Market_Portfolio

September 29, 2021

1 Market Index Portfolio

1.1 Invest in the Markets of Economy

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.mlab as mlab
import seaborn as sns
from tabulate import tabulate
from scipy.stats import norm
import math

import warnings
warnings.filterwarnings("ignore")

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

[2]:
```
# input
symbols = ['^GSPC','^DJI','^IXIC','^RUT']
start = '2007-01-01'
end = '2019-01-01'

# Read data
df = yf.download(symbols,start,end)['Adj Close']

# View Columns
df.head()
```

```
[*********************100%***********************]  4 of 4 downloaded
```

[2]:

Date	^DJI	^GSPC	^IXIC	^RUT
2007-01-03	12474.519531	1416.599976	2423.159912	787.419983
2007-01-04	12480.690430	1418.339966	2453.429932	789.950012
2007-01-05	12398.009766	1409.709961	2434.250000	775.869995

```
2007-01-08  12423.490234  1412.839966  2438.199951  776.989990
2007-01-09  12416.599609  1412.109985  2443.830078  778.330017
```

[3]:
```
df.tail()
```

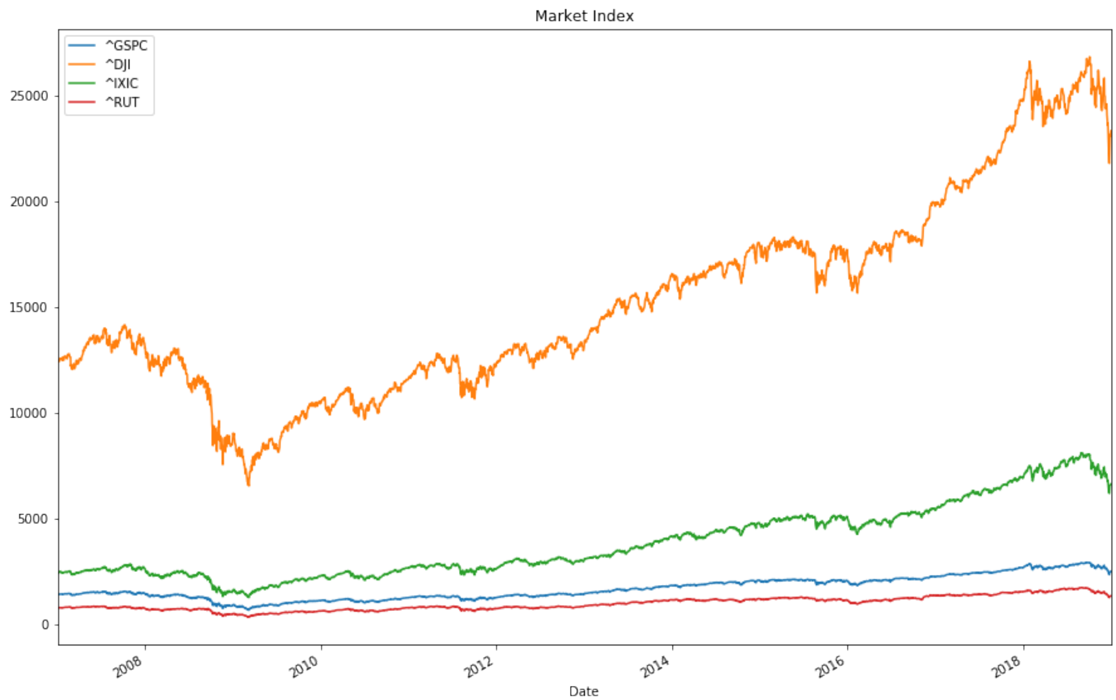
[3]:
```
                    ^DJI        ^GSPC        ^IXIC         ^RUT
Date
2018-12-24  21792.199219  2351.100098  6192.919922  1266.920044
2018-12-26  22878.449219  2467.699951  6554.359863  1329.810059
2018-12-27  23138.820313  2488.830078  6579.490234  1331.819946
2018-12-28  23062.400391  2485.739990  6584.520020  1337.920044
2018-12-31  23327.460938  2506.850098  6635.279785  1348.560059
```

[4]:
```
from datetime import datetime
from dateutil import relativedelta

d1 = datetime.strptime(start, "%Y-%m-%d")
d2 = datetime.strptime(end, "%Y-%m-%d")
delta = relativedelta.relativedelta(d2,d1)
print('How many years of investing?')
print('%s years' % delta.years)
```

```
How many years of investing?
12 years
```

[5]:
```
for s in symbols:
    df[s].plot(label = s, figsize = (15,10))
plt.title('Market Index')
plt.legend()
```

[5]:
```
<matplotlib.legend.Legend at 0x1ec60463198>
```



[6]:
```python
for s in symbols:
    print(s + ":",  df[s].max())
```

```
^GSPC: 2930.75
^DJI: 26828.390625
^IXIC: 8109.689941
^RUT: 1740.75
```

[7]:
```python
for s in symbols:
    print(s + ":",  df[s].min())
```

```
^GSPC: 676.530029
^DJI: 6547.049805
^IXIC: 1268.640015
^RUT: 343.26001
```

[8]:
```python
returns = pd.DataFrame()
for s in symbols:
    returns[s + " Return"] = (np.log(1 + df[s].pct_change())).dropna()

returns.head(4)
```

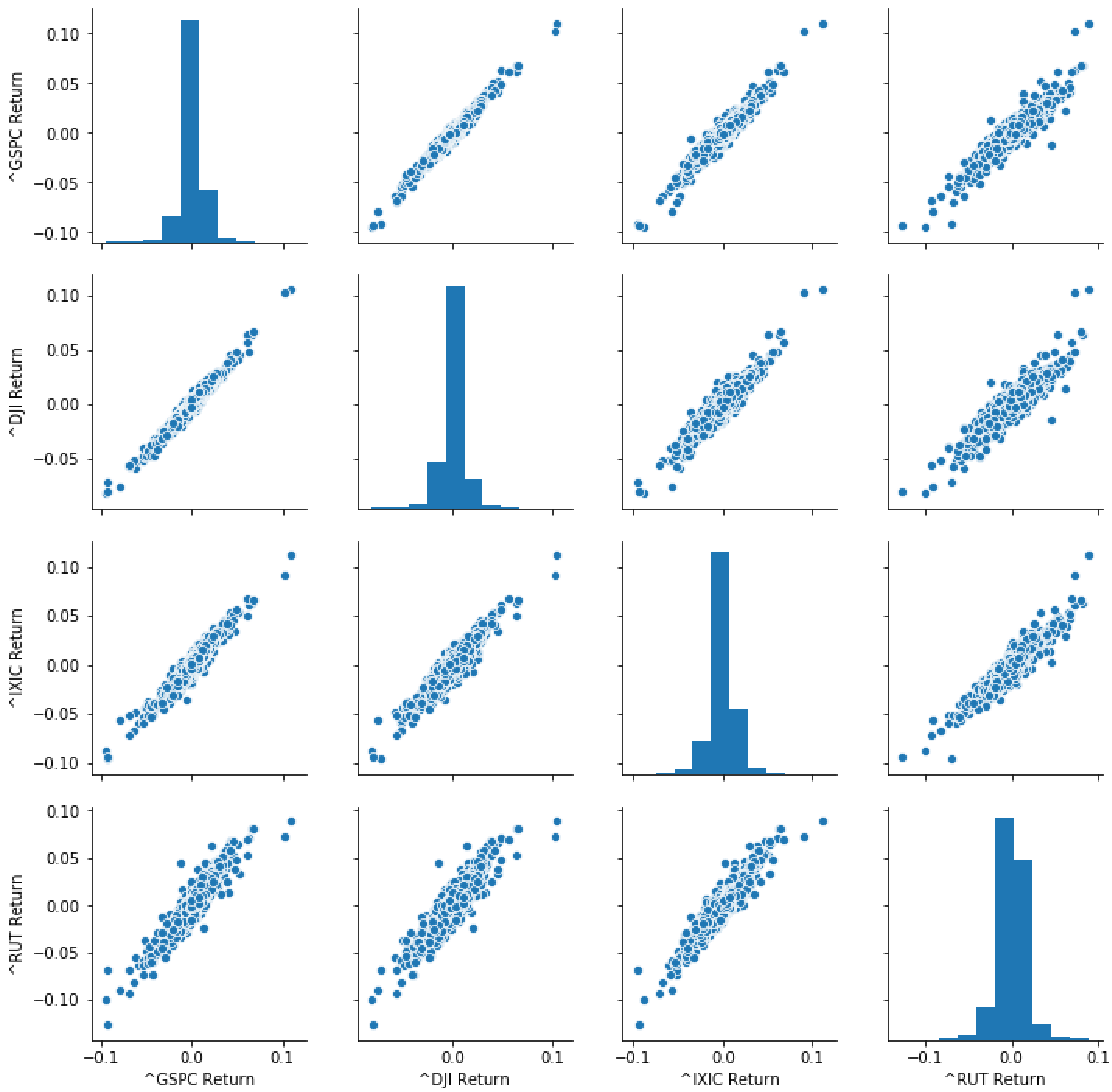
[8]:

	^GSPC Return	^DJI Return	^IXIC Return	^RUT Return
Date				
2007-01-04	0.001228	0.000495	0.012415	0.003208

```
2007-01-05      -0.006103     -0.006647      -0.007848     -0.017985
2007-01-08       0.002218      0.002053       0.001621      0.001442
2007-01-09      -0.000517     -0.000555       0.002306      0.001723
```

[9]:
```
sns.pairplot(returns[1:])
```

[9]:
```
<seaborn.axisgrid.PairGrid at 0x1ec628339e8>
```



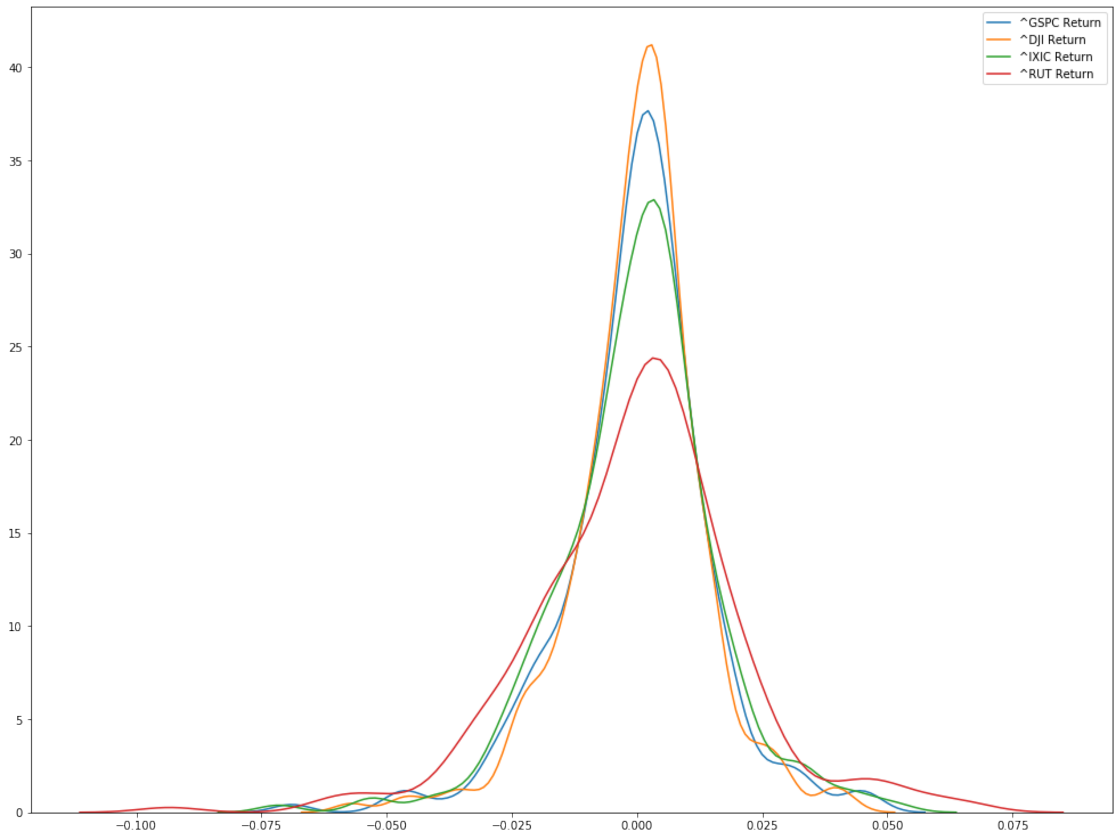
[10]:
```
# dates each bank stock had the best and worst single day returns.
print('Best Day Returns')
print('-'*20)
print(returns.idxmax())
print('\n')
```

```
print('Worst Day Returns')
print('-'*20)
print(returns.idxmin())
```

```
Best Day Returns
--------------------
^GSPC Return   2008-10-13
^DJI Return    2008-10-13
^IXIC Return   2008-10-13
^RUT Return    2008-10-13
dtype: datetime64[ns]


Worst Day Returns
--------------------
^GSPC Return   2008-10-15
^DJI Return    2008-10-15
^IXIC Return   2008-09-29
^RUT Return    2008-12-01
dtype: datetime64[ns]
```

[11]:

```
plt.figure(figsize=(17,13))

for r in returns:
    sns.kdeplot(returns.ix["2011-01-01" : "2011-12-31 "][r])
```



[12]:
```
returns.corr()
```

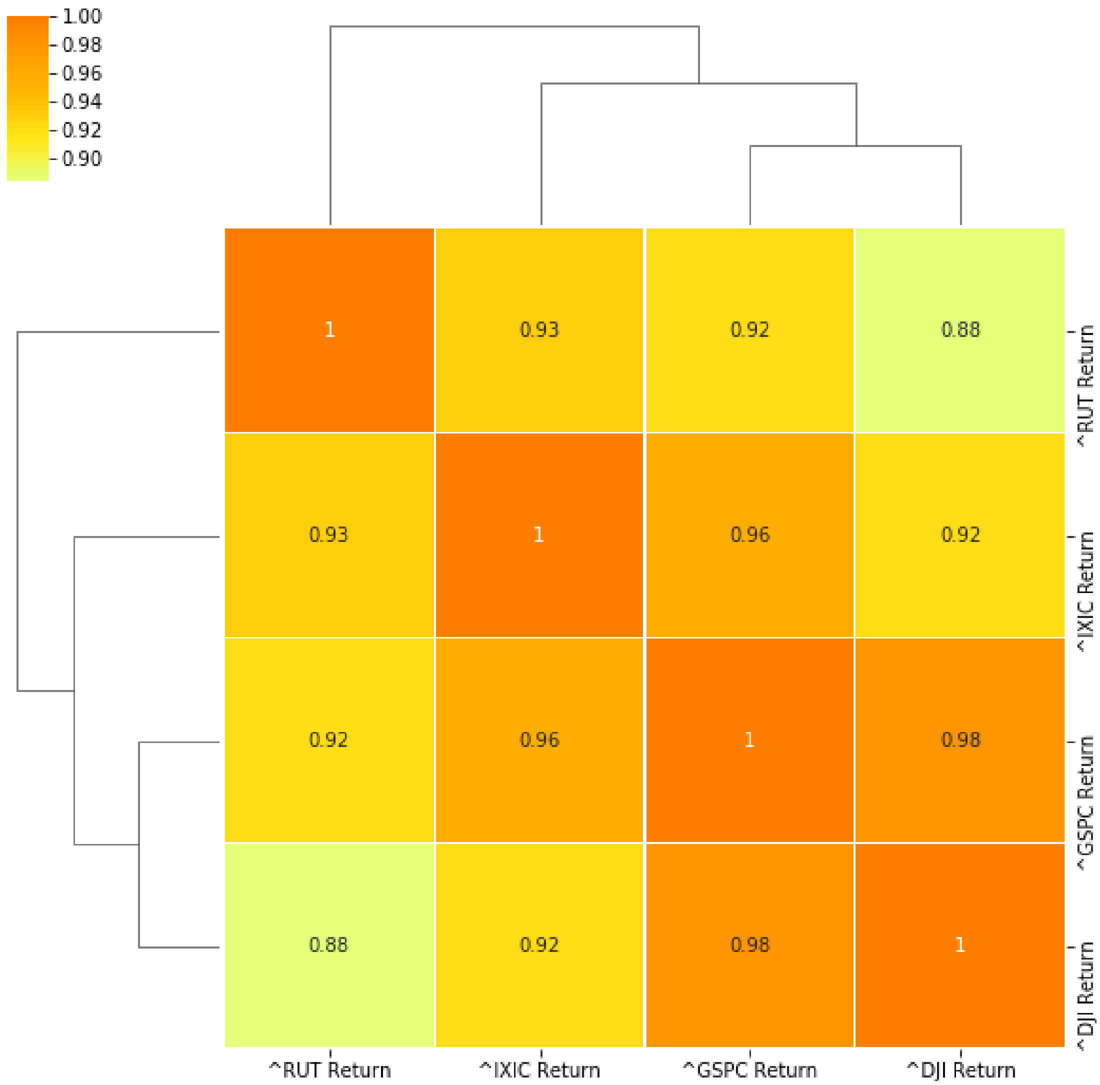
[12]:

	^GSPC Return	^DJI Return	^IXIC Return	^RUT Return
^GSPC Return	1.000000	0.981037	0.957363	0.921292
^DJI Return	0.981037	1.000000	0.921473	0.884198
^IXIC Return	0.957363	0.921473	1.000000	0.931116
^RUT Return	0.921292	0.884198	0.931116	1.000000

[13]:
```
# Heatmap for return of all the banks
plt.figure(figsize=(15,10))
sns.heatmap(returns.corr(), cmap="cool",linewidths=.1, annot= True)

sns.clustermap(returns.corr(), cmap="Wistia",linewidths=.1, annot= True)
```

[13]: <seaborn.matrix.ClusterGrid at 0x1ec62f656a0>

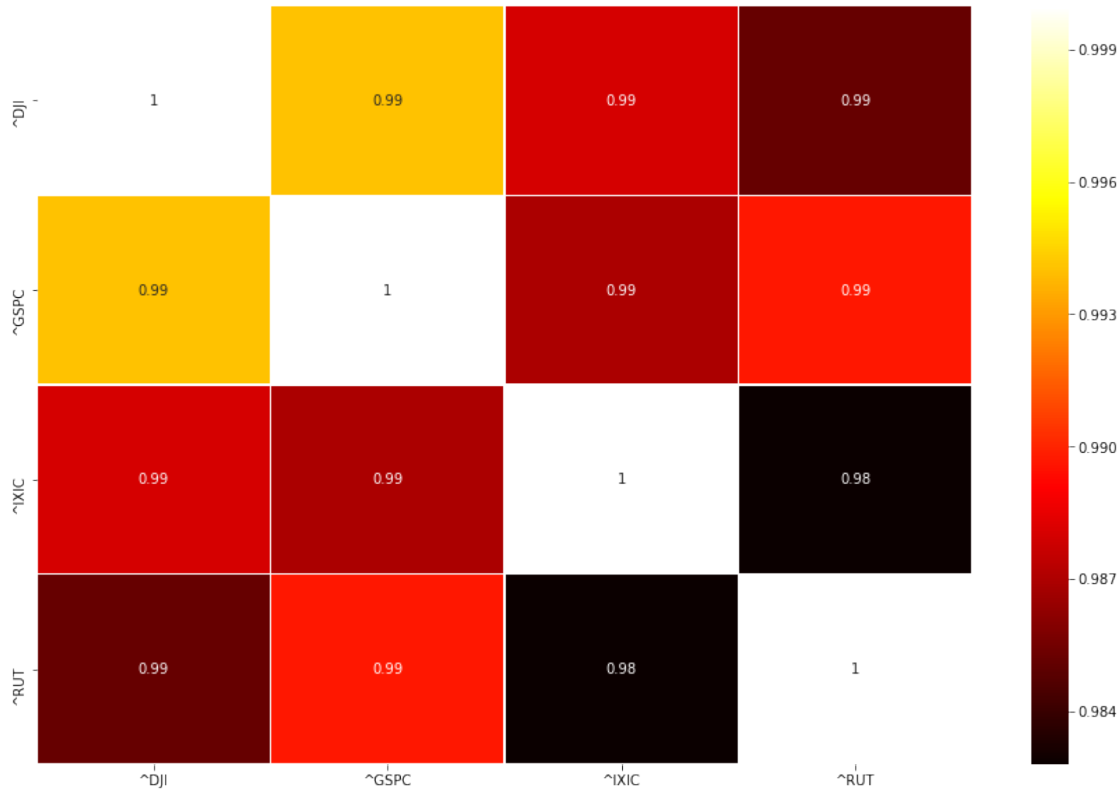

^GSPC Return
^DJI Return
^IXIC Return
^RUT Return
1
0.98
0.96
0.92
0.98
1
0.92
0.88
0.96
0.92
1
0.93
0.92
0.88
0.93
1
^GSPC Return
^DJI Return
^IXIC Return
^RUT Return
1.00
0.98
0.96
0.94
0.92
0.90



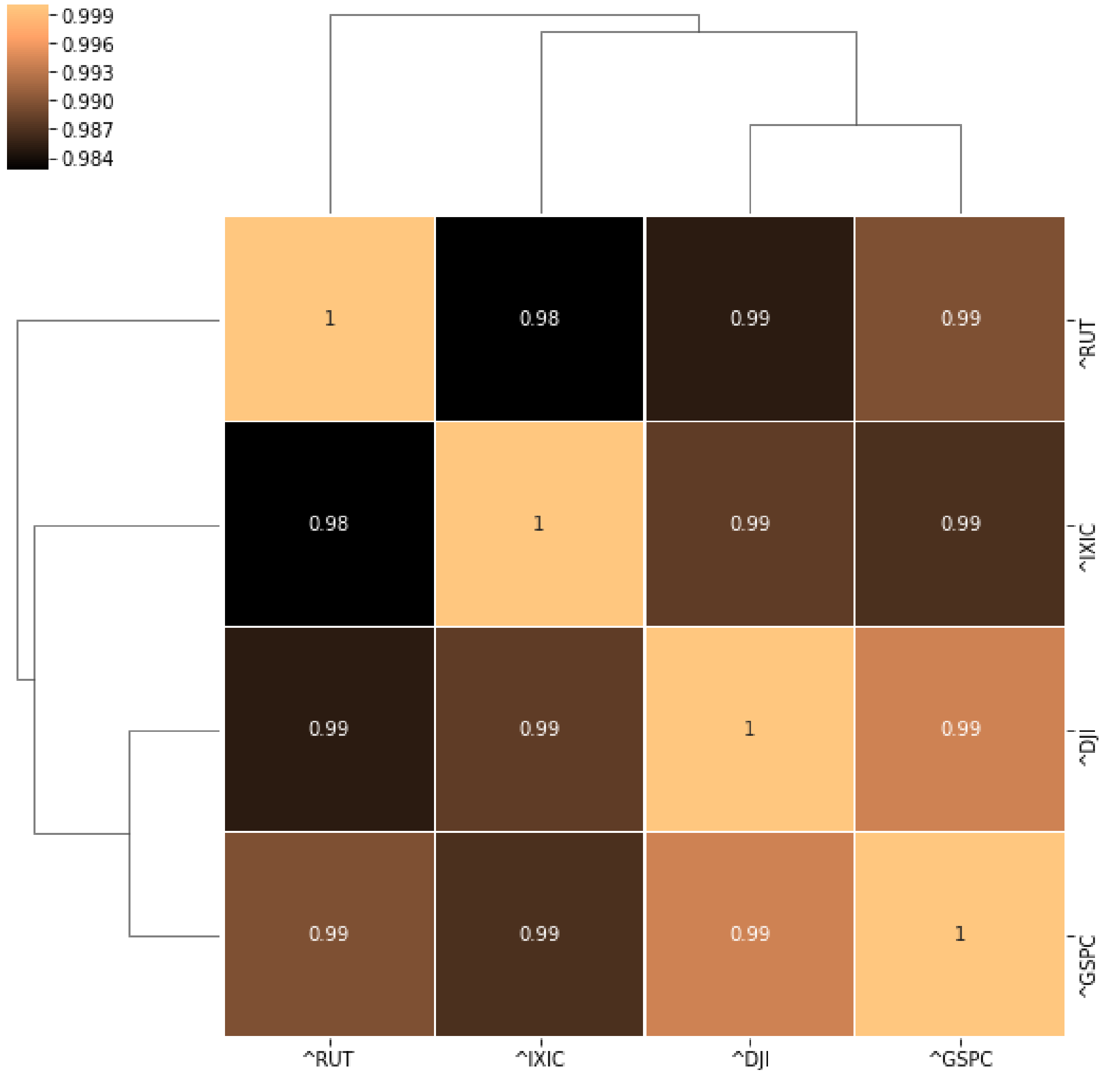
[14]:

```
plt.figure(figsize=(15,10))
sns.heatmap(df.corr(), cmap="hot",linewidths=.1, annot= True)

sns.clustermap(df.corr(), cmap="copper",linewidths=.1, annot= True)
```

[14]: <seaborn.matrix.ClusterGrid at 0x1ec62fa1908>



^DJI
^GSPC
^IXIC
^RUT
1
0.99
0.99
0.99
0.99
1
0.99
0.99
0.99
0.99
1
0.98
0.99
0.99
0.98
1
^DJI
^GSPC
^IXIC
^RUT
0.999
0.996
0.993
0.990
0.987
0.984



[15]:
```
Cash = 100000
print('Percentage of invest:')
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x in zip(df.columns, percent_invest):
    cost = x * Cash
    print('{}: {}'.format(i, cost))
```

```
Percentage of invest:
^DJI: 25000.0
^GSPC: 25000.0
^IXIC: 25000.0
^RUT: 25000.0
```

[16]:
```
print('Number of Shares:')
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x, y in zip(df.columns, percent_invest, df.iloc[0]):
    cost = x * Cash
    shares = int(cost/y)
    print('{}: {}'.format(i, shares))
```

```
Number of Shares:
^DJI: 2
^GSPC: 17
^IXIC: 10
^RUT: 31
```

[17]:
```
print('Beginning Value:')
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x, y in zip(df.columns, percent_invest, df.iloc[0]):
    cost = x * Cash
    shares = int(cost/y)
    Begin_Value = round(shares * y, 2)
    print('{}: ${}'.format(i, Begin_Value))
```

```
Beginning Value:
^DJI: $24949.04
^GSPC: $24082.2
^IXIC: $24231.6
^RUT: $24410.02
```

[18]:
```
print('Current Value:')
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x, y, z in zip(df.columns, percent_invest, df.iloc[0], df.iloc[-1]):
    cost = x * Cash
    shares = int(cost/y)
    Current_Value = round(shares * z, 2)
    print('{}: ${}'.format(i, Current_Value))
```

```
Current Value:
^DJI: $46654.92
^GSPC: $42616.45
^IXIC: $66352.8
^RUT: $41805.36
```

[19]:
```
result = []
percent_invest = [0.25, 0.25, 0.25, 0.25]
for i, x, y, z in zip(df.columns, percent_invest, df.iloc[0], df.iloc[-1]):
    cost = x * Cash
    shares = int(cost/y)
    Current_Value = round(shares * z, 2)
    result.append(Current_Value)
```

```
print('Total Value: $%s' % round(sum(result),2))
```

```
Total Value: $197429.53
```

[20]:
```
# Calculate Daily Returns
returns = df.pct_change()
returns = returns.dropna()
```

[21]:
```
# Calculate mean returns
meanDailyReturns = returns.mean()
print(meanDailyReturns)
```

```
^DJI     0.000275
^GSPC    0.000267
^IXIC    0.000424
^RUT     0.000302
dtype: float64
```

[22]:
```
# Calculate std returns
stdDailyReturns = returns.std()
print(stdDailyReturns)
```

```
^DJI     0.011592
^GSPC    0.012487
^IXIC    0.013446
^RUT     0.015714
dtype: float64
```

[23]:
```
# Define weights for the portfolio
weights = np.array([0.25, 0.25, 0.25, 0.25])
```

[24]:
```
# Calculate the covariance matrix on daily returns
cov_matrix = (returns.cov())*250
print (cov_matrix)
```

```
           ^DJI     ^GSPC     ^IXIC      ^RUT
^DJI   0.033595  0.035503  0.035910  0.040216
^GSPC  0.035503  0.038981  0.040191  0.045147
^IXIC  0.035910  0.040191  0.045201  0.049157
^RUT   0.040216  0.045147  0.049157  0.061729
```

[25]:
```
# Calculate expected portfolio performance
portReturn = np.sum(meanDailyReturns*weights)
```

[26]:
```
# Print the portfolio return
print(portReturn)
```

```
0.000316967142224249
```

[27]:
```
# Create portfolio returns column
returns['Portfolio'] = returns.dot(weights)
```

[28]:
```
returns.head()
```

[28]:
```
                ^DJI     ^GSPC     ^IXIC      ^RUT  Portfolio
Date
2007-01-04  0.000495  0.001228  0.012492  0.003213   0.004357
2007-01-05 -0.006625 -0.006085 -0.007818 -0.017824  -0.009588
2007-01-08  0.002055  0.002220  0.001623  0.001444   0.001835
2007-01-09 -0.000555 -0.000517  0.002309  0.001725   0.000741
2007-01-10  0.002059  0.001940  0.006343  0.000694   0.002759
```

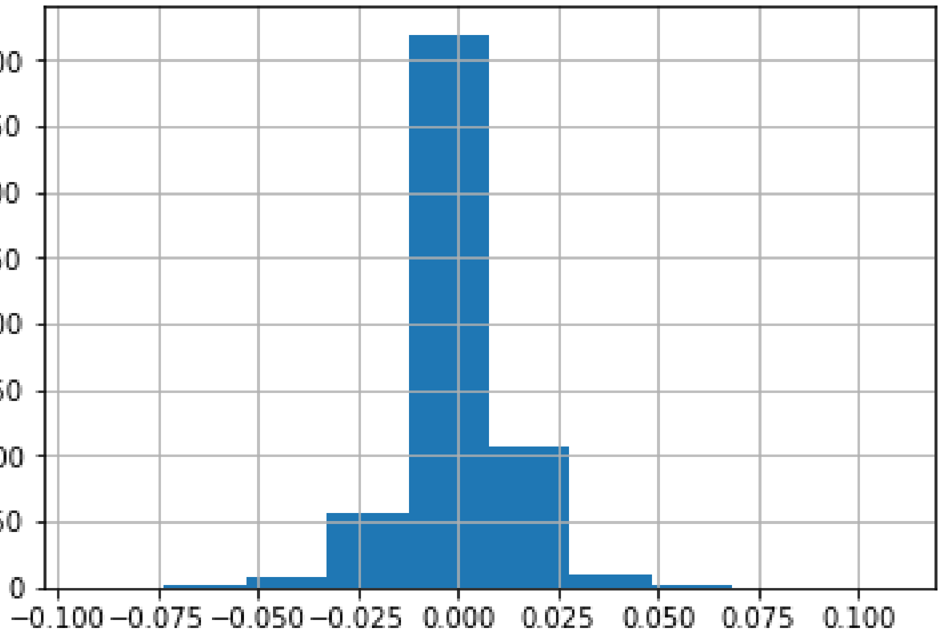
[29]:
```
returns.tail()
```

[29]:
```
                ^DJI     ^GSPC     ^IXIC      ^RUT  Portfolio
Date
2018-12-24 -0.029100 -0.027112 -0.022118 -0.019480  -0.024453
2018-12-26  0.049846  0.049594  0.058363  0.049640   0.051861
2018-12-27  0.011381  0.008563  0.003834  0.001511   0.006322
2018-12-28 -0.003303 -0.001242  0.000764  0.004580   0.000200
2018-12-31  0.011493  0.008492  0.007709  0.007953   0.008912
```

[30]:
```
# Calculate cumulative returns
daily_cum_ret=(1+returns).cumprod()
print(daily_cum_ret.tail())
```

```
                ^DJI     ^GSPC     ^IXIC      ^RUT  Portfolio
Date
2018-12-24  1.746937  1.659678  2.555721  1.608951   1.890883
2018-12-26  1.834014  1.741988  2.704881  1.688819   1.988945
2018-12-27  1.854887  1.756904  2.715252  1.691372   2.001520
2018-12-28  1.848761  1.754723  2.717328  1.699119   2.001920
2018-12-31  1.870009  1.769625  2.738276  1.712631   2.019761
```

[31]:
```
returns['Portfolio'].hist()
plt.show()
```



[32]:
```
# 99% confidence interval
# 0.01 empirical quantile of daily returns
var99 = round((returns['Portfolio']).quantile(0.01), 3)
```

[33]:
```
print('Value at Risk (99% confidence)')
print(var99)
```

```
Value at Risk (99% confidence)
-0.038
```

[34]:
```
# the percent value of the 5th quantile
print('Percent Value-at-Risk of the 5th quantile')
var_1_perc = round(np.quantile(var99, 0.01), 3)
print("{:.1f}%".format(-var_1_perc*100))
```

```
Percent Value-at-Risk of the 5th quantile
3.8%
```

[35]:
```
print('Value-at-Risk of 99% for 100,000 investment')
print("${}".format(-var99 * 100000))
```

```
Value-at-Risk of 99% for 100,000 investment
$3800.0
```

[36]:
```
# 95% confidence interval
# 0.05 empirical quantile of daily returns
```

```
var95 = round((returns['Portfolio']).quantile(0.05), 3)
```

[37]:
```
print('Value at Risk (95% confidence)')
print(var95)
```

```
Value at Risk (95% confidence)
-0.021
```

[38]:
```
print('Percent Value-at-Risk of the 5th quantile')
print("{:.1f}%".format(-var95*100))
```

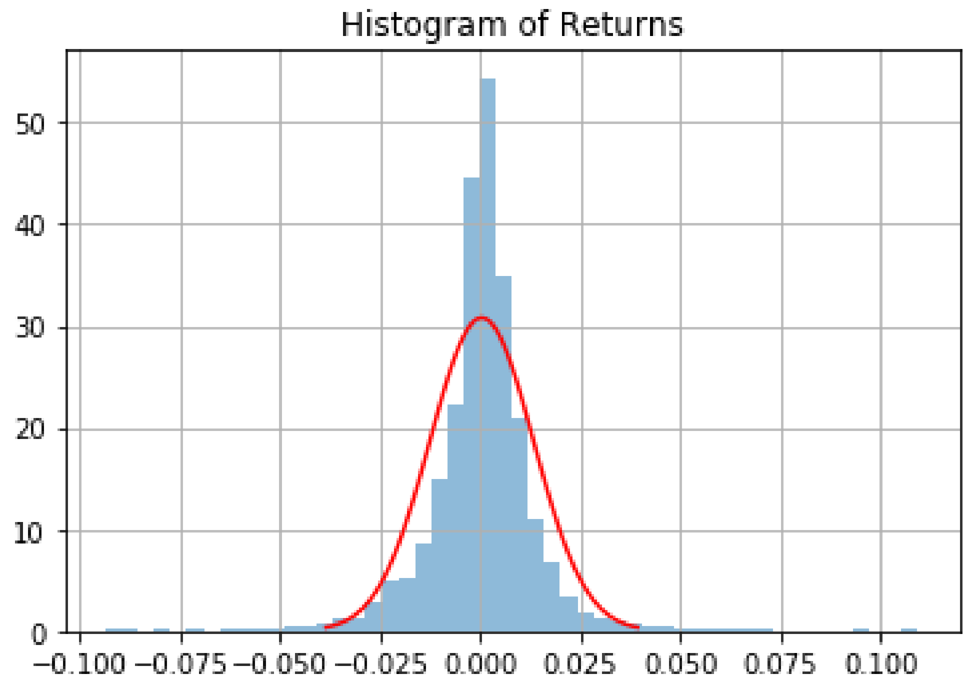
```
Percent Value-at-Risk of the 5th quantile
2.1%
```

[39]:
```
# VaR for 100,000 investment
print('Value-at-Risk of 99% for 100,000 investment')
var_100k = "${}".format(int(-var95 * 100000))
print("${}".format(int(-var95 * 100000)))
```

```
Value-at-Risk of 99% for 100,000 investment
$2100
```

[40]:
```
mean = np.mean(returns['Portfolio'])
std_dev = np.std(returns['Portfolio'])
```

[41]:
```
returns['Portfolio'].hist(bins=50, normed=True, histtype='stepfilled', alpha=0.
 ↪5)
x = np.linspace(mean - 3*std_dev, mean + 3*std_dev, 100)
plt.plot(x, mlab.normpdf(x, mean, std_dev), "r")
plt.title('Histogram of Returns')
plt.show()
```

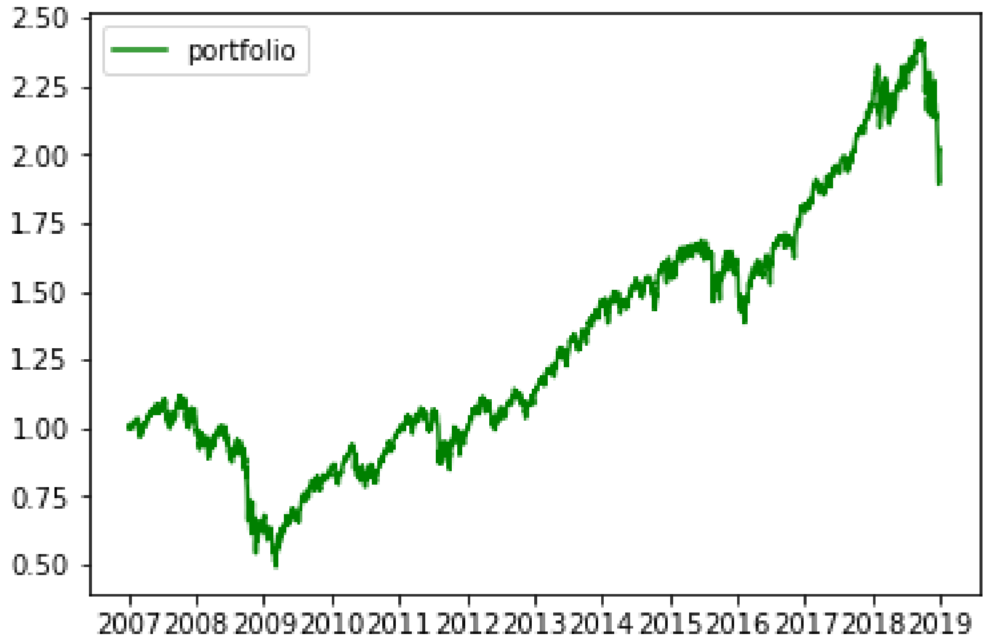


[42]:
```
VaR_90 = norm.ppf(1-0.9, mean, std_dev)
VaR_95 = norm.ppf(1-0.95, mean, std_dev)
VaR_99 = norm.ppf(1-0.99, mean, std_dev)
```

[43]:
```
print(tabulate([['90%', VaR_90], ['95%', VaR_95], ['99%', VaR_99]],
 ↪headers=['Confidence Level', 'Value at Risk']))
```

```
Confidence Level      Value at Risk
------------------  ---------------
90%                       -0.016288
95%                       -0.0209953
99%                       -0.0298254
```

[44]:
```
import matplotlib.dates

# Plot the portfolio cumulative returns only
fig, ax = plt.subplots()
ax.plot(daily_cum_ret.index, daily_cum_ret.Portfolio, color='green',
 ↪label="portfolio")
ax.xaxis.set_major_locator(matplotlib.dates.YearLocator())
plt.legend()
plt.show()
```



[45]:

```
# Print the mean
print("mean : ", returns['Portfolio'].mean()*100)

# Print the standard deviation
print("Std. dev: ", returns['Portfolio'].std()*100)

# Print the skewness
print("skew: ", returns['Portfolio'].skew())

# Print the kurtosis
print("kurt: ", returns['Portfolio'].kurtosis())
```

```
mean :  0.03169671422242502 4
Std. dev:  1.2959088461033625
skew:  -0.1356565088202002
kurt:  8.2654291395102
```

[46]:

```
# Calculate the standard deviation by taking the square root
port_standard_dev = np.sqrt(np.dot(weights.T, np.dot(weights, cov_matrix)))

# Print the results
print(str(np.round(port_standard_dev, 4) * 100) + '%')
```

```
20.49%
```

[47]:
```python
# Calculate the portfolio variance
port_variance = np.dot(weights.T, np.dot(cov_matrix, weights))

# Print the result
print(str(np.round(port_variance, 4) * 100) + '%')
```

```
4.2%
```

[60]:
```python
# Calculate total return and annualized return from price data
total_return = (returns['Portfolio'][-1] - returns['Portfolio'][0]) /␣
↪returns['Portfolio'][0]

# Annualize the total return over 5 year
annualized_return = ((1+total_return)**(1/12))-1
```

[61]:
```python
# Calculate annualized volatility from the standard deviation
vol_port = returns['Portfolio'].std() * np.sqrt(250)
```

[62]:
```python
# Calculate the Sharpe ratio
rf = 0.001
sharpe_ratio = (annualized_return - rf) / vol_port
print(sharpe_ratio)
```

```
0.2950049998055262
```

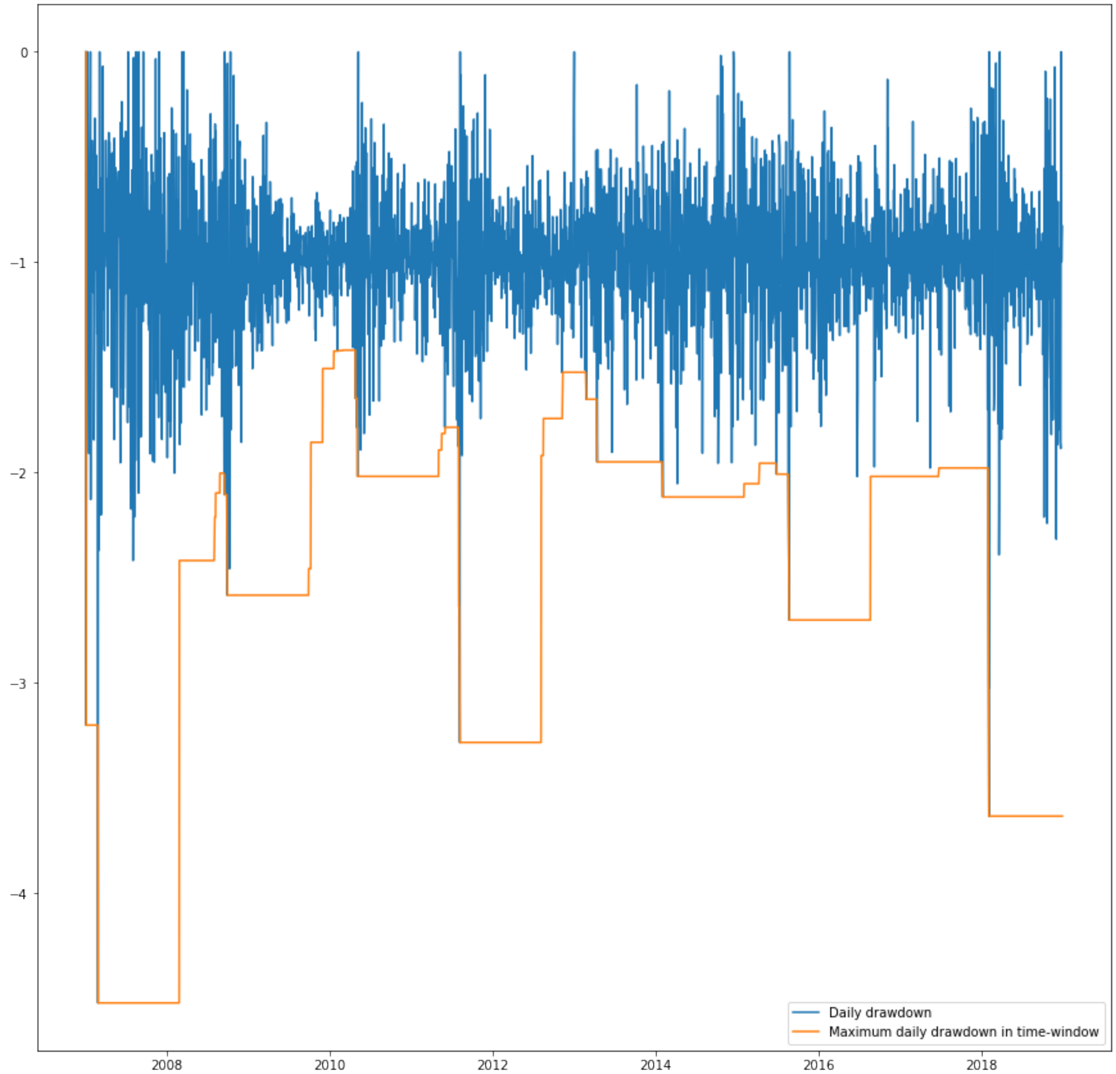
[51]:
```python
# Create a downside return column with the negative returns only
target = 0
downside_returns = returns.loc[returns['Portfolio'] < target]

# Calculate expected return and std dev of downside
expected_return = returns['Portfolio'].mean()
down_stdev = downside_returns.std()

# Calculate the sortino ratio
rf = 0.01
sortino_ratio = (expected_return - rf)/down_stdev

# Print the results
print("Expected return: ", expected_return*100)
print('-' * 50)
print("Downside risk:")
print(down_stdev*100)
print('-' * 50)
print("Sortino ratio:")
print(sortino_ratio)
```

```
Expected return:  0.031696714222425024
--------------------------------------------------
```

```
Downside risk:
^DJI         0.968455
^GSPC        1.040483
^IXIC        1.083221
^RUT         1.231423
Portfolio    1.038719
dtype: float64
--------------------------------------------------
Sortino ratio:
^DJI        -0.999843
^GSPC       -0.930628
^IXIC       -0.893911
^RUT        -0.786329
Portfolio   -0.932209
dtype: float64
```

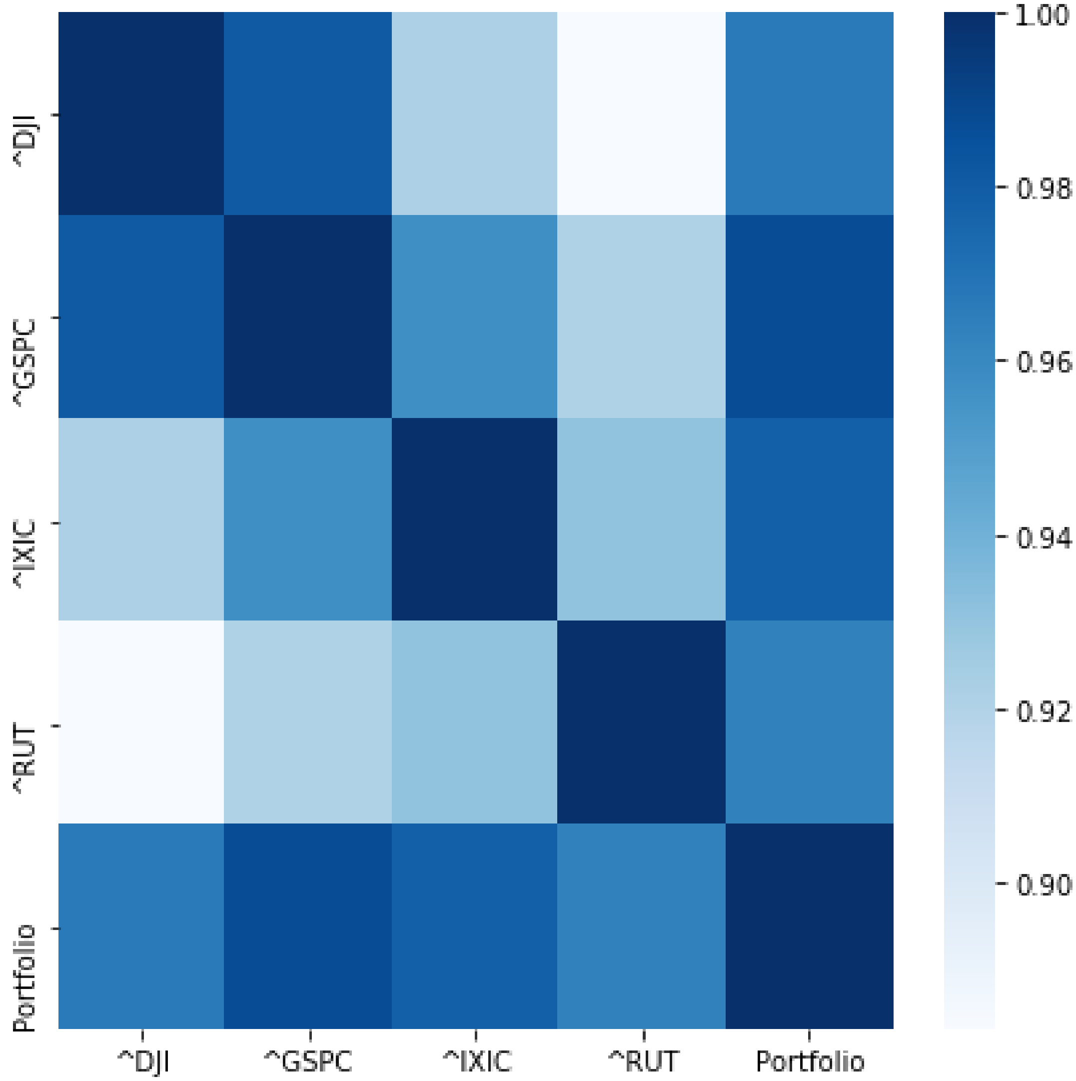
[52]:

```
# Calculate the max value
roll_max = returns['Portfolio'].rolling(center=False,min_periods=1,window=252).
↪max()

# Calculate the daily draw-down relative to the max
daily_draw_down = returns['Portfolio']/roll_max - 1.0

# Calculate the minimum (negative) daily draw-down
max_daily_draw_down = daily_draw_down.
↪rolling(center=False,min_periods=1,window=252).min()

# Plot the results
plt.figure(figsize=(15,15))
plt.plot(returns.index, daily_draw_down, label='Daily drawdown')
plt.plot(returns.index, max_daily_draw_down, label='Maximum daily drawdown in␣
↪time-window')
plt.legend()
plt.show()
```



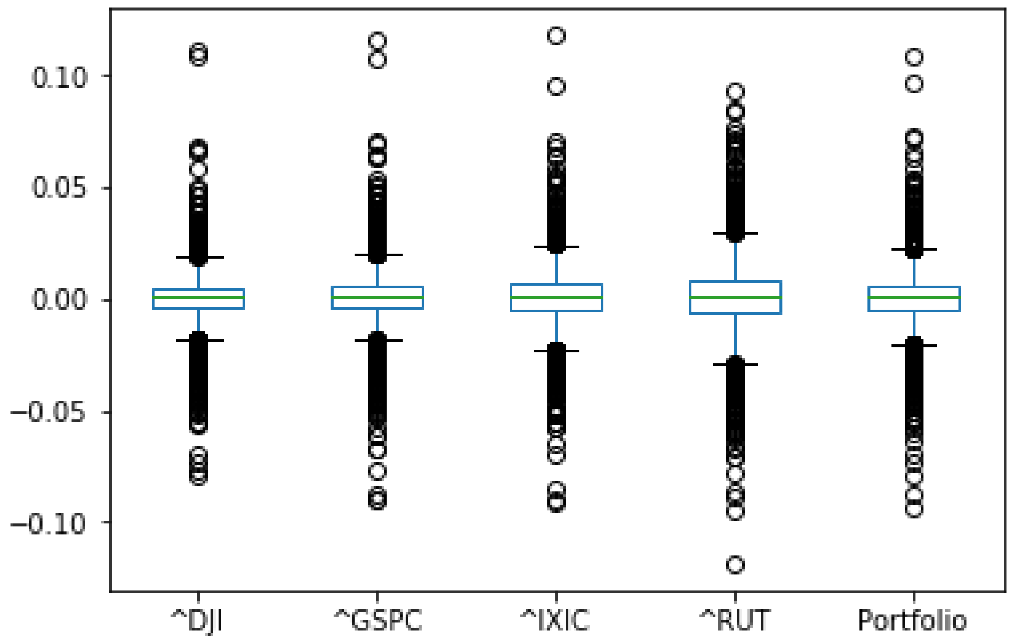
[53]:
```
plt.figure(figsize=(7,7))
corr = returns.corr()

# plot the heatmap
sns.heatmap(corr,
        xticklabels=corr.columns,
        yticklabels=corr.columns,
            cmap="Blues")
```

[53]: <matplotlib.axes._subplots.AxesSubplot at 0x1ec62cb2438>

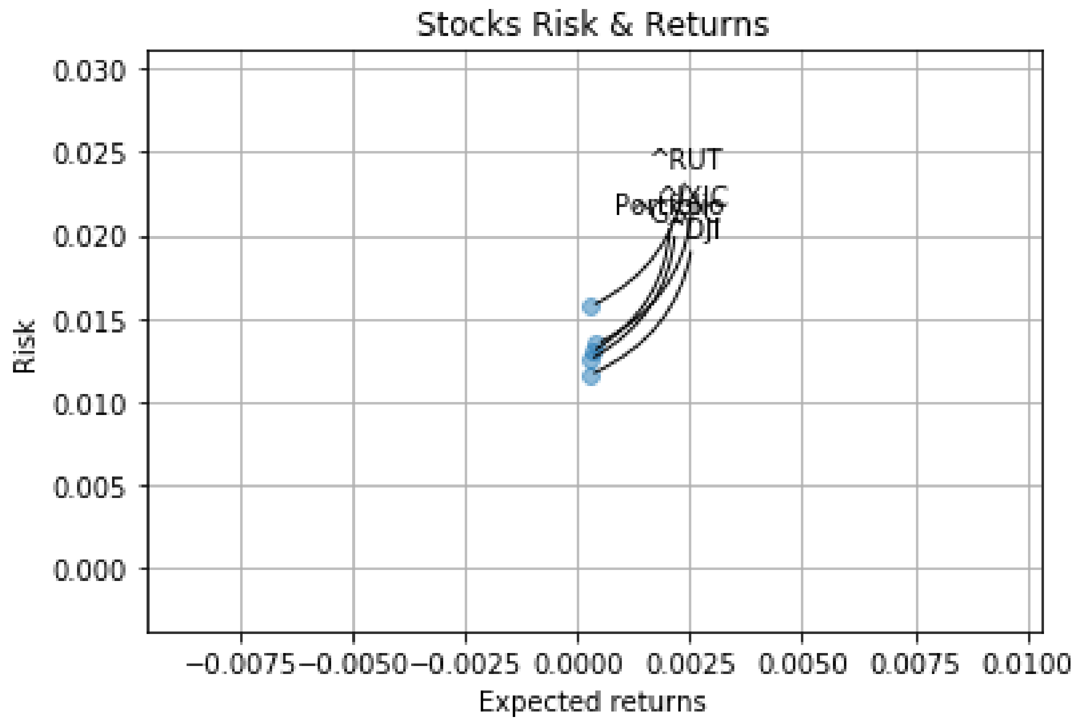


[54]:
```
# Box plot
returns.plot(kind='box')
```

[54]: <matplotlib.axes._subplots.AxesSubplot at 0x1ec6329dcf8>



[55]:
```
rets = returns.dropna()

plt.scatter(rets.mean(), rets.std(),alpha = 0.5)

plt.title('Stocks Risk & Returns')
plt.xlabel('Expected returns')
plt.ylabel('Risk')
plt.grid(which='major')

for label, x, y in zip(rets.columns, rets.mean(), rets.std()):
    plt.annotate(
        label,
        xy = (x, y), xytext = (50, 50),
        textcoords = 'offset points', ha = 'right', va = 'bottom',
        arrowprops = dict(arrowstyle = '-', connectionstyle = 'arc3,rad=-0.3'))
```



[63]:

```
area = np.pi*20.0

sns.set(style='darkgrid')
plt.figure(figsize=(12,8))
plt.scatter(rets.mean(), rets.std(), s=area)
plt.xlabel("Expected Return", fontsize=15)
plt.ylabel("Risk", fontsize=15)
plt.title("Return vs. Risk for Market Index", fontsize=20)

for label, x, y in zip(rets.columns, rets.mean(), rets.std()) :
    plt.annotate(label, xy=(x,y), xytext=(50, 0), textcoords='offset points',
                 arrowprops=dict(arrowstyle='-',␣
 ↪connectionstyle='bar,angle=180,fraction=-0.2'),
                 bbox=dict(boxstyle="round", fc="w"))
```

[57]:
```
table = pd.DataFrame()
table['Returns'] = rets.mean()
table['Risk'] = rets.std()
table.sort_values(by='Returns')
```

[57]:

	Returns	Risk
^GSPC	0.000267	0.012487
^DJI	0.000275	0.011592
^RUT	0.000302	0.015714
Portfolio	0.000317	0.012959
^IXIC	0.000424	0.013446

[58]:
```
table.sort_values(by='Risk')
```

[58]:

	Returns	Risk
^DJI	0.000275	0.011592
^GSPC	0.000267	0.012487
Portfolio	0.000317	0.012959
^IXIC	0.000424	0.013446
^RUT	0.000302	0.015714

[59]:
```
rf = 0.001
table['Sharpe_Ratio'] = ((table['Returns'] - rf) / table['Risk']) * np.sqrt(252)
```

```python
table
```

[59]:

	Returns	Risk	Sharpe_Ratio
^DJI	0.000275	0.011592	-0.993474
^GSPC	0.000267	0.012487	-0.931663
^IXIC	0.000424	0.013446	-0.679756
^RUT	0.000302	0.015714	-0.705175
Portfolio	0.000317	0.012959	-0.836695