Image Representation

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Key Concepts & Terms

We will be looking at the following concepts:-

Digital Representation

Bitmap Image

Resolution   Low Resolution   High Resolution

Pixels

Bit-Depth   Colour-Depth

Meta-Data

Factors Affecting File Size

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Analogue (Photographic) & Digital (Computer) Representations of Images

(1) A Photograph is an analogue representation of an image.

Image 1 - Analogue Representation of Image - Continuous across surface

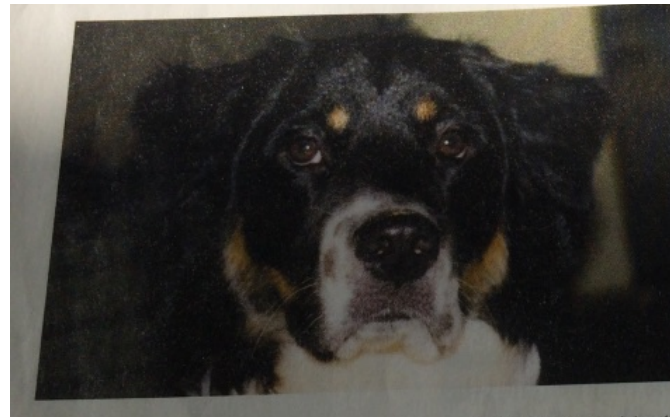**Image 2 - Digital Representation of Image - Pixelated across surface**

(2) By analogue we mean, the representation is continuous across its surface with one colour blending into another.

(3) However, the computer represents images in a different form i.e a digital form and are digitized.

(4)The digitization of picture is the act of representing it as a collection of individual dots called pixels.

(5) Note that although the term 'dot' is used - these dots have dimensions.

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Seeing Pixels in More Detail

Part of the Image 1 is magnified so that we can see some of the pixels which make up the image

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Resolution, Pixels & Digitization

(1) So, Pixels are individual dots used to represent a picture.

**(2) Pixel stands for Picture Element.**

(3) The number of pixels used to represent a picture is known as the Resolution of the picture.

(4) So, the Resolution is defined as the number of pixels used to represent a picture.

(5) Resolution = Height in Pixels * Width in Pixels

(6) Note that although we use the word dots, these dots do have dimensions.

Calculating the Resolution of a Pixelated Image

18 Pixels Wide

11 Pixels Height
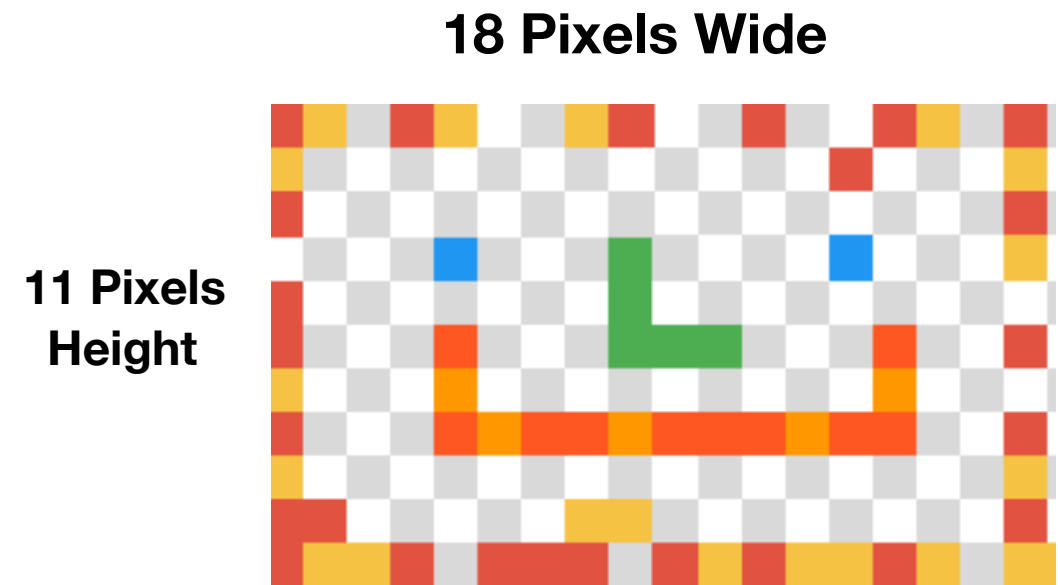
Resolution = Height in Pixels * Width in Pixels

= 18 * 11

= 198 Pixels

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High Resolution & Low Resolution Compared

(1) The Higher the Resolution, the Better the Quality of the Picture.

(2) Conversely, the Lower the Resolution, the Lower the Quality of the Picture.

(3) Note that, images that are made up of Pixels are sometimes called Bitmap Images.

Image 1 of Map of Italy with Higher Resolution

This image has a Resolution of 144 Pixels (per inch)

Image 2 of the Map of Italy at Higher Resolution

This image has a Resolution of 50 Pixels (per inch)

We can visibly see that the image of resolution is of higher quality than that of the lower quality image.

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Question About Resolution

(1) A bitmap image is stored with pixels dimensions of 3000 pixels
Wide by 2000 pixels tall.

What is the resolution of the image? Just provide a single number.

Question & Answer About Resolution

(1) A bitmap image is stored with pixels dimensions of 3000 pixels Wide by 2000 pixels tall.

What is the resolution of the image? Just provide a single number.

Answer

Resolution = Height in Pixels * Width in Pixels

= 3000 * 2000

= 6000, 0000

Bit-Depth or Colour-Depth

(1) Now, Each Single Pixel is associated with a single colour.

(2) And each colour is represented by a specified number of bits.

(3) The colour of each Pixel is represented by a binary code (i.e. of 1s' and 0s').

(5) Black and White images only use 2 colours, so they only need 1-bit To represent each pixel, a 0 for White and 1 for Black (or vice versa)

(6) We say this is an example of 1-bit depth or 1-colour depth.

(4) The number of colours available to an image is related to the number of bits the code has.

1 Bit Depth = 2 different colours can be represented

0	1	0	1
1	0	1	0
0	1	0	1
1	0	1	0
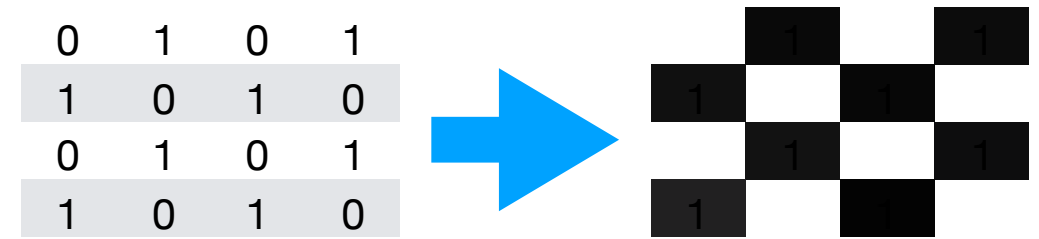
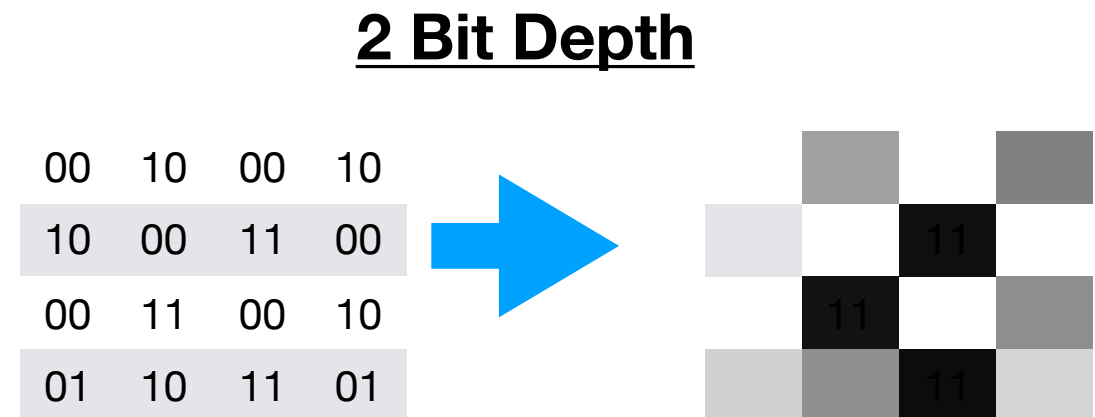| Bit Pattern	Colour	Example
0	Colour 1	White
1	Colour 2	Black

If 1-bit, is used then the maximum number of colours Which can be represented is 2 - from 2 to the power 1.

This is an example of 1 bit-depth.

Each colour can be represented can be represented by one of 2 binary values 0 & 1.

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2-Bit Depth = 4 colours represented = 2^2

Bit Pattern	Colour	Example
00	Colour 1	White
01	Colour 2	Light Grey
10	Colour 3	Dark Grey
11	Colour 4	Black

2 Bit Depth

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


**If 2-bits, are used then the maximum number of colours
Which can be represented is 4 - from 2 to the power 2.**

This is an example of 2 bit-depth.

**Each colour can be represented can be represented by
one of four binary values 00, 01, 10, 11.**

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3-Bit Depth = 8 colours represented = 2^3

Bit Pattern	Colour
000	Colour 1
001	Colour 2
010	Colour 3
011	Colour 4
100	Colour 5
101	Colour 6
110	Colour 7
111	Colour 8

**If 3-bits, are used then the maximum number of colours
Which can be represented is 8 - from 2 to the power 3.**

This is an example of 3 bit-depth.

**Each colour can be represented can be represented by one of
8 binary values 000, 001, 010, 011, 100, 101, 110, 111.**

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4-Bit Depth = 16 colours represented = 2^4

Bit Pattern	Colour
0000	Colour 1
0001	Colour 2
0010	Colour 3
0011	Colour 4
0100	Colour 5
0101	Colour 6
0110	Colour 7
0111	Colour 8

Bit Pattern	Colour
1000	Colour 9
1001	Colour 10
1010	Colour 11
1011	Colour 12
1100	Colour 13
1101	Colour 14
1110	Colour 15
1111	Colour 16

**If 4-bits, are used then the maximum number of colours
Which can be represented is 16 - from 2 to the power 4.**

This is an example of 4 bit-depth.

**Each colour can be represented can be represented by one of
16 binary values 0000, 0001, 0010, 0011, 0100, 0101, 0110,
0111, 1000, 1001, 1010, 1011, 1100, 1110, 1111.**

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Relationship between Bit-Depth & Number of Colours which can be Represented

Bit-Depth	Number of Colours that can be represented	Formula
1	2	2^1
2	4	2^2
3	8	2^3
4	16	2^4
5	32	2^5
6	64	2^6
7	128	2^7
8	256	2^8
….	…….	……
16	65,536	2^{16}
24	16, 777, 216	2^{24}
N	……..	$\mathbf{2^N}$

Number of Colours which can be Represented = 2^N

Where N = Bit-Depth

Increasing the Bit-Depth increases the Number of Colours that can be Represented.

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Question About Bit-Depth

(1) A bitmap image is stored with pixels dimensions of 3000 pixels
Wide by 2000 pixels tall.

Each Pixel is represented by an 8-digit binary number.

What is the maximum number of colours that can be represented in an 8-bit image?

Question & Answer About Bit-Depth

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What is the maximum number of colours that can be represented in an 8-bit image?

<u>Answer</u>

No of Colours = 2^8

<u>= 256</u>

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Factors Affecting File Size (Resolution & Bit-Depth)

(1) Formula for calculating the File Size of an Image is:-

Learn the formula

(2) File Size = Resolution * Bit-Depth

(3) So, what would be the effect of increasing the resolution?

**(4) We can see from the formula that increasing the resolution
Will result in the file size being increased.**

(5) Conversely, decreasing the resolution will decrease the file size.

(3) So, what would be the effect of increasing the Bit-Depth?

**(4) We can see from the formula that increasing the Bit-Depth
Will result in the file size being increased.**

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Question about File Size

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Each Pixel is represented by an 8-digit binary number.

Calculate the size of the image file.

Question & Answer about File Size

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Calculate the size of the image file.

Answer

File Size = Resolution * Bit-Depth

= 6000, 000 * 8

= 48, 000, 000 bits

= 48 MB

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Meta-Data of an Image

(1) Meta-data is data about data.

(2) Meta-data is the information stored in an image file which helps the computer
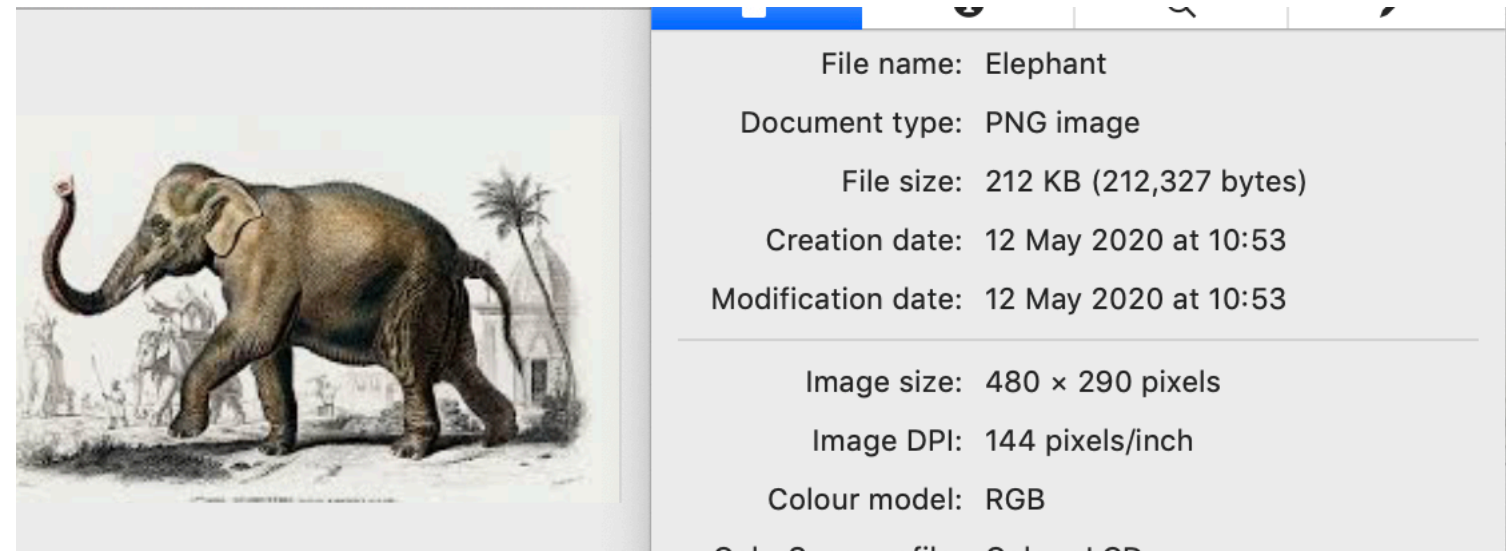Recreate the image on the screen.

(3) **Meta-data usually includes information about the:-**

	Attribute	Example
1	Filename	Elephant
2	File Format	PNG image
3	File Size	212 KB
4	Resolution (or Image Size)	408 by 290 Pixels
5	More information related to Resolution	144 Pixels / Inch
6	Bit-Depth	Here it says RGB which means it is 24-bit depth

(4) The Purpose of Meta-Data

(5) **Meta-Data allows the devices to display the image on screen as intended.**

The Meta-Data of an Image

File name: Elephant
Document type: PNG image
File size: 212 KB (212,327 bytes)
Creation date: 12 May 2020 at 10:53
Modification date: 12 May 2020 at 10:53

Image size: 480 × 290 pixels
Image DPI: 144 pixels/inch
Colour model: RGB

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Question About Meta-Data

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Suggest 3 pieces of meta-data that may be stored in the file.

Question & Answer About Meta-Data

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Suggest 3 pieces of meta-data that may be stored in the file.

Answer

(1) File Format (2) File Size (3) Resolution (4) Bit-Depth

How to recognise Files which are Bitmap Images

Bitmap Images typically have the following file extensions:-

(1) *.jpeg (or *.jpg)

(2) *.png

(3) *.tiff

(4) *.gif

That's all folks for now