STATS 3005 Time Series III
Practical 5
2018

1 Outline

At the end of this practical you should be able to:

- Use simulation to investigate various AR, MA, ARMA and ARIMA processes.
- Based on the experience with the simulations, recognise stationarity and non-stationarity in real data.

2 Properties of ARIMA processes

The `arima.sim` function can be used to simulate ARIMA models in `R` as illustrated in lectures. For each of the processes below, simulate a series of length 200 and obtain:

- A time series plot;
- The periodogram;
- The ACF;
- The PACF.

To see all plots in the same pane, you can use the command

```
par(mfrow=c(2,2))
```

1. AR(1) for $\alpha = 0.9, 0.2, -0.4, -0.8$.
2. AR(2) for $(\alpha_1 = 1, \alpha_2 = -0.5)$; $(\alpha_1 = -1, \alpha_2 = -0.5)$; $(\alpha_1 = 0.25, \alpha_2 = 0.5)$; $(\alpha_1 = -0.25, \alpha_2 = 0.5)$.
3. MA(2) for $\beta = 0.9, 0.2, -0.4, -0.8$.
4. MA(2) for $(\beta_1 = 1, \beta_2 = 0.5)$; $(\beta_1 = -1, \beta_2 = 0.5)$; $(\beta_1 = 0.25, \beta_2 = -0.5)$; $(\beta_1 = -0.25, \beta_2 = -0.5)$.
5. ARMA(1, 1) for $(\alpha = 0.8, \beta = 0.8)$; $(\alpha = -0.8, \beta = 0.8)$; $(\alpha = 0.8, \beta = -0.8)$; $(\alpha = -0.8, \beta = -0.8)$.
6. ARIMA(1, 1, 1) for $(\alpha = 0.8, \beta = 0.8)$; ARIMA(1, 2, 1) for $(\alpha = 0.8, \beta = 0.8)$; ARIMA(1, 2, 1) for $(\alpha = 0.8, \beta = 0.8)$.

3 The Mauna Loa Data

Recall for the Mauna Loa Data, the residual series after fitting a cubic regression with seasonal effects was obtained as follows.

```
data(co2)
times=time(co2)
month=factor(rep(c("jan","feb","mar","apr","may","jun","jul","aug","sep","oct","nov",
lm.seasonal=lm(co2~month+times+I(times^2)+I(times^3))
res=co2-fitted(lm.seasonal)
```

1. Obtain plots of the residual series, the periodogram, the ACF and the PACF.
2. Does the residual series appear stationary?
3. Obtain plots of the differenced residual series, the periodogram, the ACF and the PACF and comment.

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