

Problem Set #2

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5/5 points earned
(100%)

Quiz passed!



1 / 1
points

1.

This question will give you further practice with the Master Method. Suppose the running time of an algorithm is governed by the recurrence $T(n) = 7 * T(n/3) + n^2$. What's the overall asymptotic running time (i.e., the value of $T(n)$)?

Note: If you take this quiz multiple times, you may see different variations of this question.

☐ $\theta(n^{2.81})$

☒ $\theta(n^2)$

Correct Response

$a=7, b=3, d=2$. Since $b^d > a$, this is case 2 of the Master Method.

☐ $\theta(n^2 \log n)$

☐ $\theta(n \log n)$



1 / 1
points

2.

Consider the following pseudocode for calculating a^b (where a and b are positive integers)

```
1 FastPower(a,b) :  
2   if b = 1  
3     return a  
4   else  
5     c := a*a  
6     ans := FastPower(c,[b/2])  
7   if b is odd  
8     return a*ans  
9   else return ans  
10 end
```

Here $[x]$ denotes the floor function, that is, the largest integer less than or equal to x .

Now assuming that you use a calculator that supports multiplication and division (i.e., you can do multiplications and divisions in constant time), what would be the overall asymptotic running time of the above algorithm (as a function of b)?

- ☐ $\Theta(b)$
- ☐ $\Theta(\sqrt{b})$
- ☐ $\Theta(b \log(b))$
- ☒ $\Theta(\log(b))$

Correct Response

Constant work per digit in the binary expansion of b .



1 / 1
points

3.

Let $0 < \alpha < .5$ be some constant (independent of the input array length n). Recall the Partition subroutine employed by the QuickSort algorithm, as explained in lecture. What is the probability that, with a randomly chosen pivot element, the Partition subroutine produces a split in which the size of the smaller of the two subarrays is $\geq \alpha$ times the size of the original array?

- ☒ $1 - 2 * \alpha$

Correct Response

That's correct!

- ☐ $1 - \alpha$
- ☐ α
- ☐ $2 - 2 * \alpha$



1 / 1
points

4.

Now assume that you achieve the approximately balanced splits above in every recursive call --- that is, assume that whenever a recursive call is given an array of length k , then each of its two recursive calls is passed a subarray with length between αk and $(1 - \alpha)k$ (where α is a fixed constant strictly between 0 and .5). How many recursive calls can occur before you hit the base case? Equivalently, which levels of the recursion tree can contain leaves? Express your answer as a range of possible numbers d , from the minimum to the maximum number of recursive calls that might be needed.



$$-\frac{\log(n)}{\log(\alpha)} \leq d \leq -\frac{\log(n)}{\log(1-\alpha)}$$



Correct Response

That's correct!

- ☐ $-\frac{\log(n)}{\log(1-2*\alpha)} \leq d \leq -\frac{\log(n)}{\log(1-\alpha)}$
- ☐ $0 \leq d \leq -\frac{\log(n)}{\log(\alpha)}$
- ☐ $-\frac{\log(n)}{\log(1-\alpha)} \leq d \leq -\frac{\log(n)}{\log(\alpha)}$



1 / 1
points

5.

Define the recursion depth of QuickSort to be the maximum number of successive recursive calls before it hits the base case --- equivalently, the number of the last level of the corresponding recursion tree. Note that the recursion depth is a random variable, which depends on which pivots get chosen. What is the minimum-possible and maximum-possible recursion depth of QuickSort, respectively?





Minimum: $\Theta(\log(n))$; Maximum: $\Theta(n)$

Correct Response

The best case is when the algorithm always picks the median as a pivot, in which case the recursion is essentially identical to that in MergeSort. In the worst case the min or the max is always chosen as the pivot, resulting in linear depth.

- ☐ Minimum: $\Theta(\log(n))$; Maximum: $\Theta(n \log(n))$
- ☐ Minimum: $\Theta(1)$; Maximum: $\Theta(n)$
- ☐ Minimum: $\Theta(\sqrt{n})$; Maximum: $\Theta(n)$

