Big O Notation

Big O notation describes the upper bound of an algorithm's running time as a function of the input size. It provides a high-level understanding of the algorithm's efficiency and scalability, helping to identify potential performance bottlenecks.

- **O(1)**: Constant time; the operation's duration is independent of the input size.
- **O(n)**: Linear time; the operation's duration grows linearly with the input size.
- **O(log n)**: Logarithmic time; the operation's duration grows logarithmically with the input size.
- **O(n log n)**: Log-linear time; common in efficient sorting algorithms like merge sort and quicksort.
- **O(n^2)**: Quadratic time; the operation's duration grows quadratically with the input size, often seen in simple nested loops.

Best, Average, and Worst-Case Scenarios

- **Best Case**: The minimal time an algorithm takes to complete, usually occurring with optimal input.
- **Average Case**: The expected time taken for random input, giving a realistic performance expectation.
- **Worst Case**: The maximum time an algorithm could take, providing an upper bound on performance, crucial for ensuring the system's worst-case efficiency.

Time Complexity

- **Linear Search**:
  - **Best Case**: O(1) - When the target is the first element.
  - **Average Case**: O(n) - On average, half the array is searched.
  - **Worst Case**: O(n) - When the target is the last element or not present.
- **Binary Search**:
  - **Best Case**: O(1) - When the target is the middle element on the first check.
  - **Average/Worst Case**: O(log n) - Divides the search space in half each time.

Binary Search is generally more suitable for e-commerce platforms due to its O(log n) complexity, making it highly efficient for large datasets. However, it requires the data to be sorted, which adds overhead when inserting new products.

Linear Search can be used for unsorted data or when the dataset is relatively small, as it doesn't require sorting. However, its O(n) complexity makes it less efficient for large datasets.