A07_G44206031

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Call in the R package

```
library(quadprog)
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 3.4.4
```

The return of the 3 stocks are listed as follows

```
mu_return_vector <- c(0.05, 0.04, 0.06)
```

The Variance and Covariance of the 3 stocks is the matrix below

```
sigma <- matrix(c(0.01, 0.002, 0.005,
                  0.002, 0.008, 0.006,
                  0.005, 0.006, 0.012),
                nrow=3, ncol=3)
```

Mapping the parameters

```
D.Matrix <- 2*sigma
d.Vector <- rep(0, 3)
A.Equality <- matrix(c(1,1,1), ncol=1)
A.Matrix <- cbind(A.Equality, mu_return_vector,
                  diag(3))
```

Create vecotors for risks and returns. Choose 500 points between 0,035 and 0.06. For each return, a minimum risk can be obtained.Minimus risk is out$value.

```
return = seq(0.035, 0.06,by = 0.00005)
risk = rep(0,length(return))
```

Obtain the minimum risks for all the 500 return by the following loop.

```
for (i in return) {

  b.Vector <- c(1, i, rep(0, 3))

  out <- solve.QP(Dmat=D.Matrix, dvec=d.Vector,
                  Amat=A.Matrix, bvec=b.Vector,
                  meq=1)

  risk[which(return==i)] <- out$value}
```

Transform risk and return into dataframe and plot using ggplot.

```
data = as.data.frame(risk)
data$return <- return
```

Plot the efficient frontier using ggplot

```
ggplot(data, aes(x=risk, y=return )) + geom_line(color = 'red')+ xlab('Risk appetite'
) +
  ylab('Expected return') + labs(title = 'Efficient Frontier')
```