Sample Questions from past tests

Some Divide and Conquer questions

```
int foofoo(int A[]){
        n=A.size
        if (n<4) return 1;
        for(i=2 to n){
            call boo(A[1..i/2]);
        }

        int x=foofoo(A[1 ..n/y])+foofoo(A[n/y ..2n/y]) ;
        return foofoo(A[1 ..n/y]) +x ;
}
```

Given $boo(a) = O(a)$

a.) Provide the recurrence of the code above.

b.) Solve the recurrence using the tree method.

c.) What if we passed the data by value and copied over the entire array A every time. What would be the runtime of the above algorithm? Provide the recurrence and solve in any method.

Suppose you are choosing between the following 3 algorithms

Algorithm A solves problems by dividing them into 3 subproblems of half size and then calling itself to solve each subproblem and combining the solution in quadratic time.

Algorithm B solves the problem by dividing them into 4 subproblems of 1/4 size and then calling itself to solve each subproblem and combining the solution in linear time.

Algorithm C solves problems by dividing them into 2 subproblems of size 1/2 of the original and solving them with a different function that computes in quadratic time and combining the solution in linear time.

Order the algorithms by their big-O from asymptotically smallest to largest, explain your reasoning. provide recurrences, prove their big-O (you can use any method to get the BiG-O - sub., tree or masters)
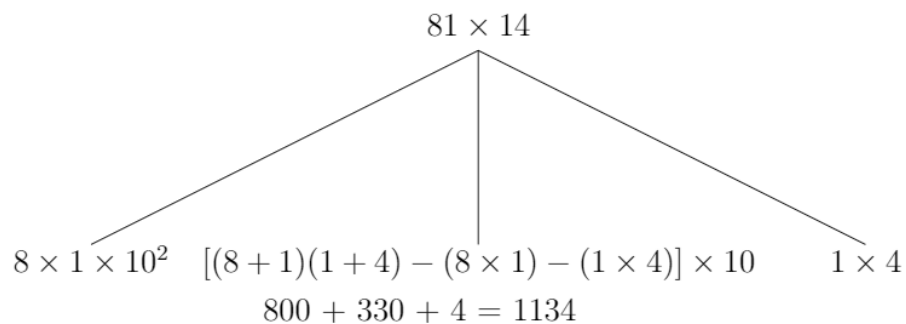
Selection questions

In selection, if we group by 9 instead of seven, would the algorithm still be linear? Show the recurrence and solve it via substitution.

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Generate 21 random numbers between 0 and 20. Show the first level of recursion on the list of 21 numbers, searching for the 4th smallest if your group size was 7 instead of 5.

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Draw the full recurrence tree for integer multiplication for $x = 81$ and $y = 14$ and show the final calculation step.

$$81 \times 14$$

$$8 \times 1 \times 10^2 \qquad [(8+1)(1+4) - (8 \times 1) - (1 \times 4)] \times 10 \qquad 1 \times 4$$

$$800 + 330 + 4 = 1134$$

Z-algorithm

Problem 3. (25pts) Given a string S such that S_i is the ith character of string S. We compute the Z-algorithm, such that Z_i is the z-score for the substring starting at index i. Please answer the following:

(a) Given $Z_k = 8$ $Z_3 = 2$ please state what is the value of Z_{k+2}?

$Z_{k+2} =$

(b) Given $Z_k = 8$ $Z_5 = 6$ please state what is the value of Z_{k+4} ?

$Z_{k+4} =$

(c) Given $Z_j = 4$ and $Z_k = 5$ state wether the following is true, false, or might be true and your reasoning
TRUE FALSE MAYBE :character in S at $j+2$ is equal to the character at k+2 ? $S_{j+2} = S_{k+2}$

(d) Given $Z_j = 4$ and $Z_k = 5$ state wether the following is true, false, or might be true and your reasoning
TRUE FALSE MAYBE :character in S at $j+4$ is equal to the character at k+4 ? $S_{j+4} = S_{k+4}$

(e) if $Z_2 = 3$ and $Z_8 = 15$
TRUE FALSE MAYBE :character in S at 3 is equal to the character at 9

Suffix Tree

You are deciding which algorithm to implement for you pattern P search in text T.
Your given that some requirements:

Pattern: the the size of the pattern is always **n** i.e. $|P| = n$

Text: $|T| = n^5$.

Number of Searches performed: You will search for X different patterns inside the same pattern T. $X = n^4$

Which algorithm should you use: Suffix Tree vs. Z-algorithms

What about SA ?