# California State University, Fresno

# DEPARTMENT OF COMPUTER SCIENCE

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| Class: | **Algorithms & Data Structures** | | | Semester: | **Sp 2022** |
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| Laboratory number: | **Lab 4 Heaps** | | |
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**1. Statement of Objectives**

Introduce the elements of this experiment. Include a description of the objectives, scope, significance, and major accomplishments of this lab. Briefly explain what is covered in this report.

The purpose of this lab is to learn the implementation of heaps. A heap class is written that contains the standard heap methods. Those methods include:

*modifyValue()*: O(lgn)

*insertValue()*: O(lgn)

*heapify()*: O(lgn)

*extractRoot()*: O(lgn)

*buildHeap()*: O(n)

*heapSort()*: O(nlgn)

The most difficult of these methods to understand and implement are *heapify()*, *buildHeap()*, and *heapsort()*.

*heapify()*: accepts a specific node in the heap and compares it to the children of the node.

*buildHeap()*: calls on *heapify()* in order to maintain the heap property.

*heapSort()*: swaps the first and last node in a heap, then calls *heapify()* to place the root node in the correct position

These three methods are used to build and maintain the properties of a heap.

**2. Experimental Procedure**

List the procedure used in this lab. Include how you approached the question and why.

This lab was straightforward as the header file was given. When starting on the assignment the approach was taken to focus on the least complicated functions first. Each function was tested individually to ensure it was working properly before moving on to the next. With this approach it was easier to identify errors.

Some modifications were made to the methods in the header file. These changes were made so the maximum and minimum versions of the heap would match each other. *ascendingHeapSort()* and *descendingHeapSort()* were also changed to not only print, but also modify the contents of the array.

**3. Analysis**

Discuss the experimental results. Include the screenshots of the results.

A clock was not used in this lab. There was also only one data structure being analyzed so the results are just based on the logic of this single data structure. Once the methods were written properly the program ran as expected.

A screenshot of a computer

Description automatically generated with medium confidence

Text

Description automatically generated

After testing the heap functions, main.cpp was modified to accommodate user input.

Text

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**4. Encountered Problems**

Describe the issues you faced and how you tackled them. Also, you can explain if you could not solve the issue. You should also include errors and discrepancies.

There are several problems that were found during the implementation of this program. The first issue that was encountered was choosing with array to store data in. I quickly realized that the program was designed to store an array in main and therefore I did not use the array that was provided in the header file. Writing the functions was relatively straightforward and there was not much variance needed from the pseudocode provided by the text book.

The most difficult part of writing the header file was finding logic errors that occurred due to incorrect loop parameters and small logical oversights. Other than this a good amount of time was spent on attempting to make a friendly user interface. Sanitizing the input proved difficult and therefore it was not implemented in the program.

**5. Conclusions**

Summarize your conclusions with a list of what you learnt in this lab.

This lab took several hours to complete and it helped with my understanding of heaps. In the past I did not place much of an emphasis on debugging but now as the data structures become more complex I see that this tool is necessary to find mistakes in the code. In this lab I became much more proficient with debugging as it often took following logic through several functions to find a single mistake in the code. I also struggled with sanitization of input and know that I need to place more of an emphasis on learning this skill in the future.

**6. References**

List the references used in this report.

Book:

Introduction to Algorithms by Thomas H. Cormen