# Asymptotic notation cheat sheet

**Rough Guide**

| class | in English | meaning | key phrases |
|---|---|---|---|
| $f(n) = O(g(n))$ | big-oh | $f(n) \leq g(n)$ | $f(n)$ is asymptotically no worse than $g(n)$<br>$f(n)$ grows no faster than $g(n)$ |
| $f(n) = \Theta(g(n))$ | big-theta | $f(n) \approx g(n)$ | $f(n)$ is asymptotically equivalent to $g(n)$<br>$f(n)$ grows the same as $g(n)$ |
| $f(n) = \Omega(g(n))$ | big-omega | $f(n) \geq g(n)$ | $f(n)$ is asymptotically no better than $g(n)$<br>$f(n)$ grows at least as fast as $g(n)$ |

**Formal Definitions**

| class | formally | working |
|---|---|---|
| $f(n) = O(g(n))$ | $\exists c > 0,\ \exists n_0,\ \forall n > n_0, f(n) \leq c \cdot g(n)$ | |
| $f(n) = \Theta(g(n))$ | $\exists c_1, c_2 > 0,\ \exists n_0,\ \forall n > n_0, c_1 \cdot g(n) \leq f(n) \leq c_2 \cdot g(n)$ | $f(n) = O(g(n))$ and $g(n) = O(f(n))$ |
| $f(n) = \Omega(g(n))$ | $\exists c > 0,\ \exists n_0,\ \forall n > n_0, c \cdot g(n) \leq f(n)$ | $g(n) = O(f(n))$ |

**Using Limits**

$$\text{If } \lim_{n\to\infty} \frac{f(n)}{g(n)} = \begin{cases} 0 & \text{then } f(n) = O(g(n)) \\ \text{some finite, non-zero, positive constant} & \text{then } f(n) = \Theta(g(n)) \\ \infty & \text{then } f(n) = \Omega(g(n)) \end{cases}$$