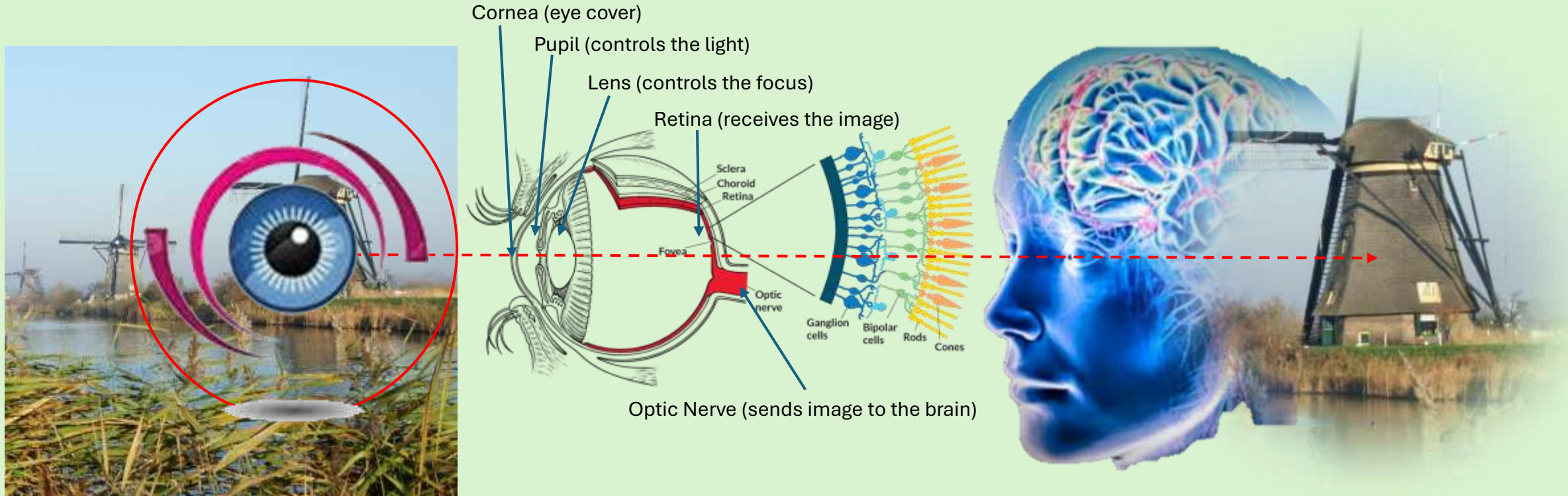


# Pixels, Images & Printing (revisited)



# How the brain receives an image



Light reflects off objects and enters the eye through the Cornea.

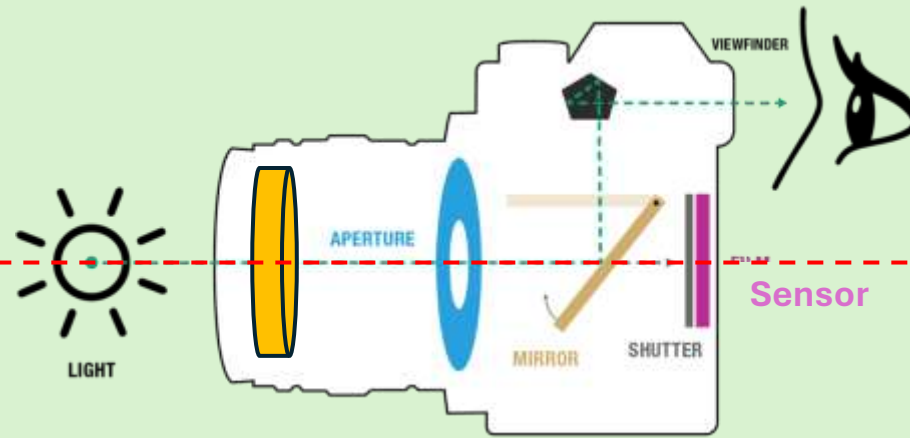
The Pupil regulates the amount of light, while the Lens focuses the image.

The Retina receives the light as Cones and Rods, which are cells that convert the light into electronic signals.

The signals travel to the brain through the Optic Nerve, and the brain translates the signals into Visual Information.

Because the eye can see more of the image than it needs, any peripheral vision is ignored.

# How a camera takes a picture



Light reflects off the objects and enters the camera through the Lens.

The light travels through the Aperture that controls the amount of light into the camera

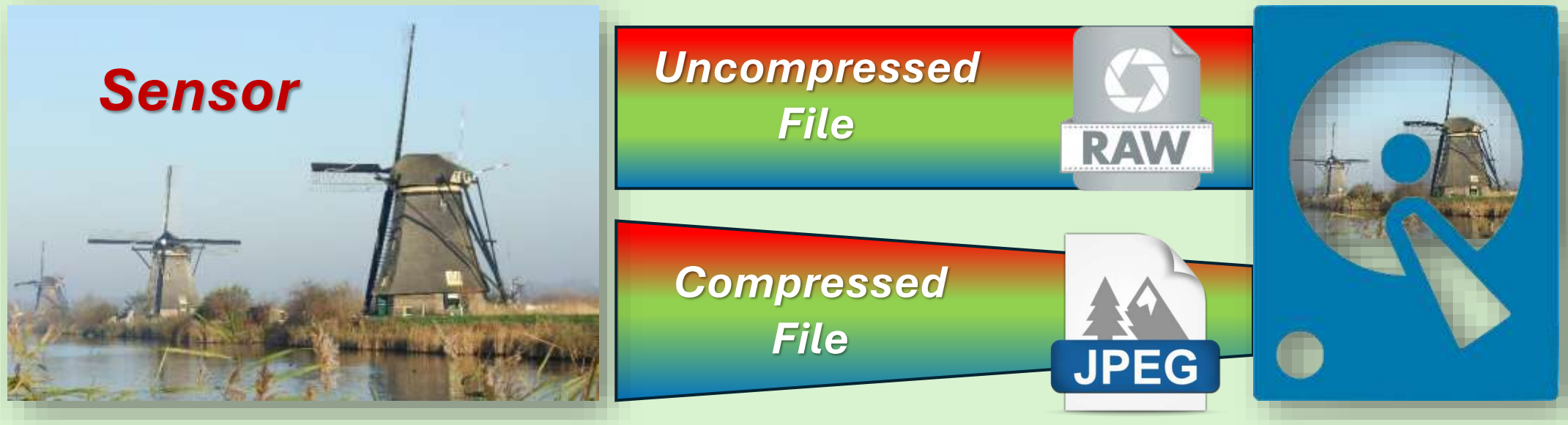
Light reflects off a Mirror to a Prism which directs the image through the Viewfinder

When the Shutter button is pressed, the image is exposed to the Sensor

The image is processed on the Sensor to create a digital image containing lots of coloured Pixels.

***Just like our eyes, this entire process happens in a fraction of a second, allowing us to capture moments in incredible detail.***

# How an image is stored



After processing the sensor image, the data is packaged into a specific file format such as RAW or JPEG.

**RAW:** An uncompressed file retaining all sensor data for maximum editing flexibility. A Raw file needs lots of storage space.

**JPEG:** A compressed, smaller file with some data loss. A Jpeg file needs less storage space.

The formatted file is written to the camera's memory, such as an SD card or internal storage.

# Comparison of saved file size.



# What is a Pixel ?

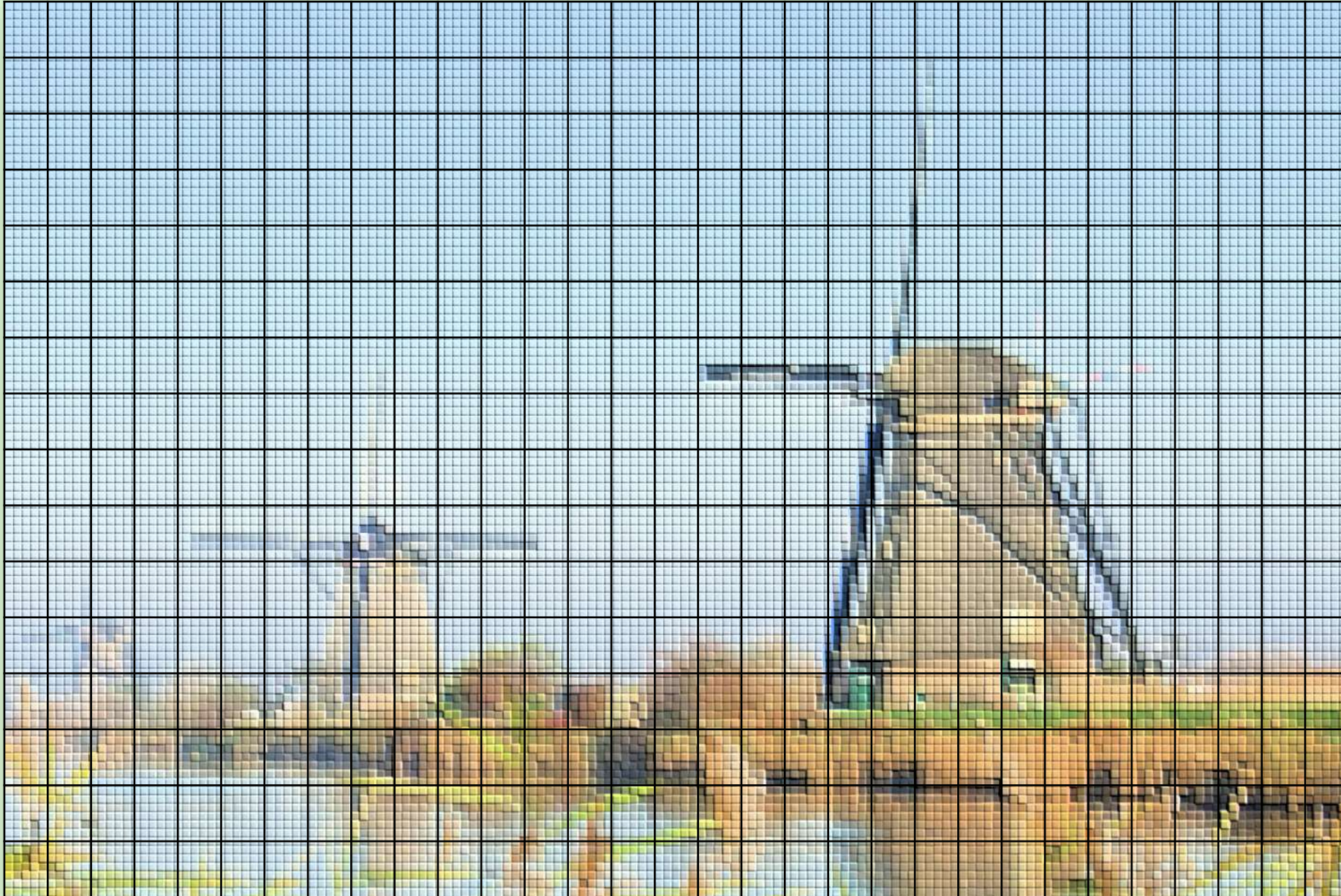
A pixel is the smallest unit of a digital image or display. It's essentially a tiny dot of light that can be any colour.

A digital image uses thousands of pixels to form an image, laid out like graph paper.

This digital image is referred to as a Bitmap, which will be compressed when saved to memory.



# What is pixel resolution



Pixel resolution refers to the number of individual pixels in each dimension of the Bitmap.

Commonly described in terms of **width x height**

A resolution of 4000 x 3000 means that the image has: 4000 pixels horizontally & 3000 pixels vertically, giving a density of 12,000,000 pixels, or 12 megapixels.

# Image from memory to monitor - PPI



## *We are now talking about PPI.*

While an image is in memory, it is saved as lots and lots of numbers, but when the data needs to be processed or viewed it has to be converted into a correct resolution.

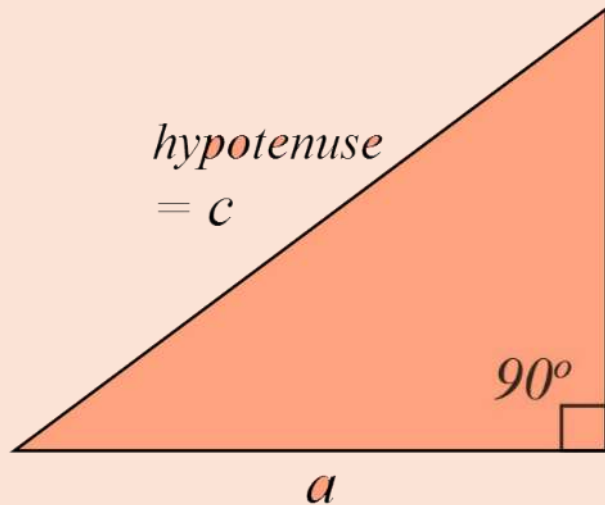
This applies to when it is viewed on a monitor or printed as a photograph.

## **Example:**

Image resolution = 4000 x 3000 pixels.

Screen resolution = 1024 x 768 pixels.

Screen size = 24 inch



$$c^2 = a^2 + b^2$$

Pythagoras Theorem

Because both the image and monitor have different pixel resolutions, the pixels will be juggled to match that of the monitor.

**What happens next?**

To calculate the PPI of a monitor we apply the science of the Pythagoras Theorem, using the screen size, which in this case is 24 inches, and the screen resolution.

As predicted the image has to be adjusted or squeezed to match the resolution of the monitor, which results in a loss detail and clarity.

Using the table we can see that an image with a resolution of 4000x3000 pixels works well with a 4K monitor, but not so well with a standard monitor.



Step	Expression	Description	Monitor Resolution	Approx PPI
<b>1 - Diagonal in Pixels</b>	$\sqrt{[(\text{width in pixels})^2 + (\text{height in pixels})^2]}$	Take the square root of the sum, yielding the diagonal in pixels.	Std - 1024x768 HD - 1920x1080 4K - 3840x2160	54
<b>2 - Compute PPI</b>	$(\text{Diagonal in pixels}) \div (\text{Diagonal in inches})$	Divide the diagonal pixel count by the physical diagonal size (24 inches) to get the PPI.		94
				184

To calculate the Pixels Per Inch (PPI) of a monitor we apply the science of the Pythagoras Theorem, using the screen size, which in this case is 24 inches, and the screen resolution.

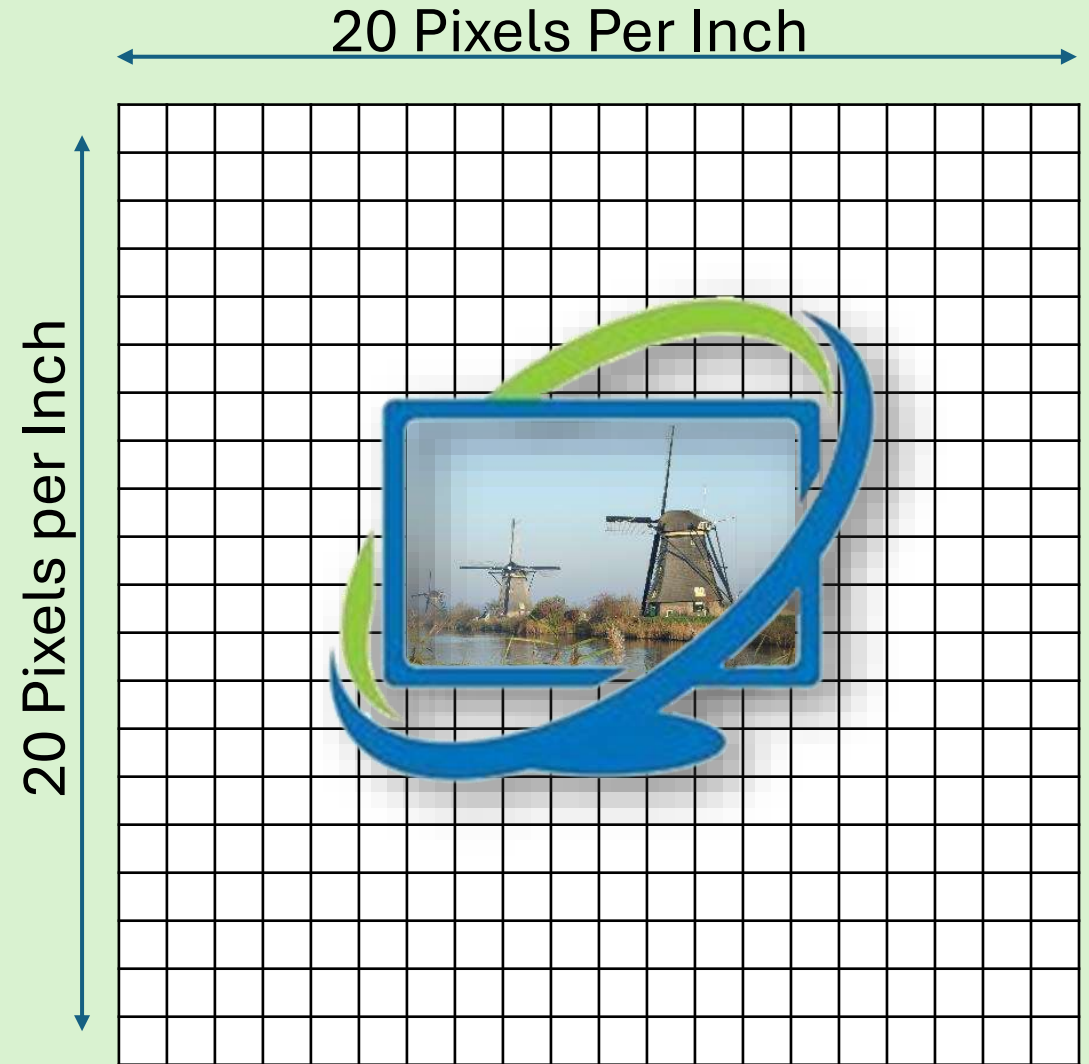
Which using a 24-Inch monitor give the following results :

- A Standard monitor resolution of 1024x768 pixel = Approx 54 PPI
- A High-Definition monitor resolution of 1920x1080 pixels = Approx 94 PPI
- An Ultra HD 4K monitor resolution of 3840x2160 pixels = Approx 184 PPI

**PPI therefore refers to the number of pixels that will fit in a linear inch.**

Sufficient to say that:

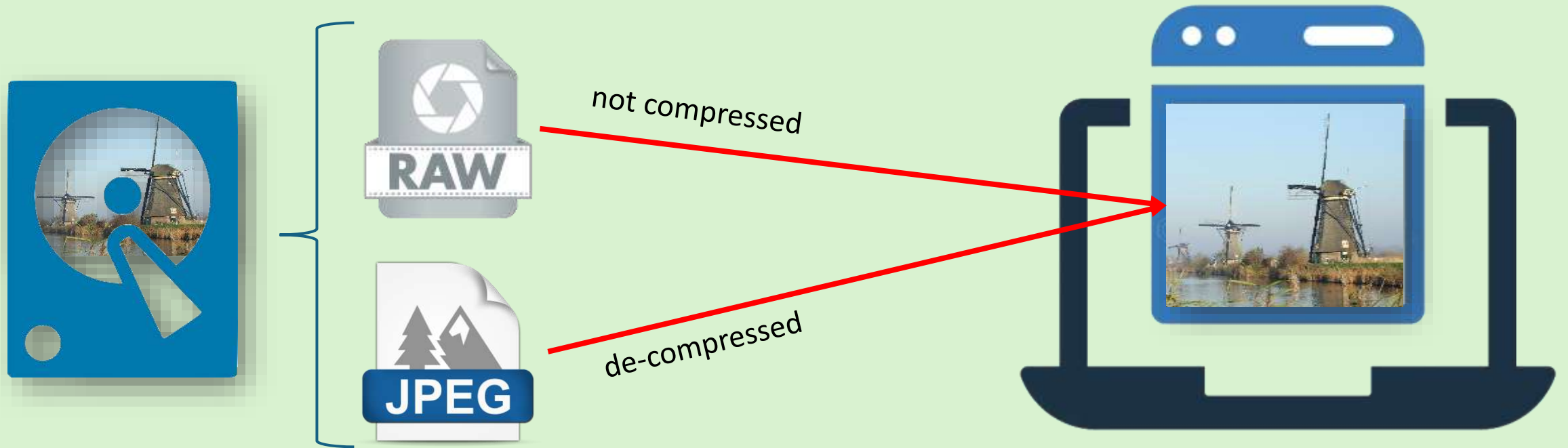
Using the same picture file, a larger monitor resolution will display a clearer, sharper image than a small monitor resolution.



# Storage to Monitor and Back



# Storage to Monitor



When an image is copied from storage to a computer for either processing or viewing, it may need to be prepared.

Because RAW files are not compressed files, they can be post-processed immediately, provided you have the necessary software..

JPEG files, on the other hand are compressed into storage, and need to be de-compressed for post-processing.

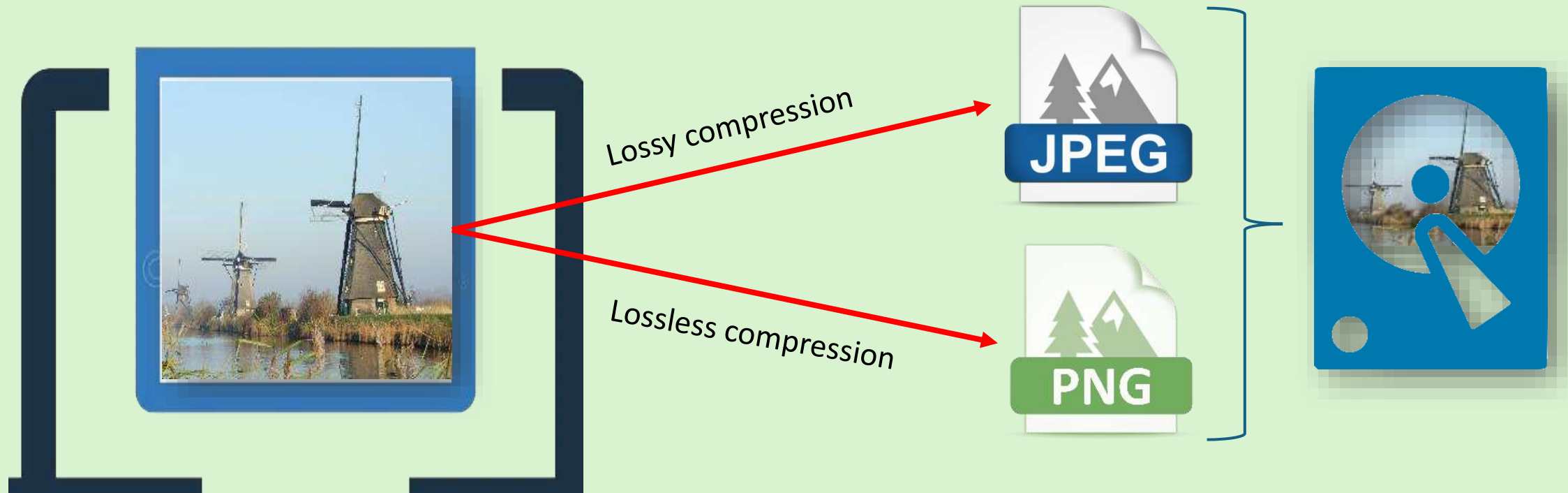
# Post Processing



During post-processing of an image, lots of actions and alterations may be made, such as cropping, changing light and shade etc., all of which will affect the original image.

When processing RAW files, there is a need for special software which can access the file.

# Saving changes



On completion of post-processing, the image will be saved to storage for another time.

A RAW file must be saved as a new Raster or Vector file, which can later be processed again, this could be a JPEG or PNG file

The JPEG file that was processed may be saved to replace the original file, however, this is not good practice, because once again saving a JPEG file means even more details being lost in compression. A good idea would be to save a copy to protect the original image, this could also be either a JPEG or PNG file.

# ***What is Image Compression?***



**Image compression** works by reducing the file size of an image while maintaining as much visual quality as possible.

There are two main types of image compression: **lossy** and **lossless**.



## Lossy Compression



**JPEG compression** is a form of **lossy compression**, a method that discards some image data that the human eye is less likely to notice, achieving high compression rates.



## Lossless Compression

This method retains nearly all image data, which means that the original image can be perfectly reconstructed.

Lossless compression is ideal where quality is critical, such as medical imaging or archival purposes.

This method is usually applied to PNG files

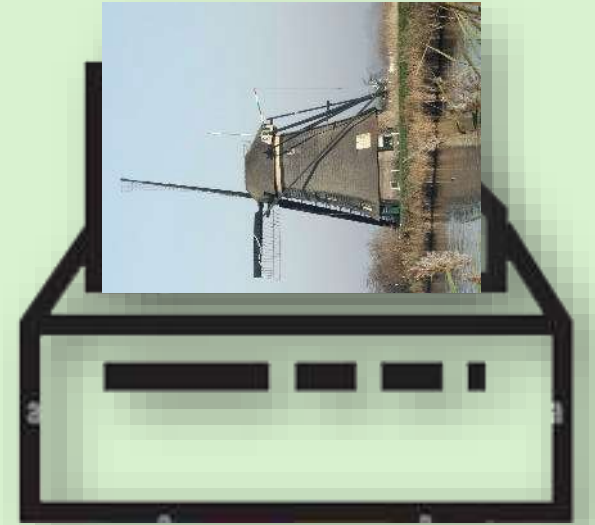
The level of JPEG compression can be adjusted on the camera which may have these extra settings

- **Normal JPEG (Default)**  
which may take about one-tenth to one-twentieth the space of an uncompressed file, but with noticeable compression artifacts and loss of quality.
- **Fine JPEG**  
takes up about one-third to one-fifth as much space as an uncompressed image, with little discernible loss in resolution or detail.
- **Super Fine JPEG**  
With even less loss of data, but much larger files.

*By way of reference, a Raw file would be created as an uncompressed image, with no loss of data.*



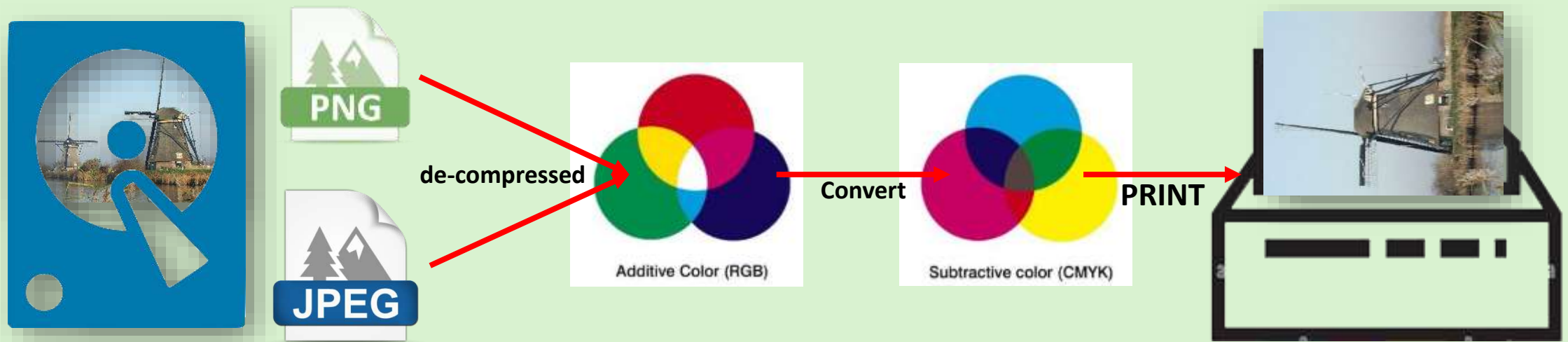
# Printing the image



Sending an image to a printer, involves several processing steps to ensure the image is accurately and efficiently transferred for printing.

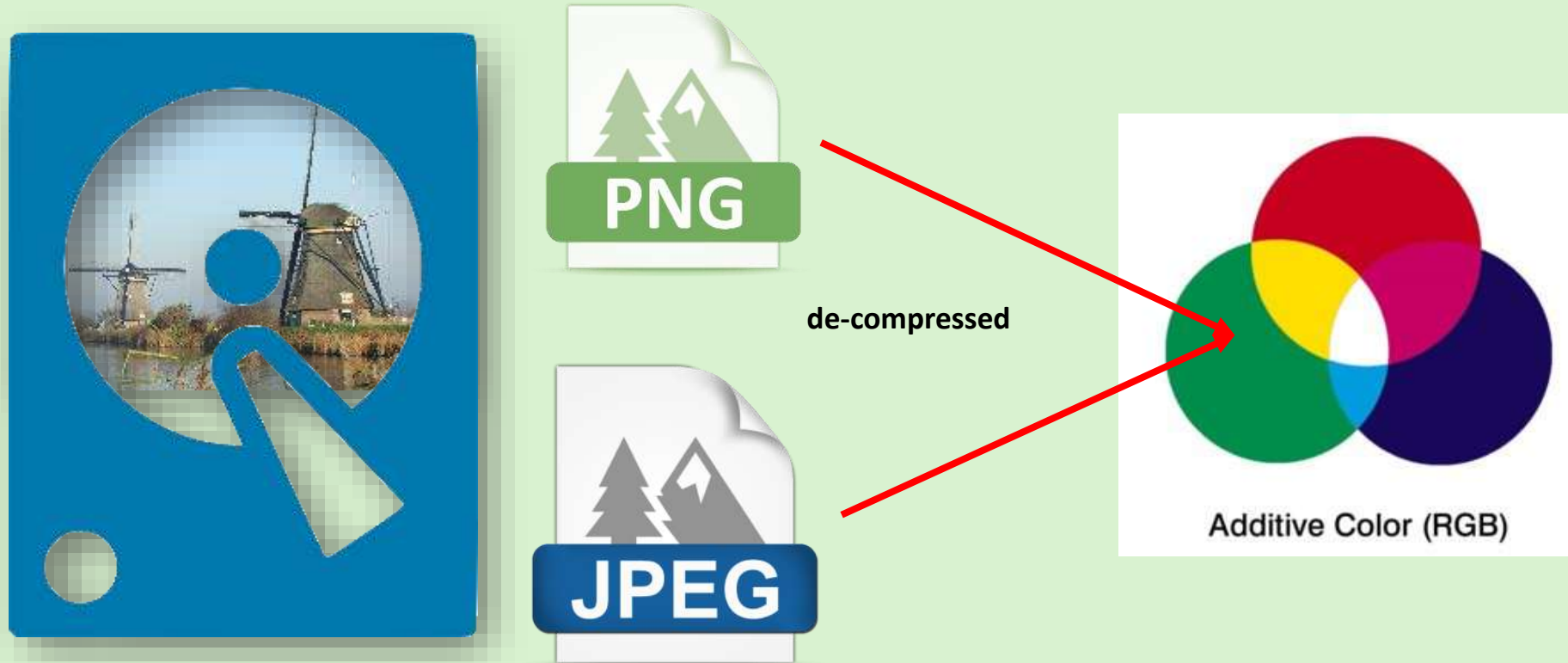
*And because the image is being transferred from a digital state to a physical state, this process is a lot less forgiving than sending images to a screen.*

# Printing an image



When an image is selected for printing, it doesn't take what's visible on the computer screen but extracts a saved copy from memory, once again going through the whole process of decompressing the file.

# Printing an image

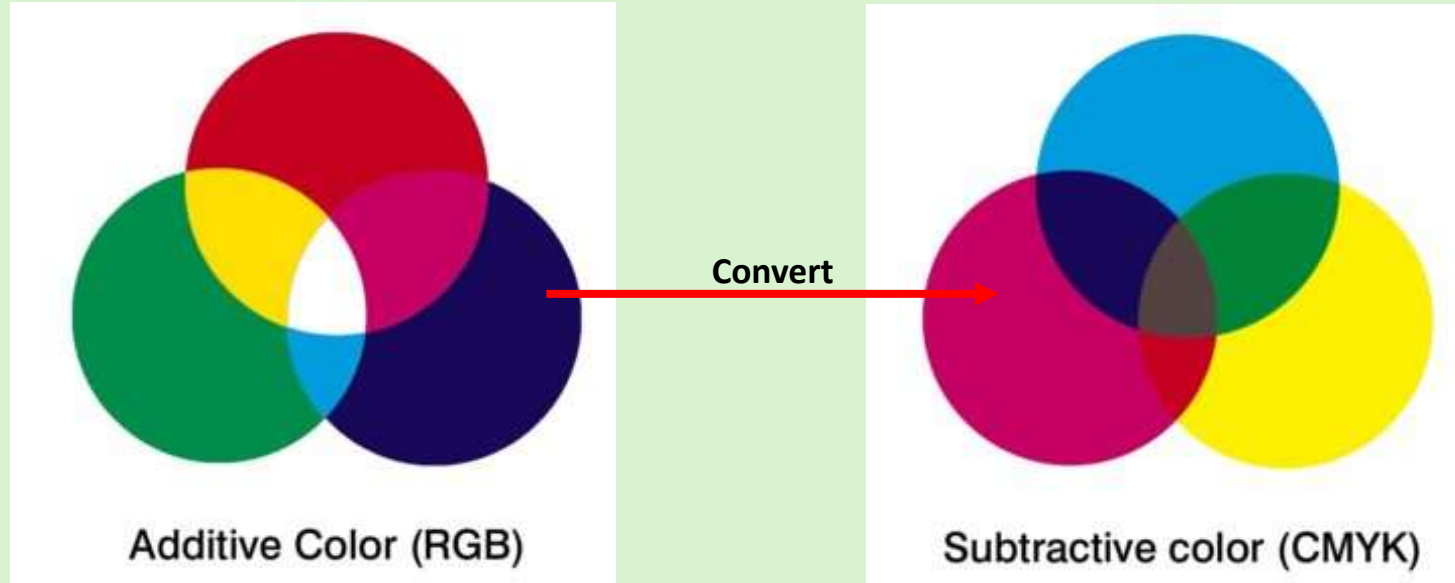


The image has three very important things to consider as it is translated from a digital computer file to a printable file.

The file is converted from RGB format it is to CMYK, working in Dots per Inch (DPI), the printers equivalent to RGB

The colour is processed to match the printers Colour Space and Colour Gamut.

# Converting from JPEG to CMYK

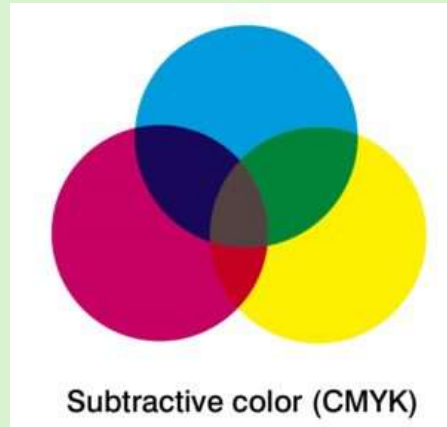


Two ways to specify colour for use in traditional offset printing and on-screen viewing, are **RGB** or **CMYK**.

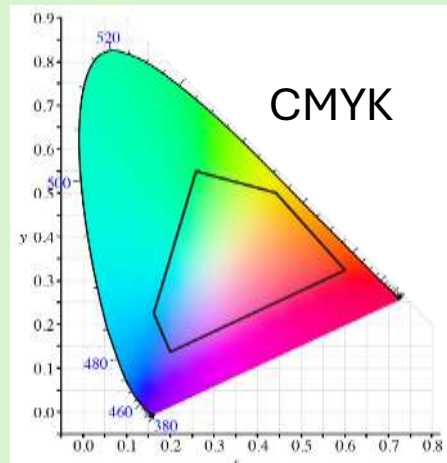
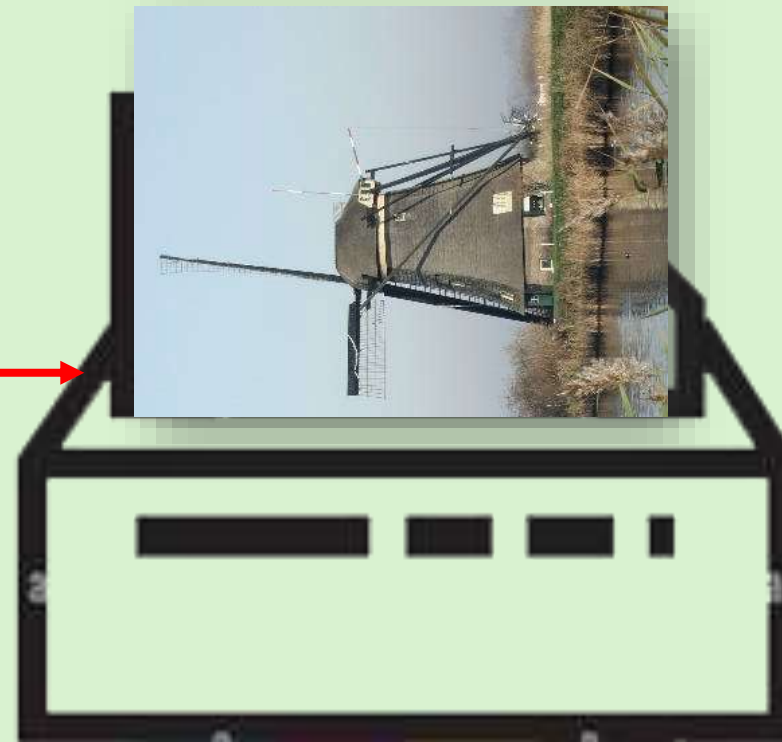
**RGB colors** (red, green, blue) are called “additive colours” because an individual colour is created from nothing by adding different values and intensities of each primary colour. When all three primary colours are combined at their maximum intensity, you see white.

**CMYK colours** (cyan, magenta, yellow, black) are subtractive. This means that a CMYK colour starts with all the colours, and when the colours are subtracted, you end up with black.

# Printing an image

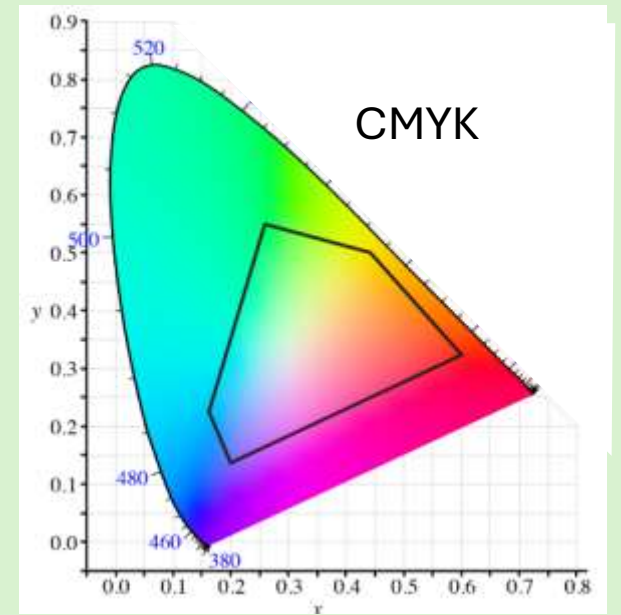
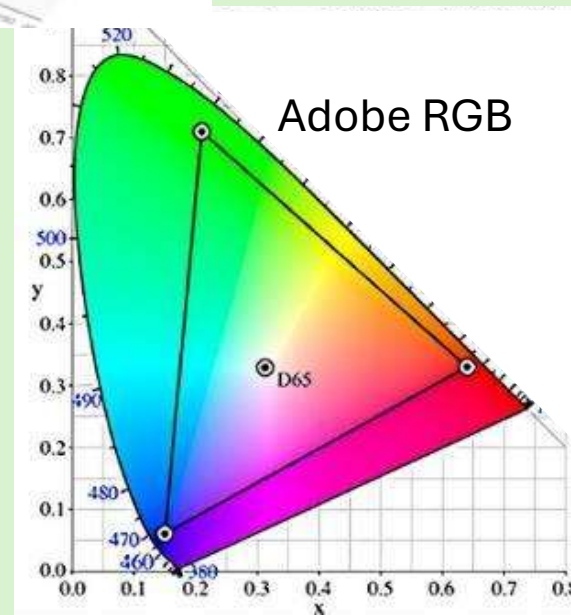
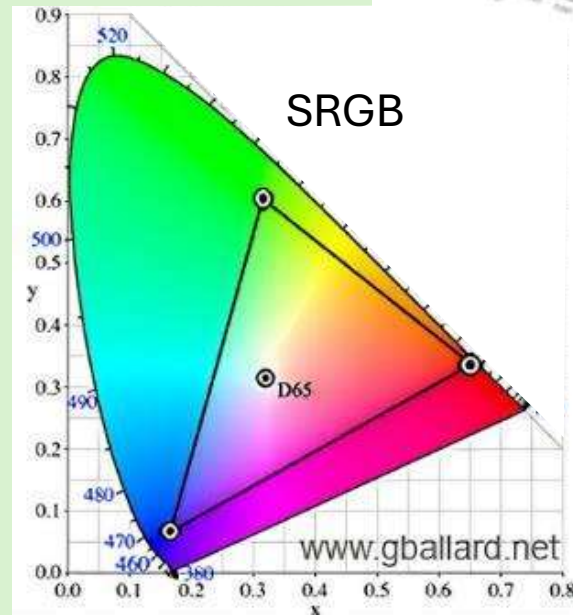
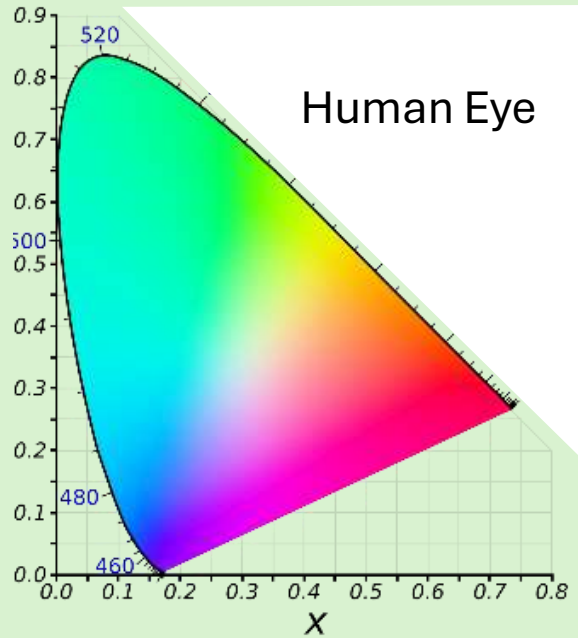
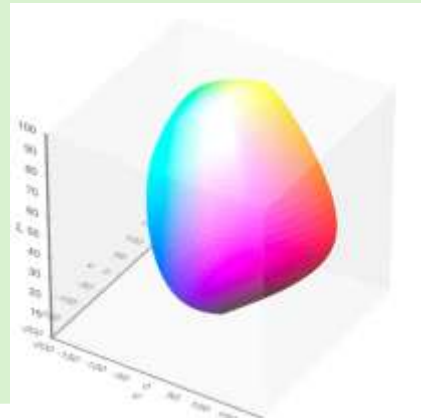


**PRINT** →



Only when the image data has been converted to match the file format, colour space and colour gamut of the printer, it will place the file in a printer buffer area and start to print.

# Colour Space and Colour Gamut



A **colour space** is a specific organisation of colours that allows for reproducible representations of colour, whether in analog or digital form. It defines how colours are represented and interpreted and can be based on parameters such as RGB values or other colour models.

A **color gamut** refers to the range of colours that a particular device can produce or record.

Essentially, it describes the subset of colours within a colour space that can be reproduced by a specific application, system, or device.

***Well, that's all the  
colours sorted  
out, let's get back  
to Pixels and  
things.***

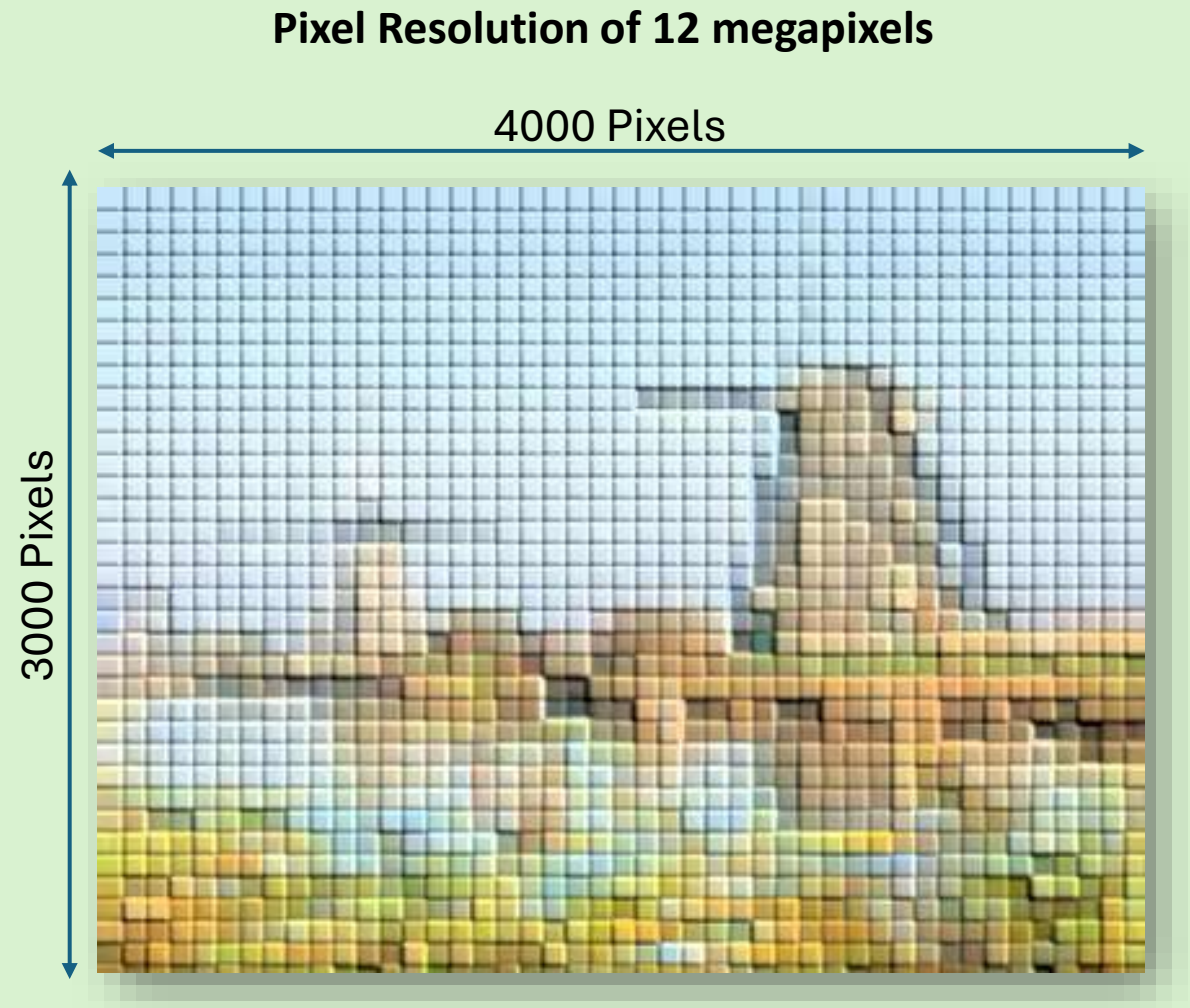


# How do we use pixels in a printer?

We mentioned earlier that the pixel resolution of a digital image is measured in Pixels per Inch (PPI)

Pixel resolution in a printer, also known as print resolution, is the level of detail a printer can produce.

Pixels and DPI (dots per inch) serve different purposes in digital imaging and printing, but they're interconnected when converting digital images to printed material.



Here's how the conversion process generally works:

**Understanding Pixels:**

Pixels are the smallest units of a digital image. The resolution of a digital image is usually described in terms of the number of pixels it contains (e.g., 4000 x 3000 pixels = 12000000 ).

**Understanding DPI:**

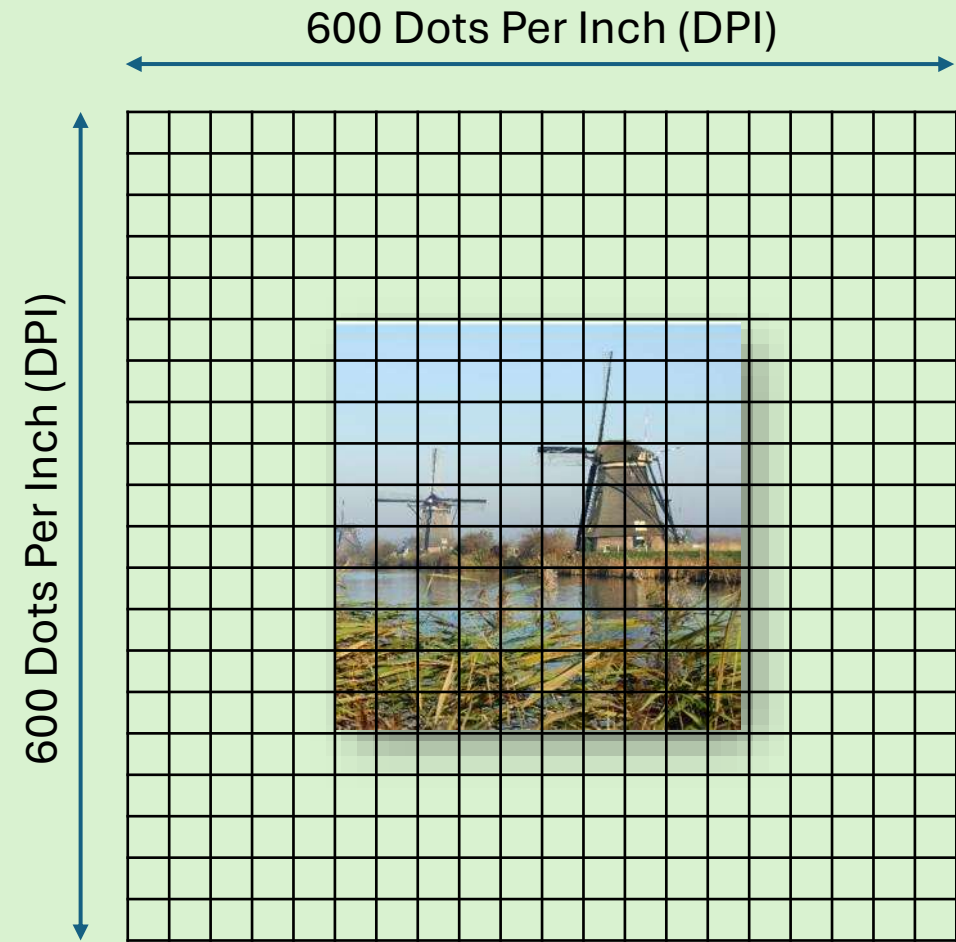
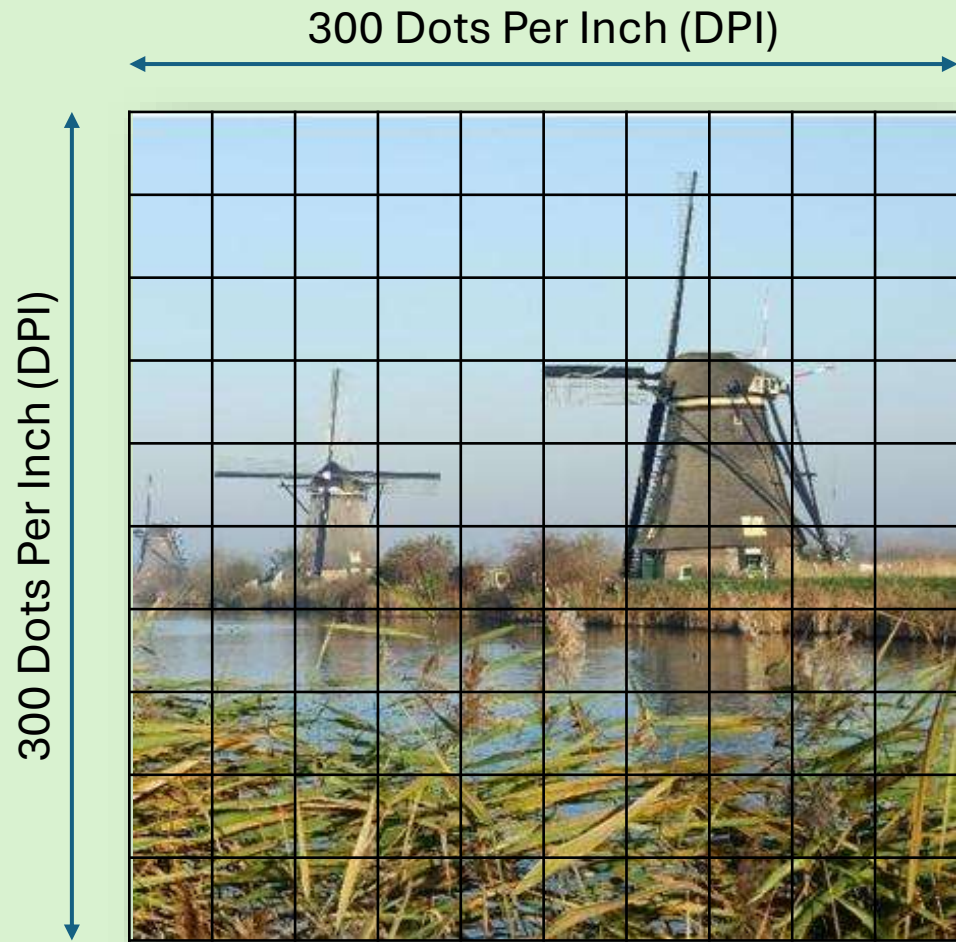
DPI refers to the number of ink dots a printer can place **along a one inch line**. Higher DPI means more dots and, consequently, better print quality.

154 Pixels Per Inch (PPI)



154 Pixels per Inch (PPI)





**Converting Pixels to DPI:** To convert digital image resolution (in pixels) to print resolution (in DPI), you need to know the size you want the printed image to be. The basic formula is:

Print Size (in inches) = Number of Pixels divided by number of Dots per inch (DPI)

**For example,** if you have an image that's 3000 x 2000 pixels and you want to print it at 300 DPI, the print size would be:

Width in inches = 3000 pixels / 300 DPI = 10 inches, Height in inches = 2000 pixels / 300 DPI = 6.67 inches

A 600 DPI print of the same image would be 5 inches x 3.33 inches, ***half the size of the other.***

**Print Quality:**

Higher DPI means better print quality, especially for images and detailed graphics. Text also appears crisper and more readable.


**Common Print Resolutions:**

Basic printers often have resolutions around 300 DPI, suitable for general text documents.

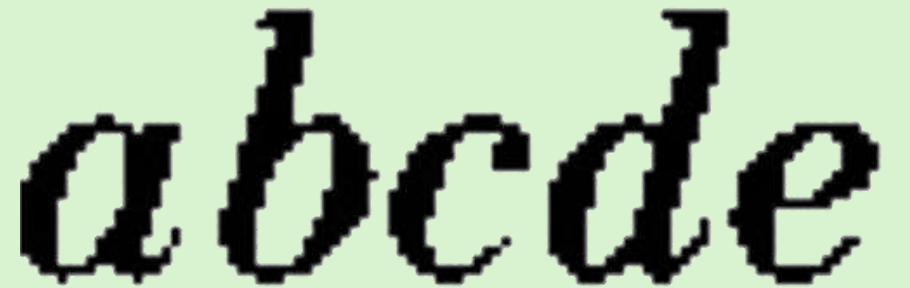
Photo printers typically have resolutions of 1200 DPI or higher to produce high-quality images.

Professional and commercial printers can go beyond 2400 DPI for extremely detailed and fine prints.

The other things to think about are the paper quality and whether the paper you are using is suitable for your photograph.



200 dpi



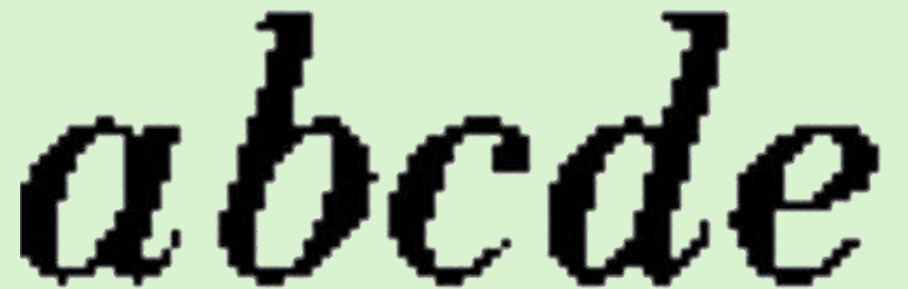
300 dpi



600 dpi



200 dpi



300 dpi



600 dpi

### Adjusting DPI:

If you want to print an image at a different size, you can adjust the DPI resolution.

- Reducing the DPI can make the image larger but may reduce quality.
- Increasing the DPI will improve quality but can make the image smaller.

Paper Size (Inches)	DPI	Image Dimensions (Pixels)	Image File Size
(A5) - 5.83 x 8.27	300	1749 x 2481	4,339,269 - (4Mb)
-:-	600	3498 x 4962	17,357,076 - (17Mb)
(A4) - 8.27 x 11.69	300	2481 x 3507	8,700,867 - (8Mb)
-:-	600	4962 x 7014	34,803,468 - (35 Mb)
(A3) - 11.69 x 16.54	300	3507 x 4962	17401734 - (17Mb)
-:-	600	7014 x 9924	69,606,936 - (69 Mb)

The example shows how many original pixels are required to print a physical image at either 300 or 600 dots per Inch (DPI).

To print an A4 image at 300 DPI you would need a digital image of over 8Mb.





**And that's it in a nutshell.**

**Nobody said,  
“it was going to be easy“ !**