

# How Rmarkdown changed my life

Rob J Hyndman

30 January 2020

# Let's go back in time

# Let's go back in time



# Let's go back in time



# Let's go back in time



# **Writing papers and reports**

# Wordstar 2000

DEMO.DOC Pg 1 Ln 1 Col 9 (0.80") Insert Horiz  
POWER OF WordStar 2000 PLUS RELEASE 3 STUNS WORLD!

WordStar 2000 Plus Release 3 is

WORD PUBLISHING

Graphics and Text Integration  
Unmatched Font Control  
Page Preview  
HPFont  
True PostScript Support

WordStar 2000 plus release 3 is

→—S P E E D—→

WordStar 2000 Plus Release 3 is

# WordPerfect

File Edit View Layout Tools Font Graphics Window Help

I actually liked WordPerfect 6.x, which had a nice graphical preview if you wanted. The white text on blue remained my favorite color combination, which Word for DOS also used.

The familiar "Reveal Codes" command also continued to function and made the journey into WordPerfect for Windows. █

It is a shame WordPerfect has not evolved and was discontinued for the Apple Macintosh many years ago.

{ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ } ▲  
[Bold On]The familiar "Reveal Codes" command also continued to function[SRT]  
and made the journey into WordPerfect for Windows.[Bold Off][HRT]  
[HRT]

It is a shame WordPerfect has not evolved and was discontinued[SRT]  
Courier 12pt Bold Doc 1 Pg 1 Ln 1.83" Pos 6"

# TeX/LaTeX

The screenshot shows the WinEdt 10.0 interface with a LaTeX document titled "Thesis.tex". The left sidebar displays a tree view of the document structure, including chapters, sections, and labels. The main editor area contains LaTeX code. A context menu is open over a specific block of code, listing various TeX engines and related tools. The right side of the screen shows the compilation report, which indicates 64 pages, 0 errors, 0 warnings, and 0 bad boxes.

```
\bigskip
\goodbye
\begin{defn}
Let $S$ be a basic weak neighborhood of a vector $s$ in $h$.
\begin{equation}\label{e:WeakBase}
\|W\setminus g(\cap_{k=1}^n h_k)\|_h < 1, \quad h_k \in h, \quad k=1, \dots, n, \quad n < \text{infty}.
\end{equation}
A continuous nonnegative function $Gamma_W(h)$, defined by
\begin{equation}\label{e:CIF}
Gamma_W(g) = \prod_{k=1}^n \max\{0, 1 - \text{abs}(f-g, h_k)\},
\end{equation}
is called a (em continuous indicator function) of $S$.
\end{defn}
\medskip
```

PDFTeXify Compilation Report (Pages: 64)  
Errors: 0   Warnings: 0   Bad Boxes: 0

File Edit Search Insert Document Project View Tools Macros Accessories TeX Options Window Help

Tree - Thesis.tex

Thesis.tex Doc2 T2.tex

PDFTeXify  
PDFLaTeX  
PDFTeX  
TeXify  
LaTeX  
TeX  
AMSTeX  
ConTeXt  
LuaLaTeX  
LuaTeX  
XeLaTeX  
XeTeX

SC(s, h). The convex set \$col(L)(A) \subset \sum\_{k=1}^n \alpha\_k h\_k\$ is called a Lomonosov space) associated with the set \$S\$, and a \$L(L)(A)\$ is called a (em Lomonosov function).

Console - PDFTeXify ... (Exit Code=0)

? A 1:1 908 Wrap Indent INS LINE Spell TexHard UTF-8 --src Thesis.tex

S

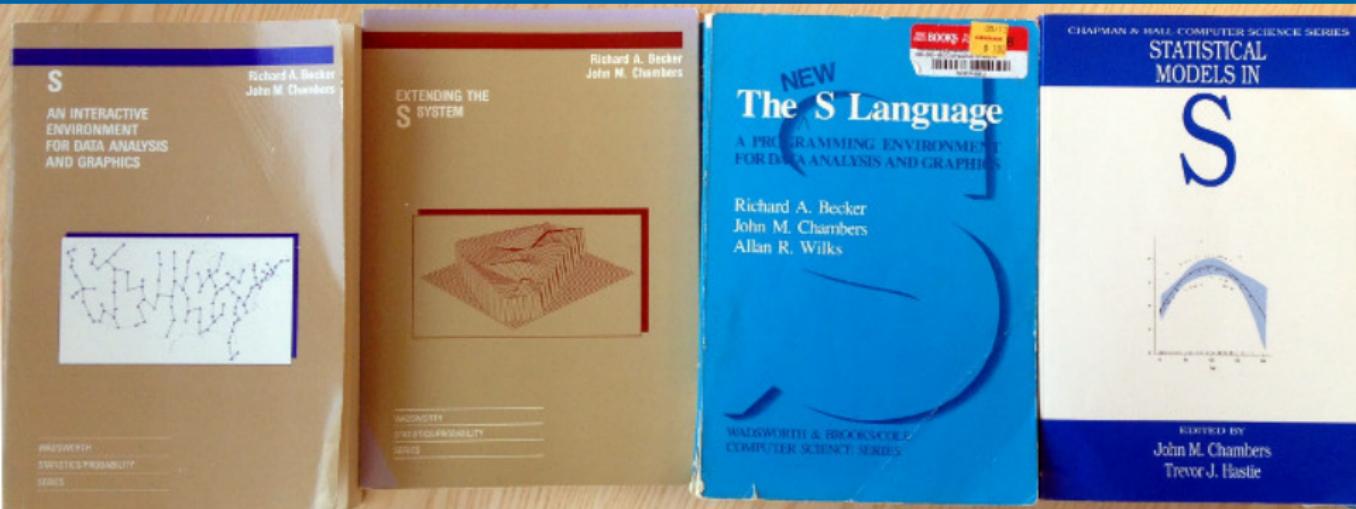


Photo credit: Rasmus Bååth

S-PLUS - OptionPricing.ssc - S-PLUS Workbench

File Edit Source Navigate Search Project Run Window Help

Navigator      publish... run.Opt... simopti... pptscri... FameGAR... OptionPricing.ssc

```

1 OptionPricing <- function(sources.dir, results.dir, properties.list, par:
2
3   library(winjava)
4   source(paste(sources.dir, "simoptions.ssc", sep=""))
5
6   ## parameters
7   nsims<-1000 ## number of simulations
8
9   optiondays <- switch(as.character(parameter.list$Expiration),
10     "3 Months"=92, "1 Year"=250, "2 Years"=500) ## length of option
11
12   strike <- as.numeric(as.character(parameter.list$Strike))
13
14   vol<- 40 ## returns volatility, annualized (40 = 40%) [Should be ca.
15   startprice <- 100 ## option start price
16
17   method <- switch(as.character(parameter.list$Model),
18     "Gaussian"="gbm", "Mixture"="normmix") ## method to estimate opt:
19
20   ## read in data
21   print(properties.list)
22   filename=paste(properties.list@inputs.root,"/OptionPricing/SP500.xls")

```

Outline      History View

OptionPricing/sources.dir, results

- nsims
- optiondays
- strike
- vol
- 40
- startprice
- method
- filename
- SP500
- equityname
- SP500.price
- SP500.r
- SP500.ts
- dev.off
- ops

Console View      Objects View      Search Path View      Output View      Tasks      Problems

```

> objects()
[1] ".Last.value"      ".Random.seed"      "OptionPricing"    "a.name"
[5] "attribute.vec"    "barrabata"       "dat"             "dl.str"
[9] "dnormix"          "file.vec"        "g.mod"          "grp.co"
[13] "grp.na"           "intra"          "keep"           "last.dump"
[17] "local.dir"        "lookback.len"   "lstdy"          "monthlyData"
[21] "msfit.ret"        "mu"              "parameter.list" "parameter.vec"
[25] "path.gbm"         "path.normix"   "pdata"          "pdnormix"
[29] "pred"              "pred.len"        "price"          "properties.list"
[33] "q_99"              "results.dir"    "ret"            "rng"
[37] "sd"                "server.dir"    "sim.option"    "sianormix"
[41] "source.vec"        "sources.dir"   "stk"            "stockData"
[45] "sys"               "tody"           "var.95"         "varData"
[49] "weeklyData"        "xx"             "xmax"          "xmin"
[53] "xx"                "ymax"

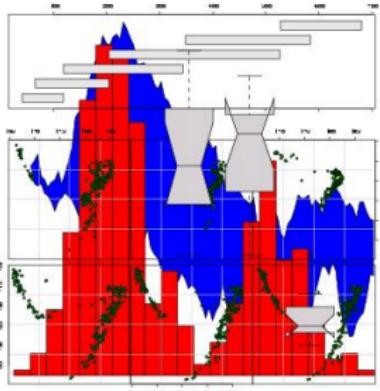
```

# R (c.2000)



## The R Project for Statistical Computing

(Web pages currently under construction!)



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R is 'GNU S' - A language and environment for statistical computing and graphics. R is similar to the award-winning S system, which was developed at Bell Laboratories by John Chambers et al. It provides a wide variety of statistical and graphical techniques (linear and nonlinear modelling, statistical tests, time series analysis, classification, clustering, ...).

R is designed as a true computer language with control-flow constructions for iteration and alternation, and it allows users to add additional functionality by defining new functions. For computationally intensive tasks, C, C++ and Fortran code can be linked and called at run time.

# Makefiles

The screenshot shows a web browser window with the title 'Makefiles for R/LaTeX projects'. The address bar contains the URL 'robjhyndman.com/hyndsoft/makefiles/'. The page header includes the name 'Rob J Hyndman' and navigation links for 'Hyndsoft blog', 'Publications', 'Software', 'Seminars', 'Teaching', 'Research team', and 'About'. Below the header is a search bar and a set of small icons. The main content area features a large heading 'Makefiles for R/LaTeX projects'.

## Makefiles for R/LaTeX projects

### Hyndsoft

31 October 2012

computing, LaTeX, organization, productivity, R, reproducible research

**Updated:** 21 November 2012

`Make` is a marvellous tool used by programmers to build software, but it can be used for much more than that. I use `make` whenever I have a large project involving R files and LaTeX files, which means I use it for almost all of the papers I write, and almost of the consulting reports I produce.

If you are using a Mac or Linux, you will already have `make` installed. If you are using Windows and have Rtools installed, then you will also have `make`. Otherwise, Windows users will need to install it. One implementation is in GnuWin.

A typical project of mine will include several R files containing code that fit some models, and generate tables and graphs. I try to set things up so I can re-create all the results by simply running the R files. Then I will have a LaTeX file which contains the paper or report I am writing. The tables and graphs produced by R are pulled in to the LaTeX file. Consequently, all I need to do is run all the R files, and then process the tex file, and the paper/report

# Makefiles

```
# Usually, only these lines need changing
TEXFILE= paper
RDIR= .
FIGDIR= ./figs

# list R files
RFILES := $(wildcard $(RDIR)/*.R)
# pdf figures created by R
PDFFIGS := $(wildcard $(FIGDIR)/*.pdf)
# Indicator files to show R file has run
OUT_FILES:= $(RFILES:.R=.Rout)
# Indicator files to show pdfcrop has run
CROP_FILES:= $(PDFFIGS:.pdf=.pdfcrop)

all: $(TEXFILE).pdf $(OUT_FILES) $(CROP_FILES)

# May need to add something here if some R files depend on others.

# RUN EVERY R FILE
$(RDIR)/%.Rout: $(RDIR)%.R $(RDIR)/functions.R
    R CMD BATCH $<

# CROP EVERY PDF FIG FILE
$(FIGDIR)%.pdfcrop: $(FIGDIR)%.pdf
    pdfcrop $< $< && touch $@

# Compile main tex file and show errors
$(TEXFILE).pdf: $(TEXFILE).tex $(OUT_FILES) $(CROP_FILES)
    latexmk -pdf -quiet $(TEXFILE)

# Run R files
R: $(OUT_FILES)

# View main tex file
view: $(TEXFILE).pdf
    evince $(TEXFILE).pdf &

# Clean up stray files
clean:
```

# Makefiles

 **Yihui Xie** @xieyihui · Nov 21, 2012  
@robjhyndman yihui.name/knitr/demo/chi... or another way of separating R from reports: [yihui.name/knitr/demo/ext...](http://yihui.name/knitr/demo/ext...)

Q 1    ↗    ❤ 1    ⬆ ⬇

 **Rob J Hyndman**  
@robjhyndman

Replies to [@xieyihui](#)

**@xieyihui** I know, but I reckon my way is simpler.  
Does knitr have any real advantages over my approach with a Makefile?

3:47 PM · Nov 21, 2012 · Twitter Web Client

---

 View Tweet activity

---

1 Like

Q    ↗    ❤    ⬆ ⬇

 **Yihui Xie** @xieyihui · Nov 22, 2012  
Replies to [@robjhyndman](#)  
@robjhyndman In fact I use Makefile frequently together with knitr. I'll elaborate later in a blog post.

Q    ↗    ❤    ⬆ ⬇

# Rmarkdown templates



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Department of Econometrics and Business Statistics

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## **FFORMA: Feature-based Forecast Model Averaging**

Pablo Montero-Manso, George Athanasopoulos,  
Rob J Hyndman, Thiyanga S Talagala

January 2019

Working Paper 19/18

# Rmarkdown templates



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## FFORMA: Feature-based Forecast Model Averaging

Pablo Montero-Manso, George Athanasopoulos,  
Rob J Hyndman, Thiyanga S Talagala

January 2019

Working Paper 19/18



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**Exploratory data analysis  
for Huawei**

**Mr Mitchell O'Hara-Wild**  
BComm (Hons)

**Mr Justin Carmody**  
BSc, MBusA

**Professor Rob J Hyndman**  
BSc (Hons), PhD, AStat

**Dr Souhaib Ben Taleb**  
BSc, MSc, PhD

Report for  
Huawei

26 March 2018

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# Rmarkdown templates



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## FFORMA: Feature-based Forecast Model Averaging

Pablo Montero-Manso, George Athanasopoulos,  
Rob J Hyndman, Thiyanga S Talagala



MONASH  
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**Exploratory data analysis  
for Huawei**

Mr Mitchell O'Hara-Wild  
BComm (Hons)

Mr Justin Carmody  
BSc, MBUSA

## Templates



[robjhyndman/MonashEBSTemplates](#)

- `MonashEBSTemplates::workingpaper`
- `MonashEBSTemplates::report`

# **Evolution of a website**

# Evolution of a website

## Rob Hyndman's Home Page

---

Hi. I am a Senior Lecturer in [Statistics](#) in the [Department of Mathematics](#) at [Monash University](#).

### Subjects I am lecturing in 1997

[MAT1060: Statistical methods](#)

[MAT2061: Methods of Statistics](#)

[MAS3421: Time Series](#)

[S4082: Forecasting](#)

[S4122: Computer Intensive Methods in Statistics](#)

### Administrative responsibilities

- I am Director of the [Key Centre for Statistical Science](#)
- I am [Book Review](#) Editor for the *Australian Journal of Statistics*.

### Research Interests

- Time series analysis: particularly non-Gaussian time series, non-linear time series and time series with explanatory variables.
- Density estimation and smoothing: particularly estimating and visualizing conditional density estimates.
- Statistical computing.

A list of my published and unpublished [research papers](#) is available (including postscript copies for most of them).

### Web resources

- [Statistical resources on the WWW](#).
- My [Time Series Data Library](#)
- My collection of [Time Series and Forecasting resources on the WWW](#)
- My [LaTeX](#) page.

# Evolution of a website

## Rob J Hyndman's Home Page

- [Teaching](#)
- [Statistical research](#)
- [Administrative tasks](#)
- [S-plus functions for Time Series](#)

### Series

- [Forecasting book](#)
- [Web resources](#)
- [Religious interests](#)
- [Family](#)
- [How to contact me](#)

Hi. I am a Senior Lecturer in [Statistics](#) in the [Department of Mathematics and Statistics](#) at [Monash University](#).

Contact me by e-mail at [Rob.Hyndman@sci.monash.edu.au](mailto:Rob.Hyndman@sci.monash.edu.au) or as follows.

Dr Rob J Hyndman  
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- [Research](#)
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- [Forecasting book](#)
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- [S-plus functions](#)

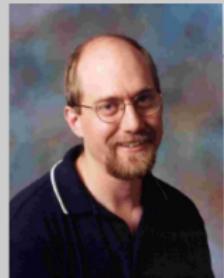
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- [Family](#)
- [Miscellaneous](#)
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Hi. I am [Director of Consulting](#) and Associate Professor in the [Department of Econometrics and Business Statistics](#) at [Monash University](#).  
I can be contacted as follows:

Associate Professor Rob J Hyndman  
Department of Econometrics & Business Statistics  
Monash University, VIC 3800, Australia.

E-mail: [Rob.Hyndman@buseco.monash.edu.au](mailto:Rob.Hyndman@buseco.monash.edu.au) .  
Phone: (03) 9905 2358  
Fax: (03) 9905 5474

If you visit, you will find me in Room 671 in the Menzies Building, Clayton campus.



# Evolution of a website

Hi. You have reached the personal home page of Rob J Hyndman.

I am Professor of Statistics in the [Department of Econometrics and Business Statistics](#) at [Monash University](#).



## Contact details:

Professor Rob J Hyndman  
Department of Econometrics & Business Statistics  
Monash University, VIC 3800, Australia.

E-mail: [Rob.Hyndman@buseco.monash.edu.au](mailto:Rob.Hyndman@buseco.monash.edu.au) .

Phone: (03) 9905 2358

Fax: (03) 9905 5474

Office: Room 671, Menzies Building, Clayton campus.

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## News articles on population forecasting and the elderly

- [Monash News \(May 2004\)](#)
- [Sunday Age \(16 May 2004\)](#)

Please note: This is a *personal* page; any material found here does not necessarily reflect the views of Monash University.

[Official disclaimer](#)

# Evolution of a website



Rob J Hyndman

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- [Home page](#)
- [Publications](#)
- [Talks](#)
- [New exponential smoothing book](#)
- [Forecasting textbook](#)
- [International Journal of Forecasting](#)
- [Time Series Data Library](#)
- [R packages](#)
- [LaTeX](#)
- [Search for research](#)
- [Research team](#)
- [Dandenong Bible Education Centre](#)
- [Religious interests](#)
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- [About me](#)

Publications



Talks



New exponential  
smoothing book



Forecasting  
textbook



International  
Journal  
of Forecasting



Time Series  
Data Library



R packages



L<sup>A</sup>T<sub>E</sub>X



Search for research



Research team

# Evolution of a website



# Rob J Hyndman

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## Website update

MONDAY, 13 AUGUST 2007

This website is undergoing its most major upgrade since its launch in 1993. There are two new blogs: one on [research issues](#) and one [answering Bible questions](#). There are also some new RSS feeds (look under Library/Useful news feeds). All of the old content is also here, but rearranged and repackaged. If you find anything that doesn't work properly, please [let me know](#).

LAST UPDATED ( WEDNESDAY, 29 AUGUST 2007 )

## Time Series Data Library



## Downtime

FRIDAY, 24 AUGUST 2007

This website will be down on Thursday 30 August from 5pm for up to four hours. This is to enable the server to be relocated. Sorry for any inconvenience!

LAST UPDATED ( FRIDAY, 24 AUGUST 2007 )

## FORECASTING

METHODS AND APPLICATIONS

(SECOND EDITION)



## Forecasting with exponential smoothing: the state space approach

SUNDAY, 12 AUGUST 2007



New research monograph to be published by Springer in 2008.



Hits: 544



[Read More](#)

# Evolution of a website



Rob J Hyndman

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GO

## Updated website

2009

In [News](#) [No Comments](#)

Jul This website has just undergone a major facelift. I've switched from Joomla to Wordpress, which will make it much simpler to maintain and develop. I hope you also find it easier to locate what you're looking for.

A few things have been removed including my link collections and feed collections. I decided these were not sufficiently useful and too difficult to maintain. The feeds are still available on the relevant webpages in any case. I will be adding some entries on the research tips blog about maintaining feed and link collections, so watch out for them.

Another area that has been removed is my collection of statistical quotations. This is now maintained by [Andrey Kostenko](#), and is available [here](#).

My Bible answers blog has moved to [BibleQ.info](#). Unfortunately, the extensive comments on some posts have been lost. Sorry about that.

Everything else should be here somewhere. Please [ask](#) if anything is broken, or if you can't find what you're after. Happy browsing!



### MY OTHER WEBPAGES

- [International Journal of Forecasting](#)
- [Time series data library](#)
- [Forecasting textbook](#)
- [Exponential smoothing book](#)
- [NEF-FOR: Forecasting papers](#)
- [Dandenong Bible Education Centre](#)
- [Bible answers blog](#)

## Rainbow plots, bagplots and boxplots for functional data

2009

In [Refereed papers](#)

Jul

### **Journal of Computational and Graphical Statistics (2010), to appear**

ROB J HYNDMAN AND HAN LIN SHANG

**Abstract:** We propose new tools for visualizing large numbers of functional data in the form of smooth curves or surfaces. The proposed tools include functional versions of the bagplot and boxplot, and make use of the first two robust principal component scores, Tukey's data depth and highest density

# Evolution of a website



Rob J Hyndman

Monash University, Australia

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Search this site

Rob J Hyndman is Professor of Statistics in the [Department of Econometrics and Business Statistics](#) at Monash University, and Editor-in-Chief of the [International Journal of Forecasting](#).

He develops statistical models, algorithms and software for forecasting, analysing and visualizing data.

Rob has written more than 100 research papers and 5 books. He also maintains an active consulting practice, and has provided advice to hundreds of clients around the world.

He has won awards for his research, teaching, consulting and graduate supervision.



Recent activity

[robjhyndman.com](http://robjhyndman.com)

# Evolution of a website

Rob J Hyndman

Hyndsoft blog

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Seminars

Teaching

Research team

About

## Forecasts are always wrong

18 October 2019

forecasting, podcast

Recently I was interviewed for the Monash Business School podcast "Thought Capital" on the topic of forecasting. You can listen to the episode [here](#) (or read the transcript).

## Non-Gaussian forecasting using fable

17 October 2019

time series, graphics, statistics, R, tidyverts, forecasting

library(tidyverse) library(tsibble) library(lubridate) library(feasts) library(fable) In my previous post about the new fable package, we saw how fable can produce forecast distributions, not just point forecasts. All my examples used Gaussian (normal) distributions, so in this post I want to show how non-Gaussian forecasting can be done. As an example, we will use eating-out expenditure in my home state of Victoria. `vic_cafe <- tsibbledata::aus_retail %>% filter( State == "Victoria", Industry == "Cafes, restaurants and catering services" ) %>% select(Month, Turnover) vic_cafe %>% autoplot(Turnover) + ggtitle("Monthly turnover of Victorian cafes")` Forecasting with transformations Clearly the variance is increasing with the level of the series, so we will consider modelling a Box-Cox transformation of the data.

[READ MORE...](#)

## Tidy forecasting in R

29 September 2019

time series, graphics, statistics, R, tidyverts, forecasting

The fable package for doing tidy forecasting in R is now on CRAN. Like tsibble and feasts, it is also part of the tidyverts family of packages for analysing, modelling and forecasting many related time series (stored as tsibbles). For a brief introduction to tsibbles, see this post from last month. Here we will forecast Australian tourism data by state/region and purpose. This data is stored in the tourism tsibble where Trips contains domestic visitor nights in thousands.

[READ MORE...](#)

## Recent publications

- Earo Wang, Dianne Cook, Rob J Hyndman (2020) Calendar-based graphics for visualizing people's daily schedules. *J Computational & Graphical Statistics*, to appear. [ABSTRACT](#) [DOI](#) [PDF](#)
- George Athanasopoulos, Puwasala Gamakumara, Anastasios Panagiotelis, Rob J Hyndman and Mohamed Affan (2020) Hierarchical forecasting. *Macroeconomic forecasting in the era of big data*, ed. P. Fuleky, Springer, Chapter 21, pp.689–719. [ABSTRACT](#) [DOI](#) [PDF](#)
- Jeremy Forbes, Dianne Cook, Rob J Hyndman (2020) Spatial modelling of the two-party preferred vote in Australian federal elections: 2001–2016. *Australian and New Zealand Journal of Statistics*, to appear. [ABSTRACT](#) [DOI](#) [PDF](#)
- Earo Wang, Di Cook and Rob J Hyndman (2020) A new tidy data structure to support exploration and modeling of temporal data. *Journal of Computational & Graphical Statistics*, to appear. [ABSTRACT](#) [DOI](#) [PDF](#)
- Pablo Montero-Manso, George Athanasopoulos, Rob J Hyndman, Thiyanga S Talagala (2020) FFORMA: Feature-based Forecast Model Averaging. *International Journal of Forecasting*, 36(1), 86–92. [ABSTRACT](#) [DOI](#) [PDF](#)

## Recent and upcoming seminars

- ☞ Tidy time series & forecasting in R. (27 January 2020) [MORE INFO...](#)
- ☞ The journal game. (29 October 2019) [MORE INFO...](#)
- ☞ Tidy time series analysis in R. (27 September 2019) [MORE INFO...](#)
- ☞ Feature-based time series analysis. (27 September 2019) [MORE INFO...](#)
- ☞ Tidy time series analysis in R. (26 September 2019) [MORE INFO...](#)

# Evolution of a website

Rob J Hyndman

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library(tidyverse) library(tsibble) library(lubridate) library(feasts) library(fable) In my previous post about the new fable package, we saw how fable can produce forecast distributions, not just point forecasts. All my examples used Gaussian (normal) distributions, so in this post I want to show how non-Gaussian forecasting can be done. As an example, we will use eating-out expenditure in my home state of Victoria. vic\_cafe <- tsibbledata::aus\_retail %>% filter( State == "Victoria", Industry == "Cafes, restaurants and catering services" ) %>% select(Month, Turnover) vic\_cafe %>% autoplot(Turnover) + ggtitle("Monthly turnover of Victorian cafes") Forecasting with transformations Clearly the variance is increasing with the level of the series, so we will consider modelling a Box-Cox transformation of the data.

[READ MORE...](#)

## Tidy forecasting in R

29

## Blogdown theme

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 [rbind/robjhyndman.com](https://github.com/robjhyndman)  
*(Adaptation of [hugo-finite](#) with  
inspiration from Kieran Healy)*

## Recent publications

- Earo Wang, Dianne Cook, Rob J Hyndman (2020) Calendar-based graphics for visualizing people's daily schedules. *J Computational & Graphical Statistics*, to appear. [ABSTRACT](#) [DOI](#) [PDF](#)
- George Athanasopoulos, Puwasala Gamakumara, Anastasios Panagiotelis, Rob J Hyndman and Mohamed Affan (2020) Hierarchical forecasting. *Macroeconomic forecasting in the era of big data*, ed. P. Fuleky, Springer, Chapter 21, pp.689–719. [ABSTRACT](#) [DOI](#) [PDF](#)
- Jeremy Forbes, Dianne Cook, Rob J Hyndman (2020) Spatial modelling of the two-party preferred vote in Australian federal elections: 2001–2016. *Australian and New Zealand Journal of Statistics*, to appear. [ABSTRACT](#) [DOI](#) [PDF](#)
- Earo Wang, Di Cook and Rob J Hyndman (2020) A new tidy data structure to support exploration and modeling of temporal data. *Journal of Computational & Graphical Statistics*, to appear. [ABSTRACT](#) [DOI](#) [PDF](#)
- Pablo Montero-Manso, George Athanasopoulos, Rob J Hyndman, Thiyanga S Talagala (2020) FFORMA: Feature-based Forecast Model Averaging. *International Journal of Forecasting*, 36(1), 86–92. [ABSTRACT](#) [DOI](#) [PDF](#)

## Recent and upcoming seminars

- ✉ Tidy time series & forecasting in R. (27 January 2020) [MORE INFO...](#)
- ✉ The journal game. (29 October 2019) [MORE INFO...](#)
- ✉ Tidy time series analysis in R. (27 September 2019) [MORE INFO...](#)
- ✉ Feature-based time series analysis. (27 September 2019) [MORE INFO...](#)
- ✉ Tidy time series analysis in R. (26 September 2019) [MORE INFO...](#)

[robjhyndman.com](http://robjhyndman.com)

15

**An online publishing venture**

# Online publishing

## Forecasting: principles and practice

An online textbook by Rob J Hyndman and George Athanasopoulos



Preface Data Authors Using R Resources FAQ  Search

### Under construction.

Chapters 1–2, 4–8 are largely complete apart from exercises. We plan to finish the remaining chapters by the end of 2012. If you have any comments or suggestions on what is here so far, feel free to add them to the comments at the end of the [Preface](#).

## Preface

Welcome to our new online textbook on forecasting. This book is intended as a replacement for [Makridakis, Wheelwright and Hyndman \(Wiley 1998\)](#).

The entire book is available online and free-of-charge. Of course, we won't make much money doing this, but textbooks never make much money anyway — the publishers make all the money. We'd rather create something that is widely used and useful, than have large publishers profit from our efforts.

Eventually a print version and a downloadable e-version of the book will be available to purchase on Amazon, but not until a few more chapters are written.

### Contents

- [open all](#) | [close all](#)
- [1 Getting started](#)
- [2 The forecaster's toolbox](#)
- [3 Judgmental forecasts](#)
- [4 Simple regression](#)
- [5 Multiple regression](#)
- [6 Time series decomposition](#)
- [7 Exponential smoothing](#)
- [8 ARIMA models](#)
- [9 Dynamic regression models](#)
- [10 Neural network models](#)
- [11 Further forecasting methods](#)
- [12 Demand forecasting](#)
- [13 Using forecasting methods in practice](#)
- [Using R](#)
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# Online publishing



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[Home](#) » Forecasting: principles and practice

## Forecasting: principles and practice

Welcome to our online textbook on forecasting. This textbook is intended to provide a comprehensive introduction to forecasting methods and to present enough information about each method for readers to be able to use them sensibly. We don't attempt to give a thorough discussion of the theoretical details behind each method, although the references at the end of each chapter will fill in many of those details. The book is written for three audiences: (1) people finding themselves doing forecasting in business when they may not have had any formal training in the area; (2) undergraduate students studying business; (3) MBA students doing a forecasting elective. We use it ourselves for a second-year subject for students undertaking a Bachelor of Commerce degree at Monash University, Australia.

For most sections, we only assume that readers are familiar with algebra, and high school mathematics should be sufficient background. Readers who have completed an introductory course in statistics will probably want to skip some of [Chapters 2 and 4](#). There are a couple of sections which require knowledge of matrices, but these are flagged.

At the end of each chapter we provide a list of "further reading". In general, these lists comprise suggested textbooks that provide a more advanced or detailed treatment of the subject. Where there is no suitable textbook, we suggest

### Book information



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# Online publishing

other words, the further ahead we forecast, the more uncertain we are.

We can imagine many possible futures, each yielding a different value for the thing we wish to forecast. Plotted in black in Figure 1.2 are the total international visitors to Australia from 1980 to 2015. Also shown are ten possible futures from 2016–2025.

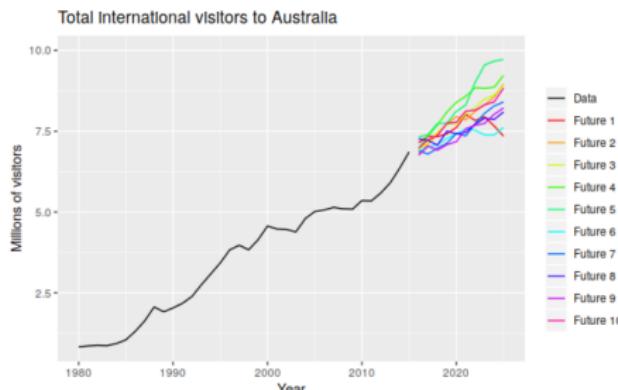


Figure 1.2: Total international visitors to Australia (1980–2015) along with ten possible futures.

When we obtain a forecast, we are estimating the *middle* of the range of possible values the random variable could take. Often, a forecast is accompanied by a **prediction interval** giving a *range* of values the random variable could take with relatively high probability. For example, a 95% prediction interval contains a range of values which should include the actual future value with probability 95%.

# Online publishing

## Forecasting: Principles and Practice

### Preface

#### 1 Getting started

##### 1.1 What can be forecast?

##### 1.2 Forecasting, planning and goals

##### 1.3 Determining what to forecast

##### 1.4 Forecasting data and methods

##### 1.5 Some case studies

##### 1.6 The basic steps in a forecasting ta...

##### 1.7 The statistical forecasting perspe...

##### 1.8 Exercises

##### 1.9 Further reading

### 2 Time series graphics

##### 2.1 t-s objects

##### 2.2 Time plots

##### 2.3 Time series patterns

##### 2.4 Seasonal plots

##### 2.5 Seasonal subseries plots

##### 2.6 Scatterplots

##### 2.7 Lag plots

##### 2.8 Autocorrelation

##### 2.9 White noise

##### 2.10 Exercises

##### 2.11 Further reading

### 3 The forecaster's toolbox

##### 3.1 Some simple forecasting methods

##### 3.2 Transformations and adjustments

##### 3.3 Residual diagnostics

##### 3.4 Evaluating forecast accuracy

##### 3.5 Prediction intervals

##### 3.6 The forecast package in R

other words, the further ahead we forecast, the less accurate our forecasts will be.

We can imagine many possible futures. Figure 1.2 shows the actual international visitors to Australia from 1980 to 2015. Also shown are ten possible future paths.

Figure 1.2: Total international visitors to Australia (1980–2015) along with ten possible futures.

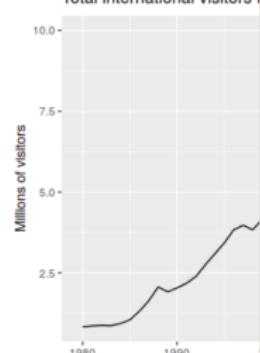


Figure 1.2: Total international visitors to Australia (1980–2015) along with ten possible futures.

When we obtain a forecast, we are estimating the range of values that the random variable could take. Often, a forecast will come with a prediction interval, which is the range of values the random variable could take with probability 95%. This means that 95% prediction interval contains a random variable with probability 95%.

24 FORECASTING: PRINCIPLES AND PRACTICE

Total international visitors to Australia

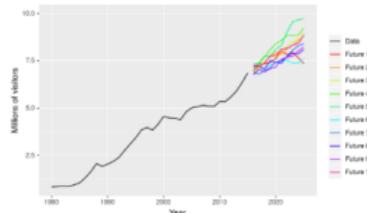


Figure 1.2: Total international visitors to Australia (1980–2015) along with ten possible futures.

interval contains a range of values which should include the actual future value with probability 95%.

Instead of plotting individual possible futures as shown in Figure 1.2, we usually show these prediction intervals instead. The plot below shows 80% and 95% intervals for the future Australian international visitors. The blue line is the average of the possible future values, which we call the **point forecasts**.

Forecasts of total international visitors to Australia

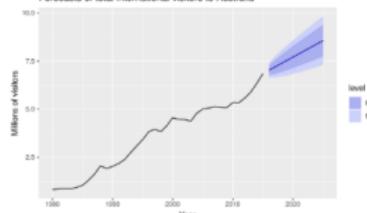


Figure 1.3: Total international visitors to Australia (1980–2015) along with 10-year forecasts and 80% and 95% prediction intervals.

We will use the subscript  $t$  for time. For example,  $y_t$  will denote the observation at time  $t$ . Suppose we denote all the information we have observed as  $\mathcal{I}$  and we want to forecast  $y_t$ . We then write  $y_t|\mathcal{I}$  meaning "the random variable  $y_t$  given what we know in  $\mathcal{I}$ ". The set of values that this random variable could

# Online publishing

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- Simple css styling

- Complicated LaTeX styling

other words, the further ahead we forecast, the more uncertain our forecast will be.

We can imagine many possible futures. We can't know which one will actually happen. Plotted in black in Figure 1.2 is the historical data up to 2015. Also shown are ten possible future paths.

Figure 1.2: Total international visitors to Australia (1980–2015)

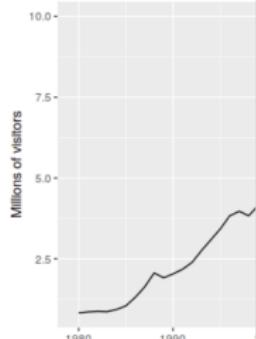


Figure 1.2: Total international visitors to Australia (1980–2015)

Total international visitors to Australia

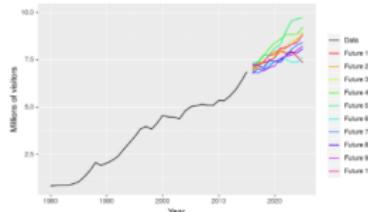


Figure 1.2: Total international visitors to Australia (1980–2015) along with ten possible futures.

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Forecasts of total international visitors to Australia

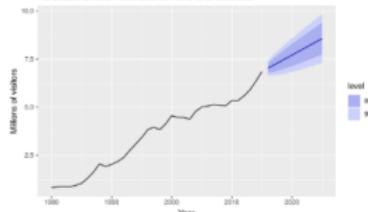


Figure 1.3: Total international visitors to Australia (1980–2015) along with 10-year forecasts and 80% and 95% prediction intervals.

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# Making slides

### 1.2 Portmanteau tests

Consider a *whole set* of  $r_k$  values, and develop a test to see whether the set is significantly different from a zero set.

#### Ljung-Box test:

$$Q^* = n(n + 2) \sum_{k=1}^h (n - k)^{-1} r_k^2$$

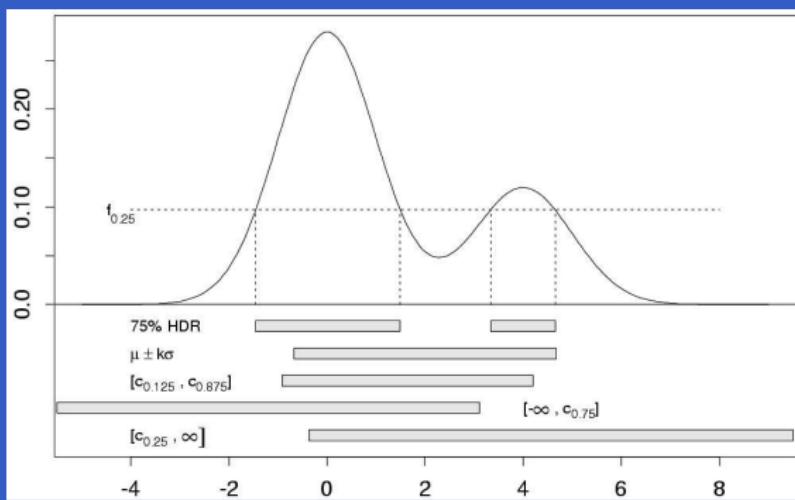
where  $h$  is the maximum lag being considered and  $n$  is the number of observations in the series.

- ◊ If each  $r_k$  close to zero,  $Q^*$  will be **relatively small**.
- ◊ If some  $r_k$  values large (positive or negative),  $Q^*$  will be **relatively large**.

:

## Example: Density forecasting

### Highest density regions



## Forecasts

$$\mathbf{Y}_t = S\mathbf{Y}_{K,t}$$

Let  $\hat{\mathbf{Y}}_n(h)$  be vector of independent (base) forecasts for horizon  $h$ , stacked in same order as  $\mathbf{Y}_t$ .

Write

$$\hat{\mathbf{Y}}_n(h) = S\beta_n(h) + \varepsilon_h$$

where

- $\beta_n(h) = E[\mathbf{Y}_{K,n+h} \mid \mathbf{Y}_1, \dots, \mathbf{Y}_n]$  is unknown mean of bottom level  $K$
- $\varepsilon_h$  has zero mean and covariance matrix  $\Sigma_h$ .

**Idea:** Estimate  $\beta_n(h)$  using regression.

# Making slides

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# How Rmarkdown changed my life

Rob J Hyndman

30 January 2020

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# **Curriculum vitae**

# Curriculum vitae

## Rob J Hyndman

Curriculum Vitae  
December 2019

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### Education and qualifications

1988 B.Sc.(Hons) University of Melbourne  
1992 Ph.D. University of Melbourne  
2000 A.Stat. Statistical Society of Australia

### Employment history

2019– Head, Department of Econometrics & Business Statistics, Monash University  
2003– Professor, Department of Econometrics & Business Statistics, Monash University  
2001–2003 Associate Professor, Department of Econometrics & Business Statistics, Monash University  
1998–2000 Senior Lecturer, Department of Econometrics & Business Statistics, Monash University  
1997–1998 Visiting Lecturer, Department of Mathematics and Statistics, Monash University  
1995–1996 Lecturer, Department of Mathematics and Statistics, Monash University  
1993–1994 Lecturer, Department of Statistics, University of Melbourne  
1985–1992 Statistical consultant, Department of Statistics, University of Melbourne

### Other positions

2011– Editor, *Journal of Statistical Software*  
2001– Associate Editor, *International Journal of Forecasting*  
2005–2010 Editor-in-Chief, *International Journal of Forecasting*  
2005–2010 Director, International Institute of Forecasters  
2001–2004 Theory and Methods Editor, *Australian & New Zealand Journal of Statistics*

### Honours and awards

2016 KNWV Visiting Professor, TU/Eindhoven, Netherlands  
2010 Dean's Award for excellence in innovation and external collaboration, Monash University  
2008 Dean's award for excellence in research, Monash University  
2008 Vice-Chancellor's award for postgraduate supervisor of the year, Monash University  
2007 Kribbs Lecture, Statistical Society of Australia (ACT branch)  
2007 Moran Medal for Statistical Science, Australian Academy of Science  
2006 Belz Lecturer, Statistical Society of Australia (Victorian branch)  
1998 Award for excellence in teaching, Monash Science Society  
1990 Finalist, Channel Ten Young Achiever Awards  
1988 Dwights Prize in Statistics, University of Melbourne  
1987 Norma McArthur Prize in Statistics, University of Melbourne  
1986 Second Maurice H. Belz Prize in Statistics, University of Melbourne

### Current memberships

- Elected Member, International Statistical Institute
- Member, International Institute of Forecasters
- Member, International Association for Statistical Computing
- Member, Statistical Society of Australia
- Member, International Society for Business and Industrial Statistics

### Research

- Since 1991 I have authored 200 papers, chapters or books on statistical topics (listed on pages 4–12).
- My current research involves the analysis of large collections of time series, and includes visualization, forecasting, model selection, machine learning and causal inference.
- I currently supervise four PhD students and two post-doctoral research fellows. I have previously supervised another 25 PhD students and 3 Masters students.
- I publish the Hyndman blog on research issues which receives an average of about 2000 pageviews per day.
- I have produced 41 R packages as a result of my research (listed on pages 21–23).

# Curriculum vitae

## Rob J Hyndman

Curriculum Vitae  
December 2019

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# **Theses**

# Theses

## Anomaly Detection in Streaming Time Series Data

A thesis submitted for the degree of

Doctor of Philosophy

by

Priyanga Dilini Talagala

Supervised by

Professor Rob J. Hyndman

Professor Kate Smith-Miles



Department of Econometrics and Business Statistics

Monash University

Australia

July 2019

# Theses

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Department of Econometrics and Business Statistics

Monash University

Australia

July 2019

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# Memos

# Memos



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## Tutors and tutorials

Rob J Hyndman

11 June 2019

Tutors are there to help in delivering a unit by running small group classes and with marking. Having a second person explaining things, in a different style in smaller groups, can be very helpful to students. Tutors are not meant to be delivering mini-lectures but instead should have content and exercises prepared for the tutorial that supports the lectures. They are there to answer student questions, explain any areas that have not been well understood, go over exercises, help with computer issues, etc.

Tutors will normally be provided for units with more than 25 enrolled students, with approximately one tutorial allocated for every 25 students (unless room constraints require a lower number). An exception is for honours units which do not have allocated tutorials, but have an additional lecture scheduled instead.

### Guidelines to the appropriate use of tutors

- All activities undertaken by the tutors are to be prepared by the lecturer involved. This includes what happens in tutorials as well as all assessment tasks.
- Assessment tasks (excluding exams) should be designed so that they can all be marked efficiently.
- Lecturers should consider how to design assessment that is both effective at testing students' knowledge and skills, while being efficient to mark.
- For each assessment task, lecturers are expected to provide tutors with a complete solution in addition to a marking scheme along with an estimate of the expected marking/assessment time.
- Please note that the payment which tutors receive includes a component for the provision of 30 minutes consultation per tutorial hour (and no more).

### Head tutors

- For units with more than 200 students, head tutors may be appointed for a specified number of hours per week where the lecturers involved have a full workload based on the Department workload model.
- Their role is to assist with the administration of the tutor team and unit including:
  - managing student queries where appropriate;
  - oversight of assignment and exam marking processes and results management;
  - maintaining (but not creating) moodle content.

• The assigned work must fit within the hours allotted to the head tutor.

### PhD students

Many of our tutors are PhD students. This provides valuable teaching experience for them, as well as providing them with a small amount of additional income. It is expected that PhD students will undertake some tutoring during their candidature, normally after they have completed their coursework. PhD supervisors will be asked to advise on what units would be most suitable for their student to tutor, and if undertaking tutoring is likely to adversely impact the student's PhD progress.

The final decisions on who tutors, and what units they tutor, will be made by the campus coordinators: John Stapleton (Clayton) and Charanjit Kaur (Caulfield and Peninsula).

# Memos



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## An Exponential Smoothing Model with a Life Cycle Trend

OPRE-2019-06-267

13 August 2019

This paper introduces a new model for life cycle trends which has some advantages over existing models. In particular, it is an extension of existing exponential smoothing models, it allows for full probabilistic forecasting, and it appears to be relatively accurate compared to the main competitor models.

A few minor comments follow.

1. p3, l11. The M4 competition required participants to make prediction intervals at a single forecast horizon, not rolling quantile forecasts. Also, the data were not all macroeconomic.
2. p4-5. I had to read these pages a couple of times before realising that you were not saying the data follow a tilted-Gompertz distribution, but that the trend had a shape described by the tilted-Gompertz density function. This could be made clearer.
3. p6, eq (1). This model is numerically unstable due to the division by  $\varepsilon_{t-1}$ . See Ch 15 of Hyndman et al. (2008).
4. p7. There doesn't seem much benefit using the notation  $1 + \varepsilon_t$  in [2] when you never use the  $\varepsilon_t$ s directly. Why not replace  $[1 + \varepsilon_t]$  with  $\varepsilon_t^{\gamma}$  where  $\varepsilon_t$  is normally distributed.
5. p7. It is perhaps worth pointing out that setting  $\gamma = 1$  leads to something similar to an ETS(M,M,M) model – the only difference being the log normal distribution rather than a normal distribution on the errors.
6. Section 2.3. The connection between the forecast function (7) and the tilted-Gompertz diffusion model is worth noting in passing, but it seems to get far more attention than it deserves. It is not clear to me how this connection leads to any insights or results that help in forecasting of life-cycle trends. If space is an issue, this is a section that could be reduced without losing the main value of the paper.
7. p19. It is a little odd to evaluate the median as a point forecast using RMSE or MAPE, neither of which lead to the median as the optimal point forecast. Since you are using pinball loss, why not average the pinball loss over a fine grid of quantiles to get something equivalent to CRPS?
8. p21. Surely the prior distributions for  $\alpha$  and  $\beta^*$  are not identical for all 170 series? How do the authors explain this?
9. p21. In the simulation study, did you generate data for the full life-cycle, or a partial life-cycle? Only the latter gives useful results here as there is no need to forecast full life-cycles. Assuming you simulated partial life-cycles, how was the time of the last observation determined?
10. p24. The ETS(A,M,N) model is numerically unstable and not recommended by Hyndman et al.
11. p38. The details of Holt (1957) are incorrect. The title was 'Forecasting trends and seasonal by exponentially weighted averages'. The 2004 version is correctly listed (with a different title).

## References

- Hyndman, RJ, AB Koehler, JK Ord & RD Snyder (2008). *Forecasting with exponential smoothing: the state space approach*. Berlin: Springer-Verlag.

# Memos



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## Tutors and tutorials

Rob J Hyndman

11 June 2019

Tutors are there to help in delivering a unit by running small group classes and with marking. Having a second person explaining things, in a different style in smaller groups, can be very helpful to students. Tutors are not meant to be delivering mini-lectures but instead should have content and exercises prepared for the tutorial that supports the lectures. They are there to answer student questions, explain any areas that have not been well understood, go over exercises, help with computer issues, etc.

Tutors will normally be provided for units with more than 25 enrolled students, with approximately one tutorial allocated for every 25 students (unless room constraints require a lower number). An exception is for honours units which do not have allocated tutorials, but have an additional lecture scheduled instead.

## Guidelines to the appropriate use of tutors

- All activities undertaken by the tutors are to be prepared by the lecturer involved. This includes what happens in tutorials as well as all assessment tasks.
- Assessment tasks (excluding exams) should be designed so that they can all be marked efficiently.
- Lecturers should consider how to design assessment that is both effective at testing students' knowledge and skills, while being efficient to mark.
- For each assessment task, lecturers are expected to provide tutors with a complete solution in addition to a marking scheme along with an estimate of the expected marking/assessment time.
- Please note that the payment which tutors receive includes a component for the provision of 30 minutes of consultation per tutorial hour (and no more).

## Head tutors

- For units with more than 200 students, head tutors may be appointed for a specified number of hours per week where the lecturers involved have a full workload based on the Department workload model.
- Their role is to assist with the administration of the tutor team and unit including:
  - managing student queries where appropriate;
  - oversight of assignment and exam marking processes and results management;
  - maintaining (but not creating) moodle content.
- The assigned work must fit within the hours allocated to the head tutor.

## PhD students

Many of our tutors are PhD students. This provides valuable teaching experience for them, as well as providing them with a small amount of additional income. It is expected that PhD students will undertake some tutoring during their candidature, normally after they have demonstrated their research competence. PhD supervisors will be asked to decide on what units would be most suitable for a student's PhD progress.

The final decisions on who tutu  
(Clayton) and Charanjit Kaur

# Template



robjhyndman/MonashEBSTemplates

■ MonashEBSTemplates::memo

## An Exponential Smoothing Model with a Life Cycle Trend

OPRE-2019-06-267

13 August 2019

This paper introduces a new model for life cycle trends which has some advantages over existing models. In particular, it is an extension of existing exponential smoothing models, it allows for full probabilistic forecasting, and it appears to be relatively accurate compared to the main competitor models.

A few minor comments follow.

1. p3, l11. The M4 competition required participants to make prediction intervals at a single forecast horizon, not rolling quantile forecasts. Also, the data were not all macroeconomic.
2. p2. I had to read these pages a couple of times realising that you were not saying the data follow a tilted-Gompertz distribution, but that the trend had a shape described by the tilted-Gompertz density function. This could be made clearer.
3. p6, eq (1). This model is numerically unstable due to the division by  $\varepsilon_{t-1}$ . See Ch 15 of Hyndman et al. (2008).
4. p7. There doesn't seem much benefit using the notation  $1 + \varepsilon_t$  in [2] when you never use the  $\varepsilon_t$ 's directly. Why not replace  $(1 + \varepsilon_t)$  with  $\varepsilon_t^{\gamma}$  where  $\varepsilon_t$  is normally distributed.
5. p7. It is perhaps worth pointing out that setting  $\gamma = 1$  leads to something similar to an ETS(M,M,M) model – the only difference being the log normal distribution rather than a normal distribution on the errors.
6. Section 2.3. The connection between the forecast function (7) and the tilted-Gompertz diffusion model is worth noting in passing, but it seems to get far more attention than it deserves. It is not clear to me how this connection leads to any insights or results that help in forecasting of life-cycle trends. If space is an issue, this is a section that could be reduced without losing the main value of the paper.
7. p19. It is a little odd to evaluate the median as a point forecast using RMSE or MAPE, neither of which lead to a fine grid of quantiles to get something equivalent to CRPS?
8. p21. Surely the prior distributions for  $\alpha$  and  $\beta^*$  are not identical for all 170 series? How do the authors explain this?
9. p23. In the simulation study, did you generate data for the full life-cycle, or a partial life-cycle? Only the latter gives useful results here as there is no need to forecast full life-cycles. Assuming you simulated partial life-cycles, how was the time of the last observation determined?
10. p24. The ETS(A,M,N) model is numerically unstable and not recommended by Hyndman et al.
11. p38. The details of Holt (1957) are incorrect. The title was 'Forecasting trends and seasonal by exponentially weighted averages'. The 2004 version is correctly listed (with a different title).

## References

Hyndman, RJ, AB Koehler, JK Ord & RD Snyder (2008). *Forecasting with exponential smoothing: the state space approach*. Berlin: Springer-Verlag.

# **Letters**

# Letters



Rob J Hyndman  
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30 November 2019

Dr Caitriona Ryan  
Senior Post-Doctoral Researcher  
I-Form Advanced Manufacturing Research Centre  
Maynooth University Hamilton Institute  
Maynooth University, Maynooth, Co. Kildare, Ireland.

Dear Triona

I am writing to invite you to visit Monash University in 2020 to work on new statistical methods in advanced manufacturing with me and others in my research group. I understand you plan to visit Queensland University of Technology in Brisbane. We would be happy to cover the domestic flights between Brisbane and Melbourne, and accommodation in Melbourne for up to 5 nights.

As you know, I have been working on algorithms for anomaly detection in large collections of time series data. I hope we can join forces and work on some new algorithms designed for the type of data you analyse with the I-Form group.

If the timing suited, it would also be good to have you speak in our departmental seminar series in a topic of your choice.

Best wishes

A handwritten signature in black ink, appearing to read "Rob J Hyndman".

# Letters



MONASH  
BUSINESS  
SCHOOL

Rob J Hyndman  
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Professor of Statistics and Head  
Department of Econometrics & Business Statistics  
 robjhyndman.com  
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## Template

[robjhyndman/MonashEBSTemplates](#)

[MonashEBSTemplates::letter](#)

# **Exams**

# Exams



MONASH University

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Semester One 2019  
Examination Period

Faculty of Business & Economics

EXAM CODES: ETC3550

TITLE OF PAPER: Applied Forecasting for Business and Economics

EXAM DURATION: 2 hours writing time

READING TIME: 10 minutes

THIS PAPER IS FOR STUDENTS STUDYING AT: (tick where applicable)

- Caulfield       Clayton       Parkville       Peninsula  
 Monash Extension       Off Campus Learning       Malaysia       South Africa  
 Other (specify) \_\_\_\_\_

During an exam, you must not have in your possession any item/material that has not been authorised for your exam. This includes books, notes, paper, electronic device/s, mobile phone, smart watch/device, calculator, pencil case, or writing on any part of your body. Any authorised items are listed below. Items/materials on your desk, chair, in your clothing or otherwise on your person will be deemed to be in your possession.

No examination materials are to be removed from the room. This includes retaining, copying, memorising or noting down content for personal use or to share with any other person by any means following your exam.

Failure to comply with the above instructions, or attempting to cheat or cheating in an exam is a discipline offence under Part 7 of the Monash University [Council] Regulations, or a breach of instructions under Part 3 of the Monash University [Academic Board] Regulations.

AUTHORISED MATERIALS

OPEN BOOK

YES     NO

CALCULATORS

Only HP 300+ or Casio FX82 (any suffix) calculator permitted

YES     NO

SPECIFICALLY PERMITTED ITEMS

If yes, items permitted are:

YES     NO

Candidates must complete this section if required to write answers within this paper

STUDENT ID: \_\_\_\_\_

DESK NUMBER: \_\_\_\_\_

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DESK NUMBER: \_\_\_\_\_

(b) Using the code below, describe what is plotted in Figure 4. Comment on the selection of window.

6 marks

```
daycare <- STL(log(Count) ~ season(window = 21)) <-> autoplot() +  
  ggtitle("Number of employees in child day care services in New York City")
```

Number of employees in child day care services in New York City  
 $\log(\text{Count}) = \text{trend} + \text{season\_year} + \text{remainder}$

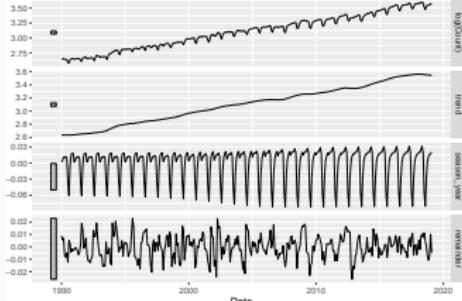


Figure 4:

(c) You are asked to provide forecasts for the next two years for the daycare series shown in Figure 1. Consider applying each of the methods and models below. Comment, in a few words each, on whether each one is appropriate for forecasting the data. No marks will be given for simply guessing whether a method or a model is appropriate without justifying your choice.

- A. Seasonal naive method.
- B. Drift method plus seasonal dummies.
- C. Holt-Winters additive damped trend method.
- D. Holt-Winters multiplicative damped trend method.
- E. ETS(M,A<sub>d</sub>,M).
- F. ARIMA(1,1,4).
- G. ARIMA(3,1,2)(1,1,0)<sub>12</sub>.
- H. ARIMA(0,1,1)(2,0,0)<sub>12</sub>.
- I. ARIMA(0,1,1)(2,0,0)<sub>12</sub>.
- J. Regression model with time and Fourier terms.

10 marks

Total: 20 marks

- END OF QUESTION 2 -

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robjhyndman/MonashEBSTemplates

■ MonashEBSTemplates::exam

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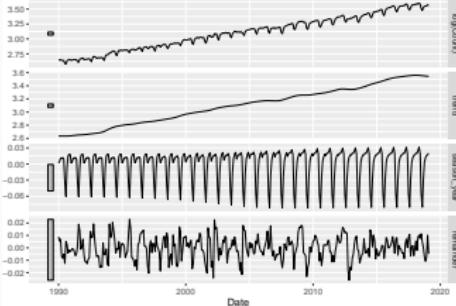


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2-  
2-  
th time and Fourier

10 marks

Total: 20 marks

# Conclusions

## What have I lost?

- The ability to write Makefiles

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- Simplicity
- Reproducibility
- Version control

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## What's next?

- Tennis club website
- Shopping list
- email, SMS, tweets, social media

# Conclusions

## What have I lost?

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## What have I gained?

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## What's next?

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# Thanks Yihui

