IE 613: Assignment 2

Submitted by: Aakash Banik (16i190010)

Question 1:

To Show: Follow-the-Regularized-Leader (FoReL) with linear loss functions and negative entropy as the regularizer is equivalent to Weighted Majority algorithm.

$$\begin{aligned} w_t &= \underset{w \in K}{argmin} \sum_{s=1}^{t-1} < w, v_s > + \frac{1}{\eta} < w, \log w > \\ &= \underset{w \in K}{argmin} \sum_{s=1}^{t-1} \sum_{j=1}^{d} w_j v_{s,j} + \frac{1}{\eta} \sum_{j=1}^{d} w_j \log w_j \\ &= \varphi(w) \text{ [Say]} \end{aligned}$$

Now,

$$\frac{\partial \varphi(w)}{\partial w_j} = 0$$

$$\Rightarrow \sum_{s=1}^{t} v_{s,j} + \frac{1}{\eta} \left[\log w_j + w_j \frac{1}{w_j} \right] = 0$$

$$\Rightarrow \log w_j = -\eta \sum_{s=1}^{t} v_{s,j} - 1$$

$$\Rightarrow w_j = \exp^{-\eta \left(\sum_{s=1}^{t} v_{s,j} - 1 \right)}$$

which is the w_j that we use to update in the Weighted Majority Algorithm.

Question 2:

File: ex2a.py

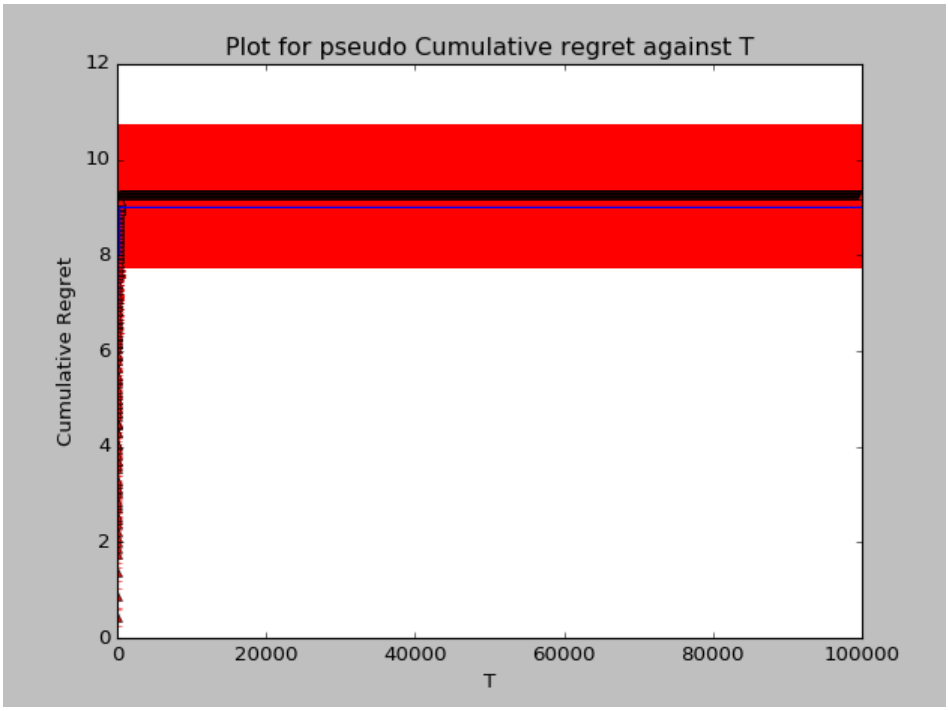

Figure 1: Plot for (pseudo) cumulative regret vs T for FTL

Question 3:

File: ex3.py
Since we proved the equivalence of WM algorithm and FoReL, we used it to get the following output.

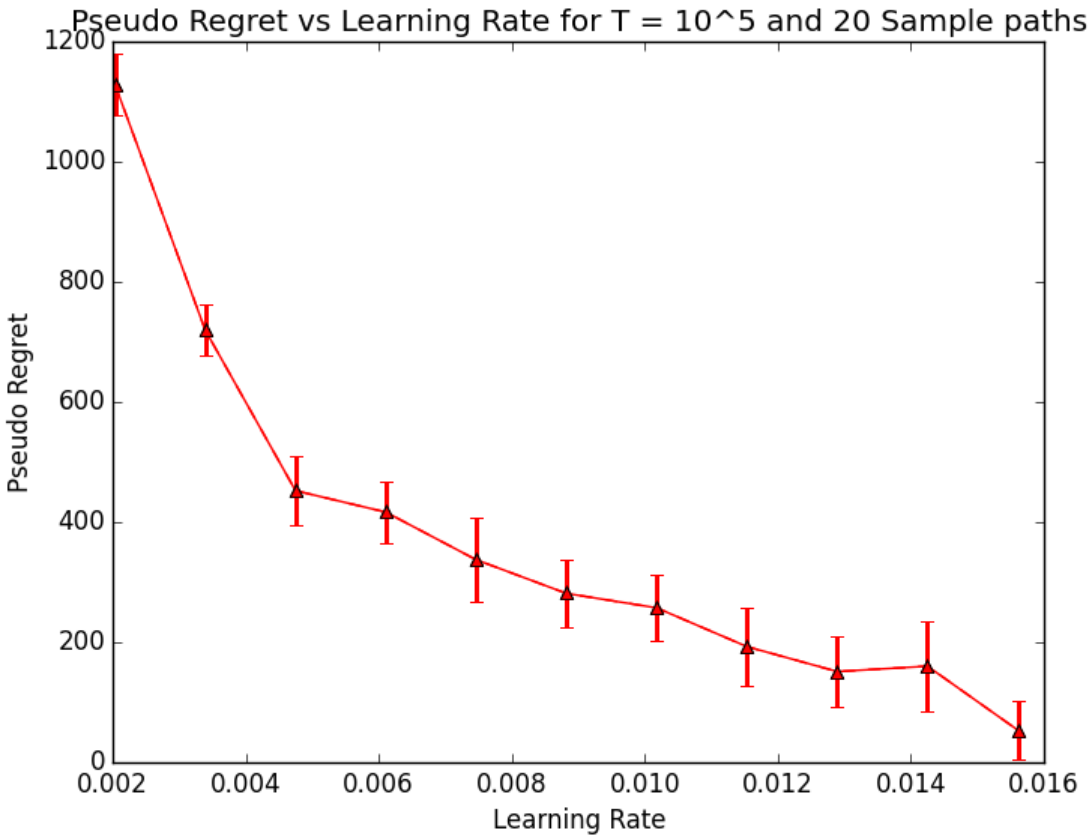

Figure 2: Pseudo Regret of FoReL for T = 10**5 and 20 Sample paths

Question 4:

File: ex4a.py,ex4b.py,ex4c.py

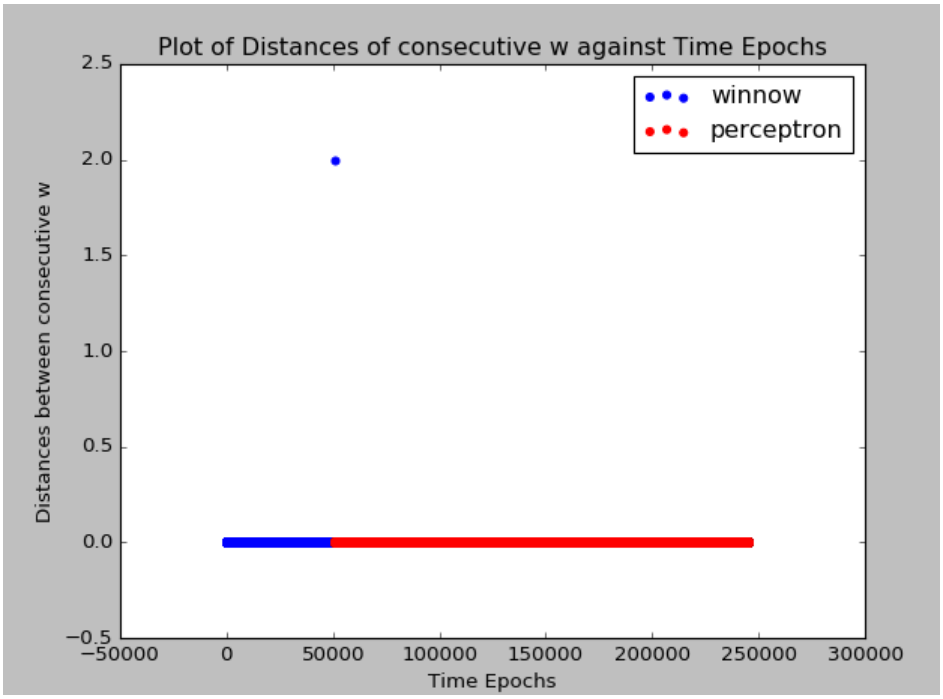

Figure 3: Plot of Distances of consecutive w against Time Epochs for Skin Segmentation Dataset

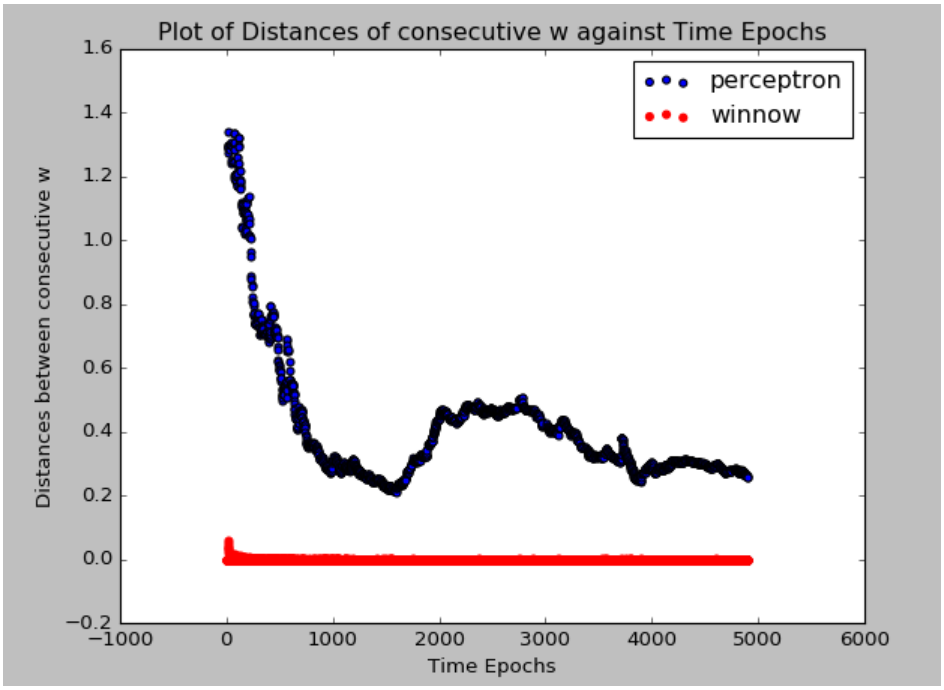

Figure 4: Plot of Distances of consecutive w against Time Epochs for Online News Popularity Dataset

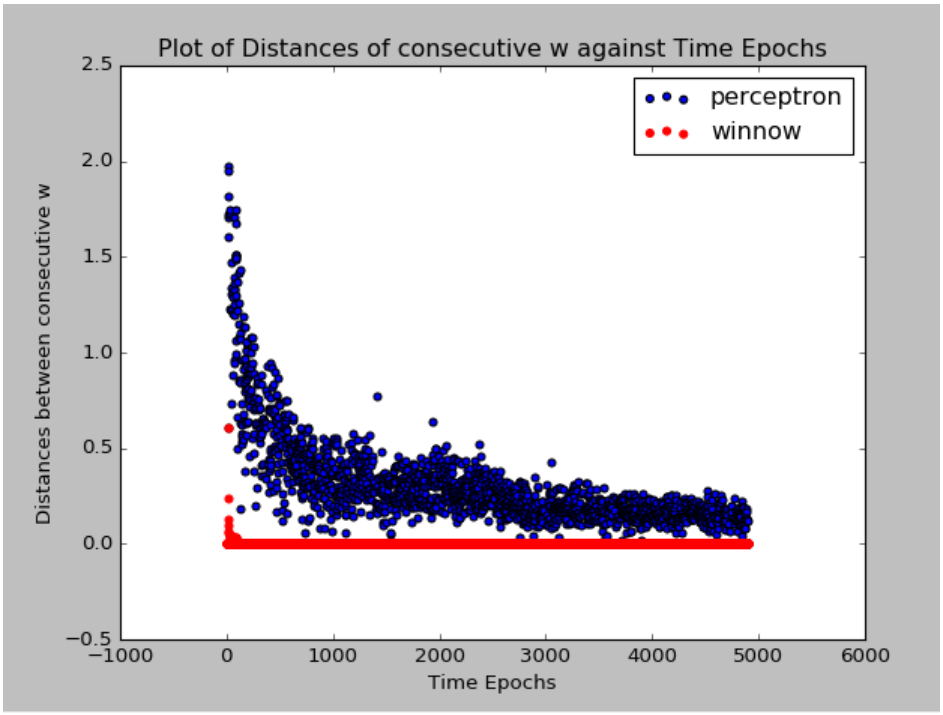

Figure 5: Plot of Distances of consecutive w against Time Epochs for Wine Quality Dataset

Question 6:

File: ex6a.py

```
>>> runfile('C:/Users/Aak/Desktop/Sem IV/IE 613/Assignment 2/ex6a.py', wdir='C:/Us
ers/Aak/Desktop/Sem IV/IE 613/Assignment 2')
No. of mistakes for Perceptron is: 5
Estimate of gamma is:  0.04151814921
Mistake Bound for perceptron is:  416.694159155
No. of Mistakes for Winnow is:  1004 when value of eta is:  0.05
No. of Mistakes for Winnow is:  1004 when value of eta is:  0.1
No. of Mistakes for Winnow is:  1004 when value of eta is:  0.15
No. of Mistakes for Winnow is:  1004 when value of eta is:  0.2
No. of Mistakes for Winnow is:  1004 when value of eta is:  0.25
No. of Mistakes for Winnow is:  1004 when value of eta is:  0.3
No. of Mistakes for Winnow is:  1004 when value of eta is:  0.35
No. of Mistakes for Winnow is:  1004 when value of eta is:  0.4
No. of Mistakes for Winnow is:  1004 when value of eta is:  0.45
No. of Mistakes for Winnow is:  1004 when value of eta is:  0.5
>>>
```

Figure 6: Output for question 6

No. of mistakes for Perceptron is: 5
Estimate of gamma is: 0.04151814921
Mistake Bound for perceptron is: 416.694159155
No. of Mistakes for Winnow is: 1004 when value of eta is: 0.05
No. of Mistakes for Winnow is: 1004 when value of eta is: 0.1
No. of Mistakes for Winnow is: 1004 when value of eta is: 0.15
No. of Mistakes for Winnow is: 1004 when value of eta is: 0.2
No. of Mistakes for Winnow is: 1004 when value of eta is: 0.25
No. of Mistakes for Winnow is: 1004 when value of eta is: 0.3
No. of Mistakes for Winnow is: 1004 when value of eta is: 0.35
No. of Mistakes for Winnow is: 1004 when value of eta is: 0.4
No. of Mistakes for Winnow is: 1004 when value of eta is: 0.45
No. of Mistakes for Winnow is: 1004 when value of eta is: 0.5