Graphics and Images

September 28, Unit 3

Computer Graphics

- "Computer graphics refers to using a computer to create or manipulate any kind of picture, image, or diagram."
- Typically you manipulate an image on your computer with a graphics editing program
 - MS Paint
  - Adobe Photoshop
  - GIMP
  - Etc.

Bitmapped Graphics

- There are two basic types of graphics:
  - *Bitmapped* and
  - *Vector*
- Bitmapped graphics are much more common
- Often they are called raster graphics
- When you create a bitmapped graphic you are basically creating a bunch of colored dots

Bitmapped Graphics, cont.

- The bitmapped graphic is stored as an array of dots, or pixels
- Each pixel gets assigned a specific color
- The more pixels you have, the more detailed the image can be
  - Imagine only have one pixel, all you get is a dot
- Some common bitmap graphics programs are:
  - Photoshop
  - Paint Shop Pro
  - GIMP
  - Photo-Paint
  - Graphic Converter
- These are *paint programs*

Exaggerated Example of a Bitmap Image
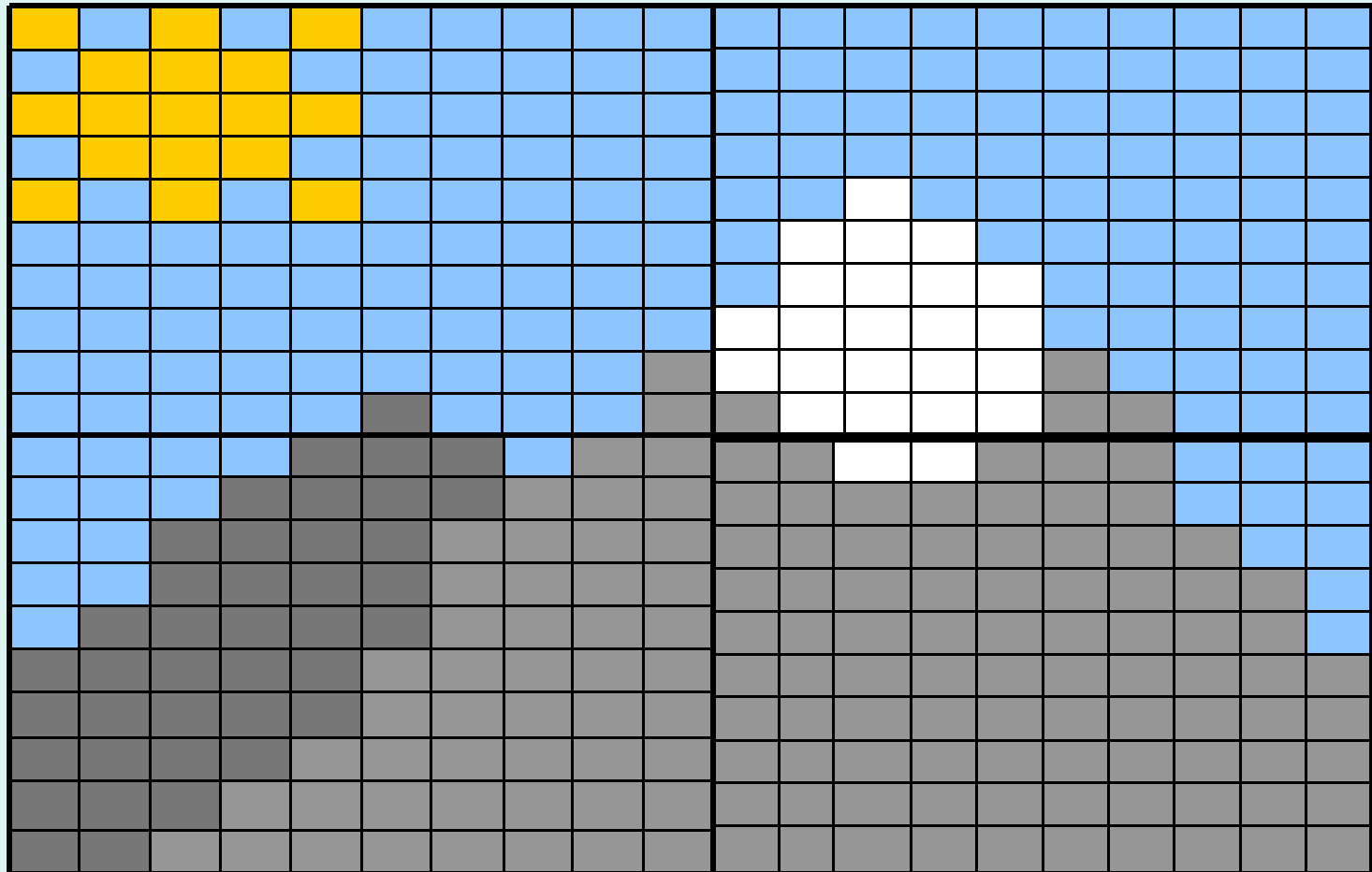
Vector Graphics

- The second major type of computer graphics
- Vector graphics are created and manipulated using *drawing programs* (as opposed to paint programs for bitmapped graphics)
- Instead of using pixels to describe the image, it describes the image using shapes
  - Circles
  - Lines
  - Curves
- Also has to store the color of these shapes
- A verbal example would be something like:
  - "A yellow circle with a center here and a radius of x, a purple line from here to here"

Vector Graphics, cont.

- The programs used with vector graphics are drawing programs
- Some of these programs include:
  - Corel Draw
  - Adobe Illustrator
  - Acrobat
- Most of these programs allow the use of bitmapped images as part of a vector image
  - Does not make them paint programs
  - Bitmaps are a type of object (like a circle) that can be inserted into a vector image

Bitmap vs. Vector Images

- Bitmap and vector images are obviously different

- Both have strengths and weaknesses

- They don't manipulate images in the same way

- They don't store images in the same way

- The images are edited differently

Bitmap Images

- Very flexible
  - Any image can be represented (with enough pixels)
- Created by scanners, digital cameras, and other similar devices
- Used most commonly, especially on the web
- Can be displayed directly on your computer screen if 1 image pixel is the same size as 1 screen pixel
- Takes a lot of memory
  - The color of each pixel must be stored
  - Can be compressed

Vector Images

- Easy to change parts of the image since each part is stored as a different shape
- Can manipulate the image smoothly
  - Rotating, changing color, size, line width, etc.
- Limited to the shapes the program can handle
- Typically takes less memory and disk space than a bitmap
- Must be converted to a bitmap to display

File Formats

- Once we've chosen which graphics format we're going to use now we have to select which file format

- Each way of storing an image is called a *file format*

- Each file format converts the image to a corresponding string of bits differently in order to store them on disk or transmit them over the Internet

- It's beyond the scope of this course to discuss how these images are converted

- But, we will discuss the common file formats

File Formats, cont.

- Hopefully, you're familiar with JPEG and GIF file formats (at least in name only)
- You can't just rename "somepicture.gif" to "somepicture.jpg" and expect to get the desired result
  - Can't just rename a .doc file as .ppt and expect a presentation out of it
- Images have to be converted from one file format to another

Common File Formats

Bitmap Formats

- GIF: graphics interchange format

- JPEG: joint photographic experts group

- PNG: portable network graphic

- BMP: Windows bitmap

- TIFF: tagged image file format

Vector Formats

- SVG : scalable vector graphics

- EPS: encapsulated postscript

- CMX: Corel meta exchange

- PICT: Macintosh Picture

- WMF: Windows metafile

How to Pick a File Format?

- **Type**: does the file format store the type of image you want to use (bitmap or vector)?
- **Portability**: can other people use images in this format?
- **Color Depth**: does the format support the number of colors you need?
- **Compression**: can make the file smaller, but it takes time to compress and decompress a file
- **Transparency**: do parts of your image need to be transparent?

Color Depth

- Image formats will only allow a certain number of different colors for each pixel
  - Depends on the number of bits assigned to each pixel
- The format stores the level of each of the three values for RGB to specify color
- R,G,and B are referred to as *components*
  - Ex. "The red component"
- *Bit depth* describes the number of colors that can be used in the image

Bit Depth

- 24-bit image allows you to specify up to 2^{24} different colors in your image
  - For each of the RGB values you can specify 2^8 different values (256 values)
    - Remember in the color section RGB went from 0-255
  - 2^8 values for R, for G, and for B gives us 2^{24} different colors
- The "24" in 24-bit says how many bits it takes to store a single color

Bit Depth cont.

- While most photos look good with 24-bit color, we can have less than that
- 15-bit color can have 2^{15} different colors with 2^5 possible values for each component
- 15-bit color is usually referred to as 16-bit color
  - Use an extra bit for green (we're more sensitive to it)

Formats with Fewer Colors

- Usually images with smaller numbers of colors are *paletted* or *indexed*

- Some colors are selected to be in the image's palette

- For each pixel, then you only have to store the number which indicates which palette color you want
  - Instead of specifying its RGB values, specify the number associated with the color
  - Red could have a value of "12"

Palettes

- If you have an 8-bit image, the palette will have 2^8 (256) colors
  - Each of the 256 colors in the palette come from the possible 2^{24} different colors in a 24-bit image
- A 1-bit image can have 2^1 (2) different colors
  - Usually black and white

Colors vs. Image Size

- It's nice to use as many colors as possible, especially when dealing with photographs
- But, the more colors, the larger the image is to store
  - More information is required for each pixel
- Can work in 24-bit color then save the image with fewer colors for storage or using online

What if your image has more colors than the color depth?

- Usually the graphics program will select colors that closely match those in your image

- If the color is not in the palette, the program can choose a separate, close color, or do *dithering*

- *Dithering* is where the program fools your eye by creating a pattern of pixels in two colors which makes you see a color between the two
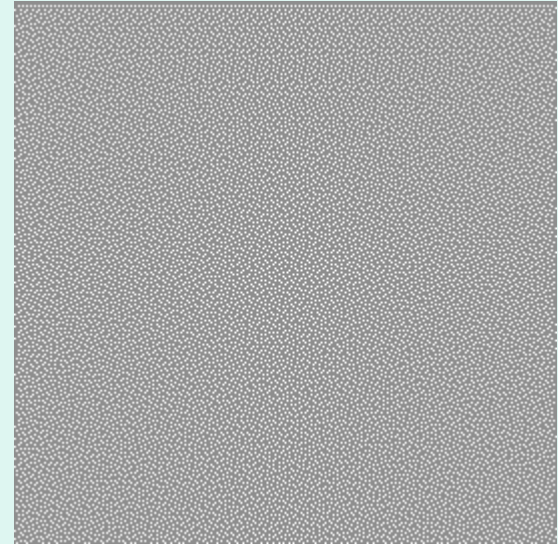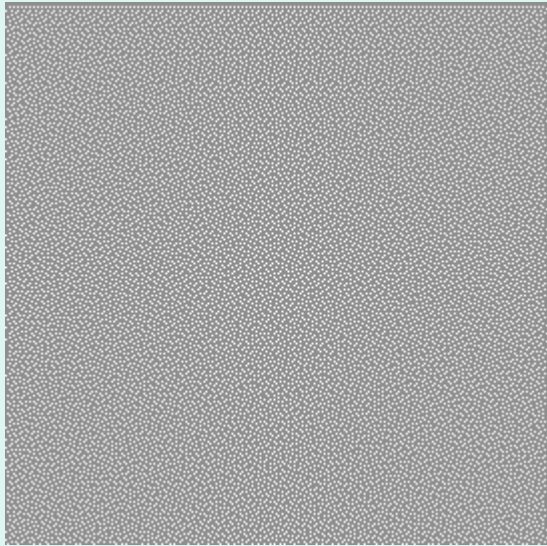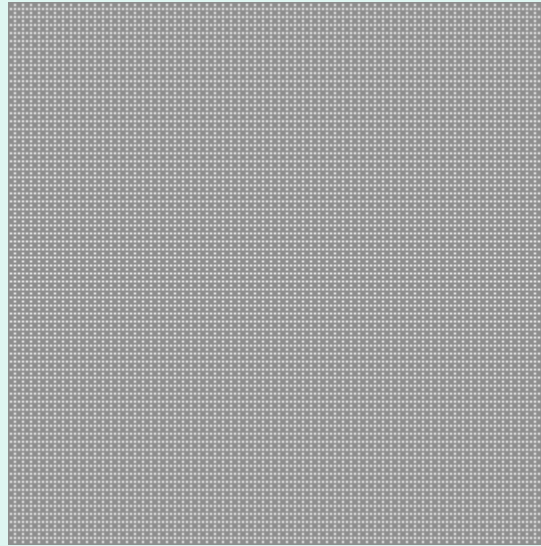
Dithering
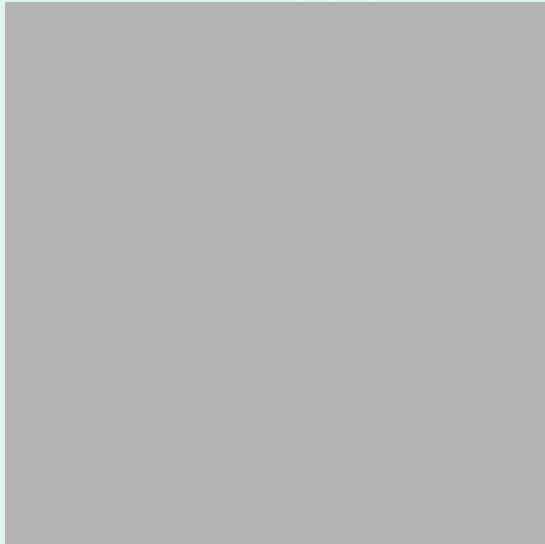
Plain Gray Image

Image which appears this shade gray because of dithering. It actually contains white and gray pixels
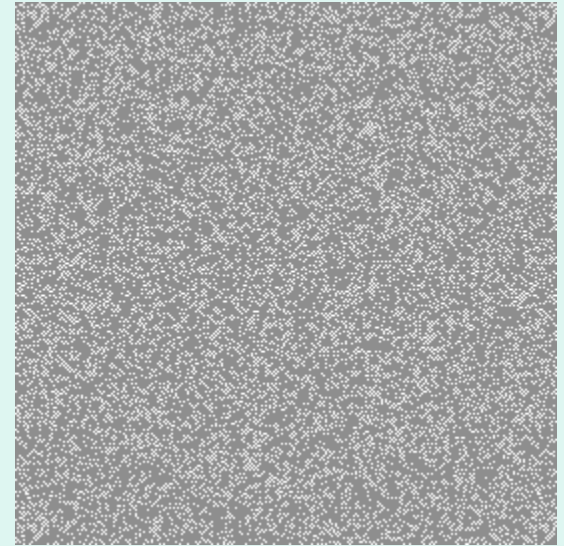
Not All Dithering is the Same

| Diffusion | Pattern | Noise |

- This shows an example of three different ways to dither the image.

- Some types of dithering may work better than others depending on the image in question.

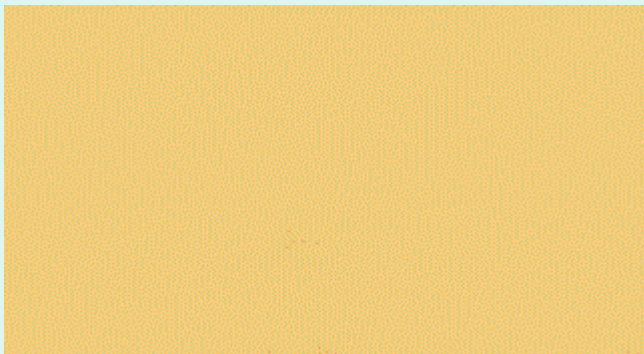- Some programs allow you to select the type of dithering (Photoshop, e.g.)
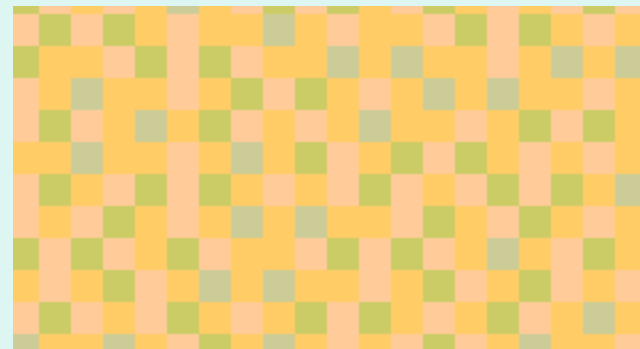
Dithering with Color

Color I want to produce

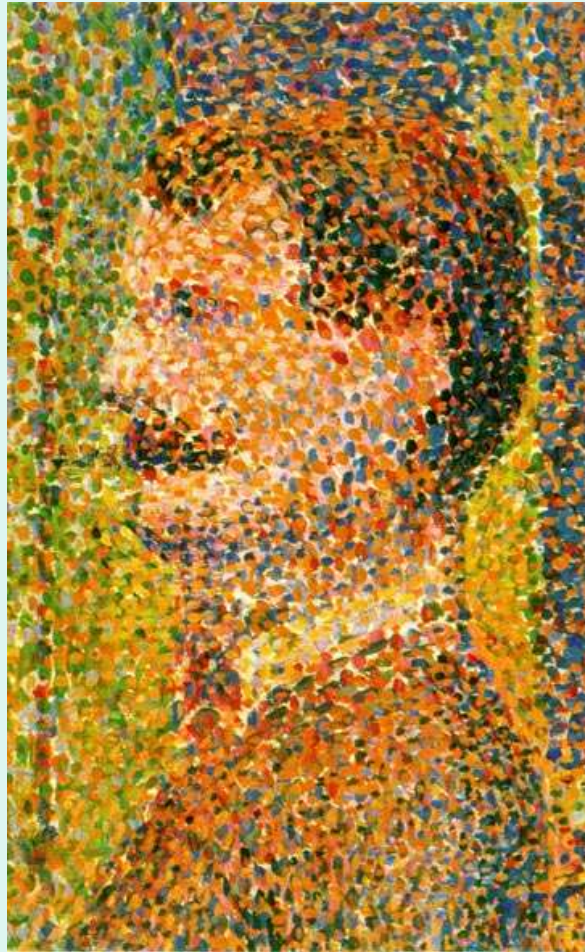Dithering with only 2 colors, orange and white

Dithering with all web-safe colors enabled

Zoomed View of dithering

Detail from Seurat's *La Parade*

Seurat's *Sunday Afternoon on the Island of La Grande Jatte*

Compression

- *Compression* is used to make files smaller
- Bitmap images, especially, can be quite large if stored without compression
  - Ex. A 640 x 480 pixel image with 24-bit color depth would take:
    - 640 * 480*24 bits = 7372800 bits = 900kB
- Windows bmp format is uncompressed
  - Should NEVER be used online

Lossy vs. Lossless Compression

- There are two main types of compression:
  - *Lossy* and
  - *Lossless*
- When an image is compressed and later uncompressed with a *lossless algorithm*, the image is exactly the same
  - Most common type
  - No information is lost
- *Lossy algorithms* produce images which may be slightly different before compression and after uncompressing
  - Some information may be lost
  - Can produce sometimes produce much smaller files than a lossless algorithm
  - Can be used when the difference isn't very noticeable
  - Often takes into account human anatomy
    - We can't tell the difference between certain values of color

JPEG

- The JPEG format was designed for photographs at high quality and in full color

- Lossy compression format

- Normally changes can't be seen except at the lowest quality settings

- Bad idea to store simple black and white files as JPEGs

- Good for 8-bit grayscale

GIF and PNG

- GIF uses LZW compression algorithm developed by Unisys
  - It's patented (or was patented)
- PNG was created as an alternative to GIF
  - FREE!!!!
- Both are used for the web frequently because they support transparency
- For this course, you should try and use PNG instead of GIF
 - Considered better algorithm
  - No patent issues

Transparency

- Allows part of the image to be transparent
  - The background will show through
- Often used with graphics on web pages
  - The image is still a rectangle
  - Parts of the background show through so it doesn't look like a rectangle
- Not all image formats support transparency

Simple Transparency

- GIF supports simple transparency
- Some pixels are marked as transparent
  - The background will show through
- Images can appear any shape
- It's "all or nothing" transparency
  - Either the pixel is completely transparent or its not

Example of GIF Transparency
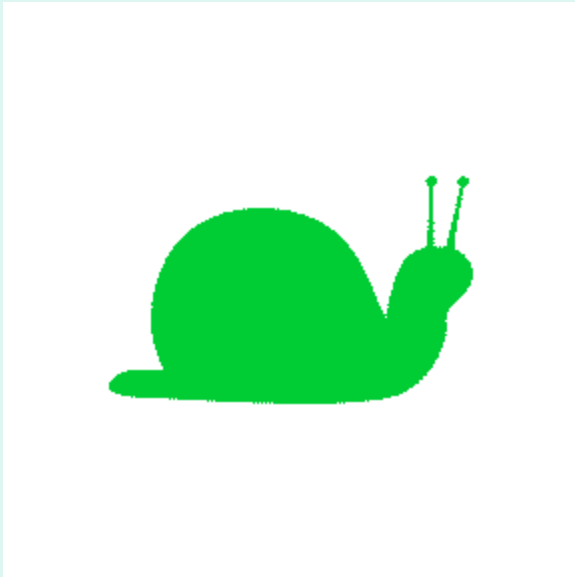
- GIF with a white background.
- Unsightly for web pages

- GIF with a transparent background.
- Image is the same size as image on left
- But, background shows through

Alpha Channel

- *Alpha channel* is a more general method of transparency
- Images now have two parts:
  - The image
  - A mask, called the alpha channel
- The alpha channel indicates how transparent each pixel is
- If supported by the program and format, you can specify partial transparency of images
- GIMP and Photoshop support full transparency
- So does the PNG format
- If it's not supported, the advanced transparency information is ignored

Why Use Transparency?

- You could simply color the background of your image to the same color as the background of your webpage

- What happens, though, if you decide to change the background color on your site?
  - Have to change every single image!

- Better to use transparency for images with shapes (like the snail)
  - Not necessary for square images like a photograph

Common File Formats for the Web

- The three most common file formats on the web are:
  - JPEG (.jpg)
  - GIF (.gif)
  - PNG (.png)
- Most programs have their own file format called a *native format*
  - These formats are unique to the program
  - Good because you can save without losing any information
    - They use no compression or lossless compression
  - Can't use these online because browsers can't display them and people can't necessarily open them

JPEG

- JPEG : Joint Photographic Experts Group
- .jpg is the file extension (normally)
- Bitmap format
- Lossless compression
- 24-bit color or 8-bit gray-scale
  - Like you'd get from a digital camera or scanner

GIF

- GIF : Graphics Interchange Format
- .gif file extension
- Bitmap format
- Lossless compression
- Used a lot on the web
- Good for simple animations and simple transparency
- Limited to 8-bit color (256 colors)
- Compression algorithm is patented

PNG

- PNG : Portable Network Graphic
- Bitmap format
- Lossless compression
- Replacement for GIF (no patent!)
- Better compression algorithm than GIF
- Supports 24-bit color and full transparency

Other Common File Formats

- You can read about the other common file formats in section 3.6 of your course pack
- The ones listed are: BMP, TIFF, EPS, and SVG
- BMP and TIFF are bitmapped graphics
- EPS and SVG are vector graphics

Be Sure to Know

- The differences between vector and bitmapped graphics
  - Their properties
  - How they work (shapes vs. pixels)
- You should be very familiar with the information about JPEG, GIF, and PNG.
- Also know BMP, and at least one vector graphics file format

Questions?
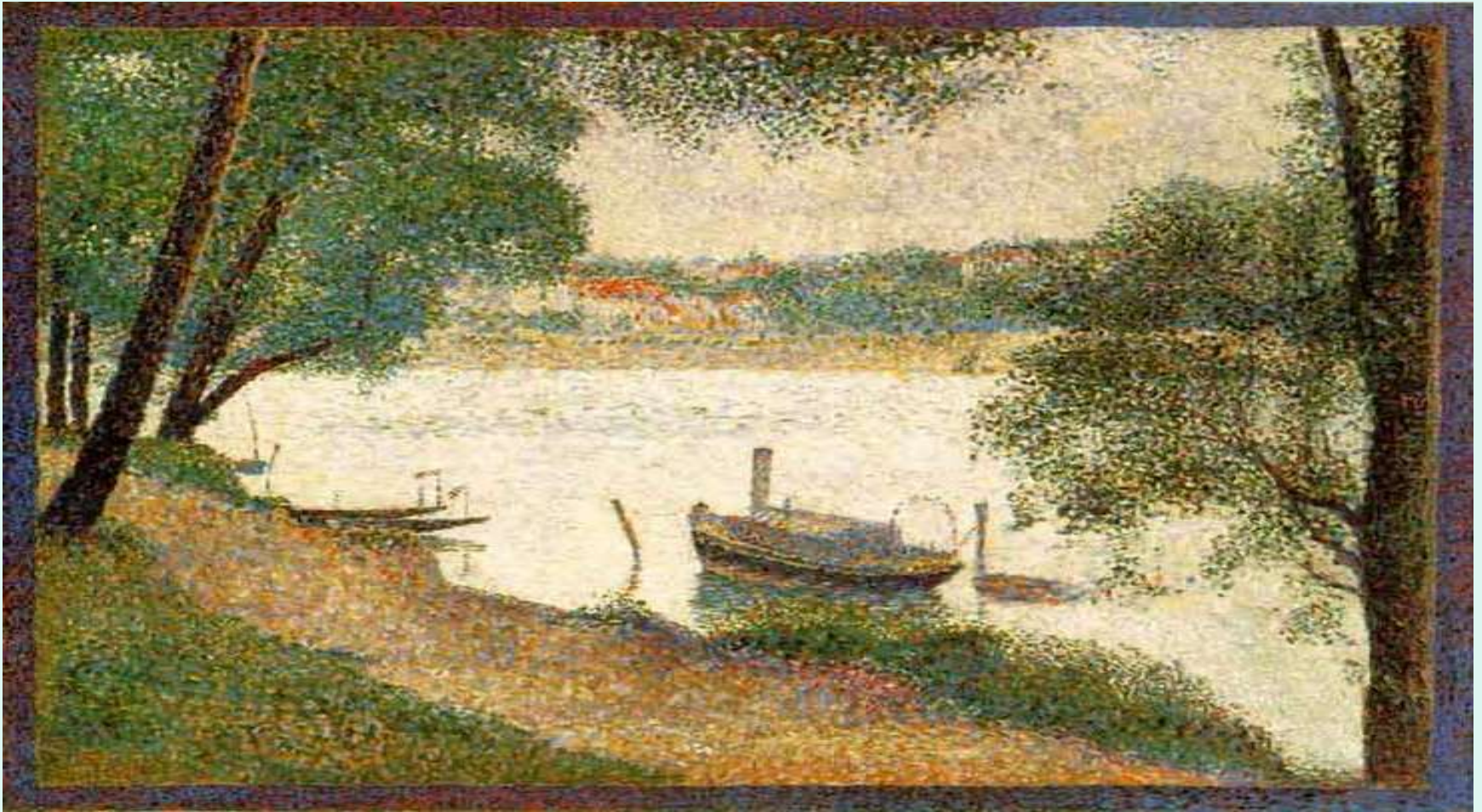
Seurat's *Grey weather, Grande Jatte*