COSC 190, AI, Computer Vision, and Cognition
Extra Credit #2, Due Friday April 28th in class
Instructor: Dr. Fred Park

Shape Descriptors: The centroid distance shape signature. The main idea with shape signatures is to map a given shape, often represented by a binary image, to a descriptor. The descriptor should have the properties that:

(i) The descriptor should ID a class of shapes, e.g. convex shapes.

(ii) The descriptor should be invariant to rotation and translation.

(iii) The descriptor should be scale invariant or at least scalable. i.e. if F: shape $\longrightarrow$ F(shape), let shape_1 and shape_2 be two different shapes such that shape_2 is twice the size of shape_1.

- If F is scale invariant, then $F(\text{shape}_1) = F(\text{shape}_2)$.
- If F is scalable, then $F(\text{shape}_2) = 2F(\text{shape}_1)$.

An easy example of a scale invariant descriptor would be a descriptor that maps a shape to the number of corners and the angles between them.

1. Show that the centroid distance signature is scalable by looking at an explicit example in matlab. Use a square of side length 2 and one of length 4 and compare their descriptors. Show in a plot that the distances double for a shape that is double the size in this example.

2. Take a square and calculate the centroid distance for it when the square is:
   - centered in an image
   - translated away from the center
   - rotated.

   Show via plotting that the centroid distance is invariant to these transformations by plotting the square and its centroid distance function under these transforms.

3. Plot the following shapes and their centroid distance (CD) functions side by side to show that their CD functions are different.
   - square
   - rectangle
   - triangle
   - circle
   - non-convex shape.