MONASH University

MONASH BUSINESS SCHOOL

ETC3550/ETC5550 Applied forecasting

Some final thoughts

OTexts.org/fpp3/

Outline

1. Assignment 1
2. Some case studies
3. Neural network models
4. Exam

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Assignment 1

Stock price forecasting (Q1 and Q5)

- Hard to beat naive forecast
- Random walk model says forecast variance = $h\sigma^2$.

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Maximum temperature at Melbourne airport on 12 April 2021. (Q2)

- Weather is relatively stationary over similar time of year and recent years.
- So take mean and var of max temp in April over last 10 years.

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Difference in points in AFL match (Q3)

- Teams vary in strength from year to year.
- Could look at distribution of for-against points from 2020 across all games for each team. Assume distributions independent.

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Seasonally adjusted estimate of total employment (Q4)

- Probably locally trended.
- Perhaps use drift method based on average monthly change in last 2 years.

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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 the program to produce forecasts automatically.

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

- 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!

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Problem: How to do the forecasting better?

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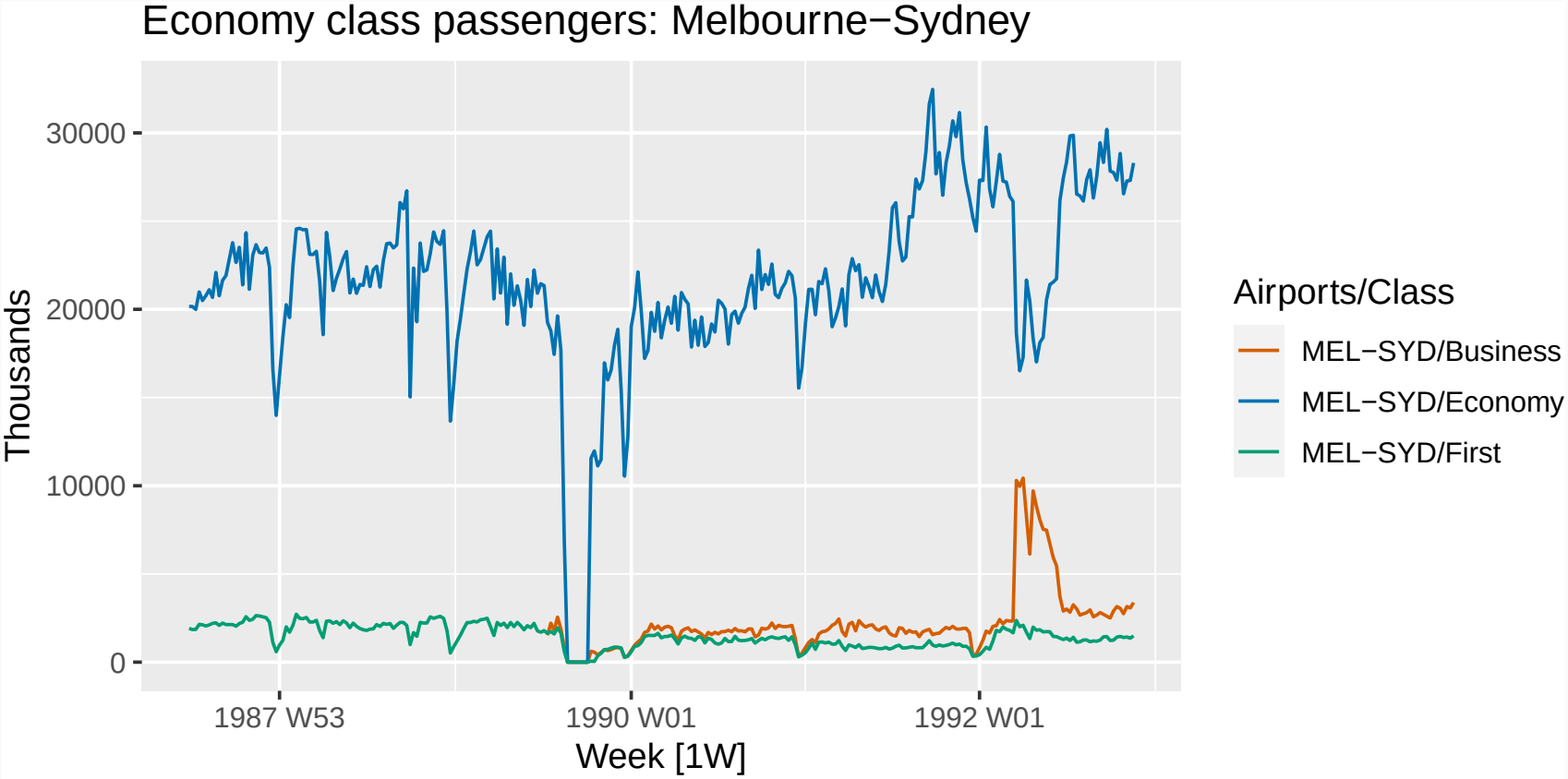
Problem: how to forecast resale value of vehicles? How should this affect leasing and sales policies?

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. They see me as a threat and do not cooperate.

CASE STUDY 4: Airline

Problem: how to forecast passenger traffic on major routes?



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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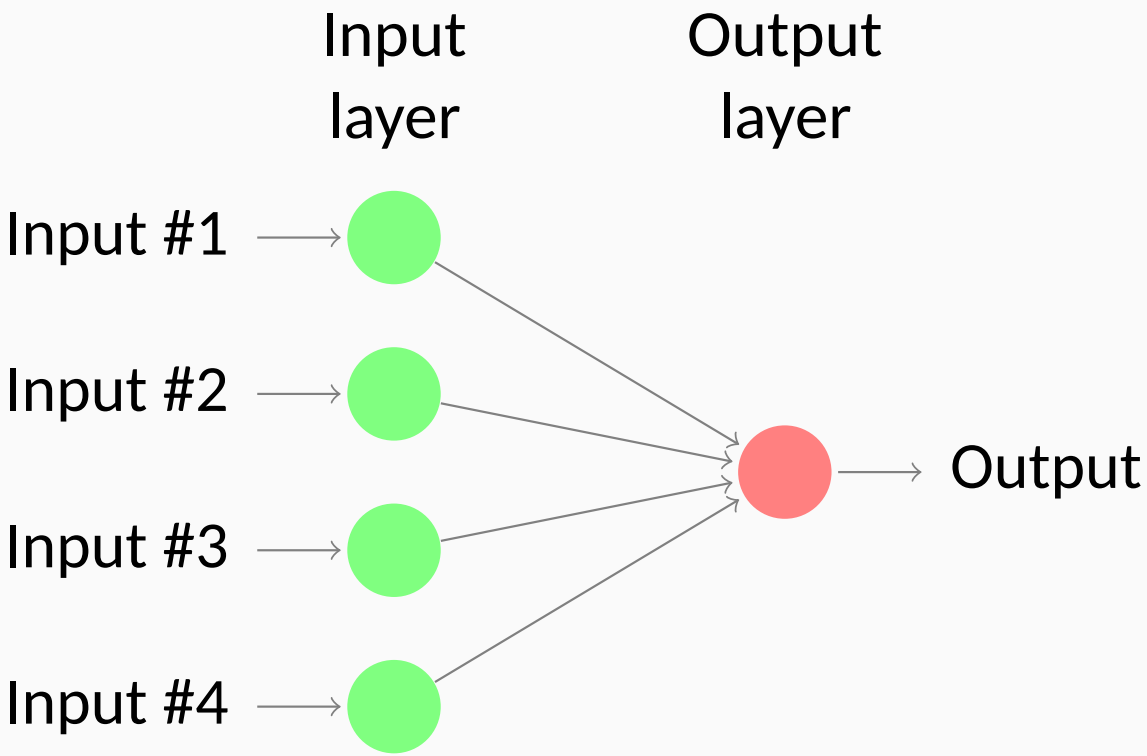
Neural network models

Simplest version: linear regression



Neural network models

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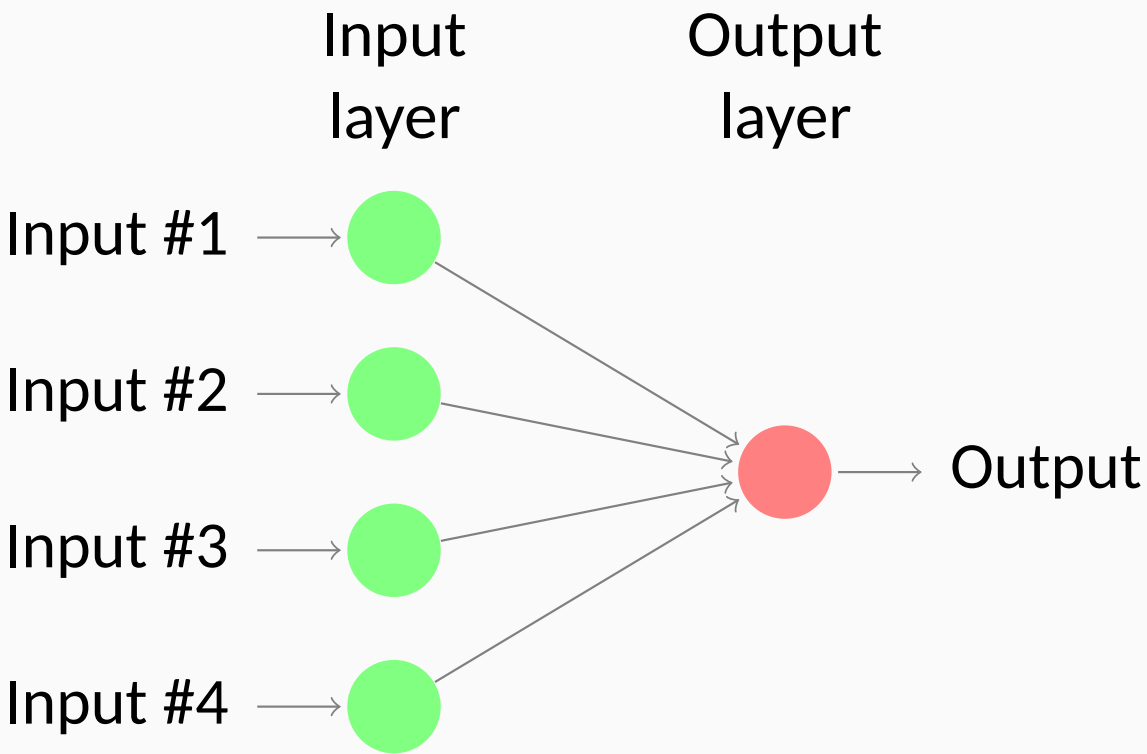
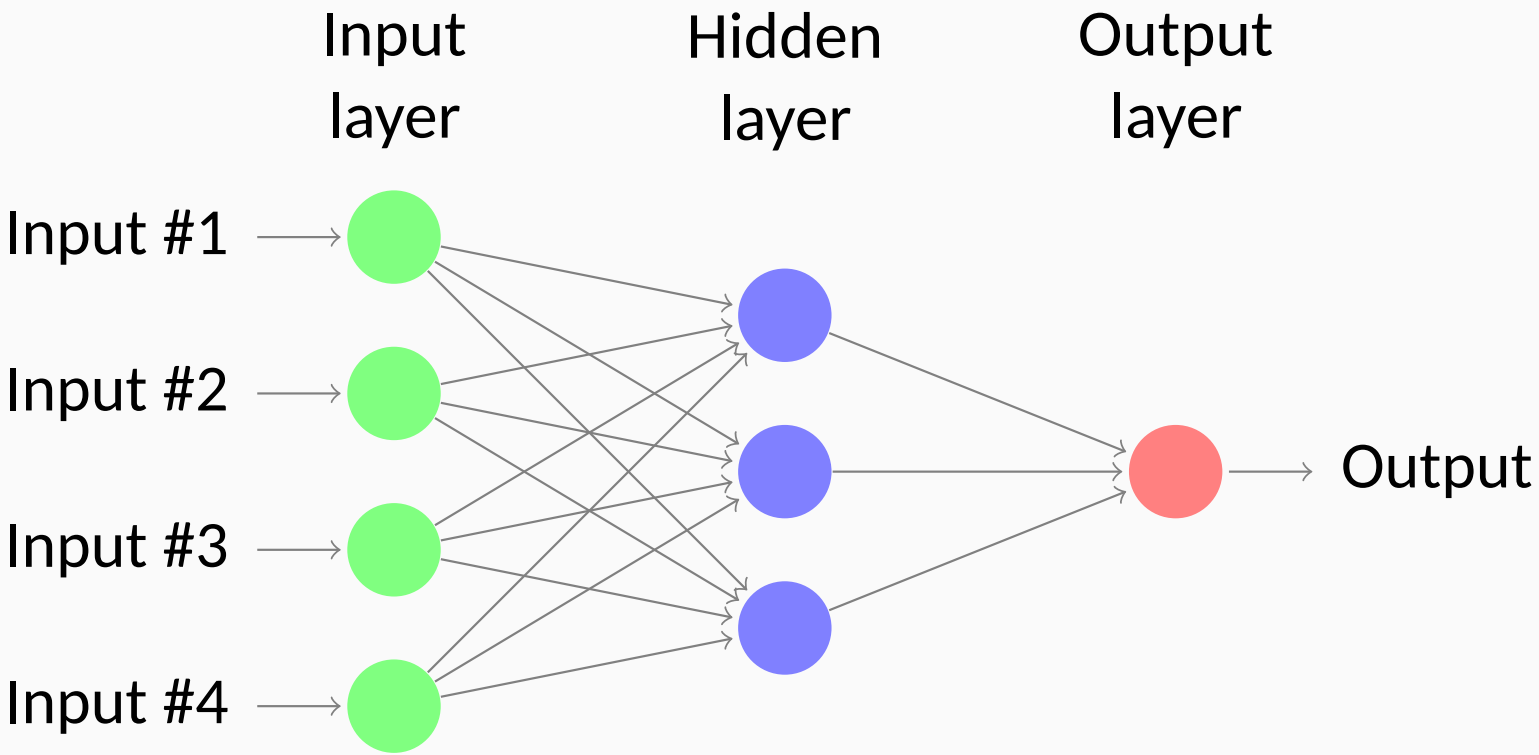


- Coefficients attached to predictors are called “weights”.
- Forecasts are obtained by a linear combination of inputs.
- Weights selected using a “learning algorithm” that minimises a “cost function”.

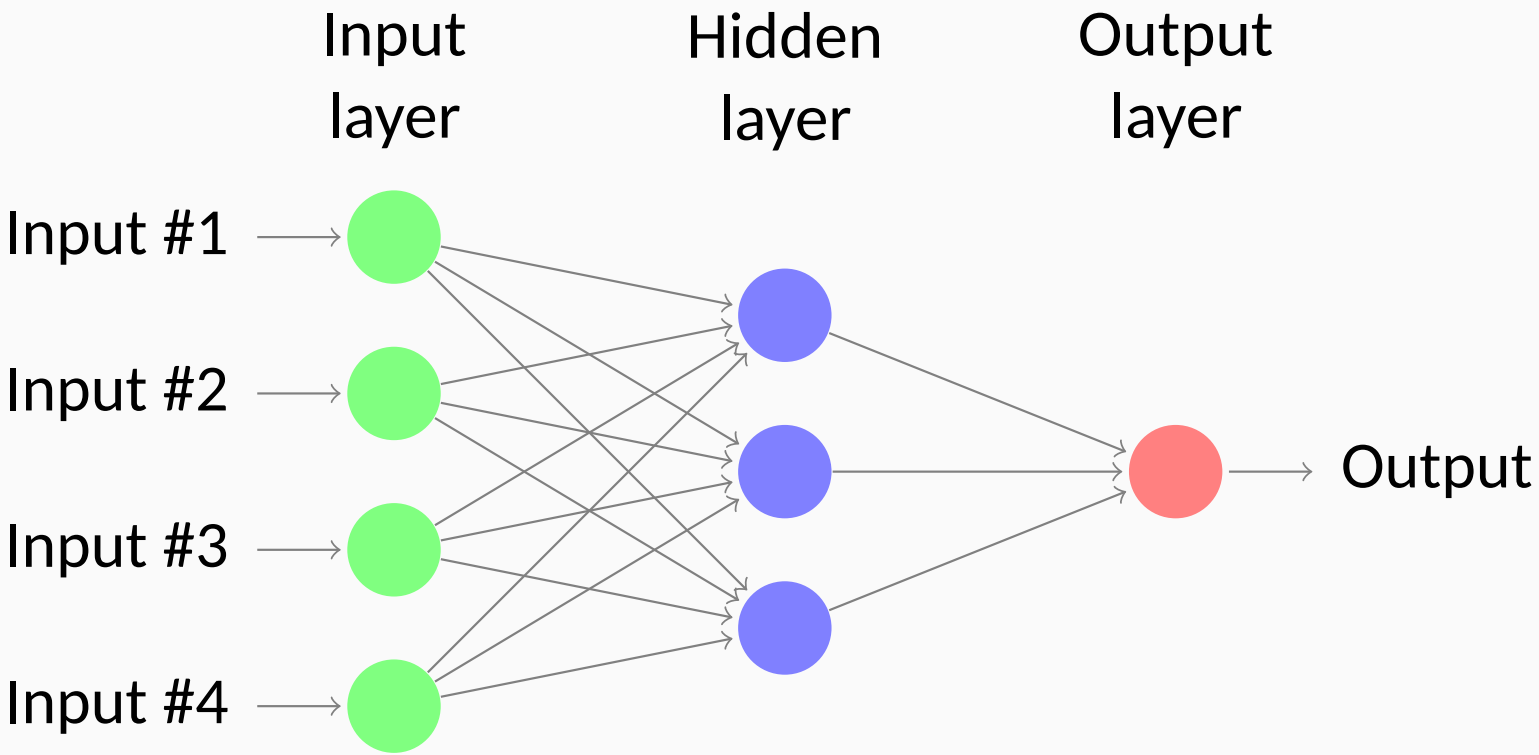
Neural network models

Nonlinear model with one hidden layer



Neural network models

Nonlinear model with one hidden layer



- A **multilayer feed-forward network** where each layer of nodes receives inputs from the previous layers.
- Inputs to each node combined using linear combination.

NNAR models

- Lagged values of the time series can be used as inputs to a neural network.
- NNAR(p, k): p lagged inputs and k nodes in the single hidden layer.
- NNAR($p, 0$) model is equivalent to an ARIMA($p, 0, 0$) model but without stationarity restrictions.
- Seasonal NNAR(p, P, k): inputs ($y_{t-1}, y_{t-2}, \ldots, y_{t-p}, y_{t-m}, y_{t-2m}, y_{t-Pm}$) and k neurons in the hidden layer.
- NNAR$(p, P, 0)_m$ model is equivalent to an ARIMA$(p, 0, 0)(P,0,0)_m$ model but without stationarity restrictions.

NNAR models in R

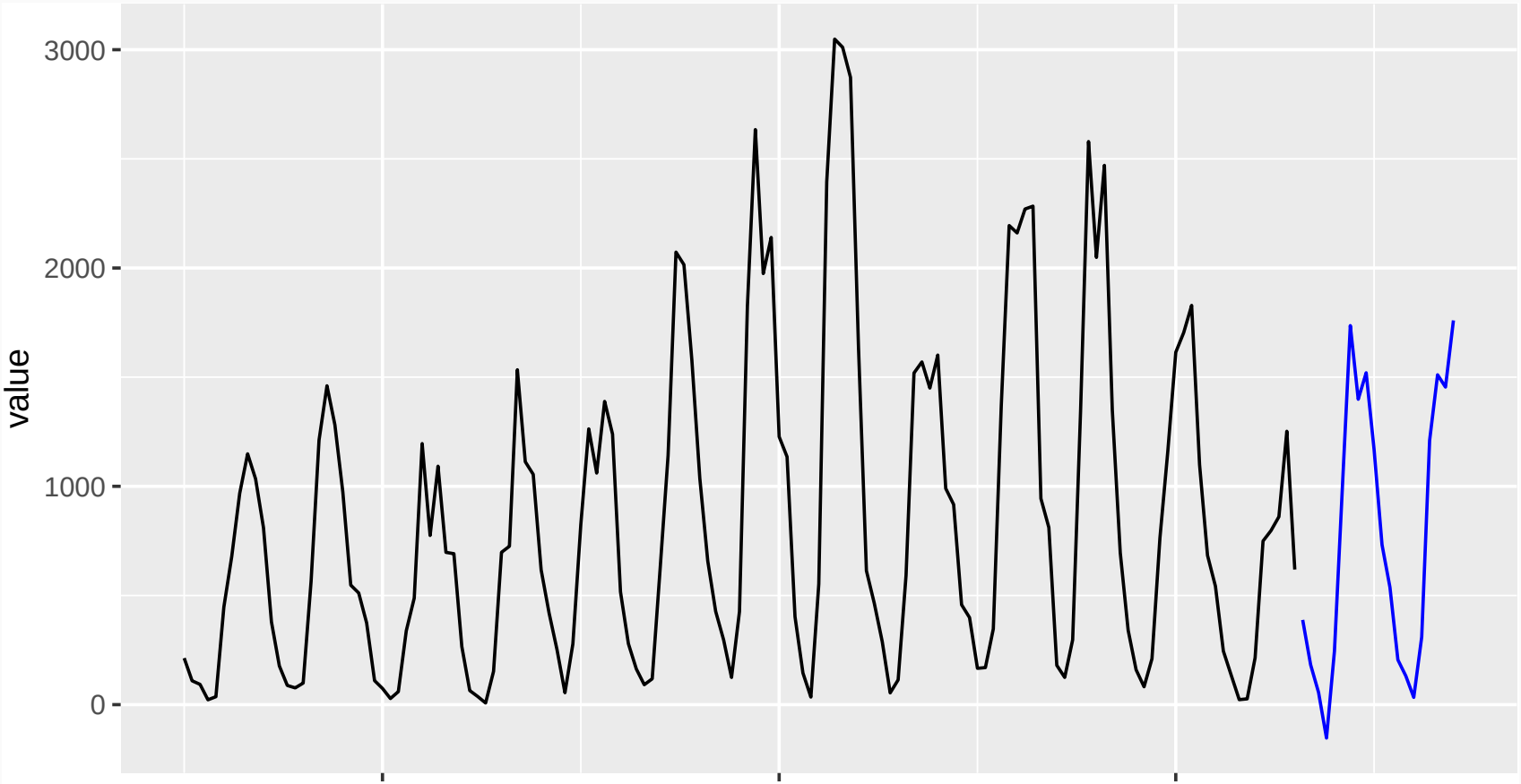
- The `NNETAR()` function fits an NNAR(p, P, k)$_m$ model.
- If p and P are not specified, they are automatically selected.
- For non-seasonal time series, default p = optimal number of lags (according to the AIC) for a linear AR(p) model.
- For seasonal time series, defaults are $P = 1$ and p is chosen from the optimal linear model fitted to the seasonally adjusted data.
- Default $k = (p + P + 1)/2$ (rounded to the nearest integer).

Sunspots

- Surface of the sun contains magnetic regions that appear as dark spots.
- These affect the propagation of radio waves and so telecommunication companies like to predict sunspot activity in order to plan for any future difficulties.
- Sunspots follow a cycle of length between 9 and 14 years.

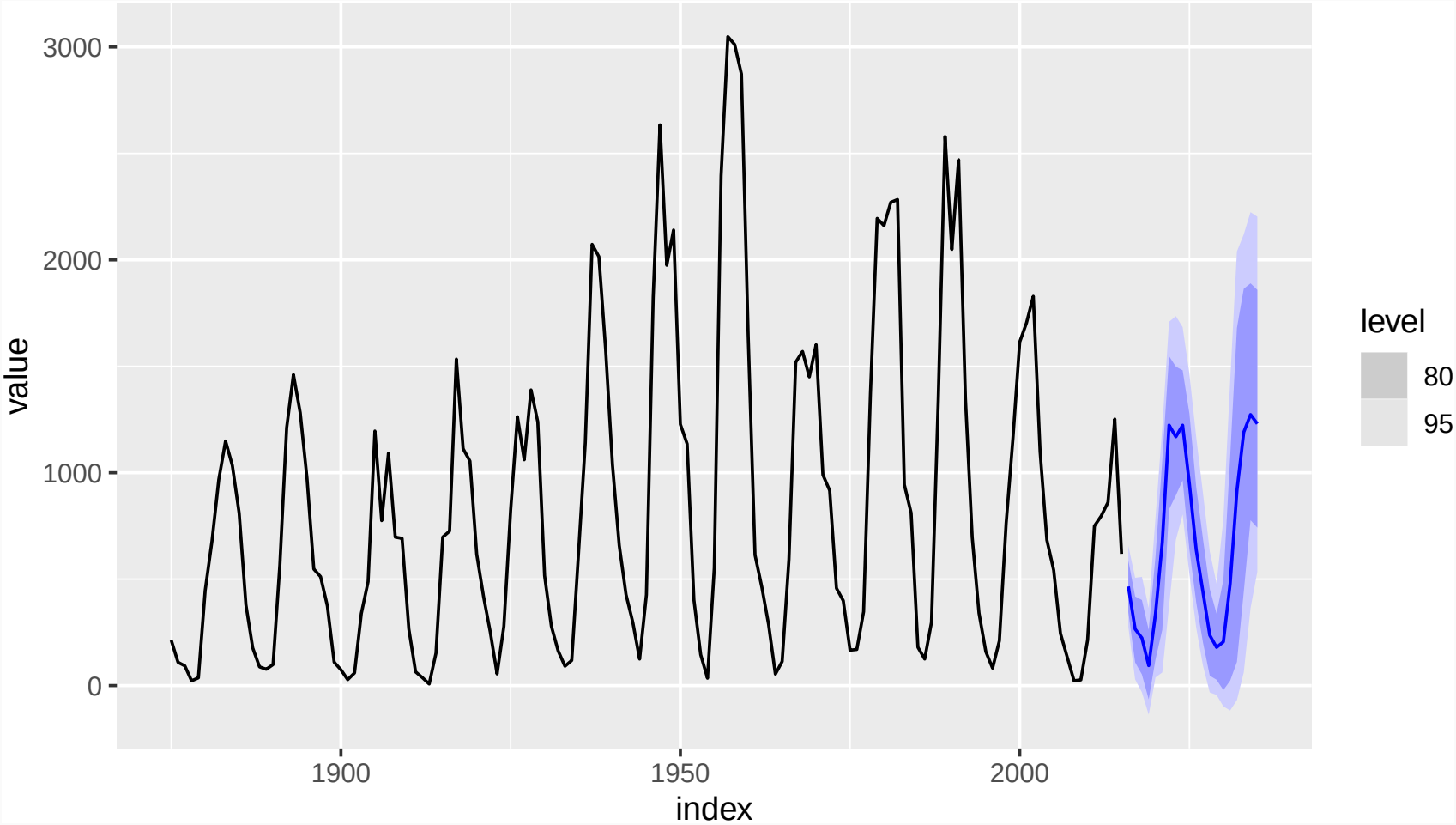
NNAR(9,5) model for sunspots

```
sunspots <- as_tsibble(fpp2::sunspotarea)
fit <- sunspots %>% model(NNETAR(value))
fit %>% forecast(h=20, times = 1) %>%
  autoplot(sunspots, level = NULL)
```



Prediction intervals by simulation

```
fit %>% forecast(h=20) %>%
  autoplot(sunspots)
```



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Exam: 9.00am (AEST) 7 June

Five questions, all to be attempted.

- **A** Short answers/explanations. Write about 1/4 page on four topics (out of six possible topics). Nuanced answers required.
- **B** Describing a time series, choosing a forecasting method
- **C** ETS models
- **D** ARIMA models
- **E** (Dynamic) regression models

• Moodle Quiz • Open book • 2 hr 40 min

Exam and R

- Parts **B**, **C** and **E** require interpretation of R output, but no coding.
- Part **D** requires some coding (part of the code will be provided) and interpretation of R output.
- All R coding will be very similar to examples you have done before.
- Submitted answers will be automatically checked for close matches.
- Enter answers on Moodle as you go, to avoid internet issues at the end.

Preparing for the exam

- Exams from 2018–2020 on Moodle. Solutions to follow by Monday.
- Exercises. Make sure you have done them all!
- Identify your weak points and practice them.
- Write your own summary of the material.
- Practice explaining the material to a class-mate.

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Help available

- Ask on Moodle forum
- See a tutor during the consultation times.

Useful resources for forecasters

Organization:

- International Institute of Forecasters.

Annual Conference:

- International Symposium on Forecasting

Journals:

- International Journal of Forecasting
- Foresight

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Please fill in your SETU