In [2]:
```python
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 AgglomerativeClustering
import matplotlib.pyplot as plt
from kneed import KneeLocator
from sklearn.preprocessing import normalize
import scipy.cluster.hierarchy as shc
```

Clustering (K-Means)

In [3]:
```python
country_codes = ['CHN','IRQ','IND']
ind1=["EN.ATM.CO2E.KT"]   # C02 Emission
ind2=["EN.ATM.METH.KT.CE"]   # Mithene Emission
```

In [4]:
```python
df1  = wb.data.DataFrame(ind1, country_codes, mrv=20).T
df1=df1.fillna(df1.mean())
df1.head()
```

Out[4]:

economy	CHN	IND	IRQ
YR1999	3149200.0	904090.0	64610.0
YR2000	3344090.0	940170.0	74570.0
YR2001	3526750.0	953880.0	84300.0
YR2002	3808330.0	987530.0	79410.0
YR2003	4413300.0	1015890.0	72080.0

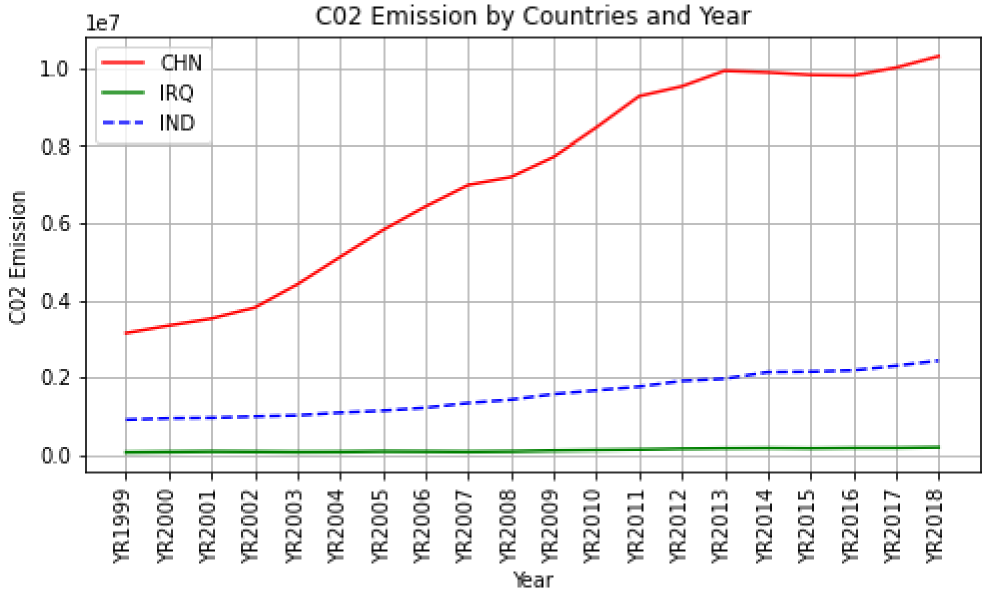
In [5]:
```python
df2  = wb.data.DataFrame(ind2, country_codes, mrv=20).T
df2=df2.fillna(df2.mean())
df2.head()
```

Out[5]:

economy	CHN	IND	IRQ
YR1999	825690.0	584490.0	10760.0
YR2000	829610.0	589050.0	11050.0
YR2001	824170.0	594700.0	11140.0
YR2002	819890.0	589390.0	11400.0
YR2003	815910.0	598510.0	10830.0

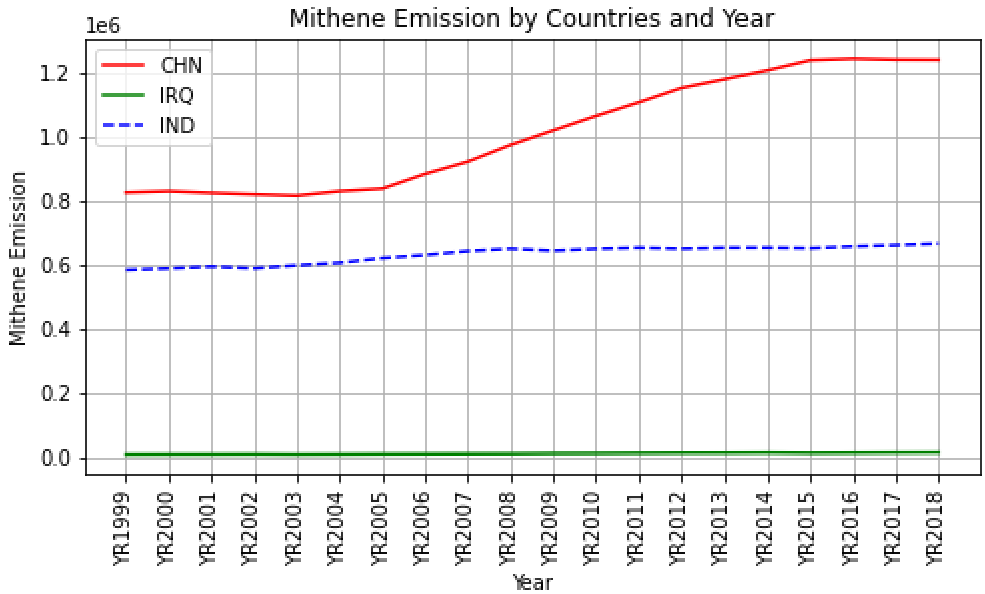
In [6]:
```python
plt.figure(figsize=(8,4))
plt.title('C02 Emission by Countries and Year')
plt.plot(df1['CHN'],"r-",label="CHN")
plt.plot(df1['IRQ'],"g-",label="IRQ")
plt.plot(df1['IND'],"b--",label="IND")
plt.xlabel("Year")
```

```
plt.xticks(rotation=90)
plt.ylabel("C02 Emission")
plt.legend(loc="upper left")
plt.grid()
plt.show()
```



In [7]:

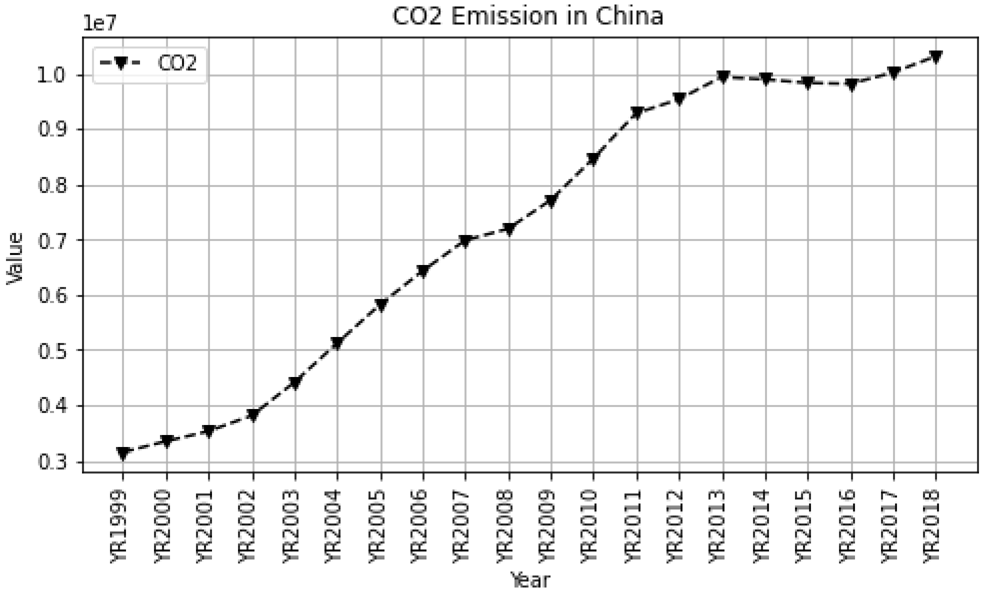
```
plt.figure(figsize=(8,4))
plt.title('Mithene Emission by Countries and Year')
plt.plot(df2['CHN'],"r-",label="CHN")
plt.plot(df2['IRQ'],"g-",label="IRQ")
plt.plot(df2['IND'],"b--",label="IND")
plt.xlabel("Year")
plt.xticks(rotation=90)
plt.ylabel("Mithene Emission")
plt.grid()
plt.legend(loc="best")
plt.show()
```

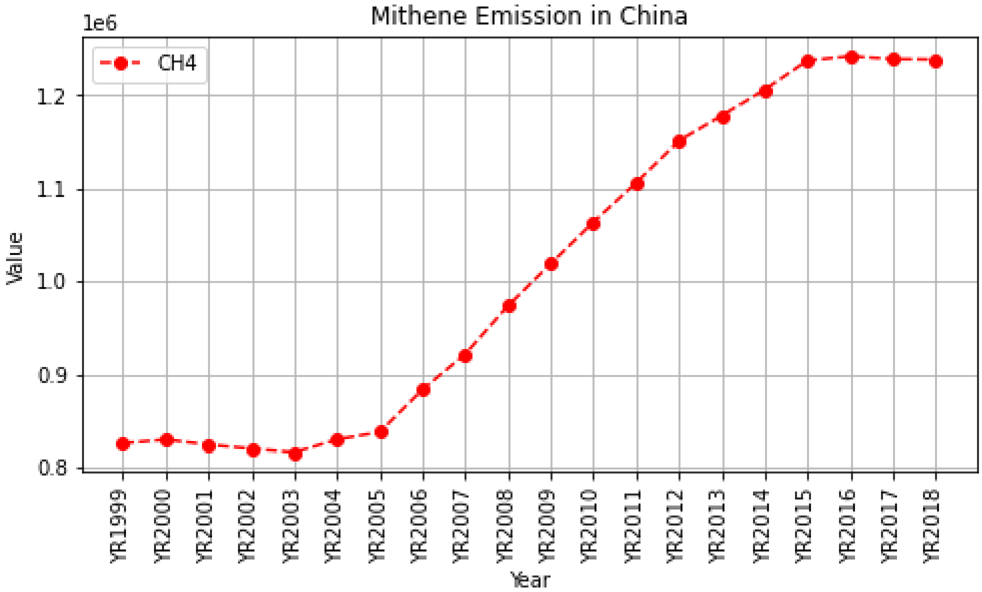


In [8]:

```
plt.figure(figsize=(8,4))
plt.title('CO2 Emission in China')
plt.plot(df1['CHN'],"kv--",label="CO2")
```

```
plt.xlabel("Year")
plt.xticks(rotation=90)
plt.ylabel("Value")
plt.legend(loc="upper left")
plt.grid()
plt.show()
plt.figure(figsize=(8,4))
plt.title('Mithene Emission in China')
plt.plot(df2['CHN'],"ro--",label="CH4")
plt.xlabel("Year")
plt.xticks(rotation=90)
plt.ylabel("Value")
plt.legend(loc="upper left")
plt.grid()
plt.show()
```

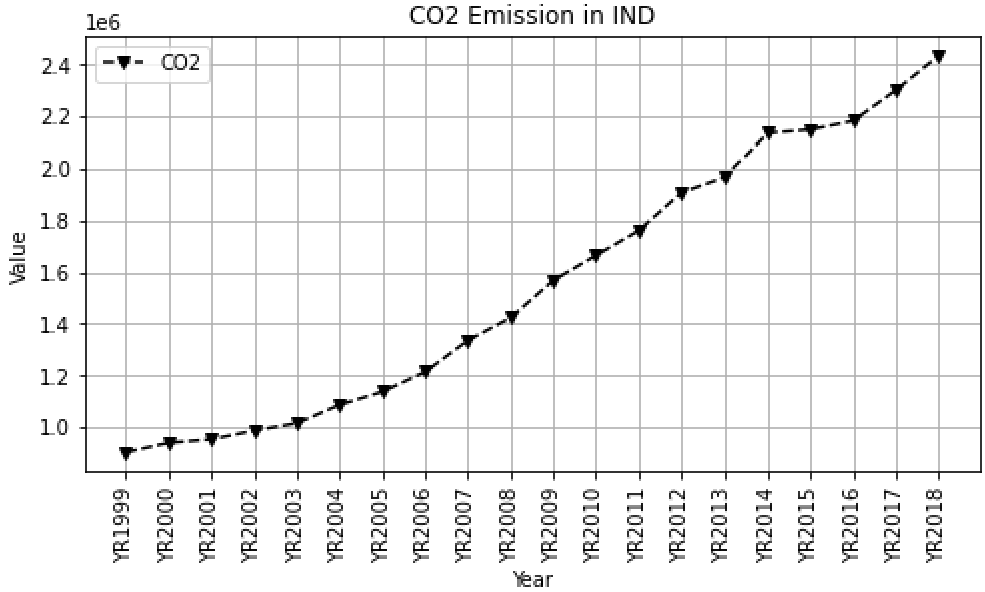


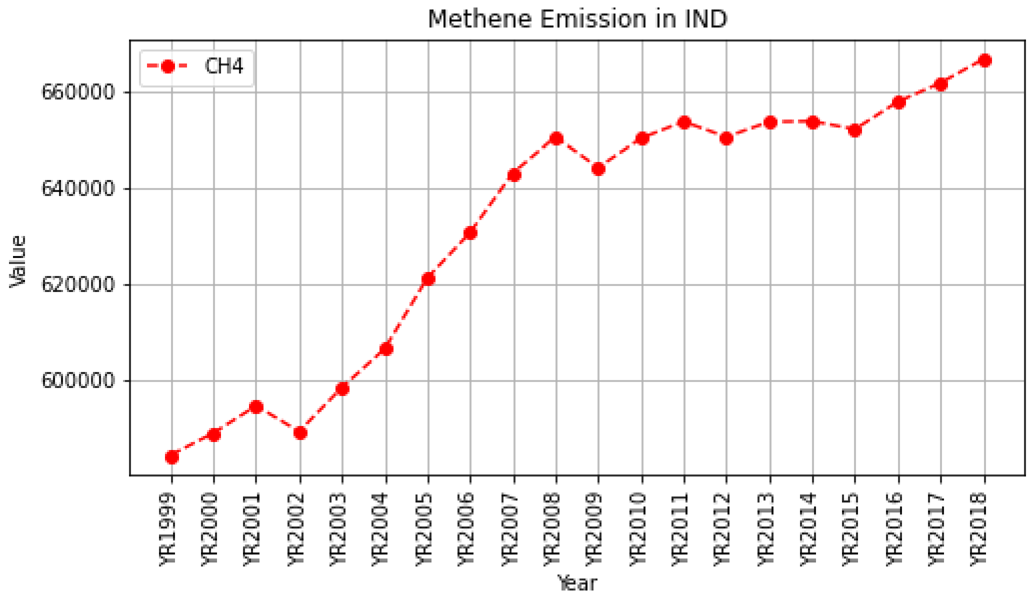


In [9]:

```
plt.figure(figsize=(8,4))
plt.title('CO2 Emission in IND')
plt.plot(df1['IND'],"kv--",label="CO2")
plt.xlabel("Year")
plt.xticks(rotation=90)
plt.ylabel("Value")
plt.legend(loc="upper left")
```

```
plt.grid()
plt.show()
plt.figure(figsize=(8,4))
plt.title('Methene Emission in IND')
plt.plot(df2['IND'],"ro--",label="CH4")
plt.xlabel("Year")
plt.xticks(rotation=90)
plt.ylabel("Value")
plt.legend(loc="upper left")
plt.grid()
plt.show()
```





In [10]:

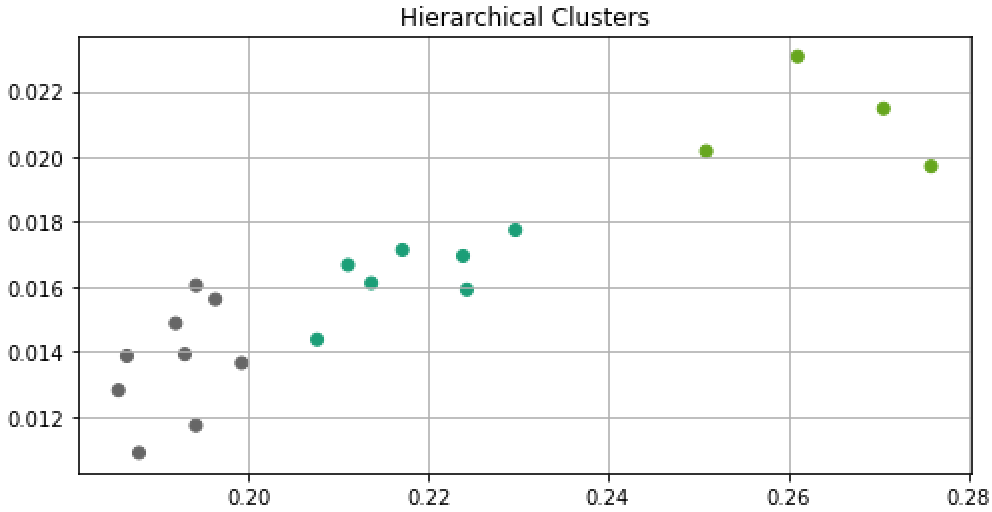
```
def normlz(data):
    nm=normalize(data)
    return nm
data=normlz(df1.values)
```

In [11]:

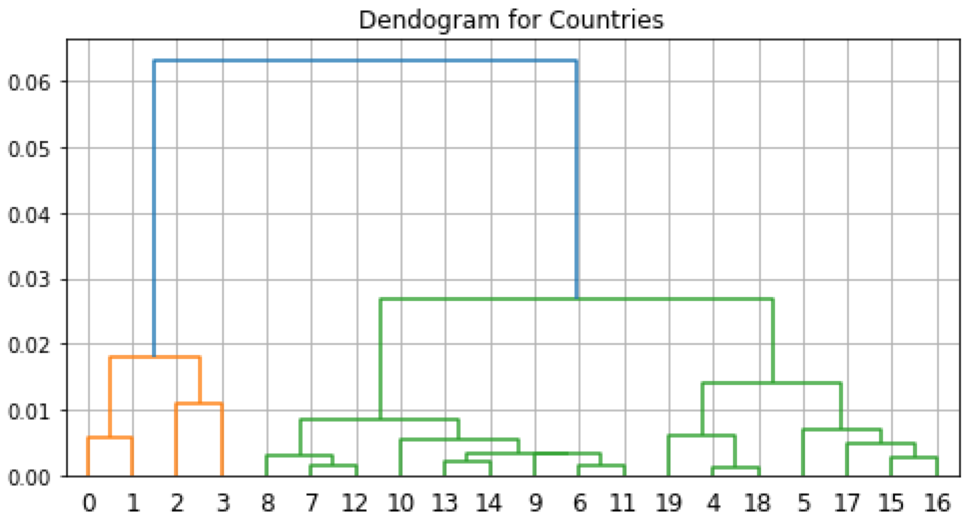
```
aggl = AgglomerativeClustering(n_clusters=3, affinity='euclidean', linka
yhat = aggl.fit_predict(data)
clusters = np.unique(yhat)
clusters
```

Out[11]: array([0, 1, 2], dtype=int64)

In [12]:
```
plt.figure(figsize=(8,4))
plt.title('Hierarchical Clusters')
plt.scatter(data[:,1],data[:,2], c=aggl.labels_, cmap='Dark2')
plt.grid()
plt.show()
```



In [16]:
```
plt.figure(figsize=(8,4))
plt.title("Dendogram for Countries")
dend = shc.dendrogram(shc.linkage(data, method='centroid'))
plt.grid()
plt.show()
```



Curve Fitting

In [18]:
```
from scipy.optimize import curve_fit
#!pip install lmfit
from lmfit import Model
```

In [19]:
```
def gaussian(x, amp, cen, wid):
    return (amp / (np.sqrt(2*np.pi) * wid)) * np.exp(-(x-cen)**2 / (2*wi
```

In [20]:

```
norml = normlz(df2.values)
y = gaussian(norml[:,1], 2.33, 0.21, 1.51) + np.random.normal(0, 0.2, no
init_vals = [1,0,1]
best_vals, covar = curve_fit(gaussian, norml[:,1], y, p0=init_vals,maxfe
gaus_model = Model(gaussian)
res = gaus_model.fit(y, x=norml[:,2], amp=5, cen=5, wid=1)
print(res.fit_report())
```

```
[[Model]]
    Model(gaussian)
[[Fit Statistics]]
    # fitting method   = leastsq
    # function evals   = 53
    # data points      = 20
    # variables        = 3
    chi-square         = 0.86097405
    reduced chi-square = 0.05064553
    Akaike info crit   = -56.9084637
    Bayesian info crit = -53.9212669
##  Warning: uncertainties could not be estimated:
[[Variables]]
    amp:  43449.6344 +/-        nan (nan%) (init = 5)
    cen: -330.729752 +/-        nan (nan%) (init = 5)
    wid:  98.4282254 +/-        nan (nan%) (init = 1)
```

In [21]:

```
res
```

Out[21]:

Model

Model(gaussian)

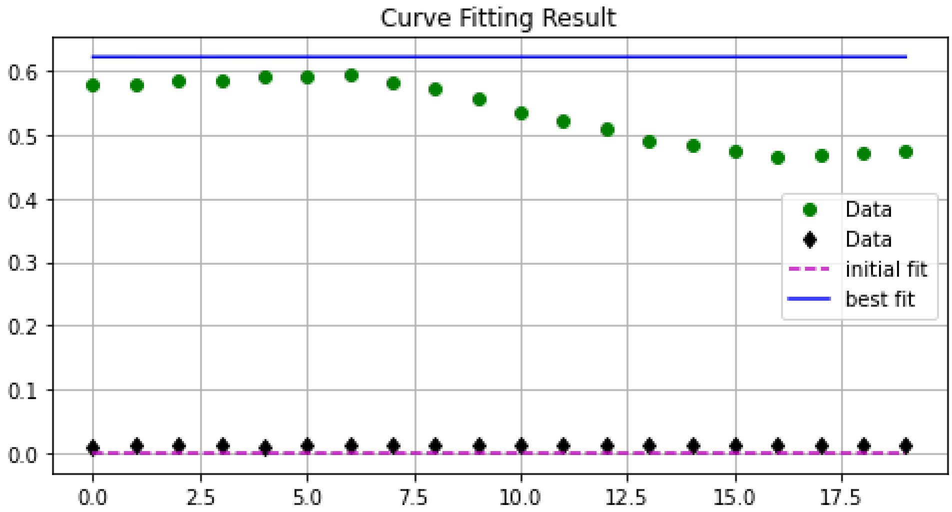
Fit Statistics

fitting method	leastsq
# function evals	53
# data points	20
# variables	3
chi-square	0.86097405
reduced chi-square	0.05064553
Akaike info crit.	-56.9084637
Bayesian info crit.	-53.9212669

Variables

name	value	standard error	relative error	initial value	min	max	vary
amp	43449.6344	nan	(nan%)	5	-inf	inf	True
cen	-330.729752	nan	(nan%)	5	-inf	inf	True
wid	98.4282254	nan	(nan%)	1	-inf	inf	True

In [22]:
```
plt.figure(figsize=(8,4))
plt.title('Curve Fitting Result')
plt.plot(norml[:,1],"go",label="Data")
plt.plot(norml[:,2],"kd",label="Data")
plt.plot(res.init_fit, 'm--', label='initial fit')
plt.plot(res.best_fit, 'b-', label='best fit')
plt.legend()
plt.grid()
plt.show()
```



In [ ]: