Limitations of Asymptotic Analysis

In practice, other considerations beside asymptotic analysis are important when choosing between algorithms. Sometimes, an algorithm with worse asymptotic behaviour is preferable.

For the sake of this discussion, let algorithm *A* be asymptotically better than algorithm *B*. Here are some common issues with algorithms that have better asymptotic behaviour:

Implementation complexity
Algorithms with better complexity are often (much) more complicated. This can increase coding time and the constants.

Small input sizes

Asymptotic analysis ignores small input sizes. At small input sizes, constant factors or low order terms could dominate running time, causing *B* to outperform *A*.

Asymptotic notations hide the multiplicative constants. Often the values of such constants are very large. See the following example:

Example:

A: $f(n) = 1000\ n^2 + 10\ n + 10 = O(n^2)$

B: $f(n) = 10\ n^3 + 10\ n + 10 = O(n^3)$

A is asymptotically better than B. However, for all values of n <100, algorithm B makes less computations than A. This should be a real concern if most of the times we receive input size of n<100.

Ignoring contribution made by the lower-order terms

Also, the contribution made by the lower-order terms may be significant.

Example:

A: $f(n) = 10n^2 + 10\ n + 10 = O(n^2)$

B: $f(n) = 10n^2 + 1000\ n + 10 = O(n^2)$

A is asymptotically similar to B. However, in actual terms, the contribution of the linear term in B is 100 times more than that in A for all values of n.

This suggests that if we choose algorithm B over A just by looking at the similarity of their asymptotic behaviour, we will end up performing 100 times more computation than what is required if we would have chosen algorithm A.

Worst case versus average performance

If *A* has better worst case performance than *B*, but the average performance of *B* given the expected input is better, then *B* could be a better choice than *A*. Conversely, if the worst case performance of *B* is unacceptable (say for life-threatening or mission-critical reasons), *A* must still be used.