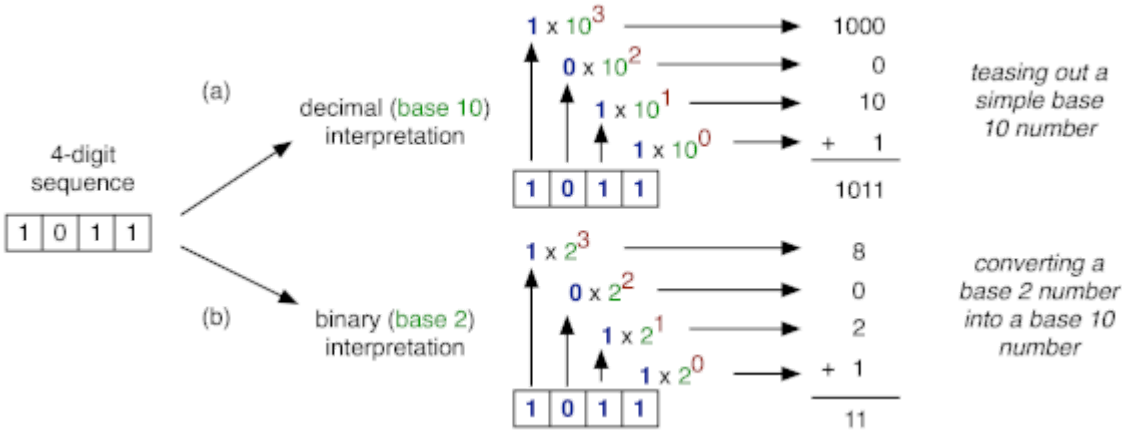
Converting between Decimal and Binary

Hardware Representations

First and foremost, as far as the computer is concerned, there is no way to move “past numbers” because to the computer, everything is a number. A computer stores everything as a series of 0’s and 1’s. Each 0 or 1 is called a bit, and there are many ways to interpret these bits. This is where types come in. A type is a programming language construct that specifies both a size and an interpretation of a series of bits stored in a computer. For example, the type for working with integers is an int, whose size is typically 32 bits and whose interpretation is an integer number directly represented in binary.

Binary Numbers

Before we delve into how to represent numbers in binary, let us briefly discuss the decimal system, which should be familiar to all of us. A decimal number is a number represented in base 10, in which there are 10 possible values for each digit (0–9). When these digits are concatenated to make strings of numbers, they are interpreted column by column. Beginning at the far right and moving to the left, we have the 1’s column, the 10’s column, the 100’s column, and so forth. The number 348, for example, has 8 ones, 4 tens, and 3 hundreds. The value of each column is formed by taking the number 10 and raising it to increasing exponents. The ones column is actually 10^{0}=1, the tens column is 10^{1}=10, the hundreds column is 10^{2}=100, and so forth. When we see a number in base 10, we automatically interpret it using the process shown in the figure below, without giving it much thought.



A binary number is a number represented in base 2, in which there are only 2 possible values for each digit (0 and 1). The 0 and 1 correspond to low and high voltage values stored in your computer. Although it might be possible for a computer to store more than two voltage values and therefore support a base larger than 2, it would be extremely difficult to support the 10 voltage values that would be required to support a base 10 number system in hardware. A familiarity with base 2 is helpful in understanding how your computer stores and interprets data.

Binary numbers are interpreted such that each bit (the name for a binary digit) holds the value 2 raised to an increasing exponent, as shown in the figure part b). We begin with the rightmost bit (also called the least significant bit) which holds the value 2^{0}=1, or the ones column. The next bit holds the value 2^{1}=2, or the twos column. In base 10, each column is ten times larger than the one before it. In base 2, each column's value grows by 2. The number 10_{2} (the subscript indicates the base) has 1 two and no ones. It corresponds to the value 2 in base 10. Congratulations! You are now technically equipped to understand the age-old joke: "There are 10 types of people in the world. Those who understand binary and those who do not."