

CS480/680: Introduction to Machine Learning

Homework 1

Due: 11:59 pm, January 28, 2021, submit on Crowdmark (yet to be set up, stay tuned).

Exercise 1: Perceptron Implementation (5 pts)

Convention: All algebraic operations, when applied to a vector or matrix, are understood to be element-wise (unless otherwise stated).

Algorithm 1.1: The perceptron algorithm.

Input: $X \in \mathbb{R}^{n \times d}$, $\mathbf{y} \in \{-1, 1\}^n$, $\mathbf{w} = \mathbf{0}_d$, $b = 0$, $\text{max_pass} \in \mathbb{N}$

Output: $\mathbf{w}, b, \text{mistake}$

```

1 for  $t = 1, 2, \dots, \text{max\_pass}$  do
2    $\text{mistake}(t) \leftarrow 0$ 
3   for  $i = 1, 2, \dots, n$  do
4     if  $y_i(\langle \mathbf{x}_i, \mathbf{w} \rangle + b) \leq 0$  then
5        $\mathbf{w} \leftarrow \mathbf{w} + y_i \mathbf{x}_i$            //  $\mathbf{x}_i$  is the  $i$ -th row of  $X$ 
6        $b \leftarrow b + y_i$ 
7        $\text{mistake}(t) \leftarrow \text{mistake}(t) + 1$ 

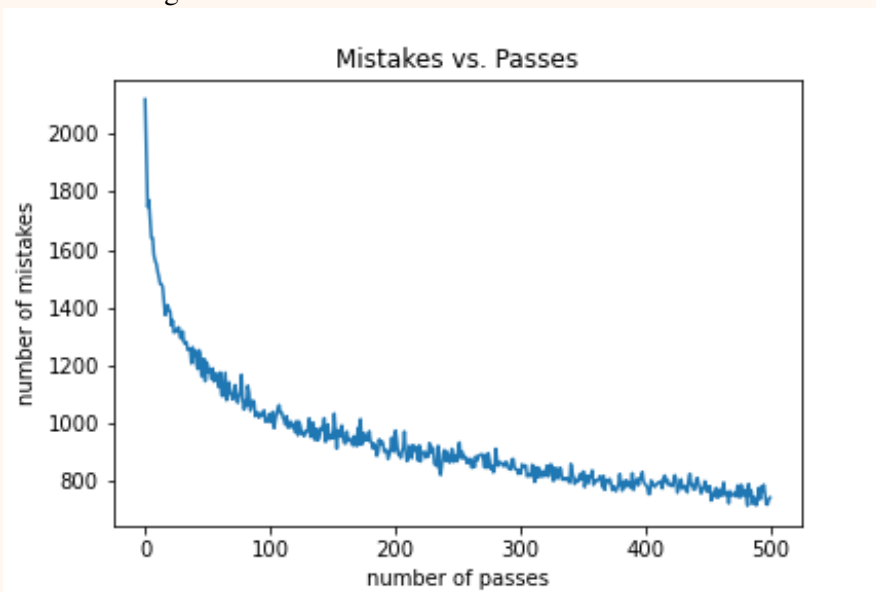
```

Implement the perceptron in Algorithm 1.1. Your implementation should take input as $X = [\mathbf{x}_1^\top, \dots, \mathbf{x}_n^\top]^\top \in \mathbb{R}^{n \times d}$, $\mathbf{y} \in \{-1, 1\}^n$, an initialization of the hyperplane parameters $\mathbf{w} \in \mathbb{R}^d$ and $b \in \mathbb{R}$, and the maximum number of passes of the training set [suggested $\text{max_pass} = 500$]. Run your perceptron algorithm on the [spambase](#) dataset (use the version on the [course website](#)), and plot the number of mistakes (y-axis) w.r.t. the number of passes (x-axis).

Ans: [Answer 1.1](#)

Answer 1.1

Resultant image:



Perceptron Implementation:

```
1  def perceptron(  
2      X: List[List[float]],  
3      y: List[int],  
4      max_pass=500  
5  )-> [List[float], float, List[int]]:  
6      """  
7      @param      X: \in R^{nxd}  
8      @param      y: \in \{-1,1\}^n  
9      @param      max_pass: \in N  
10     """  
11     X = np.array(X)  
12     y = np.array(y)  
13     [n, d] = np.shape(X)  
14     w = [0] * d # w = 0_d  
15     b = 0  
16     mistake = []  
17     for t in range(0, max_pass): # max passes / iterations  
18         mistake.append(0)  
19         for i in range(0, n):  
20             x_i = X[i, :]  
21             if (y[i] * (np.dot(x_i, w) + b)) <= 0:  
22                 w = w + y[i] * x_i  
23                 b = b + y[i]  
24                 mistake[t] += 1  
25  
26     return w, b, mistake  
27
```