

Introduction to Computer Graphics

Chapter 3

Digital Multimedia, 2nd edition

How to get images in digital form?

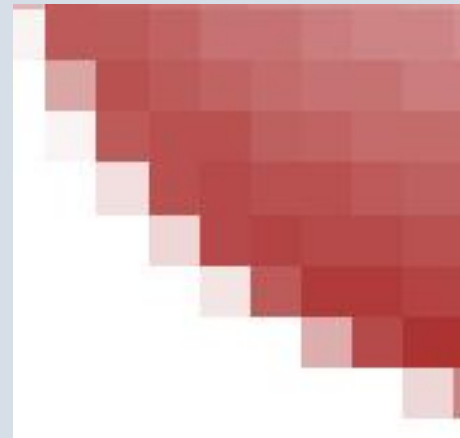
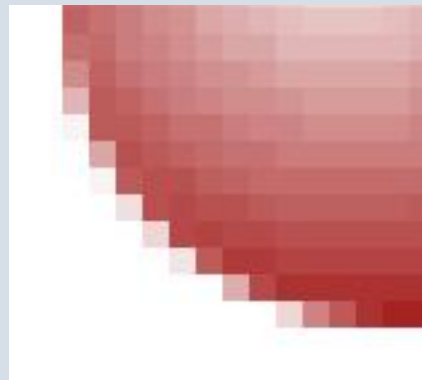
- Digitize printed image with a scanner
- Capture image from digital camera
- *Any other ways?*

How to get images in digital form?

- Grab frame from video camera
- Create in digital form using graphics package
 - Adobe Fireworks
 - Adobe Illustrator
 - Microsoft Paint
- Generate visual representation of data
 - Excel Charts

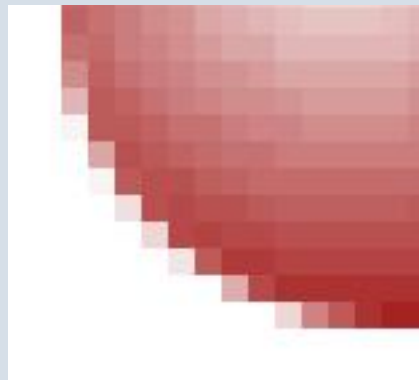
Rendering

- Image is displayed on monitor etc as array of pixels
 - Rectangular (usually square) dots of colour



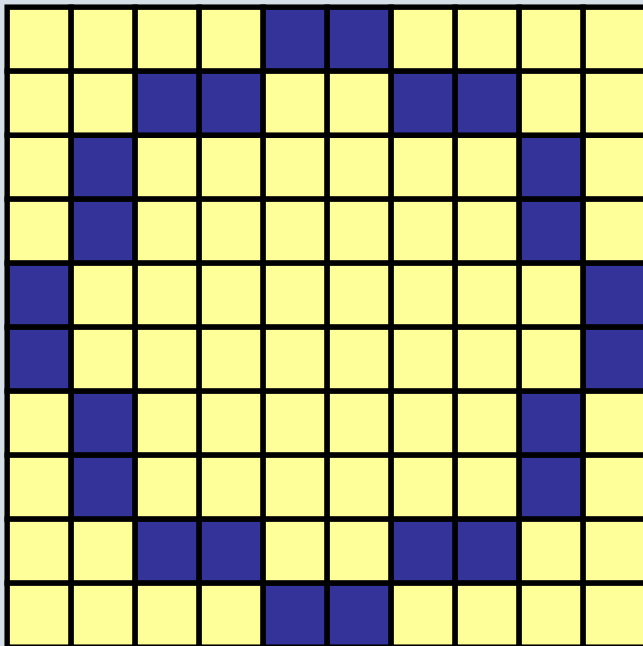
Rendering

- Program (e.g. Web browser) sets pixels to an appropriate color to produce desired image
 - Pixels merge optically to produce effect of continuous tone
- Program must maintain a model of the image
 - May be stored in a file and read by program

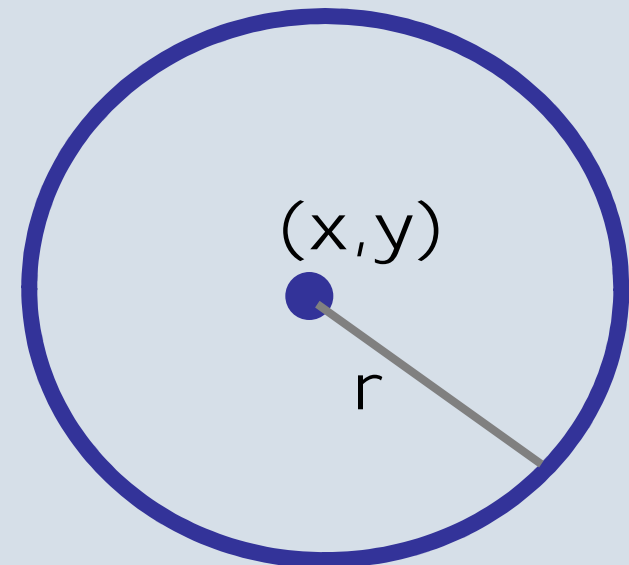


Bitmapped and Vector Graphics

- Bitmapped graphics – image is modeled as an array of pixel values

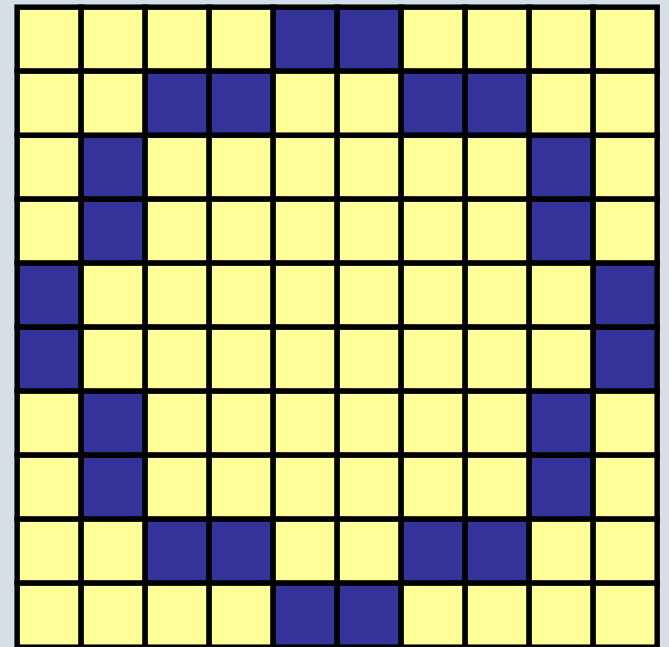


- Vector graphics – image is modeled as mathematical description of curves, shapes



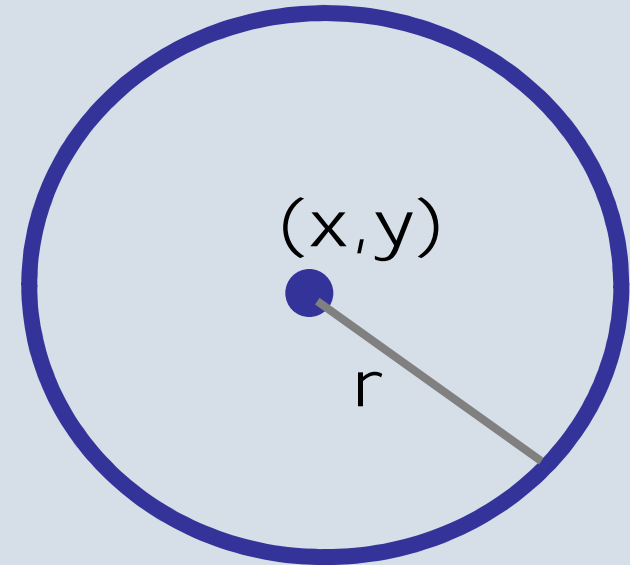
Bitmapped

- Example:
- 10 X 10 grid
- 100 pixels
- 256 colors (8 bits = 1 byte)
- 100 bytes to store the file
- What would the size be if the image was black and white only?



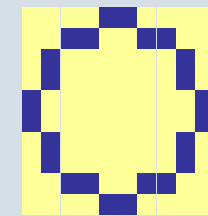
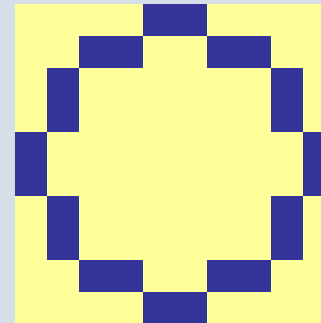
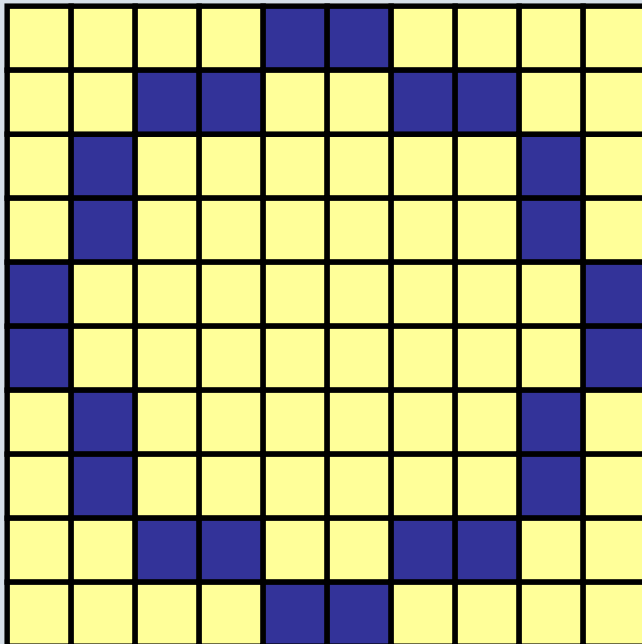
Vector

- Integer stored using 8 bits
- 4 Integers + Color
- What is the 4th integer?
- However, vector file need other information in the header?
 - What other information is needed?



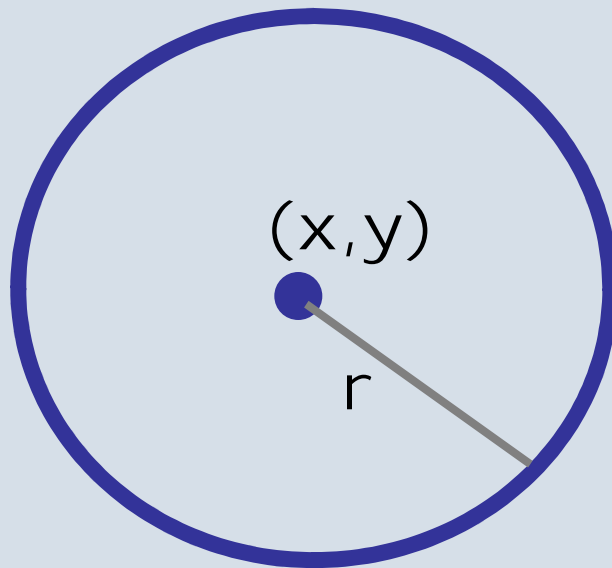
Bitmapped

- Render by direct mapping of logical pixels to physical pixels of screen



Vector

- Render by computing pixels from geometric coordinates.
- Can require more computation



Memory Requirements

- Bitmapped – any picture of $w \times h$ pixels, using c bytes per pixel occupies whc bytes
- Vector – space required depends on complexity of picture (how many shapes, segments of path, etc)
 - Usually vector graphics smaller than bitmapped

Memory Requirements

- 128 px square with 20px blue outline filled in red
- Bitmap using 24 bits per pixel
 - $128 \times 128 \times 3 = 48,000$ bytes
- Vector specified in SVG:
 - `<path fill="#F8130D" stroke="#1E338B" stroke-width="20" d="M118,118H10V10h108V118z"/>`
 - **86 bytes** (plus 198 bytes SVG boilerplate)

Memory Requirements

- 1280 px square with 20px blue outline filled in red
- Bitmap using 24 bits per pixel
 - $1280 \times 1280 \times 3 = 4,915,200$ bytes
- Vector specified in SVG:
 - `<path fill="#F8130D" stroke="#1E338B" stroke-width="20" d="M1180,1180H10V10h1080V1180z"/>`
 - **90 bytes** (plus 198 bytes SVG boilerplate)

SVG

- Scalable Vector Graphic format
- http://en.wikipedia.org/wiki/Scalable_Vector_Graphics



BITMAP
.jpeg .gif .png



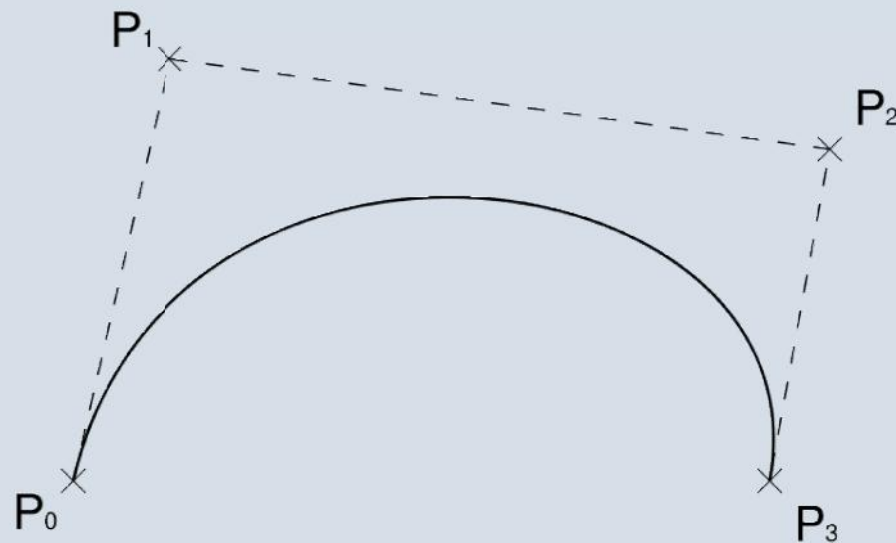
OUTLINE
.svg

Fonts

- Are fonts stored as bitmaps or vectors?

Fonts

- Fonts are stored in various vector formats
 - TrueType format (developed by Apple)
 - Type 1 format (developed by Adobe)
- Fonts stored like splines (piecewise polynomials).
- Set of Points
- Curves are functions



Painting vs. Drawing

- Vectors – drawing programs
 - Select individual graphic objects (shapes, paths, &c)
 - Transform size, position, angle,
 - Change attributes: stroke and fill
- Bitmaps – painting programs
 - Select areas of pixels
 - Apply effects and filters

Trick question

- Is Fireworks (the program we used in lab to crop images) a painting program or a drawing program?
- Do you use it to edit bitmap or vector graphics?

Painting, Drawing, Image Editing

- Painting programs often have support for tablet devices.
 - Mimics paper & pen or canvas & paint
- Drawing programs often have support for geometric objects
 - Fireworks is classic example
- Image Editing
 - Focuses on manipulating existing images rather than creating ones from scratch (Photoshop)

Scaling

- Vectors
 - Scaling is a simple mathematical operation on stored description (before rendering)
 - Curves and lines remain smooth at all sizes
- Bitmaps
 - Interpolate pixel values
 - More or less sophisticated algorithm
 - Usually produces loss of quality, blurring, jaggedness &c

Combining Vectors & Bitmaps

- Rasterize vectors
 - Lose all their vector properties
 - Also called Flattening
- Trace bitmaps
 - Difficult and can only produce an approximation (parameterized)

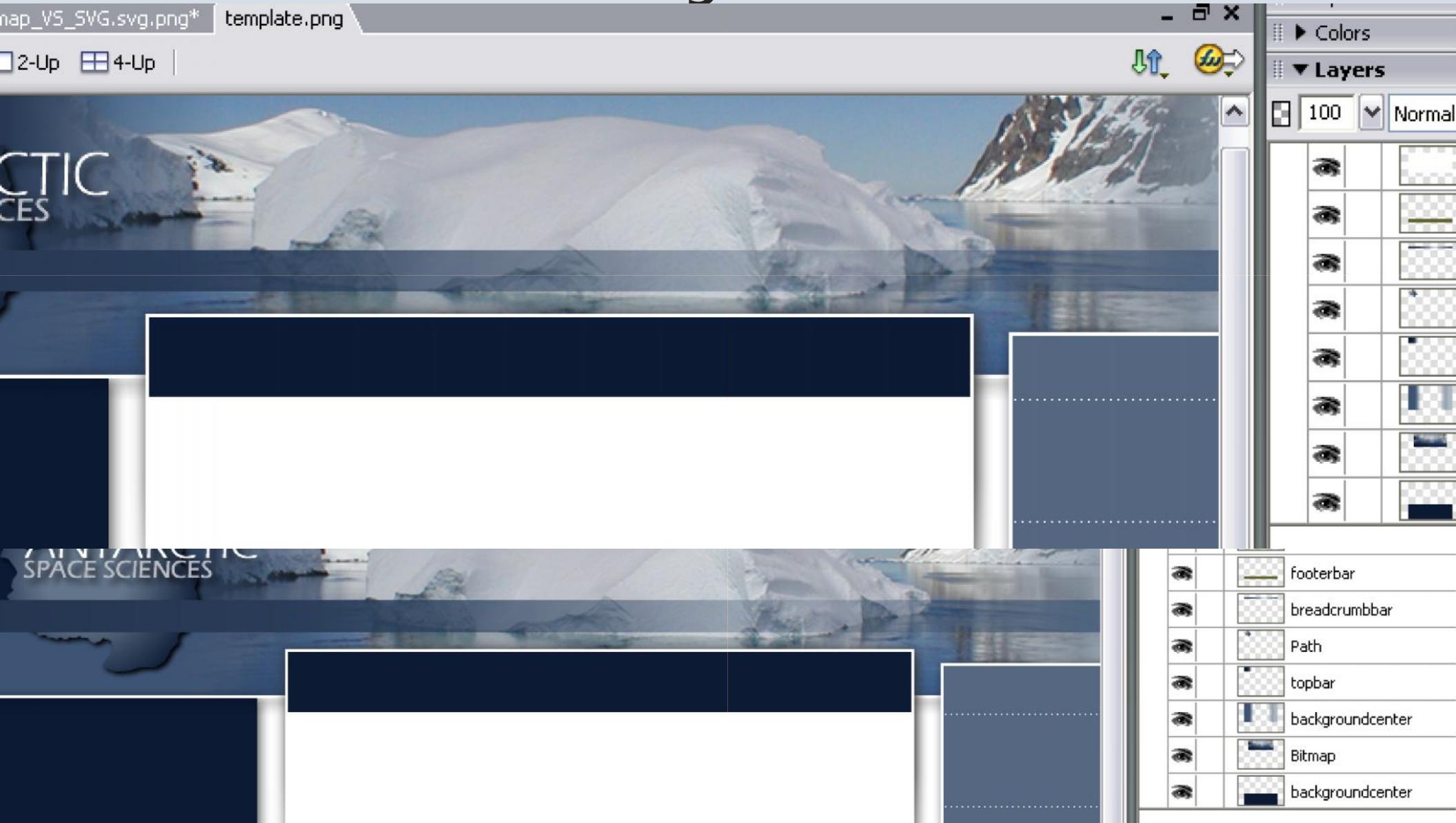
Are you getting it?

- Vectors seem so much better than bitmaps, right?
- How are they better?
- Why even use bitmaps?

Combining Vectors & Bitmaps

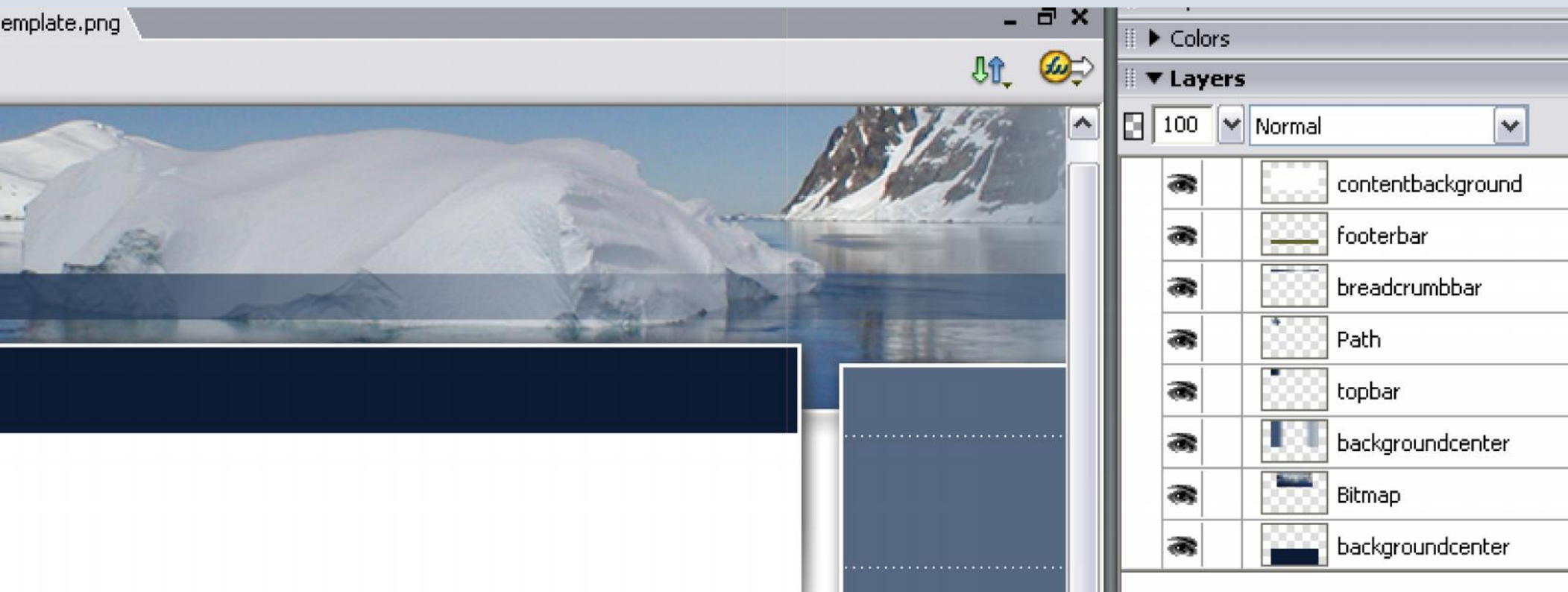
- Import bitmaps into vector drawing programs
 - Treat bitmaps as indivisible objects
- Bitmap editing programs often provide no support for importing vector images.

Layers



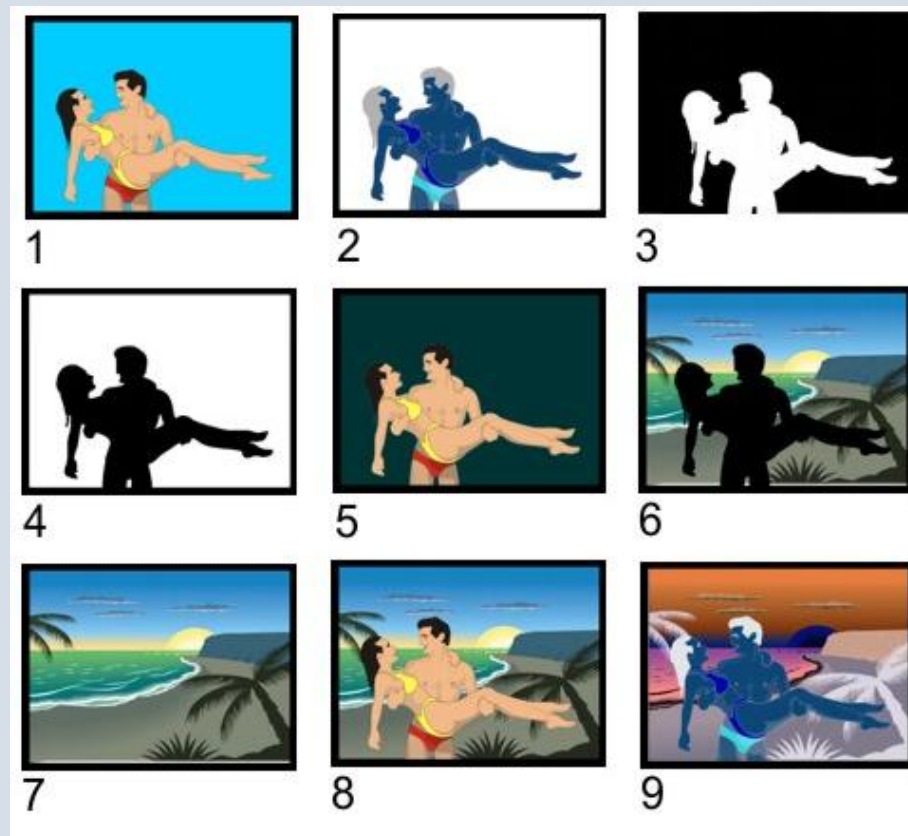
Layers

- Digital version of clear sheets, stacked on top of each other
 - Areas without colored pixels are transparent so lower layers show through



Compositing

- Combining layers using different blending modes (digital collage)
- <http://en.wikipedia.org/wiki/Compositing>



Compositing

- In video, blue screening (actually, green screening) is used to extract foreground layer to combine it with any background layer.



File Formats

- Many different graphics file formats in existence
- Different ways of encoding image data
- Goal: Reduce file size while preserving quality
- Factors: Number of colors, resolution, bitmap vs. vector.

Bitmap Formats

- Two different compression methods
 - Lossless – image can be reconstructed exactly from compressed version
 - Lossy – some information discarded, image can only be reconstructed approximately

WWW Bitmapped Formats

- GIF (CompuServe Graphics Interchange Format)
 - Lossless, 256 colours (indexed), transparency
- JPEG (Joint Photographic Experts Group)
 - Lossy (variable quality), millions of colours
- PNG (Portable Network Graphics)
 - Lossless, variable number of colours, W3C standard

Vector Formats

- SVG (Scalable Vector Graphics)
 - W3C standard, not presently widely used
- SWF (Flash)
 - Primarily for vector animation, but can be used for still vector graphics; de facto standard
- EPS (Encapsulated PostScript)
 - Primarily print, use declining, superseded by PDF