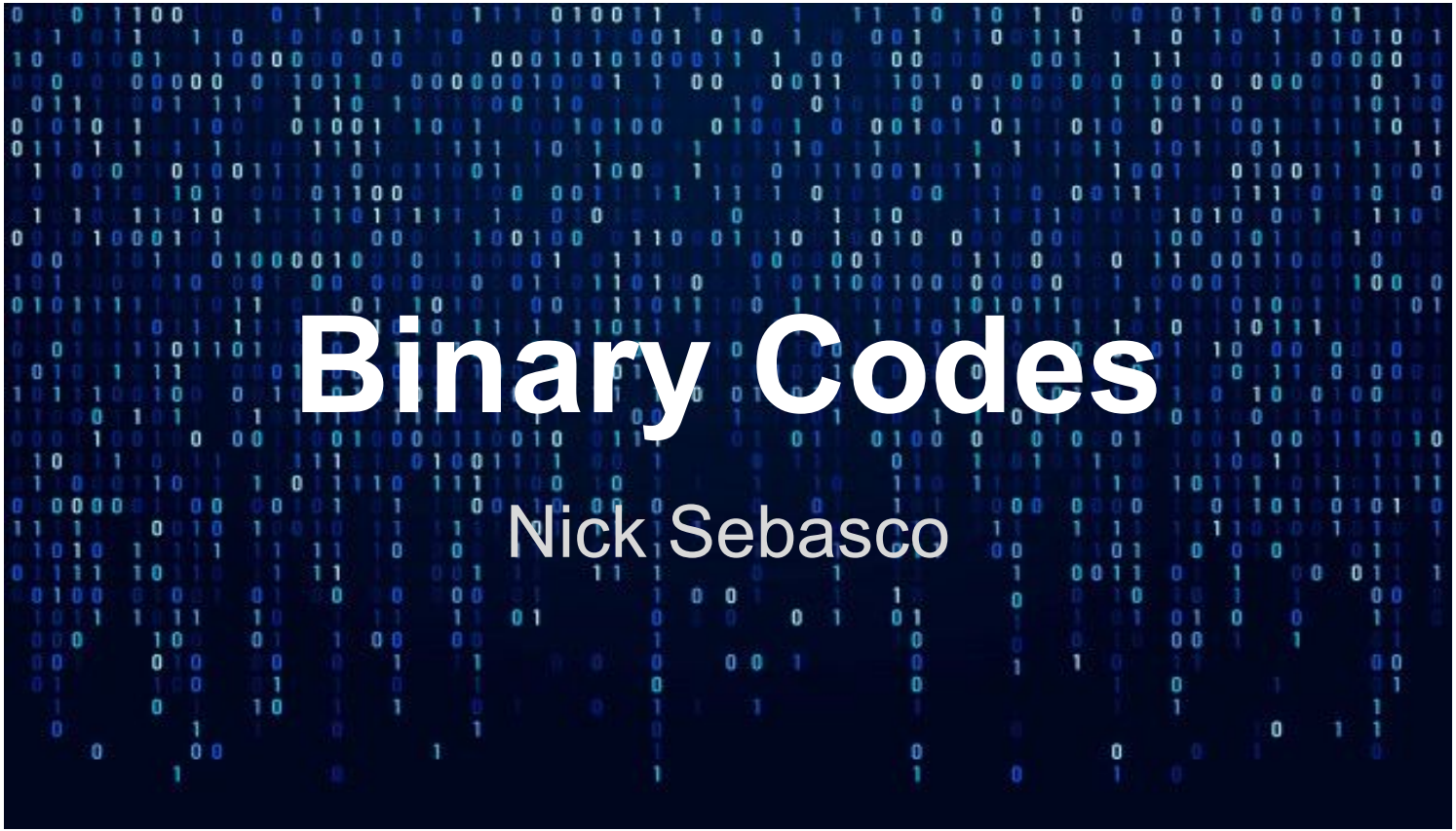

Binary Codes
Nick Sebasco

Reading and Writing Without Sight

At the age of 3 Louis Braille was playing in his father's harness making workshop a sharp tool poked him in one eye, the wound became infected, spread to the other eye, and he became totally blind.

Valentin Hauy, invented a system of raised letters that could be read by touch, the raised letters were structurally the same as normal alphabet characters as it did not occur to Hauy that a different system might be optimal for the blind.

The origins of an alternate code stemmed from Charles Barbier whom developed a system of writing for soldiers at night time. The system was called "night writing" and consisted of raised dots and dashes which corresponded to sounds (not letters or words). This proved to be cumbersome for longer messages because it created long complex codes.

Braille learned the Barbier system at age 12 and spent the following 3 years using it and improving it! By the age of 15 he had created his own code, which is still used today.

Braille contracted tuberculosis and died right after his 43rd birthday.

Figure 1. Louis Braille alongside the Braille reading & writing system.

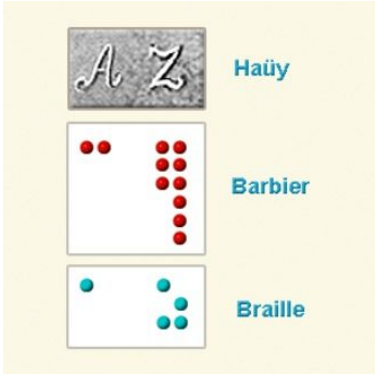


*Figure 2. The Hauy, Barbier, and Braille systems all representing the characters **A** and **Z.***

The Braille Code

How many unique codes or characters can the Braille system represent?

Each cell has two possible fates: raised or smooth.

The mathematical formula that gives the # of unique possibilities or **permutations**:

# cells	# Choices/ cell	Outcomes	# Permutations
1	0: {s, r}	0s, 0r	2
2	0: {s, r}, 1: {s, r}	0s1r, 0s1s, 0r1r, 0r1s	4
6			2^6 = 2*2*2*2*2*2 = 8*2*2*2 = 8*8 = 64
r	0: {s, r}, 1: {s, r}, … r-1: {s, r}	0s1s...r-1s, ...	2^r

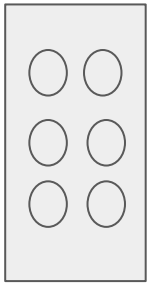


Figure 3. Each character in Braille code consists of 6 dots.

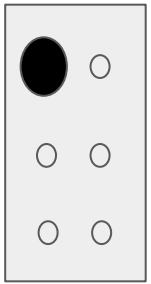


Figure 4. The braille letter A. The notation of using larger black dots is a common convention when embossing is not feasible

From Braille to Binary

Each 6 cell can be converted into a binary number. Braille is a binary code.

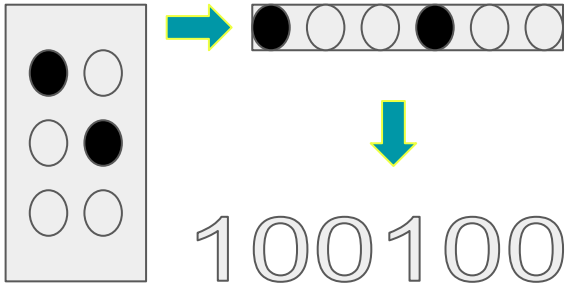
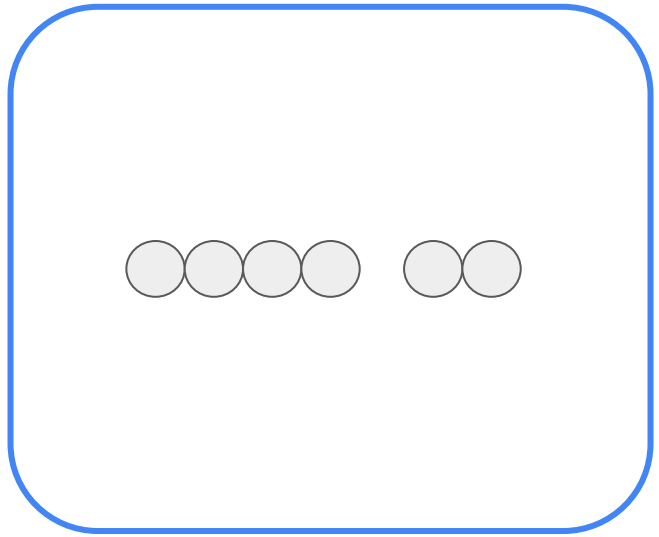


*Figure 3. The braille code for the letter **E**, encoded into a binary number. What is this number in base 10?*

Talking with your friends

Morse Code 1

A ●−	J ●−−−	S ●●●
B −●●●	K −●−	T −
C −●−●	L ●−●●	U ●●−
D −●●	M −−	V ●●●−
E ●	N −●	W ●−−
F ●●−●	O −−−	X −●●−
G −−●	P ●−−●	Y −●−−
H ●●●●	Q −−●−	Z −−●●
I ●●	R ●−●	



Morse Code 2

Morse code can be memorized and sent in a form **perceptible** to the human senses, e.g. via sound waves or visible light, such that it can be directly interpreted by persons trained in the skill.

.. ..-

Morse Code 3

How many codes can I make from 8 dits & dahs?

Dit = .

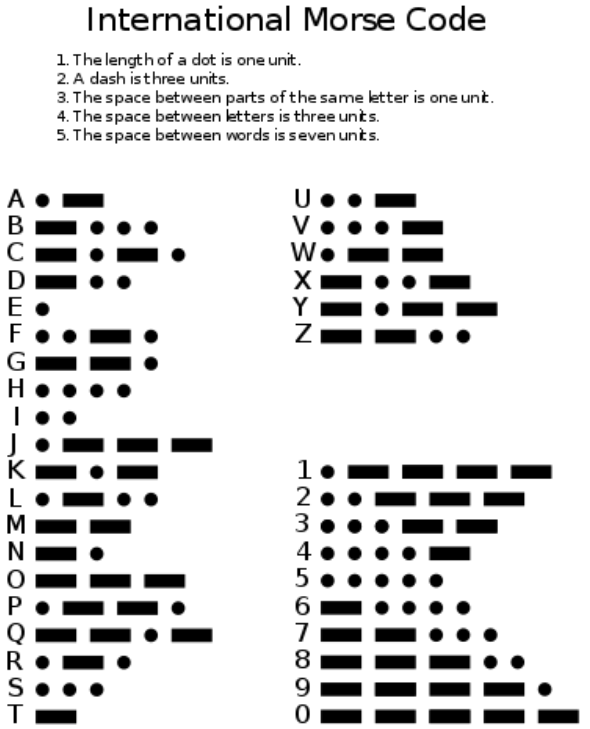
Dah = -

2^r = 2^8 = (2*2*2)*(2*2*2) * 2 * 2 = 8*8*2*2 = 64 * 2 * 2 = 128 * 2 = 256

Morse Code 4

The length of each symbol is approximately the **inverse frequency** of **occurrence**.

What is the most commonly used letter in the English language?



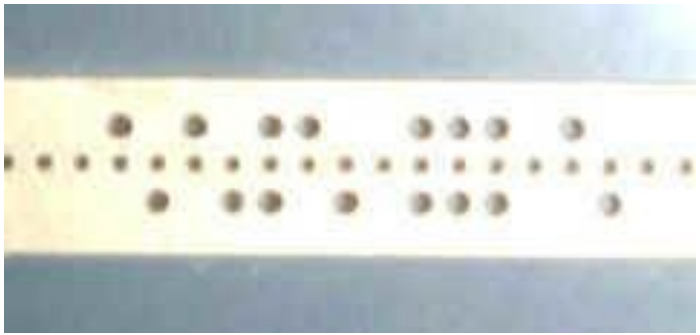
Morse Code 5: The Telegraph

Made indentations on paper tape when electric current was received.

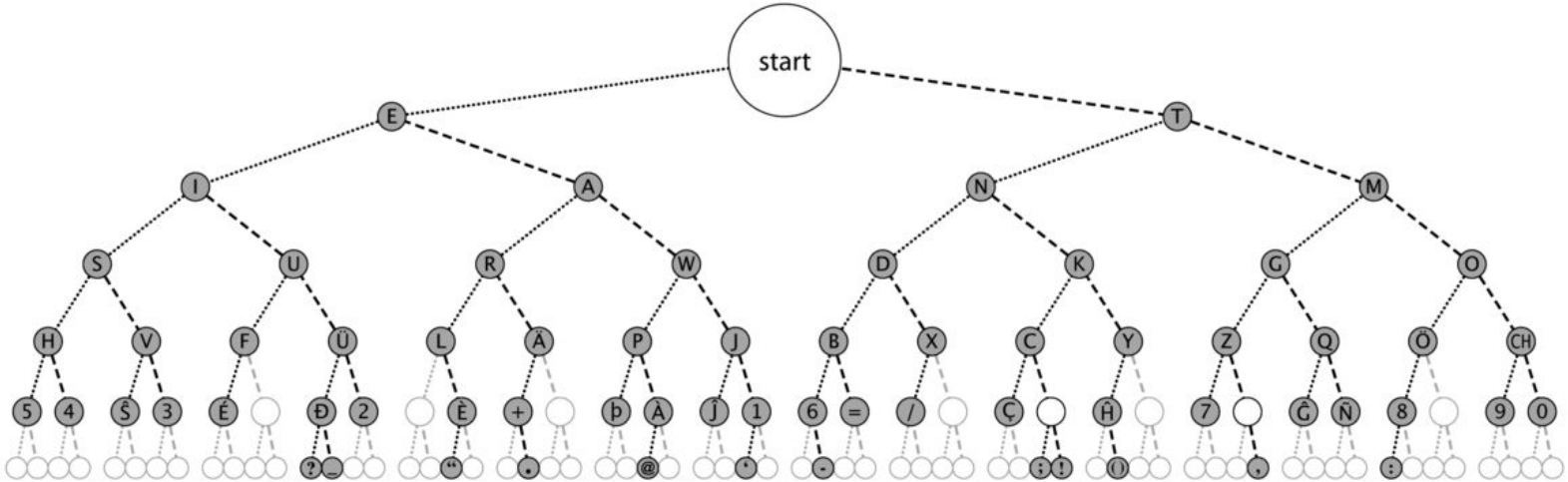
Original telegraphs made a clicking sound when it moved to mark the tape.

Operators learned to use these clicking sounds to interpret the message without ever reading the tape.

Skilled operators can interpret messages in their head a rate of 40 wpm! About 25 hours to interpret a short novel.



Morse Code 6: A Binary Tree



Data Representations

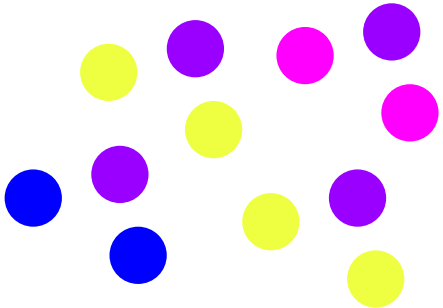
Binary Tree			List		
type	average	worst	type	average	worst
Search	O(log n)	O(n)	Search	O(n)	O(n)

Data (Information)

The essence of computing is information. Computer hardware and software products are designed to allow the input, storage, transfer and expression of various types of information.

Analog information is continuous.

Digital is discrete.



Although all are technically analog, which of these most closely exhibits continuous behavior?

Binary Information

The Latin prefix “bi” means two.

Modern computers store information digitally (discrete).

Binary digital information has two values: “ON” or “OFF”” / “TRUE” or “FALSE”/ 1 or 0

Underlying all networking structures are ones and zeroes sent over the network medium.

Binary Information Data Representation

Bits are the fundamental building blocks of computer information.

# Bits	Term
1	Bit/ Digit/ Flag
4	Nibble
8	Byte/ Octet
16	Double Byte
32	Long Word
64	Very Long Word

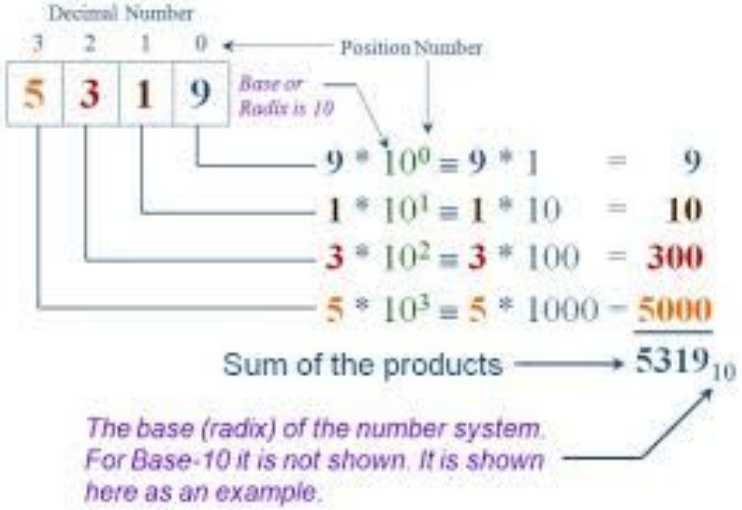
Decimal (Base 10) numbers

The numbers that humans generally use!

Every digit is 0 - 9

Why is the number 10 the foundation of our normal mathematical system?

Hold both hands up and count…



Binary Numbers

Every digit is either a 0 or 1.

A binary number with N digits can hold up to 2^N values.

Table 2: Binary and Decimal Number Equivalents

Binary Number	**1**	**1**	**0**	**1**	**0**	**0**	**1**	**1**
Power of Two	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Value of Digit Place	128	64	32	16	8	4	2	1
Value For This Number	128	64	0	16	0	0	2	1
Running Sum (from left to right)	128	128+64 = 192	192	192+16 = 208	208	208	208+2 = 210	210+1 = **211**

Sources

1. https://en.wikipedia.org/wiki/Louis_Braille#Braille_system
2. Code: The Hidden Language of Computer Hardware and Software