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EQ2320: Speech Signal Processing (Fall 2015)

Tutorial #3: Linear Prediction

1 Problem 1

A stationary random sequence has the following autocorrelation function:

$$R_{xx}(0) = 1.2, R_{xx}(4), R_{xx}(-4) = 1$$

while all the other coefficients are zero.

1. Write the normal equations for an minimum error variance (MEV) prediction of order $M = 2$ for this sequence.
2. Determine the second order predictor.
3. Write the normal equations for an minimum error variance (MEV) prediction of order $M = 4$ for this sequence.
4. Determine the fourth order predictor.

2 Problem 2

A signal $x(n)$ is formed by the following autoregressive (AR) process $x(n) + cx(n-1) = u(n)$, where $u(n)$ is a stationary white sequence with $\mathbb{E}[u(n)] = 0$, $\mathbb{E}[u^2(n)] = 1$ and $c = .85$

1. Determine the autocorrelation $R_{xx}(0), R_{xx}(1)$ and $R_{xx}(2)$.
2. Determine the optimal prediction coefficients a_1, a_2 and the corresponding prediction error variance σ_e^2

3 Extra Problem

Measurements of the a speech signal resulting in the following $N = 16$ samples.
$x(n) = \{-.884, -1.424, -1.474, -1.185, .212, 1.72$
$1.634, 1.055, -.14, -.654, -.965, -.589, -.047, -.192, -.323, -.406\}$. The sampling frequency is 8 KHz

1. Determine $R_{xx}(0), R_{xx}(1), R_{xx}(2)$
2. Determine a first order predictor for $x(n)$

3. Determine a second order predictor for $x(n)$
4. Determine the roots of the equation $A_2(z) = 0$, i.e. the poles of the filter $H_2(z) = 1/A_2(z)$