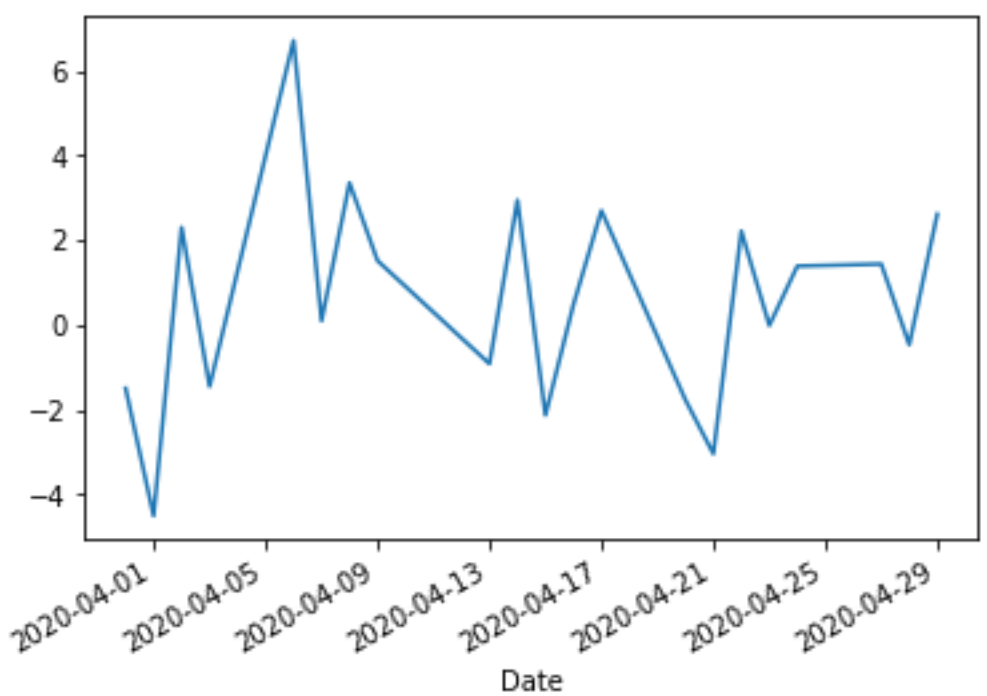
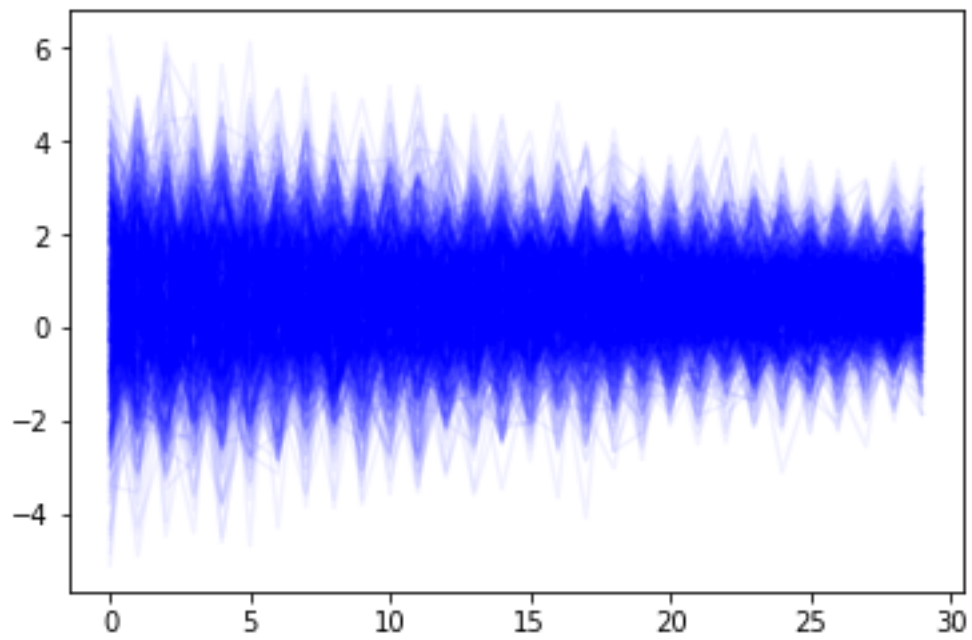
In [2]:

```
import datetime as dt
import sys

import numpy as np
import pandas as pd
import pandas_datareader.data as web
import matplotlib.pyplot as plt
from arch import arch_model

import yfinance as yf
spy_df = yf.download('SPY', start='2020-03-30',end='2020-04-30',progress=False,a


returns = 100 * spy_df['Close'].pct_change().dropna()
returns.plot()
plt.show()

model=arch_model(returns, vol='Garch', p=1, o=0, q=1, dist='Normal')
results=model.fit()
print(results.summary())

forecasts = results.forecast(horizon=30, method='simulation', simulations=1000)
sims = forecasts.simulations

lines = plt.plot(sims.values[-1,:,:].T, color='blue', alpha=0.05)
lines[0].set_label('Simulated paths')
plt.show()

print(np.percentile(sims.values[-1,:,-1].T,5))
plt.hist(sims.values[-1, :,-1],bins=50)
plt.title('Distribution of Returns')
plt.show()


```

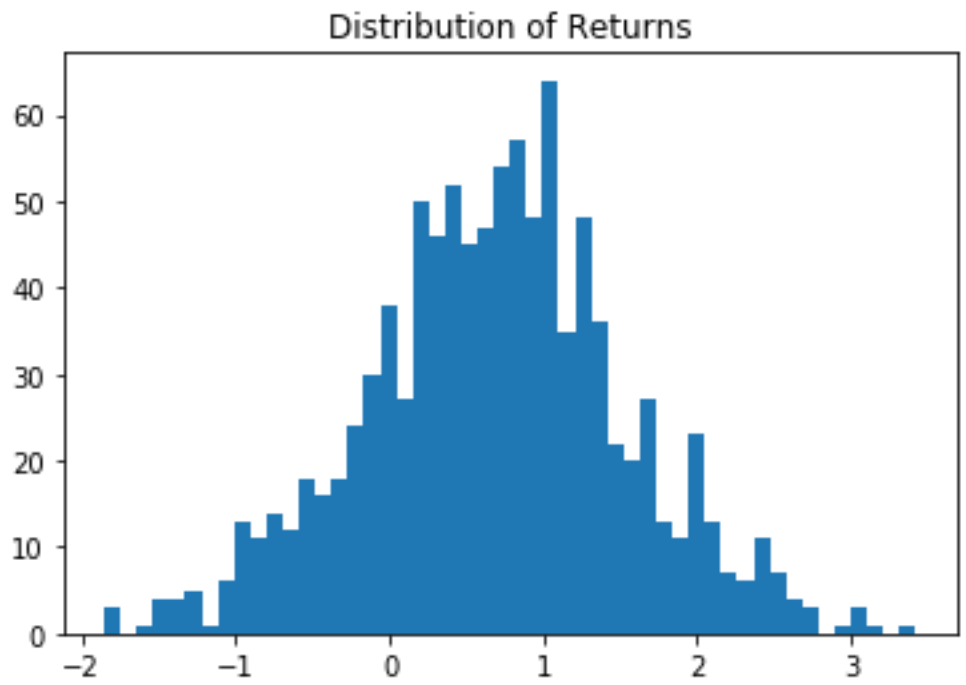


```
Iteration:      1,   Func. Count:      6,   Neg. LLF: 48.8816401260596
7
Iteration:      2,   Func. Count:     14,   Neg. LLF: 48.4588974085630
9
Iteration:      3,   Func. Count:     21,   Neg. LLF: 48.3725188088250
6
Iteration:      4,   Func. Count:     27,   Neg. LLF: 48.3144232298907
14
Iteration:      5,   Func. Count:     33,   Neg. LLF: 48.2131921401904
9
Iteration:      6,   Func. Count:     39,   Neg. LLF: 48.0538751241215
5
Iteration:      7,   Func. Count:     45,   Neg. LLF: 47.9887247113951
7
Iteration:      8,   Func. Count:     51,   Neg. LLF: 47.9879691820087
54
Iteration:      9,   Func. Count:     57,   Neg. LLF: 47.9879581779147
1
Optimization terminated successfully.    (Exit mode 0)
            Current function value: 47.987958177887236
            Iterations: 9
            Function evaluations: 57
            Gradient evaluations: 9
                    Constant Mean - GARCH Model Results
==============================================================================
========
Dep. Variable:                   Close   R-squared:
-0.001
Mean Model:             Constant Mean   Adj. R-squared:
-0.001
Vol Model:                      GARCH   Log-Likelihood:
-47.9880
Distribution:                  Normal   AIC:
103.976
Method:            Maximum Likelihood   BIC:
108.154
                                        No. Observations:
21
Date:                Wed, May 27 2020   Df Residuals:
17
Time:                        08:52:43   Df Model:
4
                              Mean Model
==============================================================================
==
                 coef    std err          t      P>|t|  95.0% Conf. In
t.
------------------------------------------------------------------------------
--
mu             0.6334      0.557      1.137      0.255 [ -0.458,  1.72
5]
                           Volatility Model
```

```
==============================================================================
==
                 coef    std err          t      P>|t|  95.0% Conf. In
t.
------------------------------------------------------------------------------
--
omega          0.0000      0.896      0.000      1.000 [ -1.757,  1.75
7]
alpha[1]   1.9071e-14  9.706e-02  1.965e-13      1.000 [ -0.190,  0.19
0]
beta[1]        0.9551      0.147      6.483  8.995e-11 [  0.666,  1.24
4]
==============================================================================
==

Covariance estimator: robust
```



-0.7522995694223263



In [ ]:

```
1
```