MONASH University

MONASH BUSINESS SCHOOL

ETF3231/5231: Business forecasting

Week 1: Intro to forecasting and R

https://bf.numbat.space/

AACSB ACCREDITED EQUIS ACCREDITED ASSOCIATION AMBA ACCREDITED

Lecturer: Professor George Athanasopoulos

- Contact details
  - Room H5.83, Building H, Caulfield.
  - Consultation online: Tuesday 3-4pm (subject to changes).
  - All general discussion questions will be answered on the discussion forum: https://edstem.org/au/courses/21006/discussion (check for answers before you ask).
  - Assignment consultations - see your tutor or post to the forum.

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- Seminars (10:00-10:50) and Lectorials (11:00-11:50), in-person, every Tuesday, Room K321.
- Tutorials in-person.

Teaching Associates

Tutorials start this week

- Joan Tan (Head Tutor)
- Ari Handayani
- Yuru (Christina) Sun
- Kulan Ranasinghe

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Speak to your tutor if you would prefer a face-to-face consultation to see whether that can be arranged.

Brief bio: George Athanasopoulos

- Professor and Head of Department of Econometrics and Business Statistics, Monash Business School.
- Past President / Director: International Institute Forecasters
  - Bridge the gap between theory and practice, with practice helping to set the research agenda and research providing useful results.
- Associate Editor: International Journal Forecasting
  - The leading academic journal in business forecasting.
- Editorial board: Journal of Travel Research

How my forecasting methodology is used:

- Forecasting Australian retail sector
- Australian tourism (latest is post-Covid19)
- Hospital admissions (UK and Mornington Peninsula)
- Monash student enrollment numbers
- Australian prison populations
- Macroeconomic variables
- Restaurant bookings
- Forecasting time series connected by aggregation constraints (very large data)

Unit objectives

- Obtain an understanding of common statistical methods used in business and economic forecasting.
- Learn how to build accurate and robust models for forecasting.
- Acquire computer skills vital for forecasting business and economic data.
- To gain insights into the problems of implementing and operating large scale forecasting systems for use in business.

We'll use R to do all this - so the course is about learning good forecasting practices using a very powerful tool.

Teaching and learning approach

- **Pre-class preparation:** watch recorded videos embedded in the textbook at http://OTexts.org/fpp3/ and read the book sections. Allow 60 minutes to do this.
- **Tuesday 10:00-10:50. In person seminar.** Review the important aspects of theory and enhance with deeper explanations or proofs when required and examples with coding. Aim: as interactive workshop as possible.
- **Tuesday 11:00-11:50. In person lectorial.** We will be going through example exercises and exam style questions. You will be practicing with me.
- Tutorials will help you with assignments. Lectorials will help with exam preparation.

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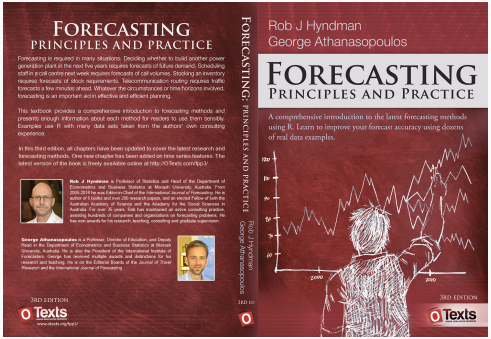
Have R installed in your laptops and ready to go. Get help in this week's tutorials if you need to. Update R, RStudio and packages.

Textbook - key reference

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

- http://OTexts.org/fpp3/
- Free online
- Printed version available here
- Data sets in associated package.
- R code for examples



Software

Available for download from CRAN: https://cran.r-project.org

Available for download from RStudio:
https://posit.co/download/rstudio-desktop/

Software

https://PollEv.com/georgeathana023

How familiar are you with R, RStudio?

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Main packages

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```
# Data manipulation and plotting functions
library(tidyverse)
# Time series manipulation
library(tsibble)
# Tidy time series data
library(tsibbledata)
# Time series graphics and statistics
library(feasts)
# Forecasting functions
library(fable)
```

Week 1 homework

- Install/update R, RStudio and required packages
- See https://otexts.com/fpp3/appendix-using-r.html
- `install.packages(c("tidyverse","fpp3", "GGally"), dependencies = TRUE)`

Week 1 homework

- Install/update R, RStudio and required packages
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- `install.packages(c("tidyverse","fpp3", "GGally"), dependencies = TRUE)`

- Work through **Getting started** (5 modules) and **Writing Documents** of StartR at https://startr.numbat.space/
- Read Chapter 1 of the textbook and watch all embedded videos. Pay particular attention to Section 1.7.
- Read Section 2.1 of the textbook and watch the embedded video.

Outline

Week	Topic	Chapter
1	Introduction to forecasting and R	1, App
2	Time series graphics	2
3	Decomposition	3
4	The forecaster’s toolbox	5
5–6	Exponential smoothing	8
7–9	Forecasting with ARIMA models	9
10–11	Multiple regression and forecasting	7
11–12	Dynamic regression	10

Assessment

- ETF3231+ETF5231: 4 short individual assignments (IA).
- ETF5231: extra 4 group assignments (GA) (see next slide).
- Assignments: total weight 40%
- Exam (2 hours): weight 60%.
- Must get at least 45% on exam and 50% overall to pass the unit.

- Assignment submission dates are to be confirmed as we go along.
- IA1 already posted. Will announce shortly.

Assignment schedule

Cohort	Week	Assessment task	Weight
ETF3231+ETF5231	2	IA1	5%
ETF5231	4	GA1	5%
ETF3231+ETF5231	6	IA2	7%
ETF5231	7	GA2	7%
ETF3231+ETF5231	8	IA3	10%
ETF5231	9	GA3	10%
ETF3231+ETF5231	11	IA4	18%
ETF5231	12	GA4	18%

For ETF5231 your mark allocated to assignments will come from individual assignments (weight 0.7 or 28%) and from group assignments (weight 0.3 or 12%).
E.g. Ass 3 mark will be: $8 \times (0.7) + 5 \times (0.3) = 7.1$.

Webpage https://bf.numbat.space/

- Includes all lecture note handouts, R code, assignments, past exams, etc.
- Ed discussion forum for asking questions, getting help from teaching team and the bot, etc.
- Assignment submissions through moodle (links in the bf webpage).
- A common question: are the lectures recorded? Yes but…

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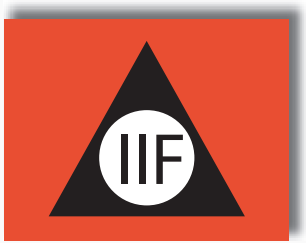
- Go to https://bf.numbat.space/assignments/A1.html.

Let's explore the website.

International Institute of Forecasters Best Student Award



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

https://forecasters.org/programs/research-awards/students

IA1: scoring

y = actual, $\hat{y}$ = point forecast, $[\hat{\ell}, \hat{u}]$ = prediction interval

Point forecasts:

$$\text{Absolute Error} = |y - \hat{y}|$$

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

Prediction intervals:

$$\text{Interval Score} = (\hat{u} - \hat{\ell}) + 10(\hat{\ell} - y)_+ + 10(y - \hat{u})_+$$

- $u_+ = max(u, 0)$
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A forecast is an estimate of the probabilities of possible futures.

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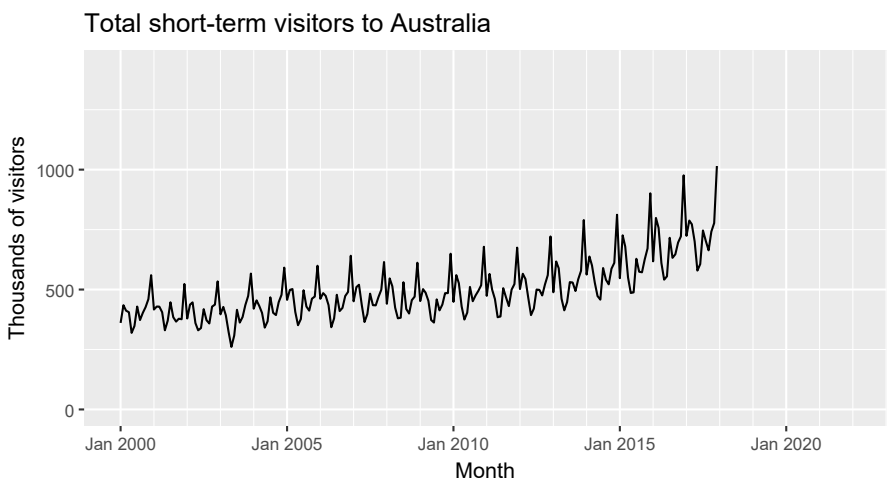

Random futures

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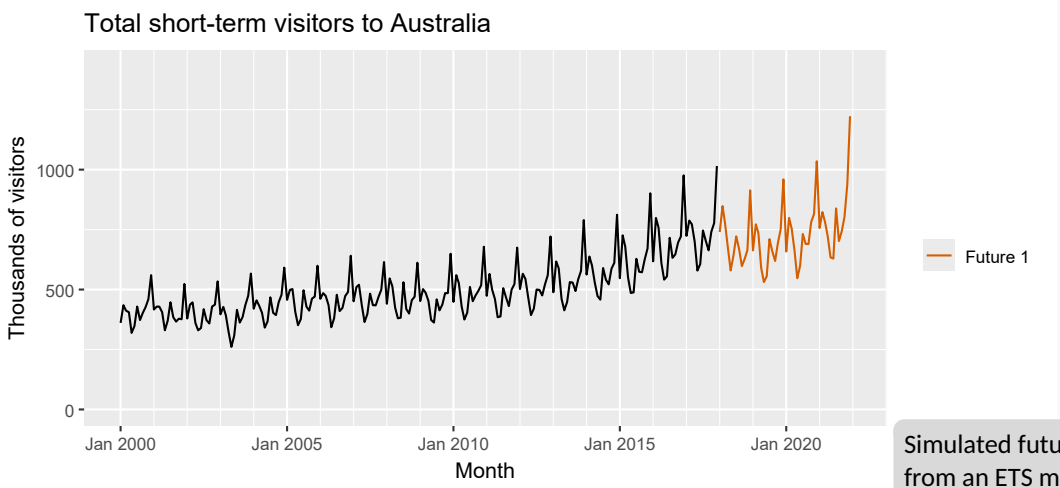

Simulated futures from an ETS model

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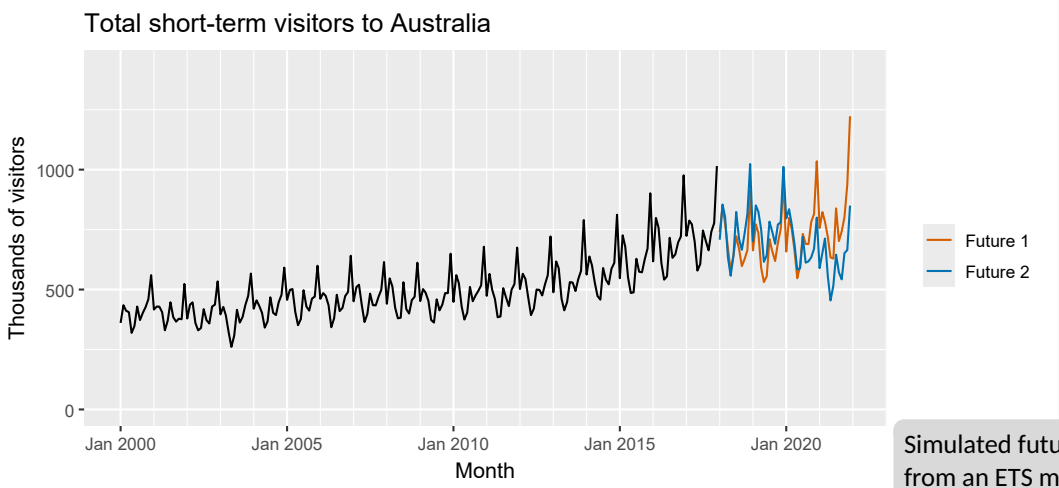

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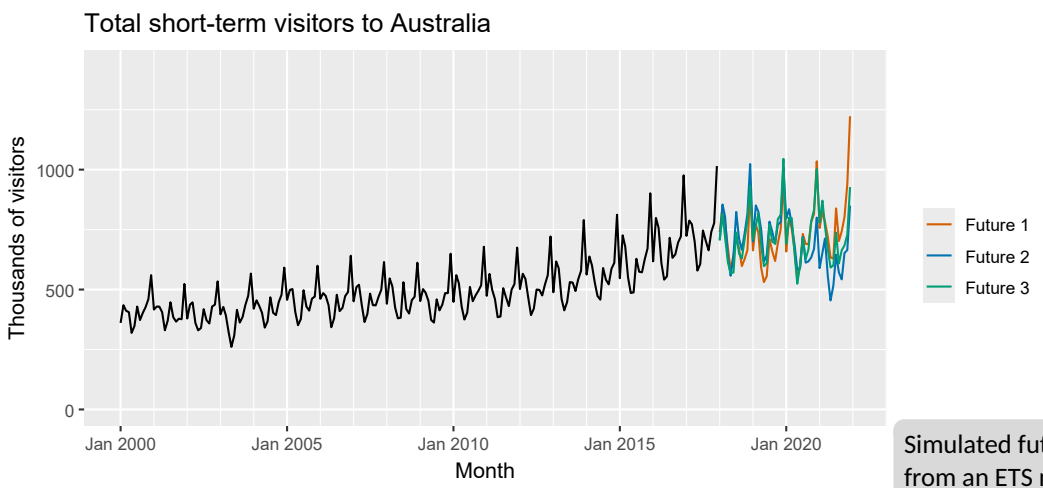

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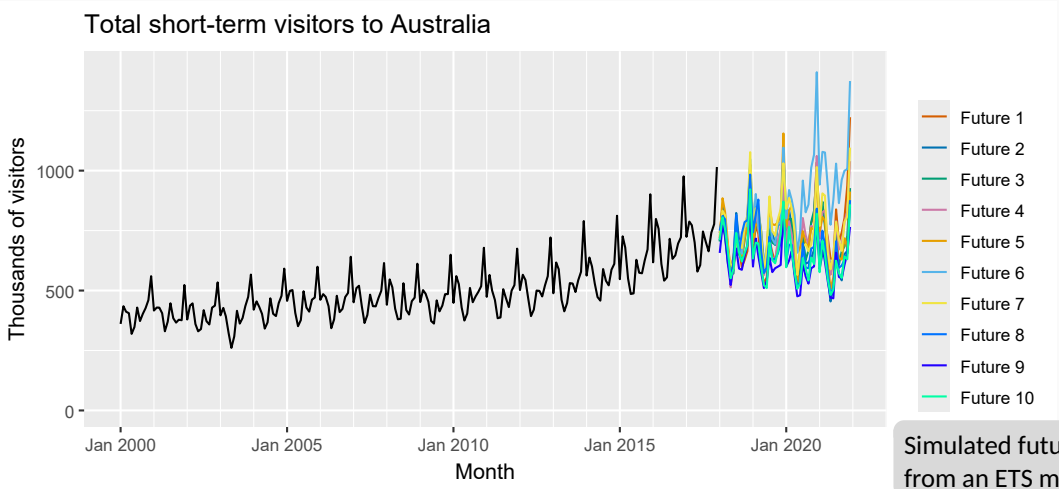

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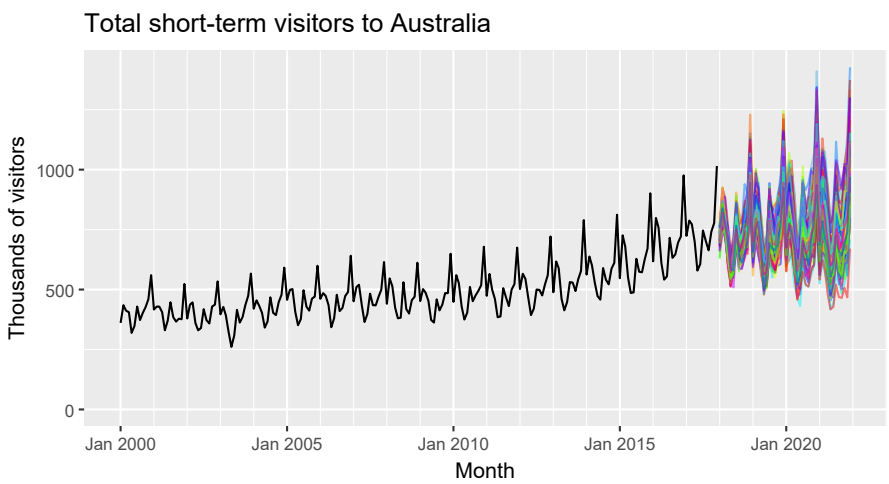

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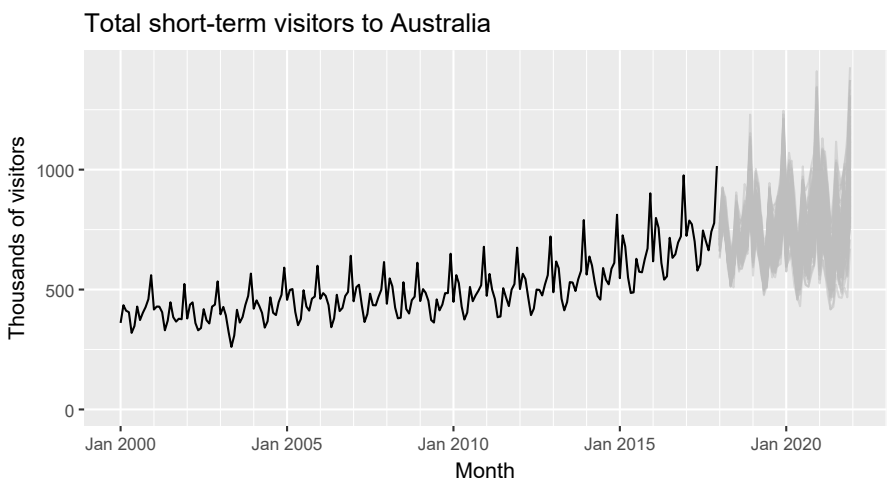

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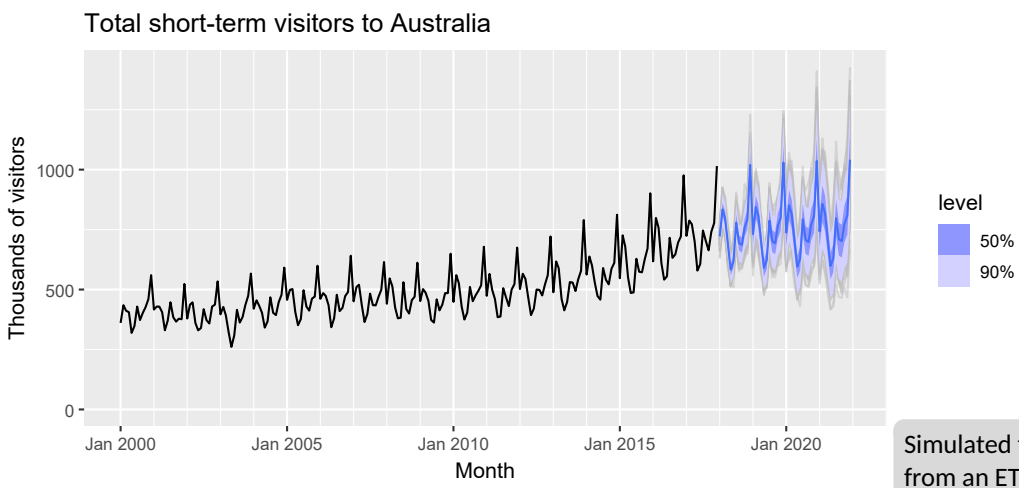

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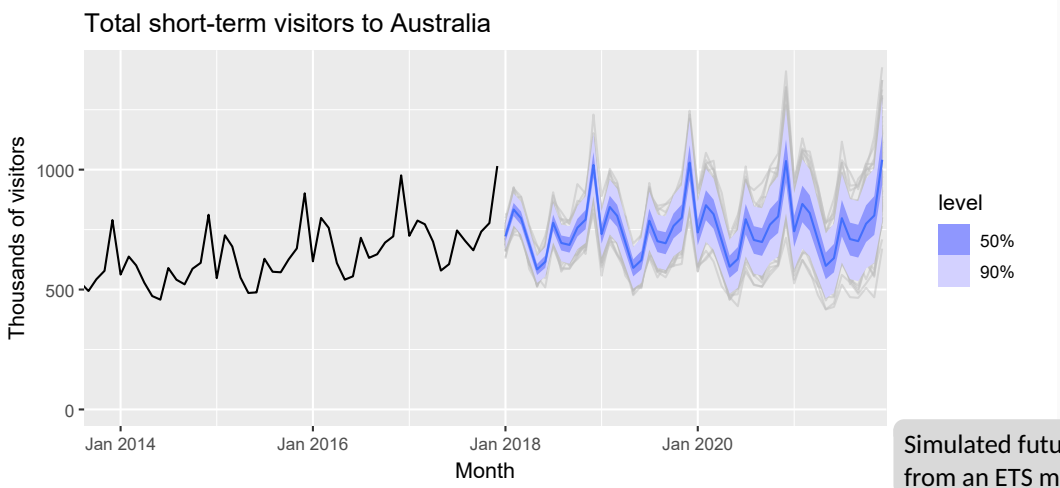

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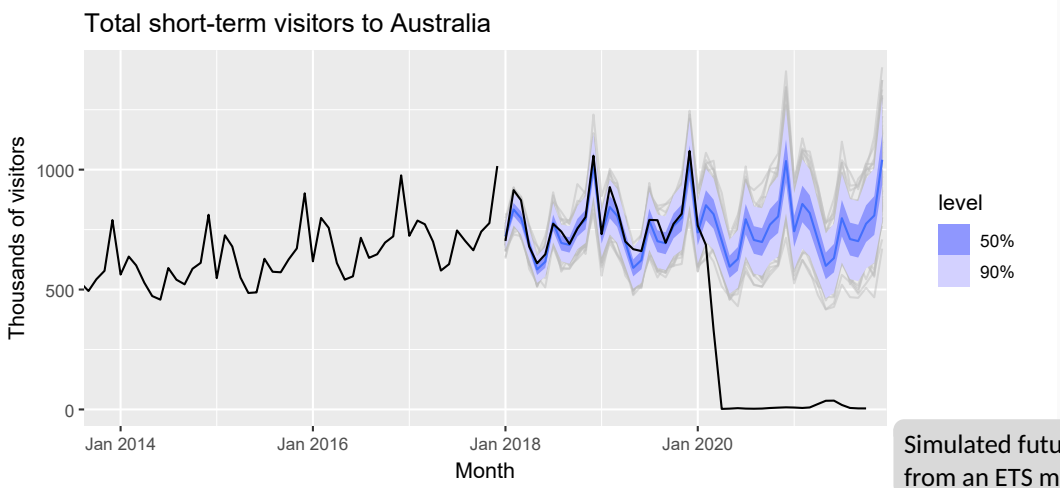

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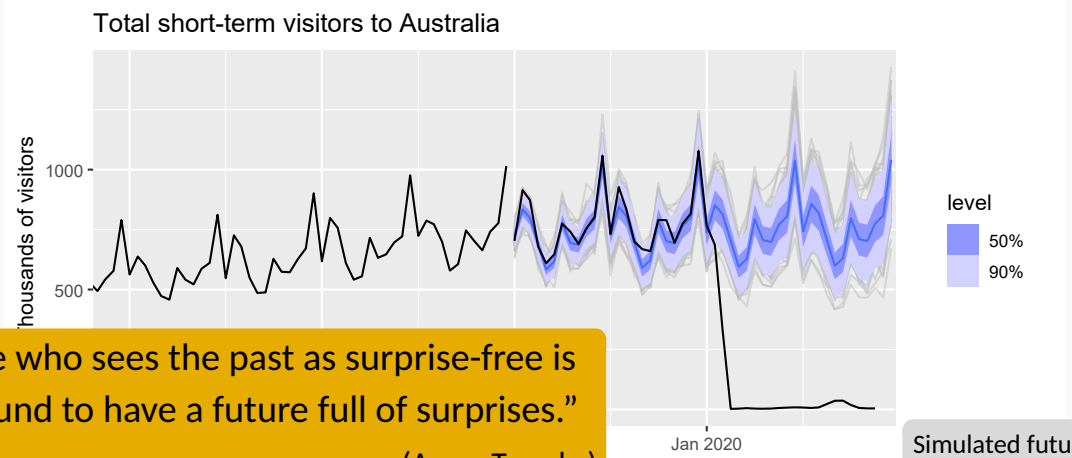

"He who sees the past as surprise-free is bound to have a future full of surprises."

(Amos Tversky)

Simulated futures from an ETS model

What is a forecast

A whole probability distribution, we call this a forecast distribution, which we summarise with the mean, we call this a point forecast and some other quantiles, we call these prediction intervals.

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
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 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
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Index | Key | Measured variables

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A unique observation on each row for the combination of key & index.

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tourism
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# A tsibble: 24,320 x 5 [1Q]
# Key:       Region, State, Purpose [304]
   Quarter Region   State           Purpose  Trips
     <qtr> <chr>    <chr>           <chr>    <dbl>
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 2 1998 Q2 Adelaide South Australia Business  110.
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Domestic visitor nights in thousands by state/region and purpose of travel.

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- A `tibble` is a `data.frame` that contains a rectangular set of data.
  - Each column contains a variable (can be of different type).
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  - Each column contains a variable (can be of different type).
  - Each row contains an observation.
- A `tsibble` allows storage and manipulation of multiple time series in R.
  - Index: contains time information about the observation.
  - Key variable(s): optional unique identifiers for each series.
  - Measured variable(s): numbers of interest.
- It works with `tidyverse` functions.

The `tsibble` index

Common 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()`