# CMPT 165 INTRODUCTION TO THE INTERNET AND THE WORLD WIDE WEB

## Unit 5
Graphics and Images

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SFU

# Learning Objectives

In this unit you will learn the following.

- **Compare** and contrast the characteristics of basic types and formats of computer graphics.

- **Identify** an appropriate format for a given image.

- **Select** an appropriate graphics file format for use in a web page.

# Topics

1. Bitmap vs. Vector
2. Scaling, Rotating, Displaying, Printing
3. Creating Images
4. Image File Formats
5. Colour Depth, Compression, Transparency
6. Common File Formats
7. Bitmap Class Demonstration
8. Vector Class Demonstration

# Computer Graphics

*def.* refers to using a computer to create or manipulate any kind of picture, image, or diagram.

- 2 ways to store images: vector and bitmap.
- Most of the web uses bitmap.
- Often need to use 2 different apps to create each type.
- Stored in files, many different formats.
- Common web formats: gif, jpeg/jpg, png, svg.

**BUT WHICH FORMAT IS BETTER TO USE?**

# Vector Images

*def.* store the instructions on how to draw an image, e.g. lines curve, rectangle, ellipse
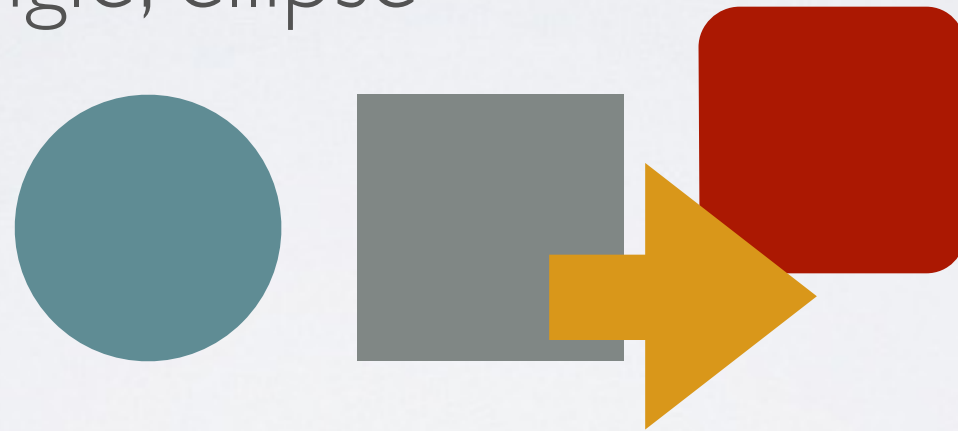
- Mathematical functions used to create the image.
- The functions used and the order used in are stored.
- Colour, gradient, shading — effects rendered as drawn.
- Good for diagrams: zoom in/out, less storage space used.
- Not so good for photos!

# Bitmap Images

*def.* images that hold the final product that is <u>rasterized.</u>

**Rasterized** is the process of converting vectors into pixels that can be displayed on a screen.

- A grid of pixels is stored.
- Hi-res images have lots of pixels.
- Each pixel can take up to 4 bytes.
- An 8MP (mega-pixel) camera, like on the iPhone 6, e.g.:
  - Photo size 3,264 x 2,448 pixels, raw ~8 MB
  - JPeg images average about 2-4 MB

# Scaling Bitmaps

**Bitmaps** are just grid of pixels:

- **Zoom in**, the pixels get bigger (a.k.a. pixelation)
    - To counter pixelation there are sophisticated resampling algorithms.
- **Zoom out**, the pixels get smaller, hi-res photo
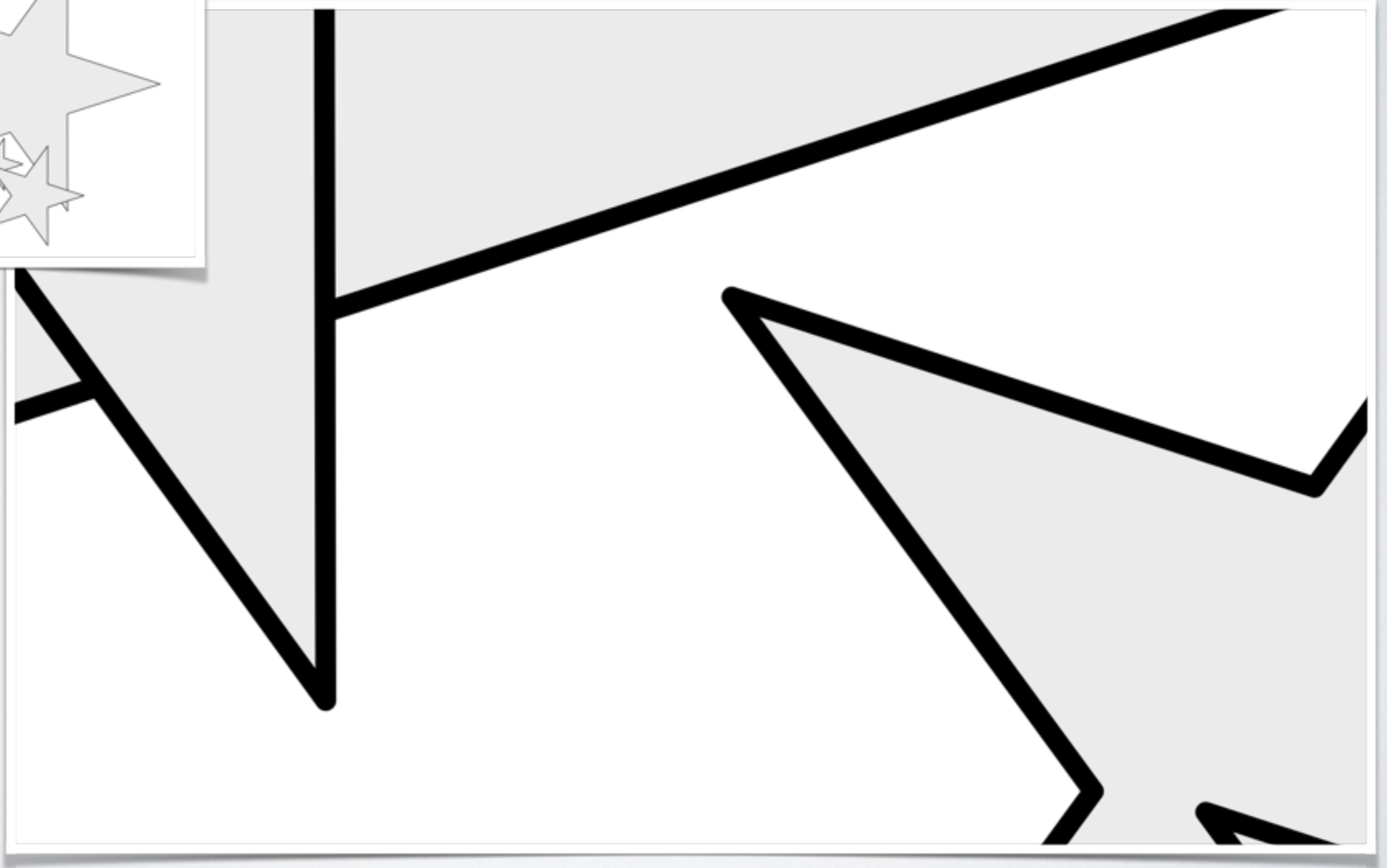
# Bitmap Zoom In

# Scaling Vectors

**Vectors** are essentially drawing instructions:

- **Zoom in**, the shapes are redrawn bigger
  - A big area, take longer to redraw, need to clipping and only draw in the viewing area.
- **Zoom out**, the shapes are redrawn smaller
  - Lots of shapes can cause slow redrawing, too.

# Vector Zoom In

# Rotating Images

- As with of other manipulations (e.g. sheering)

- Bitmap, pixels are manipulated through:

  1. a series of matrix calculations

  2. each pixel is placed per translation matrix

  3. pixel are resampled to smooth out imperfections

- Vector, the shape points are manipulated:

  1. with matrix calculations, lines are drawn

  2. image is the redrawn off screen in a buffer

  3. buffer is displayed same way bitmap is drawn

# Bitmap Rotation

# Displaying Images

- Computer screens are a grid of pixels.

- Bitmaps can easily be shown on a screen.
  1. from the (x, y) screen coordinates,
  2. draw each pixel of the bitmap to a screen pixel.

- Vector images need the:
  1. drawing instructions translated from Euclidian space to a grid of pixels.
  2. image is drawn, then rasterized to a bitmap buffer.
  3. then the rendered bitmap is displayed.

# Creating Images

- Many apps exist to edit and create bitmaps
- Fewer apps exist to create vector images
  - But vectors are becoming more popular
- Other sources: digital **cameras** and **scanners**
  - They capture images
  - We can edit these with a bitmap editor
  - We can use these as shape fill in vector images
- Vector images are easier to edit, separate shapes
- Bitmaps need to undo editing steps sequentially until you get to the edit you want to change/reapply
  - Once you exit editor, edit history is lots

# Graphics Apps

- Popular **bitmap** editing apps:
  - Adobe Photoshop (Mac and Windows)
  - Pixelmator (Mac)
  - GIMP (Mac, Windows, and Linux)
- Popular **vector** editing apps:
  - Adobe Illustrator (Mac and Windows)
  - OmniGraffle (Mac)
  - Inkscape (Mac, Windows, and Linux)

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# Image File Formats

- Can store images in many different ways on a computer.
- These are called image <u>file formats</u>
- Each file format is different and complicated.
- There are very few formats that browsers recognize and use: GIF, JPEG/JPG, PNG, and SVG
- You can tell the format by the file extension (`???.gif`).
- Browsers tell the format by the MIME type send by the web server:
  - Example: `Content-Type: image/jpeg`
  - For a review see Unit 1, Slide 21.
- You can use editors to convert one format to another.

# Class Demo

Using different file types:
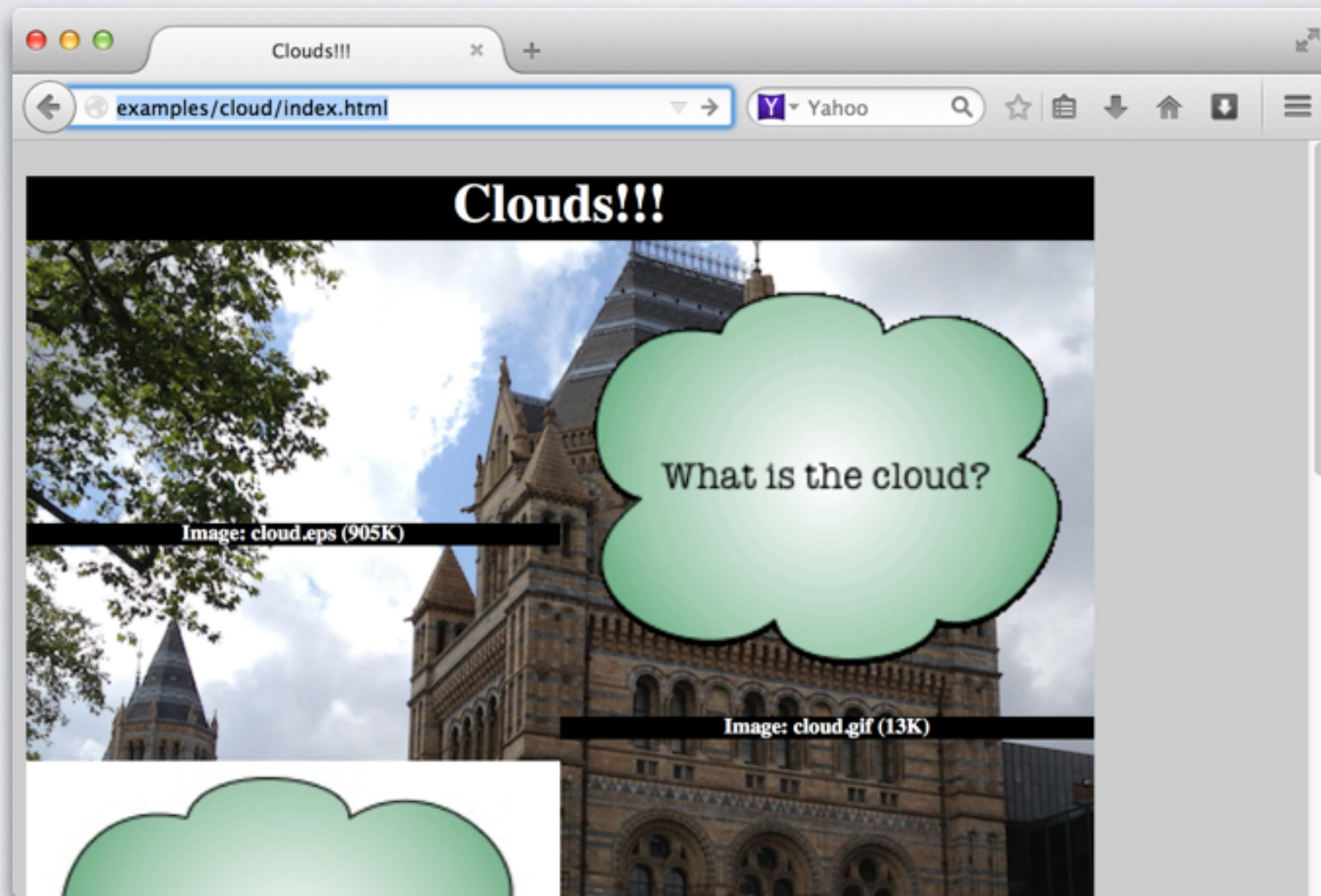


URL: examples/cloud/

# File Format Considerations

Each file format stores image information **differently**.

6 things to **consider** when choosing a file format:

1. **Type: vector or bitmap?**
2. **Can a browser display it?**
3. **File size**
4. **Colour depth**
5. **Compression**
6. **Transparency**

# Image File Sizes

- Vector files are often smaller in size compared to bitmaps.

- Consider how information is stored in each case.

- <u>Bitmap</u>, computer must store millions of pixel colours.

- <u>Vector</u>, only stores the list of shapes in the image and how they are coloured.

- **Have you used an image editor before? Did you think about this?**

What is the cloud?
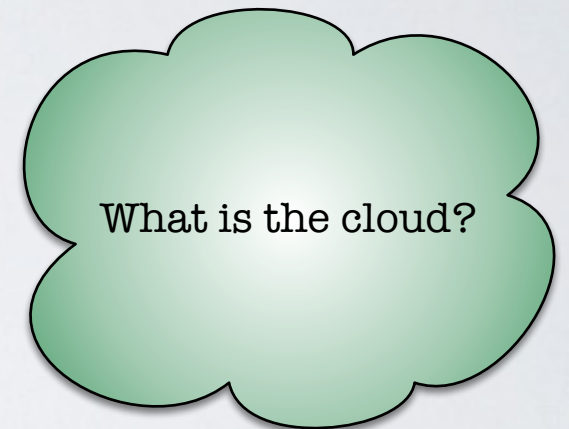
| Format | Type | Size (bytes) |
|---|---|---|
| EPS | vector | 926,618 |
| GIF | bitmap | 13,612 |
| JPEG/JPG | bitmap | 12,808 |
| PDF | vector | 20,196 |
| PNG | bitmap | 43,234 |
| SVG | vector | 2,712 |

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# Colour Depth

**Back to RGB! How many colours do you need?**

- In CSS we specify RGB in 24-bit colour #**RR****GG****BB**
  - Each colour component contained 256 shades, $2^8$
  - There are 3 colour components: $2^{(8 \times 3)} = 2^{24}$
- Some file formats use 15-bit colour
  - Each colour component has 32 shades, $2^5$
  - There are 3 colour components: $2^{(5 \times 3)} = 2^{15}$
- Some formats only use 8-bit colour, only 256 colours
  - They use a colour palette of 256 - 24-bit colours

# Colour Palettes

**What is there is no palette?**

- images using 8-bit colour, $2^3$, only 1 shade?
- this would be a very ugly image!!!

- Each pixel in the image is a colour index number 0 - 255
- This index is to an entry in a colour palette.
- Where each colour is a defined 24-bit colour.
- The palette contains only the colours used in the image.
- What if you have more than 256 colours?
  - Then we must **colour dither**

# Colour Dithering

*def.* using pixels and more than one colour to create the effect of a new colour.



Figure 5.2: Colour dithering
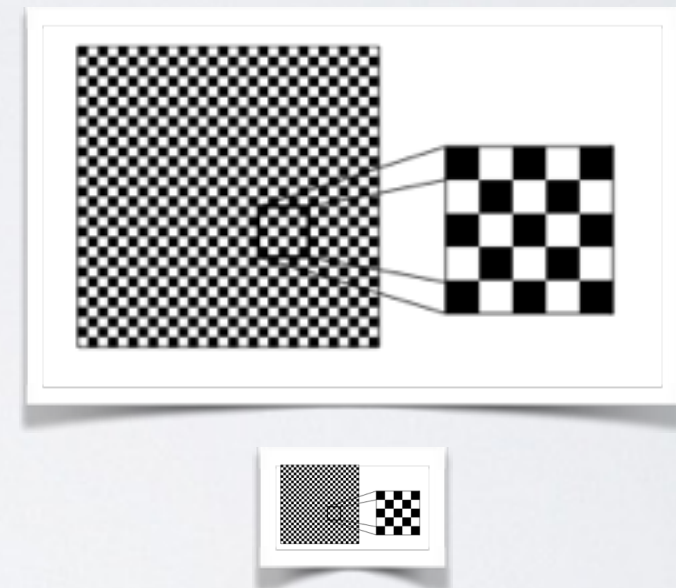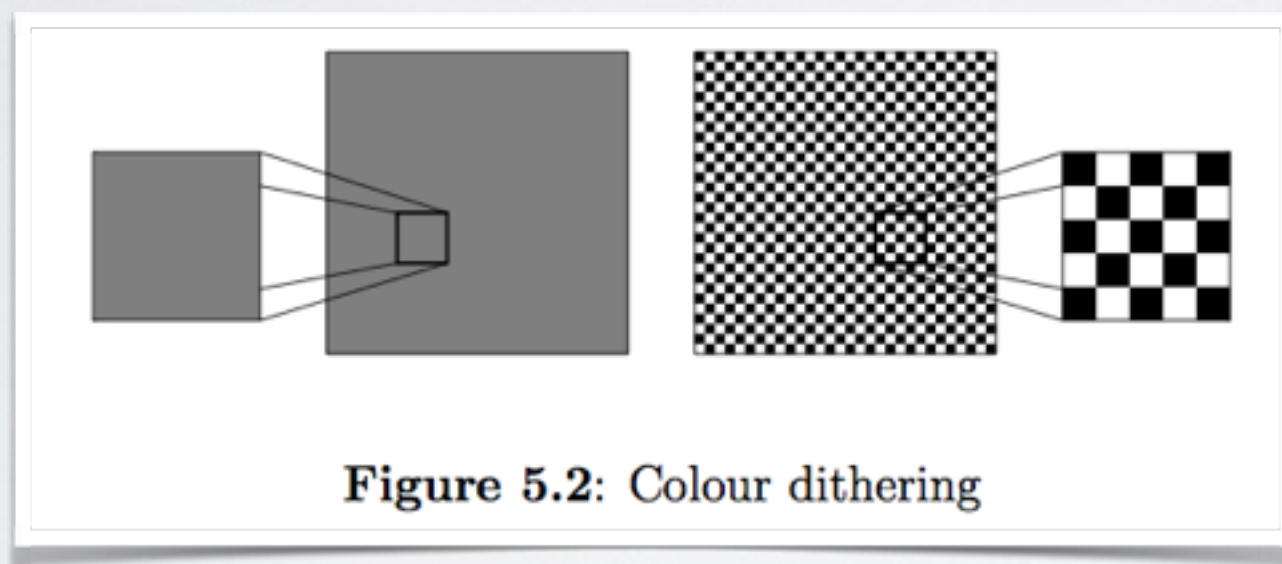
- This effect is often used in 8-bit colour images.
- Pixels need to be small enough for the effect to work!

# Compression

*def.* storing data in less space than it would normally take.

- e.g. 8MP (mega-pixel) raw photo is a 2-4 MB JPEG file

2 categories of compression: lossy and lossless

- **Lossy compression:** sacrifice image quality for file size
- **Lossless compression:** compress image without image quality loss
  - <u>Very difficult</u> to achieve!
- If pixels are small enough cannot notice effects of lossy.



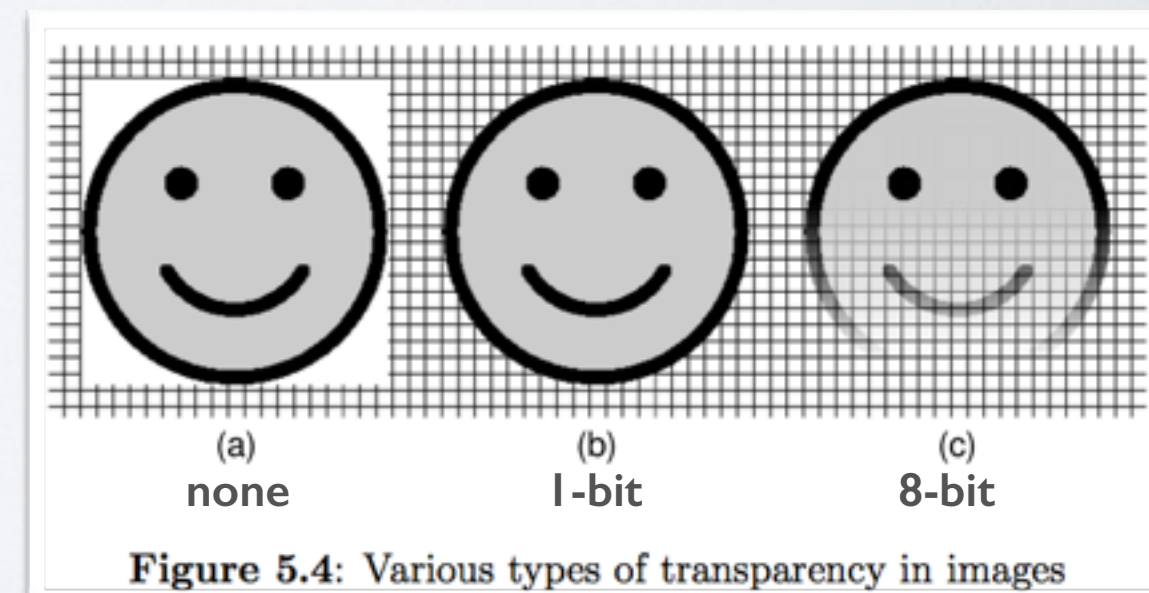**Figure 5.3**: An image with a low-quality lossy compression
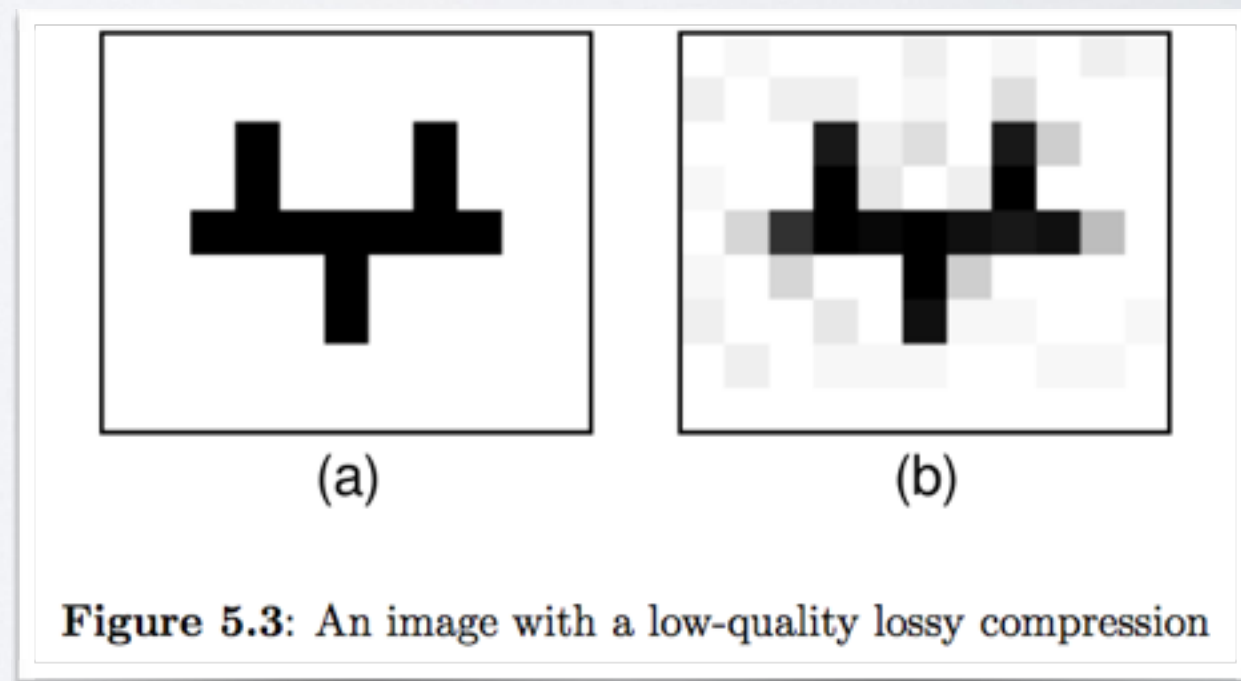
# Transparency

*def.* the ability to see the background through a foreground object. The opposite of **opacity**, the lack of transparency.

- 3 choices: <u>none</u>, <u>1-bit</u>, or <u>8-bit</u> for each pixel
- **1-bit:** simple transparency, on/off = 0% or 100%
  - 16-bit colour images, the extra bit is the transparency
- **8-bit:** called and alpha channel, 256 levels
  - 32-bit of storage 32-24=8
  - **AARRGGBB**, 1-byte each
  - 1-byte = 8-bits (or 2 nibbles)
  - Nice effects, e.g. shadow



|  (a)  |  (b)  |  (c)  |
|-------|-------|-------|
| none  | 1-bit | 8-bit |

Figure 5.4: Various types of transparency in images

# Image File Formats

## Which format to choose?

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Very few formats are supported by browsers!

😩

**GIF** or **JPEG/JPG** or **PNG** or **SVG**?

😫

# GIF Files

…stands for **Graphics Interchange Format**

- Advantages are:
  - Well supported by all browsers
  - Small file size
  - Animated images
- Disadvantages are:
  - Only 8-bit colour
  - Only1-bit transparency
  - Patented, pay royalties
  - Animated images!!!

Click me…
I dare you!

See: What is the cloud?

# JPEG/JPG Files

…stands for **Joint Photographic Experts Group**

- <u>Advantages</u> are:
  - Well supported by all browsers
  - Has 24-bit colour
  - 8-bit grey-scale photographs
  - Small file size (depending on % compression)
- <u>Disadvantages</u> are:
  - Lossy compression
  - No transparency



JPEG Compression

JPEG darkened to make lossiness visible

See: What is the cloud?
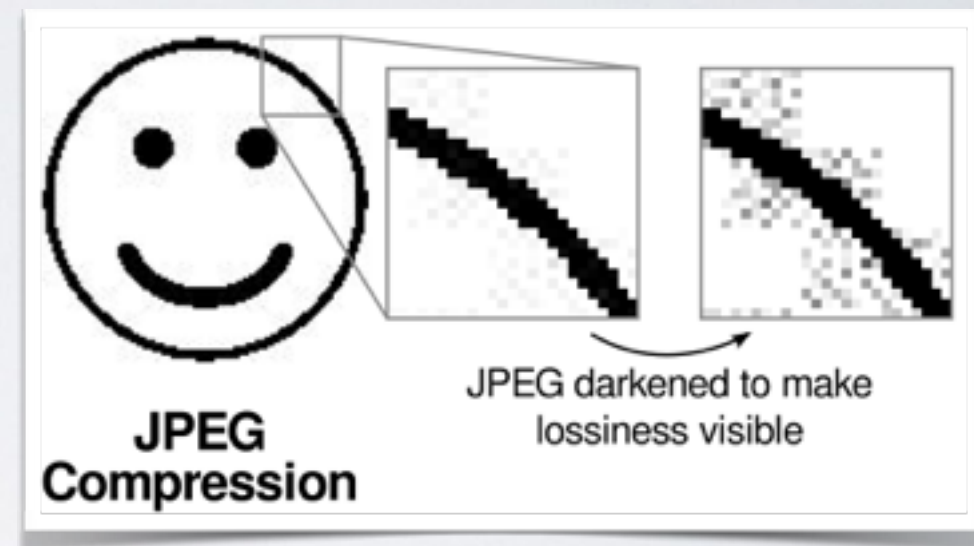
# PNG Files

…stands for **Portable Network Graphics**

- <u>Advantages</u> are:
  - Well supported by all browsers (now)
  - Has 24-bit colour
  - Has alpha channel (8-bit)
  - Lossless compression
- <u>Disadvantages</u> are:
  - Size is often a lot bigger than JPEG/JPG
  - Size can be reduced by not storing alpha channel
  - Internet Explorer didn't support alpha channel transparency in PNG images, as of version 7

See: What is the cloud?

# SVG Files

…stands for **Scalable Vector Graphics**

- <u>Advantages</u> are:
  - Scales, rotates without artifacts
  - Small file size
  - Is XML like XHTML.
- <u>Disadvantages</u> are:
  - Not supported the same way by all browsers
  - e.g. Safari and Firefox render differences.

See: What is the cloud?
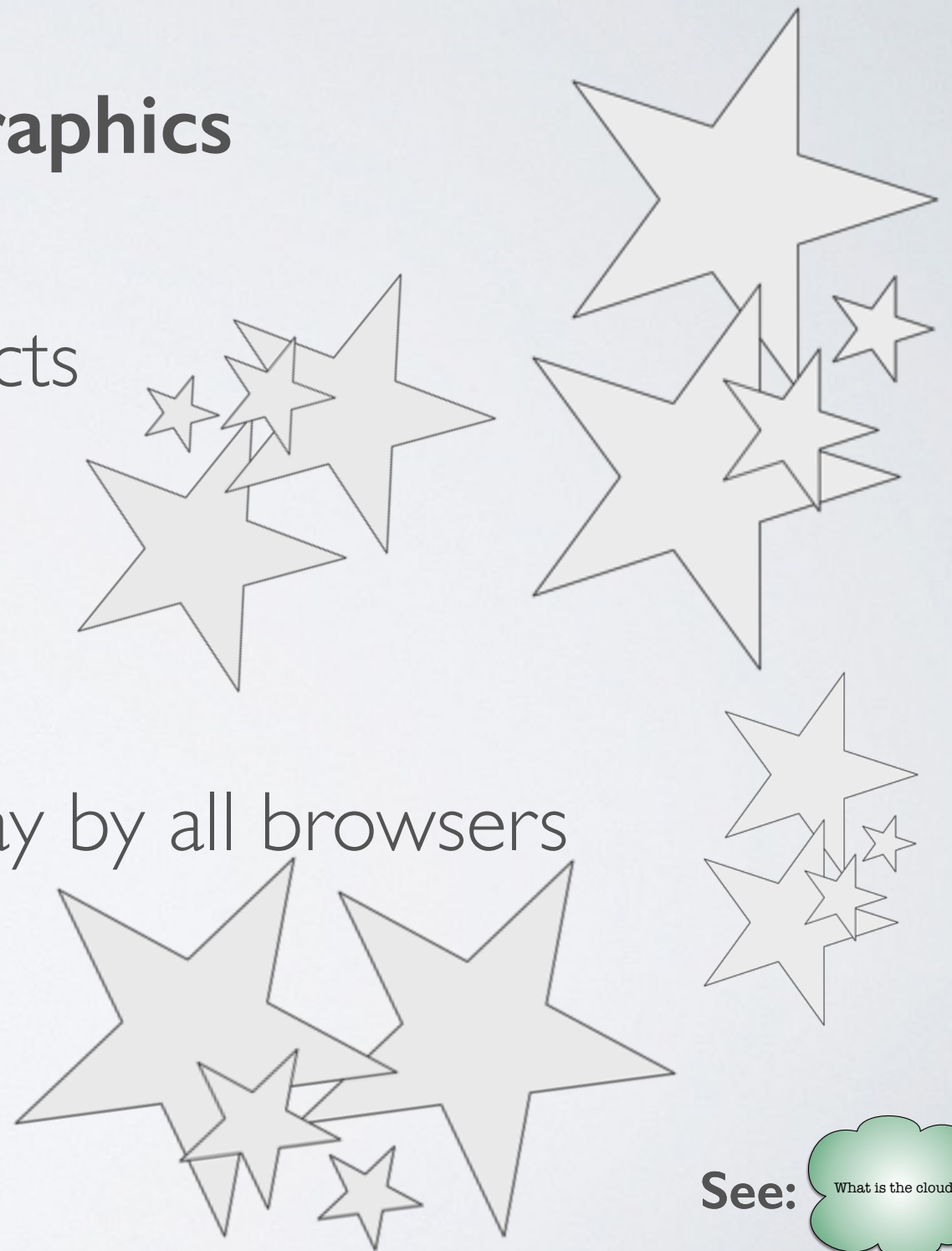
# Class Demo

Video: How to use Gimp - Basics

In-class demo of:

# Summary

- Learnt about different image file formats
- We compared different formats to each other
- Understand +/- of which format to use
- Used image editing apps to create graphics

**Next Unit:** learn more about website design concepts.

# QUESTIONS?