CS2710 : PDS Lab Tutorial Questions

Tutorial/Prep 4

Aug. 21, 2024

Information

- This document comprises tutorial questions for CS2700, which includes both conceptual/theory questions (relevant for CS2700) and programming questions (relevant for both CS2700 and CS2710; these questions can also be thought of as preparatory/practice programming questions for CS2710 Lab 4, and so also referred to as Prep 4).
- Try to solve programming problems using array/vector and strings only. (Don't use any other data structure). You can use built-in sort() if asked/required.

Conceptual questions (for CS2700)

1. [LISTS] Given two sorted arrays, how will you merge them into a third array? How will you perform the same using linked lists? Write the code for these tasks and report the running time of the code.
2. [OUTER AND INNER PRODUCTS] Given two arrays of size N each, what is the running time complexity of computing the outer product ($P[i][j] = A[i] * B[j]$ for all i, j) and inner product ($\sum_{i=1}^{n} A[i] * B[i]$).
3. [N-QUEENS!] Given an $n \times n$ chess-board, can you place n (say $n = 8$) queens in non-attacking positions (that is, no two queens can be placed in the same row or same column or same diagonal)? Write a recursive program to solve this question. Here is an example configuration for $n = 8$. Your code should print all such configurations.

```
. . . . . Q . .
. . . Q . . . .
. . . . . . Q .
Q . . . . . . .
. . . . . . . Q
. Q . . . . . .
. . . . Q . . .
. . Q . . . . .
```

4. [UNROLLING] Let $M \geq N$. If $T(M, N) = 3T(M/2, N/2) + c$ and $T(M, 1) = T(M/2) + d$ for some constants c, d, then use the method of unrolling the recurrence relation to show that $T(M, N) = O(N^{1.585} log M)$.
5. [FUN WITH POINTERS]
    1. Declare the following:

- Pointer to integer
- Pointer to pointer to integer

2. How will you access the value in the second node of a linked list pointed to by the head of the list.
3. What does this do? `*((*ptr).next).val = x;`

6. [LINEAR TIME SORTING] Show how to sort n integers in the range 0 to $n^3 - 1$ in $O(n)$ time.

Programming questions (for CS2710 Lab 4 preparation/practice, and for CS2700)

7. [AUTO-COMPLETE EXTENSION] Develop a simple auto-complete extension for the VS Code text editor. The extension will suggest the most common word in a document that matches the beginning of a user's search. Print the word that matches the beginning of the search. If multiple words match, print the most frequent one. If no words match, print "No match found".

8. [MATRIX OPERATIONS] Write a C++ program that takes a square matrix as input and computes both the square of the matrix A^2 and its transpose A^T.

9. [POLYNOMIAL DIFFERENTIATION] Write a C++ program that calculates the derivative of a polynomial using arrays. The polynomial is represented by an array of coefficients, where the index represents the power of x. The program then outputs the coefficients of the derivative polynomial.

10. [ALMOST SORTED] Create a C++ program that checks whether a given array is almost sorted or not. An array is considered almost sorted if every element is at most 1 position away from its target position (i.e., if it should be in index i in the sorted array, it is in one of the three positions $i-1, i, i+1$ in the input array). You are allowed to swap an element only once. You can assume that the array contains unique elements.