wqu-econometrics-group-6-A-w7

Contents

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KBank SCB

R Markdown

```
library("quantmod")
```

```
## Loading required package: xts
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
## Registered S3 method overwritten by 'xts':
##   method     from
##   as.zoo.xts zoo
```

```
## Loading required package: TTR
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
## Version 0.4-0 included new data defaults. See ?getSymbols.
```

```
library("e1071")
getSymbols("SPY", scr="yahoo")
```

```
## 'getSymbols' currently uses auto.assign=TRUE by default, but will
## use auto.assign=FALSE in 0.5-0. You will still be able to use
## 'loadSymbols' to automatically load data. getOption("getSymbols.env")
## and getOption("getSymbols.auto.assign") will still be checked for
## alternate defaults.
##
```

```
## This message is shown once per session and may be disabled by setting
## options("getSymbols.warning4.0"=FALSE). See ?getSymbols for details.
```

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

```
SPY500<- SPY[,"SPY.Close"]
head(SPY500)
```

```
##            SPY.Close
## 2007-01-03    141.37
## 2007-01-04    141.67
## 2007-01-05    140.54
## 2007-01-08    141.19
## 2007-01-09    141.07
## 2007-01-10    141.54
```

```
#fill NA with previous non-NA value
library(zoo)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:xts':
##
##     first, last
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
SPY500 <- na.locf(SPY500)
return <- quantmod::Delt(SPY500)
```

```
average10<- rollapply(SPY500, 10, mean)
average20<-rollapply(SPY500, 20, mean)
std10<- rollapply(SPY500, 10, sd)
std20<- rollapply(SPY500, 20, sd)
rsi5<- RSI(SPY500,5,"SMA")
rsi14<- RSI(SPY500, 14, "SMA")
macd12269<- MACD(SPY500, 12, 26, 9, "SMA")
macd7205<- MACD(SPY500, 7, 20, 5, "SMA")
bollinger_bands<-BBands(SPY500,20,"SMA",2)
direction<- data.frame(matrix(NA,dim(SPY500)[1],1))
lagreturn<- (SPY500 - Lag(SPY500, 20))/Lag(SPY500, 20)
direction[lagreturn>0.02] <- "Up"
direction[lagreturn< -0.02] <- "Down"
direction[lagreturn< 0.02 &lagreturn> -0.02] <- "NoWhere"
SPY500 <- cbind(SPY500, average10, average20, std10, std20, rsi5, rsi14, macd12269, macd7205, bollinger
head(SPY500)
```

```
##            SPY.Close SPY.Close.1 SPY.Close.2 SPY.Close.3 SPY.Close.4
## 2007-01-03    141.37          NA          NA          NA          NA
## 2007-01-04    141.67          NA          NA          NA          NA
## 2007-01-05    140.54          NA          NA          NA          NA
```

```
## 2007-01-08    141.19          NA          NA          NA          NA
## 2007-01-09    141.07          NA          NA          NA          NA
## 2007-01-10    141.54          NA          NA          NA          NA
##                  rsi rsi.1 macd signal macd.1 signal.1 dn mavg up pctB
## 2007-01-03       NA    NA   NA     NA     NA       NA NA   NA NA   NA
## 2007-01-04       NA    NA   NA     NA     NA       NA NA   NA NA   NA
## 2007-01-05       NA    NA   NA     NA     NA       NA NA   NA NA   NA
## 2007-01-08       NA    NA   NA     NA     NA       NA NA   NA NA   NA
## 2007-01-09       NA    NA   NA     NA     NA       NA NA   NA NA   NA
## 2007-01-10 53.18349    NA   NA     NA     NA       NA NA   NA NA   NA
```

```
train_sdate<- "2007-03-01"
train_edate<- "2017-03-01"
vali_sdate<- "2017-03-02"
vali_edate<- "2018-03-02"
test_sdate<- "2018-03-03"
test_edate<- "2019-10-18"
trainrow<- which(index(SPY500) >= train_sdate& index(SPY500) <= train_edate)
valirow<- which(index(SPY500) >= vali_sdate& index(SPY500) <= vali_edate)
testrow<- which(index(SPY500) >= test_sdate& index(SPY500) <= test_edate)
train<- SPY500[trainrow,]
vali<- SPY500[valirow,]
test<- SPY500[testrow,]
trainme<-apply(train,2,mean)
trainstd<-apply(train,2,sd)
trainidn<- (matrix(1,dim(train)[1],dim(train)[2]))
valiidn<- (matrix(1,dim(vali)[1],dim(vali)[2]))
testidn<- (matrix(1,dim(test)[1],dim(test)[2]))
norm_train<- (train-t(trainme*t(trainidn)))/t(trainstd*t(trainidn))
norm_vali<- (vali-t(trainme*t(valiidn)))/t(trainstd*t(valiidn))
norm_test<- (test-t(trainme*t(testidn)))/t(trainstd*t(testidn))
traindir<- direction[trainrow,1]
validir<- direction[valirow,1]
testdir<- direction[testrow,1]
library(nnet)
set.seed(1)
neural_network<- nnet(norm_train, class.ind(traindir), size=4, trace=T)
```

```
## # weights:  79
## initial  value 2292.477894
## iter  10 value 790.818756
## iter  20 value 558.454192
## iter  30 value 501.782827
## iter  40 value 479.945347
## iter  50 value 459.877532
## iter  60 value 437.096294
## iter  70 value 425.893461
## iter  80 value 419.107186
## iter  90 value 412.675545
## iter 100 value 410.010743
## final  value 410.010743
## stopped after 100 iterations
```

```
dim(norm_train)
```

```
## [1] 2519   15
```

```
vali_pred<-predict(neural_network, norm_vali)
head(vali_pred)
```

```
##                    Down    NoWhere        Up
## 2017-03-02 0.0001502134 0.01622079 0.9883595
## 2017-03-03 0.0001619169 0.01865729 0.9865608
## 2017-03-06 0.0003117574 0.07004219 0.9456502
## 2017-03-07 0.0004460157 0.13300459 0.8912861
## 2017-03-08 0.0006771546 0.26387151 0.7709039
## 2017-03-09 0.0006230756 0.21195155 0.8139530
```

```
vali_pred_class<- data.frame(matrix(NA,dim(vali_pred)[1],1))
vali_pred_class[vali_pred[,"Down"] > 0.5,1]<- "Down"
vali_pred_class[vali_pred[,"NoWhere"] > 0.5,1]<- "NoWhere"
vali_pred_class[vali_pred[,"Up"] > 0.5,1]<- "Up"
vali_pred_class[is.na(vali_pred_class)]<- "NoWhere"
library(caret)
```

```
## Loading required package: lattice
```

```
## Loading required package: ggplot2
```

```
u<- union(vali_pred_class[,1],validir)
t<-table(factor(vali_pred_class[,1],u),factor(validir,u))
confusionMatrix(t)
```

```
## Confusion Matrix and Statistics
##
##
##            Up NoWhere Down
##   Up       57       5    4
##   NoWhere  30     139    6
##   Down      0       2   10
##
## Overall Statistics
##
##                Accuracy : 0.8142
##                  95% CI : (0.7607, 0.8602)
##     No Information Rate : 0.5771
##     P-Value [Acc > NIR] : 9.120e-16
##
##                   Kappa : 0.6339
##
##  Mcnemar's Test P-Value : 2.676e-05
##
## Statistics by Class:
##
##                      Class: Up Class: NoWhere Class: Down
## Sensitivity             0.6552         0.9521     0.50000
## Specificity             0.9458         0.6636     0.99142
## Pos Pred Value          0.8636         0.7943     0.83333
## Neg Pred Value          0.8396         0.9103     0.95851
## Prevalence              0.3439         0.5771     0.07905
## Detection Rate          0.2253         0.5494     0.03953
## Detection Prevalence    0.2609         0.6917     0.04743
## Balanced Accuracy       0.8005         0.8078     0.74571
```

```
test_pred<- predict(neural_network, norm_test)
test_pred
```

```
##                    Down      NoWhere           Up
## 2018-03-05 1.211824e-02 0.9867203233 0.0103075046
## 2018-03-06 2.500869e-03 0.8184334349 0.1847360575
## 2018-03-07 1.897507e-03 0.7327613992 0.2805842737
## 2018-03-08 3.679560e-04 0.0973804845 0.9231652558
## 2018-03-09 4.376541e-05 0.0012321201 0.9991996283
## 2018-03-12 4.388062e-05 0.0012390116 0.9991949932
## 2018-03-13 6.023288e-05 0.0024213573 0.9983880951
## 2018-03-14 1.219889e-04 0.0135759849 0.9901509995
## 2018-03-15 2.828135e-04 0.0581580307 0.9551670090
## 2018-03-16 1.299002e-03 0.5909396328 0.4436802817
## 2018-03-19 1.079174e-01 0.9533191688 0.0056478047
## 2018-03-20 8.533028e-02 0.9443331323 0.0048590971
## 2018-03-21 3.853802e-01 0.7802062121 0.0004927193
## 2018-03-22 9.585487e-01 0.0206408038 0.0017553684
## 2018-03-23 9.598733e-01 0.0202049361 0.0017437786
## 2018-03-26 8.591732e-01 0.0640311936 0.0018382067
## 2018-03-27 9.577876e-01 0.0194396173 0.0018576977
## 2018-03-28 9.574579e-01 0.0187845233 0.0019154073
## 2018-03-29 8.357175e-01 0.0083888752 0.0092690857
## 2018-04-02 9.570724e-01 0.0175739664 0.0020236209
## 2018-04-03 9.274679e-01 0.0070567469 0.0057131269
## 2018-04-04 3.821437e-01 0.0008629369 0.1658204130
## 2018-04-05 1.228238e-03 0.0043968681 0.8090470273
## 2018-04-06 9.459696e-01 0.0116224681 0.0032341676
## 2018-04-09 9.458770e-01 0.0126399249 0.0030274125
## 2018-04-10 5.700197e-02 0.0257098260 0.0743511465
## 2018-04-11 5.302680e-01 0.1113975741 0.0036708471
## 2018-04-12 1.879320e-02 0.9183899624 0.0022178073
## 2018-04-13 1.213249e-01 0.6839274838 0.0019348514
## 2018-04-16 8.392312e-04 0.9911162284 0.0034527974
## 2018-04-17 7.332293e-05 0.7959699778 0.1653438131
## 2018-04-18 6.576088e-05 0.7712482206 0.1914483440
## 2018-04-19 3.777373e-04 0.6322453970 0.3736009870
## 2018-04-20 7.484896e-03 0.9975527199 0.0014545085
## 2018-04-23 9.081189e-03 0.9693790541 0.0227642931
## 2018-04-24 1.177586e-01 0.9613181756 0.0046079077
## 2018-04-25 2.341894e-02 0.9867643749 0.0065876141
## 2018-04-26 1.734009e-03 0.6368611387 0.3636446931
## 2018-04-27 1.595400e-03 0.6401953449 0.3742451770
## 2018-04-30 7.566985e-03 0.9503914942 0.0353710062
## 2018-05-01 7.285039e-04 0.9932121592 0.0031339289
## 2018-05-02 2.904753e-03 0.9973607584 0.0006331979
## 2018-05-03 9.304812e-03 0.9950102217 0.0004890227
## 2018-05-04 5.727773e-05 0.6167404130 0.3066133643
## 2018-05-07 2.219192e-05 0.2230371615 0.7425193164
## 2018-05-08 4.335382e-05 0.4993258353 0.4290926415
## 2018-05-09 1.729800e-05 0.1578322344 0.8224136440
## 2018-05-10 1.154669e-05 0.0789217817 0.9142508616
## 2018-05-11 1.135174e-05 0.0766327796 0.9169962261
## 2018-05-14 1.745176e-05 0.1704054894 0.8116689186
```

```
## 2018-05-15 8.731226e-05 0.8538993926 0.1164375728
## 2018-05-16 1.684099e-04 0.0862740382 0.9278606851
## 2018-05-17 7.330218e-04 0.3172884431 0.7257978454
## 2018-05-18 2.365891e-03 0.8255923008 0.1850442204
## 2018-05-21 2.893088e-04 0.0619400994 0.9525988532
## 2018-05-22 1.092662e-03 0.4775657183 0.5545479683
## 2018-05-23 6.154902e-04 0.2166282873 0.8158751431
## 2018-05-24 7.498349e-04 0.3121349630 0.7262725073
## 2018-05-25 9.936091e-04 0.4420658612 0.5952479479
## 2018-05-29 1.428690e-02 0.9790526820 0.0128344139
## 2018-05-30 2.468902e-04 0.0432401969 0.9670602027
## 2018-05-31 7.774210e-04 0.2858780496 0.7391175126
## 2018-06-01 8.919106e-05 0.0053183480 0.9963031034
## 2018-06-04 6.938339e-05 0.0032692343 0.9977808047
## 2018-06-05 1.843100e-05 0.1749393493 0.8052007888
## 2018-06-06 4.243773e-05 0.0025169696 0.9982490073
## 2018-06-07 1.339502e-05 0.1041206382 0.8861487264
## 2018-06-08 1.363980e-05 0.1081499333 0.8816902665
## 2018-06-11 1.522604e-05 0.1293428184 0.8582195809
## 2018-06-12 2.549962e-05 0.2564427378 0.7188416377
## 2018-06-13 2.248211e-04 0.0430006774 0.9672473384
## 2018-06-14 2.576732e-04 0.0483165100 0.9632410620
## 2018-06-15 1.919381e-03 0.7259678219 0.2840402071
## 2018-06-18 7.300971e-03 0.9304235528 0.0479483160
## 2018-06-19 1.338787e-02 0.9708849724 0.0170294036
## 2018-06-20 1.133363e-02 0.9298691510 0.0358775474
## 2018-06-21 2.888356e-02 0.9676987996 0.0109272003
## 2018-06-22 8.543595e-03 0.9363124371 0.0388919581
## 2018-06-25 2.382524e-01 0.9402660377 0.0002708075
## 2018-06-26 1.360586e-02 0.9951878718 0.0003408350
## 2018-06-27 4.843696e-01 0.5748420898 0.0007522022
## 2018-06-28 1.922041e-02 0.9168211059 0.0022168856
## 2018-06-29 6.101009e-03 0.9119082984 0.0050327730
## 2018-07-02 1.941771e-03 0.8447581678 0.0170508171
## 2018-07-03 3.822606e-02 0.5943502365 0.0058753704
## 2018-07-05 3.489918e-04 0.6246320996 0.1139361246
## 2018-07-06 4.376521e-05 0.3487795055 0.5387878383
## 2018-07-09 1.534217e-05 0.1222352513 0.8613858509
## 2018-07-10 1.731948e-05 0.1596729539 0.8208383484
## 2018-07-11 1.074607e-04 0.8592612268 0.0999913943
## 2018-07-12 3.143832e-05 0.4023813681 0.5528982954
## 2018-07-13 4.333120e-05 0.5765578862 0.3753730228
## 2018-07-16 1.529069e-04 0.9465929204 0.0391506931
## 2018-07-17 1.117129e-04 0.5138289395 0.4684209125
## 2018-07-18 1.407756e-04 0.8481150368 0.1268457597
## 2018-07-19 2.156322e-03 0.7971748084 0.2164529665
## 2018-07-20 2.971718e-03 0.8845160695 0.1211164398
## 2018-07-23 1.144529e-03 0.5337438361 0.5065200112
## 2018-07-24 2.518366e-04 0.0467610589 0.9646789572
## 2018-07-25 7.690741e-05 0.0040590379 0.9972465377
## 2018-07-26 9.582833e-05 0.0064347491 0.9955549636
## 2018-07-27 2.581526e-04 0.0495246643 0.9625763178
## 2018-07-30 9.004207e-04 0.4028315298 0.6381774274
## 2018-07-31 3.136202e-04 0.0682406943 0.9464413196
```

```
## 2018-08-01 3.269596e-04 0.0724014558 0.9425791858
## 2018-08-02 1.234351e-04 0.0104861548 0.9924736413
## 2018-08-03 3.319287e-05 0.0822873679 0.9179674742
## 2018-08-06 1.963574e-05 0.1565425429 0.8285395259
## 2018-08-07 2.720111e-05 0.0599454827 0.9415833758
## 2018-08-08 2.167055e-05 0.2401040577 0.7323663552
## 2018-08-09 3.387216e-05 0.4380133917 0.5142964739
## 2018-08-10 3.089534e-04 0.9810459807 0.0116264807
## 2018-08-13 1.451469e-03 0.9975636415 0.0009406343
## 2018-08-14 1.156176e-04 0.8904359399 0.0802339043
## 2018-08-15 2.622826e-03 0.9984663467 0.0004531602
## 2018-08-16 2.459550e-04 0.9586521655 0.0238428823
## 2018-08-17 1.210156e-04 0.8650699554 0.0901277586
## 2018-08-20 6.270880e-05 0.6865741086 0.2499329486
## 2018-08-21 4.786892e-05 0.5802939710 0.3573303513
## 2018-08-22 5.678500e-05 0.6667384516 0.2754287321
## 2018-08-23 7.858993e-05 0.7929821273 0.1607987485
## 2018-08-24 2.574982e-05 0.3066332664 0.6566864026
## 2018-08-27 1.333160e-05 0.1031859239 0.8870583695
## 2018-08-28 1.498967e-05 0.1285710210 0.8584639808
## 2018-08-29 1.462937e-05 0.0840749164 0.9104750975
## 2018-08-30 3.568383e-05 0.4639450574 0.4906127230
## 2018-08-31 6.594575e-05 0.7101937423 0.2472034866
## 2018-09-04 5.740195e-04 0.2160926077 0.8165528415
## 2018-09-05 2.286856e-03 0.9356071899 0.0534661406
## 2018-09-06 6.743177e-03 0.9538610280 0.0374063338
## 2018-09-07 1.210034e-02 0.9716210098 0.0178800694
## 2018-09-10 6.077801e-03 0.9175608169 0.0609999172
## 2018-09-11 9.377591e-04 0.6094468291 0.3719440780
## 2018-09-12 2.824213e-04 0.9699823064 0.0180055006
## 2018-09-13 4.041039e-05 0.4790570584 0.4551027141
## 2018-09-14 3.831786e-05 0.4599330869 0.4777108795
## 2018-09-17 1.060767e-04 0.8640257197 0.0981992800
## 2018-09-18 3.283637e-05 0.4008296249 0.5468351938
## 2018-09-19 2.743865e-05 0.3256253567 0.6324577907
## 2018-09-20 1.515125e-05 0.1279095970 0.8578983563
## 2018-09-21 5.303693e-05 0.6254340624 0.3118629975
## 2018-09-24 2.508359e-04 0.9538856328 0.0255005246
## 2018-09-25 6.844659e-04 0.9865576819 0.0053402408
## 2018-09-26 5.011086e-03 0.9959449799 0.0005912690
## 2018-09-27 1.801677e-03 0.9941415999 0.0015325833
## 2018-09-28 1.453613e-03 0.9926673161 0.0020813272
## 2018-10-01 4.063435e-04 0.9679201535 0.0142298769
## 2018-10-02 6.626927e-04 0.9799501390 0.0072971659
## 2018-10-03 2.984615e-04 0.9597120096 0.0206076329
## 2018-10-04 4.791925e-03 0.9957690999 0.0006282979
## 2018-10-05 1.031065e-01 0.9539851388 0.0004309594
## 2018-10-08 2.451922e-02 0.9874369013 0.0004573372
## 2018-10-09 2.986917e-02 0.9803628317 0.0005533550
## 2018-10-10 9.586534e-01 0.0205298981 0.0017592118
## 2018-10-11 9.599300e-01 0.0202309303 0.0017397855
## 2018-10-12 9.585988e-01 0.0194513475 0.0018318721
## 2018-10-15 9.587591e-01 0.0192872984 0.0018384979
## 2018-10-16 7.319578e-01 0.0104841021 0.0119209291
```

```
## 2018-10-17 5.515050e-01 0.0078647233 0.0247382148
## 2018-10-18 9.490108e-01 0.0136999970 0.0027376795
## 2018-10-19 9.442574e-01 0.0122425389 0.0031637044
## 2018-10-22 9.461373e-01 0.0119705448 0.0031387444
## 2018-10-23 9.734654e-01 0.0014112849 0.0333478442
## 2018-10-24 9.599213e-01 0.0200615867 0.0017555956
## 2018-10-25 9.578492e-01 0.0181447728 0.0019518087
## 2018-10-26 9.598014e-01 0.0200780305 0.0017534092
## 2018-10-29 9.598845e-01 0.0201615104 0.0017457960
## 2018-10-30 9.579668e-01 0.0183261537 0.0019338821
## 2018-10-31 9.394272e-01 0.0097322025 0.0039629290
## 2018-11-01 5.230481e-01 0.0091163916 0.0240132843
## 2018-11-02 8.844820e-01 0.0123609325 0.0053358319
## 2018-11-05 4.032498e-02 0.3745491161 0.0107231246
## 2018-11-06 2.515455e-04 0.8532557760 0.0611119316
## 2018-11-07 1.193352e-05 0.0843865164 0.9082239596
## 2018-11-08 1.287117e-05 0.0976648132 0.8933870267
## 2018-11-09 9.122729e-05 0.8632658179 0.1079665312
## 2018-11-12 2.041354e-01 0.9658269407 0.0002084522
## 2018-11-13 6.324894e-01 0.4866944722 0.0015600846
## 2018-11-14 8.346448e-01 0.0787263403 0.0235007485
## 2018-11-15 3.359903e-02 0.9890802047 0.0044747028
## 2018-11-16 2.226462e-02 0.9880575864 0.0063291153
## 2018-11-19 9.354109e-01 0.0119060934 0.0456988446
## 2018-11-20 9.852262e-01 0.0012355552 0.0438813117
## 2018-11-21 9.784605e-01 0.0014113233 0.0829840336
## 2018-11-23 9.858181e-01 0.0005603895 0.1337962031
## 2018-11-26 2.841211e-02 0.0723395501 0.4448966150
## 2018-11-27 1.040469e-03 0.5173357724 0.0807145712
## 2018-11-28 1.037939e-05 0.0543975181 0.9418772114
## 2018-11-29 1.381982e-05 0.0993932600 0.8909660077
## 2018-11-30 1.171494e-05 0.0806749585 0.9123368495
## 2018-12-03 1.046568e-05 0.0387024615 0.9601068263
## 2018-12-04 3.409255e-03 0.9981213490 0.0004399921
## 2018-12-06 4.396705e-02 0.9871928363 0.0003096958
## 2018-12-07 9.574378e-01 0.0210254396 0.0017640175
## 2018-12-10 9.550855e-01 0.0225884485 0.0017376903
## 2018-12-11 9.530888e-01 0.0241582701 0.0017051060
## 2018-12-12 9.311666e-01 0.0411578514 0.0015071746
## 2018-12-13 8.875347e-01 0.0728666317 0.0013995400
## 2018-12-14 9.585372e-01 0.0203211886 0.0017759135
## 2018-12-17 9.598401e-01 0.0201824054 0.0017456000
## 2018-12-18 9.640293e-01 0.0140560865 0.0026435610
## 2018-12-19 9.905110e-01 0.0003993133 0.1302653465
## 2018-12-20 9.905088e-01 0.0004067400 0.1279408676
## 2018-12-21 9.905857e-01 0.0004018029 0.1295318156
## 2018-12-24 9.905871e-01 0.0004018673 0.1295141748
## 2018-12-26 9.900511e-01 0.0003569496 0.1439967129
## 2018-12-27 9.880721e-01 0.0002432080 0.2004519030
## 2018-12-28 9.883821e-01 0.0002574589 0.1911887088
## 2018-12-31 9.824060e-01 0.0001119877 0.3632726912
## 2019-01-02 9.364841e-01 0.0076289550 0.0049653767
## 2019-01-03 9.595321e-01 0.0197952626 0.0017800480
## 2019-01-04 6.213924e-01 0.0036349246 0.0352519708
```

```
## 2019-01-07 1.116208e-02 0.0915779195 0.0861075290
## 2019-01-08 1.856239e-04 0.7092818794 0.1297141024
## 2019-01-09 6.268412e-04 0.9882299623 0.0052004397
## 2019-01-10 3.434551e-04 0.8492471947 0.1320233078
## 2019-01-11 9.529897e-04 0.4563955511 0.5919347818
## 2019-01-14 1.049767e-02 0.9923193539 0.0076504964
## 2019-01-15 7.637989e-04 0.3502231142 0.6983023572
## 2019-01-16 2.104976e-04 0.0336906922 0.9752320737
## 2019-01-17 1.271919e-04 0.0118028987 0.9916858374
## 2019-01-18 4.602869e-05 0.0013720679 0.9991054978
## 2019-01-22 1.030076e-04 0.0075690589 0.9947563173
## 2019-01-23 6.146543e-05 0.0025357578 0.9983108828
## 2019-01-24 5.762212e-05 0.0022106280 0.9985344778
## 2019-01-25 4.284167e-05 0.0011779998 0.9992360797
## 2019-01-28 5.816274e-05 0.0022550072 0.9985040366
## 2019-01-29 7.561733e-05 0.0039335106 0.9973383403
## 2019-01-30 4.215712e-05 0.0011379403 0.9992630375
## 2019-01-31 4.050729e-05 0.0010457558 0.9993246460
## 2019-02-01 4.129254e-05 0.0010893032 0.9992955174
## 2019-02-04 4.005146e-05 0.0010209120 0.9993412379
## 2019-02-05 4.016323e-05 0.0010269772 0.9993371879
## 2019-02-06 4.267252e-05 0.0011681204 0.9992427048
## 2019-02-07 7.965498e-05 0.0043915682 0.9970165975
## 2019-02-08 6.737621e-05 0.0030795233 0.9979341959
## 2019-02-11 1.240649e-04 0.0111431477 0.9921548935
## 2019-02-12 5.210663e-05 0.0017841443 0.9988258150
## 2019-02-13 5.177617e-05 0.0017602725 0.9988421215
## 2019-02-14 6.231870e-05 0.0026067497 0.9982610202
## 2019-02-15 4.656931e-05 0.0014059375 0.9990825932
## 2019-02-19 5.084586e-05 0.0016946079 0.9988869361
## 2019-02-20 4.870507e-05 0.0015467844 0.9989872982
## 2019-02-21 6.077163e-05 0.0024736575 0.9983533237
## 2019-02-22 5.010628e-05 0.0016424335 0.9989223339
## 2019-02-25 5.487447e-05 0.0019915399 0.9986842876
## 2019-02-26 7.210655e-05 0.0035499655 0.9976052620
## 2019-02-27 8.303595e-05 0.0047722387 0.9967432618
## 2019-02-28 2.079593e-04 0.0313516120 0.9767163413
## 2019-03-01 2.352816e-03 0.0002091928 0.9999963881
## 2019-03-04 3.351710e-04 0.0684454192 0.9498201832
## 2019-03-05 4.111039e-04 0.1178990000 0.9054460042
## 2019-03-06 1.978760e-03 0.7485690109 0.2632906189
## 2019-03-07 2.626821e-02 0.9756113699 0.0095005903
## 2019-03-08 1.471175e-02 0.9665137920 0.0177090966
## 2019-03-11 1.639831e-04 0.0277240556 0.9782408507
## 2019-03-12 2.353456e-05 0.2513657210 0.7164282167
## 2019-03-13 1.508229e-05 0.1272057756 0.8589761236
## 2019-03-14 1.975852e-05 0.2040109182 0.7717933688
## 2019-03-15 1.965468e-05 0.2014885948 0.7743816278
## 2019-03-18 1.693617e-05 0.1590027535 0.8235561327
## 2019-03-19 2.079637e-05 0.2237679355 0.7501804504
## 2019-03-20 6.076279e-05 0.7116468298 0.2380040286
## 2019-03-21 1.453830e-05 0.1219756995 0.8659010254
## 2019-03-22 7.123187e-03 0.9990377493 0.0001654154
## 2019-03-25 9.207851e-03 0.9986927124 0.0001734442
```

```
## 2019-03-26 6.497205e-04 0.9936986860 0.0032110756
## 2019-03-27 6.661940e-03 0.9977502926 0.0003190903
## 2019-03-28 1.488230e-03 0.9963625650 0.0012352913
## 2019-03-29 1.108401e-04 0.8842518316 0.0847793712
## 2019-04-01 2.791433e-05 0.0218383921 0.9806750609
## 2019-04-02 6.574254e-05 0.0040500072 0.9972002552
## 2019-04-03 2.488371e-05 0.0585429733 0.9428021921
## 2019-04-04 1.453530e-05 0.0540188716 0.9446018458
## 2019-04-05 2.131388e-05 0.0126996512 0.9890150623
## 2019-04-08 2.947191e-05 0.0112311870 0.9907243786
## 2019-04-09 1.304951e-04 0.0125492086 0.9910734454
## 2019-04-10 1.027106e-04 0.0074594030 0.9948211861
## 2019-04-11 5.128908e-04 0.1713811140 0.8575415815
## 2019-04-12 1.729247e-04 0.0217292275 0.9841604191
## 2019-04-15 2.400512e-04 0.0424818186 0.9680682599
## 2019-04-16 3.933728e-04 0.1027907041 0.9188525166
## 2019-04-17 9.681709e-04 0.4193811476 0.6157904068
## 2019-04-18 6.569895e-04 0.2531512110 0.7829359629
## 2019-04-22 3.227204e-04 0.0741142615 0.9420686242
## 2019-04-23 6.787404e-05 0.0030948164 0.9979166391
## 2019-04-24 1.117048e-04 0.0087230423 0.9938689162
## 2019-04-25 1.332409e-04 0.0123798788 0.9911031345
## 2019-04-26 7.967772e-05 0.0043690003 0.9970071379
## 2019-04-29 7.187777e-05 0.0043924065 0.9969578379
## 2019-04-30 4.579027e-05 0.1907774295 0.8019175207
## 2019-05-01 2.819009e-04 0.9317388659 0.0520796986
## 2019-05-02 5.837377e-04 0.9931856559 0.0036474954
## 2019-05-03 7.378193e-05 0.1101552818 0.8948684791
## 2019-05-06 2.182764e-04 0.9468895699 0.0369563112
## 2019-05-07 8.302080e-02 0.9913655505 0.0001476253
## 2019-05-08 1.504706e-01 0.9647155815 0.0002644205
## 2019-05-09 3.976059e-01 0.7568887505 0.0005229486
## 2019-05-10 2.101936e-02 0.9856962925 0.0005586445
## 2019-05-13 9.549612e-01 0.0219868864 0.0017759246
## 2019-05-14 8.715040e-01 0.0443322675 0.0022616621
## 2019-05-15 3.291752e-01 0.2117529158 0.0037063486
## 2019-05-16 7.522165e-04 0.8322299210 0.0338378908
## 2019-05-17 3.312742e-02 0.4524339743 0.0097615206
## 2019-05-20 5.855560e-01 0.0176172612 0.0126822742
## 2019-05-21 6.932172e-03 0.1481095423 0.0807394095
## 2019-05-22 1.372075e-01 0.0714041257 0.0190926633
## 2019-05-23 9.183851e-01 0.0175211025 0.0032023808
## 2019-05-24 8.046147e-01 0.0146992889 0.0071114284
## 2019-05-28 9.532454e-01 0.0171231703 0.0021893807
## 2019-05-29 9.579739e-01 0.0190065937 0.0018827373
## 2019-05-30 9.534828e-01 0.0182288066 0.0020840552
## 2019-05-31 9.587065e-01 0.0193683023 0.0018342847
## 2019-06-03 9.589124e-01 0.0194378237 0.0018231121
## 2019-06-04 6.680104e-01 0.0397148412 0.0055253775
## 2019-06-05 9.000658e-04 0.6540224587 0.0585315290
## 2019-06-06 3.452146e-05 0.3464024987 0.5797953885
## 2019-06-07 1.339898e-05 0.1026723299 0.8868451104
## 2019-06-10 1.177919e-05 0.0820969722 0.9107191741
## 2019-06-11 1.261784e-05 0.0942207844 0.8973114692
```

```
## 2019-06-12 1.898829e-05 0.1980005467 0.7810893851
## 2019-06-13 1.618994e-05 0.1501514342 0.8347367775
## 2019-06-14 1.146208e-04 0.0606637939 0.9493153165
## 2019-06-17 9.249665e-04 0.4339013387 0.6124254582
## 2019-06-18 1.172383e-04 0.0098952004 0.9930654041
## 2019-06-19 1.197361e-04 0.0103715359 0.9927247535
## 2019-06-20 6.897619e-05 0.0032371078 0.9978247277
## 2019-06-21 2.199219e-04 0.0368089790 0.9728212079
## 2019-06-24 2.286660e-04 0.0398702985 0.9704554703
## 2019-06-25 1.823475e-03 0.7721960936 0.2558874448
## 2019-06-26 1.411463e-03 0.6593866110 0.3792939104
## 2019-06-27 2.930704e-04 0.0651680980 0.9503983752
## 2019-06-28 9.181795e-05 0.0059031192 0.9959403166
## 2019-07-01 4.986089e-05 0.0016234928 0.9989348007
## 2019-07-02 4.889897e-05 0.0015574809 0.9989795518
## 2019-07-03 4.261575e-05 0.0011645587 0.9992450406
## 2019-07-05 4.602042e-05 0.0013706986 0.9991062481
## 2019-07-08 7.559557e-05 0.0039170298 0.9973468897
## 2019-07-09 7.326356e-05 0.0036634478 0.9975241572
## 2019-07-10 6.321873e-05 0.0026816327 0.9982080568
## 2019-07-11 6.496381e-05 0.0028402890 0.9980980146
## 2019-07-12 6.556819e-05 0.0028931532 0.9980606143
## 2019-07-15 8.463712e-05 0.0049350673 0.9966201880
## 2019-07-16 3.214812e-04 0.0726800096 0.9425446815
## 2019-07-17 3.722757e-03 0.8940839976 0.0994455790
## 2019-07-18 8.234292e-04 0.3348136804 0.6980467235
## 2019-07-19 4.305503e-03 0.9127484801 0.0790398966
## 2019-07-22 1.724261e-03 0.6735519718 0.3378913323
## 2019-07-23 2.474043e-04 0.0424738736 0.9674369218
## 2019-07-24 8.801736e-05 0.0054682386 0.9962118335
## 2019-07-25 7.918619e-05 0.5019184175 0.4627387455
## 2019-07-26 1.860011e-05 0.1839096774 0.7944335046
## 2019-07-29 2.456573e-05 0.2799503950 0.6841182013
## 2019-07-30 4.716400e-05 0.5878135168 0.3545019562
## 2019-07-31 3.979074e-03 0.9985205963 0.0003337220
## 2019-08-01 1.817889e-01 0.9550261644 0.0002724824
## 2019-08-02 8.695193e-01 0.1127966329 0.0011091616
## 2019-08-05 9.598974e-01 0.0202291543 0.0017408822
## 2019-08-06 9.565312e-01 0.0196249526 0.0018829780
## 2019-08-07 9.496697e-01 0.0187453691 0.0021580665
## 2019-08-08 5.520560e-03 0.7314565985 0.0139434607
## 2019-08-09 3.596559e-01 0.1397412701 0.0048568369
## 2019-08-12 9.340060e-01 0.0158937141 0.0029502216
## 2019-08-13 1.422727e-03 0.2334311260 0.1453956043
## 2019-08-14 9.574131e-01 0.0180668969 0.0019720643
## 2019-08-15 9.493061e-01 0.0131512570 0.0028087921
## 2019-08-16 2.604037e-01 0.0004915485 0.3023023692
## 2019-08-19 4.254856e-04 0.0538800398 0.5607948010
## 2019-08-20 4.759624e-01 0.0145669596 0.0194590183
## 2019-08-21 1.773944e-03 0.8678854339 0.0158407245
## 2019-08-22 8.964808e-04 0.9045023186 0.0191758151
## 2019-08-23 9.566727e-01 0.0199177315 0.0018584173
## 2019-08-26 8.125624e-01 0.1144819500 0.0014611395
## 2019-08-27 8.739938e-01 0.0482619506 0.0020900317
```

```
## 2019-08-28 6.469138e-02 0.9508782242 0.0006361852
## 2019-08-29 2.605871e-04 0.9631747260 0.0210907781
## 2019-08-30 3.213028e-04 0.9763872543 0.0132882183
## 2019-09-03 5.771738e-04 0.9883161648 0.0054049659
## 2019-09-04 3.374043e-05 0.4334480491 0.5182732125
## 2019-09-05 1.034970e-05 0.0590157023 0.9368736323
## 2019-09-06 4.416099e-05 0.0014134982 0.9990716259
## 2019-09-09 5.639387e-05 0.0021109611 0.9986026135
## 2019-09-10 6.994316e-05 0.0033338785 0.9977560949
## 2019-09-11 5.428124e-05 0.0019470430 0.9987148995
## 2019-09-12 5.122066e-05 0.0017214151 0.9988687415
## 2019-09-13 7.484142e-05 0.0038415480 0.9974012893
## 2019-09-16 1.348393e-04 0.0132826424 0.9905875655
## 2019-09-17 2.198092e-04 0.0365468360 0.9729710340
## 2019-09-18 3.253888e-04 0.0800633282 0.9383778986
## 2019-09-19 3.149137e-04 0.0754219918 0.9422213056
## 2019-09-20 3.732882e-03 0.9360790462 0.0690405582
## 2019-09-23 3.771285e-03 0.9172356255 0.0825738923
## 2019-09-24 1.480374e-02 0.9851597711 0.0097630593
## 2019-09-25 7.369917e-04 0.2947554971 0.7400412487
## 2019-09-26 8.991239e-04 0.3481556436 0.6762128222
## 2019-09-27 4.198844e-03 0.8529692073 0.1099062707
## 2019-09-30 2.272513e-04 0.9545117024 0.0271121316
## 2019-10-01 2.764144e-02 0.9843386183 0.0004946366
## 2019-10-02 9.425624e-01 0.0262418582 0.0018504975
## 2019-10-03 6.825652e-01 0.0750384378 0.0032620899
## 2019-10-04 6.511111e-04 0.5743835765 0.0896156360
## 2019-10-07 2.132557e-02 0.3217872823 0.0195086545
## 2019-10-08 9.438970e-01 0.0164544172 0.0025627838
## 2019-10-09 5.865391e-01 0.0127820987 0.0159358978
## 2019-10-10 1.337063e-02 0.1091711205 0.0675431594
## 2019-10-11 5.009182e-05 0.3682653698 0.5010113195
## 2019-10-14 8.530576e-05 0.5020114747 0.3215448836
## 2019-10-15 1.408381e-05 0.1077765748 0.8793732858
## 2019-10-16 4.315796e-05 0.5130677578 0.4201687329
## 2019-10-17 5.099163e-05 0.6345224893 0.3114959019
## 2019-10-18 1.364277e-04 0.9295343869 0.0515864800
```

```
test_pred_class<- data.frame(matrix(NA,dim(test_pred)[1],1))
test_pred_class[test_pred[,"Down"] > 0.5,1]<- "Down"
test_pred_class[test_pred[,"NoWhere"] > 0.5,1]<- "NoWhere"
test_pred_class[test_pred[,"Up"] > 0.5,1]<- "Up"
test_pred_class[is.na(test_pred_class)]<- "NoWhere"
u<- union(test_pred_class[,1],testdir)
t<-table(factor(test_pred_class[,1],u),factor(testdir,u))
confusionMatrix(t)
```

```
## Confusion Matrix and Statistics
##
##
##           NoWhere  Up Down
##   NoWhere     115  20   21
##   Up           29 145    2
##   Down          3   0   76
##
```

```
## Overall Statistics
##
##                Accuracy : 0.8175
##                  95% CI : (0.7767, 0.8537)
##     No Information Rate : 0.4015
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.7175
##
##  Mcnemar's Test P-Value : 0.0006573
##
## Statistics by Class:
##
##                      Class: NoWhere Class: Up Class: Down
## Sensitivity                  0.7823    0.8788      0.7677
## Specificity                  0.8447    0.8740      0.9904
## Pos Pred Value               0.7372    0.8239      0.9620
## Neg Pred Value               0.8745    0.9149      0.9307
## Prevalence                   0.3577    0.4015      0.2409
## Detection Rate               0.2798    0.3528      0.1849
## Detection Prevalence         0.3796    0.4282      0.1922
## Balanced Accuracy            0.8135    0.8764      0.8790
```

```
signal<-ifelse(test_pred_class=="Up",1,ifelse(test_pred_class=="Down",-1, 0))
signal
```

```
##        matrix.NA..dim.test_pred..1...1.
##   [1,]                                0
##   [2,]                                0
##   [3,]                                0
##   [4,]                                1
##   [5,]                                1
##   [6,]                                1
##   [7,]                                1
##   [8,]                                1
##   [9,]                                1
##  [10,]                                0
##  [11,]                                0
##  [12,]                                0
##  [13,]                                0
##  [14,]                               -1
##  [15,]                               -1
##  [16,]                               -1
##  [17,]                               -1
##  [18,]                               -1
##  [19,]                               -1
##  [20,]                               -1
##  [21,]                               -1
##  [22,]                                0
##  [23,]                                1
##  [24,]                               -1
##  [25,]                               -1
##  [26,]                                0
##  [27,]                               -1
##  [28,]                                0
```

```
##  [29,]                       0
##  [30,]                       0
##  [31,]                       0
##  [32,]                       0
##  [33,]                       0
##  [34,]                       0
##  [35,]                       0
##  [36,]                       0
##  [37,]                       0
##  [38,]                       0
##  [39,]                       0
##  [40,]                       0
##  [41,]                       0
##  [42,]                       0
##  [43,]                       0
##  [44,]                       0
##  [45,]                       1
##  [46,]                       0
##  [47,]                       1
##  [48,]                       1
##  [49,]                       1
##  [50,]                       1
##  [51,]                       0
##  [52,]                       1
##  [53,]                       1
##  [54,]                       0
##  [55,]                       1
##  [56,]                       1
##  [57,]                       1
##  [58,]                       1
##  [59,]                       1
##  [60,]                       0
##  [61,]                       1
##  [62,]                       1
##  [63,]                       1
##  [64,]                       1
##  [65,]                       1
##  [66,]                       1
##  [67,]                       1
##  [68,]                       1
##  [69,]                       1
##  [70,]                       1
##  [71,]                       1
##  [72,]                       1
##  [73,]                       0
##  [74,]                       0
##  [75,]                       0
##  [76,]                       0
##  [77,]                       0
##  [78,]                       0
##  [79,]                       0
##  [80,]                       0
##  [81,]                       0
##  [82,]                       0
```

```
##  [83,]                          0
##  [84,]                          0
##  [85,]                          0
##  [86,]                          0
##  [87,]                          1
##  [88,]                          1
##  [89,]                          1
##  [90,]                          0
##  [91,]                          1
##  [92,]                          0
##  [93,]                          0
##  [94,]                          0
##  [95,]                          0
##  [96,]                          0
##  [97,]                          0
##  [98,]                          1
##  [99,]                          1
## [100,]                          1
## [101,]                          1
## [102,]                          1
## [103,]                          1
## [104,]                          1
## [105,]                          1
## [106,]                          1
## [107,]                          1
## [108,]                          1
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## [112,]                          0
## [113,]                          0
## [114,]                          0
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## [116,]                          0
## [117,]                          0
## [118,]                          0
## [119,]                          0
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## [126,]                          0
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## [134,]                          0
## [135,]                          0
## [136,]                          0
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## [171,] -1
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## [177,]  0
## [178,] -1
## [179,] -1
## [180,]  0
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## [182,] -1
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## [185,] -1
## [186,]  0
## [187,]  0
## [188,]  1
## [189,]  1
## [190,]  1
```

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## [191,]  1
## [192,]  0
## [193,]  0
## [194,] -1
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## [245,]                          1
## [246,]                          1
## [247,]                          1
## [248,]                          1
## [249,]                          1
## [250,]                          1
## [251,]                          1
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## [253,]                          0
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## [290,]                          1
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## [292,]                          0
## [293,]                          0
## [294,]                          1
## [295,]                          0
## [296,]                          0
## [297,]                          0
## [298,]                          0
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## [299,]  0
## [300,] -1
## [301,] -1
## [302,]  0
## [303,]  0
## [304,]  0
## [305,] -1
## [306,]  0
## [307,]  0
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## [310,] -1
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## [313,] -1
## [314,] -1
## [315,] -1
## [316,]  0
## [317,]  1
## [318,]  1
## [319,]  1
## [320,]  1
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## [352,]  1
```

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## [353,]  1
## [354,]  0
## [355,]  0
## [356,]  0
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## [398,]  0
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## [400,] -1
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## [402,]  0
## [403,] -1
## [404,] -1
## [405,]  0
## [406,]  1
```

```
## [407,]                                0
## [408,]                                1
## [409,]                                0
## [410,]                                0
## [411,]                                0
```

```
test_return_SPY<- return[(index(return)>= test_sdate & index(return)<= test_edate), ]
test_return<- test_return_SPY*(signal)
library(PerformanceAnalytics)
```

```
##
## Attaching package: 'PerformanceAnalytics'
```

```
## The following objects are masked from 'package:e1071':
##
##     kurtosis, skewness
```

```
## The following object is masked from 'package:graphics':
##
##     legend
```

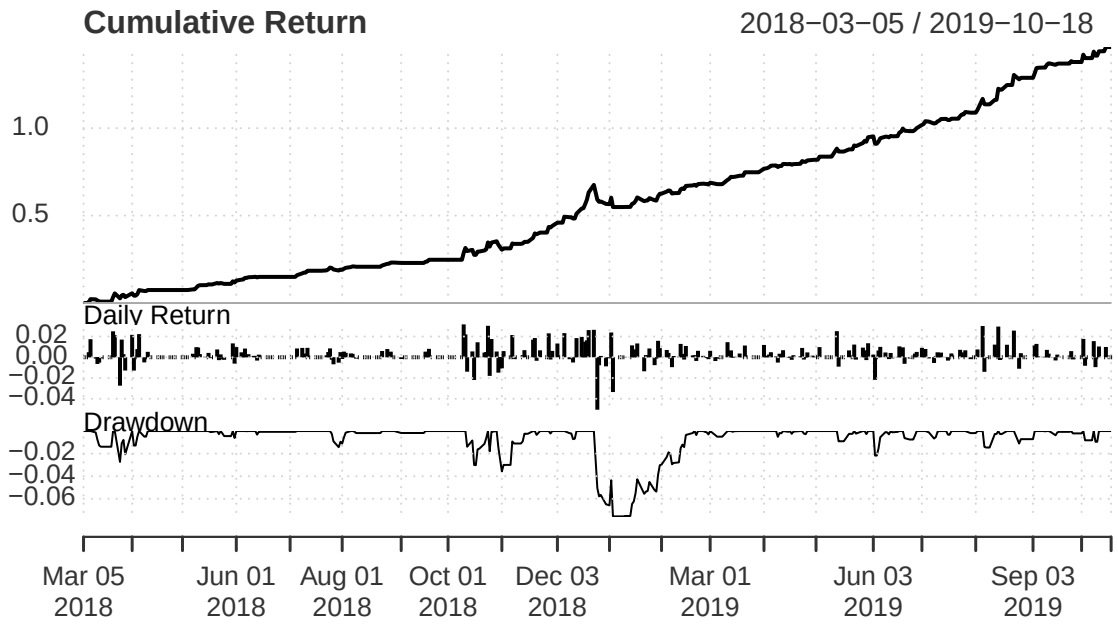
```
#calculate cummulative return
cumm_return<- Return.cumulative(test_return)
cumm_return
```

```
##                   Delt.1.arithmetic
## Cumulative Return          1.463558
```

```
#calculate annual return
annual_return<- Return.annualized(test_return)
annual_return
```

```
##                   Delt.1.arithmetic
## Annualized Return         0.7381301
```

```
charts.PerformanceSummary(test_return)
```




```
VaR(test_return, p=0.95)
```

```
##     Delt.1.arithmetic
## VaR       -0.01006893
```

```
SharpeRatio(as.ts(test_return), Rf = 0, p=0.95, FUN = "StdDev")
```

```
##                                    [,1]
## StdDev Sharpe (Rf=0%, p=95%): 0.2752382
```

```
SharpeRatio.annualized(test_return, Rf=0)
```

```
##                                  Delt.1.arithmetic
## Annualized Sharpe Ratio (Rf=0%)          5.742213
```