# ASSIGNMENT 1

RASTER IMAGES

Raster filetypes, or pixel-based images, are one of the two most common digital file categories. Pixel is a shortened form of the terms "picture element." These are the tiny single-color squares that make up your digital photographs. Images with greater amounts of detail, or higher resolution, contain more pixels. An 8 megapixel camera has about 8 million pixels, or individual light sensors.

In 1973 researchers Leon Harmon and Bela Julesz produced a famous optical illusion. They demonstrated that Abraham Lincoln's face, when coarsely pixelated, was still recognizable when blurred or reduced in size, as if seen from a distance. This finding was published in *Scientific American*, inspiring a work of art by Salvador Dalí. Below is the Harmon/Julesz effect illustrated using a desaturated self-portrait by Van Gogh.
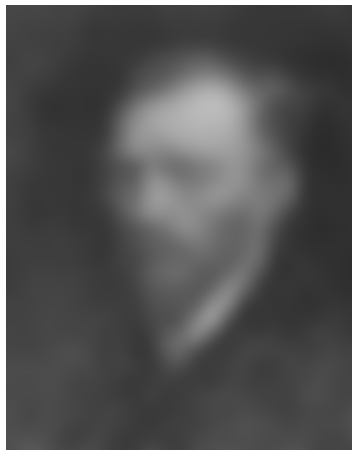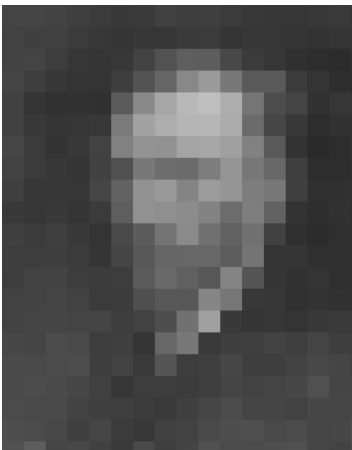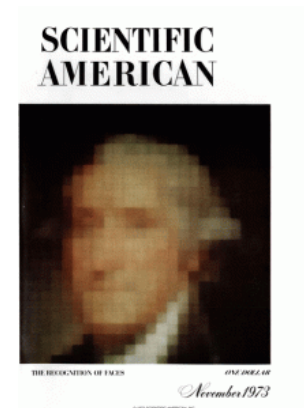
This journal cover portrays George Washington using only 624 pixels, an image previewing the article "The Recognition of Faces" in *Scientific American.* Harmon and Julesz also published "Masking in visual recognition: effects of two-dimensional filtered noise" in the journal Science (also published in 1973).

The following example uses our pixelated Van Gogh, downsampled from 1200x1522 pixels to a 16x20 pixel image, which means the Van Gogh image has been reduced from 1,826,400 (1200 times 1522) picture elements, or about 1.8 megapixels, to 320 (16 times 20).

A single row of pixels from under Van Gogh's eyes has been isolated below.
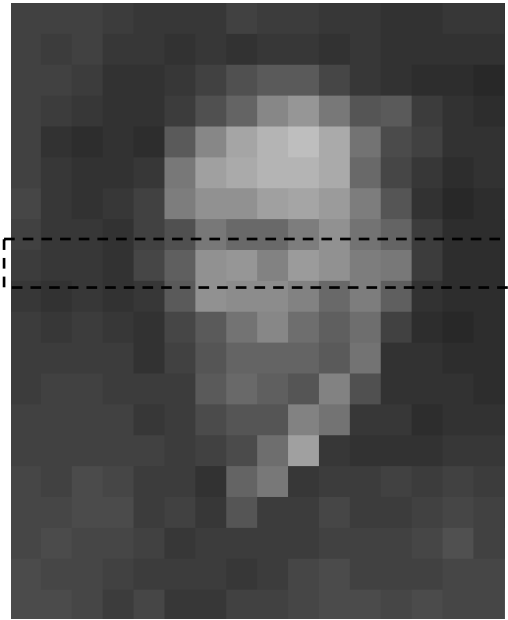
When a digital camera captures information, brightness is conventionally stored as a number between 0 and 255. 0 represents black, and 255 represents white, because color is additive – more light means more bright. A color image would use the same process but with three color channels, one for each primary color of light – Red, Green, and Blue. Assignment 2 will discuss color in more detail.
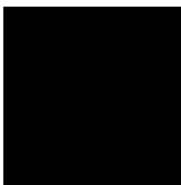
0	127.5	255

Below I have estimated the values of our row of Van Gogh pixels:

| 30	21	20	21	43	65	133	151	118	149	136	112	105	36	12	12

JPEGS

JPEG is a "lossy" form of compression for raster (pixel-based) documents. When your phone or computer saves a photograph with a .jpg or .jpeg extension, it isn't saving all of the information that was initially gathered by the digital sensor. Instead, it runs an algorithm that simplifies the information contained in the image, resulting in a smaller file and reduced image quality.

When a JPEG is created, these values are stored in a simplified form through a mathematical process. First, an average brightness is evaluated for a group of pixels, like our isolated row. In this case, the average value is 72.75.
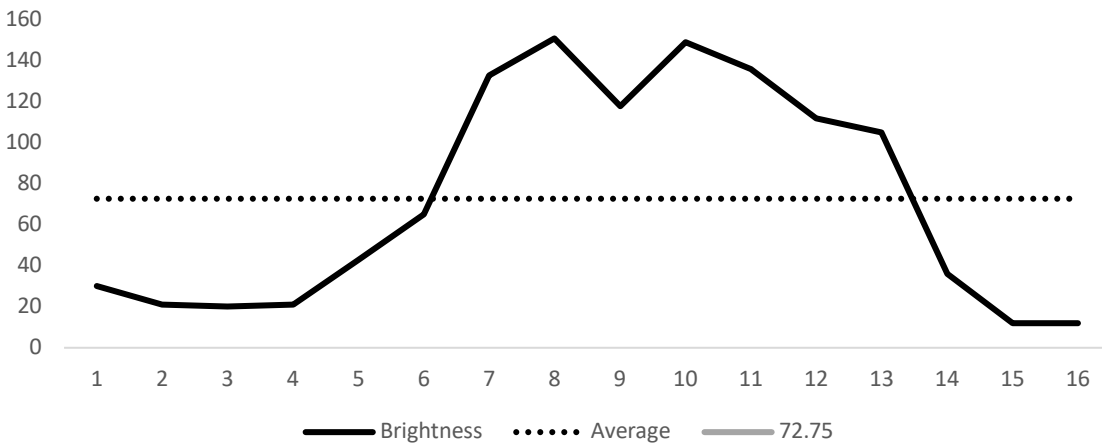

Now the goal is to make replicate this curve using only our average (72.75), sine, and cosine functions. A basic cosine function, or *y=cos(x),* looks like this:
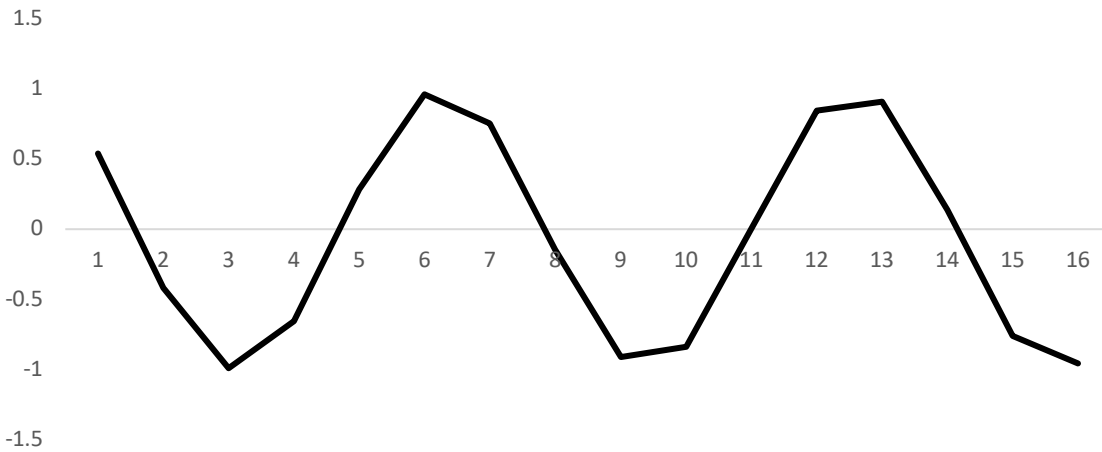
This doesn't resemble our curve yet, so the cosine formula will have to be updated to more closely match the chart created with our unique image values. These changes to the cosine function, to get closer to our original chart, are referred to as a "discrete cosine transformation." Below is an updated formula, $y=cos(x)+72.75$. This brings our y values closer to being accurate, but doesn't address the difference in shape between the two graphs.
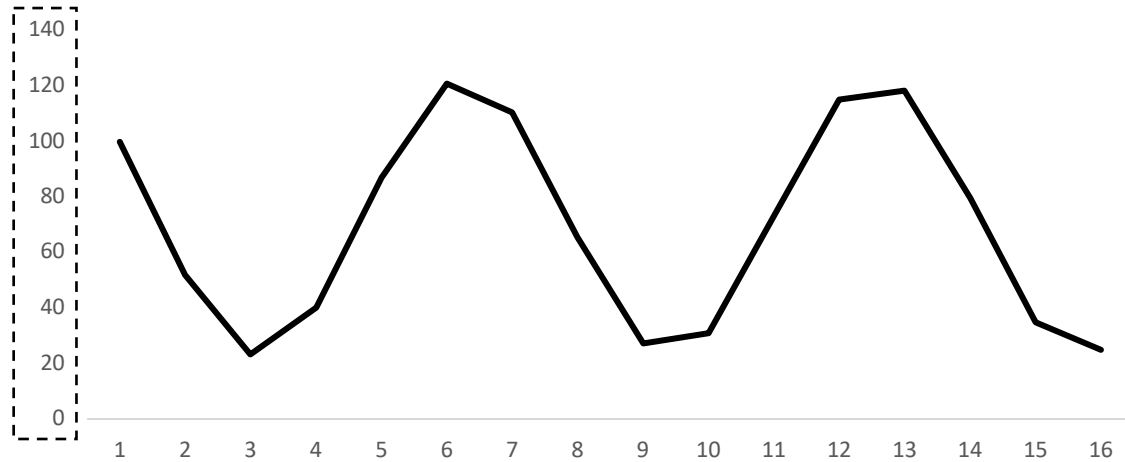
Additional adjustments can be made to the formula until the slope and frequency of the chart closely matches the source material. Here is the formula $y=50cos(x/2)+72.75$.
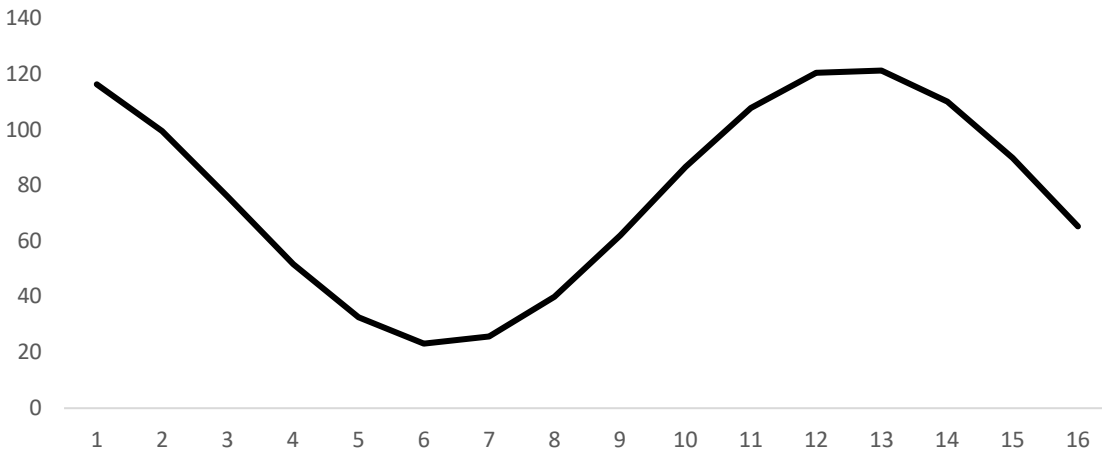
This is closer to our target graph (based on nuanced pixels), but still not matching well. JPEG formulas get very complicated. Once the right changes have been implemented, however, the formula will be more efficient than storing all of the original pixel brightness values.
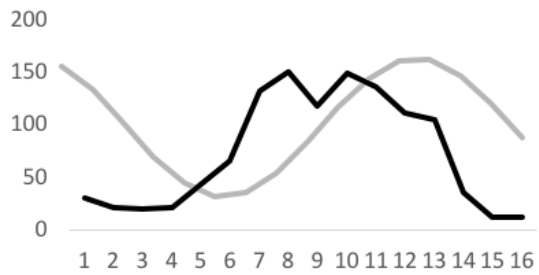
The downside of this process is that information is lost in the process. Our algorithm has a lot of room for improvement, but no matter how accurate it is, it's still only an approximation. Once an acceptable approximation is found using a formula, the original values are replaced. JPEG files are considered **destructive** because each time you save using this filetype you reduce the quality of your image. This degradation results in visible flaws referred to as "JPEG artifacting."

RELATED THINGS

Needs More JPEG

Chuck Close

Chuck Close's work was first shown at the New York Museum of Modern Art in 1973, the same year that Harmon and Julesz released their pixel studies. His illustrations are made from gridded photographs.