Learning Objectives

Understand what pixels are and how images are represented in binary

Understand and be able to explain what resolution is and explain what colour depth is.

Understand and be able to explain why it is important to include metadata in bitmap images

Keyword Definitions

Keyword	Definition
Binary	is a sequence of 0's and 1's, it can read by a computer processor, decoded and executed
Bitmap Image	is made up of **pixels**, the colour of each pixel is defined by a unique sequence of **binary**
Image Resolution	Is the amount of **pixels per inch** in an image (width by height)
Colour Depth	is the amount of bits used to generate the colour in a single pixel
HEX	Base 16 number system used to represent HEX colour codes
Compression	Algorithms used to reduce the file size of an image (Lossy & Lossless Compression)
Metadata	Additional data stored with an image

To store an image on a computer, the image is broken down into tiny elements called **pixels.**

A pixel represents just one colour.

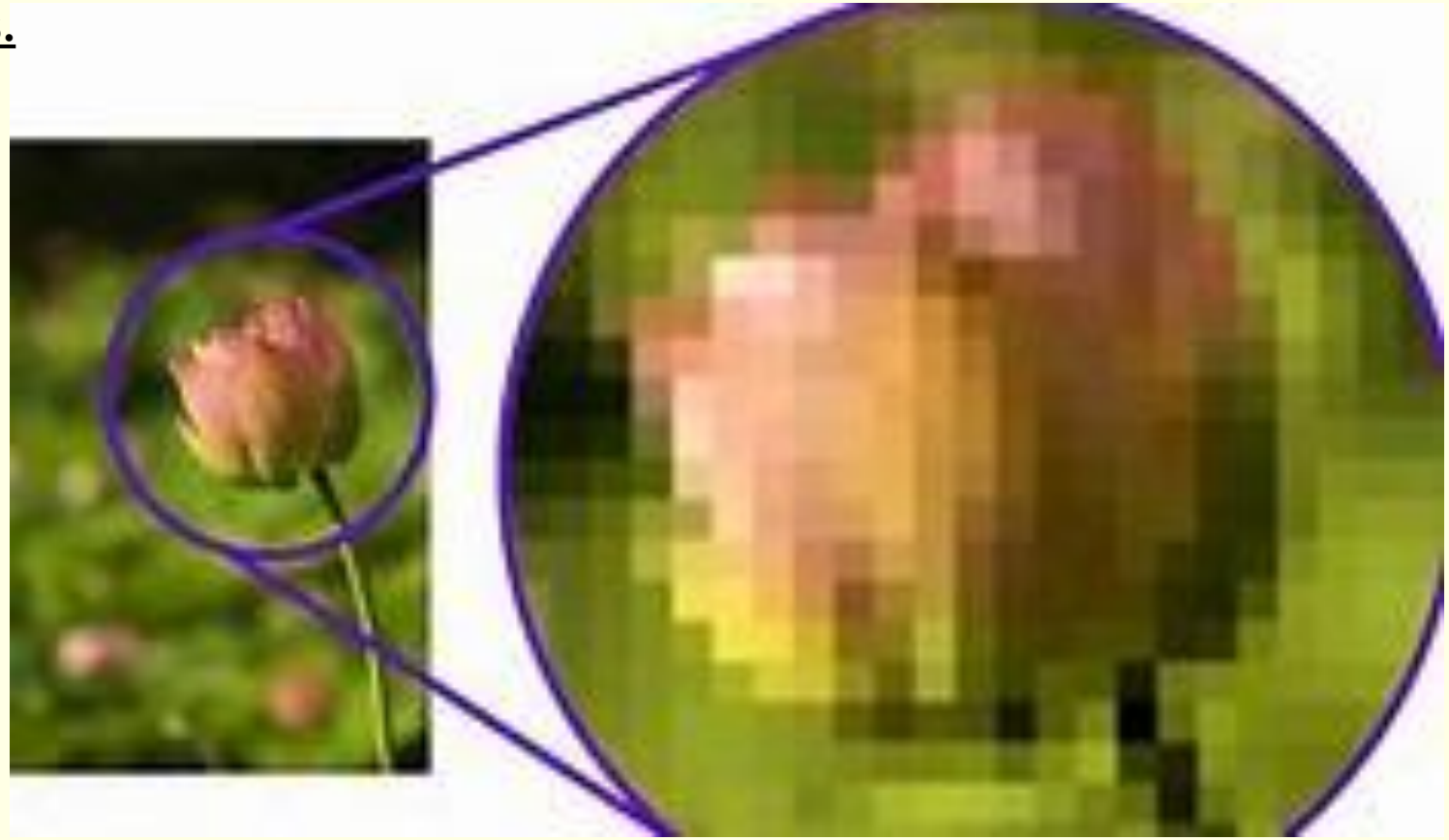


Image Resolution is the amount of pixels per inch in an image (width by height)

To generate a colour in a pixel can be between 1 to 24 bits (or more)

More bits = more colours = better image

Colour depth – is how many bits used to represent each pixel

For example: Image resolution of 1024 by 798 pixels has 1024 x 798 pixels (817,152 pixels).

Resolution

An image of size 100 x 60 when displayed in the same area as the one of 3390 x 2000 pixels, has far fewer pixels per inch and has a lower resolution
100 x 60 is pixelated but a smaller file size

File Size

Low → High

Encoding the pixel information

The colour of each pixel in a bitmal image is represented by a binary pattern

The colour depth of an image is the number of bits used to encode the colour of each pixel.

The greater number of bits per pixel = more colours

Example of 1bit colour depth (0 or 1)

Image Resolution: 8 x 8 = 64 pixels

Colour Depth: 1 bit

File size = 64 x 1 = 64 bits

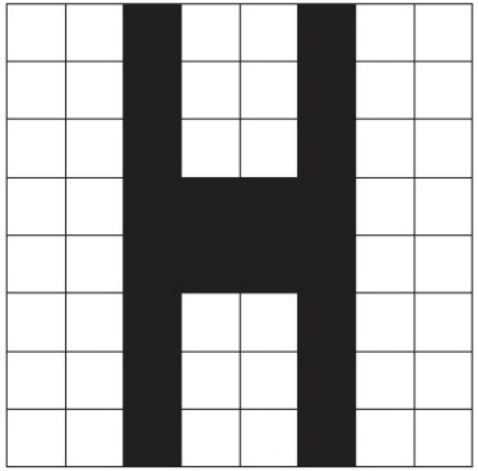
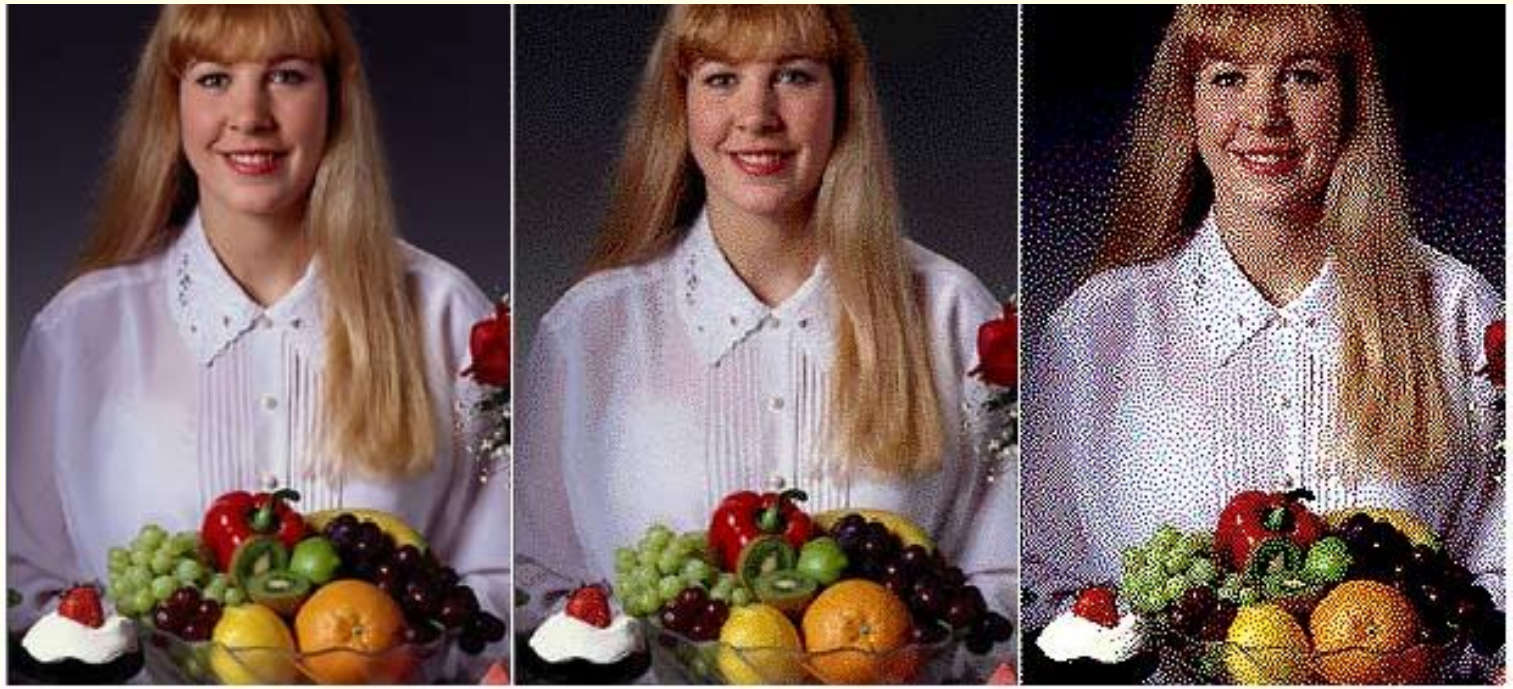


Figure 2.2.3 One-bit encoding forming the letter 'H'

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

Figure 2.2.4 Binary code for the black and white image shown in Figure 2.2.3

Colour Depth



File Size

High

Low

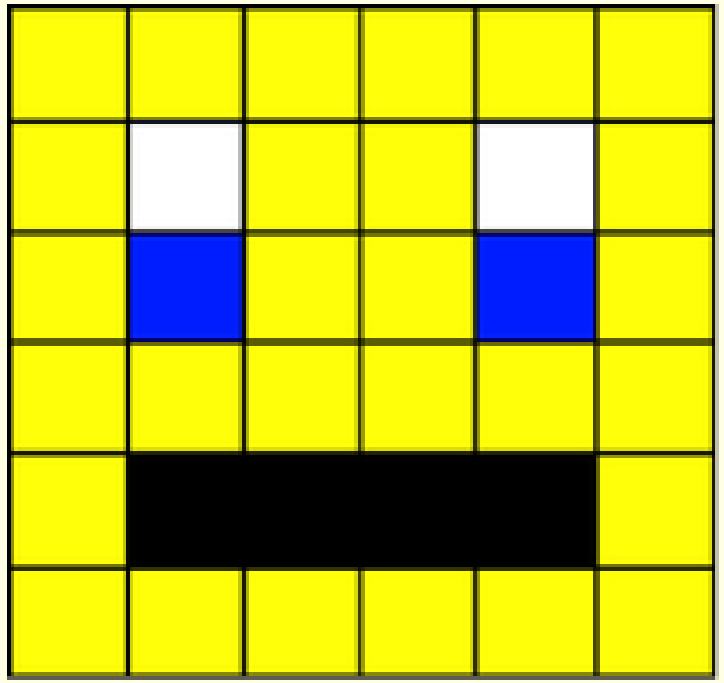
Colour Depth 2

In an image that uses 4 colours, 2 bits are needed for each pixel.

The following example uses two bits to store the following colours:

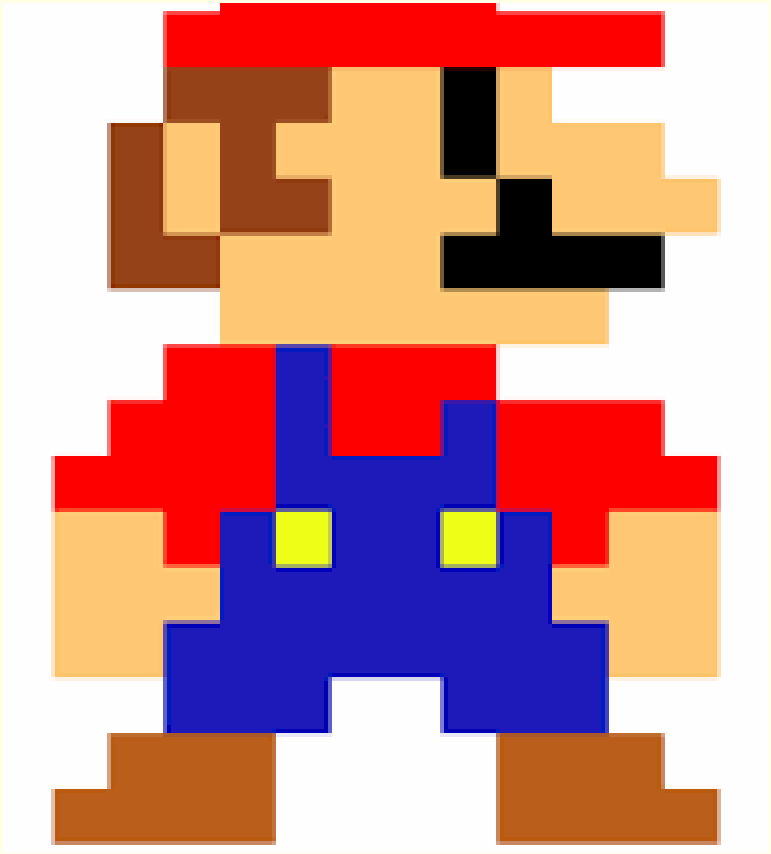
00 – White; 01 – Black; 10 – Yellow; 11 – Blue

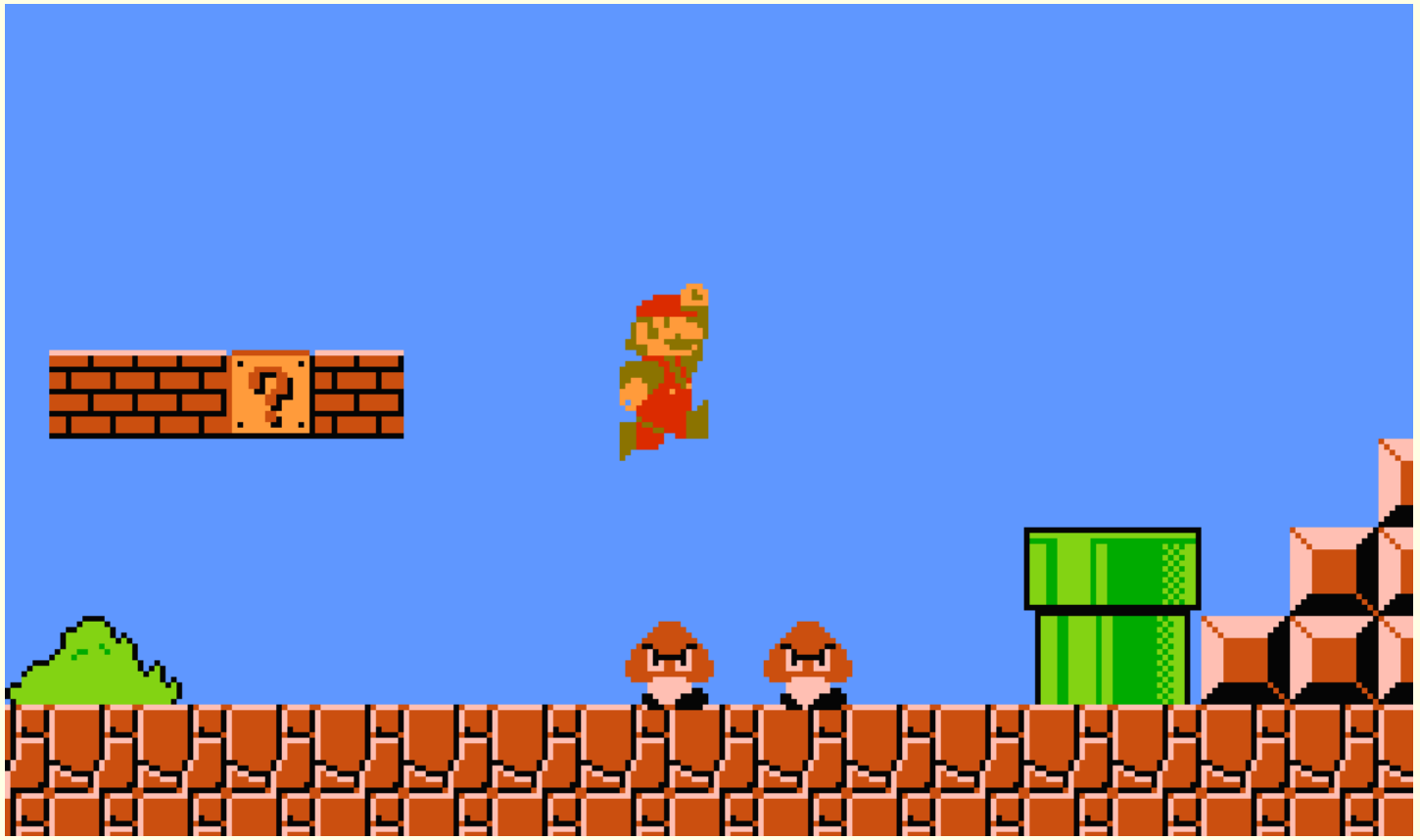
The image resolution is 8 x 8



10	10	10	10	10	10
10	00	10	10	00	10
10	11	10	10	11	10
10	10	10	10	10	10
10	01	01	01	01	10
10	10	10	10	10	10

101010101010
100010100010
101110101110
101010101010
100101010110
101010101010





8 bit colour depth gives 256 colours

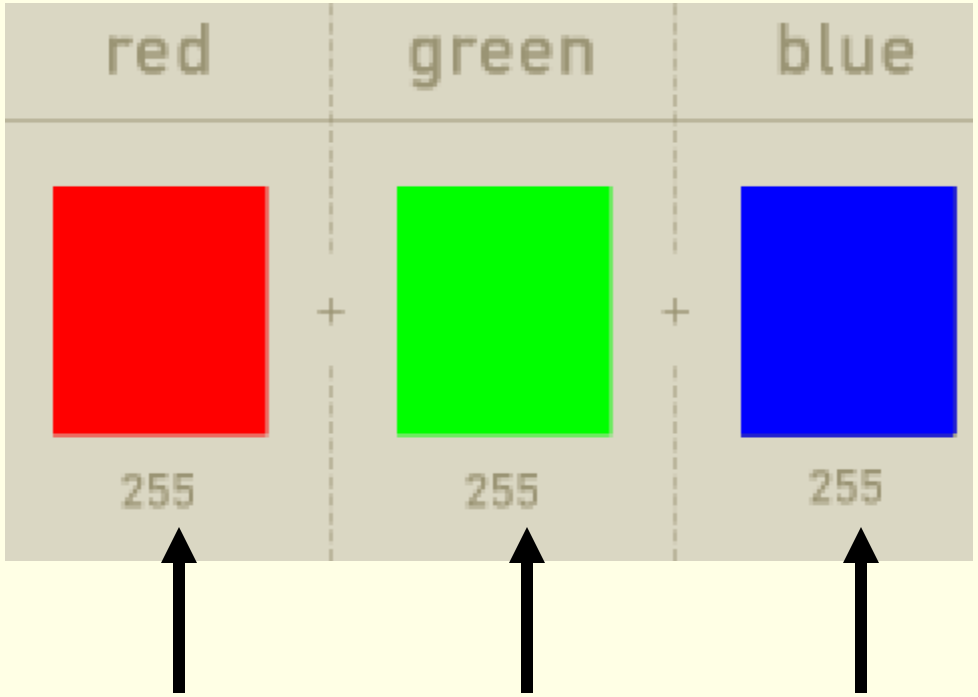
True Colour 24 bit colour depth

By mixing the appropriate amount from each of the three colour channels you can get a variety of colours

	R	G	B
	FF	FF	FF
	00	00	00
	00	00	FF
	80	00	96
	96	00	80
	00	FF	00
	FF	FF	00
	80	80	00
	FF	00	00

What gets stored for each pixel is just a combination of each channel
E.g.

FFFFFF00 means the pixel is white
96008000 means the pixel is lilac



24 bit colour depth (True Colour)

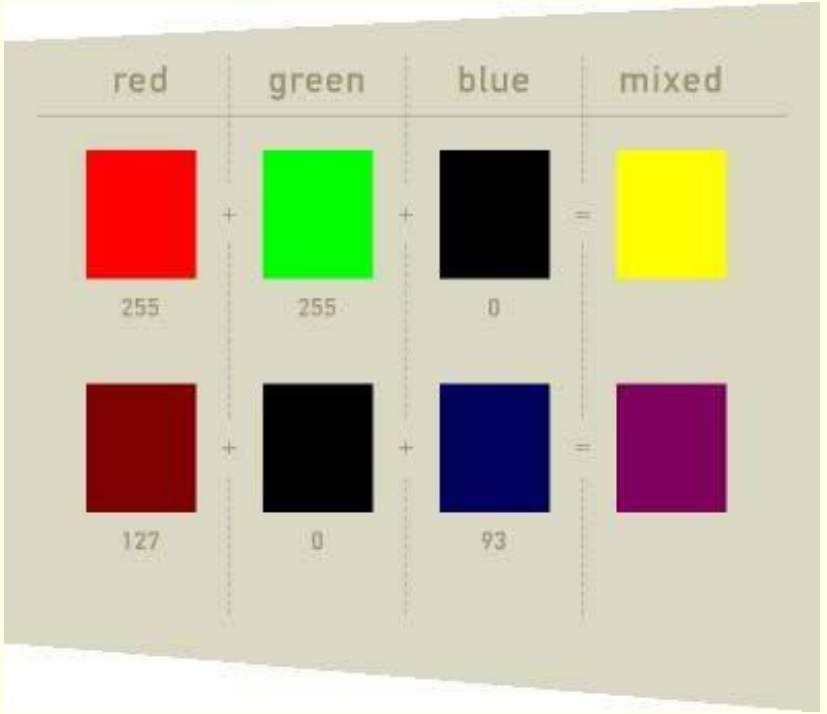
24-bit or “Truecolor “gives over 16.7 million colours

= 24 bits

111111111111111111111111

256 x 256 x 256 =

16,777,216 possible colours!



Colour depth

1 bit allows 2 different values	2 different colours (Black and White)
2 bit allows 4 different values	4 different colours
3 bit allows 8 different values	8 different colours
…	…
8 bit allows 256 different values	256 different colours
24 bit allows 16,777,216 different values	6,777,216 different colours (True Colour)

The greater the colour depth:
- The more realistic colours
- The more data needs to be stored and the larger the file size on disk

What effects the quality of an image?

- Resolution
(Number of Pixels per inch)

- Colour Depth
(Binary used to make the colour in each pixel)

Balancing quality and image file size

As the number of pixels and the colour depth increase, so too does the amount of data that has to be stored and manipulated.

If you were visiting a website with 4288 × 2848 24-bit images then, unless you had a very fast connection, you would quickly become frustrated as you waited for them all to download.

Often a compromise must be found between image quality and file size. As it happens, there's a limit to the number of colours the human eye can detect so increasing colour depth beyond 24 bits makes little sense.

In reality, images that are intended to be viewed on screen are usually compressed. You can read more about compression in Topic 2.3.

Higher image resolution + colour depth = Larger file size

Metadata

Bitmaps

```
00010001000011100000000111000111111100011100000111110000010000000 1
11000000000000001110000000000000001000000000000000000000000100000
00000000001110000000000001111111000000011111111100000000011111110
00000000001111110000010000011111100001110000111111100111110011111
```

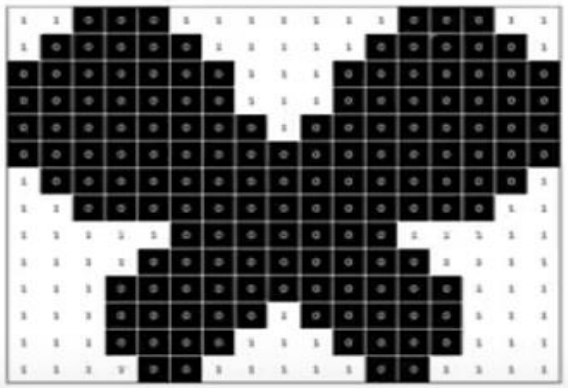
width: 17 pixels

height: 14 pixels

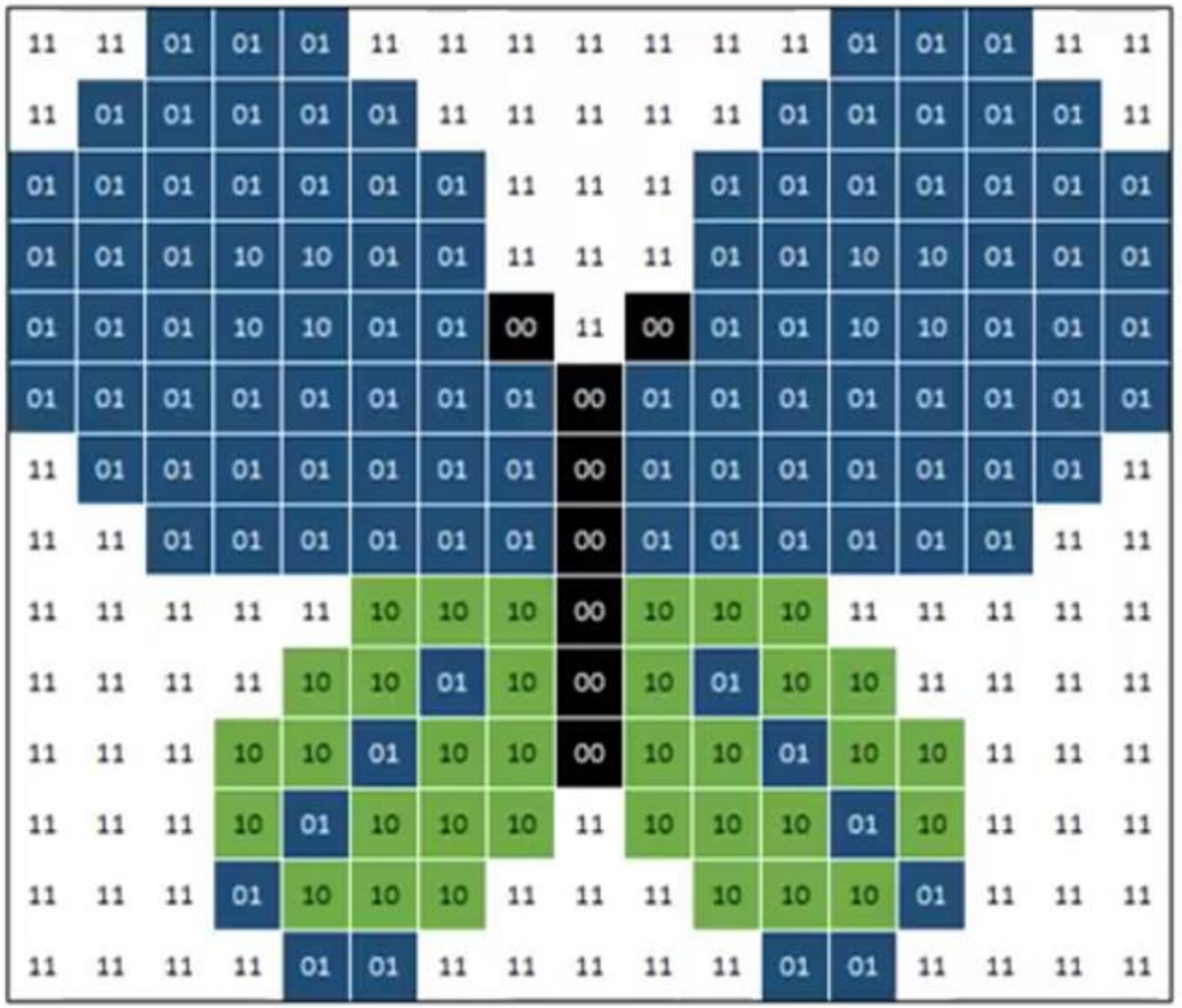
bits per pixel: 1

image data

metadata: additional data stored with the image such as width, height, colour depth of the image.



Example



Metadata

Width 17 pixels

Height 14 pixels

Colour depth 2 bit

00

01

10

11

Raw file size 476 bits

+ 10% overheads for metadata

File size 524 bits

66 bytes

Example

Metadata

Width	17	pixels
Height	14	pixels
Colour depth	3	bit

000
001
010
011
100
101
110
111

Raw file size	714	bits
+ 10% overheads for metadata		
File size	785	bits
	99	bytes