

COSC 2436 lab3: K-Largest or Smallest Values in an Array

Create a C++ program to generate a large number of random integers as specified by the user and then select a number of the largest or smallest elements. Your program should read in the seed for the random number generator, and a count of the total number of values to randomly generate. It should store those values in a dynamically allocated array. Once all the values have been generated, construct a max or min heap and remove the selected number of values for output. Your program should write the results, one value per line, to a file. **Your program will be evaluated for its runtime.**

Construct a Heap to help solve this problem. You will need to declare the class and build the methods to construct a Min Heap or Max Heap as requested. Then, provide a way to extract only a specified number of largest or smallest elements from the heap. **You should not and do not need to sort the entire array.**

1. Input files

- The input files contain three lines that specify the parameters for the execution of your program.
- The first line provides an integer that you will use to seed the random number generator (see `srand()`). This will ensure that you generate the same “random” sequence of numbers for testing.
- The second line provides, as an integer, number of values you should randomly generate. Using this value, you should dynamically allocate an array of random integers. Don’t forget to release the memory when you are done using it.
- The third line provides a word, “largest” or “smallest” and an integer. The integer is the number of largest or smallest values you need to find in the array and then output to the specified file.

2. Output files

- Output the k-maximum or k-minimum sorted values to the file, one number per line.
- For debugging, you may wish to output the time required to extract the values and consider the time complexity of your solution.

3. Example

input1.txt	output1.txt
123	7523372
100	29439913
largest 10	58320284
	86168869
	91064068
	92596215
	95168426
	128959393
	150074451
	246577027

This example should execute in about 0.2ms, input2.txt should require about 20ms and input3.txt about 200ms, depending on the system.

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While it would be tempting to sort the entire array, this would take too long, as we only require a small subset of the largest or smallest value. In the example above, we want only the largest 10 numbers out of 100. We would like to be clever in solving this problem. We know it is possible to find the largest number in an array in $O(n)$ time. If we had to do k such numbers, that is $O(kn)$. While that is still $O(n)$ provided the k is small, we would like to find the best solution possible. **Is there a faster way to repeatedly find the largest number in an array?**

4. Reminder

- Turn in your lab assignment to our Linux server, follow the link [here](#) for more instructions.
- Make sure to only have **one (1)** .cpp file with the main() function in your working directory, otherwise your program will fail the grading script.
 - Create a folder under your root directory, name the folder *lab3* (case sensitive), copy all your .cpp and .h files to the folder (ArgumentManager.h is also needed)
 - Only include the necessary files (.cpp and .h files) in your working directory in your final submission
 - To test your program, copy the input files into the server and run your program. After verifying that they pass, delete the .txt files.

Please reach out to myself or the TAs for any clarifications or typos.