MONASH University

MONASH BUSINESS SCHOOL

ETC3550/ETC5550 Applied forecasting

Week 1: Introduction to forecasting & R

Contact details

Chief Examiner: Professor Rob Hyndman

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robjhyndman.com

Tutors

- **Mitchell O'Hara-Wild**
- Maliny Po
- Nuwani Palihawadana
- Xiefei (Sapphire) Li

Brief bio

- Professor of Statistics, Monash University
- Co-author of most popular forecasting textbook in the world
- Lead developer of most popular forecasting software in the world

How my forecasting methodology is used:

- Pharmaceutical Benefits Scheme
- Electricity demand
- Australian tourism demand
- Ageing population
- COVID-19 cases

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 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

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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.

CASE STUDY 2: PBS

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- 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!

CASE STUDY 3: Car fleet company

Client: One of Australia's largest car fleet companies

Problem: how to forecast resale value of vehicles? How should this affect leasing and sales policies?

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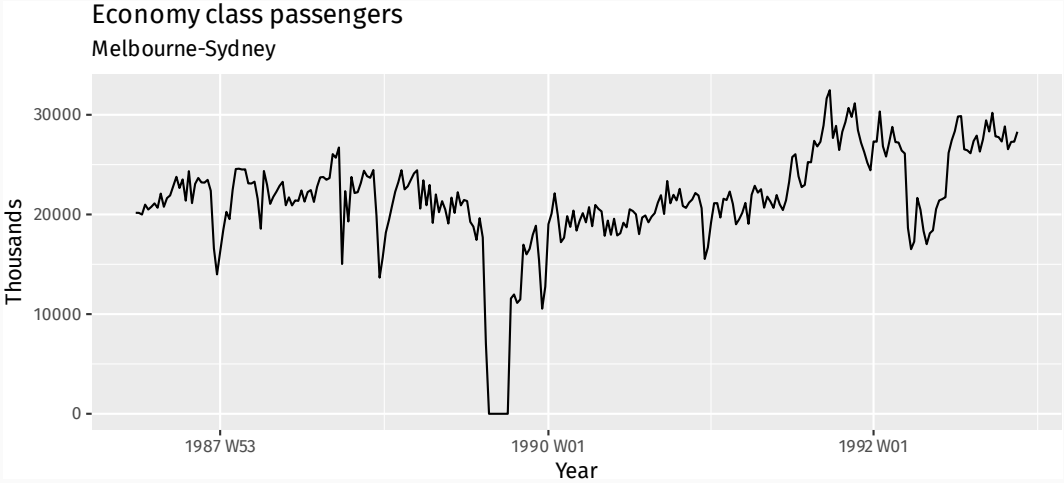
Additional information

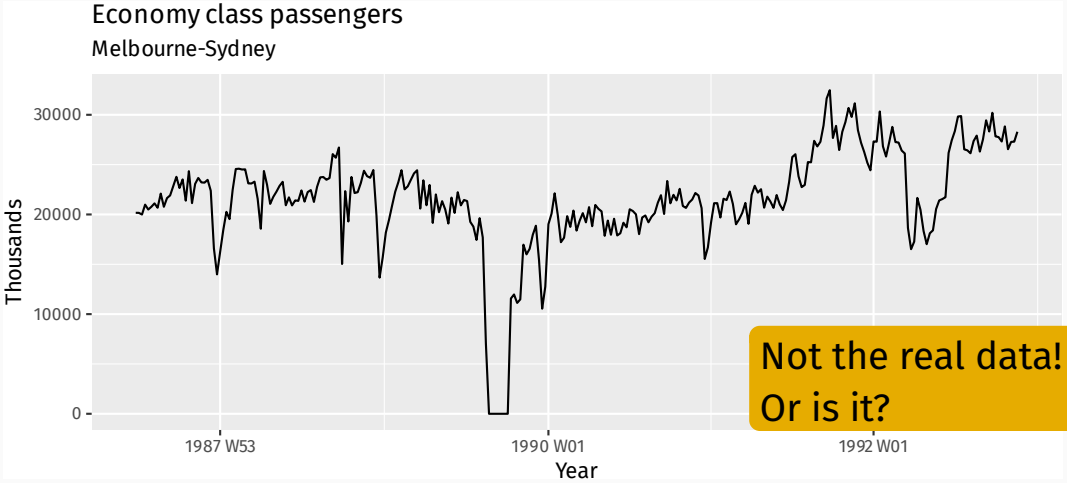
- They can provide a large amount of data on previous vehicles and their eventual resale values.
- The resale values are currently estimated by a group of specialists. They see me as a threat and do not cooperate.

CASE STUDY 4: Airline

CASE STUDY 4: Airline



CASE STUDY 4: Airline



CASE STUDY 4: 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.

Unit objectives

1. To obtain an understanding of common statistical methods used in business and economic forecasting.
2. To develop the computer skills required to forecast business and economic time series data;
3. To gain insights into the problems of implementing and operating large scale forecasting systems for use in business.

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Teaching and learning approach

- Approximately one hour of pre-recorded online videos each week
- One hour online lecture each Monday
- One hour in-person workshop each Tuesday (focus on exam)
- One hour in-person tutorial each week (focus on assignments)

Key reference

Hyndman, R. J. & Athanasopoulos, G. (2021) *Forecasting: principles and practice*, 3rd edition

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OTexts.com/fpp3/

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- Free and online
- Data sets in associated R packages
- R code for examples
- Embedded online lectures

Outline

Week	Topic	Chapter
1	Introduction to forecasting and R	1
2	Time series graphics	2
3	Time series decomposition	3
4	Simple forecasting methods	5
5	Accuracy evaluation	5
6–7	Exponential smoothing	8
8–10	ARIMA models	9
11	Multiple regression and forecasting	7
12	Dynamic regression	10

Assessment

Task	Due Date	Value
Forecasting Competition	Fri 7 Mar	2%
Weekly Quizzes	end of weeks 2–11	8%
Assignment 1	Fri 28 Mar	6%
Assignment 2	Thu 17 Apr	6%
Assignment 3	Fri 16 May	6%
Retail Project	Fri 30 May	12%
Final Exam	Official exam period	60%

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Final Exam	Official exam period	60%

- Need at least 45% for exam, and 50% for total.
- **ETC5550 students:** Extra project and exam questions.

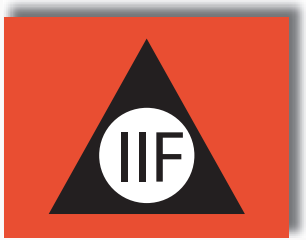
Unit website

af.numbat.space

- Includes all course materials
- Links for assignment submissions
- Link to discussion forum.

Please don’t send emails. Use the forum.

International Institute of Forecasters



- The IIF provides a prize to the top student in this subject each year.
- US$100 plus one year membership.

R

Available for download from CRAN:

https://cran.r-project.org

Available for download from RStudio:

https://www.rstudio.com/products/rstudio/download/

Main packages

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```
# Install required packages (do once)
install.packages(c("tidyverse", "fpp3", "GGally), dependencies = TRUE)
```

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```

```
# At the start of each session
library(fpp3)
```

Exercises Week 1

- Make sure you are familiar with R, RStudio and the tidyverse packages.
- Do the first five modules of `startr.numbat.space`.
- Forecasting competition

Forecasting competition: forecast the following series

1. Google closing stock price on 24 March 2025
2. Maximum temperature at Melbourne airport on 14 April 2025
3. The difference in points (Collingwood minus Essendon) scored in the AFL match between Collingwood and Essendon for the Anzac Day clash. 25 April 2025
4. The seasonally adjusted estimate of total employment for April 2025. ABS CAT 6202, to be released around mid May 2025
5. Google closing stock price on 26 May 2025

Due Friday 14 March

For each of these, give a point forecast and an 80% prediction interval.

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Prize: $50 cash prize

Forecasting competition: scoring

Y = actual, F = point forecast, $[L, U]$ = prediction interval

Point forecasts:

$$\text{Absolute Error} = |Y - F|$$

- Rank results for all students in class
- Add ranks across all five items

Prediction intervals:

$$\text{Interval Score} = (U - L) + 10(L - Y)_+ + 10(Y - U)_+$$

- $u_+ = \max(u, 0)$
- Rank results for all students
- Add ranks across all five items

`tsibble` objects

```
global_economy
```

```
# A tsibble: 15,150 x 6 [1Y]
# Key:       Country [263]
    Year Country              GDP Imports Exports Population
   <dbl> <fct>              <dbl>   <dbl>   <dbl>      <dbl>
 1  1960 Afghanistan  537777811.     7.02    4.13    8996351
 2  1961 Afghanistan  548888896.     8.10    4.45    9166764
 3  1962 Afghanistan  546666678.     9.35    4.88    9345868
 4  1963 Afghanistan  751111191.    16.9     9.17    9533954
 5  1964 Afghanistan  800000044.    18.1     8.89    9731361
 6  1965 Afghanistan 1006666638.    21.4    11.3     9938414
 7  1966 Afghanistan 1399999967.    18.6     8.57   10152331
 8  1967 Afghanistan 1673333418.    14.2     6.77   10372630
 9  1968 Afghanistan 1373333367.    15.2     8.90   10604346
10  1969 Afghanistan 1408888922.    15.0    10.1    10854428
# i 15,140 more rows
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Index | Key | Measured variables

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tourism
```

```
# A tsibble: 24,320 x 5 [1Q]
# Key:       Region, State, Purpose [304]
   Quarter Region   State Purpose  Trips
     <qtr> <chr>    <chr> <chr>    <dbl>
 1 1998 Q1 Adelaide SA    Business  135.
 2 1998 Q2 Adelaide SA    Business  110.
 3 1998 Q3 Adelaide SA    Business  166.
 4 1998 Q4 Adelaide SA    Business  127.
 5 1999 Q1 Adelaide SA    Business  137.
 6 1999 Q2 Adelaide SA    Business  200.
 7 1999 Q3 Adelaide SA    Business  169.
 8 1999 Q4 Adelaide SA    Business  134.
 9 2000 Q1 Adelaide SA    Business  154.
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# i 24,310 more rows
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Domestic visitor nights in thousands by state/region and purpose.

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   Quarter Region   State Purpose  Trips
     Index  Keys                  Measure
 1 1998 Q1 Adelaide SA    Business  135.
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Domestic visitor nights in thousands by state/region and purpose.

`tsibble` objects

- A `tsibble` allows storage and manipulation of multiple time series in R.
- It contains:
  - An index: time information about the observation
  - Measured variable(s): numbers of interest
  - Key variable(s): optional unique identifiers for each series
- It works with tidyverse functions.

The `tsibble` index

Time index variables can be created with these functions:

Frequency	Function
Annual	`start:end`
Quarterly	`yearquarter()`
Monthly	`yearmonth()`
Weekly	`yearweek()`
Daily	`as_date()`, `ymd()`
Sub-daily	`as_datetime()`