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 C

(a) Plot the series. Use a realizable moving average (the function \texttt{ma()}) to create a moving average of length 3. Add this moving average to the plot. Describe the moving average. Would it be good for estimating trend? Why or why not? Would it be good for estimating seasonal behavior? Why or why not?

(b) Repeat, but for a realizable moving average of length 6.

(c) Again, but for a smoother of length 12.

(d) Again, but for a smoother of length 24.

(e) Explain why a moving average of length equal to the number of datapoints per cycle for the seasonal component would be appropriate.

(f) Explain why even a moving average with the length equal to an integer multiple of the number of datapoints per cycle would be appropriate.
(g) What is a benefit of a moving average of length 24 over a moving average of length 12?

(h) What is a benefit of a moving average of length 12 over a moving average of length 24?

(i) Explain the trade off implied by the previous two questions.

Hypothetical dataset D

(a) Plot the series. Add a moving average of length 12 and another of length 24.

(b) In what way does the moving average of length 24 poorly estimate the trend?

(c) Explain why the moving average of length 12 would also poorly estimate the trend.

(d) Now plot the series and add a centered moving average (with the cma() function) of length 12 and of length 24.
(e) Explain why either of these centered moving averages would be better than the realizable moving average.

**Hypothetical dataset E**

(a) Plot the series. Add a centered moving average of length 12 and one of length 24.

(b) Which is smoother? Why is this so?

(c) Which is a better estimate of the trend? Why is this so?

**General questions**

(a) Under what circumstances would fitting a regression provide a better trend estimate than the moving average? Why?

(b) Under what circumstances would using a moving average as a trend estimate be better than fitting a regression? Why?
Distilled Spirits Sales

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) Plot these data and add a moving average smoother of the appropriate length.
(b) In what ways would using a linear regression trend estimate be better than the moving average for these data. Explain.

(c) Are there any ways where using a moving average for the trend estimate would be better than regression? Explain.

(d) Which method would allow us to more easily forecast into future years? Explain.

(e) Are there any assumptions on which such forecasts might be made? Are those assumptions realistic?

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.