

Computer Graphics in Scientific Research: A Simplified Approach

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Lecture Outline I

- 1 Objectives
- 2 Your Swiss Knife Software
- 3 Introduction to Computer Graphics
- 4 Two Main Types of Computer Graphics
- 5 Basic Skills
 - Working with Bitmap Graphics
 - Transparency
 - Working with Vector Graphics

Objectives I

- Know the main two types of computer graphics
- Know what is meant by tiff, tif, gpeg, png, eps, ps, etc ...
- Know when and where to use each format
- Know how to choose the correct resolution for every case
- Know how to scan your images correctly
- Know how to send your graphics to the publishers
- Know some basic skills needed by every researcher

Important Note I

- Keep all your graphics in a separate folder in their **original** editable format.
- For example, if your graphs were created with excel, then keep the original excel file.
- If they were created with Inkscape or adobe illustrator, then keep the original files created by these programs.
- This will save your time, if you need to modify these files

Short Message

Take This Short Message:

- 1 For Bitmap image, stick to **TIFF**
- 2 For Bitmap image with transparency, stick to **PNG**
- 3 For Vector image, stick to **EPS or PDF**

Picture Versus Image

What is the difference between picture and image

- Picture is the printed or drawn on papers,
- While image is that found on computer monitor, stored digitally or found inside my mind (mental image)

Objectives

Your Swiss Knife Software
Introduction to Computer Graphics
Two Main Types of Computer Graphics
Basic Skills

Sorrow – Mahmoud Mokhtar



Your Swiss Knife I

- ① Word processor
 - ① Microsoft Word
 - ② Open Office Writer (LibreOffice)

- ② Spread sheet programs
 - ① Microsoft Excel
 - ② Open office Calc (LibreOffice Calc)
 - ③ Gnumeric

- ③ Image manipulation programs
 - ① Adobe Photoshop
 - ② Gimp

Your Swiss Knife II

- ④ Vector graphics editor
 - ① Adobe Illustrator
 - ② Inkscape

- ⑤ Billiographic editor
 - ① JabRef
 - ② Bibus

- ⑥ Desktop publishing (DTP)
 - ① Adobe InDesign
 - ② LyX

What are Computer Graphics

The term computer graphics includes almost everything on computers that is not text or sound.

Color Systems I

RGB

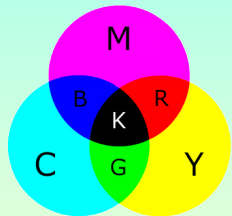
(red, green, blue) color system

CMYK

(cyan, magenta, yellow, black), used in all industrial printers and some inkjet printers

Note

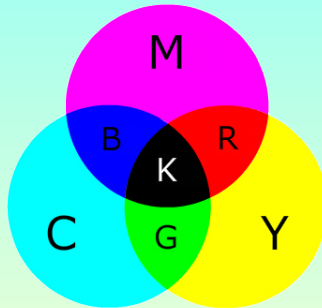
So, when sending your article to the publisher, you have to convert your images from RGB to CMYK system



Color Systems I

- RGB (red, green, blue) color system
- CMYK (cyan, magenta, yellow, black), used in all industrial printers and some inkjet printers
- So, when sending your article to the publisher, you have to convert your images from RGB to CMYK system

Color Systems II



Resolution I

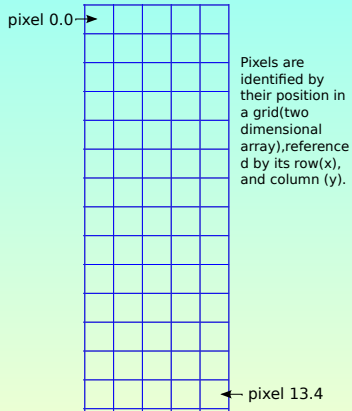
- Is the density of pixels
- Sometimes resolution is described as density of pixels in length unit (pixel per inch), in area unit (pixel per square inch, used mainly in scanners and printers), or in the whole image
- The latter i.e. is used mainly in cameras, for example a 3.1 megapixels, camera produces an image which is $2048 \times 1536 = 3,145,728$ pixels or 3.1 megapixels.

Pixel: I

- Is the smallest single component of a digital image
- Each pixel has its own address.
- The address of a pixel corresponds to its coordinates (x and y). Pixels are normally arranged in a two-dimensional grid, and are often represented using dots or squares

Pixel: II

Pixel = Smallest Picture Element



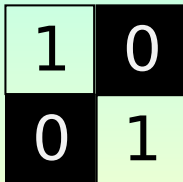
Binary Image I

- A binary image is a digital image that has only two possible values for each pixel
- Typically the two colors used for a binary image are black and white though any two colors can be used
- The color used for the object(s) in the image is the foreground color while the rest of the image is the background color

Binary Image II

Binary Image

0 = Black
1 = White



1	1	1	1	1	1	1	1	1	1
1	0	0	0	1	1	0	0	0	1
1	1	0	1	1	1	1	0	1	1
1	1	0	1	1	1	1	0	1	1
1	1	0	1	1	1	1	0	1	1
1	1	0	0	0	0	0	0	1	1
1	1	0	1	1	1	1	0	1	1
1	1	0	1	1	1	1	0	1	1
1	1	0	1	1	1	1	0	1	1
1	0	0	0	1	1	0	0	0	1
1	1	1	1	1	1	1	1	1	1

Bit Depth I

- Color depth or bit depth is the number of bits used to represent the color of a single pixel in a bitmapped image or video frame buffer
- This concept is also known as bits per pixel (bpp), particularly when specified along with the number of bits used
- Higher color depth gives a broader range of distinct colors

Bit depth (color depth) I

Color Depth

1-bits ->

2-bits ->

4-bits ->

8-bits ->

16-bits ->

24-bits ->

32-bits ->

Number of colors

2 colors only, often black and white - binary image

4 colors, CGA, gray-scale

16 (Standard VGA)





256 (Super VGA, indexed color)

65,536 (High Color)

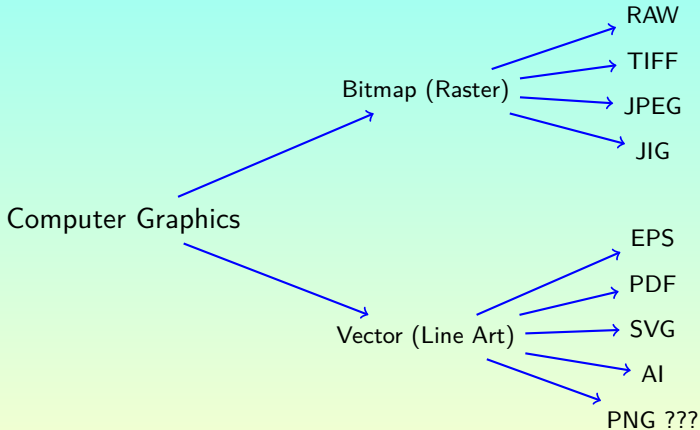
16,777,216 (True Color)

16,777,216 + alpha channel

Bit Depth I

Bits	Tones	Binary Digits	Array
<i>1 bit (2^1)</i>	<i>2 tones (0 – 1)</i>	<i>0 or 1</i>	
<i>2 bits (2^2)</i>	<i>4 tones (0 – 3)</i>	<i>00, 01, 10, 11</i>	
<i>3 bits (2^3)</i>	<i>8 tones (0 – 7)</i>	<i>000, 001, 010, 011, 100, 101, 110, 111</i>	
<i>4 bits (2^4)</i>	<i>16 tones (0 – 15)</i>	<i>0000, 0001, 0010, 0100, 1000, 0011, 0101, 1001, 1010, 0111, 1011, 1100, 1101, 1110, 1111, 0110</i>	

Two Main Types of Computer Graphics I



Bitmap Graphics

- Bitmap graphics or raster graphics consist of pixels.
- As the number of these pixels (dots) increases in the measurement unit (inch or mm), the quality of the image increases also, but always remember this is done on the expense of the file size.
- All scanned images are bitmaps, and all images from digital cameras are bitmaps.
- **The format used in bitmaps in the order of preference are:**

Bitmap Graphics - Formats - 1

- RAW
 - Is the king, but
 - not all publishers accept it because very few programs can deal with it.
- TIFF or TIF
 - Is always preferred, but
 - because there is no compression, the size of the resulting file will be large.

Bitmap Graphics - Formats - 2

- JPEG - JPG
 - This is the third choice, the file size is small because of compression.
 - Do not play with jpeg files because they are compressed and liable for distortion. Only play with the tiff and then convert it into jpeg.
 - So for every image you should have two formats. The original one in tiff (larger file size) and the second one in the jpeg format (smaller file size) to be uploaded into the Internet.

Bitmap Graphics - Formats - 3 - I

- PNG
 - PNG is a special case being more nearer to vector graphics format.
 - PNG is a bitmapped image format that employs lossless data compression.
 - PNG is the only format which can be embedded in Microsoft office PowerPoint or Word and also in Open Office.
 - The greatest advantage of PNG is its ability to support transparency and transparent background.
 - Whenever, you need to export your vector graphics into bitmaps you have to choose PNG

Bitmap Graphics - Formats - 3 - II

- Similarly, when you want to export your bitmaps e.g. TIFF or JPEG into an image without background, you have to choose PNG.
- Tip: If you need to embed your graphs or bitmaps with transparent background in Microsoft office or Open Office, then you have only one choice “PNG”, otherwise you will not need this format.

Bitmap Graphics - Formats - 4

- JIF
 - Only used when you need animations in PowerPoint presentations or in web pages.
- PSD (Adobe Photoshop)
- BMP
 - Is a windows format, useless and should not be used at all.
- WMF
 - Is a windows format, useless and should not be used at all.

Bitmap Graphics - Formats - 5

- EMF
 - Enhanced metafile, useless
- PIC
 - Is a mac format, useless and should not be used at all.
- Many other formats eg .mix, emf, most of them are useless

Vector Graphics

- Instead of displaying the image on the monitor or paper in a form of dots (pixels), the image is drawn on the screen or paper each time utilizing mathematical formulas.
- So this form of graphics is a non-pixel form (pexeless) and hence resolution independent.
- The resolution only depends on the capability of the computer monitor or printer to draw the image.
- The resulting image size is therefore very small (no pixels, only mathematical algorithm).
- The resulting image is of the highest possible quality.

Vector Graphics

- You can enlarge your image to fill the space between sky and earth. There is no pixellation. The only limit is the capability of your output device, monitor, data show, printer
- This form is the one which is always preferred in scientific work
- Put it in your head “always use vector graphics in your work, whenever, there are no other choices, your second choice will be tiff”.
- .ai, .ps, .eps, .svg, cdr (CorelDRAW) .pdf are the standard vector graphics format.
- PDF is a special case as it is a vector graphics in which you can embed bitmaps. So it is a mix.

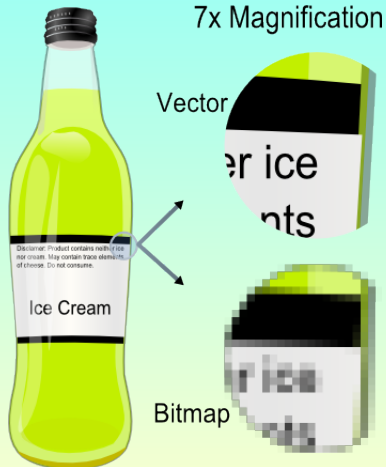
Scalable Vector Graphics (SVG)

- Scalable Vector Graphics (SVG) is a file format for two-dimensional vector graphics, both static and dynamic (i.e. interactive or animated)
- The SVG specification is an open standard that has been under development by the World Wide Web Consortium (W3C) since 1999
- All major modern web browsers have at least some degree of support and render SVG markup directly, including Mozilla Firefox, Internet Explorer 9, Google Chrome, Opera, and Safari
- SVG is the native format for [Inkscape](#)

Inkscape

- **Inkscape** is a free and Open Source vector graphics editor, with capabilities similar to Illustrator, CorelDraw, or Xara X, using the W3C standard Scalable Vector Graphics (SVG) file format
- Inkscape supports many advanced SVG features (markers, clones, alpha blending, etc.)
- It is very easy to edit nodes, perform complex path operations, trace bitmaps and much more
- Inkscape can be run on all platforms i.e. Windows, Linux and MAC operating systems
- Inkscape can be downloaded from <http://inkscape.org/>

Vector Graphics Versus Raster (bitmap) graphics



Working with Bitmap Graphics I

What are the programs dealing with bitmap graphics

Adobe Photoshop and GIMP are the main programs that can deal with bitmap graphics.

What is the best format I can use

TIFF is the preferred format for almost all publishers.

Working with Bitmap Graphics I

What is the best resolution

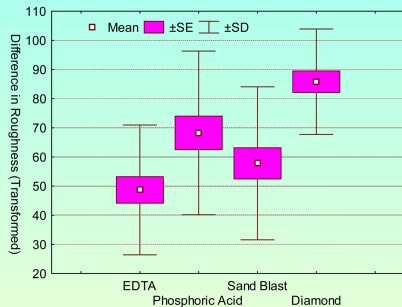
- For bitmap images the resolution of **300** pixels/inch is preferred
- For line arts, graphs and other images containing text, a resolution of **900** pixels/inch is preferred if the image is to be saved as a bitmap. The lines appear sharp even with when zoomed in. Here we would still prefer a TIFF file as it is a lossless format, while JPEG is a 'lossy' one.

bitmap graphics

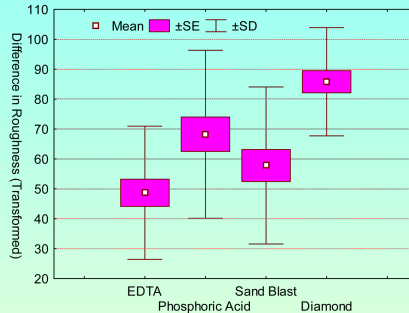
What to Do With This Graph

If I will copy or scan this graph it should be:

- 1- TIFF
- 2- Resolution should > 900 PI



bitmap graphics



What to Do With This Graph

- 1 TIFF
- 2 Resolution should be at least 900 PI

Working with Bitmap Graphics I

How to convert color space

- The color space suitable for most of the publishers is the CMYB
- In adobe Photoshop select image > mode > CMYB
- GIMP does not support the CMYB natively yet, but no problem leave the color space as it is

Working with Bitmap Graphics I

How to adjust color, brightness and contrast

Refer to the manual of Photoshop or GIMP for detailed help on this item

Working with Bitmap Graphics I

Scaling versus Resizing

- Scalling occurs when you edit an image in MS Word, PowerPoint or DTP programs and adjust its dimensions manually, either by dragging the image handle or by selecting specific width and height.
- The image in this case is said to be zoomed in or out.
- If the image is zoomed out, the fine details of the image will get smaller, (fonts become smaller, lines become thinner, cells and nuclei becomes very small) and there is a possibility that these internal details become invisible.

Working with Bitmap Graphics II

- If the image is zoomed in, the details will enlarge but the image will be blurred and hazy.
- In either case the magnification will change.

Working with Bitmap Graphics I

Sizing or resizing (also called cropping)

- Is done by selecting specific part of the image to be shown and deleting the remaining part.
- The magnification will not change and the file size will gets smaller.

Scaling Versus Cropping I



Original



Scaling



Cropping

Figure: Scaling Versus Cropping

Working with Bitmap Graphics I

Never Ever

allow a nonspecific software modify your image in any way. If you need to resize, rescale, adjust brightness or contrast, use only a specific image manipulation software such as Photoshop or GIMP.

Working with Bitmap Graphics I

How to adjust image size

This is the most important skill that every researcher should know. The steps for adjusting the print size of your image is as follows:

- 1 Start by deciding if your image is to be printed on A4 or B5 paper. You can know this by asking your publisher or by getting information about your thesis from your colleagues or university administration authorities.
- 2 Decide whether your image will occupy one or two columns

Working with Bitmap Graphics II

- 3 For A4 paper, roughly, A4 paper width is 21cm. remove at least 5cm for right and left margins. The remaining will be $21-5=17$ cm. If your image will occupy two columns then you can make its width 16cm and if it should occupy 1 column, then its width should be around 8cm.
- 4 For B5 ISO paper, the width is 17.6cm and for B5 JIS, the width is 18.2cm. We will use the least value which is the ISO i.e. 17.6cm. the margins will be around 5cm. the remaining part will be around 12cm, so two columns means an image width of about 12cm and 1 column will be 6cm.

Working with Bitmap Graphics III

- 5 In GIMP, open your image, select Image > Print Size, select your favorite unit by clicking on the tab and selecting more, then select centimeters , then go to width and type your required width and then click on the tab key in your keyboard making sure that the chain of x resolution and y resolution are linked and not broken. Finely, save your image.
- 6 In Photoshop, open Image > Image Size > Document Size, make sure that the chain of height and width is connected, enter the required width in cm, make sure that the Resample Image is **unchecked**, then click OK

Working with Bitmap Graphics IV

- ⑦ For histopathological images or images containing fine details, try to **crop** the image instead of resizing. This will prevent the image from being less magnified than the original one with loss of final details. The cropping of course, should be to the desired width.

How to crop your image I

How to crop your image




Original image



Image after cropping

How to crop your image I

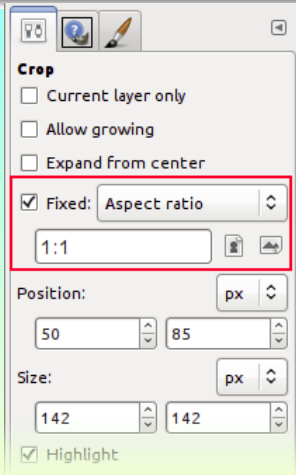
There are many reasons to crop an image; for example, fitting an image to fill a frame, removing a portion of the background to emphasize the subject, etc. To activate the crop tool. Click the  button in the Toolbox. This changes the cursor and allow you to click and drag a rectangular shape.

Click on one corner of the desired crop area and drag your mouse to create the crop rectangle. You don't have to be accurate as you can change the exact shape of the rectangle later.

How to crop your image II

After completing the click and drag motion, a rectangle with special regions is shown on the canvas. As the cursor is moved over the different areas of the selected crop area, the cursor changes. You can then drag the rectangle's corners or edges to change the dimensions of the selected area.

How to crop your image III



How to crop your image IV

As shown in the figure above, as the crop area is resized, the dimensions and ratio are shown in the status bar. If you would like to crop the image in a specific aspect ratio, such as a square, make sure the tool options are visible (Windows → Dockable Dialogs → Tool Options). In the Tool Options, check the mark next to Fixed and make sure the drop-down box next to it is set to Aspect Ratio. You can now type the desired aspect ratio on the text box below, such as “1:1”. You also have controls to change the aspect from landscape to portrait.

How to crop your image I

After you set the aspect ratio, drag one of the corners of the crop rectangle to update it. The rectangle changes to the chosen ratio, and when you drag it should maintain that ratio. You can also adjust the position and the size of the crop area in the same dialog.

Transparency I

Using Transparent Images on Word, PowerPoint, Web and in Print

From Photoshop First, if you are working in Photoshop and going to print or Web, check out the Export Transparent Image Wizard located under the Help menu. It will ask you a series of questions and export the image in the appropriate format. The image is going to the Web.

You have three choices here: GIF, PNG, or "faking it with JPEG."

Transparency I

- PNG - PNG is a newer format developed to overcome many of the limitations of GIF.
- It supports high color and partial transparency using alpha channels.
- Although PNG has been around for a while now, the biggest problem with it is that many people are still using older browsers that do not support PNG, and even some modern browsers do not support all the features of PNG.

Transparency II

- For instance, Microsoft Internet Explorer 6, which is still in wide use today, does not support alpha transparency of PNG images. Transparent PNG images do display properly in IE7, however. More on PNG

Transparency I

If your image will be used in a page layout application like Lyx, InDesign, QuarkXpress, Scribus or PageMaker.

You have three choices here: Adobe native PSD format or TIFF (alpha channels).

- Adobe native **PSD** format: PSD retains transparency among Adobe applications, so if you are working entirely in Adobe applications, just use the Photoshop native PSD format with transparency.

Transparency II

- **TIFF** (Alpha Channels): Alpha channels are bitmap masks that define transparency in shades of gray. When used in page layout applications, the TIFF format is preferred for images with alpha channel transparency.

How do I make parts of the image transparent ?

- add an Alpha-channel to your image (using Layer > Transparency > Add Alpha Channel)
- select the Eraser-tool Eraser Tool and erase what you'd like to get rid of or

Transparency III

- select a specific area using the Magic Wand Magic Wand (or another selection tool) and use Edit > Clear (or press CTRL+K) to make the selected area transparent
- There is also an ColorToAlpha-plugin which takes one color and makes all parts of the image with that color transparent. Which is quite convenient...

Beware: not all graphics-formats support transparency.

Well-known formats that support transparency are GIF and PNG.

How to crop your image I

How do I remove the Alpha-channel (transparency-information) afterwards ?

Sometimes you want to get rid of the transparency-information in your image. Of course you can save the image to a format that does not support transparency, close the image and open it again. But that's not a very nice method. You'd better just flatten the image: Layers > Flatten Image.

Working with Vector Graphics I

What are the programs dealing with vector graphics

- In MS Windows, Adobe Illustrator and CorelDraw
- In Ubuntu - Debian, many, most famous is Inkscape and Dia

Working with Vector Graphics I

Selecting proper font size

Not less than 12 pt

Selecting proper line thickness

Not less than 1 pt or better 1mm

Best format for vector graphics: PDF versus EPS

- pdf format support gradient colors while eps not
- svg is still in the beginning phase

Working with Vector Graphics I

How to convert vector graphics into bitmaps

This is not necessary and you should not try to do this because vector graphics are much more superior compared to bitmaps. If your word processor does not support embedding vector graphics, then you have to change it and use one which can do.

However, if you are obliged to do, most vector graphics software can save as or export the image into **“. png”**. png format can be embedded into almost all word processors.

Working with Vector Graphics I

Excel Charts into EPS or PDF

The figures will eventually be published in a scientific journal

A lot of the journals need figures in EPS or PDF

- 1 In Excel copy your graph and in Illustrator, past it.
- 2 In Illustrator, ungroup the graph and work with formatting issues (fonts, size, colors, etc.)
- 3 In Illustrator, save it as EPS OR PDF, you can also export it into PNG

Working with Vector Graphics I

Excel Charts into EPS or PDF

- A good solution, use Gnumeric instead of Excel
- Gnumeric has a built in conversion into EPS or PDF
- EPS or PDF can be open with Inkscape and re-adjusted

Working with Vector Graphics I

How to create arrows in Inkscape

If you want to draw a black arrow with black arrow head, follow the steps from 1 – 8. If you want to draw a colored arrow with colored arrow head, you have to do the complete steps from 1 – 12.

- 1 Select the "Draw Bezier curves and straight lines" tool (shift-F6)
- 2 Line starting point: click mouse left
- 3 Line ending point: double-click mouse left
- 4 Open "Fill and Stroke" dialog (shift-ctrl-F)

Working with Vector Graphics II

- 5 Click "Stroke style" tab
- 6 Line width: increase Width value
- 7 Line type: "Dashes" pull-down menu
- 8 Arrow style: "End Markers" and scroll down pull-down menu for quite a length till you find "Arrow2Mend".
- 9 Click "Stroke paint" tab
- 10 Select line color: adjust HSLA sliders or type-in RGBA value. You now have a colored line with a black arrow head.
- 11 Select your arrow and then select Object -> Transform
- 12 Select Extension -> Modify Path -> Color Markers to Match Stroke

Short Message: I

Take This Short Message

- 1 For Bitmap image, stick to **TIFF**
- 2 For Bitmap image with transparency, stick to **PNG**
- 3 For Vector image, stick to **EPS** or **PDF**

Column Example 1: I

Column Number 1

so so and mi mi

Column Number 2

to to and lo lo

Column with Block Example 1: I



^aThis is my faculty label

Observation 1

Do Not Eat Any Meat

Observation 2

Do Not Eat Any Fool (Fasia Faba)

Conclusion

You Will Die From Cachexia

Column with Block Example 2: 1

Column 1 Header

Column 1 Body Text

Column 2 Header

Column 2 Body Text