

# Time Series Analysis

Fall 2017

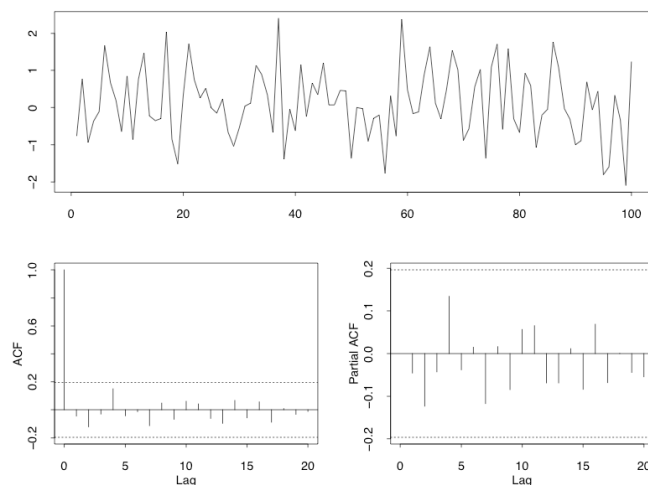
Andreas Jakobsson

## Identification

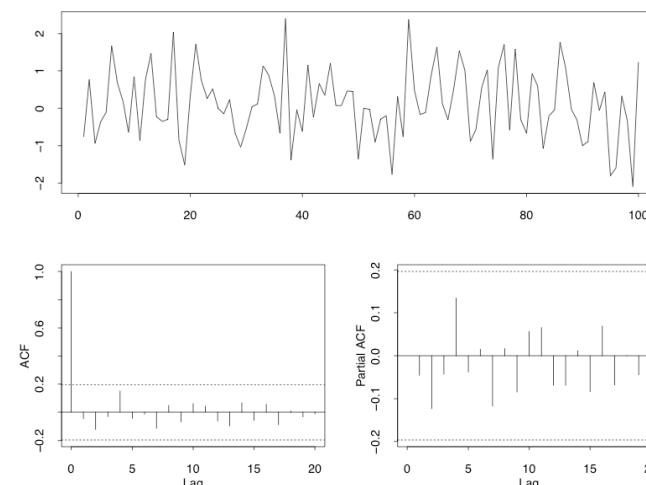
Characteristics for the autocorrelation functions:

|              | ACF $\rho(k)$  | PACF $\phi_{kk}$  |
|--------------|--|---|
| $AR(p)$      | Damped exponential and/or sine functions                   | $\phi_{kk} = 0$ for $k > p$   |
| $MA(q)$      | $\rho(k) = 0$ for $k > q$                                  | Dominated by damped exponential and or/sine functions                   |
| $ARMA(p, q)$ | Damped exponential and/or sine functions after lag $q - p$ | Dominated by damped exponential and/or sine functions after lag $p - q$ |

## What is an appropriate structure?



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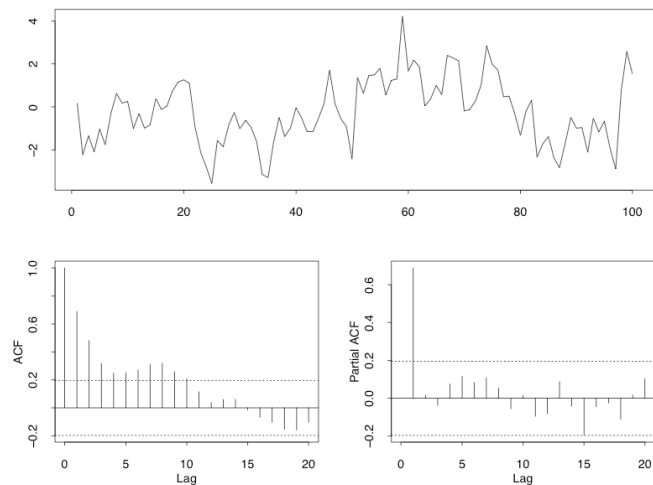


MA(1)



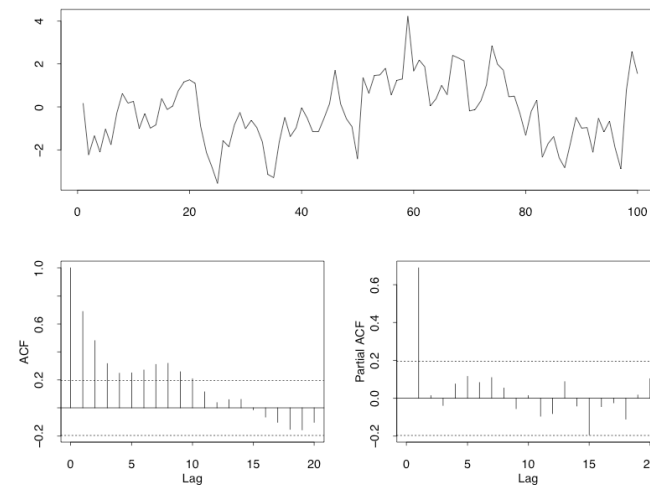
Time series analysis

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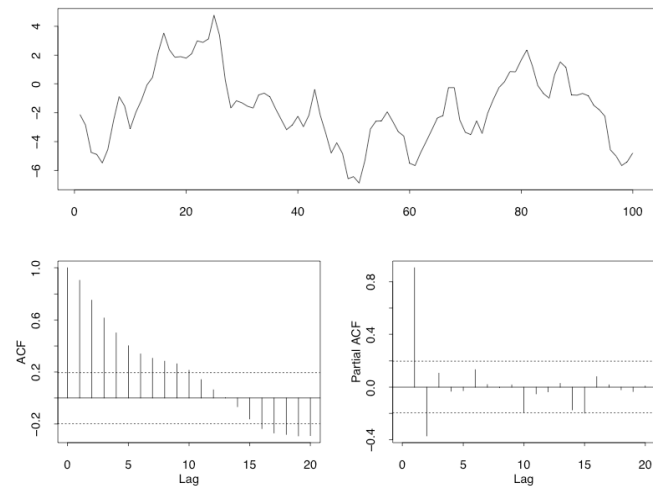


AR(1)



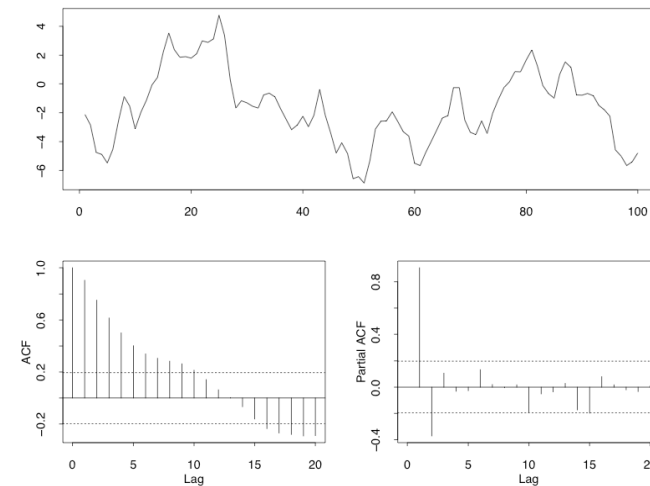
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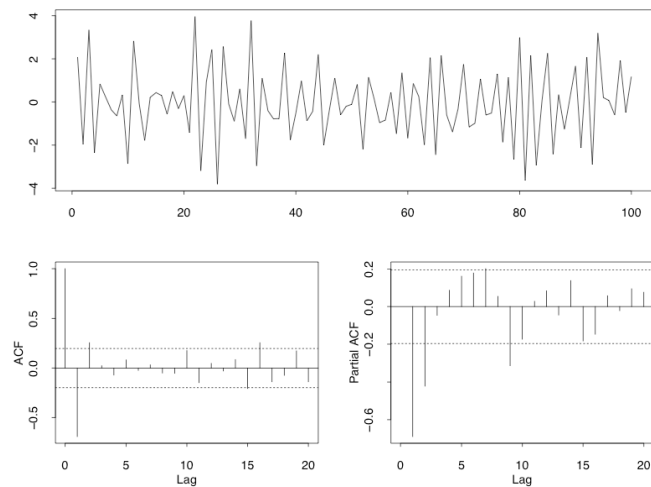


AR(2)



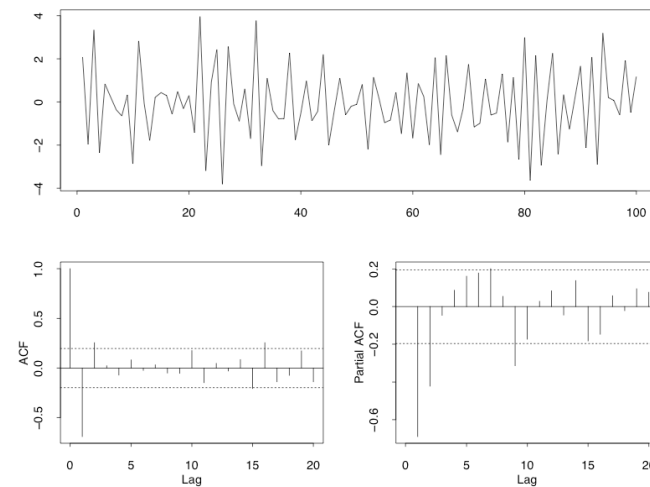
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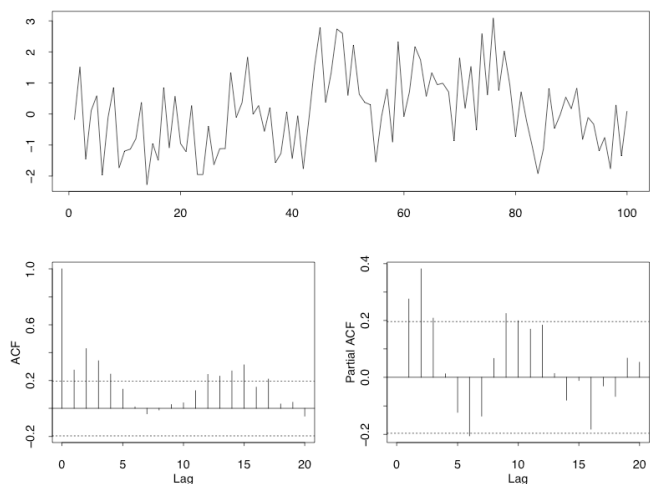


MA(2)



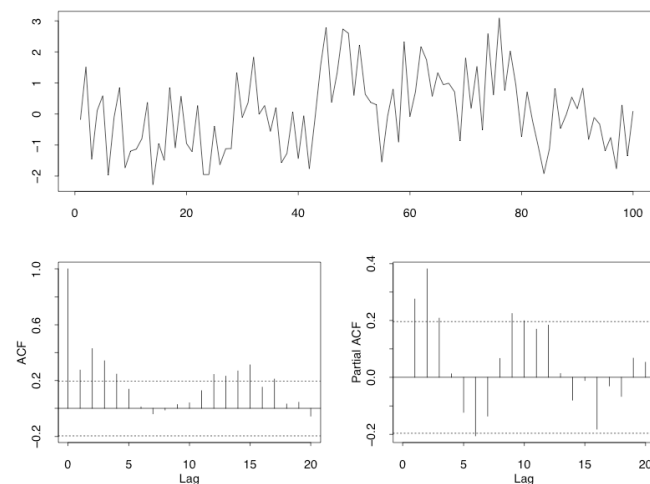
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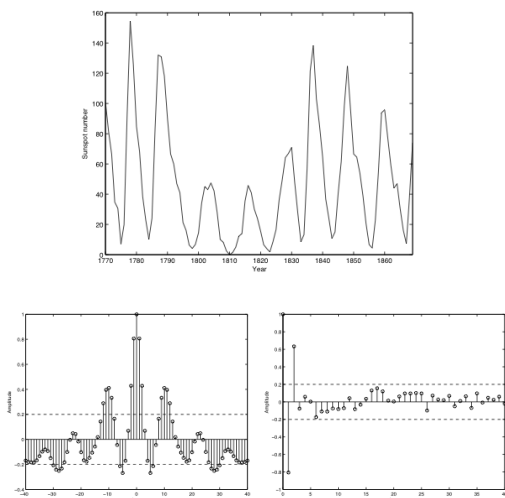


ARMA



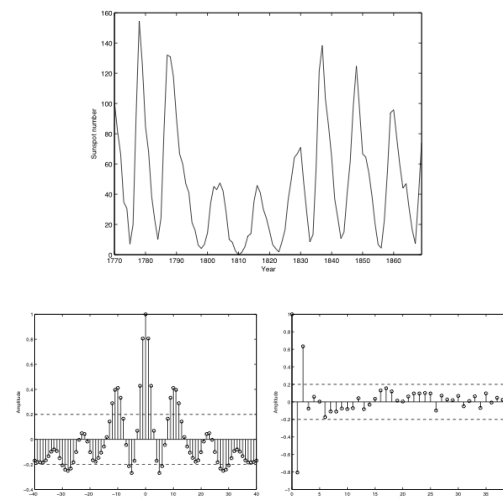
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## How can one model the sunspot data?



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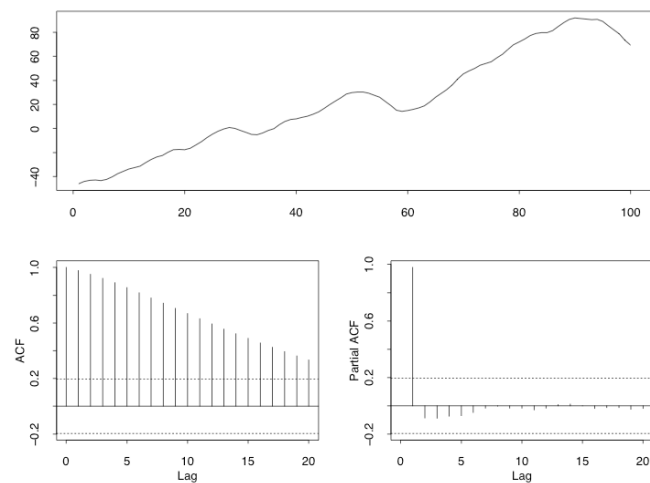


AR(2)



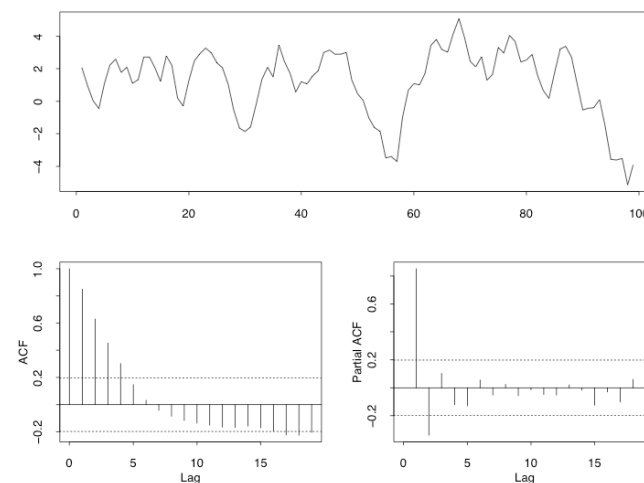
Time series analysis

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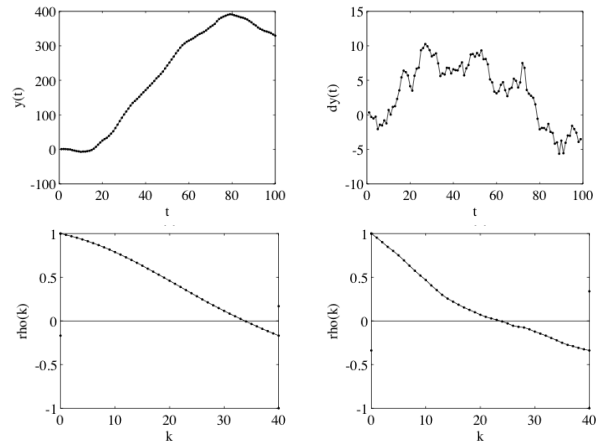


$\nabla y_t$



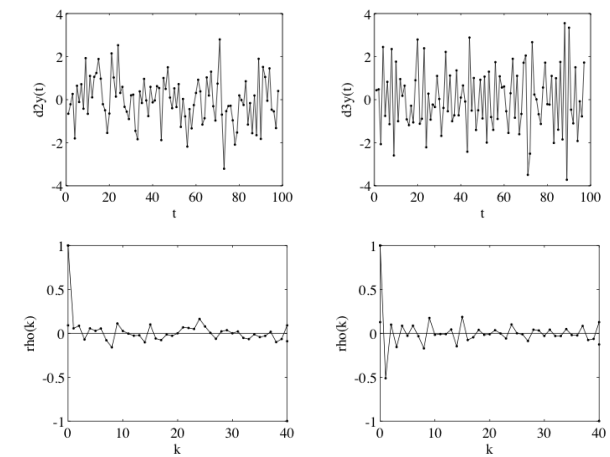
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## Simulated ARIMA(0,2,0)



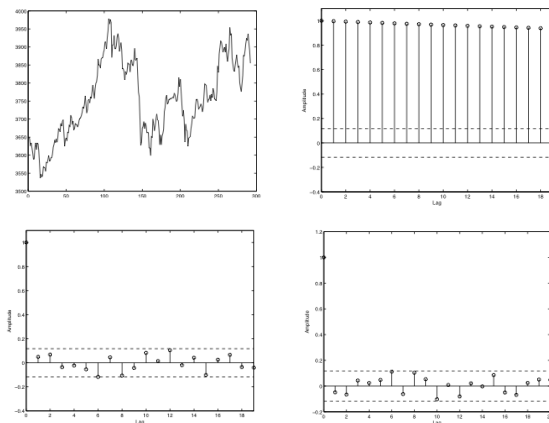
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## Simulated ARIMA(0,2,0)



Time series analysis

## Dow Jones index

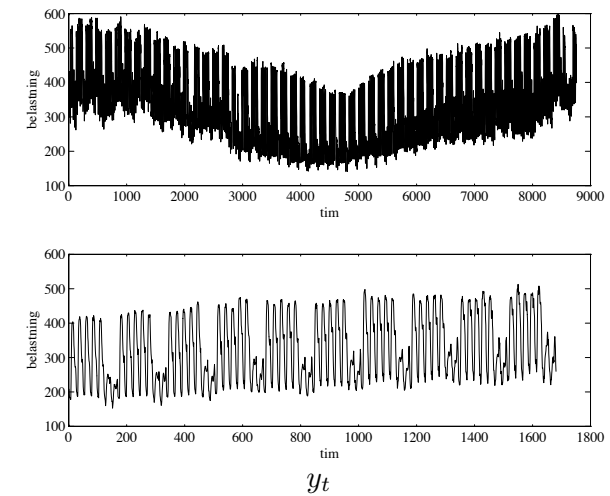


$$\nabla y_t = e_t$$



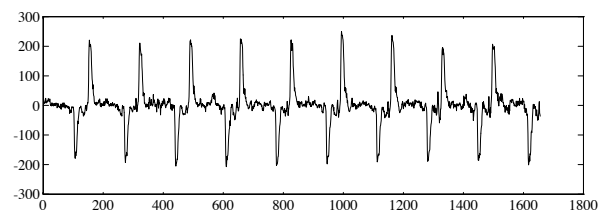
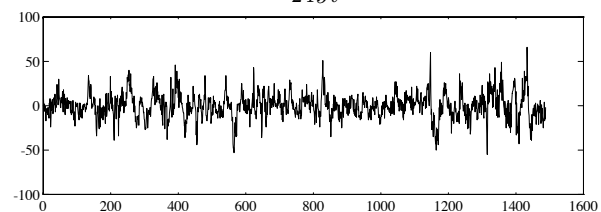
Time series analysis

## Electricity consumption

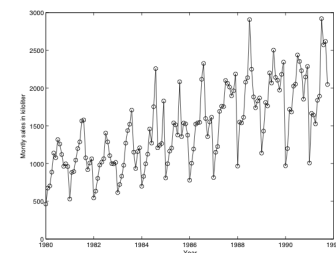




## Electricity consumption


 $\nabla_{24} y_t$ 

 $\nabla_{24} \nabla_{168} y_t$ 


## Transforming the data

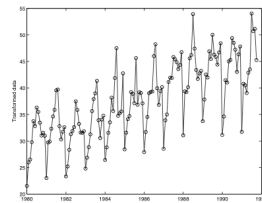
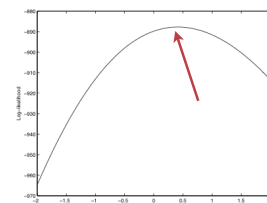
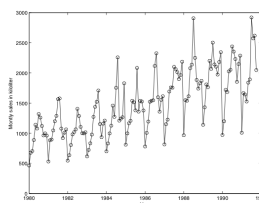


$$y_t^{(\lambda)} = \begin{cases} \lambda^{-1} (y_t^\lambda - 1), & \lambda \neq 0 \\ \log(y_t), & \lambda = 0 \end{cases}$$

$$L(\lambda) = -\frac{N}{2} \log \{ \hat{\sigma}_y^2(\lambda) \} + (\lambda - 1) \sum_{t=1}^N \log(y_t)$$



## Transforming the data



| Values of $\lambda$ | Transformation |
|---------------------|----------------|
| -2.0                | $y_t^{-2}$     |
| -1.0                | $y_t^{-1}$     |
| -0.5                | $y_t^{-1/2}$   |
| 0.0                 | $\log(y_t)$    |
| 0.5                 | $\sqrt{y_t}$   |
| 1.0                 | $y_t$          |
| 2.0                 | $y_t^2$        |