

## Using digital images in teaching and learning

# Understanding digital images

### What are digital images?

Digital images are electronic representations of images that are stored on a computer. The most important thing to understand about digital images is that you can't see them and they don't have any physical size until they are displayed on a screen or printed on paper. Until that point, they are just a collection of numbers on the computer's hard drive that describe the individual elements of a picture and how they are arranged. These elements are called pixels (short for **picture elements**), and they are arranged in a grid format with each pixel containing information about its colour or intensity.

(Note: these guidelines concern 'raster' images (sometimes known as 'bitmap' images): images that are composed of pixels. Most photo-realistic images are raster images. Another type of digital image is a 'vector' image, which is composed of lines and co-ordinates rather than dots and is more suited to line art, graphs or fonts. See <http://www.tasi.ac.uk/advice/creating/fileformat.html> for more information about the difference between the two types.)

### If it doesn't have a physical size, how do I know how big an image is?

The physical size of an image when it is displayed on a computer screen or printed out on paper depends on two factors: the image size and the image resolution.

Image size refers to the number of pixels in an image, and is measured by the number of pixels along the horizontal and vertical sides of an image, eg 600 x 400 pixels. This is the easiest (and most accurate) way to think about the size of a digital image: the number of pixels that it contains.

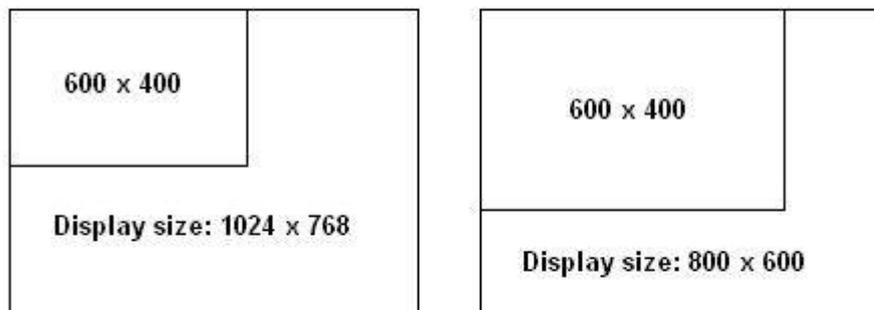
Image resolution refers to the density at which pixels are displayed: that is, how many pixels are displayed per inch of screen or paper. This is often quoted as dots per inch, or dpi, but a more accurate term is pixels per inch, or ppi.

### So how big will an image appear on my computer screen?

Computer screens are also made up of pixels: the number of pixels depends on the screen's size and display settings but most computers these days use a display size of 1024 x 768 pixels. You can check your own computer screen by right clicking on an empty part of the desktop, selecting Properties from the drop down menu, and then clicking on the Settings tab

from the resulting window. (If you are a Mac user, select Display from the System Preferences window, accessed under the Apple menu).

As a general rule, when a digital image is displayed on a computer screen, one pixel of image data is displayed in each pixel on the screen. If your screen is set to display 1024 x 768 pixels, an image containing 600 x 400 pixels would take up about two thirds of the screen when displayed. If you had an older computer which had a display area of 800 x 600 pixels, this same image would **appear** much bigger, taking up over three quarters of the screen, although the image itself still contains the same number of pixels. So images can appear as different sizes on different screens, depending on that screen's display resolution.



## But don't all computer screens have a display resolution of 72 ppi?

Although you may have heard that computer screens have a resolution of 72 ppi, the actual resolution varies from computer to computer, depending on the size of the screen and its display properties; resolutions of between 80 and 100 ppi are more common these days. You can work this out by dividing the display size in pixels by the physical size of the screen in inches. For example, my own screen measures 13 x 9.5" and has a display area of 1024 x 768 pixels, giving a display resolution of 78 ppi. However, a colleague's screen measures 17 x 10.5" and displays 1680 x 1050 pixels, giving a resolution of 98 ppi.

## If I want an image to fill a PowerPoint slide, what size does it need to be?

This will depend on the display settings of the screen or projector that the presentation will be displayed on. Most monitors and projectors these days are set to 1024 x 768 pixels, so you should aim to have an image size of that size in order to fill a whole screen. Further details about using images in PowerPoint can be found in 'Using Images in PowerPoint'.

## If I have an image that is smaller than this, can I make it big enough to fill the whole screen?

Remember how an image is displayed, with one pixel of image data per pixel of screen? If you try and make a smaller image larger, the resulting image will lose quality because there is not enough image data for the number of pixels on the screen. The computer then has to try and fill

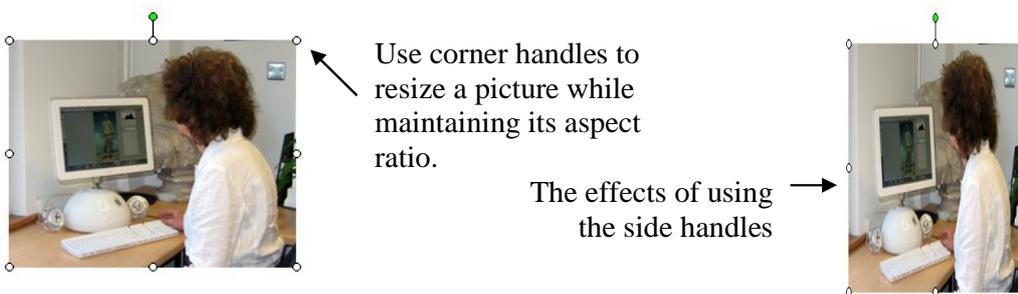
in the blank spaces itself and it does this by copying image data from the adjacent pixels, resulting in a blocked effect, called pixelation.



This image has been enlarged (although only a small section is being shown) so that you can see the effects of this pixelation.

## Can I make images smaller?

Yes, you can make an image smaller if it is too big for your requirements. When you click on an image in PowerPoint or Word, resizing handles (small dots) appear at the corners of the image and you can drag these inwards to reduce the size of the image: don't use the handles at the sides or top of the image as these will squash and distort the image, as shown in this example. Further information on resizing images is given in the section on 'Using images'.



## How can I find out the size of an image?

There are a number of ways to find out the size of an image (its pixel dimensions):

- In Windows Explorer, select an image file and look at the Details section of the Task Pane (at the left of the window).
- Right-click on an image file, select *Properties* from the pop-up menu, then select the *Summary* tab and click on the *Advanced* button. You can also see the resolution of an image in this box.
- You can also find out the size in image browsing or editing programs, such as Microsoft Office Picture Manager or Photoshop (further details on image editing programs are given in 'Modifying Images').
- Mac users can control-click on an image and select Get Info from the pop-up menu. Alternatively, in the Finder window, open the *View* menu and select *As Columns* – the image size is shown in the Preview column once an image is selected.



## How do pixel dimensions and image resolution apply to printing?

For printing, image resolution refers to the number of pixels that are needed to print each inch of the image. For example, ink jet or laser printers generally need to have around 150 ppi in order to produce a reasonable image on plain paper, and up to 300 ppi for photo quality printing.

Therefore, you need to decide how large you want the image to appear on the printed page (in inches), and multiply this by the required resolution (150 ppi) to determine how many pixels you need to get a good quality print. For example, a printed image of 6" x 4" (about half an A4 page) would require 900 x 600 pixels (6 x 150, and 4 x 150). See 'Using Images in Word' for further details on how images can be incorporated into text documents.

If you are preparing images for publication (eg publicity material or to illustrate an article), contact your publisher to find out what size of image they require as they may need a higher quality image.

## Which file format should I use?

There are four main file formats that you may come across when finding or creating images: TIFF, JPEG, GIF and PNG. Generally speaking, if you are working with photographic or other continuous tone images, you should be using JPEGs when incorporating images into teaching and learning materials because these are of good quality with a small file size. They are also the most common image file format found on the web. TIFFs, while they have excellent quality, generally have a very large file size which may make presentations run slowly, and GIFs have limited colour capabilities and so are more suitable for icons or very simple images. PNG is a newer format that share characteristics with both TIFFs and JPEGs, but it is still not a very common format. For more information on different formats, have a look at the section on 'Image formats' in this document.

## What factors affect file size?

File size is affected by three factors: pixel dimensions, image format and bit depth. In general, reducing your pixel dimensions to only what you actually require, using the JPEG format and setting the lowest possible bit depth will give you the smallest file size. You can find out more about how each of these factors affects file size by looking at the section on 'File sizes' later in this document.

## Where can I find out more information?

If you would like to learn more about digital images, there are many web sites that give further information. The following sites are a good place to start:

**Technical Advisory Service for Images (TASI):** [www.tasi.ac.uk](http://www.tasi.ac.uk)

TASI is a JISC-funded service that supports the use of digital images in higher education. Their web site has lots of information and advice on creating and using digital images in teaching and learning. In particular, the following pages may be of interest in understanding digital images:

Do images exist in the real world?

<http://www.tasi.ac.uk/advice/creating/digitalimage.html>

Resolving the units of resolution

<http://www.tasi.ac.uk/advice/creating/dpi.html>

The digital image

<http://www.tasi.ac.uk/advice/creating/image.html>

Glossary: image terminology and acronyms

[http://www.tasi.ac.uk/glossary/images\\_glossary.html](http://www.tasi.ac.uk/glossary/images_glossary.html)

**A few scanning tips:** [www.scantips.com](http://www.scantips.com)

This site has lots of information relating to digital images and scanning, and although it can be a bit wordy and repetitive, it is very good at explaining the fundamentals. In particular, the following pages give a good introduction to the basics:

What is a digital image anyway?

<http://www.scantips.com/basics1b.html>

Image Resolution for the Video Monitor Screen

<http://www.scantips.com/basics1c.html>

**All about digital photos:** [www.rideau-info.com/photos/index.html](http://www.rideau-info.com/photos/index.html)

Although this is part of a personal web site, it does offer some easy to understand explanations about digital images. In particular, The Myth of DPI (<http://www.rideau-info.com/photos/mythdpi.html>) may be helpful in understanding image size.

**Cornell University Library: Digital Imaging Tutorial**

<http://www.library.cornell.edu/preservation/tutorial/contents.html>

This tutorial on digital images offers some 'base-level' information on digital imaging as well as a few quiz questions to check your understanding. The section on basic terminology is particularly useful in explaining the basics of digital images:

<http://www.library.cornell.edu/preservation/tutorial/intro/intro-01.html>.

## Image Formats

There are four main file formats for images: TIFF, JPEG, PNG and GIF. The format of a particular file is identified by the three letter file extension at the end of a filename (.tif, .jpg, .png, and .gif respectively), and each format has unique characteristics that make it suitable for particular uses. A brief explanation of each format is given below, together with its good and bad points, as well as sources of further information.

Note: The image formats covered in this section are all 'raster' formats (images composed of pixels). Vector images (images that are composed of lines and co-ordinates) are not covered by these guidelines, but you can follow the link to the left for further information on vector file formats. The TASI web site has further details on vector file formats:

[http://www.tasi.ac.uk/advice/vector/tl\\_vector1.html](http://www.tasi.ac.uk/advice/vector/tl_vector1.html).

### TIFF (Tagged Image File Format)

**Description:** TIFF images are usually used for master image files. They contain image information in a lossless format (ie no image information is lost when images are saved) and so tend to be fairly large in size. They are therefore a good format for archiving images, but the large file size makes it an unsuitable format for use in web delivery or in presentation software, such as PowerPoint.

**Good for:** master copies of images as all image information is retained when files are saved (lossless format).

**But:** file sizes tend to be large due to lossless format, so TIFF files are not suitable for web delivery or inclusion in PowerPoint presentations.

## JPEG (Joint Photographic Experts Group)

**Description:** This is the main format that is used for photographic-type images on the web. It is a 'lossy' format: images are compressed when saved and so image information is lost each time the image is edited and saved. The benefit of compression is a reduction in file size, but the downside is that if too much compression is applied, visible artefacts such as highlighting around areas of high contrast may occur. The following images show the effects on quality and file size of differing levels of compression on the same JPEG image - notice the blurring around the edges of the statue in the final image.

**Good for:** web delivery of photographic images due to ability to compress images without too much loss of quality, therefore giving smaller file sizes than TIFF formats.

**But:** too much compression can lead to a loss of quality so care needs to be taken with the quality setting used when saving images.

No compression	10% compression	50% compression	90% compression
			
280Kb	138Kb (50% reduction in file size)	77Kb (75% reduction in file size)	38Kb (85% reduction in file size)

However, by choosing the level of compression that is used and you can control the file size and quality of the resulting image: as a general rule, you can save at 70-80% quality without noticing much degradation in image quality.

## GIF (Graphical Interchange Format)

**Description:** Another format encountered on the Internet, the GIF format is usually used for icons or graphics that contain a limited range of flat colours. It is a lossless format (no information is lost when saving), but has limited colour capabilities and so is not suitable for displaying photographs.

**Good for:** web delivery of icons and graphics due to small file size and lossless format.

**But:** supports limited range of colours, so is only suitable for certain types of images.

## PNG (Portable network graphics)

**Description:** PNG is a relatively new web graphics format, designed primarily to replace the GIF format for use on the Internet, and potentially rival TIFF in the long term as an archival format due to its better compression performance. Its main advantages over GIF are an

improved lossless compression method and support for 'true colour'. Although software support for the PNG format has been slow in developing, this is now beginning to change and it may become a more common format in the future.

**Good for:** web delivery due to lossless compression technique resulting in files of small size but high quality.

**But:** JPEG format gives better results for photographic images, and older web browsers and programs may not support the PNG format.

## Further information

For more information on file formats, have a look at the following web resources:

- MS Office picture formats – details of formats suitable to use in MS Office documents: <http://support.microsoft.com/kb/320314/en-us?spid=2530&sid=256>
- TASI Choosing a file format <http://www.tasi.ac.uk/advice/creating/format.html>
- Scantips.com - Which Image File Format? <http://www.scantips.com/basics09.html>

## File sizes

There are three main factors that determine the size of an image file: pixel dimensions; image format; and colour depth.

### Pixel dimensions

This refers to the number of pixels in an image: the more pixels that are present, the larger the file size will be. Aim to have an image that is big enough for your purpose but no bigger, as the extra pixel information will not be needed and will only slow down your software. For example, if you wish to show an image in a PowerPoint presentation slide, there is no point in using an image that is larger than 1024 x 768 pixels, as this is the usual size of most computer and projector screens. Similarly, if you wish to show two images on one slide, each image should only be a maximum of 500 x 768 pixels. Even when you resize or crop an image within PowerPoint or Word, the original image information is still retained so although the image appears smaller, it still takes up the same amount of memory. See 'Using Images in PowerPoint' for more information on resizing images and reducing file sizes. For information on software you can use to resize images, look at 'Modifying Images'.

### Image format

The format of an image file has a large effect on the file size. As discussed earlier, TIFF files are uncompressed and so file sizes are large, whereas JPEG files are compressed, resulting in smaller file sizes, depending on the amount of compression applied. For example, a screen sized TIFF file that is 2 Mb in size reduces to a mere 400 Kb when saved as a high quality JPEG – a fifth of the original file size.

Converting from one format to another can easily be done using any image editing software: see the section on 'Editing Images' to find suggestions for suitable software.

## Bit depth

Bit depth refers to how many 'bits' of information are used to store colour information in an image file (a bit is the smallest unit of information that a computer can store and it can have two values: 1 or 0, on or off). The higher the bit depth, the more accurately colours will be represented. In the case of black and white images, each pixel contains 8 bits of information to describe the greyness of each pixel. In colour images, each pixel contains 8 bits of information for each of three colour channels (red, blue and green) that make up the colour of each pixel, giving a total of 24 bits (3x8).

As you can see, the more information that is captured about colour, the larger the resulting file size will be. Therefore, if your image is black and white, you should save it in greyscale format as there is no point in recording information about the amount of red, blue and green in the image. This will reduce the file size by approximately a third.

Some scanners capture images at a higher bit depth than the standard 24 bits, but while this may be useful when editing images for colour fidelity, it is not necessary for most uses as the human eye cannot see this extra colour detail. Therefore, ensure that you images are saved in 24 bit colour (or 8 bit per channel).