COMP-558: Assignment 3
Available: Wednesday, April 3rd, 2013
Due Date: Wednesday, April 24th, 2013

Notes: You should use **MATLAB** to carry out this assignment. Be creative (but careful) in presenting your results. I expect everyone to turn in a report describing what you did, showing your results, which is based on original work. This means that *you must write your own code and any results you hand in should be based on your own implementations.* Be sure to submit your Matlab code along with your answers to the questions below.

Question I:[30 marks]
In the first step of the assignment you will implement a 2D Euclidean signed distance function. The basic idea is to assign each point (x, y) in the interior of a binary object its Euclidean distance to the nearest background pixel. By the same process, each point in the background is assigned its distance to the nearest foreground pixel, but is given a negative sign. A convenient way to do this is to use the 'bwdist' function in Matlab twice, and to combine the results. When you do so take care to offset the results so that there is a smooth transition at boundary pixels.

Test this implementation by showing your results on the three binary images available on Emmanuel's COMP 558 home page. Visualize your results $D(x, y)$ as a surface plot, where the ridges (discontinuities) will correspond to medial axis points of the interior. Also create a visualization of the gradient vector field ∇D by using the quiver plot capabilities of Matlab. Here you will see that the singularities of the quiver plot will correspond to the medial axis points.

Question II:[50 marks]
You will now implement part 1 of Algorithm 1 in the paper "Robust and Efficient Skeletal Graphs" which you can get from `http://www.cim.mcgill.ca/~shape` by clicking on publications. The basic idea is to compute an approximation of the average outward flux in a 3×3 neighborhood of each pixel. Places where the average outward flux is negative will correspond to interior medial axis points, places where it is positive to the medial axis of the background and places where it is zero to non-medial axis points.

You will see that the algorithm is in two parts, the first dealing with the average outward flux computation. One you have a working implementation, apply it to the three binary shapes in Question 1 and visualize your results. If you recall, in class we showed examples of what the results should look like for a panther shape when I gave a lecture on medial representations.

Question III: [20 marks]
Now implement part 2 of Algorithm 1 in the above paper. This part uses the average outward flux map as a tool for iteratively pealing away layers from the boundary of a binary shape, while not altering the topology of the interior object. The paper provides a simple characterization of removable points on a rectangular lattice by looking at its 3×3 neighborhood and then uses a heap datastructure for efficient implementation.

Demonstrate your results by showing pictures with different iterations of the peeling away process on the three binary shapes used above. Note: This third part of the question involves more work than the first two parts, so attempt it only once you have good implementations of Question I and II. Also, we will not be very picky about the details of your implementations but we will scan your Matlab code.