

# On the asymptotic properties of functions and programs\*

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## Abstract

During the analysis of the algorithms – besides the proof of their correctness – we typically calculate the computational (i.e. time and space) complexities of them. The efficiency of an algorithm is usually given as functions relating the size of the input to the number of some critical operations and of storage locations.

In this paper we develop some general, but easy-to-prove theorems on the order of growth of functions. We use them to give the usual asymptotic estimates for the efficiency of some algorithms. We avoid the use of the *master theorem* in the case of *merge sort* when it is typically used [1]. In this way we give a complete but easy-to-understand proof of the theorem that its time complexity is  $\Theta(n \lg n)$ .

For time complexity, in this paper we estimate the number of procedure calls + loop iterations because the running time of a program is generally proportional to this measure [2]. We emphasize that our simple but exact approach has great advantages in *education* at the undergraduate level.

*Keywords:* algorithm, growth of functions, asymptotic efficiency, time complexity, education

*MSC:* 68P05, 68P10, 68P20, 68Q25

## References

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