Data Structures 101 Project Proposal

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# Abstract This will be an educational web application meant to educate users about the various types of data structures used in modern programming. The app will allow users to learn about the various advantages and disadvantages of several data structures, as well as examples of use cases for each. It will also demonstrate the time efficiencies of each structure when performing basic functions through live testing and graphs. A quiz feature will also be available to test users' knowledge. Users that are new to the field of computer science and find it difficult to learn from textbooks and lectures will greatly benefit from this app. Project Details Accurate and in-depth knowledge in data structures is an essential component of a quality programmer. Recruiters seeking software developers often test prospective employees on this topic, and for good reason. Choosing the wrong type of data structure for a task will often lead to end products that run extremely inefficiently or sometimes, not at all. As such, tech companies will always make sure that their developers have a firm grasp on this facet of programming. However, newcomers to the field of computer science may find it difficult to understand the. There are many options, and the advantages and disadvantages of each are complex. Therefore, a method to concisely convey this knowledge is needed.

The end product will display the qualities of various data structures in an easy to understand form on static web pages. Users will be able to go through each and learn about how they function as well as their pros and cons. They will also be able to see examples of scenarios where each data structure should be used. Users will also be able to observe the time complexities of each data structure when running the 4 basic functions: access, find, insert, and delete. The access and find functions will be ran using worst case conditions which may differ depending on the structure. The time complexities will be displayed in the form of line graphs with the x-axis as the size of the data structure and the y-axis as time. Through this display, users will be able to understand how the performance of each data structure changes as their size increases. Finally, users will be able to take short quizzes regarding the information displayed. The quiz will consist of 8 multiple choice questions randomly chosen from a pool of at least 30.

In order to gauge how effective the end product is in fulfilling its purpose, user testing will be conducted. As the intended users of the program are those studying to become skilled programmers, students majoring in computer science will be the ones asked to user test. They will be given a link to the project that they can simply open on a web browser. After sufficient testing has been done, feedback will be gathered through an online survey. Initially, I planned on creating this project in Java using Javafx for the GUI. However, I decided to switch to a web page based application in Javascript instead in order to make it more accessible for users. Instead of downloading a bunch of files and running a .jar file, users can simply open a link in a browser to access the project.   
**Background**  
The only experience I’ve had making web pages consists of a single introductory course I took back during high school. As such, I consider myself to be a novice in web development. I also do not have much experience programming in Javascript, but I do in Java. Since the 2 languages have very similar syntax, I do believe that I will be able to quickly attain the same level of proficiency in Javascript as I have in Java.   
 This project is somewhat of an extension of an assignment I completed in CISC 3142, Programming Paradigms in C++. In that assignment, I was asked to measure the time needed for a few data structures to find and insert items. The measured times would then be outputted as numbers in console. I am expanding on the assignment by including more data structures and measuring the time efficiencies for more functions. That assignment was also purely back-end; I will be adding a front-end aspect by displaying the measured data as graphs.   
 As for topic of data structures, I would consider myself to be knowledgeable to the extent of what an average undergraduate CS student should know. I am familiar with all of the structures that will be covered in my project since I learned about all of them in CISC 3130. I understand the overall structure and functions of each as well as their advantages and disadvantages.

### Literature Review

* <http://bweducation.businessworld.in/article/Why-Data-Structures-And-Algorithms-Are-Important-For-Placement-/05-02-2021-374042/>
* <https://www.synergisticit.com/how-data-structures-and-algorithms-are-important-for-computer-science-graduates>
* <https://www.hackerearth.com/blog/developers/study-data-structures-algorithms/>

## Project Objectives

* The product should be able to convey accurate and concise information about various data structures in the form of web pages
* Users should be able to understand the time complexities of data structures through depicted line graphs
* Users should be able to gauge their knowledge on the topic of data structures through the quiz feature

## Obstacles & Risks

Although the tools used to create this project are few, web development is a field of programming that I am relatively new to. While I have a decent amount of experience creating applications in Java, I do not know much about creating webpages using HTML and CSS. I’ve only taken an introductory course to web development during my junior year of high school, which did not use any frameworks or libraries. As such I will require the assistance of online tutorials in order to understand how to use Bootstrap and Chart.js. Furthermore, Javascript does not have its own implementations of data structures unlike other languages such as Java and C++. In order to create the graphing feature of my project, I will need to create my own implementations in Javascript through object-oriented programming. The more complex structures such as hash tables and binary search trees will require some research into their functions and how to emulate them in Javascript.   
  
**Software and Hardware Technology Requirements**The technologies that will be used to develop this app are quite simple. As it is a webpage based application, the front end will be done in HTML and CSS using the Bootstrap framework. The back end will be done in Javascript. The graphing feature meant to showcase the time efficiencies of the data structure will make use of Chart.js, a Javascript library used for creating and displaying charts on web pages. For the quiz feature, an online database may be used to store the questions and answers, but this is uncertain as providers often charge subscription fees. A possible alternative could be just simply storing the data in a spreadsheet.

The information on the static web pages will be written directly onto the .html files for each page. The graphing feature will measure the time needed for a specified structure to perform a specific function as the size of the structure increases. The measured data will be stored and inputted into Chart.js to create the line graph. Regarding the quiz feature, the questions, choices, and correct answer will be stored into an Excel sheet and imported into a database. The quiz page will randomly select 8 entries and retrieve them using SQL select statements. The questions and answers will then be displayed on the quiz page, and the correct answer will be used to check. In the case that an online database could not be set up, the quiz page will read the entries directly from the Excel file.

## Project Management

* Agile style stand-up notes will be sent weekly to supervisor to report progress
* Direct meetings will be held in accordance to supervisor’s schedule to demo completed features and receive feedback

## Tasks

* Create and style web pages for home and covered data structures
* Write accurate implementations of each data structure in Javascript
* Create graphing feature
* Come up with questions and answers pool for quiz feature and save them in spreadsheet
* Set up database and import spreadsheet (uncertain)
* Create quiz feature
* Host project on public domain
* Conduct user testing and gather feedback
* Write final report and submit

**Estimated Development Timeline**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Task** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| Gathering specs, put together project proposal |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Create informative webpages for home and data structures |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Showcase pages to supervisor and receive feedback. Make any changes necessary. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Write up and submit Interim Report |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Implement data structures in Javascript and create graphing feature |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Demo graphing feature to supervisor and receive feedback. Make any changes necessary. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Create quiz questions and answers, Create quiz feature |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Demo quiz feature to supervisor and receive feedback. Make any changes necessary. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| User testing and feedback gathering |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Prepare final report and submit |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

## Deployment

* Project will be hosted on a public domain to allow users to access it through their browsers

## Testing

* Displayed graph of the efficiency test feature should match the actual time efficiency of the specified data structure and function. (ie. Array performing access should have graph of y = a where a is a constant)
* Quiz feature should select 8 random questions from pool each time with no repeating questions. Choices and correct answer should match with respective questions.

## Documentation & Source Code

* Project logs and stand up notes
* Github commit history with comments
* Screenshots of implementations for all covered data structures in Javascript
* Quiz question and answer pool either in the form of spreadsheet or screenshot of database table
* User feedback forms