Programming Homework A (Due 5/21)

(1) Let W_n be a white Gaussian process with zero mean and unit variance. Generate a sample function of $W_n, n = 1,2, \dots, 512$. Find and plot the periodogram of W_n from its sample function. Apply the Bartlett's smoothing procedure and investigate its effect.

(2) Let X_n be a random process consisting of two sinusoids in white noise

$$X_n = \alpha_1 \cos(n\omega_1 + \Theta_1) + \alpha_2 \cos(n\omega_2 + \Theta_2) + W_n$$

where $\alpha_1 = 2$, $\alpha_2 = 1$, $\omega_1 = 0.3\pi$, $\omega_2 = 0.33\pi$. Θ_1 and Θ_2 are uniform random variables over $(-\pi, \pi)$, and W_n is a white Gaussian process described in part (1). Assume that Θ_1, Θ_2, and W_n are independent. Find and plot the periodogram of X_n from its sample function. Apply the Bartlett's smoothing procedure and investigate its effect.

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(3) Let Y_n be an autoregressive (AR) process given by

$$Y_n = \sum_{k=1}^{4} a_k Y_{n-k} + W_n$$

where W_n is a white Gaussian process described in part (1). Find and plot the periodogram of Y_n from its sample function, and compare it with the (theoretical) power spectral density of Y_n. Apply the Bartlett's smoothing procedure and investigate its effect.

(Choose two sets of your own a_k's.)