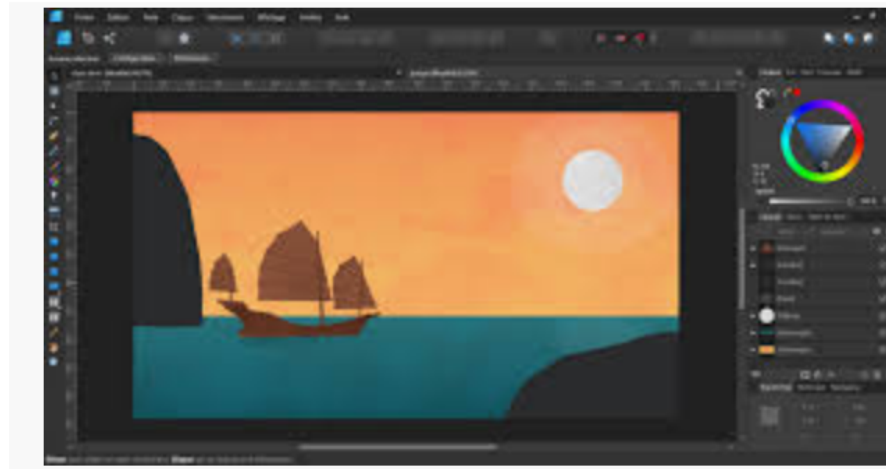


Computer Science 1033 – Week 3

GRAPHICS [?] YES, SIZE DOES MATTER!



Afternoon, n.:

That part of the day we spend worrying about how we wasted the morning. [?] Unix Fortune

Poster Assignment Hints

Follow the instructions carefully, for example:

- you get 2 marks if you named your files as stated in the instructions!
- If you get a mark for every requirement we ask for.

DON'T Collapse your layers

Name your layers with good names

Check for spelling

Text:

Contrast

Edges

Images

Crisp

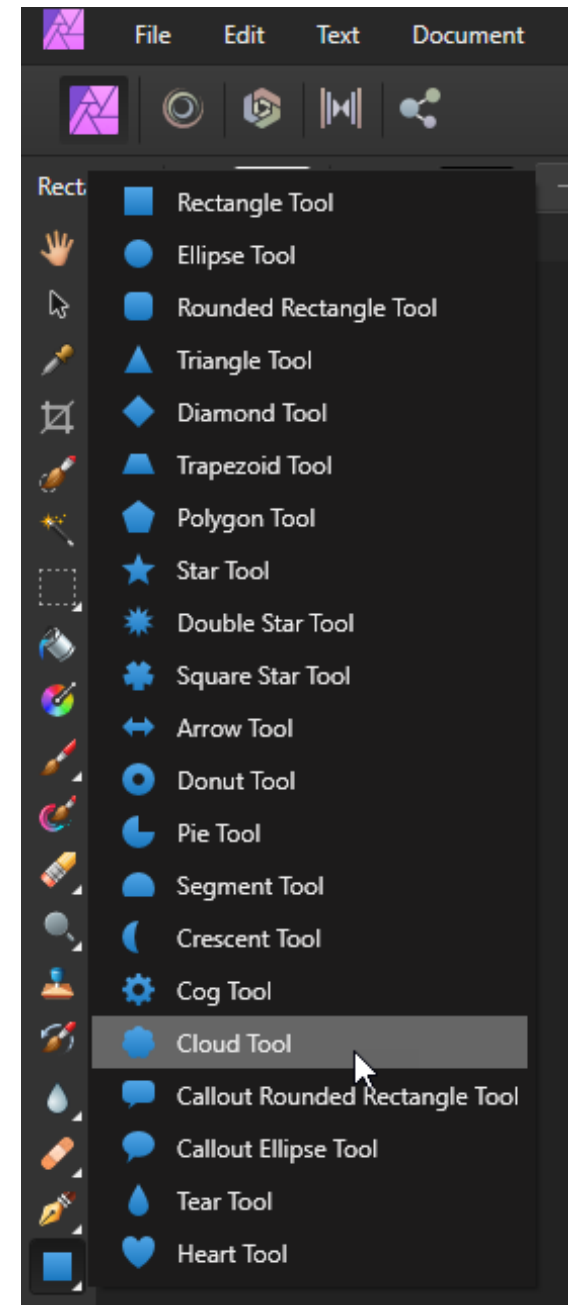
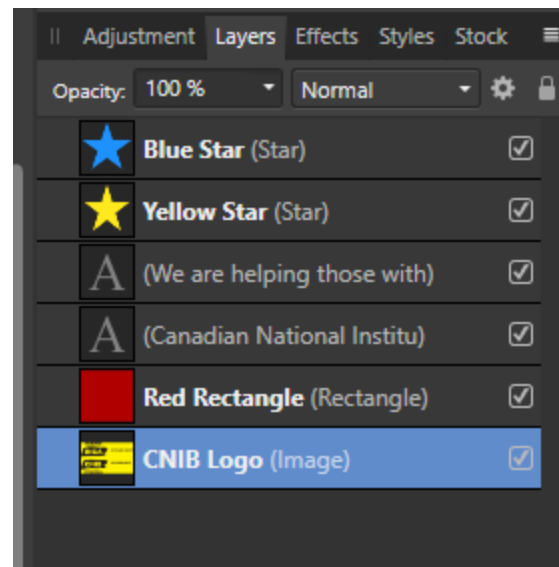
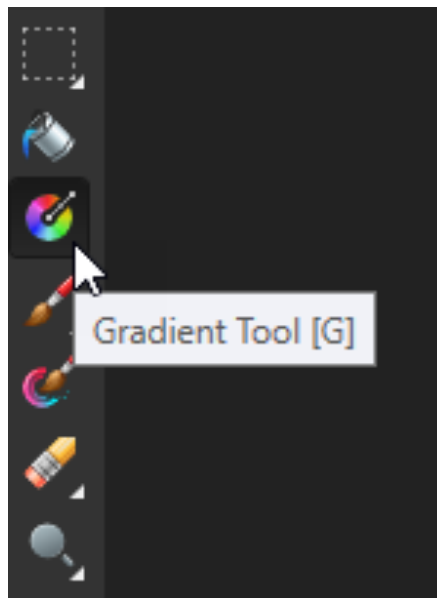
Appropriate

Colours

Hints on Assignment

Use the shape tool to create:

- A shape, you can use the custom shape tool
- Give the shape a good name, don't collapse the layers



Poster Assignment Tips

Check that you have all the required criteria such as a shape from the shape tool.
Remember to follow the CRAP rules!

Other tips

Colour Choices 

<https://color.adobe.com/create>

and <http://design-seeds.com/>

Remarks!

Remember that if you ask your instructors for a remark...they ALWAYS remark the whole assignment and you get the mark that the instructor gave you NOT the highest mark!

THINK CAREFULLY ABOUT REMARKS!

Big Ideas for This Weeks

Big Idea 1: Mo bits per pixel ... Mo Colors!

Big Idea 2: Bitmapped vs Vector:
Thumbnail Vectors Icons on the size of a bus?
IT IS DOABLE!

Big Idea 3: Mo bits, Mo problems! (The more bits you have to transmit, the slower your image will load unless you compress)

Big Idea 4: Go Smaller or Go Compressing!

Readings

Textbook readings:

- Understanding Computers
 - Files and Folders
- Graphics
 - Basics of Graphics *
 - Digitized Images *
 - File Size (first portion of Image Formats and Compression Techniques)
- * These two readings were suggested in previous weeks too. You don't have to read them if you did before!

Overview of Today's Topics

Sampling an image

Black and White, Gray and True Colour

Indexed Colour

Review and worksheet

Bitmaps vs. Vectors

Image file size

Why we need compression

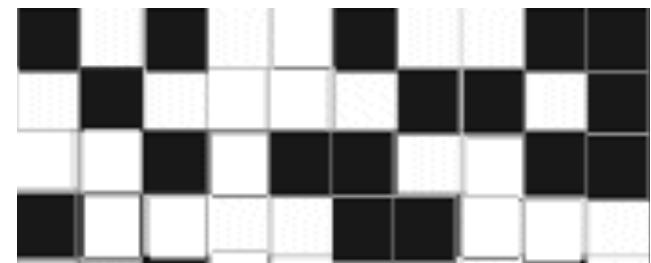
Quantizing The Image

Now that we know how many pieces our image will be broken into, how many colours will we have available to represent each pixel?

Assume for each pixel we have 1 bit to represent the colour.

1 bit can hold either 0 or 1

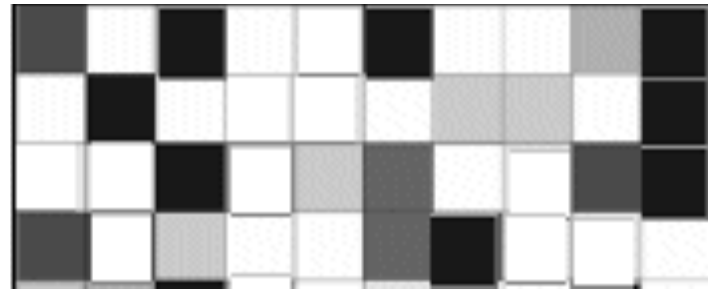
- 0 could be white
- 1 could be black



Thus 1 bit allows for 2 colours, usually black and white ($2^1 = 2$)

How many colours can 2 bit hold? $2^2 = 4$

- 00 ? White
- 01 ? Light Gray
- 10 ? Dark Gray
- 11 ? Black



Does 1 bit colour look realistic?

YES ☐ Can you tell what this image represents?



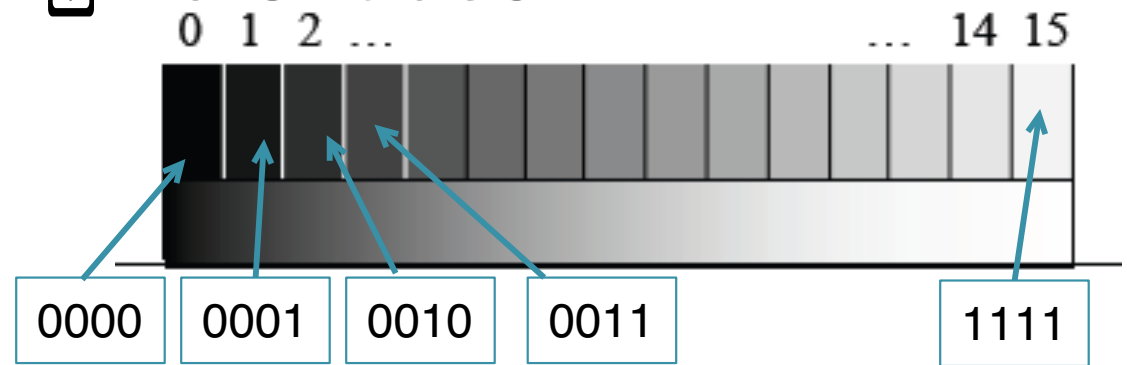
2 Bit Colour

4 shades of gray



More bits, more shades of gray

4 bit colour $2^4 = 16$ Shades



How many shades of gray will 8 bits give us?



If this image was 400 pixels by 300 pixels and we used 1 byte (8 bits) for each pixel, the file size would be:

- $400 \times 300 \times 1 \text{ byte} = 120,000 \text{ bytes}$ or ~120 kilobytes

How about some Colour?

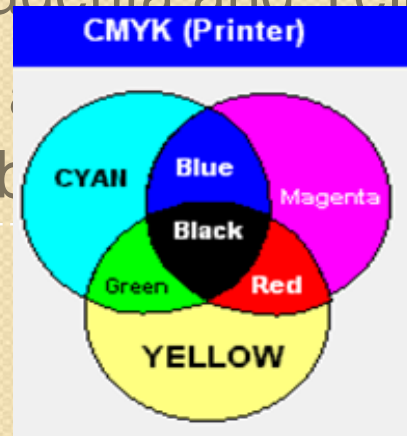


Subtractive Model - CMYK

Used for printing

Ink applied to paper

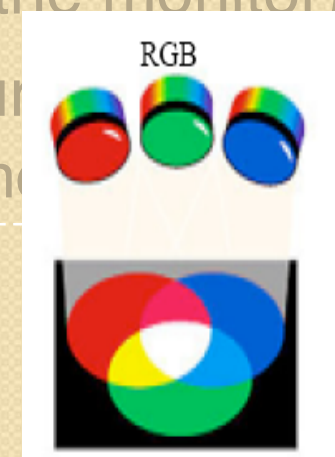
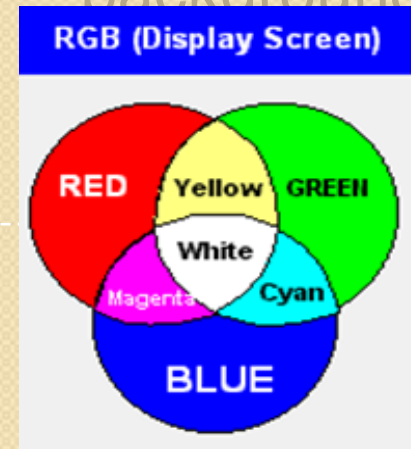
Primary Colours ? Cyan, Magenta and Yellow



Additive Model - RGB

Use on monitors

“Adding” light to a black background (the monitor)



How do we represent the colours on a Monitor?

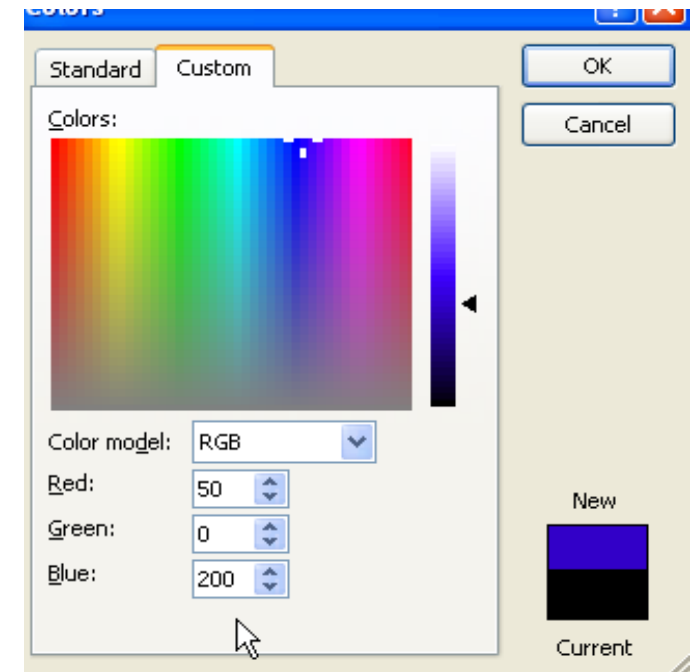
True Colour

- Can represent 2^{24} colours [?] about 16 million different colours
- $2^{24} = 2^8 \times 2^8 \times 2^8 = 256$ shades of red, \times 256 shades of green \times 256 shades of blue
- Need 3 bytes (remember: 1 byte=8 bits) for True Colour (1 byte for red, 1 byte for green, 1 byte for blue)

2 Ways to encode True Colours

1. $\langle RGB \rangle$ \langle amount of Red, amount of Green, amount of Blue \rangle DECIMAL NUMBER









































- Where 0 is no amount and 255 is the most allowed
- $\langle 255, 0, 0 \rangle$ the most of red, no green, no blue
- $\langle 0, 255, 0 \rangle$ the most green, no red, no blue
- $\langle 100, 100, 100 \rangle$ equal middle amounts of red, green and blue
- $\langle 50, 0, 200 \rangle$ a little red, a lot of blue
- $\langle 200, 0, 50 \rangle$ a lot of red, a little blue



2. Hexadecimal Code

- **#RRGGBB** [?] RR are the digit place holders for the amount of red, GG amount of Green, BB amount of Blue
- Amounts are counted in hexadecimal with these digits:
0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F
- 00 still means 0
- Hex FF= Decimal 255 (try the calculator to see)
- Hex to Dec [?] 00=0, 01=1, 02=2, 03=3, 04=4, 05=5, 06=6, 07=7, 08=8, 09=9, 0A=10, 0B=11, 0C=12, 0D=13, 0E=14, 0F=15, 10=16, 11=17,..... FD=253, FE=254, FF=255.
- **#FF0000** [?] Red
- **#00FF00** [?] Green
- **#000000** [?] Black
- **Question: what is the hex for WHITE?**

Some hexadecimal colours:

 EEEEEEE	 FFFF66	 FFCC66	 FF9966	 FF6666	 FF3366	 FF0066	 00FF00
 DDDDDD	 FFFF33	 FFCC33	 FF9933	 FF6633	 FF3333	 FF0033	 00EE00
 CCCCCC	 FFFF00	 FFCC00	 FF9900	 FF6600	 FF3300	 FF0000	 00DD00
 BBBBBB	 CCFFFF	 CCCCCF	 CC99FF	 CC66FF	 CC33FF	 CC00FF	 00CC00
 AAAAAA	 CCFFCC	 CCCCCC	 CC99CC	 CC66CC	 CC33CC	 CC00CC	 00BB00

Question: Are these colours the same:

- $\langle 0,0,0 \rangle$ and #000000?
- $\langle 0,0,0 \rangle$ and #000000?
- $\langle 9,8,7 \rangle$ and #090807
- $\langle 10,15,09 \rangle$ and #0A0F09
- $\langle 255,0,255 \rangle$ and #FF00FF
- $\langle 255,0,255 \rangle$ and #FF00FF
- $\langle 66,0,99 \rangle$ and #660099 ?
- $\langle 66,0,99 \rangle$ and #660099 ? NO

<http://easycalculation.com/color-coder.php>

<http://easycalculation.com/rgb-coder.php>

Can you represent the same number of colours using Hex as using RGB

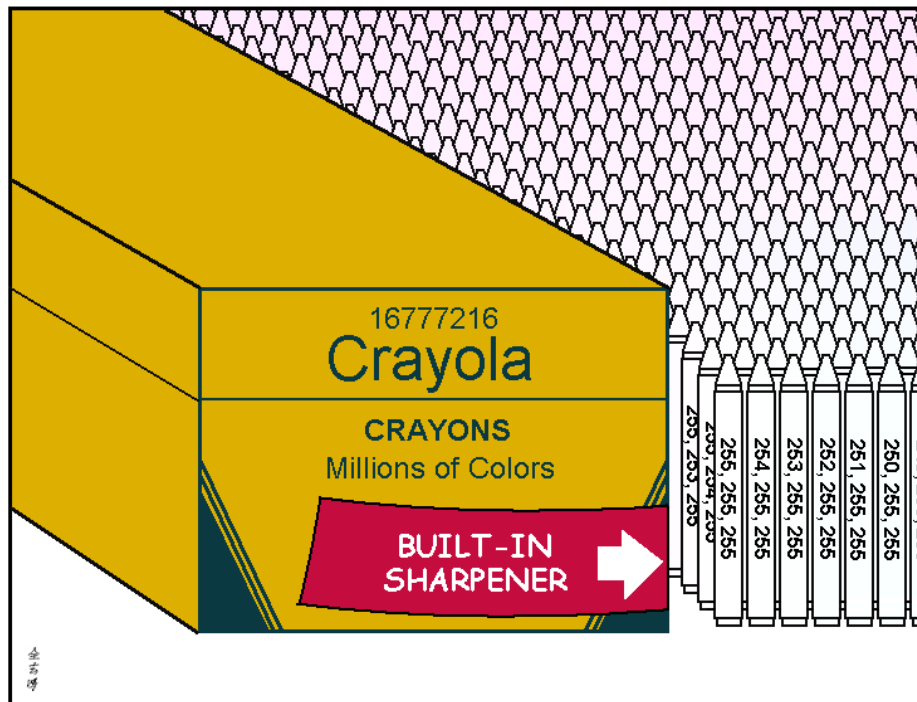
YES

<https://www.rapidtables.com/convert/number/hex-dec-bin-converter.html>

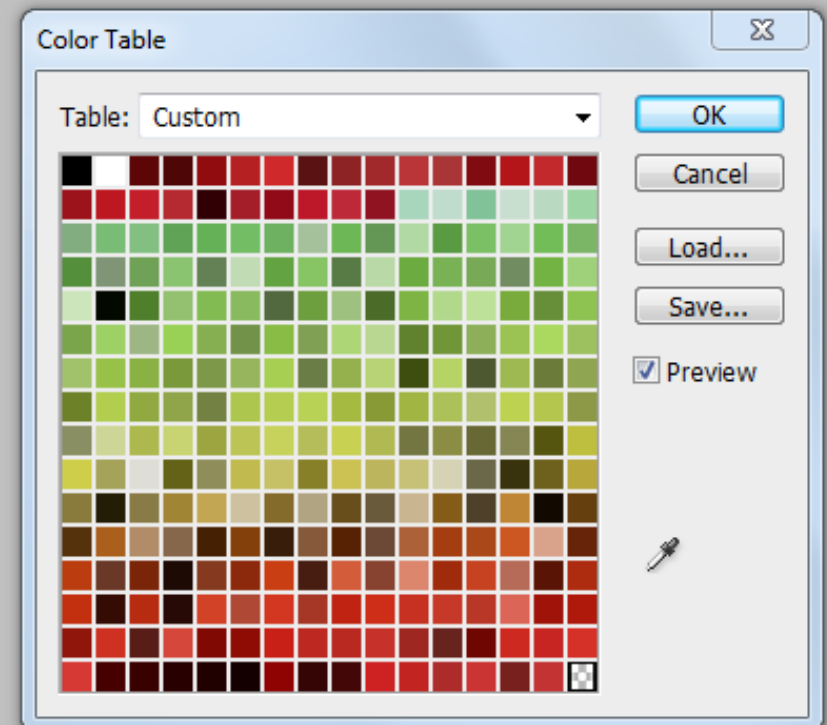
	Red	Green	Blue	How many colours?
Smallest Value (RGB)	0	0	0	
Biggest Value (RGB)	255	255	255	
Total number of shades you can represent	256	256	256	$256 \times 256 \times 256 = 16$ million colours
Smallest Value (Hex)	00	00	00	
Biggest Value (Hex)	FF	FF	FF	
Total number of shades you can represent	$16 \times 16 = 256$	$16 \times 16 = 256$	$16 \times 16 = 256$	$2^8 \times 2^8 \times 2^8 = 2^{24} = 16$ million colours
Smallest Value (Binary)	00000000	00000000	00000000	
Biggest Value (Binary)	11111111	11111111	11111111	
Total number of shades you can represent	$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^8$	$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^8$	$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^8$	$2^8 \times 2^8 \times 2^8 = 2^{24} = 16$ million colours

How many colours do we need to encode?

QUESTION: Roughly, what is the maximum number of colours the human eye can detect?



Colour Continued...Indexed Colour (not true colour)



Why do the bottom boxes appear to have no colours in them?

Indexed Colour

Indexed Colour can look pretty good even though we will only ever have at most, 8-bit colour (or 256 shades of colour)




Review:

Match the encoded colour to the correct colour name:

Encoded Colour	Colour Name
a) #FFFFFF	1. White
b) #00FF00	2. Black
c) #FAFAFA	3. Dark Gray
d) <0,0,255>	4. Light Gray
e) <0,0,0>	5. Medium Gray
f) <14,14,14>	6. Bright Green
g) <125,125,125>	7. Bright Blue

Bitmapped Images vs. Vector Graphics

Bitmapped Graphic Image

- Image consists of pixels in a grid
- Icons are an example of a bitmapped image (do you recognize this icon? )
- Icons are usually 32 pixels by 32 pixels
- When bitmapped images are enlarged (resampled), the computer adds new pixels and guesses on the colour to colour the new pixels (called **interpolation**) based on surrounding pixels
- This icon is now 245 pixels by 245 pixels
- Bitmapped images edges become jagged



Bitmapped Images

Also called *raster graphics* image

Bitmapped images are resolution dependent

- Bitmapped image on a 640 by 480 screen (lower resolution) appear larger than on a 1280 by 1024 screen (higher resolution)

Bitmapped images that are enlarged:

- Have larger file size than original
- Become distorted

All images from scanners and digital cameras are bitmapped images

Dimensions: 100 x 100

Image Size: 20k



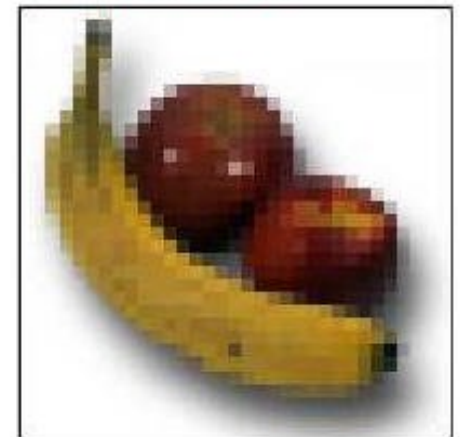
Dimensions: 200 x 200

Image Size: 48k



Dimensions: 400 x 400

Image Size: 98k



Common Bitmap Formats

Common bitmap file formats are:

- BMP (has little compression, makes big files!)
- GIF
- JPEG, JPG
- PNG
- PICT (Macintosh)
- PCX
- TIFF
- AFPHOTO (Affinity Photo)
- PSD (Adobe Photoshop)

Popular bitmap editing tools/software packages:

- Microsoft Paint
- Adobe Photoshop
- Affinity Photo
- Corel Photo-Paint
- Corel Paint Shop Pro
- The Gimp

Vector Graphics

Vector image is made up of individual, scalable objects.

Objects are defined by mathematical equations

Objects consist of lines, curves and shapes

No distortion as image is enlarged

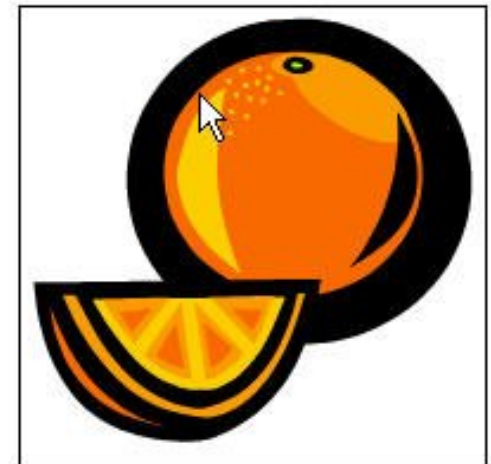
Dimensions:
100 x 100



Dimensions:
200 x 200



Dimensions:
400 x 400



Vector Graphics

As image is enlarged, still has crisp clean lines.
Most browsers don't display vector graphics without a plug in.

Only can be used with drawings, not photographs

Usually vector graphic image has a smaller file size than the same image stored as a bitmap.

Below: enlarging and shrinking an image: left using a vector graphical image, right using a bitmapped image



Vector Images

Example: HTML 5 allows it now:

https://www.w3schools.com/graphics/svg_inhtml.asp

- Try changing the values

Great for logos because

- Can be scaled down for business card
- Can be scaled up for a trade show poster

<https://youtu.be/PJFc3KIEdLM?t=61> (watch till about minute 4)

Note: the text in PDF files are Vector based
(but not the images in a pdf file)

Common Vector File Formats

Common Vector file formats include:

- AI (Adobe Illustrator)
- CDR (CorelDRAW)
- CMX (Corel Exchange)
- CGM Computer Graphics Metafile
- DXF AutoCAD
- WMF Windows Metafile
- EPS (Encapsulated PostScript)
- PDF

Popular vector drawing programs/software packages are:

- Adobe Illustrator
- Affinity Designer
- CorelDRAW
- Xara Xtreme
- Serif DrawPlus

Activity 1

Open MS Paint (
Start>Programs>Accessories>Paint)

Pick the text tool, set the font to 50pt, type in your name

Pick the text tool again, set the font to 12pt, type in your name

Select the small font and resize it to the size of the big font

Do they look the same?

Activity 2

Draw an oval in MS Paint, then select it and resize it, watch what happens

Draw an oval in Affinity Photo,

- Select *Layer>Layer Style* and give it an outline (Stroke)
- Select the oval layer and select *Edit>Transform Path>Scale* and resize it, watch what happens.

Usually when you see the command “***Document>Flatten***” in Affinity Photo, it is changing your Vector layers into a one flat Bitmapped layer!

Try it out

<http://www.csd.uwo.ca/~lreid/cs1033/vectors/star.html>

<https://upload.wikimedia.org/wikipedia/commons/e/e6/Phone.svg>

Bitmapped Graphics vs. Vector Graphics

Question: Which of these statements do you think is TRUE: A or B?

A: You can convert a vector graphic image into a bitmapped image easily but you cannot easily convert a bitmapped image into a vector graphic image.

B: You can convert a bitmapped image into a vector graphic easily but you cannot easily convert a vector graphic image into a bitmapped image.

How to lose customers before you ever even had them!

Have you ever gone to a website and then left within seconds because the graphics were taking too long to download?

Do you ever return?

<http://www.flamingpear.com/examples-sbp/images/blue-green-sea-large.jpg>

— <http://www.csd.uwo.ca/~lreid/cs1033/resolution/UncompressedGraphics.html>

How Big Is An Image?

Let's figure out how many bytes one large picture in true colour (2^{24} colours) would take up.
Roughly:

Total Numbers of pixels (Sampling) * Colour Bit Depth (Quantize)
Length (px) * width (px) * Colour bit depth(bytes)

Question: Assume we have a picture that is:

- 1600 pixels by 1200 pixels (takes up the whole screen and more depending on your resolution)
- Each pixel will need 3 bytes (8 bits for red, 8 bits for green, 8 bits for blue) to represent the colour of each pixel <R,G,B>



$5625/1024 = 5.5$ Megabytes

Save a picture this size in Affinity Photo as .raw to find size

<http://www.csd.uwo.ca/~lreid/cs1033/resolution>

- Look at the size of the file with the extension .raw

UNITS OF MEASURE:

How about kilobytes, megabytes, etc?

1 KB = 1024 B

1 MB = 1024 KB

1 GB = 1024 MB

1 TB = 1024 GB

* Some people use 1000 for these conversions.

For Printing in a Flyer or Magazine:

For Displaying in a Web Page:



File size is very important

Bigger files take longer to

Quality is important
to try to
s
want
with



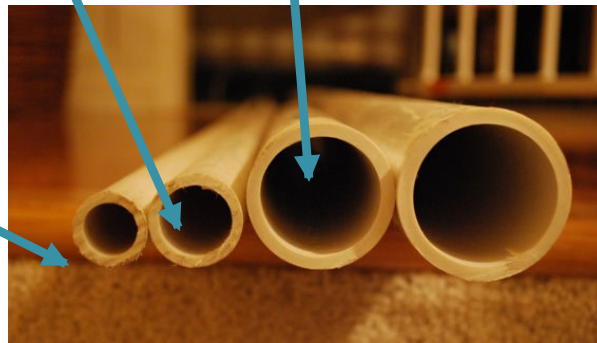
We need to decide what are we going to use the image for?

How long will it take that uncompressed sunset image to download if we are using it in a webpage?

If the client is using high speed connect at 1500 kilobits per second?

If the client is on a modem that is 56 kilobits per second

On a really old modem that is 28.8 kilobits per second?



We need to make our webpages
download as fast as possible

We want them to be the “appropriate
size” for our page, in terms of proportion

Want the image to look good (“high
quality”)

Want image to download quickly

**THUS WE NEED TO MAKE OUR IMAGE
FILES SMALLER BUT OUR IMAGE TO
STILL LOOK GOOD!**

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Why should you get your Computer Science degree at Western?

Flexible programs with lots of choices

One very popular program is our Computer Science Honours Specialization with Minor in Game Design. You could also combine two of your interests by pursuing Major in Computer Science with a Minor in Psychology or Business. Or, of course, you can just get a pure degree in Computer Science. The choice is yours!

Small classes

Many of our Computer Science classes are small enough that your professors will soon know you by name.

Industry Internship

Interested students will spend 8 to 16 months working for a company between third and fourth years of their degree. Internship placements often lead to full-time employment upon graduation with companies like Microsoft and IBM.

Below,

- Image size isn't appropriate
- Doesn't look good
- BUT it does download faster than the top page because the image is smaller

Department of Computer Science



Why should you get your Computer Science degree at Western?

Flexible programs with lots of choices

One very popular program is our Computer Science Honours Specialization with a Minor in Game Design. You could also combine two of your interests by pursuing a Major in Computer Science with a Minor in Psychology or Business. Or, of course, you can just get a pure degree in Computer Science. The choice is yours!

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World-renowned faculty

Computer Science faculty are doing cutting edge research in fields such as game design, DNA computing, internet technologies, computer algebra, imaging, and Bioinformatics. We offer many undergraduate courses in these new and exciting

How do we download faster?

Make our image file size smaller!

Question: What can we do to make our images smaller?

OPTION 1: Make the image be physically smaller [?] LESS PIXELS

(BUT that will change the size it is displayed at on the screen).

- For example, a 100 pixel by 100 image pixel (**30KB**) is smaller than a 200 pixel by 200 pixel image (**118KB**)



The Polar Bear Web Site



Welcome to the official Polar Bear website. This site will give you lots of information about Polar Bears.



Tours

Facts

200 by 200 pixels
This is how you wanted
the image to look within
your page!



The Polar Bear Web Site



Welcome to the official Polar Bear website. This site will give you lots of information about Polar Bears.



Tours

Facts

100 by 100 pixels
Did you really want the
polar bear to be this
small?

How do we download faster and keep the image the size we want it?

OPTION 2: COMPRESS THE IMAGE

FILE: use tricks to make file smaller without losing the quality of the image or the size (in pixels of the image)

- Still 200 pixels by 200 pixels but the file size is smaller than the original.

An uncompressed image that is:

- 200 by 200 pixels
- True Colour (16 million colours \Rightarrow $\langle R, G, B \rangle$)
- Will be $200 * 200 * 3$ bytes = **120,000 bytes**
- Will be $120,000 / 1024 =$ **117.2 Kilobytes**

Compression To The Rescue!



The same image that is:



- 200 by 200 pixels
- Original size was 118 kbytes
($200 \times 200 \times 3 / 1024$)
- Looks almost like true colour when:
- SAVED AS A COMPRESSED JPG WILL BE:
 - Highest Quality ? **58 KB**
 - Lowest Quality ? **25 KB**
- SAVED AS A COMPRESSED GIF WILL BE:
 - 256 Colours ? **29KB**
 - 64 Colours ? **17KB**
 - 16 Colours ? **7KB**
 - 10 Colours ? **3KB**

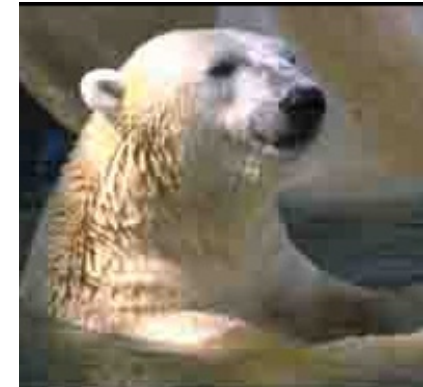
Name	Size	Type
polarbearinwater200by200_10Colours.gif	3 KB	GIF Image
polarbearinwater200by200_64Colours.gif	17 KB	GIF Image
polarbearinwater200by200_16Colours.gif	7 KB	GIF Image
polarbearinwater200by200FewerColours.gif	17 KB	GIF Image
polarbearinwater200by200_256Colours.gif	29 KB	GIF Image
polarbearinwater200by200LowestQuality.jpg	25 KB	JPEG I
polarbearinwater200by200HighestQuality.jpg	58 KB	JPEG
polarbearinwater.raw	118 KB	RAW



Raw Image
118KB



Highest Quality JPG
58 KB



Lowest Quality JPG
25KB



256 Colours GIF
29 KB



64 Colours GIF
17 KB



16 Colours GIF
7 KB



10 Colours GIF
3 KB

Note: this one is **40 times** than the uncompressed file smaller BUT the quality of the image is very poor!

Compression

Key Concept: ***Compress as much as you can
WITHOUT sacrificing quality (losing
information)!***

Is there a way we can stuff the bits and bytes
down into less bits and bytes?

Two Types of Compression

Lossless:

- Compress the original bits and bytes into less bits and bytes without losing any of the original information about the picture

- When we reopen the file, all the original information about the picture is still there!

- NO INFORMATION IS LOST



Lossy:

- When compression occurs, some of the original information is lost

- Selected portions of the image are discarded but the selected portions are the ones that will be the ones that least missed or noticed

- CANNOT GET THIS INFO BACK ONCE IT IS DISCARDED



Nerf Ball vs. Orange ?

Several different algorithms for (ways to perform) compression

Each different type of image file format represents the use of a different compression algorithm

Common compressed image file formats that are acceptable on the World Wide Web:

- gif
- jpg, jpeg
- png

Uncompressed file formats:

- bmp (for Windows)
- raw (common on digital cameras)