Image Representation

This is because computers need to use numbers, specifically binary bits, to store and process data

Representing images

Everything stored by computers has to be able to be represented as numbers. This includes images.

To do this, each point in the image needs to become a number. So, we break the image down into a grid. Each square in the grid can be represented using a number. The squares are called **pixels.**

Computer monitors divide the screen into thousands (or millions) of pixels arranged in rows and columns.

A **pixel** is a **Picture Element** – a single point in a graphical image.

Pixels and Bitmaps

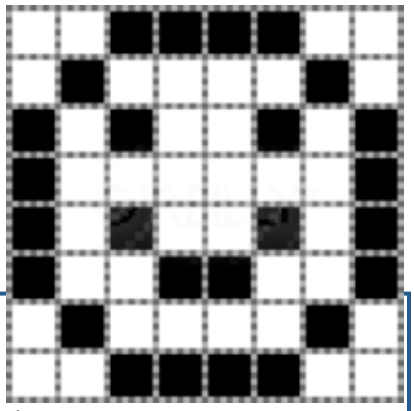
A grid of pixels is called a **bitmap**.

A binary bit is a single binary number – a 1 or a 0

A bitmap provides a simple 2-dimensional map of an image. If the image is black and white, then each pixel can be represented as a single binary digit: 0 represents black; 1 represents white.

In the bitmap shown here, the first 2 lines are:

```
11000011
10111101
```



Encoding such as this needs a **standard** to be agreed so that image files can be opened by different programs and across different operating systems.

Activity 1:

a) Define the term **pixel**
b) Explain how a **bitmap** can be used to represent a black and white image
c) Write down the binary representation of line 6 of the bitmap shown above
d) A line of a bitmap is represented as 01001100. Draw the representation of this line
e) Explain why computers need to use **bitmaps** to represent images

Bitmap Sizes

The number of pixels in a bitmap can be calculated:

pixels = width x height

In the example above, the bitmap is 8 pixels x 8 pixels, so its size is 64 pixels.

Activity 2:

a) Calculate the size of each of the following bitmaps:
(i) width 10, height 20; (ii) width 7, height 5; (iii) width 300, height 200
b) Describe how the size of a bitmap image is calculated

Adding Colour to Bitmaps

Black and white bitmaps only need 1 bit of data to represent each pixel. It can either be a 0 (black) or a 1 (white).

But what happens when we need to add colour?

Modern computers use hex codes to represent each possible colour. So, a hexcode might be #990000 or #3300FF. These are pairs of numbers which represent the amount of Red, Green and Blue in a colour (RGB).

Each pair of numbers can be as high as FF – which is the hexadecimal representation of the decimal number 255. So, including 00, each pair of numbers has 256 possible values. There are three pairs, so…

Total colours = 256 x 256 x 256

= about 16.7 million colours

16.7 million colours is enough to trick the standard human eye into believing that an image shows the full range of colours that a human eye can perceive.

Each colour is represented by 8 bits, so in total a modern hex code uses **24 bits per pixel** to show colours.

The number of bits used to represent the colour data for each pixel is called the **colour depth**.

Older systems used less colours. I remember playing computer games which used 4 colours – plus black and white. These needed 3 bits per pixel.

Colour Depth and Size

When you add colours to images the data size of the image increases.

size of image in bits = width x height x colour depth

So, if my 8 x 8 bit map used 8 bit colour depth (256 possible colours – like a GIF file), its size would be:

size = 8 pixels x 8 pixels x 8 pixels = 512 bits

GIF images use 8 bit colour depth.

Activity 3:

a) Write a definition of the term **colour depth**

b) A bitmap is 10 pixels wide and 8 pixels high. It uses 4 bit colour depth. Calculate the file size of the bitmap

c) A bitmap is 5 x 8 pixels and uses 8 bit colour depth. Calculate the image file size

Size in Bytes

You could be asked to calculate the file size of an image in Bytes. This is easy to do:

size of image in Bytes = (width x height x colour depth) / 8

Remember, there are 8 bits in a Byte

Activity 4:

a) What is the colour depth of a black and white bitmap?

b) Calculate the file size in Bytes of the following colour bitmaps:
(i) 10 x 10 at 3 bit colour depth (ii) 20 x 10 at 4 bit colour depth (iii) 10 x 8 black and white

c) Explain the impact on file size of using a greater colour depth.