PRACTICE QUESTIONS FOR CH. 3

STAT 485/685 E100/G100: Applied Time Series Analysis

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Below are a few extra practice questions on trend-fitting in time series analysis. The topics here have been covered in Videos 7-11, as well as Chapter 3 of the textbook[1]. These questions are not for marks, and no submissions need to be made.

1. The documentation for the `TSA` package can be found at `https://cran.r-project.org/web/packages/TSA/TSA.pdf`. The Index (pg. 77) gives the full list of datasets available in the package.

   (a) Choose a dataset in the package, and load it in using `data(name_of_dataset)`. Create a plot of the dataset.

   (b) Describe what you see in the plot, and which type of trend you believe may be appropriate for this data.
   (Note: You may have trouble fitting a seasonal model to a dataset that appears seasonal but whose times are not coded according to actual years/months, such as the `tuba` dataset. We recommend you don't choose this type of dataset for this reason.)

   (c) How are times coded up in the dataset? Use `time(name_of_dataset)` to see this. What does each time unit of 1 mean? Is it a month, a whole year, etc.?

   (d) Fit the trend model in part (b), and print the parameter estimates table using `summary(name_of_model)`. Give the values of the parameter estimates.

   (e) Write out the equation for the estimated mean, $\hat{\mu}_t$, at any given time t.

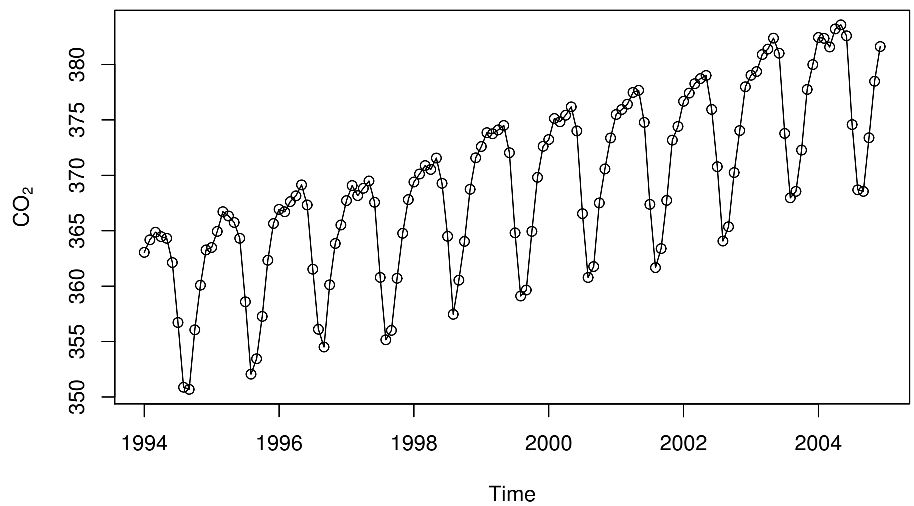
   (f) Pick a time within the bounds of your dataset. What value of t does this time correspond to? (e.g. If March 1986 is within your dataset, does it correspond to $t =$ (some whole number), or $t = 1986.167$, or ...?)

[1] Cryer, J. D., & Chan, K. S. (2008). *Time series analysis: with applications in R.* Springer Science and Business Media.

(g) Use the equation you've written out in part (e) to find the estimate of the mean, $\hat{\mu}_t$, at the time t obtained in part (f).

(h) Plot the residuals vs. time for this model. Does it appear to be a random scatter about zero? If not, explain what patterns you see and their significance.

2. The `co2` dataset in the `TSA` package gives monthly carbon dioxide measurements near the Arctic Circle, from 1994 to 2004:



In this dataset, we see both seasonal behaviour and a linear time trend. We will fit a combination of these two models: a *cosine curve plus linear time trend*:

$$\mu_t = \beta_0 + \beta_1 \, cos(2\pi f t) + \beta_2 \, sin(2\pi f t) + \beta_3 \, t$$

This can be fitted using the code:

```
> data(co2)
> har. <- harmonic(co2,1)
> my.model <- lm(co2 ~ har. + time(co2))
```

(a) Fit the cosine curve plus linear time trend model using the code above. What are the estimates of the four parameters in the model?

(b) Plot the data and the fitted trend using the code:

```
> plot(co2)
> lines(x=as.vector(time(co2)), y=as.vector(fitted(my.model)),
col='red')
```

Does the model appear to fit the data well?

(c) Plot the residuals vs. time for this model. Does it appear to be a random scatter about zero? If not, explain what patterns you see and their significance.

(d) Plot the sample ACF plot for the residuals of this model. Does it appear that the random process $\{X_t\}$ is white noise? Why or why not?