Western Engineering Outreach

Binary Words

Grade 3-5

Meet Today's ENG HERO!

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https://www.eng.uwo.ca/electrical/faculty/rahman_q/

Learning Goal:

- Learning about software engineering in a creative way
- Learning about how the binary number system works
- Curriculum connections: Grade 3- Forces causing movement, Grade 4- Light and Sound, Grade 5-Conservation of energy and resources

Materials Needed:

- Lots of beads
- Roll of string
- Clasp (optional)
- White sheet of paper
- Pencil

Engineering and Science Connections:

What is coding?
Code is a set of instructions that a programmer gives to a computer to tell the computer what they want it to accomplish.

Why do we need this set of instructions?
Computers cannot think for themselves; they can only read what they are being told. We must communicate with computers to be able to make them function.

Can we tell a computer what to do out loud?
No, we can only say instructions to humans out loud, because they will be able to understand the same language that we speak. Computers only speak very specific languages, that must be given to them through text.

What is the only language that computers understand?
The computer understands two types of data: on and off, or 1 and 0. A computer has a set of on and off switches, called transistors. Anything that a computer does is a combination of transistors turned on and off. However, transistors of a computer are represented as 1 and 0 numbers. The set of 1 and 0 numbers is called binary code, which is the only language that computers understand. Binary code is grouped into bytes or a group of 8 digits that represent 8 transistors each. Modern computers contain millions or even billions of transistors, so lots of binary code combinations.
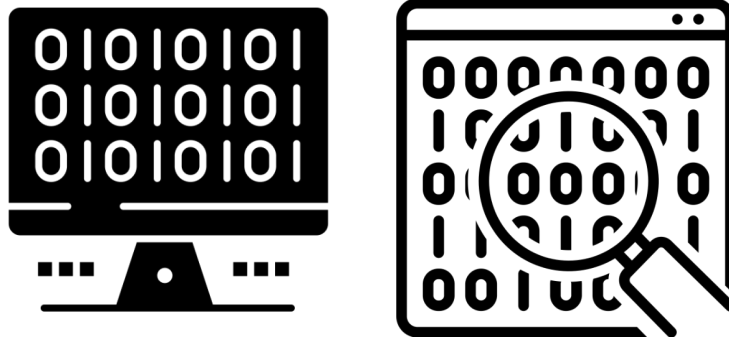
What is the Binary System?
The binary system is a number system, just like our familiar base ten numbering system. Instead of using 10 possible digits it only uses 2 possible digits of 1 and 0.

Terminologies to remember:
- The number of symbols that make up a numbering system is called a base
- Binary is a base 2 numbering system

- Hex is a base 16 numbering system
- Decimal is a base 10 numbering system

Number Systems

As with a numbering system, the value of the ith digit in a number is always the value of the ith digit times the base to the power of i. We start numbering from the rightmost digit of the number (the 1s column) and start at 1=0.

Example 1 : Consider the number 1234 (base 10 numbering system)

- $4 \times 10^0 = 4 \times 1 = 4$
- $3 \times 10^1 = 3 \times 10 = 30$
- $2 \times 10^2 = 2 \times 100 = 200$
- $1 \times 10^3 = 1 \times 1000 = 1000$
- Total =add all the pieces up =1234

Even and odd numbers in the binary system

In binary, it is very easy to tell if a number is even or odd. If the number is even the rightmost digit of the number (the 1's column) will be 0. If the number is odd, the rightmost digit will be 1.

Activity:

In today's activity, you will spell a short (2-5 letter) word out of beads in binary notation using the following binary code sheet and string them together to make a bracelet. You can use your initials or your name.

Character	Binary Code	Character	Binary Code	Character	Binary Code	Character	Binary Code	Character	Binary Code
A	01000001	Q	01010001	g	01100111	w	01110111	-	00101101
B	01000010	R	01010010	h	01101000	x	01111000	.	00101110
C	01000011	S	01010011	i	01101001	y	01111001	/	00101111
D	01000100	T	01010100	j	01101010	z	01111010	0	00110000
E	01000101	U	01010101	k	01101011	!	00100001	1	00110001
F	01000110	V	01010110	l	01101100	"	00100010	2	00110010
G	01000111	W	01010111	m	01101101	#	00100011	3	00110011
H	01001000	X	01011000	n	01101110	$	00100100	4	00110100
I	01001001	Y	01011001	o	01101111	%	00100101	5	00110101
J	01001010	Z	01011010	p	01110000	&	00100110	6	00110110
K	01001011	a	01100001	q	01110001	'	00100111	7	00110111
L	01001100	b	01100010	r	01110010	(	00101000	8	00111000
M	01001101	c	01100011	s	01110011	)	00101001	9	00111001
N	01001110	d	01100100	t	01110100	*	00101010	?	00111111
O	01001111	e	01100101	u	01110101	+	00101011	@	01000000
P	01010000	f	01100110	v	01110110	,	00101100	_	01011111

Step 1: Prepare the beads

- Prepare the beads and string for the activity; black and white beads work well for 1 and 0. Use other coloured beads to individuate where each binary letter starts and stops. Use two coloured beads to indicate where the word starts and stops.

Step 2: Make a legend

- Depending on the beads that you have available at home choose your colour combinations -it does not have to be black and white.
- Be sure to write a legend so that people can decipher your word.

Step 3: Write it on paper!

- Try writing your initials (or word) in binary on paper and line the black and white beads up to match your binary code on the page.

Step 4: Make the bracelet!

- String all beads together to make a bracelet. Tie the string or use a clasp if you have one.
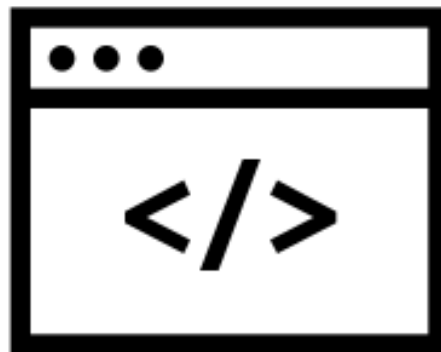
What Did You Learn?

- What language do computers speak?
- What is a binary code?
- How do you use the binary code.
- What initials are displayed in the picture if green is 1 and white is 0?

Future Learning

- Turn this activity into a fun game of charades! However, instead of yelling out your answer, you will need to translate the word into Binary Code and submit it. You can play with anyone at home and if you manage to guess what the person is pantomiming you will earn a point.

Share your creations!

We would love to see what you made. Email as at discover@uwo.ca or tag us on social media.

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Thanks for discovering with us!