Binary Numbers

Have you ever wondered how computers are able to store so much information? Computers use a system to store information (or **data**) and this system can be thought of like a special kind of code. This code is made up of a series of zeros and ones. Like this:

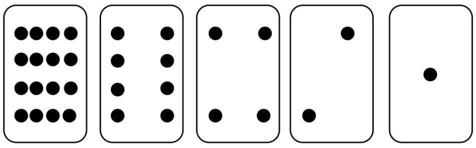
001010100010111

This type of representation, or code, is called **binary representation**. The binary number system plays an important role in how information of all kinds is stored on computers. Binary numbers are also used to communicate and transfer this information as well. Understanding binary numbers can lift a lot of the mystery from computers, because actually computers are really just machines that flip binary numbers (or **digits**) *on* and *off*. Have you ever thought of computers this way before? If you understand binary numbers, you can understand the basic process of how computers work.

This activity can help you learn more about how binary representation works and understand how words and numbers in computers are stored using *just two symbols*!

What you will need

You will need a set of five binary cards (the dots on the card indicate its value in the **decimal system**; the decimal system is the way we usually express numbers, using digits 0-9).



How does it work?

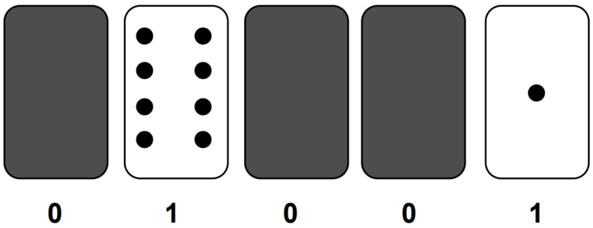
1. Usually when we write numbers, we use digits between 0 and 9 (for example 0, 1, 2, 3, 4 and so on). However, in binary representation, every number is represented using *only* the digits 0 and 1. As we said before, we can think of this like a code, so to understand binary representation we need to learn the pattern of the code. Here are some examples of numbers between 0-10 and the binary representation for each of these numbers. See if you can spot the pattern:

Usual number expression	Binary representation
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000

2. If you look at our chart, you will see that in binary representation, we start by going in order from **0** to **1**. We then we increase the number of digits, using the number 1 at the start of the next series of digits, and the last digits again go in order from 0 to 1 (1**0**, 1**1**). Again we increase the number of digits with the number 1 in the front, and now we go in order of 00, 01, 10, 11 (1**00**, 1**01**, 1**10**, 1**11**). Can you see the pattern we are following? Another way to think of binary numbers is to think of it representing the power of 2. Or in other words, every time we double our numbers on the left side of the chart, starting with the number 2, we increase the number of digits in binary representation (2 = 10, 4 = 100, 8 = 1000), Now, what do you notice about the number of dots on the cards? If you've noticed that each card has twice as many dots as the card to its right, this will help you with your answer.

3. We can use these cards to make numbers by turning some of them face down and adding up the dots that are showing.

4. When a binary number card is not showing, it represents a **zero** digit in binary. When it is showing, it represents a **one** digit in binary. This is our simple representation of the binary number system.



5. The cards above show 01001 in binary. What number is this in decimal (our usual way of expressing numbers)? Add up the numbers on the cards to get your answer. Now, can you figure out what 17 would be in binary? Can you show it using the cards?

Challenge: Try making the numbers 1, 2, 3, 4 in order. Can you work out a logical and reliable method of flipping the cards to increase any number by one?