Thesis title

Joe Bloggs

Karl Marx

School of Mathematics and Statistics
UNSW Sydney

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Acknowledgements

By far the greatest thanks must go to my supervisor for the guidance, care and support they provided.

Thanks must also go to Emily, Michelle, John and Alex who helped by proof-reading the document in the final stages of preparation.

Although I have not lived with them for a number of years, my family also deserve many thanks for their encouragement.

Thanks go to Robert Taggart for allowing his thesis style to be shamelessly copied.

Fred Flintstone, 2 November 2015.

Abstract

Contents

Chapter 1

Introduction

This is where you introduce the main ideas of your thesis, and an overview of the context and background.

Later chapters should be divided into coherent pieces describing your analysis. The final chapter should provide some concluding remarks, discussion, ideas for future research, and so on. Appendixes can contain additional material that don't fit into any chapters, but that you want to put on record. For example, additional tables, output, etc.

1.1 Rmarkdown

In this template, the rest of the chapter shows how to use Rmarkdown. The big advantage of using Rmarkdown is that it allows you to include your R code directly into your thesis, to ensure there are no errors in copying and pasting, and that everything is reproducible. It also helps you stay better organized.

For details on using *R Markdown* see http://rmarkdown.rstudio.com.

1.2 Data

Included in this template is a file called `sales.csv`. This contains quarterly data on Sales and Advertising budget for a small company over the period 1981–2005. It also contains the GDP (gross domestic product) over the same period. All series have been adjusted for inflation. We can load in this data set using the following command:

```
sales <- ts(read.csv("data/sales.csv")[,-1], start=1981, frequency=4)
```

Any data you use in your thesis can go into the data directory. The data should be in exactly the format you obtained it. Do no editing or manipulation of the data outside of R. Any data munging should be scripted in R and form part of your thesis files (possibly hidden in the output).

1.3 Figures

Figure 1.1 shows time plots of the data we just loaded. Notice how figure captions and references work. Chunk names can be used as figure labels with `fig:` prefixed. Never manually type figure numbers, as they can change when you add or delete figures. This way, the figure numbering is always correct.

1.4 Results from analyses

We can fit a dynamic regression model to the sales data.

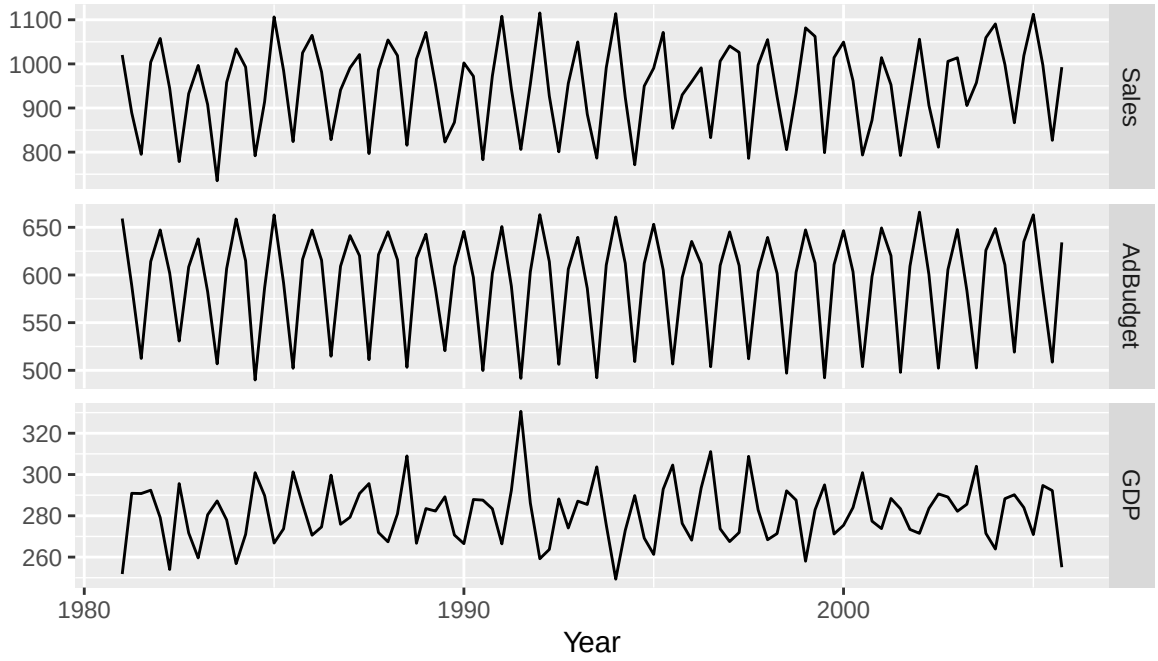


Figure 1.1: Quarterly sales, advertising and GDP data.

If y_t denotes the sales in quarter t, x_t denotes the corresponding advertising budget and z_t denotes the GDP, then the resulting model is:

$$y_t - y_{t-4} = \beta(x_t - x_{t-4}) + \gamma(z_t - z_{t-4}) + \theta_1\varepsilon_{t-1} + \Theta_1\varepsilon_{t-4} + \varepsilon_t \tag{1.4.1}$$

where $\beta = 2.28$, $\gamma = 0.97$, $\theta_1 = NA$, and $\Theta_1 = -0.90$.

1.5 Tables

Let's assume future advertising spend and GDP are at the current levels. Then forecasts for the next year are given in Table 1.1.

Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
1000.2	947.7	1052.7	919.9	1080.5
1013.1	959.3	1066.8	930.9	1095.3
1076.7	1022.9	1130.6	994.4	1159.0
1003.5	949.7	1057.4	921.2	1085.8

Table 1.1: Forecasts for the next year assuming Advertising budget and GDP are unchanged.

Again, notice the use of labels and references to automatically generate table numbers. In this case, we need to generate the label ourselves.

The `knitLatex` package is useful for generating tables from R output. Other packages can do similar things including the `kable` function in `knitr` which is

somewhat simpler but you have less control over the result. If you use `knitLatex` to generate tables, don't forget to include `results="asis"` in the chunk settings.

Chapter 2

Exponential Smoothing

2.1 Organizing your ideas

Imagine you are writing for your fellow Honours students. Topics that are well-known to them do not have to be included here. But things that they may not know about should be included. Resist the temptation to discuss everything you've read in the last year.

Do not organize your chapter around the papers you have read with one section per paper. Instead, you should organize your chapters around themes, and within each theme provide a story explaining the development of ideas. It is usually helpful to plan out a table of contents first with major section headings.

When you are discussing results from several papers or books, you will need to adopt a common notation to ensure your chapter makes sense. Do not use different notation for the same thing.

2.2 Citations

All citations should be done using markdown notation as shown below. This way, your bibliography will be compiled automatically and correctly.

Exponential smoothing was originally developed in the late 1950s (Brown, 1959, 1963; Holt, 1957; Winters, 1960). Because of their computational simplicity and interpretability, they became widely used in practice.

Empirical studies by Makridakis and Hibon (1979) and Makridakis et al. (1982) found little difference in forecast accuracy between exponential smoothing and ARIMA models. This made the family of exponential smoothing procedures an attractive proposition (see Chatfield et al., 2001).

The methods were less popular in academic circles until Ord, Koehler, and Snyder (1997) introduced a state space formulation of some of the methods, which was extended in Hyndman et al. (2002) to cover the full range of exponential smoothing methods.

2.3 External Scripts

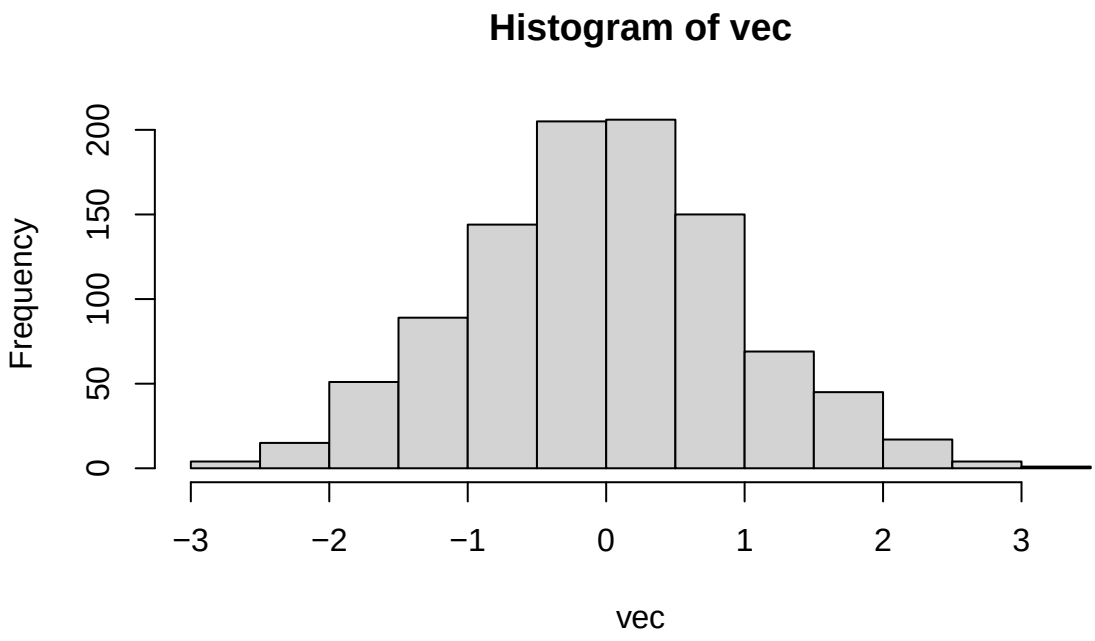
You can include scripts that are not directly embedded into the Rmd format by using `code=xfun::read_utf8("path/scripts/script.R")` in the chunk options eg: {`r echo=TRUE, code=xfun::read_utf8('scripts/histnorm.R')`}:

```
# histnorm.R
# Takes 1000s draws of a normal distribution and plots it's histogram

# draw samples
```

```r
vec <- rnorm(1000)

# plot histogram
hist(vec)
```



or by using labelled blocks in your script and using them as individual chunks

Appendix A

Additional stuff

You might put some computer output here, or maybe additional tables.

Note that line 5 must appear before your first appendix. But other appendices can just start like any other chapter.

References

[1] RG Brown. *Smoothing, forecasting and prediction of discrete time series*. Englewood Cliffs, New Jersey: Prentice Hall, 1963.

[2] RG Brown. *Statistical forecasting for inventory control*. McGraw-Hill, New York, 1959.

[3] C Chatfield, AB Koehler, JK Ord, and RD Snyder. A new look at models for exponential smoothing. *The Statistician* **50** (2001), 147–159.

[4] CE Holt. *Forecasting trends and seasonals by exponentially weighted averages*. O.N.R. Memorandum 52/1957. Carnegie Institute of Technology, 1957.

[5] RJ Hyndman, AB Koehler, RD Snyder, and S Grose. A state space framework for automatic forecasting using exponential smoothing methods. *International Journal of Forecasting* **18**(3) (2002), 439–454.

[6] S Makridakis, A Anderson, R Carbone, R Fildes, M Hibon, RLJ Newton, E Parzen, and R Winkler. The accuracy of extrapolation (time series) methods: results of a forecasting competition. *Journal of Forecasting* **1** (1982), 111–153.

[7] S Makridakis and M Hibon. Accuracy of forecasting: an empirical investigation (with discussion). *Journal of Royal Statistical Society (A)* **142** (1979), 97–145.

[8] JK Ord, AB Koehler, and RD Snyder. Estimation and prediction for a class of dynamic nonlinear statistical models. *Journal of American Statistical Association* **92** (1997), 1621–1629.

[9] PR Winters. Forecasting sales by exponentially weighted moving averages. *Management Science* **6** (1960), 324–342.