NAME - Sai Bhavani pindi

In [1]:

```
pip install wbgapi
```

```
Requirement already satisfied: wbgapi in /Users/saibhavani/opt/anaconda3/lib/python3.9/site-packages (1.0.7)
Requirement already satisfied: requests in /Users/saibhavani/opt/anaconda3/lib/python3.9/site-packages (from wbgapi) (2.26.0)
Requirement already satisfied: tabulate in /Users/saibhavani/opt/anaconda3/lib/python3.9/site-packages (from wbgapi) (0.8.9)
Requirement already satisfied: PyYAML in /Users/saibhavani/opt/anaconda3/lib/python3.9/site-packages (from wbgapi) (6.0)
Requirement already satisfied: certifi>=2017.4.17 in /Users/saibhavani/opt/anaconda3/lib/python3.9/site-packages (from requests->wbgapi) (2021.10.8)
Requirement already satisfied: idna<4,>=2.5 in /Users/saibhavani/opt/anaconda3/lib/python3.9/site-packages (from requests->wbgapi) (3.2)
Requirement already satisfied: charset-normalizer~=2.0.0 in /Users/saibhavani/opt/anaconda3/lib/python3.9/site-packages (from requests->wbgapi) (2.0.4)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /Users/saibhavani/opt/anaconda3/lib/python3.9/site-packages (from requests->wbgapi) (1.26.7)
Note: you may need to restart the kernel to use updated packages.
```

In [2]:

```
import pandas as pd
import wbgapi as wb
import sklearn
from scipy.optimize import curve_fit
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans
import matplotlib.pyplot as plt
import seaborn as sns
from scipy.optimize import curve_fit
import warnings
from sklearn.preprocessing import StandardScaler
```

In [3]:

```
#Function creation for loading of the data
def output(flnm):
    text=pd.read_csv(flnm)
    return text
```

In [4]:

```
#Calling the function
text=output("World Indicator Repository.csv")
```

In [5]:

```
#Seeing first few rows
text.head(5)
```

Out[5]:

	Country Name	Country Code	Series Name	Series Code	2017 [YR2017]	2018 [YR2018]	[YI
0	Afghanistan	AFG	Access to clean fuels and technologies for coo...	EG.CFT.ACCS.ZS	29.7	30.9	
1	Afghanistan	AFG	Access to clean fuels and technologies for coo...	EG.CFT.ACCS.RU.ZS	13	13.85	
2	Afghanistan	AFG	Access to clean fuels and technologies for coo...	EG.CFT.ACCS.UR.ZS	80.9	81.6	
3	Afghanistan	AFG	Access to electricity (% of population)	EG.ELC.ACCS.ZS	97.69999695	96.61613464	97.699
4	Afghanistan	AFG	Access to electricity, rural (% of rural popul...	EG.ELC.ACCS.RU.ZS	97.09197235	95.58617401	97.07

In [6]:

```
text1=text.transpose()
text1.head(6)
```

Out[6]:

	0	1	2	3	
Country Name	Afghanistan	Afghanistan	Afghanistan	Afghanistan	
Country Code	AFG	AFG	AFG	AFG	
Series Name	Access to clean fuels and technologies for coo...	Access to clean fuels and technologies for coo...	Access to clean fuels and technologies for coo...	Access to electricity (% of population)	electr of
Series Code	EG.CFT.ACCS.ZS	EG.CFT.ACCS.RU.ZS	EG.CFT.ACCS.UR.ZS	EG.ELC.ACCS.ZS	EG.ELC
2017 [YR2017]	29.7	13	80.9	97.69999695	
2018 [YR2018]	30.9	13.85	81.6	96.61613464	

6 rows × 1867 columns

In [7]:

```
indctrs_GDP = ['NY.GDP.MKTP.PP.CD','SL.TLF.CACT.NE.ZS']
c_cde = ["GHA","ARG",'DNK','BGD','CHE','ESP','BRA','LUX','IND','AUS']
indctrs_CLIM=['EN.ATM.CO2E.PC','EN.ATM.PM25.MC.T1.ZS']
dataset_GDP  = wb.data.DataFrame(indctrs_GDP, c_cde, mrv=6)
dataset_CLIM = wb.data.DataFrame(indctrs_CLIM, c_cde, mrv=6)

#NY.GDP.MKTP.PP.CD: GDP, PPP in USD
#SL.TLF.CACT.NE.ZS: Labor force participation rate, total (% of total popu
#EN.ATM.CO2E.PC:        CO2 emissions calculated in metric tons per capita
#EN.ATM.PM25.MC.T1.ZS   PM2.5 pollution, population exposed to levels exce
```

In [8]:

```
# GDP indicators
dataset_GDP.columns = [a.replace('YR','') for a in dataset_GDP.columns]
dataset_GDP=dataset_GDP.stack().unstack(level=1)
dataset_GDP.index.names = ['Cntry_Code', 'Year']
dataset_GDP.columns
dataset_GDP.fillna(0)
dataset_GDP.head(8)
```

Out[8]:

	series	NY.GDP.MKTP.PP.CD	SL.TLF.CACT.NE.ZS
Cntry_Code	**Year**		
ARG	**2016**	8.852275e+11	NaN
	2017	1.039331e+12	58.810001
	2018	1.036428e+12	59.599998
	2019	1.033558e+12	60.290001
	2020	9.425083e+11	56.020000
AUS	**2016**	1.143149e+12	64.870003
	2017	1.190694e+12	65.169998
	2018	1.253361e+12	65.629997

In [9]:

```
#Climate indicators
dataset_CLIM.columns = [a.replace('YR','') for a in dataset_CLIM.columns]
dataset_CLIM=dataset_CLIM.stack().unstack(level=1)
dataset_CLIM.index.names = ['Cntry_Code', 'Year']
dataset_CLIM.columns
dataset_CLIM.fillna(0)
dataset_CLIM.head(8)
```

Out[9]:

	series	EN.ATM.CO2E.PC	EN.ATM.PM25.MC.T1.ZS
Cntry_Code	**Year**		
ARG	**2013**	4.359886	0.825134
	2014	4.216361	0.177212
	2015	4.314434	0.306158
	2016	4.227539	0.061206
	2017	4.089472	0.061212
	2018	3.987234	NaN
AUS	**2013**	16.398646	0.000000
	2014	15.755876	0.000000

In [10]:

```
dataset_GDP.head(10)
```

Out[10]:

	series	NY.GDP.MKTP.PP.CD	SL.TLF.CACT.NE.ZS
Cntry_Code	**Year**		
ARG	**2016**	8.852275e+11	NaN
	2017	1.039331e+12	58.810001
	2018	1.036428e+12	59.599998
	2019	1.033558e+12	60.290001
	2020	9.425083e+11	56.020000
AUS	**2016**	1.143149e+12	64.870003
	2017	1.190694e+12	65.169998
	2018	1.253361e+12	65.629997
	2019	1.312637e+12	65.949997
	2020	1.369885e+12	65.029999

In [11]:

```
#Resetting index and treatment of null values
dataset1=dataset_GDP.reset_index()
dataset2=dataset_CLIM.reset_index()
dataset3=dataset1.fillna(0)
dataset4=dataset2.fillna(0)
```

In [12]:

```
#Joining climate and gdp data
dataset_final = pd.merge(dataset3, dataset4)
dataset_final.head(12)
```

Out[12]:

series	Cntry_Code	Year	NY.GDP.MKTP.PP.CD	SL.TLF.CACT.NE.ZS	EN.ATM.CO2E.PC	EN.AT
0	ARG	2016	8.852275e+11	0.000000	4.227539	
1	ARG	2017	1.039331e+12	58.810001	4.089472	
2	ARG	2018	1.036428e+12	59.599998	3.987234	
3	AUS	2016	1.143149e+12	64.870003	15.872080	
4	AUS	2017	1.190694e+12	65.169998	15.738647	
5	AUS	2018	1.253361e+12	65.629997	15.475516	
6	BGD	2016	6.080474e+11	56.090000	0.466776	
7	BGD	2017	6.644037e+11	58.330002	0.492907	
8	BGD	2018	7.338574e+11	0.000000	0.512837	
9	BRA	2016	2.939094e+12	63.480000	2.143498	
10	BRA	2017	3.018706e+12	63.790001	2.164422	
11	BRA	2018	3.146321e+12	63.860001	2.041874	

In [13]:

```
#Dataset normalization
data = dataset_final.iloc[:,2:]
dataset_final.iloc[:,2:] = (data-data.min())/ (data.max() - data.min())
dataset_final.head(6)
```

Out[13]:

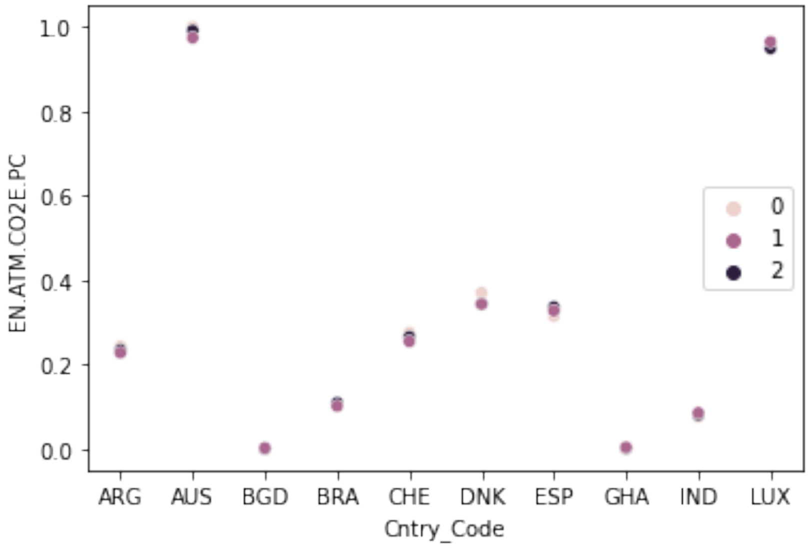
series	Cntry_Code	Year	NY.GDP.MKTP.PP.CD	SL.TLF.CACT.NE.ZS	EN.ATM.CO2E.PC	EN.AT
0	ARG	2016	0.091399	0.000000	0.244121	
1	ARG	2017	0.108592	0.857664	0.235159	
2	ARG	2018	0.108268	0.869185	0.228522	
3	AUS	2016	0.120174	0.946041	1.000000	
4	AUS	2017	0.125479	0.950416	0.991339	
5	AUS	2018	0.132470	0.957124	0.974258	

In [14]:

```
#Clustering by K-means algorithm
dataset_final1 = dataset_final.drop('Cntry_Code', axis = 1)
kms = KMeans(n_clusters=3, init='k-means++', random_state=0).fit(dataset_f
```

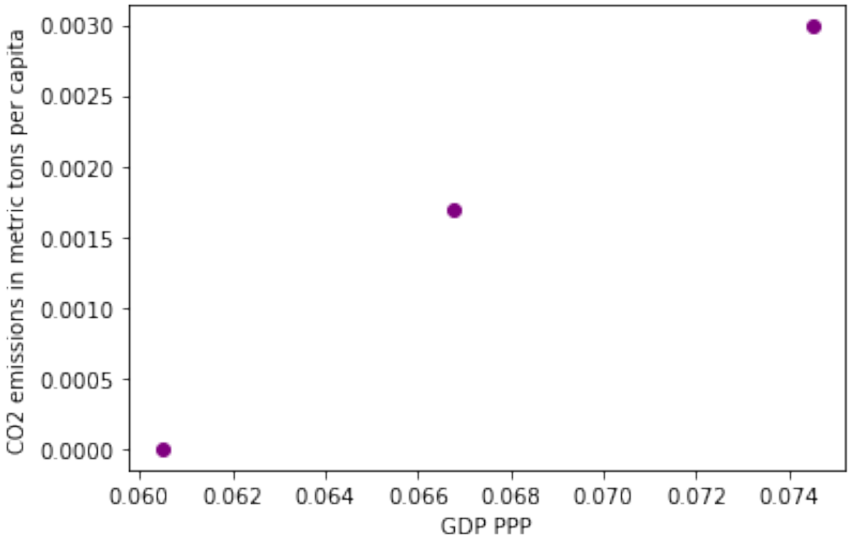
In [15]:

```
#Clustering the data based on CO2 emissions (metric tons per capita)
sns.scatterplot(data=dataset_final, x="Cntry_Code", y="EN.ATM.CO2E.PC", hue
plt.legend(loc='center right')
plt.show()
```



In [16]:

```
#Scatter plot for relationship between
cont=dataset_final[(dataset_final['Cntry_Code']=='BGD')]
data = cont.values
x, y = data[:, 2], data[:, 4]
plt.scatter(x, y,color="purple")
plt.xlabel('GDP PPP')
plt.ylabel('CO2 emissions in metric tons per capita')
plt.show()
```



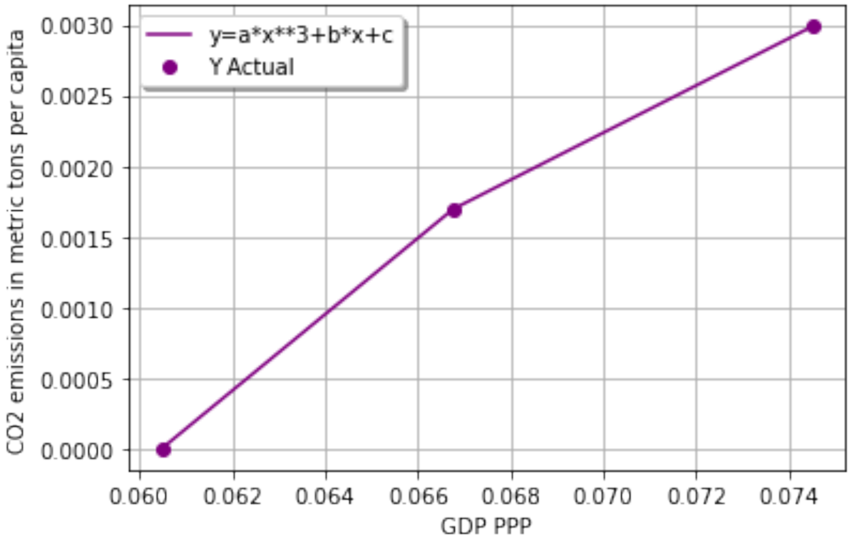
In [17]:

```
#Using curve_fit function for Bangladesh which has a low CO2 emissions (me
x, y = data[:, 2], data[:, 4]

def f(x, a, b, c):
    return a*x**3+b*x+c
prm, co = curve_fit(f, x, y)
print("Covariance ->: ", co)
print("Params ->: ", prm)
prm, _ = curve_fit(f, x, y)
a, b, c = prm[0], prm[1], prm[2]
yfit = a*x**3+b*x+c

with warnings.catch_warnings(record=True):
    plt.plot(x, yfit, label="y=a*x**3+b*x+c",color="purple")
    plt.grid(True)
    plt.xlabel('GDP PPP')
    plt.ylabel('CO2 emissions in metric tons per capita')
    plt.plot(x, y, 'bo', label="Y Actual",color="purple")
    plt.legend(loc='best', fancybox=True, shadow=True)
    plt.show()
```

```
Covariance ->:  [[inf inf inf]
 [inf inf inf]
 [inf inf inf]]
Params ->:  [-3.63058502e+01  7.10970111e-01 -3.49663317e-02]
/Users/saibhavani/opt/anaconda3/lib/python3.9/site-packages/scipy/optimize/
minpack.py:833: OptimizeWarning: Covariance of the parameters could not be
estimated
  warnings.warn('Covariance of the parameters could not be estimated',
```



In [18]:

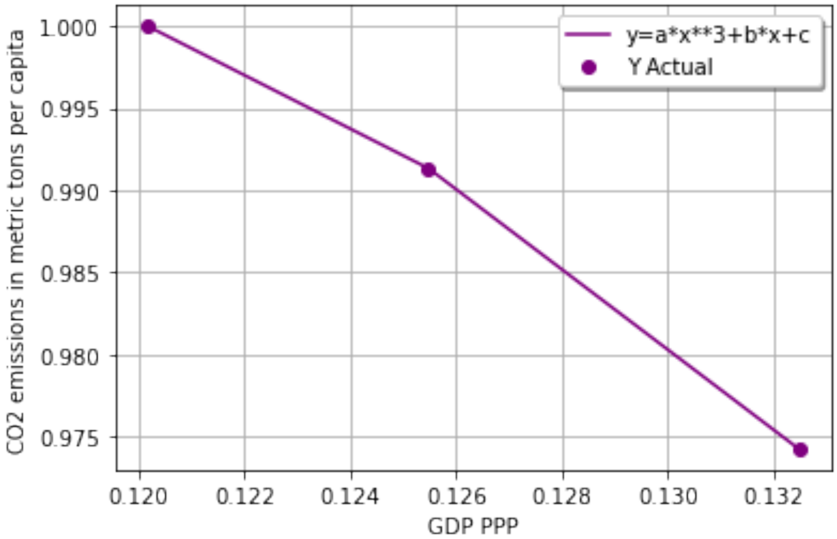
```
#Using curve_fit function for Australia which has a high CO2 emissions (me
cont1=dataset_final[(dataset_final['Cntry_Code']=='AUS')]
data2 = cont1.values

x, y = data2[:, 2], data2[:, 4]

def f(x, a, b, c):
    return a*x**3+b*x+c
prm, co = curve_fit(f, x, y)
print("Covariance ->: ", co)
print("Params ->: ", prm)
prm, _ = curve_fit(f, x, y)
a, b, c = prm[0], prm[1], prm[2]
yfit = a*x**3+b*x+c

with warnings.catch_warnings(record=True):
    plt.plot(x, yfit, label="y=a*x**3+b*x+c",color="purple")
    plt.grid(True)
    plt.xlabel('GDP PPP')
    plt.ylabel('CO2 emissions in metric tons per capita')
    plt.plot(x, y, 'bo', label="Y Actual",color="purple")
    plt.legend(loc='best', fancybox=True, shadow=True)
    plt.show()
```

```
Covariance ->:  [[inf inf inf]
 [inf inf inf]
 [inf inf inf]]
Params ->:  [-174.26176324    6.25525835    0.55071692]
/Users/saibhavani/opt/anaconda3/lib/python3.9/site-packages/scipy/optimize/
minpack.py:833: OptimizeWarning: Covariance of the parameters could not be
estimated
  warnings.warn('Covariance of the parameters could not be estimated',
```



In [19]:

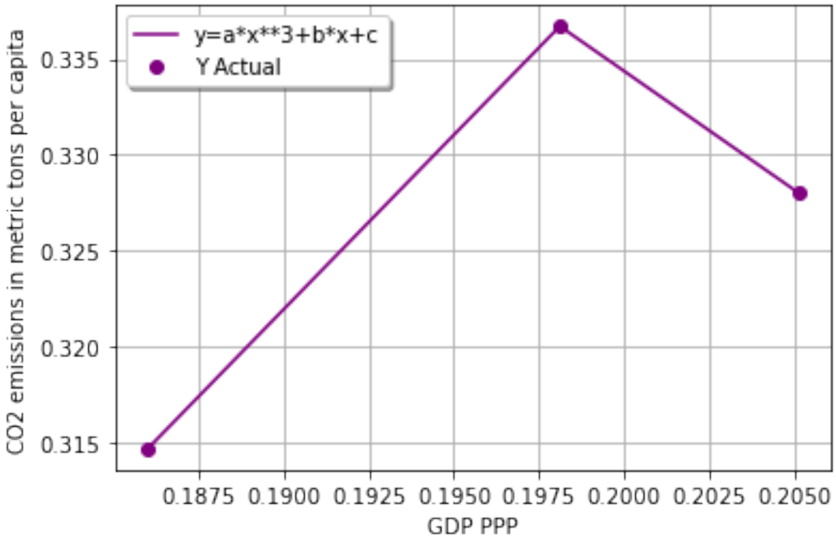
```
#Using curve_fit function for Spain which has a medium CO2 emissions (metr
cont4=dataset_final[(dataset_final['Cntry_Code']=='ESP')]
data4 = cont4.values

x, y = data4[:, 2], data4[:, 4]

def f(x, a, b, c):
    return a*x**3+b*x+c
prm, co = curve_fit(f, x, y)
print("Covariance ->: ", co)
print("Params ->: ", prm)
prm, _ = curve_fit(f, x, y)
a, b, c = prm[0], prm[1], prm[2]
yfit = a*x**3+b*x+c

with warnings.catch_warnings(record=True):
    plt.plot(x, yfit, label="y=a*x**3+b*x+c",color="purple")
    plt.grid(True)
    plt.xlabel('GDP PPP')
    plt.ylabel('CO2 emissions in metric tons per capita')
    plt.plot(x, y, 'bo', label="Y Actual",color="purple")
    plt.legend(loc='best', fancybox=True, shadow=True)
    plt.show()
```

```
/Users/saibhavani/opt/anaconda3/lib/python3.9/site-packages/scipy/optimize/
minpack.py:833: OptimizeWarning: Covariance of the parameters could not be
estimated
  warnings.warn('Covariance of the parameters could not be estimated',
Covariance ->:  [[inf inf inf]
 [inf inf inf]
 [inf inf inf]]
Params ->:  [-271.85082678   31.91435753   -3.87210173]
```



CONCLUSION

The country which has a high CO2 emissions in metric tons per capita has an indirect relationship between the CO2 emissions (metric tons per capita) and the purchase power parity GDP. The country which has a medium CO2 emissions in metric tons per capita has an direct relationship between the CO2 emissions (metric tons per capita) and the purchase power parity GDP at the beginning which is converted to an indirect relationship after a certain threshold of GDP, PPP. The country which has a low CO2 emissions in metric tons per capita has a direct relationship between the CO2 emissions (metric tons per capita) and the purchase power parity GDP.

In [20]:
```
def err_ranges(x, func, param, sigma):
    import itertools as iter
    # initiate arrays for lower and upper limits
    lower = func(x, *param)
    upper = lower

    uplow = []   # list to hold upper and lower limits for parameters
    for p,s in zip(param, sigma):
        pmin = p - s
        pmax = p + s
        uplow.append((pmin, pmax))

    pmix = list(iter.product(*uplow))

    for p in pmix:
        y = func(x, *p)
        lower = np.minimum(lower, y)
        upper = np.maximum(upper, y)

    return lower, upper
```

In [ ]:

In [ ]: