Model Selection

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

# Import the linear models from scikit-learn
from sklearn import linear_model
from sklearn import metrics
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.pipeline import Pipeline
from sklearn.linear_model import LogisticRegression, LogisticRegressionCV
from sklearn.linear_model import SGDClassifier
from sklearn.pipeline import make_pipeline
from sklearn.preprocessing import RobustScaler
from sklearn.svm import SVC
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import KFold, cross_validate, train_test_split
from sklearn.ensemble import RandomForestClassifier,GradientBoostingClassifier,R

%matplotlib inline
```

BIO

In [2]:
```
##Load the data
BIO_train_0 = pd.read_csv("BIO/BIO_Group0_training.csv",index_col=[0])
print('Train:', BIO_train_0['Report Date'].iloc[0], 'to',BIO_train_0['Report Dat
print('Shape', BIO_train_0.shape)
#BIO_val_0 =

BIO_test_0 = pd.read_csv("BIO/BIO_Group0_testing.csv",index_col=[0])
print('Test:', BIO_test_0['Report Date'].min(), 'to',BIO_test_0['Report Date'].m
print('Shape', BIO_test_0.shape)
```

```
Train: 2020/3/2 to 2020/12/31
Shape (305, 7)
Test: 2021-01-01 to 2021-06-30
Shape (181, 7)
```

In [3]:
```
BIO_train_0['Return'] = BIO_train_0['Stock price'].pct_change()
BIO_train_0['Next Day Return'] = BIO_train_0['Return'].shift(-1)
BIO_train_0['Next Day Y_boolean'] = BIO_train_0['Y_boolean'].shift(-1)
BIO_train_0 = BIO_train_0.iloc[:-1]

BIO_test_0['Return'] = BIO_test_0['Stock price'].pct_change()
BIO_test_0['Next Day Return'] = BIO_test_0['Return'].shift(-1)
BIO_test_0['Next Day Y_boolean'] = BIO_test_0['Y_boolean'].shift(-1)
BIO_test_0 = BIO_test_0.iloc[:-1]
```

In [4]:
```
BIO_train_0
```

Out[4]:

	Report Date	Stock price	Y_boolean	Dummy_Dividends	Interest Coverage	Net Profit Margin	RSI_ratio	R
0	2020/3/2	368.950012	1	0	0.07402	0.000000	0.345478	
1	2020/3/3	370.000000	0	0	0.07402	0.000000	0.345478	0.0(
2	2020/3/4	384.929993	1	0	0.07402	0.000000	0.345478	0.0
3	2020/3/5	386.679993	1	0	0.07402	0.000000	0.345478	0.0(
4	2020/3/6	374.559998	-1	0	0.07402	0.000000	0.345478	-0.0
...	...	...	...	...	...	...	...	
299	2020/12/26	573.529999	0	0	0.00000	0.798007	0.164341	-0.0
300	2020/12/27	572.759995	0	0	0.00000	0.798007	0.089561	-0.0(
301	2020/12/28	571.989990	0	0	0.00000	0.798007	0.014782	-0.0(
302	2020/12/29	574.919983	1	0	0.00000	0.798007	0.122708	0.0(
303	2020/12/30	574.830017	0	0	1.00000	1.000000	0.177799	-0.0(

304 rows × 10 columns

In [5]:
```
BIO_test_0
```

Out[5]:

	Report Date	Stock price	Y_boolean	Dummy_Dividends	Interest Coverage	Net Profit Margin	RSI_ratio	Return
0	2021-01-01	581.020004	-1	0.0	1.000000	1.0000	0.487185	NaN
1	2021-01-02	579.100006	-1	0.0	1.000000	1.0000	0.450982	-0.003305
2	2021-01-03	577.180008	-1	0.0	1.000000	1.0000	0.414778	-0.003315
3	2021-01-04	575.260010	-1	0.0	1.000000	1.0000	0.378575	-0.003327
4	2021-01-05	584.130005	1	0.0	1.000000	1.0000	0.551551	0.015419
...	...	...	...	...	...	...	...	...
175	2021-06-25	633.559998	0	0.0	2.791308	0.1537	0.437018	0.002627
176	2021-06-26	636.940002	1	0.0	2.791308	0.1537	0.435792	0.005335
177	2021-06-27	640.320007	1	0.0	2.791308	0.1537	0.434566	0.005307
178	2021-06-28	643.700012	1	0.0	2.791308	0.1537	0.433339	0.005279
179	2021-06-29	645.559998	0	0.0	2.791308	0.1537	0.452905	0.002890

180 rows × 10 columns

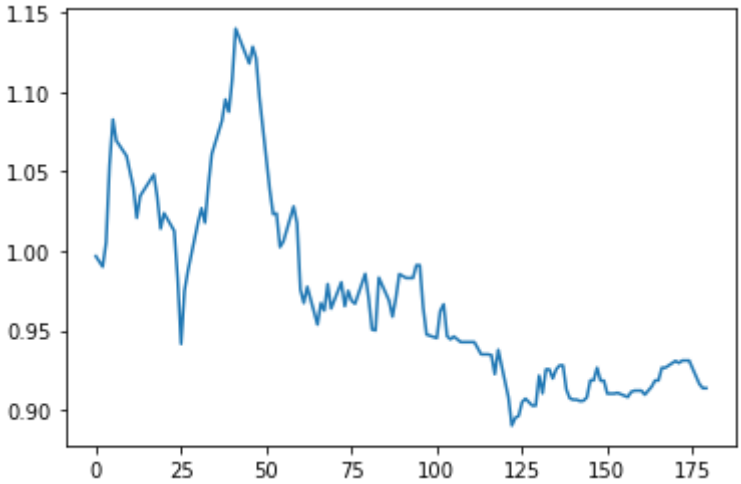
In [6]:
```
# Random Forest
from sklearn.ensemble import RandomForestClassifier

BIO_train_0_features = BIO_train_0.iloc[:,4:7]
BIO_train_0_target =BIO_train_0["Next Day Y_boolean"]
BIO_test_0_features = BIO_test_0.iloc[:,4:7]
BIO_test_0_target =BIO_test_0["Next Day Y_boolean"]

rf = RandomForestClassifier(random_state=0,
                            n_jobs=-1,
                            n_estimators=100,
                            class_weight='balanced'
                           )
model = rf.fit(BIO_train_0_features,BIO_train_0_target)
print("training score" , model.score(BIO_train_0_features,BIO_train_0_target))
print("testing score" , model.score(BIO_test_0_features,BIO_test_0_target))
```

```
training score 0.9703947368421053
testing score 0.37222222222222223
```

In [20]:
```
import pyfolio as pf
from finrl.plot import backtest_plot
```

In [8]:
```
df = BIO_test_0.copy()
df['Report Date'] = pd.to_datetime(df['Report Date'])
df['predicted'] = model.predict(BIO_test_0_features)
df['portfolio return'] = df['predicted'] * df['Next Day Return']
df['portfolio cumulative return'] = np.cumprod(df['portfolio return'] + 1)
plt.plot(df['portfolio cumulative return'])
```

Out[8]:
```
[<matplotlib.lines.Line2D at 0x7fd3f95501f0>]
```



In [9]:
```
returns = pd.Series(df['portfolio return'].values,
                    pd.to_datetime(df['Report Date'].dt.strftime("%Y-%m-%d %H:%M
returns.index.name = 'date'
```

In [10]:
```
returns
```

Out[10]:
```
date
2021-01-01 00:00:00+00:00   -0.003305
2021-01-02 00:00:00+00:00   -0.003315
2021-01-03 00:00:00+00:00   -0.003327
2021-01-04 00:00:00+00:00    0.015419
2021-01-05 00:00:00+00:00    0.048054
                               ...
2021-06-25 00:00:00+00:00   -0.005335
2021-06-26 00:00:00+00:00   -0.005307
2021-06-27 00:00:00+00:00   -0.005279
2021-06-28 00:00:00+00:00   -0.002890
2021-06-29 00:00:00+00:00   -0.000000
Length: 180, dtype: float64
```

In [26]:
```
df_account_value = df[['Report Date', 'portfolio cumulative return']]
df_account_value.columns = ['date', 'account_value']
df_account_value
```

Out[26]:

	date	account_value
0	2021-01-01	0.996695
1	2021-01-02	0.993391
2	2021-01-03	0.990086
3	2021-01-04	1.005353
4	2021-01-05	1.053664
...	...	...
175	2021-06-25	0.926051
176	2021-06-26	0.921137
177	2021-06-27	0.916275
178	2021-06-28	0.913627
179	2021-06-29	0.913627

180 rows × 2 columns

In [30]:
```
backtest_plot(df_account_value,
              baseline_ticker='SPY',
              baseline_start = '2021-01-01',
              baseline_end = '2021-06-29')
```

```
[**********************100%***********************]  1 of 1 completed
Shape of DataFrame:  (122, 8)
```

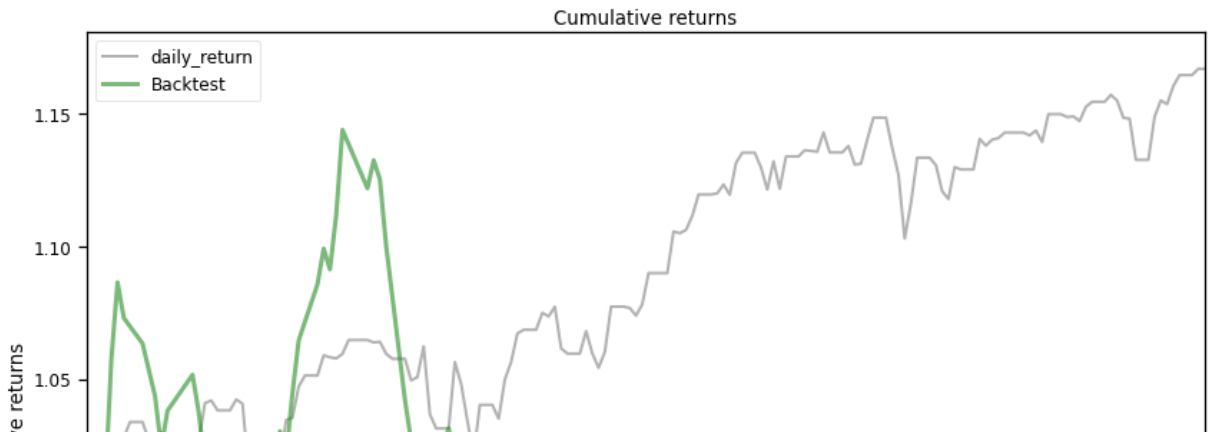
Start date	2021-01-01
End date	2021-06-29
Total months	8
	Backtest

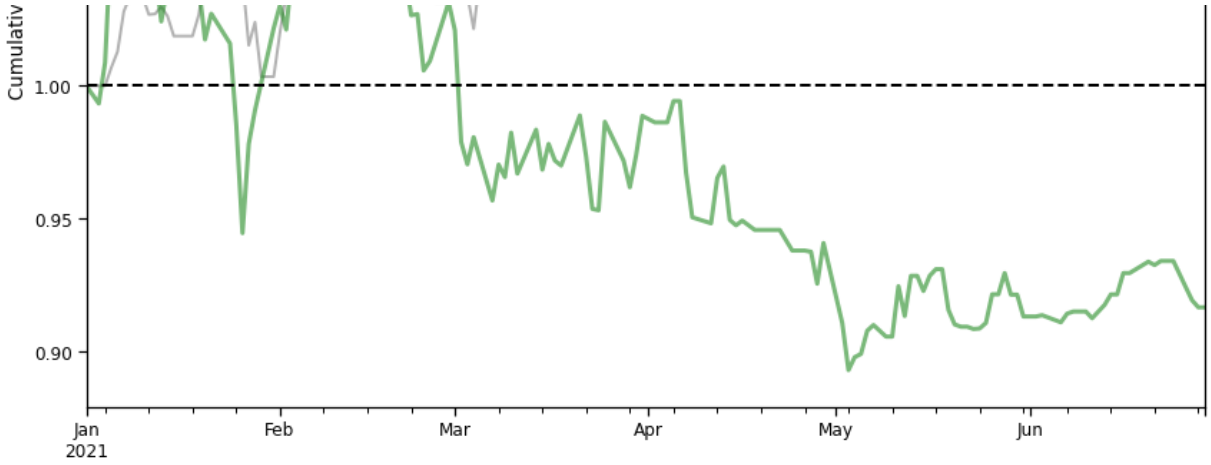
Start date	2021-01-01
End date	2021-06-29
Total months	8

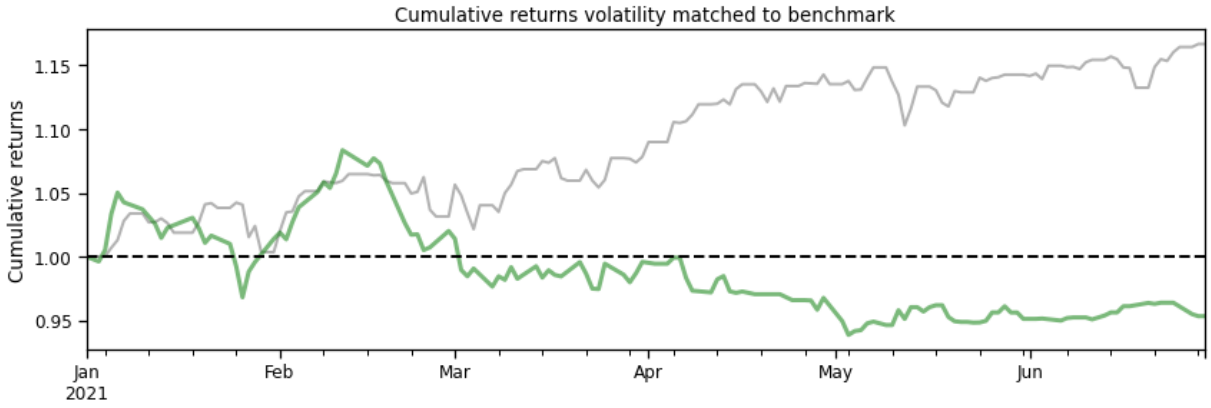
	Backtest
Annual return	-11.47%
Cumulative returns	-8.334%
Annual volatility	18.974%
Sharpe ratio	-0.55
Calmar ratio	-0.52
Stability	0.69
Max drawdown	-21.921%
Omega ratio	0.90
Sortino ratio	-0.78
Skew	NaN
Kurtosis	NaN
Tail ratio	0.93
Daily value at risk	-2.432%
Alpha	-0.08
Beta	-0.07

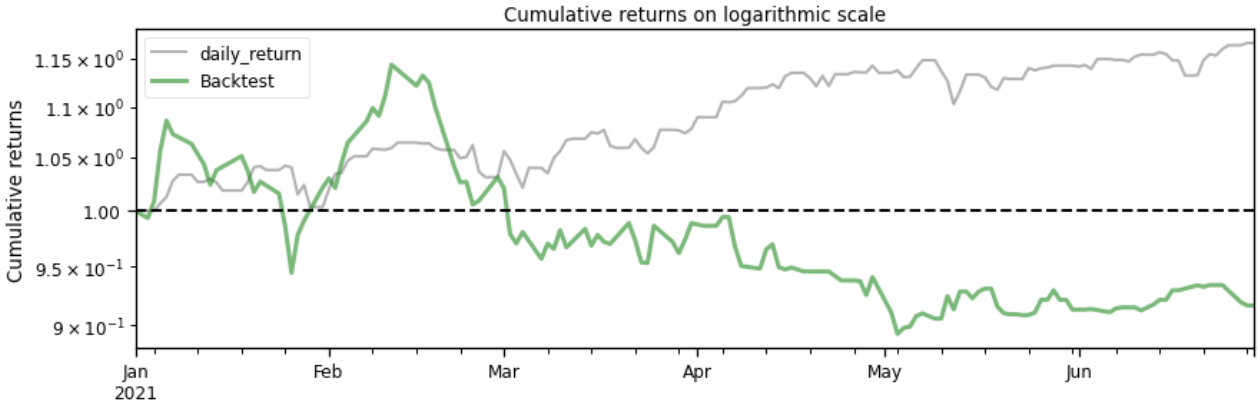
Worst drawdown periods	Net drawdown in %	Peak date	Valley date	Recovery date	Duration
0	21.92	2021-02-11	2021-05-03	NaT	NaN
1	13.05	2021-01-06	2021-01-26	2021-02-08	24
2	0.71	2021-02-08	2021-02-09	2021-02-10	3
3	0.66	2021-01-01	2021-01-03	2021-01-04	2
4	NaN	NaT	NaT	NaT	NaN

Stress Events	mean	min	max
New Normal	-0.04%	-4.16%	4.81%

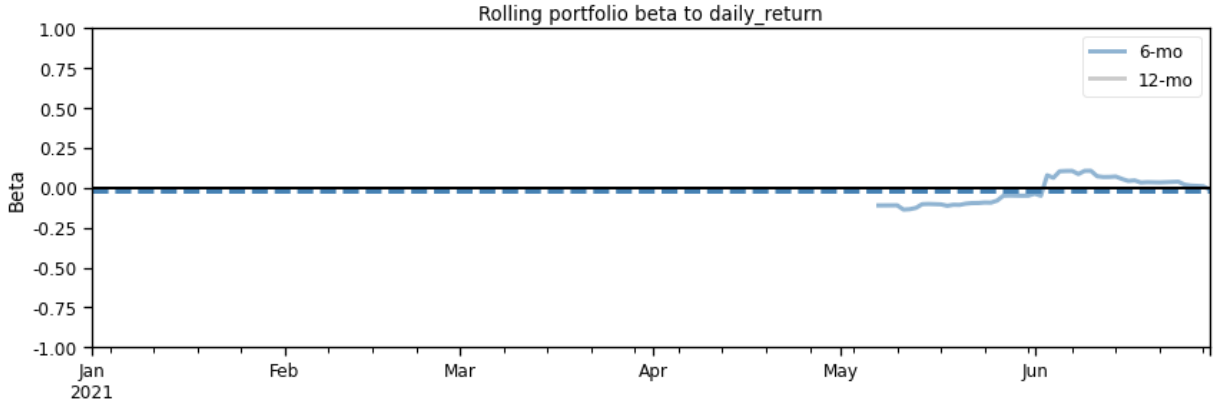


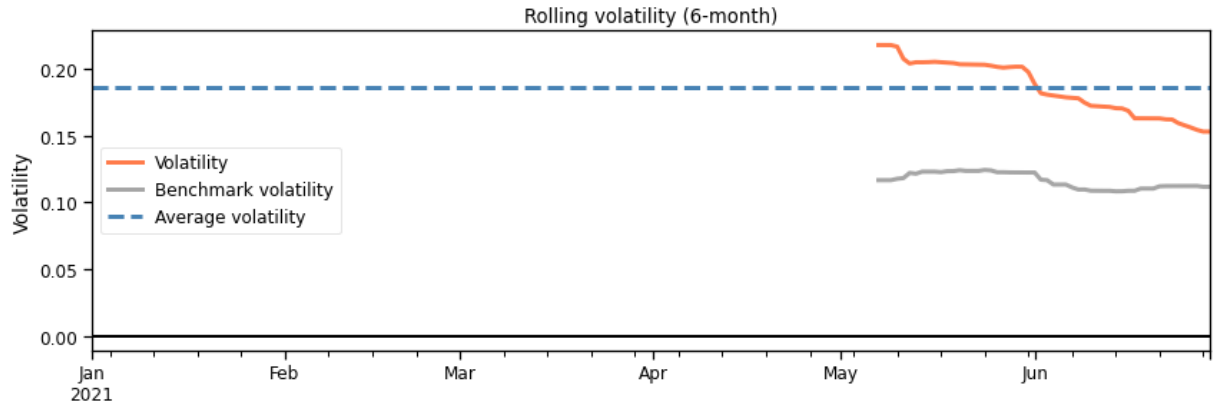

Cumulativ
1.00
0.95
0.90
Jan
2021
Feb
Mar
Apr
May
Jun

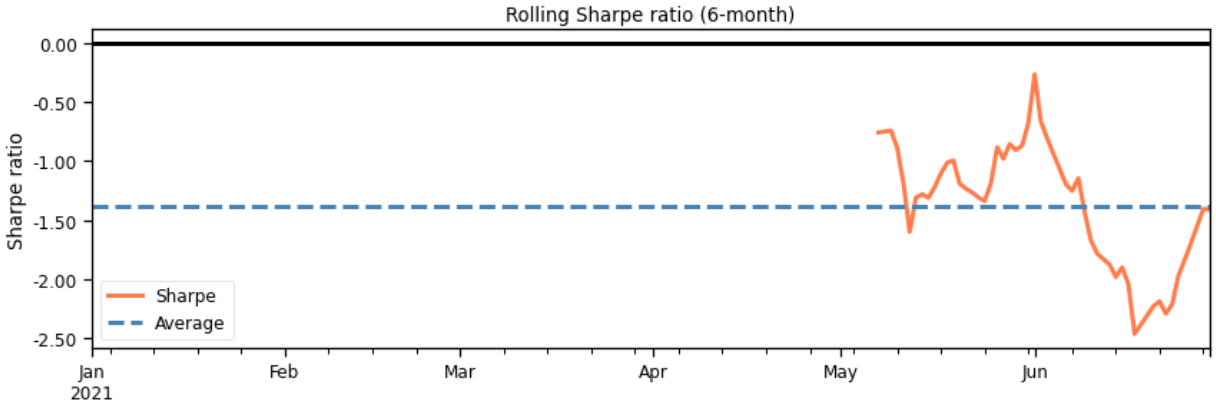

Cumulative returns volatility matched to benchmark
Cumulative returns
1.15
1.10
1.05
1.00
0.95
Jan
2021
Feb
Mar
Apr
May
Jun

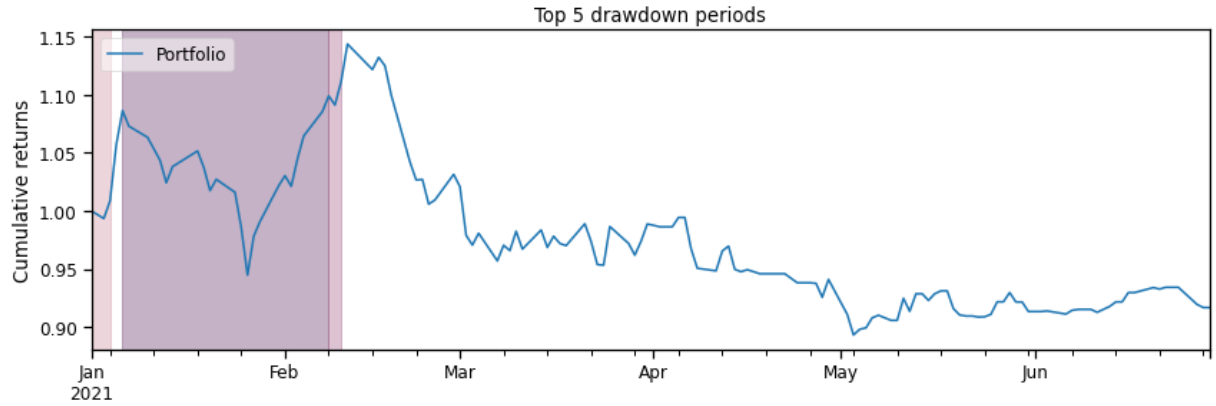

Cumulative returns on logarithmic scale
daily_return
Backtest
Cumulative returns
1.15 × 10^0
1.1 × 10^0
1.05 × 10^0
1.00
9.5 × 10^−1
9 × 10^−1
Jan
2021
Feb
Mar
Apr
May
Jun


Returns
Returns
0.04
0.02
0.00
−0.02
−0.04
Jan
2021
Feb
Mar
Apr
May
Jun

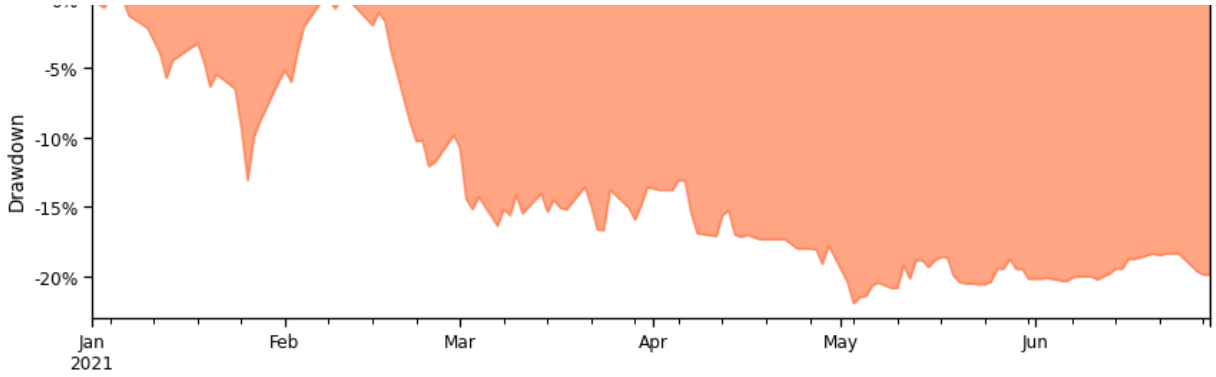

Rolling portfolio beta to daily_return
Beta
6-mo
12-mo
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
Jan
2021
Feb
Mar
Apr
May
Jun

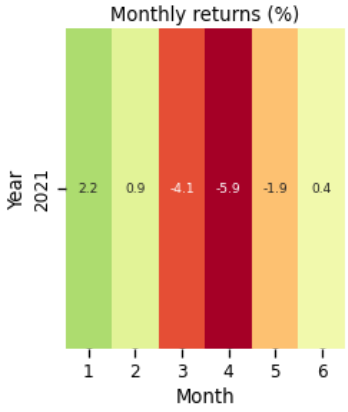

Rolling volatility (6-month)
Volatility
Volatility
Benchmark volatility
Average volatility
0.20
0.15
0.10
0.05
0.00
Jan
2021
Feb
Mar
Apr
May
Jun


Rolling Sharpe ratio (6-month)
Sharpe ratio
Sharpe
Average
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
Jan
2021
Feb
Mar
Apr
May
Jun

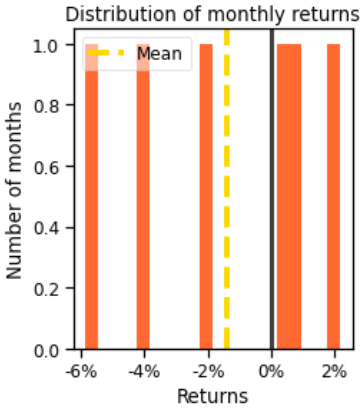

Top 5 drawdown periods
Cumulative returns
Portfolio
1.15
1.10
1.05
1.00
0.95
0.90
Jan
2021
Feb
Mar
Apr
May
Jun

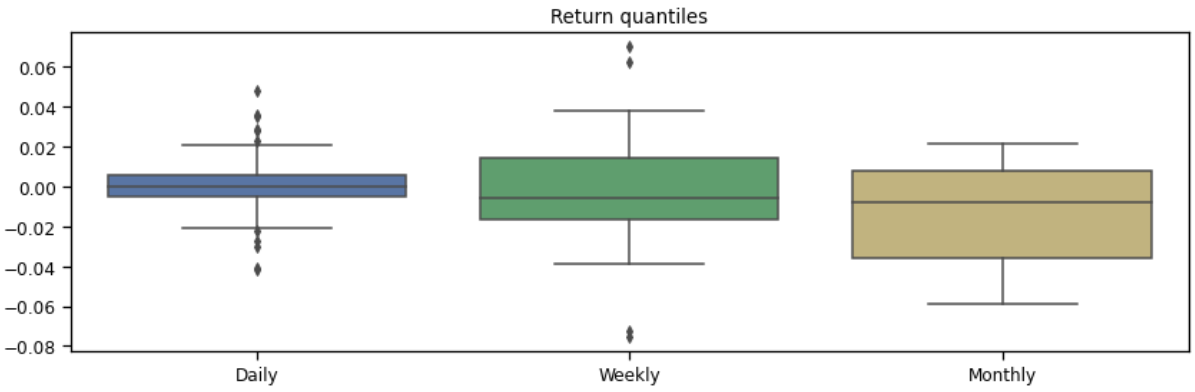

Underwater plot
0%

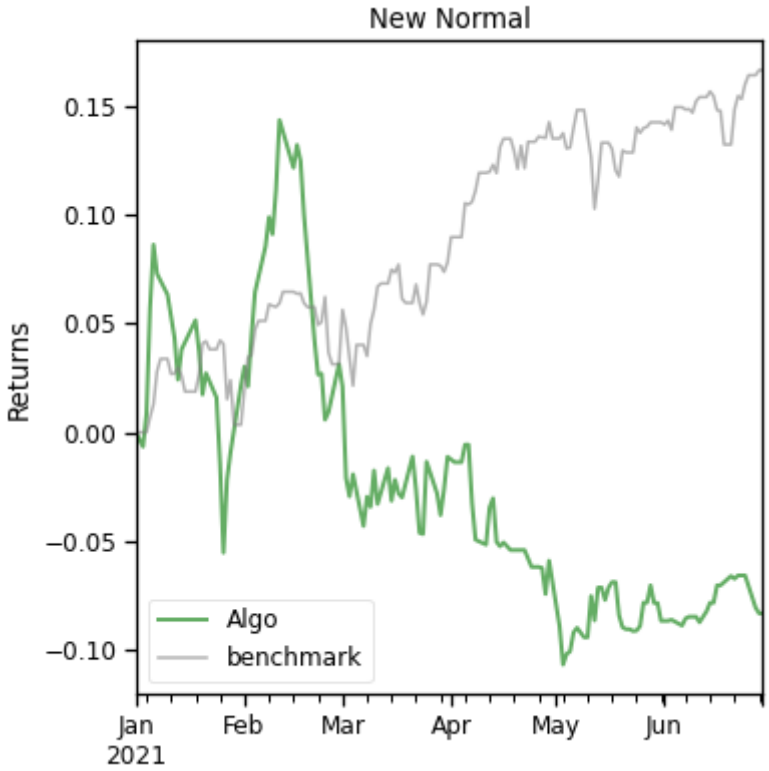

Drawdown
-5%
-10%
-15%
-20%
Jan
2021
Feb
Mar
Apr
May
Jun


Monthly returns (%)
Year
2021
2.2
0.9
-4.1
-5.9
-1.9
0.4
1
2
3
4
5
6
Month


Annual returns
Mean
Year
2021
-8%
-6%
-4%
-2%
0%
Returns


Distribution of monthly returns
Mean
Number of months
1.0
0.8
0.6
0.4
0.2
0.0
-6%
-4%
-2%
0%
2%
Returns


Return quantiles
0.06
0.04
0.02
0.00
−0.02
−0.04
−0.06
−0.08
Daily
Weekly
Monthly



In [12]:
```
pf.create_full_tear_sheet(returns)
```

Start date	2021-01-01
End date	2021-06-29
Total months	8

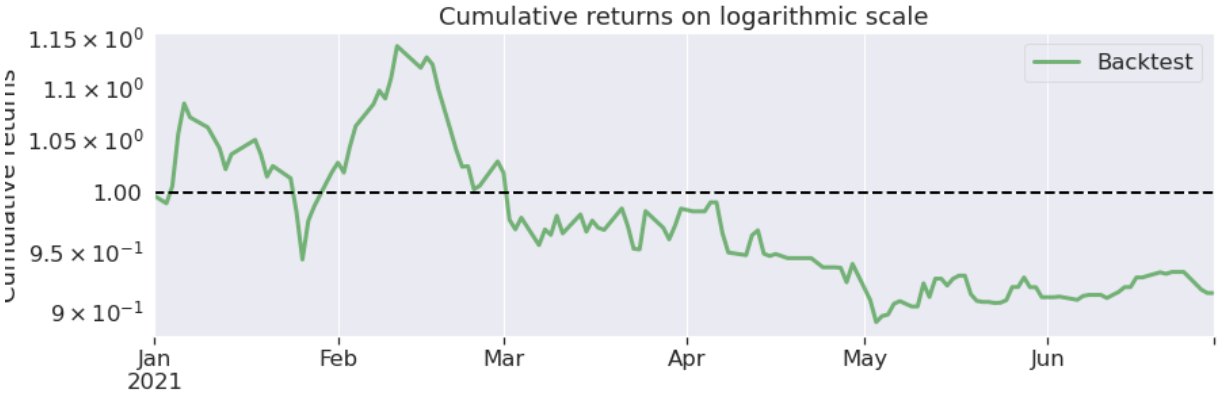
	Backtest
Annual return	-11.88%
Cumulative returns	-8.637%
Annual volatility	18.924%
Sharpe ratio	-0.57
Calmar ratio	-0.54
Stability	0.68
Max drawdown	-21.921%
Omega ratio	0.90
Sortino ratio	-0.81
Skew	0.18
Kurtosis	2.72
Tail ratio	0.93
Daily value at risk	-2.427%

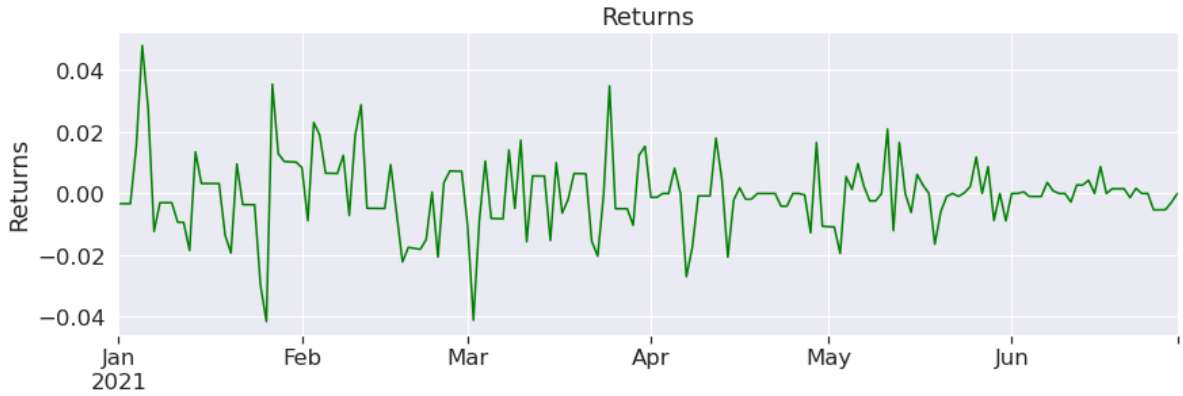
Worst drawdown periods	Net drawdown in %	Peak date	Valley date	Recovery date	Duration

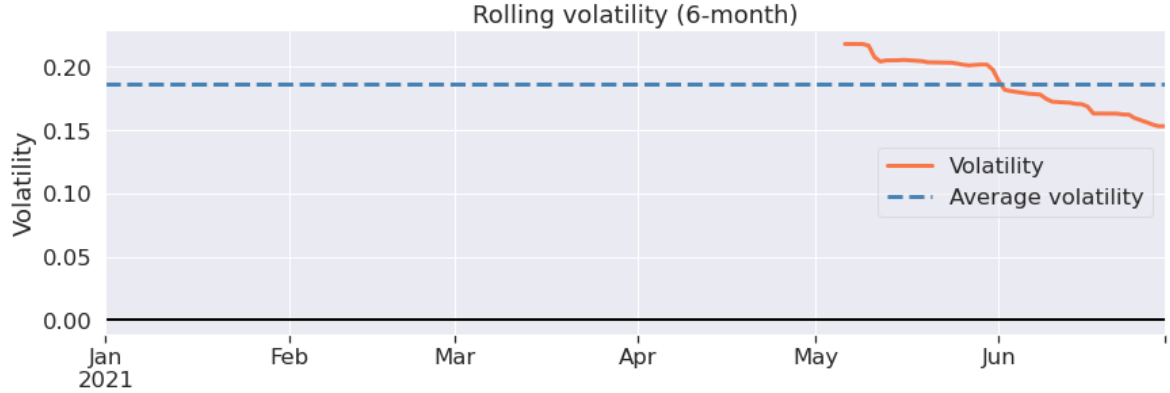
Worst drawdown periods	Net drawdown in %	Peak date	Valley date	Recovery date	Duration
0	21.92	2021-02-11	2021-05-03	NaT	NaN
1	13.05	2021-01-06	2021-01-26	2021-02-08	24
2	0.71	2021-02-08	2021-02-09	2021-02-10	3
3	0.66	2021-01-01	2021-01-03	2021-01-04	2
4	NaN	NaT	NaT	NaT	NaN

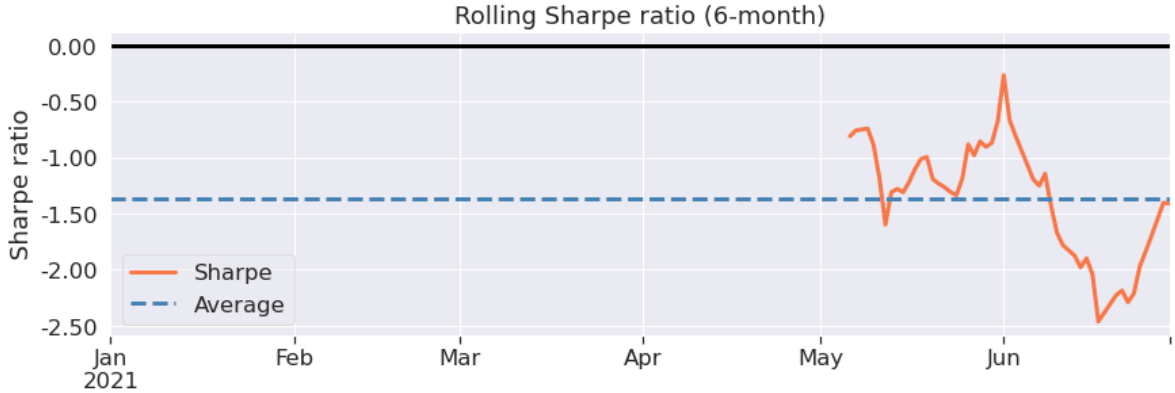
```
/opt/anaconda3/lib/python3.9/site-packages/pyfolio/timeseries.py:1258: FutureWar
ning: Indexing a timezone-aware DatetimeIndex with a timezone-naive datetime is
deprecated and will raise KeyError in a future version.  Use a timezone-aware ob
ject instead.
  period = returns_dupe.loc[start:end]
```

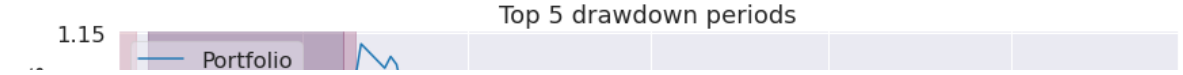
Stress Events	mean	min	max
New Normal	-0.04%	-4.16%	4.81%

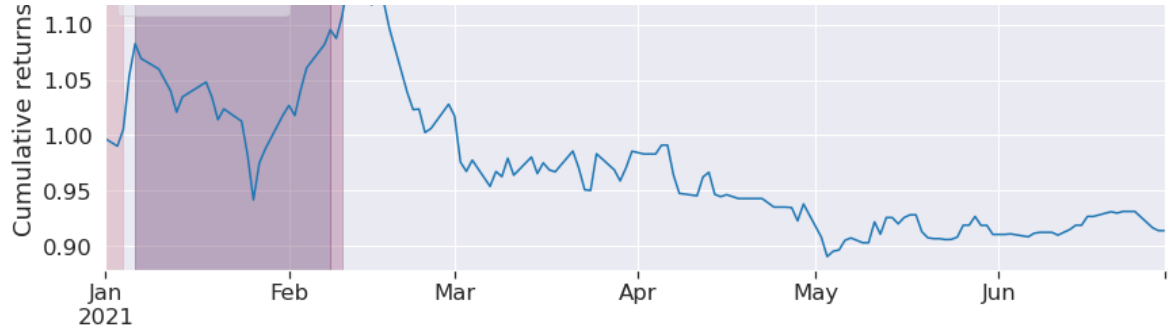

Cumulative returns on logarithmic scale
Backtest
Jan
2021
Feb
Mar
Apr
May
Jun

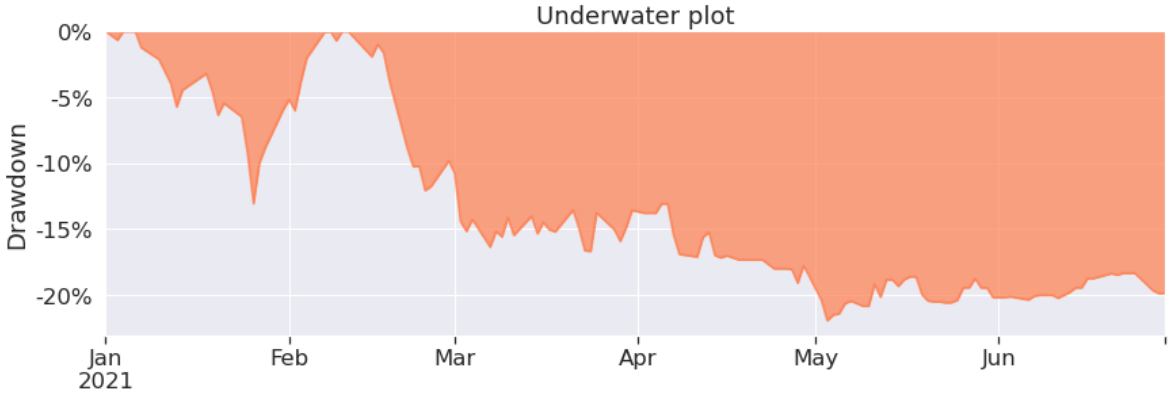

Returns
Returns
Jan
2021
Feb
Mar
Apr
May
Jun

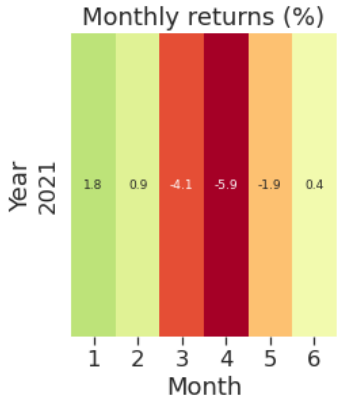

Rolling volatility (6-month)
Volatility
Volatility
Average volatility
Jan
2021
Feb
Mar
Apr
May
Jun

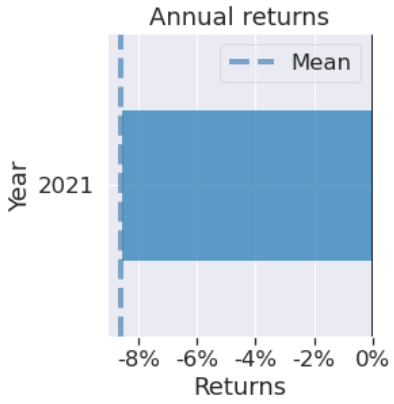

Rolling Sharpe ratio (6-month)
Sharpe ratio
Sharpe
Average
Jan
2021
Feb
Mar
Apr
May
Jun

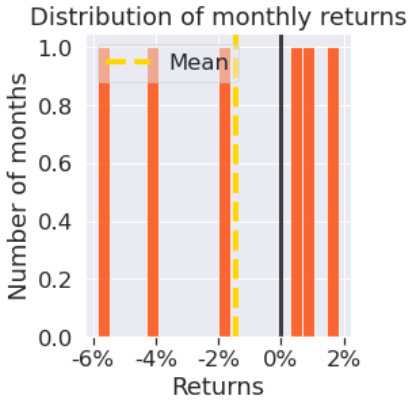

Top 5 drawdown periods
Portfolio


Cumulative returns
1.10
1.05
1.00
0.95
0.90
Jan
2021
Feb
Mar
Apr
May
Jun

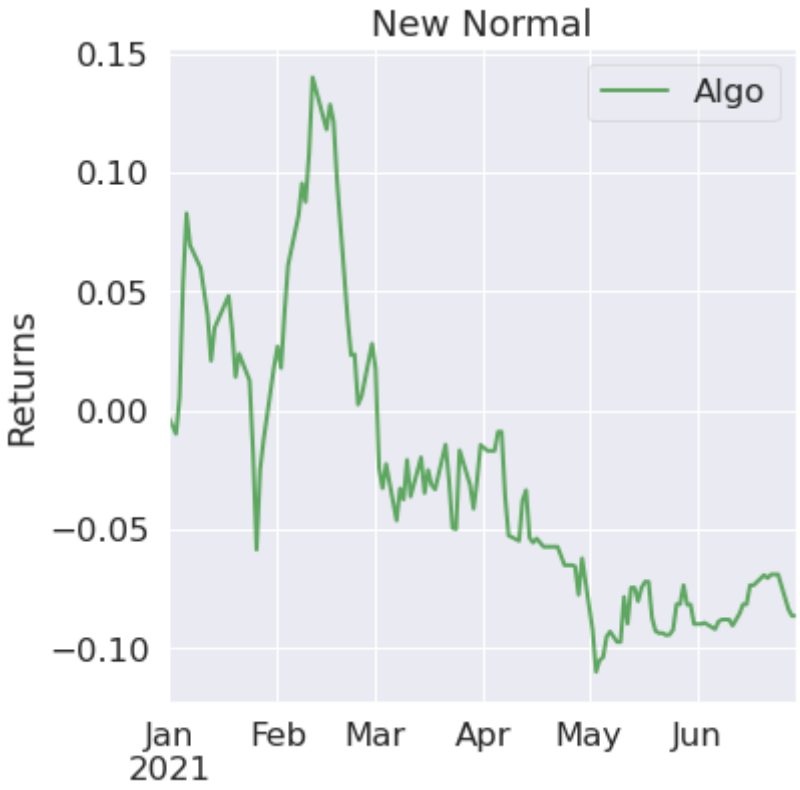

Underwater plot
Drawdown
0%
-5%
-10%
-15%
-20%
Jan
2021
Feb
Mar
Apr
May
Jun


Monthly returns (%)
Year
2021
1.8
0.9
-4.1
-5.9
-1.9
0.4
1
2
3
4
5
6
Month


Annual returns
Mean
Year
2021
-8%
-6%
-4%
-2%
0%
Returns


Distribution of monthly returns
Mean
Number of months
1.0
0.8
0.6
0.4
0.2
0.0
-6%
-4%
-2%
0%
2%
Returns


Return quantiles
0.06
0.04
0.02
0.00
−0.02
−0.04
−0.06
−0.08
Daily
Weekly
Monthly



In [ ]:

In [ ]:

In [ ]:
```
for column in BIO_train_0.columns[4:7]:
    plt.plot(BIO_train_0_features[column])
    plt.show()
```

In [ ]:
```
BIO_train_1 = pd.read_csv("BIO/BIO_Group1_training.csv",index_col=[0])
print('Train:', BIO_train_1['Report Date'].min(), 'to',BIO_train_1['Report Date'
print('Shape', BIO_train_1.shape)
BIO_test_1 = pd.read_csv("BIO/BIO_Group1_testing.csv",index_col=[0])
print('Test:', BIO_test_1['Report Date'].min(), 'to',BIO_test_1['Report Date'].m
print('Shape', BIO_test_1.shape)
```

In [ ]:
```
BIO_train_1
```

In [ ]:
```
BIO_train_1_features = BIO_train_1.iloc[:,7:18]
BIO_train_1_target =BIO_train_1["Y_boolean"]
BIO_test_1_features = BIO_test_1.iloc[:,7:18]
BIO_test_1_target =BIO_test_1["Y_boolean"]

rf = RandomForestClassifier(random_state=0,
                            n_jobs=-1,
                            n_estimators=100,
                            class_weight='balanced'
                           )
```

```
model = rf.fit(BIO_train_1_features,BIO_train_1_target)
print("training score" , model.score(BIO_train_1_features,BIO_train_1_target))
print("testing score" , model.score(BIO_test_1_features,BIO_test_1_target))
```

In [ ]:
```
for column in BIO_train_1.columns[7:18]:
    plt.plot(BIO_train_1_features[column])
    plt.show()
```

In [ ]:
```
BIO_train_2 = pd.read_csv("BIO/BIO_Group2_training.csv",index_col=[0])
print('Train:', BIO_train_2['Report Date'].min(), 'to',BIO_train_2['Report Date'
print('Shape', BIO_train_2.shape)
BIO_test_2 = pd.read_csv("BIO/BIO_Group2_testing.csv",index_col=[0])
print('Test:', BIO_test_2['Report Date'].min(), 'to',BIO_test_2['Report Date'].m
print('Shape', BIO_test_2.shape)
```

In [ ]:
```
BIO_train_2_features = BIO_train_2.iloc[:,3:13]
BIO_train_2_target =BIO_train_2["Y_boolean"]
BIO_test_2_features = BIO_test_2.iloc[:,3:13]
BIO_test_2_target =BIO_test_2["Y_boolean"]

model = rf.fit(BIO_train_2_features,BIO_train_2_target)
print("training score" , model.score(BIO_train_2_features,BIO_train_2_target))
print("testing score" , model.score(BIO_test_2_features,BIO_test_2_target))
```

In [ ]:
```
BIO_train_3 = pd.read_csv("BIO/BIO_Group3_training.csv",index_col=[0])
print('Train:', BIO_train_3['Report Date'].min(), 'to',BIO_train_3['Report Date'
print('Shape', BIO_train_3.shape)
BIO_test_3 = pd.read_csv("BIO/BIO_Group1_testing.csv",index_col=[0])
print('Test:', BIO_test_3['Report Date'].min(), 'to',BIO_test_3['Report Date'].m
print('Shape', BIO_test_3.shape)
```

In [ ]:
```
BIO_train_3_features = BIO_train_3.iloc[:,3:18]
BIO_train_3_target =BIO_train_3["Y_boolean"]
BIO_test_3_features = BIO_test_3.iloc[:,3:18]
BIO_test_3_target =BIO_test_3["Y_boolean"]

model = rf.fit(BIO_train_3_features,BIO_train_3_target)
print("training score" , model.score(BIO_train_3_features,BIO_train_3_target))
print("testing score" , model.score(BIO_test_3_features,BIO_test_3_target))
```

In [ ]:
```
BIO_train_4 = pd.read_csv("BIO/BIO_Group4_training.csv",index_col=[0])
print('Train:', BIO_train_4['Report Date'].min(), 'to',BIO_train_4['Report Date'
print('Shape', BIO_train_4.shape)
BIO_test_4 = pd.read_csv("BIO/BIO_Group4_testing.csv",index_col=[0])
print('Test:', BIO_test_4['Report Date'].min(), 'to',BIO_test_4['Report Date'].m
print('Shape', BIO_test_4.shape)
```

In [ ]:
```
BIO_train_4_features = BIO_train_4.iloc[:,3:10]
BIO_train_4_target =BIO_train_4["Y_boolean"]
BIO_test_4_features = BIO_test_4.iloc[:,3:10]
BIO_test_4_target =BIO_test_4["Y_boolean"]
```

```
model = rf.fit(BIO_train_4_features,BIO_train_4_target)
print("training score" , model.score(BIO_train_4_features,BIO_train_4_target))
print("testing score" , model.score(BIO_test_4_features,BIO_test_4_target))
```

Logistic Regression

In [ ]:
```
# RobustScaler removes the median and scales the data according to the quantile
log_l2 = make_pipeline(RobustScaler(), LogisticRegression(max_iter=1000, penalty
model = log_l2.fit(BIO_train_0_features,BIO_train_0_target)
print("training score" , model.score(BIO_train_0_features,BIO_train_0_target))
print("testing score" , model.score(BIO_test_0_features,BIO_test_0_target))
```

In [ ]:
```
model =log_l2.fit(BIO_train_1_features,BIO_train_1_target)
print("training score" , model.score(BIO_train_1_features,BIO_train_1_target))
print("testing score" , model.score(BIO_test_1_features,BIO_test_1_target))
```

In [ ]:
```
model = log_l2.fit(BIO_train_2_features,BIO_train_2_target)
print("training score" , model.score(BIO_train_2_features,BIO_train_2_target))
print("testing score" , model.score(BIO_test_2_features,BIO_test_2_target))
```

In [ ]:
```
model =log_l2.fit(BIO_train_3_features,BIO_train_3_target)
print("training score" , model.score(BIO_train_3_features,BIO_train_3_target))
print("testing score" , model.score(BIO_test_3_features,BIO_test_3_target))
```

In [ ]:
```
model = log_l2.fit(BIO_train_4_features,BIO_train_4_target)
print("training score" , model.score(BIO_train_4_features,BIO_train_4_target))
print("testing score" , model.score(BIO_test_4_features,BIO_test_4_target))
```

In [ ]:
```
sgdc_j = SGDClassifier(alpha=0.0001, epsilon=0.01, eta0=0.5, random_state=12345)
model = sgdc_j.fit(BIO_train_0_features,BIO_train_0_target)
print("training score" , model.score(BIO_train_0_features,BIO_train_0_target))
print("testing score" , model.score(BIO_test_0_features,BIO_test_0_target))
```

In [ ]:
```
model = sgdc_j.fit(BIO_train_1_features,BIO_train_1_target)
print("training score" , model.score(BIO_train_1_features,BIO_train_1_target))
print("testing score" , model.score(BIO_test_1_features,BIO_test_1_target))
```

In [ ]:
```
model = sgdc_j.fit(BIO_train_2_features,BIO_train_2_target)
print("training score" , model.score(BIO_train_2_features,BIO_train_2_target))
print("testing score" , model.score(BIO_test_2_features,BIO_test_2_target))
```

In [ ]:
```
model = sgdc_j.fit(BIO_train_3_features,BIO_train_3_target)
print("training score" , model.score(BIO_train_3_features,BIO_train_3_target))
print("testing score" , model.score(BIO_test_3_features,BIO_test_3_target))
```

In [ ]:
```
model = sgdc_j.fit(BIO_train_4_features,BIO_train_4_target)
print("training score" , model.score(BIO_train_4_features,BIO_train_4_target))
print("testing score" , model.score(BIO_test_4_features,BIO_test_4_target))
```

Support Vector Machine (SVM)

In [ ]:
```
svm = make_pipeline(RobustScaler(), SVC(gamma='auto'))
model = svm.fit(BIO_train_0_features,BIO_train_0_target)
print("training score" , model.score(BIO_train_0_features,BIO_train_0_target))
print("testing score" , model.score(BIO_test_0_features,BIO_test_0_target))
```

In [ ]:
```
model = svm.fit(BIO_train_1_features,BIO_train_1_target)
print("training score" , model.score(BIO_train_1_features,BIO_train_1_target))
print("testing score" , model.score(BIO_test_1_features,BIO_test_1_target))
```

In [ ]:
```
model = svm.fit(BIO_train_2_features,BIO_train_2_target)
print("training score" , model.score(BIO_train_2_features,BIO_train_2_target))
print("testing score" , model.score(BIO_test_2_features,BIO_test_2_target))
```

In [ ]:
```
model = svm.fit(BIO_train_3_features,BIO_train_3_target)
print("training score" , model.score(BIO_train_3_features,BIO_train_3_target))
print("testing score" , model.score(BIO_test_3_features,BIO_test_3_target))
```

In [ ]:
```
model = svm.fit(BIO_train_4_features,BIO_train_4_target)
print("training score" , model.score(BIO_train_4_features,BIO_train_4_target))
print("testing score" , model.score(BIO_test_4_features,BIO_test_4_target))
```

ZTS

In [ ]:
```
## Random Forest
ZTS_train_0 = pd.read_csv("ZTS/ZTS_Group0_training.csv",index_col=[0])
print('Train:', ZTS_train_0['Report Date'].min(), 'to',ZTS_train_0['Report Date'
print('Shape', ZTS_train_0.shape)
ZTS_test_0 = pd.read_csv("ZTS/ZTS_Group0_testing.csv",index_col=[0])
print('Test:',ZTS_test_0['Report Date'].min(), 'to',ZTS_test_0['Report Date'].ma
print('Shape', ZTS_test_0.shape)
```

In [ ]:
```
ZTS_train_0_features = ZTS_train_0.iloc[:,3:11]
ZTS_train_0_target = ZTS_train_0["Y_boolean"]
ZTS_test_0_features = ZTS_test_0.iloc[:,3:11]
ZTS_test_0_target =ZTS_test_0["Y_boolean"]

model = rf.fit(ZTS_train_0_features,ZTS_train_0_target)
print("training score" , model.score(ZTS_train_0_features,ZTS_train_0_target))
print("testing score" , model.score(ZTS_test_0_features,ZTS_test_0_target))
```

In [ ]:
```
ZTS_train_1 = pd.read_csv("ZTS/ZTS_Group1_training.csv",index_col=[0])
```

```
print('Train:', ZTS_train_1['Report Date'].min(), 'to',ZTS_train_1['Report Date'
print('Shape', ZTS_train_1.shape)
ZTS_test_1 = pd.read_csv("ZTS/ZTS_Group1_testing.csv",index_col=[0])
print('Test:',ZTS_test_1['Report Date'].min(), 'to',ZTS_test_1['Report Date'].ma
print('Shape', ZTS_test_1.shape)
```

In [ ]:
```
ZTS_train_1_features = ZTS_train_1.iloc[:,3:12]
ZTS_train_1_target = ZTS_train_1["Y_boolean"]
ZTS_test_1_features = ZTS_test_1.iloc[:,3:12]
ZTS_test_1_target =ZTS_test_1["Y_boolean"]

model = rf.fit(ZTS_train_1_features,ZTS_train_1_target)
print("training score" , model.score(ZTS_train_1_features,ZTS_train_1_target))
print("testing score" , model.score(ZTS_test_1_features,ZTS_test_1_target))
```

In [ ]:
```
ZTS_train_2 = pd.read_csv("ZTS/ZTS_Group2_training.csv",index_col=[0])
print('Train:', ZTS_train_2['Report Date'].min(), 'to',ZTS_train_2['Report Date'
print('Shape', ZTS_train_2.shape)
ZTS_test_2 = pd.read_csv("ZTS/ZTS_Group2_testing.csv",index_col=[0])
print('Test:',ZTS_test_2['Report Date'].min(), 'to',ZTS_test_2['Report Date'].ma
print('Shape', ZTS_test_2.shape)
```

In [ ]:
```
ZTS_train_2_features = ZTS_train_2.iloc[:,3:11]
ZTS_train_2_target = ZTS_train_2["Y_boolean"]
ZTS_test_2_features = ZTS_test_2.iloc[:,3:11]
ZTS_test_2_target =ZTS_test_2["Y_boolean"]

model = rf.fit(ZTS_train_2_features,ZTS_train_2_target)
print("training score" , model.score(ZTS_train_2_features,ZTS_train_2_target))
print("testing score" , model.score(ZTS_test_2_features,ZTS_test_2_target))
```

In [ ]:
```
ZTS_train_3 = pd.read_csv("ZTS/ZTS_Group3_training.csv",index_col=[0])
print('Train:', ZTS_train_3['Report Date'].min(), 'to',ZTS_train_3['Report Date'
print('Shape', ZTS_train_3.shape)
ZTS_test_3 = pd.read_csv("ZTS/ZTS_Group3_testing.csv",index_col=[0])
print('Test:',ZTS_test_3['Report Date'].min(), 'to',ZTS_test_3['Report Date'].ma
print('Shape', ZTS_test_3.shape)
```

In [ ]:
```
ZTS_train_3_features = ZTS_train_3.iloc[:,3:16]
ZTS_train_3_target = ZTS_train_3["Y_boolean"]
ZTS_test_3_features = ZTS_test_3.iloc[:,3:16]
ZTS_test_3_target =ZTS_test_3["Y_boolean"]

model = rf.fit(ZTS_train_3_features,ZTS_train_3_target)
print("training score" , model.score(ZTS_train_3_features,ZTS_train_3_target))
print("testing score" , model.score(ZTS_test_3_features,ZTS_test_3_target))
```

In [ ]:
```
ZTS_train_4 = pd.read_csv("ZTS/ZTS_Group4_training.csv",index_col=[0])
print('Train:', ZTS_train_4['Report Date'].min(), 'to',ZTS_train_4['Report Date'
print('Shape', ZTS_train_4.shape)
ZTS_test_4 = pd.read_csv("ZTS/ZTS_Group4_testing.csv",index_col=[0])
```

```
print('Test:',ZTS_test_4['Report Date'].min(), 'to',ZTS_test_4['Report Date'].ma
print('Shape', ZTS_test_4.shape)
```

In [ ]:
```
ZTS_train_4_features = ZTS_train_4.iloc[:,3:16]
ZTS_train_4_target = ZTS_train_4["Y_boolean"]
ZTS_test_4_features = ZTS_test_4.iloc[:,3:16]
ZTS_test_4_target =ZTS_test_4["Y_boolean"]

model = rf.fit(ZTS_train_4_features,ZTS_train_4_target)
print("training score" , model.score(ZTS_train_4_features,ZTS_train_4_target))
print("testing score" , model.score(ZTS_test_4_features,ZTS_test_4_target))
```

In [ ]:
```
## Logistic Regression
sgdc_j = SGDClassifier(alpha=0.0001, epsilon=0.01, eta0=0.5, random_state=12345)
model = sgdc_j.fit(ZTS_train_0_features,ZTS_train_0_target)
print("training score" , model.score(ZTS_train_0_features,ZTS_train_0_target))
print("testing score" , model.score(ZTS_test_0_features,ZTS_test_0_target))
```

In [ ]:
```
model = sgdc_j.fit(ZTS_train_1_features,ZTS_train_1_target)
print("training score" , model.score(ZTS_train_1_features,ZTS_train_1_target))
print("testing score" , model.score(ZTS_test_1_features,ZTS_test_1_target))
```

In [ ]:
```
model = sgdc_j.fit(ZTS_train_2_features,ZTS_train_2_target)
print("training score" , model.score(ZTS_train_2_features,ZTS_train_2_target))
print("testing score" , model.score(ZTS_test_2_features,ZTS_test_2_target))
```

In [ ]:
```
model = sgdc_j.fit(ZTS_train_3_features,ZTS_train_3_target)
print("training score" , model.score(ZTS_train_3_features,ZTS_train_3_target))
print("testing score" , model.score(ZTS_test_3_features,ZTS_test_3_target))
```

In [ ]:
```
model = sgdc_j.fit(ZTS_train_4_features,ZTS_train_4_target)
print("training score" , model.score(ZTS_train_4_features,ZTS_train_4_target))
print("testing score" , model.score(ZTS_test_4_features,ZTS_test_4_target))
```

Support Vector Machine (SVM)

In [ ]:
```
ZTS_train_0_features
```

In [ ]:
```
svm = make_pipeline(RobustScaler(), SVC(gamma='auto'))
model = svm.fit(ZTS_train_0_features,ZTS_train_0_target)
print("training score" , model.score(ZTS_train_0_features,ZTS_train_0_target))
print("testing score" , model.score(ZTS_test_0_features,ZTS_test_0_target))
```

In [ ]:
```
model = svm.fit(ZTS_train_1_features,ZTS_train_1_target)
print("training score" , model.score(ZTS_train_1_features,ZTS_train_1_target))
print("testing score" , model.score(ZTS_test_1_features,ZTS_test_1_target))
```

In [ ]:
```
model = svm.fit(ZTS_train_2_features,ZTS_train_2_target)
print("training score" , model.score(ZTS_train_2_features,ZTS_train_2_target))
print("testing score" , model.score(ZTS_test_2_features,ZTS_test_2_target))
```

In [ ]:
```
model = svm.fit(ZTS_train_3_features,ZTS_train_3_target)
print("training score" , model.score(ZTS_train_3_features,ZTS_train_3_target))
print("testing score" , model.score(ZTS_test_3_features,ZTS_test_3_target))
```

In [ ]:
```
model = svm.fit(ZTS_train_4_features,ZTS_train_4_target)
print("training score" , model.score(ZTS_train_4_features,ZTS_train_4_target))
print("testing score" , model.score(ZTS_test_4_features,ZTS_test_4_target))
```