UNIVERSITY OF ILLINOIS
Department of Electrical and Computer Engineering
ECE 417 Multimedia Signal Processing

Lecture 18 Sample Problems

Problem 18.1

Consider a two-layer ConvNet with only one output node, one hidden node, one input channel, and max-pooling over the whole image:

$$\begin{aligned} z &= \sigma(b) \\ b &= vy \\ y &= \max_{n_1} \max_{n_2} a[n_1, n_2] \\ a[n_1, n_2] &= u[n_1, n_2] * x[n_1, n_2] \end{aligned}$$

Start with

$$u[n_1, n_2] = \begin{cases} 1 & n_1 = n_2 = 0 \\ 0 & \text{otherwise} \end{cases}$$

and $v = 1$. The training criterion is

$$E = \frac{1}{2} \sum_{i=1}^{2} (z_i - \zeta_i)^2$$

and the training database has just the following two tokens in it:

$$(x_i, \zeta_i) = \Big\{ (\vec{0}, 0),\ (s[n_1, n_2], 1) \Big\}$$

That is, the first training token is an all-zeros image from class $\zeta = 0$, and the second training token is an image containing the signal $s[n_1, n_2]$ of class $\zeta = 1$. Assume that $s[n_1, n_2]$ is so small that $\sigma'(s[n_1, n_2]) \approx \frac{1}{2}$ and $\sigma'(s[n_1, n_2]) \approx \frac{1}{4}$ for all values of (n_1, n_2). Given these assumptions, find $\frac{\partial E}{\partial u[n_1, n_2]}$.