EE798L: Machine Learning for Wireless Communications **EE Dept. IITK**

MATLAB Assignment-1

Sparse Bayesian Learning (10 marks) *Mar. 2023*

1. Read and understand [R1] given below up to Section IV.
2. Generate the synthetic data as follows:
   - Generate a $N \times M$ design/dictionary matrix $\mathbf{\Phi}$, whose entries are each drawn from a standardized Gaussian distribution, i.e., $\mathcal{N}(0, 1)$.
   - Generate the $M \times 1$ sparse weight vector $\mathbf{w}$ such that it has D_0 randomly selected nonzero entries (with standardized Gaussian distributed nonzero components).
   - Generate the noise entries $\epsilon_n \sim \mathcal{N}(0, \sigma^2)$ for all $n = 1, \ldots, N$. Generate the observations $\mathbf{t} = \mathbf{\Phi w} + \boldsymbol{\epsilon}$.
3. Generate $\mathbf{t}$ for $N = 20$, $M = 40$, $D_0 = 7$, noise variances -20, -15, -10, -5 and 0 dB.
4. Apply SBL for regression from [R1] to get the maximum aposterior estimate of the weight vector $\mathbf{w}$, which is given by (13).
5. Plot the normalized mean squared error (NMSE), defined as

$$\text{NMSE} = \frac{||\mathbf{w}_{MP} - \mathbf{w}||^2}{||\mathbf{w}||^2}$$

   for above noise variances.

[R1] Sparse Bayesian Learning and the Relevance Vector Machine Michael E. Tipping, Journal of Machine Learning Research 1 (2001) 211244

Please follow these Coding instructions:

- Properly comment your code.
- The code should execute and generate the desired output.
- Your submission should be self-contained (should include all the files required for running it).
- Avoid hard-coding the values of the variables for specific configurations. The code should be generic.

Please follow these submission instructions

- Deadline is 12th of March, 11:59 pm.
- All codes should be in one .zip folder. Please do not submit separate files.
- Upload your properly commented in drive link which will be provided to you. Name your code as rollno.zip.
- Please submit one final zip file.
- Please do not mail your file to me.

Please also read this carefully.

- Each one of you have to individually do all the reading and MATLAB assignments. You can discuss with your friends but you will have to completely write your own code.
- Copying also means sharing your code with some else for them to copy. We will not differentiate between the two acts, and both such cases will be awarded zero. Our decision will be final.