Processamento Digital de Sinais
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Lista de exercícios 1B – Sinais e sistemas digitais

P2.11 Consider the following discrete-time systems:

$$T_1[x(n)] = x(n)u(n) \qquad T_2[x(n)] = x(n) + n\,x(n+1)$$

$$T_3[x(n)] = x(n) + \frac{1}{2}x(n-2) - \frac{1}{3}x(n-3)x(2n) \qquad T_4[x(n)] = \sum_{k=-\infty}^{n+5} 2x(k)$$

$$T_5[x(n)] = x(2n) \qquad T_6[x(n)] = \text{round}[x(n)]$$

where round[$\cdot$] denotes rounding to the nearest integer.

1. Use (2.10) to determine analytically whether these systems are linear.
2. Let $x_1(n)$ be a uniformly distributed random sequence between $[0, 1]$ over $0 \le n \le 100$, and let $x_2(n)$ be a Gaussian random sequence with mean 0 and variance 10 over $0 \le n \le 100$. Using these sequences, verify the linearity of these systems. Choose any values for constants a_1 and a_2 in (2.10). You should use several realizations of the above sequences to arrive at your answers.

P2.12 Consider the discrete-time systems given in Problem P2.11.

1. Use (2.12) to determine analytically whether these systems are time-invariant.
2. Let $x(n)$ be a Gaussian random sequence with mean 0 and variance 10 over $0 \le n \le 100$. Using this sequence, verify the time invariance of the above systems. Choose any values for sample shift k in (2.12). You should use several realizations of the above sequence to arrive at your answers.

P2.15 Determine analytically the convolution $y(n) = x(n) * h(n)$ of the following sequences, and verify your answers using the `conv_m` function.

1. $x(n) = \{2, -4, 5, \underset{\uparrow}{3}, -1, -2, 6\}$, $h(n) = \{1, \underset{\uparrow}{-1}, 1, -1, 1\}$
2. $x(n) = \{1, 1, \underset{\uparrow}{0}, 1, 1\}$, $h(n) = \{1, -2, -3, \underset{\uparrow}{4}\}$
3. $x(n) = (1/4)^{-n}[u(n+1) - u(n-4)]$, $h(n) = u(n) - u(n-5)$
4. $x(n) = n/4[u(n) - u(n-6)]$, $h(n) = 2[u(n+2) - u(n-3)]$

P2.19 A linear and time-invariant system is described by the difference equation

$$y(n) - 0.5y(n-1) + 0.25y(n-2) = x(n) + 2x(n-1) + x(n-3)$$

1. Using the `filter` function, compute and plot the impulse response of the system over $0 \le n \le 100$.
2. Determine the stability of the system from this impulse response.
3. If the input to this system is $x(n) = [5 + 3\cos(0.2\pi n) + 4\sin(0.6\pi n)]\,u(n)$, determine the response $y(n)$ over $0 \le n \le 200$ using the `filter` function.

Fonte: Ingle/Proakis, Digital Signal Processing Using Matlab - 3ª Edição.