

Lecture 1: Introduction

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and . . .

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Lecture 1: Introduction

Grenoble – January 2015

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Outline of the lecture

- 1 Introduction
 - Examples of time series
 - 2 Modeling approach
 - 3 Historical considerations



What is a time series

Definition by examples

- Data obtained from observations collected sequentially over time are extremely common.
 - ▶ In business: weekly interest rates, daily closing stock prices, monthly price indices, yearly sales figures
 - ▶ In meteorology: daily high and low temperatures, annual precipitation and drought indices
 - ▶ In agriculture: annual figures for crop and livestock production, soil erosion, and export sales.
 - ▶ In the biological sciences: electrical activity of the heart at millisecond intervals.
 - ▶ In ecology: record the abundance of an animal species.
 - The list of areas in which time series are studied is virtually endless .

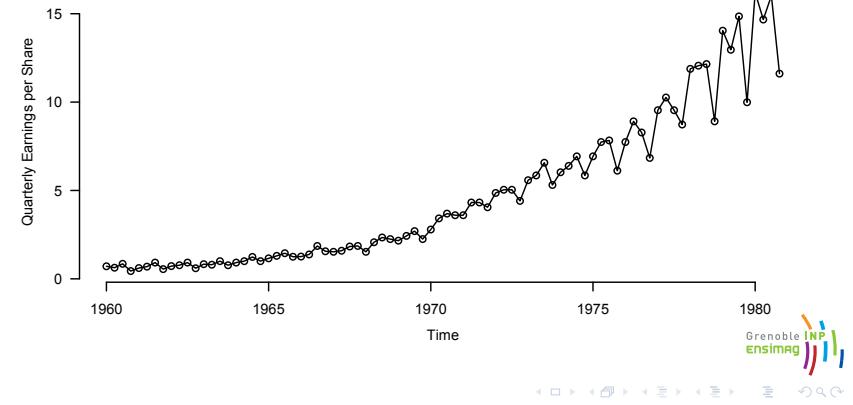


Johnson & Johnson Quarterly Earnings Modeling

It begins by observing the primary patterns in the time history:

- increasing underlying trend and variability;
- a somewhat regular oscillation superimposed on the trend that seems to repeat over quarters.

Johnson & Johnson Quarterly Earnings Graphical representation



Johnson & Johnson Quarterly Earnings Plotting in R

```
require(astsa)
plot(jj, type="o", ylab="Quarterly_Earnings_per_Share", 
  las=1, frame=FALSE)
plot(log(jj), type="o", ylab="Quarterly_Earnings_per_Share", 
  las=1, frame=FALSE)
```

Look at a simple system. . .

Regular deposits

- Initial deposits of 100€, 150€, 200€, then 75€, in quarter 1, 2, 3, then 4, over 20 years, with an annual growth rate of 5%;

$$x_t = (1 + .05)x_{t-4}$$

Look at a simple system....

Regular deposits

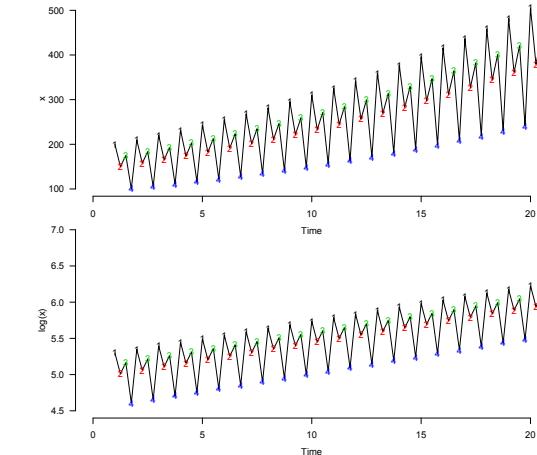
```

x <- c(200,150,175,100,rep(0,76))
for(t in 5:80)x[t] <- x[t-4]*1.05
x <- ts(x,frequency=4)
ts2.plot(x,las=1,frame=FALSE,las=1)
text(seq(1,21,.25)[1:80],x,1:4,col=1:4)
ts2.plot(log(x),frame=FALSE,ylim=c(4.5,7),las=1)
text(seq(1,21,.25)[1:80],log(x),1:4,col=1:4)

```

Regular deposits

Graphical representation



Look at a simple system...

Regular deposits

- Initial deposits of 100€, 150€, 200€, then 75€, in quarter 1, 2, 3, then 4, over 20 years, with an annual growth rate of 5%;

$$x_t = (1 + .05 + \varepsilon)x_{t-4}$$

Look at a simple system...

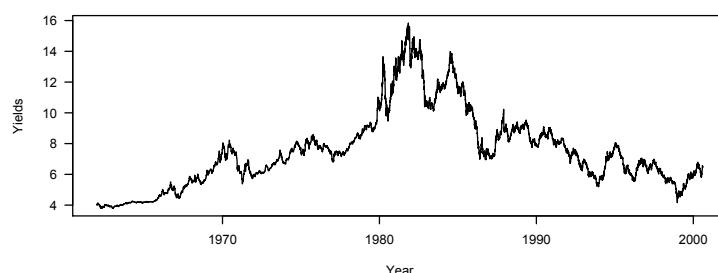
Regular deposits but random interest rates

```
x <- c(200,150,175,100,rep(0,76))
for(t in 5:80)x[t] <- x[t-4]*(1+.05+rnorm(1,0,0.05))
x <- ts(x,frequency=4)
ts2.plot(x,las=1,frame=FALSE,las=1)
text(seq(1,21,.25)[1:80],x,1:4,col=1:4)
ts2.plot(log(x),frame=FALSE,las=1)
text(seq(1,21,.25)[1:80],log(x),1:4,col=1:4)
```



Daily Yields on Treasury Securities (from January 1962)

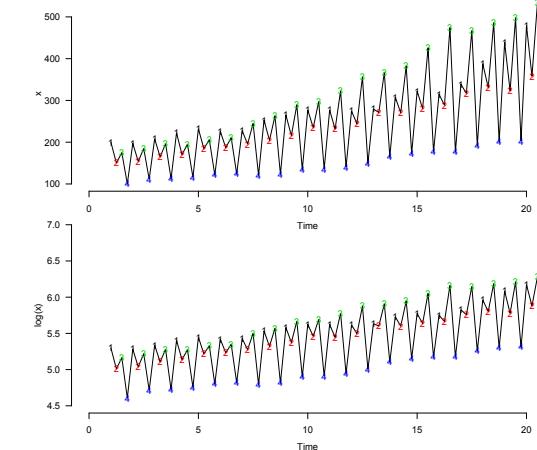
U.S. Fed <http://www.federalreserve.gov/Releases/H15/data.htm>



```
library(tseries)
data(tcmd); plot(tcmd[,4],ylab='Yields',xlab='Year',type='l'
→ ,las=1)
```

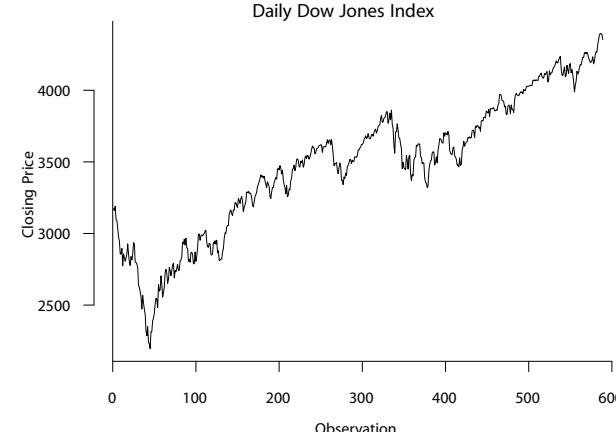
Regular deposits with random interest rates

Graphical representation



Closing price of the Dow Jones index (from 2009/01/03)

Daily Dow Jones Index



Global Warming

A measure of... (1880–2009)

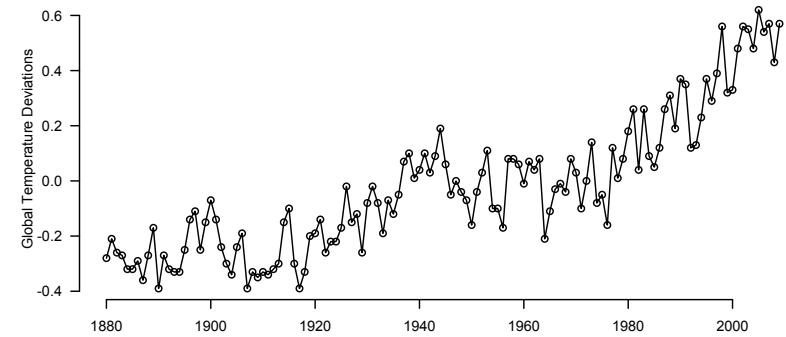
- Global mean land–ocean temperature index from 1880 to 2009
- The base period 1951–1980
- Apparent upward trend in the series during the latter part of the twentieth century; that has been used as an argument for the global warming hypothesis.
- ▶ Note also the leveling off at about 1935
- ▶ another rather sharp upward trend at about 1970.

The question of interest for global warming proponents and opponents is whether the overall trend is natural or whether it is caused by some human-induced interface.



Global Warming

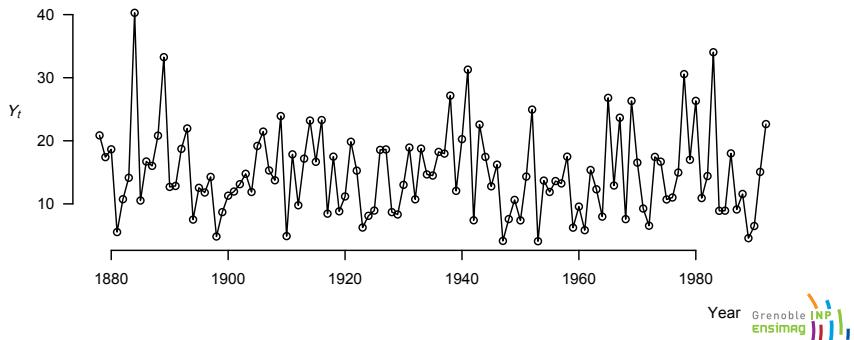
A measure of... (1880–2009)



Yearly average global temperature deviations in Celsius degrees

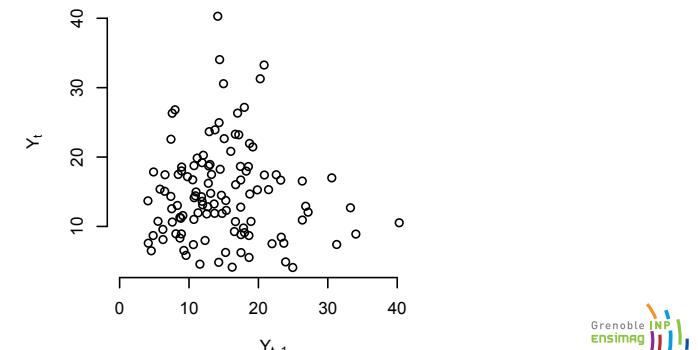
Annual rainfall

Los Angeles



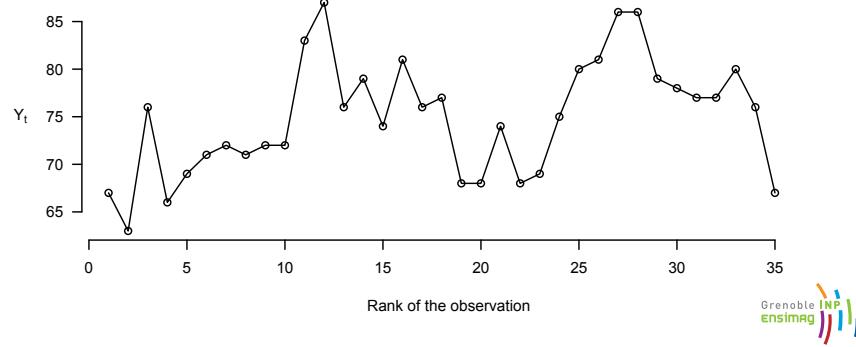
Rainfall

Y_t vs Y_{t-1} : no trend



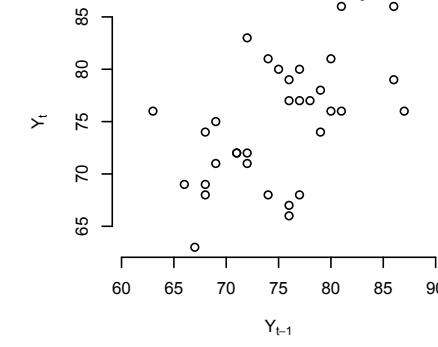
Industrial chemical process

Color property of consecutive batches



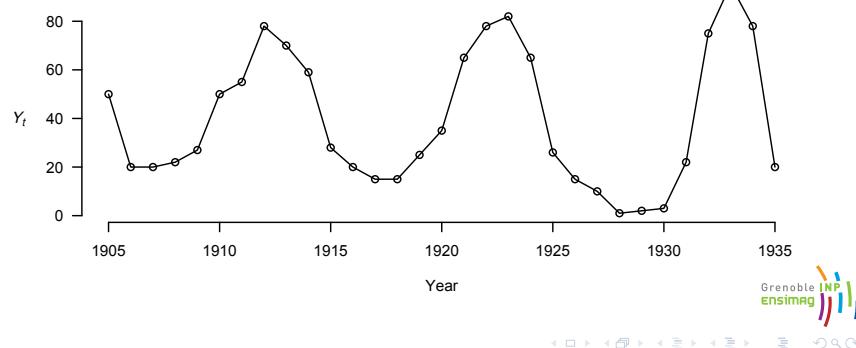
Chemical process

Y_t vs Y_{t-1} : slight upward trend



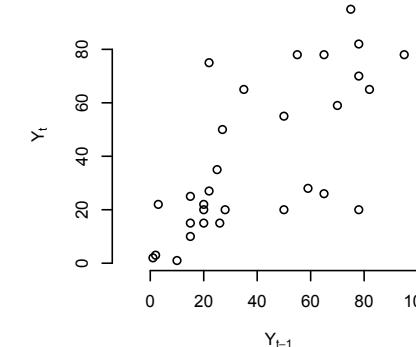
Abundance of Canadian Hare

Estimated population: 1905–1935



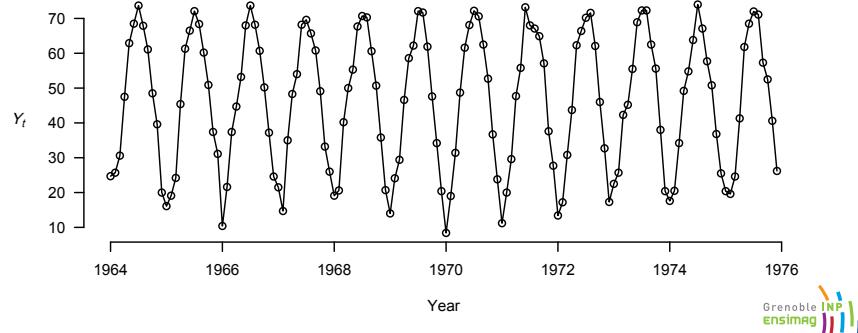
Abundance of Canadian Hare

Y_t vs Y_{t-1} : slight upward trend



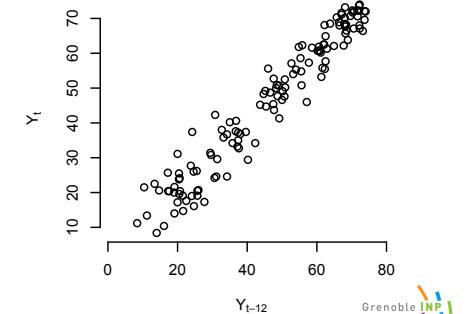
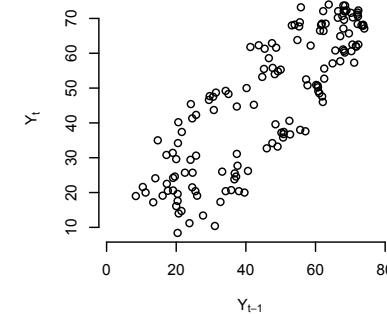
Average Monthly Temperature, Dubuque, Iowa

Fahrenheit degrees: 1964–1976



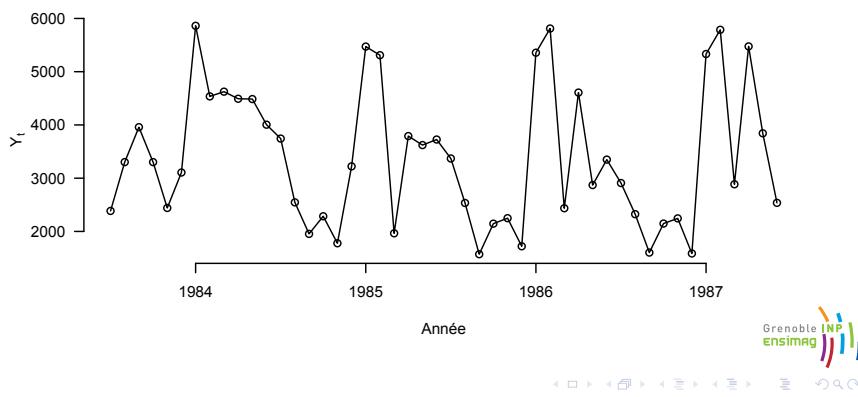
Average Monthly Temperature, Dubuque, Iowa

Y_t vs $Y_{t-\ell}$, $\ell = 1; 12$: clear upward trend



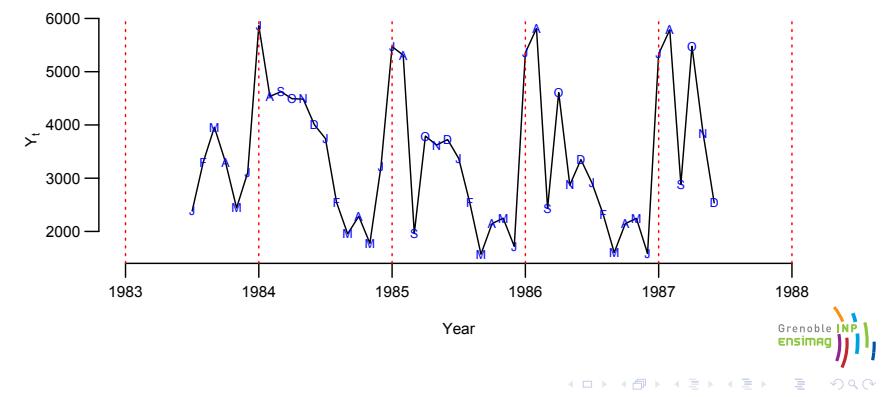
Monthly Oil Filter Sales

Produced by John Deer: 1985–1987



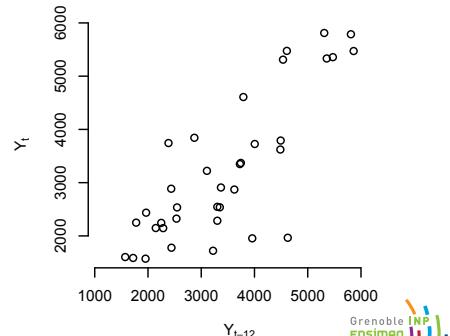
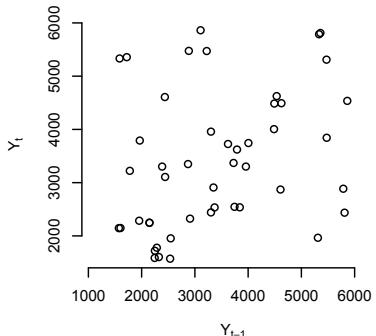
Monthly Oil Filter Sales

Produced by John Deer: 1985–1987



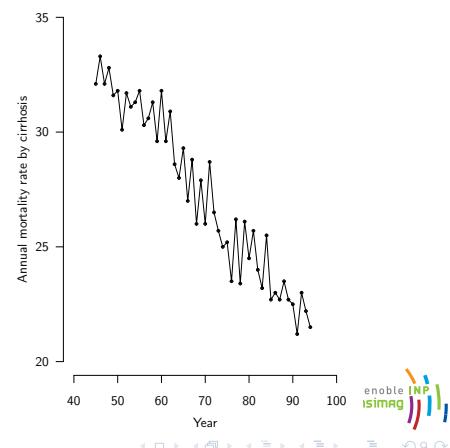
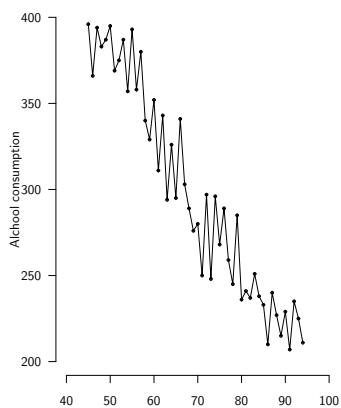
Monthly Oil Filter Sales

Y_t vs Y_{t-1} : slight upward trend ?
 Y_t vs Y_{t-12} : clear upward trend



Annual mortality rate by cirrhosis

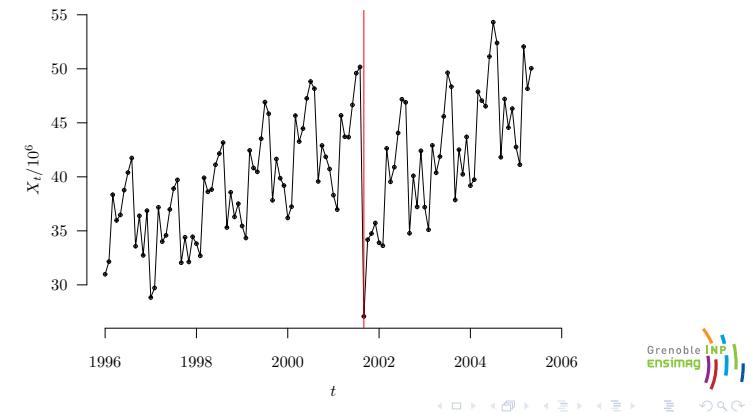
Any link with Alcohol consumption?



Monthly U.S. Airline Miles

Cryer and Chan (2008)

Monthly data starting January 1996



Lecture 1: Introduction

- └ Modeling approach

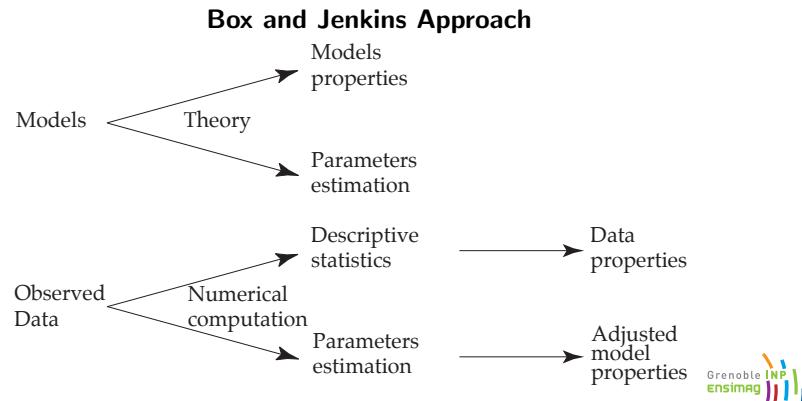
Outline of the lecture

- ## 1 Introduction

② Modeling approach

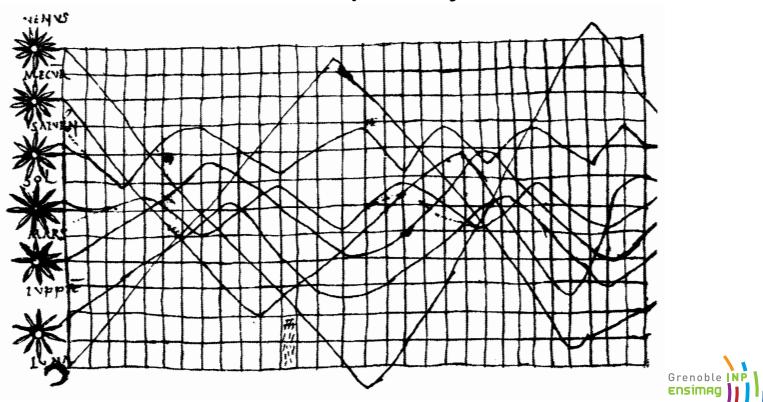
Modeling approach

Devising or use of mathematical models



Back to the 10th century (Cryer and Chan, 2008, p. 9)

Inclinations of the planetary orbits



Outline of the lecture

1 Introduction

- Examples of time series

2 Modeling approach

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References

Cryer, J. D. and K.-S. Chan (2008). *Time Series Analysis: With Applications in R* (2 ed.). Springer texts in statistics. New York: Springer.

Shumway, R. H. and D. S. Stoffer (2011). *Time Series Analysis and Its Applications: With R Examples* (3 ed.). Springer texts in statistics. New York: Springer.

Shumway, R. H. and D. S. Stoffer (2016). *Time Series Analysis and Its Applications: Using the R Statistical Package* (EZ ed.). Pittsburg: Free Dog Publishing.

Tsay, R. (2010). *Analysis of Financial Time Series* (3 ed.). John Wiley Sons Inc.

