

Introduction

The project was done using Python. For the first part of the project, two synthetic datasets with drift were generated with AGRAWAL and SEA methods respectively, and the two real datasets were imported to the work-space. Then the classification models that were given in the report were implemented using Python libraries. Finally, the HoeffdingTreeClassifier ensemble method was implemented from scratch and accuracy of all the classifiers were reported.

Interleaved Test-Then-Train method was used for training and for the accuracy evaluation of the classifiers for each dataset. Prequential accuracy plot with sliding windows and overall accuracy was reported for all the classifiers and datasets. For the AGRAWALDataset, sliding windows prequential plots as well as total accuracy vs. total number of samples prequential plots were given. This was done for one dataset because this step was not required for the project but provided good insight on the overall performance of the classifiers.

Results

ARF- AGRAWALDataset

Prequential Evaluation

[100%] [608.47s]

ARF - Accuracy : 0.9890

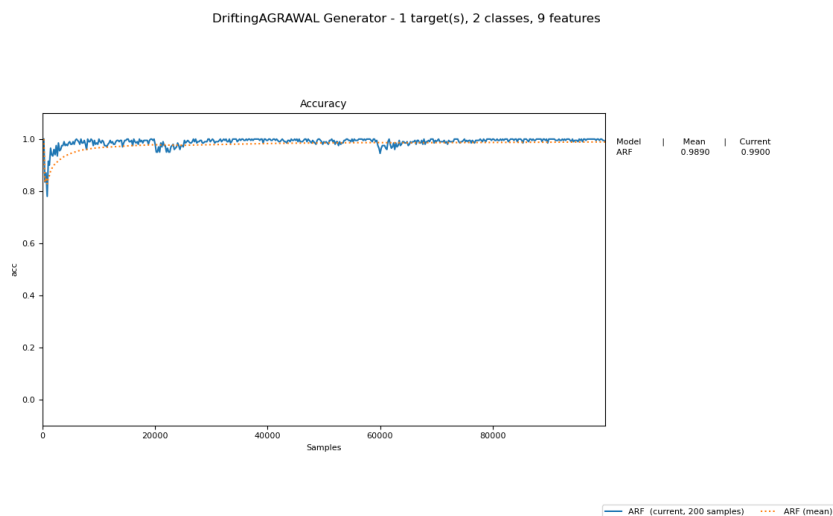


Figure 1- Prequential Accuracy Plot(ARF-ARGWAL)

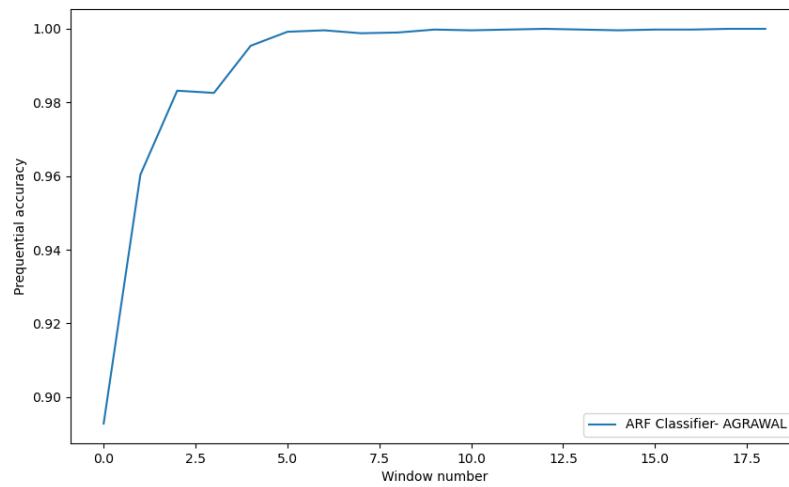


Figure 2- Sliding Window Prequential Accuracy Plot(ARF-ARGWAL)

Overall accuracy of ARF Classifier- AGRAWAL: 0.9905

SAM-KNN- AGRAWALDataset

Prequential Evaluation

[100%] [71.11s]

SAM_kNN - Accuracy : 0.6632

DriftingAGRAWAL Generator - 1 target(s), 2 classes, 9 features

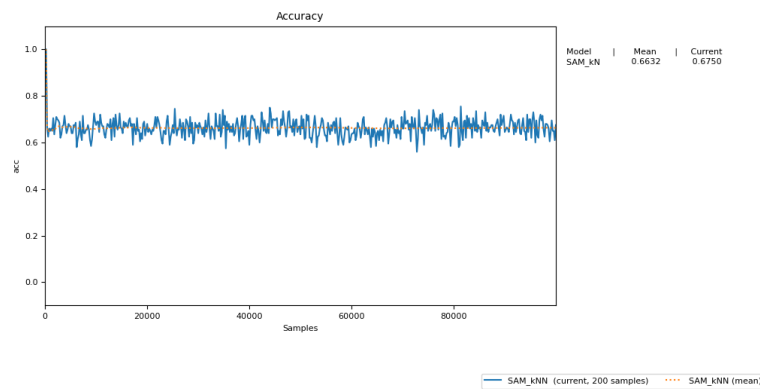


Figure 3- Prequential Accuracy Plot(SAM-KNN-ARGWAL)

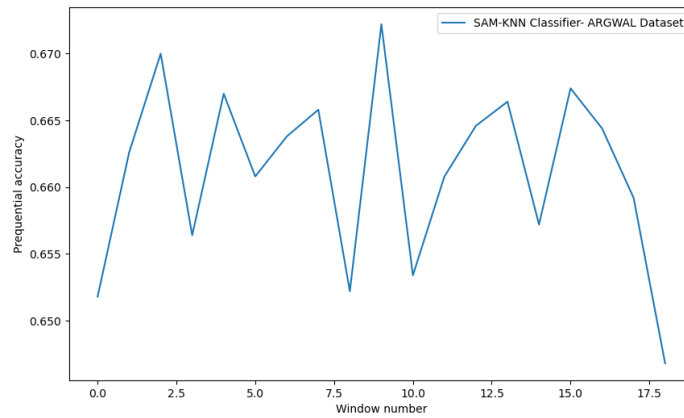


Figure 4- Sliding Window Prequential Accuracy Plot(SAM-KNN-ARGWAL)

Overall accuracy of SAM-KNN Classifier- ARGWAL Dataset: 0.6614

SRP- AGRAWALDataset

Prequential Evaluation

#####----- [40%] [3037.54s]

SRP - Accuracy : 1.0000

DriftingAGRAWAL Generator - 1 target(s), 2 classes, 9 features

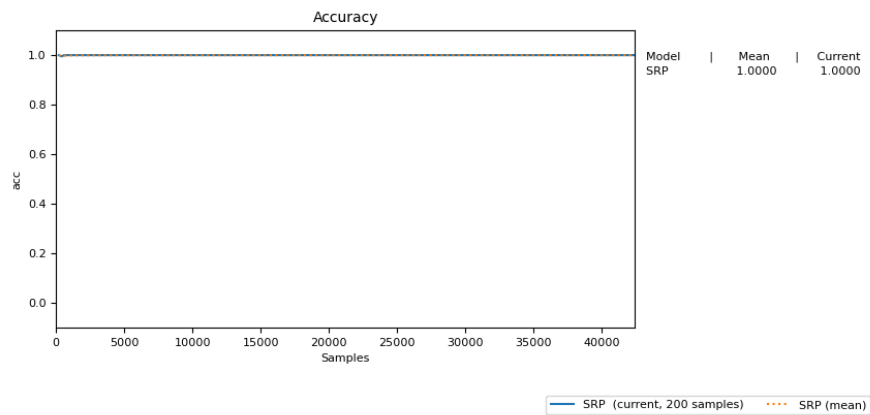


Figure 5- Prequential Accuracy Plot(SRP-ARGWAL)

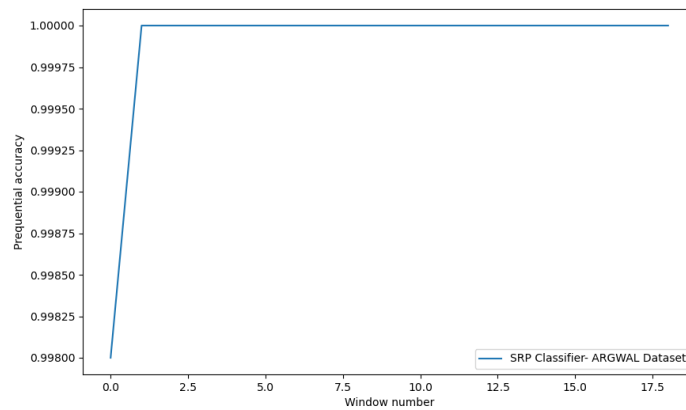


Figure 6- Sliding Window Prequential Accuracy Plot(SRP-ARGWAL)

Overall accuracy of SRP Classifier- ARGWAL Dataset: 0.9999

For ARGWAL dataset, SRP method was bugged for me. I tried decreasing the number of classifiers but kept getting the accuracy as 1.

DWM- AGRAWALDataset

Prequential Evaluation

[100%] [103.72s]

DWM - Accuracy : 0.8771

DriftingAGRAWAL Generator - 1 target(s), 2 classes, 9 features

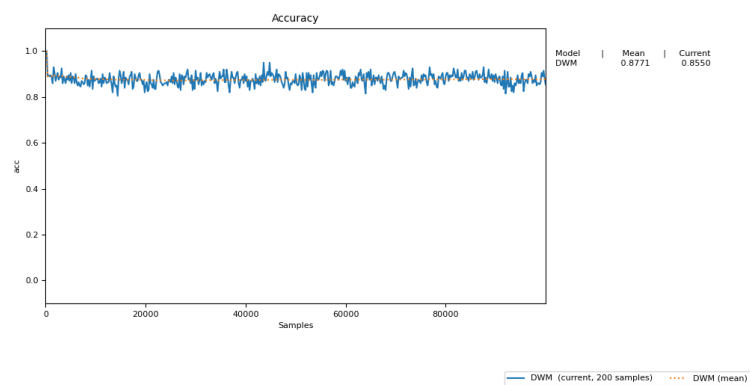


Figure 7- Prequential Accuracy Plot(DWM-ARGWAL)

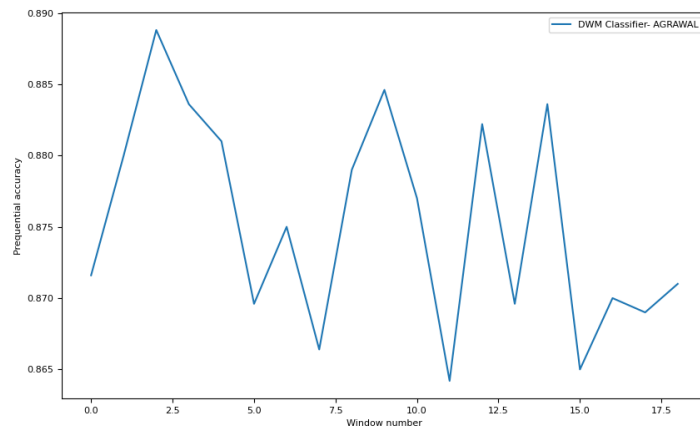


Figure 8- Sliding Window Prequential Accuracy Plot(DWM-ARGWAL)

Overall accuracy of DWM Classifier- AGRAWAL: 0.8754

Ensemble- AGRAWALDataset

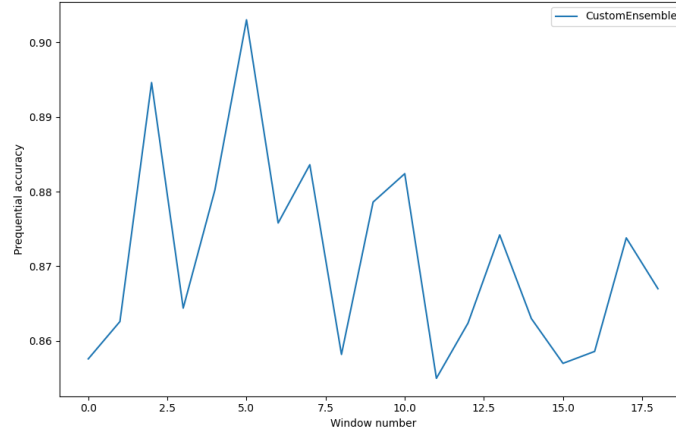


Figure 9- Sliding Window Prequential Accuracy Plot(Ensemble-ARGWAL)

Overall accuracy of CustomEnsemble: 0.8706

ARF- SEADataset

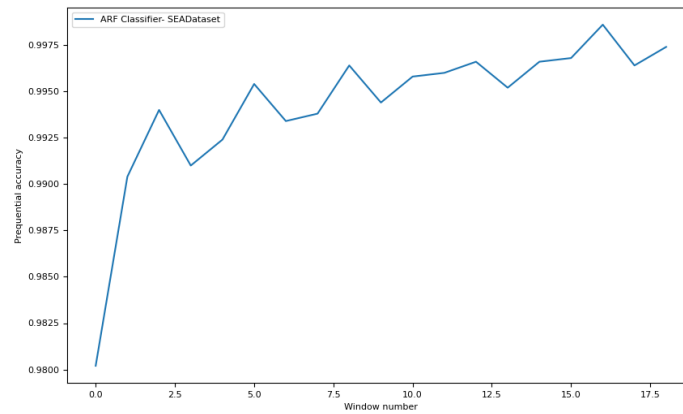


Figure 10- Sliding Window Prequential Accuracy Plot(ARF-SEA)

Overall accuracy of ARF Classifier- SEADataset: 0.9943

SAM-KNN- SEADataset

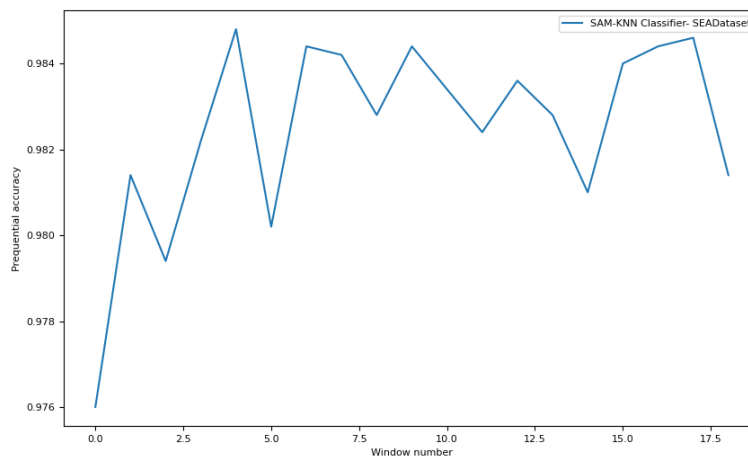


Figure 11- Sliding Window Prequential Accuracy Plot(SAM-KNN-SEA)

Overall accuracy of SAM-KNN Classifier- SEADataset: 0.9827

SRP- SEADataset

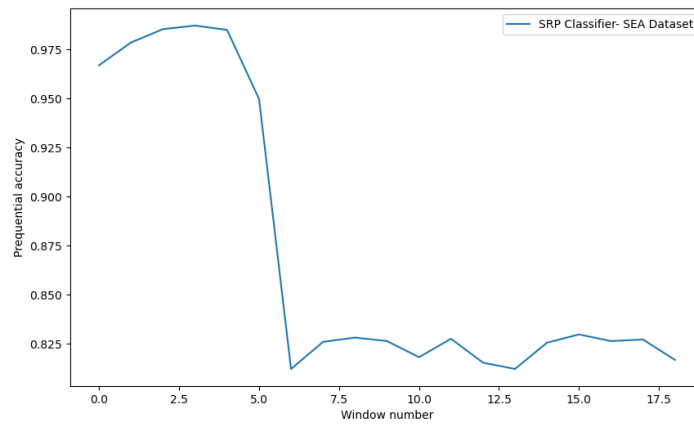


Figure 12- Sliding Window Prequential Accuracy Plot(SRP-SEA)

Overall accuracy of SRP Classifier- SEA Dataset: 0.8683

DWM- SEADataset

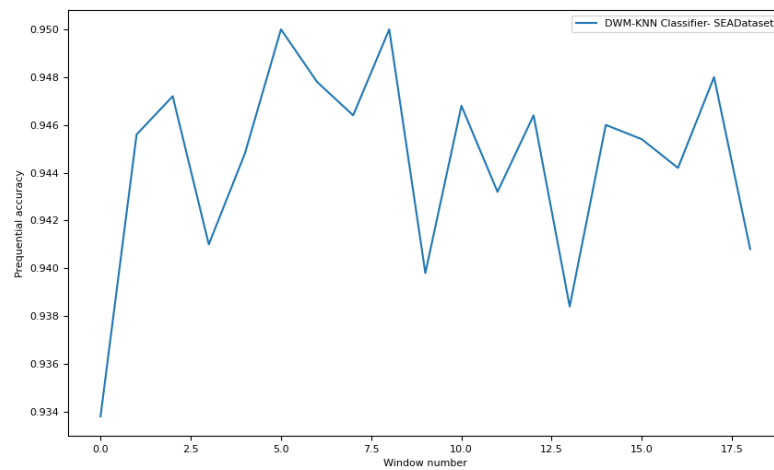


Figure 13- Sliding Window Prequential Accuracy Plot(DWM-SEA)

Overall accuracy of DWM-KNN Classifier- SEADataset: 0.9446

Ensemble- SEADataset

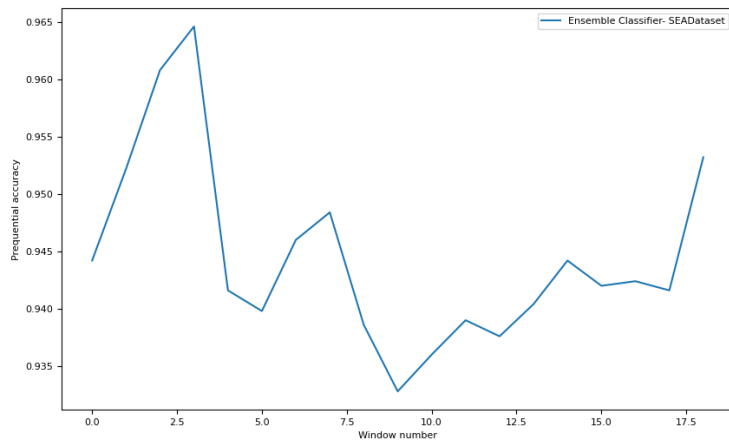


Figure 14- Sliding Window Prequential Accuracy Plot(Ensemble-SEA)

Overall accuracy of Ensemble Classifier- SEADataset: 0.9445

ARF- Spam Dataset

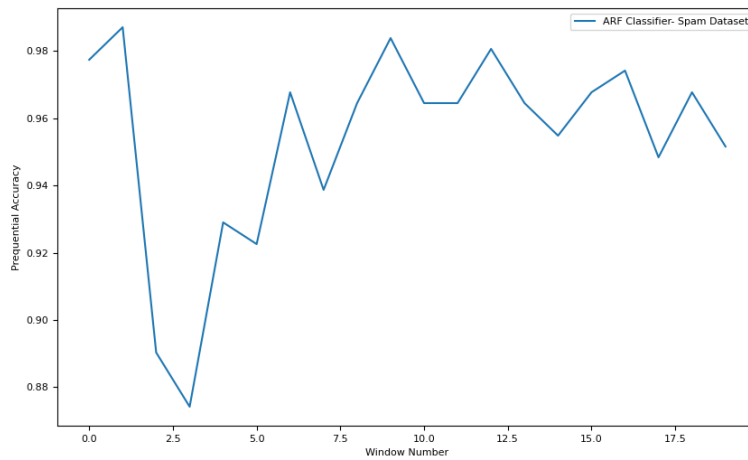


Figure 15- Sliding Window Prequential Accuracy Plot(ARF-Spam)

Overall accuracy of ARF Classifier- Spam Dataset: 0.9538

SAM-KNN- Spam Dataset

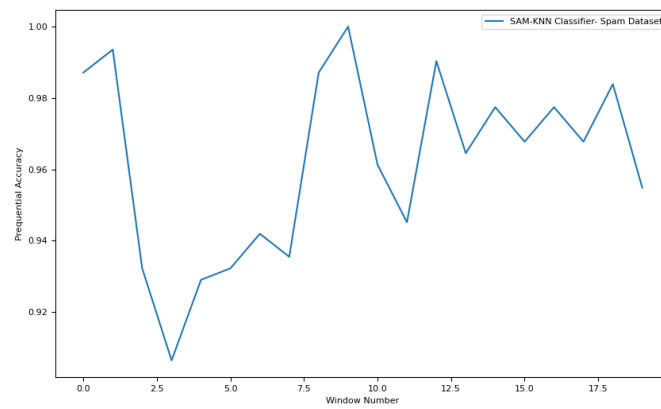


Figure 16- Sliding Window Prequential Accuracy Plot(SAM-KNN-Spam)

Overall accuracy of SAM-KNN Classifier- Spam Dataset: 0.9619

SRP- Spam Dataset

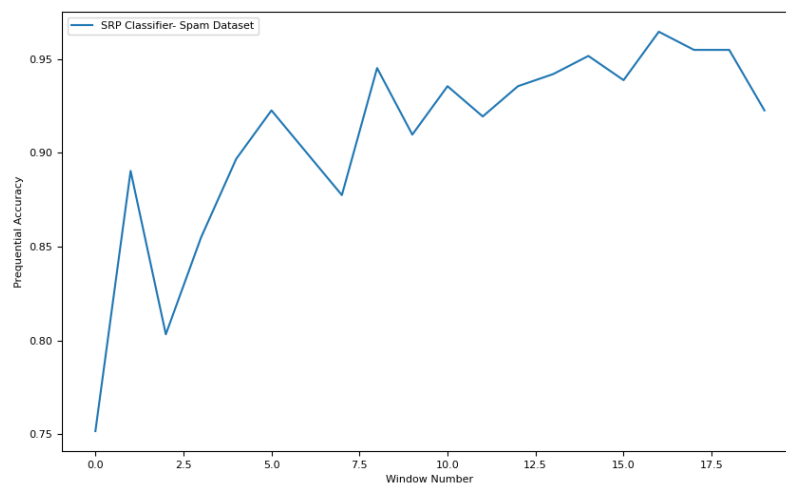


Figure 17- Sliding Window Prequential Accuracy Plot(SRP-Spam)

Overall accuracy of SRP Classifier- Spam Dataset: 0.9087

DWM- Spam Dataset

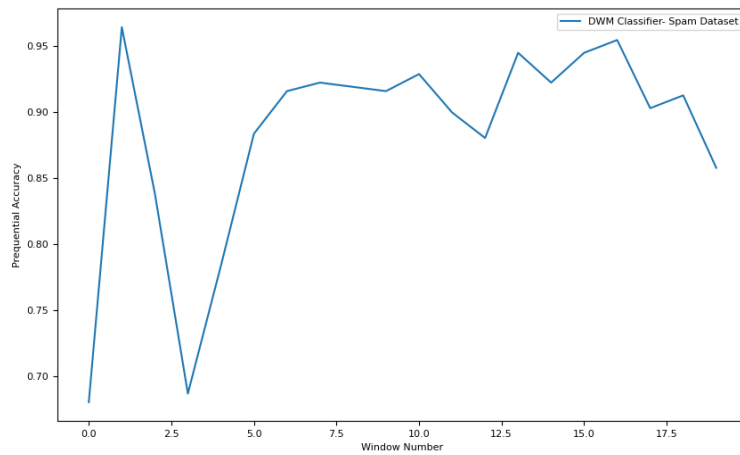


Figure 18- Sliding Window Prequential Accuracy Plot(DWM-Spam)

Overall accuracy of DWM Classifier- Spam Dataset: 0.8835

Ensemble- Spam Dataset

spam.csv - 1 target(s), 2 classes

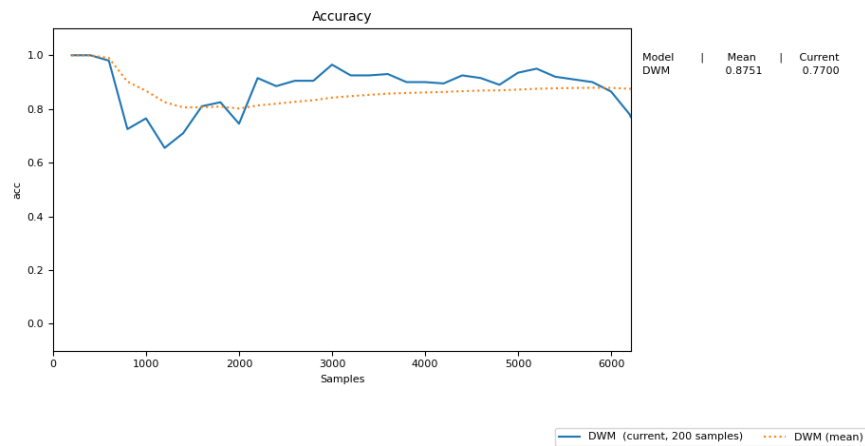


Figure 19- Prequential Accuracy Plot(Ensemble-Spam)

Accidentally wrote DWM on plot but ensemble.

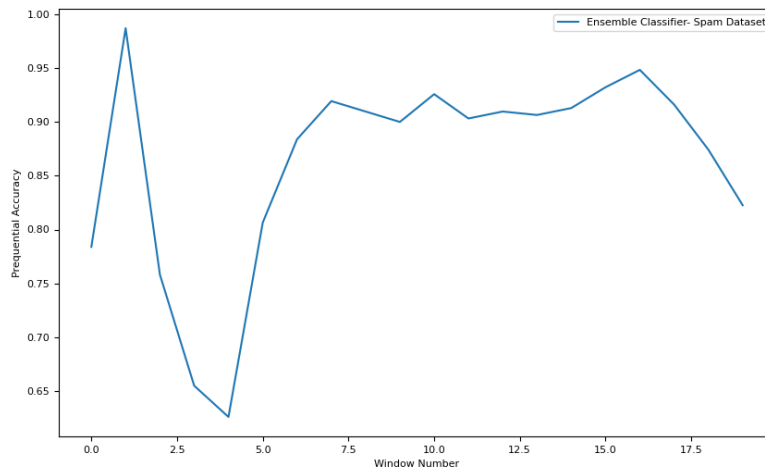


Figure 20- Sliding Window Prequential Accuracy Plot(Ensemble-Spam)

Overall accuracy of Ensemble Classifier- Spam Dataset: 0.8640

ARF- Electricity Dataset

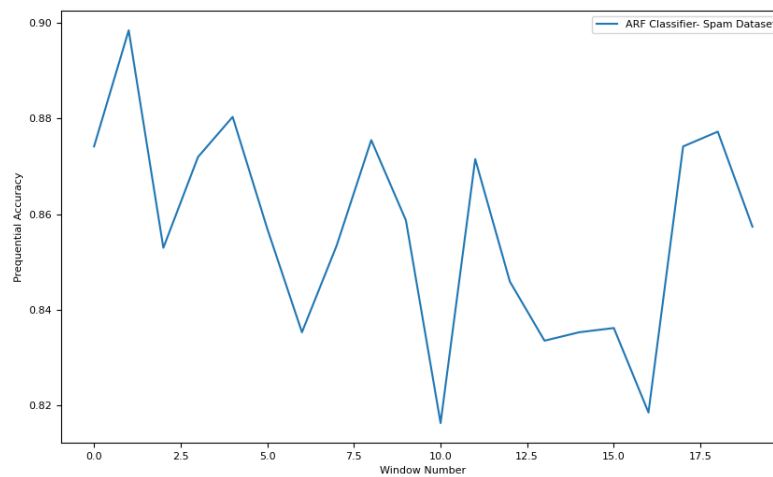


Figure 21- Sliding Window Prequential Accuracy Plot(ARF-Electricity)

Overall accuracy of ARF Classifier- Spam Dataset: 0.8562

SAM-KNN- Electricity Dataset

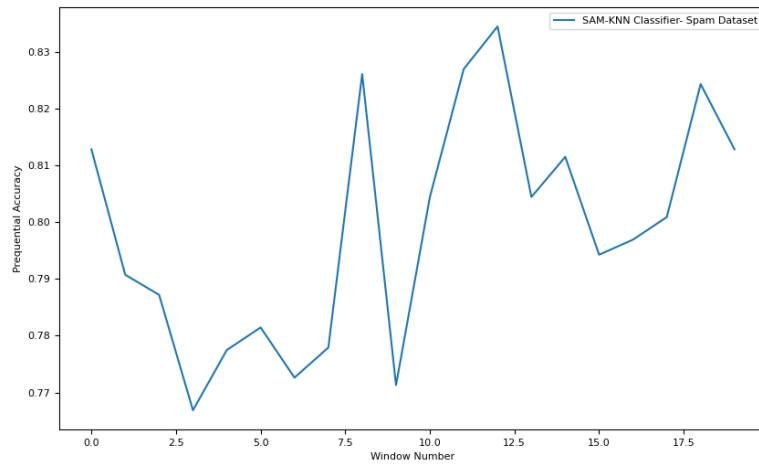


Figure 22- Sliding Window Prequential Accuracy Plot(SAM-KNN-Electricity)

Overall accuracy of SAM-KNN Classifier- Spam Dataset: 0.7988

SRP- Electricity Dataset

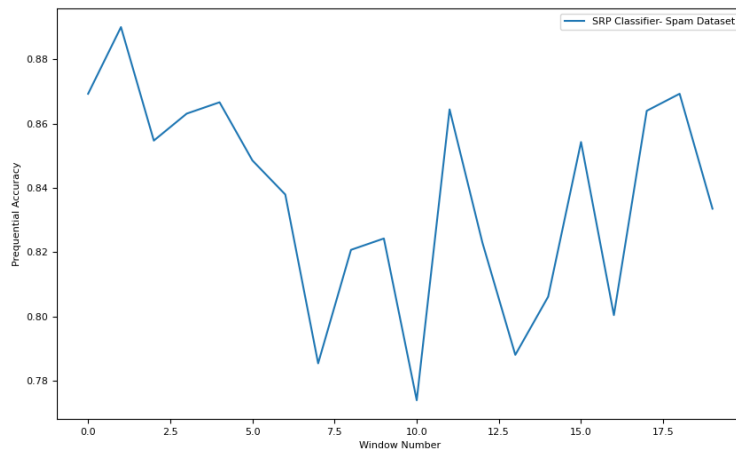


Figure 23- Sliding Window Prequential Accuracy Plot(SRP-Electricity)

Overall accuracy of SRP Classifier- Spam Dataset: 0.8369

DWM- Electricity Dataset

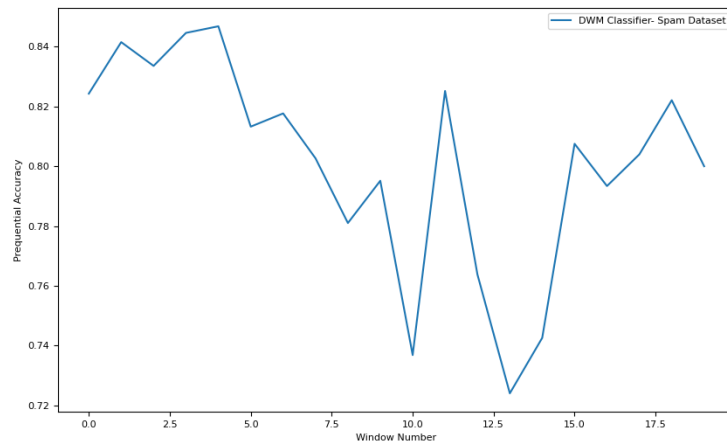


Figure 24- Sliding Window Prequential Accuracy Plot(DWM-Electricity)

Overall accuracy of DWM Classifier- Spam Dataset: 0.8010

Ensemble- Electricity Dataset

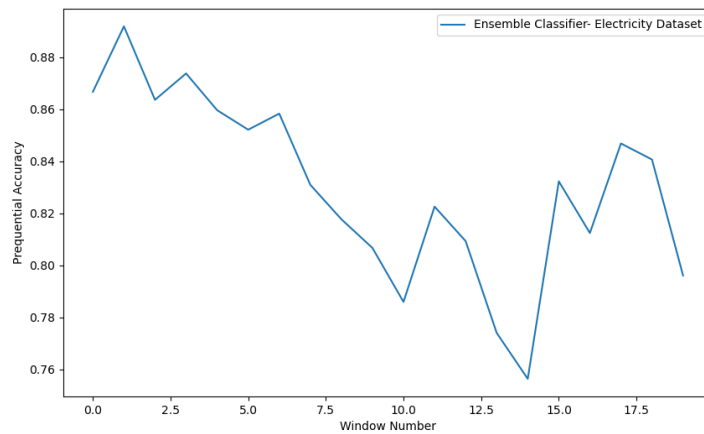


Figure 25- Sliding Window Prequential Accuracy Plot(Ensemble-Electricity)

Overall accuracy of Ensemble Classifier- Electricity Dataset: 0.8298

Discussion

For the electricity dataset ensemble performed better than DWM and SRP but the ensemble training time was much greater than those two methods. On spam dataset, ensemble classifier performed the worst across the classifiers. On synthetic datasets, ARF classifier performed the best, but this is probably due to the fact that ARF classifier training took the most time, reflecting the model's complexity. For better results, model's complexity can be adjusted to be more similar. Not only ARF but other model's accuracy was also high, this might be due to generated synthetic datasets having less drift compared to real datasets. So ensemble models did not perform particularly well in this case compared to other classifiers.

To enhance the robustness of the ensemble, we can include the utilization of advanced drift detection mechanisms, the incorporation of a greater variety of base learners into the ensemble, and the exploration of ensemble learning strategies such as stacking or boosting. By implementing these enhancements, we can potentially improve the ensemble's performance.

The declines in the prequential accuracy plot signify intervals during which the models encounter a decline in their predictive accuracy. This decline can be attributed to concept drift in the data, which means the alteration of the underlying data distribution and resulting in a deterioration of the model's performance. These accuracy drops emphasize the necessity of effectively adapting the models to address concept drift, which may involve updating the models.

For this project, the focus was on implementing and assessing classification models made for data streams with concept drift. Employing the Interleaved Test-Then-Train methodology, both the overall accuracy and prequential accuracy of these models were computed. By comparing the ensemble model's performance against state-of-the-art approaches, potential areas for enhancement were underlined. The prequential accuracy plot proved invaluable in discerning the model's performance trends, revealing accuracy declines during concept drift phases. Ultimately, this assignment provided practical experience in effectively managing concept drift in data streams and evaluating classification model performance under such circumstances.