Assignment #2: Optimal Linear Prediction

Laboratorio de Tratamiento Digital de Señales

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Statement of the problem

Consider Figure 1 where:

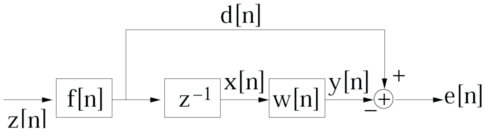

Figure 1: Linear prediction scenario.

- $z[n]$ is a white Gaussian noise with zero mean and **unknown** variance σ_z^2
- $f[n]$ is the impulse response of an IIR filter with z-transform $F(z) = \frac{1}{(1+\alpha_1 z^{-1}+\alpha_2 z^{-2})}$
- block z^{-1} delays the input signal by a sampling interval.
- $w[n]$ is a linear predictor for $d[n]$

1. **Implement the Levinson-Durbin recursion as a matlab function which takes an $M+1$-long autocorrelation vector as input and outputs the M-th order predictor coefficients.**
2. **Filter the provided signals `z1` to `z4` with $F(z)$ (coefficients $\alpha_1 = -\frac{1}{3}$ and $\alpha_2 = -\frac{1}{7}$) in order to obtain `h1` to `h4`.**
3. **Assuming only signals `h1` to `h4` are available, estimate the optimal linear predictor coefficients $w[n]$ using the previously coded function. Consider orders $M = 1, \ldots, 5$. Compute an estimate for the excitation noise σ_z^2. Use the results to fill in Tables 1 - 4 below and comment on them.**
4. **Once you have finished the numerical approach, analytically compute the predictor coefficients $w[n]$ of least mean square error for orders 2 and 3.**
5. **Consider a system taking as input $d[n]$ and returning $e[n]$. Give its z-transform. What is the relation between this filter and filter $f[n]$? What is the relation between signals $e[n]$ and $z[n]$?**

Table 1: Predictor coefficients for z_1

	Order				
Coefficient	1	2	3	4	5
w_1					
w_2					
w_3					
w_4					
w_5					
$\mathbb{E}\{\|e\|^2\}$					

Table 2: Predictor coefficients for z_2

	Order				
Coefficient	1	2	3	4	5
w_1					
w_2					
w_3					
w_4					
w_5					
$\mathbb{E}\{\|e\|^2\}$					

Table 3: Predictor coefficients for z_3

	Order				
Coefficient	1	2	3	4	5
w_1					
w_2					
w_3					
w_4					
w_5					
$\mathbb{E}\{\|e\|^2\}$					

Table 4: Predictor coefficients for z_4

	Order				
Coefficient	1	2	3	4	5
w_1					
w_2					
w_3					
w_4					
w_5					
$\mathbb{E}\{\|e\|^2\}$					