CSE252 – Computer Vision – Assignment #4
Instructor: Prof. Serge Belongie.
`http://www-cse.ucsd.edu/classes/sp03/cse252`
Target Due Date: Tue. May 27, 2003.

1. Optical Flow.
   (a) Implement the Lucas-Kanade optical flow algorithm. Demonstrate it on the translating square sequence in `frames.mat`.
   Matlab hints: `quiver`.
   (b) Use the eigenvalues of $A^T A$ to identify the regions with reliable optical flow.

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's 1989 PAMI paper. 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. 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.