Pictures In Your Thesis
A Guide for Graduate Students

Michael A. Covington
Institute for Artificial Intelligence
The University of Georgia
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Introduction

This is a brief guide for scholars who need to produce pictures (photos, drawings, or diagrams) to illustrate theses or other academic work. It is designed to give you a quick orientation rather than lots of technical detail.

Kinds of graphics

A **raster (bitmap) graphic** is an array of pixels. Common file formats are TIFF, PNG, and JPEG. Raster graphics come out cameras and scanners and are edited with software such as Photoshop and (if you prefer freeware) GIMP.

A raster graphic has a specific resolution in dots per inch (dpi). Clearly printed type and diagrams are 300 or 600 dpi. Photographs should be 75 or preferably 150 dpi in order to look sharp.

A **vector graphic** is a set of instructions to draw lines, curves, and lettering. The advantage of vector graphics is that, with a relatively small file size, they can be rendered sharply at any size and resolution. Vector graphics are created by Adobe Illustrator, Microsoft Visio (particularly recommended), and other software. Portable vector file formats are WMF and EMF (the two kinds of Windows metafiles).

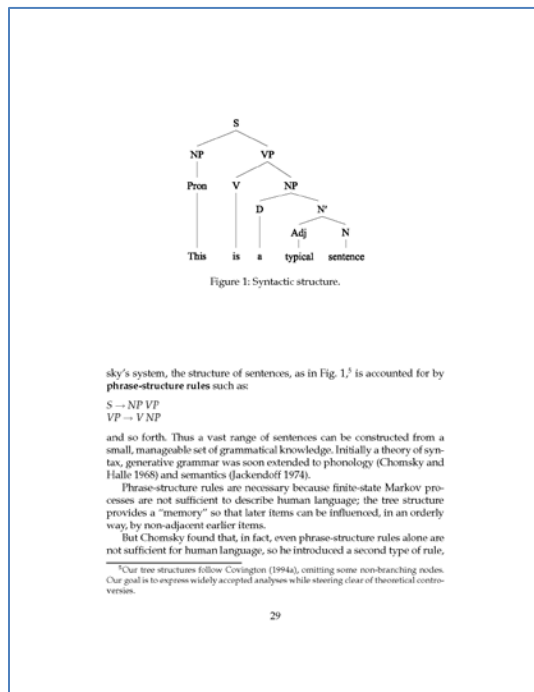The Adobe EPS and PDF file formats are containers for both raster graphics and vector graphics.

The file formats of particular pieces of software (such as Visio's VSD) are not portable and generally not interpreted correctly by other software, even when it claims to be able to.

Vector graphics have a **disadvantage**: their appearance may depend on the software that finally renders them, and even the fonts installed on a particular computer. For that reason, many of us like to convert our vector graphics into 600-dpi raster graphics as the very last step, after we've gotten everything perfect and have decided on the final size. The pixels on a raster graphic aren't going to move around. Conversion can be done with Adobe Photoshop, which opens many vector formats and rasterizes them.

Key concepts for LaTeX users

Floating illustrations

In LaTeX, as in published books, pictures normally do not interrupt the text at fixed positions. Instead, they "float" to the top of the page or to a separate page, and they are referred to by figure number. Here is an example:

Distinguish some LaTeX keywords: **table** and **figure** create floating regions (which are given table and figure numbers respectively), **tabular** makes words and numbers actually line up in columns, and **includegraphics** brings in a picture.

To control the amount of space between figures/tables and the text, you can include a command such as

\textfloatsep 0.75 in

just before **\begin{document}**.

File formats for importing into LaTeX

I strongly recommend that you use MikTeX's TeXworks (which uses pdfLaTeX) rather than plain LaTeX.

In plain LaTeX, the only file format supported is EPS. Relatively few programs other than Adobe products will export to EPS. (Visio used to do it incorrectly, and more recent versions don't even try.)

pdfLaTeX supports JPG, PNG, and PDF. Adobe products export to PDF; many different products export to PNG. I mentioned already the advantage of rendering diagrams as PNG for final presentation. Photographs, of course, are JPG.

Caution: Many products will save as PDF, but what they produce is an image of the entire page, not just your picture or diagram. Of course, you can finesse this by changing the page size to just fit your diagram before saving.

Code to put in a figure

A typical figure in LaTeX looks like this:

\begin{figure}
\centerline{\includegraphics{myfile.pdf}}
\caption{This is a picture of a widget.}
\label{figwidget}
\end{figure}

The **\label** command lets you refer to the figure as "**Fig. \ref{figwidget}**" in the text.

For more information about illustrations in LaTeX, see:
http://en.wikibooks.org/wiki/LaTeX/Importing_Graphics

Key concepts for Word users

Illustration placement is done manually

Although there are some very clumsy ways to simulate it, Word does not normally use floating figures. Normally, you will place a figure manually between paragraphs in the middle of a page, or on a page by itself. You will have to adjust page breaks if you change the amount of text before or after the figure.

Use "Paste Special" to avoid linking to other software

If you run Excel, Visio, or Photoshop at the same time as Word, you might be tempted to select something in the other software's window and copy and paste it into the Word window.

Don't! You'll actually create a link to Excel, Visio, Photoshop, or whatever. This will create a Word document that actually depends on the other software! Results will be messy.

Instead, in Word, choose **Paste, Paste Special,** and paste as "device-independent bitmap" or any appropriate object type.

For greatest safety, put your graphic on a file (PNG, JPG, WMF, or EMF) and insert it by using **Insert, Picture.**

How to draw good diagrams

For drawing diagrams I recommend Microsoft Visio. The "power tool" for advanced users is Adobe Illustrator, but it takes some time to learn how to use.

Be consistent and neat. Use established notations and symbols, and don't change styles (line widths, kinds of type, symbology, etc.) unless necessary.

Line things up. If a line is supposed to be horizontal, make it exactly horizontal. If two lines are supposed to meet, make sure they do. The "snap to grid" feature in any graphics program is essential for doing this. In Visio, "snap to grid" is always on and cannot be turned off. This is one reason beginners can make good diagrams easily with Visio.

Keep the ink-to-information ratio low. That is, don't put ink on the page unless it conveys information. Don't litter the chart with unnecessary grid lines or the like.

Save your original diagram in Visio's or Illustrator's native format, but consider exporting it as a 600-dpi PNG file for use in your document (Word or LaTeX). Don't export with less than 600 dots per inch, or it won't look sharp.

Screen shots

In Windows, Shift-PrtSc copies an image of the whole screen to the Windows clipboard, and Alt-PrtSc copies just the current window. To show just part of the window, paste the screen shot into Photoshop or GIMP and then select just part of it.

Screen shots taken in this way do not show the mouse cursor arrow, and drop-down menus often close. The Institute has a license for FullShot, a software utility for taking screen shots without hiding the mouse cursor or disrupting menus.

How to take good photographs

The camera can't see what you can't see. When you take a picture, make sure the object of interest is really visible and the camera is focused on it.

For sharp pictures keep the camera steady (preferably on a tripod) and make sure there's plenty of light.
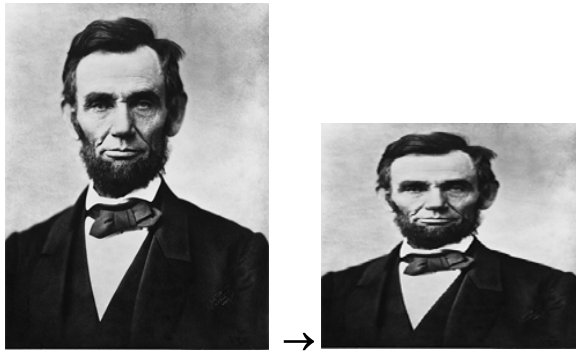
How to edit a photograph for use

Photographs are never usable as they come out of the camera; they always need editing. Here is a checklist of key concepts. Do the editing with Photoshop, GIMP, or the software provided with the camera.
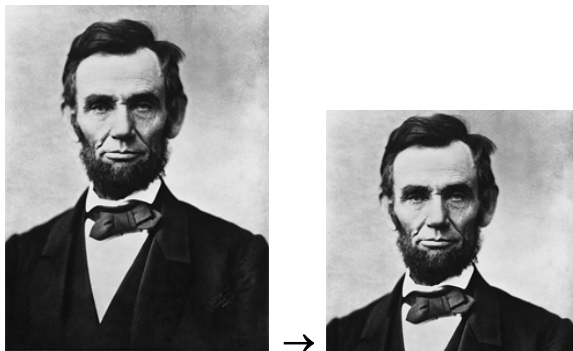
Crop, don't reshape!

The one thing you must never do is change the shape of a photographic image; the result will be grotesque and will prove you are incompetent.

Don't do this!

Mr. Lincoln was not short and squat like that!

Instead, do this:

That is, **trim away** the unwanted parts of the picture; don't try to reshape the whole thing. The Crop tool in Photoshop is handy for this. Realize that some shapes are not going to be possible; a picture of the Eiffel Tower is not going to be short and wide.
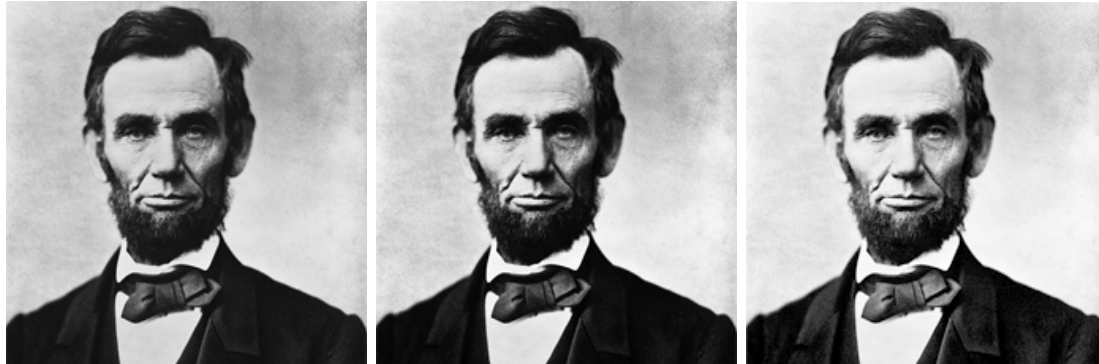
Consider converting to grayscale

If your picture is in color, ask whether it needs to be. You can cut the file size approximately by a factor of 4 by converting to grayscale (black-and-white). Some people will print your picture in black-and-white. On the other hand, in this day of PDF files and electronic storage, there is no compelling reason not to have color pictures.
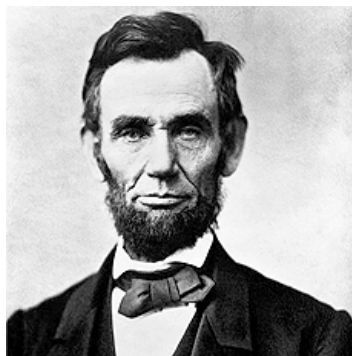
Adjust brightness levels

In general, a good picture should go from white to black. Mr. Lincoln doesn't meet that criterion until we use the Auto Tone feature in Photoshop.

But his beard and coat are still too dark, so we press Ctrl-L (Levels) and move the middle slider to the left to lighten the midtones. That gives us the third, and best, image. *Many photographs, especially of machines, need this done to them.*

Sharpen or unsharp-mask

You can generally bring out more detail with the Sharpen or Unsharp Mask filters in Photoshop. Don't overdo it; it's easy to get grotesque results. On the other hand, don't neglect the opportunity to make important detail more visible. Here is Mr. Lincoln with some sharpening:

Quite an improvement over the original, isn't it?

Convert to 8 bits per pixel

If you have not already done so, convert your photograph to 8 bits per pixel (rather than 16 or 32) to save file space. Do this after you are through adjusting the levels.

Resize as the very last step

The very last step is to choose the size, and the number of dots (pixels) per inch, for the finished photograph. In the old days we used 300 dpi for line diagrams and 75 dpi for photographs. Nowadays, we can afford the file space to do twice that. So resize (resample) your picture to its final intended size in inches, 150 dpi if it's a photograph and 600 dpi if it's a diagram, and save as PNG.

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