

Project Report

Project

Implement intersection, union, and difference algorithms of convex polygons.

The project is implemented using Processing 4. The first step of the project is to implement the system of representing faces and edges in the processing system. This is done by implementing two classes, MyFace and MyEdge. For the MyEdge class, the object simply stores the two end points of the edge, each point is a PVector object. For MyFace class, the object stores an ArrayList of MyEdge, which stores all the edges of the face.

Problems

To compute intersection, union, and difference of two convex polygons, there are two crucial problems need to be solved. The first is the intersection between two edges of the two polygons, because the intersection of the edges becomes the new points that creates new edges for the resulting faces. The other is to check whether a point is inside a polygon, this is crucial in deciding whether a point or edge should be kept or removed when doing union and difference computation.

Intersection

To compute the intersection of two convex polygons, the first step is to calculate the intersection points of the two polygons. This can be achieved by iterating through each edge of each polygon and to check if the two edges intersect. To check whether if two edges intersect, we use the algorithm introduced in lecture 3. First, we check if the two lines are parallel by computing the angle between the two lines. If the two lines are parallel, we treat them as if they do not intersect, because for the purpose of this project, we can ignore the case when the two lines are coincided. If the two lines are not parallel, we then check if the intersection of the two lines are on these two edges by computing t_1 and t_2 , and check if t_1 and t_2 are both between 0 and 1. If so, the two edge intersects.

The intersection points of the edges will cut the original edge and results in two new edges. One is outside of the overlaying polygon; another is inside the polygon. To compute the intersection, we need to add the edge that is inside the overlaying polygon to the intersection face. To decide whether an edge is inside the polygon, we can check the endpoint of the edge. If one of the points is inside the edge, then this is the new edge that is inside the overlaying polygon and need to be added to the intersection face.

After handling the intersection case, we also need to add all the edges that is in the overlaying polygon. We can do so by iterating through the edges of each polygon, and check if both endpoints of the edge is inside the other polygon, if so, add the edge into the intersection face. The result of these edges produces the intersection polygon.

Difference

To compute the difference of two convex polygons, the first step is to also to calculate the intersection points of the two polygons. The intersections points will cut the intersecting edge

into two edges. Next, we need to decide which edge to add to the difference face. The edge that is outside of the overlaying polygon is a part of the difference face, the edge that is inside the overlaying polygon will be ignored. We also need to add the edge from the other polygon created by the intersection that is inside this polygon into the difference face. Then, we need to ignore all the edges that is completely inside the overlaying polygon and add all the edges from the other polygon that is completely inside this polygon. Then add all the edges that is outside of the overlaying polygon, and these edges crates the difference face.

Union

Computing the union of the two polygons is easy after being able to compute both the intersection polygon and difference polygon. Simply calculate the difference between two polygons, then delete all the edges that is in the intersection face. The result is the union of the two polygons.

Result

The result of the project works very well. The program can compute and represent intersection, union, and difference between two polygons correctly. It can also move the polygon around. The only limitation is that the project can only compute the results between two polygons. Computation of more than two polygons are not yet implemented, which was considered in the proposal.

The object of the project is achieved, I gained much understanding of the algorithm computing the intersection, union, and difference between polygons, and made something interesting.