

The Analysis of Time Series: An Introduction

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Outline

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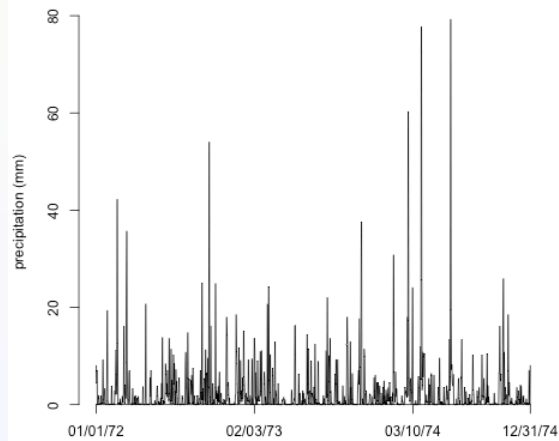
Terminology

- A time series is a collection of observations made sequentially through time.
- A time series is said to be **continuous** when observations are made continuously through time. A time series is said to be **discrete** when observations are taken only at specific times, usually equally spaced.
- Discrete time series can arise in several ways.
 - Given a continuous time series, we could digitize the values at equal intervals of time to give a discrete time series, sometimes called a **sampled** series.
 - A different type of discrete series arises when a variable does not have an instantaneous value but we can **aggregate** the values over equal intervals of time.
 - Some time series are inherently discrete.

- Much statistical theory is concerned with random samples of independent observations.
- The special feature of time-series analysis is the fact that successive observations are usually *not* independent and that the analysis must take into account the **time order** of the observations.
- When successive observations are dependent, future values may be predicted from past observations.
- Most time series are **stochastic** in that the future is only partly determined by past values, so that exact predictions are impossible.
- Time series prediction is in the sense that the future values have a probability distribution, which is conditioned by a knowledge of past values.

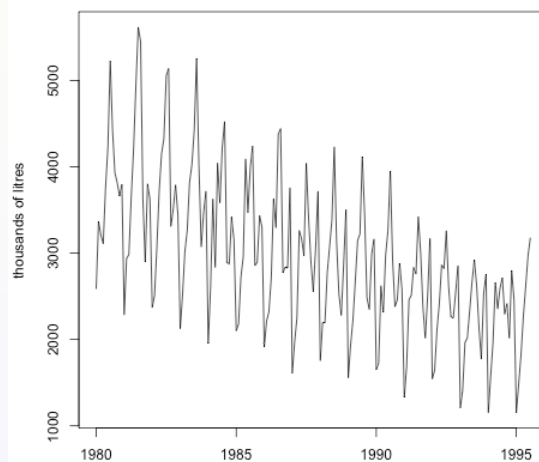
Some Representative Time Series

Figure 1: Daily precipitation, Hveravellir, 1 Jan 1972–31 Dec 1974. Source: Tong (1990). http://robjhyndman.com/tsdldata/data/Hveravellir_rain.dat



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Figure 2: Monthly Australian sales of fortified wine: thousands of litres (01/1980–07/1995). Source: ABS. <http://robjhyndman.com/tsdldata/data/fortif.dat>



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Figure 3: Average monthly temperatures in Dubuque, Iowa. (01/1964–12/1975)
Source: Cryer (1986). <http://robjhyndman.com/tsdldata/data/cryer2.dat>

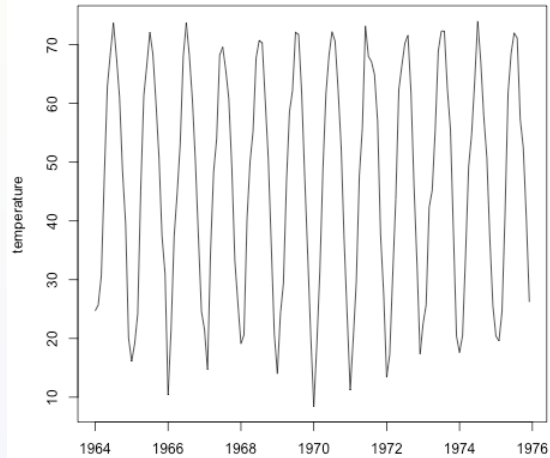


Figure 4: Annual CPI, U.S. (1860–1970) Source: Hipel and McLeod (1994).
<http://robjhyndman.com/tsdldata/cnelson/cpi.dat>

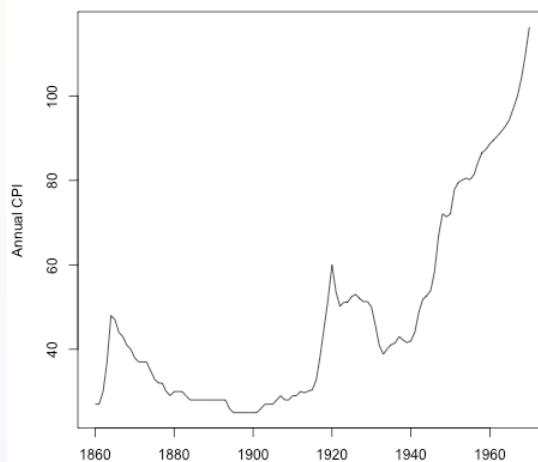
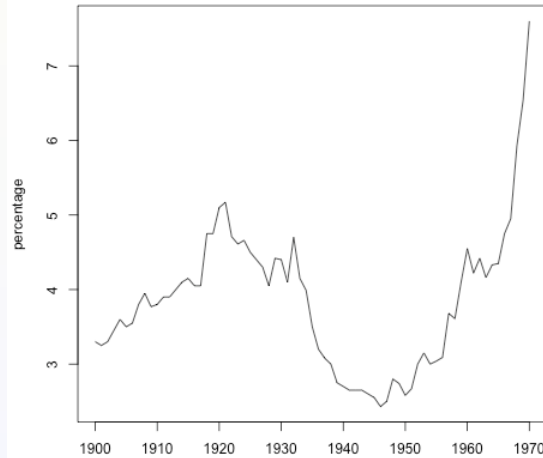


Figure 5: Annual bond yield, U.S. (1900–1970) Source: Hipel and Mcleod (1994).
<http://robjhyndman.com/tsdldata/cnelson/bnd.dat>



Objectives of Time Series Analysis

- 1 **Description:** The first step in time series analysis is usually to plot the observations against time to give what is called a *time plot*, and then to obtain simple descriptive measures of the main properties of the series. (Trend; seasonal effect; outliers; sudden or gradual change of the series; ...)
- 2 **Explanation:** When observations are taken on two or more variables, it may be possible to use the variation in one time series to explain the variation in another series.
- 3 **Prediction:** Given an observed time series, one may want to predict the future values of the series.
- 4 **Control:** Time series are sometimes collected or analysed so as to improve control over some physical or economic system. Control procedures vary considerably in style and sophistication.