

Homework 1

CSE 317: Design and Analysis of Algorithms

Due: 23:59 on November 8, 2024 on LMS

Submission Instructions:

Make a PDF file of your theory questions. Put all your code files and theory PDF file in a single ZIP file as `homework1-<your_student_ID>.zip`. Submit it on the LMS.

Theory Questions

1. (5 + 5 points) Let A be an array of n distinct numbers. If $i < j$ and $A[i] > A[j]$, then the pair (i, j) is called an *inversion* of A . Design an efficient algorithm to count the number of inversions in A . Analyze the time complexity of your algorithm.
2. (5 + 5 points) Let A be a binary array of n elements i.e., each element $A[i] \in \{0, 1\}$ for $1 \leq i \leq n$. Furthermore, all zeroes appear before all ones in the array. Design an efficient algorithm to find the index i of the first occurrence of 1 in A i.e., $A[i - 1] = 0$ and $A[i] = 1$. Analyze the time complexity of your algorithm.
3. (5 + 5 points) Let $L = \langle x_1, x_2, \dots, x_n \rangle$ be a sequence of elements that contains exactly k occurrences of the element x ($1 \leq k \leq n$). We want to find one j such that $x_j = x$. Consider the following procedure until x is found. Generate a random number i between 1 and n and check whether $x_i = x$. Which method is faster, on the average, this method or linear search? Explain.
4. (5 + 5 points) For a sequence $X = \langle x_1, x_2, \dots, x_n \rangle$, we define the mirror of X as the sequence $Y = \langle x_n, x_{n-1}, \dots, x_1 \rangle$. We say that a sequence X is beautiful if the mirror of X is the same as X . Design an $O(n^2)$ *dynamic programming* algorithm that finds the minimum number of elements to add to a given sequence X to turn it into a beautiful sequence. [We can add new elements anywhere in the sequence.]

Programming Questions

Implement all of algorithms for above problems in a programming language of your choice (C, C++, Python, Rust, or Java) and verify on the test cases.

Kindly consult the TA's for test cases.