

## Machine Learning and Adaptive Systems (ECE656)

### **Computer Assignment 1 (Performance Learning for Linear Prediction- Due March 1, 2022)**

The purpose of this computer assignment is to show how performance learning can be used to estimate the unknown parameters of a *linear predictor* directly from the data. You can MATLAB toolboxes on any other software for this assignment.

1. Download 3-years worth of historical data associated with the daily closing price of a particular stock index (e.g., APPLE) from one of the financial sites e.g., <http://finance.yahoo.com/>. Use 1/3 of the data for training and the rest for validation and testing.
2. Consider your data as a time series that could be modeled using a linear autoregressive (AR) model of the form,

$$y(n) = a_1 y(n-1) + a_2 y(n-2) + \dots a_N y(n-N) + e(n)$$

where  $N$  is the order of the AR process,  $e(n)$  is the driving input which is assumed to be a zero mean white Gaussian random process with variance  $\sigma_e^2$ , and  $a_i$ 's are the model parameters that need to be estimated via the training.

3. Choose  $N=3$  i.e. a 3<sup>rd</sup> order AR model and using an appropriate learning rule covered in class, devise a scheme to estimate the parameters  $a_1$ ,  $a_2$  and  $a_3$  directly from the data. Present the plot of the learning curve of your algorithm. Check the validity of your results by comparing them with those of the Wiener-Hopf solution using  $\underline{w}^* = R_{xx}^{-1} R_{xd}$ . Comment on the convergence behavior and accuracy (i.e. misadjustment vs speed) of the learning.
4. Study the effects of step size  $\mu$  on the results. Choose  $\mu = 10^{-4}$  and  $10^{-5}$  and compare the results.
5. Validate the performance of your stock price predictor,

$$\hat{y}(n) = a_1 y(n-1) + a_2 y(n-2) + \dots a_N y(n-N)$$

on the validation data set by determining the MSE of the estimates i.e

$$\varepsilon = \frac{1}{N} \sum_{n=1}^N (y(n) - \hat{y}(n))^2 \text{ and distribution of the error. How reliable is your predictor?}$$

What are the issues with this predictor?

6. Test the behavior of this adaptive predictor on the testing data and comment on the performance.
7. Provide your results and thorough discussions on your results in a brief report.

**Note: Please follow the posted guidelines for preparing good reports.**