EE698Z: Machine Learning for Wireless **EE Dept. IITK**

MATLAB Assignment-1

SBL and Relevance Vector Machine(10 marks) *Mar. 2021*

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

Instructions:

1. You will have to form a group of three students.
2. You will have to write the report on the paper upto Section IV. Deadline for submitting that is 11:59 pm April 15th 2021.
3. Simulate the problem given above in MATLAB. The code should execute without any problem, and output the desired plot. Code should be properly commented. Deadline for submitting the code is 11:59 pm April 25th 2021.
4. Report should be in your language and the code should be original. A group will be awarded zero marks if we feel that it has cheated. It is your responsibility to make sure that you do not share your code and report.
5. Will let you know the submission procedure later.