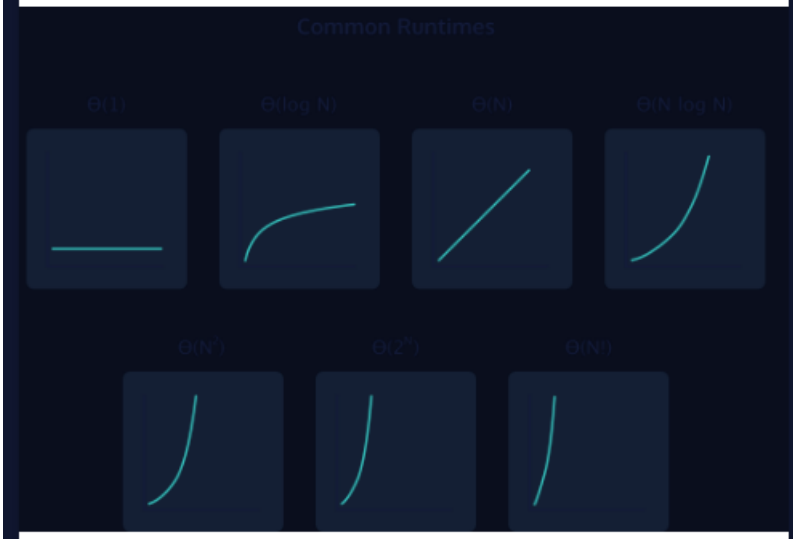
Big-O Notation

The Big-O notation describes the worst-case running time of a program. We compute the Big-O of an algorithm by counting how many iterations an algorithm will take in the worst-case scenario with an input of N. We typically consult the Big-O because we must always plan for the worst case. For example, O(log n) describes the Big-O of a binary search algorithm.

Asymptotic Notation

Asymptotic Notation is used to describe the running time of an algorithm - how much time an algorithm takes with a given input, n. There are three different notations: big O, big Theta (Θ), and big Omega (Ω). big-Θ is used when the running time is the same for all cases, big-O for the worst case running time, and big-Ω for the best case running time.

Algorithmic Common Runtimes



The common algorithmic runtimes from fastest to slowest are:

- constant: Θ(1)
- logarithmic: Θ(log N)
- linear: Θ(N)
- polynomial: Θ(N^2)
- exponential: Θ(2^N)
- factorial: Θ(N!)

Adding Runtimes

```
An algorithm with three parts has running times of Θ(2N)
+ Θ(log N) + Θ(1). We only care about the slowest part, so
we would quantify the runtime to be Θ(N). We would also drop
the coefficient of 2 since when N gets really large, the
multiplier 2 will have a small effect.
```

When an algorithm consists of many parts, we describe its runtime based on the slowest part of the program.

Big-Θ Notation

We compute the big-Θ of an algorithm by counting the number of iterations the algorithm *always* takes with an input of n. For instance, the loop in the pseudo code below will always iterate N times for a list size of N. The runtime can be described as Θ(N).

```
for each item in list:
  print item
```

Big-Ω Notation

Big-Ω (Omega) describes the best running time of a program. We compute the big-Ω by counting how many iterations an algorithm will take in the best-case scenario based on an input of N. For example, a Bubble Sort algorithm has a running time of Ω(N) because in the best case scenario the list is already sorted, and the bubble sort will terminate after the first iteration.