Assignment #4 Modulation Classification (Total 100 Points)

Problem Statement

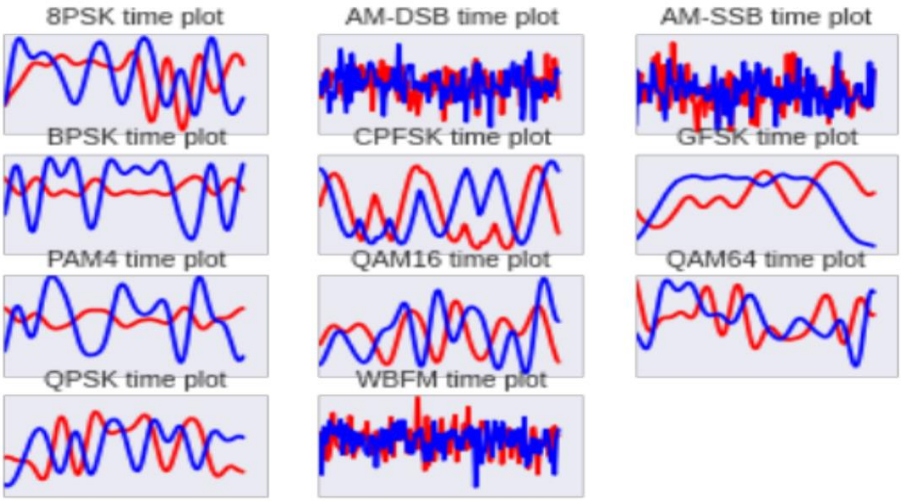
DeepSig Dataset: RadioML 2016.04C

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 the Dataset

a. http://opendata.deepsig.io/datasets/2016.10/RML2016.10b.tar.bz2

2. Create Feature Space (20 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)

3. Supervised Learning Step (45 Points)

a. Split the data into 70% for training/validation and 30% for testing.
b. Use 5% of the training and validation dataset for validation.
c. CNN Model
    i. 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.

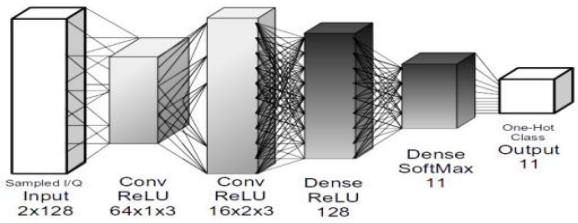


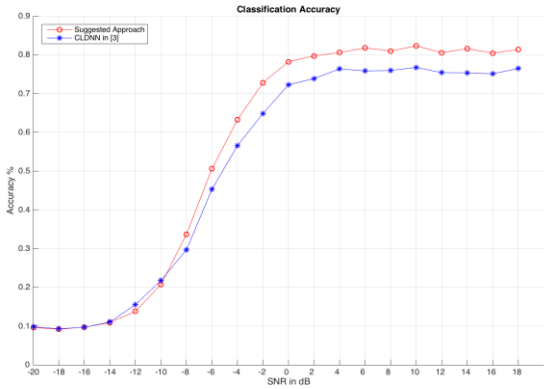
Figure 3. CNN Architecture

d. Build two models, the vanilla RNN and LSTM as classifiers and train them.
e. Apply hyperparameter tuning on the learning rate of the abovementioned models on the validation dataset

4. Big Picture (20 Points)

Compare the performance of the learned models (Different features, and different learning models) by realizing the following for each model:

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.



5. Bonus

- Students with best 3 accuracy values will get a bonus.
- Modify the architecture used for training. For example (Conv-LSTM)
- Write a well-documented report in Latex format. The report should include:
    - Data format explanation including figures of the signal
    - Data preprocessing techniques used
    - Method explanation
    - Results and analysis

6. Submission Notes

a. Work in groups of 3 students.
b. **[15 Points]** You are required to submit a clear and detailed report [in PDF format] illustrating every step in the assignment.

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

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