Strategy Design (ML Fin Data - Project 1)

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Libraries

0. Scraping the SP500

In order to test the logic within the strategy, I have fetched functions that retrieve a number of sample stocks by sector from the SP500.

```r
# to obtain relative paths
library(here)

# Load code into environment
source(here("functions", "fetch_sp500_sectors.R"))
```

```
## Getting holdings for SP500
```

0.0.1 SP500 Economic Sectors

The following function fetches and extract the economic sectors from the SP500, taken from Wikipedia.

```r
# fetch the sectors as a dataframe
sp500_sectors <- f_get_sp500_sectors()
head(sp500_sectors)
```

```
##   tickers                sectors
## 1     MMM            Industrials
## 2     AOS            Industrials
## 3     ABT            Health Care
## 4    ABBV            Health Care
## 5     ACN Information Technology
## 6    ATVI Communication Services
```

0.0.2 SP500 Sector Weight

```r
# wrap into a single argument funciton
fetch_sp500_sector_data <- function(x){f_fetch_sector_data(x, sp500, sp500_sectors)}

# call the function
head(fetch_sp500_sector_data("Information Technology"))
```

```
##   ticker                 sector      weight shares_held
## 1   AAPL Information Technology 0.069397435   165061553
## 2    ACN Information Technology 0.005495433     7085903
## 3   ADBE Information Technology 0.006348271     5120139
## 4    ADI Information Technology 0.002401180     5632532
## 5   ADSK Information Technology 0.001198005     2400798
## 6   AKAM Information Technology 0.000452342     1714319
```

0.0.3 Retrieving top sectors and stocks

Pack everything into one function to retrieve all the data

```
# Retrieve top 10 stocks by weight for each sector in the top 5 sectors from the SP500 (by weight)
sector_list <- f_retrieve_top_sp500(top_n_sectors = 6, top_n_stocks = 15, only_tickers=TRUE)
```

```
## Getting holdings for SP500
```

```
sector_list
```

```
## $Industrials
##  [1] "ADP" "BA"  "CAT" "CSX" "DE"  "ETN" "FDX" "GE"  "HON" "ITW" "LMT" "NOC"
## [13] "RTX" "UNP" "UPS"
##
## $`Health Care`
##  [1] "ABBV" "ABT"  "AMGN" "BMY"  "DHR"  "ELV"  "GILD" "ISRG" "JNJ"  "LLY"
## [11] "MDT"  "MRK"  "PFE"  "TMO"  "UNH"
##
## $`Information Technology`
##  [1] "AAPL" "ACN"  "ADBE" "AMD"  "AVGO" "CRM"  "CSCO" "IBM"  "INTC" "INTU"
## [11] "MSFT" "NVDA" "ORCL" "QCOM" "TXN"
##
## $`Communication Services`
##  [1] "ATVI"  "CHTR"  "CMCSA" "DIS"   "EA"    "GOOG"  "GOOGL" "META"  "NFLX"
## [10] "OMC"   "T"     "TMUS"  "TTWO"  "VZ"    "WBD"
##
## $Financials
##  [1] "AXP"  "BAC"  "BLK"  "C"    "CB"   "GS"   "JPM"  "MA"   "MMC"  "MS"
## [11] "PGR"  "SCHW" "SPGI" "V"    "WFC"
##
## $`Consumer Discretionary`
##  [1] "ABNB" "AMZN" "AZO"  "BKNG" "CMG"  "F"    "GM"   "HD"   "MAR"  "MCD"
## [11] "NKE"  "ORLY" "SBUX" "TJX"  "TSLA"
```

This logic is implemented under **functions/fetch_sp500_sectors.R**

0.0.4 Retrieving top sectors and stocks

```
# function to fetch all the information for one ticker into a nice xts dataframe
sp500_stocks <- lapply(sector_list,
                       f_fetch_all_tickers,
                       start_date="2018-01-01",
                       end_date="2022-12-01")
```

```
# Show the available sectors
names(sp500_stocks)
```

```
## [1] "Industrials"            "Health Care"            "Information Technology"
## [4] "Communication Services" "Financials"             "Consumer Discretionary"
```

```
# Show available stocks for Industrials
names(sp500_stocks$Industrials)
```

```
##  [1] "ADP" "BA"  "CAT" "CSX" "DE"  "ETN" "FDX" "GE"  "HON" "ITW" "LMT" "NOC"
## [13] "RTX" "UNP" "UPS"
```

```r
# access the xts of the stocks in industrials
head(sp500_stocks$Industrials$ADP)
```

```
##            direction_lead adp_adjclose_lead adp_adjclose_lag0 adp_adjclose_lag1
## 2018-01-03              1       0.003405679                NA                NA
## 2018-01-10              1       0.036716660       0.003405679                NA
## 2018-01-17             -1      -0.009797874       0.036716660       0.003405679
## 2018-01-24              1       0.022660294      -0.009797874       0.036716660
## 2018-01-31             -1      -0.084961837       0.022660294      -0.009797874
## 2018-02-07             -1      -0.007512986      -0.084961837       0.022660294
##            adp_adjclose_lag2 adp_adjclose_lag3 atr adx aaron bb chaikin_vol clv
## 2018-01-03                NA                NA  NA  NA    NA NA          NA  NA
## 2018-01-10                NA                NA  NA  NA    50 NA          NA  NA
## 2018-01-17                NA                NA  NA  NA   100 NA          NA  NA
## 2018-01-24       0.003405679                NA  NA  NA   100 NA          NA  NA
## 2018-01-31       0.036716660       0.003405679  NA  NA   100 NA          NA  NA
## 2018-02-07      -0.009797874       0.036716660  NA  NA   -50 NA          NA  NA
##            emv macd mfi      sar smi volat month_index
## 2018-01-03  NA   NA  NA 115.3586  NA    NA           1
## 2018-01-10  NA   NA  NA 115.4054  NA    NA           1
## 2018-01-17  NA   NA  NA 115.5252  NA    NA           1
## 2018-01-24  NA   NA  NA 115.9245  NA    NA           1
## 2018-01-31  NA   NA  NA 116.4665  NA    NA           1
## 2018-02-07  NA   NA  NA 125.2400  NA    NA           2
```

1. Backtesting Logic

Adding a numeric index

First, we need to create a corresponding index for each week:

```r
# count number of weeks in data from one of the dataframes
sample_xts <- sp500_stocks$Industrials$CSX
tail(sample_xts, 10)
```

```
##            direction_lead csx_adjclose_lead csx_adjclose_lag0 csx_adjclose_lag1
## 2022-09-28              1       0.006853095      -0.053209662      -0.069267283
## 2022-10-05             -1      -0.042966082       0.006853095      -0.053209662
## 2022-10-12              1       0.046554111      -0.042966082       0.006853095
## 2022-10-19              1       0.029989991       0.046554111      -0.042966082
## 2022-10-26             -1      -0.008377096       0.029989991       0.046554111
## 2022-11-02              1       0.031058456      -0.008377096       0.029989991
## 2022-11-09              1       0.059684716       0.031058456      -0.008377096
## 2022-11-16              1       0.026221708       0.059684716       0.031058456
## 2022-11-23              1       0.022307721       0.026221708       0.059684716
## 2022-11-30             NA                NA       0.022307721       0.026221708
##            csx_adjclose_lag2 csx_adjclose_lag3      atr      adx aaron
## 2022-09-28      -0.020913291       0.007554287 1.441481 16.24190  -100
## 2022-10-05      -0.069267283      -0.020913291 1.384232 17.10559   -50
## 2022-10-12      -0.053209662      -0.069267283 1.379644 18.24157   -50
## 2022-10-19       0.006853095      -0.053209662 1.394670 18.58490    50
## 2022-10-26      -0.042966082       0.006853095 1.398622 18.20787   100
## 2022-11-02       0.046554111      -0.042966082 1.385863 17.63796   100
## 2022-11-09       0.029989991       0.046554111 1.385444 17.00435    50
## 2022-11-16      -0.008377096       0.029989991 1.429341 16.04316   100
## 2022-11-23       0.031058456      -0.008377096 1.395102 15.54651   100
## 2022-11-30       0.059684716       0.031058456 1.369024 15.36369   100
```

```
##                    bb chaikin_vol        clv         emv      macd      mfi
## 2022-09-28 0.04467755  2.43234200  0.21475805 -1.787304e-04 -2.031918 46.90353
## 2022-10-05 0.13495813 -0.44268680  0.22116568 -2.096124e-04 -2.290153 46.43088
## 2022-10-12 0.07457368  0.43839330  0.07934922 -3.472192e-04 -2.649750 46.62430
## 2022-10-19 0.23730603 -1.12835800  0.03125187 -3.458817e-04 -2.983549 54.92321
## 2022-10-26 0.36428555  0.36773750 -0.10430028 -2.858648e-04 -3.232381 56.20916
## 2022-11-02 0.36718737 -8.91414900 -0.26417408 -1.913069e-04 -3.420978 48.82911
## 2022-11-09 0.43456871 -0.08886197 -0.35167976 -1.696224e-04 -3.505779 48.94612
## 2022-11-16 0.61239403 -0.69757770 -0.28307675 -6.177828e-05 -3.415472 46.83053
## 2022-11-23 0.68335600 -2.77541900 -0.16462184  6.920197e-05 -3.168499 45.87661
## 2022-11-30 0.70213009 -0.65517410  0.02947430  2.043992e-04 -2.797269 55.72098
##                sar       smi     volat month_index
## 2022-09-28 34.67000 -18.01681 0.2279791          57
## 2022-10-05 34.38840 -22.89976 0.2353109          58
## 2022-10-12 34.11806 -28.89441 0.2481376          58
## 2022-10-19 33.66998 -32.89471 0.2465206          58
## 2022-10-26 33.24878 -34.78229 0.2484444          58
## 2022-11-02 32.85285 -36.26677 0.2806964          59
## 2022-11-09 32.48068 -36.24474 0.2819226          59
## 2022-11-16 32.13084 -32.84559 0.2767814          59
## 2022-11-23 26.65000 -26.53377 0.2587499          59
## 2022-11-30 26.65000 -18.89848 0.2672197          59
```

```r
# month index are assigned automatically
sample_xts[, c( "month_index")]
```

```
##            month_index
## 2018-01-03           1
## 2018-01-10           1
## 2018-01-17           1
## 2018-01-24           1
## 2018-01-31           1
## 2018-02-07           2
## 2018-02-14           2
## 2018-02-21           2
## 2018-02-28           2
## 2018-03-07           3
##        ...
## 2022-09-28          57
## 2022-10-05          58
## 2022-10-12          58
## 2022-10-19          58
## 2022-10-26          58
## 2022-11-02          59
## 2022-11-09          59
## 2022-11-16          59
## 2022-11-23          59
## 2022-11-30          59
```

splitting data by week

Initially, the idea was to split week-by-week, however, since we have to rebalance everymonth, this might lead to inconsistent results. Therefore, here I'm splitting the data week by week:

```r
library(xts)

# spli by months
sample_xts_by_month <- split.xts(sample_xts, f= "months")
names(sample_xts_by_month)
```

```
##  [1] "Jan 2018" "Feb 2018" "Mar 2018" "Apr 2018" "May 2018" "Jun 2018"
##  [7] "Jul 2018" "Aug 2018" "Sep 2018" "Oct 2018" "Nov 2018" "Dec 2018"
## [13] "Jan 2019" "Feb 2019" "Mar 2019" "Apr 2019" "May 2019" "Jun 2019"
## [19] "Jul 2019" "Aug 2019" "Sep 2019" "Oct 2019" "Nov 2019" "Dec 2019"
## [25] "Jan 2020" "Feb 2020" "Mar 2020" "Apr 2020" "May 2020" "Jun 2020"
## [31] "Jul 2020" "Aug 2020" "Sep 2020" "Oct 2020" "Nov 2020" "Dec 2020"
## [37] "Jan 2021" "Feb 2021" "Mar 2021" "Apr 2021" "May 2021" "Jun 2021"
## [43] "Jul 2021" "Aug 2021" "Sep 2021" "Oct 2021" "Nov 2021" "Dec 2021"
## [49] "Jan 2022" "Feb 2022" "Mar 2022" "Apr 2022" "May 2022" "Jun 2022"
## [55] "Jul 2022" "Aug 2022" "Sep 2022" "Oct 2022" "Nov 2022"
```

```r
length(names(sample_xts_by_month)) # total number of months of data
```

```
## [1] 59
```

BACKTESTING_PROCEDURE

1. Assume we have N_{years} years of weekly data, giving a total of N_{months} many months. 2. We want to fix a window of $N_W = 12$ months at the time (i.e. a year of data).
2. The total number of runs is given by

$$N^{runs} = \left\lfloor \frac{N_{months} - N_W}{s} \right\rfloor + 1$$

, where $s = 1$ is the number of months to move at the time (because of monthly rebalance).

In our case, this gives

$$N^{runs} = \left\lfloor \frac{59 - 12}{1} \right\rfloor + 1 = 48$$

i.e., we can move 47 times when predicting one month at the time, starting with having all the data until month 12.

That is, $\tau = 1, \ldots, 48$

```r
# Set up backtesting simulation parameters
sample_xts <- sp500_stocks$Industrials$ADP
sectors <- names(sp500_stocks)
N_sector_best_stocks <- 3

# Formula parameters
slide <- 1
N_months <- length(names(split.xts(sample_xts, f= "months")))
N_window <- 12 # number of months in size for each window
N_runs <- floor((N_months - N_window)/slide)

# setup initial portfolio tracking variables
initial_capital <- 500000
num_tickers <- length(sectors)*N_sector_best_stocks
initial_tickers <- rep(NA, num_tickers)
weights <- rep(1/num_tickers, num_tickers) # initialize to 1/n
returns <- rep(NA, N_runs)

# repack the portfolio
portfolio <- list(tickers = initial_tickers,
                  weights = weights,
                  capital = initial_capital,
                  returns = returns
                  )
portfolio
```

```
## $tickers
##  [1] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
##
## $weights
##  [1] 0.05555556 0.05555556 0.05555556 0.05555556 0.05555556 0.05555556
##  [7] 0.05555556 0.05555556 0.05555556 0.05555556 0.05555556 0.05555556
## [13] 0.05555556 0.05555556 0.05555556 0.05555556 0.05555556 0.05555556
##
## $capital
## [1] 5e+05
##
## $returns
##  [1] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
## [26] NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
```

```r
# Initiate backtesting
print(paste(rep("-", 100), collapse = ""))
```

```
## [1] "----------------------------------------------------------------------------------------------------"
```

```r
print("BACKTESTING")
```

```
## [1] "BACKTESTING"
```

```r
print(paste(rep("-", 100), collapse = ""))
```

```
## [1] "----------------------------------------------------------------------------------------------------"
```

```r
print("")
```

```
## [1] ""
```

```r
# for every run (sliding window of time to consider)
for(tau in seq(N_runs)){
  # close any positions
  print(paste0("(tau=", tau, ") CLOSE all positions."))

  # Calculate and record profit-loss
  print("(1) COMPUTE_P/L(portfolio)")
  portfolio$capital <- portfolio$capital * (1 + runif(1, -0.05, 0.10))
  print(paste0("--> Capital:", portfolio$capital, "$"))

  # keep index counter for sectors
  i_sector <- 1

  # current portf
  cur_tickers <- rep(NA, num_tickers)

  print("")
  print("(2) PORTFOLIO_LOOP:")
  # loop through all the sectors
  for(G in sectors){
    # execute sector procedure
    print(paste0("    SECTOR_PROCEDURE(G=", G, ", tau=",tau, ")"))

    # return top 3 best stocks according to procedure
```

```r
    top_sector_stocks <- sample(names(sp500_stocks[[G]]), 3 )

    # assign best stocks to portfolio (NEED TO UPDATE LOGIC!)
    i_replace <- c(i_sector, i_sector+1, i_sector+2)
    cur_tickers[i_replace] <- top_sector_stocks
    i_sector <- i_sector + 3
  }

  # Assign tickers for this simulation
  portfolio$tickers <- as.vector(cur_tickers)

  # Display selected portfolio tickers
  print("Cur Portfolio:")
  print(portfolio$tickers)

  # Optimize portfolio weights using modified min_variance
  print("")
  print("(3) OPTIMIZE_PORTFOLIO(portfolio)")
  print("weights: ")
  print(paste(" ", portfolio$weights))
  print("")
  print("(4) LONG PORTFOLIO()")

  # Separate similuation (over)
  print(paste(rep("-", 100), collapse = ""))
}
```

```
## [1] "(tau=1) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:547505.040903343$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=1)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=1)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=1)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=1)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=1)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=1)"
## [1] "Cur Portfolio:"
##  [1] "GE"   "HON"  "ITW"  "PFE"  "DHR"  "JNJ"  "INTC" "ADBE" "AVGO" "NFLX"
## [11] "META" "OMC"  "SCHW" "CB"   "BAC"  "CMG"  "TJX"  "ORLY"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------------------"
## [1] "(tau=2) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:567791.994397036$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=2)"
```

```
## [1] "     SECTOR_PROCEDURE(G=Health Care, tau=2)"
## [1] "     SECTOR_PROCEDURE(G=Information Technology, tau=2)"
## [1] "     SECTOR_PROCEDURE(G=Communication Services, tau=2)"
## [1] "     SECTOR_PROCEDURE(G=Financials, tau=2)"
## [1] "     SECTOR_PROCEDURE(G=Consumer Discretionary, tau=2)"
## [1] "Cur Portfolio:"
##  [1] "CSX"  "ITW"  "ETN"  "LLY"  "BMY"  "PFE"  "INTC" "AMD"  "CRM"  "META"
## [11] "DIS"  "TTWO" "BAC"  "V"    "GS"   "MAR"  "MCD"  "TSLA"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
##  [4] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
##  [7] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [10] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [13] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [16] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------------"
## [1] "(tau=3) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:541184.473220247$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "     SECTOR_PROCEDURE(G=Industrials, tau=3)"
## [1] "     SECTOR_PROCEDURE(G=Health Care, tau=3)"
## [1] "     SECTOR_PROCEDURE(G=Information Technology, tau=3)"
## [1] "     SECTOR_PROCEDURE(G=Communication Services, tau=3)"
## [1] "     SECTOR_PROCEDURE(G=Financials, tau=3)"
## [1] "     SECTOR_PROCEDURE(G=Consumer Discretionary, tau=3)"
## [1] "Cur Portfolio:"
##  [1] "LMT"   "BA"    "CAT"   "ABT"   "ABBV"  "DHR"   "ORCL"  "AMD"   "ACN"
## [10] "NFLX"  "GOOGL" "CMCSA" "CB"    "AXP"   "SCHW"  "GM"    "SBUX"  "BKNG"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
##  [4] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
##  [7] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [10] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [13] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [16] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------------"
## [1] "(tau=4) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:577144.892300421$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "     SECTOR_PROCEDURE(G=Industrials, tau=4)"
## [1] "     SECTOR_PROCEDURE(G=Health Care, tau=4)"
## [1] "     SECTOR_PROCEDURE(G=Information Technology, tau=4)"
## [1] "     SECTOR_PROCEDURE(G=Communication Services, tau=4)"
## [1] "     SECTOR_PROCEDURE(G=Financials, tau=4)"
## [1] "     SECTOR_PROCEDURE(G=Consumer Discretionary, tau=4)"
## [1] "Cur Portfolio:"
##  [1] "LMT"  "BA"   "HON"  "ISRG" "ELV"  "JNJ"  "ORCL" "MSFT" "NVDA" "EA"
## [11] "DIS"  "META" "V"    "SCHW" "AXP"  "GM"   "ABNB" "AZO"
```

```
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------"
## [1] "(tau=5) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:561491.744841097$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=5)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=5)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=5)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=5)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=5)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=5)"
## [1] "Cur Portfolio:"
##  [1] "CSX"  "NOC"  "CAT"  "GILD" "TMO"  "LLY"  "MSFT" "INTU" "NVDA" "DIS"
## [11] "OMC"  "GOOG" "SCHW" "MS"   "GS"   "AZO"  "HD"   "GM"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------"
## [1] "(tau=6) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:602563.131286575$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=6)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=6)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=6)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=6)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=6)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=6)"
## [1] "Cur Portfolio:"
##  [1] "BA"   "CAT"  "UNP"  "AMGN" "PFE"  "ISRG" "IBM"  "ORCL" "CSCO"
## [10] "WBD"  "GOOGL" "VZ"   "JPM"  "PGR"  "C"    "AMZN" "AZO"  "BKNG"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
```

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## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-------------------------------------------------------------------------------------------------------"
## [1] "(tau=7) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:595386.349419874$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=7)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=7)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=7)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=7)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=7)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=7)"
## [1] "Cur Portfolio:"
##  [1] "NOC"  "BA"   "ADP"  "JNJ"  "ABBV" "MRK"  "INTC" "ACN"  "IBM"  "VZ"
## [11] "DIS"  "META" "SPGI" "SCHW" "JPM"  "CMG"  "ABNB" "TJX"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-------------------------------------------------------------------------------------------------------"
## [1] "(tau=8) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:599106.058757721$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=8)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=8)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=8)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=8)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=8)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=8)"
## [1] "Cur Portfolio:"
##  [1] "CAT"  "HON"  "ITW"  "ABT"  "BMY"  "PFE"  "MSFT" "ORCL" "AVGO" "META"
## [11] "WBD"  "TTWO" "BLK"  "SPGI" "MA"   "GM"   "NKE"  "BKNG"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-------------------------------------------------------------------------------------------------------"
## [1] "(tau=9) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:588367.030043063$"
## [1] ""
```

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## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=9)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=9)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=9)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=9)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=9)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=9)"
## [1] "Cur Portfolio:"
##  [1] "NOC"  "CSX"  "DE"   "ABT"  "PFE"  "BMY"  "INTU" "ACN"  "QCOM" "TMUS"
## [11] "CHTR" "WBD"  "MMC"  "GS"   "SCHW" "MCD"  "AMZN" "BKNG"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "---------------------------------------------------------------------------------------------"
## [1] "(tau=10) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:631201.43742559$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=10)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=10)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=10)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=10)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=10)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=10)"
## [1] "Cur Portfolio:"
##  [1] "HON"  "ADP"  "ETN"  "TMO"  "UNH"  "ISRG" "ACN"  "NVDA" "CSCO" "CHTR"
## [11] "GOOG" "EA"   "C"    "CB"   "MMC"  "ORLY" "BKNG" "AMZN"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "---------------------------------------------------------------------------------------------"
## [1] "(tau=11) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:671511.884381922$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=11)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=11)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=11)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=11)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=11)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=11)"
## [1] "Cur Portfolio:"
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## [1] "BA"   "DE"   "LMT"  "BMY"  "PFE"  "JNJ"  "AAPL" "INTU" "MSFT" "NFLX"
## [11] "ATVI" "TTWO" "SCHW" "BLK"  "JPM"  "ORLY" "MAR"  "SBUX"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
## [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------------------"
## [1] "(tau=12) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:682196.863753572$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "     SECTOR_PROCEDURE(G=Industrials, tau=12)"
## [1] "     SECTOR_PROCEDURE(G=Health Care, tau=12)"
## [1] "     SECTOR_PROCEDURE(G=Information Technology, tau=12)"
## [1] "     SECTOR_PROCEDURE(G=Communication Services, tau=12)"
## [1] "     SECTOR_PROCEDURE(G=Financials, tau=12)"
## [1] "     SECTOR_PROCEDURE(G=Consumer Discretionary, tau=12)"
## [1] "Cur Portfolio:"
##  [1] "UPS"  "RTX"  "LMT"  "MRK"  "JNJ"  "ISRG" "TXN"  "ADBE" "NVDA" "TMUS"
## [11] "VZ"   "NFLX" "MA"   "AXP"  "V"    "ABNB" "AZO"  "MCD"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------------------"
## [1] "(tau=13) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:677827.137627912$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "     SECTOR_PROCEDURE(G=Industrials, tau=13)"
## [1] "     SECTOR_PROCEDURE(G=Health Care, tau=13)"
## [1] "     SECTOR_PROCEDURE(G=Information Technology, tau=13)"
## [1] "     SECTOR_PROCEDURE(G=Communication Services, tau=13)"
## [1] "     SECTOR_PROCEDURE(G=Financials, tau=13)"
## [1] "     SECTOR_PROCEDURE(G=Consumer Discretionary, tau=13)"
## [1] "Cur Portfolio:"
##  [1] "ITW"  "CAT"  "GE"   "ISRG" "DHR"  "LLY"  "INTU" "INTC" "TXN"  "TMUS"
## [11] "VZ"   "T"    "GS"   "BLK"  "CB"   "MAR"  "NKE"  "CMG"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
```

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## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------"
## [1] "(tau=14) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:735542.99337611$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "     SECTOR_PROCEDURE(G=Industrials, tau=14)"
## [1] "     SECTOR_PROCEDURE(G=Health Care, tau=14)"
## [1] "     SECTOR_PROCEDURE(G=Information Technology, tau=14)"
## [1] "     SECTOR_PROCEDURE(G=Communication Services, tau=14)"
## [1] "     SECTOR_PROCEDURE(G=Financials, tau=14)"
## [1] "     SECTOR_PROCEDURE(G=Consumer Discretionary, tau=14)"
## [1] "Cur Portfolio:"
##  [1] "ITW"  "NOC"  "FDX"  "BMY"  "MRK"  "ABBV" "AMD"  "INTC" "MSFT" "DIS"
## [11] "NFLX" "VZ"   "WFC"  "C"    "SCHW" "MCD"  "CMG"  "NKE"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------"
## [1] "(tau=15) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:802148.498431516$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "     SECTOR_PROCEDURE(G=Industrials, tau=15)"
## [1] "     SECTOR_PROCEDURE(G=Health Care, tau=15)"
## [1] "     SECTOR_PROCEDURE(G=Information Technology, tau=15)"
## [1] "     SECTOR_PROCEDURE(G=Communication Services, tau=15)"
## [1] "     SECTOR_PROCEDURE(G=Financials, tau=15)"
## [1] "     SECTOR_PROCEDURE(G=Consumer Discretionary, tau=15)"
## [1] "Cur Portfolio:"
##  [1] "LMT"  "UPS"  "GE"   "PFE"  "JNJ"  "ELV"  "CRM"  "ORCL" "AAPL" "GOOG"
## [11] "OMC"  "EA"   "MA"   "MMC"  "WFC"  "NKE"  "AMZN" "MAR"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------"
## [1] "(tau=16) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
```

```
## [1] "--> Capital:844584.915407203$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=16)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=16)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=16)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=16)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=16)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=16)"
## [1] "Cur Portfolio:"
##  [1] "FDX"   "CSX"   "ETN"   "MDT"   "MRK"   "GILD"  "ACN"   "ORCL"  "INTU"
## [10] "EA"    "GOOGL" "META"  "GS"    "MMC"   "MS"    "AMZN"  "TJX"   "TSLA"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-------------------------------------------------------------------------------------------------"
## [1] "(tau=17) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:890173.073904181$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=17)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=17)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=17)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=17)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=17)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=17)"
## [1] "Cur Portfolio:"
##  [1] "CSX"   "FDX"   "ETN"   "MDT"   "ABBV" "MRK"   "CSCO" "ACN"   "INTC" "VZ"
## [11] "META"  "TTWO" "WFC"   "V"     "AXP"   "SBUX" "MAR"   "TJX"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-------------------------------------------------------------------------------------------------"
## [1] "(tau=18) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:914015.58800467$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=18)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=18)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=18)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=18)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=18)"
```

```
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=18)"
## [1] "Cur Portfolio:"
##  [1] "HON"  "DE"   "NOC"  "TMO"  "ISRG" "UNH"  "INTU" "AAPL" "IBM"  "META"
## [11] "TTWO" "CHTR" "PGR"  "BLK"  "CB"   "GM"   "NKE"  "BKNG"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------"
## [1] "(tau=19) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:947963.350281275$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=19)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=19)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=19)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=19)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=19)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=19)"
## [1] "Cur Portfolio:"
##  [1] "UPS"  "DE"   "ITW"  "GILD" "ABBV" "AMGN" "TXN"  "AMD"  "ORCL" "WBD"
## [11] "TMUS" "OMC"  "SCHW" "WFC"  "JPM"  "ORLY" "CMG"  "ABNB"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------"
## [1] "(tau=20) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:901684.821370154$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=20)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=20)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=20)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=20)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=20)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=20)"
## [1] "Cur Portfolio:"
##  [1] "RTX"   "UNP"   "DE"    "ISRG" "ABBV" "LLY"   "CRM"   "ACN"   "ADBE"
## [10] "EA"    "CMCSA" "NFLX" "MMC"  "SPGI" "V"     "AZO"   "MCD"   "GM"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
```

```
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-------------------------------------------------------------------------------"
## [1] "(tau=21) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:925965.161794649$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "     SECTOR_PROCEDURE(G=Industrials, tau=21)"
## [1] "     SECTOR_PROCEDURE(G=Health Care, tau=21)"
## [1] "     SECTOR_PROCEDURE(G=Information Technology, tau=21)"
## [1] "     SECTOR_PROCEDURE(G=Communication Services, tau=21)"
## [1] "     SECTOR_PROCEDURE(G=Financials, tau=21)"
## [1] "     SECTOR_PROCEDURE(G=Consumer Discretionary, tau=21)"
## [1] "Cur Portfolio:"
##  [1] "RTX"   "GE"    "FDX"   "TMO"   "ABBV"  "LLY"   "ACN"   "MSFT"  "CSCO"
## [10] "WBD"   "META"  "CMCSA" "WFC"   "V"     "JPM"   "HD"    "F"     "AZO"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-------------------------------------------------------------------------------"
## [1] "(tau=22) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:910308.797225479$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "     SECTOR_PROCEDURE(G=Industrials, tau=22)"
## [1] "     SECTOR_PROCEDURE(G=Health Care, tau=22)"
## [1] "     SECTOR_PROCEDURE(G=Information Technology, tau=22)"
## [1] "     SECTOR_PROCEDURE(G=Communication Services, tau=22)"
## [1] "     SECTOR_PROCEDURE(G=Financials, tau=22)"
## [1] "     SECTOR_PROCEDURE(G=Consumer Discretionary, tau=22)"
## [1] "Cur Portfolio:"
##  [1] "CSX"   "GE"    "ADP"   "ISRG"  "ABBV"  "JNJ"   "INTC"  "IBM"   "NVDA"
## [10] "CMCSA" "META"  "EA"    "V"     "MMC"   "GS"    "ORLY"  "BKNG"  "AMZN"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-------------------------------------------------------------------------------"
```

```
## [1] "(tau=23) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:980040.238644955$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "     SECTOR_PROCEDURE(G=Industrials, tau=23)"
## [1] "     SECTOR_PROCEDURE(G=Health Care, tau=23)"
## [1] "     SECTOR_PROCEDURE(G=Information Technology, tau=23)"
## [1] "     SECTOR_PROCEDURE(G=Communication Services, tau=23)"
## [1] "     SECTOR_PROCEDURE(G=Financials, tau=23)"
## [1] "     SECTOR_PROCEDURE(G=Consumer Discretionary, tau=23)"
## [1] "Cur Portfolio:"
##  [1] "CSX"  "NOC"  "ITW"  "MRK"  "AMGN" "PFE"  "CRM"  "ORCL" "CSCO" "WBD"
## [11] "OMC"  "NFLX" "V"    "SPGI" "BAC"  "AMZN" "TSLA" "ORLY"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-------------------------------------------------------------------------------------------------------"
## [1] "(tau=24) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1067637.63479121$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "     SECTOR_PROCEDURE(G=Industrials, tau=24)"
## [1] "     SECTOR_PROCEDURE(G=Health Care, tau=24)"
## [1] "     SECTOR_PROCEDURE(G=Information Technology, tau=24)"
## [1] "     SECTOR_PROCEDURE(G=Communication Services, tau=24)"
## [1] "     SECTOR_PROCEDURE(G=Financials, tau=24)"
## [1] "     SECTOR_PROCEDURE(G=Consumer Discretionary, tau=24)"
## [1] "Cur Portfolio:"
##  [1] "GE"   "HON"  "UPS"  "TMO"  "AMGN" "ISRG" "IBM"  "AAPL" "INTC" "OMC"
## [11] "CHTR" "META" "GS"   "AXP"  "PGR"  "TSLA" "CMG"  "ABNB"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-------------------------------------------------------------------------------------------------------"
## [1] "(tau=25) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1059850.1794185$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "     SECTOR_PROCEDURE(G=Industrials, tau=25)"
## [1] "     SECTOR_PROCEDURE(G=Health Care, tau=25)"
## [1] "     SECTOR_PROCEDURE(G=Information Technology, tau=25)"
```

```
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=25)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=25)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=25)"
## [1] "Cur Portfolio:"
##  [1] "BA"    "NOC"   "DE"    "ABBV"  "BMY"   "UNH"   "IBM"   "AVGO"  "ADBE"
## [10] "GOOG"  "CMCSA" "META"  "WFC"   "MS"    "AXP"   "AZO"   "AMZN"  "MCD"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
##  [4] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
##  [7] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [10] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [13] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [16] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------------"
## [1] "(tau=26) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1065365.06567464$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=26)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=26)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=26)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=26)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=26)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=26)"
## [1] "Cur Portfolio:"
##  [1] "ITW"   "HON"   "DE"    "LLY"   "PFE"   "UNH"   "INTC"  "TXN"   "QCOM"
## [10] "CMCSA" "VZ"    "TMUS"  "C"     "BAC"   "WFC"   "AZO"   "CMG"   "ABNB"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
##  [4] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
##  [7] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [10] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [13] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [16] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------------"
## [1] "(tau=27) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1090595.36240807$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=27)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=27)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=27)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=27)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=27)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=27)"
## [1] "Cur Portfolio:"
##  [1] "HON"   "ITW"   "DE"    "UNH"   "ABT"   "DHR"   "ADBE"  "AMD"   "NVDA" "TTWO"
## [11] "OMC"   "T"     "BLK"   "PGR"   "C"     "ORLY"  "MCD"   "BKNG"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
```

```
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------------------"
## [1] "(tau=28) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1083384.08451066$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=28)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=28)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=28)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=28)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=28)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=28)"
## [1] "Cur Portfolio:"
##  [1] "UPS"  "LMT"  "ETN"  "AMGN" "LLY"  "ABBV" "AVGO" "AMD"  "ADBE" "CHTR"
## [11] "META" "TTWO" "CB"   "BLK"  "WFC"  "AMZN" "GM"   "BKNG"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------------------"
## [1] "(tau=29) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1107469.67773833$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=29)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=29)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=29)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=29)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=29)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=29)"
## [1] "Cur Portfolio:"
##  [1] "ETN"  "DE"   "CSX"  "ISRG" "ELV"  "AMGN" "TXN"  "INTU" "AMD"  "VZ"
## [11] "ATVI" "META" "WFC"  "MA"   "JPM"  "AZO"  "CMG"  "ABNB"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
```

```
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------"
## [1] "(tau=30) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1162996.9333751$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=30)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=30)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=30)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=30)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=30)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=30)"
## [1] "Cur Portfolio:"
##  [1] "GE"   "FDX"  "UPS"  "MDT"  "ELV"  "DHR"  "ACN"  "NVDA" "MSFT" "TTWO"
## [11] "CHTR" "NFLX" "MMC"  "AXP"  "JPM"  "AZO"  "MAR"  "ABNB"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------"
## [1] "(tau=31) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1167150.35545124$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=31)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=31)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=31)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=31)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=31)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=31)"
## [1] "Cur Portfolio:"
##  [1] "BA"   "ETN"  "CAT"  "UNH"  "ISRG" "ABBV" "INTU" "ACN"  "CSCO" "GOOG"
## [11] "ATVI" "NFLX" "AXP"  "CB"   "SCHW" "TSLA" "AZO"  "F"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------"
## [1] "(tau=32) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1190686.86655146$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=32)"
```

```
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=32)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=32)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=32)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=32)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=32)"
## [1] "Cur Portfolio:"
##  [1] "UPS"  "CSX"  "DE"    "LLY"  "MRK"  "MDT"  "CSCO" "QCOM" "NVDA" "TMUS"
## [11] "META" "GOOG" "V"     "MMC"  "MA"   "TSLA" "TJX"  "AZO"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------------"
## [1] "(tau=33) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1149005.55252823$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=33)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=33)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=33)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=33)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=33)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=33)"
## [1] "Cur Portfolio:"
##  [1] "HON"   "UPS"   "DE"    "ELV"   "ABT"   "LLY"   "AMD"   "IBM"   "CRM"
## [10] "EA"    "ATVI"  "CMCSA" "C"     "BAC"   "SPGI"  "F"     "NKE"   "MAR"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------------"
## [1] "(tau=34) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1131765.1999704$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=34)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=34)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=34)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=34)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=34)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=34)"
## [1] "Cur Portfolio:"
##  [1] "CSX"  "ETN"  "BA"    "TMO"  "BMY"  "MRK"  "MSFT" "AMD"  "QCOM" "NFLX"
## [11] "DIS"  "T"     "PGR"  "BLK"  "BAC"  "GM"   "ABNB" "MAR"
```

```
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------------"
## [1] "(tau=35) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1144430.94378361$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=35)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=35)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=35)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=35)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=35)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=35)"
## [1] "Cur Portfolio:"
##  [1] "HON"  "UNP"  "CSX"  "TMO"  "MDT"  "MRK"  "TXN"  "ADBE" "ORCL" "CHTR"
## [11] "TTWO" "OMC"  "SPGI" "MA"   "CB"   "CMG"  "SBUX" "AMZN"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------------"
## [1] "(tau=36) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1168947.505685$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=36)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=36)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=36)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=36)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=36)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=36)"
## [1] "Cur Portfolio:"
##  [1] "DE"   "UNP"  "CSX"  "LLY"  "TMO"  "AMGN" "AAPL" "INTU" "CSCO"
## [10] "DIS"  "CMCSA" "META" "WFC"  "MMC"  "CB"   "CMG"  "SBUX" "AMZN"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
```

```
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------"
## [1] "(tau=37) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1168330.38850416$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=37)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=37)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=37)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=37)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=37)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=37)"
## [1] "Cur Portfolio:"
##  [1] "RTX"  "ADP"  "UNP"  "JNJ"  "MRK"  "ISRG" "INTC" "TXN"  "AMD"  "NFLX"
## [11] "WBD"  "META" "PGR"  "CB"   "GS"   "MCD"  "SBUX" "NKE"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------"
## [1] "(tau=38) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1277869.58443392$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=38)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=38)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=38)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=38)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=38)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=38)"
## [1] "Cur Portfolio:"
##  [1] "LMT"  "ETN"  "CAT"  "GILD" "LLY"  "ABT"  "MSFT" "ADBE" "CRM"  "TMUS"
## [11] "T"    "GOOG" "BAC"  "MA"   "BLK"  "ORLY" "TSLA" "SBUX"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------"
## [1] "(tau=39) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1365383.55820442$"
## [1] ""
```

```
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=39)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=39)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=39)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=39)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=39)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=39)"
## [1] "Cur Portfolio:"
##  [1] "BA"   "UNP"  "HON"  "PFE"  "ELV"  "MRK"  "TXN"  "AAPL" "NVDA" "TMUS"
## [11] "OMC"  "WBD"  "C"    "BAC"  "SCHW" "ABNB" "HD"   "MAR"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------------"
## [1] "(tau=40) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1443732.61722064$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=40)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=40)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=40)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=40)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=40)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=40)"
## [1] "Cur Portfolio:"
##  [1] "NOC"  "ITW"  "ADP"  "ABBV" "GILD" "ABT"  "CRM"  "NVDA" "AMD"  "CHTR"
## [11] "EA"   "GOOG" "SPGI" "SCHW" "WFC"  "NKE"  "ABNB" "GM"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "----------------------------------------------------------------------------------------------"
## [1] "(tau=41) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1586460.14691173$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=41)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=41)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=41)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=41)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=41)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=41)"
## [1] "Cur Portfolio:"
```

```
## [1] "CAT" "UPS" "GE" "UNH" "DHR" "ELV" "INTC" "NVDA" "INTU" "VZ"
## [11] "TMUS" "EA" "MMC" "C" "AXP" "ORLY" "TSLA" "MAR"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
## [1] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [4] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [7] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [10] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [13] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [16] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "------------------------------------------------------------------------------------------------"
## [1] "(tau=42) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1542363.13590917$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=42)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=42)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=42)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=42)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=42)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=42)"
## [1] "Cur Portfolio:"
## [1] "CSX" "NOC" "UNP" "ISRG" "ABBV" "JNJ" "AAPL" "AVGO" "ORCL" "GOOG"
## [11] "META" "OMC" "GS" "BAC" "AXP" "MCD" "F" "ABNB"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
## [1] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [4] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [7] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [10] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [13] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [16] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "------------------------------------------------------------------------------------------------"
## [1] "(tau=43) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1609103.13420407$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=43)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=43)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=43)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=43)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=43)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=43)"
## [1] "Cur Portfolio:"
## [1] "UNP" "ETN" "CAT" "BMY" "ISRG" "MRK" "AMD" "ORCL" "AVGO" "NFLX"
## [11] "ATVI" "GOOG" "AXP" "BAC" "MMC" "F" "NKE" "HD"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
## [1] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [4] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
## [7] " 0.0555555555555556" " 0.0555555555555556" " 0.0555555555555556"
```

```
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "------------------------------------------------------------------------------------------"
## [1] "(tau=44) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1619814.19017003$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=44)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=44)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=44)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=44)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=44)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=44)"
## [1] "Cur Portfolio:"
##  [1] "ADP"  "HON"  "CSX"  "GILD" "UNH"  "ABT"  "QCOM" "INTC" "ADBE" "WBD"
## [11] "GOOG" "META" "SCHW" "MA"   "V"    "AZO"  "NKE"  "GM"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "------------------------------------------------------------------------------------------"
## [1] "(tau=45) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1542219.67210473$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=45)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=45)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=45)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=45)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=45)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=45)"
## [1] "Cur Portfolio:"
##  [1] "CAT"  "UNP"  "LMT"  "ABBV" "DHR"  "PFE"  "ACN"  "INTU" "MSFT" "GOOG"
## [11] "CHTR" "EA"   "BAC"  "JPM"  "C"    "MCD"  "TSLA" "GM"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "------------------------------------------------------------------------------------------"
## [1] "(tau=46) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
```

```
## [1] "--> Capital:1596955.93310763$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=46)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=46)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=46)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=46)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=46)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=46)"
## [1] "Cur Portfolio:"
##  [1] "CSX"  "FDX"  "UPS"  "UNH"  "ISRG" "TMO"  "CSCO" "CRM"  "INTC" "T"
## [11] "NFLX" "ATVI" "CB"   "PGR"  "V"    "HD"   "AMZN" "AZO"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------------"
## [1] "(tau=47) CLOSE all positions."
## [1] "(1) COMPUTE_P/L(portfolio)"
## [1] "--> Capital:1727485.90201717$"
## [1] ""
## [1] "(2) PORTFOLIO_LOOP:"
## [1] "    SECTOR_PROCEDURE(G=Industrials, tau=47)"
## [1] "    SECTOR_PROCEDURE(G=Health Care, tau=47)"
## [1] "    SECTOR_PROCEDURE(G=Information Technology, tau=47)"
## [1] "    SECTOR_PROCEDURE(G=Communication Services, tau=47)"
## [1] "    SECTOR_PROCEDURE(G=Financials, tau=47)"
## [1] "    SECTOR_PROCEDURE(G=Consumer Discretionary, tau=47)"
## [1] "Cur Portfolio:"
##  [1] "HON"   "GE"    "ADP"   "UNH"   "BMY"   "ISRG"  "NVDA"  "ADBE"  "CSCO"
## [10] "CMCSA" "TMUS"  "EA"    "AXP"   "MMC"   "JPM"   "HD"    "AMZN"  "TJX"
## [1] ""
## [1] "(3) OPTIMIZE_PORTFOLIO(portfolio)"
## [1] "weights: "
##  [1] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [4] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
##  [7] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [10] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [13] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [16] "  0.0555555555555556" "  0.0555555555555556" "  0.0555555555555556"
## [1] ""
## [1] "(4) LONG PORTFOLIO()"
## [1] "-----------------------------------------------------------------------------------------------"
```

SECTOR_PROCEDURE

1. Sector G contains tickers $\{S_1, S_1, \ldots, S_{|G|}\}$, where $|G|=$ number of stocks per sector (before selection).
2. For each ticker, want to calculate **current window:**

$$[t_1 = \text{week } W_{s \times \tau} \ , \ t_{12} = \text{week } W_{s \times \tau + 11}]$$

e.g. with $s = 1$ (slide one month at the time)

$$\begin{cases} \tau = 1 \implies [t_1 = W_1 \ , \ t_{12} = W_{12}] \\ \tau = 2 \implies [t_1 = W_2 \ , \ t_{12} = W_{13}] \\ \vdots \\ \tau = i \implies [t_1 = W_i \ , \ t_{12} = W_{i+11}] \\ \vdots \\ \tau = 48 \implies [t_1 = W_{48} \ , \ t_{12} = W_{59}] \end{cases}$$

EXTRACT_STATIC_FEATURES()

We had a set of features for some stock:

```r
# sample stock dataframe
sample_xts <- sp500_stocks$Industrials$ADP
head(sample_xts, 5)
```

```
##            direction_lead adp_adjclose_lead adp_adjclose_lag0 adp_adjclose_lag1
## 2018-01-03              1       0.003405679                NA                NA
## 2018-01-10              1       0.036716660       0.003405679                NA
## 2018-01-17             -1      -0.009797874       0.036716660       0.003405679
## 2018-01-24              1       0.022660294      -0.009797874       0.036716660
## 2018-01-31             -1      -0.084961837       0.022660294      -0.009797874
##            adp_adjclose_lag2 adp_adjclose_lag3 atr adx aaron bb chaikin_vol clv
## 2018-01-03                NA                NA  NA  NA    NA NA          NA  NA
## 2018-01-10                NA                NA  NA  NA    50 NA          NA  NA
## 2018-01-17                NA                NA  NA  NA   100 NA          NA  NA
## 2018-01-24       0.003405679                NA  NA  NA   100 NA          NA  NA
## 2018-01-31       0.036716660       0.003405679  NA  NA   100 NA          NA  NA
##            emv macd mfi      sar smi volat month_index
## 2018-01-03  NA   NA  NA 115.3586  NA    NA           1
## 2018-01-10  NA   NA  NA 115.4054  NA    NA           1
## 2018-01-17  NA   NA  NA 115.5252  NA    NA           1
## 2018-01-24  NA   NA  NA 115.9245  NA    NA           1
## 2018-01-31  NA   NA  NA 116.4665  NA    NA           1
```

```r
# function that extracts the static (no-changing) features from a matrix of features
f_extract_static_features <- function (stock_data, tau = NULL){

  # Calculate the beginning and end of the current window
  t1 = tau;
  t12 = tau + 11

  # Subset that for which tau corresponds to that feature
}
```