Homework 12, due April 10th, 11:59pm

April 4, 2019

1.Download the files `HW12train.zip` and `HW12test.zip` from Canvas, containing training and test patches of size 64×64 for the problem of predicting the resolution of an image. The first two digits in each file name represent the resolution y_i of the patch (between 10% and 96%).

The goal of this project is to train a regression CNN to predict the resolution. We will use the following loss functions on the training examples $(\mathbf{x}_i, y_i), i = 1, ..., n$. The square loss:

$$S(\mathbf{w}) = \frac{1}{n} \sum_{i=1}^{n} (y_i - f_{\mathbf{w}}(\mathbf{x}_i))^2 + \lambda \mathbf{w}^T \mathbf{w} \tag{1}$$

and the symmetric Lorenz loss

$$L(\mathbf{w}) = \frac{1}{n} \sum_{i=1}^{n} \log(1 + (y_i - f_{\mathbf{w}}(\mathbf{x}_i))^2) + \lambda \mathbf{w}^T \mathbf{w} \tag{2}$$

where $f_{\mathbf{w}}(\mathbf{x})$ is the CNN with weight $\mathbf{w}$ on input $\mathbf{x}$, with $\lambda = 0.0001$.

The CNN contains five convolutional layers with stride 1 and zero padding, the first four with filters of size 5×5, and the last of the appropriate size to obtain a 1×1 output. The first three convolutions have 32 filters, the fourth has 64 filters, and the last has one filter. The first three convolutions are followed by 2×2 max pooling with stride 2,1,2 respectively. The fourth convolution is followed by ReLU.

a) Train a CNN using the square loss (1) on the training patches of size 64×64. Use the appropriate optimizer (SGD, Adam, etc), number of epochs, learning rate, minibatch size and momentum to obtain a good training. Show a plot of the loss function vs epoch number. Show another plot of the training and test R^2 vs epoch number. (3 points)

b) Repeat point a) using jittering, obtained for each minibatch by extracting a random patch of size 62×62 from the original patches. (3 points)

c) Repeat point b) using the symmetric Lorenz loss (2). (3 points)

d) On two separate plots, plot the test residuals $r_i = y_i - f_{\mathbf{w}}(\mathbf{x}_i)$ vs y_i for the models obtained at b) and c). (1 point)