Forecasting Inflation Rates

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Seasonal Models

Seasonality: A recurring pattern over a fixed time interval

- Frequency can be of different length
- Monthly data = Frequency of 12

Dataset: Monthly US inflation rates

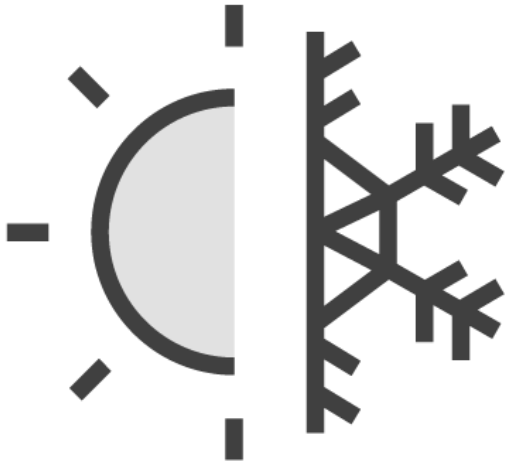
Modeling seasonal time series data

Standard models:

- Seasonal decomposition
- Seasonal ARIMA
- Holt-Winters exponential smoothing

Visualizing seasonal data

Seasonality in Time Series



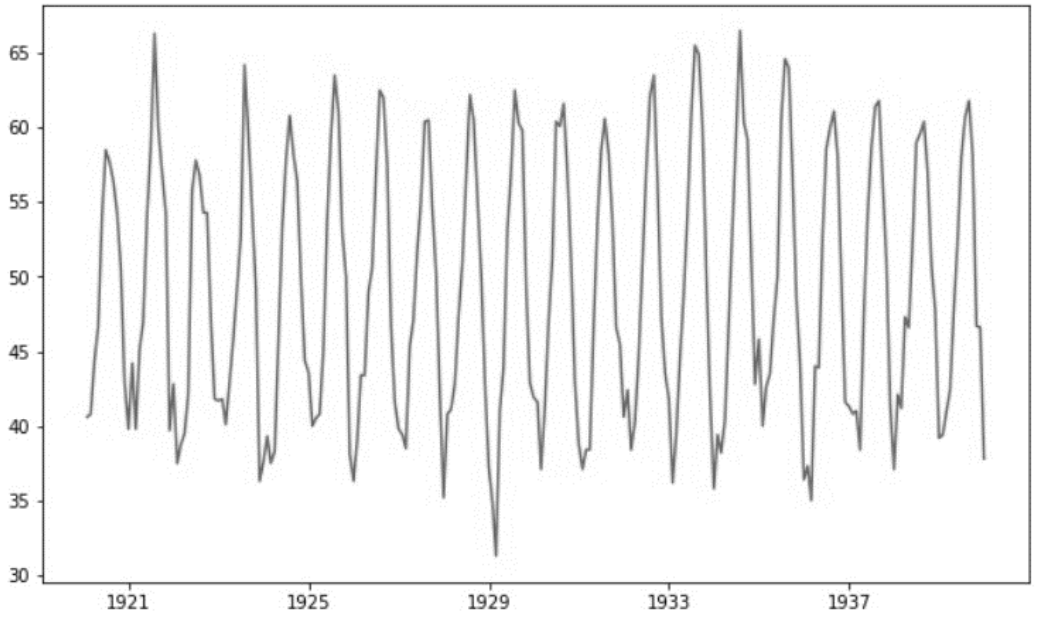
Seasonal time series

Adjusted analytical approach

Frequency to frame the recurring pattern

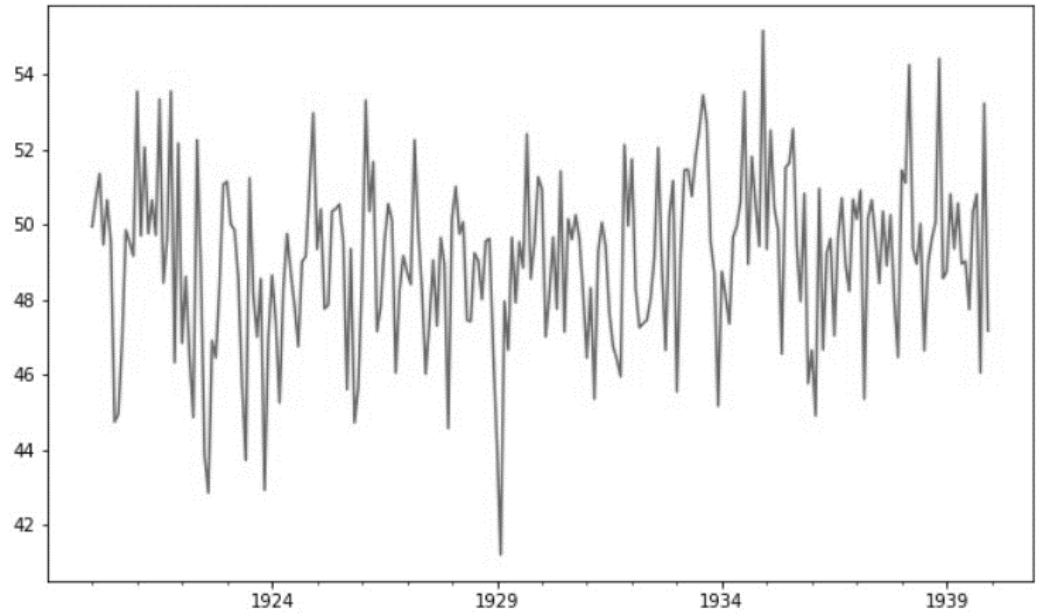
- Function: `ts(frequency = )`

Temperature Measurements



Time Series with Seasonality

Recurring pattern over a given time interval



Time Series without Seasonality

The recurring pattern disappears when seasonality is extracted

Multiple Seasonality

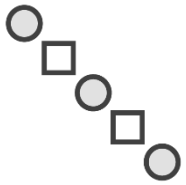
Daily Recurring Patterns

More orders placed in the evening than in the morning

Weekly Recurring Patterns

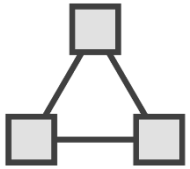
More orders placed in the weekend than during the week

Standard Models for Seasonal Datasets



Seasonal ARIMA (SARIMA)

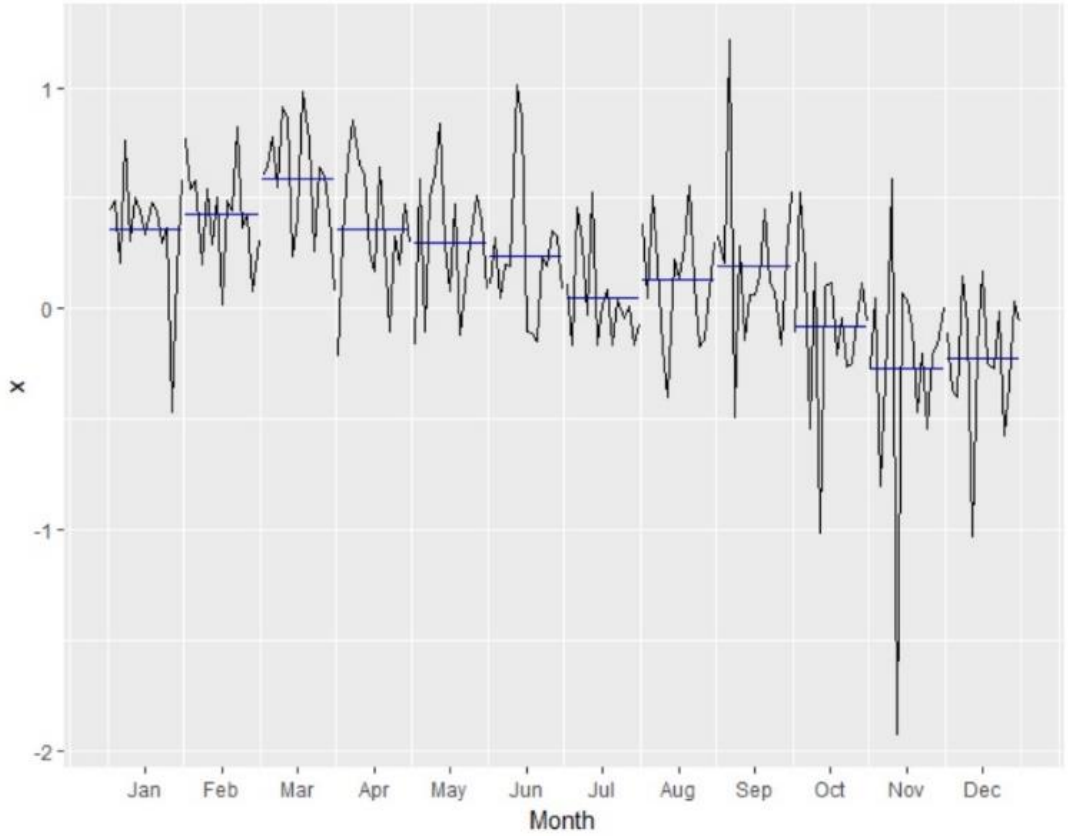
Holt-Winters exponential smoothing



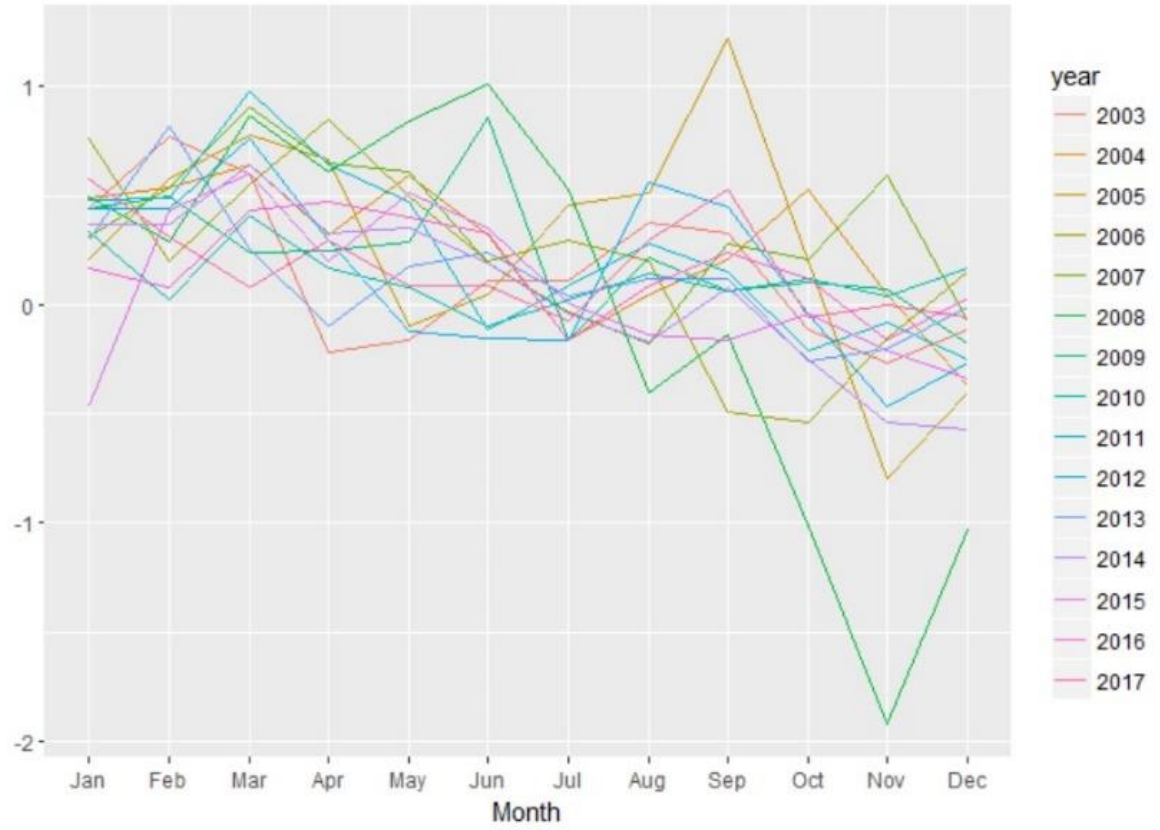
Seasonal decomposition: Trend, seasonality, and residuals

Visualizing time series data helps to identify patterns like trend or seasonality

Visualizing Seasonal Time Series



Month plot



Season plot

The US Inflation Dataset

Inflation rates

A measure of change in purchasing power

Affects investment opportunities

- Stocks, property, precious metals, oil

The era of cheap money

- Currency depreciation

Monthly US inflation rates (2003-2017)

Source: statbureau.org

Month-on-month inflation rate

- More intuitive than the year-on-year change
- The difference between two consecutive months
- Monthly rates can be negative

No trend

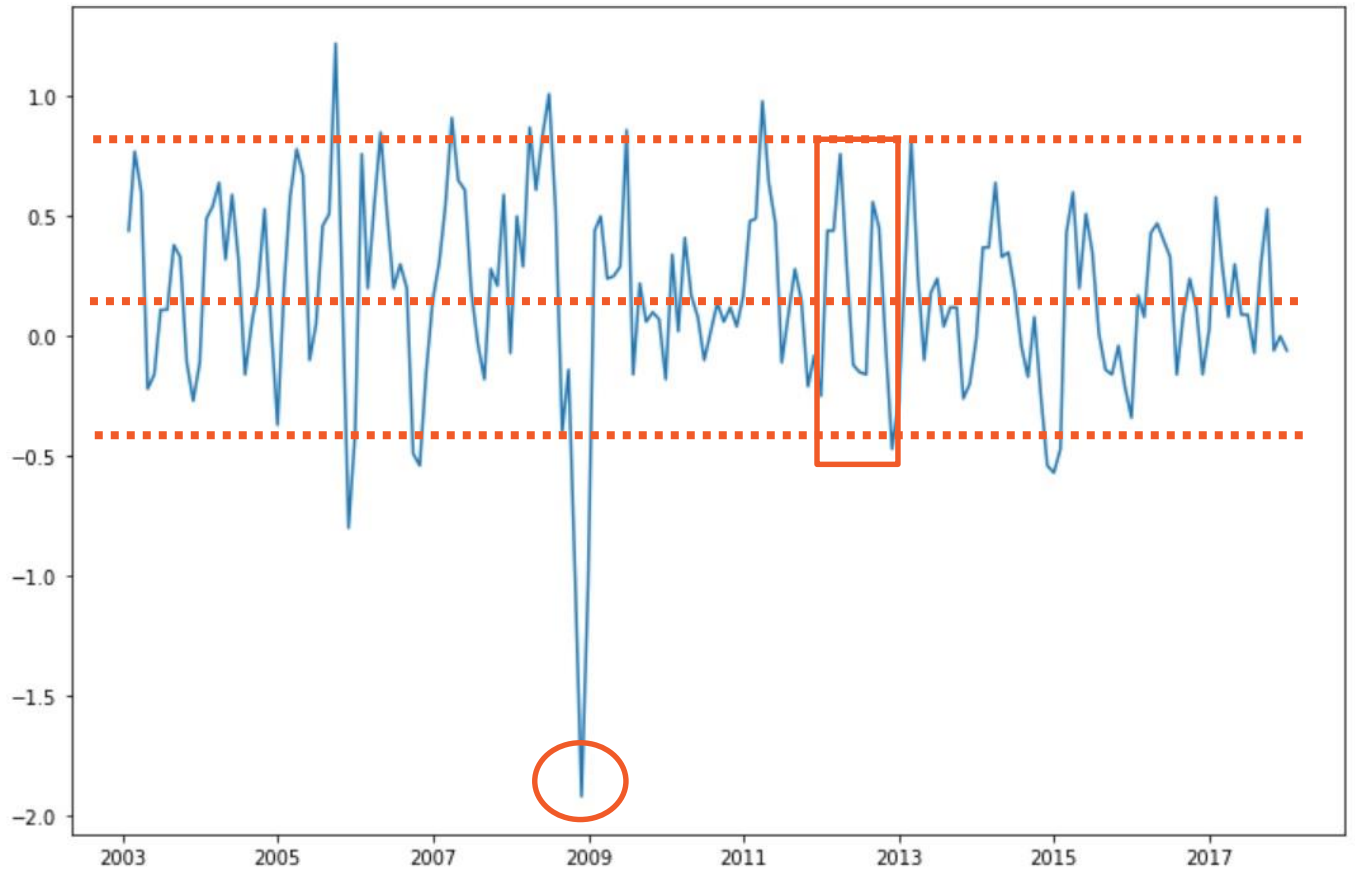
Financial crash in 2008

Seasonal dataset

12 observations/cycle

Negative values

Constant variance



Importing the Data into R

Pasting the data into R

Avoid row IDs and headers

- Time stamp will be generated in R

Chronologically ordered vector

Pre-format the data in Excel

Tools and functions for time series analysis require the data to be in ‘ts’ format

```
mydata = scan()
ts(mydata, start = c(2003, 3), frequency = 12)
```

Specifying an Offset in the Timestamp

Use the ‘start’ argument with two integers

- Start year
- Start month

Seasonal Decomposition

Seasonal Decomposition

Dividing the data into trend, seasonality, and remainder

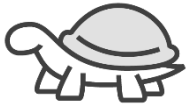
Additive and multiplicative methods

Simple, easy to use approach

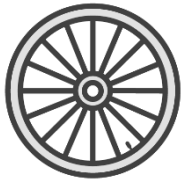
Possible drawbacks

Drawbacks of Seasonal Decomposition

First observations are NA



Slow to catch changes



Constant seasonal component

Alternative Methods

X 11

SEATS

STL

Model values for all observations

Adjusted seasonal component

STL Decomposition

Seasonal and trend decomposition with loess

Robust against outliers

Additive model is preferred

Seasonal and trend cycles may adjust

Argument `s.window`

- Number of required seasonal cycles
- $x \geq 7; x \nmid 2$

Forecasting with STL Decomposition

Feeding an 'STL' object into the `forecast()` function

Feeding a 'ts' object into the `stlf()` function

Seasonal ARIMA Model

ARIMA Parameter Selection

Manual Method

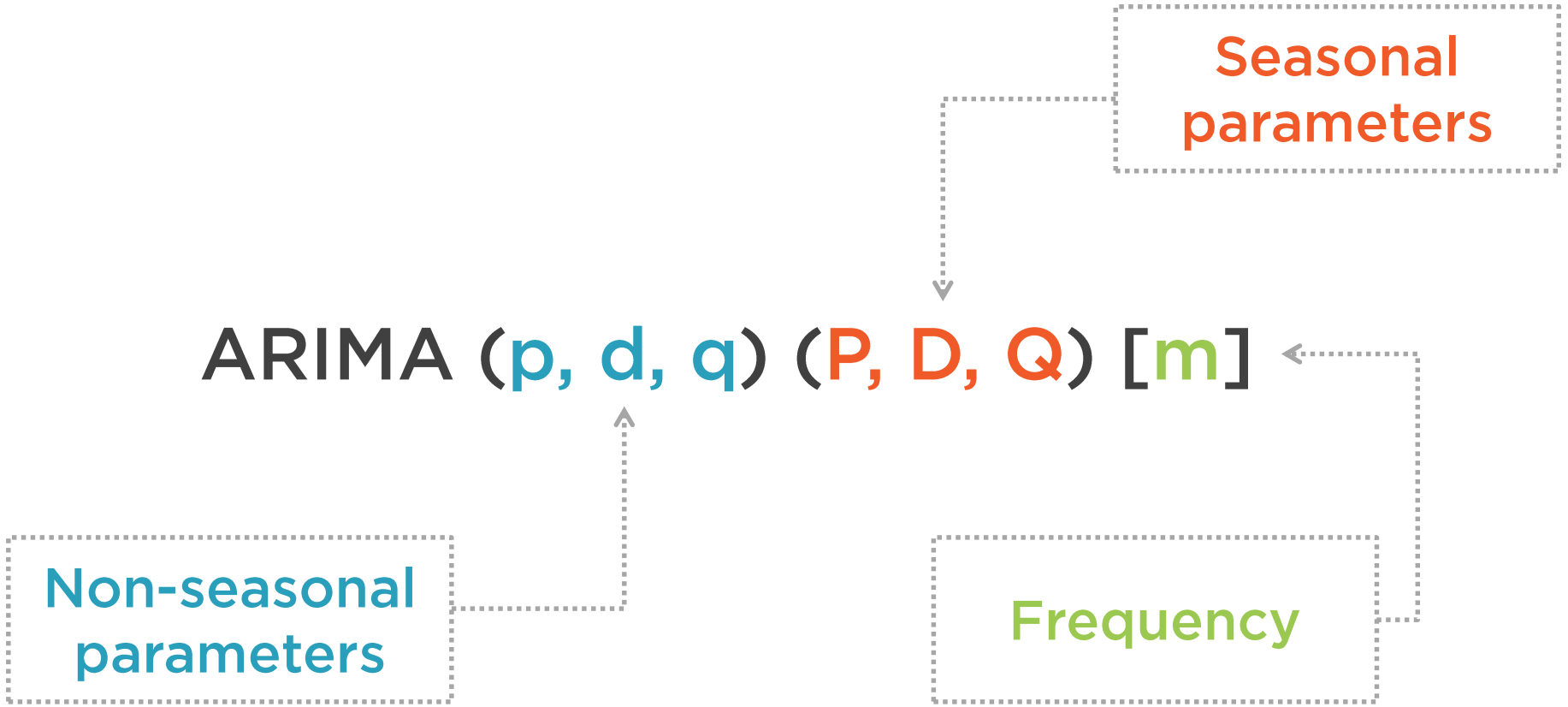
Parameter identification via differencing and data visualization (ACF, PACF)

Automated Method

R estimates the parameters automatically by using the `auto.arima()` function

Seasonal ARIMA models have two sets of parameters

Seasonal ARIMA Model Parameters



Only models of the same class can be compared with the information criterion

Comparison of Models Improves the Analysis

Seasonal ARIMA model

Exponential smoothing model

ETS model

Exponential Smoothing Model

Exponential Smoothing

Two methods with the 'forecast' library

- Function: ets()
- Function: hw() – Holt-Winters exponential smoothing

Comparing the model and forecast to previous models

Selects a seasonal model automatically

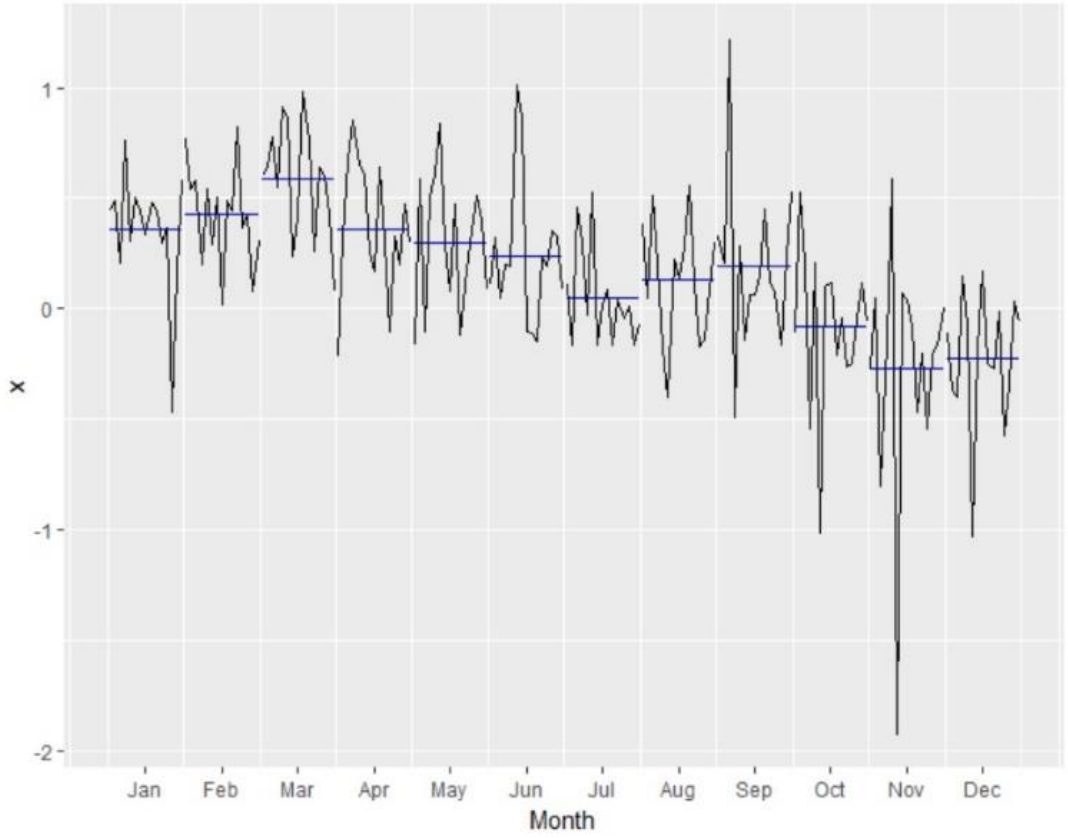
Month Plot

Extracts patterns by plotting the seasons (months, days) of a cycle (years, weeks, or other given frequency) in chronological order.

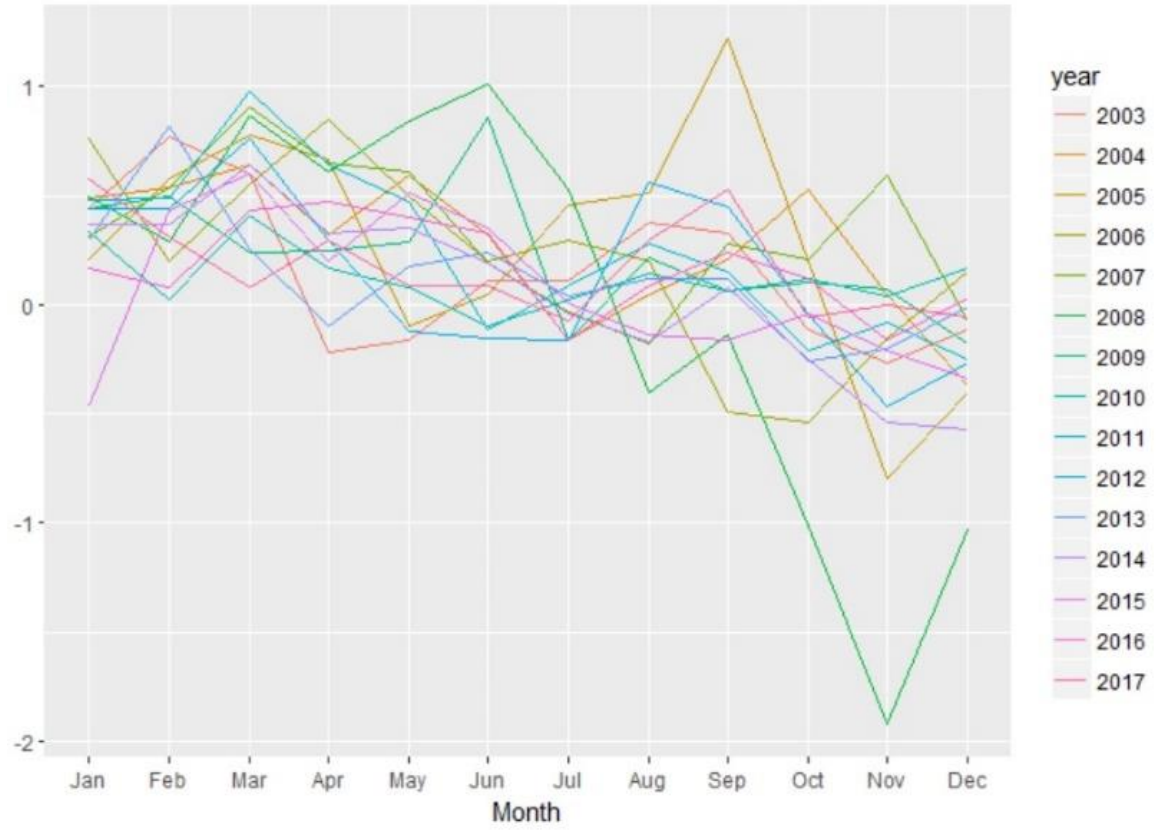
Season Plot

Extracts and emphasizes patterns by plotting seasonal cycles (years, weeks, or other given frequency) over one another.

Visualizing Seasonal Time Series



Month plot



Season plot

Seasonal Models

Working with a seasonal time series

- Identifying and capturing recurring patterns
- The frequency influences the availability of models

Getting a first impression with seasonal decomposition

- Functions: `decompose()`, `stl()`

Seasonal ARIMA model (SARIMA)

- Function: `auto.arima()`

Holt-Winters exponential smoothing

- Functions: `ets()`, `hw()`