In [103…

```
import warnings
warnings.filterwarnings("ignore")
import pandas as pd
import numpy as np
import wbgapi as wb
import matplotlib.pyplot as plt
plt.style.use('classic')
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 [104…

```
country_codes = ['ITA','KOR','IND']
ind1=["EN.POP.DNST"]
ind1m=["Population density"]
ind2=["NY.GDP.PCAP.PP.CD"]
ind2m=["GDP Per Capita"]
```

In [105…

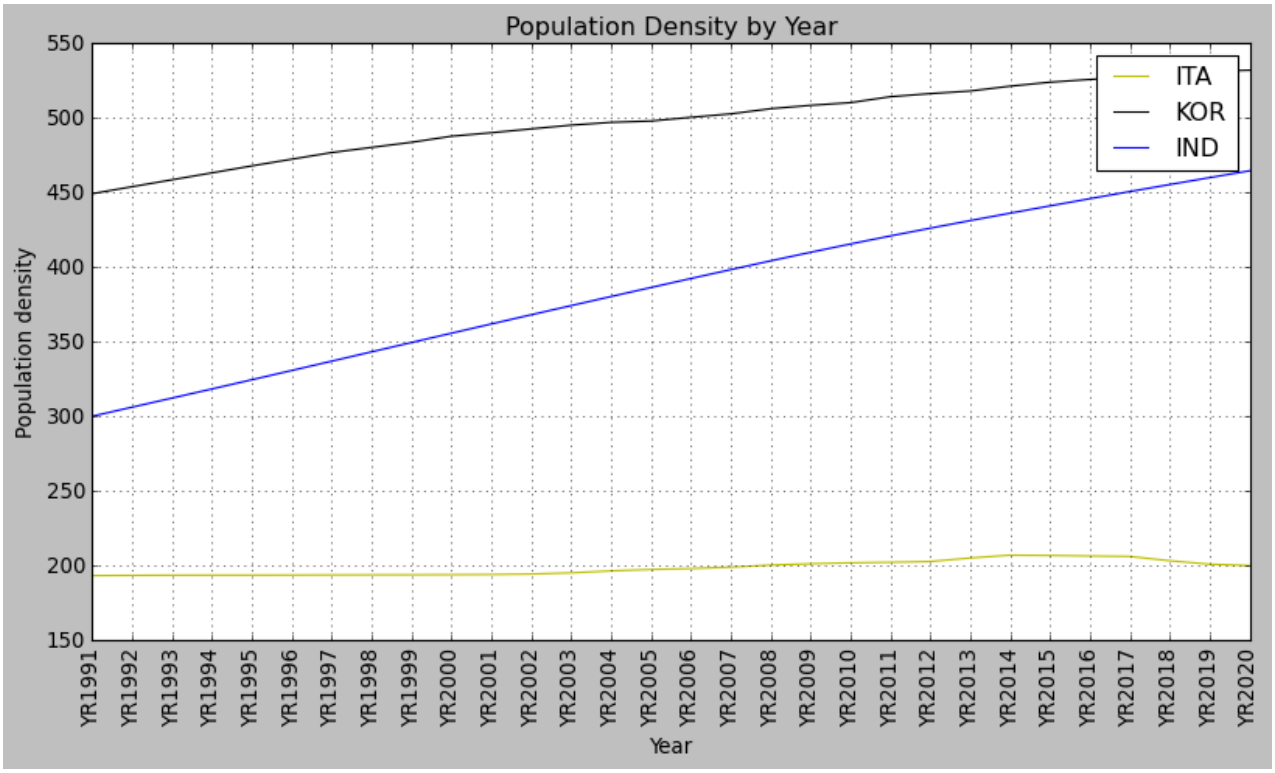
```
my_data1  = wb.data.DataFrame(ind1, country_codes, mrv=30).T
my_data1=my_data1.fillna(my_data1.median())
my_data1.head()
```

Out[105…

economy	IND	ITA	KOR
YR1991	299.770012	192.983989	448.846195
YR1992	305.835489	193.115117	453.534750
YR1993	311.922166	193.233215	458.165333
YR1994	318.042852	193.272585	462.798466
YR1995	324.204839	193.275655	467.478654

In [106…

```
plt.figure(figsize=(12,6))
plt.title('Population Density by Year')
plt.plot(my_data1[country_codes[0]],"y",label=country_codes[0])
plt.plot(my_data1[country_codes[1]],"k",label=country_codes[1])
plt.plot(my_data1[country_codes[2]],"b",label=country_codes[2])
plt.xlabel("Year")
plt.xticks(rotation=90)
plt.ylabel("{}".format(ind1m[0]))
plt.grid()
plt.legend()
plt.show()
```



In [107…

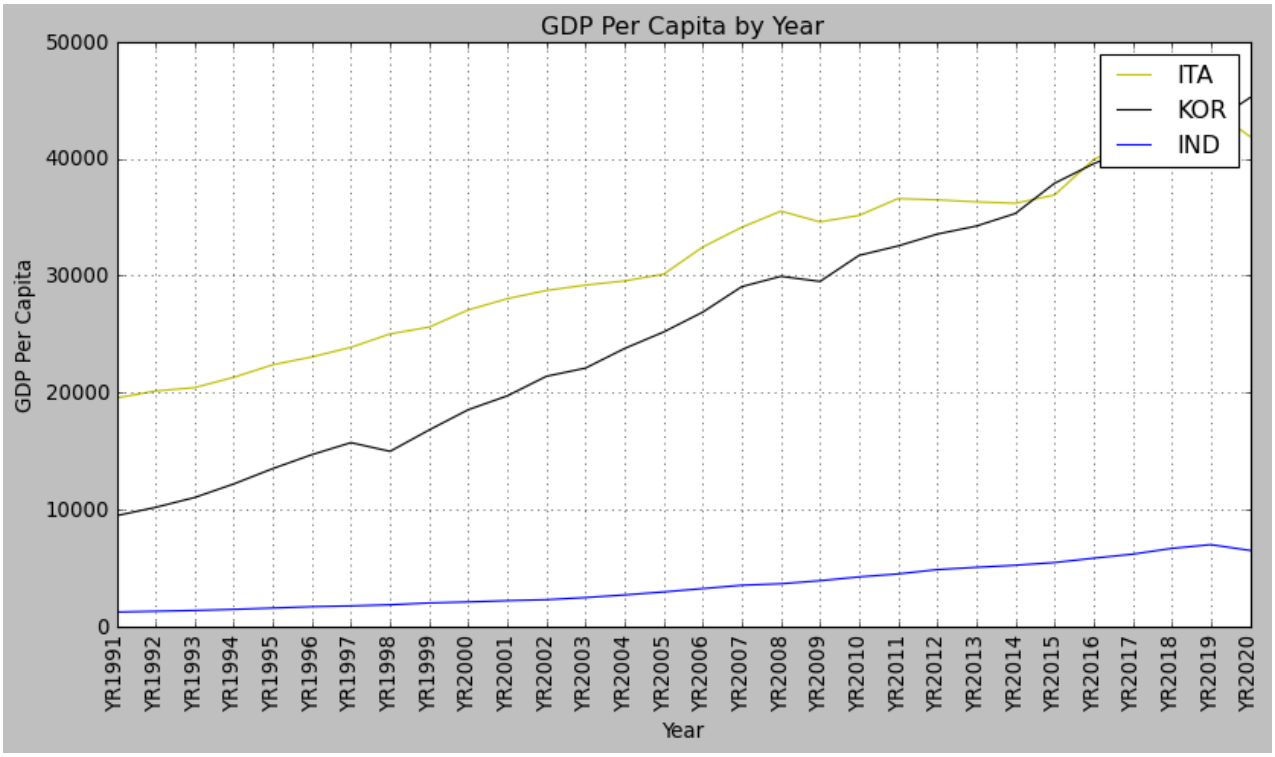
```
my_data2  = wb.data.DataFrame(ind2, country_codes, mrv=30).T
my_data2=my_data2.fillna(my_data2.mean())
my_data2.head()
```

Out[107…

economy	IND	ITA	KOR
YR1991	1229.302914	19540.324568	9474.642596
YR1992	1299.945950	20138.670537	10184.855665
YR1993	1366.779103	20427.727502	11030.711948
YR1994	1460.267846	21308.402242	12187.254966
YR1995	1573.332562	22382.897962	13502.582742

In [108…

```
plt.figure(figsize=(12,6))
plt.title('GDP Per Capita by Year')
plt.plot(my_data2[country_codes[0]],"y",label=country_codes[0])
plt.plot(my_data2[country_codes[1]],"k",label=country_codes[1])
plt.plot(my_data2[country_codes[2]],"b",label=country_codes[2])
plt.xlabel("Year")
plt.xticks(rotation=90)
plt.ylabel("{}".format(ind2m[0]))
plt.grid()
plt.legend()
plt.show()
```

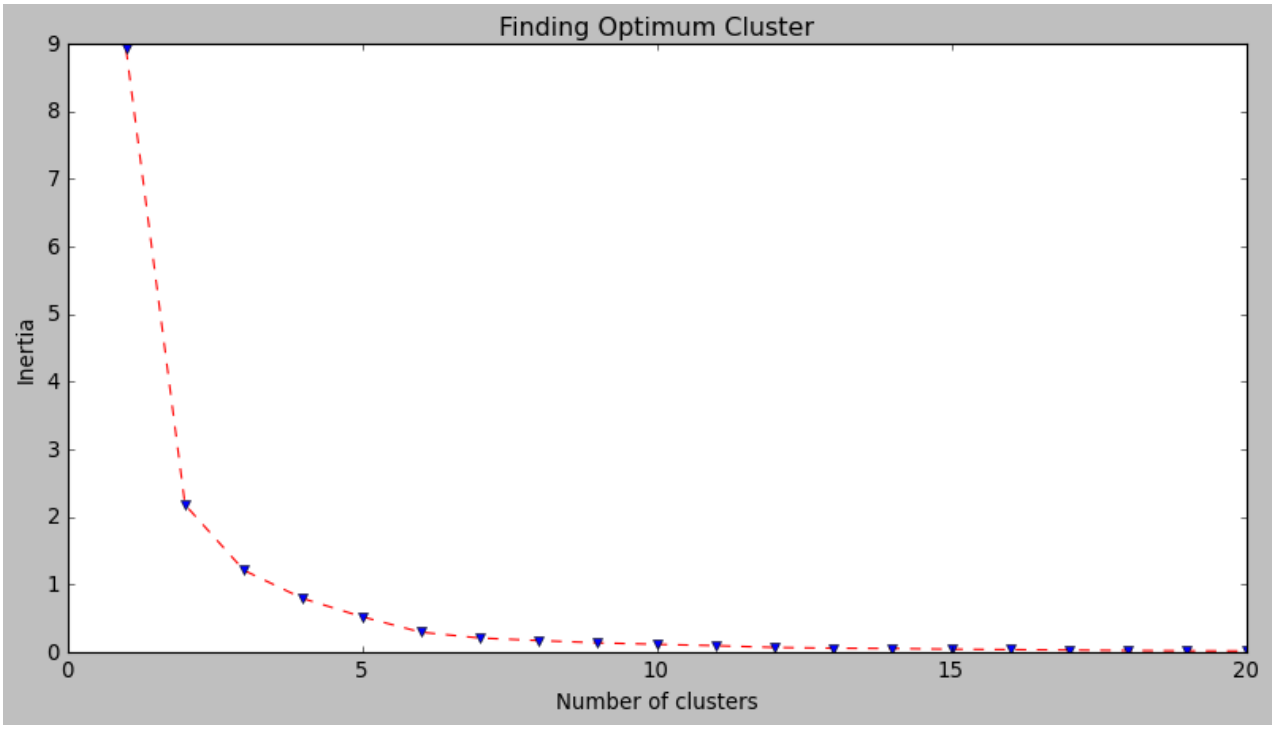


In [109…

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

In [110…

```
elb_list = []
for i in range(1, 21):
    kmeans = KMeans(n_clusters=i, init='k-means++', max_iter=300,  random_state=0)
    kmeans.fit(norml)
    elb_list.append(kmeans.inertia_)
plt.figure(figsize=(12,6))
plt.title('Finding Optimum Cluster')
plt.plot(range(1, 21), elb_list,"r--")
plt.plot(range(1, 21), elb_list,"vb")
plt.xlabel('Number of clusters')
plt.ylabel('Inertia')
plt.show()
```



In [111…

```
kmeans = KMeans(n_clusters=3, max_iter=100, n_init=50, random_state=0)
pred_y = kmeans.fit(norml)
for i in range(len(kmeans.cluster_centers_)):
    print("{} Custer Centre(Co-ord): {},{},{}".format(i,kmeans.cluster_centers_[i][0],k
```

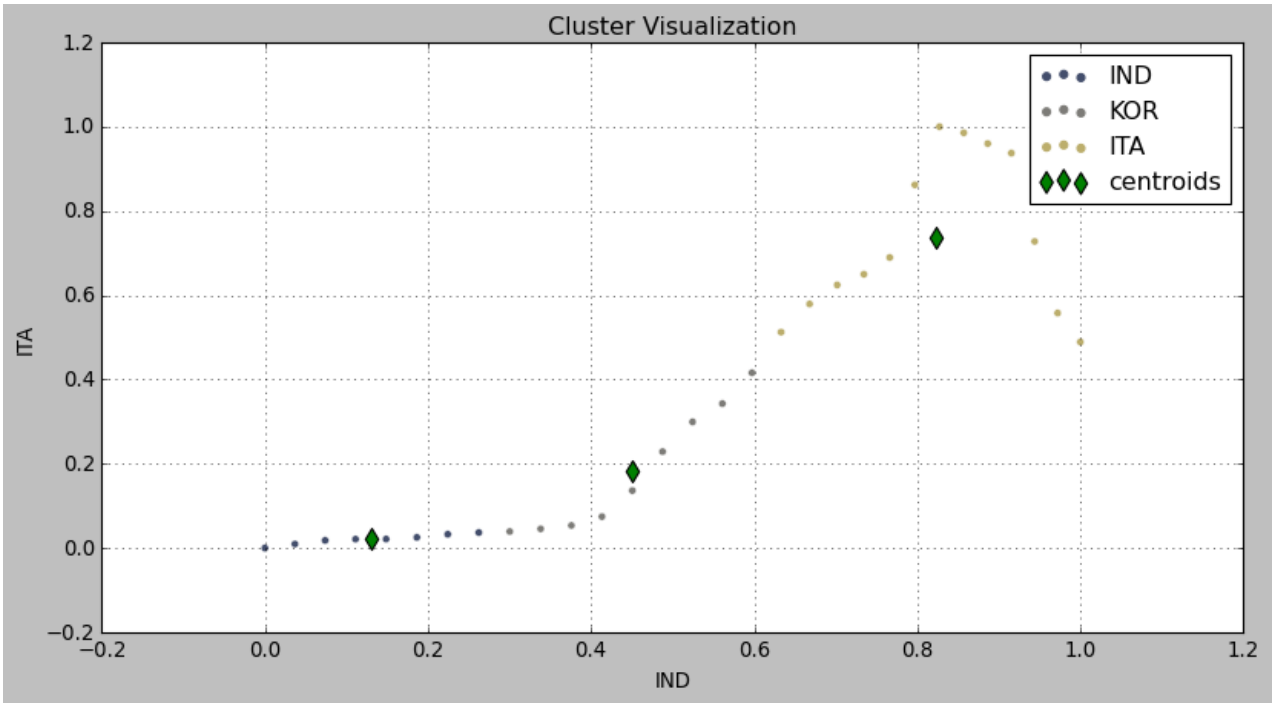
```
0 Custer Centre(Co-ord): 0.13045815464163002,0.02063530796242552,0.1938668296106768
1 Custer Centre(Co-ord): 0.8233324941047491,0.7364914615232437,0.859192655110083
2 Custer Centre(Co-ord): 0.44990523576047636,0.1818237378698419,0.5429161875196864
```

In [112…

```
klb=[]
for i in kmeans.labels_:
    if i==0:
        klb.append(my_data1.columns[0])
    elif i==1:
        klb.append(my_data1.columns[1])
    elif i==2:
        klb.append(my_data1.columns[2])
```

In [113…

```
df=pd.DataFrame(norml,columns=my_data1.columns)
plt.figure(figsize=(12,6))
plt.title('Cluster Visualization')
sns.scatterplot(data=df, x="IND", y="ITA", hue=klb,palette="cividis")
plt.scatter(kmeans.cluster_centers_[:,0], kmeans.cluster_centers_[:,1], marker="d", c="
plt.grid()
plt.legend()
plt.show()
```



Curve Fitting

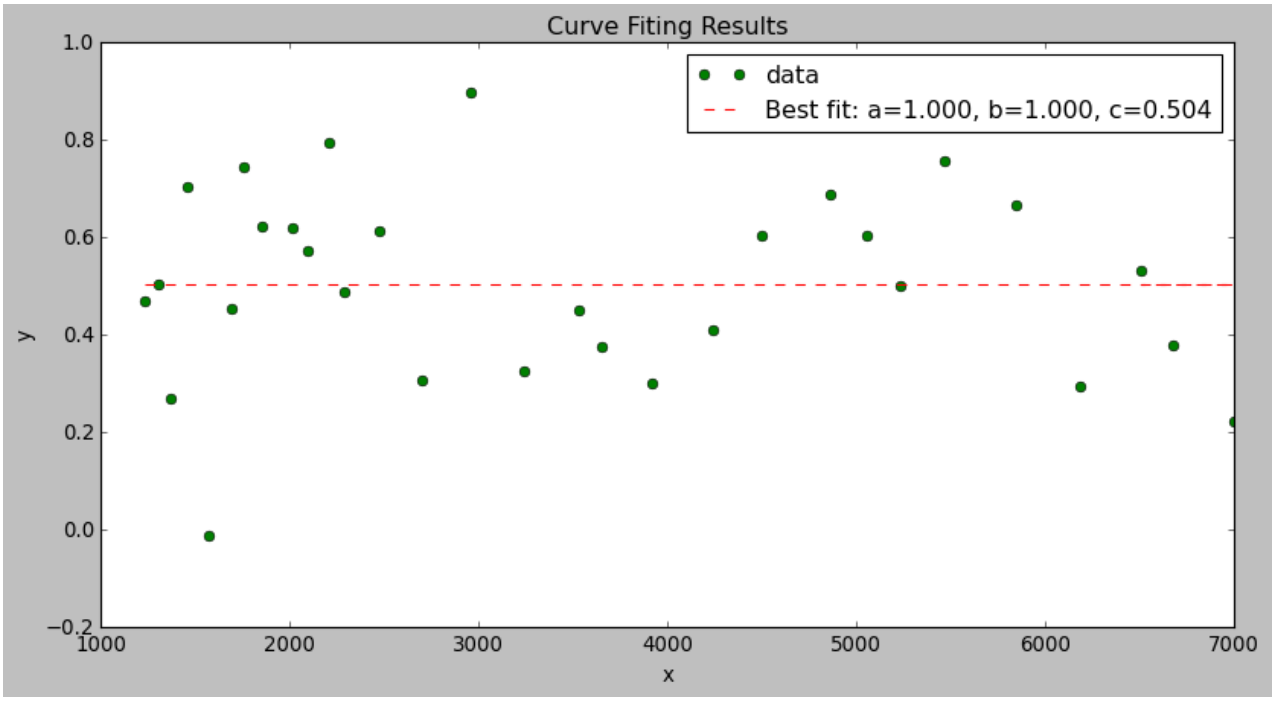
In [114…
```
from scipy.optimize import curve_fit
```

In [115…
```
def exponent(x, a, b, c):
    return a * np.exp(-b * x) + c
```

In [116…
```
y = exponent(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 [117…
```
popt, pcov = curve_fit(exponent, my_data2.values[:,1], ydata)
```

In [119…
```
plt.figure(figsize=(12,6))
plt.title('Curve Fiting Results')
plt.plot(my_data2.values[:,0], ydata, 'go', label='data')
plt.plot(my_data2.values[:,0], exponent(my_data2.values[:,0], *popt), 'r--',label='Best
plt.xlabel('x')
plt.ylabel('y')
plt.legend()
plt.show()
```


Curve Fiting Results
data
Best fit: a=1.000, b=1.000, c=0.504
y
x
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
1000
2000
3000
4000
5000
6000
7000

In [ ]: