



Binary Numbering System

Conversions

How do computer store information?

In a computer circuit, an electronic signal may be on or off. This can be represented as a 1 (on) or 0 (off).

But in real life, we use digits 0 through 9. How can we represent a “regular” number using 1’s and 0’s?

Decimal Numbers

In the *decimal system*, each digit of a number is a *multiple of a power of 10*.

For example:

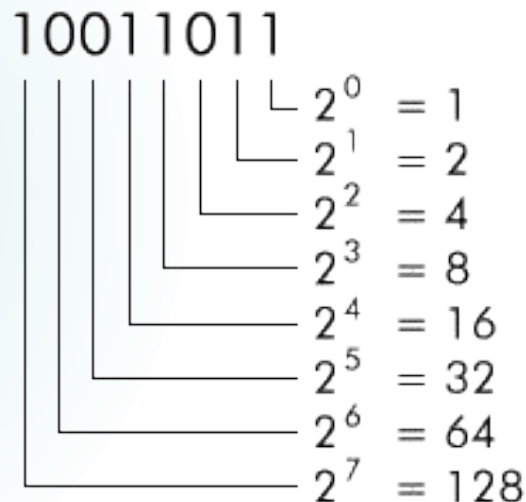
$$2054 = 2 \times 10^3 + 0 \times 10^2 + 5 \times 10^1 + 4 \times 10^0$$

We don't really *think* of numbers this way...
It's just natural!

Binary Numbers

Since computers can only interpret 1's and 0's (on or off signals), they must use a different number system.

The *binary system* represents numbers using 1's and 0's where each digit is a *multiple* of a *power of 2*. Each digit is called a *bit*.



Binary Numbers - Examples

What does each binary number represent in binary?

$(101)_2$



$(1111)_2$



$(0)_2$



$(101101)_2$



Bits & Bytes

One **byte** contains 8-bits. It's an 8-digit binary number.

What is the largest number that can be stored in one byte?

$$(11111111)_2 = 255$$

Still, that's not very big! To accommodate that, we need to look at *many* bits...

Representing Large Numbers



Suppose we want to encode a decimal number that is *larger* than a byte (255). There's an issue when it comes to using binary to store larger numbers...

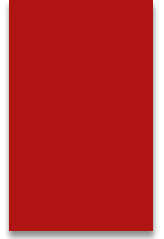
It takes too many bits!

Think about it...

It takes EIGHT digits in binary to represent the THREE digit decimal number 255.

Can you imagine trying to represent the number 123,456,789?

123,456,789



Here it is!

111010110111100110100010101

You can break down each column to
verify if this is correct

Going From Decimal to Binary

- There are 2 ways to go the other way:
From decimal (base 10) to binary (base 2)

Make sure you understand both methods here:

<https://www.wikihow.com/Convert-from-Decimal-to-Binary>

Important one to understand is the **Short Division by Two with Remainder Method**



Try this...

- Convert 156 to binary on your own ...