

EEN218

Even Nicer Test Than The Last One

21st April 2011

Who are you?

What is your student number?

Did you cheat on this test?

Sign that statement.

Don't make any marks in my boxes.

These are my boxes.

Question	5	6	7	8
Out of	33	33	33	1
Grade				

5

There are three fairly simple data structures that are frequently used to store large amounts of data:

- the Array,
- the Vector (or “array that can grow”)
- the Linked List.

a.

Compare and contrast these three: State their relative advantages and disadvantages, Describe the circumstances that would make each a good or bad choice, think in terms of memory use, program speed, and any other reasonable consideration.

b.

How many bytes of memory would you expect

- i. an int,
- ii. a pointer

to occupy?

Any reasonable answer is acceptable. The only reason for part b is to make you state some of the assumptions you need to make in answering part c.

c.

If 3,000,000 ints are to be stored, what is the total amount of memory that would be occupied using each of the three data structures mentioned above?

Explain how you reach your answer, and state any assumptions you had to make.

d.

Why is the C++ constant `NULL` important? Why is it used at the end of a linked list?

6

You have heard of the Collatz Sequence before, you met it during the first mid-term. It is a very simple thing - take any number, and if it is even divide it by two; if it is odd multiply it by three and add one.

if n is even, $n = n \div 2$

if n is odd, $n = n \times 3 + 1$

Repeat that process over and over again until the number is equal to one.

For example, if you start with 6, the sequence is 6, 3, 10, 5, 16, 8, 4, 2, 1. It is impossible to predict how long the sequence will be. Starting from 31, the sequence is 107 steps long, but starting from 32 it is only 6 steps long.

Your task is to write a function that calculates the Collatz sequence from any given starting point (this will be the function's parameter), and stores it in the correct order in a linked list.

Your function should take only one parameter, which must be an int. It must return as its result a linked list containing the sequence.

You must also fully define any necessary structs.

Keep in mind that the order of the sequence is important. `collatz(6)` should return a linked list that contains the numbers 6, 3, 10, 5, 16, 8, 4, 2, 1 in exactly that order.

A correct answer is more important than an efficient answer, but for full marks your function should not be *excessively* inefficient.

7

a

Fully explain why Binary Chop Search is a Logarithmic algorithm.

b

If it takes Merge-Sort one minute to sort 1,000,000 data items, how long should it take to sort:

- i. 2,000,000 items
- ii. 1,000,000,000 items
- iii. 1,000 items

and

- iv. roughly how long would you expect Selection-Sort to take to sort the original 1,000,000 items?

c

If it takes Binary Chop Search one micro-second (on average) to find one item out of a database of 1,000,000, how long should it take to search through a database of:

- i. 2,000,000 items
- ii. 1,000,000,000 items
- iii. 1,000 items

and

- iv. roughly how long would you expect Merge-Sort to have taken to sort the original 1,000,000 items?

8

Answer either part a or part b, not necessarily both, and certainly not neither.

- a. What is the (musical) interval between a tone of 100 Hz and a tone of 3200 Hz?
So why should music engineers know two-to-the-power-of's after all?
- b. Draw around the outline of your hand, and draw faces on each of the fingertips.