Time Series: Models and Trend

We think of a time series as being composed of three components, trend, seasonality and irregular terms: $y_t = T_t + S_t + I_t$. (Note: some books speak of a fourth component, cyclical, which can be viewed as a mid-run departure from the long-run linear trend, but that’s squishy so we don’t really worry about it ... if there is such a component, the methods we use will lump such cyclical component in with $T_t$ or $I_t$.) The first step in any time series is to estimate the trend in the series.

Hypothetical dataset A

(a) Plot the series. Describe any seasonality or trend evident in the series.

(b) Plot the ACF for the series. Describe how the ACF is reflecting the trend (if any) or seasonality (if any) in the series.

(c) Now fit a linear trend to the series (there should be code to help out with this). Does the linear trend fit well? Explain.

(d) Now plot the residuals of the linear trend (again, there should be code to help out). Do the residuals, which we can view as a detrended version of our series have any trend?

(e) Plot the ACF for the “detrended” (residual) series. Describe how the ACF is reflecting characteristics evident in the time series plot.
Hypothetical dataset B

(a) Plot the series. Describe any seasonality or trend evident in the series.

(b) Plot the ACF for the series. Describe how the ACF is reflecting the trend (if any) or seasonality (if any) in the series.

(c) Now fit a linear trend to the series (there should be code to help out with this). Does the linear trend fit well? Explain.

(d) Now plot the residuals of the linear trend (again, there should be code to help out). Do the residuals, which we can view as a “detrended” version of our series have any trend? Why would removing a linear trend from this dataset not be sufficient for detrending the series?

(e) Plot the ACF for the “detrended” (residual) series. Describe how the ACF is reflecting characteristics evident in the time series plot.
Hypothetical dataset C

(a) Plot the series. Describe any seasonality or trend evident in the series.

(b) Plot the ACF for the series. Describe how the ACF is reflecting the trend (if any) or seasonality (if any) in the series.

Hypothetical dataset D

(a) Plot the series. Describe any seasonality or trend evident in the series.

(b) Plot the ACF for the series. Describe how the ACF is reflecting the trend (if any) or seasonality (if any) in the series.

(c) Fit a linear trend and use the residuals as a “detrended” version of the series. How does this change the ACF? Are there any features now evident which were not evident in the original series? Explain why.
Distilled Spirits Sales, seasonal differences
Data on the sales of distilled spirits (in gallons) for the US are given each month (starting in January 1975) for a 11 year period in the dataset Spirits.

(a) Create a time series plot of the original series. Create the ACF for this original series. Comment on how the overall trend and seasonality are reflected in the ACF.

(b) Perform a seasonal difference to calculate $y_t - y_{t-12}$. Create the ACF for this differenced data. What does this ACF say about the seasonally differenced data? Be sure to comment both on seasonality and trend. Are there any other features of the ACF that seem noticeable?

Note: be sure to save the code you created to answer these questions, print it out and attach to the lab when you turn it in.