Images, sound and compression

Data representation of images

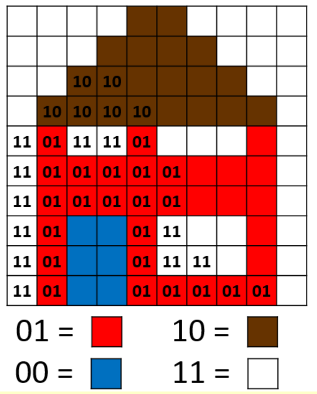
File types include BMP, JPG, GIF, PNG, TIF

- Bitmap images are made up of PIXELS. **A Pixel** is the smallest identifiable area of an image (sometimes called a dot). Each pixel is a single colour and is given a binary value to represent the colour.
- The **resolution** of an image is the concentration of pixels within a specific area. I.e. the number of pixels per inch (PPI) or the pixel density of an image (also called DPI).
- The **dimensions** of an image are the number of pixels e.g. 1920 x 1080 = Width X Height

Creating an image

Each pixel is given a binary value. Using 1 bit gives 2 colours (1 black and 0 white). The more bits per pixel the more colour combinations there are.

E.g. 1 bit = 2 colours, 2 bits = 4 colours, 3 bits = 9 colours, 4 bits = 16 colours, 8 bit = 64 colours, 16 bit = 256 colours (these all count 0 as a colour possibility)



24 bit gives `true' RGB colour

The number of bits per pixel is called the **colour depth**. The larger the colour depth the more possible colours a pixel can be and so the more data for the image, equating to a larger image file.

Image File Sizes

Image file size (bits) = Colour depth (bits per pixel) X Number of pixels in image (Area)

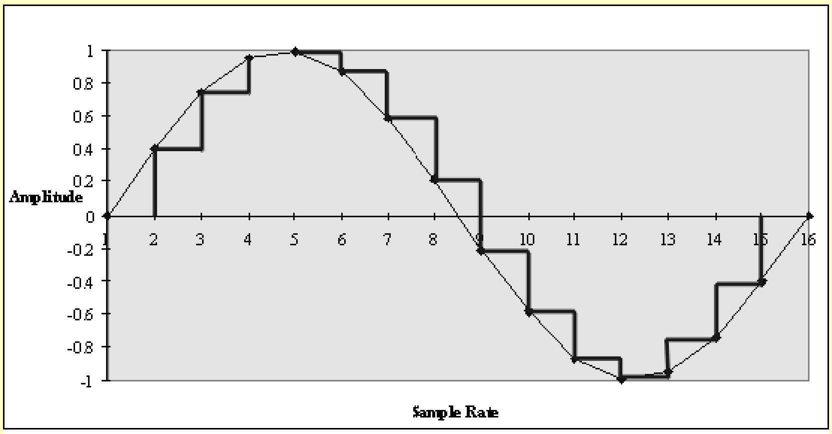
E.g. 3 X (20 X 20) = 1200 bits (then divide by 8 to get in bytes)

1) The greater the resolution of the image for a given dimension (the higher the pixel density) and so the larger the file size
2) The higher the colour depth of each pixel the more colours and so the more bits per pixel are required to store the image. Therefore the larger the image file.

Image Metadata = data stored with an image that describes to the computer hwo to interpret the binary data. This could include: colour depth, resolution (PPI), dimensions (Width X Height px), author, date created etc.

Representing Sound

Sound files too are described by **metadata** to make sure the computer can interpret the data accurately. The data stored includes the **sample rate** and **resolution (or bit depth)**. Sound is analogue (constantly changing) and so the computer needs to convert it to digital format so it can be stored in binary. This requires sampling the sound wave at intervals to assign each point on the wave with a binary values.



Sample rate is the frequency with which the measurements of an analogue sound is measured (Hz).

By increasing the sampling rate, the sound is sampled more frequently and so the digital representation will be more accurate to the original sound. This improves quality and so increases file size as there is more data to store.

CD quality audio has 44,100 of these measurements a second. That's called 44.1 kilohertz (KHz).

Resolution/Bit depth = refers to the number of bits used to represent the volume of the sound a particular point. The higher the bit depth, the larger the range of volumes that can be **accurately described.**

It is not just about increasing the maximum volume that can be represented but more importantly **increasing the accuracy of the volumes measured**.

CD quality audio has 65,536 volumes to choose from for every sample that's measured. That's called 16-bit audio (2^16 = 65,536).

Increasing both sample rate and bit depth will make the **reconstructed digital sound** more representative of the original analogue sound – improving quality so increasing file size.

Human hearing range is between 20 to 20,000 HZ and varies depending on age.

File size (bits) = number of samples X Resolution (bits)

However, `the Nyguist-Shannon sampling theorem' suggests a sample rate of twice the maximum frequency of the sample needed will make the sound reconstruction more accurate. Given that human hearing is up to a maximum of 20 KHz, the sound is usually represented with a sampling rate of 44.1 KHz.

File size (bits) = Bit depth (bits) X Sampling rate (Hz) X Time of audio (s)

Compression

*****File compression reduces the size of a file to save storage space or increase transfer speeds between devices and networks.

File compression was originally developed to save storage space on disks. However, with memory becoming cheaper and later, it is less important, but the reduction in file size has become ever more important in sharing and transmitting data.

Internet service providers (ISPs) and mobile phone networks impose limits and charges on bandwidth.

Images on websites need to be in a compressed format to load quickly – even on a fast connection, music, video and photos from the internet must take advantage of compression. This is particularly so when streaming media. Buffering actually refers to downloading a certain amount of data to a temporary storage area or buffer, before starting to play a section of the music or movie.

.WAV = uncompressed sound

1) **Lossy compression (MP3/JPG/MPEG)**

Lossy compression moves information where it is unnecessary. It will not be able to fully reconstruct the original file.
Lossy compression works by removing non-essential information (such as frequencies of sound above human hearing, removing quiet sounds that are played at the same time as louder ones, reducing bit depths or colour depths of images, reducing frame rates of videos, and sometimes reducing the resolution of an image or video.

Images: This significantly reduces the file size but can cause `colour banding' and loss of visible detail (reducing quality). A heavily compressed image will display compression artefacts making it look untidy/blocky.
Sounds: Telephone communication uses lossy compression to reduce latency. We can understand the sender's voice but there is a noticeable loss of quality.

2) **Lossless compression (M4A/FLAC/ CD audio)**

Lossless compression retains all information to reconstruct the original file exactly.

Lossless compression works by recording patterns of data rather than the actual data where possible. It records a pattern of repeated values and some data on how to interpret the repeated values back into their original positions.
On decompression, the computer can reverse the procedure and reconstruct the original image with no loss of quality.
This is great for computer programs, and text files when losing data values would not be appropriate and cause corruption.
Sounds, videos and images that use lossless compression have much better playback qualities.

Lossless compression does give a greatly reduced file size however the file size is larger than a file using lossy compression.

Image: Lossless compression leaves out repeated details. It will find areas of pixels which are the same colour and record them as multiples of that value. This means the reconstructed file is identical to the original with no loss of quality. Also used for computer programs as they won't work if data is removed to save space.
Sounds: Leaves out repeated details and instead makes a note of how many times it has been repeated. This allows the reconstructed sound to be identical to the original with no loss of quality.