CSE 672 Fall 2010 Assignment 2: Playing with Low-Level Descriptive Models

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Problem 1: Gibbs Sampling

Implement a Gibbs sampler and sample the following Ising model. Let Λ be a 128×128 lattice and each site $s \in \Lambda$ takes values from $\{-1, +1\}$ (map -1 to black and $+1$ to white in the sampled image). You should presume that your lattice sits on torus. In other words, the pixel at the far right of the lattice is a neighbor to the far left of the lattice (wraps around). Same for the top and bottom and the four corners. The Ising model to sample is

$$\Pi(x) = \frac{1}{Z} \exp\left[-\beta \sum_{s \sim t} x_s x_t\right]. \tag{1}$$

There is no external field. Initialize it randomly and run the sampler for a *good enough number of sweeps* to get a good sample. Generate samples for $\beta = \{0.2, 0.4, 0.6, 0.8, -0.2\}$. You can check your results against the Ants In Fields demonstration program. Submit the images and code electronically. (You may use whatever programming language you want, Matlab, Python, C, Java, ...)

Pleasure Problem: Designing an MRF Model

This problem is for your benefit; you need to turn in anything for it.

In this problem, you need to formulate an MRF model based on the following description—the Photomontage problem. You are given a set of m images $\{I_1, \ldots, I_m\}$ defined over the dimension lattice Λ (for simplicity). Consider the images as functions on sites $I \colon \Lambda \mapsto \mathbb{R}$. The task is to create a photomontage of all m images (you know the registration between the images in a global coordinate frame – a new lattice you will use to define the photomontage, say Λ_M). The goal of making the photomontage is to produce a natural image that smoothly varies the boundaries between images (note this is not super-resolution). Your label set for each set $s \in \Lambda_M$ is the index of which image to use for this intensity in the photomontage, i.e., $x_s \in \{1, \ldots, m\}$. Things to consider:

1. For a given pixel in the photomontage, not all images will be in the field of view. (This is not latent.)
2. When two neighboring pixels are assigned to the same image, they should be considered natural and not induce a seam or cost.
3. But, when two neighboring pixels are assigned to different images, a seam is created and it should induce a cost based on the pixel intensities.

Formulate the model and justify it. There are many plausible answers, but there are a few components in mind that each must incorporate.