Homework 5

Machine Learning, W19

Only typed solutions are acceptable. I will not accept hand-written solutions.

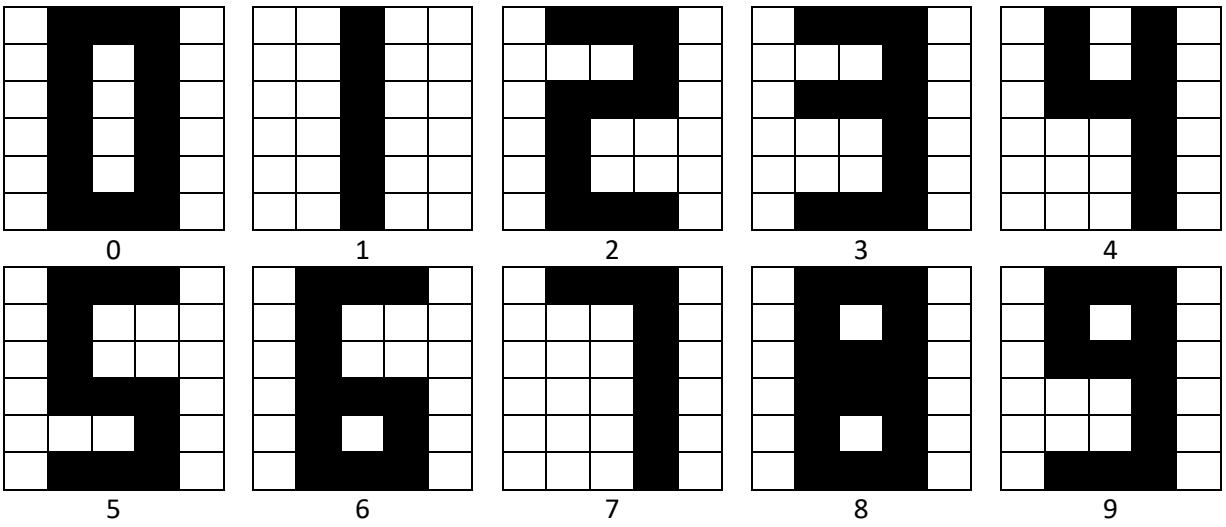
Do not forget to write down the pledge!

Before starting this assignment, read about implementation of NN in python in the following links:

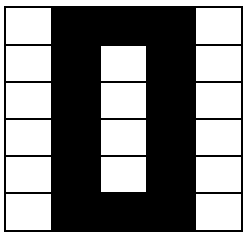
https://scikit-learn.org/stable/modules/neural_networks_supervised.html

https://scikit-learn.org/stable/modules/generated/sklearn.neural_network.MLPClassifier.html

In this assignment you are supposed to use the following patterns to construct the dataset.



1) Use the above pictures to construct a dataset for the digits of 0 to 9. For each digit you can construct an array (a one dimensional array). Here is an example for 0:



Pattern of 0

0	1	2	3	4
5	6	7	8	9
10	11	12	13	14
…				
			…	24

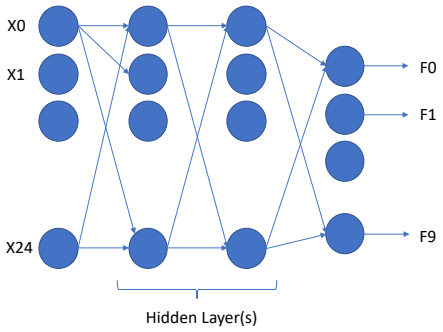
Indexing of the pixels

Array:
0, 1, 1, 1, 0, 0, 1, 0, 1, 0, 0, 1, 0, …, 1, 0

Representation in one dimension

2) Construct a larger dataset by inserting a bit of noise. To do that, for each pattern, select one pixel at random and toggle that pixel (i.e., if it is 0 change it to 1, if it is 1 change it to 0). Do this process N times per pattern. Use N=0 (no noise is injected), N=1, N=5, N=10, and N=15. For each value of N, store the dataset in a proper variable or file. For the rest of this assignment, these datasets are called dataset_N. So as an example, dataset_10 means the dataset that has been generated with N=10.

3) Use a MLP to do the digit classification. The following figure illustrates the general structure of the neural network:



X0 to X24 are the inputs.

F0 to F9 are the corresponding outputs for each digit. As an example, if the input digit is 5, then F5 should have the maximum value, while if the input digit is 3, F3 has the maximum value.

Each hidden layer has 24 neurons and we may have 1, or 2 hidden layers. It is obvious that the output layer has 10 neurons.

Use the appropriate MLP and training and test datasets for each of the following cases. In this The error is calculated using the following equation

$$error = \frac{1}{n}\sum_{i=1}^{n} \mathbf{1}\left(F_i, \hat{F}_i\right)$$

where, n is the size of the test dataset, F_i is the target label of the test data point and $\hat{F}_i$ is the predicted label. $\mathbf{1}\left(F_i, \hat{F}_i\right)$ is 1 if $F_i \neq \hat{F}_i$ and is 0 otherwise.

i. With dataset_0 for the training, dataset_5 for the test, and one hidden layer
ii. With dataset_1 for the training, dataset_5 for the test, and one hidden layer
iii. With dataset_5 for the training, dataset_5 for the test, and one hidden layer
iv. With dataset_10 for the training, dataset_5 for the test, and one hidden layer
v. With dataset_15 for the training, dataset_5 for the test, and one hidden layer
vi. With dataset_0 for the training, dataset_5 for the test, and two hidden layer
vii. With dataset_1 for the training, dataset_5 for the test, and two hidden layer
viii. With dataset_5 for the training, dataset_5 for the test, and two hidden layer
ix. With dataset_10 for the training, dataset_5 for the test, and two hidden layer
x. With dataset_15 for the training, dataset_5 for the test, and two hidden layer

Submission: Submit your code and results in a single PDF file.