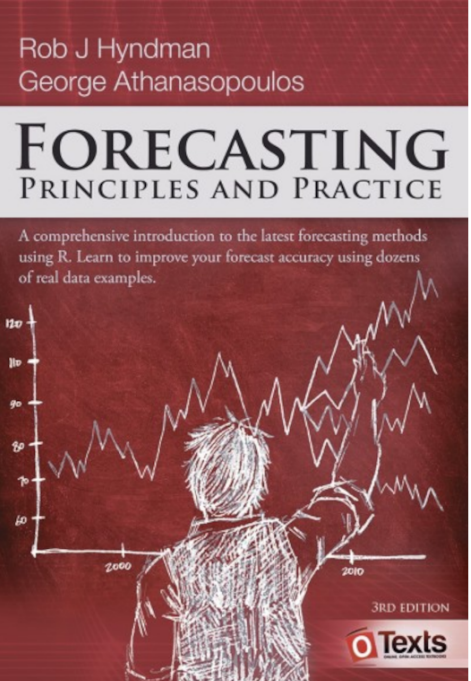


# 3. Time series decomposition

3.5 Methods used in official statistics

OTexts.org/fpp3/

# History of time series decomposition

- Classical method originated in 1920s.
- Census II method introduced in 1957. Basis for X-11 method and variants (including X-12-ARIMA, X-13-ARIMA)
- STL method introduced in 1983
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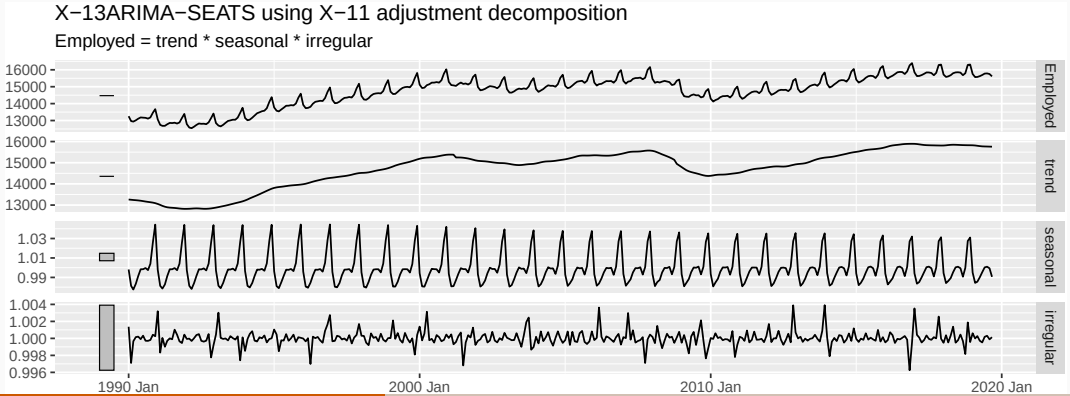
## National Statistics Offices

- ABS uses X-12-ARIMA
- US Census Bureau uses X-13ARIMA-SEATS
- Statistics Canada uses X-12-ARIMA
- ONS (UK) uses X-12-ARIMA
- EuroStat use X-13ARIMA-SEATS

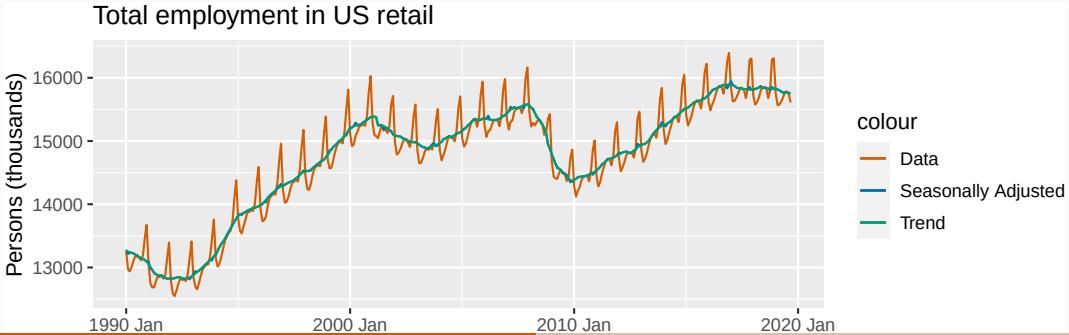
# X-11 decomposition

```
x11_dcmp <- us_retail_employment |>
  model(x11 = X_13ARIMA_SEATS(Employed ~ x11())) |>
  components()
autoplot(x11_dcmp)
```



# X-11 decomposition

```
x11_dcmp |>
  ggplot(aes(x = Month)) +
  geom_line(aes(y = Employed, colour = "Data")) +
  geom_line(aes(y = season_adjust, colour = "Seasonally Adjusted")) +
  geom_line(aes(y = trend, colour = "Trend")) +
  labs(y = "Persons (thousands)", title = "Total employment in US retail")
```



# X-11 decomposition

**Advantages**

- Relatively robust to outliers
- Completely automated choices for trend and seasonal changes
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**Disadvantages**

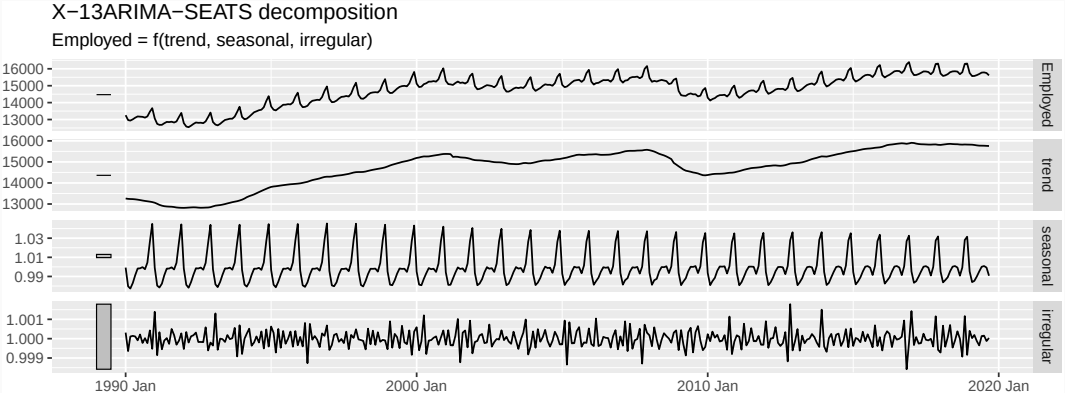
- No prediction/confidence intervals
- Ad hoc method with no underlying model
- Only developed for quarterly and monthly data

# Extensions: X-12-ARIMA and X-13-ARIMA

- The X-11, X-12-ARIMA and X-13-ARIMA methods are based on Census II decomposition.
- These allow adjustments for trading days and other explanatory variables.
- Known outliers can be omitted.
- Level shifts and ramp effects can be modelled.
- Missing values estimated and replaced.
- Holiday factors (e.g., Easter, Labour Day) can be estimated.

# X-13ARIMA-SEATS

```
seats_dcmp <- us_retail_employment |>
  model(seats = X_13ARIMA_SEATS(Employed ~ seats())) |>
  components()
autoplot(seats_dcmp)
```



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- Allows estimates at end points
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