CSE252C – Object Recognition – Assignment #3

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`http://www-cse.ucsd.edu/classes/sp11/cse252c`

Target Due Date: Monday May 9, 2011.

1. Pairwise Clustering.

   (a) Run the script `make_pointset.m` to produce the pointset shown in class consisting of an annulus and an off-center clump. Calculate and display the affinity matrix using the Gaussian weighted Euclidean distance $w_{ij} = e^{-(d_{ij}/\alpha)^2}$.

   (b) Implement the Normalized Cuts algorithm to partition this pointset into two clusters. Run your algorithm with several choices of α and discuss the resulting partitions.

2. Spline Interpolation.

   (a) Let $U(x) = |x|^3$ denote the cubic spline, which is the 1D counterpart to the thin plate spline (TPS). Prove that in order for the function

   $$f(x) = a + bx + \sum_{i=1}^{n} w_i U(x - x_i)$$

   to have a square integrable second derivative, the following constraints must be satisfied:

   $$\sum_{i=1}^{n} w_i = 0 \quad \text{and} \quad \sum_{i=1}^{n} w_i x_i = 0.$$

   (b) Reproduce Fig. 4 in Bookstein (1989). You do not need to reproduce the principal warps part (i.e., the signed segments or the little table), but you do need to show the interpolated grid points and compute the integral bending norm.

   (c) Repeat the previous step using regularization, i.e., replace K by $K + \lambda I$, and demonstrate the effect of varying λ.

3. Matching with Shape Contexts and Thin Plate Splines.

   This exercise makes use of the files in `http://vision.ucsd.edu/sc_demo/`.

   (a) Apply `demo_2.m` to produce a 10×10 distance matrix between two different sets of MNIST digits 0 through 9.

   (b) Implement either Scott & Longuet-Higgins (1991) or SoftAssign. Demonstrate its application to a small assignment problem of your choice (chosen for illustrative purposes), and compare the result to that of Hungarian.

   (c) Repeat the above 10×10 distance matrix computation using SLH or SoftAssign in place of Hungarian. Discuss any differences you observe in the results.