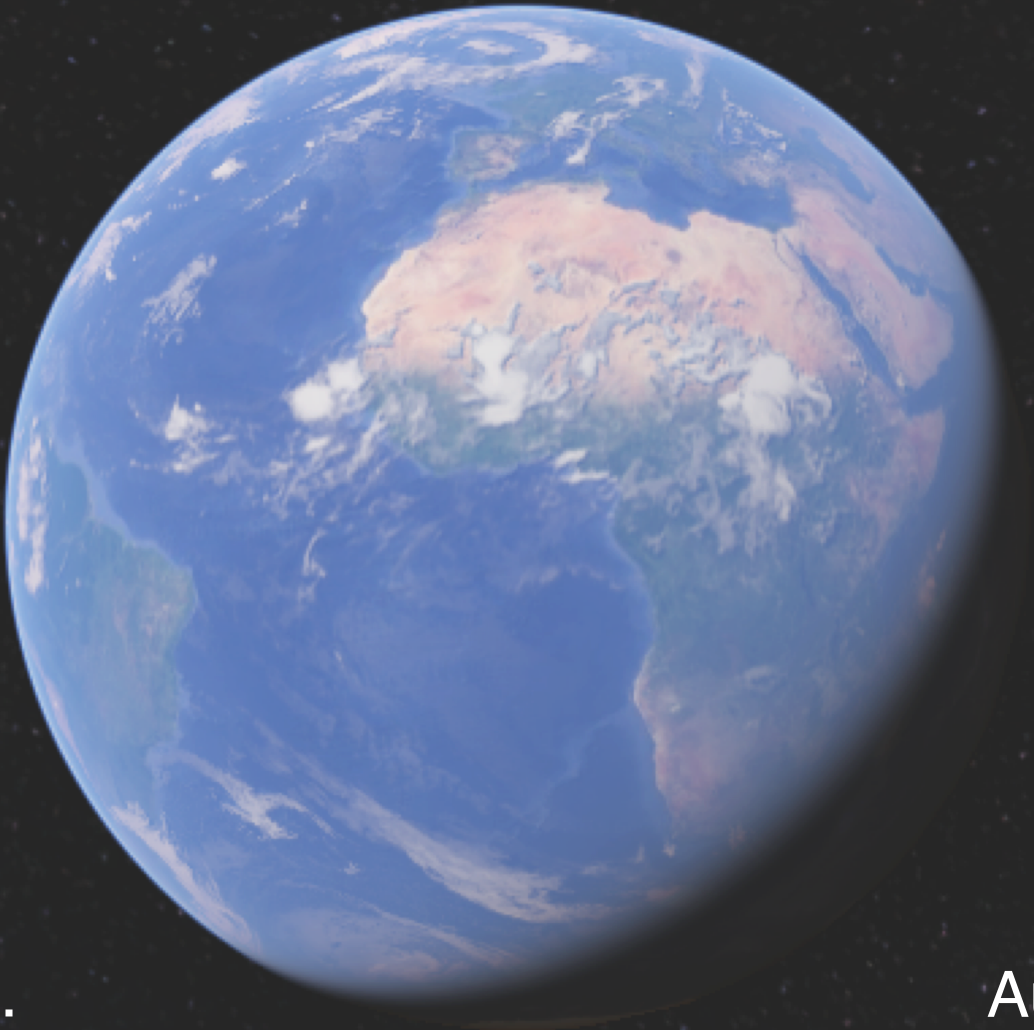
Activity 4 – Measuring Area from Images



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AP 186

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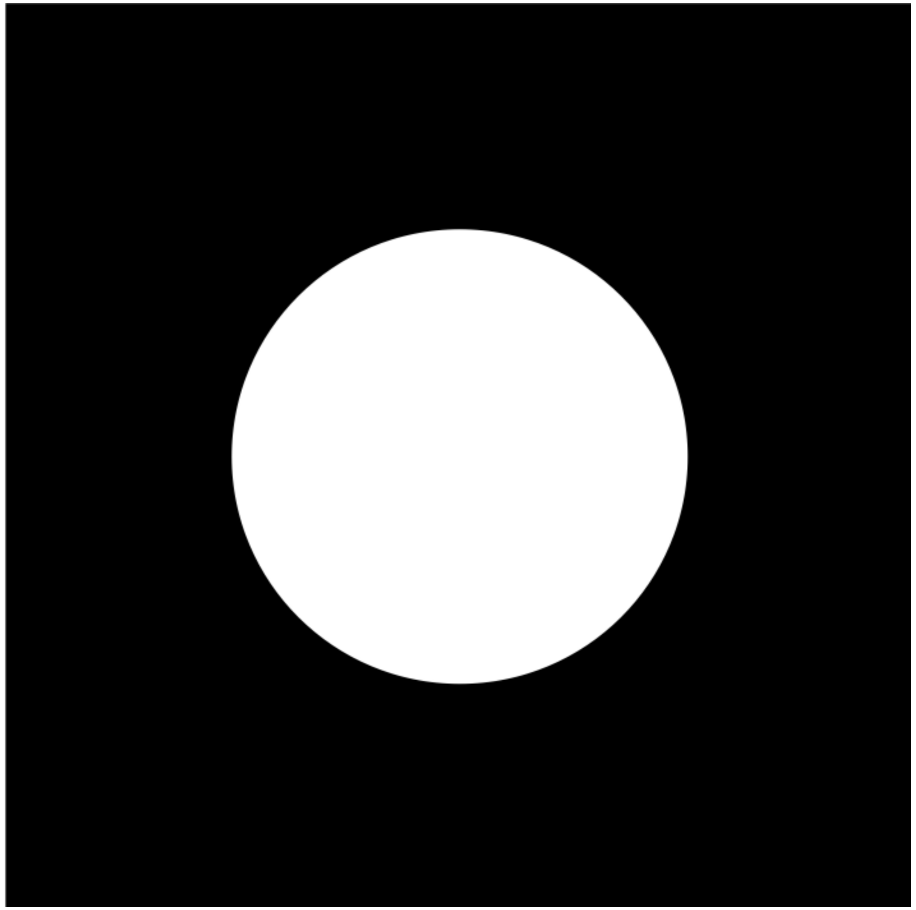
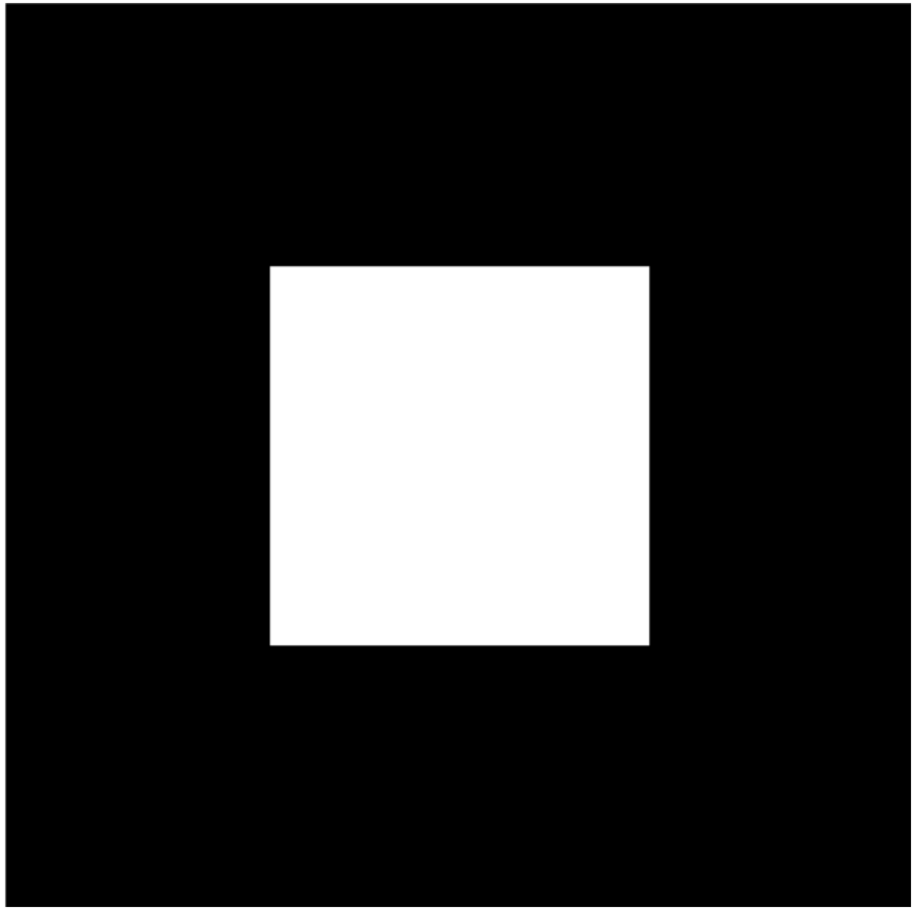
Regular Geometric Shapes used:


Circle

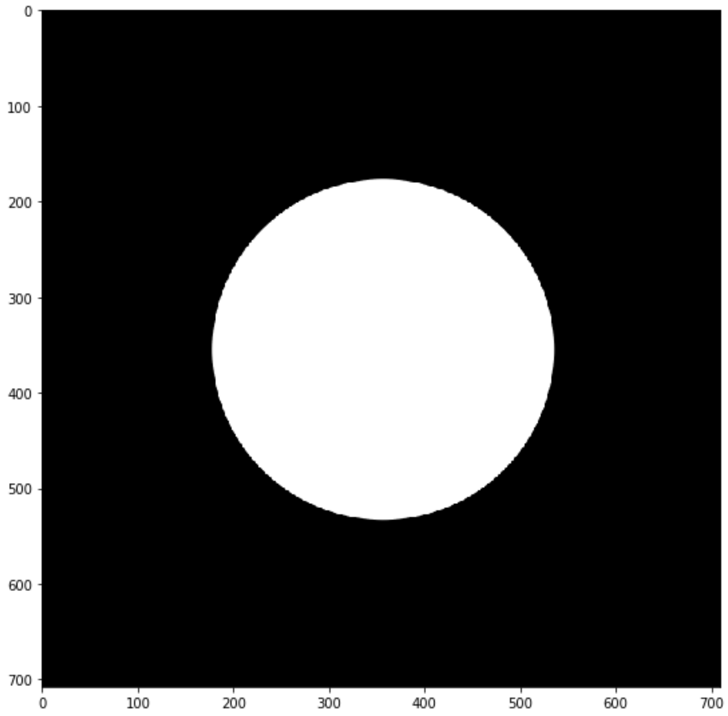

Square

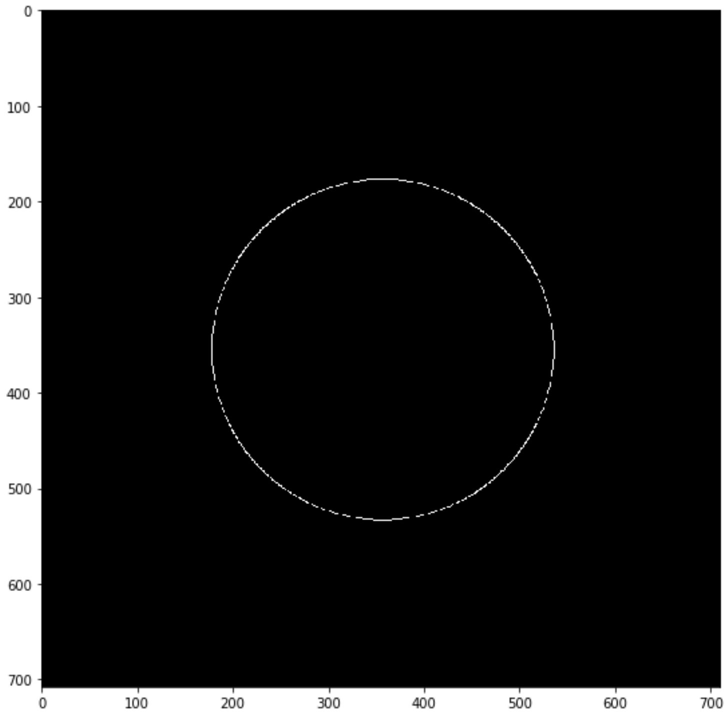
How to measure the area? A step-by-step guide

1. Find the edge of the region
2. Sort the `x` and `y` values in increasing θ
3. Use the `x` and `y` values to obtain the area using Green's Theorem:

$$A = \frac{1}{2}\sum_{i=1}^{N_b}[x_i y_{i+1} - y_i x_{i+1}]$$

1. Find the edge of the region





Using the `cv2` package from Python, the Canny algorithm was used to find the edge of the circle.

We can also find the center and radius of the circle using the `x` and `y` values. In this specific example, the radius is equal to `179 pixels`, which means that the theoretical area is equal to `100659.77 pixel`^{2}.

2. Sort the `x` and `y` values in increasing θ

Since we know the x and y values of the edge, we can solve for the r and θ values. Here is a summary of the values:

	X	Y	r	theta
15	-177	-1	177.002825	-3.135943
14	-177	-2	177.011299	-3.130294
13	-177	-3	177.025422	-3.124645
12	-177	-4	177.045192	-3.118998
11	-177	-5	177.070607	-3.113352

After sorting the values, we can now solve the area under the curve (or in this case, within the edge) using Green's Theorem.

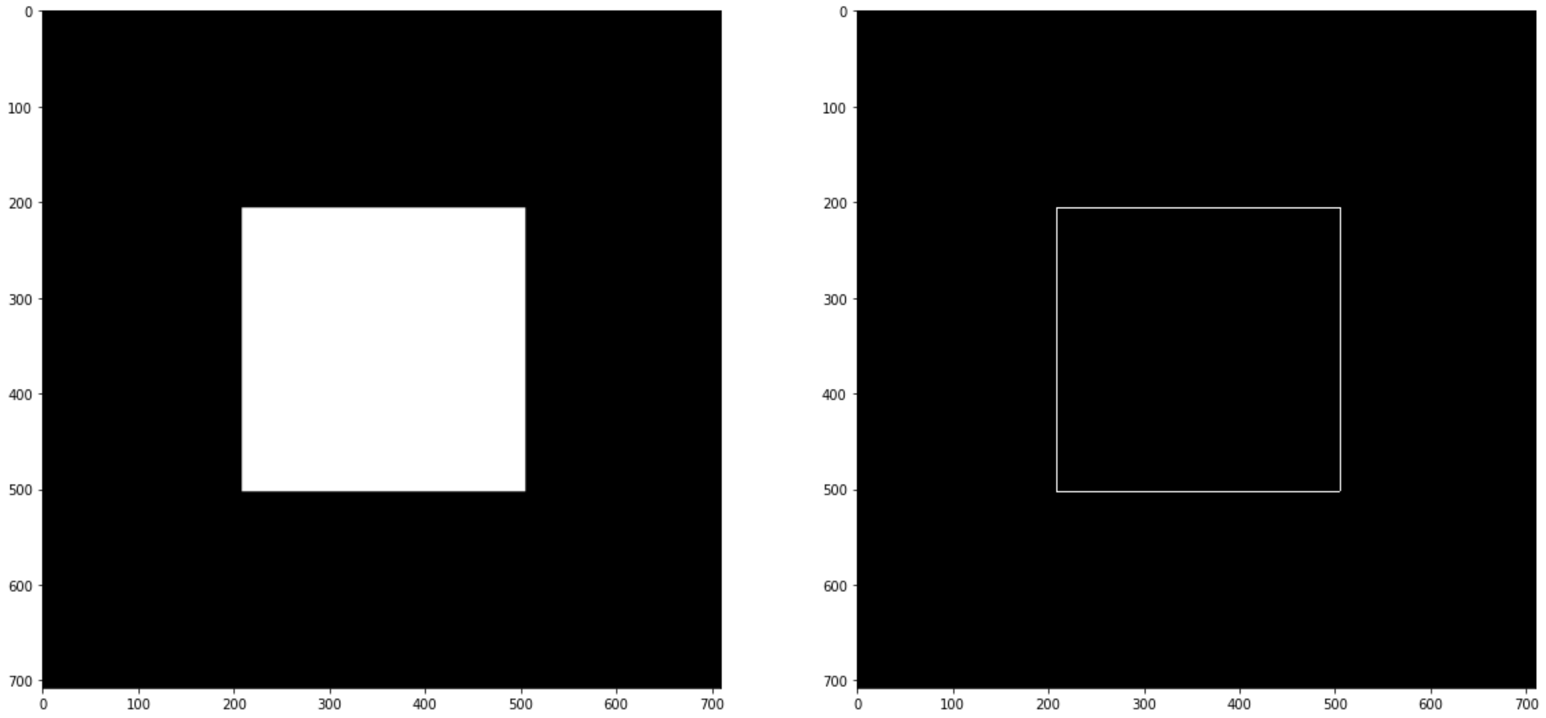
3. Use the `x` and `y` to obtain the area

Now we apply the Green's theorem. The clip of code below shows how I implemented Green's theorem.

```
def Area(x, y):
    area = 0
    for i in range(len(x) - 1):
        area += x[i]*y[i+1] - x[i+1]*y[i]
    return np.abs(area/2)
```

The area measured using Green's theorem is equal to `99736.5 pixel`^{2}. Comparing this to the theoretical value, it has a percent deviation of just `0.917%`.

Second Example: Square

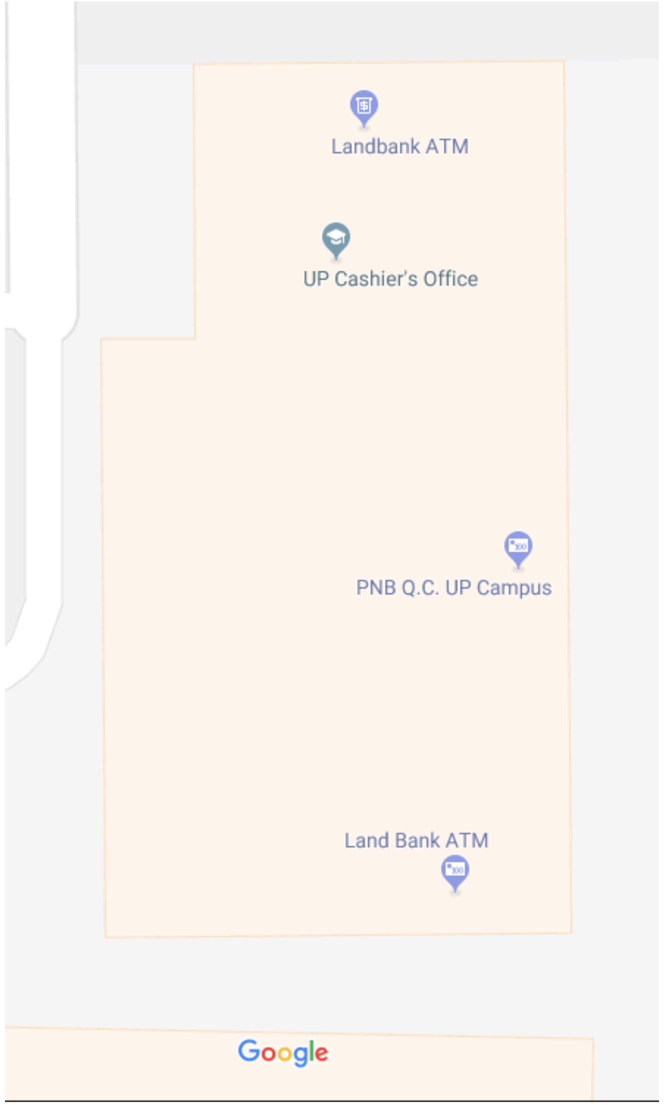


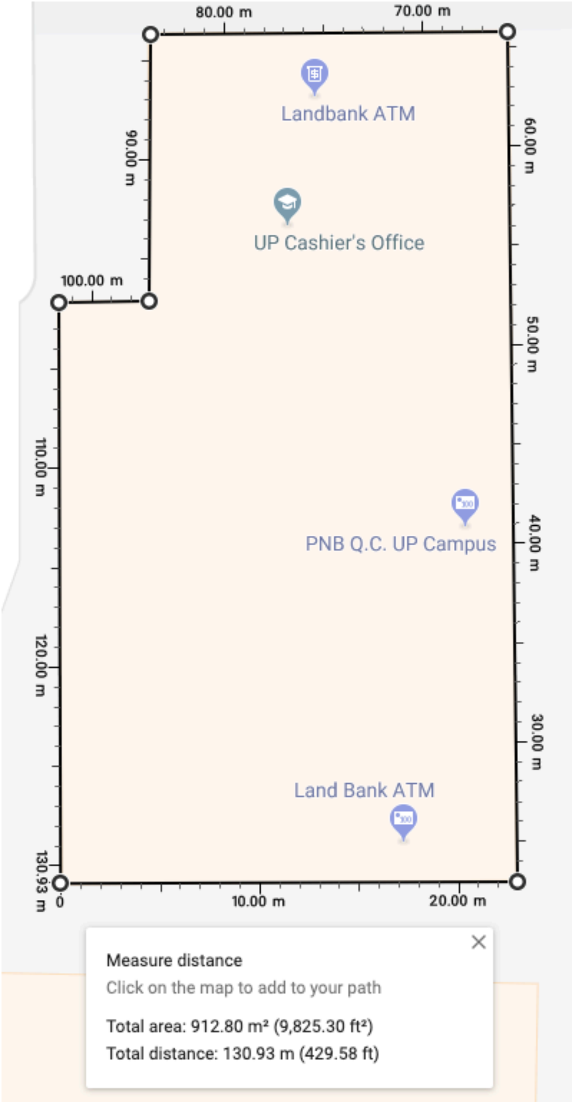
Theoretical area
- 88804 pixel^2

Green’s theorem:
- 88133 pixel^2

Percent error:
- 0.756%

Applying Green's Theorem to Maps…



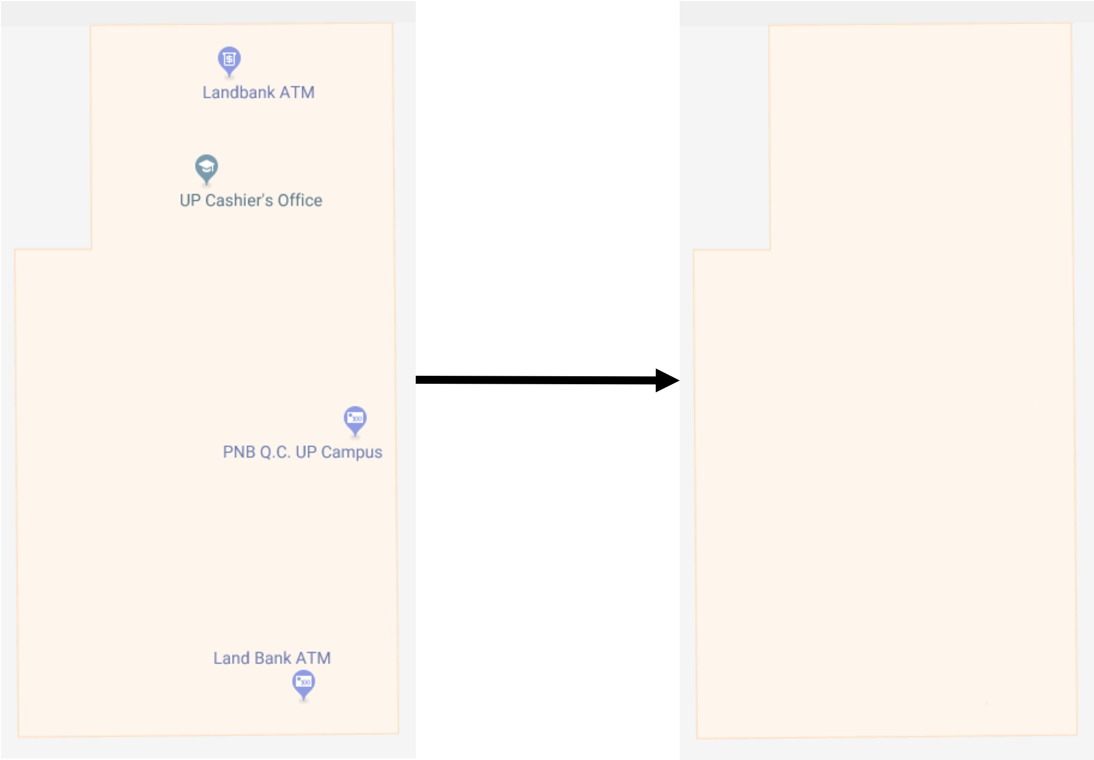


I used the building of UP Cashier's Office since it looks simple enough to apply the concepts that I enjoyed learning by doing this activity. To find the theoretical area, I used the built in measuring tool of google maps.

I also used the photo with the scales to make a calibration curve in order to convert the x and y pixel values of the edge of the building to meters.

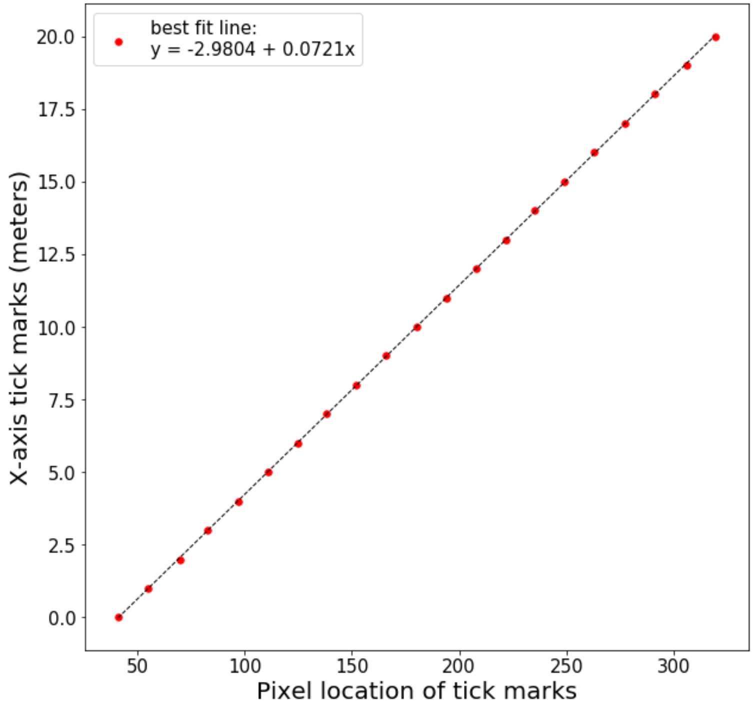
Applying Green’s Theorem to Maps…

I preprocessed the image to remove the labels of the building, in order for my program to correctly identify the edges of the building.



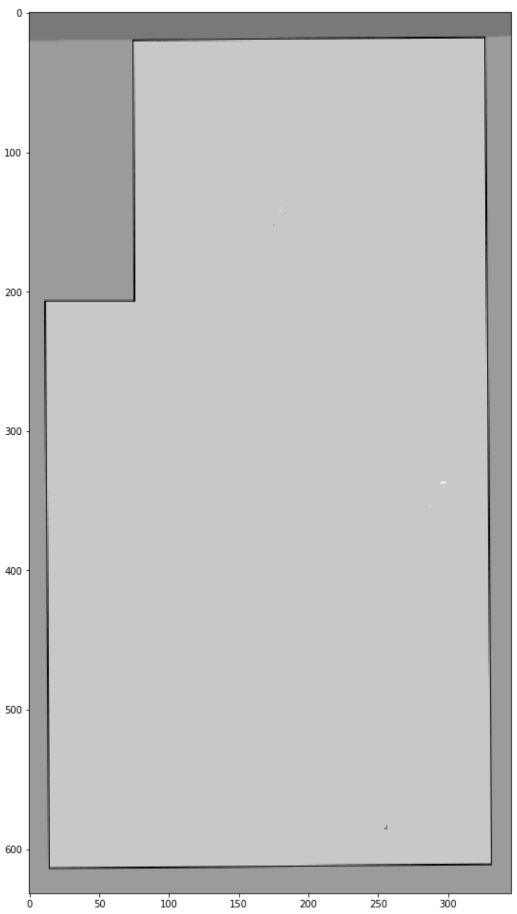
Continuation…

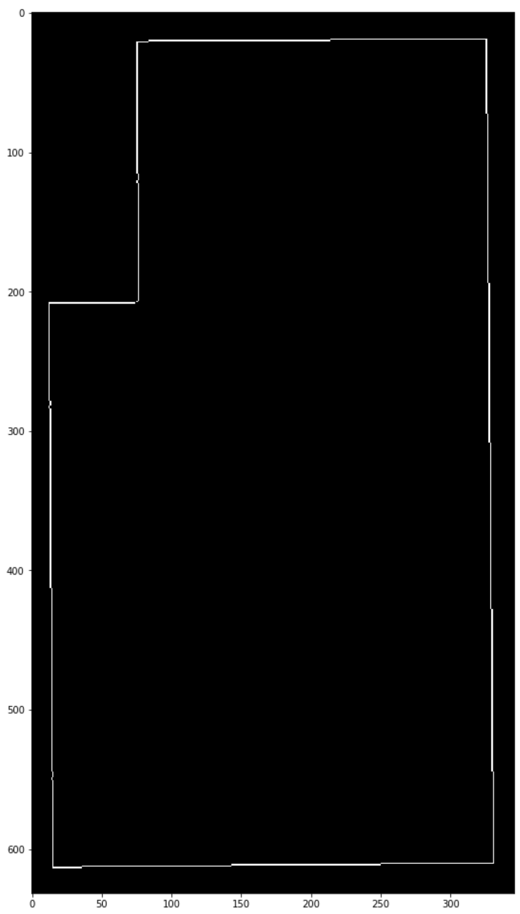
Now we solve for the x and y values of the edge of the building. Then, using the scaled picture, a calibration curve was created to covert the values in meters (X_m, Y_m). Then we apply the Green's theorem to these values Note that the scale of google maps is the same even if you change the orientation of the image.



	X	Y	r	theta	X_m	Y_m
198	-151	-1	151.003311	-3.134970	-13.8675	-3.0525
197	-151	-2	151.013244	-3.128348	-13.8675	-3.1246
196	-151	-3	151.029798	-3.121728	-13.8675	-3.1967
195	-151	-4	151.052971	-3.115109	-13.8675	-3.2688
194	-151	-5	151.082759	-3.108492	-13.8675	-3.3409

Finally…





Theoretical value:

- 912.80 m^2

Area using Green's Theorem:

- 903.73 m^2

Percent error:

- 0.99%

Conclusion:

We can see that we can use the Green’s Theorem to estimate the area of enclosed regions. These estimations are accurate proven by the small percent deviations from the theoretical values.

Self-evaluation

- Technical Correctness = 5 / 5
- Quality of Presentation = 5 / 5
- Initiative = 2
    - Helped my classmates in their coding problems
    - Made a program that can be easily understood
    - Used the previous learnings and applied it to this activity
    - Studied Green’s theorem in advance

- Link to Jupyter Notebook used: http://tiny.cc/Activity4AP186