Homework 1

Algorithms, Fall 2022

Honor code: *Work on this assignment alone or with one partner. Between different teams, collaboration is at level 1 [verbal collaboration only]. There are lots of resources online, such as animations, visualizations, practice problems, videos, and solutions— which you are encouraged to explore to deepen your understanding. However, you must be careful not to search for the specific problems in the assignment with the intent of getting hints for the solutions. Searching for the assignment problems on the internet violates academic honesty for this class.*

1. **Finding the 1's in a Matrix:** Consider an $n \times n$ array A which consists of 0's and 1's. Suppose each row consists of 1's and 0's such that, in any row i of A, all the 1's come before any 0's. Assuming A is already in memory, describe a method running in $O(n)$ time (*not* $O(n^2)$ time) for finding the row of A that contains the most 1's.

   We expect: Pseudocode and a brief English description of the idea of your algorithm. A brief justification on why is it correct. Analysis of its running time.

2. **Finding min and max:** Describe a method for finding both the minimum and the maximum of n numbers with fewer than $3n/2$ comparisons in total. (Hint: Start by counting how many comparisons it takes to find the min and the max, and go from there).

   We expect: Pseudocode and a brief English description of the idea of your algorithm. A brief justification on why it finds the min and max correctly. Its analysis as function of n showing that it performs fewer than $3n/2$ comparisons.

Evaluation

The assignment will be evaluated along three general criteria:

1. **Correctness**: Does the algorithm solve the problem correctly?

2. **Analysis**: Is the running time of your algorithm analyzed? Is the algorithm efficient?

3. **Style**: An important goal of the assignments is to develop a good algorithmic writing style. Is the algorithm well described and high-level pseudocode included ? Does it look professional and neat? Is the explanation written carefully in complete sentences, and well-organized logic? Is it easily human-readable? Is it easy to understand? detailed guidelines below[1]:

   - Assignments should be typed. Feel free to annotate the pdf to add figures and formulas which are too time-consuming to type. I recommend learning LaTex, but: some problems will require a lot of formatting (e.g. recurrences) which will be a time sink. In that case, simply annotate the equations on the pdf using the iPad.

   - Write each problem on a separate page (this leaves us space to write comments)

   - One of the skills you'll develop is how to communicate algorithms clearly. We expect your assignments to be clearly written and easily human-readable, with complete sentences and well-organized logic, and should definitely not be your first draft.

   - When the problem asks for an algorithm, please write *pseudocode*. Pseudocode should be clear enough that a student who took 1101 can understand what your algorithm is doing, and could implement it in a language of their choice, without thinking too hard. At the same time, pseudocode is **not actual code**, and should *not* include details that are straightforward and make the ideas too detailed/long and hard to follow. For e.g.it is preffered to say "find the max element in the array" (basic straightforward process) rather then spell it out. Check lecture notes for examples of pseudo-code.

   - It is good practice to include an English description of what your pseudocode is doing, to help out the reader.

   - Try to put yourself in the position of the reader. If you hadn't been thinking of this problem for 3 hours, would your answers make sense to you?

   - Try to finish the assignment early, then step away for a day or two, and then come back to it and read it again. Chances are you'll find something you can write more clearly.

   - Look at posted solutions for style advice (if solutions are not posted, ask).

   - Remember the study groups/office hours and come talk to us. The homeworks are not exams—they are not there to test you— they are there to create opportunities to learn. We expect everyone to do well on the homework, and to take the time to write carefully. With quick questions, message me on Slack. I respond the same day.

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[1]Credit: inspired most recently by Stanford University, cs161