ECE 1511, [redacted]

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Problem set 3

Problem 1: You are given three values of an autocorrelation function - $R_x(0) = 2.280$, $R_x(1) = 0.768$ and $R_x(2) = 0.4608$ and are told that these values correspond to a random process $x[n]$ modeled as

$$x[n] + a_1 x[n-1] + a_2 x[n-2] = u[n]$$

where $u[n]$ is a white noise process.

a) Find the model parameters a_1, a_2 and σ_u^2 from the data given.

b) Derive an expression for extrapolation of the correlation function values $R_x(\ell)$, $\ell > 2$ and use it to find the values $R_x(3)$, $R_x(4)$ of the modeled random process.

Problem 2: Write or use a computer algorithm to implement Levinson recursion. Test the algorithm by computing the linear prediction parameters for a real correlation function whose first five values are

2.0 0.95 0.9025 0.8573 0.8145

a) Print out the parameters for all orders up to the maximum order (4).

b) Repeat for a correlation function whose first five values are

2.25 1.4125 1.6181 0.9860 1.2582

c) Generate a white noise sequence $u(n)$ of variance $\sigma_u^2 = 1$ and length 128 samples, that is $u[n]$, $n = 0, 1, \ldots, 127$

d) Using the solutions for the order 4 filters from parts (a) and (b) generate the outputs of the filters with input the process $u[n]$

e) Estimate the autocorrelation functions of the random processes generated in part (d) and repeat parts (a) and (b) using the autocorrelation estimates

f) Compare your results from part (e) with those of parts (a) and (b) and comment appropriately.