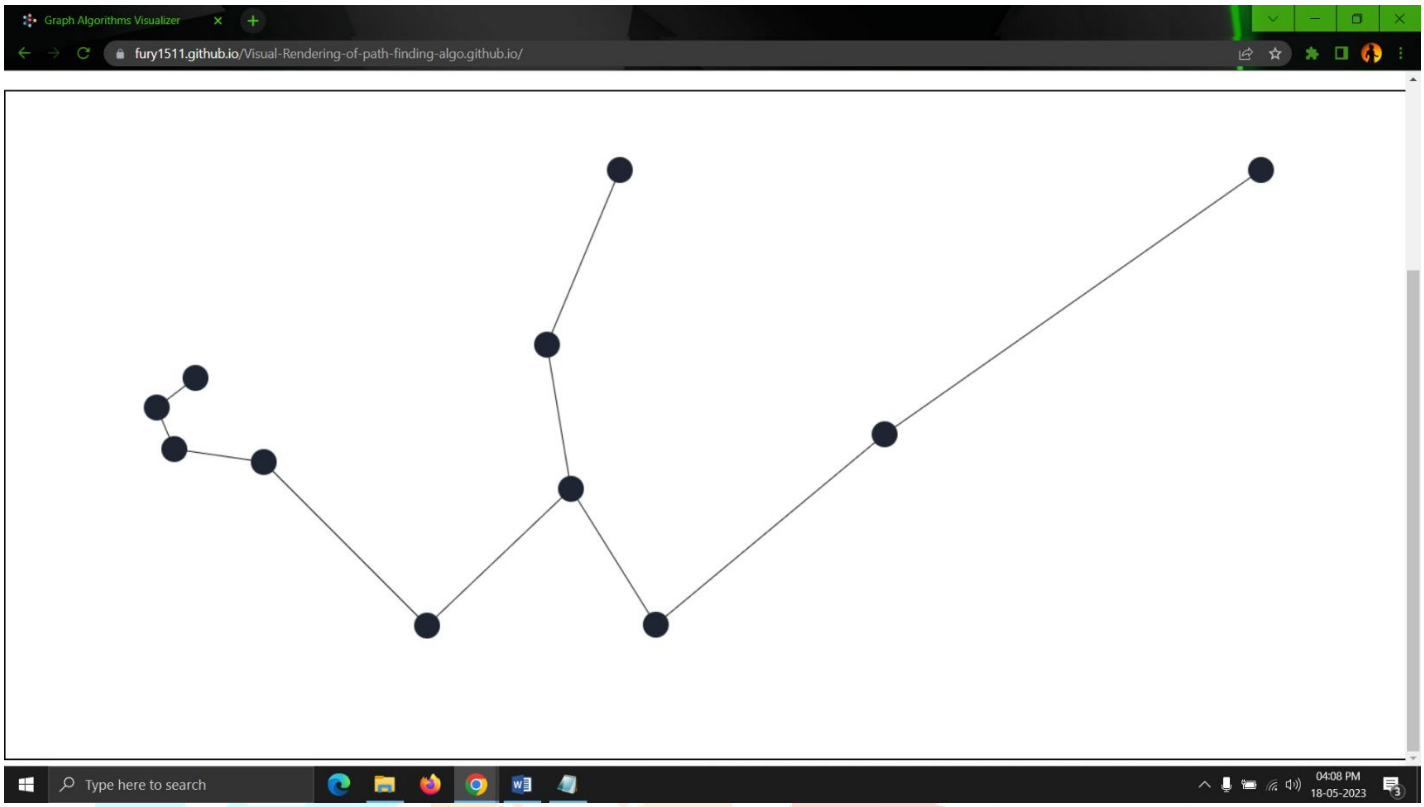
Implementation of Dijkstra Algorithm



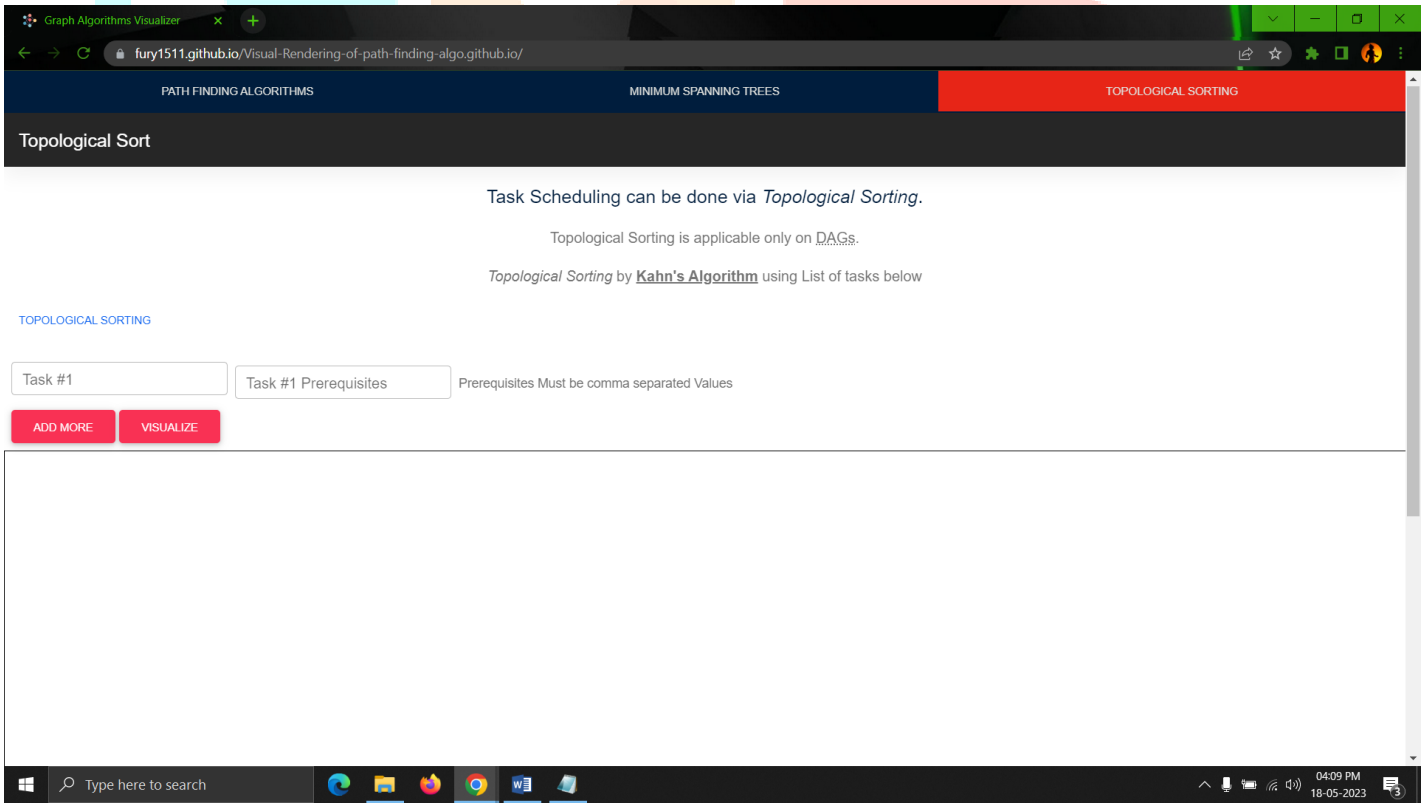
Implementation of Greedy BFS Algorithm



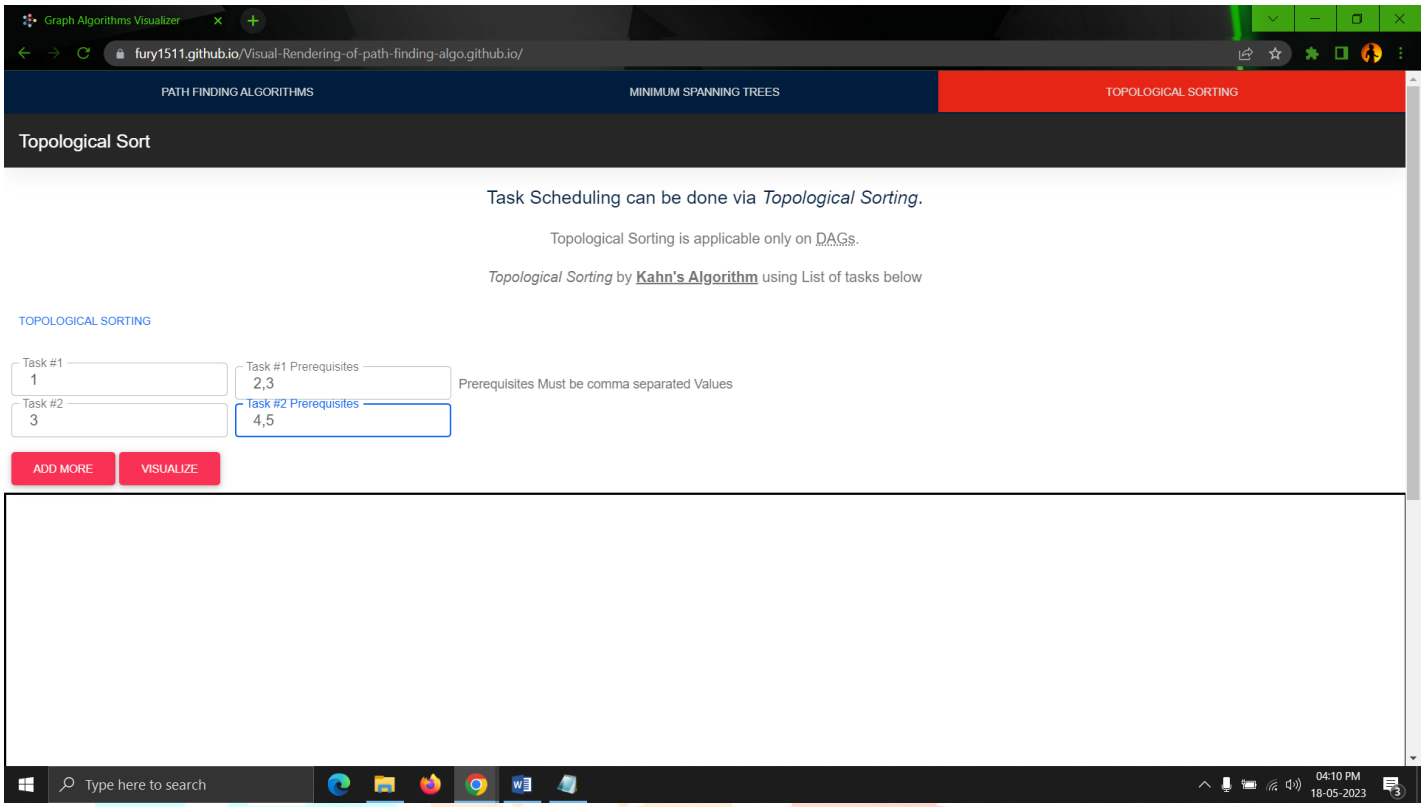
UI of Minimum Spanning Tree



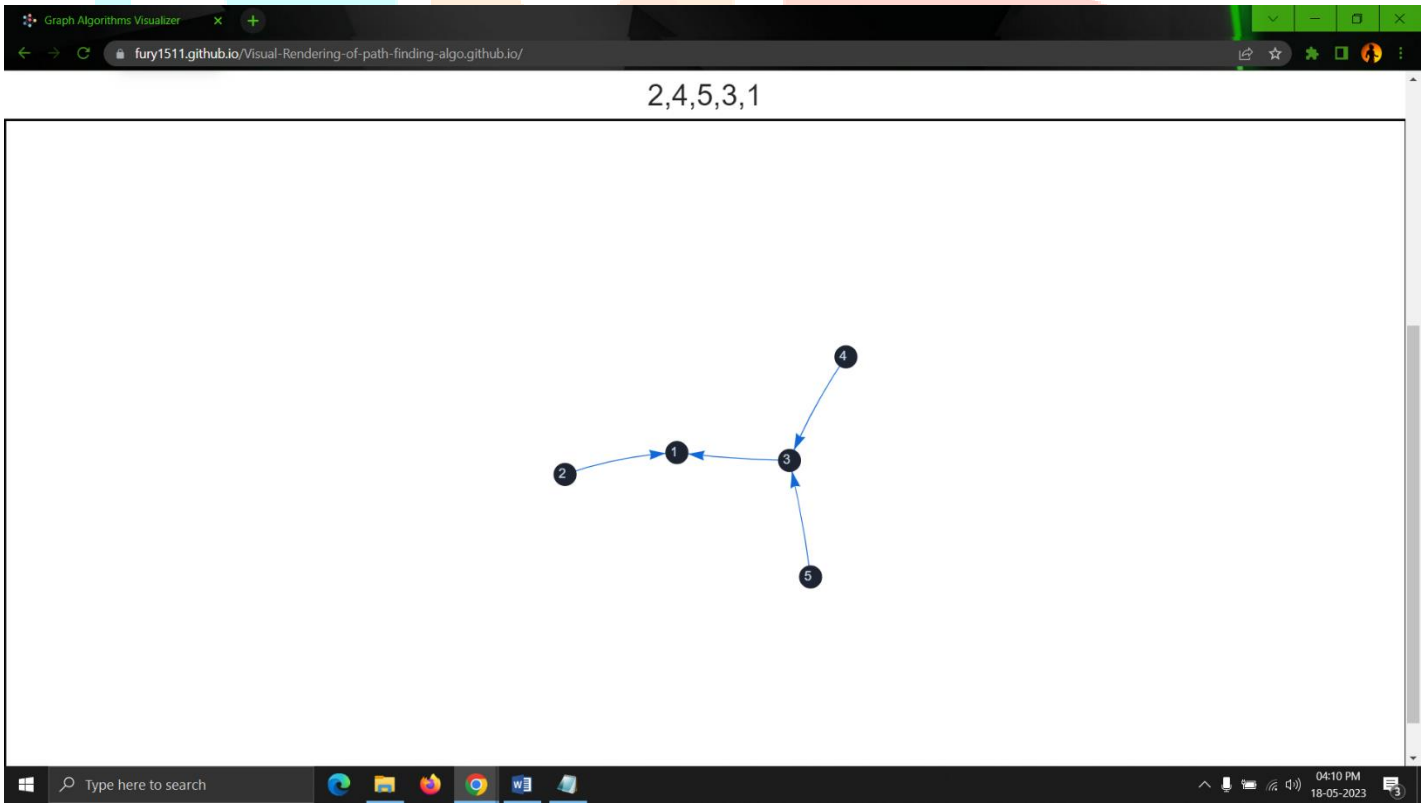
Implementation of Minimum Spanning Tree



UI of Topological Sorting



Inputs of Topological Sorting



Output of Topological Sorting

V. CONCLUSION

In the preceding section, We have tried to answer the question how the value of visualization can be assessed. As a conclusion, We think there is not a single answer, but that it depends on the point of view one adopts. One view is to consider visualization purely from a technological point of view, aiming for effectiveness and efficiency. This requires that costs and benefits are assessed.

According to our findings, algorithm visualization can be seen as a valuable supporting tool, used in addition to standard ways of education in the field of computer science. Within the paper we provided an overview of the algorithm visualization platform as well as our practical experiences with the system. We believe (and the results of questionnaire support our belief) it helps to improve the quality of education in the field and contribute to the solution for some of the problems in higher education mentioned at the beginning of the paper. The pathfinding algorithm visualizer is a tool that can be used to visualize how pathfinding algorithms work. The visualizer will take in a pathfinding algorithm and input data (such as a map of a maze), and will output a visual representation of how the algorithm works. The pathfinding algorithm visualizer will be developed in JavaScript, using the JavaScript library for the graphical user interface (GUI). The visualizer will be tested with a variety of different pathfinding algorithms and input data. This paper concludes that visualizer can be achievable in near future in each and every algorithm learning. It is part of our project; the new pathfinding has been designed and implemented. Pathfinding is plotting by computer application of the route between two points it is more particular variant on solving maze. A part of project describes about develop pathfinding algorithm and implementation of still behaviour. And we also successfully Implemented Minimum spanning Tree and Topological Sorting. The visualization above demonstrates the pathfinding algorithm in action. The algorithm is able to find the path from the start point to the end point, avoiding obstacles along the way. This is a valuable tool for pathfinding in video games and other applications where pathfinding is required.

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