In [178…

```
import warnings
warnings.filterwarnings("ignore")
import pandas as pd
import numpy as np
import wbgapi as wb
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.cluster import KMeans
import matplotlib.pyplot as plt
from kneed import KneeLocator
from sklearn.preprocessing import MinMaxScaler
```

Clustering (K-Means)

In [179…

```
country_codes = ['IDN','GUM','PYF']
ind1=["EN.POP.DNST"]
ind1m=["Population density"]
ind2=["NY.GDP.MKTP.CD"]
ind2m=["GDP"]
```

In [180…

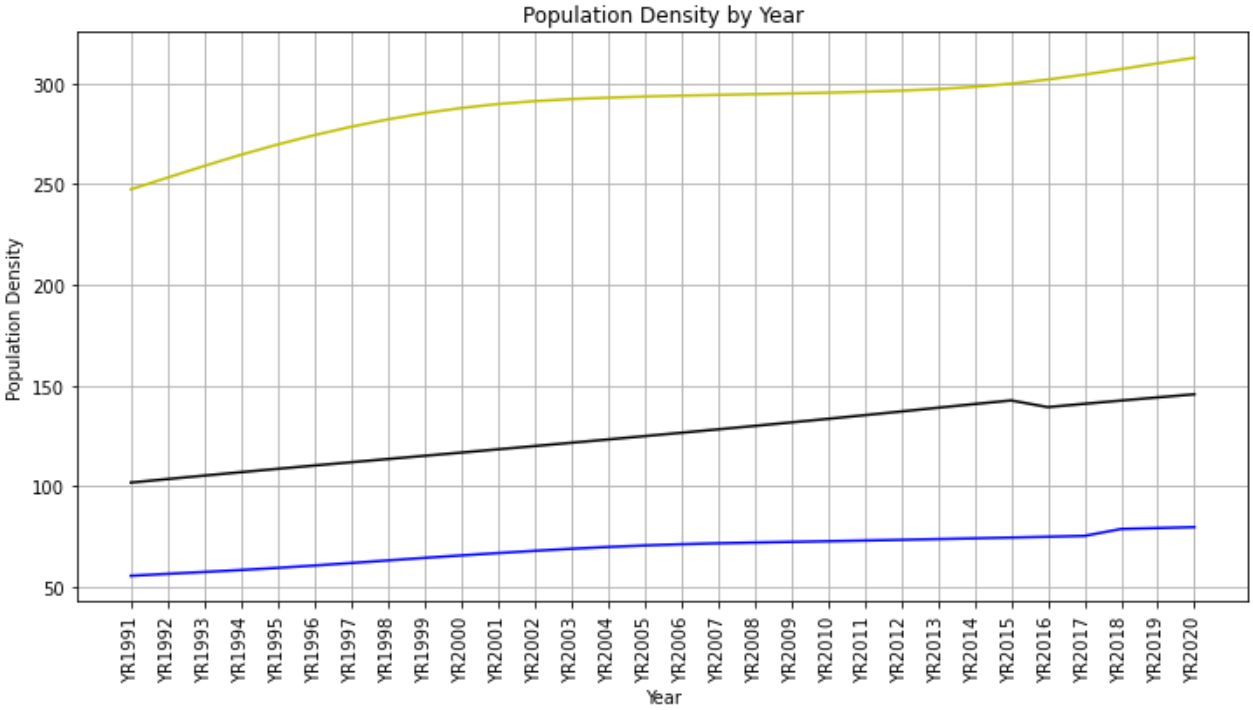
```
my_data1  = wb.data.DataFrame(ind1, country_codes, mrv=30).T
my_data1=my_data1.fillna(my_data1.median())
my_data1.head()
```

Out[180…

economy	GUM	IDN	PYF
YR1991	247.320370	101.896088	55.660109
YR1992	253.135185	103.633746	56.622404
YR1993	258.912963	105.351261	57.553005
YR1994	264.455556	107.043867	58.523497
YR1995	269.553704	108.709162	59.580328

In [181…

```
plt.figure(figsize=(12,6))
plt.title('Population Density by Year')
plt.plot(my_data1['GUM'],"y")
plt.plot(my_data1['IDN'],"k")
plt.plot(my_data1['PYF'],"b")
plt.xlabel("Year")
plt.xticks(rotation=90)
plt.ylabel("Population Density")
plt.grid()
plt.show()
```



In [182…

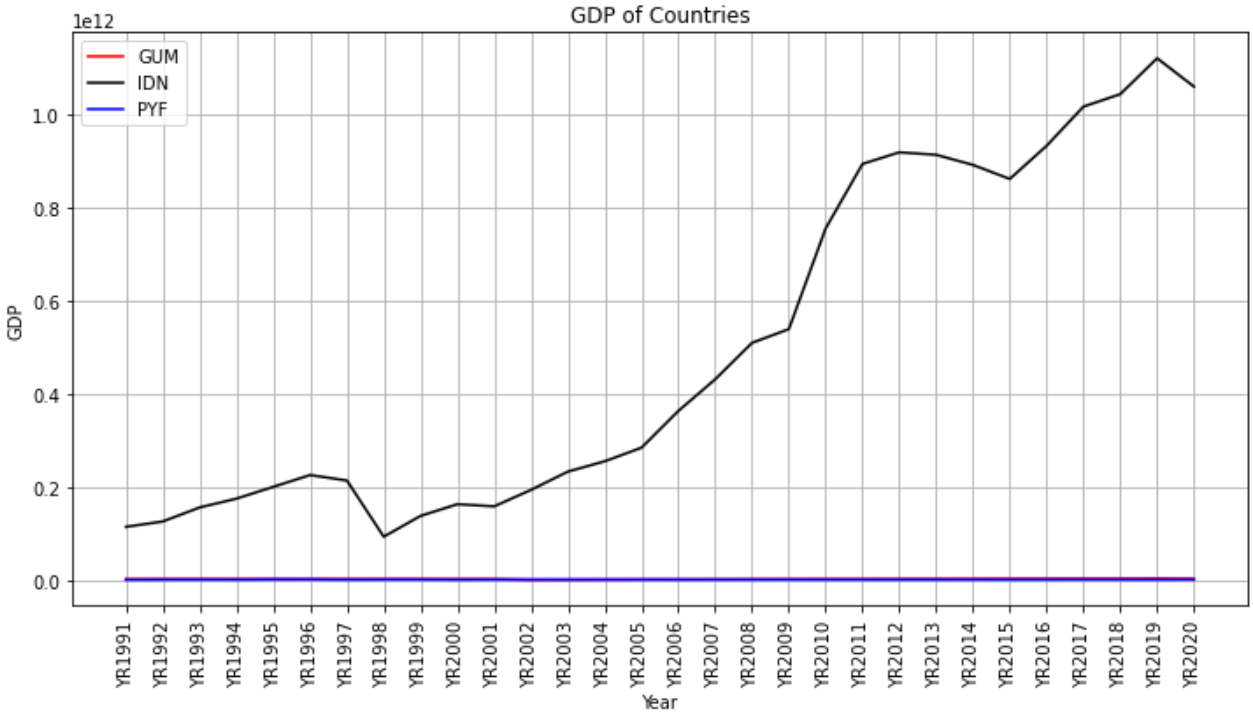
```
my_data2  = wb.data.DataFrame(ind2, country_codes, mrv=30).T
my_data2=my_data2.fillna(my_data2.mean())
my_data2.head()
```

Out[182…

economy	GUM	IDN	PYF
YR1991	5.018632e+09	1.166220e+11	3.267368e+09
YR1992	5.018632e+09	1.280270e+11	3.558215e+09
YR1993	5.018632e+09	1.580067e+11	3.694600e+09
YR1994	5.018632e+09	1.768921e+11	3.522272e+09
YR1995	5.018632e+09	2.021320e+11	3.982377e+09

In [183…

```
plt.figure(figsize=(12,6))
plt.title('GDP of Countries')
plt.plot(my_data2['GUM'],"r",label="GUM")
plt.plot(my_data2['IDN'],"k",label="IDN")
plt.plot(my_data2['PYF'],"b",label="PYF")
plt.xlabel("Year")
plt.xticks(rotation=90)
plt.ylabel("GDP")
plt.legend()
plt.grid()
plt.show()
```

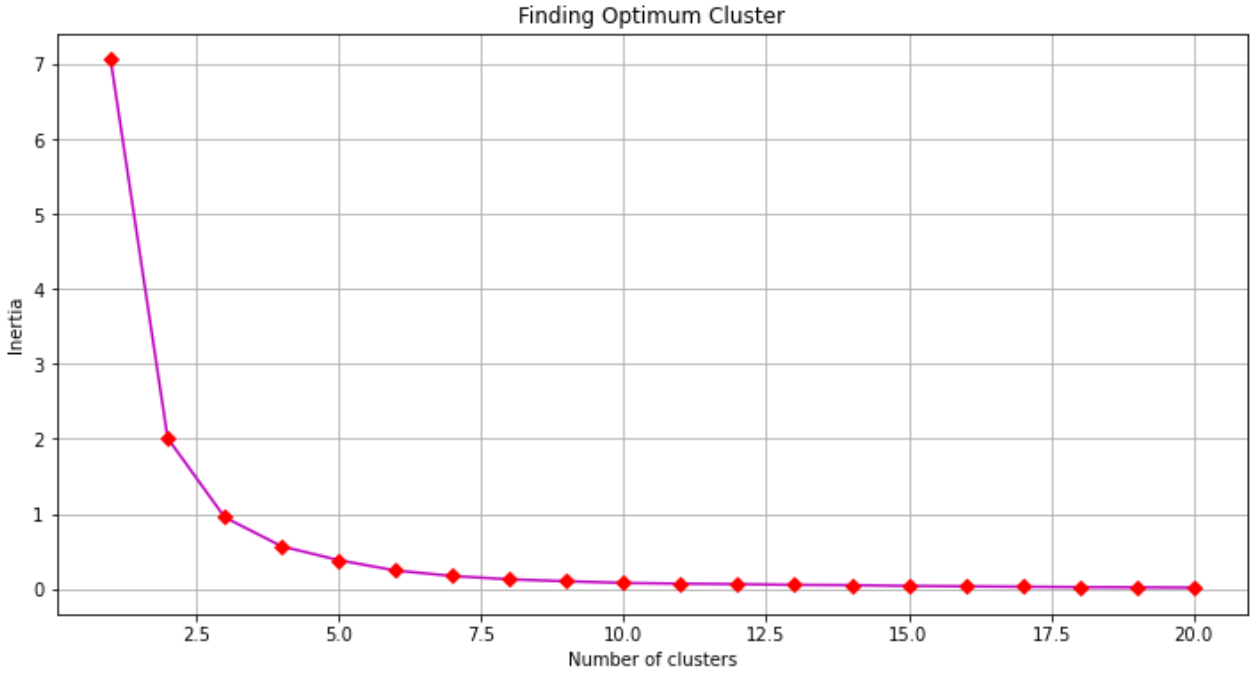


In [184…

```
def norm(data):
    minmax=MinMaxScaler()
    norml=minmax.fit_transform(data)
    return norml
norml=norm(my_data1.values)
```

In [185…

```
elb = []
for i in range(1, 21):
    kmeans = KMeans(n_clusters=i, init='k-means++', max_iter=300,  random_s
    kmeans.fit(norml)
    elb.append(kmeans.inertia_)
plt.figure(figsize=(12,6))
plt.title('Finding Optimum Cluster')
plt.plot(range(1, 21), elb,"m-")
plt.plot(range(1, 21), elb,"Dr")
plt.xlabel('Number of clusters')
plt.ylabel('Inertia')
plt.grid()
plt.show()
```



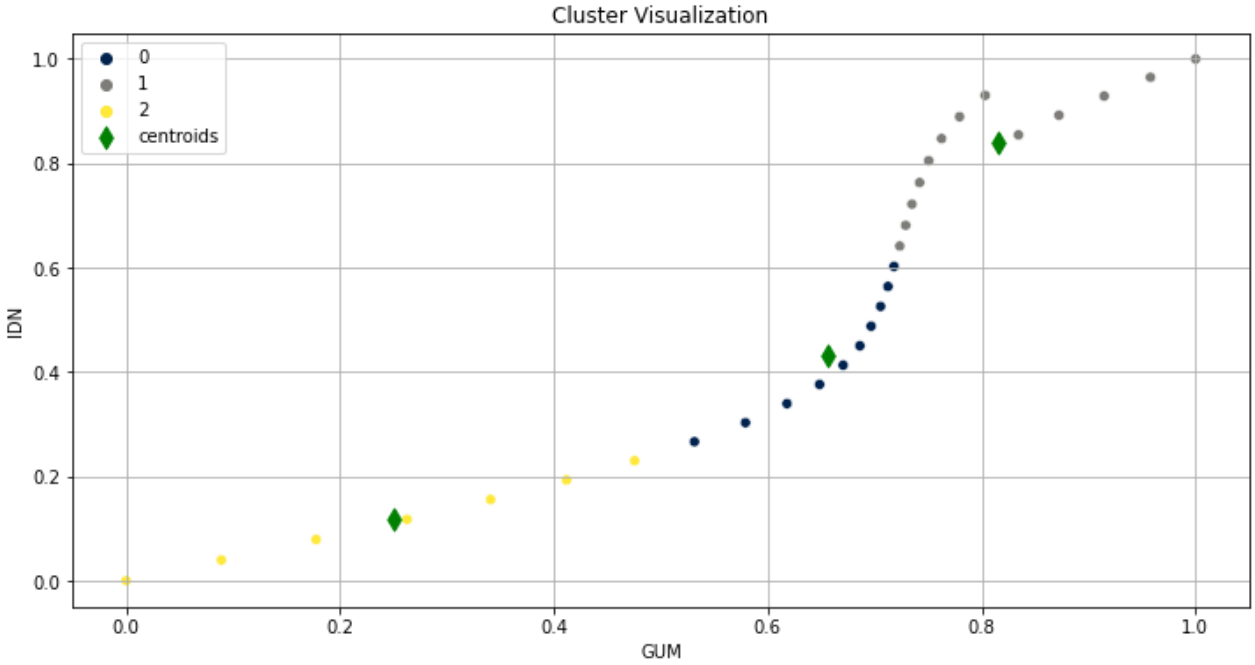
In [186…
```
kmeans = KMeans(n_clusters=3, init='k-means++', max_iter=300, n_init=10, ra
pred_y = kmeans.fit(norml)
pred_y
```

Out[186… `KMeans(n_clusters=3, random_state=0)`

In [187…
```
kmeans.cluster_centers_
```

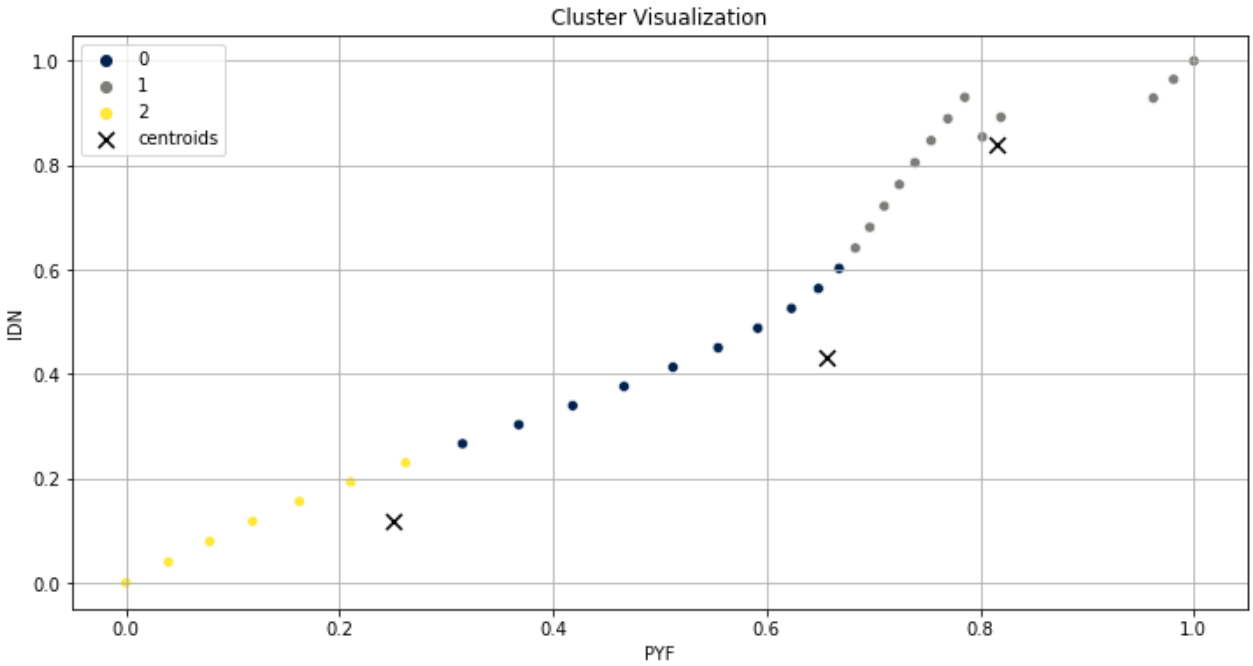
Out[187…
```
array([[0.6565711 , 0.43277793, 0.5165339 ],
       [0.81562698, 0.83992609, 0.80195419],
       [0.25107254, 0.11637434, 0.12452746]])
```

In [188…
```
df=pd.DataFrame(norml,columns=my_data1.columns)
plt.figure(figsize=(12,6))
plt.title('Cluster Visualization')
sns.scatterplot(data=df, x="GUM", y="IDN", hue=kmeans.labels_,palette="civi
plt.scatter(kmeans.cluster_centers_[:,0], kmeans.cluster_centers_[:,1], mar
plt.grid()
plt.legend()
plt.show()
```



In [189…

```
plt.figure(figsize=(12,6))
plt.title('Cluster Visualization')
sns.scatterplot(data=df, x="PYF", y="IDN", hue=kmeans.labels_,palette="civ
plt.scatter(kmeans.cluster_centers_[:,0], kmeans.cluster_centers_[:,1], ma
plt.grid()
plt.legend()
plt.show()
```



Curve Fitting

In [190…

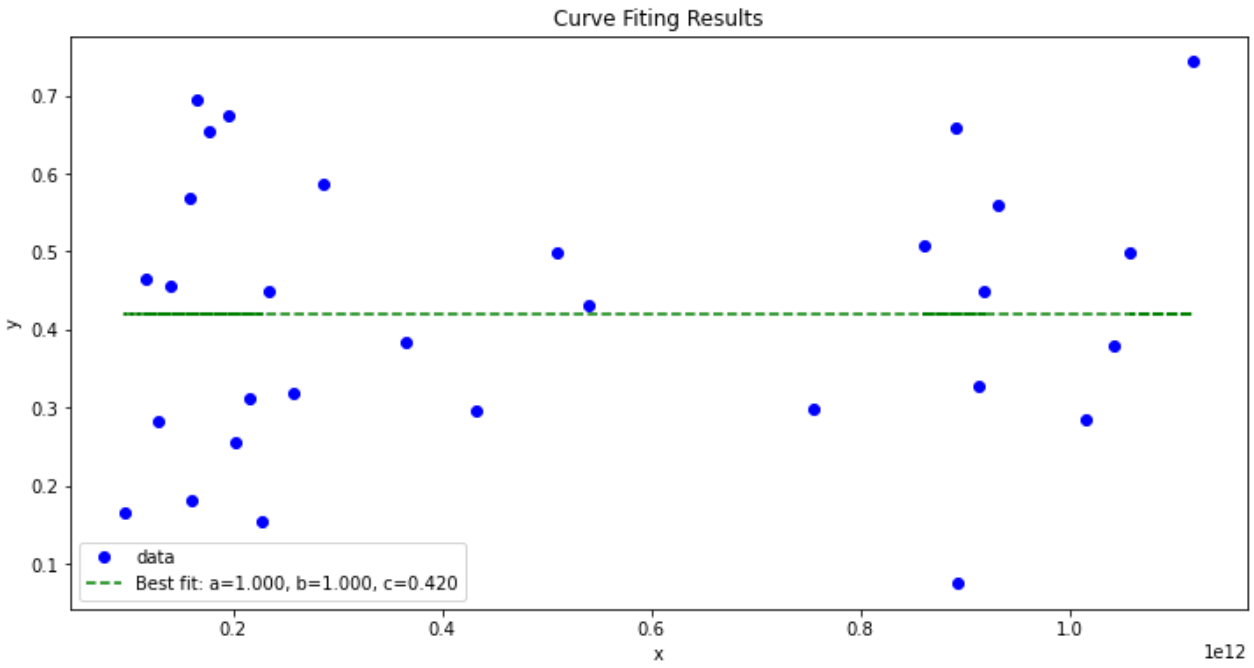
```
from scipy.optimize import curve_fit
```

In [195…
```
def func(x, a, b, c):
    return a * np.exp(-b * x) + c
```

In [196…
```
y = func(my_data2.values[:,1], 1.5, 0.9, 0.5)
rng = np.random.default_rng()
y_noise = 0.2 * rng.normal(size=my_data2.values[:,1].size)
ydata = y + y_noise
```

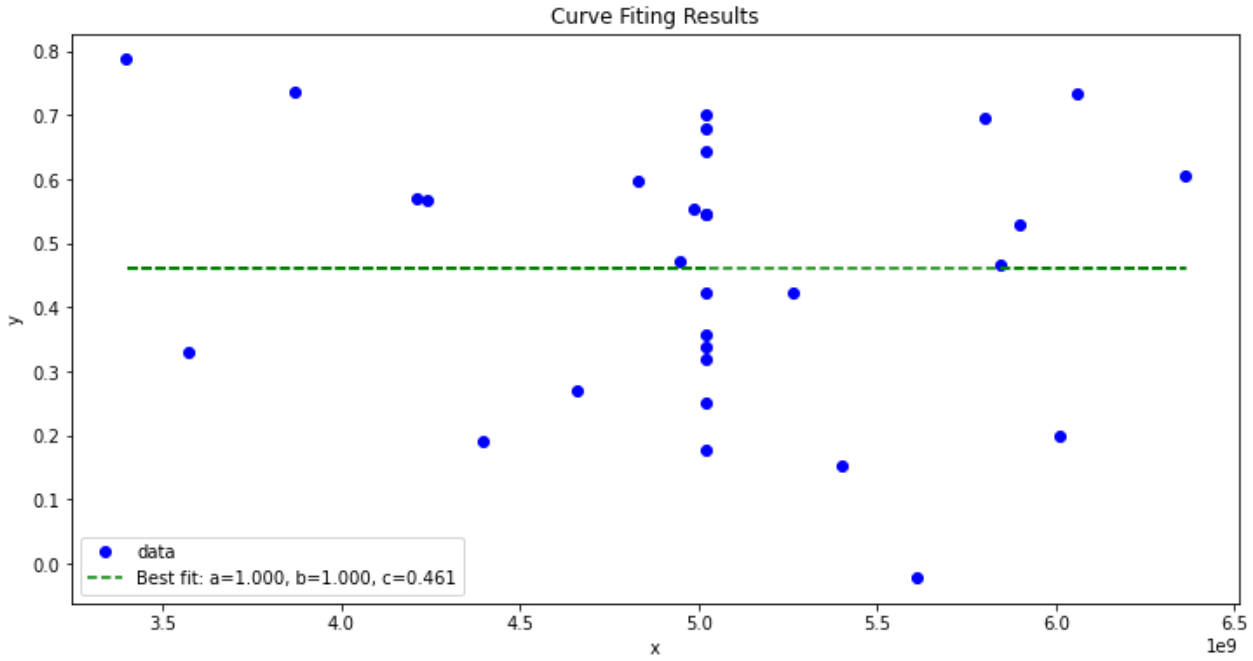
In [197…
```
popt, pcov = curve_fit(func, my_data2.values[:,1], ydata)
```

In [198…
```
plt.figure(figsize=(12,6))
plt.title('Curve Fiting Results')
plt.plot(my_data2.values[:,1], ydata, 'bo', label='data')
plt.plot(my_data2.values[:,1], func(my_data2.values[:,0], *popt), 'g--',lab
plt.xlabel('x')
plt.ylabel('y')
plt.legend()
plt.show()
```



In [199…

```
y0 = func(my_data2.values[:,0], 1.5, 0.9, 0.5)
rng0 = np.random.default_rng()
y0_noise = 0.2 * rng0.normal(size=my_data2.values[:,0].size)
y0data = y0 + y0_noise
popt0, pcov0 = curve_fit(func, my_data2.values[:,0], y0data)
plt.figure(figsize=(12,6))
plt.title('Curve Fiting Results')
plt.plot(my_data2.values[:,0], y0data, 'bo', label='data')
plt.plot(my_data2.values[:,0], func(my_data2.values[:,0], *popt0), 'g--',la
plt.xlabel('x')
plt.ylabel('y')
plt.legend()
plt.show()
```



In [ ]: