CSE 353 Assignment 3 - Perceptron

Due Oct 28 2021 5:00PM

Main TA for this assignment:
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This assignment is to implement the perceptron learning algorithm (PLA) on classifying linear-separable data and its variant (e.g., pocket perceptron, PLA_Pocket) on classifying non-linear-separable data.

1. One linear separable data set ('X_LinearSeparable.txt' and 'Y_LinearSeparable.txt') is provided, where dataset X (3*20) contains 20 training samples. Each column in X is a sample (the first element of each sample is a constant, '1'). Y (1*20) contains the ground truth binary labels of all samples.

x_0 ← ignore

(a) Implement your PLA algorithm on this training dataset;
(b) Plot the data and the decision boundary learnt from your PLA algorithm;
(c) Report your training error rate.

Note:
In Matlab, refer to the following to load data:
X = dlmread('X_LinearSeparable.txt'); %X: (1+d)*N; d=2 in this dataset for visualization; N=20 in this dataset;
Y = dlmread('Y_LinearSeparable.txt'); %Y: 1*N
In Python, use np.loadtxt() to load data. The delimiter is ',' in the txt files.

x = np.loadtxt('X_....txt')
y = np.loadtxt('Y_....txt')

3 [20] 3×20 array

2. One noisy data set ('X_NonLinearSeparable.txt' and 'Y_NonLinearSeparable.txt') that is not linear separable is provided.

(a) Implement your Pocket_PLA algorithm on this training dataset;
(b) Plot the data and the decision boundary learnt from your Pocket_PLA algorithm;
(c) Report your training error rate.

3. A dataset of handcrafted features of handwritten digits ('X_Digits_HandcraftedFeature_Train.txt' and 'Y_Digits_HandcraftedFeature_Train.txt') is provided, where dataset X (3*1561) contains 1561 training

① find w via pocket PLA

② load - test

samples (1005 digit '1' and 556 digit '5'). Each column in X is a sample (the first element of each sample is a constant, '1'; and the rest two elements are the symmetry and mean intensity features extracted from the handwritten digital image). Y (1*1561) contains the ground truth binary labels of all samples.

(a) Train your Pocket_PLA algorithm on this training dataset to obtain w_pocket;
(b) Load the testing dataset X_test and Y_test from 'X_Digits_HandcraftedFeature_Test.txt' and 'Y_Digits_HandcraftedFeature_Test.txt', respectively. Apply your w_pocket onto this testing dataset X_test to obtain the predicted labels (Y_test_pred). Compare Y_test_pred with the ground truth labels (Y_test) and report your testing error rate;
(c) Plot the testing data and the decision boundary determined by the w_pocket.

4. A dataset of raw pixel features of handwritten digits ('X_Digits_RawFeature_Train.txt' and 'Y_Digits_RawFeature_Train.txt') is provided, where dataset X (257*1561) contains 1561 training samples. Each column in X is a sample (the first element of each sample is a constant, '1'; and the rest 256 elements represent the vectorized image of 16 x 16 pixels). Y (1*1561) contains the ground truth binary labels of all samples.

(a) Train your Pocket_PLA algorithm on this training dataset to obtain w_pocket;
(b) Load the testing dataset X_test and Y_test from 'X_Digits_RawFeature_Test.txt' and 'Y_Digits_RawFeature_Test.txt', respectively. Apply your w_pocket onto this testing dataset and report your testing error rate;

Optional:

Implement the Adaptive Linear Neuron algorithm, its batch version, variants of the cyclic strategies in PLA.

Upload your codes with enough comments and a brief report to Blackboard by the due date & time, including

a) Introduction. Brief summary of what you think the assignment is about,

b) Method. Brief outline of your (algorithmic) approach,

c) Experiments. Tables and/or pictures of intermediate and final results that convince us that the program does what you think it does.

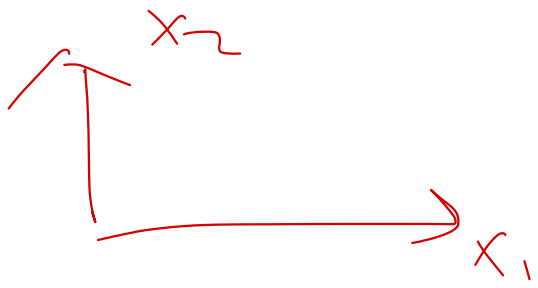
d) Discussions and Conclusions. Any design decisions you had to make and your experimental observations. What do you observe about the behavior of your program when you run it? Does it seem

to work the way you think it should? Play around a little with different setting to see what happens. Note, your open-ended exploration is highly valued.

$19 \quad 6 \quad 2$

$19x_0 + 6x_1 + 2x_2 = 0$

$19 \quad 0$



$19 + 2x_2 = 0$

$x_2 = -9.5$

$x - y = 0$

$-9 - 19x_1 - 17x_2 = 0$