CS70
Samples of Complexities

These tables are adapted from Figures 1.2 and 1.3 in Garey & Johnson, *Computers and Intractability: A Guide to the Theory of NP-Completeness*, W.H. Freeman and Company, 1979, ISBN 0-7167-1045-5.

Here are the running times of various algorithms if one step takes one microsecond. Unless otherwise specified, the running times are given in seconds.

Time complexity function	Size n 10	20	30	40	50	60
1	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
$\log_2 n$	0.000003	0.000004	0.000005	0.000005	0.000006	0.000006
n	0.000010	0.000020	0.000030	0.000040	0.000050	0.000060
$n \log_2 n$	0.000033	0.000086	0.000147	0.000213	0.000282	0.000354
n^2	0.000100	0.000400	0.000900	0.001600	0.002500	0.003600
n^3	0.001	0.008	0.027	0.064	0.125	0.216
n^5	0.1	3.2	24.3	1.7 minutes	5.2 minutes	13.0 minutes
2^n	0.001024	1.049	17.9 minutes	12.7 days	35.7 years	366 centuries
3^n	0.059049	58.1 minutes	6.5 years	3855 centuries	2.3×10^8 centuries	1.3×10^{13} centuries

Here is the effect of improved technology (or more patience) on the size of a solvable problem. For example, if a linear-complexity problem of size N_1 can be solved in one hour using a present-day computer, then a problem of size $100N_1$ can be solved using a computer 100 times faster, or by waiting for 100 hours. (There is no line in the table for $n \log_2 n$ because there is no closed-form expression for arbitrary n.)

Time complexity function	With present computer	With 100 times more power	With 1000 times more power
$\log_2 n$	N_0	N_0^{100}	N_0^{1000}
n	N_1	$100N_1$	$1000N_1$
n^2	N_2	$10N_2$	$32N_2$
n^3	N_3	$4.6N_3$	$10N_3$
n^5	N_4	$2.5N_4$	$4.0N_4$
2^n	N_5	$N_5 + 6.6$	$N_5 + 10$
3^n	N_6	$N_6 + 4.2$	$N_6 + 6.3$