

STA 542 – Homework 4

Due: Wednesday, September 30, at the start of class

Credit. This homework is graded for effort rather than correctness. A substantive attempt addresses every assigned part, shows the reasoning behind each answer, and interprets any computational output. Full effort credit does not require a correct solution: show what you tried, including unsuccessful approaches, and identify precisely where you remain stuck.

Submission. Submit one ordered hard copy, secured with a staple or paper clip, with your name clearly written on the first page. Mathematical and statistical reasoning must be written legibly by hand; tablet handwriting is welcome. R code, numerical output, tables, and plots may be printed and appended, or sketched when exact output is unnecessary. Label every computational exhibit, refer to it in the handwritten response, and explain what it shows.

Problems

Problem 1. Filtering real time series.

Download and unzip `filtering-workbook.zip`. The workbook *Filtering Real Time Series* describes eleven real time series and provides code to load and plot each one. You are encouraged to explore all eleven series, but only need to submit answers to parts (a)–(e) for **four**. Try to choose four series for which different filtering techniques are appropriate.

- (a) **Choose a filter.** Based on a plot of the time series, propose a filter that you think will make it weakly stationary, and explain which features of the plot motivate your choice.
- (b) **Does the filter need fitting?** If so, explain what you fit and how. Apply the filter and plot the result.
- (c) **Is the filter invertible? What is lost?** Explain your answer. If information is lost, give a scientific question that can no longer be answered from the filtered data alone.
- (d) **Examine the result.** Plot the sample ACVF. Estimate the long-run variance using the Bartlett estimator and run KPSS at a few bandwidths. Explain your bandwidth choices and report the results.
- (e) **Assess stationarity.** How convincing is a weakly stationary model for the filtered series? Support your answer using the plots and results.

Problem 2. What would help you understand this homework better?

Look back over your work on Problem 1. Identify three points that you would like to understand better, using the categories below. Each response should refer to a specific series and subpart of this homework.

- (a) **A mathematical step.** Choose a calculation or mathematical argument that you found difficult or could not fully justify. This might concern combining filters, reconstructing observations, or calculating a weighted covariance sum.
- (b) **A statistical idea.** Choose a statistical idea used in your analysis that remains unclear. For example, what does failure to reject a null hypothesis establish, or how does choosing a method after looking at the data affect its interpretation? The idea should arise in this homework, even if it also applies to independent data.
- (c) **A time-series idea.** Choose something about dependence or learning from one observed path that you would like to understand better. This could arise when choosing a filter, interpreting an ACVF, or assessing whether the same covariance structure describes the whole record.

For each response, write a short paragraph addressing the following:

- Identify the series and subpart and formulate your own question. Explain what you understood or could do, and where your reasoning became uncertain.
- Suggest how you could explore the question using a specific result, proof, example, or exercise from the course workbooks. Describe a possible activity, such as working through a simpler case or discussing your attempted reasoning with a TA.
- Describe a short calculation, explanation, or example you could attempt without notes to check your understanding.

These are possible approaches to further study; you are not being asked to complete additional work for this assignment.