

CSCI 432 Group Work 3

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1 Analyze the runtime of randomized quicksort

Randomized quicksort and vanilla quicksort are only different in how the elements to pivot around are selected, other than that they are the exact same. So in reality, the runtime will be the exact same as quicksort ($n \log n$) because they behave the same other than the fact that randomized quicksort randomly picks an element to pivot around and vanilla quicksort does not. So randomized quicksort, in theory, will have a time complexity of $n \log n$.

2 Algorithms where we use randomization to find a deterministic answer are known as Las Vegas algorithms. Monte Carlo algorithms also use randomization, but might not always give the right answer; however, they either have a high probability of being correct.

2.1 Give a Monte Carlo algorithm to estimate Π

Algorithmic: Monte Carlo Pi Estimation

Loop Invariant: $\text{circleArea} \leq \text{squareArea}$

```
circleArea = 0
squareArea = 1000000
for i in range(1,1000000) do
    x = randReal(0,1)
    y = randReal(0,1)
    if insideCircle(x,y) then
        circleArea ++
    end if
end for
pi = 4 * circleArea/squareArea
return pi
```

2.2 Let n be the number of random numbers used by your algorithm. Explain why as $n \rightarrow \infty$ the expectation of the output for your algorithm is π

As we increase our size of n , our estimated value of π approaches the expected value. Also the more values we generate, the less effect outliers will have on our calculation.

2.3 Implement this algorithm and plot a line graph of the values returned for atleast at 10 values of n

1. $n = 10$: 2.8
2. $n = 50$: 3.04
3. $n = 100$: 3.480
4. $n = 500$: 3.248
5. $n = 1000$: 3.128
6. $n = 5000$: 3.132
7. $n = 10000$: 3.144
8. $n = 50000$: 3.125
9. $n = 100000$: 3.142
10. $n = 500000$: 3.143