Time Series Analysis

Lecture 4

Mixed Autoregressive Moving Average (ARMA) Models

Autoregressive Integrated Moving Average (ARIMA) Models

Seasonal ARIMA (SARIMA) Models

datascience@berkeley

Putting Everything Together: ARIMA Modeling

Part 1: The Data

The Data: Australian Electricity Production Series

- This example uses the Australian Electricity Production series that comes with the textbook. This corresponds to the example on page 138 of the textbook.
- The data can be downloaded from the authors' website.
- The data contain three variables, but we will use only the electricity production series (elec); summary statistics are provided below.

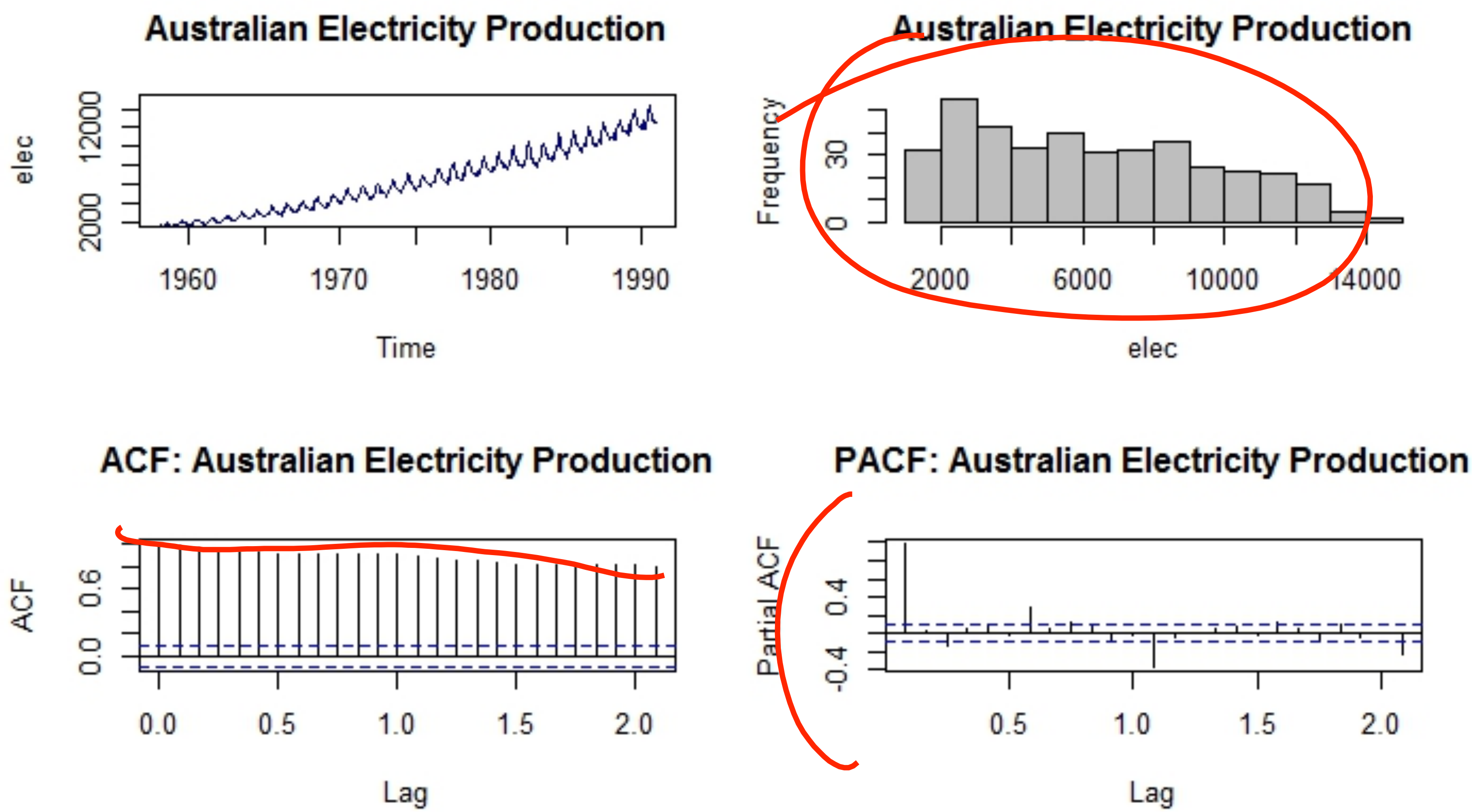
```
> str(cbe)
'data.frame': 396 obs. of  3 variables:
 $ choc: int  1451 2037 2477 2785 2994 2681 3098 2708 2517 2445 ...
 $ beer: num  96.3 84.4 91.2 81.9 80.5 70.4 74.8 75.9 86.3 98.7 ...
 $ elec: int  1497 1463 1648 1595 1777 1824 1994 1835 1787 1699 ...
```

```
> elec <- ts(cbe$elec,start=1958,freq=12)
> str(elec)
 Time-Series [1:396] from 1958 to 1991: 1497
```

```
> summary(elec)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
   1460    3240    5890    6310    8820   14300
> quantile(elec, c(0.01,0.05,0.1,0.25,0.5,0.75,0.9,0.95,0.99))
   1%    5%   10%   25%   50%   75%   90%   95%   99%
 1597  1848  2108  3239  5891  8820 11332 12192 13844
```

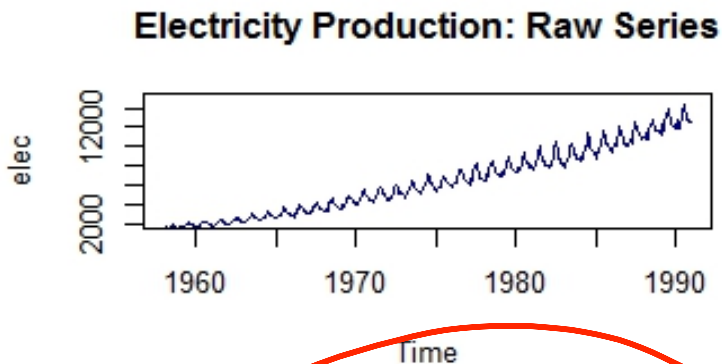
The Raw Series

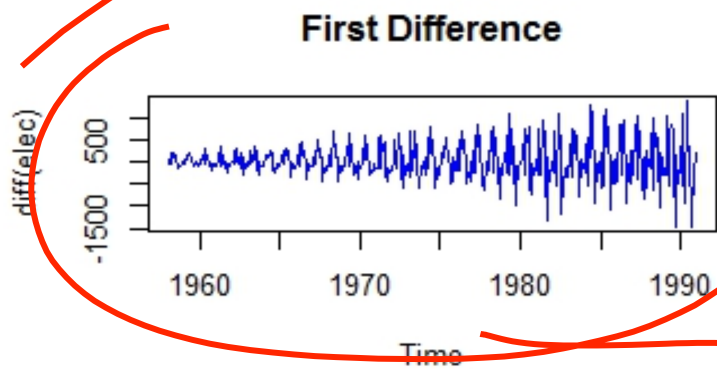
- The raw series appears to have both an upward trend and seasonality.
- The ACF graph shows a very strong autocorrelation even after 20 months, suggesting a strong candidate for first differencing.

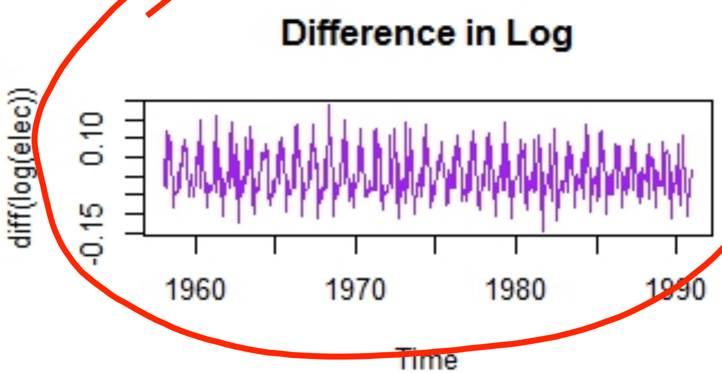


The Transformed Series

- The first differenced series takes out the trend, but the volatility increases over time.
- The difference in log, which approximates percentage change, also takes out the changing volatility.





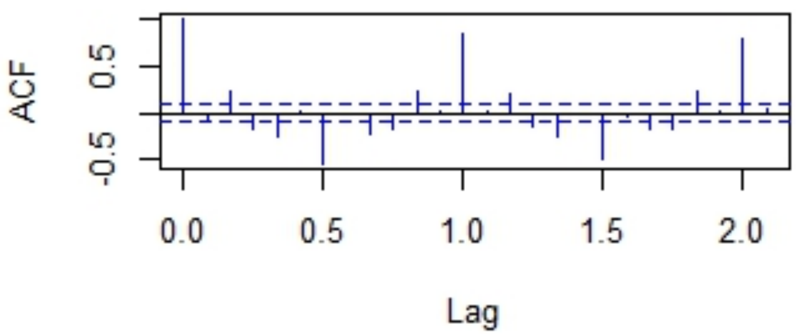



```
> summary(diff(elec))
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  -1470    -197     -30      28     258    1380
> summary(diff(log(elec)))
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 -0.145  -0.038  -0.007   0.005   0.051   0.188
```

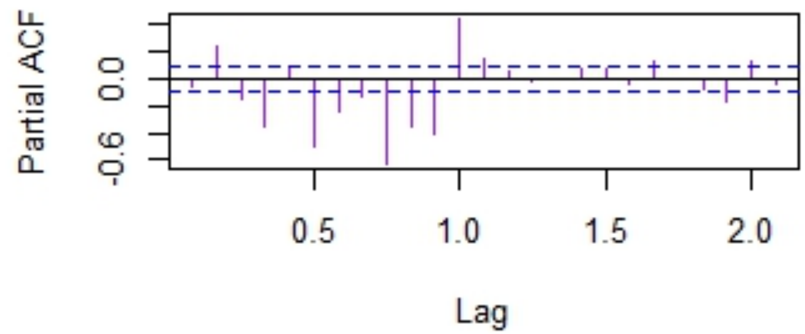
The Transformed Series

- The ACFs and the PACFs of the transformed series show seasonal effects.

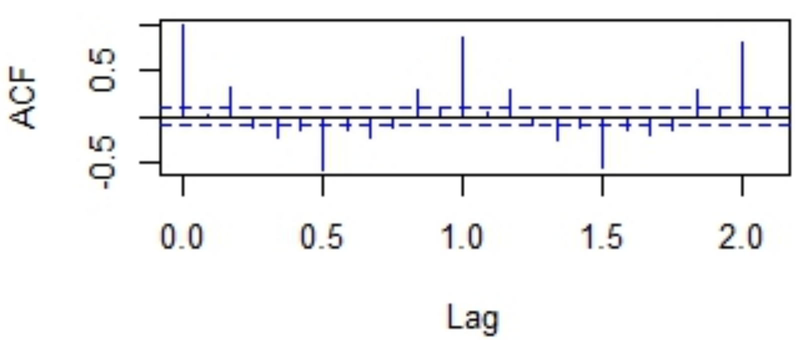
ACF: First Difference Series



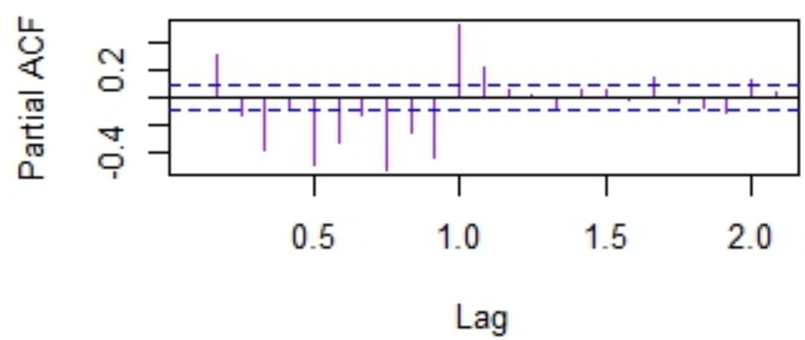
PACF: First Difference Series



ACF: First Difference in Log Series



PACF: First Difference in Log Series



Berkeley SCHOOL OF INFORMATION