EE/CprE/SE 491 - sddec22-13
Simultaneous Call Transmission (SCT)
Week 9

April 4th, 2022 - April 10th, 2022
Client: Collins Aerospace
Faculty Advisor: Dr. Andrew Bolstad

Team Members

- Hani El-Zein - *Digital Signal Processing Lead and Research*
- Sullivan Jahnke - *Project Manager and Machine Learning Co-Lead*
- Tyler Mork - *Reports and Communication Systems Co-Lead*
- Json Rangel - Reports, *Webmaster, and Communication Systems Co-Lead*
- Austin Rognes - *Research and Machine Learning Co-Lead*

Week 9 Summary

Week 9 consisted of continuous adjustments on the complex baseband simulation. Current problems have arisen when implementing low pass filters and have delayed further progress on proper data extraction. Currently, the extracted data is taken at a sampling rate of 48 kHz across a 0 to 25 kHz bandwidth. This causes a massive quantity of data that is unneeded in the long run. A low pass filter and extraction could reduce the size of the data significantly.

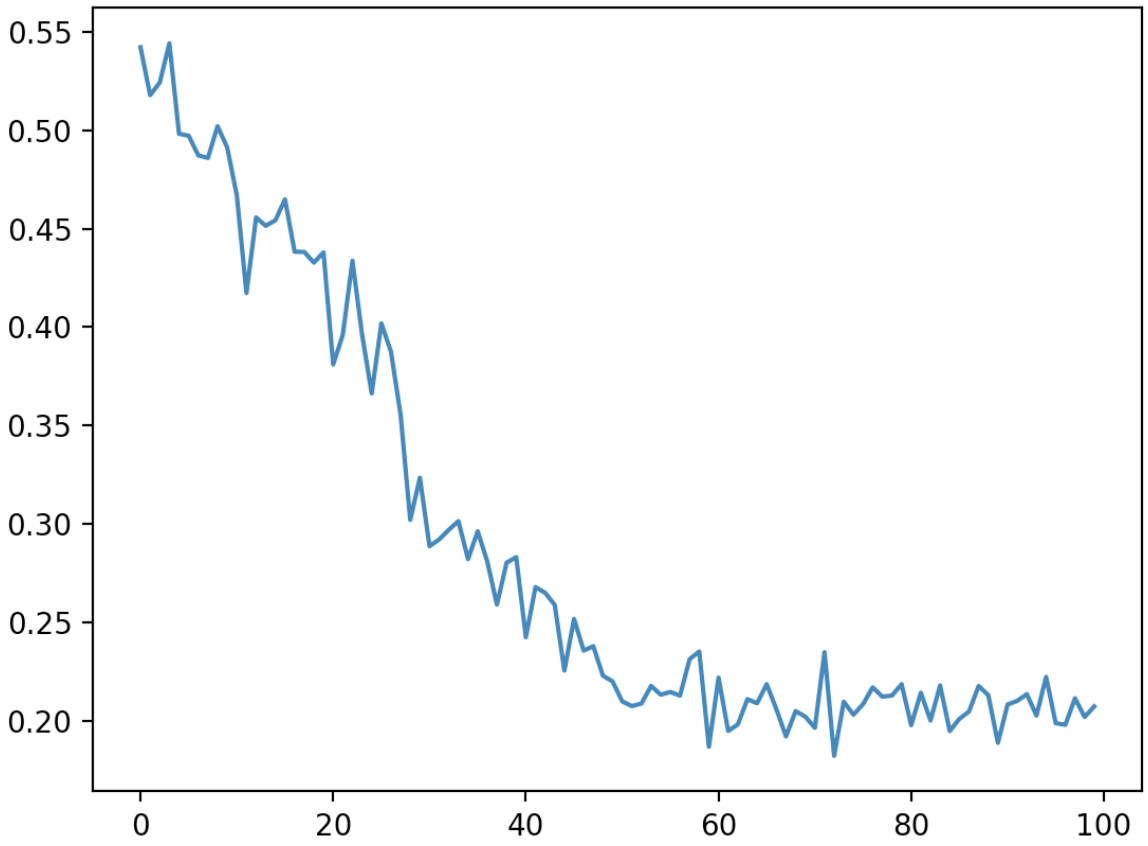
Further attempts at adjusting the current algorithm setup to that of the intended data import has been made as well. Through discussion, it was realized that import data will be a 2-Dimensional array consisting of real and imaginary vectors. The data will require Fourier Transformed as well as converted into phase and magnitude vectors. Python allows for 2-Dimensional Fourier Transforms and will require phase and magnitude calculations by using the real and imaginary array data.

More discussions will be required in regard to parsing the imported data and the ideal length of data required to effectively run the algorithm. Data will consist of multiple scenario simulations where an interference is present, not present, continuously present, and introduced at a delay. Noise is expected to be present at all times of transmission. Doppler effect and other signal phenomena will be introduced at a later period when the algorithm can efficiently operate under the above conditions.

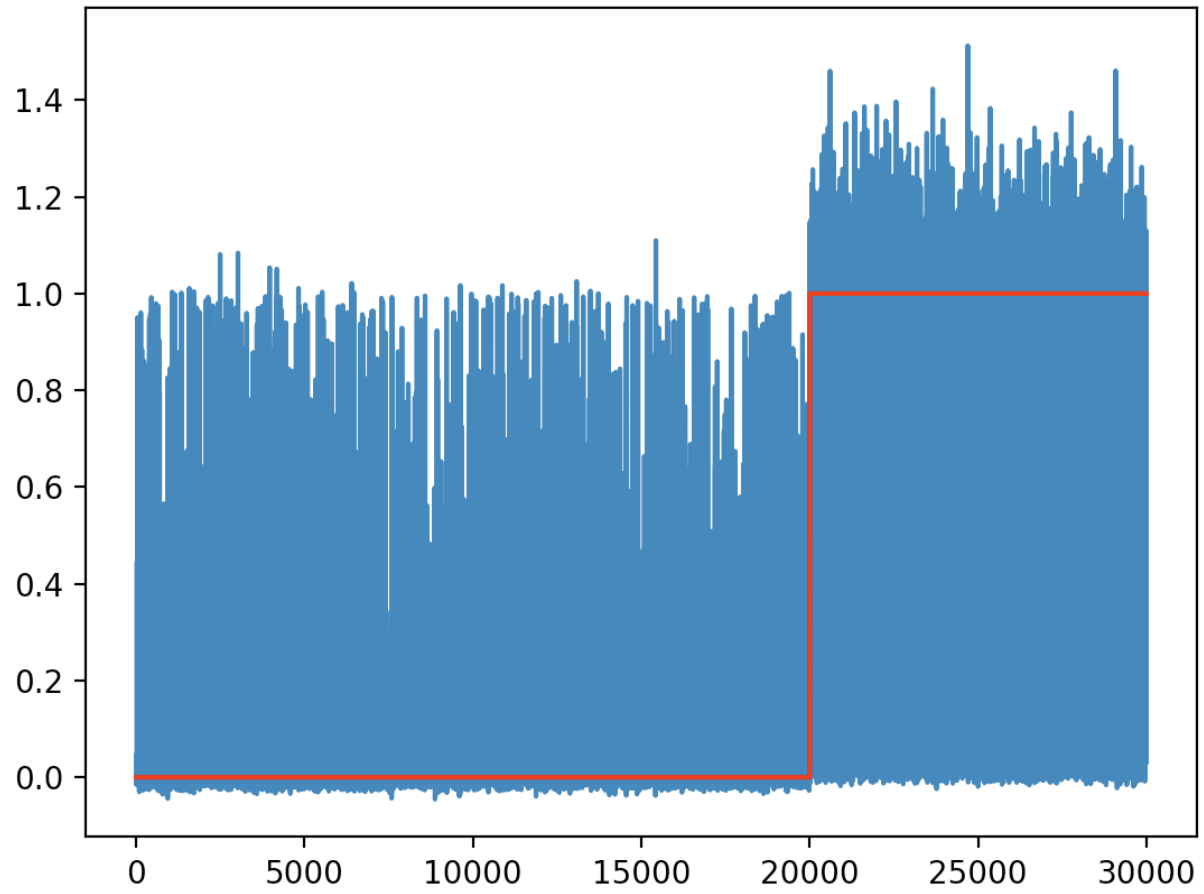
Past Week Accomplishments

Our machine learning algorithm successfully trained on a generated sample set. 20,000 random waves and 10,000 SCT waves were generated. SCT waves were generated by combining some portions of 2 random waves by averaging them. This is unrealistic to what actually happens but is a start in the right direction. Random waves

were labeled 0 and SCT waves were labeled 1. Then the ML algorithm was run through 100 epochs. Below is the training accuracy:



It had about a 20% miss rate, not the best but definitely visible. When ran on a new set of random data and SCT data, this is the plot we got:



The red line shows what each wave should be labeled as, 0s first, then 1s for SCT events. The blue is the predicted outcome.

Individual Contributions

Team Member	Contribution	Weekly Hours	Total Hours
Hani El-Zein	Matlab practice	2	24
Sullivan Jahnke	Python Tensorflow Keras algorithm	3	31.5
Tyler Mork	Further contribution to complex baseband simulation. Errors and filtering adjustments and additions to optimize training data	5	35.5
Json Rangel	Digital baseband modulation practice within Simulink. Additional research into complex baseband. Uploaded extremely basic IQ demodulation model to GitHub repository.	2	32
Austin Rognes	Python Tensorflow Keras algorithm	4	26

Plans for Upcoming Week

Further ground is to be made on implementing low pass filters into the complex baseband simulation. It is intended to design them such that the bandwidth is reduced to near audio range. This would allow for reduced sampling rates and smaller data files. The next step following would be to export the data as .mat files or find a proper way to convert to .csv files.

The algorithm will be further adjusted to compensate for the raw data being imported and work will be performed to apply fourier transformations and mathematical conversions to phase and magnitude. Phase and magnitude is our assumed method of depicting an SCT event where they can be plotted as a phasor. A single transmission results in a single phasor consistently rotating or moving about the origin in a certain direction. An interfering signal would cause a second phasor to be produced with different phase and magnitude. Detecting that event would establish our method of SCT event detection.