Computer Systems

How Data is Stored in a Computer System

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Introduction

P2

Recording data in computer

The computer is an electronic device.

The current passes through the circuits.
High voltage represents 1 and low voltage represents 0

Data is stored in memory and on the hard disk in the form of 1 and 0.
The binary system is used to represent the data.

Text, numbers, pictures, audio are stored in the this way.

Characters (Letters, Punctuation)

ASCII
ASCII stands for American Standard Code for Information Interchange.

Computers can only understand numbers- binary numbers

an ASCII code is the numerical representation of a character such as 'a' or '@'
or an simple action of some sort like a beep..

In the ASCII character table also contains simple control codes for actions such as
Line feed - the return key
Form feed - a new page
Escape - the escape key
back space – the delete key

ASCII table

Extract from the ASCII table

Decimal	Octal	Hex	Binary	Character
065	101	41	01000001	A
066	102	42	01000010	B
067	103	43	01000011	C
068	104	44	01000100	D
069	105	45	01000101	E
070	106	46	01000110	F
071	107	47	01000111	G
072	110	48	01001000	H
073	111	49	01001001	I
074	112	4A	01001010	J
075	113	4B	01001011	K
076	114	4C	01001100	L
077	115	4D	01001101	M
078	116	4E	01001110	N
079	117	4F	01001111	O
080	120	50	01010000	P
081	121	51	01010001	Q
082	122	52	01010010	R
083	123	53	01010011	S
084	124	54	01010100	T
085	125	55	01010101	U
086	126	56	01010110	V
087	127	57	01010111	W
088	130	58	01011000	X
089	131	59	01011001	Y

Subtraction (and TWOS COMPLEMENT)

All mathematical operations take place as a form of addition!
The computer does not actually do subtraction!

Subtraction is achieved by 'complementing' the number to be subtracted and then adding the numbers.

Flip the Bits
In the binary system the complement of 1 is 0 because 1+0 gives 1.
One is the highest available digit, so 0 is the ones complement of 1, and vice versa.

So the ones complement of 1110101 is 0001010

Within the computer, however, **TWO's complement** is used.
To find the twos complement simply add 1 to the one's complement.

Value	1110101
ones complement	0001010
add 1	1 +
twos complement	0001011

Subtraction example

In decimal 5-2 = 3

In binary the numbers must be expressed as equal length numbers
(add leading zeros if needed) and so must the answer. Any final carry is ignored.

5= 101 ----------> 101
3= 011 ones complement 100
1 +
twos complement 101 new sum 101 +
010
1 carry ignored

final answer = 010 = decimal 2

Sign Magnitude
Representation of Negative Numbers

In the decimal system a negative number has a minus (-) sign in front of it, i.e. -7. But the registers can only store 0 or 1.

Methods used to represent signed numbers:

a) Signed magnitude
In the decimal system a sign may be placed in front of the number to indicate positive or negative.
85 or +85 is positive
-85 is negative

There is a sign and the magnitude of the number.

In binary register the most significant bit (MSB) is the left most digit. This is used to represent the sign of the number.
0 means it is positive, and
1 means it is negative.

The rest of the bits are used to represent the value.

The weighting of the digit positions becomes:

sign	64	32	16	8	4	2	1

To represent -85 in an 8 bit register:

+85 = 01010101 MSB is 0 = positive
-85 = 11010101 MSB is 1 = negative

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

neg 64 + 16 + 4 + 1 = -85

b) Radix (or base) complement
We have used this already in the example of subtraction.

The weighting of the digit positions changes:

-128	64	32	16	8	4	2	1

This is best shown as an example:

To represent -85 in an 8 bit register:

+85 = 01010101 MSB is 0

10101010 The ones complement
1 + Add one for the.....
10101011 twos complement

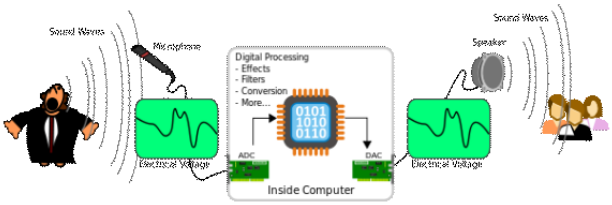
-128	64	32	16	8	4	2	1
1	0	1	0	1	0	1	1

-128 + 32 + 8 + 2 + 1 = -85

Sound

An analogue sound wave is picked up by a microphone and converted to digital via an Analogue to Digital (ADC) converter.
The ADC converts the electrical signals into digital values which can be stored on a computer.

To play digital audio you convert the sound from digital values into analogue electrical signals using the Digital to Analogue Converter (DAC)
These signals are then passed to a speaker.



Images

A large part of using modern computers involves pictures and video.

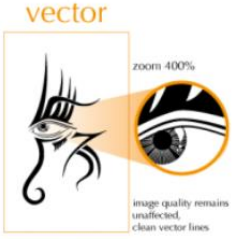
Bitmap Graphics – The image is made up of dots (pixels).
Each pixcel is represented by a binary value.
So for an High definition image more pixels are needed.

High resolution image Zoom= Low resolution

Images

Vector Graphics - images defined using mathematics and geometry such as points, lines, curves, and shapes or polygon(s).
Allowing for scalability.
Objects and properties stored mathematically.

Vector Images can be zoomed in & out with no loss of quality.



Summary

Text, numbers, pictures, audio are stored digitally inside the computer.

- The program will need to recognise what type of data it is dealing with.
- Sound files are typically given extensions like .WAV or .MP3
- Image files are typically given extensions like .mpg or .png
- Text files are typically given extensions like .txt or .dat
- Program files are identified by the extension .exe or .com
- WordProcessing files will store a combination of character and images
  These will have an extension to identify the application that they belong to.

  .doc is a word file
  .xls is an excel spreadsheet file.