MONASH University

MONASH BUSINESS SCHOOL

Forecasting: principles and practice

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2.2 Seasonality and trends

Outline

1. Time series components
2. STL decomposition
3. Lab session 12
4. Forecasting and decomposition
5. Lab session 13

Time series patterns

Trend pattern exists when there is a long-term increase or decrease in the data.

Seasonal pattern exists when a series is influenced by seasonal factors (e.g., the quarter of the year, the month, or day of the week).

Cyclic pattern exists when data exhibit rises and falls that are *not of fixed period* (duration usually of at least 2 years).

Time series decomposition

$$Y_t = S_t + T_t + R_t$$

where
$Y_t =$ data at period t
$S_t =$ seasonal component at period t
$T_t =$ trend-cycle component at period t
$R_t =$ remainder (or irregular or error) component at period t

Time series decomposition

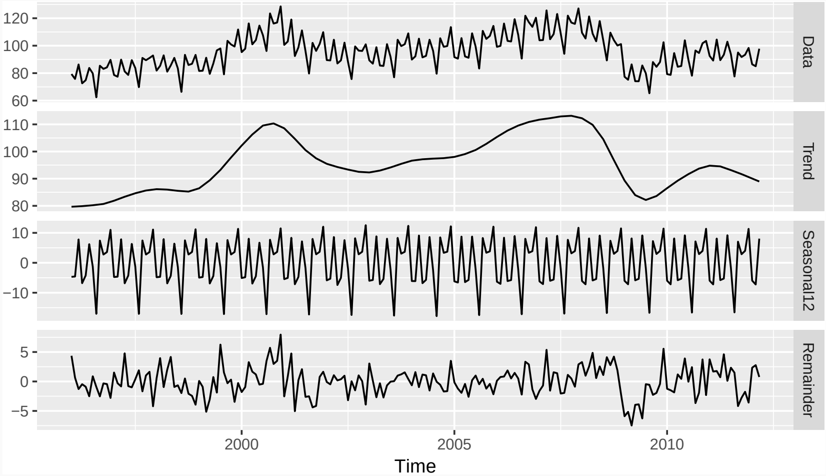
$$Y_t = S_t + T_t + R_t$$

where $Y_t =$ data at period t
$S_t =$ seasonal component at period t
$T_t =$ trend-cycle component at period t
$R_t =$ remainder (or irregular or error) component at period t

- Additive model appropriate if magnitude of seasonal fluctuations does not vary with level.
- If seasonal are proportional to level of series, use a Box-Cox transformation first.

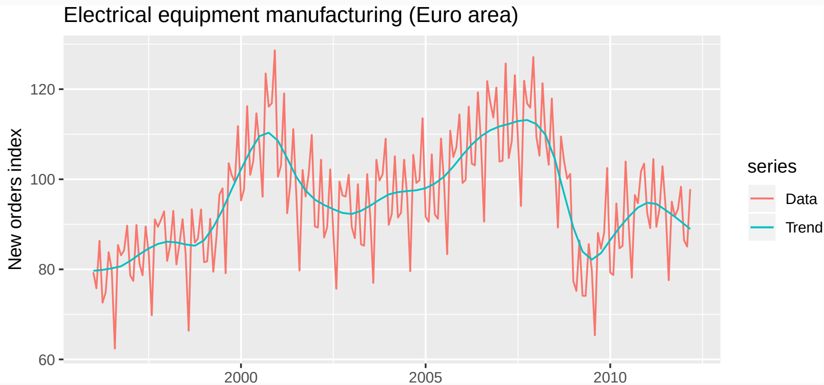
Euro electrical equipment

```
fit <- mstl(elecequip)
autoplot(fit)
```



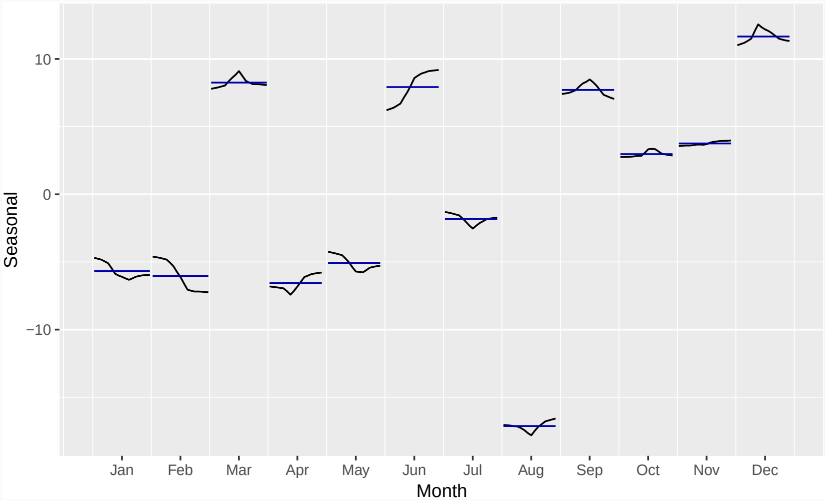
Euro electrical equipment

```r
autoplot(elecequip, series="Data") +
 autolayer(trendcycle(fit), series="Trend") +
 ylab("New orders index") + xlab("") +
 ggtitle("Electrical equipment manufacturing (Euro area)")
```



Euro electrical equipment

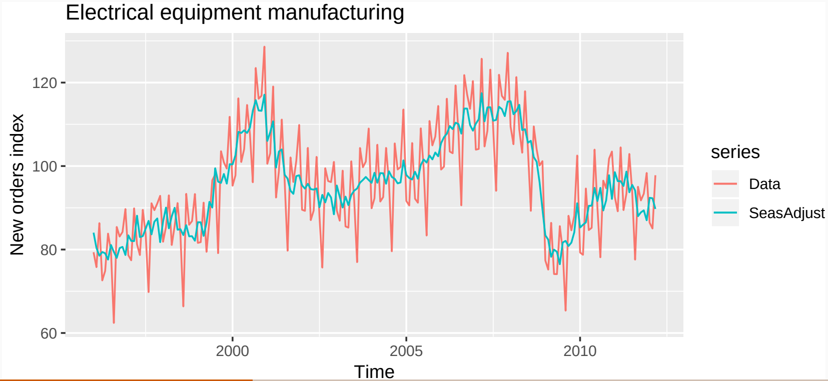
```
ggmonthplot(seasonal(fit)) + ylab("Seasonal")
```



Seasonal adjustment

Seasonally adjusted data given by $Y_t - S_t = T_t + E_t$

```
autoplot(elecequip, series="Data") +
  autolayer(seasadj(fit), series="SeasAdjust") +
  ylab("New orders index") +
  ggtitle("Electrical equipment manufacturing")
```



History of time series decomposition

- Classical method originated in 1920s.
- Census II method introduced in 1957. Basis for modern X-12-ARIMA method.
- STL method introduced in 1983
- TRAMO/SEATS introduced in 1990s.

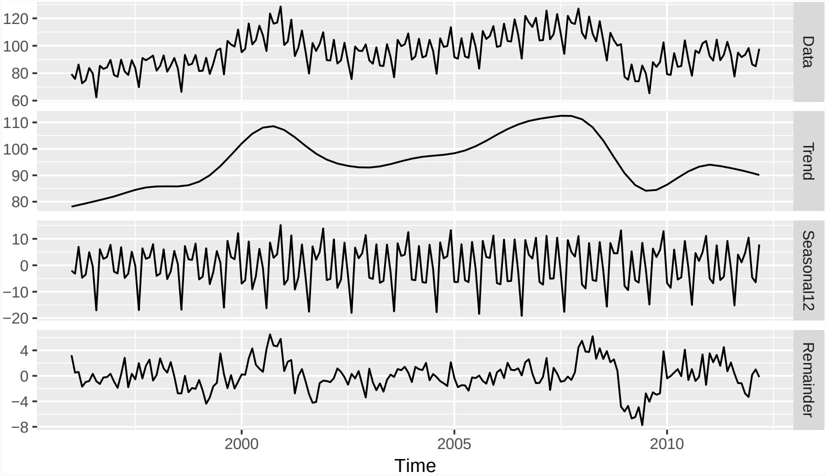
Outline

STL decomposition

- STL: “Seasonal and Trend decomposition using Loess”,
- Very versatile and robust.
- Will handle any type of seasonality.
- Seasonal component allowed to change over time, and rate of change controlled by user.
- Smoothness of trend-cycle also controlled by user.
- Robust to outliers
- No trading day or calendar adjustments.
- Only additive.

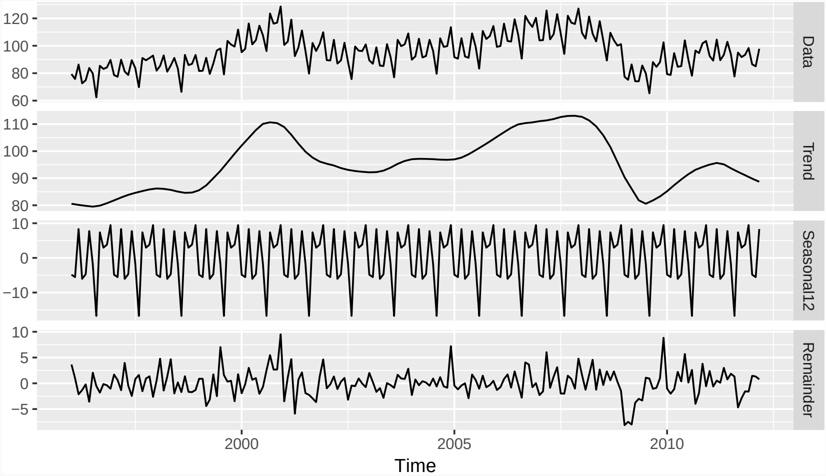
Euro electrical equipment

```
elecequip %>%
  mstl(s.window=5) %>%
  autoplot()
```



Euro electrical equipment

```
elecequip %>%
  mstl(t.window=15, s.window='periodic', robust=TRUE) %>%
  autoplot()
```



STL decomposition in R

- `t.window` controls wiggliness of trend component.
- `s.window` controls variation on seasonal component.
- `seasonal()` extracts seasonal component
- `trendcycle()` extracts trend component
- `remainder()` extracts remainder component
- `seasadj()` computes seasonally adjusted data

Outline

Lab Session 12

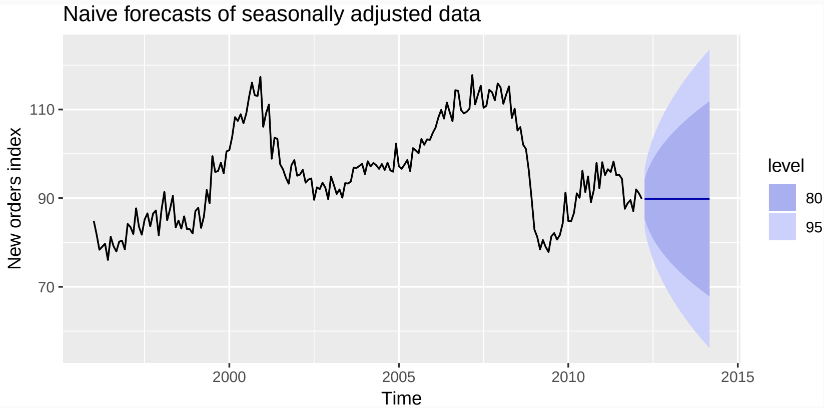
Outline

Forecasting and decomposition

- Forecast seasonal component by repeating the last year (`snaive`)
- Forecast seasonally adjusted data using non-seasonal time series method. E.g.,
  - Holt's method
  - Random walk with drift model
- Combine forecasts of seasonal component with forecasts of seasonally adjusted data to get forecasts of original data.
- Sometimes a decomposition is useful just for understanding the data before building a separate forecasting model.

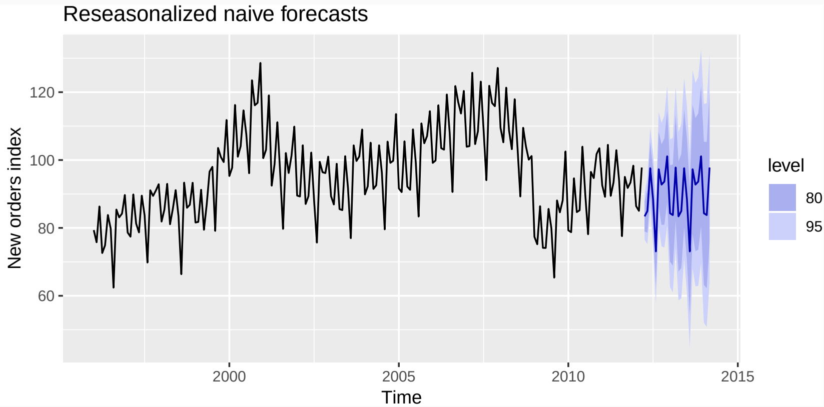
Seas adj elec equipment

```
mstl(elecequip, t.window=15, s.window="periodic") %>%
  seasadj() %>% naive(h=24) %>%
  autoplot() + ylab("New orders index") +
  ggtitle("Naive forecasts of seasonally adjusted data")
```



Seas adj elec equipment

```
mstl(elecequip, t.window=15, s.window="periodic") %>%
  forecast(method="naive", h=24) %>%
  autoplot() + ylab("New orders index") +
  ggtitle("Reseasonalized naive forecasts")
```



Decomposition and prediction intervals

- It is common to take the prediction intervals from the seasonally adjusted forecasts and modify them with the seasonal component.
- This ignores the uncertainty in the seasonal component estimate.
- It also ignores the uncertainty in the future seasonal pattern.

Some more R functions

```
fcast <- stlf(elecequip, method='naive')

fcast <- stlf(elecequip, method='naive',
  h=36, s.window=11, robust=TRUE)
```

Outline

Lab Session 13