

Forecasting and the importance of being uncertain

Rob J Hyndman



MONASH University

Outline

- 1 **Dangers and difficulties of forecasting**
- 2 **Forecasting mortality and fertility**
- 3 **Forecasting the PBS**
- 4 **Forecasting peak electricity demand**
- 5 **Final thoughts**

Outline

1 Dangers and difficulties of forecasting

2 Forecasting mortality and fertility

3 Forecasting the PBS

4 Forecasting peak electricity demand

5 Final thoughts

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.

Those “unforeseen events”

Precautions should be taken against running into unforeseen occurrences or events. (Horoscope, *New York Times*)

Those “unforeseen events”

Precautions should be taken against running into unforeseen occurrences or events. (Horoscope, *New York Times*)

We are ready for any unforeseen event which may or may not occur.

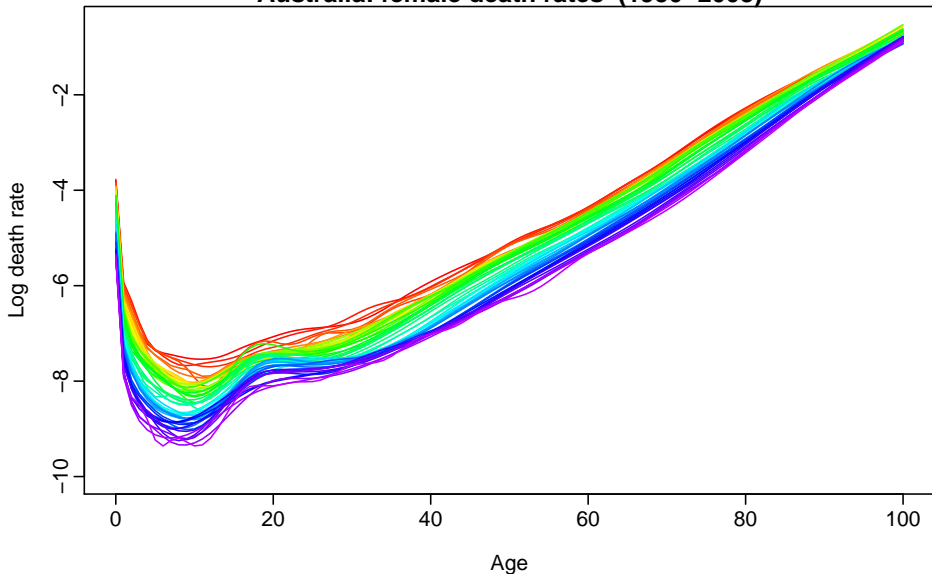
(Dan Quayle)

Outline

- 1 Dangers and difficulties of forecasting
- 2 Forecasting mortality and fertility**
- 3 Forecasting the PBS
- 4 Forecasting peak electricity demand
- 5 Final thoughts

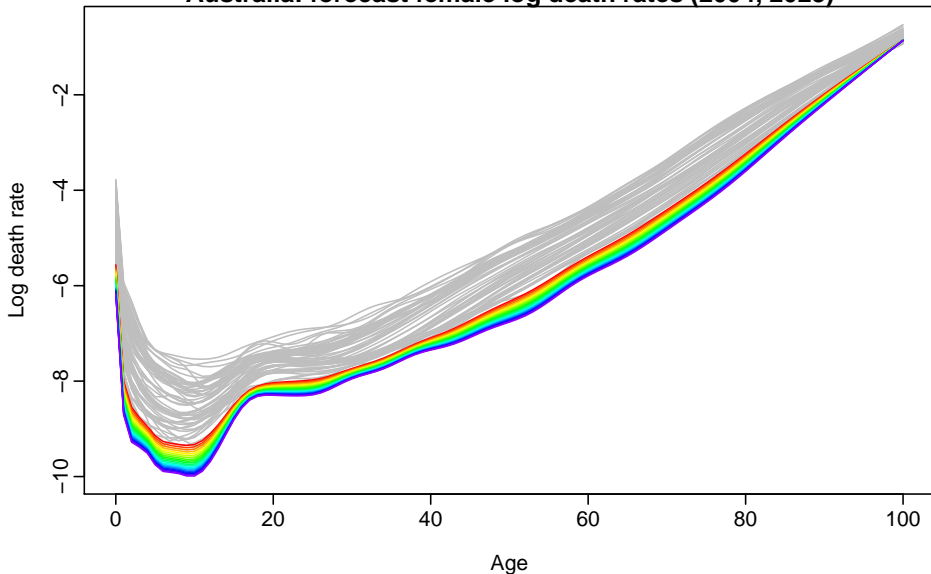
Mortality: female

Australia: female death rates (1950–2003)



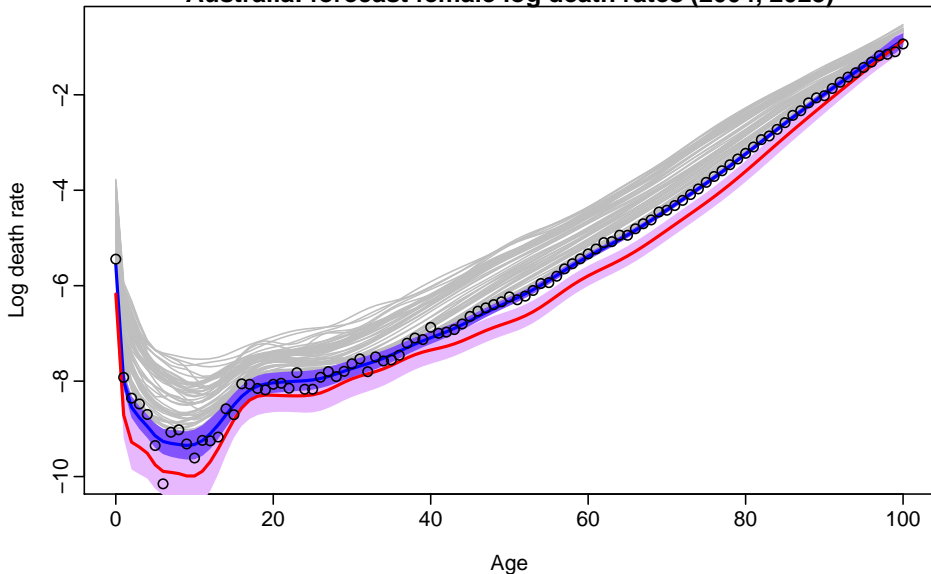
Mortality: female

Australia: forecast female log death rates (2004, 2023)



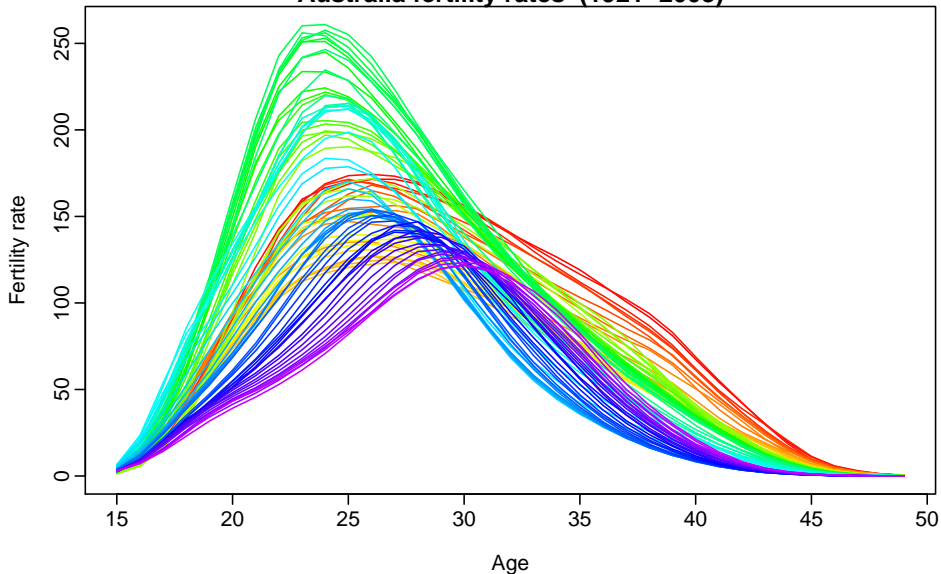
Mortality: female

Australia: forecast female log death rates (2004, 2023)



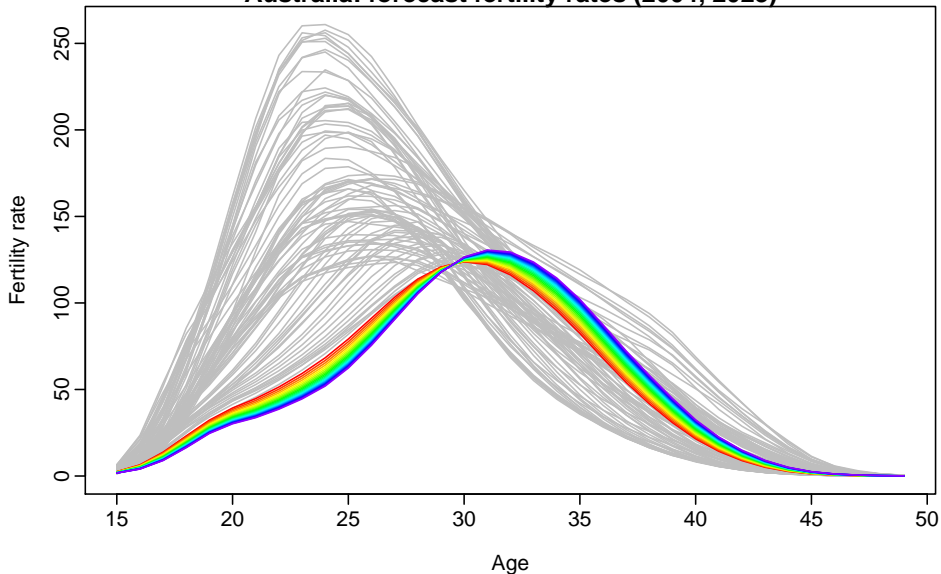
Fertility

Australia fertility rates (1921–2003)



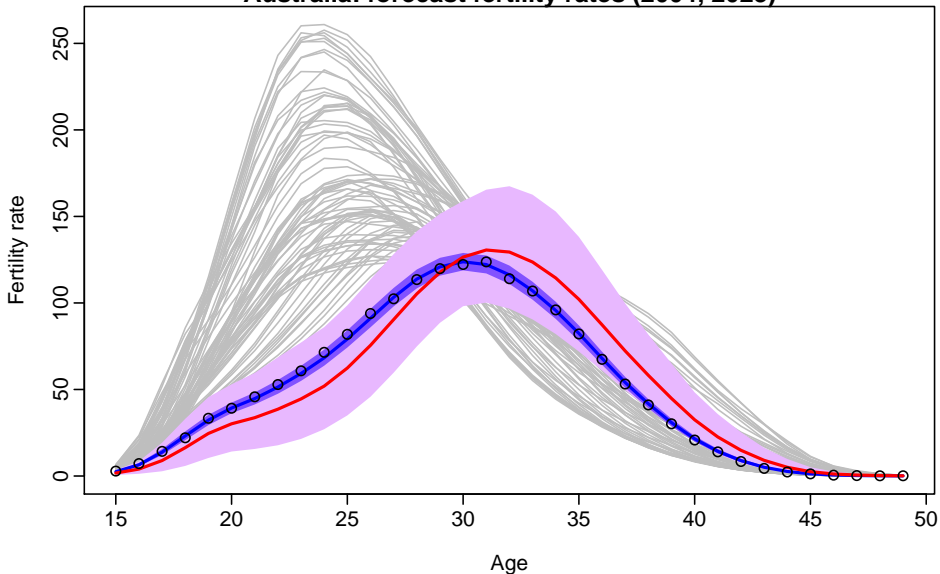
Fertility

Australia: forecast fertility rates (2004, 2023)



Fertility

Australia: forecast fertility rates (2004, 2023)



Forecasting mortality and fertility

Key papers

- Erbas, B., Hyndman, R.J., and Gertig, D.M. (2007) “Forecasting age-specific breast cancer mortality using functional data models”. *Statistics in Medicine*, **26**(2), 458-470.
- Hyndman, R.J., and Ullah, Md. S. (2007) “Robust forecasting of mortality and fertility rates: a functional data approach”. *Computational Statistics and Data Analysis*, to appear.

Forecasting mortality and fertility

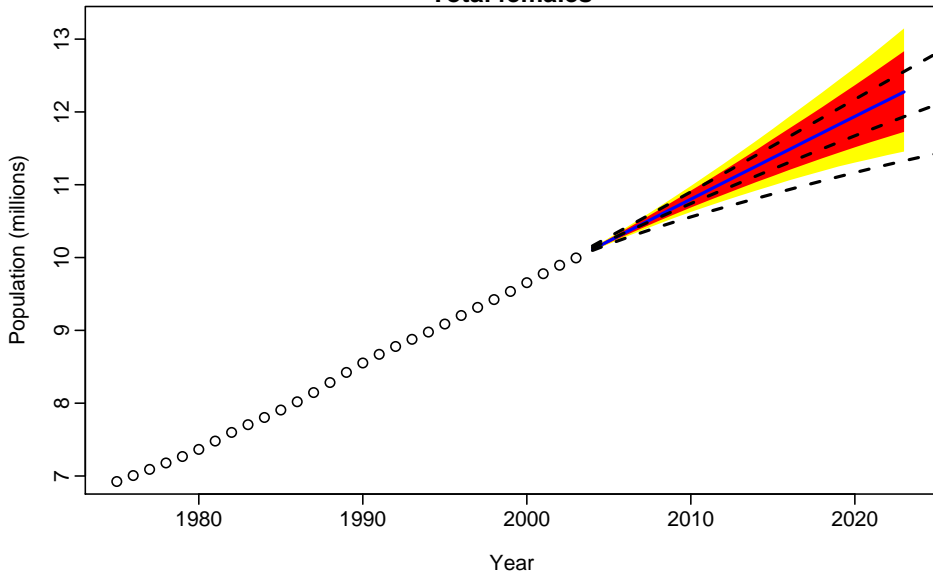
Key papers

- Erbas, B., Hyndman, R.J., and Gertig, D.M. (2007) “Forecasting age-specific breast cancer mortality using functional data models”. *Statistics in Medicine*, **26**(2), 458-470.
- Hyndman, R.J., and Ullah, Md. S. (2007) “Robust forecasting of mortality and fertility rates: a functional data approach”. *Computational Statistics and Data Analysis*, to appear.

Since 2005, these methods have formed the basis of all official cancer mortality and incidence forecasts from the Australian Institute of Health and Welfare.

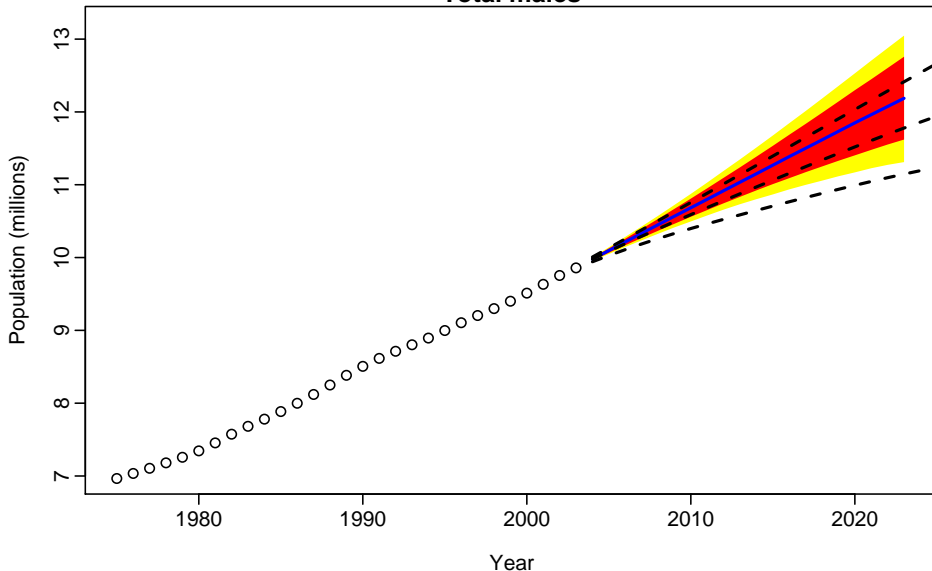
Forecasting population

Total females



Forecasting population

Total males



Outline

- 1 Dangers and difficulties of forecasting
- 2 Forecasting mortality and fertility
- 3 Forecasting the PBS**
- 4 Forecasting peak electricity demand
- 5 Final thoughts

Forecasting the PBS

Estimation of forward estimates for the Pharmaceutical Benefit Scheme

Department of Health and Ageing

- \$5 billion budget. Underforecasted by \$500–\$800 million in 2000 and 2001.

Forecasting the PBS

Estimation of forward estimates for the Pharmaceutical Benefit Scheme

Department of Health and Ageing

- \$5 billion budget. Underforecasted by \$500–\$800 million in 2000 and 2001.
- Thousands of products. Seasonal demand.

Forecasting the PBS

Estimation of forward estimates for the Pharmaceutical Benefit Scheme

Department of Health and Ageing

- \$5 billion budget. Underforecasted by \$500–\$800 million in 2000 and 2001.
- Thousands of products. Seasonal demand.
- Subject to covert marketing, volatile products, uncontrollable expenditure.

Forecasting the PBS

Estimation of forward estimates for the Pharmaceutical Benefit Scheme

Department of Health and Ageing

- \$5 billion budget. Underforecasted by \$500–\$800 million in 2000 and 2001.
- Thousands of products. Seasonal demand.
- Subject to covert marketing, volatile products, uncontrollable expenditure.
- All forecasts being done with the FORECAST function in MS-Excel applied to 10 year old data!

Forecasting the PBS

Estimation of forward estimates for the Pharmaceutical Benefit Scheme

Department of Health and Ageing

- We developed some new **time series models** — automated exponential smoothing state space modelling applied to about 100 product groups.

Forecasting the PBS

Estimation of forward estimates for the Pharmaceutical Benefit Scheme

Department of Health and Ageing

- We developed some new **time series models** — automated exponential smoothing state space modelling applied to about 100 product groups.
- Models allowed for time-changing trend and seasonal patterns and provide prediction intervals.

Forecasting the PBS

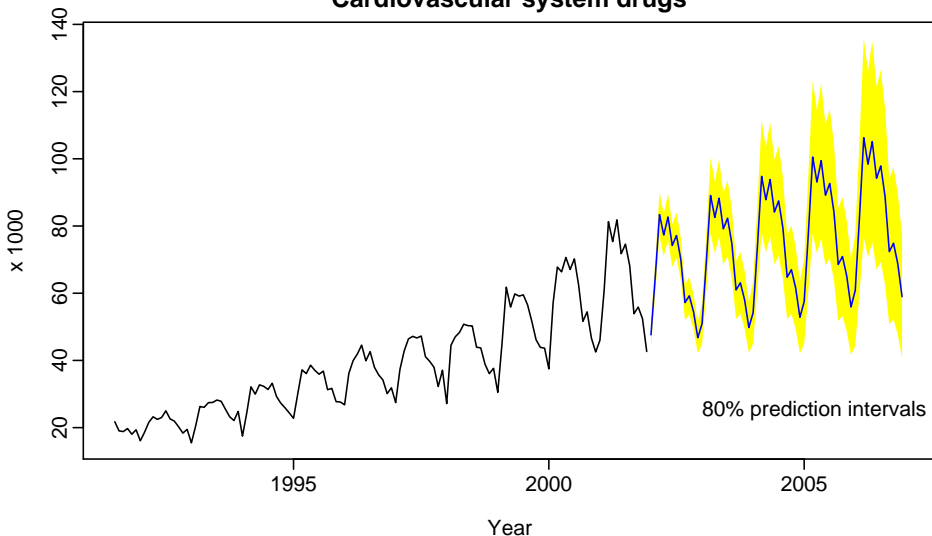
Estimation of forward estimates for the Pharmaceutical Benefit Scheme

Department of Health and Ageing

- We developed some new **time series models** — automated exponential smoothing state space modelling applied to about 100 product groups.
- Models allowed for time-changing trend and seasonal patterns and provide prediction intervals.
- Forecast error now a few \$million per year.

Forecasting the PBS

**Total monthly scripts: concession copayments
Cardiovascular system drugs**



Forecasting the PBS

Key papers

- Hyndman, R.J., Koehler, A.B., Snyder, R.D., and Grose, S. (2002) "A state space framework for automatic forecasting using exponential smoothing methods". *International J. Forecasting*, **18**(3), 439–454.
- Hyndman, R.J., Koehler, A.B., Ord, J.K., and Snyder, R.D. (2005) "Prediction intervals for exponential smoothing using two new classes of state space models". *Journal of Forecasting*, **24**(1), 17–37.

Forecasting the PBS

Key papers

- Hyndman, R.J., Koehler, A.B., Snyder, R.D., and Grose, S. (2002) "A state space framework for automatic forecasting using exponential smoothing methods". *International J. Forecasting*, **18**(3), 439–454.
- Hyndman, R.J., Koehler, A.B., Ord, J.K., and Snyder, R.D. (2005) "Prediction intervals for exponential smoothing using two new classes of state space models". *Journal of Forecasting*, **24**(1), 17–37.

Forthcoming monograph

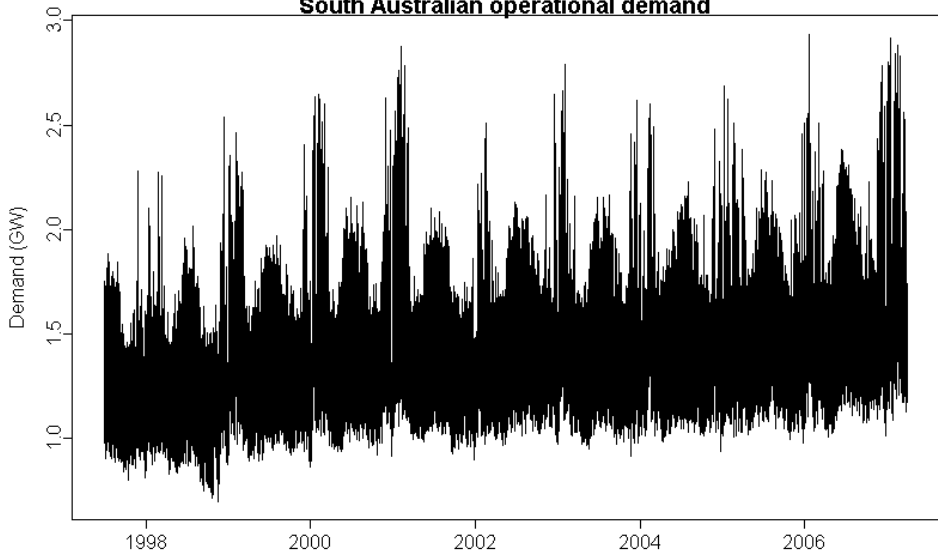
Forecasting with exponential smoothing: the state space approach by Hyndman, Koehler, Ord and Snyder (Springer, 2008).

Outline

- 1 Dangers and difficulties of forecasting
- 2 Forecasting mortality and fertility
- 3 Forecasting the PBS
- 4 Forecasting peak electricity demand**
- 5 Final thoughts

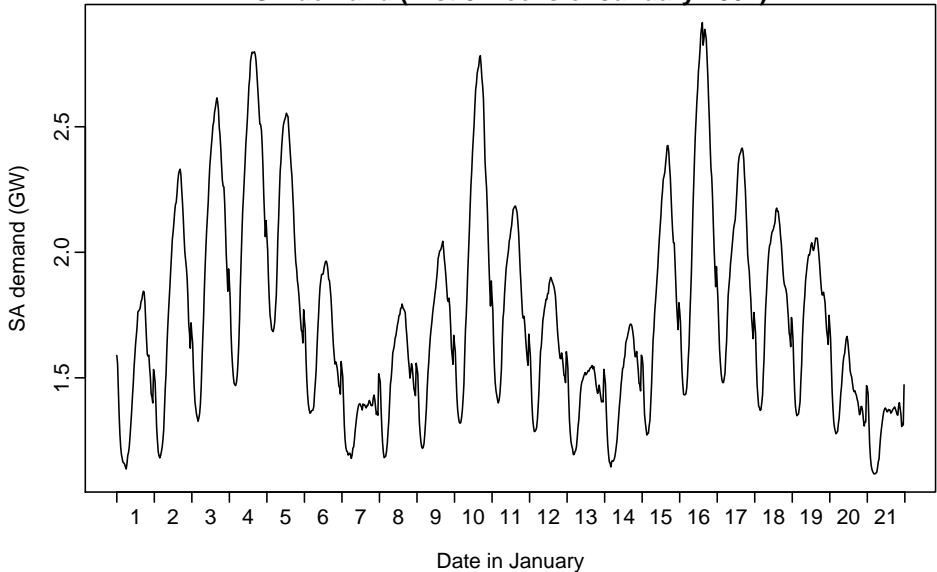
Peak electricity demand

South Australian operational demand

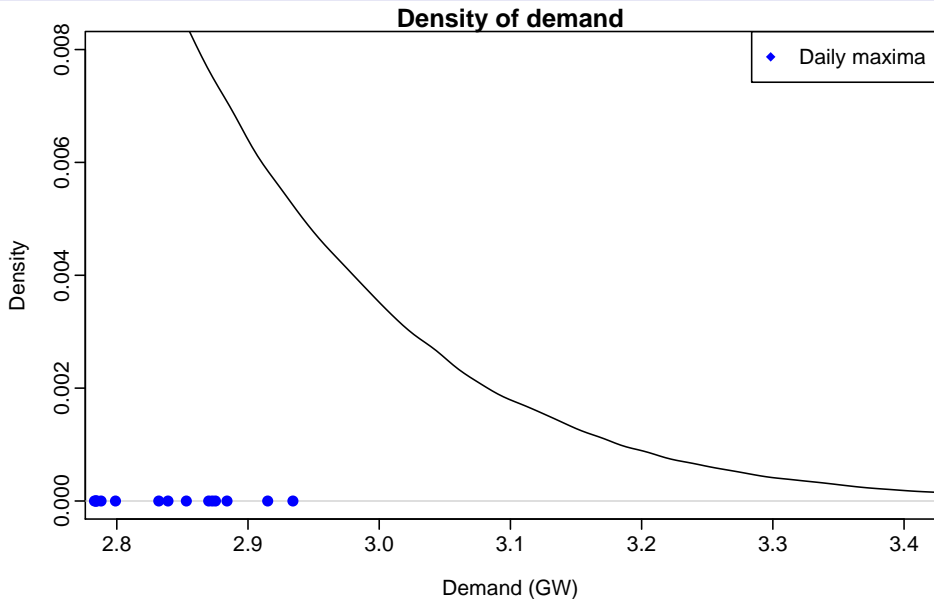


Peak electricity demand

SA demand (first 3 weeks of January 2007)



Peak electricity demand



Outline

- 1 Dangers and difficulties of forecasting
- 2 Forecasting mortality and fertility
- 3 Forecasting the PBS
- 4 Forecasting peak electricity demand
- 5 Final thoughts**

Final thoughts

- Uncertainty statements are **essential** when making predictions.

Final thoughts

- Uncertainty statements are **essential** when making predictions.
- Good statistical models can often be applied to diverse applications.

Final thoughts

- Uncertainty statements are **essential** when making predictions.
- Good statistical models can often be applied to diverse applications.
- Working in demography, oncology, epidemiology, pharmaco-epidemiology, energy, meteorology, and other fields keeps life interesting!

Final thoughts

- Uncertainty statements are **essential** when making predictions.
- Good statistical models can often be applied to diverse applications.
- Working in demography, oncology, epidemiology, pharmaco-epidemiology, energy, meteorology, and other fields keeps life interesting!

Final thoughts

- Uncertainty statements are **essential** when making predictions.
- Good statistical models can often be applied to diverse applications.
- Working in demography, oncology, epidemiology, pharmaco-epidemiology, energy, meteorology, and other fields keeps life interesting!

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

(Anonymous)