Pattern Analysis Joint Meeting
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Worksheet 10: Monday June 29 / Friday July 2 2021

Please watch the video prior to the lecture, and think about the questions below. In the joint meeting, you will have 20 minutes time to discuss the questions with your group. Afterwards, we will jointly discuss your solution proposals.

You can print this sheet and use the space below for your notes.

Task 1: Slight Variation to the Denoising Task: Input Values

We would like to denoise a binary image, much like the example in the lecture. However, assume that we are forced to work on binary pixel intensities of 0 and 1 instead of -1 and 1.

Task 1: We saw a denoising example for pixel values in {-1, 1}

What happens if we have pixel values of {0, 1}?

a) What issue do we run into with our Gibbs sampler?
if $x_i=0$, then it does not matter anymore what y_i is, so we don't have a minimum for $x_i = y_i$

b) How can we fix it?
Define a new function, e.g.

$$E(x_i, y_i) = \begin{cases} 0 & \text{if } x_i = y_i \\ 1 & \text{otherwise} \end{cases}$$

$$E(x_i, y_i) = \| x_i - y_i \|_2^2$$

← unary potential
(pairwise is analogous with x_j)

→ Energy calculation:

Potential: $e^{-\left(\sum E(x_i,y_i) + \sum E(y_i,\right.}$

$x=0$:

$E(x_i, y_i) = -\eta x_i y_i$

$E(x_i, x_j) = \beta x_i x_j$

Task 2: Non-Binary Intensities

Following up on question 1, the use of binary intensities appears quite limiting. What could we do in order to denoise grayscale images, e.g., with 256 different gray values?

Task 2: Non-binary Intensities

Denoising of 256-value grayscale pictures

- median filter, Gauss-filter ... certainly works

⇒ How can we adjust our MRF formulation?

Just represent the 256 grayvalues in a range $[0, \ldots, \text{gray}_{\text{MAX}}]$ and choose potential functions in the style of task 1, i.e., a distance function like L_1 or L_2 distance,

⇒ We have min. energy for two identical inputs, and increasing energy for diverging inputs.

Task 3: Sampling Order

Tony has the impression that it is inefficient to randomly select points when doing inference via Gibbs sampling: what if one of these points is not selected for a very long time? He proposes to investigate different deterministic sampling patterns that visit all points within a guaranteed number of iterations.

Propose

(a) one deterministic pattern that might potentially work quite well, and

(b) another pattern that will probably lead to bad results?