

# Forecasting in R

Introduction to forecasting

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# Outline

- 1 Learning objectives
- 2 From decision making to forecasting
- 3 Forecasting process
- 4 What can be forecasted?
- 5 Time series data and models
- 6 How to present forecast
- 7 Case study

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# Learning outcomes

You should be able to:

- 1 Describe the forecasting process
- 2 Identify what to forecast
- 3 Explain factors affecting forecastability
- 4 Identify ways to present forecast

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# Why do organisations need forecasting?

Why do you use forecast?

- An important aid to planning and decision making
  - ▶ To inform decisions
  - ▶ To provide evidences

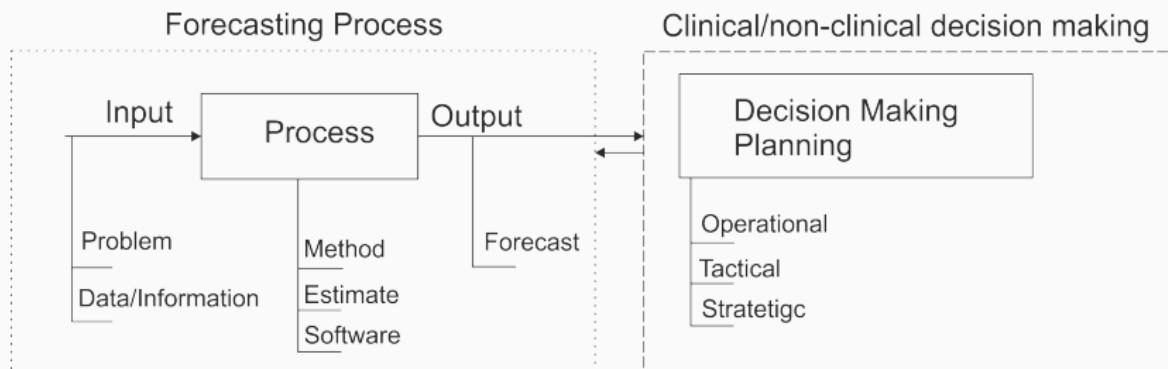
# Tailor forecasting to decisions

- It has implications on how we generate forecast and how we measure its accuracy



# Forecasting and decision making

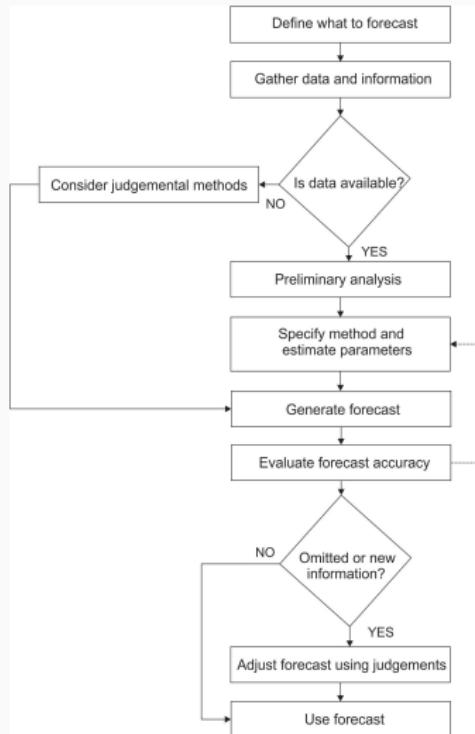
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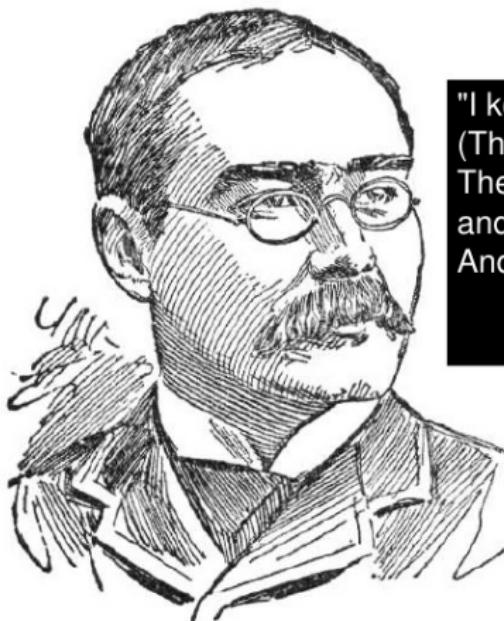
# Forecasting process



# Statistical forecasting steps

- **Step 1:** Problem definition
- **Step 2:** Gathering information
- **Step 3:** Preliminary (exploratory) analysis
- **Step 4:** Choosing and fitting models
- **Step 5:** Evaluating and using a forecasting model

# Six honest serving-men



"I keep six honest serving-men  
(They taught me all I knew);  
Their names are What and Why  
and When  
And How and Where and Who"

- Rudyard Kipling

# Gathering information

- Secondary historical data
- Knowledge of any future events
- Deterministic variables, e.g. holidays
- Stochastic variables, e.g. temperature
- Collective judgement
- Expertise of key personnel

# Further considerations

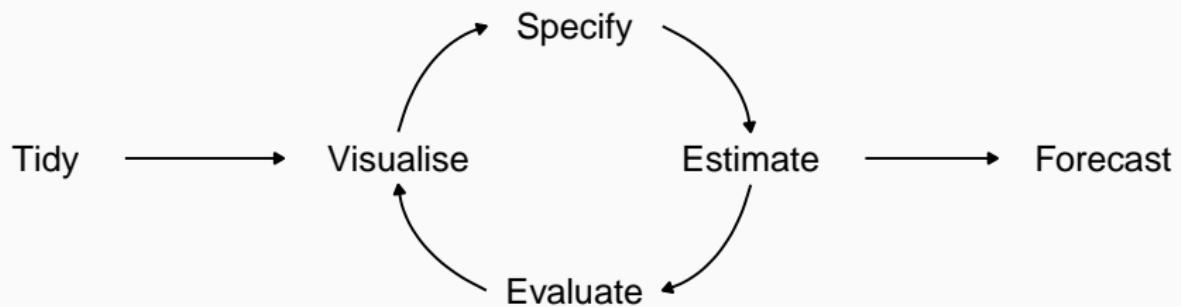
- How much will the forecast cost?
- Is the model easy to understand?
- Accuracy requirements
- Quality of data
- Forecasting support system, software, ...

# A tidy forecasting workflow

The process of producing forecasts can be split up into a few fundamental steps.

- 1 Preparing data
- 2 Data visualisation
- 3 Specifying a model
- 4 Model estimation
- 5 Accuracy & performance evaluation
- 6 Producing forecasts

# A tidy forecasting workflow



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# Forecasting is difficult



# What can we forecast?



# What can we forecast?



# What can we forecast?



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# What can we forecast?



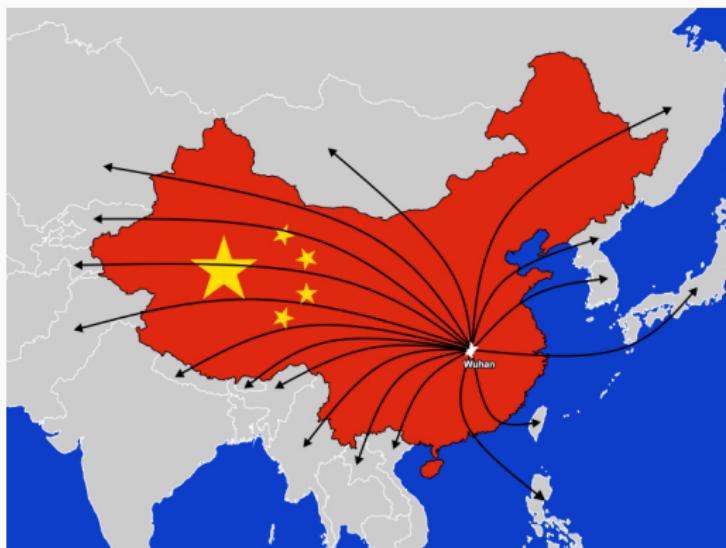
# What can we forecast?



# What can we forecast?



# What can we forecast?



# Which is easiest to forecast?

- 1 Google stock price tomorrow
- 2 exchange rate of \$US/GBP next week
- 3 total consumption of triangular bandages in A&E departement next month
- 4 daily A&E attendance in 30 day time
- 5 daily electricity demand in 3 days time
- 6 maximum temperature in Nottingham Airport tomorrow
- 7 time of sunrise tomorrow
- 8 Coronavirus outbreak in China

# Factors affecting forecastability

- What makes something easy/difficult to forecast?

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- What makes something easy/difficult to forecast?

Something is easier to forecast if:

- we have a good understanding of the factors that contribute to it;
- there is lots of data available;
- the forecasts cannot affect the thing we are trying to forecast;
- there is relatively low natural/unexplainable random variation;
- the future is somewhat similar to the past.

# Key step in forecasting

- Often in forecasting, a key step is knowing:
  - ▶ when something can be forecast accurately
  - ▶ when forecasts are no better than tossing a coin.
- Good forecasting models capture the genuine patterns and relationships which exist in the historical data, but do not replicate past events that will not occur again.

# Forecasting situation and models

- Forecasting situations vary widely in their time horizons, factors determining actual outcomes, types of data patterns, and many other aspects;
- The choice of model depends on data availability and forecast situation.

	No data	Past data	Exogenous variable
Judgemental	X		
Explanatory			X
Time series		X	

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# What is a forecast?

Forecast:

- an honest estimation of the future
- based on all of the information available at the time when we generate the forecast

# Available data/information

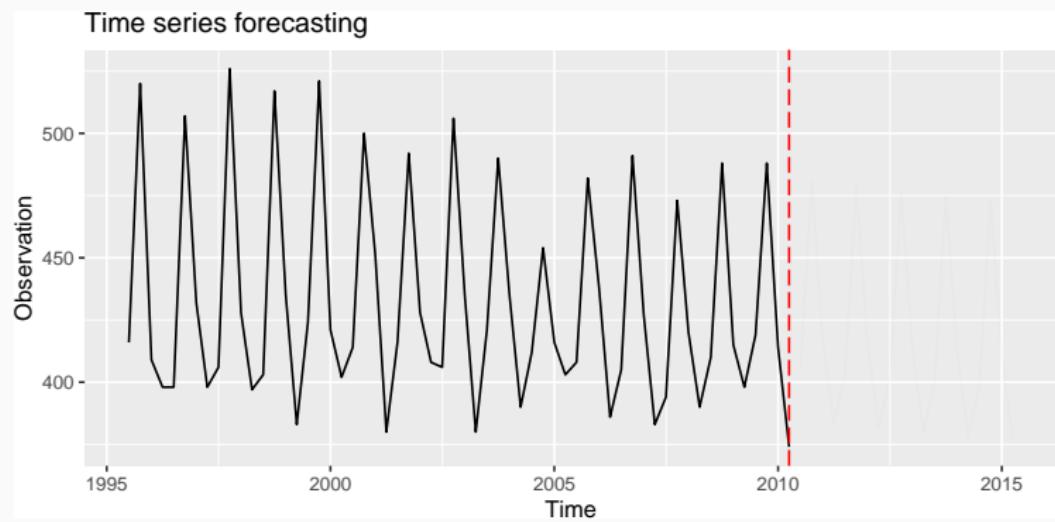
- 1 Historical data/time series
- 2 Knowledge of any future events/variables
  - ▶ Deterministic variables
  - ▶ Stochastic variables
  - ▶ New information

# Time series data

- Time series consist of sequences of observations collected over time.
- We will assume the time periods are equally spaced.
  - ▶ Hourly patient attendance in a hospital
  - ▶ Daily average waiting time in A&E
  - ▶ Weekly calls in a Clinical Desk Service
  - ▶ Monthly consumption of cough medicine in NHS England

# What will happen next?

- Time series forecasting is estimating how the sequence of observations will continue into the future.



# Time Series forecasting models

- There are many different kinds of time series models:
  - ▶ Simple methods, e.g. naive
  - ▶ Exponential smoothing models
  - ▶ ARIMA
  - ▶ Regression
  - ▶ etc

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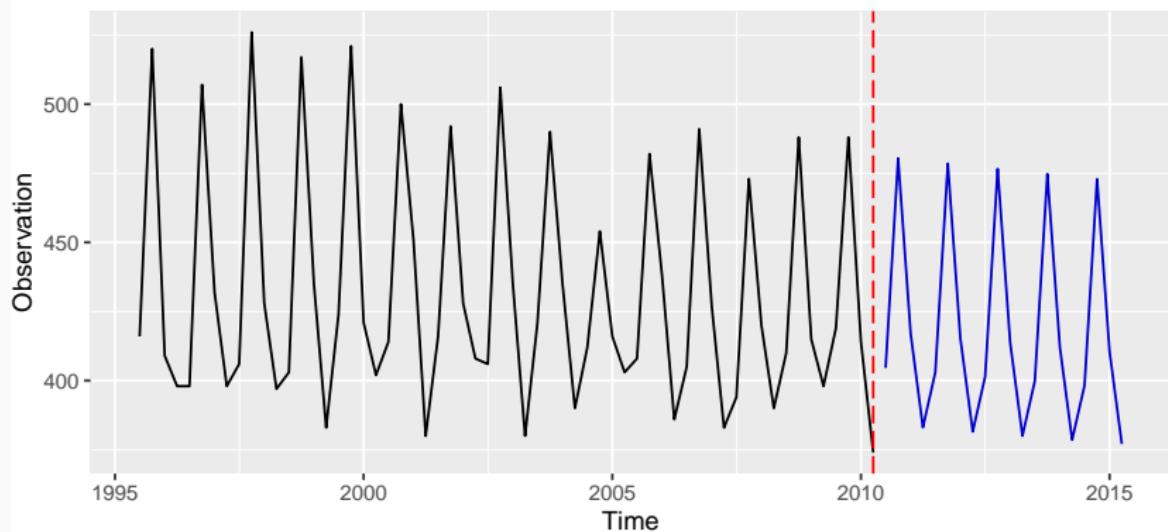
# How to present forecasts?

A forecast should acknowledge that the future is uncertain and provide information of that uncertainty.

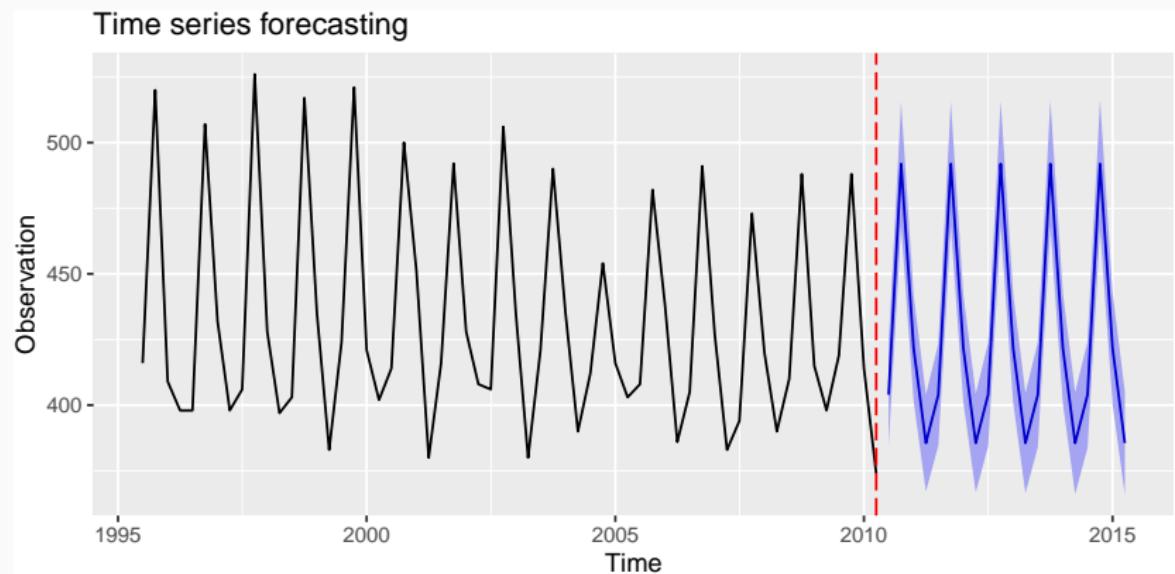
- Point forecasts
- Prediction intervals
- Forecast as probability distribution

# Point forecasts

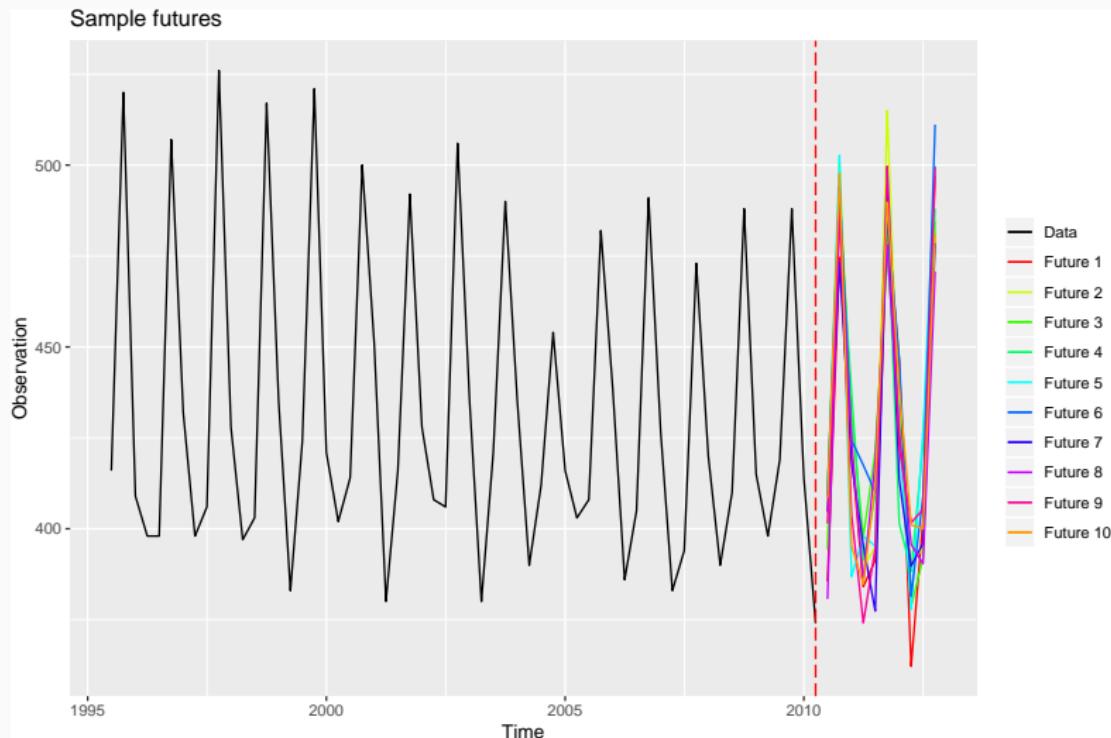
Time series forecasting



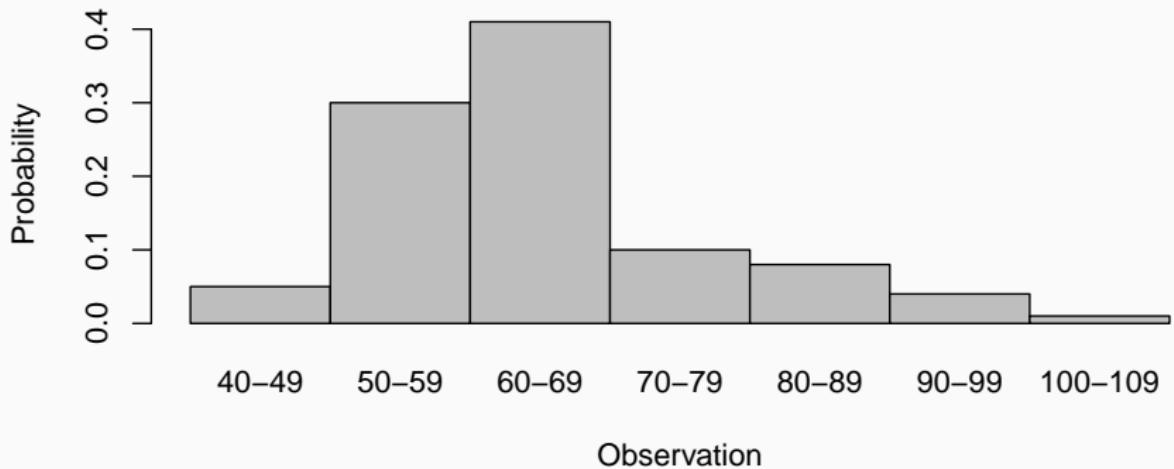
# Prediction interval forecasts



# Sample futures



# Forecast as probability distribution



# Current situation in your organisation

Think about the forecasting process in your organisation:

- How do you present forecasts?
- Do you need to adjuste statistical forecasts?
- When and How you do it?

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# Case Study : A&E

**Problem:** how to forecast A&E attendnace 42 days in advance to inform staffing?

## Additional information

- They can provide a large amount of data on previous attendnace
- Attendance might be affected by seasons, day of week, holidays, six nations, festive days, etc.