In [53]:
```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import datetime
import statsmodels.api as sm
import yfinance as yf
import scipy.stats as st
import math
import Plib as pl
import seaborn as sns
from scipy import stats
from pandas.plotting import register_matplotlib_converters
register_matplotlib_converters()
from statsmodels import regression
from pandas_datareader import data as pdr
from copulalib.copulalib import Copula
from statsmodels.distributions.empirical_distribution import ECDF
plt.style.use('ggplot')
yf.pdr_override()
```

In [ ]:
```

```

In [54]:
```
df11 = pdr.get_data_yahoo("^GSPC", start="2000-07-03", end="2019-06-03").Close.rename('GSPC')
df12 = pdr.get_data_yahoo("^VIX", start="2000-07-03", end="2019-06-03").Close.rename('VIX')
index_prices=pd.concat([df11, df12], axis=1).dropna()
lreturns=np.log(index_prices/index_prices.shift(1))
lreturns.dropna(inplace=True)

X=np.array(lreturns['GSPC'])
Y=np.array(lreturns['VIX'])
xlabel='GSPC' #labels
ylabel='VIX'   #labels

#Uniform marginals by applying the empirical CDF to sample values
Xecdf=ECDF(X,side='right') #default side is rightsided [a,b)
Yecdf=ECDF(Y,side='right')
U=Xecdf(X)
V=Yecdf(Y)

%matplotlib inline
plt.scatter(U,V,marker='o',alpha=0.7)
plt.xlabel(xlabel)
plt.ylabel(ylabel)
plt.title('Gaussian Copula with uniform marginals obtained by empirical CDF',fontsize=12)
plt.show()
```

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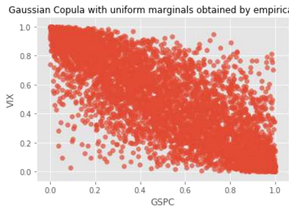
[**********************100%**********************]  1 of 1 downloaded
```



In [55]:
```
# Test clayton copula
clayton = Copula(X, Y, family='clayton')
clayton.theta,clayton.tau
```

Out[55]:
```
(-0.740680698334949, -0.5881595695036465)
```

In [56]:
```
#spearman and pearson correlation
clayton.sr,clayton.pr
```

Out[56]:
```
(-0.7798942301319888, -0.7338167318109027)
```

In [57]:
```
frank = Copula(X, Y, family='frank')
frank.theta,frank.tau
```

Out[57]:
```
(-7.6217041015625, -0.5881595695036465)
```

In [58]:
```
#spearman and pearson correlation
frank.sr,frank.pr
```

Out[58]:
```
(-0.7798942301319888, -0.7338167318109027)
```

In [ ]:
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In [59]:
```
fig, axs = plt.subplots(2,2,figsize=(18., 18.))
fig.suptitle('Copulas Plots')

clayton = Copula(X, Y, family='clayton')
frank = Copula(X, Y, family='frank')

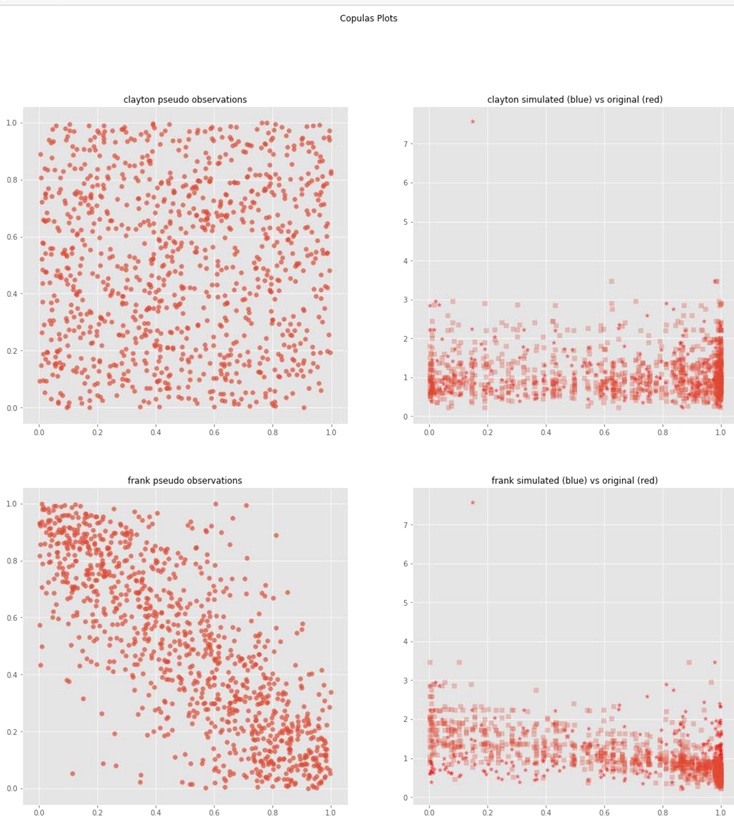
u,v = clayton.generate_uv(1000)
axs[0][0].scatter(u,v,marker='o',alpha=0.7)
axs[0][0].set_title('clayton pseudo observations',fontsize=12)

ux=ppf(x,u)
vy=ppf(y,v)
axs[0][1].scatter(x,y,marker='*',color='r', alpha=0.5) #original samples
axs[0][1].scatter(ux,vy,marker='s', alpha=0.3) #simulated realisations
axs[0][1].set_title('clayton simulated (blue) vs original (red)',fontsize=12)


u,v = frank.generate_uv(1000)
axs[1][0].scatter(u,v,marker='o',alpha=0.7)
axs[1][0].set_title('frank pseudo observations',fontsize=12)

ux=ppf(x,u)
vy=ppf(y,v)
axs[1][1].scatter(x,y,marker='*',color='r', alpha=0.5) #original samples
axs[1][1].scatter(ux,vy,marker='s', alpha=0.3) #simulated realisations
axs[1][1].set_title('frank simulated (blue) vs original (red)',fontsize=12)

plt.show()
```



In [ ]:
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