

NOTES. The lowest grade among all twelve homework will be dropped, so **NO** late submission will be accepted. All homework assignment must be written on standard 8.5 by 11 paper. Computer generated output without detailed explanations and remarks will not receive any credit. You may type out your answers, but make sure to use different fonts to distinguish your own words from the computer output. Please submit the hard copy of your homework solution in class. For the simulation and data analysis problems, keep the code you develop as you may be asked to present your work later.

**1** (100 pts). Tourism is one of the largest economic components of Hawaii (another is the Pearl Harbor Navy Base). The data `hawaii-new.dat` contains monthly record of the number of tourists visited Hawaii from January, 1970 to December, 1995. The first column shows the year-month. The second column is the total. The third and fourth columns show the number of west-bound (mainly from US and Canada) and east bound (mainly from Japan and Australia) visitors. Perform the following analysis.

- (a) Draw time series plots of the three series on the **same** graph. Comment on what you observe (trend, seasonality, variance, possible outliers, relationship between the three series and others).
- (b) Perform a log transformation of the **total** series. Draw a time plot and comment on it.
- (c) If you are to use a polynomial trend model for the log transformed **total** series, which order of the polynomial (e.g. linear, quadratic, cubic etc) will you use? Your decision should be based on sound statistical reasoning and formal testing or variable selection procedure. Fit the trend model, plot the fitted line with the log-transformed time series and plot the de-trended series. What do you think about the results?
- (d) Fit a trend-seasonal model to the log transformed total series. Plot the fitted values with the log transformed data and plot the de-trend-de-seasoned series. Comment on the estimated coefficients of the seasonal factors.
- (e) Use the trend-seasonal model in (d) to predict the total number of tourists (in log) who will visit Hawaii each month in 1996, assuming the noises in the trend-seasonal model are i.i.d. Plot your predictions (in dash lines) with the last three years of the original data.
- (f) For the log transformed total series, determine the difference(s) needed to make the series stationary (by look). Show your working process.
- (g) Perform a 13-month moving average (with half weights for the first and last month) of the **original total** series. Plot the moving average with the original series. Comment on what you observe.
- (h) Calculate the de-trended series  $\tilde{x}_t$  using what you calculated in Part (g). Estimate the seasonal components  $s_t$  using  $\tilde{x}_t$ .
- (i) Re-estimate the trend using a moving average for the de-seasoned series  $x_t - \hat{s}_t$ . Plot  $\hat{m}_t + \hat{s}_t$  together with original series  $x_t$ .
- (j) Plot the de-seasoned and de-trended series  $x_t - \hat{s}_t - \hat{m}_t$ . Compare your result with Part (d).