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CS 325 Fall 2020
Homework 1

1. $2/n, 37, \sqrt{n}, n, nloglogn, nlogn, nlog(n^2), nlog^2n, n^{1.5}, n^2, n^2logn, n^3, 2^{\frac{n}{2}}, 2^n$

$$nlog(n^2) = 2nlogn = O(nlogn)$$

$nlog(n^2)$ and nlogn grow at the same rate

2. which grows faster? nlogn or $n^{1+\frac{\epsilon}{\sqrt{logn}}}$ when $\epsilon > 0$?
assume: f(x) > g(x) and prove by contradition, where nlogn = f(x) and $n^{1+\frac{\epsilon}{\sqrt{logn}}}$ = g(x)

$$\begin{aligned}
nlogn &> n^{1+\frac{\epsilon}{\sqrt{logn}}} \\
n \cdot logn &> n \cdot n^{\frac{\epsilon}{\sqrt{logn}}} \\
loglogn &> logn^{\frac{\epsilon}{\sqrt{logn}}} = \frac{\epsilon}{\sqrt{logn}} logn \\
loglogn &> \frac{\epsilon}{logn\frac{1}{2}} = \frac{\epsilon}{logn\frac{1}{2}} \cdot \frac{2logn}{2} \\
loglogn &> \epsilon\sqrt{logn} \\
\text{let X = logn and we get} \\
\epsilon\sqrt{X}^{<} logX \\
(\epsilon\sqrt{X})^2 &< (logX)^2 \\
\epsilon^2 L &< log^2 L
\end{aligned}$$

Because ϵ is a constant greater than 0, we can see from the above that $log^2X < \epsilon^2 X$, this is then a contradiction to our statement above showing that $n^{1+\frac{\epsilon}{\sqrt{logn}}}$ grows faster.

3. a. O(n)
b. O(n^2)
$c.O(n^3)$
$d.O(n^2)$
$e.O(n^5)$
$f.O(n^4)$

Figure 1: mergeTime table

CS325/Week_1/mergeTime.png

Figure 2: mergeTime graph

CS325/Week_1/mergeTimegraph.png

Figure 3: insertTime table

CS325/Week_1/insertTime.png

Figure 4: insertTime graph

CS325/Week_1/insertTimegraph.png

The merge sort equation that best fits the graph curve is an nlogn line, the best fit for the mergesort graph is an n^2 line.

The experimental run times vs the theoretical running times of the algorithms compare closely of nlogn for Merge sort, and n^2 for insertion sort. The merge sort curve looks linear however, this is likely because the times are too close together to display a proper curve. This means that the variation of the run times was too small.

Figure 5: combined algorithms graph

CS325/Week_1/combinedgraph.png