CS435 assignment

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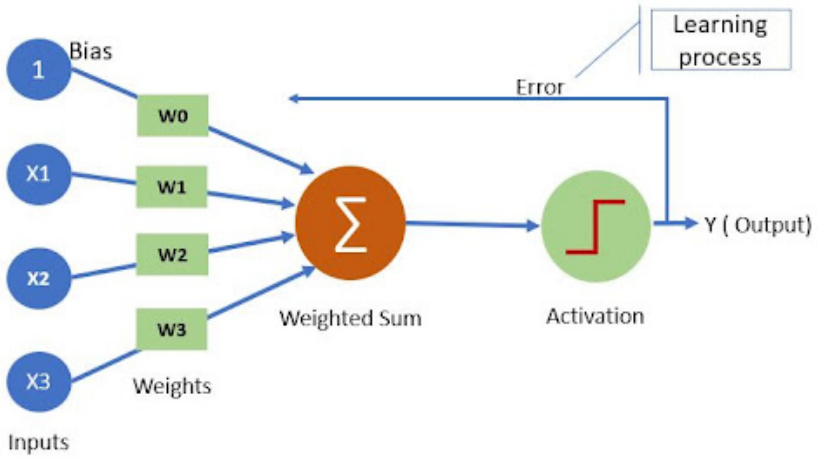
-binary classifier Perceptron

It's a classification algorithm, a supervised one that takes the shape or the idea of a single neural cell, where inputs or features produce a single output that output either helps correct the next patch of weights, if the activation (the predicted value) doesn't match the actual correct classification y value if it's in the training process or it gives a single prediction either correct or wrong then that prediction gets compared to the actual y value updating only on error,



Single Layer Perceptron

As seen in the image a set of inputs or features and a single value called bias which is essentially acts as a safe measure, in that it prevents a non-zero threshold, that value along with the weights and features get tested by applying the activation equation,

$$a = \sum_{i=0}^{D} w_d x_d = \boldsymbol{w}^\top \boldsymbol{x}$$

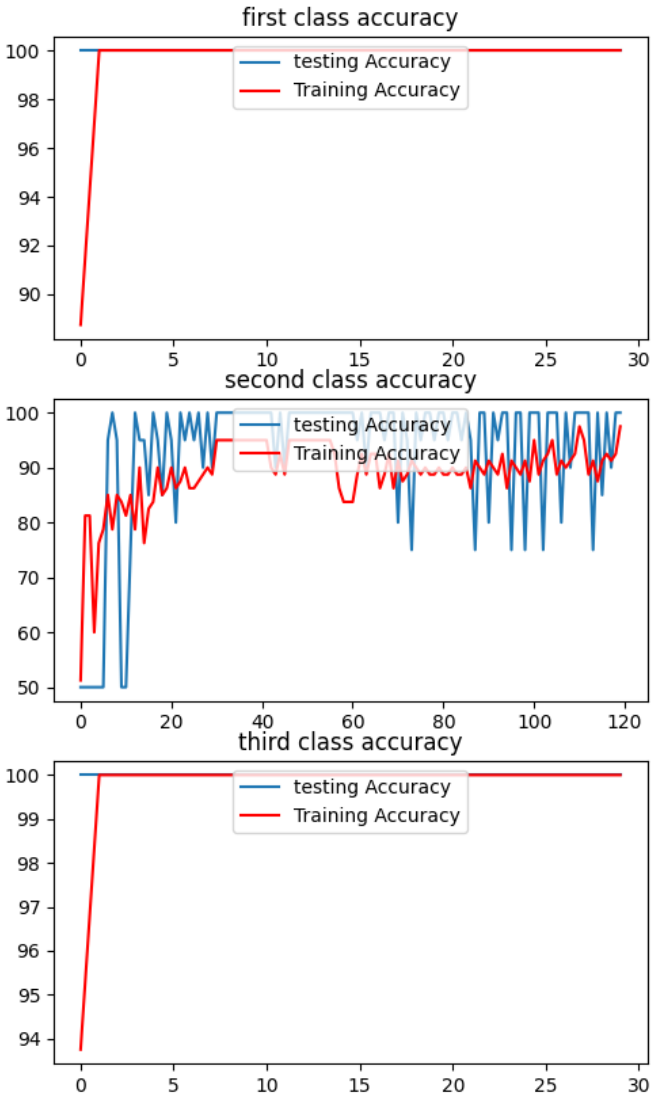
As seen in the equation a is the result of a summation or a loop which covers all elements, where each element in the W matrix gets multiplied by the corresponding value of the x matrix that value is then added to the bias value to make sure no cases of a zero threshold, then finally the activation value gets tested against the y values (the actual truth values)

Algorithm 5 PERCEPTRONTRAIN(**D**, *MaxIter*)

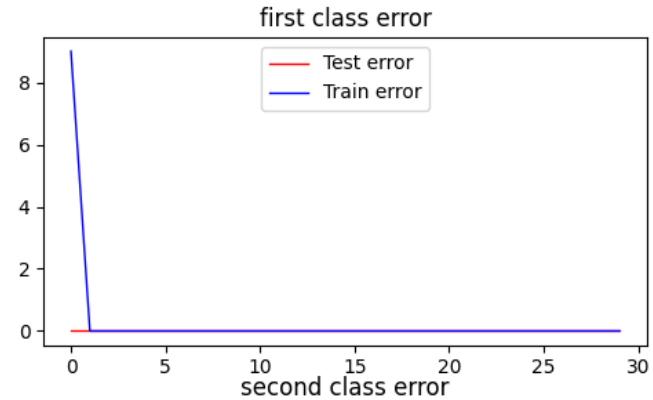
```
w_d ← 0, for all d = 1 ... D                          // initialize weights
b ← 0                                                  // initialize bias
for iter = 1 ... MaxIter do
    for all (x,y) ∈ D do
        a ← Σ_{d=1}^{D} w_d x_d + b                    // compute activation for this example
        if ya ≤ 0 then
            w_d ← w_d + yx_d, for all d = 1 ... D      // update weights
            b ← b + y                                  // update bias
        end if
    end for
end for
return w_0, w_1, ..., w_D, b
```

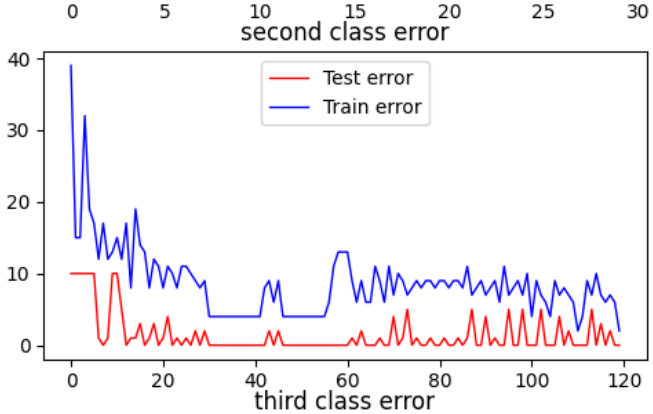
It goes like this in the algorithm if y*a is <=0 then our prediction is wrong and the weights needs to be adjusted, we ably the following equation in which we add the value of multiplying the value of y with the value of x (both are matrixes of the same size since y is a classifier) then said value gets added to the weight updating them in the process, and since we have y values as (1,-1) for correct or incorrect, if a negative value is added meaning we incorrectly classified a negative instance as a positive so we need to lower the activation and we do that by decreasing the W values, but if we incorrectly classified a positive value as negative value we need to do the opposite, increasing the W value by adding a positive x value to it.

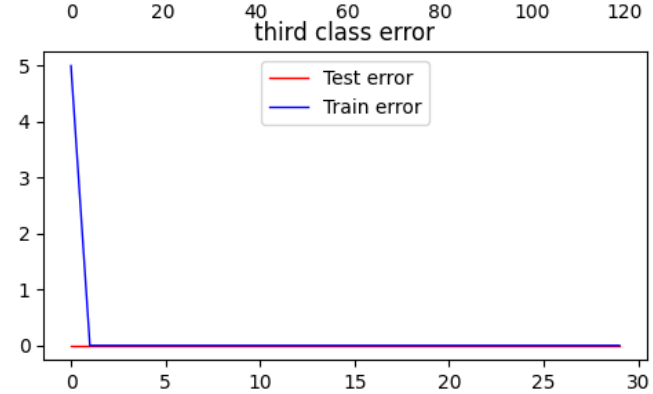
$$w = w + yx$$

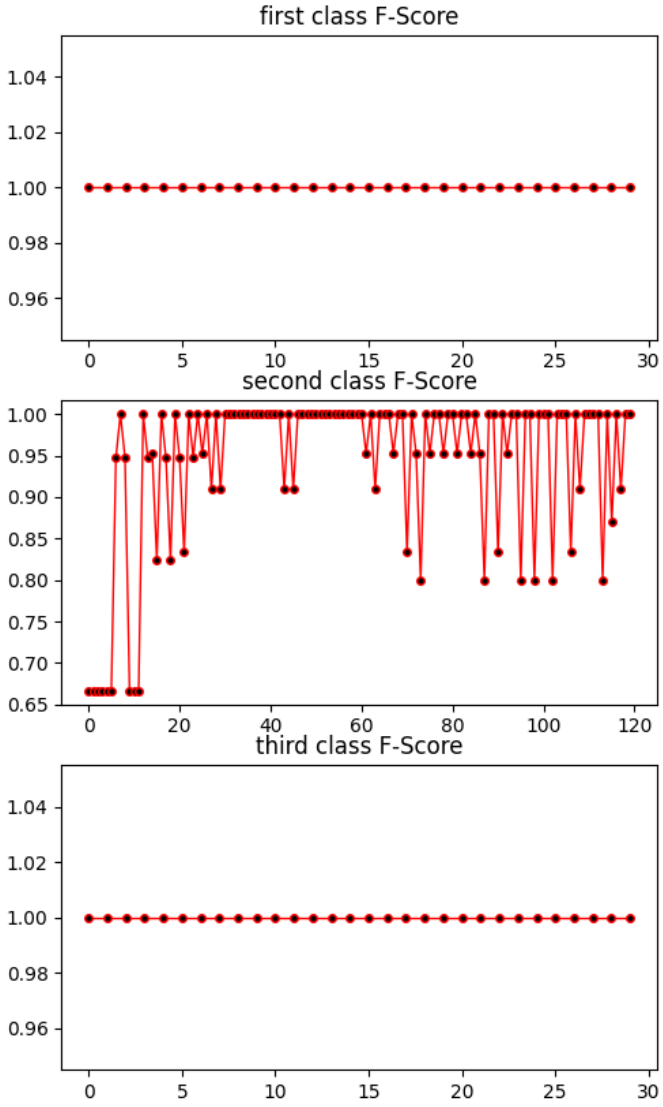


We can see that the first class is easily separated from any other class so the algorithm was able to discriminate between it and the other classes meaning **one** iterations is enough, but for class 2 and 3 not so much i found that iterations from **35 to 40** yielded the best result,


first class error
Test error
Train error
0
2
4
6
8
0
5
10
15
20
25
30


second class error
Test error
Train error
0
10
20
30
40
0
20
40
60
80
100
120


third class error
Test error
Train error
0
1
2
3
4
5
0
5
10
15
20
25
30



After 30 iterations depending on the shuffle(**if no shuffle is done the algorithm starts to forget what it had learned giving a 60% accuracy**) it could be between 85 and 96(class 2-3) if you see a value **-1 in f-score this means N/A where tp and tn were both 0**.