A tutorial on conducting portfolio optimization

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Contents

1 Start up

```
inslib <- function(x){
    x <-as.character(substitute(x))
    if(!x %in% rownames(installed.packages()))
    {install.packages(x,repos="http://cran.stat.ucla.edu")}
    eval(parse(text=paste("library(",x,")",sep="")))}


inslib("quadprog")
inslib("xts")
inslib("Rglpk")
inslib("corpcor")
source("mvo.constrained.r")
source("efront.constrained.r")
source("barplot.wts.r")
source("constraint.sets.r")
load("crsp.short.Rdata")
```

```
n.stocks <- 5
names(midcap.ts)
```

```
##  [1] "MAT"    "EMN"    "LEG"    "AAPL"   "UTR"    "HB"     "BNK"
##  [8] "APA"    "LNCR"   "BMET"   "DBD"    "FAST"   "AF"     "CPWR"
## [15] "EC"     "SNV"    "HSY"    "TXT"    "APCC"   "LXK"    "market"
## [22] "t90"
```

```
names(smallcap.ts)
```

```
##  [1] "MODI"   "MGF"    "MEE"    "FCEL"   "OII"    "SEB"    "RML"
##  [8] "AEOS"   "BRC"    "CTC"    "TNL"    "IBC"    "KWD"    "TOPP"
## [15] "RARE"   "HAR"    "BKE"    "GG"     "GYMB"   "KRON"   "market"
## [22] "t90"
```

```
names(largecap.ts)
```

```
##  [1] "AMAT"   "AMGN"   "CAT"    "DD"     "G"      "GENZ"   "GM"
##  [8] "HON"    "KR"     "LLTC"   "MSFT"   "ORCL"   "PG"     "PHA"
## [15] "SO"     "TXN"    "UTX"    "WM"     "WYE"    "YHOO"   "market"
## [22] "t90"
```

```
returns.ts = midcap.ts[,1:n.stocks]
returns = coredata(midcap.ts[,1:n.stocks])
sum=1
mu.target=0.02
w.initial=rep(1/n.stocks,n.stocks)
toc=0.3
upper=rep(0.5,n.stocks)
lower=rep(0,n.stocks)

set.seed(1234)
group=c(sample(1:2,n.stocks,replace=T))
upper.group=c(0.5,0.5)
lower.group=c(-0.5,0.5)
ptc=0.001
digits=4
wts.only=T
mu.min = NULL
mu.max = NULL
rf = .003
npoints = 20
wts.plot = T
printout = F
bar.ylim = c(-1,4)
```

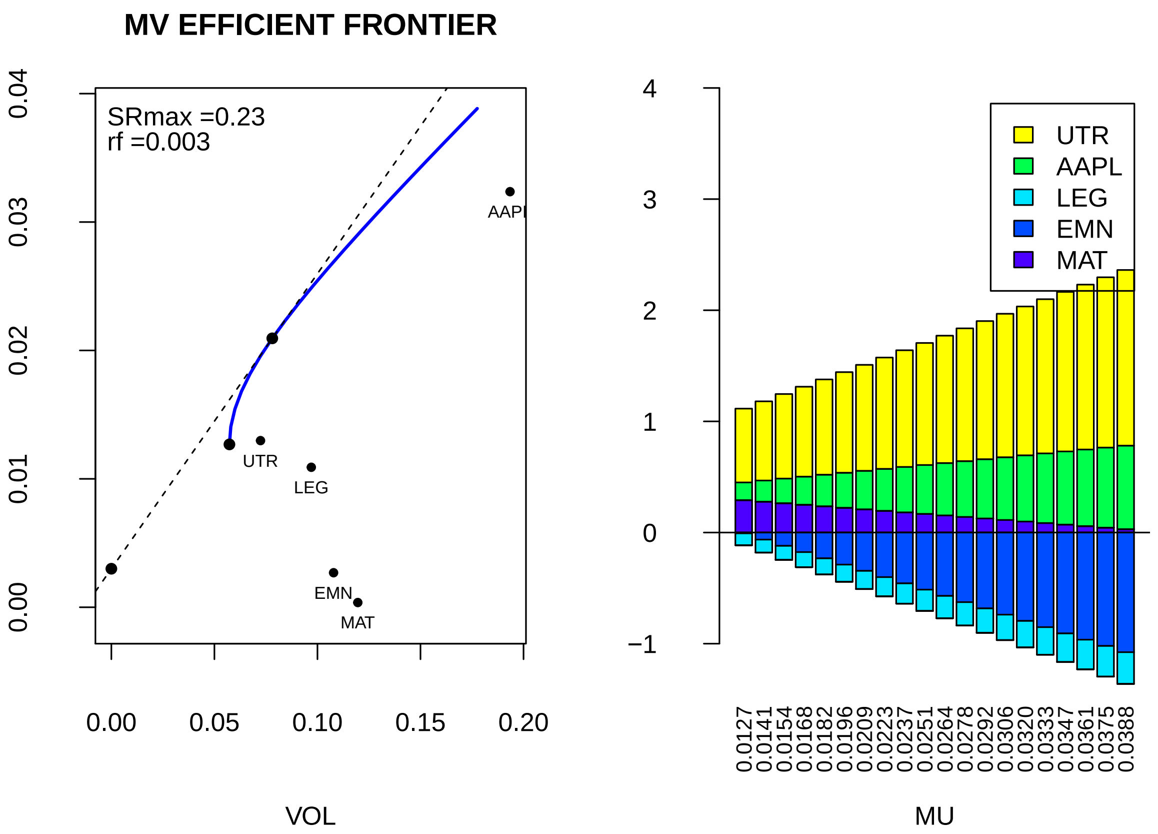
Intial parameter values on constraints:

```
list.arg <- list(
        sum=sum,
        mu.target=mu.target,
        group=group,
        upper.group=upper.group,
        lower.group=lower.group,
        upper=upper,
        lower=lower,
        toc=toc,
        w.initial=w.initial,
        ptc=ptc)
list.arg
```

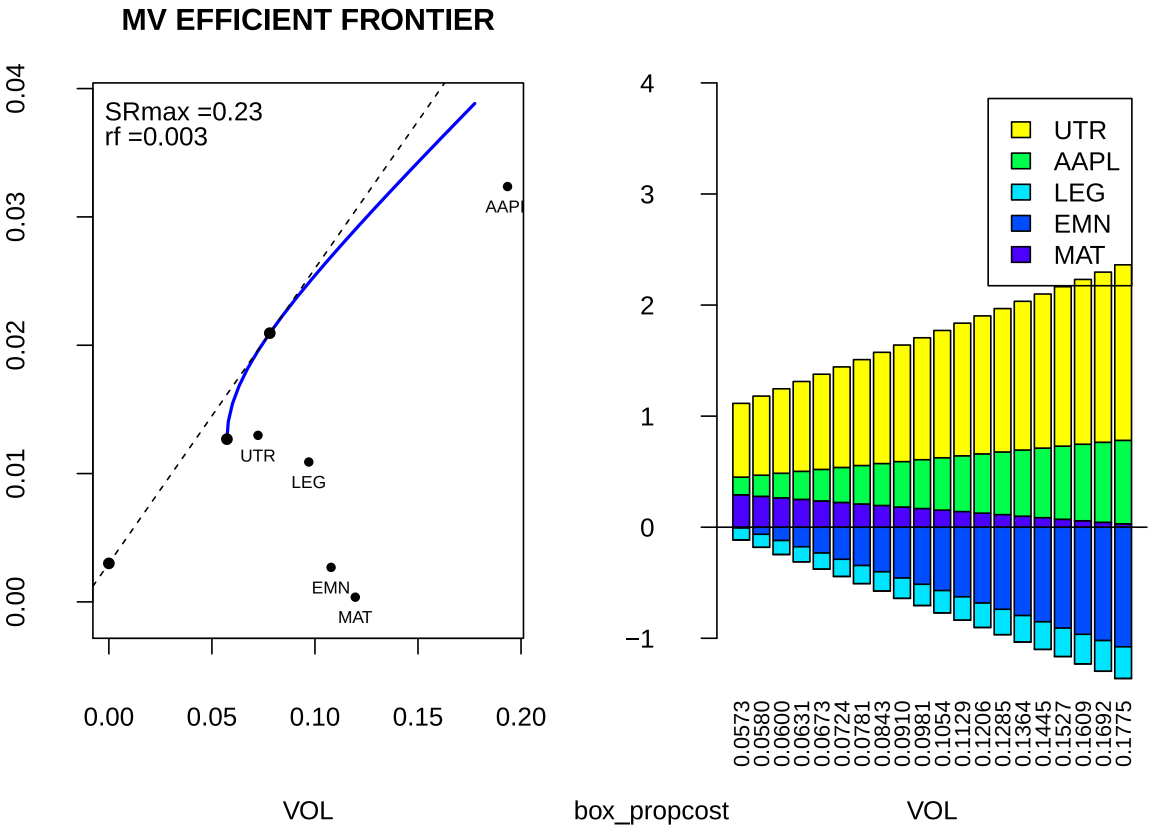
```
## $sum
## [1] 1
##
## $mu.target
## [1] 0.02
##
## $group
## [1] 1 2 2 2 2
##
## $upper.group
## [1] 0.5 0.5
##
## $lower.group
## [1] -0.5  0.5
##
## $upper
## [1] 0.5 0.5 0.5 0.5 0.5
##
## $lower
## [1] 0 0 0 0 0
##
## $toc
## [1] 0.3
##
## $w.initial
## [1] 0.2 0.2 0.2 0.2 0.2
##
## $ptc
## [1] 0.001
```

2 Null constraint

```
cset=NULL # gmv
#wt plot using MU on horizontal
efrontPlot(returns, cset, rf = .003, npoints = 20,wts.plot = T,
        bar.ylim = c(-1,4),list.arg=list.arg, wts.xlab="MU")
```



```
#wt plot using VOL on horizontal
efrontPlot(returns, cset, rf = .003, npoints = 20,wts.plot = T,
        bar.ylim = c(-1,4),list.arg=list.arg, wts.xlab="VOL")
mtext(paste(clist,collapse="_"),side=1,line=5)
```

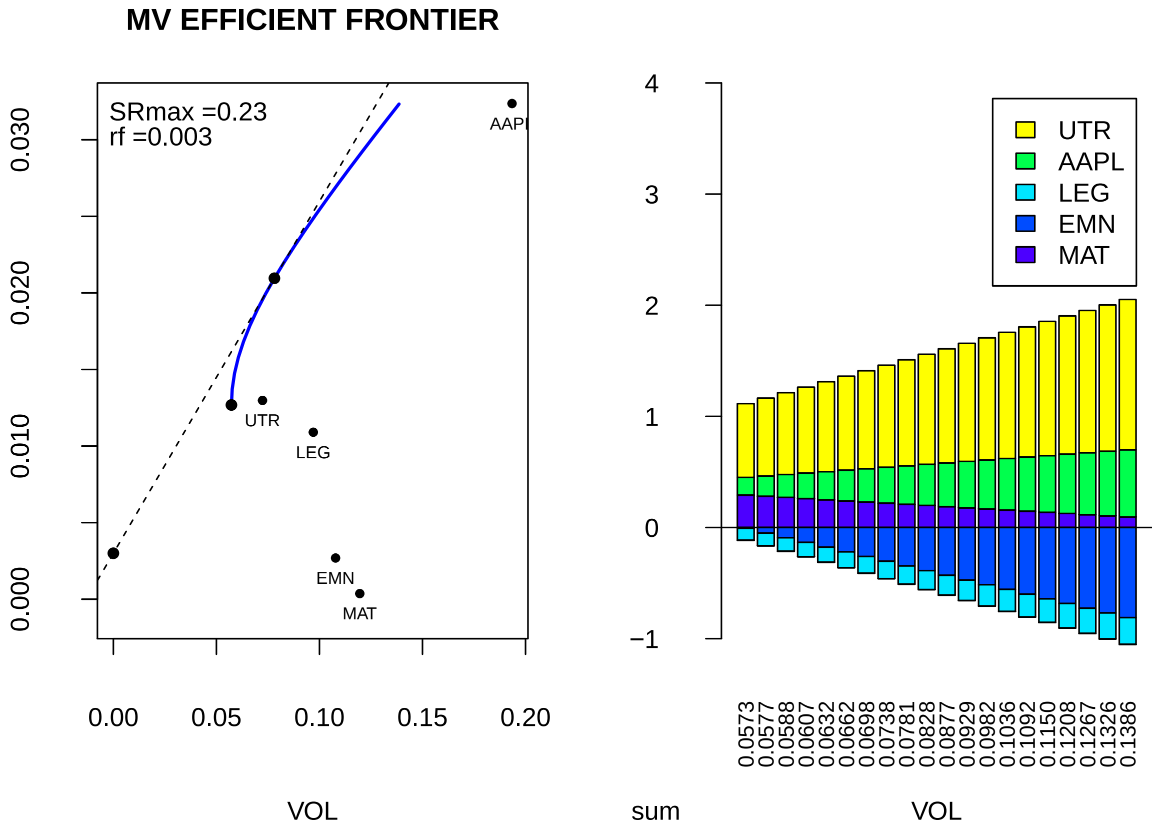


3 Full investment constraint

```r
clist <- c("sum")
cset <- NULL
cset <-combine.cset(clist=clist,returns=returns,list.arg=list.arg)
```

```
## sum
```

```r
efrontPlot(returns, cset, rf = .003, npoints = 20,wts.plot = T,
        bar.ylim = c(-1,4),list.arg=list.arg)
mtext(paste(clist,collapse="_"),side=1,line=5)
```



Full investment and long only constraints ========-

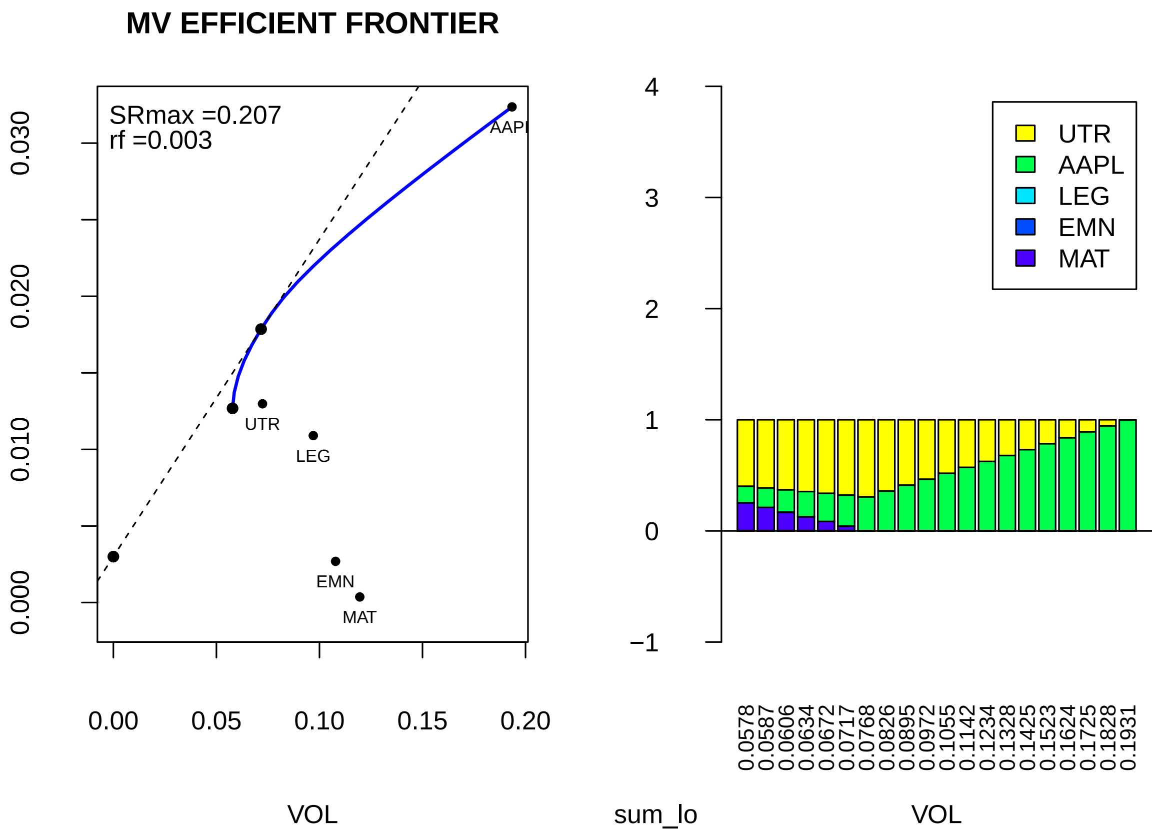
```
clist <- c("sum","lo")
cset <- NULL
cset <-combine.cset(clist=clist,returns=returns,list.arg=list.arg)
```

```
## sum
## lo
```

```
gmv(returns, cset=cset, wts.only=T,digits=4)
```

```
## $WTS
##    MAT    EMN    LEG   AAPL    UTR
## 0.2622 0.0000 0.0000 0.1433 0.5945
##
## $MU.PORT
## [1] 0.0124
##
## $SD.PORT
## [1] 0.0578
```

```r
efrontPlot(returns, cset, rf = .003, npoints = 20,wts.plot = T,
        bar.ylim = c(-1,4),list.arg=list.arg)
mtext(paste(clist,collapse="_"),side=1,line=5)
```



Full investment, long only and box constraints =========-

```r
clist <- c("sum","lo","box")
cset <- NULL
cset <-combine.cset(clist=clist,returns=returns,list.arg=list.arg)
```

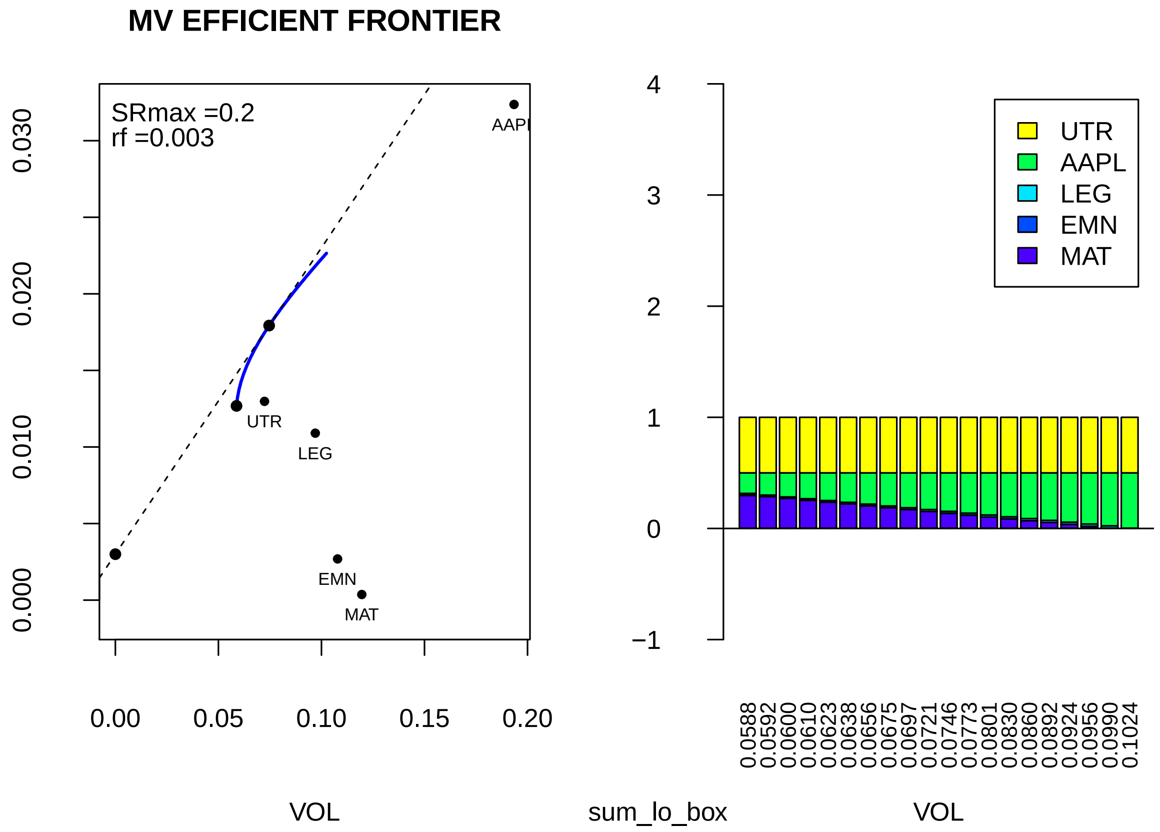
```
## sum
## lo
## box
```

```r
gmv(returns, cset=cset, wts.only=T,digits=4)
```

```
## $WTS
##    MAT    EMN    LEG   AAPL    UTR
## 0.3008 0.0372 0.0000 0.1620 0.5000
##
## $MU.PORT
## [1] 0.0119
```

```
##
## $SD.PORT
## [1] 0.0585
```

```
efrontPlot(returns, cset, rf = .003, npoints = 20,wts.plot = T,
        bar.ylim = c(-1,4),list.arg=list.arg)
mtext(paste(clist,collapse="_"),side=1,line=5)
```



Full investment, long only and group constraints ========-

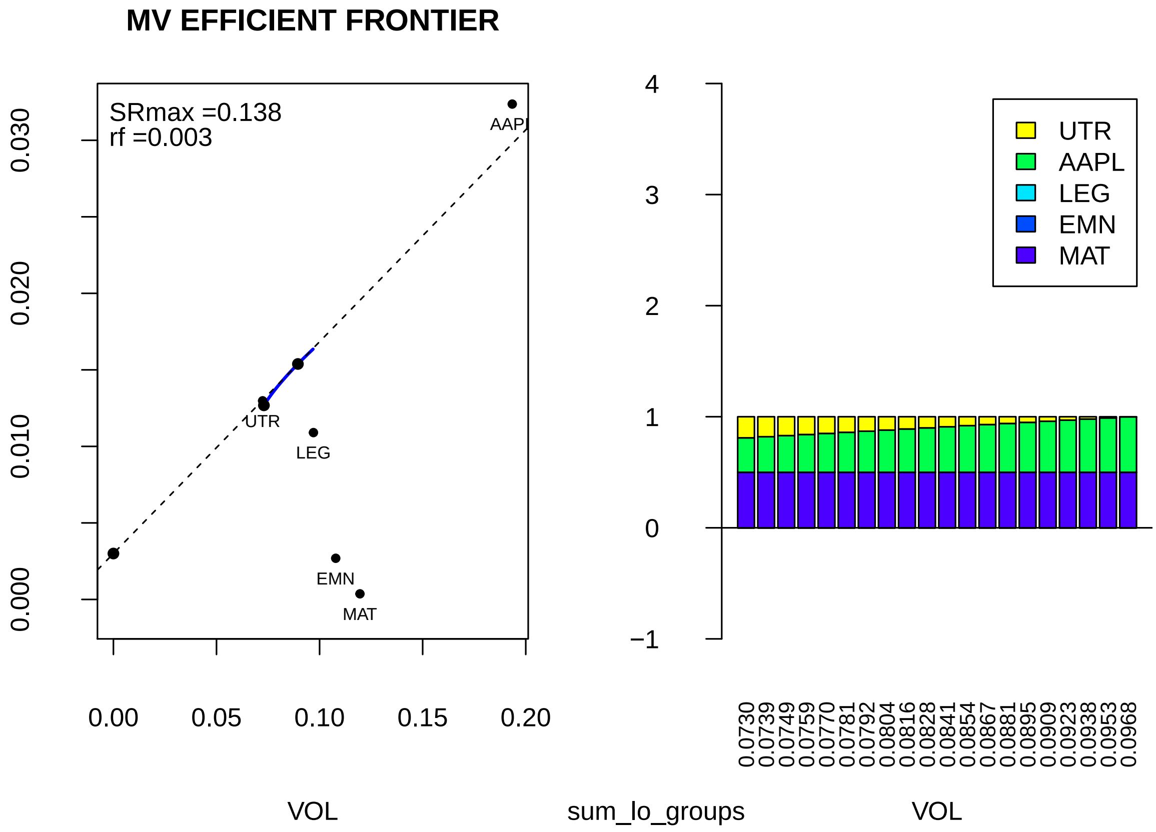
```
clist <- c("sum","lo","groups")
cset <- NULL
cset <-combine.cset(clist=clist,returns=returns,list.arg=list.arg)
```

```
## sum
## lo
## groups
```

```
gmv(returns, cset=cset, wts.only=T,digits=4)
```

```
## $WTS
##    MAT    EMN    LEG   AAPL    UTR
## 0.5000 0.0000 0.0000 0.1574 0.3426
##
## $MU.PORT
## [1] 0.0097
##
## $SD.PORT
## [1] 0.0657
```

```
efrontPlot(returns, cset, rf = .003, npoints = 20,wts.plot = T,
        bar.ylim = c(-1,4),list.arg=list.arg)
mtext(paste(clist,collapse="_"),side=1,line=5)
```



4 Full investment, long only and mean return constraints

```
clist <- c("sum","lo","mu.target")
cset <-combine.cset(clist=clist,returns=returns,list.arg=list.arg)
```

```
## sum
## lo
## mu.target
```

```
gmv(returns, cset=cset, wts.only=T,digits=4)
```

```
## $WTS
##    MAT    EMN    LEG   AAPL    UTR
## 0.0000 0.0000 0.0000 0.3622 0.6378
##
## $MU.PORT
## [1] 0.02
##
## $SD.PORT
## [1] 0.0831
```

5 Full investment, long only, box and group constraints

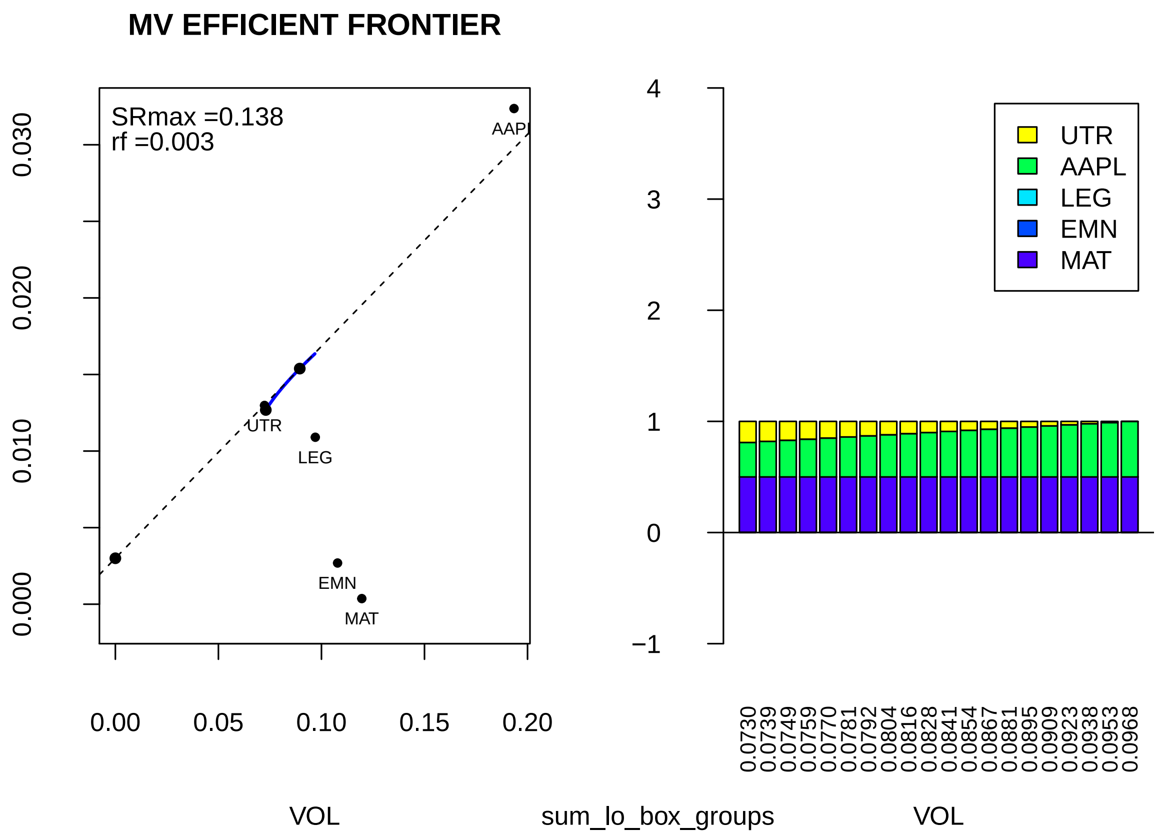
```
clist <- c("sum","lo","box","groups")
cset <- NULL
cset <-combine.cset(clist=clist,returns=returns,list.arg=list.arg)
```

```
## sum
## lo
## box
## groups
```

```
gmv(returns, cset=cset, wts.only=T,digits=4)
```

```
## $WTS
##    MAT    EMN    LEG   AAPL    UTR
## 0.5000 0.0000 0.0000 0.1574 0.3426
##
## $MU.PORT
## [1] 0.0097
##
## $SD.PORT
## [1] 0.0657
```

```
efrontPlot(returns, cset, rf = .003, npoints = 20,wts.plot = T,
        bar.ylim = c(-1,4),list.arg=list.arg)
mtext(paste(clist,collapse="_"),side=1,line=5)
```



6 Full investment, long only and turnover (2 versions) constraints

```
clist <- c("sum","lo","turnover")
cset <- NULL
cset <-combine.cset(clist=clist,returns=returns,list.arg=list.arg)
```

```
## sum
## lo
## turnover
```

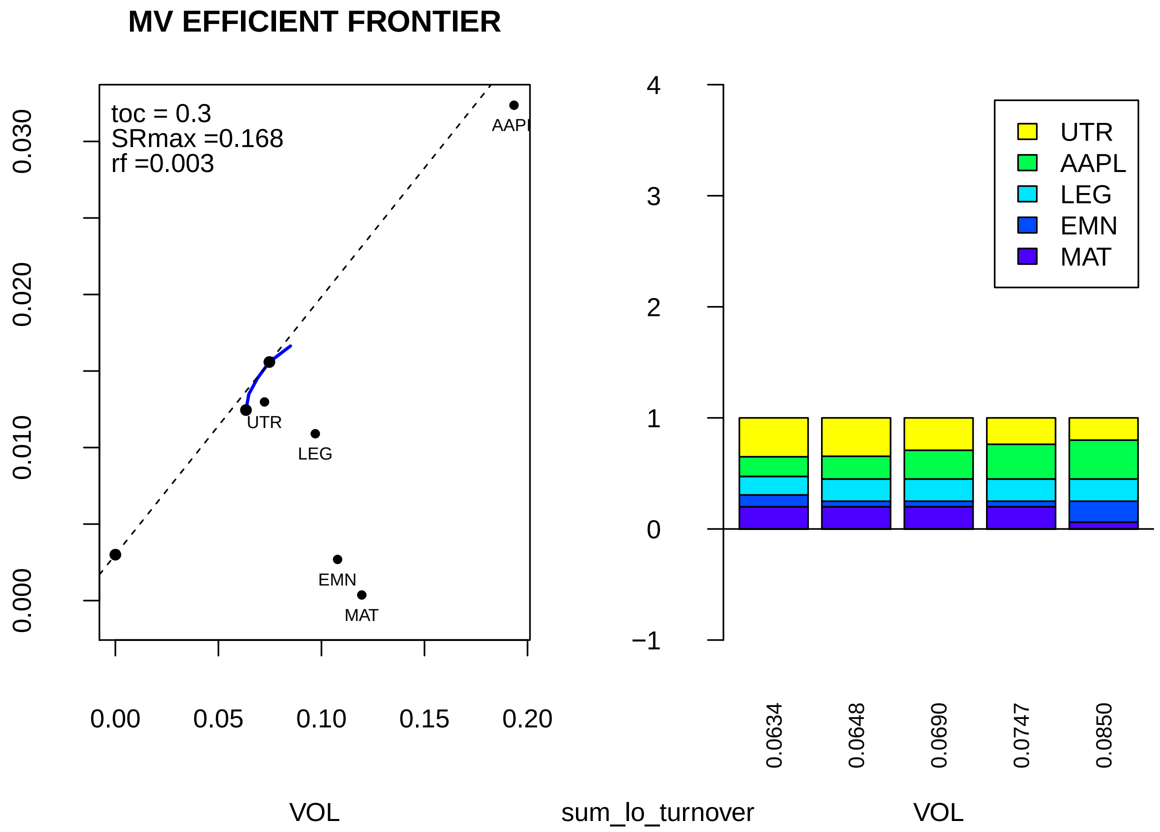
```
gmv(returns, cset=cset, wts.only=T,digits=4)
```

```
## $WTS
##    MAT    EMN    LEG   AAPL    UTR
## 0.2000 0.1477 0.1544 0.1479 0.3500
##
## $MU.PORT
## [1] 0.0115
##
## $SD.PORT
## [1] 0.063
```

```
efrontPlot(returns, cset, rf = .003, npoints = 20,wts.plot = T,
        bar.ylim = c(-1,4),list.arg=list.arg)
```

```
## [1] "turnover/propcost constraints reduced the max mean return in efficient frontier plot"
```

```
mtext(paste(clist,collapse="_"),side=1,line=5)
```



```
# 1+4+1+4+4+2+2+1+4+4+4
# sum+lo+mu.target+box+box+group+group+turnover+w.sell+w.buy+w.initial

clist <- c("sum","lo","turnover.doug")
cset <- NULL
cset <-combine.cset(clist=clist,returns=returns,list.arg=list.arg)
```

```
## sum
## lo
## turnover.doug
```

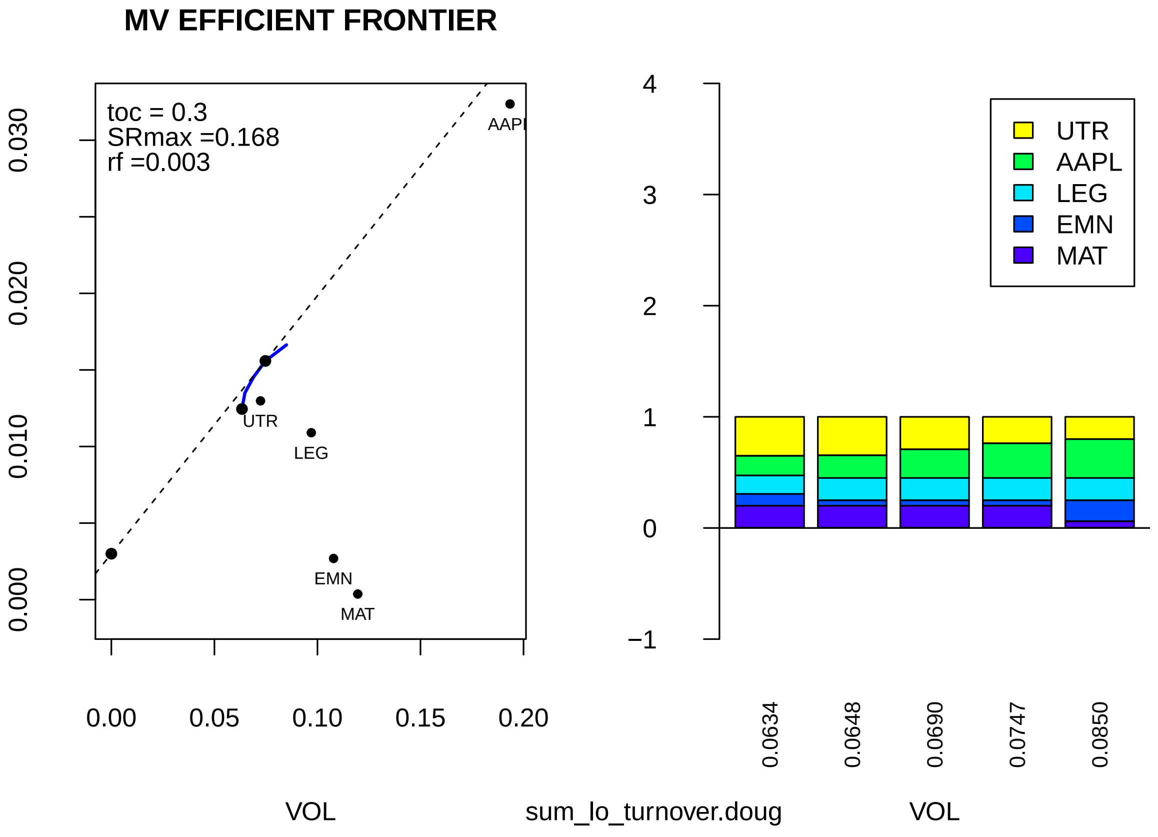
```
gmv(returns, cset=cset, wts.only=T,digits=4)
```

```
## $WTS
##    MAT    EMN    LEG   AAPL    UTR
## 0.2000 0.1477 0.1544 0.1479 0.3500
##
## $MU.PORT
## [1] 0.0115
##
## $SD.PORT
## [1] 0.063
```

```
efrontPlot(returns, cset, rf = .003, npoints = 20,wts.plot = T,
        bar.ylim = c(-1,4),list.arg=list.arg)
```

```
## [1] "turnover/propcost constraints reduced the max mean return in efficient frontier plot"
```

```
mtext(paste(clist,collapse="_"),side=1,line=5)
```



```
# 1+4+1+4+4+2+2+1+4+4+4
# sum+lo+mu.target+box+box+group+group+turnover+w.sell+w.buy+w.initial
```

7 Propcost constraints

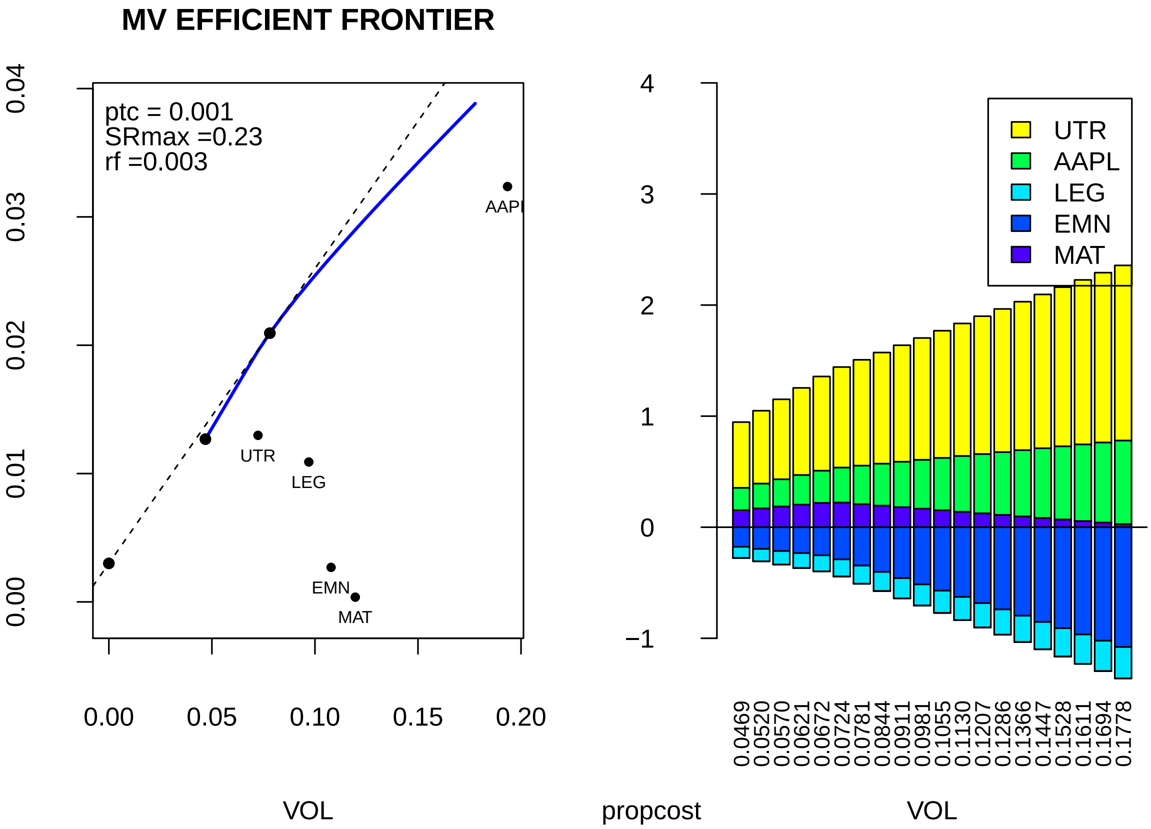
```
clist <- c("propcost")
cset <- NULL
cset <-combine.cset(clist=clist,returns=returns,list.arg)
```

```
## propcost
```

```
gmv(returns, cset=cset, wts.only=T,digits=4)
```

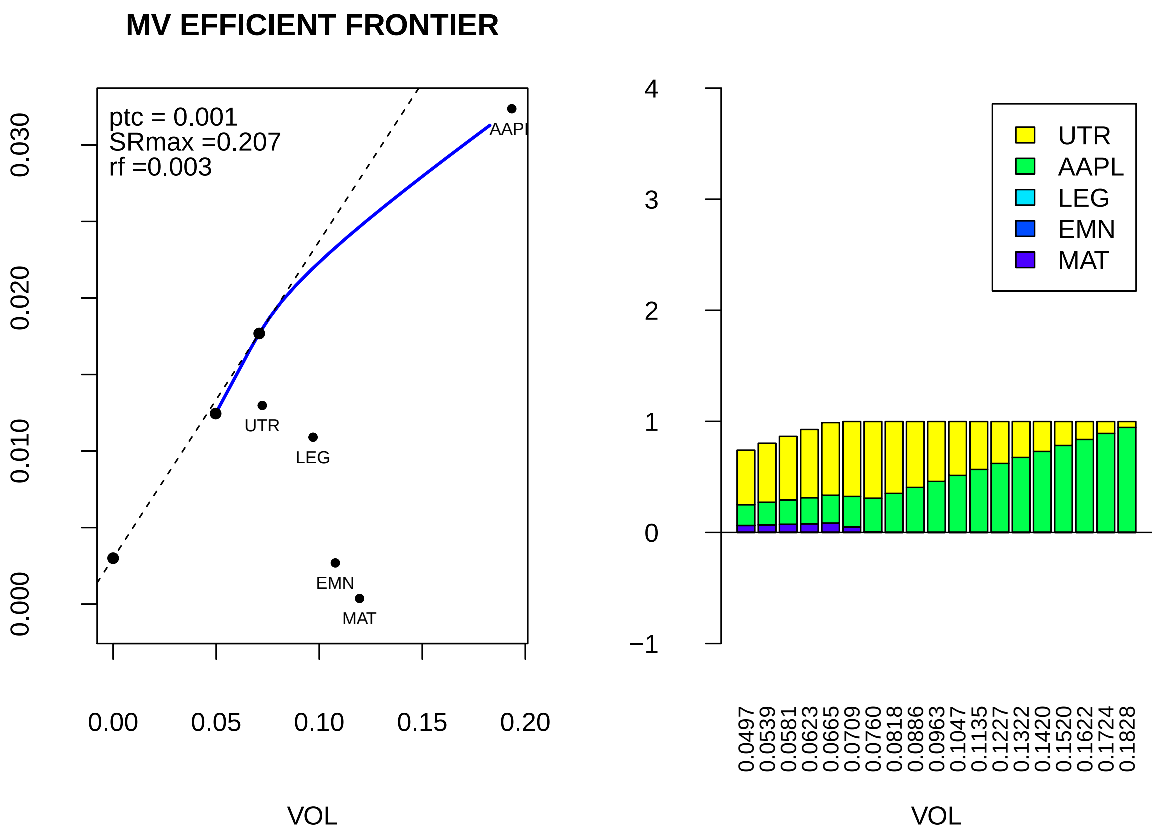
```
## $WTS
##  MAT  EMN  LEG AAPL  UTR
##    0    0    0    0    0
##
## $MU.PORT
## [1] 0
##
## $SD.PORT
## [1] 0
```

```
# global minum variance portfolio can always be achieved if all the initial weights are consumed by pro

efrontPlot(returns, cset, rf = .003, npoints = 20,wts.plot = T,
        bar.ylim = c(-1,4),list.arg=list.arg)
mtext(paste(clist,collapse="_"),side=1,line=5)
```



8 Long only and propcost constraints

```
clist <- c("lo","propcost")
cset <- NULL
cset <-combine.cset(clist=clist,returns=returns,list.arg)

try(efrontPlot(returns, cset, rf = .003, npoints = 20,wts.plot = T,
        bar.ylim = c(-1,4),list.arg=list.arg))
```



```
# Expected warning msg: no solution, consider relaxing constraints
```

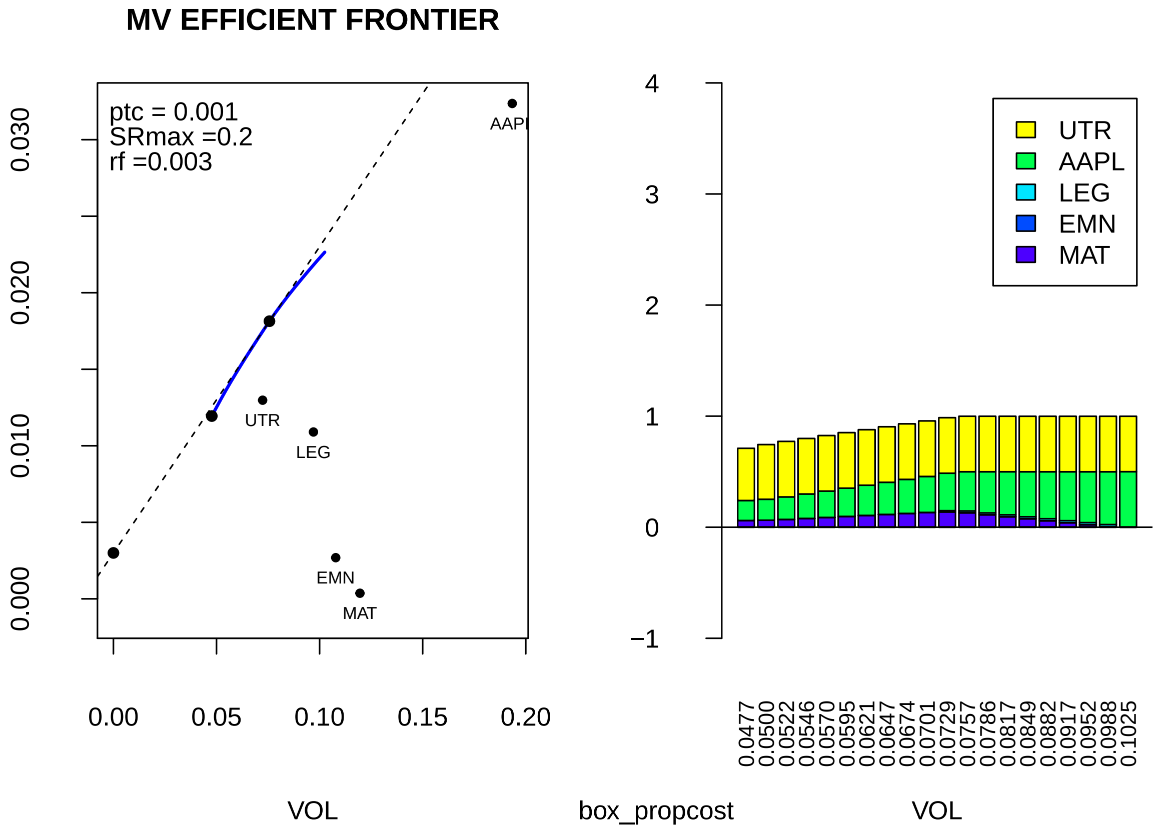
```
## lo
## propcost

## [1] "turnover/propcost constraints reduced the max mean return in efficient frontier plot"
```

9 Box and propcost constraints

```
clist <- c("box","propcost")
cset <- NULL
cset <-combine.cset(clist=clist,returns=returns,list.arg)
```

```
## box
## propcost
```

```
efrontPlot(returns, cset, rf = .003, npoints = 20,wts.plot = T,
        bar.ylim = c(-1,4),list.arg=list.arg)
mtext(paste(clist,collapse="_"),side=1,line=5)
```



10 Sum, box and propcost constraints (Bad example, expecting errors)

```
clist <- c("sum","box","propcost")
list.arg <- list( sum=sum,
                  upper=upper,
                  lower=lower,
                  ptc=ptc,
                  w.initial=w.initial)
print(list.arg)
```

```
## $sum
## [1] 1
##
## $upper
## [1] 0.5 0.5 0.5 0.5 0.5
##
## $lower
## [1] 0 0 0 0 0
##
```

```
## $ptc
## [1] 0.001
##
## $w.initial
## [1] 0.2 0.2 0.2 0.2 0.2
```

```
cset <- NULL
cset <-try(combine.cset(clist=clist,returns=returns,list.arg))
```

```
## sum
```

```
# Expected error msg: Error in propcost.modify(cset.i) :
# sum constraint are not combinable with propcost constraint
```