In [47]:
```
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
sns.set()
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

In [48]:
```
country_codes = ['TUR','GHA','IND']
ind1=["EN.ATM.CO2E.KT"]  # C02 Emission
ind2=["EN.ATM.NOXE.KT.CE"]  # Nitrus Oxide Emission
```

In [49]:
```
df1  = wb.data.DataFrame(ind1, country_codes, mrv=20).T
df1=df1.fillna(df1.mean())
df1.head()
```

Out[49]:

economy	GHA	IND	TUR
YR1999	6580.0	904090.0	192870.0
YR2000	5740.0	940170.0	216620.0
YR2001	6210.0	953880.0	197780.0
YR2002	7420.0	987530.0	208120.0
YR2003	7130.0	1015890.0	219160.0

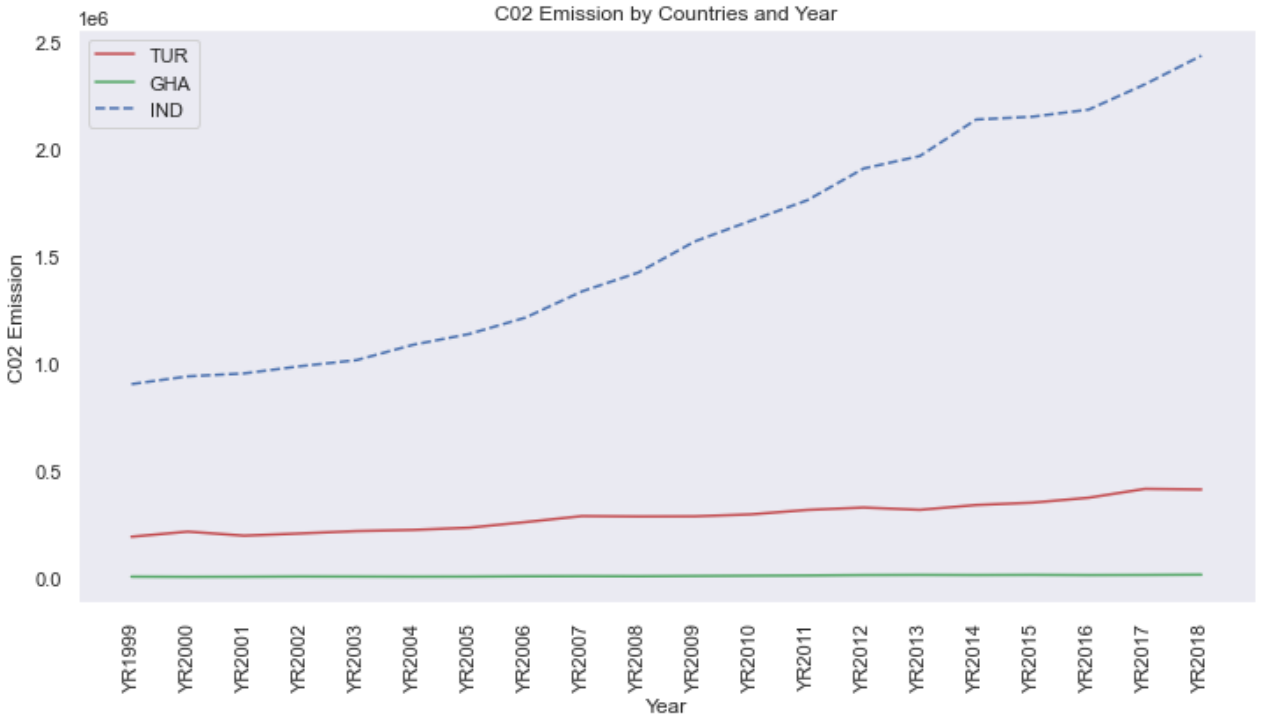
In [50]:
```
df2  = wb.data.DataFrame(ind2, country_codes, mrv=20).T
df2=df2.fillna(df2.mean())
df2.head()
```

Out[50]:

economy	GHA	IND	TUR
YR1999	4120.0	182970.0	28080.0
YR2000	4750.0	180770.0	27620.0
YR2001	4200.0	185000.0	25020.0
YR2002	4160.0	179100.0	25360.0
YR2003	4540.0	186410.0	26220.0

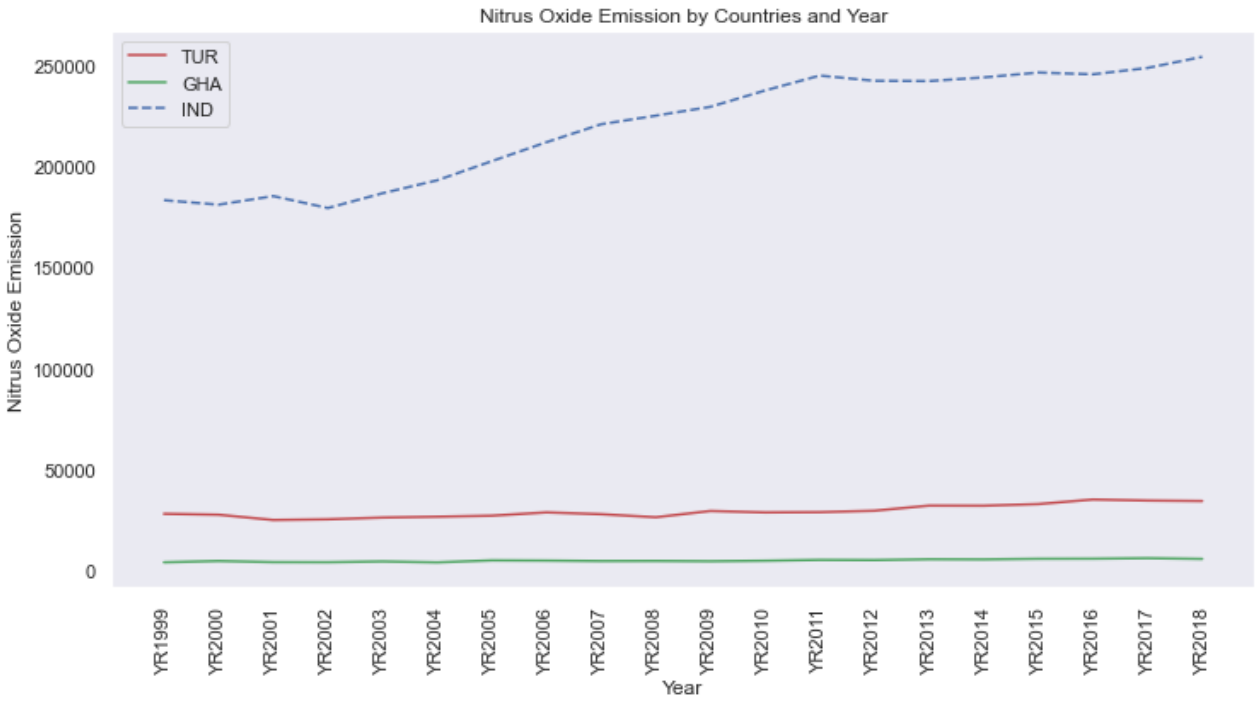
In [51]:
```
plt.figure(figsize=(12,6))
```

```
plt.title('C02 Emission by Countries and Year')
plt.plot(df1['TUR'],"r-",label="TUR")
plt.plot(df1['GHA'],"g-",label="GHA")
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()
```



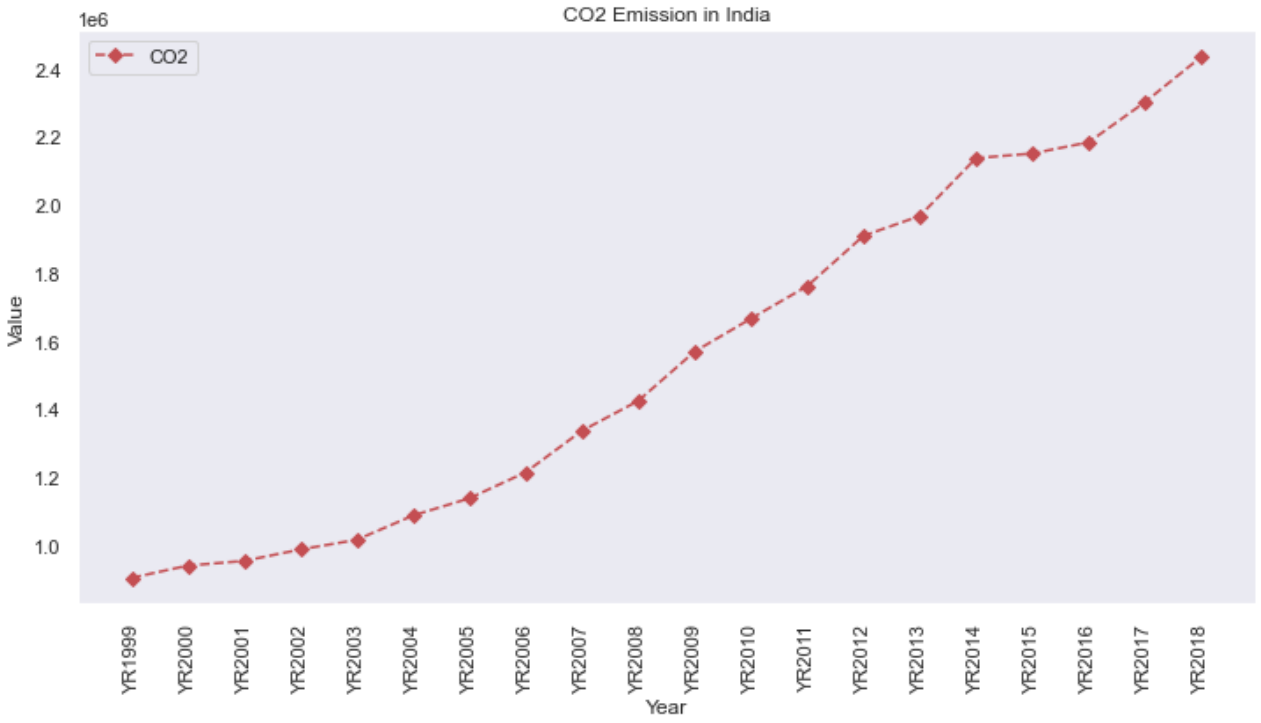
In [52]:

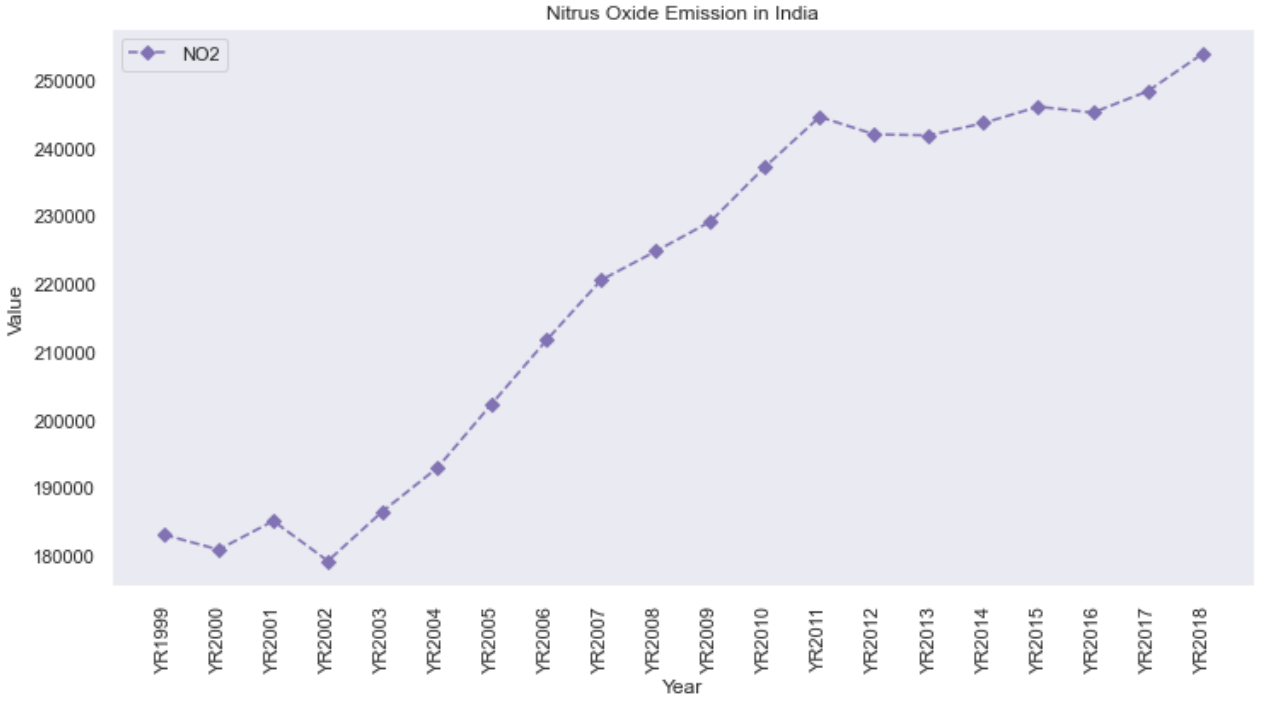
```
plt.figure(figsize=(12,6))
plt.title('Nitrus Oxide Emission by Countries and Year')
plt.plot(df2['TUR'],"r-",label="TUR")
plt.plot(df2['GHA'],"g-",label="GHA")
plt.plot(df2['IND'],"b--",label="IND")
plt.xlabel("Year")
plt.xticks(rotation=90)
plt.ylabel("Nitrus Oxide Emission")
plt.grid()
plt.legend(loc="best")
plt.show()
```



In [53]:

```
plt.figure(figsize=(12,6))
plt.title('CO2 Emission in India')
plt.plot(df1['IND'],"rD--",label="CO2")
plt.xlabel("Year")
plt.xticks(rotation=90)
plt.ylabel("Value")
plt.legend(loc="upper left")
plt.grid()
plt.show()
plt.figure(figsize=(12,6))
plt.title('Nitrus Oxide Emission in India')
plt.plot(df2['IND'],"mD--",label="NO2")
plt.xlabel("Year")
plt.xticks(rotation=90)
plt.ylabel("Value")
plt.legend(loc="upper left")
plt.grid()
plt.show()
```





In [54]:
```
def normlz(data):
    nm=normalize(data)
    return nm
data=normlz(df1.values)
data[:20]
```

Out[54]:
```
array([[0.00711769, 0.97796862, 0.20863057],
       [0.0059493 , 0.97445163, 0.22451866],
       [0.00637454, 0.97915377, 0.20302033],
       [0.007352  , 0.97847958, 0.20621264],
       [0.00686048, 0.97748882, 0.21087564],
       [0.00596307, 0.97930299, 0.20231188],
       [0.00604246, 0.97930815, 0.20228454],
       [0.00678727, 0.97763225, 0.21021207],
```

```
       [0.00662023, 0.97738013, 0.21138652],
       [0.00589296, 0.98024142, 0.19771704],
       [0.00623922, 0.9835578 , 0.18048583],
       [0.00659122, 0.98443245, 0.17563971],
       [0.00682399, 0.9840847 , 0.17756894],
       [0.00734219, 0.98544944, 0.16981018],
       [0.00753349, 0.98713863, 0.15968899],
       [0.00664079, 0.98750948, 0.1574196 ],
       [0.0069441 , 0.98687011, 0.16136659],
       [0.00636955, 0.98557869, 0.16909783],
       [0.00631958, 0.98404112, 0.17782897],
       [0.00652398, 0.98589492, 0.16723832]])
```

In [55]:

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

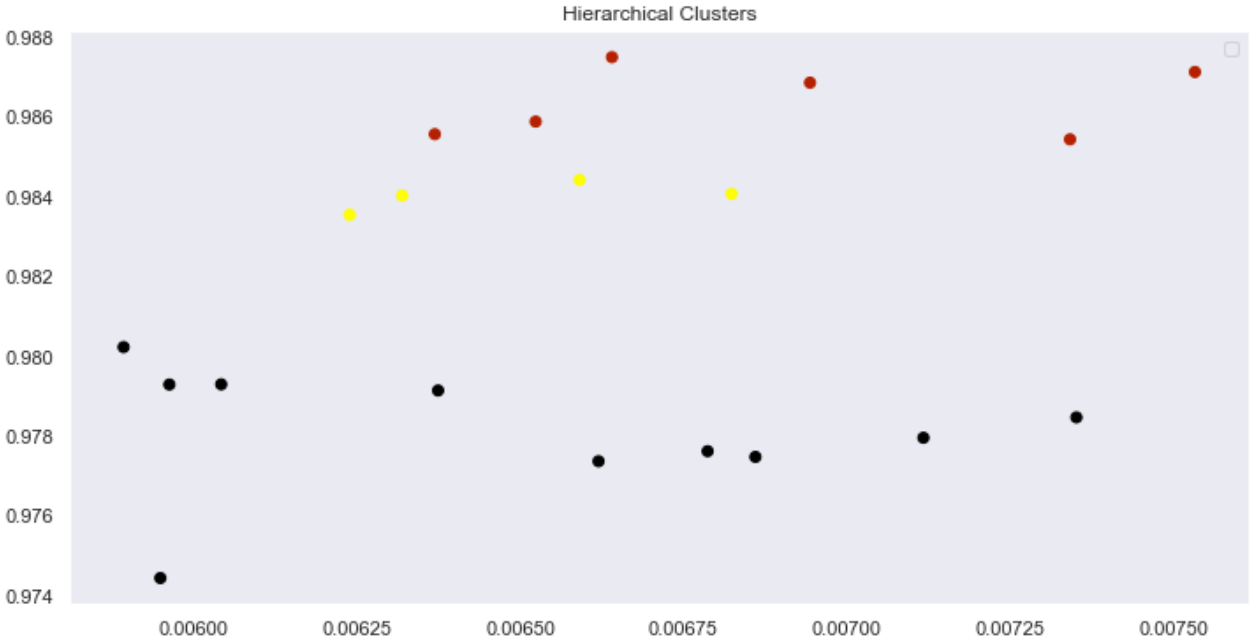
Out[55]:

```
array([0, 1, 2], dtype=int64)
```

In [56]:

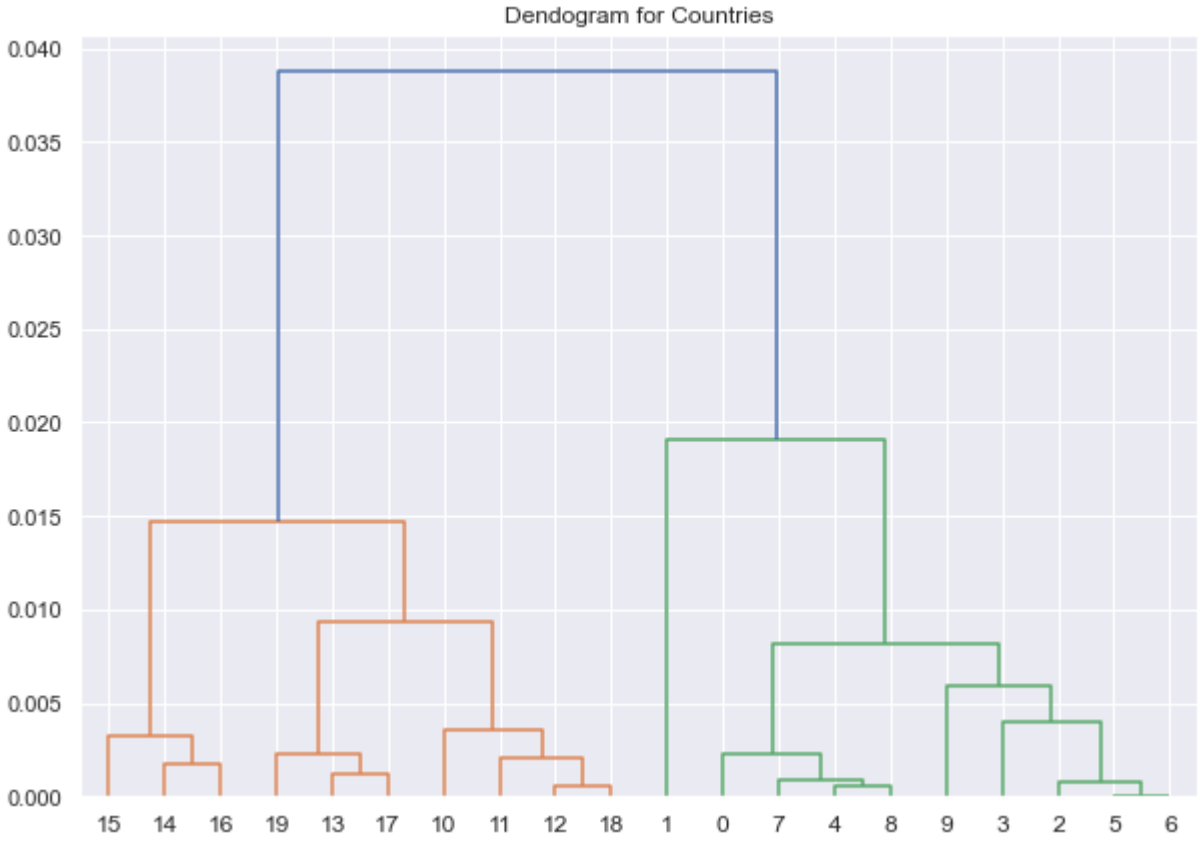
```
plt.figure(figsize=(12,6))
plt.title('Hierarchical Clusters')
plt.scatter(data[:,0],data[:,1], c=aggl.labels_, cmap='gnuplot')
plt.grid()
plt.legend()
plt.show()
```

```
No handles with labels found to put in legend.
```



In [57]:

```
plt.figure(figsize=(10, 7))
plt.title("Dendogram for Countries")
dend = shc.dendrogram(shc.linkage(data, method='centroid'))
```



Curve Fitting

In [58]:
```
from scipy.optimize import curve_fit
#!pip install lmfit
from lmfit import Model
```

In [59]:
```
def exponen(x, amp, cen, wid):
    return (amp / (np.sqrt(2*np.pi) * wid)) * np.exp(-(x-cen)**2 / (2*wid**2))
```

In [60]:
```
norml = normlz(df2.values)

y = exponen(norml[:,1], 2.7, 0.21, 1.51) + np.random.normal(0, 0.2, norml.shape[0])

init_vals = [1, 0, 1]
best_vals, covar = curve_fit(exponen, norml[:,1], y, p0=init_vals,maxfev=5000)
gssmodel = Model(exponen)
```

In [61]:
```
crvres = gssmodel.fit(y, x=norml[:,1], amp=8, cen=3, wid=1)
crvres
```

Out[61]:

Model

Model(exponen)

Fit Statistics

fitting method	leastsq
# function evals	1133
# data points	20
# variables	3
chi-square	0.84786186
reduced chi-square	0.04987423
Akaike info crit.	-57.2153966
Bayesian info crit.	-54.2281998

Variables

name	value	standard error	relative error	initial value	min	max	vary
amp	0.00447429	0.00131316	(29.35%)	8	-inf	inf	True
cen	0.99027782	5.9426e-04	(0.06%)	3	-inf	inf	True
wid	0.00267373	8.7863e-04	(32.86%)	1	-inf	inf	True

Correlations (unreported correlations are < 0.100)

amp	wid	0.9521
amp	cen	-0.4389
cen	wid	-0.3544

In [62]:

```
plt.figure(figsize=(12,6))
plt.title('Curve Fitting Result')
plt.plot(norml[:,1],"ro")
plt.plot(norml[:,2],"gv")
plt.plot(crvres.init_fit, 'k--', label='initial fit')
plt.plot(crvres.best_fit, 'b-', label='best fit')
plt.legend()
plt.grid()
plt.show()
```


Curve Fitting Result
1.0
0.8
0.6
0.4
0.2
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
initial fit
best fit

In [ ]: