Homework #3 – Segmentation

CAP 5415, Computer Vision, Fall, 2016, Department of Computer Science, Florida State University

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Points: 70
Due: At the beginning of class on Monday, October 31, 2016
Hardcopy required for submission with source codes attached.

Problem 1 (10 points) Given the following image, we want to segment it using the k-means algorithm with k=2. Initially two cluster centers are x_1=1.0 and x_2=4.0.

2	2	4	1	0
2	2	1	4	0
0	3	4	3	2
0	4	3	3	2
2	2	0	0	2

1) Run the k-means algorithm until it converges. You need to show the updated cluster centers after each iteration.

2) Show the segmentation result using the cluster centers obtained in 1) above.

Problem 2 (**20 points**). Suppose we like to segment the following toy image using normalized cut (as discussed in Section 5.4 of the textbook),

94	122	99	101	111	101
99	92	103	87	107	116
93	109	113	84	86	106
5	17	6	54	56	53
13	11	5	56	44	50
0	10	5	49	42	51

Here the affinity matrix is computed using Equation (5.48) in the textbook, where F at a pixel is simply its value, and $r = 4.5$, $\sigma_F = 10$, and $\sigma_s = 25$.

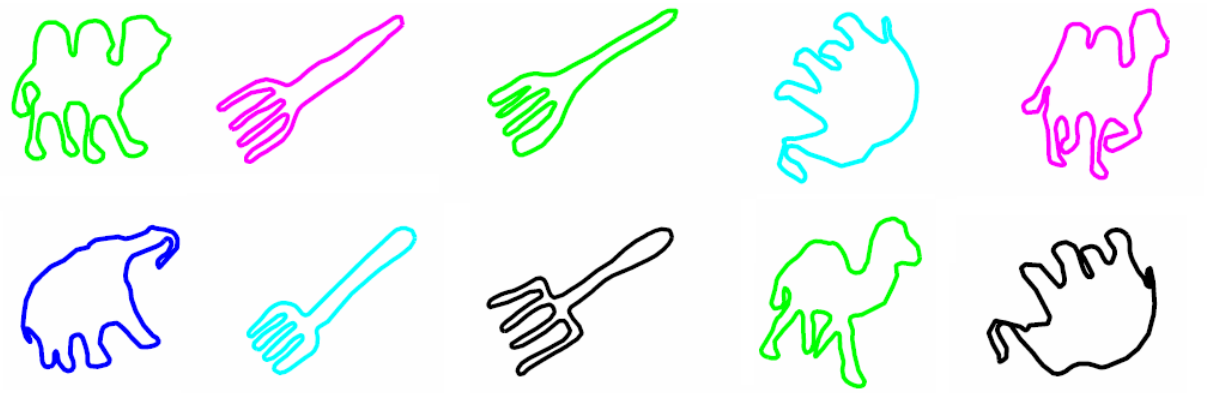
1) Compute the affinity matrix using the given parameters. Visualize your matrix by showing it as an image.

2) Use the normalized cut algorithm to segment the above image. You need to show the necessary intermediate steps.

Problem 3 (**25 points**). The following shows the pairwise distance among 10 shapes.

0	0.5314	0.8560	0.6683	0.2386	0.4541	0.5435	0.5677	0.2384	0.6241
0.5314	0	0.2849	0.8356	0.5833	0.5312	0.1830	0.3080	0.8882	0.8285
0.8560	0.2849	0	0.8871	0.5328	0.9378	0.1819	0.2540	0.4688	0.8663
0.6683	0.8356	0.8871	0	0.7352	0.3215	0.8752	0.8551	0.7236	0.0985
0.2386	0.5833	0.5328	0.7352	0	0.7034	0.5169	0.5167	0.2796	0.7271
0.4541	0.5312	0.9378	0.3215	0.7034	0	0.6894	0.8497	0.4047	0.3187
0.5435	0.1830	0.1819	0.8752	0.5169	0.6894	0	0.2110	0.8696	0.8670
0.5677	0.3080	0.2540	0.8551	0.5167	0.8497	0.2110	0	0.7913	0.8194
0.2384	0.8882	0.4688	0.7236	0.2796	0.4047	0.8696	0.7913	0	0.8879
0.6241	0.8285	0.8663	0.0985	0.7271	0.3187	0.8670	0.8194	0.8879	0

The 10 shapes (from left to right, then top to bottom) are



The pairwise distance as a text file can be found at http://www.cs.fsu.edu/~liux/courses/cap5415-2016/assignments/kimia10_pairwise.txt as a Matlab file can be found at http://www.cs.fsu.edu/~liux/courses/cap5415-2016/assignments/subset_pairwise.mat. Answer the following questions.

1) Explain how agglomerative clustering can be used to form hierarchical clusters of the given shapes.

2) Compute the hierarchical clusters using the single-link clustering and the complete-link clustering respectively.

3) Show which subclusters are merged in steps 3 and 4 in the single-link clustering and the complete-link clustering respectively.

4) A common problem in hierarchical clustering is to identify natural clusters based on the threshold changes in the cluster hierarchy. Explain which clustering (the single-link clustering or the complete-link clustering) is better in terms of identifying natural clusters.

Problem 4 (**15 points**). Explain how the cube map representation (see pp. 223-224 in the textbook) can be used to detect lines using $x\, n_x + y\, n_y - d = 0$. Here we ignore the polarity of lines. Specifically, you need to show:

1) How the three subspaces being defined and used.

2) How to choose one of the three subspaces given a detected edge point at (x, y).

3) How to accumulate votes in each of the subspaces for a detected edge point at (x, y).