# A Tour to Business Forecasting

## Past, Present, and the Future

by

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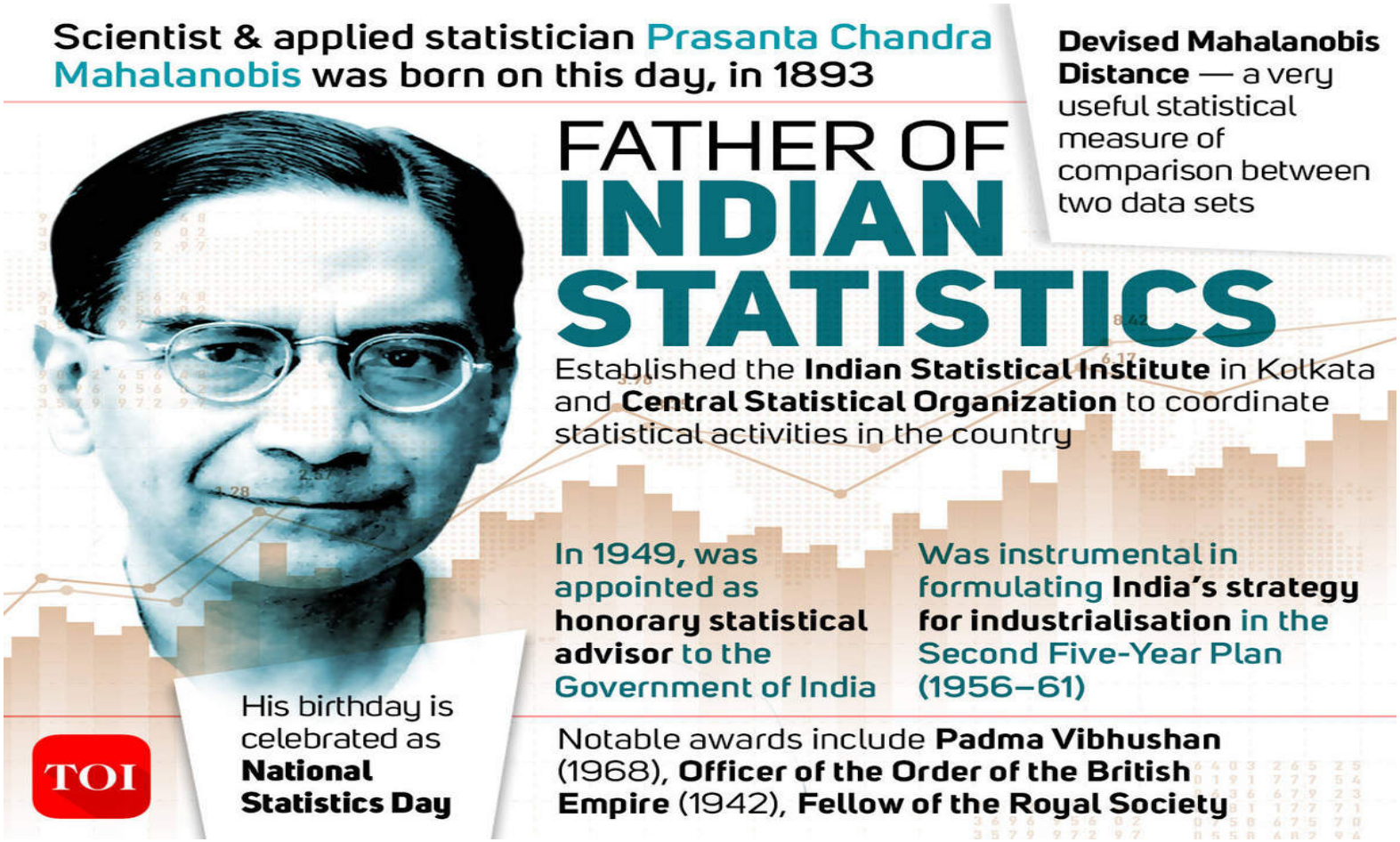
# Birthday of PC Mahalanobis — National Statistics Day

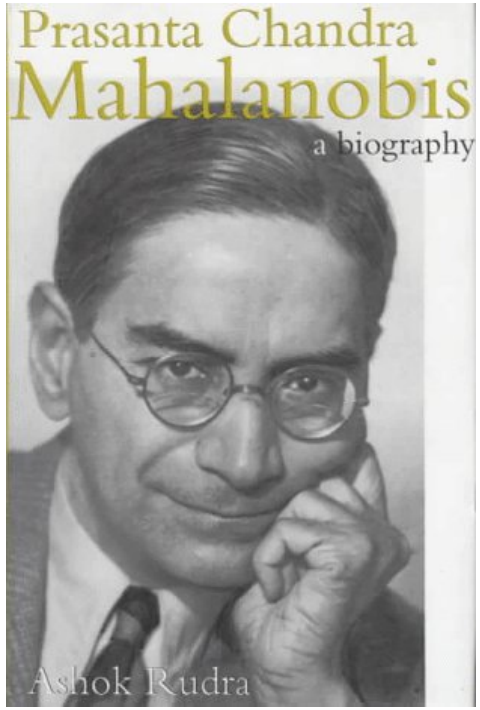


# PCM views on Statistics

*"Statistics is the universal tool of inductive inference, research in natural and social sciences, and technological applications.*

*Statistics must have a clearly defined purpose, one aspect of which is scientific advance and the other, human welfare and national develop ment"*

*- Professor P C Mahalanobis.*




- Three Views of Statistics:
  1. Statistics as a Mathematical Science
  2. Statistics as a Data Science (ML, AI)
  3. Statistics as a Key Technology (Quality, Reliability, Operations Management)

# Role of data: Present

# The World is Data Rich

Astronomy

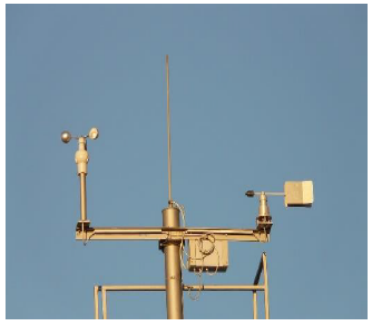
Social Networks


Healthcare

Banking


Genomics

Weather measurements



# Recent Trends and Buzzwords

- Statistics is the study of the collection, analysis, interpretation, presentation and organization of data. Statistics as a key Technology has its applications ranging from natural science, technology to social sciences and human welfare.
- Data science is the study of the generalizable extraction of knowledge from data, yet the key word is science.
- Machine learning gives computers the ability to learn without being explicitly programmed.
- Artificial Intelligence is the study of intelligent agents: any device that perceives its environment and takes actions that maximize its chance of success at some goal.
- Forecasting is estimating how the sequence of observations will continue into the future. Whether it is the rise/fall in exchange rates, the outcome of elections, or winners at the Oscars, there is sure to be something you want to know.

# Reputations can be made and lost by making Forecast

"I think there is a world market for maybe five computers."

(Chairman of IBM, 1943)

"There is no reason anyone would want a computer in their home."

(President, DEC, 1977)

"There's no chance that the iPhone is going to get any significant market share. No chance." (Steve Ballmer, CEO Microsoft, April 2007)

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

*"Prediction is very difficult, especially if it's about the future!"*
*- Niels Bohr, Danish Physicist & Nobel laureate in Physics.*

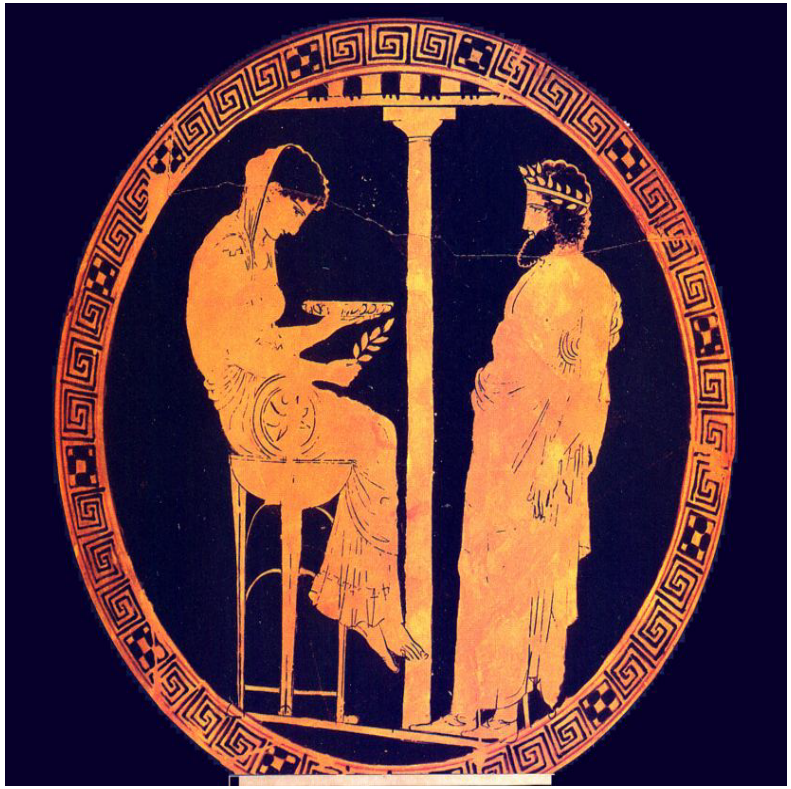
# Past of Forecasting

- Forecasting has fascinated people for thousands of years, sometimes being considered a sign of divine inspiration, and sometimes being seen as a criminal activity.
- The Jewish prophet Isaiah wrote in about 700 BC "Tell us what the future holds, so we may know that you are gods." (Isaiah 41:23)
- One hundred years later, in ancient Babylon, forecasters would foretell the future based on the distribution of maggots in a rotten sheep's liver.

**Forecasting by maggots: Clay model of sheep's liver, stored in British Museum.**

# Past of Forecasting

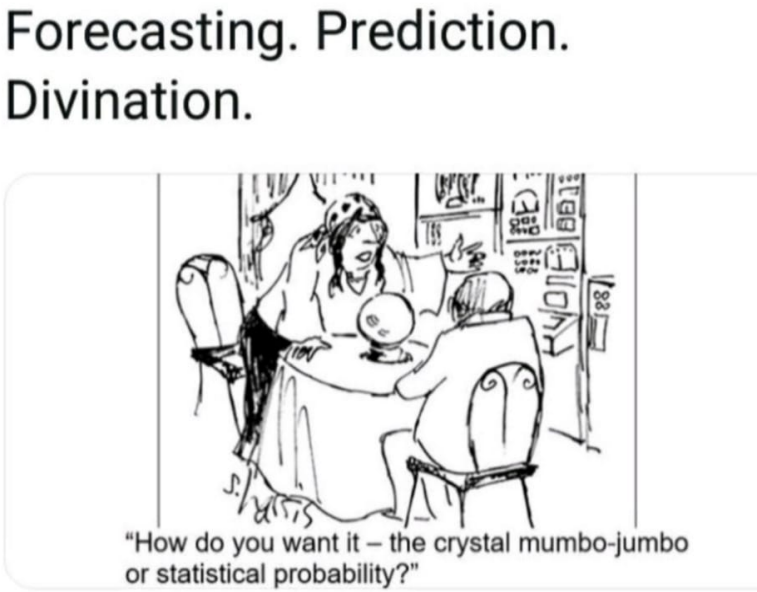
- Beginning in the 800 BC, a priestess known as the Pythia would answer questions about the future at the Temple of Apollo on Greece's Mount Parnassus.
- It is said that she, the Oracle of Delphi, dispensed her wisdom in a trance – caused, some believe, by the hallucinogenic gases that would seep up through natural vents in the rock.



**Forecasting by hallucination**

# Forecasters are to blame!

- Forecasters had a tougher time under the emperor Constantius, who issued a decree in AD357 forbidding anyone "to consult a soothsayer, a mathematician, or a forecaster – May curiosity to foretell the future be silenced forever."
- A similar ban on forecasting occurred in England in 1736 when it became an offence to defraud by charging money for predictions. The British Vagrancy Act (1736) made it an offence to defraud by charging money for predictions. The punishment was three months' imprisonment with hard labour!




**Vagrant forecasters**

# Forecasters are to blame!

- News report on 16 August 2006: A Russian woman is suing weather forecasters for wrecking her holiday. A court in Uljanovsk heard that Alyona Gabitova had been promised 28 degrees and sunshine when she planned a camping trip to a local nature reserve, newspaper Nowyje Iswestija said.

- But it did nothing but pour with rain the whole time, leaving her with a cold. Gabitova has asked the court to order the weather service to pay the cost of her travel.

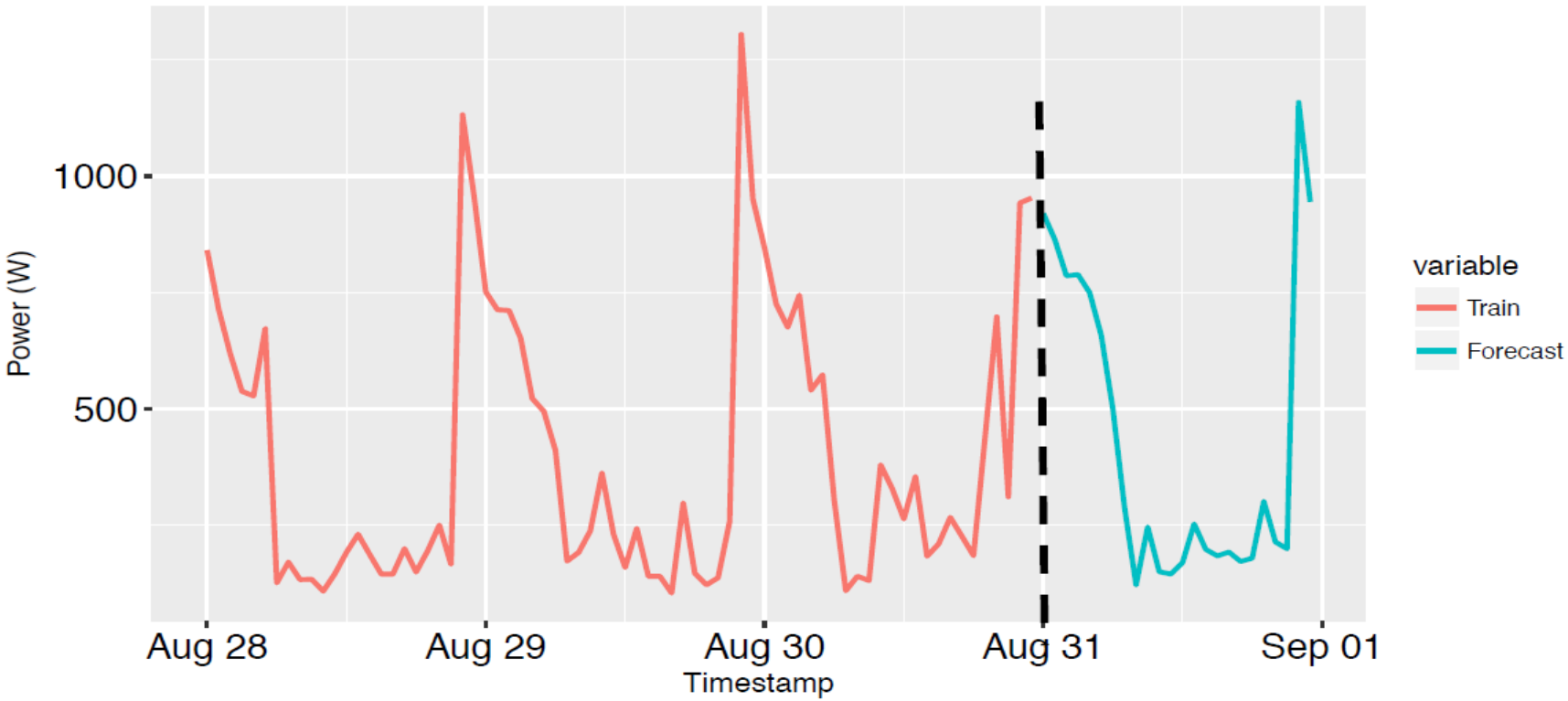

**Weather Rock**

# Introduction to Forecasting

- Time series is a set of observations, each one being recorded at a specific time. (e.g., Forecasting of major economic variables like Annual GDP of a country, Unemployment, Inflation, Exchange rates, Production and Consumption).
- Discrete time series is one in which the set of time points at which observations are made is a discrete set. (e.g., All above including irregularly spaced data)
- Continuous time series are obtained when observations are made continuously over some time intervals. (e.g., ECG graph)
- Forecast is an estimate of the probability distribution of a variable to be observed in the future.

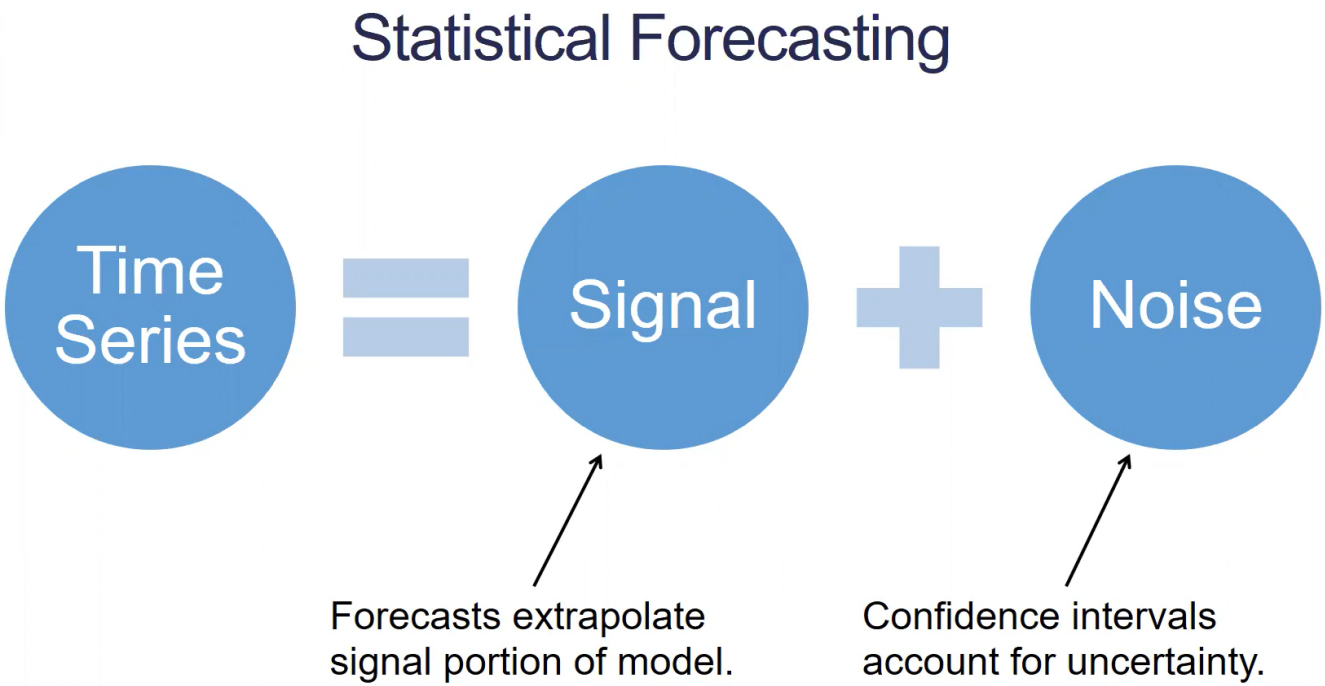
# Statistical Forecasting : Assumptions

- Time series Forecasting : Data collected at regular intervals of time (e.g., Weather and Electricity Forecasting).
- Assumptions: (a) Historical Information is available; (b) Past patterns will continue in the future.
- Statistical models, though, only work in the short term, are not very good for long-term forecasting because these assumption.



# Statistical Forecasting

The science of forecasting got going properly in the 1980s when People realised that if you took all of the ideas that people had developed in different fields, and you thought of it as a collection of techniques and overlaid that with analytical and scientific thinking, then forecasting itself could be considered a scientific discipline.



# Advantages of Statistical models

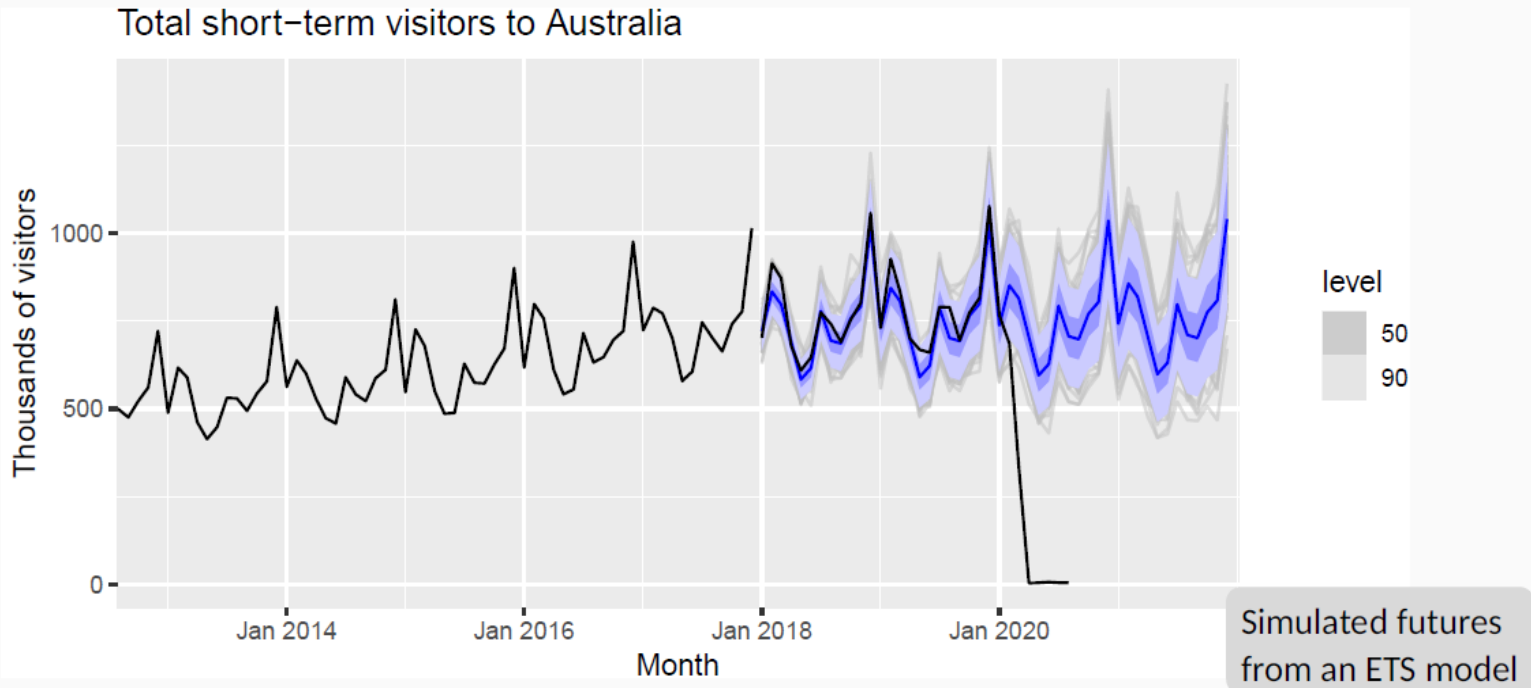
1. Based on empirical data
2. Objective measure of uncertainty.
3. Computable, Replicable, Testable.
4. Able to compute prediction intervals.

# Advantages of Machine Learning models

1. Smart algorithms, few assumptions and applied to huge data sets.
2. Solve problems which traditional statistical methods can't handle (largely due to size of data sets).
3. Strong emphasis on out-of-sample predictive performance (the test data).
4. Recognition that many problems are about prediction not p-values.

# Random futures

A forecast is an estimate of the probability distribution of a variable to be observed in the future.




Mathematical/Statistical/ML models are simplifications of reality – and life is sometimes too complex to model accurately.

# Exercise: Which is easiest to forecast?

- Exchange rate of USD/INR next week.
- Daily electricity demand in 3 days time.
- Time of sunrise this day next year.
- Maximum temperature tomorrow.
- Google stock price tomorrow.

# Which is easiest to forecast? (Easy to Tough)

1. Time of sunrise this day next year.
2. Maximum temperature tomorrow.
3. Daily electricity demand in 3 days time.
4. Google stock price tomorrow.
5. Exchange rate of USD/INR next week.

**How do we measure "easiest"?**

**What makes something easy/difficult to forecast?**

# Forecastability factors

Something is easier to forecast if:

- We have a good understanding of the factors that contribute to it, and can measure them (for stock price and exchange rates causes are mostly unknown).
- There is lots of data available.
- The future is somewhat similar to the past.
- The forecasts cannot affect the thing we are trying to forecast (say, Warren Buffett, CEO of Berkshire Hathaway, make some comment that stock price may change!).
- When should we give up? When there is insufficient data? When the models give implausible forecasts?.

# What can we forecast? - Stock Price

Publicly available stock price data: https://finance.yahoo.com/

# What can we forecast? - Sales

Time series models are extremely useful in pharmaceutical sales forecasting and in predicting demand for items.

# What can we forecast? - Electricity

Models for electricity demand were developed so that they could plan generation capacity.

# Business Forecasting — Case Study - 1

Client: Car fleet companies around the world.

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

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. Statistical/ML-based forecasters can help the Car fleet companies.

# Business Forecasting — Case Study - 2

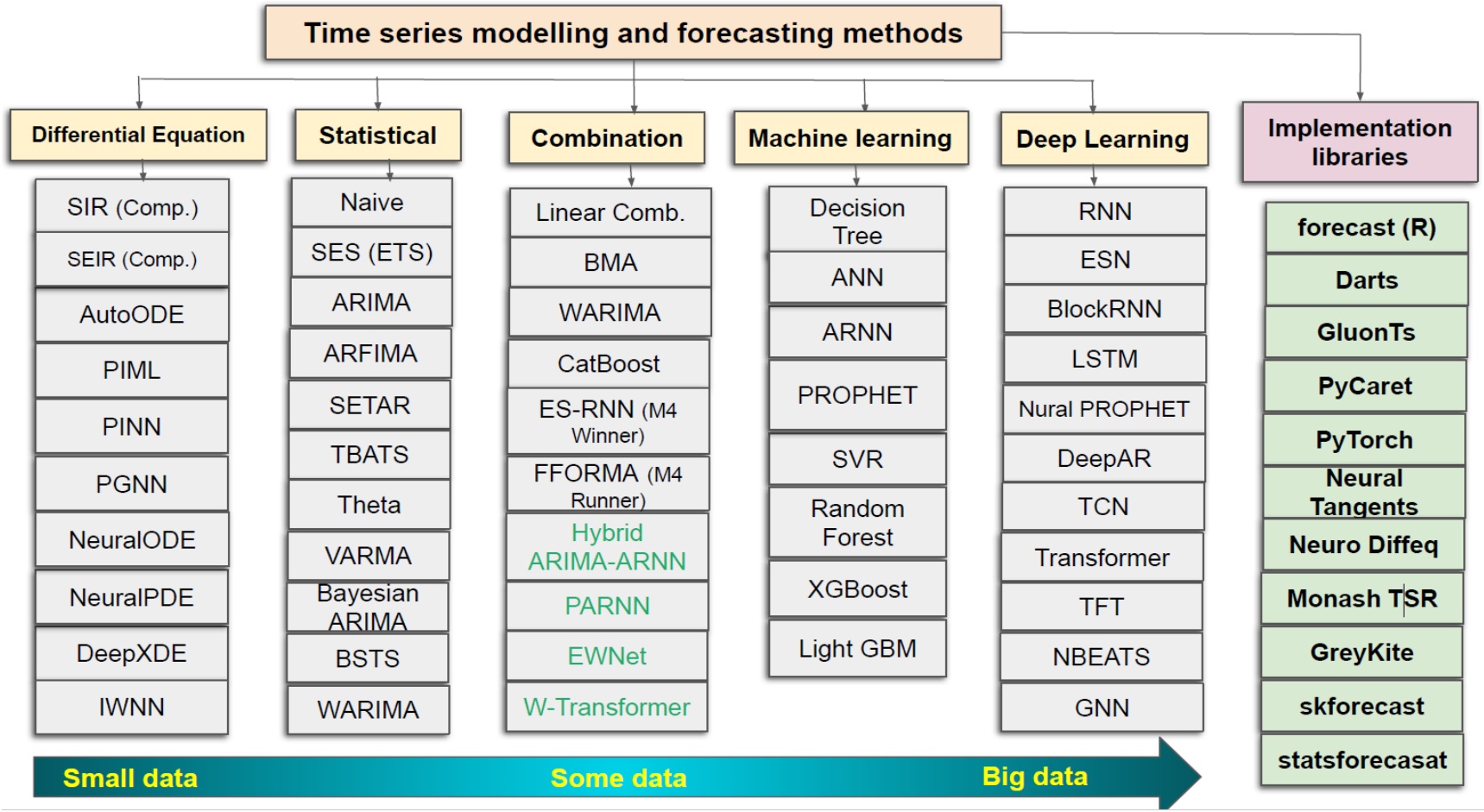
Client: Airline Company.

**Problem: How to forecast passenger traffic on major routes (say, Economy class passengers)?**

Additional information:

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

# List of Various Forecasting Models




The most Applied Forecasting Book for Students: `https://otexts.com/fpp3/`.

# The bright future of forecasting

- What about interpretable neural networks and deep learning?
- Will we ever be able to forecast "black swans"?
- Does more data mean better forecasts?
- Are there many jobs for forecasters?
- Urgent need for a course on "Applied Forecasting for Business & Economics" for both science, arts, and business students at Woxsen University, if not any.
- Various resources are available at `www.forecasters.org`

# HAPPY FORECASTING

"A good forecaster is not smarter than everyone else, he merely has his ignorance better organised."