Stock_Data_Science_Python

September 29, 2021

1 Data Science 101 for Python

1.1 Statistical Data Analysis

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

import warnings
warnings.filterwarnings("ignore")

# fix_yahoo_finance is used to fetch data
import fix_yahoo_finance as yf
yf.pdr_override()
```

[2]:
```
# input
symbol = 'AMD'
start = '2014-01-01'
end = '2019-01-01'

# Read data
dataset = yf.download(symbol,start,end)

# View Columns
dataset.head()
```

```
[**********100%**********]  1 of 1 downloaded
```

[2]:

Date	Open	High	Low	Close	Adj Close	Volume
2014-01-02	3.85	3.98	3.84	3.95	3.95	20548400
2014-01-03	3.98	4.00	3.88	4.00	4.00	22887200
2014-01-06	4.01	4.18	3.99	4.13	4.13	42398300
2014-01-07	4.19	4.25	4.11	4.18	4.18	42932100
2014-01-08	4.23	4.26	4.14	4.18	4.18	30678700

[3]:
```
# Create more data
dataset['Increase_Decrease'] = np.where(dataset['Volume'].shift(-1) >␣
 ↪dataset['Volume'],1,-1)
dataset['Buy_Sell_on_Open'] = np.where(dataset['Open'].shift(-1) >␣
 ↪dataset['Open'],1,-1)
dataset['Buy_Sell'] = np.where(dataset['Adj Close'].shift(-1) > dataset['Adj␣
 ↪Close'],1,-1)
dataset['Returns'] = dataset['Adj Close'].pct_change()
dataset = dataset.dropna()
dataset.head()
```

[3]:

Date	Open	High	Low	Close	Adj Close	Volume	Increase_Decrease	Buy_Sell_on_Open	Buy_Sell	Returns
2014-01-03	3.98	4.00	3.88	4.00	4.00	22887200	1	1	1	0.012658
2014-01-06	4.01	4.18	3.99	4.13	4.13	42398300	1	1	1	0.032500
2014-01-07	4.19	4.25	4.11	4.18	4.18	42932100	-1	1	-1	0.012107
2014-01-08	4.23	4.26	4.14	4.18	4.18	30678700	-1	-1	-1	0.000000
2014-01-09	4.20	4.23	4.05	4.09	4.09	30667600	-1	-1	1	-0.021531

1.2 Measuring Central Tendency

[4]:
```
print("Mean Values in the Distribution")
print("-"*35)
print(dataset.mean())
print("**********************************")
print("Median Values in the Distribution")
print("-"*35)
print(dataset.median())
```

```
Mean Values in the Distribution
-----------------------------------
Open                 8.169578e+00
High                 8.358266e+00
Low                  7.972641e+00
Close                8.167780e+00
Adj Close            8.167780e+00
Volume               4.353071e+07
Increase_Decrease   -8.989658e-02
Buy_Sell_on_Open     1.193317e-02
```

```
Buy_Sell            -3.977725e-03
Returns              1.971264e-03
dtype: float64
**********************************
Median Values in the Distribution
----------------------------------
Open                         5.10
High                         5.19
Low                          5.00
Close                        5.10
Adj Close                    5.10
Volume                31793700.00
Increase_Decrease           -1.00
Buy_Sell_on_Open             1.00
Buy_Sell                    -1.00
Returns                      0.00
dtype: float64
```

[5]:
```
print("Mode Value")
print(dataset.mode())
```

```
Mode Value
   Open  High   Low  Close  Adj Close    Volume  Increase_Decrease  \
0  2.36   2.8  2.65   2.28       2.28  11839300               -1.0
1   NaN   NaN   NaN    NaN        NaN  34758600                NaN

   Buy_Sell_on_Open  Buy_Sell  Returns
0               1.0      -1.0      0.0
1               NaN       NaN      NaN
```

1.3 Measuring Variance

[6]:
```
# Measuring Standard Deviation
print("Measuring Standard Deviation")
print(dataset.std())
```

```
Measuring Standard Deviation
Open                6.482962e+00
High                6.659404e+00
Low                 6.280754e+00
Close               6.476459e+00
Adj Close           6.476459e+00
Volume              4.088962e+07
Increase_Decrease   9.963475e-01
Buy_Sell_on_Open    1.000327e+00
Buy_Sell            1.000390e+00
Returns             3.921139e-02
dtype: float64
```

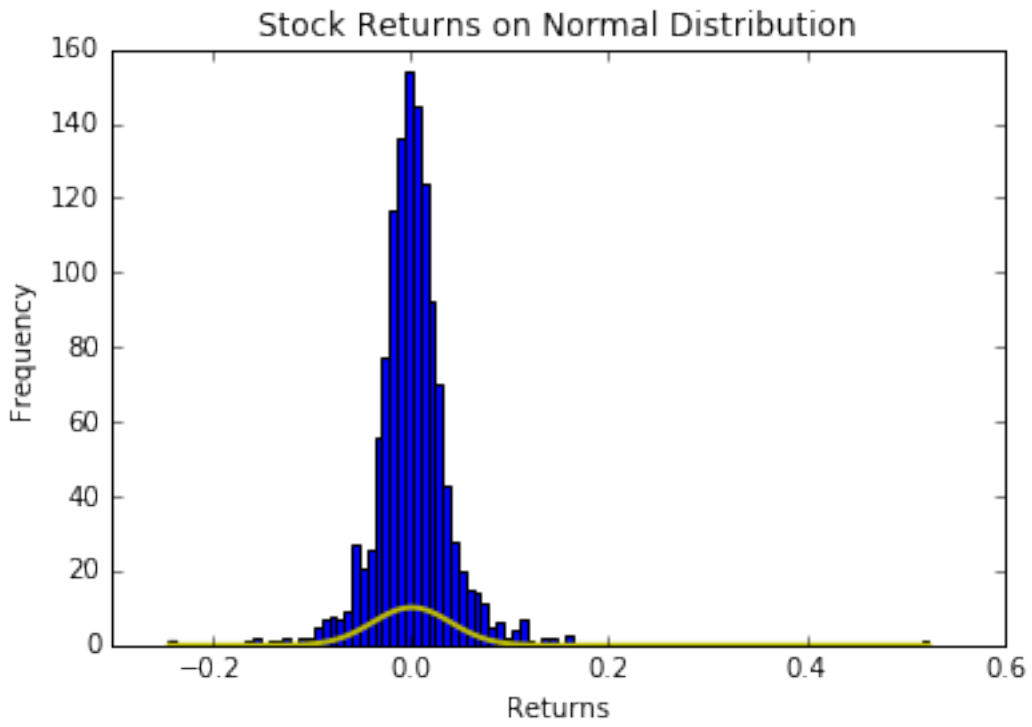
[7]:
```
# Measuring Skewness
print("Measuring Skewness")
print(dataset.skew())
```

```
Measuring Skewness
Open                 1.261225
High                 1.280989
Low                  1.227398
Close                1.256451
Adj Close            1.256451
Volume               2.080052
Increase_Decrease    0.180740
Buy_Sell_on_Open    -0.023897
Buy_Sell             0.007965
Returns              1.814307
dtype: float64
```

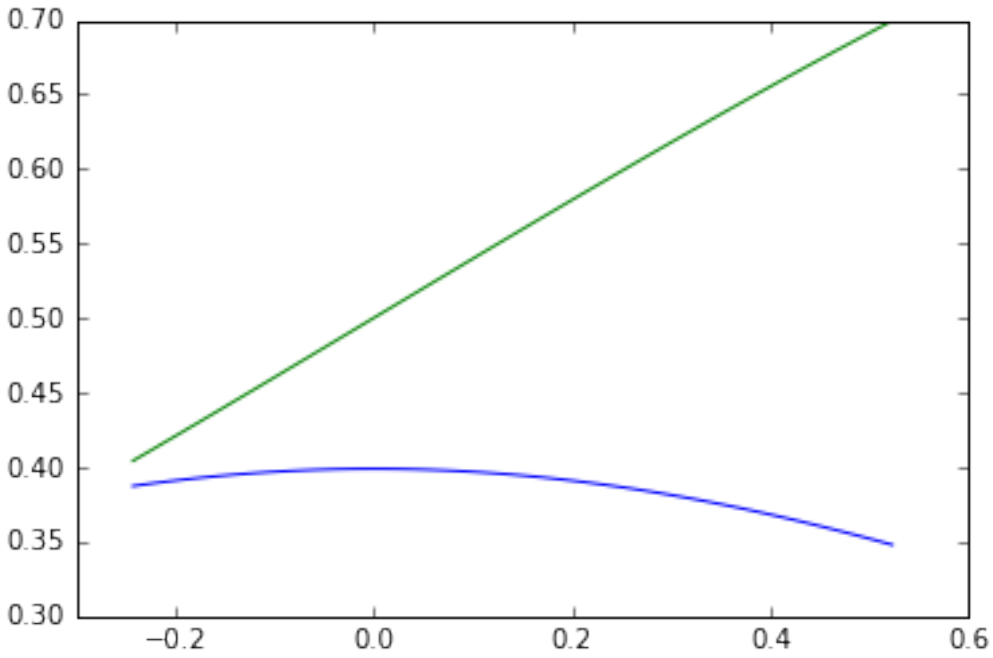
1.4 Normal Distribution

[8]:
```
import math
import matplotlib.mlab as mlab

# Define Variables
mu = dataset['Returns'].mean() # Mean Returns
sigma = dataset['Returns'].std() # Volatility
```

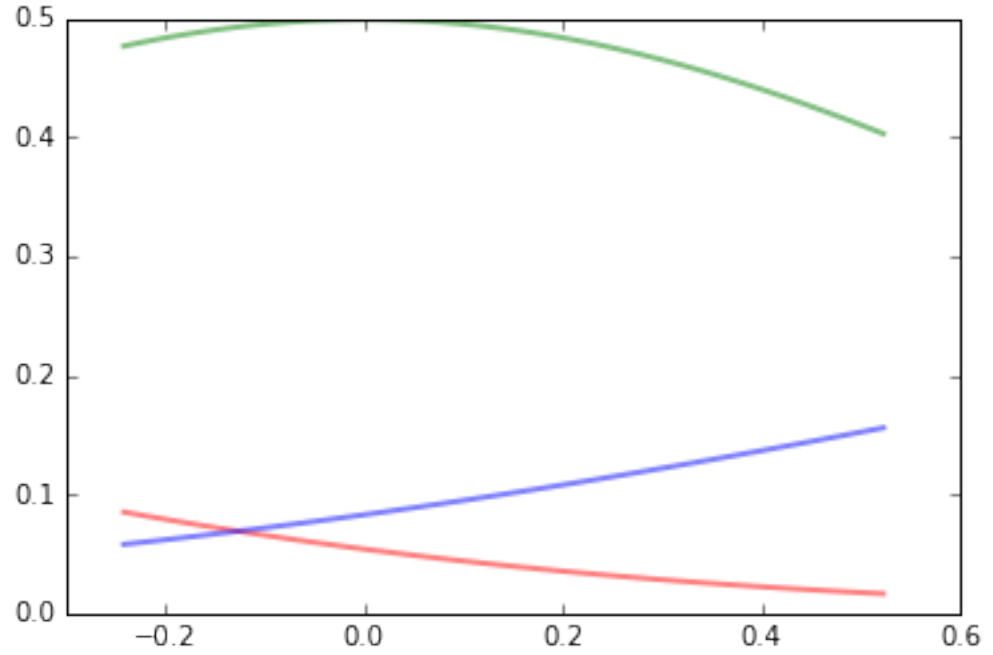
[9]:
```
[n,bins,patches] = plt.hist(dataset['Returns'], 100)
# Daily returns using normal distribution
s = mlab.normpdf(bins, mu, sigma)
# Create the bins and histogram
plt.plot(bins, s, color='y', lw=2)
plt.title("Stock Returns on Normal Distribution")
plt.xlabel("Returns")
plt.ylabel("Frequency")
plt.show()
```



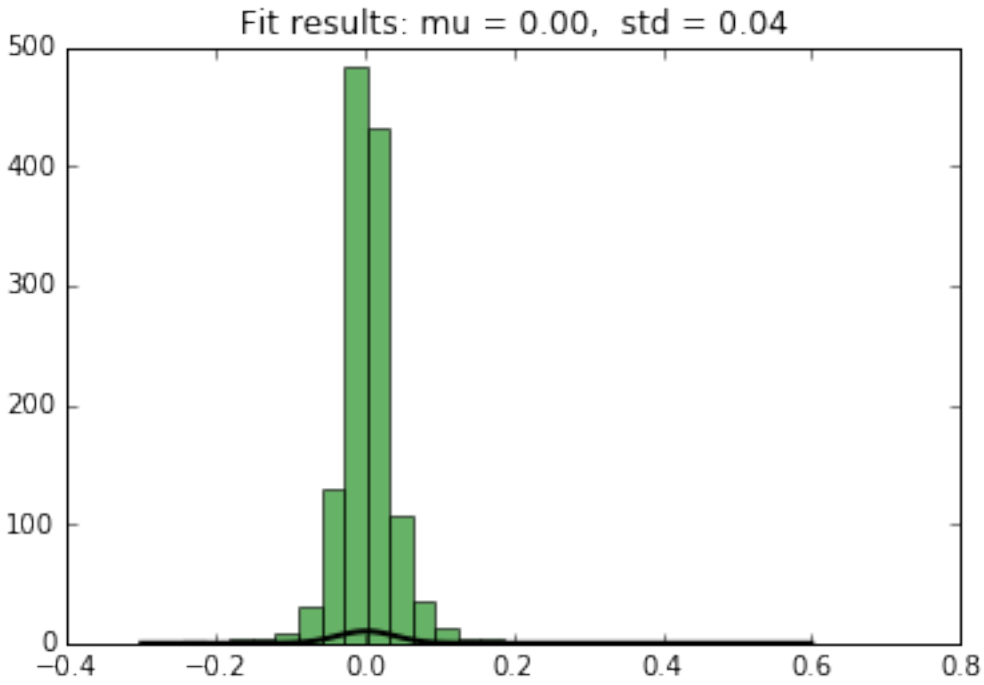
[10]:
```
from scipy.stats import norm

mu = dataset['Returns'].mean()
sigma = dataset['Returns'].std()

x_min = dataset['Returns'].min()
x_max = dataset['Returns'].max()



def plot_normal(x_range, mu=0, sigma=1, cdf=False, **kwargs):
    x = x_range
    if cdf:
        y = norm.cdf(x, mu, sigma)
    else:
        y = norm.pdf(x, mu, sigma)
    plt.plot(x, y, **kwargs)

x = np.linspace(x_min, x_max, 100)
plot_normal(x)
plot_normal(x, cdf=True)
```



[11]:
```
plot_normal(x, -2, 1, color='red', lw=2, ls='-', alpha=0.5)
plot_normal(x, 2, 1.2, color='blue', lw=2, ls='-', alpha=0.5)
plot_normal(x, 0, 0.8, color='green', lw=2, ls='-', alpha=0.5)
```



[12]:
```
mu, std = norm.fit(dataset['Returns'])

# Plot the histogram.
plt.hist(dataset['Returns'], bins=25, alpha=0.6, color='g')

# Plot the PDF.
xmin, xmax = plt.xlim()
x = np.linspace(xmin, xmax, 100)
p = norm.pdf(x, mu, std)
plt.plot(x, p, 'k', linewidth=2)
title = "Fit results: mu = %.2f,  std = %.2f" % (mu, std)
plt.title(title)

plt.show()
```



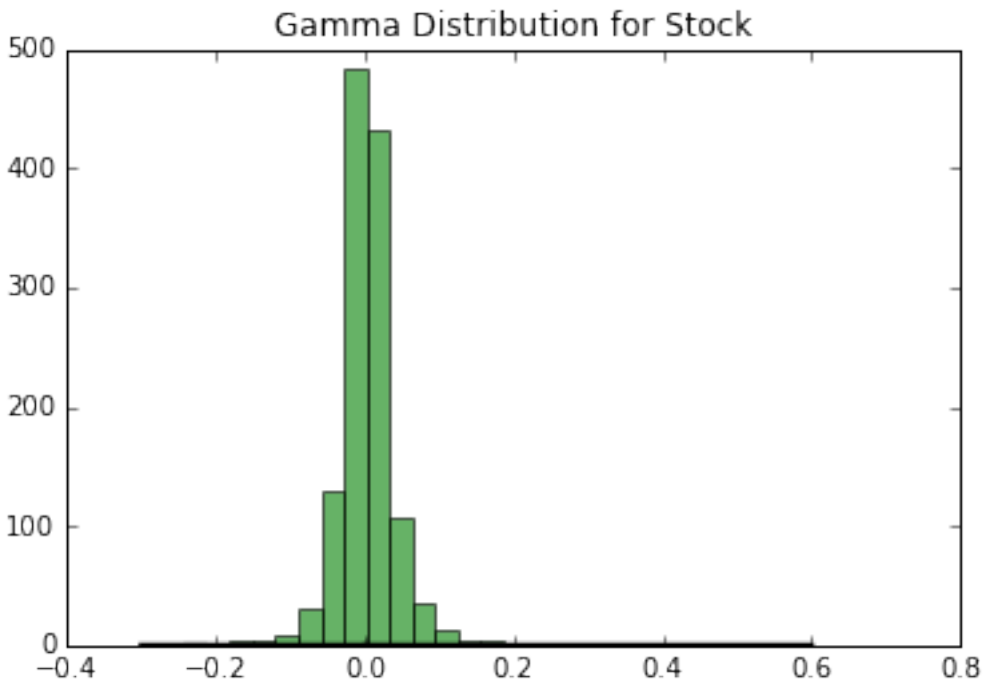
2 Gamma Distribution

[26]:
```
from scipy import stats

# input
symbol = 'AAPL'
market = 'SPY'
start = '2014-01-01'
```

```
end = '2018-01-01'

# Read data
dataset1 = yf.download(symbol,start,end)
dataset2 = yf.download(market,start,end)

stock_ret = dataset1['Adj Close'].pct_change().dropna()
mkt_ret = dataset2['Adj Close'].pct_change().dropna()

beta, alpha, r_value, p_value, std_err = stats.linregress(mkt_ret, stock_ret)
print(beta, alpha)
```

```
[*********************100%***********************]  1 of 1 downloaded
[*********************100%***********************]  1 of 1 downloaded
1.06902764917 0.000487690199643
```

[27]:
```
from scipy.stats import gamma

mu, std = gamma.stats(dataset['Returns'])

# Plot the histogram.
plt.hist(dataset['Returns'], bins=25, alpha=0.6, color='g')

# Plot the PDF.
xmin, xmax = plt.xlim()
x = np.linspace(xmin, xmax, 1171)
p = gamma.pdf(x, alpha, scale=1/beta)
plt.plot(x, p, 'k', linewidth=2)
plt.title("Gamma Distribution for Stock")

plt.show()
```



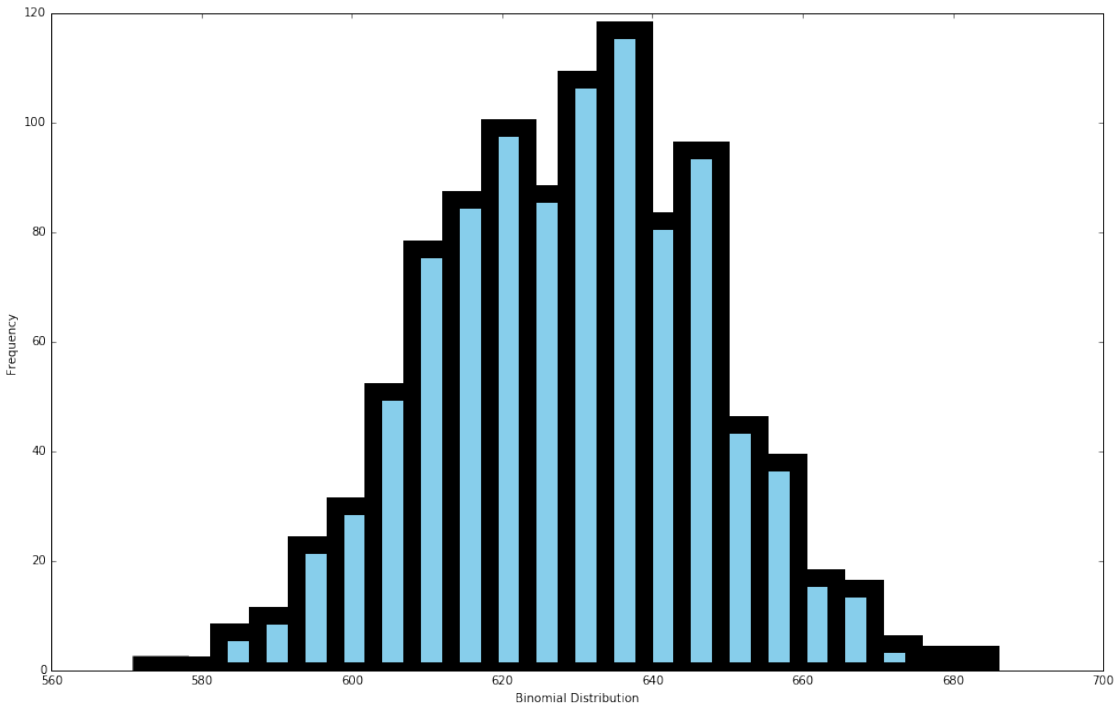
2.1 Binomial Distribution

[15]:
```
from scipy.stats import binom

n = 10 # number of trials
p = 0.5 # probaility of success and failure
k = np.arange(0,21) # * number of repeat the trial
binomial = binom.pmf(k, n, p)
binomial
```

[15]:
```
array([ 0.00097656,  0.00976563,  0.04394531,  0.1171875 ,  0.20507813,
        0.24609375,  0.20507813,  0.1171875 ,  0.04394531,  0.00976563,
        0.00097656,  0.        ,  0.        ,  0.        ,  0.        ,
        0.        ,  0.        ,  0.        ,  0.        ,  0.        ,  0.
])
```

[32]:
```
data_binom = binom.rvs(n=len(dataset['Adj Close']),p=0.5,size=1000)

plt.figure(figsize=(16,10))
ax = sns.distplot(data_binom,
                  kde=False,
                  color='skyblue',
                  hist_kws={"linewidth": 15,'alpha':1})
ax.set(xlabel='Binomial Distribution', ylabel='Frequency')
```

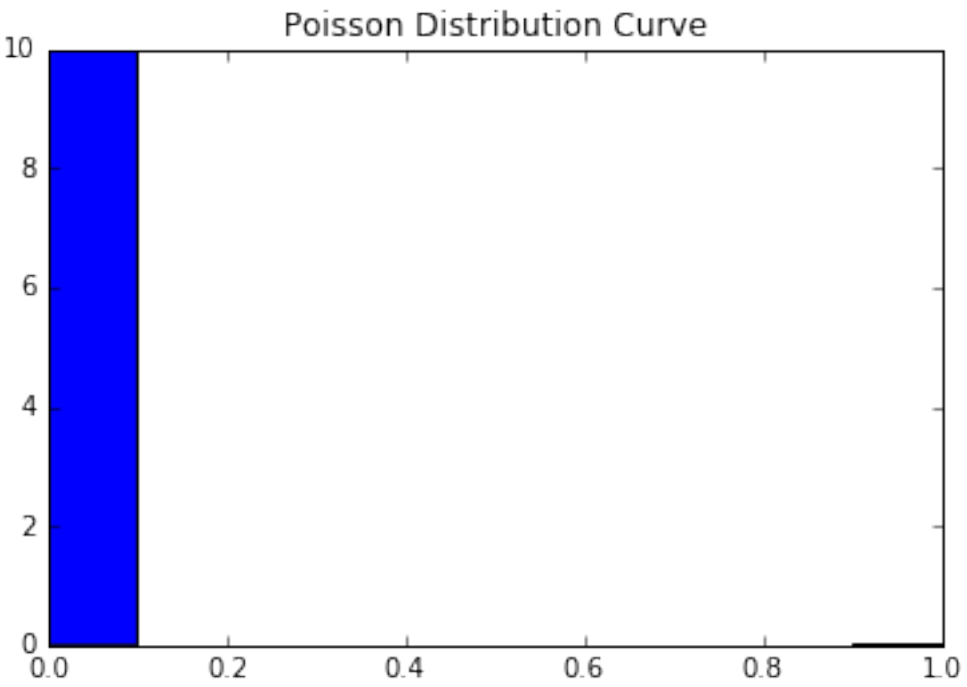
[32]:
```
[<matplotlib.text.Text at 0x1de1b6047b8>,
 <matplotlib.text.Text at 0x1de231f45c0>]
```



2.2 Poisson Distribution

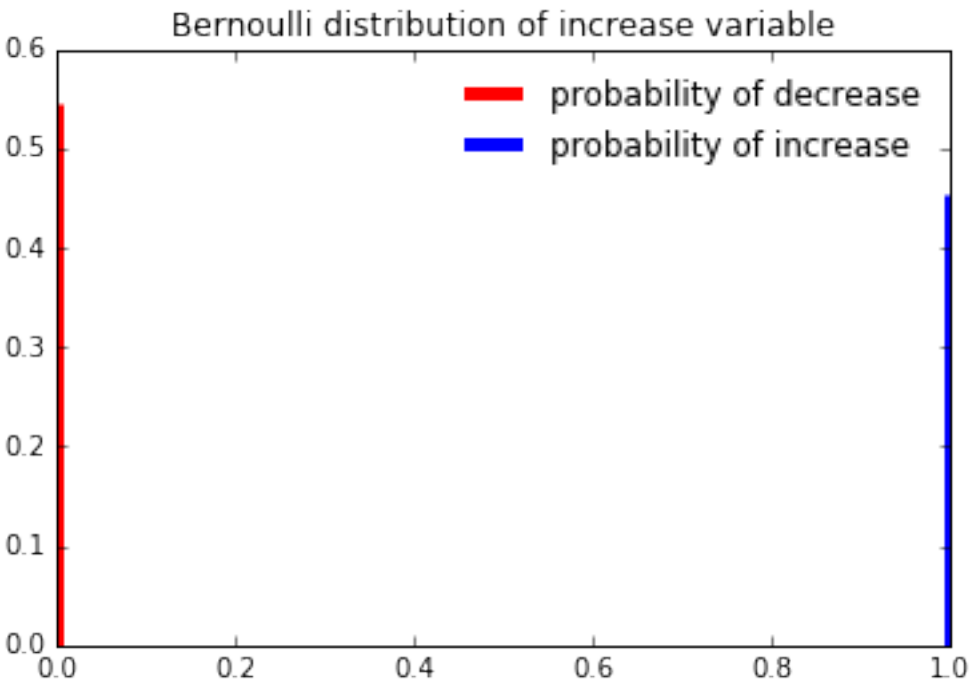
[16]:
```
from scipy.stats import poisson

mu = dataset['Returns'].mean()
dist = poisson.rvs(mu=mu, loc=0, size=1000)
print("Mean: %g" % np.mean(dataset['Returns']))
print("SD: %g" % np.std(dataset['Returns'], ddof=1))

plt.hist(dist, bins=10, normed=True)
#plt.xlabel()
plt.title('Poisson Distribution Curve')
plt.show()
```

```
Mean: 0.00197126
SD: 0.0392114
```



2.3 Bernoulli Distribution

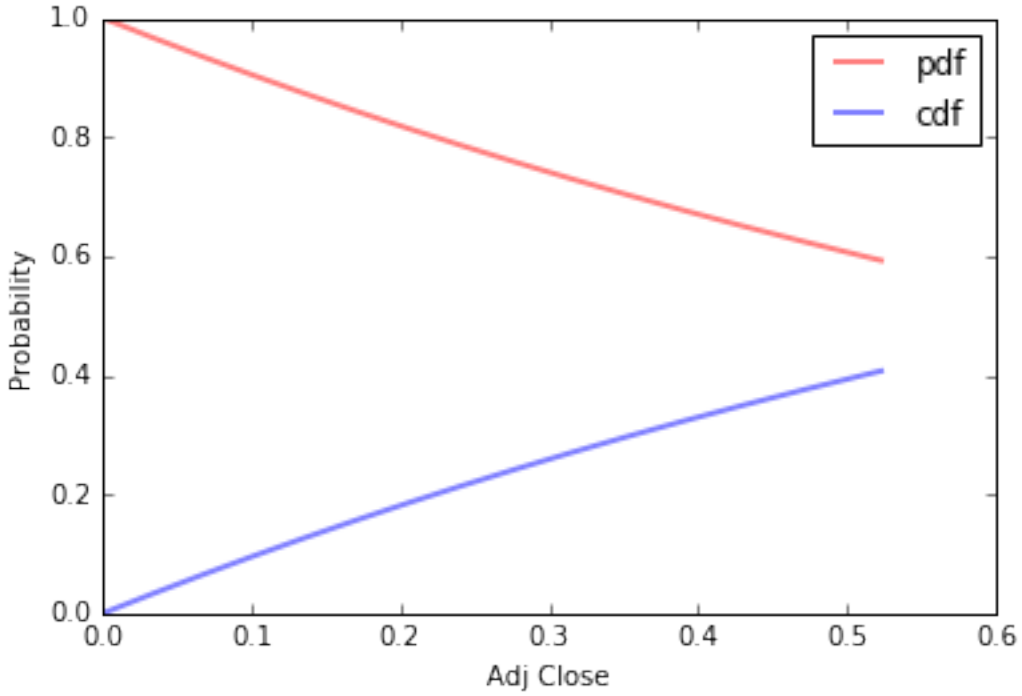
[17]:
```
from scipy.stats import bernoulli

countIncrease = dataset[dataset.Increase_Decrease == 1].Increase_Decrease.
↪count()
countAll = dataset.Increase_Decrease.count()

Increase_dist = bernoulli(countIncrease / countAll)
# the given value is the probability of outcome 1 (increase) (let's call it p).␣
↪# The probability of the opposite outcome (0 - decrease) is 1 - p.

_, ax = plt.subplots(1, 1)
ax.vlines(0, 0, Increase_dist.pmf(0), colors='r', linestyles='-', lw=5,␣
↪label="probability of decrease")
ax.vlines(1, 0, Increase_dist.pmf(1), colors='b', linestyles='-', lw=5,␣
↪label="probability of increase")
ax.legend(loc='best', frameon=False)
plt.title("Bernoulli distribution of increase variable")
plt.show()
```



2.4 Exponential Distribution

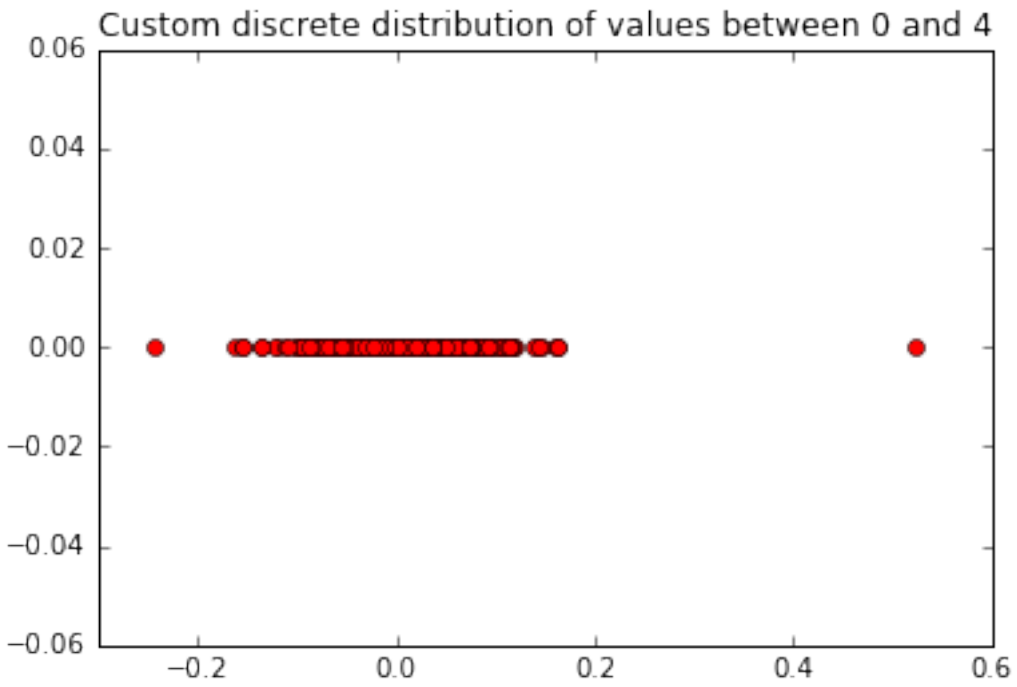
[18]:
```
from scipy.stats import expon

mu = dataset['Returns'].mean()
sigma = dataset['Returns'].std()

x_m = dataset['Returns'].max()

def plot_exponential(x_range, mu=0, sigma=1, cdf=False, **kwargs):
    if cdf:
        y = expon.cdf(x, mu, sigma)
    else:
        y = expon.pdf(x, mu, sigma)
    plt.plot(x, y, **kwargs)


x = np.linspace(0, x_m, 5000)
plot_exponential(x, 0, 1, color='red', lw=2, ls='-', alpha=0.5, label='pdf')
plot_exponential(x, 0, 1, cdf=True, color='blue', lw=2, ls='-', alpha=0.5,␣
 ↪label='cdf')
plt.xlabel('Adj Close')
plt.ylabel('Probability')
plt.legend(loc='best')
```

```
plt.show()
```



3 Discrete random variable

[19]:
```
from scipy.stats import rv_discrete

increase_probability = pd.DataFrame({'probability': dataset.groupby(by =␣
 ↪"Increase_Decrease", as_index=False).size() / dataset.Increase_Decrease.
 ↪count()}).reset_index()

values = increase_probability.Increase_Decrease
probabilities = increase_probability.probability
custom_discrete_dist = rv_discrete(values=(values, probabilities))

x = dataset['Returns']

_, ax = plt.subplots(1, 1)
ax.plot(x, custom_discrete_dist.pmf(x), 'ro', lw=2)
plt.title('Custom discrete distribution of values between 0 and 4')
plt.show()
```



3.1 P-Value

[20]:
```
from scipy import stats

# input
symbol = 'AAPL'
market = 'SPY'
start = '2014-01-01'
end = '2018-01-01'

# Read data
dataset1 = yf.download(symbol,start,end)
dataset2 = yf.download(market,start,end)

stock_ret = dataset1['Adj Close'].pct_change().dropna()
mkt_ret = dataset2['Adj Close'].pct_change().dropna()

beta, alpha, r_value, p_value, std_err = stats.linregress(mkt_ret, stock_ret)
print(beta, alpha)
print("R-squared=", r_value**2)
print("p-value =", p_value)
```

```
[*********************100%***********************]  1 of 1 downloaded
[*********************100%***********************]  1 of 1 downloaded
```

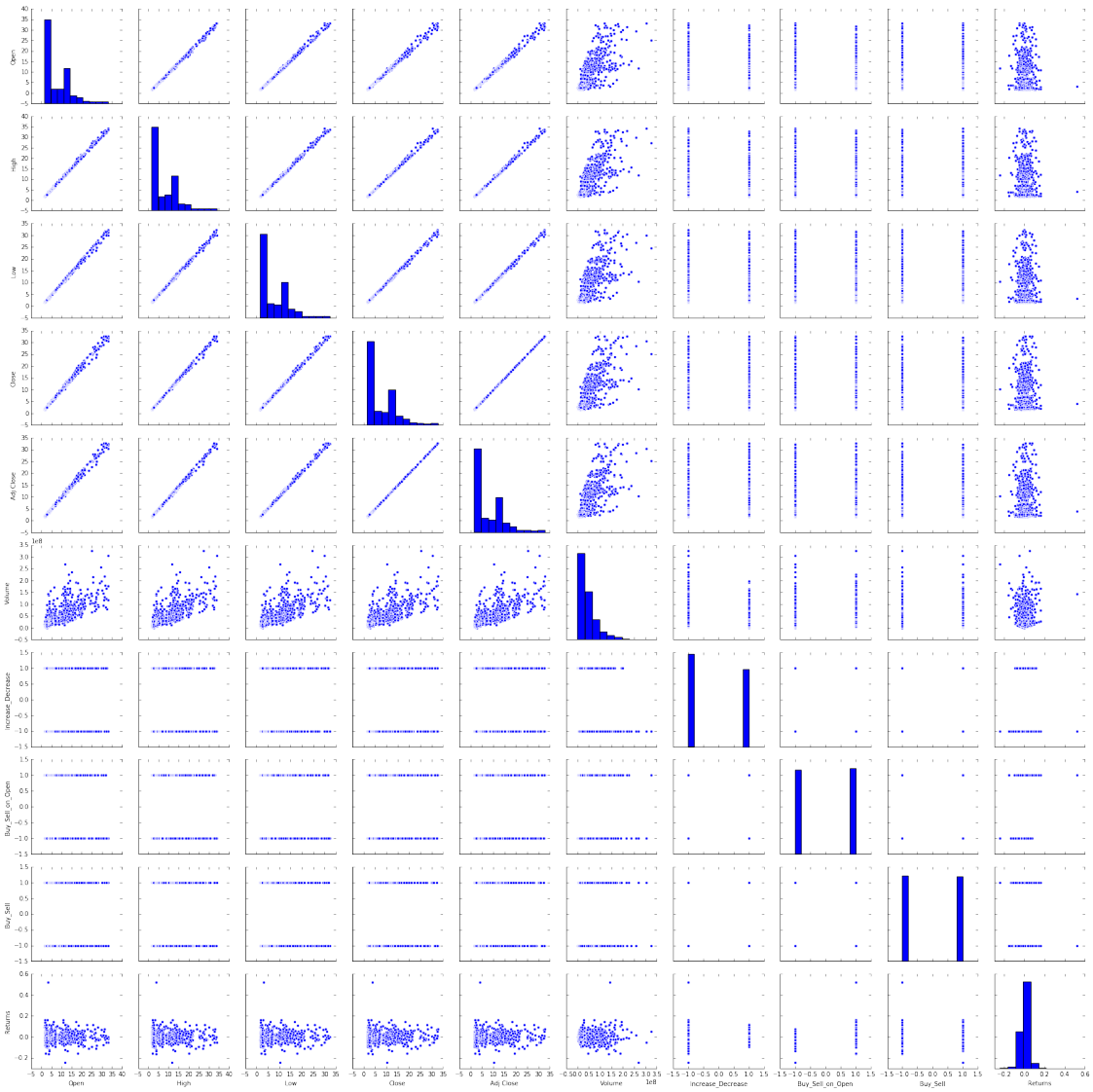
```
1.06902764917 0.000487690199643
R-squared= 0.32122047131
p-value = 1.49445000812e-86
```

[21]:
```
if p_value < alpha:  # null hypothesis: x comes from a normal distribution
    print("The null hypothesis can be rejected")
else:
    print("The null hypothesis cannot be rejected")
```

```
The null hypothesis cannot be rejected
```

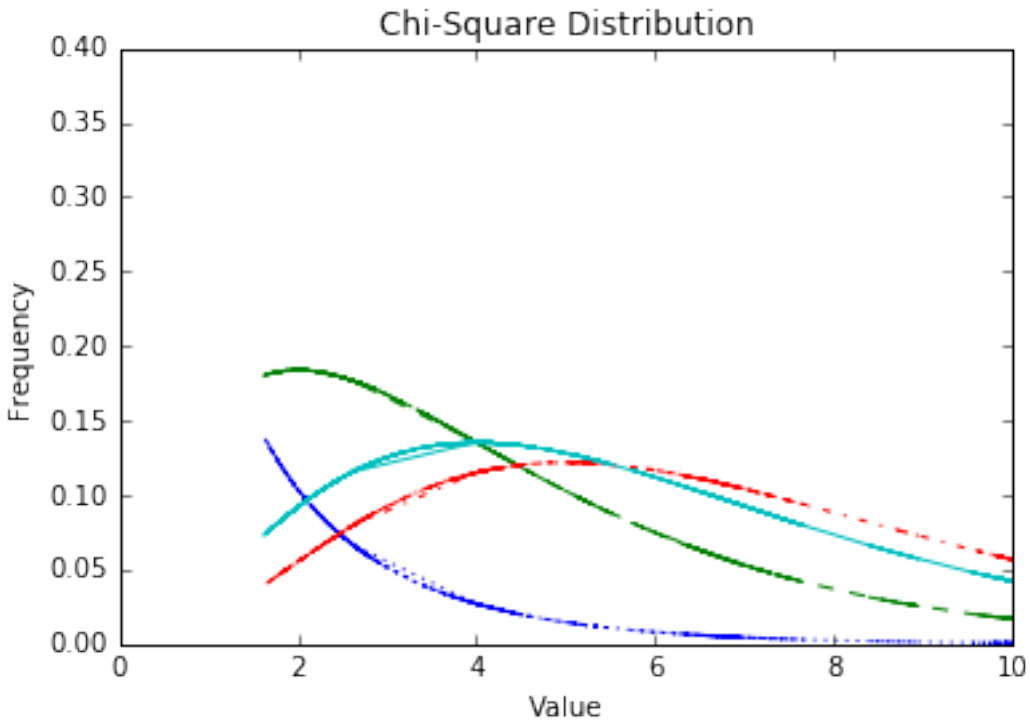
3.2 Correlation

[22]:
```
sns.pairplot(dataset, kind="scatter")
plt.show()
```



4 Chi-square Test

[23]:
```
from scipy import stats

x = dataset['Adj Close']
fig,ax = plt.subplots(1,1)

linestyles = [':', '--', '-.', '-']
deg_of_freedom = [1, 4, 7, 6]
for df, ls in zip(deg_of_freedom, linestyles):
  ax.plot(x, stats.chi2.pdf(x, df), linestyle=ls)

plt.xlim(0, 10)
plt.ylim(0, 0.4)

plt.xlabel('Value')
plt.ylabel('Frequency')
plt.title('Chi-Square Distribution')

plt.legend()
plt.show()
```



4.1 Linear Regression

[24]:
```
sns.regplot(x = "Adj Close", y = "Open", data = dataset)
plt.show()
```