Pixilation and Resolution

name:_______________

What happens when you take a small image on a computer and make it much bigger? Does the enlarged image look just like the small image? What has changed? Take a look at the example below:

How are the two pictures different? Similar?

Ans: small looks sharp while large looks grainy. Both have same image distribution, but larger one is scaled up.

What you are experiencing is a phenomenon called "pixilation." But what is a "pixel?" And why does pixilation occur?

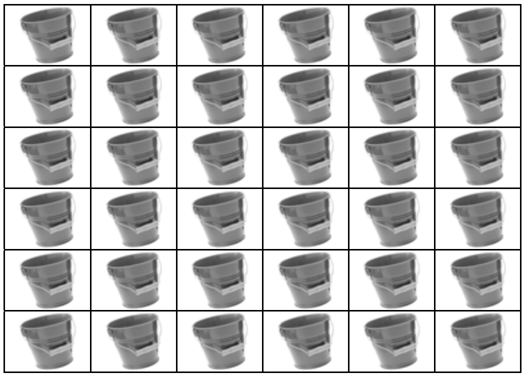
Let's first discuss what a pixel is. From your past experiences with pixels, jot down in the space below what a pixel is. Think about where you have seen pixels and where you have heard the term used. A class discussion will follow.

Ans: unit cell that stores information about how much light intensity hits it. Pixels are arranged in a matrix (grid) to build up a full image. The smallest element of a digital picture.

A pixel is actually short for ***pic**ture* ***el**ement*, where “pix” is commonly used as an abbreviation for picture. A pixel is essentially the tiny dot that makes up a digital image. A large group of pixels, usually arranged in table of rows and columns, is used to capture or display an image. What are some examples of this?

Ans: digital camera captures image onto high density matrix of pixels. Screen on camera displays captured image by lighting up pixel matrix.

Let’s first talk about how a group of pixels can capture an image. As seen below, consider a pixel grid of 6x6 pixels. As an analogy, think of each pixel as being a bucket that holds water where the water is like light.



6x6 pixel grid or “bucket grid”

What happens when you put water into a bucket? Unless the water is frozen, the water takes the form of the bucket and will spread out evenly in the bucket. The bucket knows nothing of the shape of the water if it was previously frozen. So imagine placing a frozen sheet of ice over the buckets. This sheet of ice happens to be thick in some places and thin in other places. When the ice melts, each bucket will capture an amount of water proportionate to the amount of ice directly above it.

Do you see how this translates into pixels? The bucket is the pixel, the ice is the image, and the buckets filled with water are the captured image in the pixels. So when a pixel is used to capture an image, the pixel doesn’t care about the “shape’ of the light that it captures, but only how much light it receives.

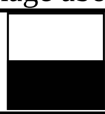
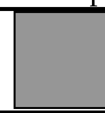
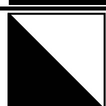
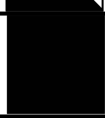
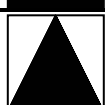
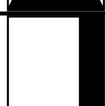
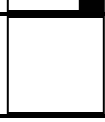
In this exercise we will only consider black-and-white images for simplicity. When the pixel or bucket is full of water (full of light), it can be represented by the color white. When the bucket receives no water (gets no light) it can be represented by the color black. But what happens if the bucket is half full of water (pixel is half full of light)? 1/4 full? 3/4 full? 1/16 full? Discuss your answer below:

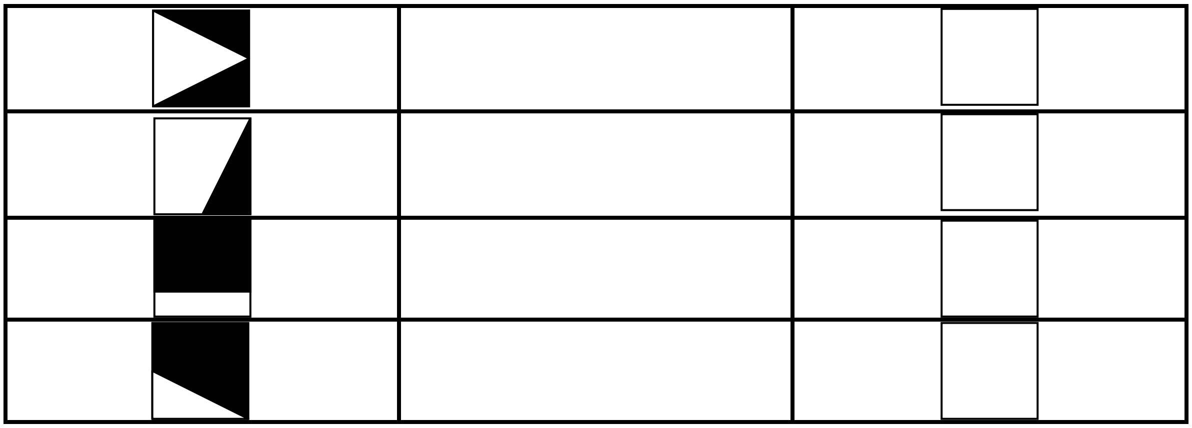
Ans: use grayscale representation. Middle gray for 1/2 and so on.

You may have guessed it, but what is between black and white? Gray. We can use shades of gray for these mid-tones. Depending on how expensive the pixel grid that you use is, and how good the electronics are for it, the levels of gray can be broken up into a few or a lot of shades. Typically, the human eye is sensitive to 256 shades of gray. However, we are only going to consider the 5 shades in the legend below.

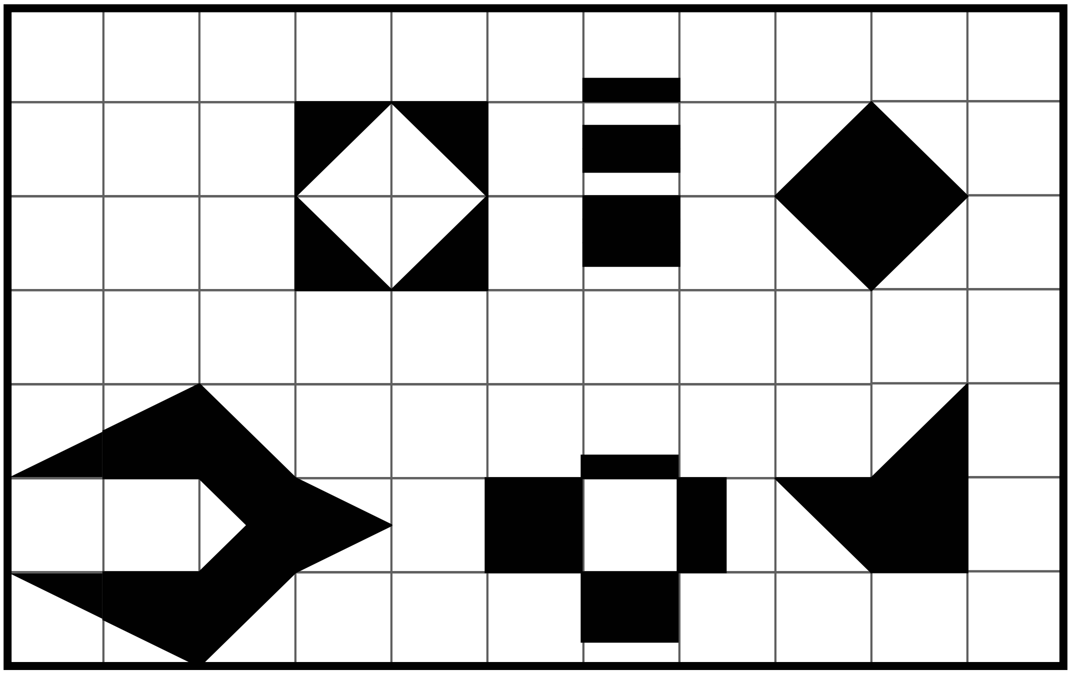
% Gray	100%	75%	50%	25%	0%
Shade Gray					

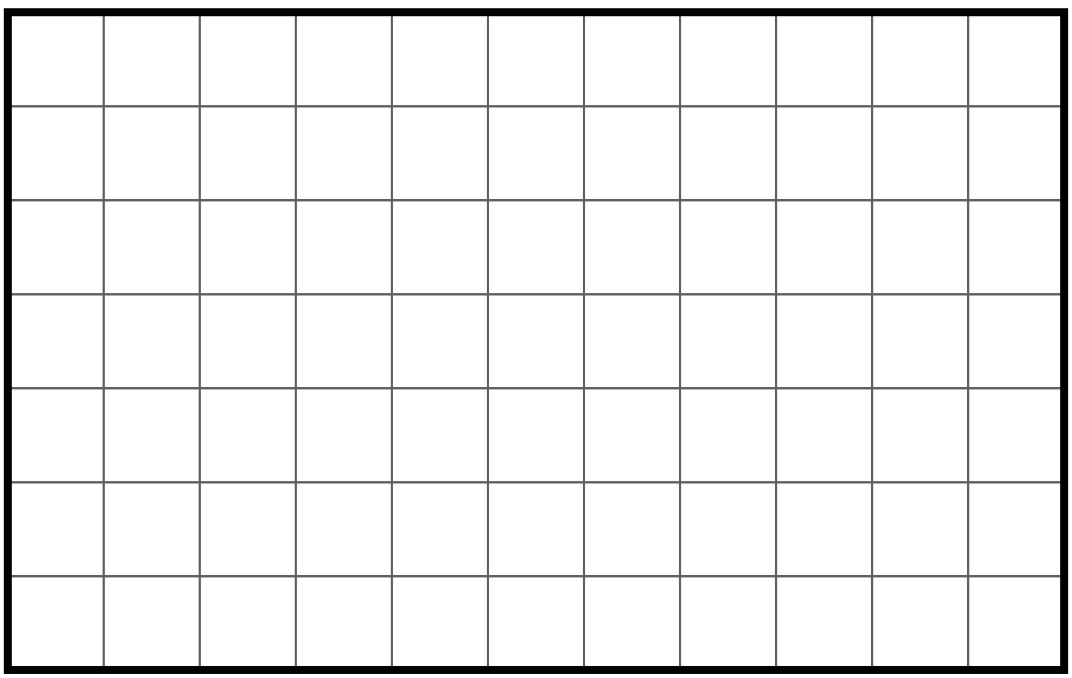
Remember that white means 100% full, and black means 0% full. The shades of gray are somewhere in between. Now let's practice a bit. In the 1st column of the table is a single pixel with an "ice" image over it. In the second fill in how full the pixel will be when it captures the image. In the last column shade in the pixel to show how full it is. Don't forget to use the grayscale legend above. The first one is done for you. The smallest fraction we will deal with here is ¼.

Pixel with "ice" (light) image above	% full the pixel will be when the ice melts	Shaded gray pixel with "water" captured
	½ or 50%	
		
		
		
		
		

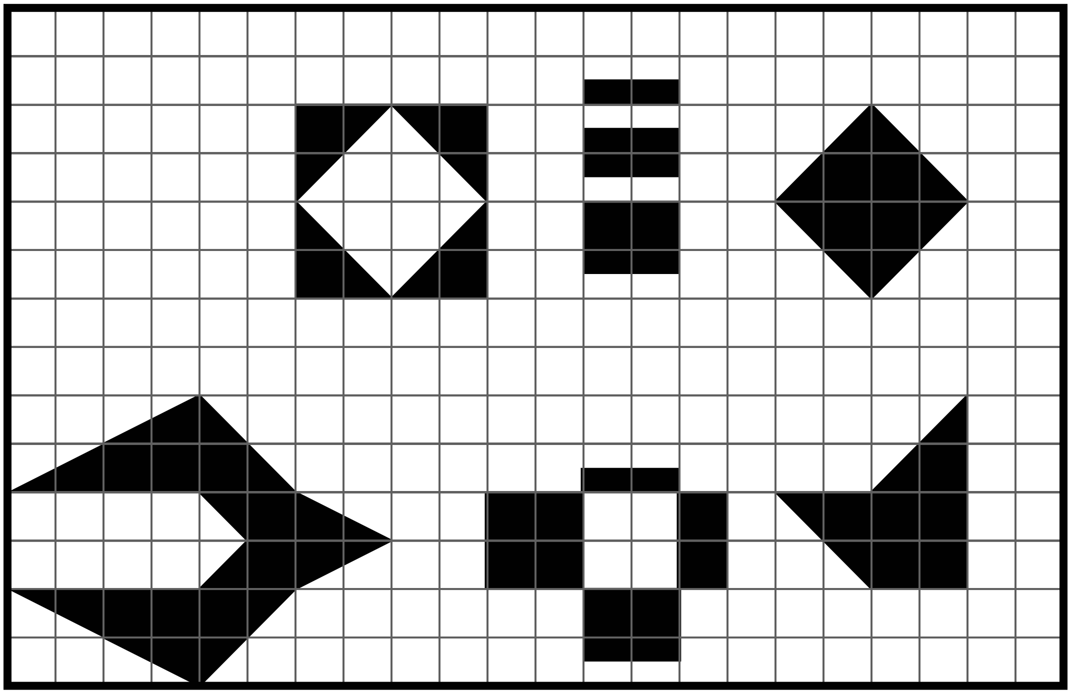


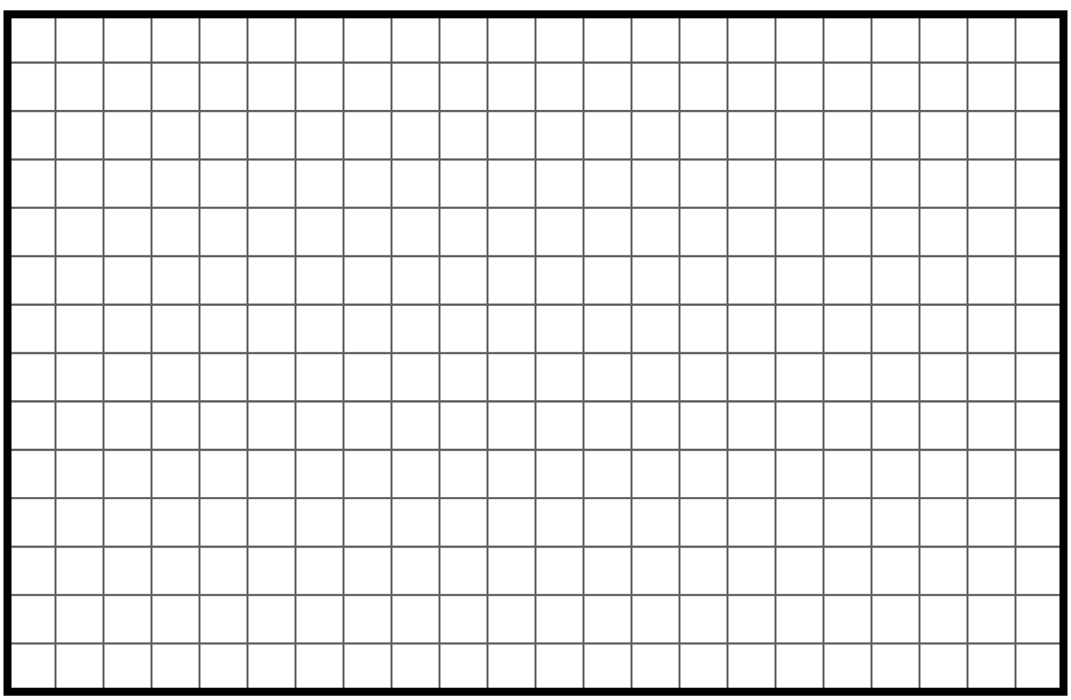
Now, using the same techniques, let’s do the same thing on an image. Remember that each cell in the grid is a pixel. The grid on the top has an image superimposed on top of it. On the bottom, you need to shade in the grayscale that the pixel will have when it has captured the image.





Do the same thing, but now let’s make the pixels half the size. How does the captured image change compared to the previous?





What would happen if you made the pixels ½ as big again? And again? And again?

Ans: better representation of the shape of the actual image

How does the number of shades of gray affect the outcome of the captured image?

Ans: more shades of gray will have better "blending" and will improve capture image significantly. Having few shades of gray is essentially pixilation in color vs spatial distribution.

Comment on how pixilation affects a curved shape? Use sketches if necessary.

Ans: curves will look like a "staircase"

How is this similar to the task where we were trying to figure out what was on the bottom of the lake? How is it different? What role does pixilation play in this task? How could the pixilation be fixed?

Ans: each sample of the lake floor is a pixel. The height information from the measurement is the shade of gray. Pixilation is dependent on how many samples are taken, the density of measurements. Could be improved by taking more samples, and making the sampling probe smaller (smaller pixel).