IDP – COMMUNICATION

WIFI-SENSING

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1 Data Handling

- Every .dat file consists of 3*30*30000 samples,
  3 $\implies$ no. of receivers[a,b,c].
  30 $\implies$ Sub carriers[1,2,....,30]
  30,000 $\implies$ Samples over time. For 30 sec while Sampling rate = 1kHz
- All the CSI magnitude plots are more or less the same w.r.t carrier index.While they differ w.r.t receiver indices.So as to increase the dataset , we divided the whole 30 sec sample of one recording into 6 "5-SECOND" chunks.
- We considered the 'b' receiver only .
  The dataset values of the features are the mean of the corresponding feature(statistical parameter) calculated over all 30 subcarriers.
- For e.g : S(i) :CSI magnitude of subcarrier of index i
  noact-1-01 : noactivity-01.dat file 's 1st 5 sec chunk
- Since the data has been parsed each part has 6000 samples.The data point 'noact-1-01'deals with 1*30*6000 samples.

$$Varianceofnoact-1-01 = \frac{Var(S(1)) + Var(S(2)) + ... + Var(S(30))}{30} \tag{1}$$

2 CLASSIFIER

We were provided a data set which has fewer "no-activity" datapoints comapared to "activity". Mathematically it is of the ratio 1:60. .Hence we chose a **One class SVM** model for classifiaction.

2.1 Breif description

This algorithm is usually used for outlier detection, and since we have fewer noactivity cases we fed them as outliers. Please refer to Analysis-submission.ipynb file shared in the mail thread to look at our analysis in selecting variance and Interquartile range as features.

2.2 Features for classification

We used the below statistical parameters as features we considered the magnitude of the CSI values at present. We chose only 'b' receiver and computed the features.

2.2.1 Variance

Once the magnitude of all the CSI samples are calculated we wanted to exploit on the difference vairances between noactivity and activity datapoints.

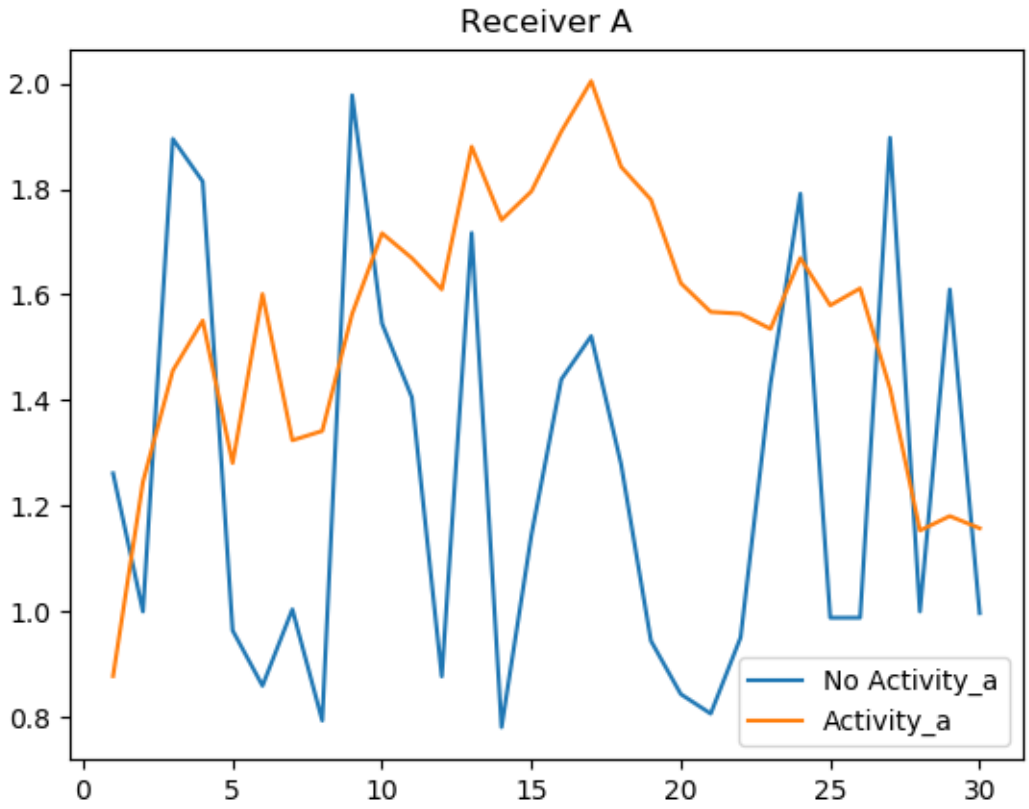

Figure 1: Receiver A

2.2.2 Inter Quartile Range

In simple words an interquartile range is a measure of where the bulk of the values lie. In order to calculate the interquartile range we have to arrange the data in ascending order and then apply the below given formula.

$$IQR = Q_3 – Q_1 \tag{2}$$

where, Q3 is the median of second half of data and Q1 is the median of first half of data.

2.2.3 Reason for considering receiver b only

- Please refer Figure 1, 2 and 3 for the comparision of No Activity data and Activity Data for Receiver A,B and C respectively.

3 What next

- As of now we have considered only the amplitude of CSI and have used CSI Amplitude variance and CSI Amplitude interquartile range as features for ML model trained.

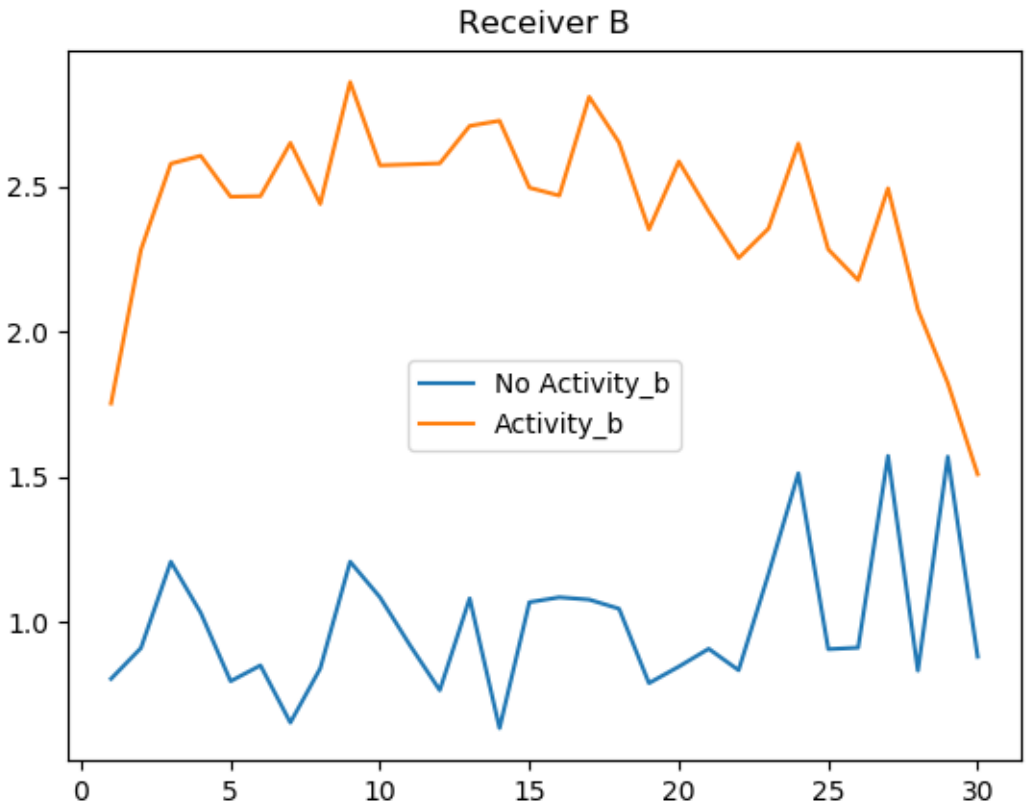

Figure 2: Receiver B

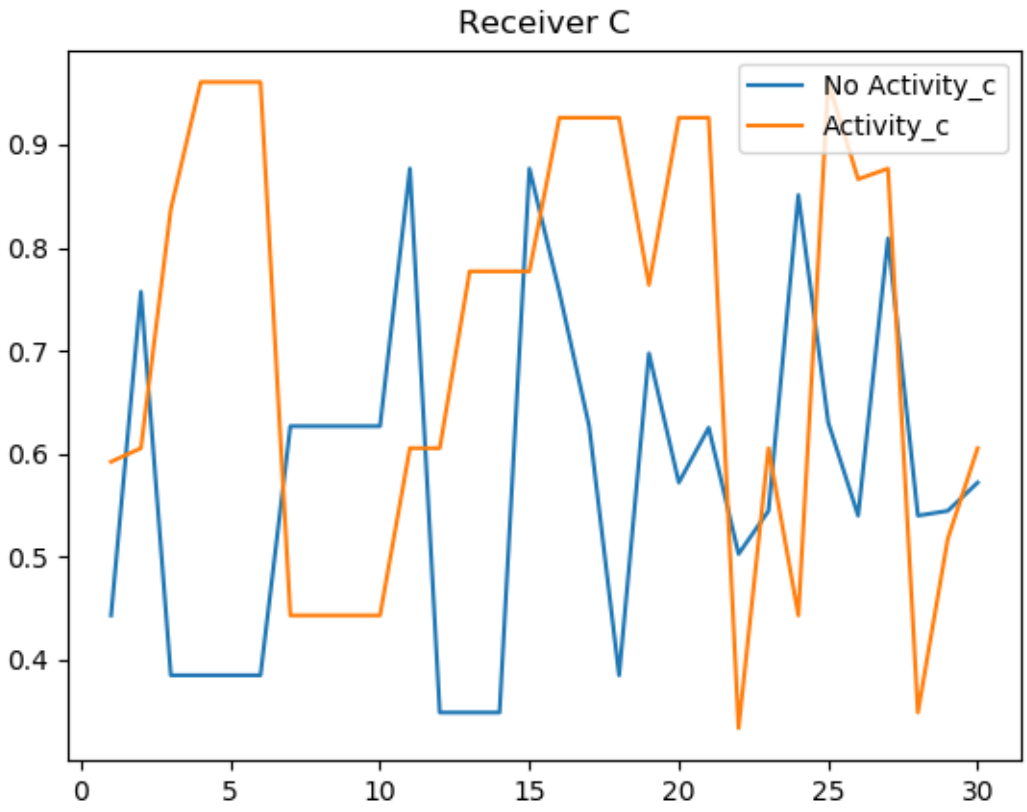

Figure 3: Receiver C

- In some of research papers, entropy and median deviation were also considered as features for amplitude. We are trying to optimize them as right now we are not getting promising results in our analysis of entropy and median deviation.
- With these features we are getting an accuracy of around 98.67%.
- So now we are working to improve the accuracy by exploring other features like phase difference and frequency.
- Similar to how human motion causes distortion to amplitude of CSI, phase difference between two recievers also gets distorted because of human motion.
- Phase difference can also be used to differentiate between simple human motion(standing, walking etc...) and intense human motion(like fighting or falling etc...).
- Because of Doppler effect(which comes into picture because of relative motion between human and transceivers) frequency will also get changed.
- From frequency analysis we can also calculate the direction of human motion and also the velocity of human motion. We would require a bit more complex dataset for this.
- But right now we are facing some difficulties in calculating phase difference and doing analysis using frequency.

4 References

- https://ieeexplore.ieee.org/document/8794643
- https://www.mdpi.com/1424-8220/18/10/3379