

Exercise 6: Basics of computer science, part I

Data and Digital Storage

The logic and mathematics of the digital world are essential tools in computer science. Since in the most basic way computers work with binary digits (0s and 1s), a basic grasp of data representation and arithmetics in binary base is extremely important. In order to thoroughly understand binary bases, an understanding of general number bases and arithmetics using different number bases is needed.

Problem 1: Data Representation

1. Why do we use base-2 for data storage in computers?
2. How many Bits are in a Byte? How many in a Word?
3. How many Bytes are in the following: 1KiB, 1MiB, 1GiB?
4. What is the minimum amount of bits needed for a complete representation of the English alphabet, which has 26 characters?
5. A book contains 1337 pages, with 4000 characters per page (including spaces). How much data is stored in the book, if we use the ASCII format to represent all characters (and assuming no compression)?

Problem 2: Number Bases

1. Convert the following binary numbers to base-10: 10, 101, 101111.
2. Convert the following base-10 numbers to base-2: 5, 16, 109.
3. Convert the same numbers to base-3 and base-16.
4. How many bits are needed to represent two hexadecimal digits? How many different numbers can be represented with two hexadecimal digits?
5. Convert the following 4-digit binary numbers to hexadecimal numbers: 0000, 0110, 1100, 1111.
6. Convert the following 2-digit hexadecimal numbers to binary numbers: 04, 1E, A7, FF.
7. YouTube uses Base64 to generate unique ID numbers for each video on their servers. To represent Base64 all 10 digits are used (0-9) plus all lowercase English letters (a-z) plus all uppercase English letters (A-Z) plus two more signs: '-' (minus) and '_' (underscore). Since YouTube uses 11 digits per video ID - how many unique IDs can this method yield?