CS 498 AML: Homework 7

Rauhul Varma (rvarma2), Tadas Aleksonis (alekson2)

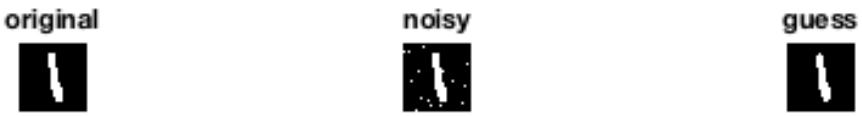
Mean field inference for binary images

The MNIST dataset consists of 60,000 images of handwritten digits, curated by Yann LeCun, Corinna Cortes, and Chris Burges. You can find it here, together with a collection of statistics on recognition, etc. We will use the first 500 of the training set images.

Obtain the MNIST training set, and binarize the first 500 images by mapping any value below .5 to -1 and any value above to 1. For each image, create a noisy version by randomly flipping 2% of the bits. Now denoise each image using a Boltzmann machine model and mean field inference. Use theta_{ij}=0.2 for the H_i, H_j terms and theta_{ij}=2 for the H_i, X_j terms.

a. Report the fraction of all pixels that are correct in the 500 images.
   Across all 500 images we found that **98.12**% of all pixels were correct

b. Prepare a figure showing the original image, the noisy image, and the reconstruction for
   a. the most accurate reconstruction: (99.62% accurate)



   b. the least accurate reconstruction: (93.62% accurate)

Assume that theta_{ij} for the H_i, H_j terms takes a constant value c. We will investigate the effect of different values of c on the performance of the denoising algorithm. Think of your algorithm as a device that accepts an image, and for each pixel, predicts 1 or -1. You can evaluate this in the same way we evaluate a binary classifier, because you know the right value of each pixel. A **receiver operating curve** is a curve plotting the true positive rate against the false positive rate for a predictor, for different values of some useful parameter. We will use c as our parameter.

c. Using at least five values of c in the range -1 to 1, plot a receiver operating curve for your denoising algorithm.