ECE4580 Homework #10

Due: Apr. 13, 2017

Problem 1. (50 pts) Implement the Bayesian relaxation algorithm for image segmentation. This requires not only the means, but also the standard deviations associated to the means. Allow for two options in the invocation, (i) run for a number of iterations as decided by user, and (ii) run to convergence based on a negative argument for the number of iterations.

Recall that the energy to maximize is:

$$\mathcal{E}(\mu, s) = \int_D \mathcal{N}\left(I(\mathbf{x}); \mu_{\mathbf{s}(\mathbf{x})}, \mathbf{\Sigma}_{\mathbf{s}(\mathbf{x})}\right) \, \mathrm{d}\mathbf{x} - \lambda \int_{\mathbf{D}} ||\nabla \mathbf{P}(\mathbf{x})||_{\mathbf{2}}^{\mathbf{2}} \, \mathrm{d}\mathbf{x}$$

where $I : D \to \mathbb{R}$ is the image proper, the pairings (μ_c, Σ_c) for $c = \{\, 1 \ldots k \,\}$ are the class means and covariances, $s : D \to \{\, 1, \ldots, k \,\}$ is the segmentation map, and $\mathcal{N}(\cdot; \mu, \Sigma)$ is the normal distribution. As before, λ is a weighting factor that tries to modulate the importance of the second term relative to the first.

One important thing to note about the stubs is that the argument list requires the standard deviation and not the (co)variances. This is because of the simple relationship between the two for scalar random variables. With that in mind, a stripped down version of the algorithm is:

1. Start with initial guess of Gaussian parameters, e.g., means and standard deviations, and homogeneous priors.
2. Using Gaussian parameters, generate likelihoods for each class.
3. Using Bayes' rule, generate the posteriors (normalize).
4. Smooth the posteriors using your favorite smoother (you choose the smoothing parameters).
5. Normalize the probabilities (across the classes for each pixel).
6. Segment based on the *maximum a posteriori* estimate.
7. Use segmentation to update parameters.
8. Repeat (2)-(7) until desired number of iterations, or to convergence.

The function stub is called `segBayes.m`, and the script file you should prepare is called `segmentB.m`. Select two of the images from the Matlab file to process and go for it. Turn in the code and the results. Explain the output and your selection. Compare to at least one of the other segmentation strategies (k-means or ICM).

Problem 2. (20 pts) Move on to the next activity of the learning module. The group submission should reflect the work of the group, and should also be submitted individually with the name of your partner in the document. If submitting video or links to video for the pair, then only one member need to do so, while the other member should just note as much. The prior expectaction for deliverables continues to hold.