Computer Science 1033 – Week 3

GRAPHICS → YES, SIZE DOES MATTER!

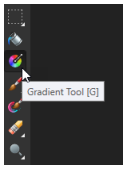
Afternoon, n.:
That part of the day we spend worrying about how we wasted the morning.→ Unix Fortune

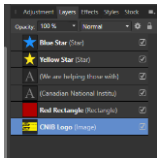
Poster Assignment Hints

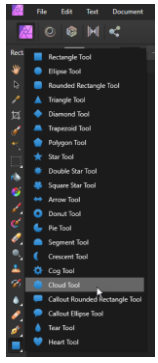
- Follow the instructions carefully, for example:
  - you get 2 marks if you named your files as stated in the instructions!
  - If you get a mark for every requirement we ask for.
- DON'T Collapse your layers
- Name your layers with good names
- Check for spelling
- Text:
  - Contrast
  - Edges
- Images
  - 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 (called Disputes in Kritik)

- Your poster will be marked by your peers.
- There are several rubric items, you can see the rubric items BEFORE the assignment is due, so check them out to do better.
- If the rubric item is NON subjective, you will get the majority (mode) mark for the item (i.e. if 4 out of 5 graders gave you 1 out of 4 and the last grader gave you 4 out of 4, you will get 1 out of 4, not the average (not (1*4+4)/5 = 1.6).
- If the rubric item is subjective, you will get the average mark for the item (i.e. if 4 out of 5 graders gave you 1 out of 4 and last grader gave you 4 out of 4, you will get 1.6 out of 4)
- You can dispute your mark but we will ONLY check the non subjective rubric items, not the subjective ones. We will not change the subjective ones.
- Please wait till you can see your completed rubric and read your entire rubric over carefully before entering a dispute. If you still want to dispute, only list the rubric item numbers that were marked incorrectly in the dispute.

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!

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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

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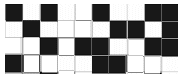
Quantizing The Image

- 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 ($2^1 \rightarrow 2$)

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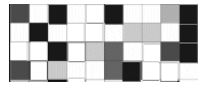
- How many colours can 2 bit hold? $2^2 \rightarrow 4$
  - 00 → White
  - 01 → Light Gray
  - 10 → Dark Gray
  - 11 → Black



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Does 1 bit colour look realistic?

- YES → Can you tell what this image represents?

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2 Bit Colour

- 4 shades of gray

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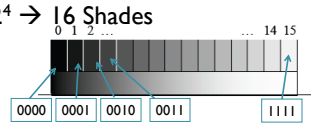
More bits, more shades of gray

- 4 bit colour → 2^4 → 16 Shades



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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 X 300 X 1 byte → 120,000 bytes or ~120 kilobytes

http://www.modernimaging.com/bit_depth.htm

How about some Colour?

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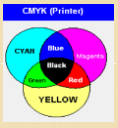
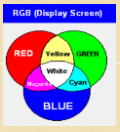
Subtractive Model - CMYK	Additive Model - RGB
• Used for printing • Ink applied to paper • Primary Colours → Cyan, Magenta and Yellow • Ink when applied removes (subtracts) the white	• Use on monitors • "Adding" light to a black background (the monitor) • Primary Colours → Red, Green and Blue





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, X 256 shades of green X 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)

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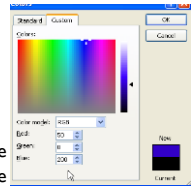
2 Ways to encode True Colours

- ***1. <RGB>* <amount of Red, amount of Green, amount of Blue> DECIMAL NUMBER**
  - Where 0 is no amount and 255 is the most allowed
  - <255, 0, 0> → the most of red, no green, no blue
  - <0, 255, 0> → the most green, no red, no blue
  - <100,100,100> → equal middle amounts of red, green and blue
  - <50, 0, 200> → a little red, a lot of blue
  - <200, 0, 50> → a lot of red, a little blue



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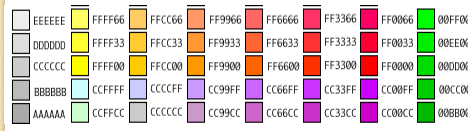
- **2. Hexadecimal Code**
  - **#RRGGBB** → RR are the digit place holders for the amount of red, GG amount of Green, BB amount of Blue
  - Amounts are counted in hexadecimal with these digits: 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F
  - 00 still means 0
  - Hex FF= Decimal 255 (try the calculator to see)
  - 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:



Question:Are these colours the same:

- <0,0,0> and #000000?
  - <0,0,0> and #000000?
  - <9,8,7> and #090807
  - <10,15,09> and #0A 0F 09
- <255,0,255> and #FF00FF
  - <255,0,255> and #FF00FF
- <66,0,99> and #660099 ?
  - <66,0,99> and #660099 ? NO

http://easycalculation.com/color-coder.php
http://easycalculation.com/rgb-coder.php

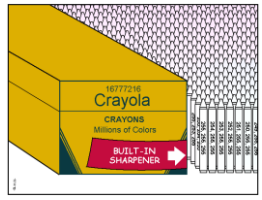
Can you represent the same number of colours using Hex as using RGB

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

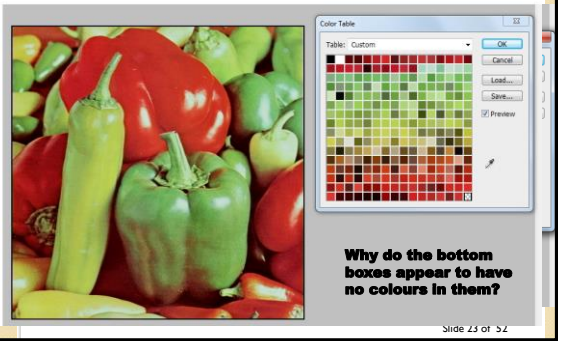
	Red	Green	Blue	How many colours?
Smallest Value (RGB)	0	0	0	
Biggest Value (RGB)	255	255	255	
Total number of shades you can represent	256	256	256	256X256X256→16 million colours
Smallest Value (Hex)	00	00	00	
Biggest Value (Hex)	FF	FF	FF	
Total number of shades you can represent	16X16→ $2^4X2^4→2^8$	16X16→ $2^4X2^4→2^8$	16X16→ $2^4X2^4→2^8$	$2^8X2^8X\ 2^8 → 2^{24}$→16 million colours
Smallest Value (Binary)	00000000	00000000	00000000	
Biggest Value (Binary)	11111111	11111111	11111111	
Total number of shades you can represent	2X2X2X2 X2X2X2X $2→2^8$	2X2X2X2 X2X2X2X $2→2^8$	2X2X2X2 X2X2X2X $2→2^8$	$2^8X2^8X\ 2^8 → 2^{24}$→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)



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)

http://www.csd.uwo.ca/~lreid/cs033/BitDepth/

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

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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

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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

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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

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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

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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/PJFc3KlEdLM?t=61 (watch till about minute 4)
- Note: the text in PDF files are Vector based (but not the images in a pdf file)

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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

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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?

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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!

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Try it out

- http://www.csd.uwo.ca/~lreid/cs1033/vectors/star.html
- https://upload.wikimedia.org/wikipedia/commons/e/e6/Phone.svg

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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.

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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

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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 Big 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>
  - **How many bytes, kilobyte and megabytes is the image? →**
  - 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.*

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For Printing in a Flyer or Magazine:	For Displaying in a Web Page:
• File size doesn't matter • Most important issue is the quality of the image! • Image will be printed with at least 300dpi	• File size is very important • Bigger files take longer to download • Quality is important too but want to try to get best quality with smallest file size.

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?

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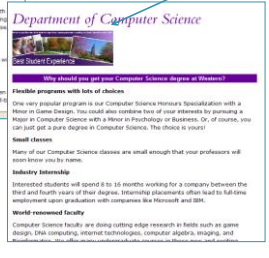
Below,
-Image size isn't appropriate
-Doesn't look good
-BUT it does download faster than the top page because the image is smaller



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**)

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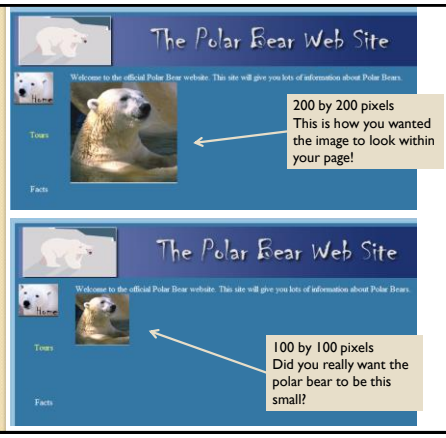

How do we download faster and keep the image the size we want it?

- **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 → <R,G,B>)
  - Will be 200 * 200 * 3 bytes = **120,000 bytes**
  - Will be 120,000 / 1024 = **117.2 Kilobytes**

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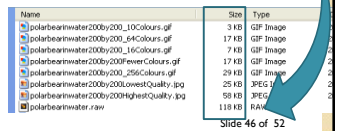
Compression To The Rescue!

- The same image that is:

  - 200 by 200 pixels
  - Original size was 118 kbytes (200*200*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**



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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?

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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** ☺

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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)

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