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Final Project Report

The purpose of my project was to perform set operations on multiple (>2) convex polygons (Union, Intersection, Set Difference, Symmetric Difference). To be honest, at first, I believed that the project was going to be easier than it was, because on an abstract level it is not hard to understand. I decided to start my project by first getting the intersection of multiple polygons and then modifying my algorithm to be able to find the union, set difference, and symmetric difference.

I decided to write a brute force version of the intersection algorithm for convex polygons. To do this, I had four nested four loops. The first two would get two different polygons to be compared, and the second two would traverse all their respective polygons edges to check if they intersected. If, the polygons intersected I would add the points to a new polygon (which would be my intersection polygon), and then I would check the points from the first polygon to see if it was inside of the other polygon, and the points from the second polygon to check if they were inside of the first polygon by using a point in polygon function. Once I had all the necessary points, I needed to figure out a way to organize them so that I could get the right edges. I did this by basically getting the centroid of these points and comparing all the angles to that point and organizing them in a counterclockwise manner.

The next algorithm I decided to approach was the union algorithm. I quickly realized that my intersection algorithm was not going to work for this, so I had to find another approach. To make things easier for myself I decided to create two graphs (one for each polygon) and traverse both. I added edges from the intersection points to the corresponding point and removing edges and points that were inside of the other polygon. Once I had these, I would then basically join the two graphs into one, organize the points by performing a DFS and then I would use that union to union it with another polygon and so on.

After doing the union algorithm I decided to work on the set difference of polygons. I realized that my union algorithm was going to work for the set differences of polygons with some slight modifications. I would check the first polygon created and then subtract all other polygons by checking if there were any points inside of the first polygon, if they were, I would add these to the first polygon and modify the edges accordingly. Lastly, I did the symmetric difference algorithm which was basically getting the set differences of all the polygons instead of just getting the set difference of one (subtracting polygons from each other).

I encountered some problems with my union and symmetric differences algorithm. My union algorithm seems to get the correct union every time, but if I had two different pairs of intersecting polygons (for example polygon 1 intersecting polygon 2 and polygon 3 intersecting polygon 4) it would only get one of the union polygons. I tried my best to fix it and even though it works a lot better now, it still fails in cases where there are many different pairs of intersections. As for my symmetric difference algorithm, I was getting the edges and points of the symmetric differences, but when I try to add these to the pshape vertices in some cases it would draw the wrong pshape (especially when there is only two polygons). Both work on most cases but there are still some deficiencies and things that I wanted to improve but unfortunately, I ran out of time.

In conclusion, I think that overall my project was a success. I learned that even though things might seem easy at an abstract level, implementing them is not easy at all. My intersection algorithm and set difference algorithm seem to work all the time. Overall I am pleased with what I achieved because I dedicated a lot of time to this project, had to learn a lot of things that I previously did not now and even though all my algorithms don’t work 100% of the time, I am very happy with what I did. When I submitted my mid project report, I was nervous because I thought that I was not going to finish or that things were not going to work out so being able to write these algorithms was a big boost of confidence for myself.