



Dealing with higher dimensions

Arnaud Amsellem

The R Trader



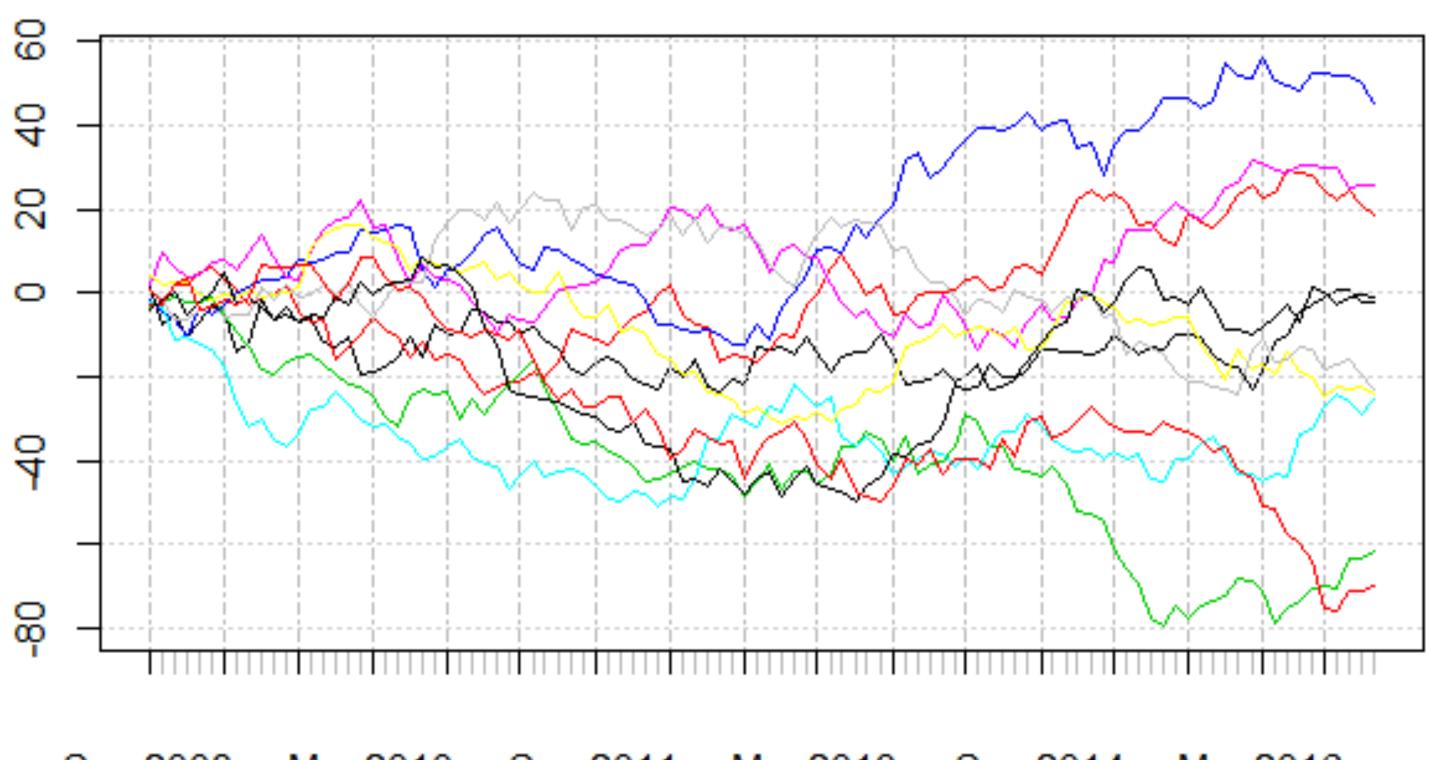
Multiple time series

- Identify how they interact
- Eg.: single stock price reaction to interest rates change
- Eg.: stock price reaction of several stocks to interest rates change
- Identify patterns



10 time series

10 time series

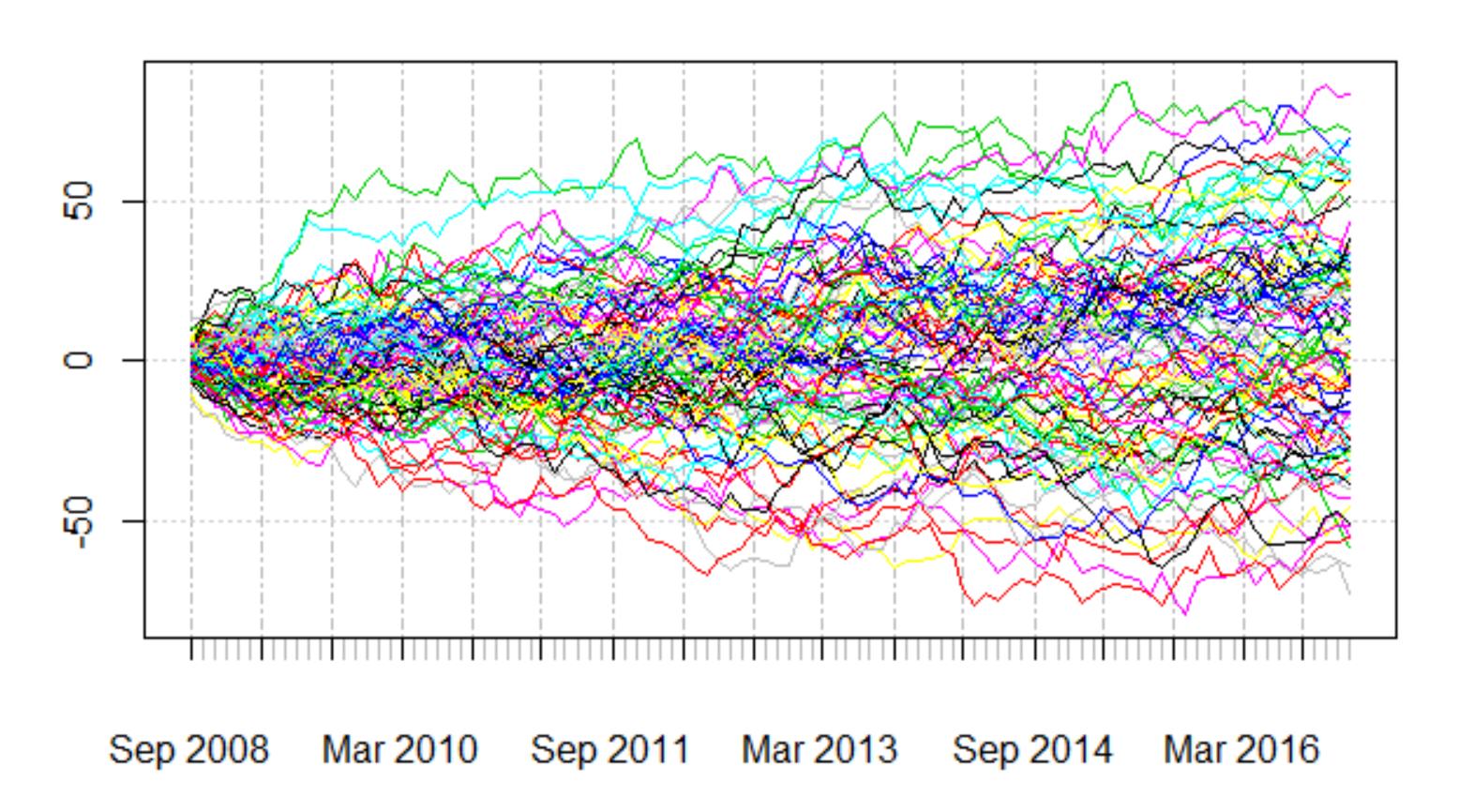


Sep 2008 Mar 2010 Sep 2011 Mar 2013 Sep 2014 Mar 2016



100 time series

100 time series







Let's practice!





Multivariate time series

Arnaud Amsellem

The R Trader





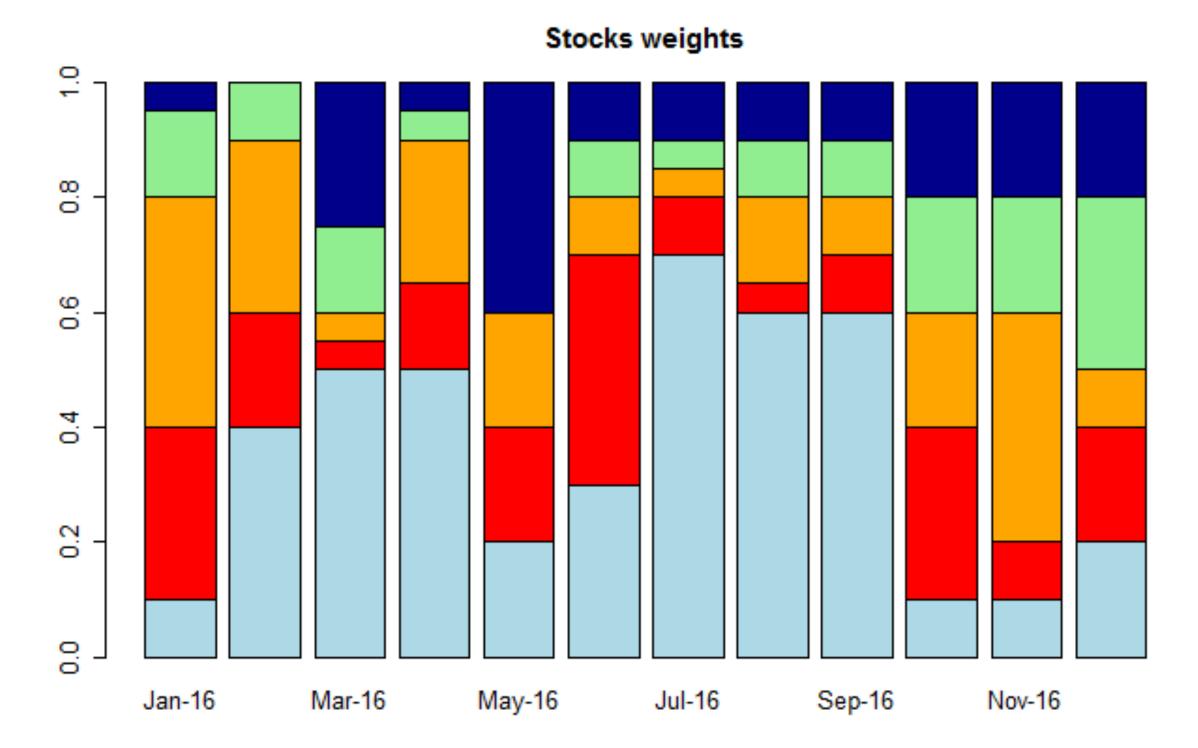
Stocks

```
> head(my_stocks)
              Stock B
                        Stock C
                                  Stock D
    Stock A
                                            Stock E
    -0.0320
              -0.0092
                                  -0.0314
                        -0.0286
                                            -0.0209
    -0.0358
              -0.0148
                         0.0001
                                  -0.0162
                                             0.0016
3
     0.0092
               0.0126
                         0.0139
                                  -0.0016
                                            -0.0127
     0.0149
                                   0.0246
                                             0.0332
               0.0290
                         0.0377
4
                                  -0.0016
5
    -0.0226
              -0.0084
                         0.0011
                                            -0.0102
    -0.0079
                        -0.0249
6
              -0.0126
                                  -0.0059
                                            -0.0187
> head(stock_weights)
       Stock A Stock B Stock C Stock D Stock E
Jan-16
           0.1
                   0.30
                           0.40
                                    0.15
                                            0.05
Feb-16
           0.4
                   0.20
                           0.30
                                    0.10
                                            0.00
Mar-16
           0.5
                   0.05
                           0.05
                                    0.15
                                            0.25
Apr-16
           0.5
                           0.25
                                    0.05
                                             0.05
                   0.15
May-16
           0.2
                           0.20
                                    0.00
                                             0.40
                   0.20
Jun-16
           0.3
                   0.40
                           0.10
                                             0.10
                                    0.10
```





Stacked chart







Correlation matrix with numbers

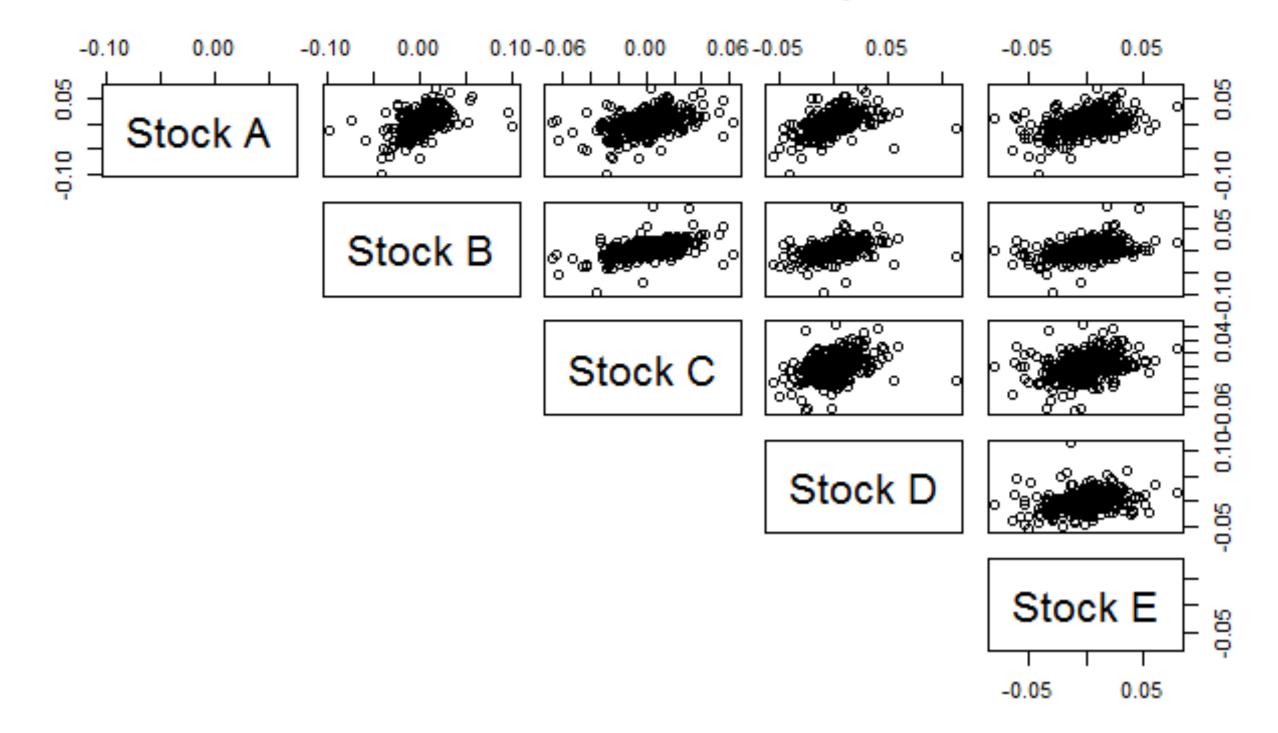
```
round(cor(my_stocks), digit = 4)
                                     Stock D
                                               Stock E
          Stock A Stock B
                            Stock C
Stock A
         1.0000
                  0.4841
                            0.4292
                                      0.5085
                                               0.4029
Stock B
         0.4841
                 1.0000
                            0.5133
                                     0.3955
                                               0.4329
Stock C
         0.4292
                 0.5133
                            1.0000
                                     0.3628
                                               0.3414
Stock D
         0.5085
                  0.3955
                                               0.2939
                            0.3628
                                     1.0000
                  0.4329
Stock E
                            0.3414
         0.4029
                                      0.2939
                                               1.0000
```





Correlation matrix with scatterplots

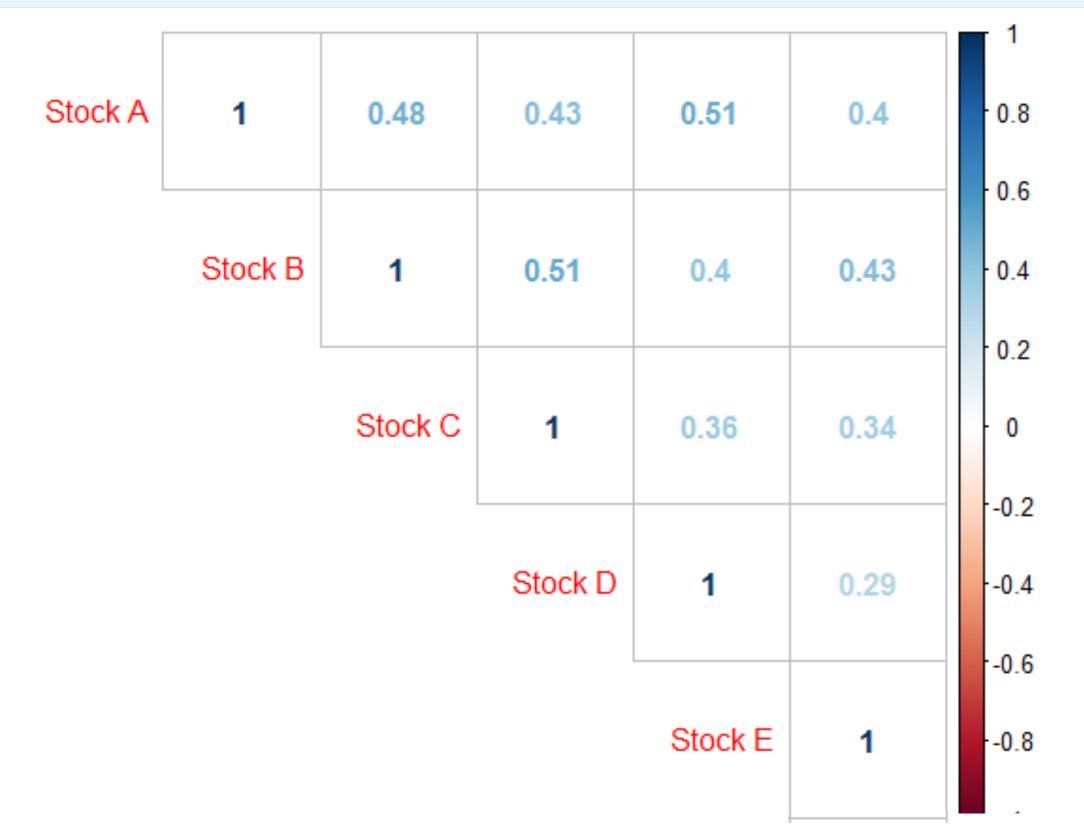
Stocks Correlation Scatterplots





corrplot()

```
> corrplot(my_stocks,
    method = "number",
    type = "upper")
```







Let's practice!





Higher dimension time series

Arnaud Amsellem

The R Trader



100 x 100 correlation matrix

> cor_mat

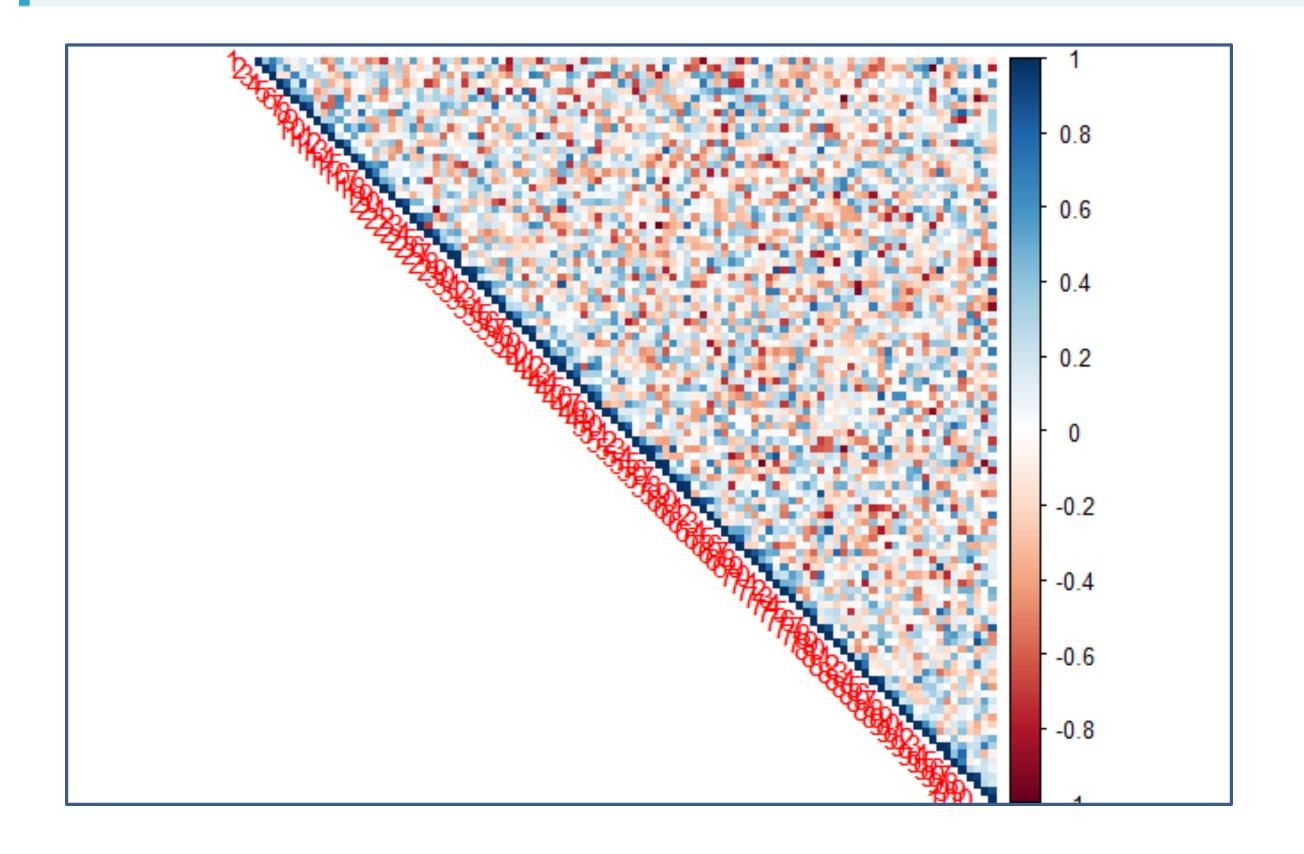
100x100 Correlation Matrix

-0 -1 0.1 -0 -0 -0 0 0.3 -0 -0 0.5 -0 0 0.3 -0 -0 0.5 -0 0 0 0.3 -0 -0 0.5 -0 0 0 0.3 0 0 0.3 0 0 0.3 0 0 0.3 0 0 0.3 0.2 0 -0 -0 0.4 0.3 0 0 0.3 0 0 0.3 0.2 0 -0 -0 0.4 0.3 0 0.2 0 0 0.3 0 0 0.3 0 0 0.3 0 0 0.3 0.2 0 -0 0.4 0.3 0 0.3 0 0.3 0 2 02 01 02 02 -0 0.1 -0 -1 -0 02 0 0.1 -0 -1 -0 02 0 0.1 -0 -0 0.3 0.5 -0 -0 -0 0.3 0.5 -0 -0 -0 0.7 0.3 -0 -0 -0 0.3 -0 -0 -0 0.1 0.3 0.1 -0 -0 0.7 0.3 -0 -0 -0 0.1 0.3 0.1 -0 -0 0.7 0.3 -0 -0 -0 0.1 0.3 0.1 0.1 -0 -0 0.7 0.3 -0 0.3 0.1 -0 -0 0.7 0.3 -0 0.3 0.1 -0 -0 0.7 0.3 -0 0.3 0.1 -0 -0 0.7 0.3 -0 0.3 0.1 -0 -0 0.7 0.3 -0 0.3 0.1 -0 -0 0.7 0.3 -0 0.3 0.1 -0 0.7 0.3 -0 0.3 0.1 -0 0.7 0.3 -0 0.3 0.1 -0 0.7 0.3 -0 0.3 0.1 -0 0.7 0.3 -0 0.3 0.1 -0 0.7 0.3 -0 0.3 0.1 -0 0.7 0.3 -0 0.3 0.1 -0 0.7 0.3 -0 0.3 0.1 -0 0.7 0.3 -0 0.3 0.1 -56 0.6 -1 -0 -0 0.7 0.5 -0 -0 0.7 0.5 -0 -0 0.7 0.5 -0 -0 0.7 0.5 -0 -0 0.3 0.7 -1 0.4 0 -0 0.3 0.4 -1 -0 -0 0.3 0.4 -1 -0 -0 0.3 0.4 -1 -0 -0 0.3 0 0.2 -0 0.6 0 -0 0.3 0.4 0.5 0.4 0 9 0 -0 -0 10 1 0.1 0.4 0.1 0 0.1 -0 10.4 0.1 0 0.1 -0 0.2 0.5 -1 -0 -0 -1 0.6 -0 -1 0.6 -0 -1 0.6 -0 -1 0.6 -0 -1 0.6 -0 -1 0.6 -0 -1 0.6 -0 -1 0.6 -0 -1 0.6 -0 -1 0.6 -0 -1 0.6 -0 -1 0.6 -0 0.1 0.4 -1 0 0.8 -1 0. **50** 0.5 -0 -0 -1 -0 -0 -1 0.2 0.1 -0 0.2 -0 -1 0.2 0.1 -0 0.2 -0 -1 0.4 0.0 -0 -1 0.4 0.0 -0 -0 0.4 0.3 0.5 -0 -0 -0 0.4 0.3 0.5 -0 -0 -1 0.4 0.0 -0 -1 0.5 -0 -0 -0 -0 0.6 0.1 -0 0.4 0.0 -0 0.4 0.3 0.5 -0 -0 -0 0.6 0.1 -0 0.6 0.1 -0 0.4 0.0 0.2 0.1 0.5 -0 -0 -0 0.5 0.1 -0 0.2 0.1 0.5 -0 -0 -0 0.5 0.1 -0 0.2 0.1 0.5 -0 -0 -0 -0 0.5 0.1 -0 0.4 0.3 0.5 -0 -0 -0 0.5 0.1 -0 0.5 -0 -0 0.5 0.1 -0 0.5 0.1 -0 0.5 0.1 -0 0.5 0.1 -0 0.5 0.1 -0 0.5 0.1 0.5 0.1 -0 0.1 -0 0.5 0.1 -0 0.1 -0 0.1 -0 0.1 -0 0.1 -0 0.1 -0 0.1 -0 0.1 -0 0.1 -0 0.1 -0 0



Correlation matrix as heatmap

```
> corrplot(cor_mat, method = "color", type = "upper")
```







Let's practice!