

Application for Data Visualization and Algorithm Simulation

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Abstract—Algorithms are finite pieces of statements or instructions that are used together to solve a problem. Data and the process applied on the data constitute the scope of our application. Algorithms and data structures along with methods to store and process that data are an integral part of computer science. It is necessary today that students and instructors have a clearer and better understanding of how the common algorithms function and how data behaves. We have created an application that allows its users to perform both of these crucial tasks in a platform-independent fashion. Data visualization means presenting data in a graphical or pictorial form clearly and effectively.

There are few standalone-agnostic data visualization and algorithm simulation applications. However, they implement very few Data Structures and Algorithms, not covering different types of algorithms. We have implemented algorithms from different areas in computer science such as Machine Learning, Data Structures, and Algorithms, Data Visualizations, etc. There are various platforms for each domain however very few platforms provide the facility to implement on a single platform. Our web or desktop application would possibly include algorithms of major domains for Educational purposes.

Index Terms— Algorithm visualisation, Data visualisation, Data Structure and Algorithms, Simulation.

I. INTRODUCTION

Data visualization means presenting data in a graphical or pictorial form clearly and effectively. There are few standalone-agnostic data visualization and algorithm simulation applications^[3]. However, they implement very few Data Structures and Machine Learning Algorithms^[2], not covering different types of algorithms. We have implemented algorithms from different areas in computer science such as Machine Learning, Data Structures, and Algorithms, Data Visualizations, etc. There are various platforms^[1] for each domain however very few platforms provide the facility to implement on a single platform. Our web or desktop application would possibly include algorithms of major domains for Educational purposes.

- The application will provide an interactive interface for data visualization and simulation of various algorithms.

- The intended use of this visualization application is to aid students to understand the workings of an algorithm.
- The application will aim to provide instructors with a tool to explain the working of the algorithm in a simple and more convenient way.

II. LITERATURE SURVEY

There was a need to display a massive amount of data in a way that was readily available and easy to understand. Organizations generate data every day. As a result, the amount of data available on the web has increased dramatically. It is difficult for users to visualize, explore, and use this enormous data. The paper presents a brief introduction to data visualization. Data visualization means presenting data in a graphical or pictorial form clearly and effectively. It is concerned with the design, development, and application of computer-generated graphical representation of the data^[4]. It provides effective data representation of data originating from different sources. This enables decision-makers to see analytics in visual form and makes it easy to make sense of the data. It helps them discover patterns, comprehend information, and form an opinion. It makes information easy to understand. It is an innovative way of representing large and complex data. The advent of computer graphics has shaped modern visualization. Data visualization uses computer graphics to show patterns, trends, and relationships among elements of the data. It is hard to quantify the merit of a data visualization technique. This is the reason for having a multitude of visualization algorithms and associated software. Most of these software's have not taken advantage of the multi-touch interactions and direct manipulation capabilities of the new devices. Big data, structured and unstructured, introduces a unique set of challenges for developing visualizations. This is because we must take into account the speed, size, and diversity of the data.

A. Using Algorithms Visualizations in Computer Science Education.^[5]

With the increasing number of students, the introduction of appropriate methods into the process of their education is also required. Our scope here is higher education in the field of computer science. So within the paper, we discuss the extension of standard methods of teaching algorithms, using the whiteboard or slides, with the algorithm visualizations. The paper discusses the possibility of enriching the standard methods of teaching algorithms, with algorithm visualizations. Algorithms and data structures are an essential part of knowledge in a framework of computer science that has a stable position in computer science curricula since every computer scientist or every professional programmer should have basic knowledge from the area. Algorithm visualization illustrates how algorithms work graphically. It mainly aims to simplify and deepen the understanding of algorithms' operation. Algorithm visualization is used to attract students' attention during the lecture, explain concepts visually, encourage a practical learning process, and facilitate better communication between students and instructors. Based on the analysis of existing solutions, they decided to develop their algorithm visualization platform named VizAlgo. The platform intends to be used as a support tool within the subject Data structures and algorithms, taught in a bachelor study program at the author's home institution. They introduce the VizAlgo algorithm visualization platform, present their practical experiences and describe possible future directions, based on their experiences and exploration performed using a simple questionnaire. Algorithm visualization helps to understand the principles but does not replace the need to implement algorithms by students in a chosen programming language. Another drawback of using algorithm visualizations within our subject is the lack of the tool offering required visualizations in a single package with the unified interface.

B. Design and Evaluation of a Web-Based Dynamic Algorithm Visualization Environment for Novices.^[6]

Researchers have acknowledged that the students need to develop a wide range of knowledge and skills, which also include critical thinking, information management skills, algorithmic thinking, and problem-solving skills, beyond the simple notion related to the use of computers and the internet. Teaching basic algorithmic concepts to novices is not a simple task. Existing research has given considerable information about students' alternative conceptions and faulty mental models about abstract programming concepts and constructs, as well as their difficulties in solving programming problems. Various algorithm visualization systems are proposed as alternative and efficient instructional environments for introductory programming courses. They include dynamic features, based on animation techniques, aiming at illustrating the behaviour of basic algorithms and fostering students' experimentation and algorithmic knowledge construction. The paper presents DAVE, a web-based dynamic algorithm visualization environment designed to support secondary education students' learning about basic algorithms. DAVE facilitates students' experimentation with array algorithms by allowing the modification of both code and data. The presentation of preliminary results obtained from an evaluation study

provided evidence of the usability of the system and its potential to support students' development of efficient mental models regarding basic array algorithms.

To achieve a high level of learners' involvement, an AV system should allow students

- To change pre-existing algorithm visualizations
- To construct their visualizations and reflect on them.

Most of the existing systems require the installation of additional software, which could be an API or a runtime environment (like Java). Existing web-based visualization environments are directed to program visualization. Therefore, DAVE has the ambition to cover the need for a fully web-based algorithm visualization environment appropriate for introductory algorithmic courses at both secondary and university levels. The system needs to extend its scope by adding other languages such as C, Python, and other data structures, such as graphs, trees, stacks, and queues.

III. PROPOSED METHOD

Currently available tools for data visualization are bulky and are often not platform-independent. Available simulators do not include a wide range of algorithms and are limited in their scope. Our web or desktop application includes algorithms from computer science domains for educational purposes.

The idea is to build a standalone, platform-independent algorithm simulation and data visualization web application that allows users to simulate and implement the wide range of algorithms from various computer science domains and help them to visualize the data.

The application will help students in the visualizing data belonging to various domains and various formats.

The application will also be helpful for students to understand the working of several common computer science algorithms. The idea is to build a standalone, platform-independent algorithm simulation and data visualization web application that allows users to simulate and implement the wide range of algorithms from various computer science domains and help them to visualize the data.

The tasks are depicted as in figure 1.

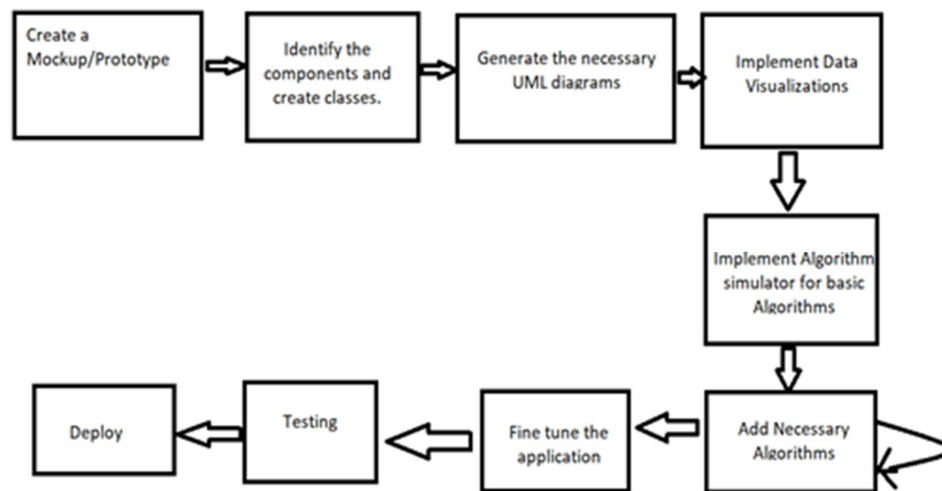


Figure 1. Block diagram

The steps involved in the creation of the application are:

- Create a sample mock-up/prototype.
- Identify the components and create classes.
- Generated the UML diagram as shown in figure 2 and figure 3.
- Implement data visualization on basic data formats.
- Implement an algorithm simulator for basic algorithms.
- Add other necessary algorithms.
- Fine-tune the application.
- Unit testing and End-to-end testing.

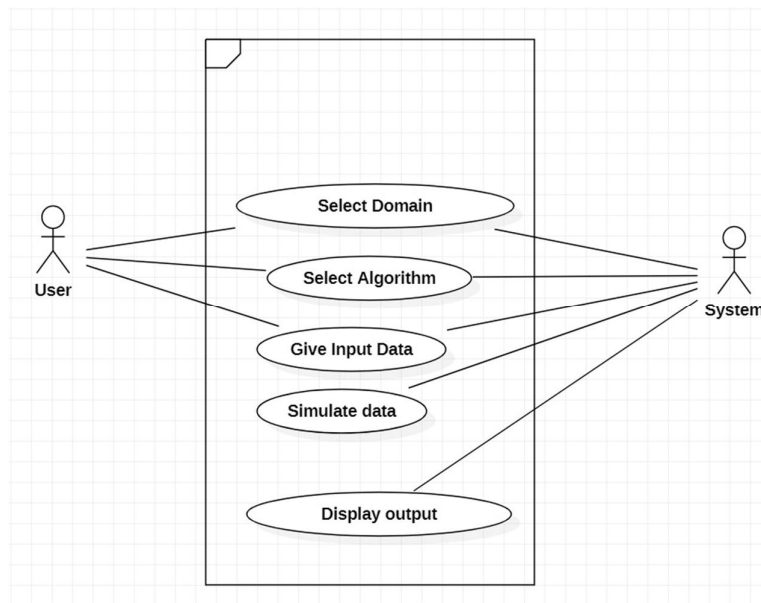


Figure 2. Use Case diagram

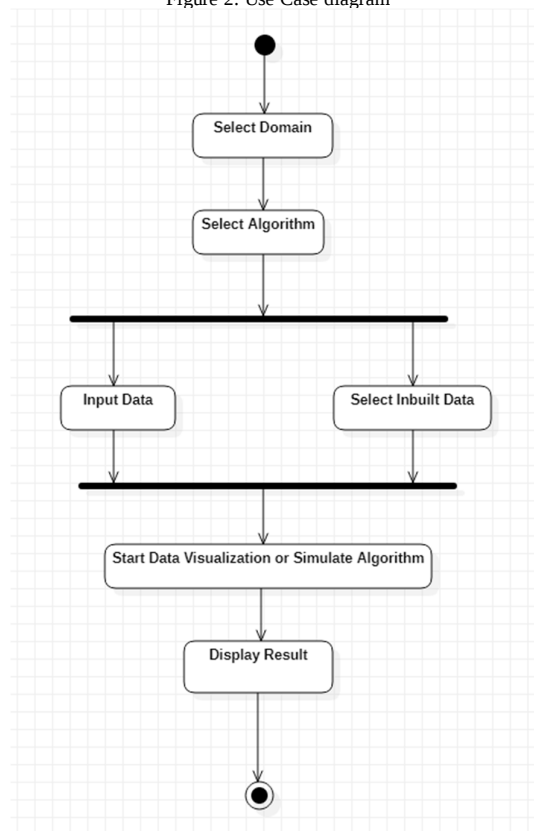


Figure 3. Activity diagram

- Deploying the application.
- Implementation data visualization for runtime inputs:
- Implemented various charts using Chart.js.

- Added buttons for runtime input to add and remove entries from the chart.
- Implementation algorithm simulator for basic algorithms:
- Implemented various algorithms using vanilla javascript.
 - Animated the algorithms using third-party animation files.
 - Added controls for user interaction.
- Deploying the project as a website:
- Deployed the project using github pages.
 - Purchased the domain using github student developer pack.
 - The domain is valid for 1 year.
- Deploying the project as a desktop application:
- Made a desktop application using nativefier.
 - Command used for making desktop application:
 - o `npm install -g nativefier`
 - o `nativefier 'xyz.com'`
 - To implement the commands, the website url was provided that was deployed earlier.

IV. OUTCOME

1. A platform independent application that simulates and visually represents the functioning of various algorithms in the field of computer science.
2. An application that allows for visualization of data and its features in a platform independent manner.

V. CONCLUSION AND FUTURE SCOPE

Thus we have created an application named EdVisualize that allows students and instructors to simulate various common computer science algorithms and allows users to visualize data of varying formats. The application can be expanded to include more and more algorithms as and when needed.

- The application will help in the visualization of data belonging to various domains and various data formats.
- The application will also be helpful for students to understand the working of several commonly used algorithms.
- The application is useful for teachers. Teachers can use the application as an innovative teaching tool.
- The scope of this project is to add algorithms of various domains such as Artificial Intelligence and Machine Learning.

The links for the website and desktop application are below:

Website Link: <http://edvisualize.tech/>

Github: <https://github.com/idflood/ThreeNodes.js#readme>

Desktop Application:

<https://drive.google.com/drive/folders/1us2JBt8y68EKdAhcNwiaoEHNQkxLcTo7?usp=sharing>

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