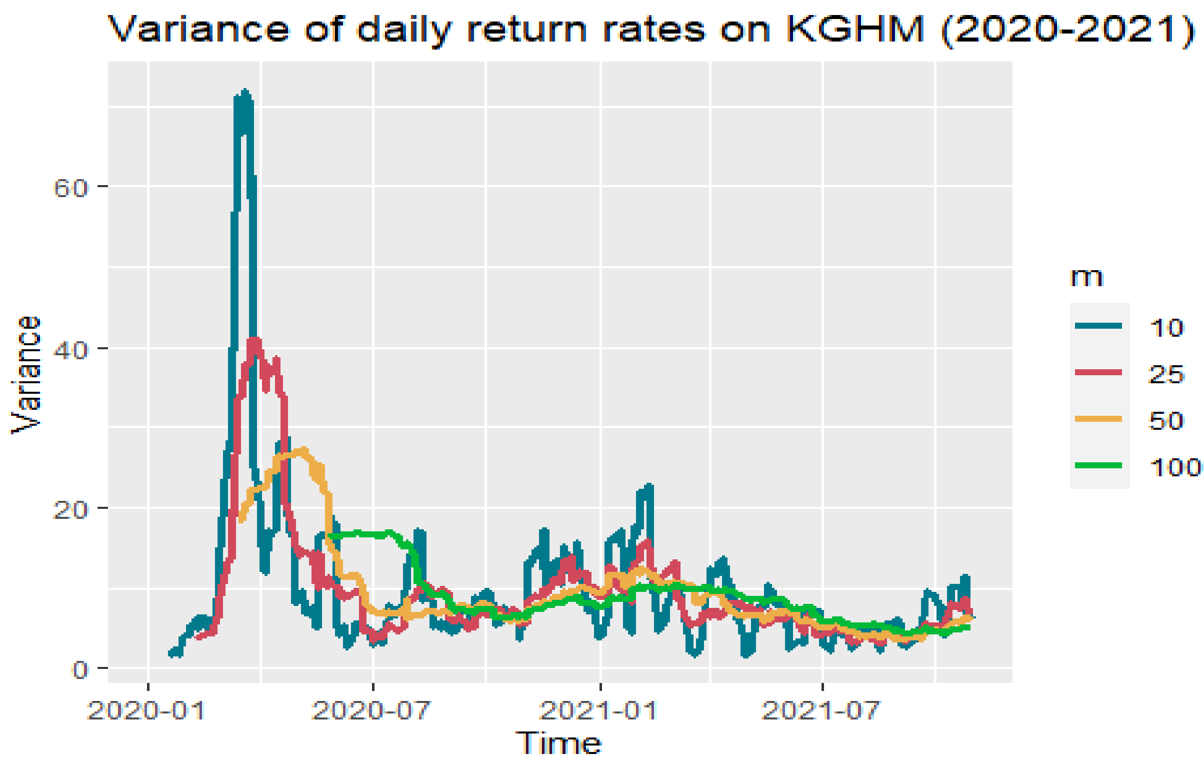
Exercises_2

12 12 2021

1. Exercise 1

```
library(ggplot2)
library(dplyr)
library(GGally)

kgh_d_2020 <- read.csv("kgh_d_2020.csv", header = TRUE)
kgh_d_2021 <- read.csv("kgh_d_2021.csv", header = TRUE)
lts_d_2021 <- read.csv("lts_d_2021.csv", header = TRUE)
pge_d_2021 <- read.csv("pge_d_2021.csv", header = TRUE)
usdpln_d <- read.csv("usdpln_d.csv", header = TRUE)

close_d_2020 <- kgh_d_2020$Zamkniecie
rate_of_return_d_2020_l <- rep(0, 461)
for(i in 1:461){
  rate_of_return_d_2020_l[i] = 100 * log(close_d_2020[i + 1]/close_d_2020[i])
}

variation_return <- function(x, m){
  x_mean <- mean(x)
  vr <- c()
  for(i in (m + 1):461){
    s = 0
    for(j in 1:m){
      s = s + (x[i - j] - x_mean)^2
    }
    s = 1/(m - 1) * s
    vr <- append(vr, s)
  }
  return(vr)
}

data1 <- data.frame(
  day <- kgh_d_2020$Data[2:462],
  m_10 <- rep(NA, 461),
  m_25 <- rep(NA, 461),
  m_50 <- rep(NA, 461),
  m_100 <- rep(NA, 461)
)
colnames(data1) <- c("day","m_10", "m_25", "m_50", "m_100")

vr_10 <- variation_return(rate_of_return_d_2020_l, 10)
vr_25 <- variation_return(rate_of_return_d_2020_l, 25)
```

```r
vr_50 <- variation_return(rate_of_return_d_2020_l, 50)
vr_100 <- variation_return(rate_of_return_d_2020_l, 100)

for(i in 1:length(vr_10)){
  data1$m_10[i + 10] = vr_10[i]
}

for(i in 1:length(vr_25)){
  data1$m_25[i + 25] = vr_25[i]
}

for(i in 1:length(vr_50)){
  data1$m_50[i + 50] = vr_50[i]
}

for(i in 1:length(vr_100)){
  data1$m_100[i + 100] = vr_100[i]
}

ggplot() +
  geom_line(aes(x=as.Date(data1$day),y=data1$m_10,color='#00798c'), size =
1.3) +
  geom_line(aes(x=as.Date(data1$day),y=data1$m_25,color='#d1495b'), size =
1.3) +
  geom_line(aes(x=as.Date(data1$day),y=data1$m_50,color='#edae49'), size =
1.3) +
  geom_line(aes(x=as.Date(data1$day),y=data1$m_100,color='#00BA38'), size =
1.3) +
  ggtitle("Variance of daily return rates on KGHM (2020-2021)") +
  ylab('Variance')+xlab('Time') +
  scale_colour_manual(name = 'm',values
=c('#00798c'='#00798c','#d1495b'='#d1495b','#edae49'='#edae49','#00BA38'='#00
BA38'),
  labels = c('10','25','50','100'))
```



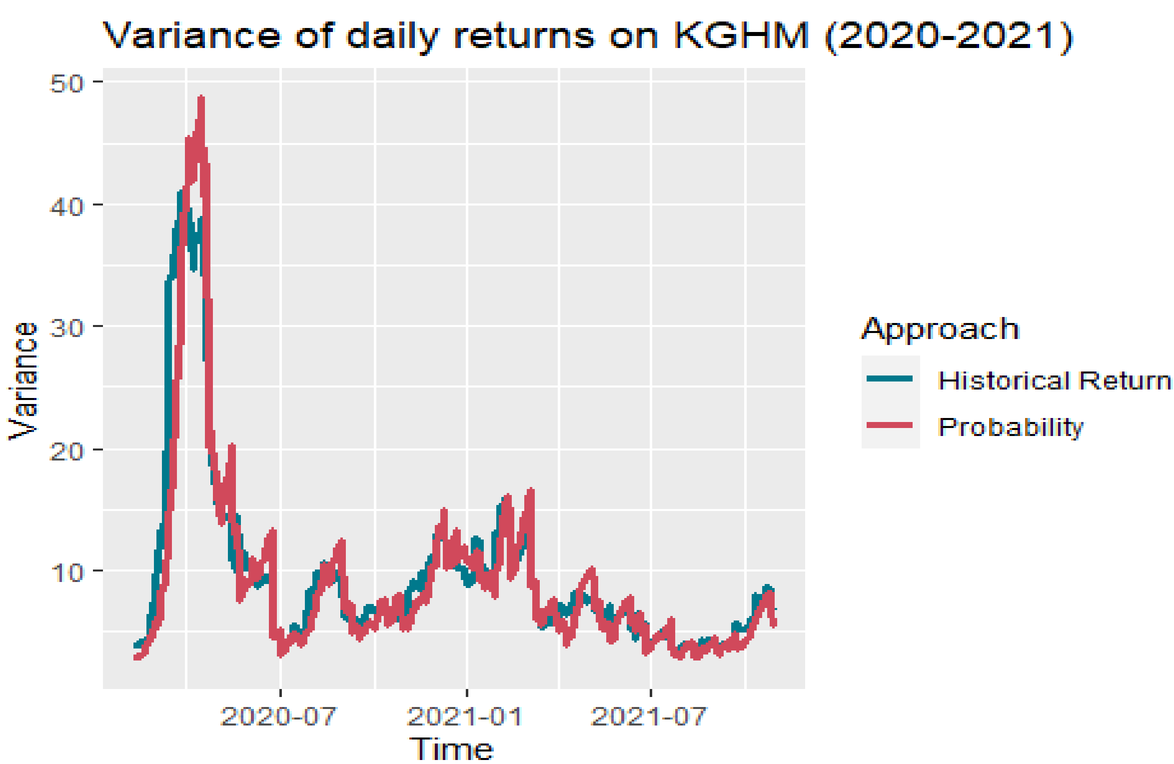
Interpretation

The presented visualization shows that as the size increases, the graph becomes smoother and loses its accuracy. In this case, the risk for KGHM relatevly decreases over time.

2. Exercise 2

```
w_sum = 0
for(i in 1:25){
  w_sum = w_sum + i
}

weights <- c()
for(i in 1:25){
  rank = i/w_sum
  weights <- append(weights, rank)
}

vr_25_2 <- c()
for(i in 26:461){
  s = 0
  for(j in 1:25){
    s = s + weights[j] * (rate_of_return_d_2020_l[i - j]^2)
  }
  vr_25_2 <- append(vr_25_2, s)
}
```

```
data2 <- data.frame(
  day <- kgh_d_2020$Data[27:462],
  w1 <- vr_25,
  w2 <- vr_25_2
)
colnames(data2) <- c("day","historical", "probability")

length(vr_25)

## [1] 436

ggplot() +
  geom_line(aes(x=as.Date(data2$day),y=data2$historical,color='#00798c'),
size = 1.3) +
  geom_line(aes(x=as.Date(data2$day),y=data2$probability,color='#d1495b'),
size = 1.3) +
  ggtitle("Variance of daily returns on KGHM (2020-2021)") +
  ylab('Variance')+xlab('Time') +
  scale_colour_manual(name = 'Approach',values
=c('#00798c'='#00798c','#d1495b'='#d1495b'),
                      labels = c('Historical Return',"Probability"))
```

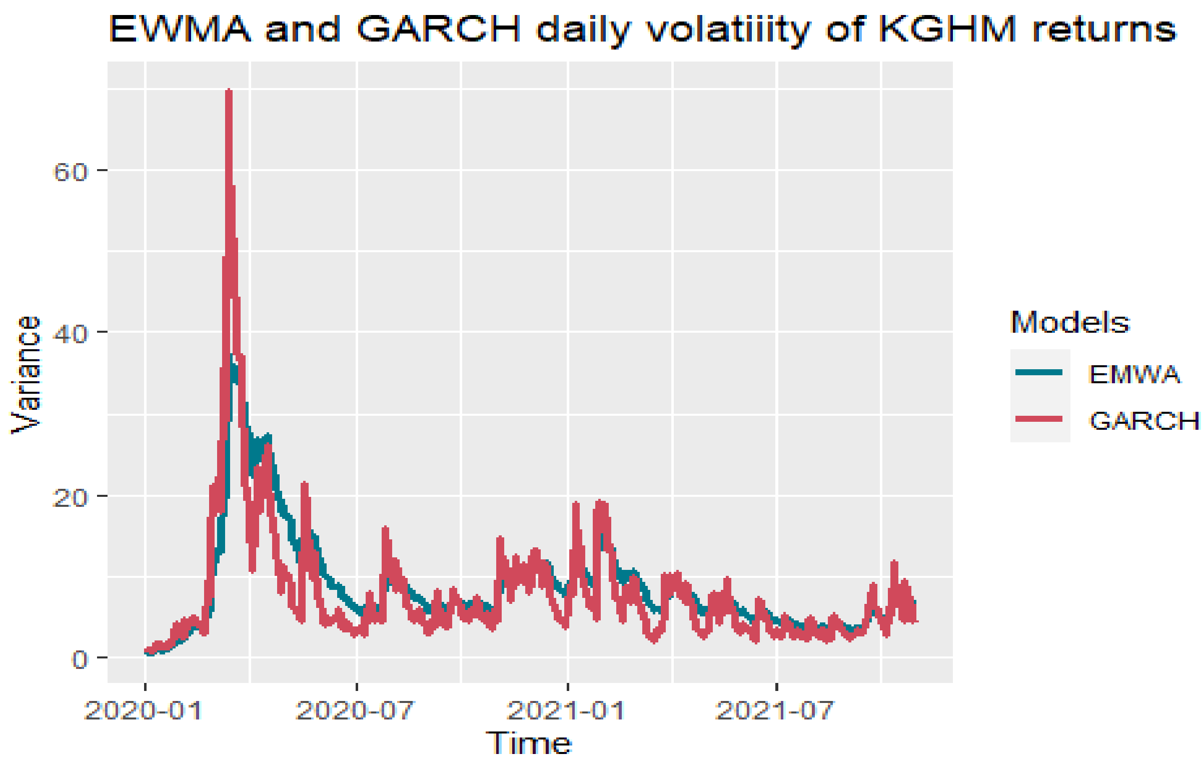


Interpretation

When analyzing the chart, it can be concluded that the rates of return are similar to each other in periods of decline, because they regularly overlap, and they are different in periods of increases.

3. Exercise 3

```
ewma <- function(x, l){
  var_ewma <- c()
  lambda = l
  s = (1 - lambda) * x[1]^2
  var_ewma <- append(var_ewma, s)
  for(i in 1:461){
    s = lambda*s + (1 - lambda) * x[i]^2
    var_ewma <- append(var_ewma, s)
  }
  return(var_ewma)
}
var_ewma <- ewma(rate_of_return_d_2020_l, 0.94)

garch <- function(x, g, a, b, lr_vr){
  var_garch <- c()
  gamma = g
  alpha = a
  beta = b
  long_run_vr = lr_vr
  s = gamma * long_run_vr + alpha * x[1]^2
  var_garch <- append(var_garch, s)
  for(i in 1:461){
    s = gamma * long_run_vr + alpha * x[i]^2 + beta * s
    var_garch <- append(var_garch, s)
  }
  return(var_garch)
}

var_garch <- garch(rate_of_return_d_2020_l, 0.02, 0.15, 0.83, 0.00015)


ggplot() +
  geom_line(aes(x=as.Date(kgh_d_2020$Data),y=var_ewma,color='#00798c'), size
= 1.3) +
  geom_line(aes(x=as.Date(kgh_d_2020$Data),y=var_garch,color='#d1495b'), size
= 1.3) +
  ggtitle("EWMA and GARCH daily volatiiity of KGHM returns") +
  ylab('Variance')+xlab('Time') +
  scale_colour_manual(name = 'Models',values
=c('#00798c'='#00798c','#d1495b'='#d1495b'),
                      labels = c('EMWA',"GARCH"))
```

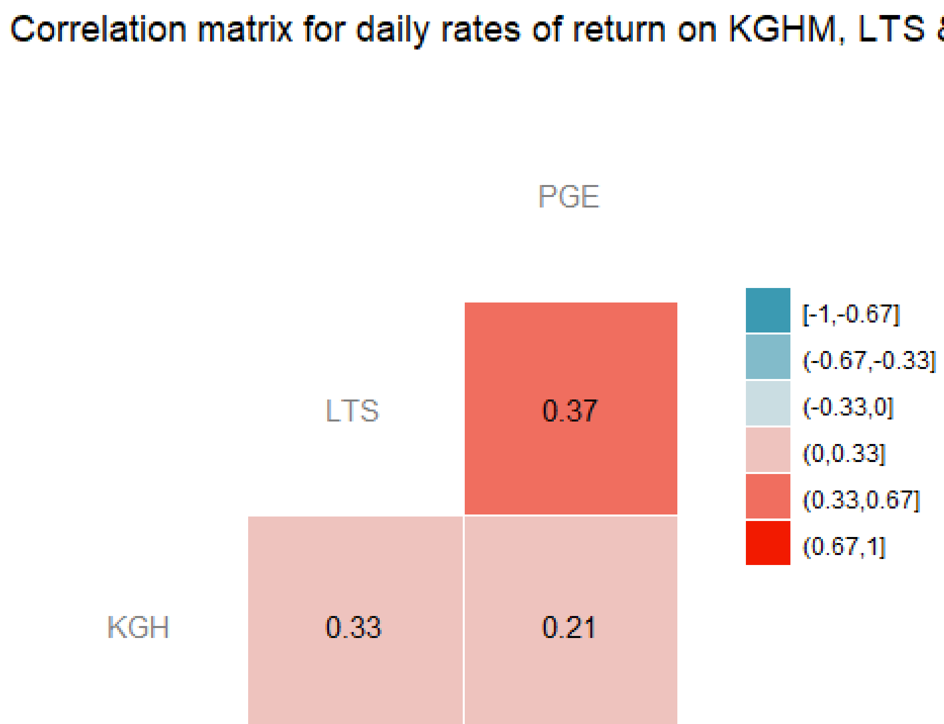


Interpretation The presented visualization shows that GARCH is more sensitive to changes than EWMA.

4. Exercise 4

```
close_kgh_d_2021 <- kgh_d_2021$Zamkniecie
rate_of_return_kgh_d_2021_l <- rep(0, 483)
for(i in 1:209){
  rate_of_return_kgh_d_2021_l[i] = 100 * log(close_kgh_d_2021[i +
1]/close_kgh_d_2021[i])
}

close_lts_d_2021 <- lts_d_2021$Zamkniecie
rate_of_return_lts_d_2021_l <- rep(0, 483)
for(i in 1:209){
  rate_of_return_lts_d_2021_l[i] = 100 * log(close_lts_d_2021[i +
1]/close_lts_d_2021[i])
}

close_pge_d_2021 <- pge_d_2021$Zamkniecie
rate_of_return_pge_d_2021_l <- rep(0, 483)
for(i in 1:209){
  rate_of_return_pge_d_2021_l[i] = 100 * log(close_pge_d_2021[i +
1]/close_pge_d_2021[i])
}
```

```r
data4 <- data.frame(
  kgh <- rate_of_return_kgh_d_2021_l,
  lts <- rate_of_return_lts_d_2021_l,
  pge <- rate_of_return_pge_d_2021_l
)
colnames(data4) <- c("KGH","LTS", "PGE")

ggcorr(data4,
       nbreaks = 6,
       label = TRUE,
       label_size = 4,
       label_round = 2,
       color = "grey50") +
  ggtitle("Correlation matrix for daily rates of return on KGHM, LTS & PGE")
```



Interpretation

The values of the correlation matrix indicate weak relationships between the variables representing the daily rates of return.

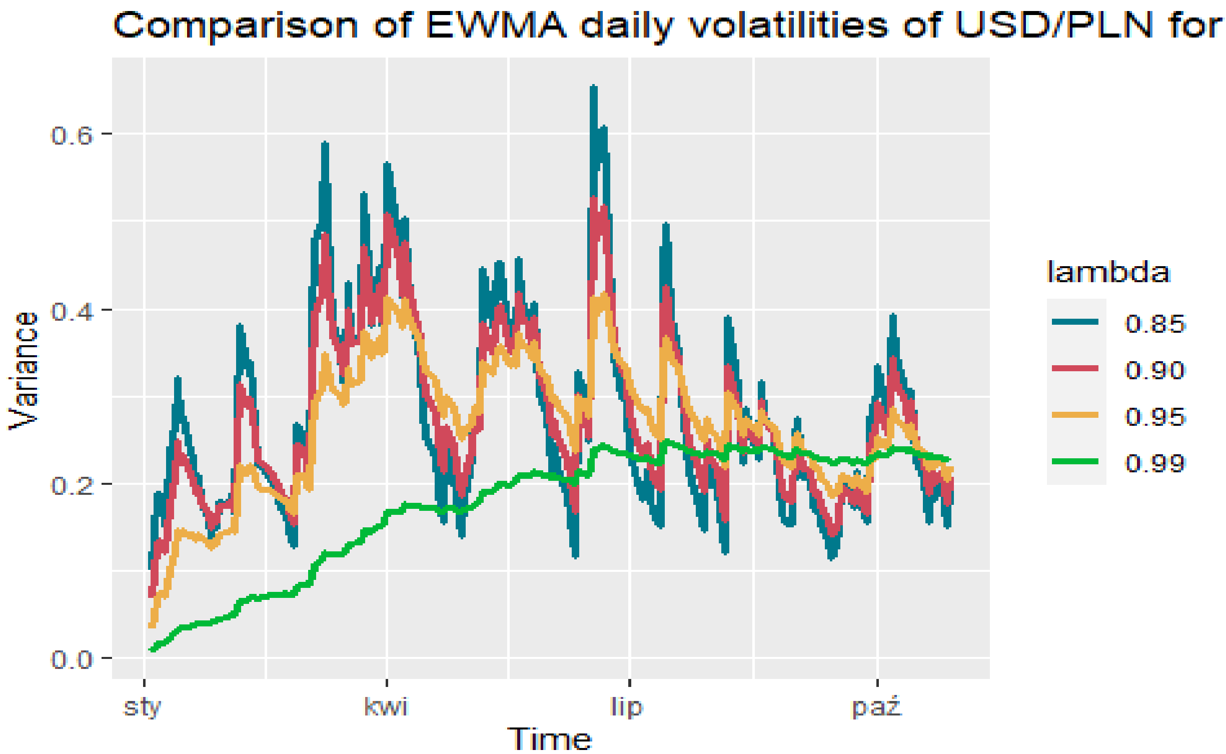
5. Exercise 5

Interpretation Diversifying the portfolio with non-correlated assets can mitigate volatility and risk. In contrast autocorelation rises risk.

6. Exercise 6

```
close_usdpln_d_2021 <- usdpln_d$Zamkniecie
rate_of_return_d_usdpln_2021_l <- rep(0, 213)
for(i in 1:213){
  rate_of_return_d_usdpln_2021_l[i] = 100 * log(close_usdpln_d_2021[i +
1]/close_usdpln_d_2021[i])
}

data6 <- data.frame(
  day <- usdpln_d$Data[1:213],
  l_0_85 <- rep(NA, 213),
  l_0_90 <- rep(NA, 213),
  l_0_95 <- rep(NA, 213),
  l_0_99 <- rep(NA, 213)
)
colnames(data6) <- c("day","l_85", "l_90" , "l_95", "l_99")

ewma <- function(x, l){
  var_ewma <- c()
  lambda = l
  s = (1 - lambda) * x[1]^2
  var_ewma <- append(var_ewma, s)
  for(i in 1:461){
    s = lambda*s + (1 - lambda) * x[i]^2
    var_ewma <- append(var_ewma, s)
  }
  return(var_ewma)
}

l <- c(0.85, 0.90, 0.95, 0.99)
for(i in 1:4){
  vr_i <- ewma(rate_of_return_d_usdpln_2021_l,l[i])
  for(k in 1:length(vr_i)){
    data6[k, i + 1] = vr_i[k]
  }
}

ggplot() +
  geom_line(aes(x=as.Date(data6$day),y=data6$l_85,color='#00798c'), size =
1.3) +
  geom_line(aes(x=as.Date(data6$day),y=data6$l_90,color='#d1495b'), size =
1.3) +
  geom_line(aes(x=as.Date(data6$day),y=data6$l_95,color='#edae49'), size =
1.3) +
  geom_line(aes(x=as.Date(data6$day),y=data6$l_99,color='#00BA38'), size =
1.3) +
  ggtitle("Comparison of EWMA daily volatilities of USD/PLN for different
lambda values") +
  ylab('Variance')+xlab('Time') +
```

```
  scale_colour_manual(name = 'lambda',values
=c('#00798c'='#00798c','#d1495b'='#d1495b','#edae49'='#edae49','#00BA38'='#00
BA38'),
                      labels = c('0.85','0.90','0.95','0.99'))
```



Interpretation

The choice of the lambda value significantly affects the results. The graph shows that as the value of this variable increases, the accuracy of the results obtained decreases. Among the tested lambda, the most accurate, i.e. probably the best results, is generated by lamda = 0.85.