2.5 Binary Numbers

Objectives: You will be able to:

- Count forward and backward in binary.
- Explain why binary numbers are important in computer science.
- Use binary digits to encode and decode messages.

Journal Entry

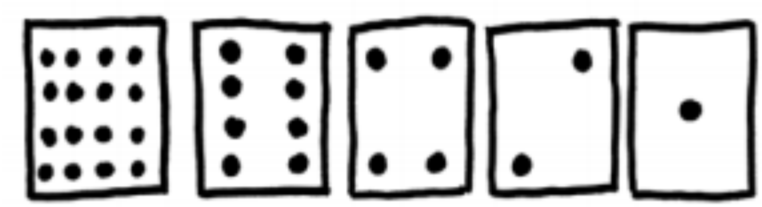
How high can you count with your ten fingers?

What are Binary Numbers?

The *Binary Numbers* system is a base-2 system of numbers that uses only the digits 0 and 1. Digits like 2, 3, 4, 5, 6, 7, 8, or 9 are not used. However, the values of these digits can be expressed using the *Binary Numbers* system [2 = 0010, 3 = 0011, 4 = 0100, 5 = 0101, 6 = 0110, 7= 00111], 8 = 1000, and 9 = 1001].

Take a close look at the banner below and you will see binary numbers in the background, some of them are highlighted spelling "CODE".

Activity: Counting the Dots



1. In groups, make five cards with 1 dot, 2 dots, 4 dots, 8 dots, 16 dots
2. What do you notice when you arrange the cards from largest on the left) to the smallest on the right)? How many dots would the next card have?
3. How would we make the number 3? 6? 12? 19?
4. In groups, count from 1-10.
    - Write these numbers in binary.
5. In groups, continue counting to 31 in binary using the cards. 1 = 00001)
6. In your journal, complete this table:

		128		32			4	2	1
2^9								2^1	2^0

Decimals Numbers to Binary Numbers

Watch Video: Converting from Decimal to Binary

- http://viewpure.com/H4BstqvgBow

In the video above, the first task is to convert the decimal number 13, what we are familiar with, to its binary equivalent 1s and 0s).

Using the Counting the Dots activity above as a reference, how would you write the number 13 in binary?

Or we could ask, what powers of 2 do we need to make up 13?

Powers of Two

$2^0 = 1$
$2^1 = 2$
$2^2 = 4$
$2^3 = 8$
$2^4 = 16$
$2^5 = 32$
$2^6 = 64$
$2^7 = 128$

Problem Solving: 13 = what binary number

What is the largest power of two that is less than or equal to 13? 8. Eight down 5 to go! 13 - 8 = 5)

What is the largest power of two that is less than or equal to 5? 4. So we have 8 + 4 = 12. One to go!

The largest power of two left is 1.

So 13 = 8 + 4 + 1. But we still have to convert this to its Binary form.

With the powers of two table you created above, you can not assign Binary Numbers to 8 + 4 + 1.

16	8	4	2	1
0	1	1	0	1

13 = 01101

Notice that the numbers increase from right to left. That means if there is a 0 furthest to the left we can exclude that number.

13 = 1101

Binary to Decimal

To convert Binary Numbers to Decimal Numbers you can use the same Powers of Two table.

What is the decimal number 111000?

1. Make a powers of two table equal to or less than 56

32	16	8	4	2	1

2. What is the largest number equal to or less than 56? 32. 56 - 32 = 24)
3. What is the largest number equal to or less than 24? 16. 24 - 16 = 8)
4. We are left with an 8 which is a base-2 number.

So let's add up the numbers... 32 + 16 + 8 = 56

32	16	8	4	2	1
1	1	1	0	0	0

Practice your Binary Counting Skills

- Fun Binary Quiz @ http://acc6.its.brooklyn.cuny.edu/~gurwitz/core5/binquiz.html

Resources

- Bell, Tim, Ian Witten and Mike Fellows. Computer Science Unplugged. Canterbury, New Zealand: 2002.
- Computer Science Unplugged Activity 1: Count the Dots - Binary Numbers, p. 3-13.

Video: Introduction to Binary Numbers

- http://viewpure.com/ku4KOFQ-bB4 [Start video at 5:35]

Video: Adding in Binary

- http://viewpure.com/RgklPQ8rbkg