EE615: Problem set 4

Problems 3.4 (except (b)), 3.5, 3.6, problem 3.X1, Computer assignment. Note: you can ignore comments about the lattice predictor in the problems. Just find the quantities asked for, e.g., κ_i.

Problem 3.X1

A signal is given by

$$x(n) = s(n) + w(n)$$

It is known that $s(n)$ is an AR process of order 1 with a_1=0.2 and σ_v=1. The noise $w(n)$ is independent of the signal $s(n)$, but it is not white. The autocorrelation function for $w(n)$ is

$$r_w(k) = 0.5^{|k|}$$

It is desired to extract the signal $s(n)$ out of the noise

1. Find the non-causal Wiener-filter for estimating $s(n)$.
2. Find the causal Wiener-filter for estimating $s(n)$.

Computer assignment

Write an implementation of the Levinson-Durbin algorithm in Matlab (and yes, an implementation already exists in Matlab. Don't try to copy that function). The input to the function should be a vector of correlation values $[r(0),...,r(M)]$. The output should be

1. the set of filter coefficients up to order M, conveniently arranged in a matrix **A** so that $\mathbf{A}(m,k) = a_{m-1,k-1}$, $k \le m$, 0 otherwise.
2. The vector of reflection coefficients.
3. The vector of prediction error powers.

Test the algorithm on the following three sets of correlation coefficients (all starting with $r(0)$):

1. 2.0, 0.95, 0.9025, 0.8375, 0.8145
2. 2.25, 1.4125, 1.6181, 0.9860, 1.2582
3. 1.707, 0.5+0.5i, 0.707i (that is, complex data)

Also, check the results by solving the Wiener-equations directly (in Matlab).