Bruce Campell NCSU ST 534 HW 5

Problems 4.13, 4.16, 4.18*, and 4.27 from CH4

Shumway, Robert H.; Stoffer, David S. Time Series Analysis and Its Applications: With R Examples (Springer Texts in Statistics)

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4.13 chiken price data.

Analyze the chicken price data (chicken) using a nonparametric spectral estimation procedure. Aside from the obvious annual cycle discovered in Example 2.5, what other interesting cycles are revealed?

4.16 Cepstral Analysis.

The periodic behavior of a time series induced by echoes can also be observed in the spectrum of the series; this fact can be seen from the results stated in Problem 4.7. Using the notation of that problem, suppose we observe $x_t = s_t + As_{t-D} + n_t$, which implies the spectra satisfy $f_x(\omega) = [1 + A2 + 2Acos(2\pi \ \omega \ D)]f_s(\omega) + f_n(\omega)$. If the noise is negligible ($fn(\omega) \approx 0$) then $logf_x(\omega)$ is approximately the sum of a periodic component, $log[1+A2+2Acos(2\pi \ \omega \ D)]$, and $logf_s(\omega)$. Bogart et al. [27] proposed treating the detrended log spectrum as a pseudo time series and calculating its spectrum, or cepstrum, which should show a peak at a quefrency corresponding to 1/D. The cepstrum can be plotted as a function of quefrency, from which the delay D can be estimated. For the speech series presented in Example 1.3, estimate the pitch period using cepstral analysis as follows. The data are in speech.

(a)

Calculate and display the log-periodogram of the data. Is the periodogram periodic,as predicted?

(b)

Perform a cepstral (spectral) analysis on the detrended logged periodogram, and use the results to estimate the delay D. How does your answer compare with the analysis of Example 1.27, which was based on the ACF?

4.18 Consider two time series $x_t = w_t - w_{t-1}$, $y_t = \frac{1}{2}(w_t + w_{t-1})$, formed from the white noise series w_t with variance $\sigma^2 = 1$.

(a)

Are x_t and y_t jointly stationary? Recall the cross-covariance function must also be a function only of the lag h and cannot depend on time.

(b)

Compute the spectra $f_y(\omega)$ and $f_x(\omega)$, and comment on the difference between the two results.

(c)

Suppose sample spectral estimators $\bar{f}_y(.10)$ are computed for the series using $L = 3$. Find a and b such that

$$P\{a \leq \bar{f}_y(0.10) \leq b\} = 0.90$$

This expression gives two points that will contain 90% of the sample spectral values. Put 5% of the area in each tail.

4.27 Production vs Unemployment Analysis

Consider the bivariate time series records containing monthly U.S. production (prod) as measured by the Federal Reserve Board Production Index and the monthly unemployment series (unemp).

(a)

Compute the spectrum and the log spectrum for each series, and identify statistically significant peaks. Explain what might be generating the peaks. Compute the coherence, and explain what is meant when a high coherence is observed at a particular frequency.

(b)

What would be the effect of applying the filter $u_t = x_t - x_{t-1}$ followed by $v_t = ut - u_{t-12}$ to the series given above? Plot the predicted frequency responses of the simple difference filter and of the seasonal difference of the first difference.

(c)

Apply the filters successively to one of the two series and plot the output. Examine the output after taking a first difference and comment on whether stationarity is a reasonable assumption. Why or why not? Plot after taking the seasonal difference of the first difference. What can be noticed about the output that is consistent with what you have predicted from the frequency response? Verify by computing the spectrum of the output after filtering