Pictures in your Thesis:
Computer Graphics Literacy for Graduate Students
Michael A. Covington
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1. Two kinds of graphics files

Bitmap or **raster** **graphics:** array of pixels
   File formats: JPG (JPEG), TIFF, GIF, BMP
   Software: Adobe Photoshop (CS and Elements),
     Corel Photo-Paint, Windows Paint, anything w. "paint" in its name

Vector **graphics:** file of commands of where to draw lines, curves, etc.
   File formats: proprietary for software (.AI, .CDR, .VSD);
     "metafiles" (.EMF, .WMF) for exchange between Windows programs;
   Software: Adobe Illustrator, Corel Draw, Microsoft Visio
  PostScript (.PS, .EPS) files can contain either bitmaps or vectors.
    If bitmapped, they can be edited with Adobe Photoshop.

2. Advantages and disadvantages

Bitmap:
 For photographs, scanned images, and pictures on web pages.
    + File formats are standardized, shared by many software pkgs.
    + Complete control over appearance of finished product
     (no worries about how particular software will render it)
    – Large files, sometimes absurdly large
    – Small pictures do not enlarge well
    – Resizing is an information-losing operation

Vector:
 For diagrams.
    + Sharp at any size; resizing is effortless.
    + Software gives you a lot of help laying out a diagram.
    (The built-in grid alignment of Visio is especially nice.)
    + Files are small, even when very complex.
    – Files are not generally portable between different software.
    – Even when portable, files are often rendered differently by
      different programs; be on the lookout for errors!
 It is often wise to convert your vector graphic to a bitmap at the last step,
 when it's completely finished, so that you can have total control over
 every pixel. Vector graphics programs can "save as" bitmaps.
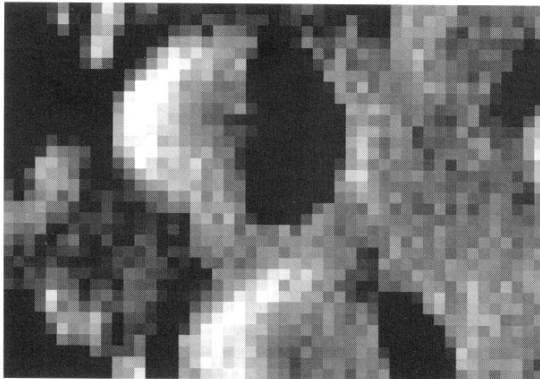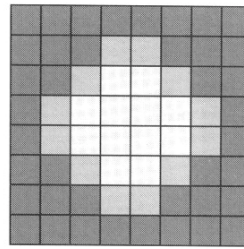
3. Working with bitmap graphics

Figure 12.4 Bitmap image shown as a picture (left) and as an array of numbers (right).

Figure 12.3 A small part of Fig. 12.2 showing individual pixels.

How many pixels do you need?
For display on computer screen: 1024x768 is whole screen.
     Pictures on web are usually on the order of 300x500 pixels.
For sharp continuous-tone photographs: about 150 pixels per inch.
     A 4x6 snapshot is 600x900 pixels = 0.5 megapixel.
For sharp line diagrams: about 300 pixels per inch.

Color
There are several ways a file can represent the colors of pixels:
(a) "Bitmap" in the strict sense: Every pixel black or white.
   (Makes a small file, but not all software handles it properly.)
(b) Grayscale (black and white with shades of gray).
(c) Paletted color (codes that pick colors from a set).
(d) RGB color (three numbers each 0 to 255 for the primary colors).
Grayscale and RGB are preferred.
CMYK is a seldom-seen variant of RGB where the numbers represent the four printing inks, cyan, magenta, yellow, and black.

Data compression
A bitmap graphic can take up a *lot* of bytes.
Lossless compression: TIFF and GIF have modes where the file is compressed without loss (e.g., by using concise codes for repeated pixels).
Lossy compression: JPEG compresses the file by discarding low-contrast detail, and you have a choice how much. *TIP:* Always save with maximum JPEG quality, and don't edit a JPEG file repeatedly; instead, convert it to TIFF or BMP, which will prevent any further loss. (MS Word has trouble importing TIFF.)

Layers

Photoshop and Photo-Paint allow you to have *layers* (separate, superimposed bitmaps) in a single image. Thus, you can put text, or another picture, on top of an existing picture and move it around until it's where you want it.

Until you *flatten* the image (make it into just one bitmap), you cannot save in most of the portable file formats.

4. Changing the size of a bitmap graphic

There are *two ways*:

(a) Keep the same pixels, and change the number of pixels per inch.

  Advantage: Entire image remains intact. Nothing is lost.
  Disadvantage: File remains big even if you're going to display
        or print it small.
  Good for images to be printed.
  Do not do this with images to be displayed on the Web. You
     cannot change the number of pixels per inch on someone's
     screen, and if you try, images won't look good.

(b) *Resample* the image to convert it to a different number of pixels.

  Advantage: Finished product is the right size.
  Disadvantage: This is an information-losing operation.
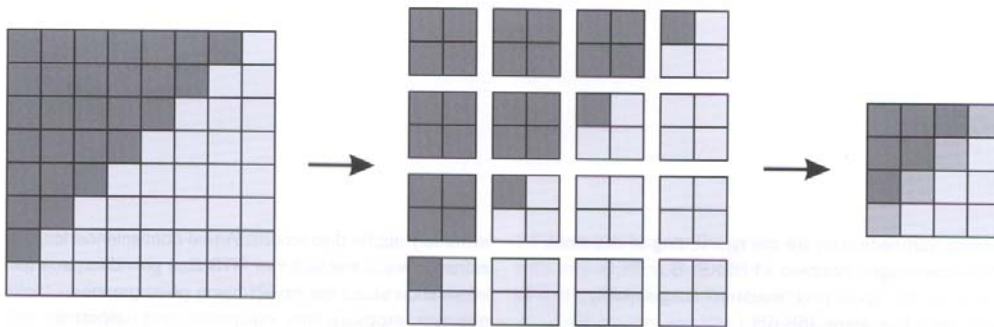   If you shrink an image and enlarge it again, detail will be lost.

Figure 12.6   How to shrink a bitmap. By averaging each group of pixels that are to be combined, the resampling algorithm preserves some information about features too small to show clearly.
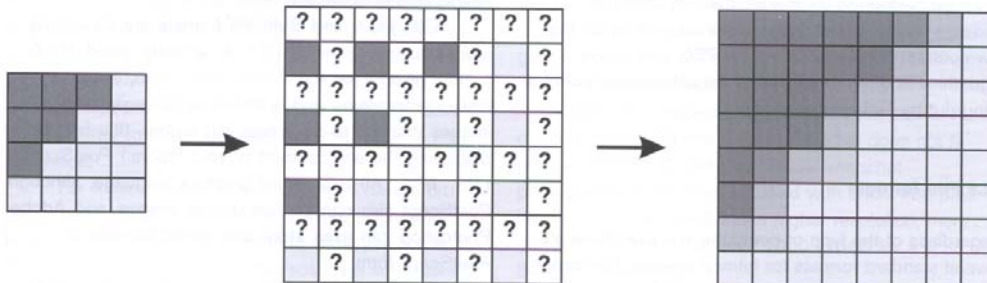

Figure 12.7   How a bitmap is enlarged. First the pixel array is expanded, then the missing pixel values are filled in by averaging their neighbors. This reduces the stairstep appearance of diagonal lines.

Caution: Do not change one dimension without changing the other. Results will be funny! And correct perspective is destroyed.

Drag from the corners, not the edge or top!

5. Working with digital camera photos
Suggested workflow:
a. Open the picture in Photoshop (Elements or CS).
b. Crop the picture. (Marquee tool, Image, Crop.)
c. Adjust levels for good black, good white, good midtones.
d. Sharpen if appropriate.
e. If you want a black-and-white picture, convert to grayscale.
f. Resize as appropriate.
g. Sharpen again if needed.
Color management is somewhat tricky.

5a. Taking a picture of the Windows screen
Simply hold down Shift and press PrtSc,
or hold down Alt and press PrtSc.
These take a picture of the whole screen or the current window
(respectively) for pasting into Photoshop or even Word.

6. Working with vector graphics
Your diagram will consist of lines, shapes, circles...
Important concepts:
- "Snap to grid" (automatic in Visio, optional in Corel Draw)
    so there is no meaningless irregularity in positioning.
- Draw with lines that are wide enough to remain visible
    (e.g., 1 point = 1/72 inch wide). Default "hairlines"
    are too thin.
- Avoid meaningless variation in the way things look,
    are labeled, or are positioned.
- Build objects out of smaller objects.
- Remember that you can draw guide lines and then erase them.

7. Working with 3- or 4-dimensional graphics
Lightwave is a 4-dimensional graphics program that resembles
a draw program, but in 3-space with movement (time dimension).
Objects are then rendered as animated bitmaps (movies).

8. What makes a good graphic?
   a. Good ink-to-information ratio
        (a minimum of needless ink).
   b. Standard, consistent style.
   c. Clear thinking.

8a. Respect copyrights.
   Do not scan and reproduce something you found in a book.
   This can be legal under specific circumstances as "fair use,"
   but get expert advice.

9. Recommended practices for illustrating a thesis

a. Draw your diagram in Visio. Be sure to use a consistent style.

b. When finished, save as .vsd (for further editing) and also as a 300-dpi .bmp file (for further conversion). (Visio won't save .eps directly.)

c. In Photoshop, open your .bmp file and save as .eps.

d. It's ready for importing into LaTeX with \includegraphics.

If starting with a photograph or screen shot, skip steps a and b; go to Photoshop directly.

If writing with Word, you do not need to convert to .eps; instead, import the .bmp file into Word.

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