

# Forecasting: principles and practice

**Rob J Hyndman**

Introduction to Forecasting

# Outline

## 1 Background

## 2 Case studies

# Resources

- Slides
- Exercises
- Textbook
- Useful links

[robjhyndman.com/uwa2017](http://robjhyndman.com/uwa2017)

# Brief bio

- Professor of Statistics, Monash University
- Editor-in-Chief, *International Journal of Forecasting*

## How my forecasting methodology is used:

- Pharmaceutical Benefits Scheme
- Cancer incidence and mortality
- Electricity demand
- Ageing population
- Fertilizer sales

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# Assumptions

- This is not an introduction to R. I assume you are broadly comfortable with R code and the RStudio environment.
- This is not a statistics course. I assume you are familiar with concepts such as the mean, standard deviation, quantiles, regression, normal distribution, likelihood, etc.
- This is not a theory course. I am not going to derive anything. I will teach you forecasting tools, when to use them and how to use them most effectively.

# Key reference

Hyndman, R. J. & Athanasopoulos, G. (2017)  
*Forecasting: principles and practice*, 2nd ed.

[OTexts.org/fpp2/](https://OTexts.org/fpp2/)

- Free and online
- Data sets in associated R package
- R code for examples

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- 1 Guru: I wrote the book, done it for decades, now I do the conference circuit.
- 2 Expert: It has been my full time job for more than a decade.
- 3 Skilled: I have been doing it for years.
- 4 Comfortable: I understand it and have done it.
- 5 Learner: I am still learning.
- 6 Beginner: I have heard of it and would like to learn more.
- 7 Unknown: What is forecasting? Is that what the weather people do?

# Poll: How proficient are you in using R?

- 1 Guru: The R core team come to me for advice.
- 2 Expert: I have written several packages on CRAN.
- 3 Skilled: I use it regularly and it is an important part of my job.
- 4 Comfortable: I use it often and am comfortable with the tool.
- 5 User: I use it sometimes, but I am often searching around for the right function.
- 6 Learner: I have used it a few times.
- 7 Beginner: I've managed to download and install it.
- 8 Unknown: Why are you speaking like a pirate?

# Install required packages

```
install.packages("fpp2", dependencies=TRUE)
```

# Approximate outline

Day	Topic	Chapter
1.1	Time series graphics	2
1.2	The forecaster's toolbox	3
1.3	Seasonality and trends	6
1.4	Exponential smoothing	7
2.1	ETS state space models	7
2.2	Transformations	3
2.3	Stationarity and differencing	8
2.4	Non-seasonal ARIMA models	8
2.5	Seasonal ARIMA models	8
3.1	Time series cross-validation	3
3.2	Dynamic regression	9
3.3	Hierarchical forecasting	10
3.4	Advanced models	11

# Outline

1 Background

2 Case studies

# CASE STUDY 1: Paperware company

**Problem:** Want forecasts of each of hundreds of items. Series can be stationary, trended or seasonal. They currently have a large forecasting program written in-house but it doesn't seem to produce sensible forecasts. They want me to tell them what is wrong and fix it.



## Additional information

- Program written in COBOL making numerical calculations limited. It is not possible to do any optimisation.
- Their programmer has little experience in numerical computing.
- They employ no statisticians and want the program to produce forecasts automatically.

# CASE STUDY 1: Paperware company

## Methods currently used

- A 12 month average
- C 6 month average
- E straight line regression over last 12 months
- G straight line regression over last 6 months
- H average slope between last year's and this year's values.  
(Equivalent to differencing at lag 12 and taking mean.)
- I Same as H except over 6 months.
- K I couldn't understand the explanation.



# CASE STUDY 2: PBS



# CASE STUDY 2: PBS

The **Pharmaceutical Benefits Scheme** (PBS) is the Australian government drugs subsidy scheme.

- Many drugs bought from pharmacies are subsidised to allow more equitable access to modern drugs.
- The cost to government is determined by the number and types of drugs purchased. Currently nearly 1% of GDP.
- The total cost is budgeted based on forecasts of drug usage.

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**ABC News Online**  
AUSTRALIAN BROADCASTING CORPORATION



**NewsRadio**  
Streaming audio news

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Select a Topic  
from the list below

Click "Refresh" or "Reload"  
on your browser for the latest edition.

This Bulletin: Wed, May 30 2001 6:22 PM AEST

## POLITICS

### Opp demands drug price restriction after PBS budget blow-out

The Federal Opposition has called for tighter controls on drug prices after the Pharmaceutical Benefits Scheme (PBS) budget blew out by almost \$800 million.

The money was spent on two new drugs including the controversial anti-smoking aid Zyban, which dropped in price from \$220 to \$22 after it was listed on the PBS.

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- [Weather](#)
- [Rural](#)
- [Local News](#)
- [Broadband](#)

## SPECIALS

- [Federal Election](#)

**the Public Record**  
For full election coverage

## FEATURES

**the Public Record**  
Federal Election 2001

For a fresh perspective on  
the federal election, reach  
into ABC Online's  
campaign weblog, [The Poll  
Vault](#).

Audio News Online

# CASE STUDY 2: PBS

- In 2001: \$4.5 billion budget, under-forecasted by \$800~million.
- Thousands of products. Seasonal demand.
- Subject to covert marketing, volatile products, uncontrollable expenditure.
- Although monthly data available for 10 years, data are aggregated to annual values, and only the first three years are used in estimating the forecasts.
- All forecasts being done with the FORECAST function in MS-Excel!

Problem: How to do the forecasting better?

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# CASE STUDY 3: Airline



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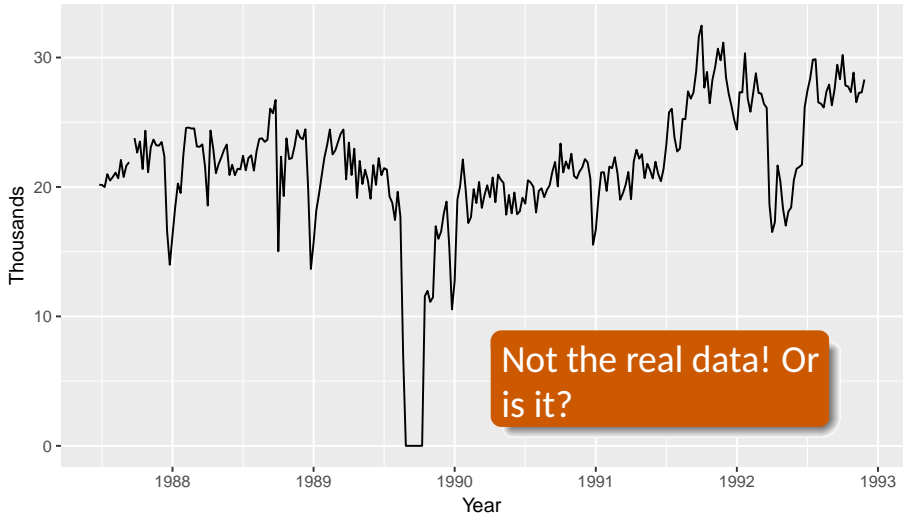
Economy class passengers: Melbourne–Sydney





# CASE STUDY 3: Airline

Economy class passengers: Melbourne–Sydney



# CASE STUDY 3: Airline

**Problem:** how to forecast passenger traffic on major routes?

## Additional information

- They can provide a large amount of data on previous routes.
- Traffic is affected by school holidays, special events such as the Grand Prix, advertising campaigns, competition behaviour, etc.
- They have a highly capable team of people who are able to do most of the computing.