



## **Assignment#3 Modulation Classification (Total 100Points)**

Submit a report and the codes used. Report should detail and illustrate every step in the assignment. Report will worth (25 points).

### **Problem Statement**

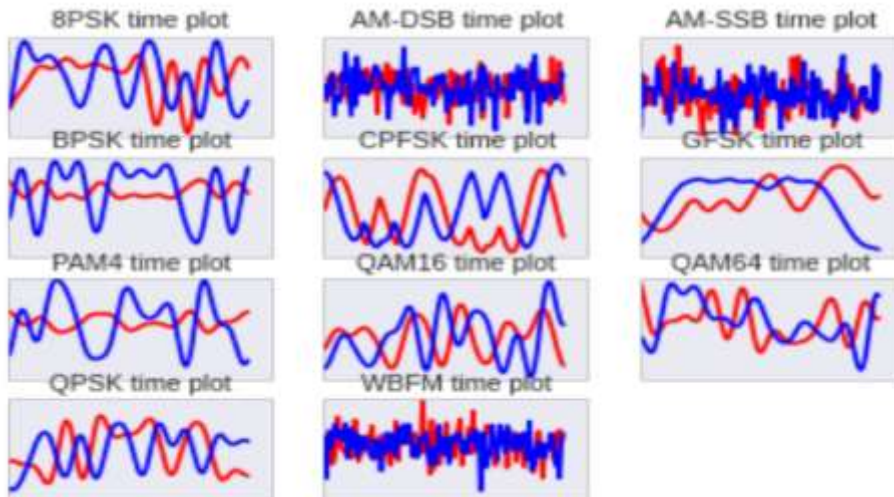
DeepSig Dataset: RadioML 2016.04C

A synthetic dataset, generated with GNU Radio, consisting of 11 modulations. This is a variable-SNR dataset with moderate LO drift, light fading, and numerous different labeled SNR increments for use in measuring performance across different signal and noise power scenarios.

#### **1. Download Data (10 points)**

- <http://opendata.deepsig.io/datasets/2016.10/RML2016.10b.tar.bz2>

#### **2. Create feature Spaces (30 points)**



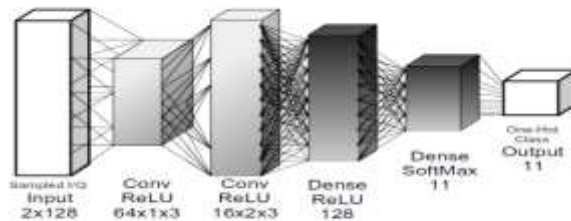
Every sample is presented using two vectors each of them has 128 elements. You might try the raw features and you can make a battery of more features such as

1. Raw time series as given (two channels)
2. First derivative in time (two channels)
3. Integral in time (two channels)
4. Combinations of 1, 2 and 3. (More channels)

#### **4. Supervised Learning Step (40 Points)**

- Split the data into 50% for training/validation and 50% for testing.

- You will use a Fully Connected Neural Net as a baseline. You will need to tune the parameters for best performance. For simplicity use ReLU and ADAM with default parameters. Ensure you change number of layers and number of units. Use Early stopping on a validation set of size 5% of the data.
- You will apply the CNN architecture shown below. The number of channels in the input layer might be changed as you apply different types of features.



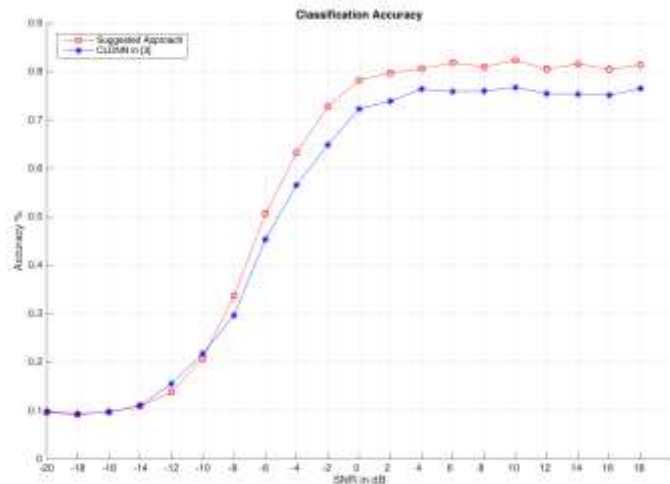
**Figure 3. CNN Architecture**

## 5. Big Picture (20 Points)

You need to compare the performance of the learned models against important factors.

- Features used
- Architecture choice.

1. Plots of the accuracy against the SNR as below.
2. Report the average overall accuracy as well as the results at SNR=0dB.
3. Show confusion matrices and find the most confusing classes.



## 6. Bonus (20 Points)

- Best results in the class will get 20 points bonus
- Second best results will get 10 points bonus.

## 7. References

- [1] T. O'shea, N. West "Radio Machine Learning Dataset Generation with GNU Radio",  
<https://pubs.gnuradio.org/index.php/grcon/article/download/11/10/>
- [2] T. O'Shea, J. Corgan, and T. Clancy "Convolutional Radio Modulation Recognition Networks" <https://arxiv.org/pdf/1602.04105.pdf>
- [3] N. West, T. O'shea "Deep Architectures for Modulation Recognition",  
<https://arxiv.org/pdf/1703.09197.pdf>
- [4] K. Karra, S. Kuzdeba, J. Peterson "Modulation recognition using hierarchical deep neural networks"  
<http://ieeexplore.ieee.org/document/7920746/?anchor=authors>

**GOOD LUCK**