Vaccine_Portfolio

September 29, 2021

1 Pharmaceutical Companies Racing for Vaccine Portfolio Risk and Returns (Coronavirus)

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

import warnings
warnings.filterwarnings("ignore")

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

[2]:
```python
# input
# Pharmaceutical Companie Vanccine
symbols = ['MRNA','INO','NVAX','GILD','JNJ','PFE','SNY','GSK']
start = '2019-12-01'
end = '2020-04-20'
```

[3]:
```python
df = pd.DataFrame()
for s in symbols:
    df[s] = yf.download(s,start,end)['Adj Close']
```

```
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```

[4]:
```python
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?
0 years
```

[5]:
```
number_of_years = delta.years
```

[6]:
```
days = (df.index[-1] - df.index[0]).days
days
```

[6]:
```
137
```

[7]:
```
df.head()
```

[7]:
```
                 MRNA   INO  NVAX       GILD         JNJ        PFE  \
Date
2019-12-02  19.760000  2.51  5.22  64.901039  136.489655  37.902821
2019-12-03  21.280001  2.55  4.77  64.851959  136.290924  37.665249
2019-12-04  21.270000  2.47  4.88  65.519424  138.496857  37.754337
2019-12-05  20.639999  2.33  4.55  64.714546  138.675705  37.645451
2019-12-06  18.940001  2.38  4.35  65.843346  139.490524  37.902821

                  SNY        GSK
Date
2019-12-02  45.820000  44.344246
2019-12-03  45.549999  44.067894
2019-12-04  46.610001  44.482418
2019-12-05  46.080002  44.620594
2019-12-06  46.029999  44.916679
```

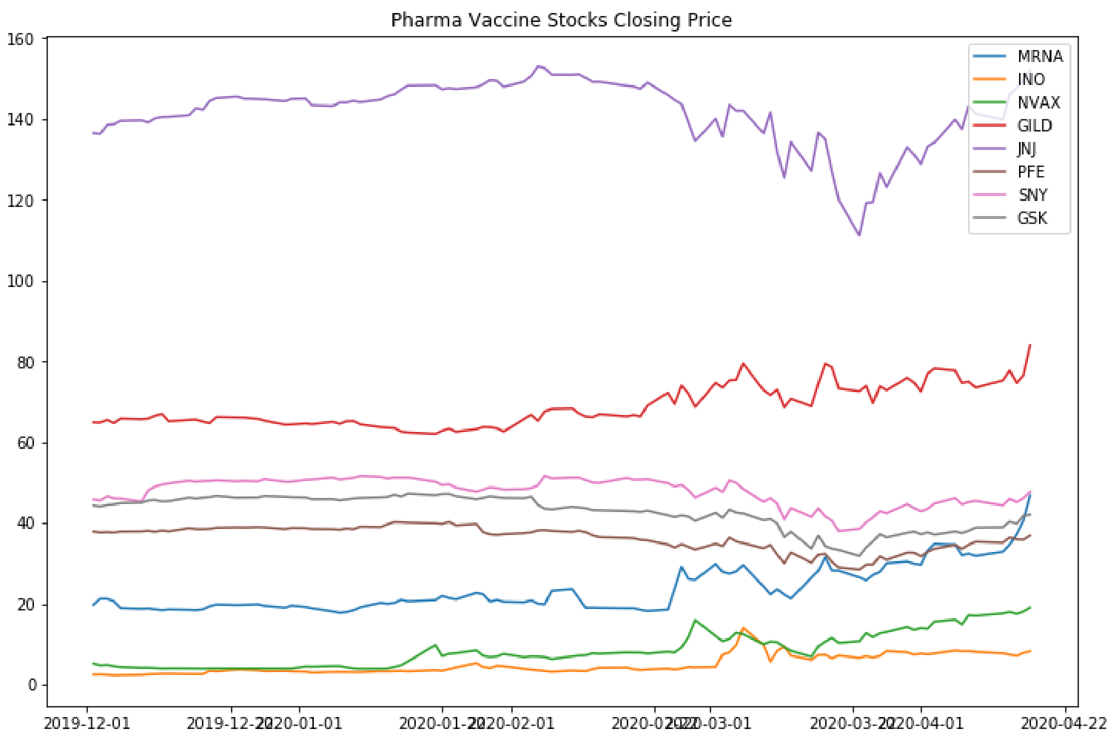
[8]:
```
df.tail()
```

[8]:
```
                 MRNA   INO       NVAX       GILD         JNJ        PFE  \
Date
2020-04-13  32.900002  7.76  17.639999  75.279999  139.770004  35.139999
2020-04-14  34.660000  7.44  18.000000  77.750000  146.029999  36.439999
2020-04-15  37.250000  7.14  17.530001  74.629997  147.660004  35.970001
2020-04-16  40.599998  7.89  18.100000  76.540001  149.669998  35.880001
2020-04-17  46.849998  8.26  19.080000  83.989998  152.020004  36.910000

                  SNY        GSK
Date
```

```
2020-04-13  44.380001  38.939999
2020-04-14  45.970001  40.380001
2020-04-15  45.150002  39.820000
2020-04-16  46.130001  41.799999
2020-04-17  47.750000  42.070000
```

[9]:
```
plt.figure(figsize=(12,8))
plt.plot(df)
plt.title('Pharma Vaccine Stocks Closing Price')
plt.legend(labels=df.columns)
```

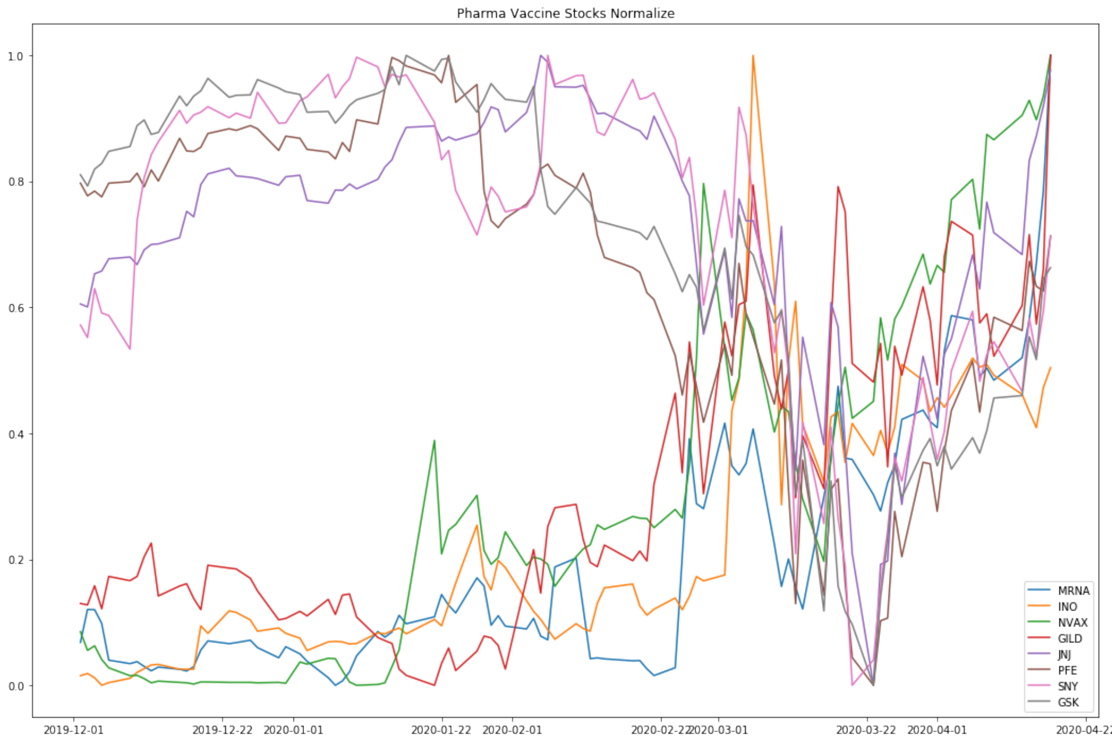
[9]: `<matplotlib.legend.Legend at 0x29458c66ef0>`



[10]:
```
# Normalize the data
normalize = (df - df.min())/ (df.max() - df.min())
```

[11]:
```
plt.figure(figsize=(18,12))
plt.plot(normalize)
plt.title('Pharma Vaccine Stocks Normalize')
plt.legend(labels=normalize.columns)
```

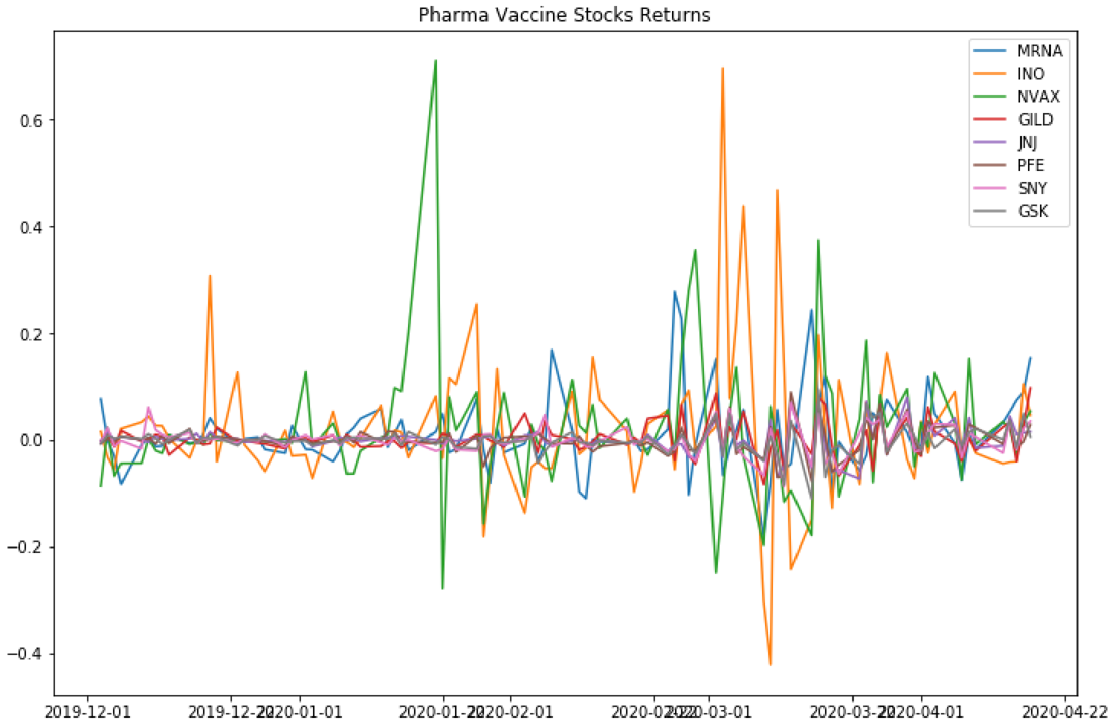
[11]: `<matplotlib.legend.Legend at 0x29458cdffd0>`



[12]:
```
stock_rets = df.pct_change().dropna()
```

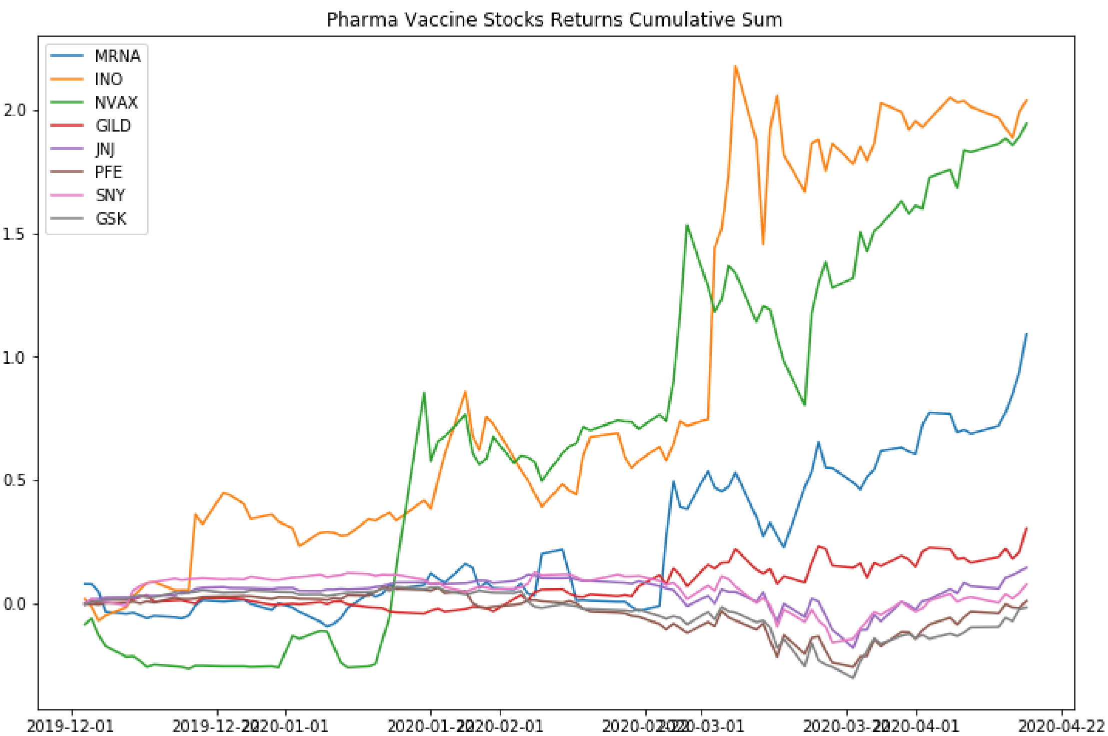
[13]:
```
plt.figure(figsize=(12,8))
plt.plot(stock_rets)
plt.title('Pharma Vaccine Stocks Returns')
plt.legend(labels=stock_rets.columns)
```

[13]: <matplotlib.legend.Legend at 0x29458d3fbe0>

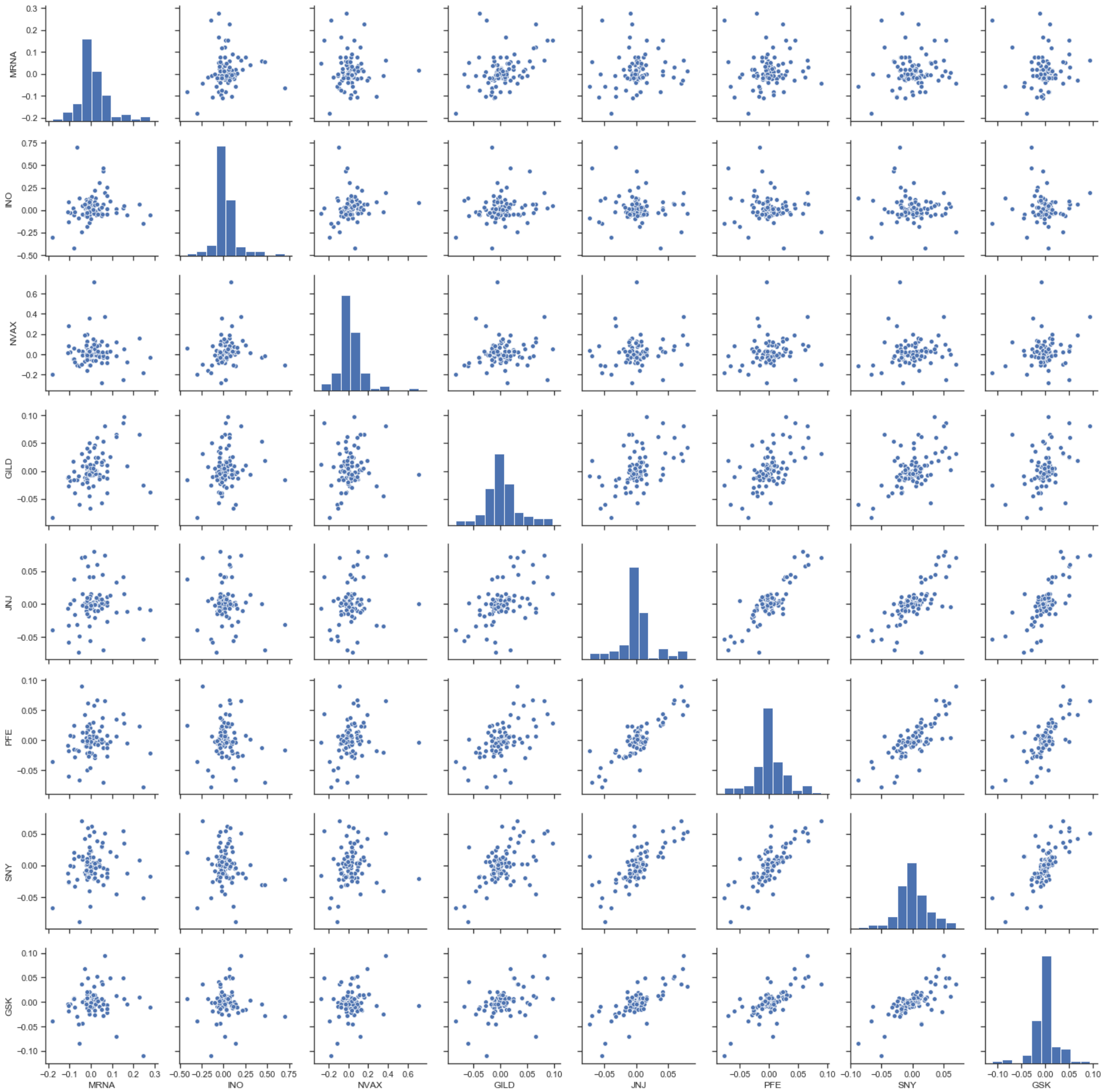


[14]:
```python
plt.figure(figsize=(12,8))
plt.plot(stock_rets.cumsum())
plt.title('Pharma Vaccine Stocks Returns Cumulative Sum')
plt.legend(labels=stock_rets.columns)
```

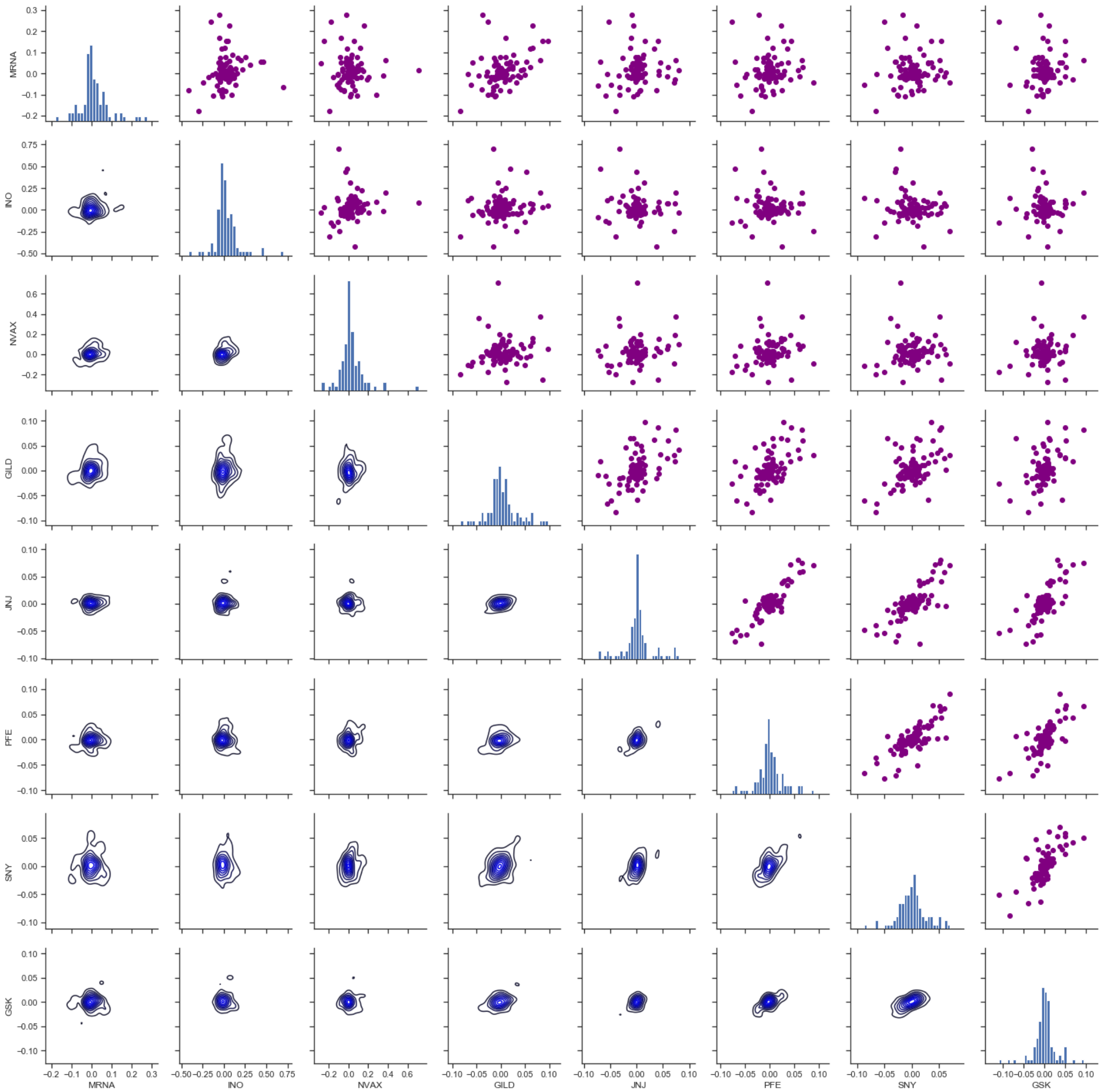
[14]: <matplotlib.legend.Legend at 0x29458da27f0>



[15]:
```
sns.set(style='ticks')
ax = sns.pairplot(stock_rets, diag_kind='hist')

nplot = len(stock_rets.columns)
for i in range(nplot) :
    for j in range(nplot) :
        ax.axes[i, j].locator_params(axis='x', nbins=6, tight=True)
```

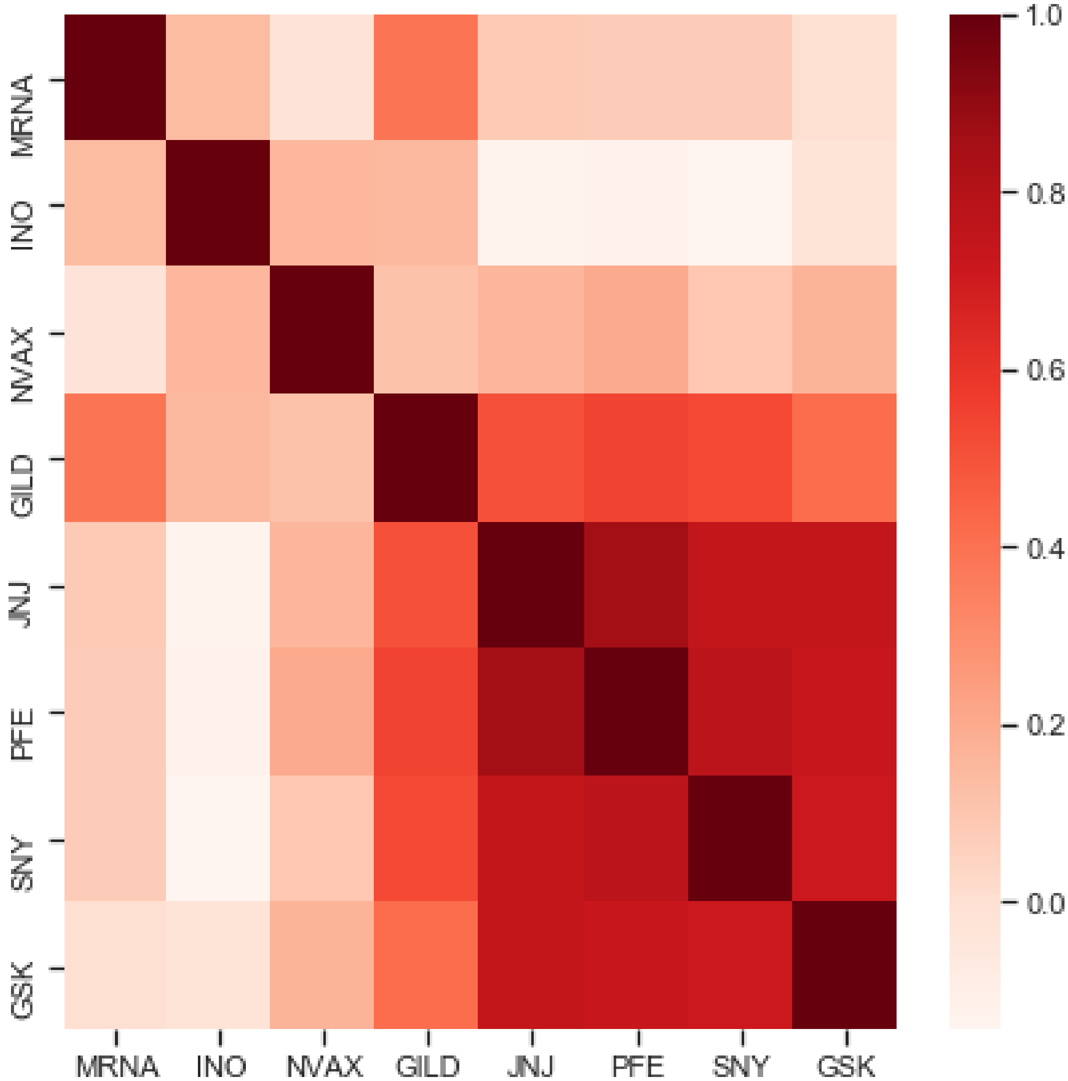


[16]:
```
ax = sns.PairGrid(stock_rets)
ax.map_upper(plt.scatter, color='purple')
ax.map_lower(sns.kdeplot, color='blue')
ax.map_diag(plt.hist, bins=30)
for i in range(nplot) :
    for j in range(nplot) :
        ax.axes[i, j].locator_params(axis='x', nbins=6, tight=True)
```



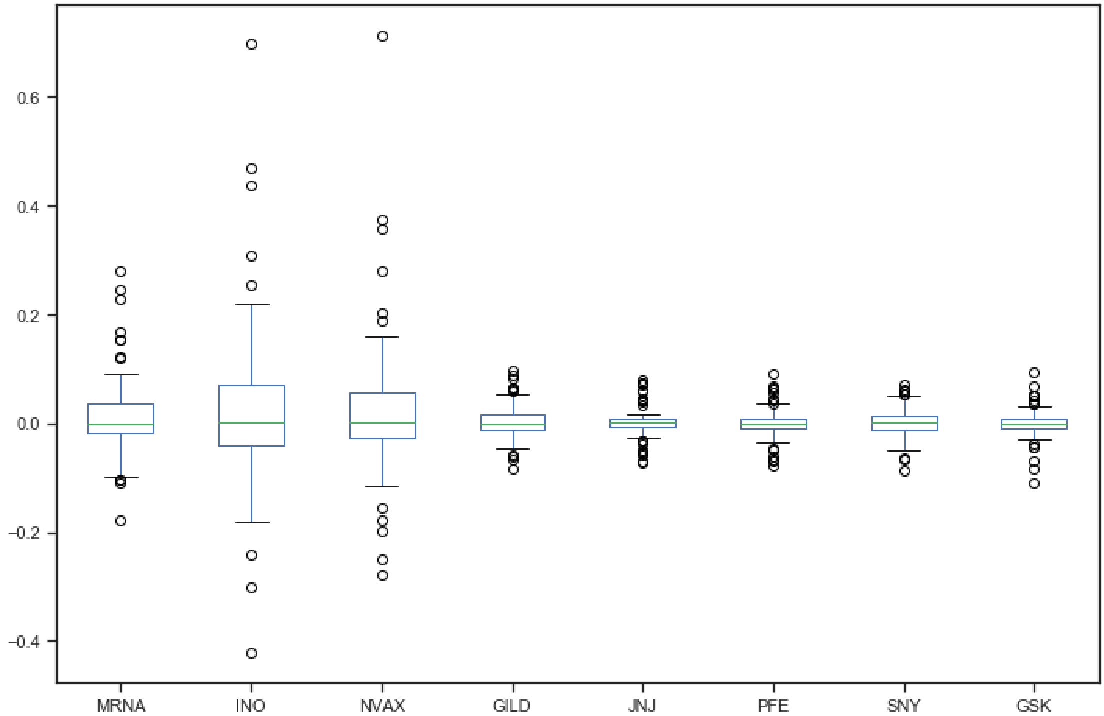

```
[17]: plt.figure(figsize=(7,7))
      corr = stock_rets.corr()

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

```
[17]: <matplotlib.axes._subplots.AxesSubplot at 0x2945c523668>
```

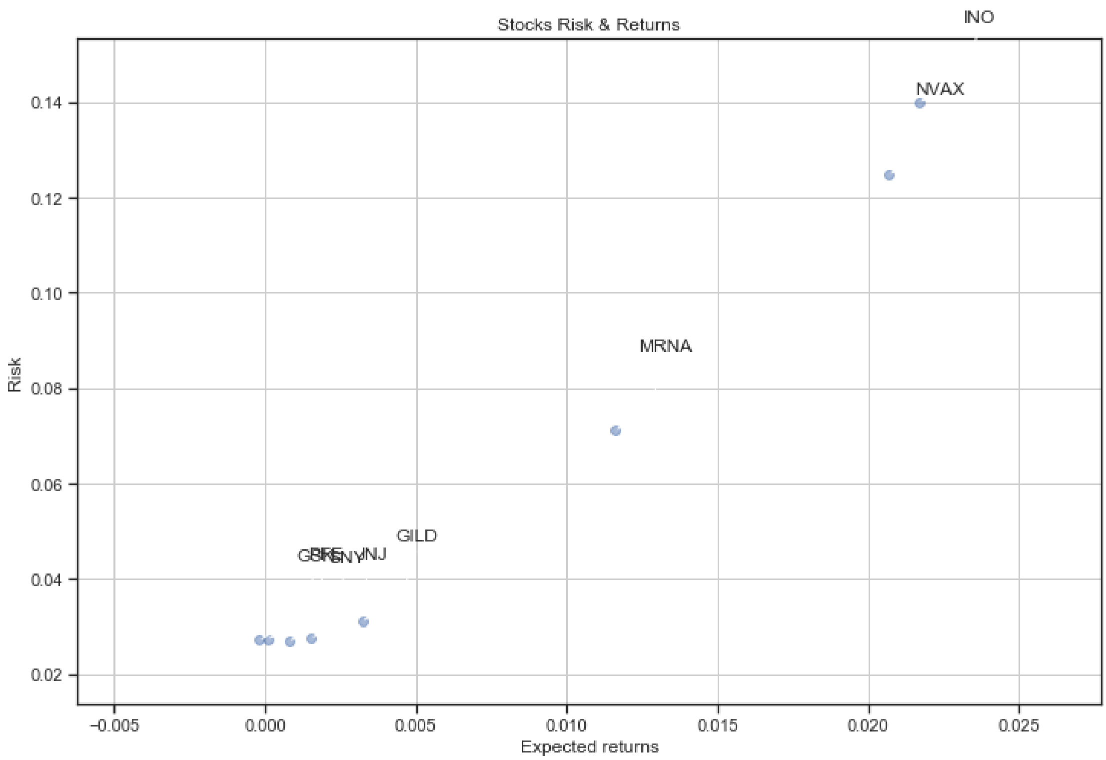



```
[18]: # Box plot
      stock_rets.plot(kind='box',figsize=(12,8))
```

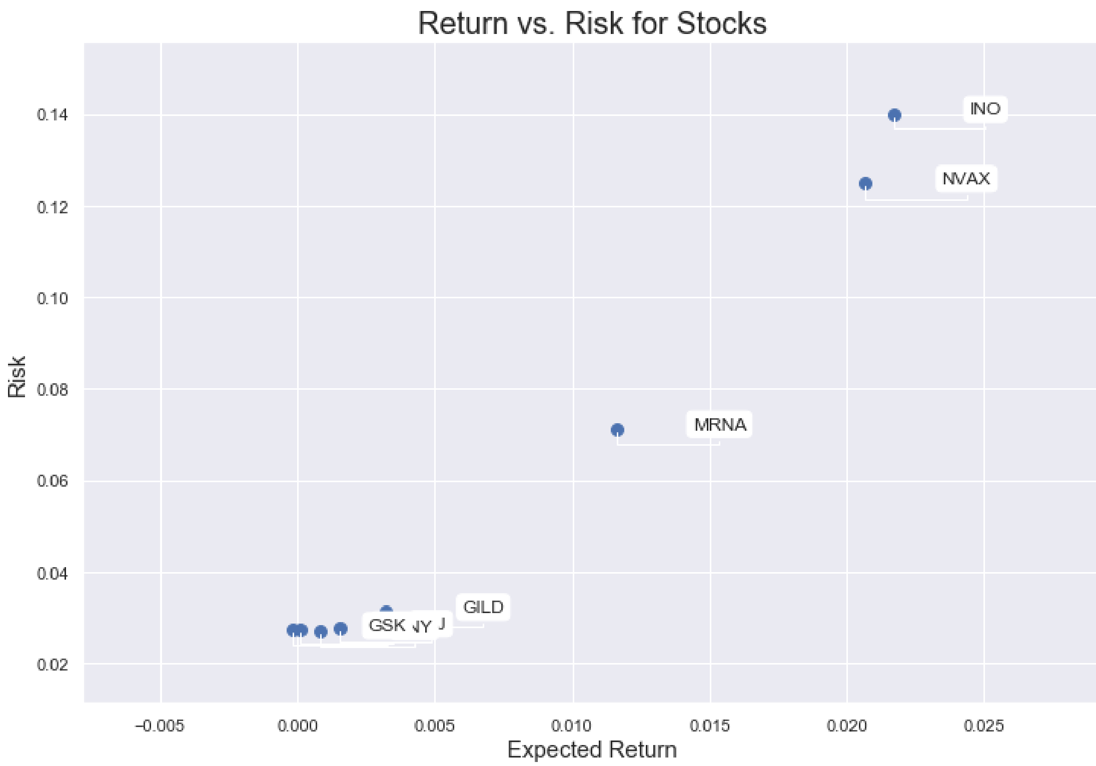
```
[18]: <matplotlib.axes._subplots.AxesSubplot at 0x294606bb2b0>
```



[19]:
```
rets = stock_rets.dropna()

plt.figure(figsize=(12,8))
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'))
```



[20]:
```
rets = stock_rets.dropna()
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 Stocks", 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"))
```



[21]:
```
rest_rets = rets.corr()
pair_value = rest_rets.abs().unstack()
pair_value.sort_values(ascending = False)
```

[21]:
```
GSK   GSK     1.000000
SNY   SNY     1.000000
INO   INO     1.000000
NVAX  NVAX    1.000000
GILD  GILD    1.000000
JNJ   JNJ     1.000000
PFE   PFE     1.000000
MRNA  MRNA    1.000000
PFE   JNJ     0.861104
JNJ   PFE     0.861104
PFE   SNY     0.773973
SNY   PFE     0.773973
GSK   JNJ     0.748842
JNJ   GSK     0.748842
      SNY     0.741214
SNY   JNJ     0.741214
PFE   GSK     0.724004
GSK   PFE     0.724004
      SNY     0.718149
```

```
SNY   GSK    0.718149
GILD  PFE    0.548195
PFE   GILD   0.548195
SNY   GILD   0.530566
GILD  SNY    0.530566
      JNJ    0.508266
JNJ   GILD   0.508266
GSK   GILD   0.415257
GILD  GSK    0.415257
MRNA  GILD   0.388209
GILD  MRNA   0.388209
               …
NVAX  JNJ    0.161689
JNJ   NVAX   0.161689
INO   NVAX   0.158875
NVAX  INO    0.158875
GILD  INO    0.148613
INO   GILD   0.148613
      SNY    0.143877
SNY   INO    0.143877
MRNA  INO    0.138433
INO   MRNA   0.138433
JNJ   INO    0.128131
INO   JNJ    0.128131
      PFE    0.121590
PFE   INO    0.121590
GILD  NVAX   0.119585
NVAX  GILD   0.119585
      SNY    0.095427
SNY   NVAX   0.095427
JNJ   MRNA   0.084960
MRNA  JNJ    0.084960
PFE   MRNA   0.076733
MRNA  PFE    0.076733
SNY   MRNA   0.075363
MRNA  SNY    0.075363
NVAX  MRNA   0.025567
MRNA  NVAX   0.025567
INO   GSK    0.022506
GSK   INO    0.022506
MRNA  GSK    0.000692
GSK   MRNA   0.000692
Length: 64, dtype: float64
```

[22]:
```
# Normalized Returns Data
Normalized_Value = ((rets[:] - rets[:].min()) /(rets[:].max() - rets[:].min()))
Normalized_Value.head()
```

[22]:
```
                MRNA       INO      NVAX      GILD       JNJ       PFE  \
Date
2019-12-03  0.560520  0.390338  0.193969  0.457627  0.467620  0.425739
2019-12-04  0.391456  0.347992  0.304473  0.518717  0.582954  0.477449
2019-12-05  0.327780  0.325339  0.212763  0.393884  0.485582  0.446007
2019-12-06  0.212560  0.395282  0.236698  0.558254  0.515552  0.504231
2019-12-09  0.374029  0.406161  0.236979  0.449443  0.482727  0.467975

                 SNY       GSK
Date
2019-12-03  0.519081  0.508605
2019-12-04  0.704538  0.584934
2019-12-05  0.484243  0.554183
2019-12-06  0.549652  0.571410
2019-12-09  0.455701  0.551892
```

[23]:
```python
Normalized_Value.corr()
```

[23]:
```
          MRNA       INO      NVAX      GILD       JNJ       PFE       SNY  \
MRNA  1.000000  0.138433 -0.025567  0.388209  0.084960  0.076733  0.075363
INO   0.138433  1.000000  0.158875  0.148613 -0.128131 -0.121590 -0.143877
NVAX -0.025567  0.158875  1.000000  0.119585  0.161689  0.201658  0.095427
GILD  0.388209  0.148613  0.119585  1.000000  0.508266  0.548195  0.530566
JNJ   0.084960 -0.128131  0.161689  0.508266  1.000000  0.861104  0.741214
PFE   0.076733 -0.121590  0.201658  0.548195  0.861104  1.000000  0.773973
SNY   0.075363 -0.143877  0.095427  0.530566  0.741214  0.773973  1.000000
GSK  -0.000692 -0.022506  0.168451  0.415257  0.748842  0.724004  0.718149

           GSK
MRNA -0.000692
INO  -0.022506
NVAX  0.168451
GILD  0.415257
JNJ   0.748842
PFE   0.724004
SNY   0.718149
GSK   1.000000
```

[24]:
```python
normalized_rets = Normalized_Value.corr()
normalized_pair_value = normalized_rets.abs().unstack()
normalized_pair_value.sort_values(ascending = False)
```

[24]:
```
GSK   GSK     1.000000
SNY   SNY     1.000000
INO   INO     1.000000
NVAX  NVAX    1.000000
GILD  GILD    1.000000
```

JNJ	JNJ	1.000000
PFE	PFE	1.000000
MRNA	MRNA	1.000000
PFE	JNJ	0.861104
JNJ	PFE	0.861104
PFE	SNY	0.773973
SNY	PFE	0.773973
GSK	JNJ	0.748842
JNJ	GSK	0.748842
	SNY	0.741214
SNY	JNJ	0.741214
PFE	GSK	0.724004
GSK	PFE	0.724004
	SNY	0.718149
SNY	GSK	0.718149
GILD	PFE	0.548195
PFE	GILD	0.548195
SNY	GILD	0.530566
GILD	SNY	0.530566
	JNJ	0.508266
JNJ	GILD	0.508266
GSK	GILD	0.415257
GILD	GSK	0.415257
MRNA	GILD	0.388209
GILD	MRNA	0.388209
		…
NVAX	JNJ	0.161689
JNJ	NVAX	0.161689
INO	NVAX	0.158875
NVAX	INO	0.158875
GILD	INO	0.148613
INO	GILD	0.148613
	SNY	0.143877
SNY	INO	0.143877
MRNA	INO	0.138433
INO	MRNA	0.138433
JNJ	INO	0.128131
INO	JNJ	0.128131
	PFE	0.121590
PFE	INO	0.121590
GILD	NVAX	0.119585
NVAX	GILD	0.119585
	SNY	0.095427
SNY	NVAX	0.095427
JNJ	MRNA	0.084960
MRNA	JNJ	0.084960
PFE	MRNA	0.076733

```
MRNA  PFE     0.076733
SNY   MRNA    0.075363
MRNA  SNY     0.075363
NVAX  MRNA    0.025567
MRNA  NVAX    0.025567
INO   GSK     0.022506
GSK   INO     0.022506
MRNA  GSK     0.000692
GSK   MRNA    0.000692
Length: 64, dtype: float64
```

[25]:
```
print("Stock returns: ")
print(rets.mean())
print('-' * 50)
print("Stock risks:")
print(rets.std())
```

```
Stock returns:
MRNA    0.011607
INO     0.021686
NVAX    0.020682
GILD    0.003224
JNJ     0.001522
PFE     0.000088
SNY     0.000800
GSK    -0.000191
dtype: float64
--------------------------------------------------
Stock risks:
MRNA    0.071217
INO     0.139997
NVAX    0.124842
GILD    0.031218
JNJ     0.027595
PFE     0.027393
SNY     0.026974
GSK     0.027188
dtype: float64
```

[26]:
```
table = pd.DataFrame()
table['Returns'] = rets.mean()
table['Risk'] = rets.std()
table.sort_values(by='Returns')
```

[26]:

	Returns	Risk
GSK	-0.000191	0.027188
PFE	0.000088	0.027393

```
SNY   0.000800  0.026974
JNJ   0.001522  0.027595
GILD  0.003224  0.031218
MRNA  0.011607  0.071217
NVAX  0.020682  0.124842
INO   0.021686  0.139997
```

[27]:
```
table.sort_values(by='Risk')
```

[27]:
```
       Returns      Risk
SNY   0.000800  0.026974
GSK  -0.000191  0.027188
PFE   0.000088  0.027393
JNJ   0.001522  0.027595
GILD  0.003224  0.031218
MRNA  0.011607  0.071217
NVAX  0.020682  0.124842
INO   0.021686  0.139997
```

[28]:
```
rf = 0.01
table['Sharpe Ratio'] = (table['Returns'] - rf) / table['Risk']
table
```

[28]:
```
       Returns      Risk  Sharpe Ratio
MRNA  0.011607  0.071217      0.022566
INO   0.021686  0.139997      0.083475
NVAX  0.020682  0.124842      0.085561
GILD  0.003224  0.031218     -0.217069
JNJ   0.001522  0.027595     -0.307241
PFE   0.000088  0.027393     -0.361833
SNY   0.000800  0.026974     -0.341075
GSK  -0.000191  0.027188     -0.374827
```

[29]:
```
table['Max Returns'] = rets.max()
```

[30]:
```
table['Min Returns'] = rets.min()
```

[31]:
```
table['Median Returns'] = rets.median()
```

[32]:
```
total_return = stock_rets[-1:].transpose()
table['Total Return'] = 100 * total_return
table
```

[32]:
```
       Returns      Risk  Sharpe Ratio  Max Returns  Min Returns  \
MRNA  0.011607  0.071217      0.022566     0.278107    -0.179669
INO   0.021686  0.139997      0.083475     0.697039    -0.420142
NVAX  0.020682  0.124842      0.085561     0.710801    -0.278004
```

```
GILD  0.003224  0.031218     -0.217069     0.097335    -0.083520
JNJ   0.001522  0.027595     -0.307241     0.079977    -0.072984
PFE   0.000088  0.027393     -0.361833     0.089607    -0.077346
SNY   0.000800  0.026974     -0.341075     0.069733    -0.087520
GSK  -0.000191  0.027188     -0.374827     0.094446    -0.110436

      Median Returns  Total Return
MRNA       -0.001416     15.394089
INO         0.003205      4.689485
NVAX        0.001202      5.414362
GILD       -0.000844      9.733469
JNJ         0.000477      1.570125
PFE        -0.001499      2.870677
SNY         0.001084      3.511812
GSK         0.000322      0.645934
```

[33]:
```python
table['Average Return Days'] = (1 + total_return)**(1 / days) - 1
table
```

[33]:
```
       Returns      Risk  Sharpe Ratio  Max Returns  Min Returns  \
MRNA  0.011607  0.071217      0.022566     0.278107    -0.179669
INO   0.021686  0.139997      0.083475     0.697039    -0.420142
NVAX  0.020682  0.124842      0.085561     0.710801    -0.278004
GILD  0.003224  0.031218     -0.217069     0.097335    -0.083520
JNJ   0.001522  0.027595     -0.307241     0.079977    -0.072984
PFE   0.000088  0.027393     -0.361833     0.089607    -0.077346
SNY   0.000800  0.026974     -0.341075     0.069733    -0.087520
GSK  -0.000191  0.027188     -0.374827     0.094446    -0.110436

      Median Returns  Total Return  Average Return Days
MRNA       -0.001416     15.394089             0.001046
INO         0.003205      4.689485             0.000335
NVAX        0.001202      5.414362             0.000385
GILD       -0.000844      9.733469             0.000678
JNJ         0.000477      1.570125             0.000114
PFE        -0.001499      2.870677             0.000207
SNY         0.001084      3.511812             0.000252
GSK         0.000322      0.645934             0.000047
```

[34]:
```python
initial_value = df.iloc[0]
ending_value = df.iloc[-1]
table['CAGR'] = ((ending_value / initial_value) ** (252.0 / days)) -1
table
```

[34]:
```
       Returns      Risk  Sharpe Ratio  Max Returns  Min Returns  \
MRNA  0.011607  0.071217      0.022566     0.278107    -0.179669
INO   0.021686  0.139997      0.083475     0.697039    -0.420142
```

NVAX	0.020682	0.124842	0.085561	0.710801	-0.278004
GILD	0.003224	0.031218	-0.217069	0.097335	-0.083520
JNJ	0.001522	0.027595	-0.307241	0.079977	-0.072984
PFE	0.000088	0.027393	-0.361833	0.089607	-0.077346
SNY	0.000800	0.026974	-0.341075	0.069733	-0.087520
GSK	-0.000191	0.027188	-0.374827	0.094446	-0.110436

	Median Returns	Total Return	Average Return Days	CAGR
MRNA	-0.001416	15.394089	0.001046	3.893715
INO	0.003205	4.689485	0.000335	7.944202
NVAX	0.001202	5.414362	0.000385	9.849802
GILD	-0.000844	9.733469	0.000678	0.606831
JNJ	0.000477	1.570125	0.000114	0.219232
PFE	-0.001499	2.870677	0.000207	-0.047651
SNY	0.001084	3.511812	0.000252	0.078845
GSK	0.000322	0.645934	0.000047	-0.092300

[35]:
```python
table.sort_values(by='Average Return Days')
```

[35]:

	Returns	Risk	Sharpe Ratio	Max Returns	Min Returns	\
GSK	-0.000191	0.027188	-0.374827	0.094446	-0.110436	
JNJ	0.001522	0.027595	-0.307241	0.079977	-0.072984	
PFE	0.000088	0.027393	-0.361833	0.089607	-0.077346	
SNY	0.000800	0.026974	-0.341075	0.069733	-0.087520	
INO	0.021686	0.139997	0.083475	0.697039	-0.420142	
NVAX	0.020682	0.124842	0.085561	0.710801	-0.278004	
GILD	0.003224	0.031218	-0.217069	0.097335	-0.083520	
MRNA	0.011607	0.071217	0.022566	0.278107	-0.179669	

	Median Returns	Total Return	Average Return Days	CAGR
GSK	0.000322	0.645934	0.000047	-0.092300
JNJ	0.000477	1.570125	0.000114	0.219232
PFE	-0.001499	2.870677	0.000207	-0.047651
SNY	0.001084	3.511812	0.000252	0.078845
INO	0.003205	4.689485	0.000335	7.944202
NVAX	0.001202	5.414362	0.000385	9.849802
GILD	-0.000844	9.733469	0.000678	0.606831
MRNA	-0.001416	15.394089	0.001046	3.893715