Ch 3: Time series decomposition

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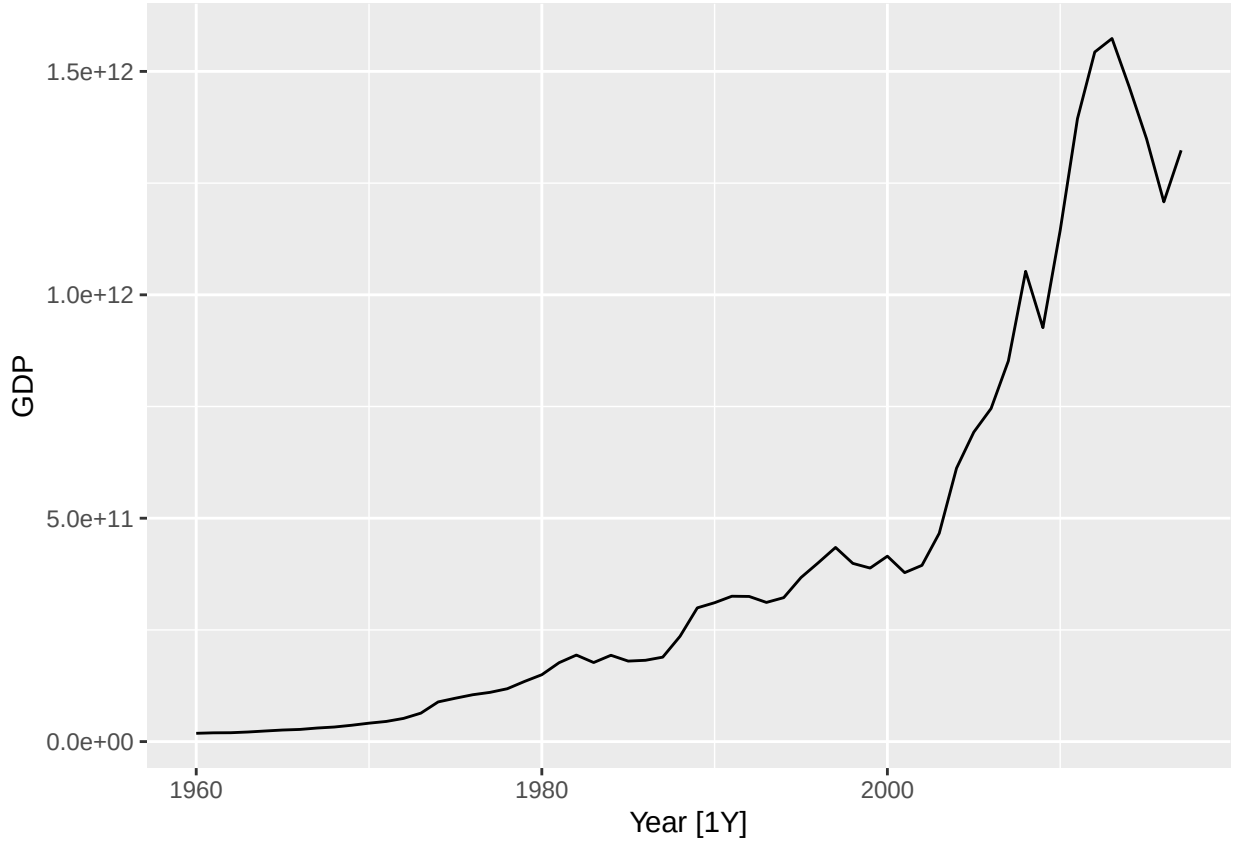
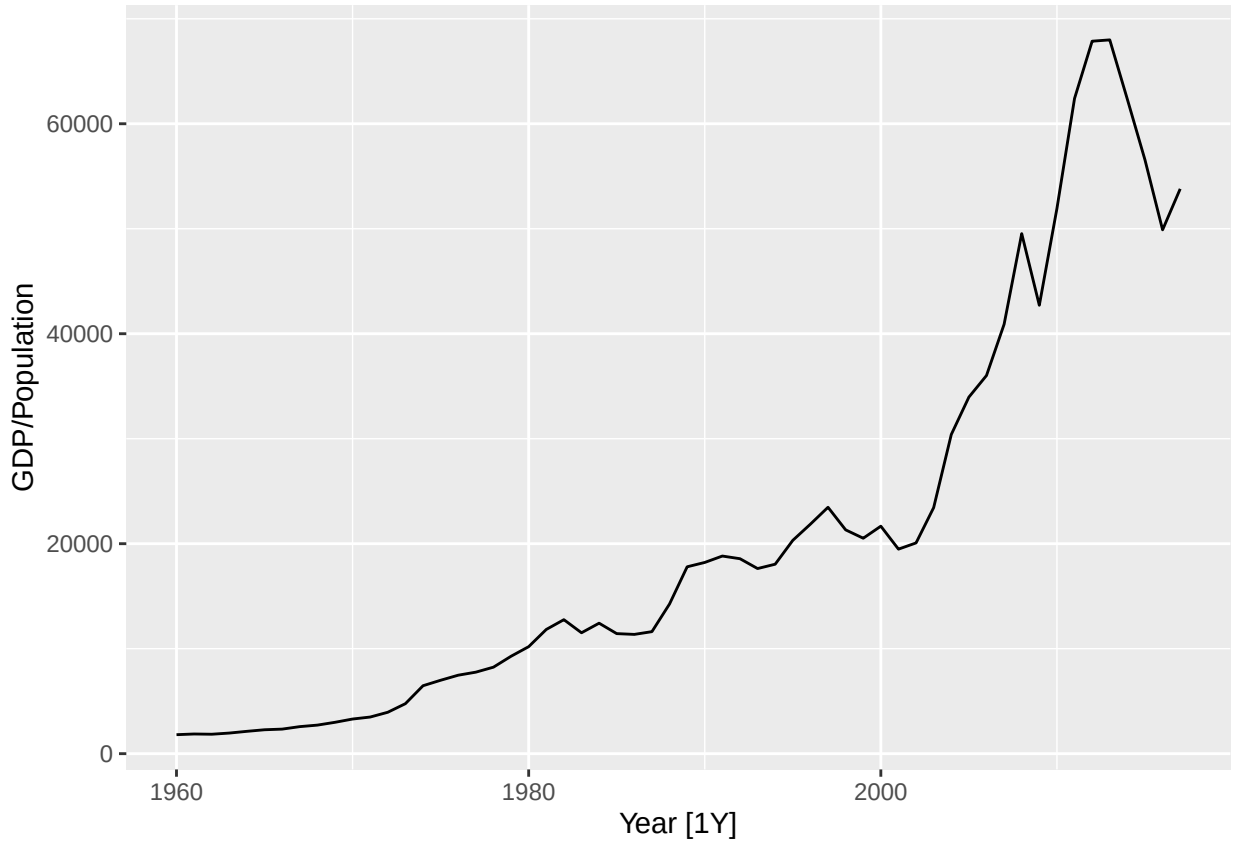
Transormations and adjustments

Per capita adjustments

```
global_economy %>%
filter(Country == "Australia") %>%
autoplot(GDP)
```



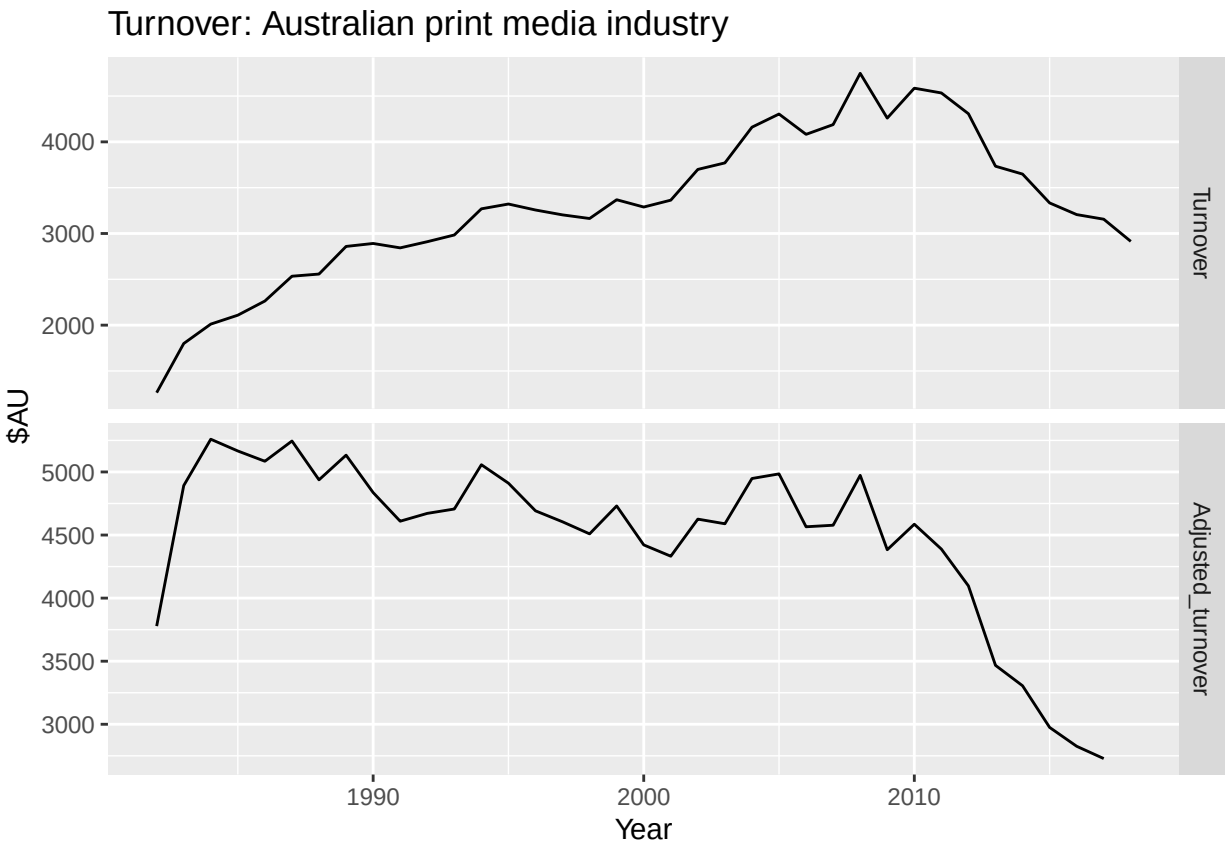
```
global_economy %>%
filter(Country == "Australia") %>%
autoplot(GDP / Population)
```



Inflation adjustments

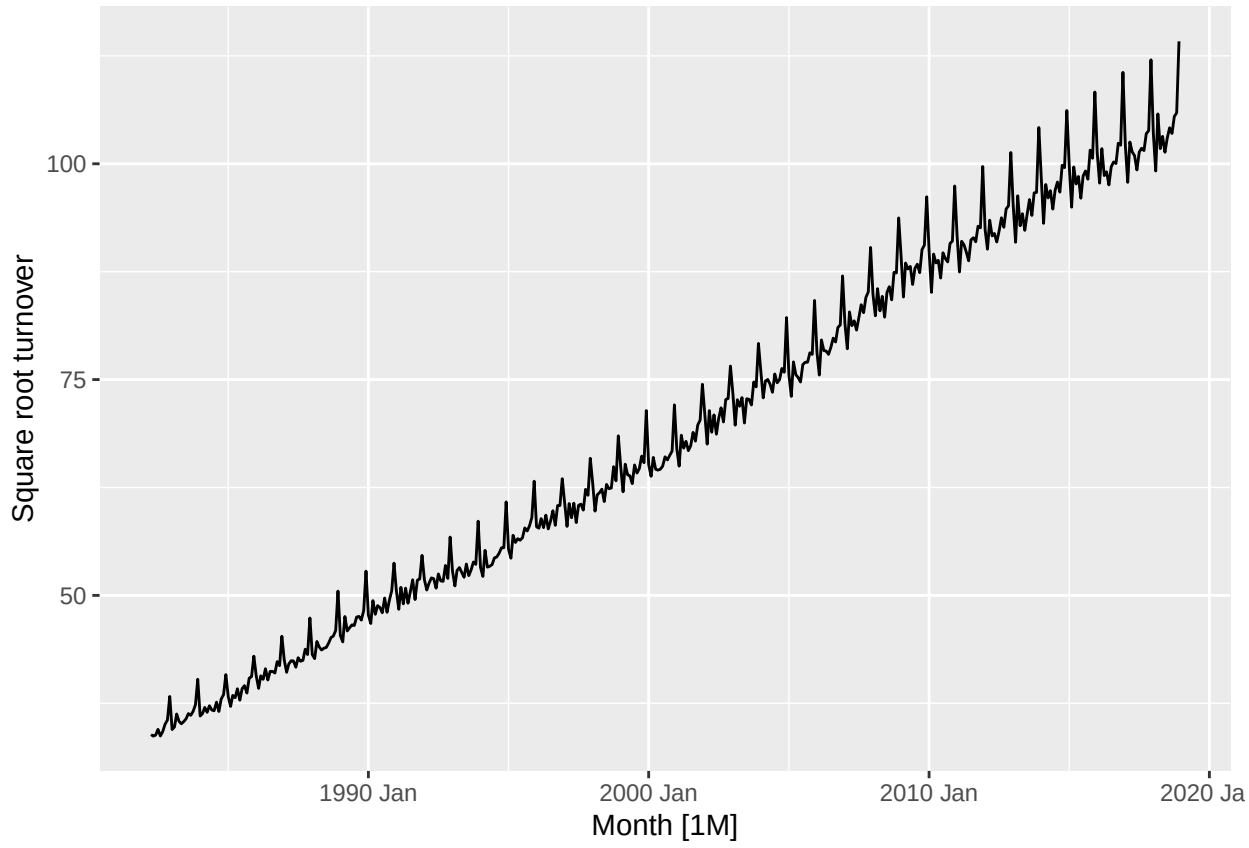
```
print_retail <- aus_retail %>%
filter(Industry == "Newspaper and book retailing") %>%
group_by(Industry) %>%
index_by(Year = year(Month)) %>%
summarise(Turnover = sum(Turnover))

aus_economy <- global_economy %>%
filter(Code == "AUS")

print_retail %>%
left_join(aus_economy, by = "Year") %>%
mutate(Adjusted_turnover = Turnover / CPI*100) %>%
pivot_longer(c(Turnover, Adjusted_turnover),
names_to = "Type", values_to = "AUD") %>%
mutate(Type = factor(Type, levels=c("Turnover","Adjusted_turnover"))) %>%
ggplot(aes(x = Year, y = AUD)) +
geom_line() +
facet_grid(Type ~ ., scales = "free_y") +
labs(title = "Turnover: Australian print media industry", y = "$AU")
```

```
## Warning: Removed 1 row(s) containing missing values (geom_path).
```

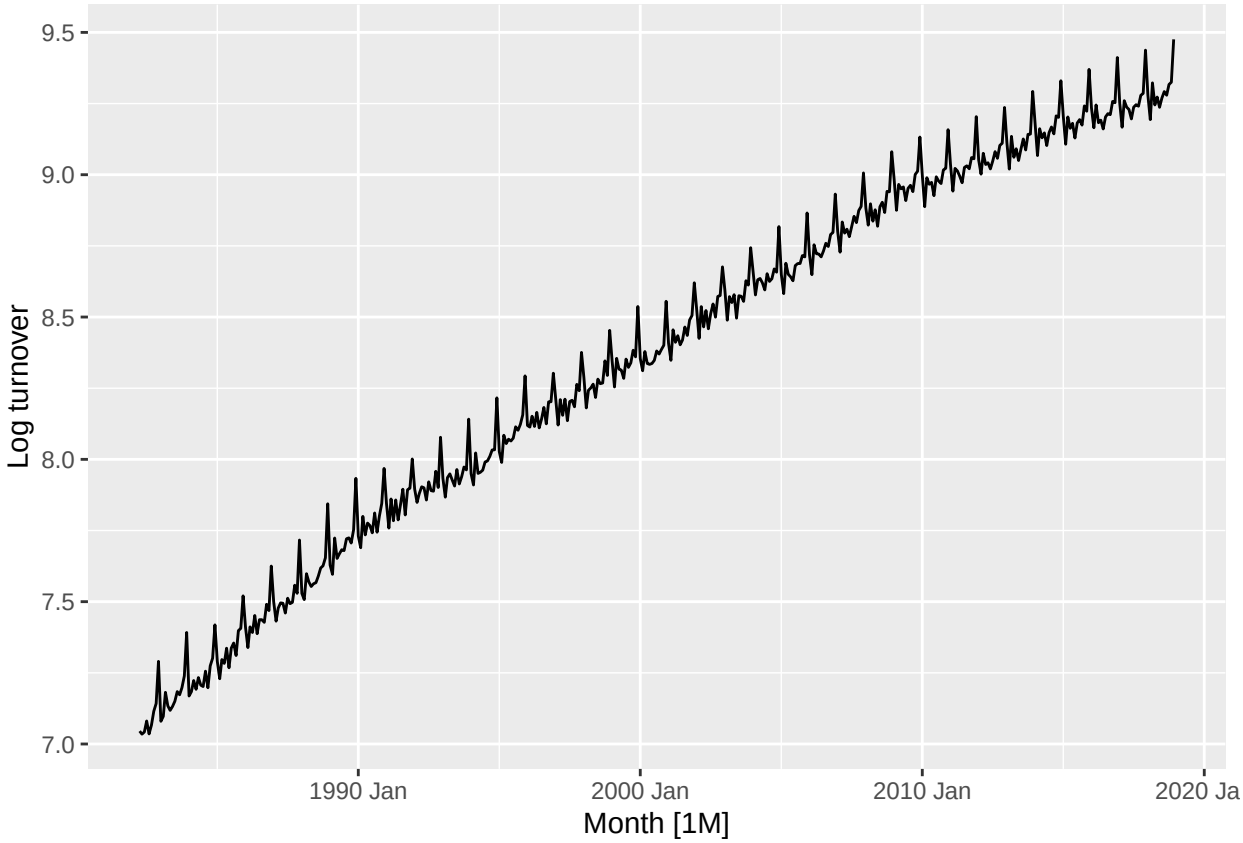


Mathematical Transformations

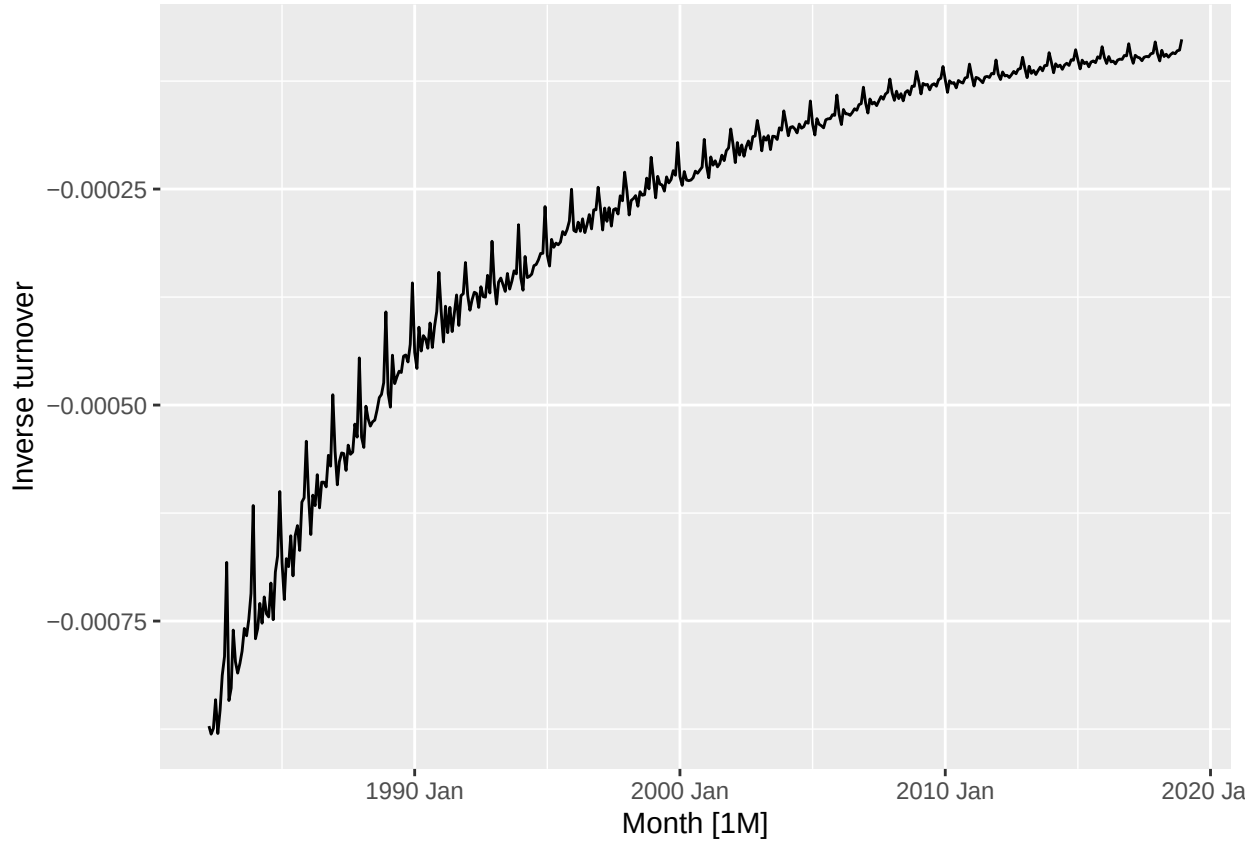
```
food <- aus_retail %>%
filter(Industry == "Food retailing") %>%
summarise(Turnover = sum(Turnover))

food %>% autoplot(sqrt(Turnover)) +
labs(y = "Square root turnover")
```




```
food %>% autoplot(log(Turnover)) +
labs(y = "Log turnover")
```




```
food %>% autoplot(-1/Turnover) +
labs(y = "Inverse turnover")
```

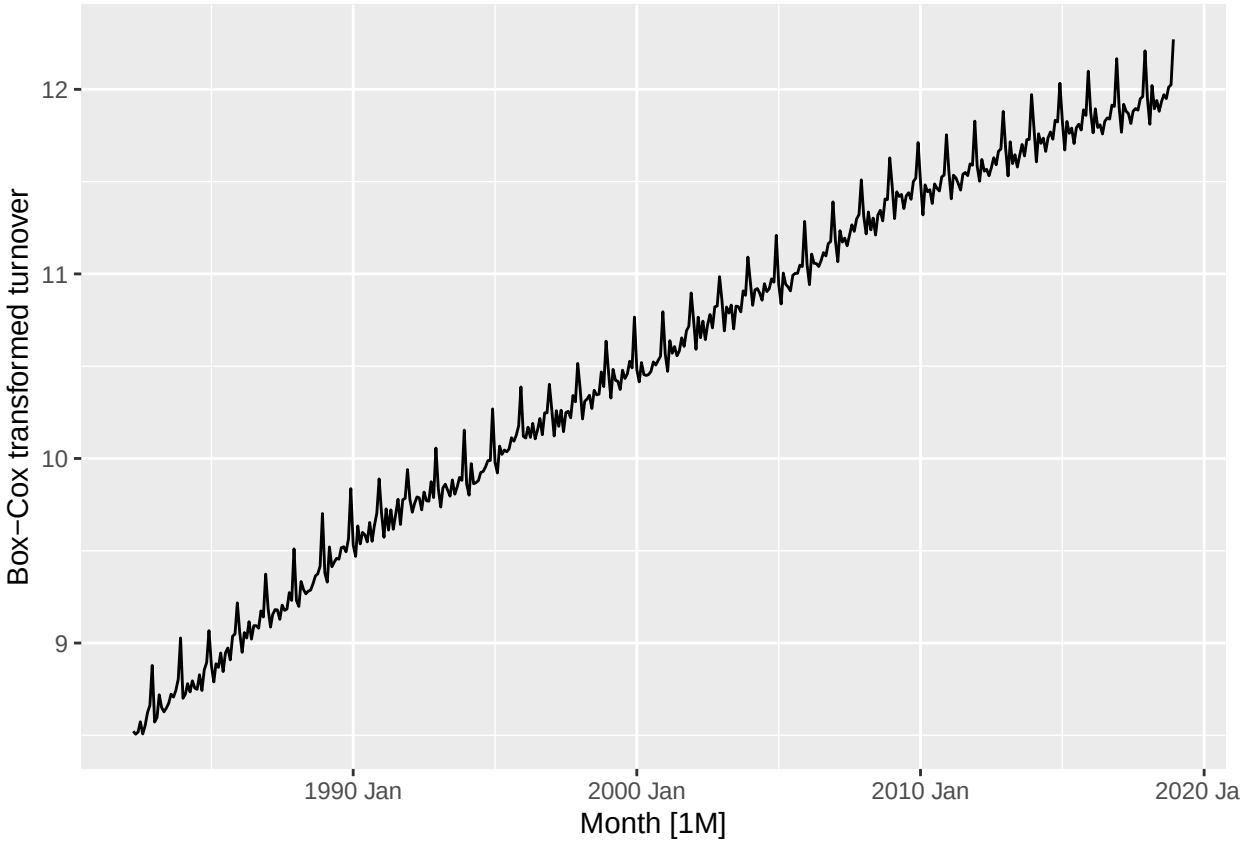


Box-Cox Transformations

```
food %>%
features(Turnover, features = guerrero)
```

```
## # A tibble: 1 x 1
##   lambda_guerrero
##             <dbl>
## 1          0.0524
```

```
food %>% autoplot(box_cox(Turnover, 0.0524)) +
labs(y = "Box-Cox transformed turnover")
```

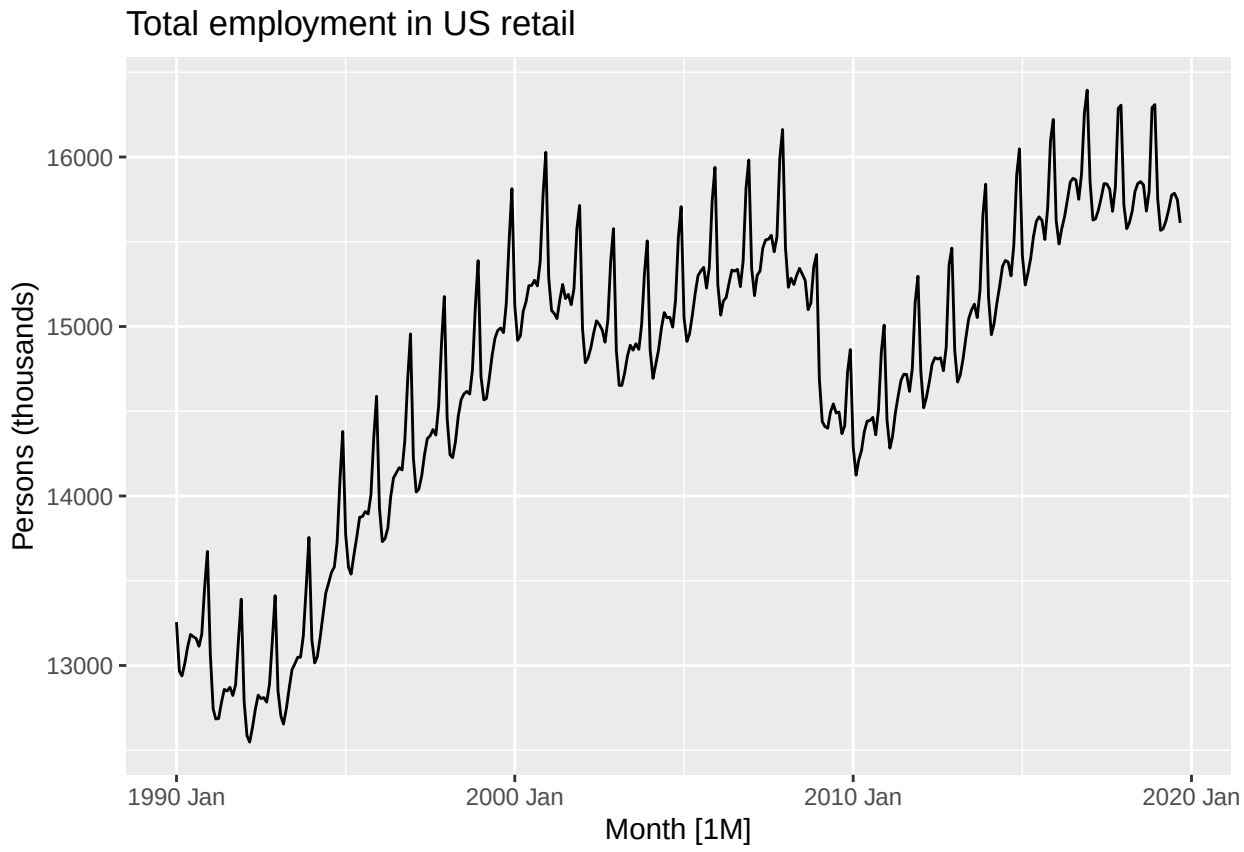


Time series decomposition

```
us_retail_employment <- us_employment %>%
filter(year(Month) >= 1990, Title == "Retail Trade") %>%
select(-Series_ID)
us_retail_employment
```

```
## # A tsibble: 357 x 3 [1M]
##       Month Title        Employed
##       <mth> <chr>           <dbl>
##  1 1990 Jan Retail Trade   13256.
##  2 1990 Feb Retail Trade   12966.
##  3 1990 Mar Retail Trade   12938.
##  4 1990 Apr Retail Trade   13012.
##  5 1990 May Retail Trade   13108.
##  6 1990 Jun Retail Trade   13183.
##  7 1990 Jul Retail Trade   13170.
##  8 1990 Aug Retail Trade   13160.
##  9 1990 Sep Retail Trade   13113.
## 10 1990 Oct Retail Trade   13185.
## # ... with 347 more rows
```

```
us_retail_employment %>%
autoplot(Employed) +
labs(y="Persons (thousands)", title="Total employment in US retail")
```




```
us_retail_employment %>%
model(stl = STL(Employed))
```

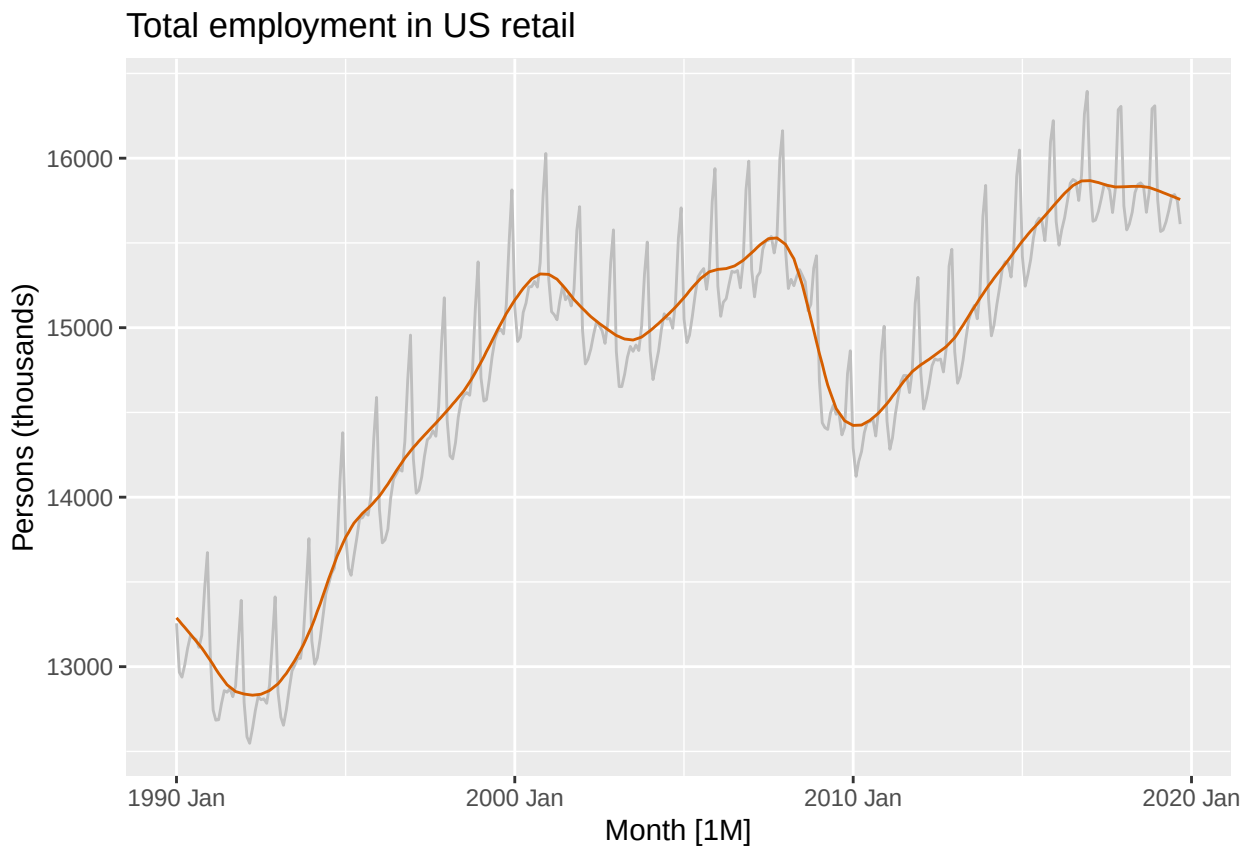
```
## # A mable: 1 x 1
##       stl
##   <model>
## 1   <STL>
```

```
dcmp <- us_retail_employment %>%
model(stl = STL(Employed))
components(dcmp)
```

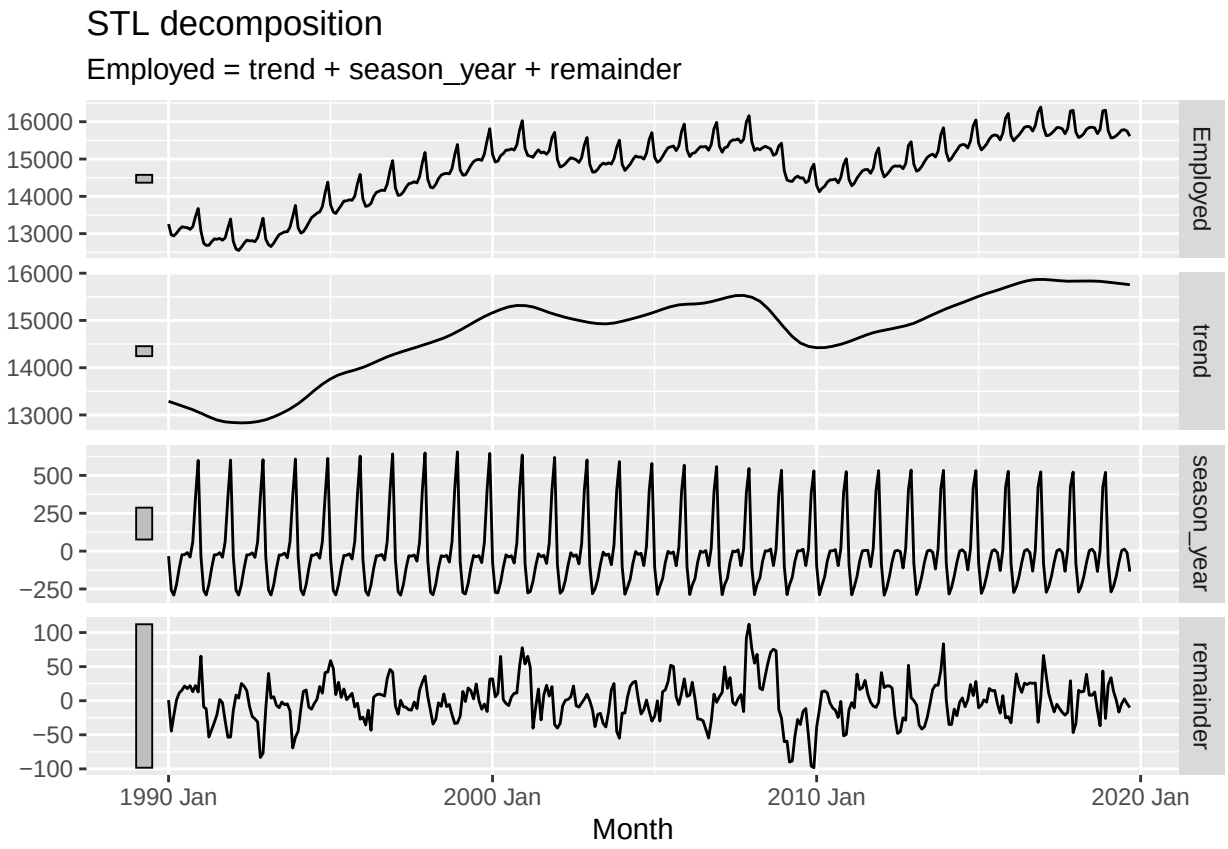
```
## # A dable: 357 x 7 [1M]
## # Key:     .model [1]
## # :        Employed = trend + season_year + remainder
##    .model    Month Employed  trend season_year remainder season_adjust
##    <chr>     <mth>    <dbl>  <dbl>       <dbl>     <dbl>         <dbl>
##  1 stl    1990 Jan   13256. 13288.      -33.0      0.836        13289.
##  2 stl    1990 Feb   12966. 13269.     -258.     -44.6          13224.
##  3 stl    1990 Mar   12938. 13250.     -290.     -22.1          13228.
```

```
##  4 stl    1990 Apr   13012. 13231.     -220.       1.05         13232.
##  5 stl    1990 May   13108. 13211.     -114.      11.3          13223.
##  6 stl    1990 Jun   13183. 13192.      -24.3     15.5          13207.
##  7 stl    1990 Jul   13170. 13172.      -23.2     21.6          13193.
##  8 stl    1990 Aug   13160. 13151.       -9.52    17.8          13169.
##  9 stl    1990 Sep   13113. 13131.      -39.5     22.0          13153.
## 10 stl    1990 Oct   13185. 13110.       61.6     13.2          13124.
## # ... with 347 more rows
```

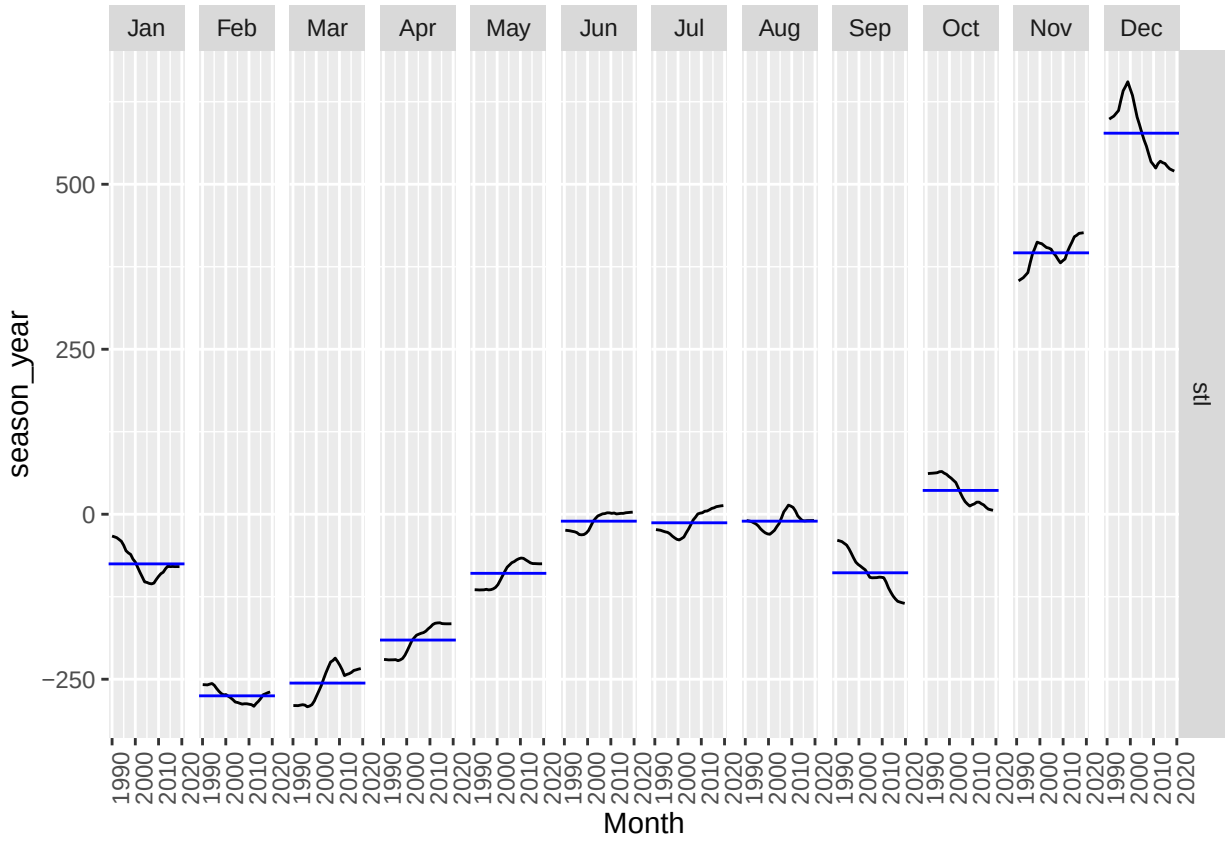
```
us_retail_employment %>%
autoplot(Employed, color='gray') +
autolayer(components(dcmp), trend, color='#D55E00') +
labs(y="Persons (thousands)", title="Total employment in US retail")
```




```
components(dcmp) %>% autoplot()
```

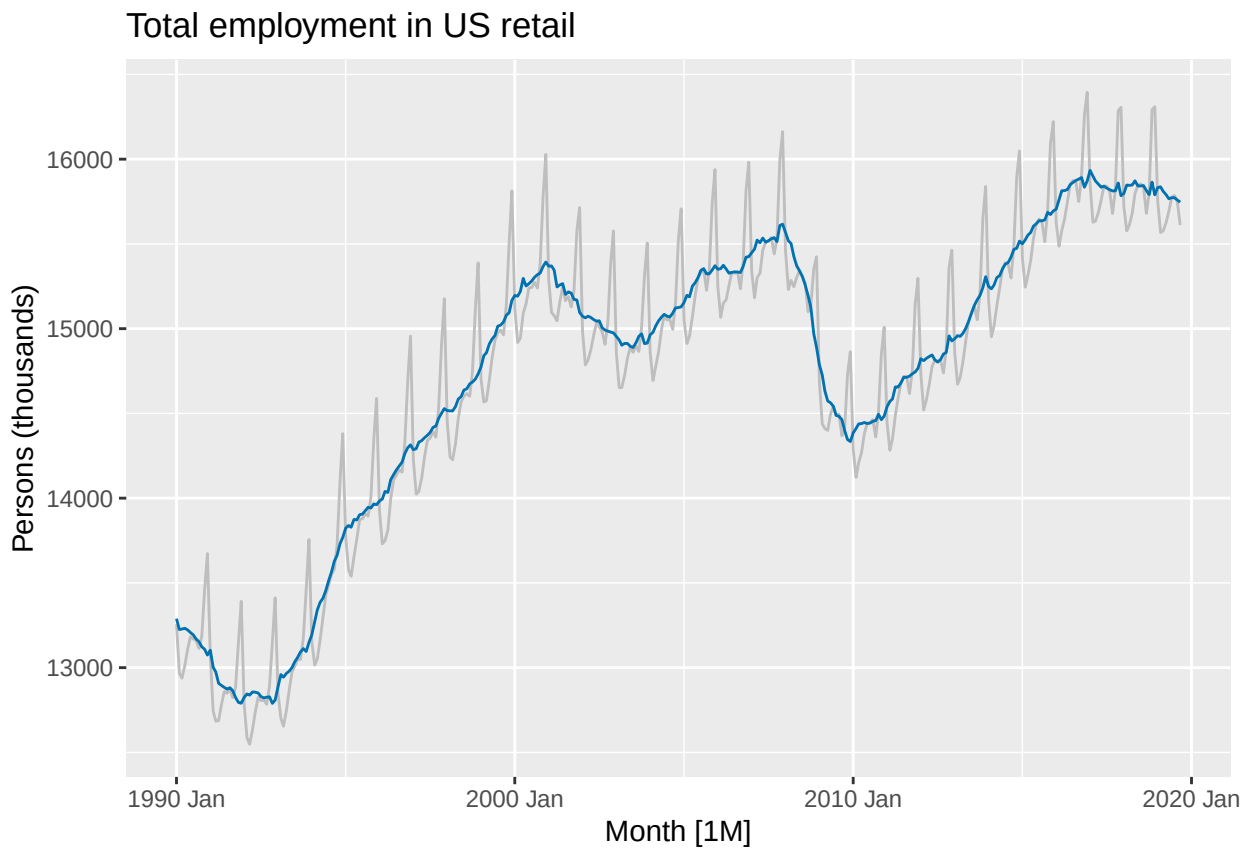



```
components(dcmp) %>% gg_subseries(season_year)
```



Seasonal adjustment

```
us_retail_employment %>%
autoplot(Employed, color='gray') +
autolayer(components(dcmp), season_adjust, color='#0072B2') +
labs(y="Persons (thousands)", title="Total employment in US retail")
```



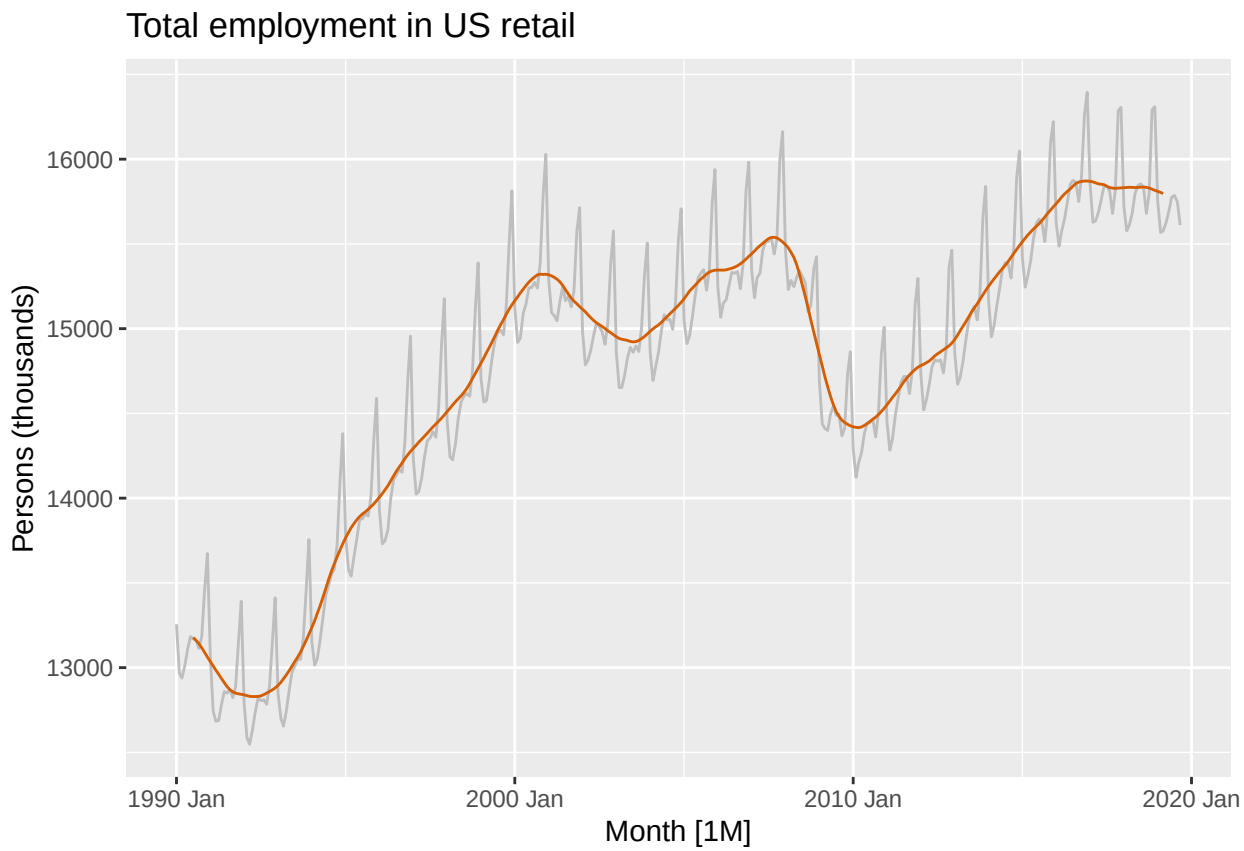
Moving averages

```
global_economy %>% filter(Country == "Australia") %>%
autoplot(Exports) +
labs(y="% of GDP", title= "Total Australian exports")
```

Moving average trend-cycle

```
us_retail_employment_ma <- us_retail_employment %>%
mutate(
`12-MA` = slider::slide_dbl(Employed, mean,
.before = 5, .after = 6, .complete = TRUE),
`2x12-MA` = slider::slide_dbl(`12-MA`, mean,
.before = 1, .after = 0, .complete = TRUE)
)
us_retail_employment_ma %>%
autoplot(Employed, color = "gray") +
autolayer(us_retail_employment_ma, vars(`2x12-MA`),
color = "#D55E00") +
labs(y = "Persons (thousands)",
title = "Total employment in US retail")
```

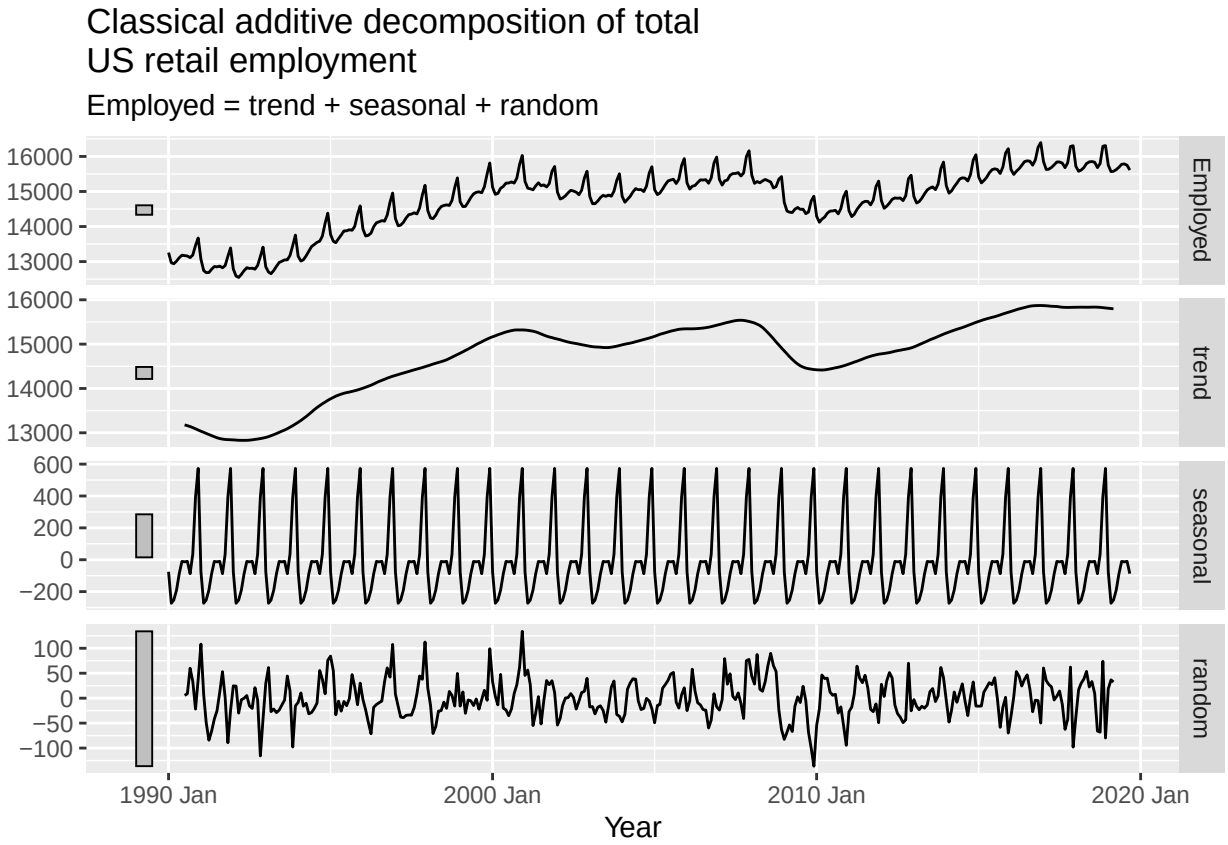
```
## Warning: Removed 12 row(s) containing missing values (geom_path).
```



##Classical decomposition

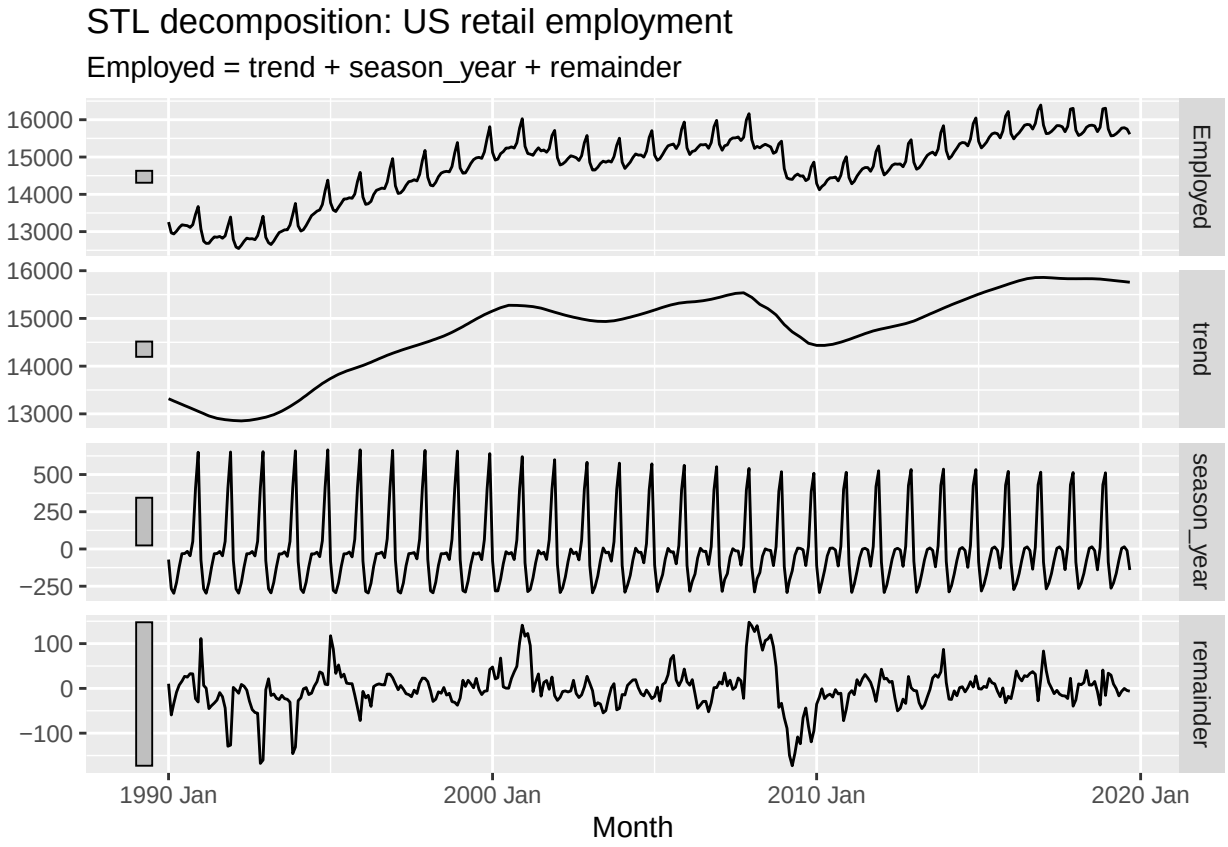
```
us_retail_employment %>%
model(classical_decomposition(Employed, type = "additive")) %>%
components() %>%
autoplot() + xlab("Year") +
ggtitle("Classical additive decomposition of total
US retail employment")
```

```
## Warning: Removed 6 row(s) containing missing values (geom_path).
```



STL decomposition

```
us_retail_employment %>%
model(STL(Employed ~ season(window=9), robust=TRUE)) %>%
components() %>% autoplot() +
labs(title = "STL decomposition: US retail employment")
```




```
us_retail_employment %>%
model(STL(Employed ~ season(window=5))) %>%
components()
```

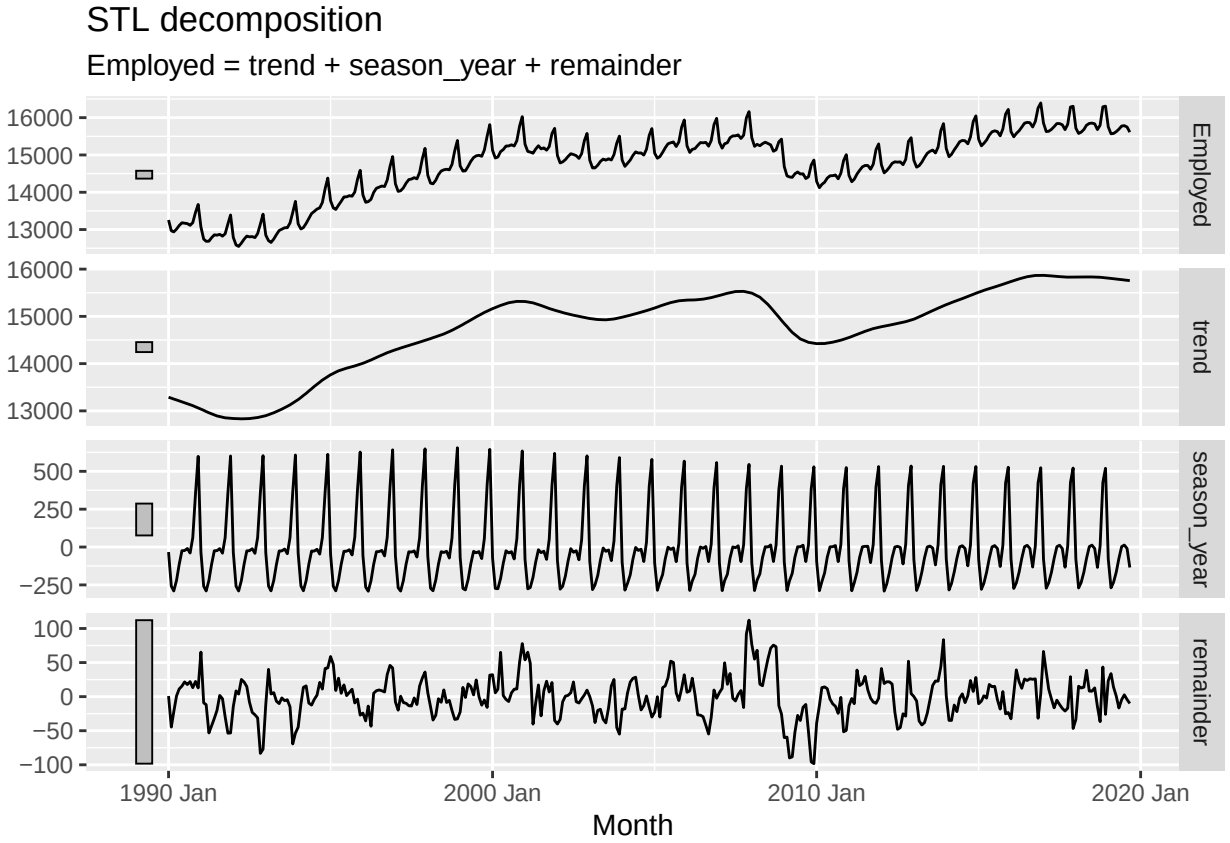
```
## # A dable: 357 x 7 [1M]
## # Key:     .model [1]
## # :        Employed = trend + season_year + remainder
##    .model              Month Employed  trend season_year remainder season_adjust
##    <chr>               <mth>    <dbl>  <dbl>       <dbl>     <dbl>         <dbl>
##  1 STL(Employed ~ ~ 1990 Jan   13256. 13294.       -2.16    -36.2         13258.
##  2 STL(Employed ~ ~ 1990 Feb   12966. 13273.     -260.      -47.3         13226.
##  3 STL(Employed ~ ~ 1990 Mar   12938. 13252.     -289.      -25.1         13227.
##  4 STL(Employed ~ ~ 1990 Apr   13012. 13231.     -221.        2.25        13233.
##  5 STL(Employed ~ ~ 1990 May   13108. 13209.     -111.        9.96        13219.
##  6 STL(Employed ~ ~ 1990 Jun   13183. 13188.      -18.8      14.1         13202.
##  7 STL(Employed ~ ~ 1990 Jul   13170. 13166.      -17.9      22.1         13188.
##  8 STL(Employed ~ ~ 1990 Aug   13160. 13144.       -2.53     18.1         13162.
##  9 STL(Employed ~ ~ 1990 Sep   13113. 13122.      -34.0      25.3         13147.
## 10 STL(Employed ~ ~ 1990 Oct   13185. 13100.       54.3      30.7         13131.
## # ... with 347 more rows
```

```
us_retail_employment %>%
model(STL(Employed ~ trend(window=15) +
season(window="periodic"),
```

```
robust = TRUE)
) %>% components()
```

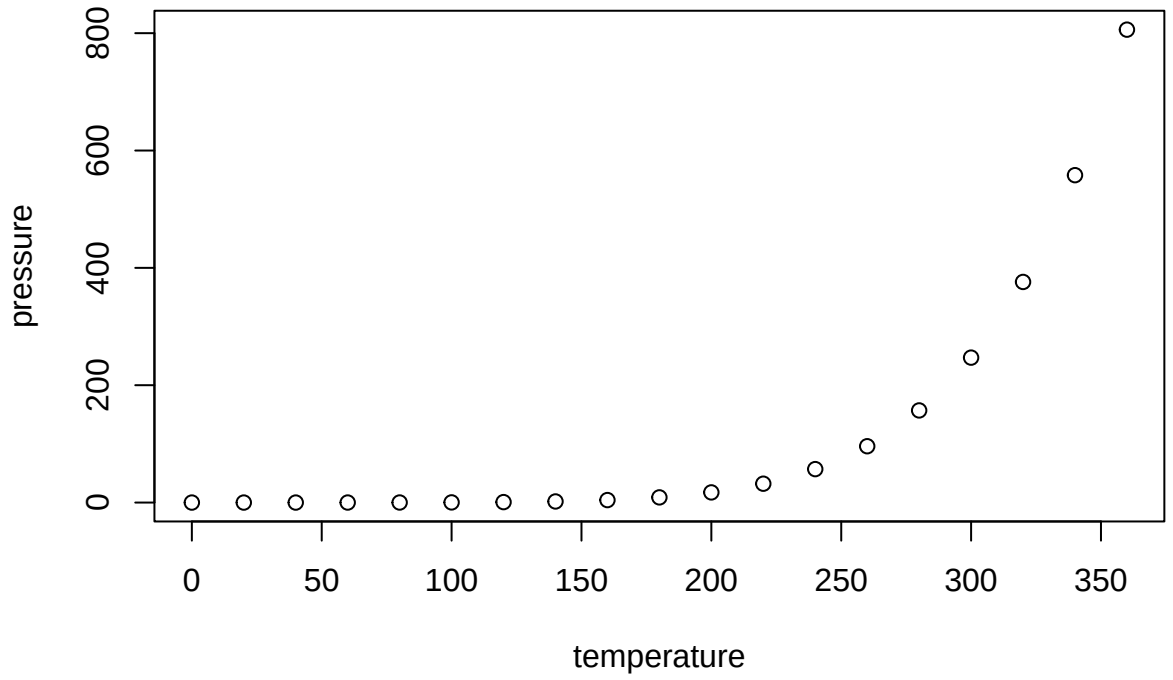
```
## # A dable: 357 x 7 [1M]
## # Key:     .model [1]
## # :        Employed = trend + season_year + remainder
##    .model              Month Employed  trend season_year remainder season_adjust
##    <chr>               <mth>    <dbl>  <dbl>       <dbl>     <dbl>         <dbl>
##  1 "STL(Employed ~~ 1990 Jan   13256. 13247.      -80.8      89.9         13337.
##  2 "STL(Employed ~~ 1990 Feb   12966. 13235.     -273.        4.72        13240.
##  3 "STL(Employed ~~ 1990 Mar   12938. 13223.     -258.      -26.5         13197.
##  4 "STL(Employed ~~ 1990 Apr   13012. 13211.     -186.      -12.6         13198.
##  5 "STL(Employed ~~ 1990 May   13108. 13198.      -88.4      -1.74        13197.
##  6 "STL(Employed ~~ 1990 Jun   13183. 13186.       -8.47      5.67        13191.
##  7 "STL(Employed ~~ 1990 Jul   13170. 13173.      -10.9       8.17        13181.
##  8 "STL(Employed ~~ 1990 Aug   13160. 13157.      -11.5      13.5         13171.
##  9 "STL(Employed ~~ 1990 Sep   13113. 13142.      -88.0      59.2         13201.
## 10 "STL(Employed ~~ 1990 Oct   13185. 13116.       39.0      29.8         13146.
## # ... with 347 more rows
```

```
us_retail_employment %>% model(STL(Employed)) %>%
components() %>% autoplot()
```



Including Plots

You can also embed plots, for example:



Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.