MONASH University

MONASH BUSINESS SCHOOL

ETC3550/ETC5550
Applied forecasting

Revision

OTexts.org/fpp3/

Outline

1. Some case studies
2. Review of topics covered
3. Exam

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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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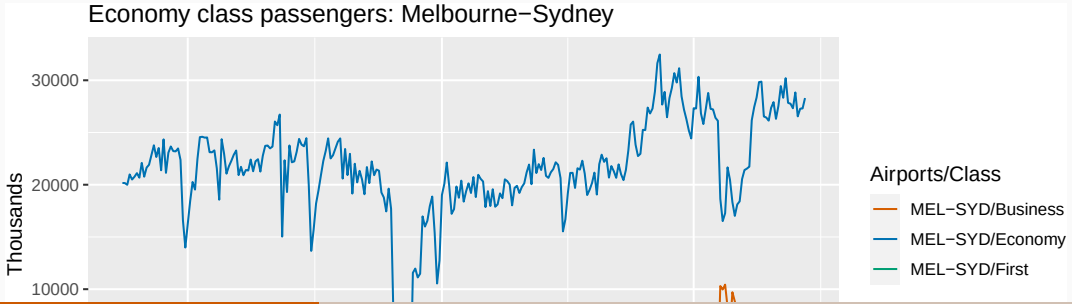
Additional information

- 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

```
ansett %>%
  filter(Airports == "MEL-SYD") %>%
  autoplot(Passengers) +
  labs(title="Economy class passengers: Melbourne-Sydney",
       y="Thousands")
```



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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1. Introduction to forecasting and R

- time series data and `tsibble` objects.
- what makes things hard/easy to forecast.
- Reading and writing simple R code. Interpreting R output.

2. Time series graphics

- time plot.
- season plot.
- subseries plot.
- lag plot.
- ACF.
- white noise.

3: Time series decomposition

- Describing a time series: seasonality, trend, cycles, changing variance, unusual features.
- Difference between seasonality and cyclicity.
- Interpreting a decomposition.
- Seasonal adjustment.
- Forecasting and decomposition.

5. The forecasters' toolbox

- Four benchmark methods: naive, seasonal naive, drift, mean.
- Transformations to stabilize changing variance.
- Forecasting involves distributions of future observations.
- Residual diagnostics: ACF, white noise, LB test.
- Training/test sets. Out-of-sample accuracy.
- Problem of over-fitting.
- Measures of forecast accuracy: MAE, MSE, RMSE, MAPE, MASE.
- One-step prediction intervals based on RMSE from residuals.
- Time series cross-validation.

8: Exponential smoothing

- Simple exponential smoothing.
- Holt's local trend method
- Damped trend methods
- Holt-Winters seasonal method (additive and multiplicative versions)
- ETS state space formulation
- Interpretation of output in R.
- Computing forecasts by setting future ε_t to 0.
- Assumptions for prediction intervals

9: ARIMA models

- Stationarity.
- Differencing: first-differences and seasonal-differences. What to use when.
- White noise, random walk, AR(p), MA(q), ARMA(p,q), ARIMA(p,d,q), ARIMA$(p,d,q)(P,D,Q)_s$.
- Backshift operator notation
- ACF, PACF. Model identification.
- ARIMA models, Seasonal ARIMA models
- Order selection and goodness of fit (AICc)
- Interpretation of output in R.

9: ARIMA models (cont'd)

- Expanding out an ARIMA model for forecasting
- Finding point forecasts for given ARIMA process
- Assumptions for prediction intervals
- One-step prediction intervals based on RMSE
- Effect of differencing on forecasts.
- Effect of a constant on forecasts.
- ARIMA vs ETS

6: Multiple regression

- Dummy variables, seasonal dummies, piecewise linear trends, interventions
- Harmonic regression
- AIC, AICc, BIC, R^2, adjusted R^2
- variable selection
- Interpretation of R output.
- ex ante vs ex post forecasts
- scenario forecasting

10: Dynamic regression models

- Regression with ARMA errors
- Using lagged predictors
- Difference between regression residuals and ARIMA residuals.
- Problems with OLS and autocorrelated errors
- Forecasting for regression models with ARMA errors
- Stochastic vs deterministic trends
- Dynamic harmonic regression

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Exam: 9.30am (AEST) 2 July

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
  (with extra part for PG students)

• Moodle Quiz • Open book • 3.5 hours

Exam and R

- Parts **B**–**C** require interpretation of R output, but no coding.
- Parts **D**–**E** require 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.
- Every student will have different data sets.
- 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 2015–2019 on Moodle. Solutions to follow soon.
- 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 your tutor during the consultation times.

Useful resources for forecasters

Organization:

- International Institute of Forecasters.

Annual Conference:

- 2020 International Symposium on Forecasting, ~~Rio de Janeiro, Brazil~~. **Online**

Journals:

- International Journal of Forecasting
- Foresight

Links to all of the above at **forecasters.org**

Happy forecasting

Good forecasters are not smarter than everyone else, they merely have their ignorance better organised.

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Please fill in your SETU