An Introduction to Theoretical Computer Science

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Chapter 1

Foundations

Before one can begin a thorough study of the theory of computation, some basic mathematical background is in order. The reader experienced in various areas of discrete may skip this chapter, but it would be useful nonetheless, to reestablish the language of mathematics in which computer science is laid out.

We begin with a discussion of logic, proofs, and basic mathematical vocabulary. After that, key concepts such as asymptotic notation, algebraic structures, and other mathematical prerequisites are explained. The chapter ends with a quick review of basic data structures and a pointer to further reading on the topic.

1.1 Mathematical Logic and Proofs

We will now establish the language in which all our results will be conveyed. Before we start however, consider the meaning of the word "proof." Forget for a minute the mathematical perspective from which we are approaching this. An intuitive definition of a proof is a way of ascertaining truth from prior knowledge. In other words, a proof is anything that shows the truth of a new idea using the truth found in existent ones. For our purposes, we will define a proof in the following way.

Definition 1.1. *A **proof** is a sequence of logical deductions that, given certain assumptions, allows one to ascertain the truth of a statement.*

The key word here is probably *assumptions*. The statement of a theorem is useless without the assumptions made in the proof. There will be, of course, some theorems where these assumptions will not be stated. This will be either due to the implicitness or obviousness of the assumptions.

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