Understanding binary

Understanding computers

3rd Edition

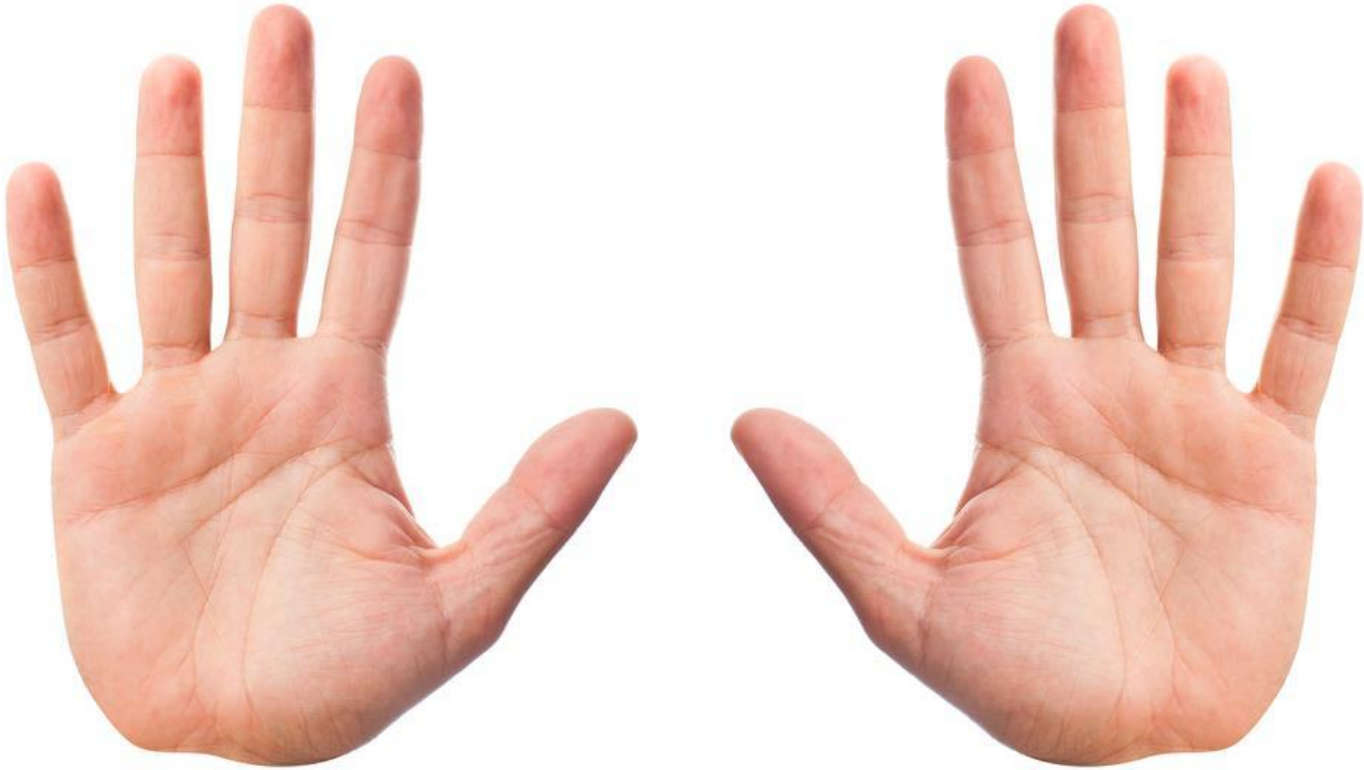
PG ONLINE

Objectives

- Understand why all data is represented in binary in a computer
- Define a Bit, Byte, Kb, Mb and Gb
- Convert integers to binary numbers
- Convert binary numbers to integers
- Show how characters can be represented using ASCII

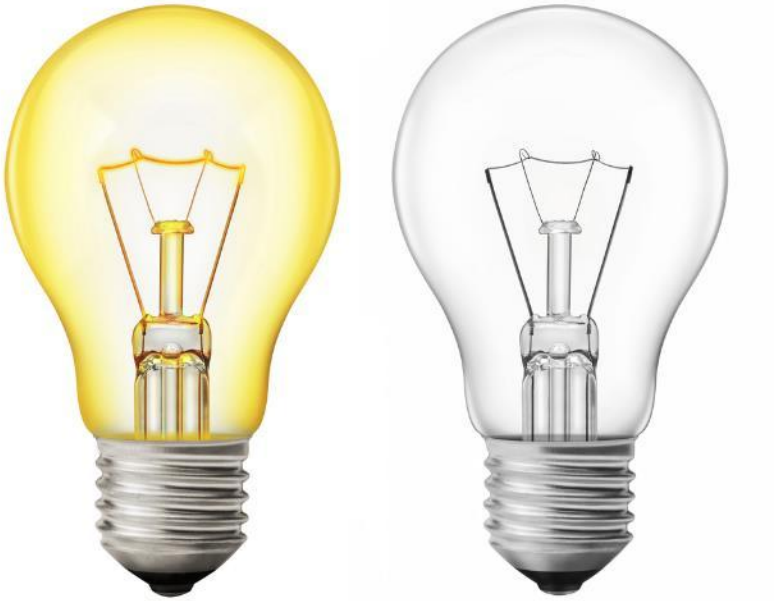
Decimal number system
(Sometimes called the Denary system)

- Why 10 digits?



What about computers?

- Computer use millions of electronic circuits and switches which can either be **On** or **Off**



- **On** is represented by **1** and **Off** is represented by **0**

Binary – On & Off

- The standard On / Off symbol on a switch is a 1 and a 0:

Bits and bytes

- 0 or a 1 = 1 Bit (Binary Digit)
- 8 Bits = 1 Byte
- 1000 Bytes = 1 Kilobyte (Kb)
- 1000 Kb = 1 Megabyte (Mb)
- 1000 Mb = 1 Gigabyte (Gb)
- 1 Byte = 1 Character of text
  - How many Gb in a Terabyte?
  - How many bytes in a Megabyte?

Binary representation

- One switch can only represent 2 possible states
  - **On** or **Off**

- Two switches can represent 4 states
  - **On** & **On**
  - **On** & **Off**
  - **Off** & **On**
  - **Off** & **Off**

Binary representation

Number of Switches	Possible combinations or states
1	2
2	4
3	
4	
5	
6	
7	
8	

Binary to denary conversion

128	64	32	16	8	4	2	1
							
0	1	0	1	0	0	0	1

= 64 + 16 + 1

= 81

How our decimal number system works

100	10	1
5	8	3

- The number 583 represents five 100s + eight 10s + three 1s. **500** + **80** + **3**
- As we move from right to left, each digit is worth ten times the previous one

The Binary system

4	2	1
1	0	1

- In Binary, there are only two digits, 0 and 1
- As we move from right to left, each digit is worth twice as much as the previous one
- What decimal number does the binary number above translate into?

Binary to Decimal conversion

- Work out the Binary numbers from 0 to 10

Decimal	Binary
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Binary to Decimal conversion

- Work out the Binary numbers from 0 to 10

Decimal	Binary
0	0
1	01
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010

Worksheet 3a

- Try Challenge 1 on the worksheet

Decimal to Binary

- Convert 28 to Binary
- Method
- Working right to left write out the numbers 1, 2, 4, 8 and so on doubling each time to 128

128	64	32	16	8	4	2	1

Decimal to Binary

- Convert 28 to Binary
- Method
- Working right to left write out the numbers 1, 2, 4, 8 and so on doubling each time to 128

128	64	32	16	8	4	2	1
0	0	0	1	0	0	0	0

28 has a 16 in it, with remainder 12

Put a 1 under the number 16

Decimal to Binary

- Convert 28 to Binary
- Method
- Working right to left write out the numbers 1, 2, 4, 8 and so on doubling each time to 128

128	64	32	16	8	4	2	1
0	0	0	1	1	0	0	0

12 has an 8 in it, remainder 4

Put a 1 under the number 8

Decimal to Binary

- Convert 28 to Binary
- Method
- Working right to left write out the numbers 1, 2, 4, 8 and so on doubling each time to 128

128	64	32	16	8	4	2	1
0	0	0	1	1	1	0	0

Put a 1 under the number 4

28 = 16 + 8 + 4

The binary number is 00011100

Activity

- Try the questions on **Worksheet 3a** to convert binary numbers to and from decimal numbers

Representing characters

- How are characters represented in binary?
- How many characters are there on your keyboard?
- How many bits would be needed to represent up to 128 characters?

ASCII

American Standard Code for Information Interchange

- Numerous different codes for representing data have been invented, but ASCII is used nowadays on nearly all computers
- Originally only 7 bits were used but now the eighth bit is used to give extra characters such as ©, ® etc.
  - How many different characters can be encoded using seven bits?
  - How about eight bits?

ASCII Table

Decimal	Binary	Character	Decimal	Binary	Character	Decimal	Binary	Character
32	00100000	space	64	01000000	@	96	01100000	`
33	00100001	!	65	01000001	A	97	01100001	a
34	00100010	"	66	01000010	B	98	01100010	b
35	00100011	£	67	01000011	C	99	01100011	c
36	00100100	$	68	01000100	D	100	01100100	d
37	00100101	%	69	01000101	E	101	01100101	e
38	00100110	&	70	01000110	F	102	01100110	f
39	00100111	'	71	01000111	G	103	01100111	g
40	00101000	(	72	01001000	H	104	01101000	h
41	00101001	)	73	01001001	I	105	01101001	i
42	00101010	*	74	01001010	J	106	01101010	j
43	00101011	+	75	01001011	K	107	01101011	k
44	00101100	,	76	01001100	L	108	01101100	l

ASCII

- It is a character-encoding scheme originally based on the English alphabet
- ASCII codes represent text in computers, communications equipment, and other devices that use text
- For example: a lower case '**f**' is represented by the following combination of bits in the ASCII table

  f = 1100110 or in 8 Bits, 01100110

- 8 bits is called a Byte

Numbers in ASCII

- Numbers as well as letters and other symbols are represented in ASCII
  - What is the bit pattern for the character 5 in ASCII?
  - What is the bit pattern in binary for the number 5?
- When 5 is pressed on the keyboard, the ASCII bit pattern is sent to the computer. It can't be used for arithmetic!

Challenges

- **Challenge 1:** Use the ASCII table on the ASCII Worksheet to write down the binary equivalent of your first name
- **Challenge 2:** Write a brief coded message for someone in binary using the ASCII Code sheet

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