# Time Series Data

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Time series are analyzed to understand the past and to predict the future, enabling managers or policy makers to make properly informed decisions.

A time series analysis quantifies the main features in data and the random variation.

These reasons, combined with improved computing power, have made time series methods widely applicable in government, industry, and commerce.

The Kyoto Proto col is an amendment to the United Nations Framework Convention on Climate Change.

It opened for signature in December 1997 and came into force on February 16, 2005.

The arguments for reducing greenhouse gas emissions rely on a combination of science, economics, and time series analysis.

Decisions made in the next few years will affect the future of the planet.

During 2006, Singapore Airlines placed an initial order for twenty Boeing 787-9s and signed an order of intent to buy twenty-nine new Airbus planes, twenty A350s, and nine A380s (superjumbos).

The airline’s decision to expand its fleet relied on a combination of time series analysis of airline passenger trends and corporate plans for maintaining or increasing its market share.

Time series methods are used in everyday operational decisions.

For example, gas suppliers in the United Kingdom have to place orders for gas from the offshore fields one day ahead of the supply.

Variation about the average for the time of year depends on temperature and, to some extent, the wind speed.

Time series analysis is used to forecast demand from the seasonal average with adjustments based on one-day-ahead weather forecasts.

Time series models often form the basis of computer simulations.

Some examples are assessing different strategies for control of inventory using a simulated time series of demand; comparing designs of wave power devices using a simulated series of sea states; and simulating daily rainfall to investigate the long-term environmental effects of proposed water management policies.

## Time series

In most branches of science, engineering, and commerce, there are variables measured sequentially in time.

Reserve banks record interest rates and exchange rates each day.

The government statistics department will compute the country’s gross domestic pro duct on a yearly basis.

Newspapers publish yesterday’s no on temperatures for capital cities from around the world.

Meteorological offices record rainfall at many different sites with differing resolutions.

When a variable is measured sequentially in time over or at a fixed interval, known as the sampling interval, the resulting data form a time series.

Observations that have been collected over fixed sampling intervals form a historical time series.

In this book, we take a statistical approach in which the historical series are treated as realizations of sequences of random variables.

A sequence of random variables defined at fixed sampling intervals is sometimes referred to as a discrete-time stochastic process, though the shorter name time series model is often preferred.

The theory of stochastic processes is vast and may be studied without necessarily fitting any models to data.

However, our focus will be more applied and directed towards model fitting and data analysis, for which we will be using R.

The main features of many time series are trends and seasonal variations that can be modelled deterministically with mathematical functions of time.

But, another important feature of most time series is that observations close together in time tend to be correlated (serially dependent).

Much of the methodology in a time series analysis is aimed at explaining this correlation and the main features in the data using appropriate statistical models and descriptive methods.

Once a good model is found and fitted to data, the analyst can use the model to forecast future values, or generate simulations, to guide planning decisions.

Fitted models are also used as a basis for statistical tests.

For example, we can determine whether fluctuations in monthly sales figures provide evidence of some underlying change in sales that we must now allow for.

Finally, a fitted statistical model provides a concise summary of the main characteristics of a time series, which can often be essential for decision makers such as managers or politicians.

Sampling intervals differ in their relation to the data.

The data may have been aggregated (for example, the number of foreign tourists arriving per day) or sampled (as in a daily time series of close of business share prices).

If data are sampled, the sampling interval must be short enough for the time series to provide a very close approximation to the original continuous signal when it is interpolated.

In a volatile share market, close of business prices may not suffice for interactive trading but will usually be adequate to show a company’s financial performance over several years.

At a quite different timescale, time series analysis is the basis for signal processing in telecommunications, engineering, and science.

Continuous electrical signals are sampled to provide time series using analog-to-digital (A/D) converters at rates that can be faster than millions of observations per second.

# Correlation

# Forecasting Strategies

# Basic Stochastic Models

# Regression

# Stationary Models

# Non-stationary Models

# Long Memory Processes

# Spectral Analysis

# System Identification

# Multivariate Models

# State Space Models

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