Topics in Statistical Sciences 1 – Exam exercise 4

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This exercise is about the state space models and the Kalman filter as discussed in lectures 10, 11 and 12 of Topics in Statistical Sciences 1. During the oral exam you will have 20 min to present the exercise. You decide what topics to cover and how to present them, however, we will ask questions to any part of the exercise and presentation.

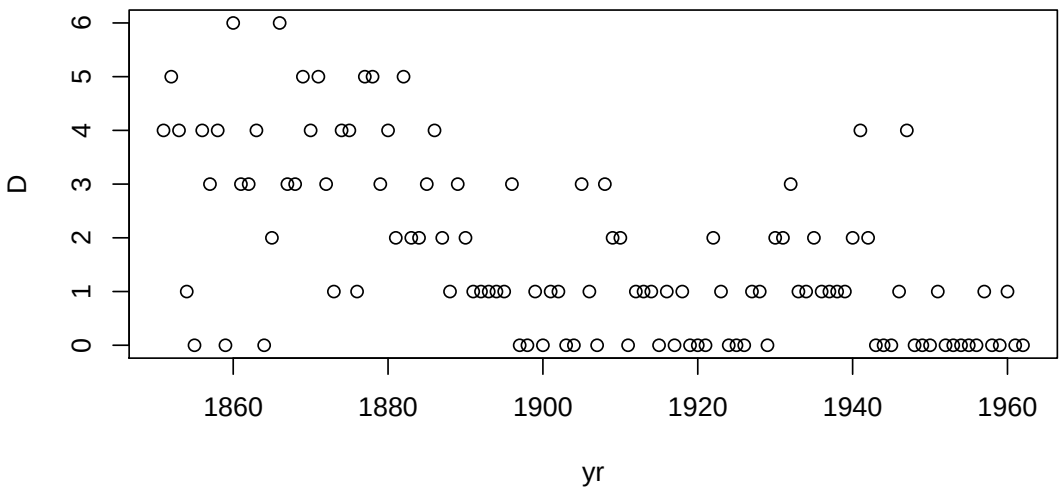
1 Kalman filter

Consider the dynamic linear model in the general form given in Section 2.4 of the book "Dynamic Linear Models with R". Prove the Kalman filter equations of Section 2.7.2 in the same book.

2 Coal mining disasters

The following data gives the annual number of coalmine disasters in the UK from 1851 to 1962.

```
D = c(4,5,4,1,0,4,3,4,0,6,
  3,3,4,0,2,6,3,3,5,4,5,3,1,4,4,1,5,5,3,4,2,5,2,2,3,4,
  2,1,3,2,1,1,1,1,1,3,0,0,1,0,1,1,0,0,3,1,0,3,2,2,0,1,
  1,1,0,1,0,1,0,0,0,2,1,0,0,0,1,1,0,2,2,3,1,1,2,1,1,1,
  1,2,4,2,0,0,0,1,4,0,0,0,1,0,0,0,0,0,1,0,0,1,0,0)
yr = 1851:1962
N = length(D)
plot(yr, D)
```



1. Judging from looking at data, is classical ARIMA modelling a viable road to model these data? Why? Why not?
2. Is there any evidence of serial correlation in data?
3. Using the `dlm` package define a local level model (also known as random walk plus noise model).
4. Plot the filtered values; plot the forecasts.
5. Fit the variance parameters to data.
6. Plot the filtered values; plot the forecasts again.
7. Looking at data, there is some evidence of a change point. Fit a local level model that allows for such a change point.
8. Plot the filtered values; plot the forecasts again.
9. What do you conclude from all this?