

Why Does Performance Analysis Matter?



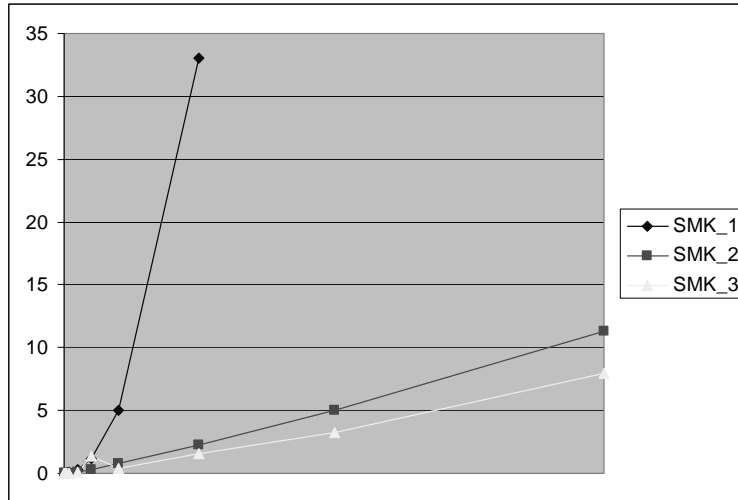
Check out the table of time complexity functions!



Comparison of Time Complexity Functions

	10	20	30	40	50	60
n	.00001 second	.00002 second	.00003 second	.00004 second	.00005 second	.00006 second
n^2	.0001 second	.0004 second	.0009 second	.0016 second	.0025 second	.0036 second
n^3	.001 second	.008 second	.027 second	.064 second	.125 second	.216 second
n^5	.1 second	3.2 seconds	24.3 seconds	1.7 minutes	5.2 minutes	13.0 minutes
2^n	.001 second	1.0 second	17.9 minutes	12.7 days	35.7 years	366 centuries
3^n	.059 second	58 minutes	6.5 years	3855 centuries	2×10^8 centuries	1.3×10^{13} centuries

Timings of Sorting_Machine



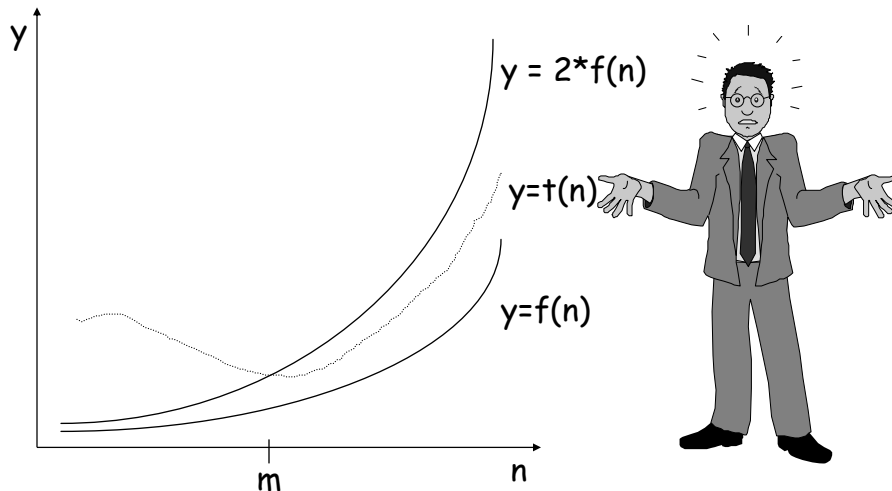
Example: A Messy Timing Function

- Based on
 - using the Sorting_Machine to sort n items
 - selection sort used to implement the Sorting_Machine
 - $t_{\text{sel-sort}}(n) = c_1 * n + c_2 + c_3 * n * (n+1)/2$

Simplify with Big-Oh Notation

- Used to simplify the description of timing functions
- Definition:
Let $f: \text{integer}^{\geq 0} \rightarrow \text{integer}^{\geq 0}$. Then,
 $O(f) = \{t: \text{integer}^{\geq 0} \rightarrow \text{integer}^{\geq 0} \text{ where}$
there are constants $c > 0$ and
 $m \geq 0$ such that $t(n) \leq c * f(n)$
for all $n \geq m\}$
- When t is in $O(f)$, we say t is $O(f)$

What Does t is $O(f)$ Mean?



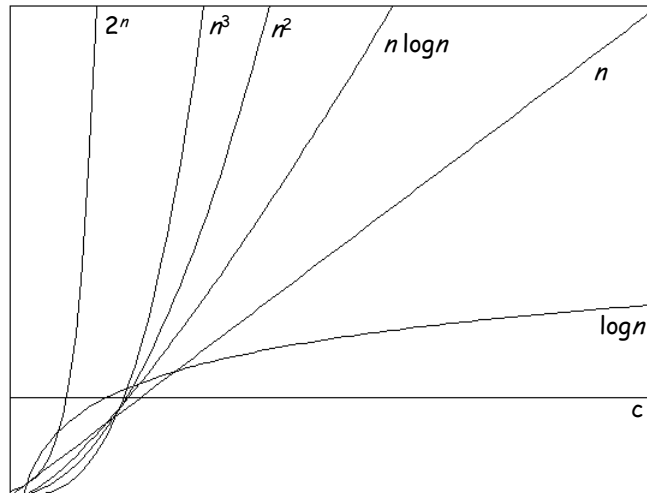
Big-Oh Continued...

- Is $t_{\text{sel-sort}}$ in $O(n^2)$?
- Is $t_{\text{sel-sort}}$ in $O(n^3)$?
- Is $t_{\text{sel-sort}}$ in $O(n)$?
- Is $t_{\text{sel-sort}}$ in $O(n * \log_2(n))$?

Some Important Timing Functions

- **constant** time: c
- **log** time: $c * \log n$
- **linear** time: $c * n$
- ***n-log-n*** time: $c * n * \log n$
- **quadratic** time: $c * n^2$

Growth of Common Functions



Big-Oh Example Comparisons of Running Times

Size of Problem	Poor Algorithm $O(n^2)$		Better Algorithm $O(n \log n)$
	Good Implement.	Poor Implement.	?
n	$T(n)=5n^2$ ms	$T(n)=10n^2$ ms	$T(n)=50 n \log n$ ms
10	.0005 sec.	.001 sec.	.002 sec.
100	.05 sec.	.1 sec.	.03 sec.
1,000	5 sec.	10 sec.	.5 sec.
10,000	8 min.	16 min.	6.6 sec.
100,000	14 hours	28 hours	83 sec.
1,000,000	58 days	116 days	17 min.