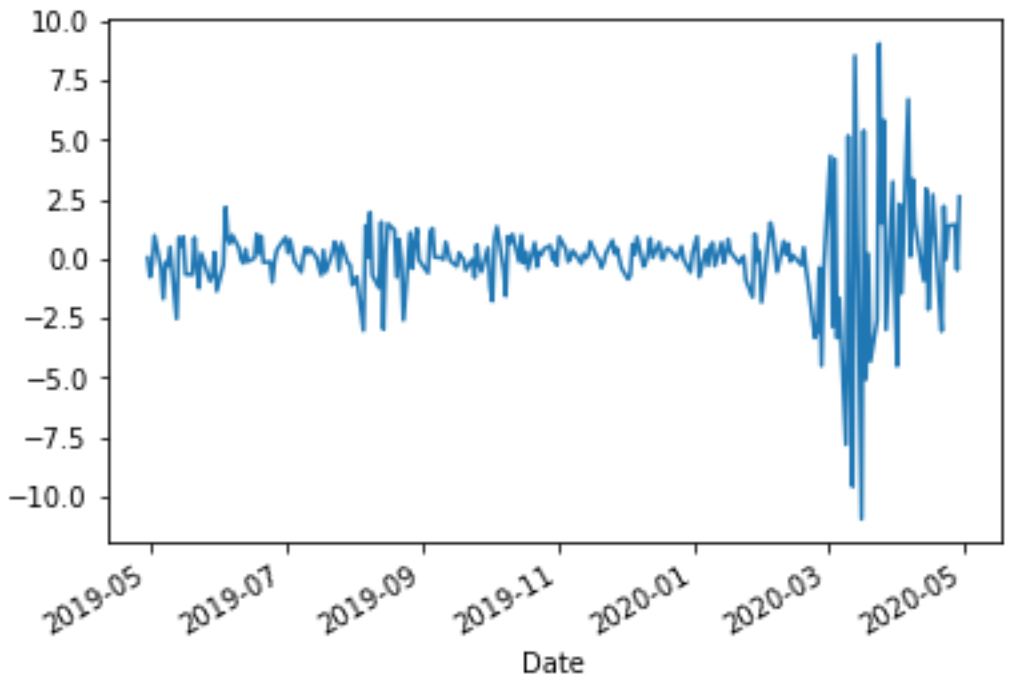
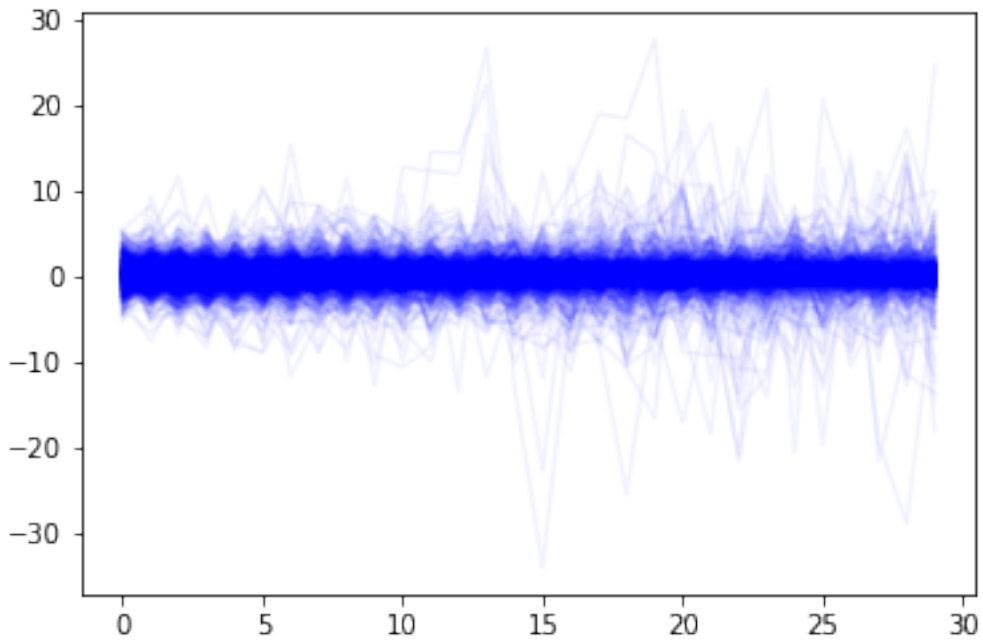
In [2]:

```
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='2019-04-30',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()


```

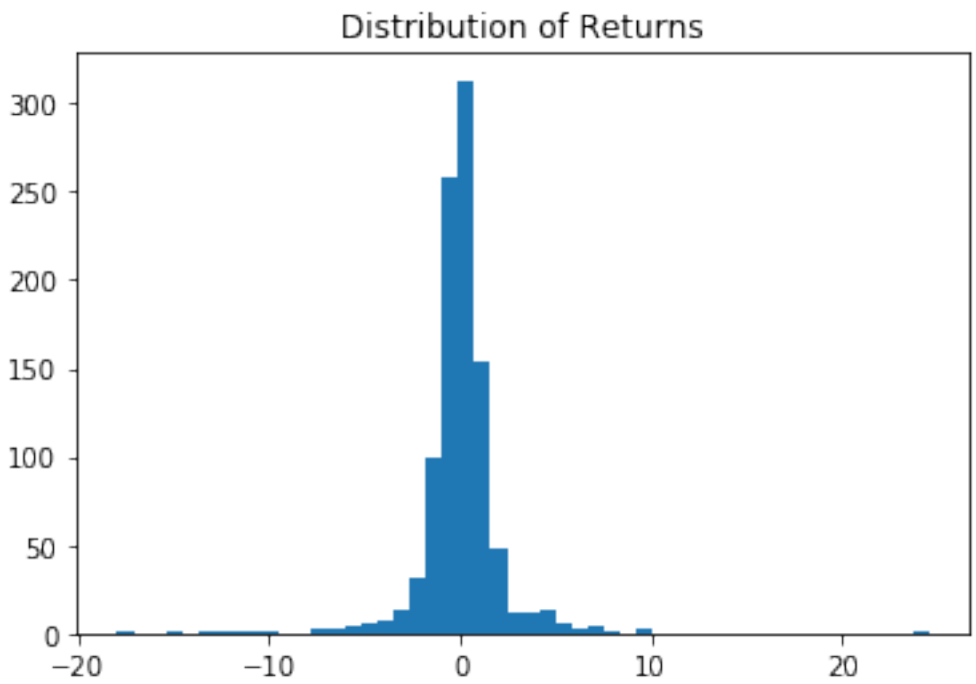


```
Iteration:      1,   Func. Count:      6,   Neg. LLF: 372.786193459044
74
Iteration:      2,   Func. Count:     15,   Neg. LLF: 370.784466912032
94
Iteration:      3,   Func. Count:     23,   Neg. LLF: 367.586171011776
3
Iteration:      4,   Func. Count:     30,   Neg. LLF: 365.727585957851
3
Iteration:      5,   Func. Count:     37,   Neg. LLF: 363.478192111465
9
Iteration:      6,   Func. Count:     44,   Neg. LLF: 362.740063121238
73
Iteration:      7,   Func. Count:     51,   Neg. LLF: 362.289491230907
74
Iteration:      8,   Func. Count:     57,   Neg. LLF: 361.211919056819
06
Iteration:      9,   Func. Count:     64,   Neg. LLF: 361.070018230821
23
Iteration:     10,   Func. Count:     70,   Neg. LLF: 361.067771068990
96
Iteration:     11,   Func. Count:     76,   Neg. LLF: 361.067489044825
3
Iteration:     12,   Func. Count:     82,   Neg. LLF: 361.067483415498
2
Optimization terminated successfully.    (Exit mode 0)
            Current function value: 361.06748373104165
            Iterations: 12
            Function evaluations: 82
            Gradient evaluations: 12
                    Constant Mean - GARCH Model Results
==============================================================================
========
Dep. Variable:                    Close   R-squared:
-0.004
Mean Model:             Constant Mean   Adj. R-squared:
-0.004
Vol Model:                        GARCH   Log-Likelihood:
-361.067
Distribution:                    Normal   AIC:
730.135
Method:            Maximum Likelihood   BIC:
744.269
                                        No. Observations:
253
Date:                Wed, May 27 2020   Df Residuals:
249
Time:                        08:57:25   Df Model:
4
                                Mean Model
==============================================================================
====
                 coef    std err          t      P>|t|    95.0% Conf.
Int.
------------------------------------------------------------------------------
```

```
----
mu             0.1504   4.141e-02      3.633   2.803e-04 [6.927e-02,  0.
232]
                             Volatility Model
============================================================================
======
                 coef    std err          t      P>|t|      95.0% Conf
. Int.
----------------------------------------------------------------------------
------
omega          0.0414   1.805e-02      2.294   2.178e-02 [6.034e-03,7.68
0e-02]
alpha[1]       0.3312   8.647e-02      3.831   1.278e-04     [  0.162,
0.501]
beta[1]        0.6688   6.153e-02     10.869   1.622e-27     [  0.548,
0.789]
============================================================================
======

Covariance estimator: robust
```



-2.4285703286434672



In [ ]:

```
1
```