

Note: Any questions regarding this problem set should be addressed to me, me only. It is a violation of University Policy to discuss examinations question without instructor approval.

Problem 1: The monthly values of the average hourly for US apparel and textile workers for July 1981 to July 1987 are the file `wages` of the library TSA. (a) Plot the series and write a few lines on what you observe.

(b) Fit a linear trend model using least squares. Give the plot of the linear trend and superpose it with that of the data. Give the estimated regression equation.

(c) Plot the standardized residuals from the linear regression versus time. Comments?

(d) Fit a quadratic time trend model using least squares. Give the plot of linear trend and superpose it. Give the estimated regression equation. Plot the residuals and comment on any patterns.

(e) Perform a diagnostic check of the residuals. Comments.

(f) Plot the autocorrelation function for the standardized residuals from the quadratic regression.

(g) Investigate the normality of the standardized residuals from the quadratic regression. Comment.

Problem 2: A data set of 57 consecutive measurements from a machine tool are in the TSA package.

(a) Estimate the parameters of a (mean-centered) AR(1) model for this series. Use the least squares method and maximum likelihood, and report the estimated parameters from each of these methods. Comment on any similarities and differences. Give the confidence intervals of your parameters.

(b) Estimate the parameters of a (mean-centered) AR(2) model for this series. Use the least squares method and maximum likelihood, and report the estimated parameters from each of these methods. Comment on any similarities and differences.

(c) Derive the confidence intervals for the parameters ϕ_1 and ϕ_2 . Does the confidence interval for ϕ_2 suggests it should be included in the model?

(d) Compare the results of the maximum likelihood fits from parts (a) and (b). Which model do you believe is preferable? Briefly explain your answer.

(e) Compare the two models using AIC, BIC. Which one do you prefer?. Does any of the quantities suggests one model is better than the other?. If so, how much do you gain in errors reduction if any. Is that in line with your answer in (d)?

Problem 3: Are sales trends for two industrial products related? The two time series objects described below contain Sales of chemicals and allied products; and Sales of motor vehicles and parts, in the U.S. for each month from Jan. 1971 to Dec. 1991. File is `petr.txt`

You should analyze the data in the "chemicals" time series and the "vehicles" time series and write a report to address such questions as:

- (i) What trend model(s) best capture the trends in sales of chemicals over time?
- (ii) What trend model(s) best capture the trends in sales of vehicles over time? Once the trend has been accounted for, what can you say about the behavior of the detrended data, for both models? Can either the original time series or the detrended series be described using any common models?
- (iii) For the various models you tried, assess their fit. Can any transformations improve the fit? Is there any apparent association between chemical sales and vehicle sales over time? If so, describe the association.
- (iv) Make conclusions that relate to how the sales amounts (for both chemicals and vehicles) change, both long-term over the observed period of years, and in terms of patterns of month-to-month variation.

Problem 4: France has enjoyed a long and storied history as a world leader in culture, food, literature, film, and revolutions. Over its history, the average life expectancy of people in France has changed notably. The time series object described below contains the annual average life expectancy in France (measured in years lived), measured during the years 1816 to 2019. The data is in the file FLE.txt

Analyze the data in the time series and write a report addressing the following:

- (a) What trend model(s) best capture the trends in French life expectancy over time?
- (b) Are there any noticeable patterns, or observations apparent in the series? Can you tell from your plot what could be the causes of your observations?
- (c) Regardless of what you observe, suppose you apply some transformation to the data, how does the new data look like? Any changes in trend?
- (d) For the various models you tried, assess the fit of the models using any tools at your disposal. Perform any necessary test to make sure your model is appropriate. Write down the equation of your final model. Are any transformations of the data necessary? Perform all diagnostics tests.

Now conclude with brief summary: How the life expectancy changes over time, both long-term over the observed period of years, and in terms of patterns of year-to-year variation. Add any necessary graphs, tests and/or confidence interval etc...