Highsted Knowledge Organiser

Computer Science: Binary Data Representation (1) - Year 10 – Term 1

What I need to know

- What is a bit
- Why does the computer need binary representation to represent data
- How to represent number in binary digits
- How to represent characters in ASCII
- How to do binary arithmetic

Key Vocabulary

- Data units	- Bit (0 and 1)
- Binary system	- Denary
- Decimal	- Hexadecimal
- ASCII	- Binary addition

Student reference point

What is binary?

- Binary is a number system that only represents two digits 0 and 1.
- All data that we want a computer to process needs to be converted in this binary format.
- The binary system is also known as the base 2 number system, where data is converted using the power of 2.

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

Binary to Denary Conversion

128	64	32	16	8	4	2	1
1	0	1	0	1	1	0	1
128+32+8+4+1 1= 173							

Denary to Binary Conversion

Convert 199 to binary

128	64	32	16	8	4	2	1
199-128= 70	70-64 = 6	6-32 = -26	6-16 = -10	6-8 = -2	6-4 = 2	2-2 =1	1-1=0
1	1	0	0	0	1	1	1

Hexadecimal

- Hexadecimal uses 0-9 and A-F digits.
- It uses 4 bits called a nibble.

Hexadecimal (3C) to Binary

3 = 0011 C = 1100

00111100

Binary to Denary

128	64	32	16	8	4	2	1
0	0	1	1	1	1	0	0
32+16+8+4 = 60							

ASCII – Representing Text

The code used to represent text is called the ASCII code.
Each character (from a traditional keyboard) is converted to an ASCII number.
A = 65, a = 90, space = 31 and so on
An ASCII table has 128 characters. Unicode which has more characters are used for emojis and other languages.

Binary Addition

Starting from the right-hand side add 9 and 11.

	16	8	4	2	1
9 =		1	0	0	1
11 =		1	0	1	1
9+11 = 20	1	0	1	0	0
Carry bits	1		1	1	

Rules

Rules	
0+0 =	0
0+1=	1
1+1=	0 carry 1
1+1+1=	1 carry 1

Binary Shift

Binary shift is used to multiply and divide binary numbers.

Multiply 6 by 2. Shift the bits to the left by 1 place.

	16	8	4	2	1
6 =		0	1	1	0
6x2 = 12	0	1	1	0	0

Divide 20 by 4. Shift the bits to the right by 2 places.

	16	8	4	2	1
20 =	1	0	1	0	0
20/4=5	0	0	1	0	1

Challenge question

- Show that the hexadecimal equation 10 + 25 + 3A = 6F is correct.
- Explain with examples the terms overflow and underflow.

Suggested reading

- https://www.bbc.co.uk/bitesize/topics/zgv8dp3/articles/z9j2jsg
- https://isaaccomputerscience.org/concepts/data_numbases_binary_arithmetic_gcse?examBoard=ocr&stage=all

Highsted Knowledge Organiser

Computer Science: Binary Data Representation (2) - Year 10 – Term 1

What I need to know

- How images are represented in binary
- How is sound represented in binary
- What is lossy and lossless compression

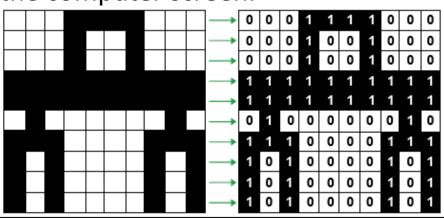
Key Vocabulary

- Pixel	- Resolution
- Metadata	- Colour depth
- Analogue	- Digital
- Amplitude	- Frequency
- Sample rate	- Bit rate
- Bit depth	- File size
- Lossy compression	- Lossless compression

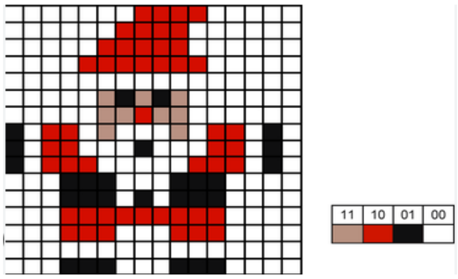
Student reference point

Binary Images

Images are made up of **pixels** which is made up of binary numbers (0/1). Each pixel is represented as a dot on the computer screen.



Images with more than 2 colours have more bits for each pixel.

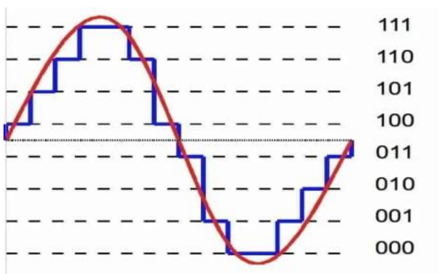


Bit depth represent the number of colours in an image.

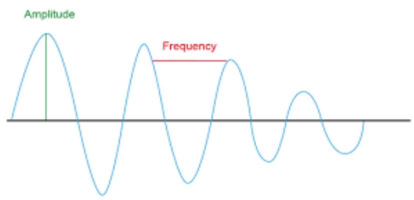
Bit depth	Number of colours
1 (2^1)	2
3 (2^3)	8
16 (2^{16})	65,536
24(2^{24})	16.7 million
32 (2^{32})	4.3 billion

Binary Sound

Sound needs to be converted to binary for the computer to understand and process. The **analogue** sound is thus converted to **digital** signal using binary numbers.

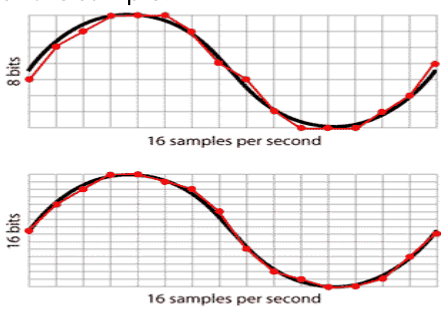


Sound is represented as waves on a graph.
Amplitude shows how loud the sound is.
Frequency shows how many waves are sampled in a second.
Sample rate shows how many times a sound sample is collected in a second.



Bit depth

Bit depth shows the number of bits used to collect samples per seconds. The more bits, the better the quality of the sample.



Lossy Compression	Lossless Compression
- Removes information from a file to reduce file size - Quality will be affected if it is a text or an image.	- Compression that tries to reduce file size without removing any information. - Quality isn't affected and is widely used for source code files.

Challenge question

- Calculate the file size of an image file in KB, using this formula: **pixels along width x pixels along height x colour depth**
- Calculate the file size of sound file in MB, using this formula: **number of channels x sample rate x bit depth**

Suggested reading

- https://www.bbc.co.uk/bitesize/guides/zfspfcw/revision/8
- https://www.bbc.co.uk/bitesize/guides/zfspfcw/revision/9

Highsted Knowledge Organiser

Computer Science: Fetch-Decode-Execute Cycle – Year 10

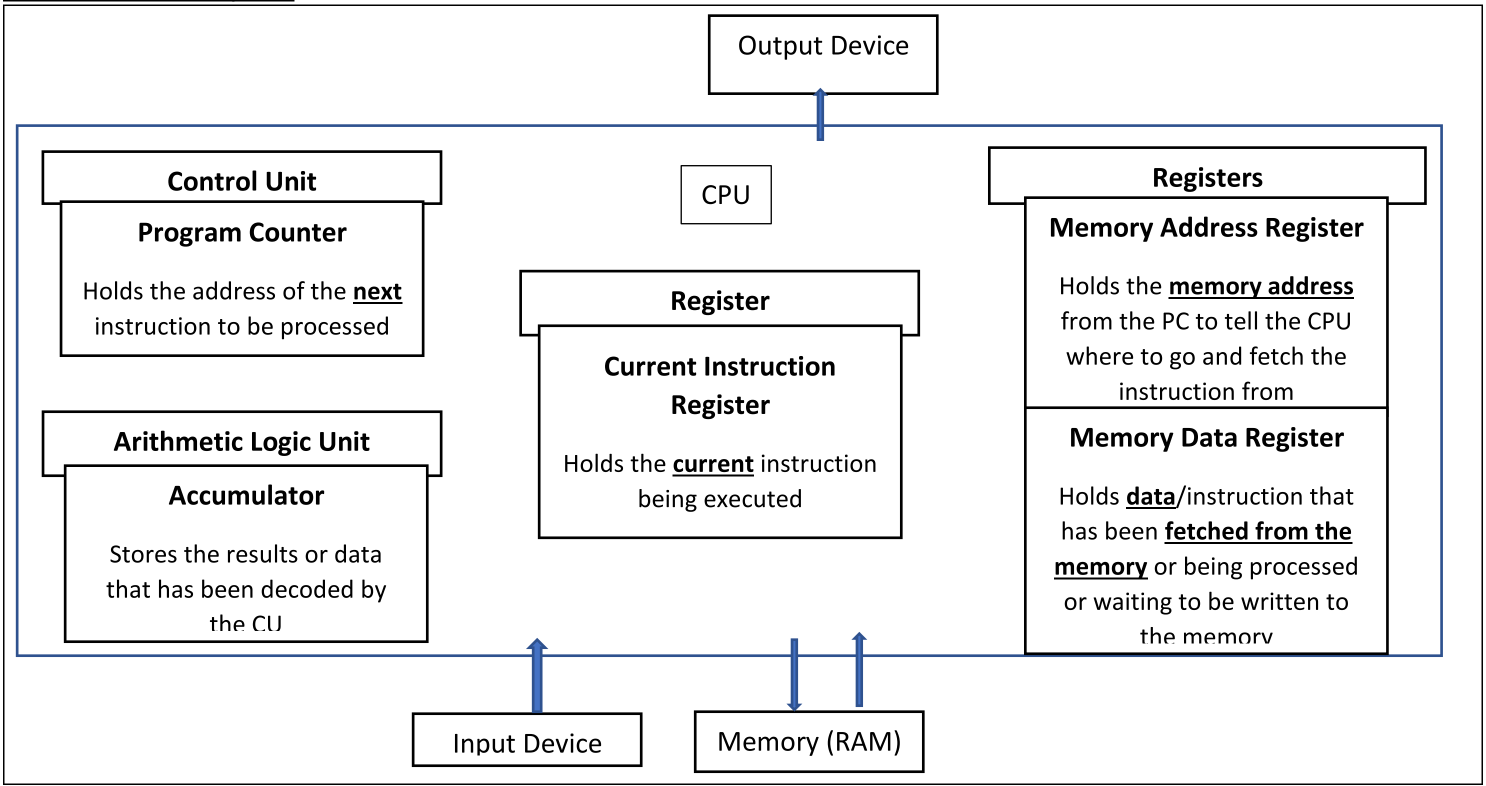
What I need to know

- Purpose of the CPU
- Components of the CPU
- How the CPU process data (FDE)

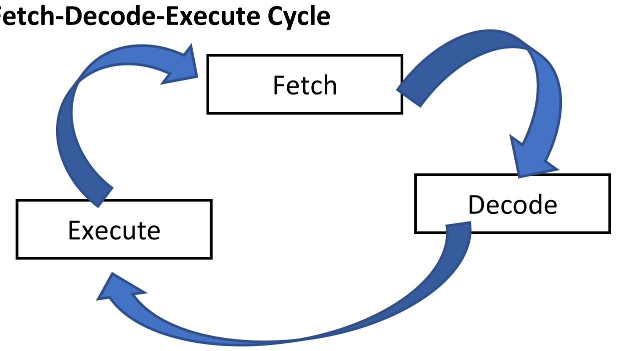
Key Vocabulary

- CPU	- Von Neumann
- Registers	- PC
- MAR	- MDR
- CU	- ACC
- Fetch	- Decode
- Execute	-

Student reference point



Fetch-Decode-Execute Cycle



Fetch
- Memory address is copied from the PC to the MAR.
- The PC is incremented to the next address
- The Data is fetched from the address and put in the MDR

Decode
- The instruction in the MDR is decoded in the CU

Execute
- The decoded instruction is executed
- The data is either sent to the ALU to be processed or written to the memory or more data fetched from the memory

Challenge question

- How can we make the fastest computer in the world?

Suggested reading

- https://www.bbc.co.uk/bitesize/guides/zbfny4j/revision/2