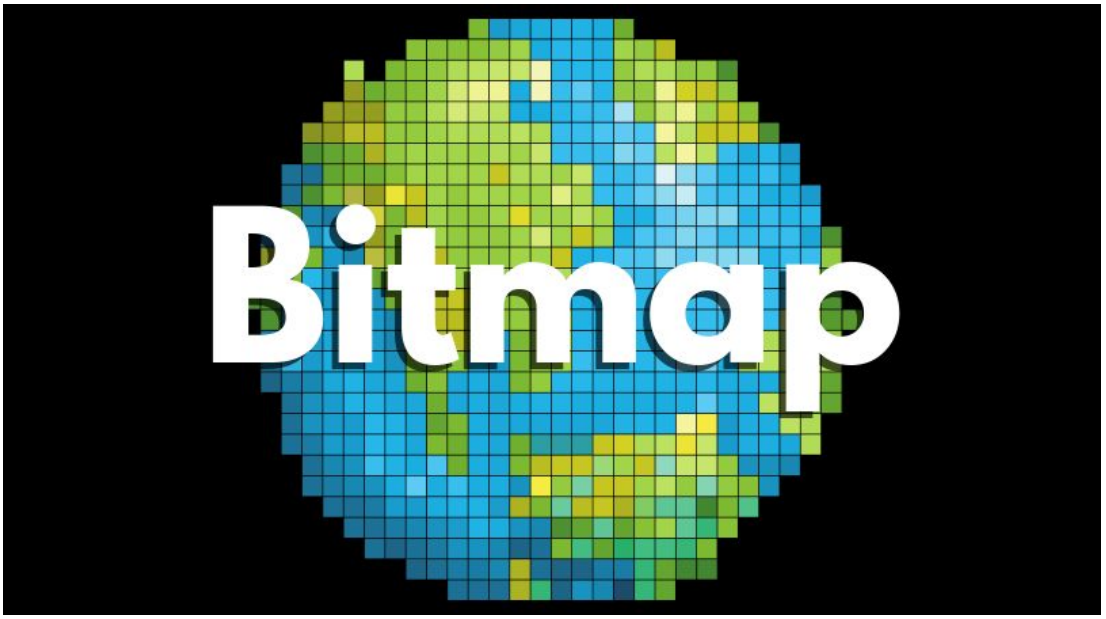
Storing files

Bitmap images



A bitmap file stores an image as a grip of pixels, where each pixels where each pixel is a single colour. The file stores a list of the colour for each pixel, stored as a binary code indicating colour.

Pixels

Pixel is short for Picture Element. Each pixel is a square of a single colour. The smaller the pixel in an image, the more detail will be visible.

Colour Depth

Colour Depth is the number of bits used to encode the colour of each pixel. Clearly the more bits the more colours you can encode.

Number of bits	Number of colours
1	2
2	4
8	256
16	65 536

More generally, for a colour depth of n, 2^n colours can be shown.
Most modern cameras and smartphones have a colour depth of 24 bits.

Question 1 - How many colours can be represented with a colour depth of 5?

Question 2 - to show 1024 colours what colour depth is required?

Question 3 - how many colours can a modern smartphone show?

Image Size

The size of the image is given by the Width of the image in pixels, times the Height in pixels. E.g. 2000 x 1000.

Resolution

Resolution is measured as the number of pixels per inch, when the image is displayed, i.e. the density of the pixels (note - this is not how many people commonly talk about resolution - they confuse resolution with Image Size above). The higher the resolution the smaller the pixels will be, so the more details will be visible in the image. A typical resolution for printing is 300 dpi (dots per inch), the iPhone X manages roughly 430 pixels per inch.

Image File Size

If you know the number of pixels in an image, and how many bits each pixel will take up, you can calculate the total storage size of the image. I.e.

Storage size = W x H x D

Where W = image width in pixels, H = image width in pixels and D = Colour Depth in bits.

The better the quality the image is, the larger the file size needs to be - better quality images have a higher resolution, and greater colour depth.

Question 4 - An image is made up of 100 X 200 pixels, and has a colour depth of 8. What is the size of the image file, in bytes?

Question 5 - An image is made up of 500 X 1000 pixels, and has a colour depth of 16. What is the size of the image file, in bytes?

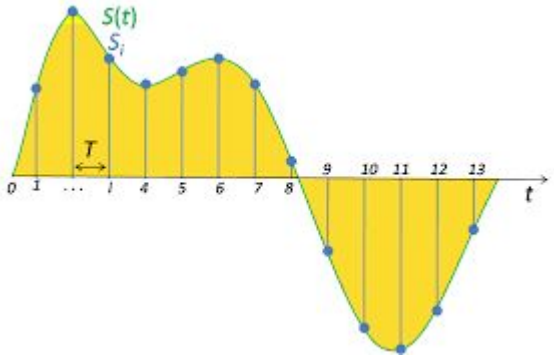
Question 6 - An image is made up of 256 X 1024 pixels, and contains 64 colours. What is the size of the image file, in bytes?

Question 7 - An image is made up of 512 X 2048 pixels, and contains 256 colours. What is the size of the image file, in kilobytes?

Question 8 - For real bitmaps the actual size of the file, as found on a hard drive, will actually be slightly bigger than the calculated file size. Why is this?

Question 9 - Rather than using bitmaps to store images, we usually use other file formats like jpeg and gif. Why is this? What advantages do they give?

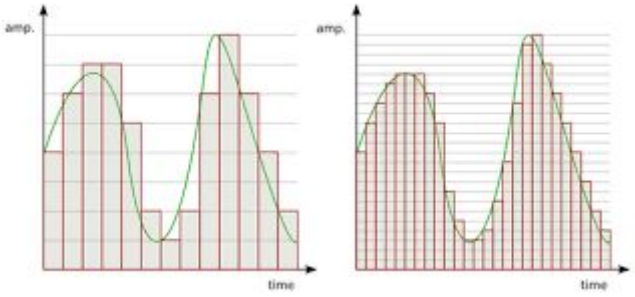
Storing Sound



Sampling is the process of measuring the size of a sound wave at regular intervals. The measurements are stored as digital data, and then sound can then be reproduced later by rebuilding the sound wave based on the measurements.

Sampling frequency

The **sampling frequency** is the number of samples that are taken each second. The higher the sampling frequency, the more accurately the sound will be stored and reproduced.



You can see above that in the second image the blocks more accurately reproduce the curved, original, wave than in the first image.

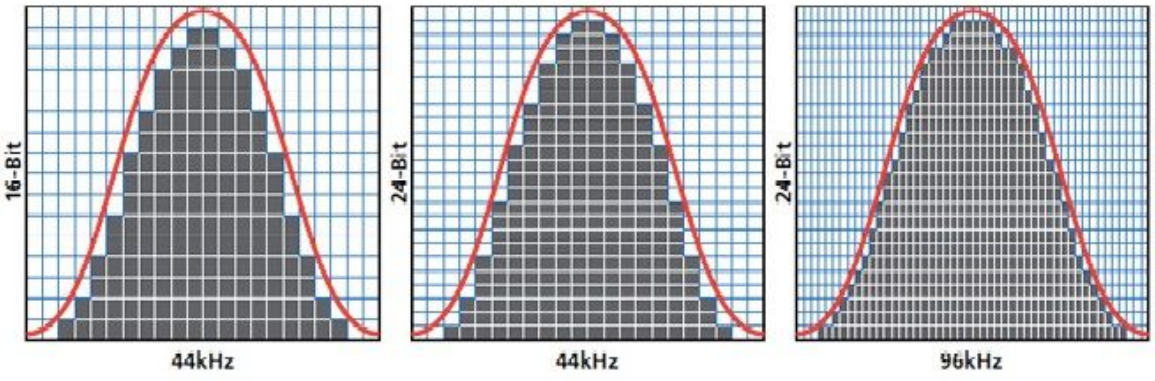
Sampling frequency is measured in Hertz (Hz). 1Hz means one per second.

For example, CDs have a sampling frequency of 44 100 Hz, whilst Blue-rays use 96 000 Hz.

Bit Depth

Bit depth for sounds is equivalent to colour depth in bitmaps. The bit depth describes the number of bits used to encode each sample. The higher the bit depth the more accurately each individual sample will be, and the better the dynamic range of the sound will be reproduced.

Using 8 bits of bit depth allow for 256 gradations of volume, whilst using 16 bits will allow 65 536 gradations.



As bit depth and sample rate increase, more information is captured—resulting in higher-quality audio

In the above image, the sample rate is represented by the number of vertical lines, and the bit depth is represented by the number of horizontal lines. Too few lines means you have to less accurately represent the original curve.

Audio File Sizes

We can calculate the size of an audio file by the following equation -

File size = sample frequence x bit depth x recording length

File size is measured in bits, sample frequency is in Hertz, bit depth in bits and recording length in seconds.

So, the longer a song is, the larger the file. The higher the sample frequency, the larger the file, but the better the quality of the sound. The larger the bit depth, the larger the file, but the better the quality of the sound.

Question 10 - A digital file never perfectly reproduces an analogue sound. Why not?

Question 11 - Given that digital files are never perfect reproductions of the original analogue sounds, why are digital recordings still generally considered to be of better quality than analogue recordings?

Question 12 - A 10 second audio file uses a bit depth of 8 bits and a sampling frequency of 20 000 Hz. What is the file size in kbytes?

Question 13 - A 3 minute audio file uses a bit depth of 16 bits and a sampling frequency of 10 000 Hz. What is the file size in kbytes?

Question 12 - An audio file takes up 10Mbytes. If it uses a 16 bits for bit depth, and has a sampling rate of 60 kHz, how long is the audio clip likely to be?