Swansea University
Prifysgol Abertawe

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

PRIFYSGOL
BANGOR
UNIVERSITY

Cardiff Metropolitan University | Prifysgol Metropolitan Caerdydd

Ariennir yn Rhannol gan **Lywodraeth Cymru**
Part Funded by **Welsh Government**

i.t.wales
www.itwales.com

PRIFYSGOL
ABERYSTWYTH
UNIVERSITY

PRIFYSGOL
glyndŵr
UNIVERSITY

University of South Wales
Prifysgol De Cymru

technoteach
technocamps

Common File Types

List all the file types you can think of and what type of data they represent

Why File Types?

Almost all computer systems have an operating system which acts as an interface between the programs that run on the computer and its hardware. Different types of data are represented and stored in many different ways and the operating system needs to know which file type each file is.

There are also many different file types for the same type of data – they may just represent the data in a different way or even represent the data in a compressed way.

File Types

File Extension	Information	File Extension	Information
doc	Storage of formatted text, graphics, etc.	odf	Storage of formatted text, graphics, etc.
jpg	Storage of graphics in a compressed format	wav	Storage of uncompressed audio information
wmv	Storage of audio information in a compressed format	mov	Storage of compressed video information
png	Storage of graphics in a lossless compressed format	mp3	Storage of compressed audio information
mp4	Storage of loss less compressed video information	pdf	Storage of documents in an un-editable format
zip	Storage of compressed files of any format	txt	Storage of plain text

Analogue & Digital Devices

Activity: Digital and Analogue Devices

You have **one minute** to list as many digital and analogue devices as you can think of.

Analogue vs. Digital Data

Analogue

Analogue means "is like" hence the words analogous and analogy.

Analogue data tries to be as authentic and "like" the original data as possible. It captures every aspect of the data.

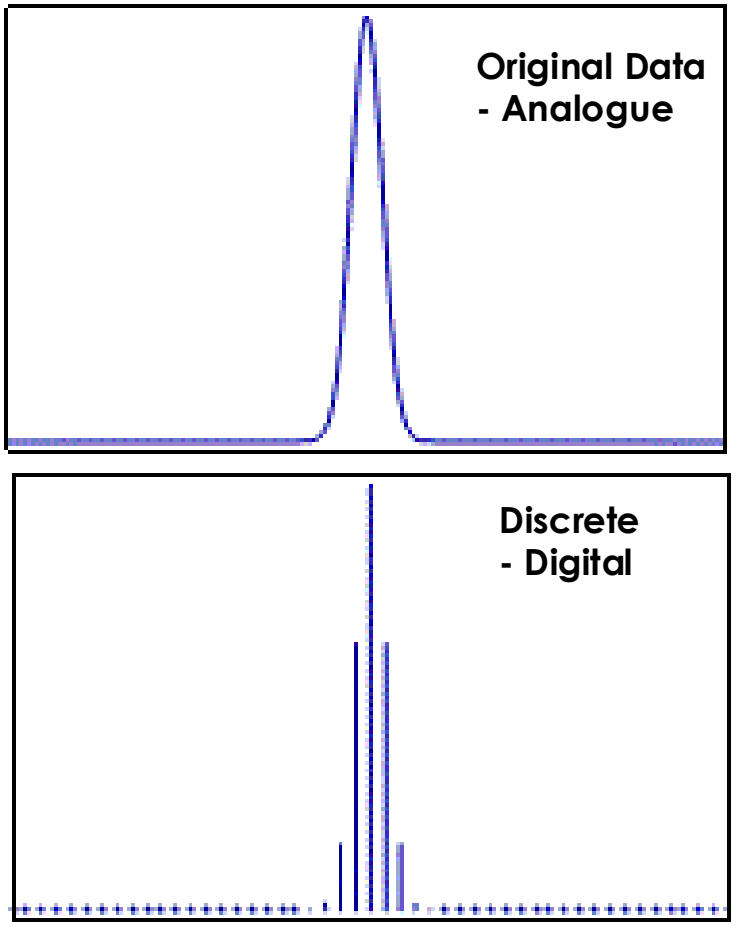
Most importantly, analogue data is continuous. There are no gaps in the data. It is **not** discrete.

Digital

The word **digital** derives from us counting using our digits. We have a discrete amount of fingers (and toes!) to count with.

Digital data usually takes discrete samples from the original data to give a representation of the data.

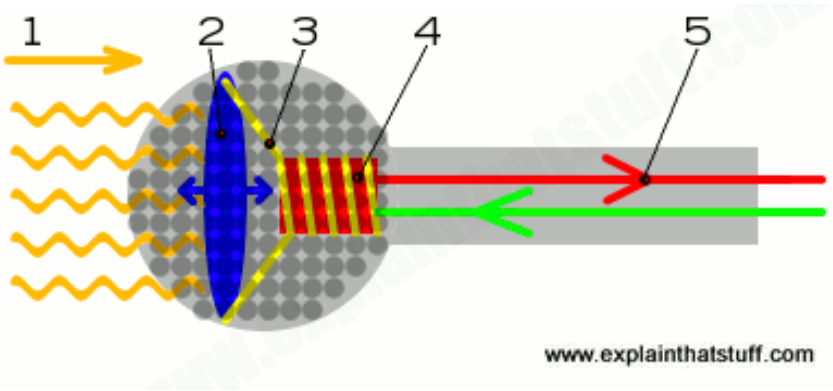
The quality depends on how many samples are taken (the sample rate) and how much data can be stored at each point.



Example – Recording Sound

When you speak or sing, your sound waves vibrate parts inside a microphone which converts the movement into an electric current.

This current gets converted by an ADC (i.e. sound card) into binary (0s and 1s) and can be stored in a computer.



Sound Quality – Sample Rate

Higher Sample Rate
Higher Quality

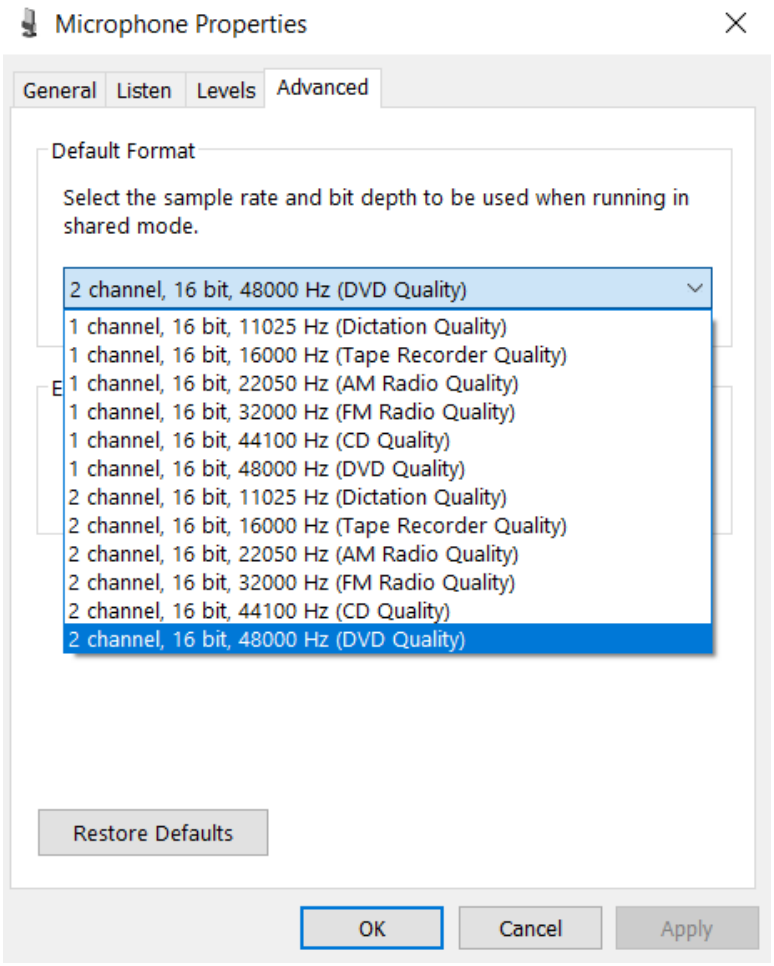
48,000Hz

32,000Hz

16,000Hz

11,025Hz

Lower Sample Rate
Lower Quality

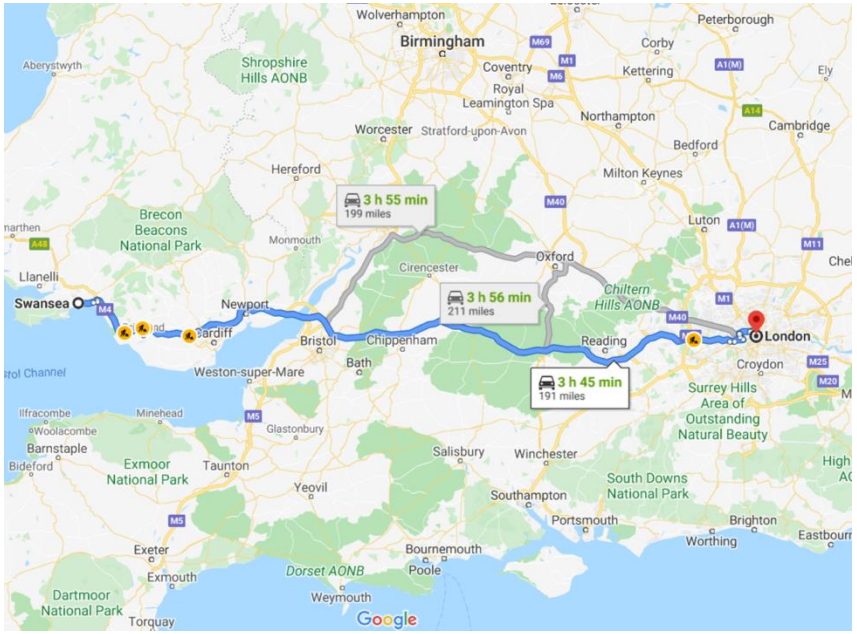


Sample Rate – M4 Analogy

Imagine you wanted to get a real idea of the UK's communities by driving along the length of the M4.

If you only make a few stops at say Swansea, Bristol and London, then you would have quite a low sample rate.

If you make a lot more stops along the way and visit every small town and village, you will get a more accurate idea of the UK's communities.



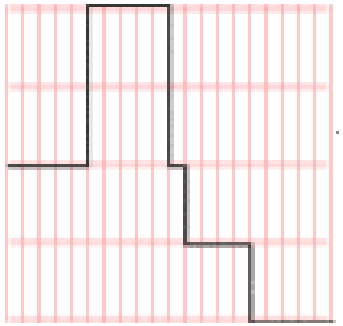
Sound Quality – Bit Depth

Every time a sample is taken, the bit depth affects how much information is captured.

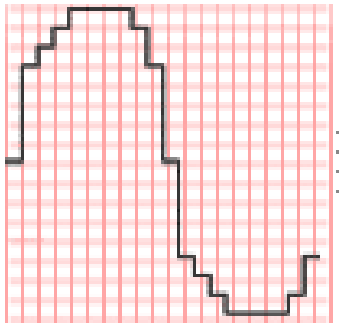
Higher bit depth captures more detail and more accurate readings of the amplitude.

With lower bit-depth, amplitudes are more likely to be rounded up or down further from their actual values.

Low Bit Depth



High Bit Depth



https://thehub.musiciansfriend.com/tech-tips/sample-rate-and-bit-depth-an-introduction-to-sampling

Data Storage

Bits are the basic building blocks of data storage and all computers.

They are the smallest possible unit for data storage.

A bit depth of **16** has **65,536** possible values (ranging from 0 to 65,535).

Bit-Depth – Ladder Analogy

Imagine you're a professional ladder climber.

A ladder with rungs that are really far apart would be a struggle, you would need to jump up or drop down significantly to reach the next rung.

Adequately spaced you can do your job more efficiently.

Lots of rungs can be unnecessary as it means you are using more materials than needed and it is less efficient.

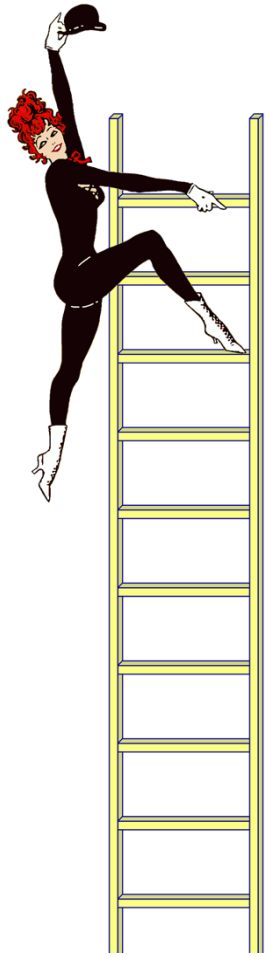


Image Equivalents of Sample Rate and Bit-Depth?

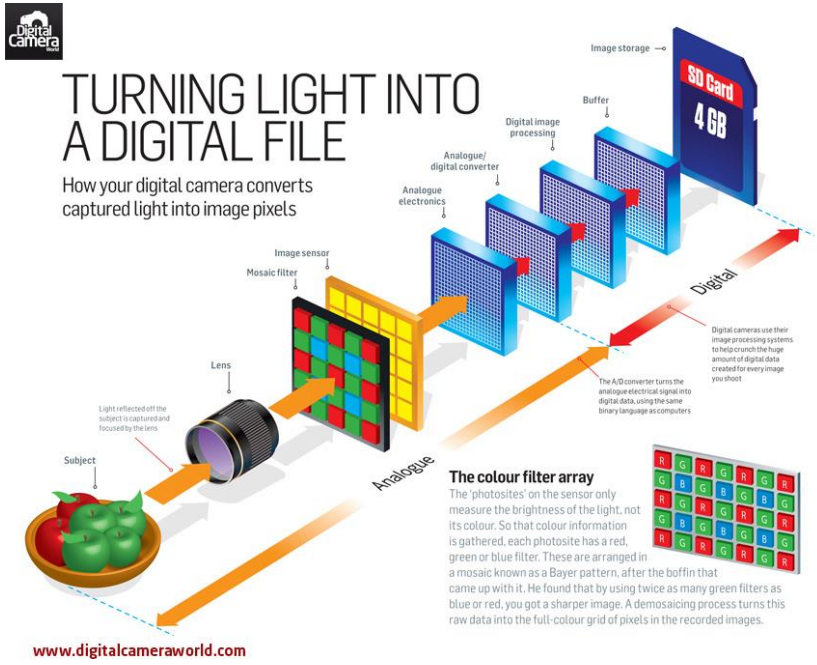
Can you think of the equivalent factors to **Sample rate** and **Bit-depth** when considering capturing images instead of sound?

Example – Capturing Light

In the early days of photography, images were captured using light-sensitive films which had to be chemically treated after they had been exposed to light.

Now cameras use light sensors which are a grid of many small areas that detect light energy hitting them, much like solar panels.

These energy levels get converted to electric current, to binary values and are then processed into an image.



Bitmap Images

A bitmap image is comprised of many tiny parts, called pixels, which can be many different colours.

Bitmap images can be edited by erasing or changing the colour of individual pixels.

Examples of bitmap graphic formats include GIF, JPEG, and PNG. The image displayed on a computer monitor is also a bitmap.

Image Quality – Resolution

Resolution is how many pixels are used to represent an image of a given size.

Full High definition has a resolution of 1920 x 1080 pixels.

Now most UHD displays have a resolution of 3840 x 2160.

This means they have 8294400 pixels which can display different colours.

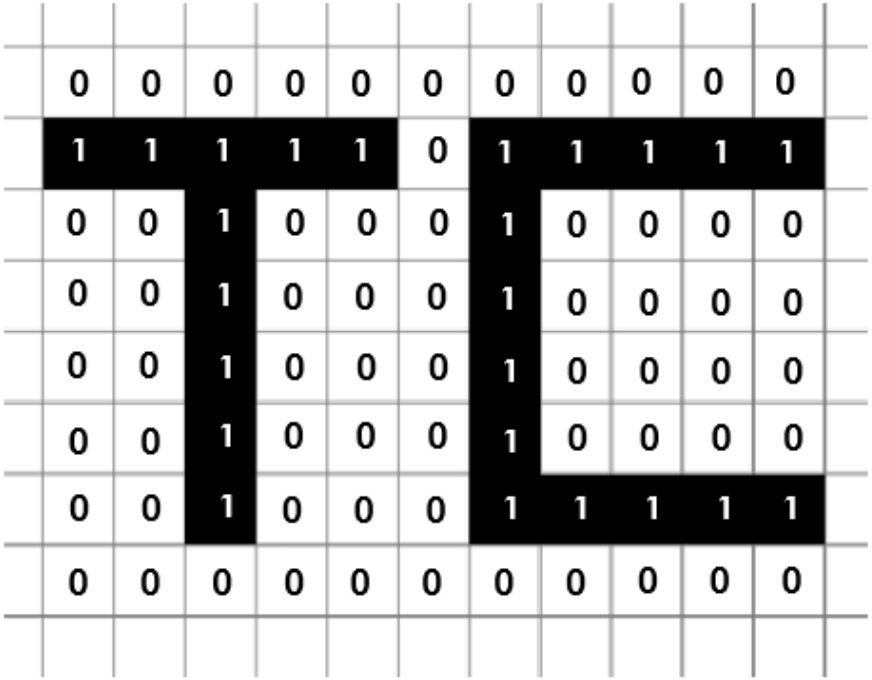
The higher the resolution, the higher the image quality.

Image Quality – Colour Depth

Colour depth is how many bits are used to store each pixel. A 1-bit colour depth could only store one of two colours, i.e. Black and White represented by 1 and 0

2-bit can store 4 values: 0, 1, 10, 11.

16-bits will allow 2^{16} = 65,536 different values to be stored.

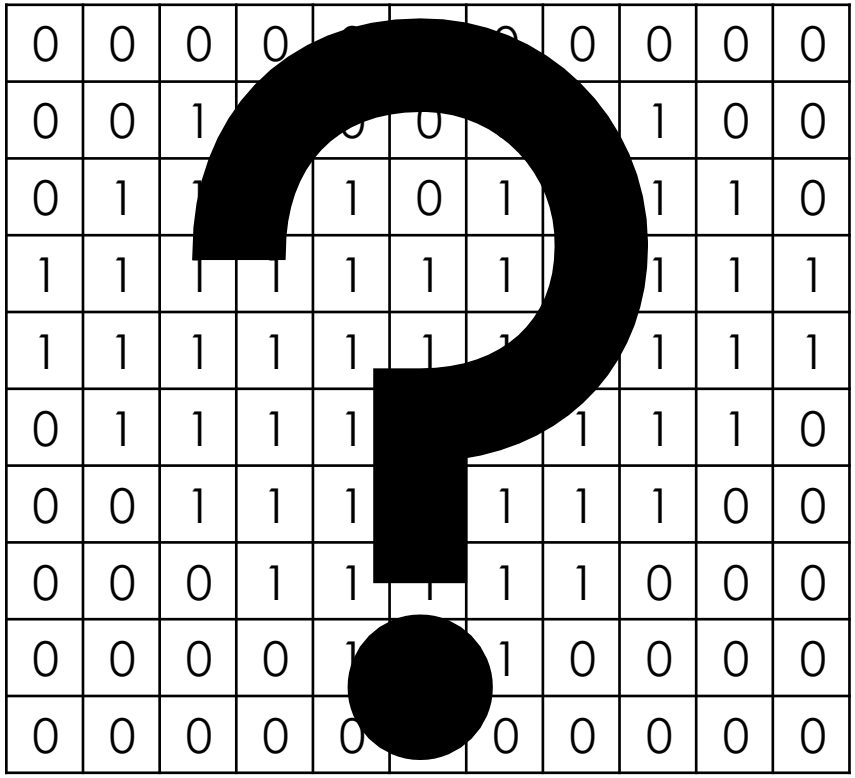


Activity: Pixel Art

Have a go at creating some pixel art.

Using the grid that is already filled in, colour in the squares labelled 1 and leave the 0s blank – this will reveal a hidden piece of art.

Create some of your own using an empty grid. Once you're done, let the person sat next to you colour in the squares to reveal your art.



Activity: Pixel Art

Have a go at creating some pixel art.

Using the grid that is already filled in, colour in the squares labelled 1 and leave the 0s blank – this will reveal a hidden piece of art.

Create some of your own using an empty grid. Once you're done, let the person sat next to you colour in the squares to reveal your art.

0	0	0	0	0	0	0	0	0	0	0
0	0	1	1	0	0	0	1	1	0	0
0	1	1	1	1	0	1	1	1	1	0
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1	1	0
0	0	1	1	1	1	1	1	1	0	0
0	0	0	1	1	1	1	1	0	0	0
0	0	0	0	1	1	1	0	0	0	0
0	0	0	0	0	1	0	0	0	0	0

Activity: Pixel Art

Have a go at creating some pixel art.

Using the grid that is already filled in, colour in the squares labelled 1 and leave the 0s blank – this will reveal a hidden piece of art.

Create some of your own using an empty grid. Once you're done, let the person sat next to you colour in the squares to reveal your art.

0	0	0	0	0	0	0	0	0	0	0
0	0	1	1	0	0	0	1	1	0	0
0	1	1	1	1	0	1	1	1	1	0
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1	1	0
0	0	1	1	1	1	1	1	1	0	0
0	0	0	1	1	1	1	1	0	0	0
0	0	0	0	1	1	1	0	0	0	0
0	0	0	0	0	1	0	0	0	0	0

Activity: Pixel Art

Have a go at creating some pixel art.

Using the grid that is already filled in, colour in the squares labelled 1 and leave the 0s blank – this will reveal a hidden piece of art.

Create some of your own using an empty grid. Once you're done, let the person sat next to you colour in the squares to reveal your art.

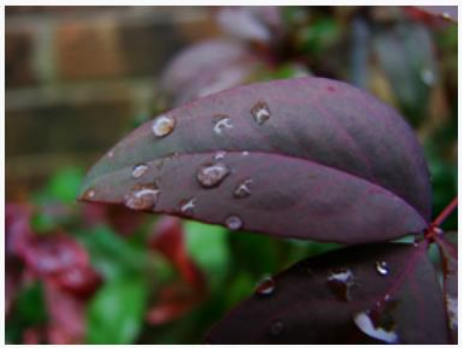
0	0	0	0	0	0	0	0	0	0	0
0	0	1	1	0	0	0	1	1	0	0
0	1	1	1	1	0	1	1	1	1	0
1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1	1	0
0	0	1	1	1	1	1	1	1	0	0
0	0	0	1	1	1	1	1	0	0	0
0	0	0	0	1	1	1	0	0	0	0
0	0	0	0	0	1	0	0	0	0	0

Higher Colour Depth

Greyscale images tend to be 8-bit, meaning they store 256 shades of grey.

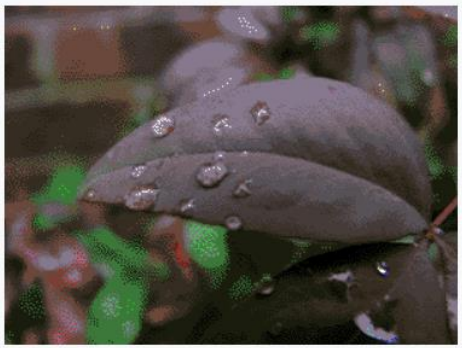
Some displays can now use 30-bit colour depth which is knowns as "Deep Colour". 30 bits means each pixel can store 1,073,741,824 different colours.

Higher Colour Depth



24 bit.png
16,777,216 colors
98 KB

8 bit.png
256 colors
37 KB (−62%)



4 bit.png
16 colors
13 KB (−87%)

2 bit.png
4 colors
6 KB (−94%)

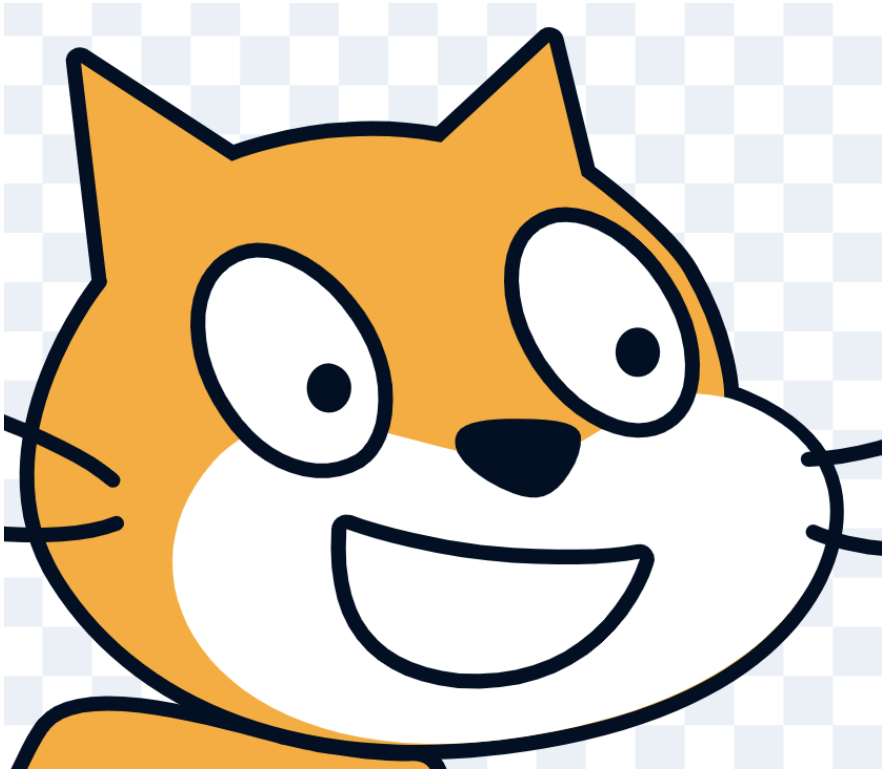
1 bit.png
2 colors
4 KB (−96%)

https://en.wikipedia.org/wiki/Color_depth

Vector Graphics

Rather than a grid of pixels, a vector graphic consists of shapes, curves, lines, and text which together make a picture.

Vector graphics are constructed using formulas describing shapes, colours and instructions about where to place each of the components.



Data Storage

Bits are the basic building blocks of not only data storage, but all computers. They are the smallest possible unit for data storage.

When 4 bits are combined, you get a **nibble**.

When 8 bits are combined, you get a **byte**. Bytes are used to store a single character; whether it's a letter, number, or punctuation.

Activity: Data Storage

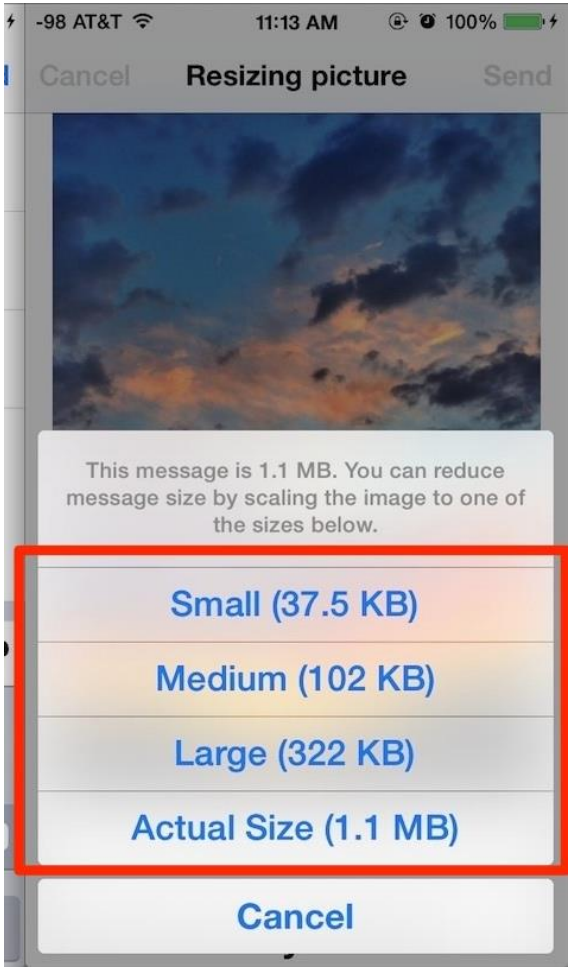
Take out your mobile phones - try and find the size of an image that you've taken.

Data Storage

Most storage you will come across will be expressed in bytes but having thousands or millions or even billions of bytes can be hard to keep track of as there are so many zeros.

So just like other measurements, we have other units of volume:

- 1 Kilobyte (KB) = 1024 bytes
- 1 Megabyte (MB) = 1024 KB
- 1 Gigabyte (GB) = 1024 MB
- 1 Terabyte (TB) = 1024 GB
- 1 Petabyte (PB) = 1024 TB



Data Compression

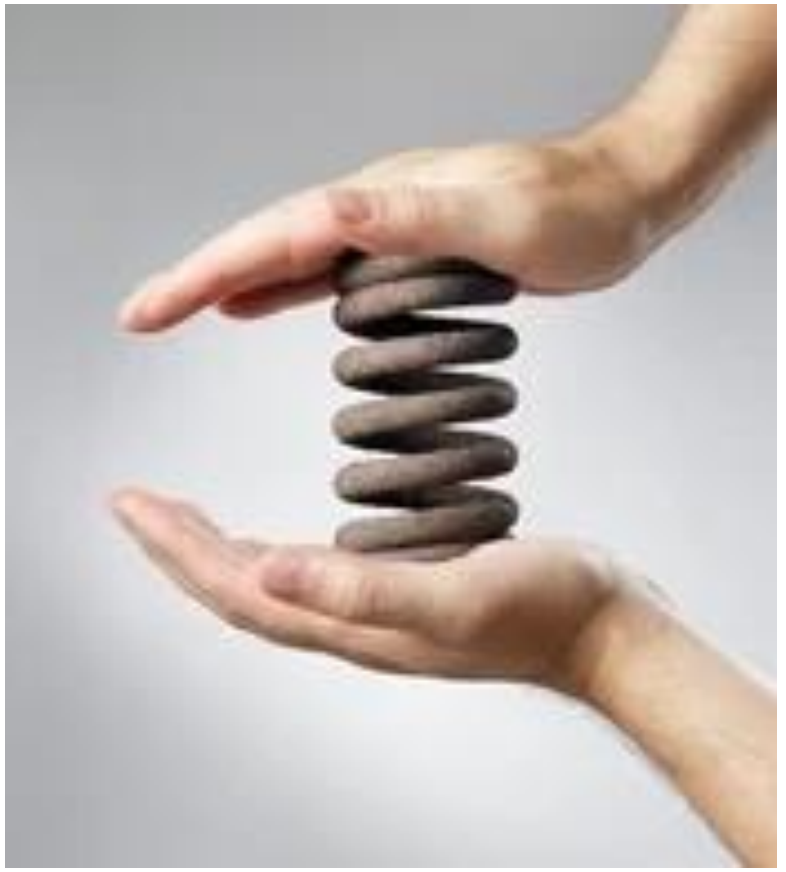
Sometimes we want to reduce the size of our images to send them or to reduce their loading time.

There are two types of compression techniques:

- **Lossy**
- **Lossless**

The compression ratio is:

Original size : Compressed size



Lossy

Some data from the original file is removed. This can significantly reduce the size of the file but this does mean there can be a big loss in quality of the file.

The data removed cannot be retrieved again, therefore this process is irreversible. Once you convert to Lossy, you can't go back!

This example has a compression ratio of **17:8** (85:40).

JPEG - Least compression - 85K

Four score and seven years ago our fathers brought forth on this continent, a new nation, conceived in Liberty, and dedicated to the proposition that all men are created equal.

JPEG - Most compression - 40K

Four score and seven years ago our fathers brought forth on this continent, a new nation, conceived in Liberty, and dedicated to the proposition that all men are created equal.

Lossless

With lossless compression, files are reduced in size without the loss of data. This means that the quality remains the same and does not get worse, like lossy. Also, you can decompress the file to its original quality.

However, lossless compression does not usually achieve the same file size reduction as lossy compression.

This example has a compression ratio of **25:1**

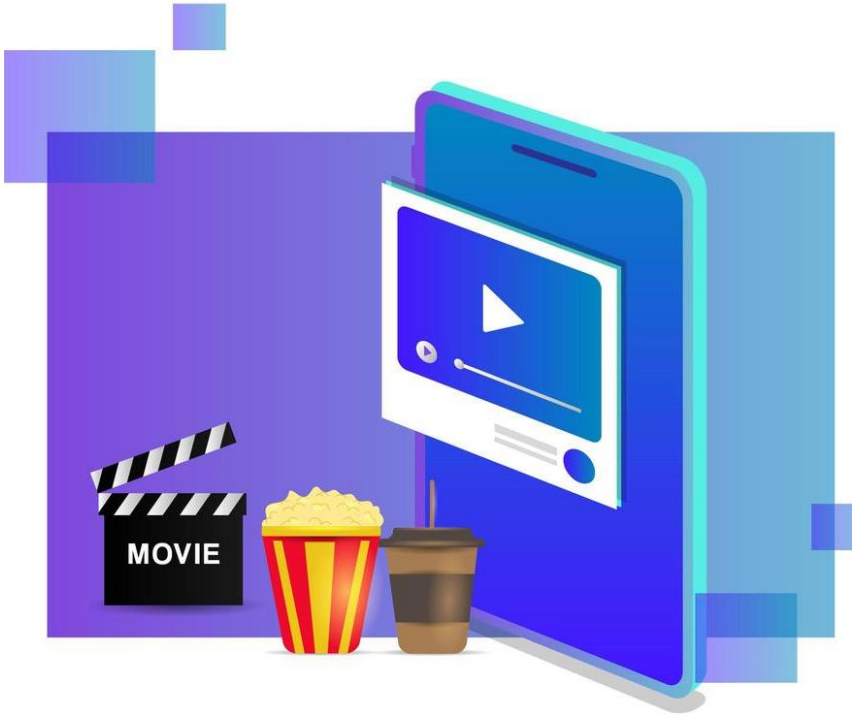
Original - 2.7MB

Compressed – 711KB

Streaming

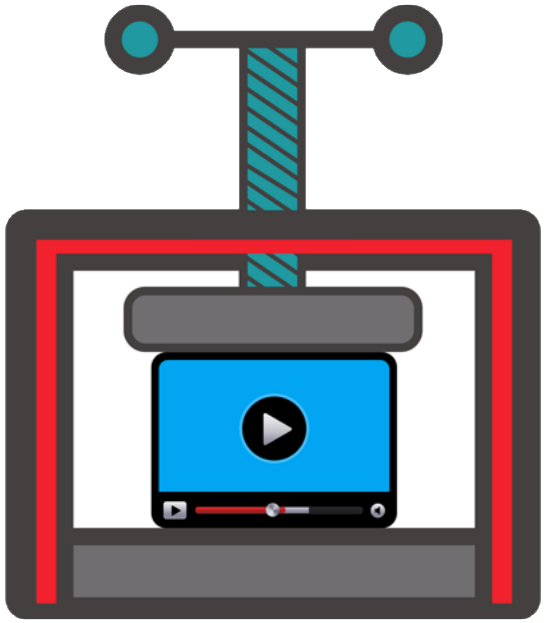
This is very helpful when streaming and downloading files.

Streaming high-quality images, music and video requires a lot of data. Data is streamed by the service to the web application, web browser or native app. Streamed files are not stored permanently but can still be viewed immediately. The file is downloaded in the background while the content is being viewed in the foreground.



Video Compression

Videos are compressed when they are streamed over a network. Streaming a HD video requires a high-speed internet connection. Without it, the user would experience buffering and regular drops in quality. A HD video is usually around 3 mbps, A SD video is around 1,500 kbps.



A buffer is a temporary storage area used to hold the downloaded sections of the video that have not yet been played. If the connection gets interrupted, the buffer will go down and will begin buffering whilst it catches up.

Storage Mediums

Can you name any devices that can be used to store data?

Such as your coursework, an image, a video.

Magnetic Storage

Magnetic devices use magnetic fields to magnetise individual sections of a metal spinning disk.

Each section represents **one bit**. Magnetised sections represent 1s and demagnetised sections represent 0s. These sections are so tiny that disks can contain terabytes of data.

Examples:

Hard drive

Floppy disk

Cassette tape

Optical Storage

Optical devices use a laser to scan the surface of a spinning disc made from metal or plastic.

The surface of the disc is divided into tracks, with each track containing many flat areas (lands) and hollows (pits). Each land and pit represents one bit of the track. Lands represent 1s and pits represent 0s.

Examples:

CD

DVD

Blu-ray

Solid State Storage

Solid state devices have no moving parts and are based on electronic circuits.

They store data in binary patterns using billions of tiny low-voltage switches called transistors. Transistors that conducts an electric current represent 1s and transistors that do not conduct a current represent 0s.

Examples:

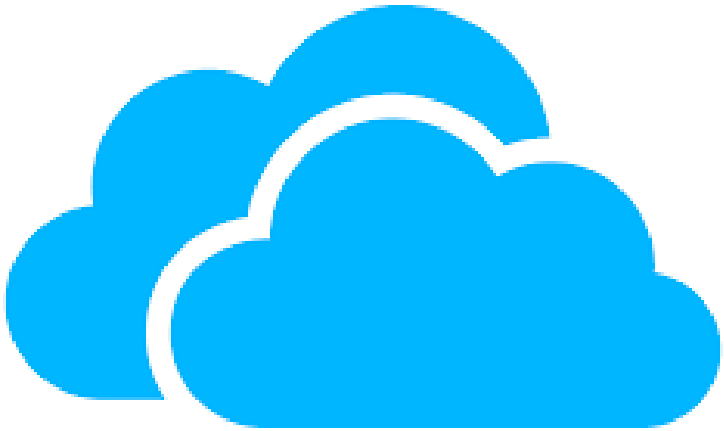
Memory Stick

SD Card

SIM Card

Cloud Storage

Cloud storage stores data at a remote location online. It allows computers, tablets and smartphones to send and retrieve files online, these files are sent to and from a server that is connected to the internet.



Discussion: Benefits and Disadvantages of Digital Data

What are the benefits of each method of storing data digitally?

Are there disadvantages? What are they?

Hint: think about the devices and their capacity, durability and portability.

File Types

File Extension	Information	File Extension	Information
doc	Storage of formatted text, graphics, etc.	odf	Storage of formatted text, graphics, etc.
jpg	Storage of graphics in a compressed format	wav	Storage of uncompressed audio information
wmv	Storage of audio information in a compressed format	mov	Storage of compressed video information
png	Storage of graphics in a lossless compressed format	mp3	Storage of compressed audio information
mp4	Storage of loss less compressed video information	pdf	Storage of documents in an un-editable format
zip	Storage of compressed files of any format	txt	Storage of plain text