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# FORECASTING

## PRINCIPLES AND PRACTICE

A comprehensive introduction to the latest forecasting methods using R. Learn to improve your forecast accuracy using dozens of real data examples.



3RD EDITION

 **OTexts**  
Open Texts Publishing

## 3. Time series decomposition

3.5 Methods used in official statistics

[OTexts.org/fpp3/](http://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
- TRAMO/SEATS introduced in 1990s.

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## National Statistics Offices

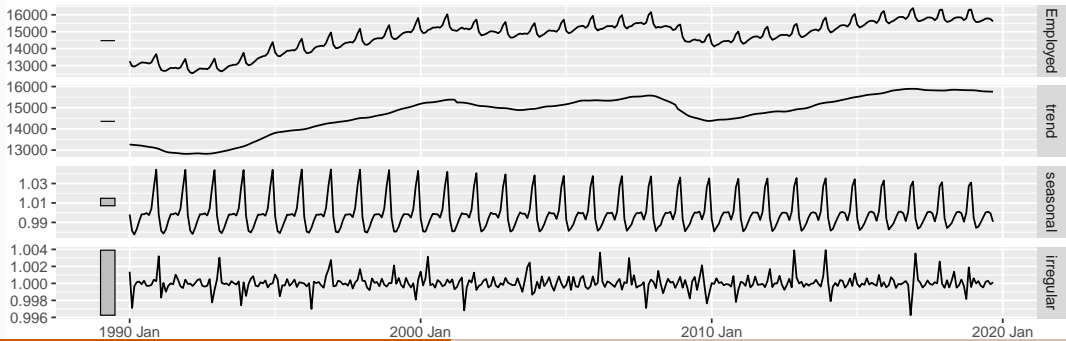
- ABS uses X-12-ARIMA
- US Census Bureau uses X-13ARIMA-SEATS
- Statistics Canada uses X-12-ARIMA
- ONS (UK) uses X-12-ARIMA
- EuroStat use X-13ARIMA-SEATS

# X-11 decomposition

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

X-13ARIMA-SEATS using X-11 adjustment decomposition

$\text{Employed} = \text{trend} * \text{seasonal} * \text{irregular}$



# X-11 decomposition

## Advantages

- Relatively robust to outliers
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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

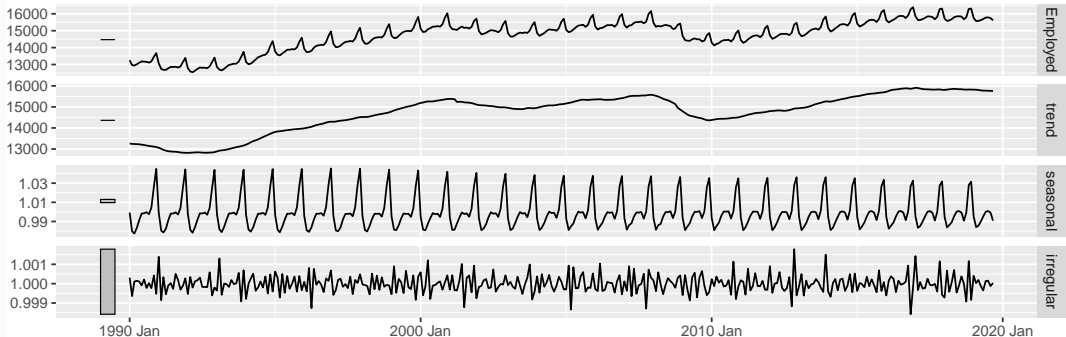
- The X-11, X-12-ARIMA and X-13-ARIMA methods are based on Census II decomposition.
- These allow adjustments for trading days and other explanatory variables.
- Known outliers can be omitted.
- Level shifts and ramp effects can be modelled.
- Missing values estimated and replaced.
- Holiday factors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

## X-13ARIMA-SEATS decomposition

$\text{Employed} = f(\text{trend}, \text{seasonal}, \text{irregular})$





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- Model-based
- Smooth trend estimate
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