Big O notation

Big O notation is a mathematical way to describe **the efficiency and scalability of an algorithm**. It focuses on how the **time or space complexity** of an algorithm grows relative to the input size, usually represented as "n".

Big O tells us how quickly an algorithm's execution time increases as the number of data elements increases. This is especially important in large-scale applications like e-commerce platforms where search operations are performed on thousands or even millions of products.

For example, a linear search has a time complexity of **O(n)**, meaning the time to find an item grows linearly with the number of items. In contrast, a binary search has a time complexity of **O(log n)**, which means it becomes exponentially faster as the dataset grows. Big O notation helps developers **choose the most efficient algorithm** by comparing their performance regardless of the system or hardware.

Best, average, and worst-case scenarios for search operations

In analyzing algorithms, we often look at three scenarios: **best case**, **average case**, and **worst case**.

The **best-case scenario** represents the most favourable outcome , for example, in a linear search, the item is found at the first position, so the time complexity is **O(1)**.

The **average-case scenario** reflects what we typically expect during normal use in linear search, this means finding the item somewhere in the middle, resulting in **O(n)** time.

For **binary search**, the average case remains **O(log n)** since the search space is halved each time.

Finally, the **worst-case scenario** accounts for the most time-consuming situation for linear search, this is when the item is not present or is at the last index (**O(n)**), and for binary search, it’s still **O(log n)** even when the item isn’t found, as it still follows the divide-and-conquer approach. Understanding these scenarios helps developers **predict and plan for performance bottlenecks**, especially in data-heavy applications like product searches in e-commerce platforms.