CMPSC 16: Problem Solving w/ Computers (C++)
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Practice Questions *Warning: this was created independently of the exam!*

1. Fundamentals.

    a. Identify and define the purpose of each of the five core components of the computer.

    b. Explain the difference between variable declaration and initialization. When would you use one over the other?

    c. Explain the difference between function declaration and definition. What is the use case for each of these?

    d. Explain the difference between an object file and an executable. What conditions need to be met to convert a cpp file into an object file? What about an executable file? What terminal command would you use to generate each of these files? What is the default name of the generated files? How can we change the default name of the file?

2. Branches, Loops, and Iterables.

    a. You are given a function rand9() that generates an integer between 1 to 9 inclusive with equal probability. Write a function rand10() that generates an integer between 1 and 10 inclusive with equal probability.

    b. Write a function makeChange() which takes as input an integer c cents and returns the minimum number of coins (pennies, nickels, dimes, and quarters) needed to sum to c cents. For example, for 76 cents, the function should return 4 since 3 quarters + 1 penny is the minimum number of coins needed to provide exact change.

    c. Write a function harmonicSeries() which takes as input an integer n and returns an array a of size n where a[i] represents the ith number in the harmonic series. Implement this algorithm iteratively and recursively. Recall that the harmonic series is 1, 1+1/2, 1+1/2+1/3, …

3. Objects.

    a. What is the significance of the keywords public and private? What is the difference between a struct and a class?

    b. What is the difference between an array, vector, and linked list? What are the advantages and disadvantages of each?

    c. How do you represent a struct, class, array, cstring, or linked list in a box and pointer diagram?

4. Streams.

    a. Explain the difference between return, cout, and exit.

    b. Explain the difference between cerr, cout, and stringstream.

    c. Write a function csvSum() that takes two string parameters inpath and outpath. This function should read the CSV file at path inpath, sum each row, and output the sum of each row in a new file at path outpath, where each sum is on a newline.

5. Pointers

    a. What is the difference between a pointer and an array? How are each of these represented in a box and pointer diagram?

    b. Assume a pointer or an array is passed by value into a function. How is this represented in a box and pointer diagram? What if they are passed by reference into a function?

    c. Explain the difference between the stack and the heap. What is one or the other used and why is this important?

    d. Explain the differences between compile-time error, segmentation fault, undefined behavior, memory leak, and logic error.

    e. What is a int**** and why is this variable type relevant?

6. Problem Solving

a. Given the head of a linked list, remove the nth node from the end of the list and return its head.

b. Given the head of a singly linked list, reverse the list, and return the reversed list.

c. Given the head of a singly linked list, return true if it is a palindrome or false otherwise.

d. You are given two integer vectors nums1 and nums2, sorted in non-decreasing order, and two integers m and n, representing the number of elements in nums1 and nums2 respectively. Merge nums1 and nums2 into a single vector sorted in non-decreasing order.

e. Given a string s containing just the characters '(', ')', '{', '}', '[' and ']', determine if the input string is valid. An input string is valid if: Open brackets must be closed by the same type of brackets. Open brackets must be closed in the correct order. Every close bracket has a corresponding open bracket of the same type.

f. Given two binary strings a and b, return their sum as an integer.

g. In a population of n people, at most k have been infected by a deadly virus. Our task is to identify the infected people and treat them. The infection can be detected by testing a patient's blood. Unfortunately the test is very expensive, and so we want to minimize the number of tests to carry out. Fortunately, one can mix the blood samples of multiple people and test at once. In such a group test, if at least one of the patients is infected, the test result is positive; otherwise, it is negative. Specifically, for a subset S of people, test(S) carries out one test and returns a YES if at least one person in S is infected, and NO otherwise. Describe an algorithm that identifies all the infected people.