Fuel_Cell_Portfolio

September 29, 2021

1 Fuel Cell Portfolio Risk and Returns

[2]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import math

import warnings
warnings.filterwarnings("ignore")

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

[3]:
```
# input
# 4 Fuel Cell
symbols = ['FCEL','PLUG','BLDP','BE']
start = '2019-01-01'
end = '2020-12-22'
```

[4]:
```
df = pd.DataFrame()
for s in symbols:
    df[s] = yf.download(s,start,end)['Adj Close']
```

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

[5]:
```
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?
1 years
```

[6]:
```
number_of_years = delta.years
```

[7]:
```
months = (d2.year - d1.year) * 12 + (d2.month - d1.month)
months
```

[7]:
```
23
```

[8]:
```
days = (df.index[-1] - df.index[0]).days
days
```

[8]:
```
719
```

[9]:
```
df.head()
```

[9]:

Date	FCEL	PLUG	BLDP	BE
2019-01-02	6.84	1.33	2.71	10.12
2019-01-03	6.60	1.26	2.77	10.47
2019-01-04	6.72	1.34	2.98	11.83
2019-01-07	6.96	1.53	3.17	12.41
2019-01-08	7.08	1.60	3.18	12.73

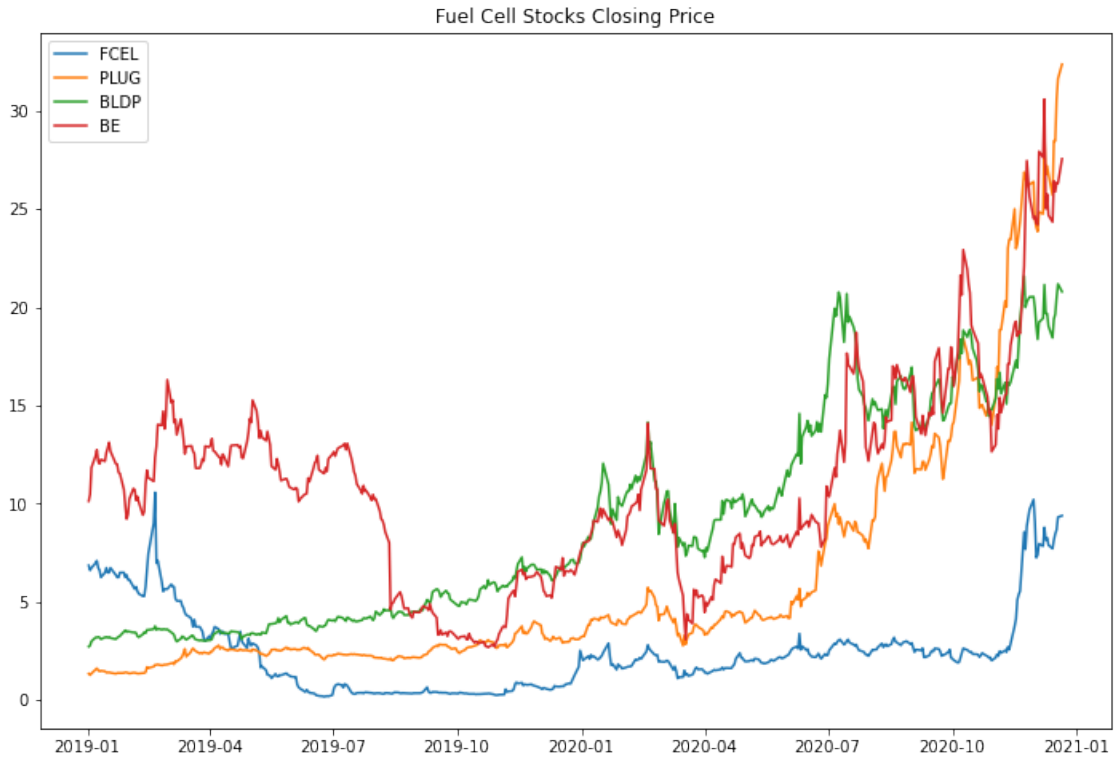
[10]:
```
df.tail()
```

[10]:

Date	FCEL	PLUG	BLDP	BE
2020-12-15	8.14	28.469999	19.389999	26.420000
2020-12-16	8.45	28.459999	19.639999	25.879999
2020-12-17	8.66	30.570000	20.480000	26.330000
2020-12-18	9.30	31.629999	21.180000	26.309999
2020-12-21	9.38	32.369999	20.790001	27.549999

[11]:
```
plt.figure(figsize=(12,8))
plt.plot(df)
plt.title('Fuel Cell Stocks Closing Price')
plt.legend(labels=df.columns)
```

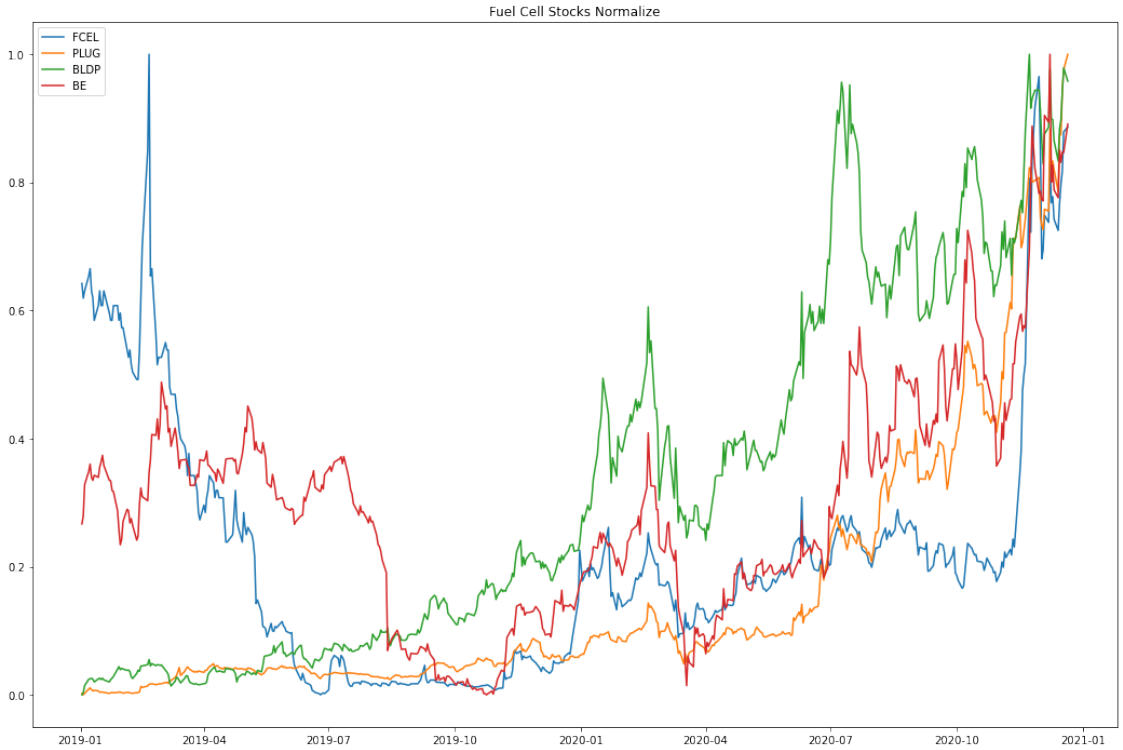
[11]:
```
<matplotlib.legend.Legend at 0x172d3ed8a58>
```



[12]:
```
# Normalize the data
normalize = (df - df.min())/ (df.max() - df.min())
```

[13]:
```
plt.figure(figsize=(18,12))
plt.plot(normalize)
plt.title('Fuel Cell Stocks Normalize')
plt.legend(labels=normalize.columns)
```

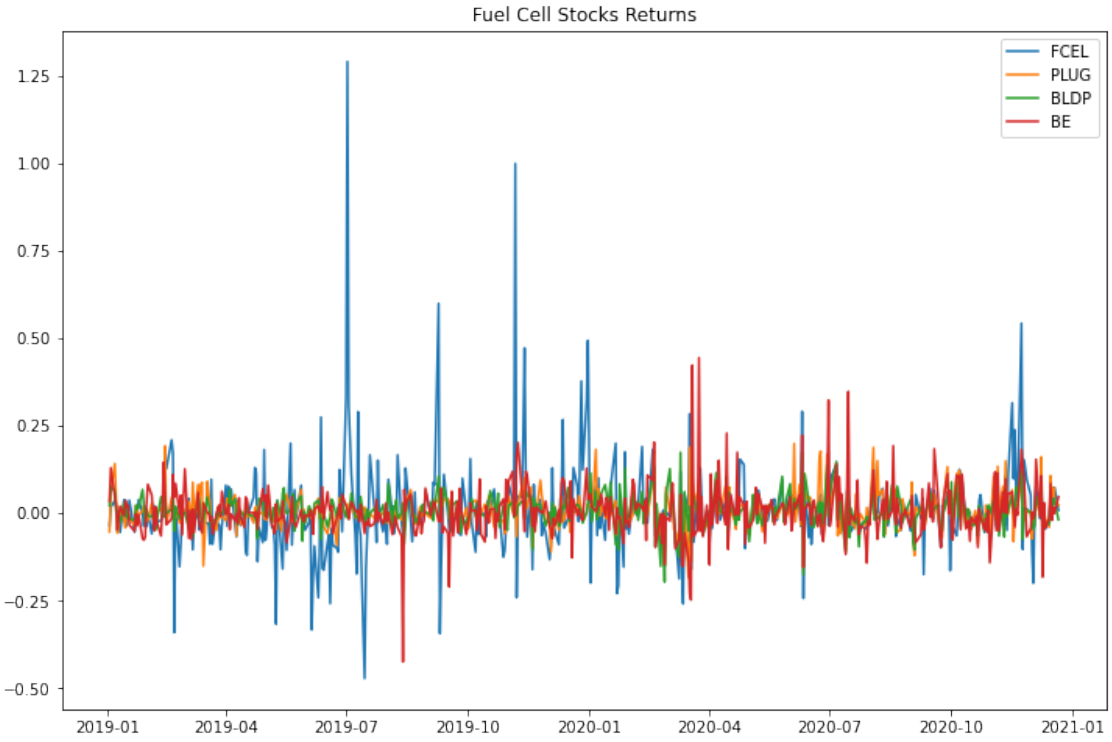
[13]:
```
<matplotlib.legend.Legend at 0x172d4634cc0>
```



[14]:
```
stock_rets = df.pct_change().dropna()
```

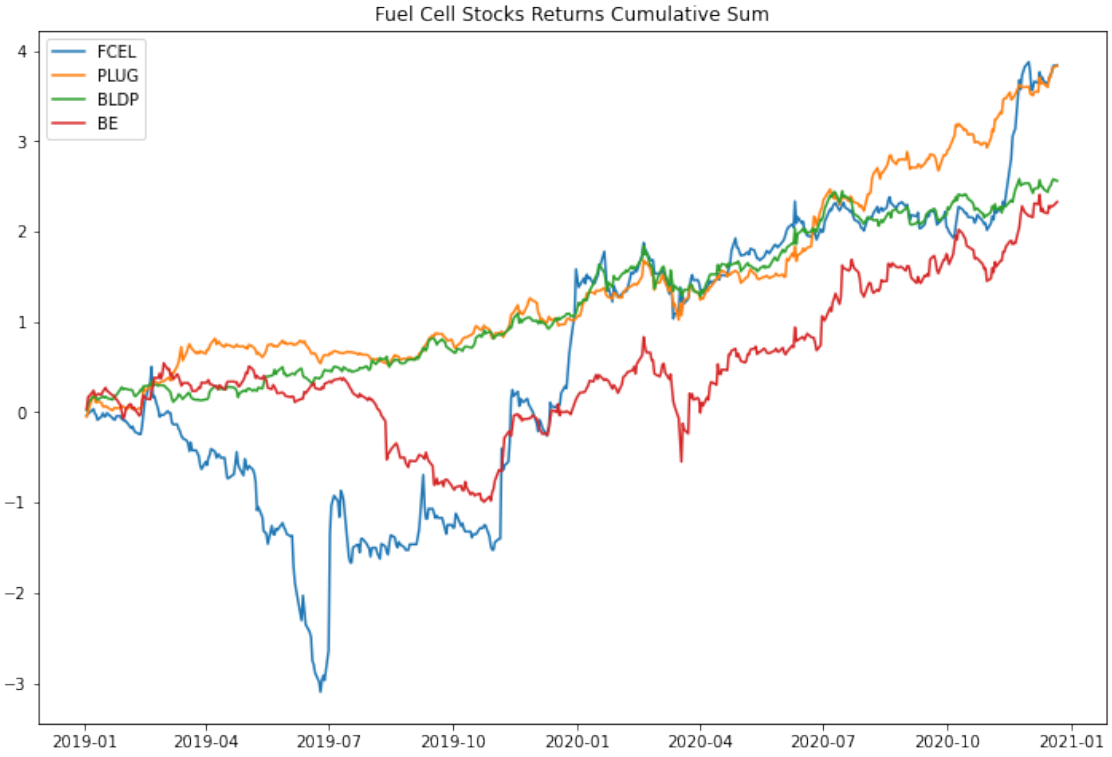
[15]:
```
plt.figure(figsize=(12,8))
plt.plot(stock_rets)
plt.title('Fuel Cell Stocks Returns')
plt.legend(labels=stock_rets.columns)
```

[15]: <matplotlib.legend.Legend at 0x172d3d80f60>

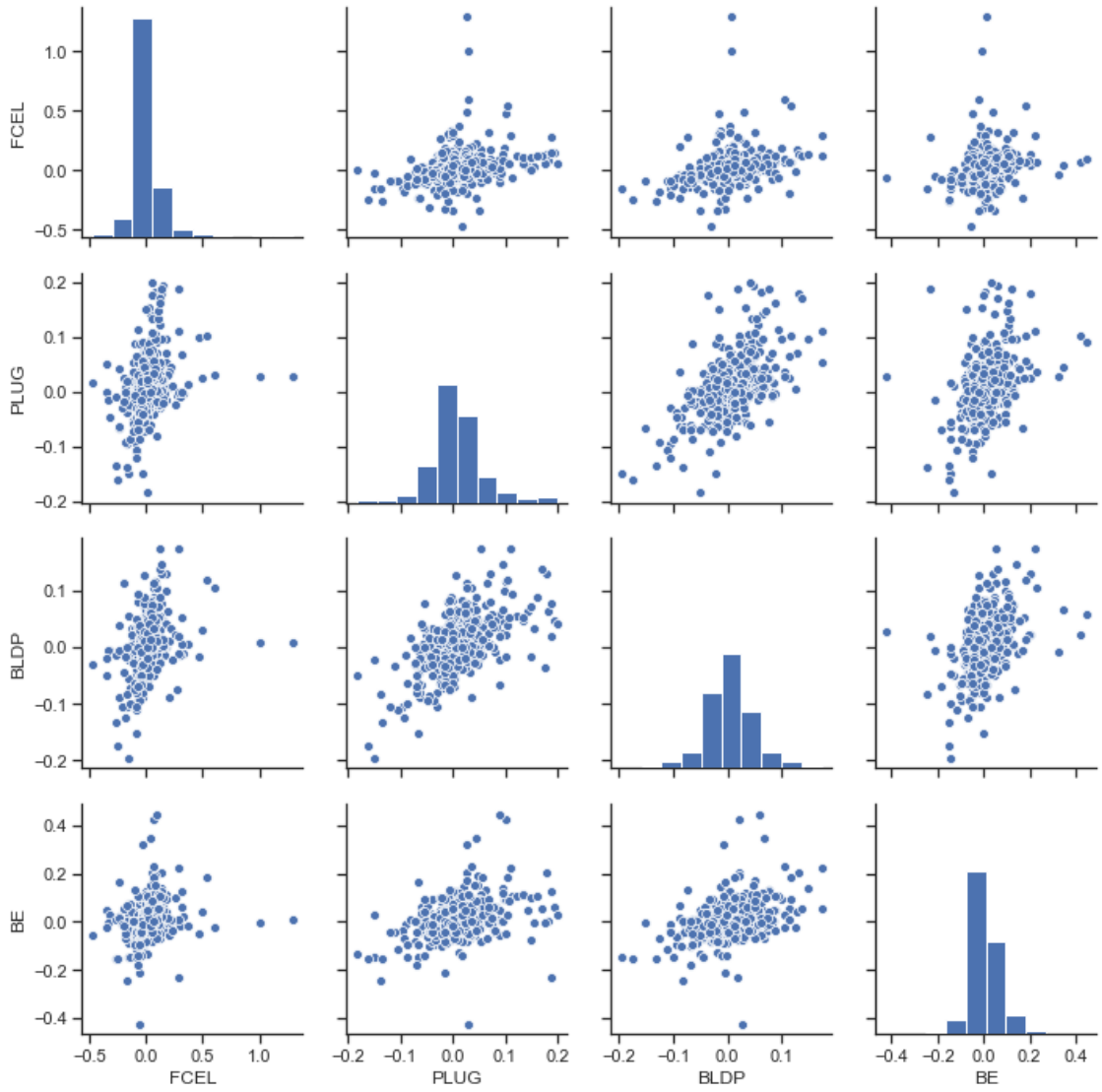


[16]:
```
plt.figure(figsize=(12,8))
plt.plot(stock_rets.cumsum())
plt.title('Fuel Cell Stocks Returns Cumulative Sum')
plt.legend(labels=stock_rets.columns)
```

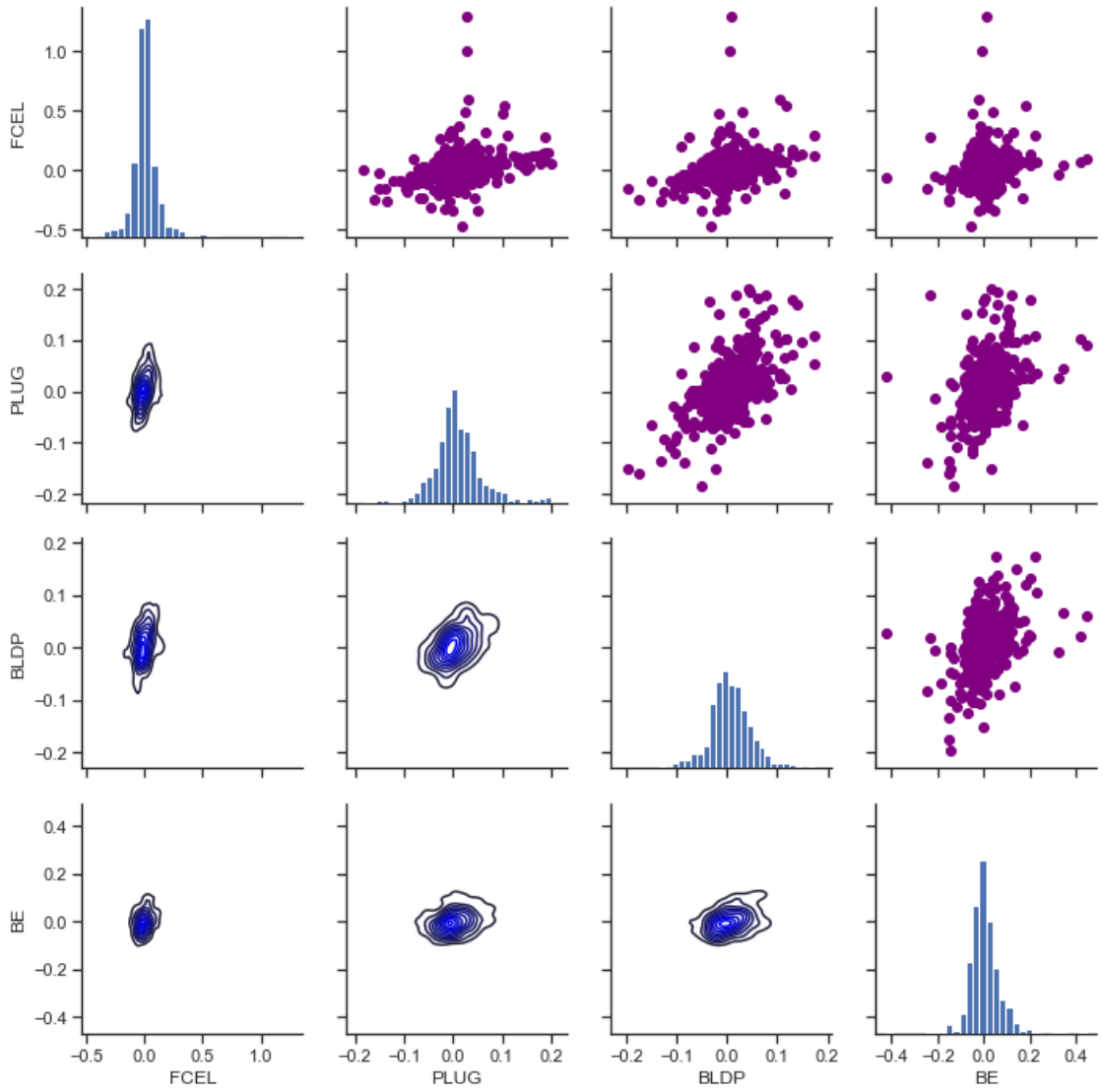
[16]: <matplotlib.legend.Legend at 0x172d471d780>



[17]:
```
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)
```

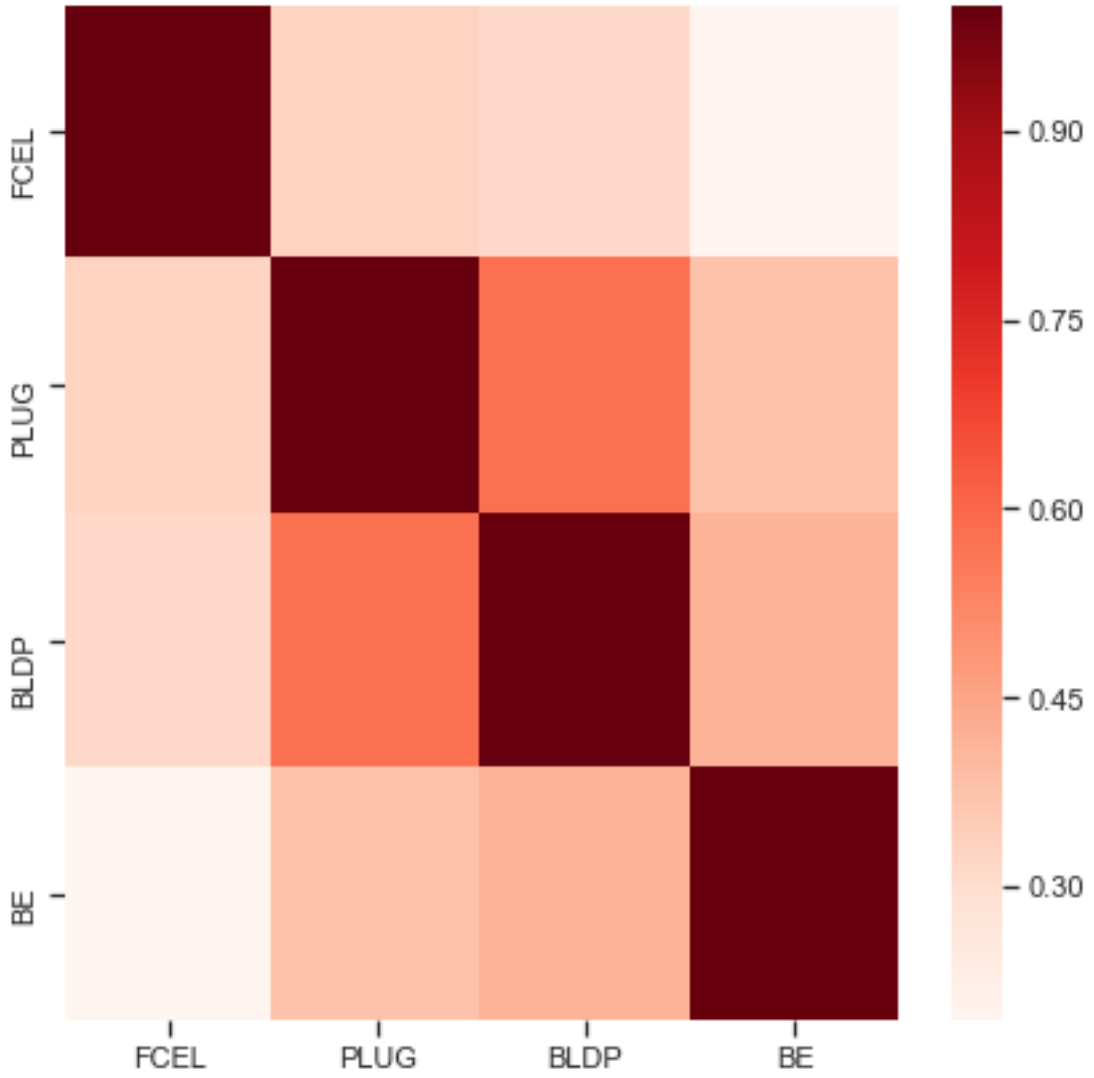


[18]:
```
ax = sns.PairGrid(stock_rets)
ax.map_upper(plt.scatter, color='purple')
ax.map_lower(sns.kdeplot, color='blue')
ax.map_diag(plt.hist, bins=30)
for i in range(nplot) :
    for j in range(nplot) :
        ax.axes[i, j].locator_params(axis='x', nbins=6, tight=True)
```



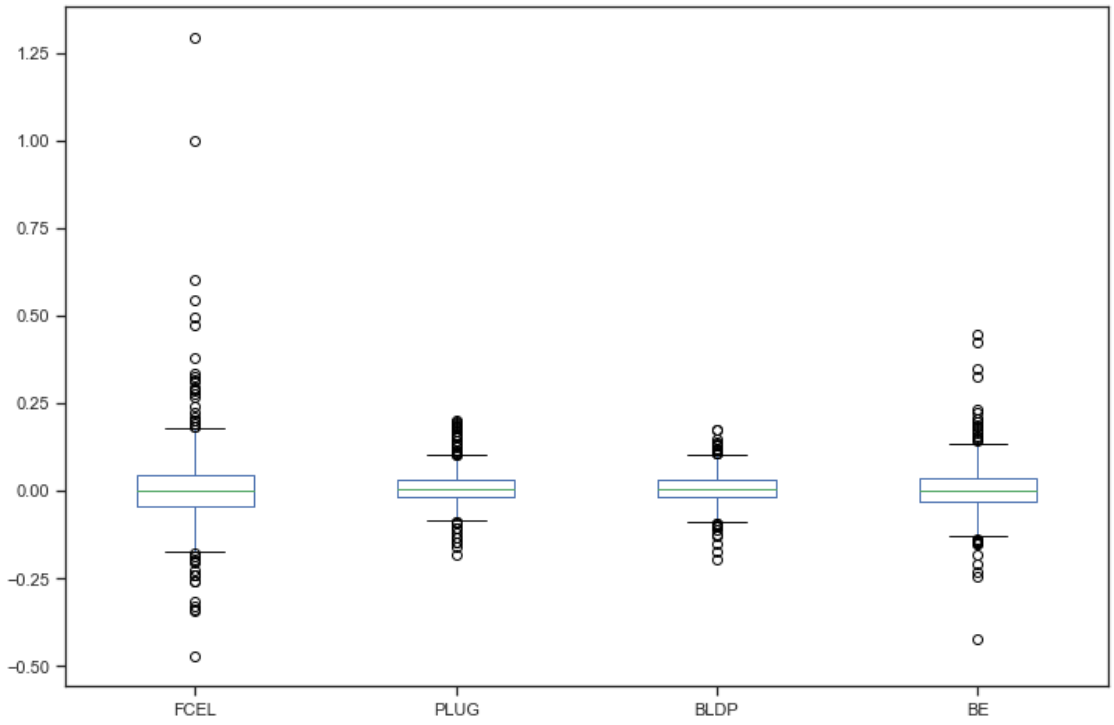
[19]:
```
plt.figure(figsize=(7,7))
corr = stock_rets.corr()

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

[19]: <AxesSubplot:>

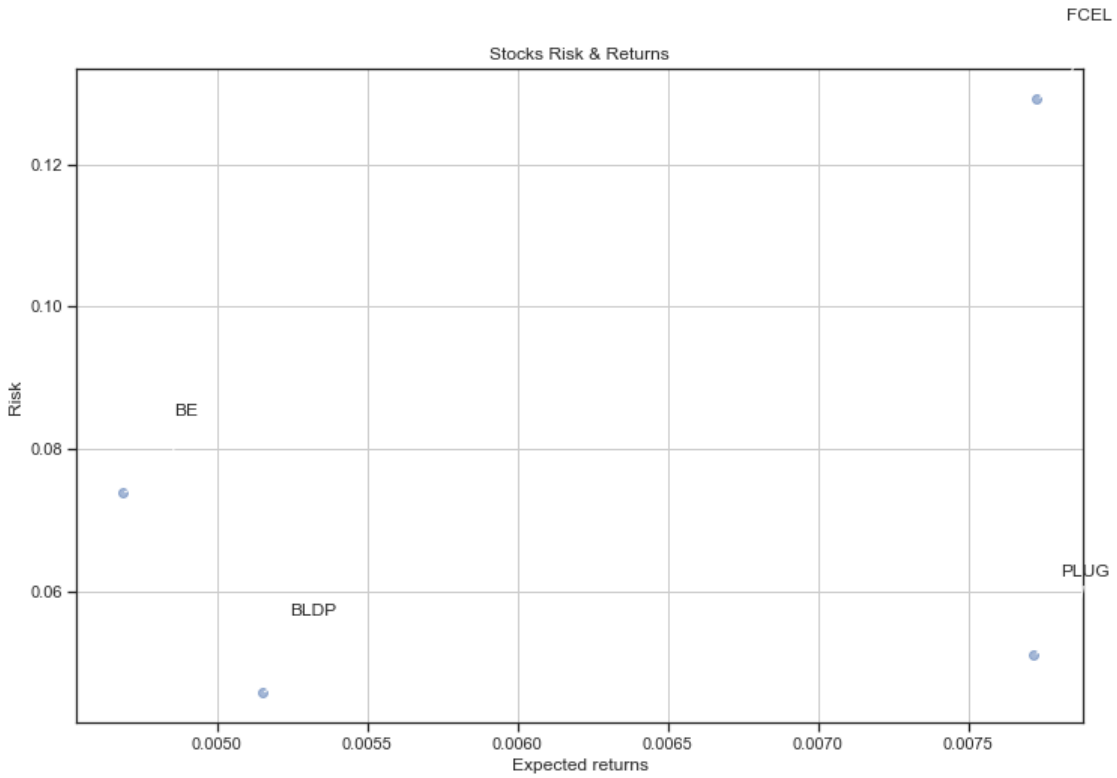


[20]:
```
# Box plot
stock_rets.plot(kind='box',figsize=(12,8))
```

[20]: <AxesSubplot:>



[21]:
```
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'))
```



[22]:
```
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"))
```

[23]:
```
rest_rets = rets.corr()
pair_value = rest_rets.abs().unstack()
pair_value.sort_values(ascending = False)
```

[23]:
```
BE    BE      1.000000
BLDP  BLDP    1.000000
PLUG  PLUG    1.000000
FCEL  FCEL    1.000000
BLDP  PLUG    0.583591
PLUG  BLDP    0.583591
BE    BLDP    0.414691
BLDP  BE      0.414691
BE    PLUG    0.377969
PLUG  BE      0.377969
      FCEL    0.328346
FCEL  PLUG    0.328346
BLDP  FCEL    0.315060
FCEL  BLDP    0.315060
BE    FCEL    0.193360
FCEL  BE      0.193360
dtype: float64
```

[24]:
```
# Normalized Returns Data
Normalized_Value = ((rets[:] - rets[:].min()) /(rets[:].max() - rets[:].min()))
```

```
Normalized_Value.head()
```

[24]:

Date	FCEL	PLUG	BLDP	BE
2019-01-03	0.247824	0.341986	0.589592	0.528423
2019-01-04	0.278024	0.645599	0.734531	0.638008
2019-01-07	0.287964	0.850317	0.701980	0.545029
2019-01-08	0.277491	0.599216	0.538322	0.518305
2019-01-09	0.238890	0.332526	0.546787	0.435368

[25]:
```
Normalized_Value.corr()
```

[25]:

	FCEL	PLUG	BLDP	BE
FCEL	1.000000	0.328346	0.315060	0.193360
PLUG	0.328346	1.000000	0.583591	0.377969
BLDP	0.315060	0.583591	1.000000	0.414691
BE	0.193360	0.377969	0.414691	1.000000

[26]:
```
normalized_rets = Normalized_Value.corr()
normalized_pair_value = normalized_rets.abs().unstack()
normalized_pair_value.sort_values(ascending = False)
```

[26]:
```
BE    BE      1.000000
BLDP  BLDP    1.000000
PLUG  PLUG    1.000000
FCEL  FCEL    1.000000
BLDP  PLUG    0.583591
PLUG  BLDP    0.583591
BE    BLDP    0.414691
BLDP  BE      0.414691
BE    PLUG    0.377969
PLUG  BE      0.377969
      FCEL    0.328346
FCEL  PLUG    0.328346
BLDP  FCEL    0.315060
FCEL  BLDP    0.315060
BE    FCEL    0.193360
FCEL  BE      0.193360
dtype: float64
```

[27]:
```
print("Stock returns: ")
print(rets.mean())
print('-' * 50)
print("Stock risks:")
print(rets.std())
```

```
Stock returns:
```

```
FCEL    0.007728
PLUG    0.007717
BLDP    0.005150
BE      0.004684
dtype: float64
-------------------------------------------------
Stock risks:
FCEL    0.129199
PLUG    0.051032
BLDP    0.045654
BE      0.073768
dtype: float64
```

[28]:
```
table = pd.DataFrame()
table['Returns'] = rets.mean()
table['Risk'] = rets.std()
table.sort_values(by='Returns')
```

[28]:

	Returns	Risk
BE	0.004684	0.073768
BLDP	0.005150	0.045654
PLUG	0.007717	0.051032
FCEL	0.007728	0.129199

[29]:
```
table.sort_values(by='Risk')
```

[29]:

	Returns	Risk
BLDP	0.005150	0.045654
PLUG	0.007717	0.051032
BE	0.004684	0.073768
FCEL	0.007728	0.129199

[30]:
```
rf = 0.001
table['Sharpe Ratio'] = (table['Returns'] - rf) / table['Risk']
table
```

[30]:

	Returns	Risk	Sharpe Ratio
FCEL	0.007728	0.129199	0.052072
PLUG	0.007717	0.051032	0.131632
BLDP	0.005150	0.045654	0.090897
BE	0.004684	0.073768	0.049945

[31]:
```
table['Max Returns'] = rets.max()
```

[32]:
```
table['Min Returns'] = rets.min()
```

[33]:
```
table['Median Returns'] = rets.median()
```

[34]:
```
total_return = stock_rets[-1:].transpose()
table['Total Return'] = 100 * total_return
table
```

[34]:

	Returns	Risk	Sharpe Ratio	Max Returns	Min Returns	Median Returns	Total Return
FCEL	0.007728	0.129199	0.052072	1.291667	-0.472222	0.000000	0.860214
PLUG	0.007717	0.051032	0.131632	0.199041	-0.183432	0.001465	2.339550
BLDP	0.005150	0.045654	0.090897	0.174118	-0.196191	0.002915	-1.841357
BE	0.004684	0.073768	0.049945	0.444730	-0.425000	-0.002473	4.713036

[35]:
```
table['Average Return Days'] = (1 + total_return)**(1 / days) - 1
table
```

[35]:

	Returns	Risk	Sharpe Ratio	Max Returns	Min Returns	Median Returns	Total Return	Average Return Days
FCEL	0.007728	0.129199	0.052072	1.291667	-0.472222	0.000000	0.860214	0.000012
PLUG	0.007717	0.051032	0.131632	0.199041	-0.183432	0.001465	2.339550	0.000032
BLDP	0.005150	0.045654	0.090897	0.174118	-0.196191	0.002915	-1.841357	-0.000026
BE	0.004684	0.073768	0.049945	0.444730	-0.425000	-0.002473	4.713036	0.000064

[36]:
```
initial_value = df.iloc[0]
ending_value = df.iloc[-1]
table['CAGR'] = ((ending_value / initial_value) ** (252.0 / days)) -1
table
```

[36]:

	Returns	Risk	Sharpe Ratio	Max Returns	Min Returns	Median Returns	Total Return	Average Return Days	CAGR
FCEL	0.007728	0.129199	0.052072	1.291667	-0.472222	0.000000	0.860214	0.000012	0.117038
PLUG	0.007717	0.051032	0.131632	0.199041	-0.183432	0.001465	2.339550	0.000032	2.061094
BLDP	0.005150	0.045654	0.090897	0.174118	-0.196191	0.002915	-1.841357	-0.000026	1.042399
BE	0.004684	0.073768	0.049945	0.444730	-0.425000	-0.002473	4.713036	0.000064	0.420500

[37]:
```
table.sort_values(by='Average Return Days')
```

[37]:

	Returns	Risk	Sharpe Ratio	Max Returns	Min Returns	Median Returns	Total Return	Average Return Days	CAGR
BLDP	0.005150	0.045654	0.090897	0.174118	-0.196191	0.002915	-1.841357	-0.000026	1.042399
FCEL	0.007728	0.129199	0.052072	1.291667	-0.472222	0.000000	0.860214	0.000012	0.117038
PLUG	0.007717	0.051032	0.131632	0.199041	-0.183432	0.001465	2.339550	0.000032	2.061094
BE	0.004684	0.073768	0.049945	0.444730	-0.425000	-0.002473	4.713036	0.000064	0.420500