



# ETC3550/ETC5550 Applied forecasting

Week 3: Time series decomposition



- 1 White noise and random walks
- 2 Transformations
- 3 Time series decomposition
- 4 The ABS stuff-up

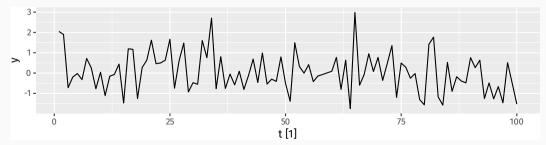
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#### White noise

White noise data consists of purely random draws from the same distribution with mean zero and constant variance.

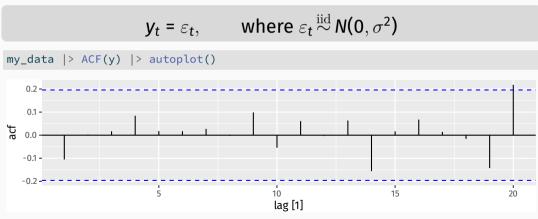
$$y_t = \varepsilon_t$$
, where  $\varepsilon_t \stackrel{\text{iid}}{\sim} N(0, \sigma^2)$ 

```
my_data <- tsibble(t = seq(100), y = rnorm(100), index = t)
my_data |> autoplot(y)
```



#### White noise

White noise data consists of purely random draws from the same distribution with mean zero and constant variance.



#### **Random walks**

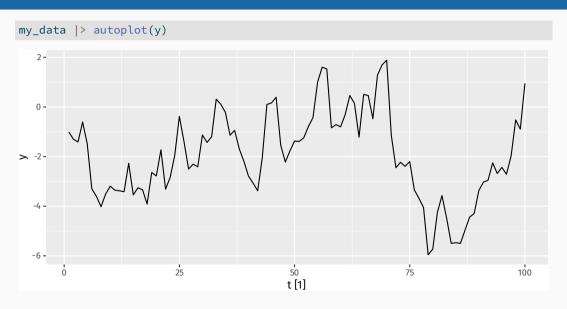
Random walks are a type of time series where the value at time t is equal to the previous value plus a random amount from a white noise process.

$$y_t = y_{t-1} + \varepsilon_t$$
, where  $\varepsilon_t \stackrel{\text{iid}}{\sim} N(0, \sigma^2)$ 

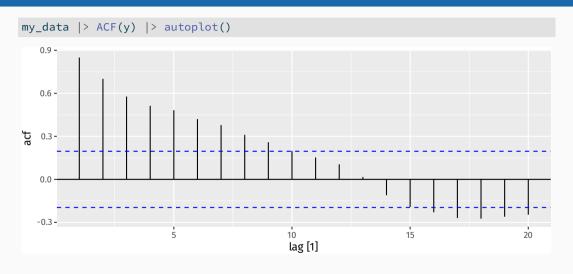
Equivalently, we can take the cumulative sum of a white noise process.

$$y_T = y_0 + \sum_{t=1}^T \varepsilon_t$$
, where  $\varepsilon_t \stackrel{\text{iid}}{\sim} N(0, \sigma^2)$ 

#### **Random walks**



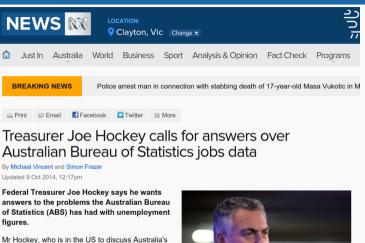
#### **Random walks**



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The rate was 6.1 per cent after jumping to a 12-year high of 6.4 per cent the previous month.

G20 agenda, said last month's unemployment

figures were "extraordinary".





## ABS jobs and unemployment figures - key questions answered by an expert

A professor of statistics at Monash University explains exactly what is seasonal adjustment, why it matters and what went wrong in the July and August figures



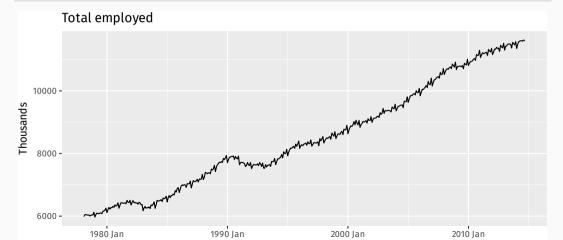
School leavers come on to the jobs market at the same time, causing a seasonal fluctuation. Photograph: Brian Snyder/Reuters

The Australian Bureau of Statistics has <u>retracted its seasonally adjusted</u> employment data for July and August, which recorded huge swings in the jobless rate. The ABS is also planning to review the methods it uses for easonal

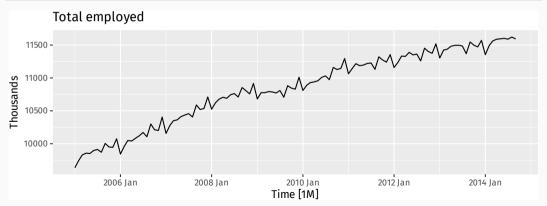
#### employed

```
# A tsibble: 440 x 4 [1M]
      Time Month Year Employed
     <mth> <ord> <dbl>
                         <dbl>
                  1978
1 1978 Feb Feb
                         5986.
2 1978 Mar Mar 1978
                       6041.
3 1978 Apr Apr 1978
                         6054.
4 1978 May May 1978
                         6038.
5 1978 Jun Jun 1978
                         6031.
6 1978 Jul Jul
                  1978
                         6036.
7 1978 Aug Aug
                  1978
                         6005.
8 1978 Sep Sep
                 1978
                         6024.
9 1978 Oct Oct
               1978
                         6046.
10 1978 Nov Nov
                  1978
                         6034.
# i 430 more rows
```

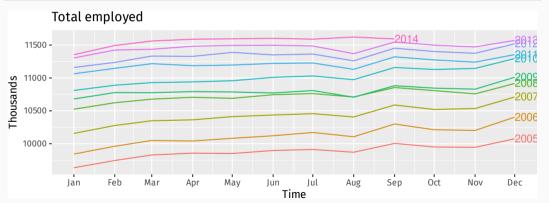
```
employed |>
  autoplot(Employed) +
  labs(title = "Total employed", y = "Thousands")
```



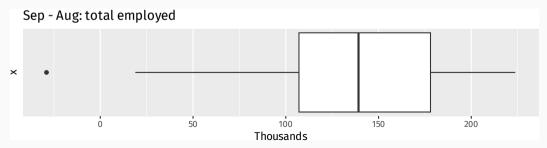
```
employed |>
  filter(Year >= 2005) |>
  autoplot(Employed) +
  labs(title = "Total employed", y = "Thousands")
```



```
employed |>
  filter(Year >= 2005) |>
  gg_season(Employed, labels = "right") +
  labs(title = "Total employed", y = "Thousands")
```

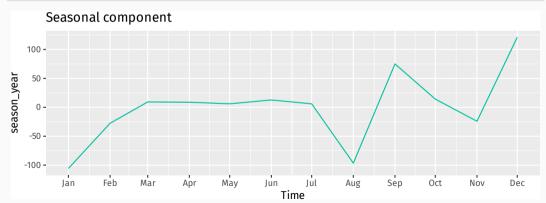


```
employed |>
  mutate(diff = difference(Employed)) |>
  filter(Month == "Sep") |>
  ggplot(aes(y = diff, x = 1)) +
  geom_boxplot() +
  coord_flip() +
  labs(title = "Sep - Aug: total employed", y = "Thousands") +
  scale_x_continuous(breaks = NULL, labels = NULL)
```

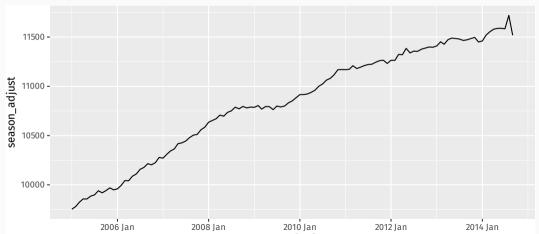


```
dcmp <- employed |>
  filter(Year >= 2005) |>
  model(stl = STL(Employed ~ season(window = 11), robust = TRUE))
components(dcmp) |> autoplot()
     STL decomposition
     Employed = trend + season year + remainder
                                                                                         mploye
                                                                                          trend
        2008 lan
                                              2010 lan
                                                              2012 lan
                2006 lan
                                                                             2014 lan
                                             Time
```

```
components(dcmp) |>
  filter(year(Time) == 2013) |>
  gg_season(season_year) +
  labs(title = "Seasonal component") + guides(colour = "none")
```



```
components(dcmp) |>
  as_tsibble() |>
  autoplot(season_adjust)
```



- August 2014 employment numbers higher than expected.
- Supplementary survey usually conducted in August for employed people.
- Most likely, some employed people were claiming to be unemployed in August to avoid supplementary questions.
- Supplementary survey not run in 2014, so no motivation to lie about employment.
- In previous years, seasonal adjustment fixed the problem.
- The ABS has now adopted a new method to avoid the bias.