Applied Machine Learning

Denoising Autoencoders

Denoising Autoencoders

- Noise and Autoencoders
- Perceptual Loss
- Training a Denoising Autoencoder

Noise in Autoencoders

- Cost function sensitive to noise: $||\mathscr{D}(Z_i, \theta_d) - I_i||^2$
- Denoising autoencoders account for potential noise at the input: noise(I_i)
  - Additive Gaussian Noise
    - per pixel: add independent samples of normal random variable
  - Salt and pepper noise
    - select at random a predefined number of pixels: replace with random selection of [0,1]
  - Masking Noise:
    - select at random a predefined number of pixels: set to 0
  - Masking Blocks
    - select predefined blocks of pixels: set to 0
    - selection of blocks to train the network to complete them in case they are blocked in source images

Denoising Autoencoders - Loss

- Perceptual loss
  - Accounts for perceptual changes at the output
  - Input to network: I_k
  - At layer i: Output: $D_i(I_k)$ dimensions: $W_i \times H_i \times F_i$
    - flattened: $\mathbf{d}_i(I_k)$ number of components: $W_i H_i F_i$
  - Feature reconstruction loss at layer i between images I_1 and I_2: $$\mathscr{L}_{\text{fr},i}(I_1, I_2) = \frac{\|\mathbf{d}_i(I_1), \mathbf{d}_i(I_2)\|^2}{W_i H_i F_i}$$
- Perceptual loss between images: $$\mathscr{L}_{\text{per}(I_1,I_2)} = \sum_i w_i \mathscr{L}_{\text{fr},i}(I_1, I_2)$$
- General Loss $$\mathscr{L}_{\text{gen}}(\mathscr{D}(Z_i, \theta_d), I_i) = \lambda_1 \mathscr{L}_{\text{per}}(\mathscr{D}(Z_i, \theta_d), I_i) + \lambda_2 \|\mathscr{D}(Z_i, \theta_d) - I_i\|^2$$

Denoising Autoencoder - Training

- Dataset of N images $I_1, \ldots I_N$
- Apply model noise to each image I_i: noise(I_i)
- Output at encoder: $Z_i = \mathscr{E}(\text{noise}(I_i), \theta_e)$
- Output at decoder: $\mathscr{D}(Z_i, \theta_d)$
- Loss: $\mathscr{L}_{\text{gen}}(\mathscr{D}(Z_i, \theta_d), I_i)$
- Train through Stochastic Gradient Descent

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