

# EE 550

## Artificial Neural Networks

### Homework 2

Due: 13/03/2020

#### Implementation of Binary Hopfield Model

This project requires the implementation of binary Hopfield model.

- 1) Create 5 sample patterns from letters of  $A, C, K, T, W$  and plot the patterns in  $10 \times 10$  grid by setting light pixels as 1 and dark pixels as -1 on the grid to visualize those letters.
- 2) Convert each number to a 100-element vector, i.e.,  $x_i^s \in \{\pm 1\}$ .
- 3) Implement the Hopfield algorithm to obtain weight matrix that stores 5 sample patterns.
- 4) Distort the original sample patterns by adding zero-mean ( $\mu = 0$ ) Gaussian noise with three different standard deviations ( $\sigma_1 = 0.5, \sigma_2 = 0.8, \sigma_3 = 1.1$ ) to each pattern. You can obtain noisy binary image with the following formula in MatLab:

$$I_{noisy} = I_{original} + \sigma * randn(10) + \mu$$
$$I_{noisy,binary} = sign(I_{noisy})$$

where  $I_{original}$  is original image,  $I_{noisy,binary}$  is distorted image whose elements are 1 or  $-1$ ;  $randn(10)$  returns an  $10 \times 10$  matrix containing pseudorandom values drawn from the standard normal distribution.

- 5) Iterate each case until convergence for each pattern and standard deviation. Plot the resulting image after each epoch as shown in Figure 1.



Figure 1: Sample plot

**NOTES:**

- 1) Please upload all your files (codes and report) to Moodle with the file convention
- 2) There will be a demo after due date. During demo, you will asked to download your code from Moodle and run it.
- 3) Plagiarism will not be tolerated.
- 4) Late submission will not be accepted.