MONASH University

MONASH BUSINESS SCHOOL

ETC3550/ETC5550
Applied forecasting

Ch1. Getting started

OTexts.org/fpp3/

Outline

1. The dark history of forecasting
2. What can we forecast?
3. Time series data and random futures
4. Some case studies
5. Assignment 1

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Forecasting by maggots

Clay model of sheep's liver

Used by Babylonian forecasters approximately 600 B.C.

Now in British Museum.

Forecasting by hallucination

Forecasting by hallucination

Forecasting and the law

Anyone who consults a soothsayer on account of curiosity of the future will suffer capital punishment.

Codex Theodosianus 9.16.4

Reputations can be made and lost

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(Chairman of IBM, 1943)

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"We're going to be opening relatively soon … The virus … will go away in April." (Donald Trump, February 2020)

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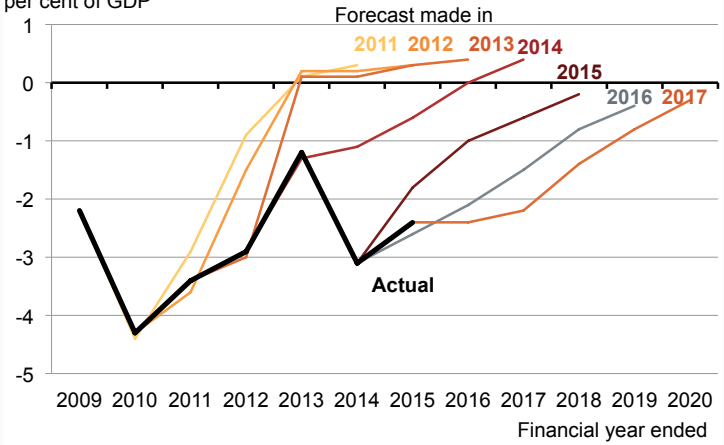
Forecasts that aren't forecasts

Commonwealth plans to drift back to surplus show the triumph of experience over hope

GRATTAN Institute

Actual and forecast Commonwealth underlying cash balance

per cent of GDP



Grattan analysis of Commonwealth Budget Papers

What can we forecast?

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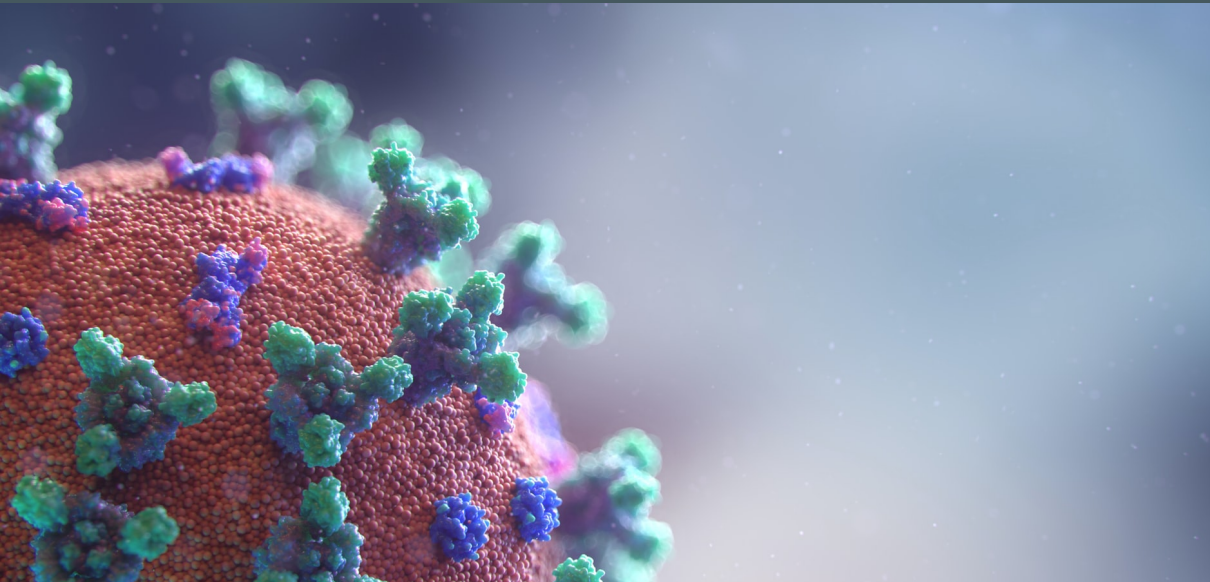

What can we forecast?

Which is easiest to forecast?

- daily electricity demand in 3 days time
- timing of next Halley's comet appearance
- time of sunrise this day next year
- Google stock price tomorrow
- Google stock price in 6 months time
- maximum temperature tomorrow
- exchange rate of $US/AUS next week
- total sales of drugs in Australian pharmacies next month

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- how do we measure "easiest"?
- what makes something easy/difficult to forecast?

Forecastability factors

Something is easier to forecast if:

1. we have a good understanding of the factors that contribute to it
2. there is lots of data available;
3. the future is somewhat similar to the past
4. the forecasts cannot affect the thing we are trying to forecast.

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Time series data

- Four-yearly Olympic winning times
- Annual Google profits
- Quarterly Australian beer production
- Monthly rainfall
- Weekly retail sales
- Daily IBM stock prices
- Hourly electricity demand
- 5-minute freeway traffic counts
- Time-stamped stock transaction data

Random futures

A forecast is an estimate of the probabilities of possible futures.

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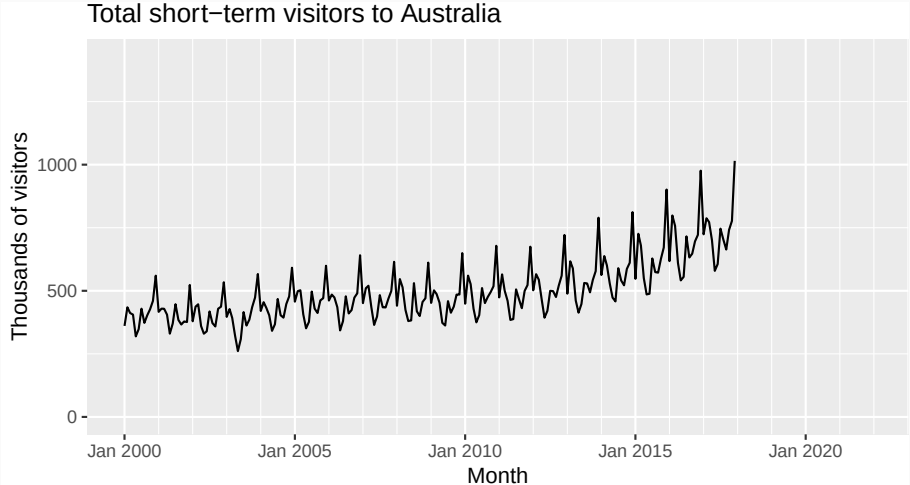

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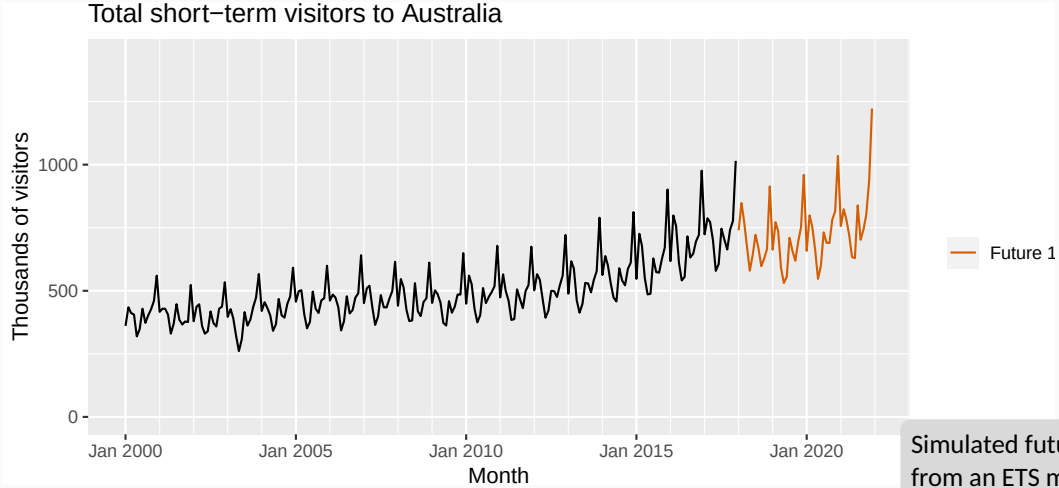

Simulated futures from an ETS model

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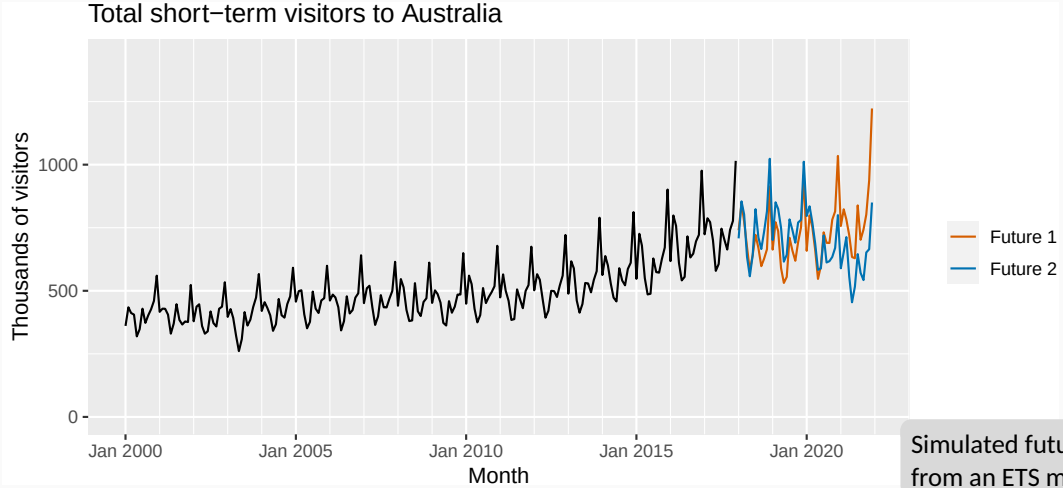

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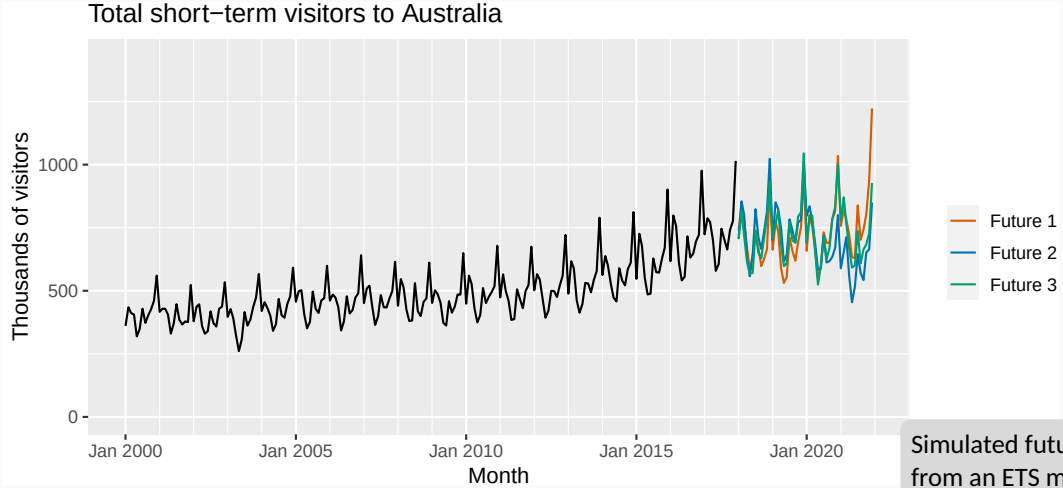

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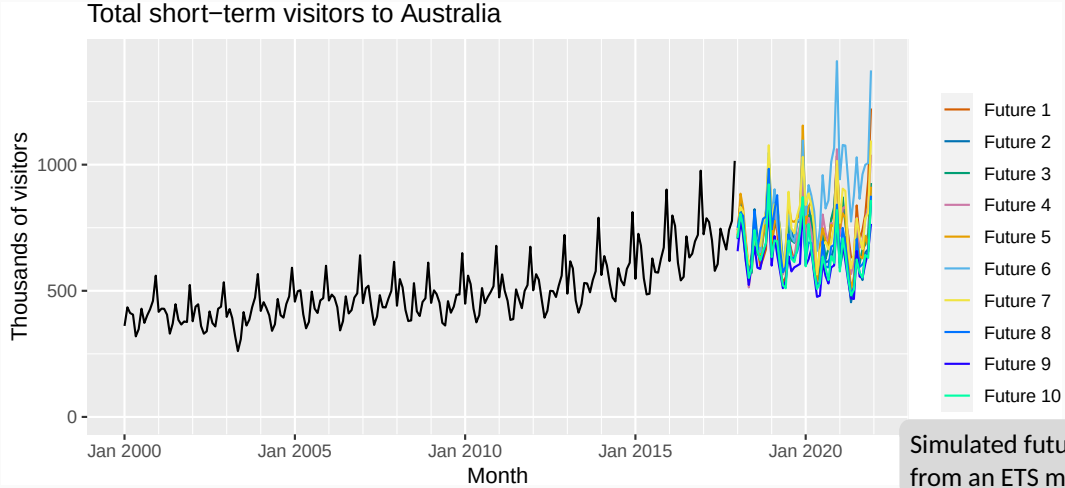

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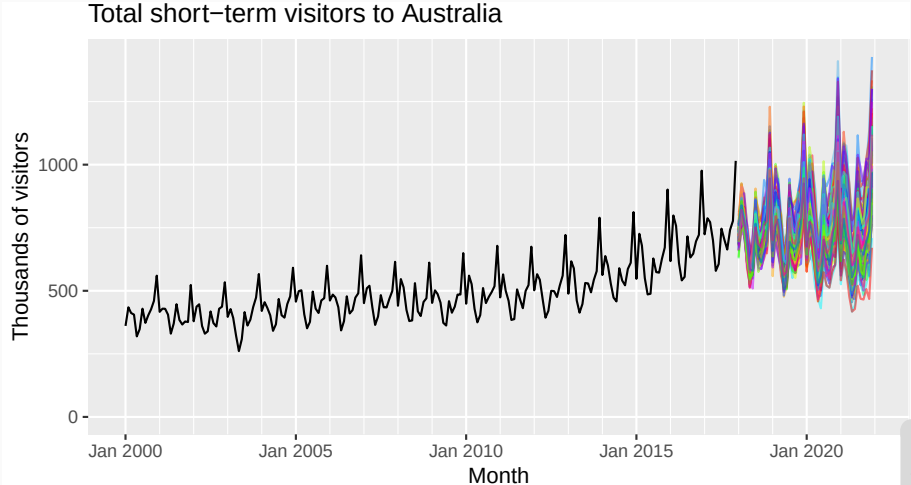

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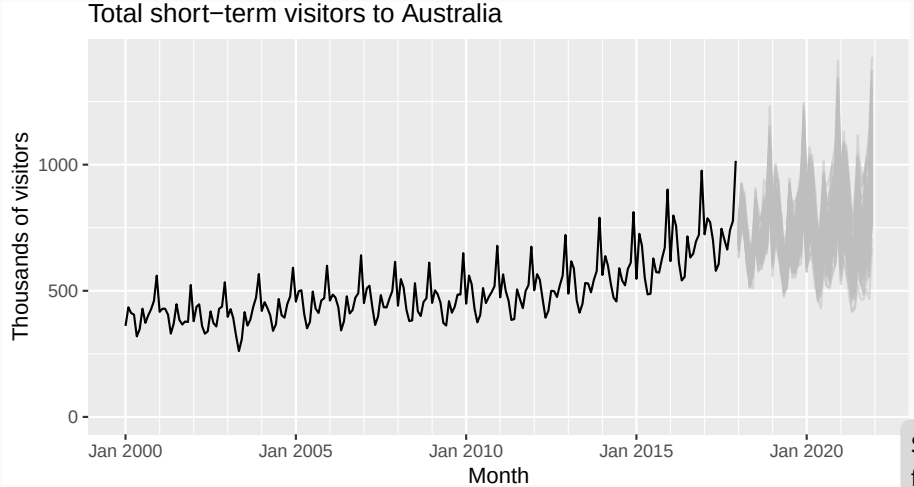

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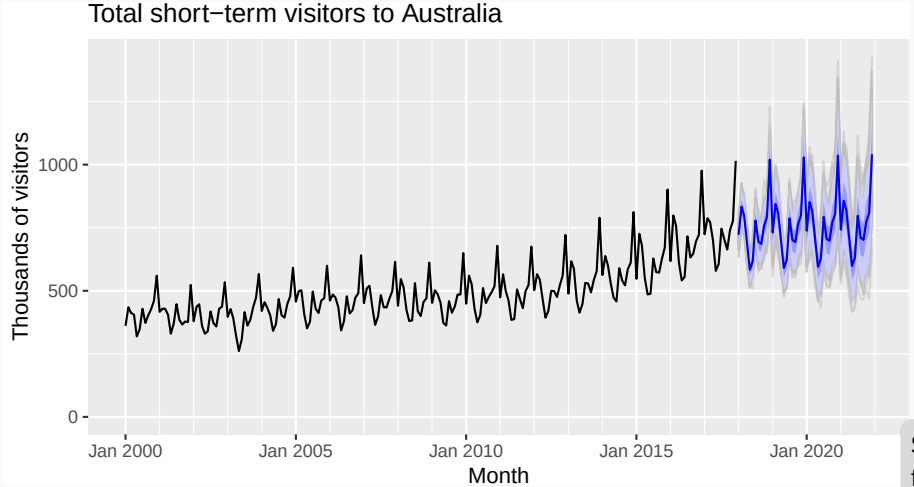

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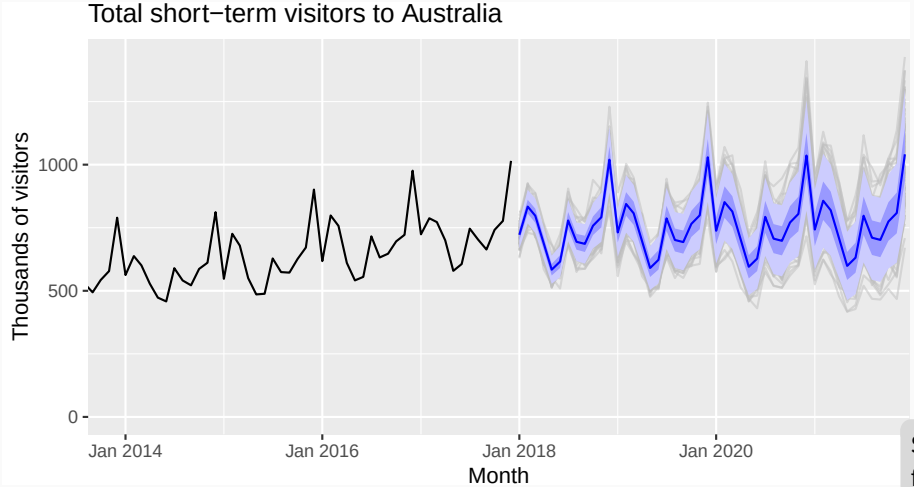

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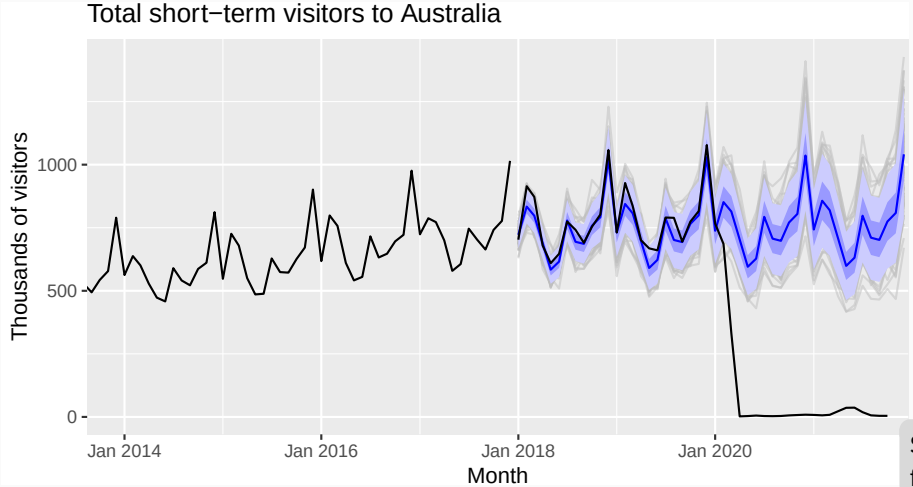

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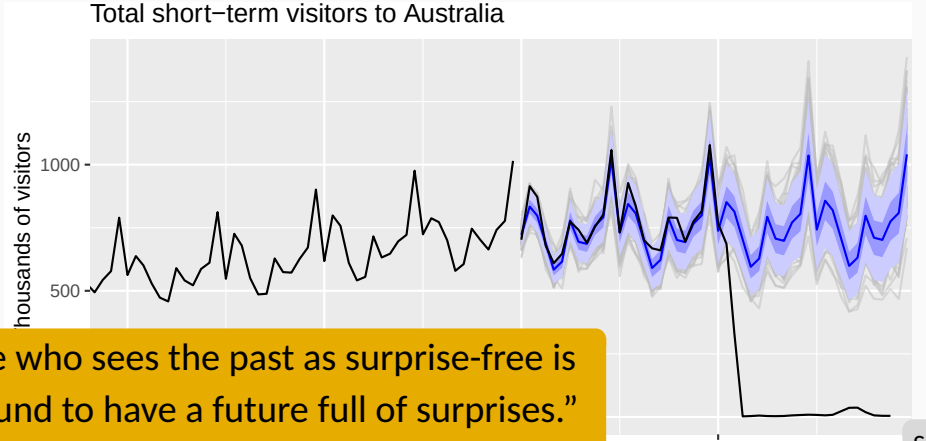

"He who sees the past as surprise-free is bound to have a future full of surprises."

(Amos Tversky)

Simulated futures from an ETS model

Statistical forecasting

- Thing to be forecast: a random variable, y_t.
- Forecast distribution: If $\mathcal{I}$ is all observations, then $y_t|\mathcal{I}$ means "the random variable y_t given what we know in $\mathcal{I}$.
- The “point forecast” is the mean (or median) of $y_t|\mathcal{I}$
- The “forecast variance” is $\text{var}[y_t|\mathcal{I}]$
- A prediction interval or “interval forecast” is a range of values of y_t with high probability.
- With time series, $y_{t|t-1} = y_t|\{y_1, y_2, \ldots, y_{t-1}\}$.
- $\hat{y}_{T+h|T} = \text{E}[y_{T+h}|y_1, \ldots, y_T]$ (an *h*-step forecast taking account of all observations up to time *T*).

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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

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

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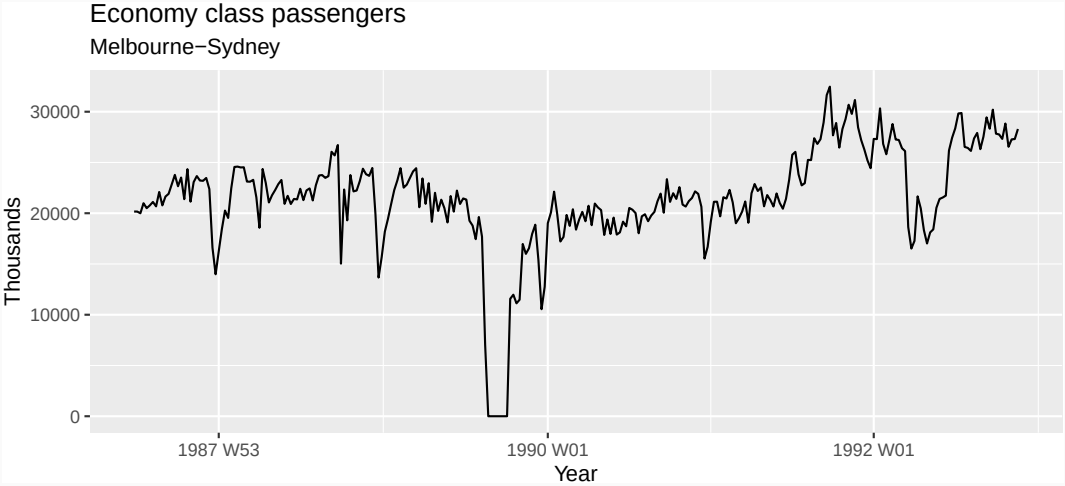

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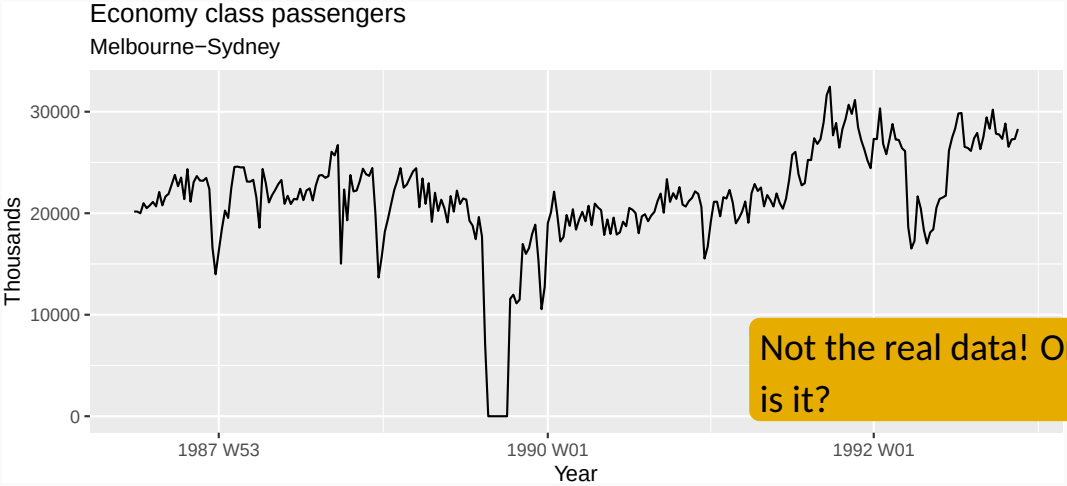

CASE STUDY 4: Airline

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.

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Assignment 1: forecast the following series

1. Google closing stock price on 21 March 2022.
2. Maximum temperature at Melbourne airport on 5 April 2022.
3. The difference in points (Collingwood minus Essendon) scored in the AFL match between Collingwood and Essendon for the Anzac Day clash. 25 April 2022.
4. The seasonally adjusted estimate of total employment for April 2022. ABS CAT 6202, to be released around mid May 2022.
5. Google closing stock price on 23 May 2022.

Due Sunday 13 March

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

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Prize: $50 Amazon gift voucher

Assignment 1: 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:

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

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