0.) Import and Clean data

In [ ]:
```
import pandas as pd
# from google.colab import drive
import matplotlib.pyplot as plt
import numpy as np
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
```

In [ ]:
```
#drive.mount('/content/gdrive/', force_remount = True)
df = pd.read_csv("Country-data.csv", sep = ",")
```

In [ ]:
```
df.head()
```

Out[ ]:

	country	child_mort	exports	health	imports	income	inflation	life_expec	total_fer	gdpp
0	Afghanistan	90.2	10.0	7.58	44.9	1610	9.44	56.2	5.82	553
1	Albania	16.6	28.0	6.55	48.6	9930	4.49	76.3	1.65	4090
2	Algeria	27.3	38.4	4.17	31.4	12900	16.10	76.5	2.89	4460
3	Angola	119.0	62.3	2.85	42.9	5900	22.40	60.1	6.16	3530
4	Antigua and Barbuda	10.3	45.5	6.03	58.9	19100	1.44	76.8	2.13	12200

In [ ]:
```
y = df['country']
X = df.drop('country', axis = 1)
X
```

Out[ ]:

	child_mort	exports	health	imports	income	inflation	life_expec	total_fer	gdpp
0	90.2	10.0	7.58	44.9	1610	9.44	56.2	5.82	553
1	16.6	28.0	6.55	48.6	9930	4.49	76.3	1.65	4090
2	27.3	38.4	4.17	31.4	12900	16.10	76.5	2.89	4460
3	119.0	62.3	2.85	42.9	5900	22.40	60.1	6.16	3530
4	10.3	45.5	6.03	58.9	19100	1.44	76.8	2.13	12200
...	...	...	...	...	...	...	...	...	...
162	29.2	46.6	5.25	52.7	2950	2.62	63.0	3.50	2970
163	17.1	28.5	4.91	17.6	16500	45.90	75.4	2.47	13500
164	23.3	72.0	6.84	80.2	4490	12.10	73.1	1.95	1310
165	56.3	30.0	5.18	34.4	4480	23.60	67.5	4.67	1310
166	83.1	37.0	5.89	30.9	3280	14.00	52.0	5.40	1460

167 rows × 9 columns

In [ ]:
```
names = df[['country']].copy()
```

1.) Fit a kmeans Model with any Number of Clusters

In [ ]:
```
scaler = StandardScaler().fit(X)
X_scaled = scaler.transform(X)
```

```
c:\ProgramData\anaconda3\lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated and will be r
emoved in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\ProgramData\anaconda3\lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be r
emoved in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\ProgramData\anaconda3\lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be r
emoved in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
c:\ProgramData\anaconda3\lib\site-packages\sklearn\utils\validation.py:767: FutureWarning: is_sparse is deprecated and will be r
emoved in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if not hasattr(array, "sparse") and array.dtypes.apply(is_sparse).any():
c:\ProgramData\anaconda3\lib\site-packages\sklearn\utils\validation.py:605: FutureWarning: is_sparse is deprecated and will be r
emoved in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype):
c:\ProgramData\anaconda3\lib\site-packages\sklearn\utils\validation.py:614: FutureWarning: is_sparse is deprecated and will be r
emoved in a future version. Check `isinstance(dtype, pd.SparseDtype)` instead.
  if is_sparse(pd_dtype) or not is_extension_array_dtype(pd_dtype):
```

In [ ]:
```
kmeans = KMeans(n_clusters = 4)
kmeans.fit(X_scaled)
```

```
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarning: The default value of `n_init` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
```

Out[ ]:

```
KMeans
KMeans(n_clusters=4)
```

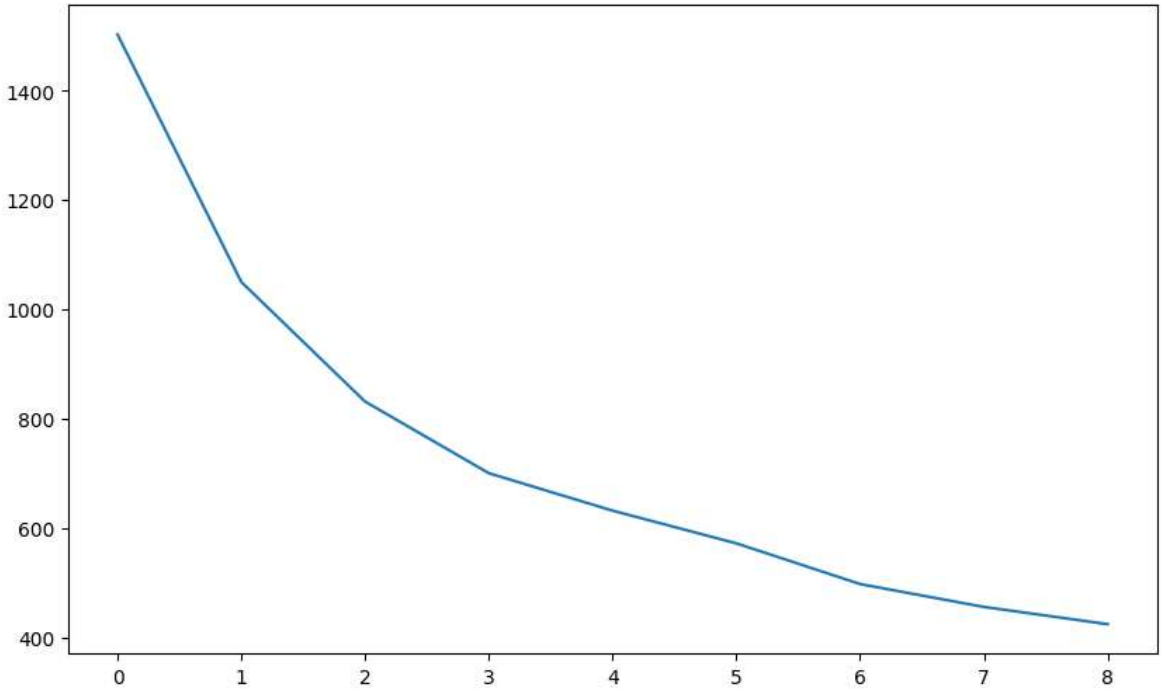
In [ ]:

```python
WCSSs = []      # with in cluster sum of squares
Ks = range(1,10)
for k in Ks:
    kmeans = KMeans(n_clusters = k)
    kmeans.fit(X_scaled)
    WCSSs.append(kmeans.inertia_)
```

```
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarning: The default value of `n_init` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarning: The default value of `n_init` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarning: The default value of `n_init` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarning: The default value of `n_init` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarning: The default value of `n_init` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarning: The default value of `n_init` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarning: The default value of `n_init` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarning: The default value of `n_init` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarning: The default value of `n_init` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
```

In [ ]:

```python
plt.figure(figsize = (10,6))
plt.plot(WCSSs)
plt.show()
```

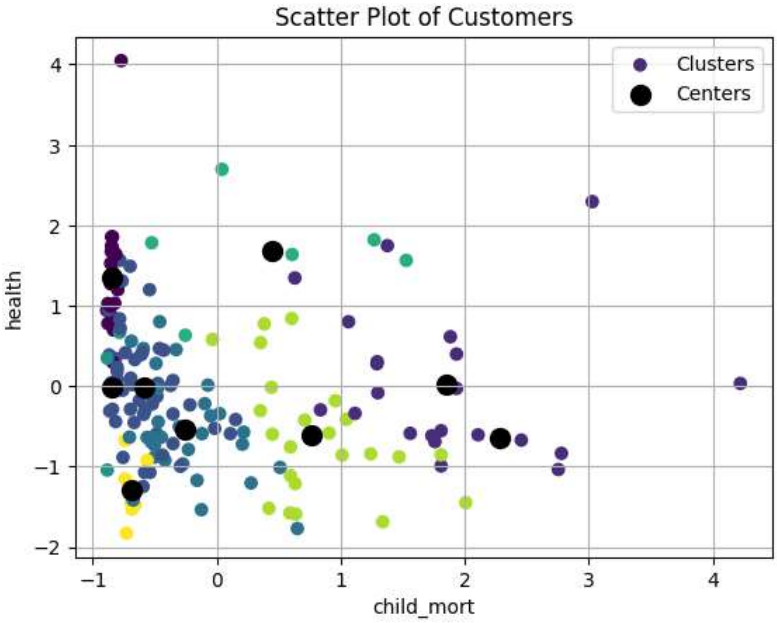


2.) Pick two features to visualize across

In [ ]:
```
X.columns
```

Out[ ]:
```
Index(['child_mort', 'exports', 'health', 'imports', 'income', 'inflation',
       'life_expec', 'total_fer', 'gdpp'],
      dtype='object')
```

In [ ]:
```
import matplotlib.pyplot as plt

x1_index = 0
x2_index = 2


scatter = plt.scatter(X_scaled[:, x1_index], X_scaled[:, x2_index], c=kmeans.labels_, cmap='viridis', label='Clusters')


centers = plt.scatter(kmeans.cluster_centers_[:, x1_index], kmeans.cluster_centers_[:, x2_index], marker='o', color='black', s=

plt.xlabel(X.columns[x1_index])
plt.ylabel(X.columns[x2_index])
plt.title('Scatter Plot of Customers')

# Generate legend
plt.legend()

plt.grid()
plt.show()
```



In [ ]:

```

```

In [ ]:

```

```

3.) Check a range of k-clusters and visualize to find the elbow. Test 30 different random starting places for the centroid means

In [ ]:

```python
WCSSs = []
ks = range(1,15)
for k in ks:
    kmeans = KMeans(n_clusters = k, n_init = 30, init = 'random')
    kmeans.fit(X_scaled)
    WCSSs.append(kmeans.inertia_)
```

```
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
```

In [ ]:

```python
# bonus optional do in 1 line of code
WCSSs = [KMeans(n_clusters = k, n_init = 30, init = 'random').fit(X_scaled).inertia_ for k in range(1,15)]
```

```
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
```

In [ ]:

```
WCSSs # wcsss is lower
```

Out[ ]:

```
[1502.9999999999998,
 1050.2145582853304,
 831.4244352086874,
 700.3229986404376,
 632.0138132211392,
 569.5042607233327,
 518.6458188977047,
 459.2910691015021,
 422.9155708106426,
 401.051460603542,
 378.1104865062954,
 368.00693560546233,
 339.46742018928677,
 323.4035237305541]
```

In [ ]:

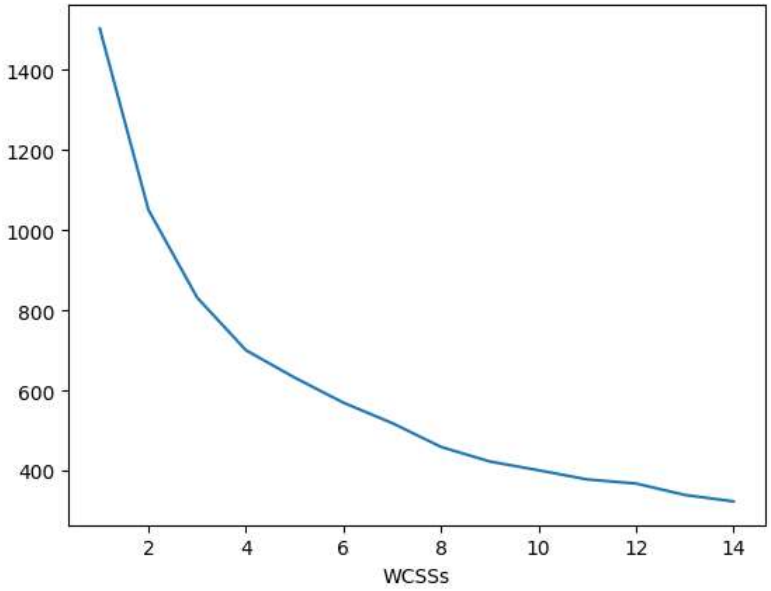
4.) Use the above work and economic critical thinking to choose a number of clusters. Explain why you chose the number of clusters and fit a model accordingly.

In [ ]:

```
plt.plot(ks,WCSSs)
plt.xlabel('WCSSs')
```

Out[ ]:

```
Text(0.5, 0, 'WCSSs')
```



6.) Do the same for a silhoutte plot

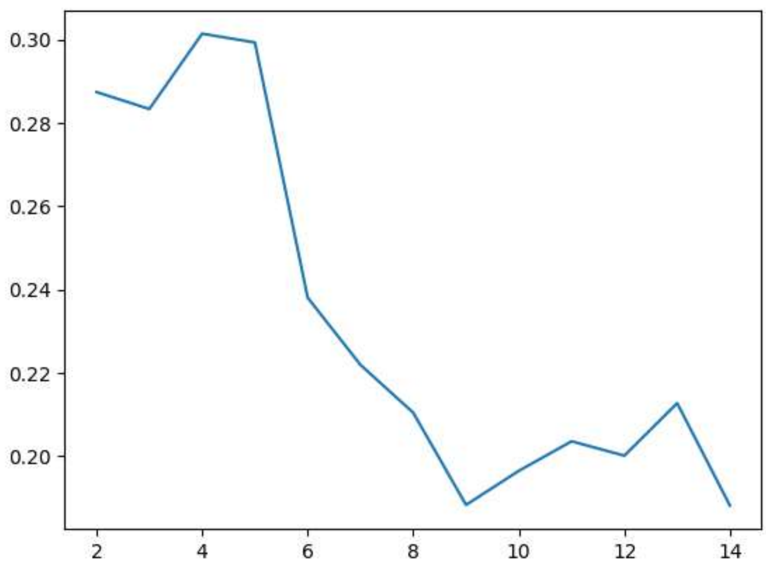
In [ ]:
```
from sklearn.metrics import silhouette_score
```

In [ ]:
```
CSSs = []
ks = range(2,15)
for k in ks:
    kmeans = KMeans(n_clusters = k, n_init = 30, init = 'random')
    kmeans.fit(X_scaled)
    labs = kmeans.labels_
    CSSs.append(silhouette_score(X_scaled,labs))
```

```
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
```

In [ ]:
```
plt.plot(ks,CSSs)
```

Out[ ]:
```
[<matplotlib.lines.Line2D at 0x1d0e689ace0>]
```



7.) Create a list of the countries that are in each cluster. Write interesting things you notice.

In [ ]:
```
kmeans = KMeans(n_clusters = 2, n_init = 30, init = 'random').fit(X_scaled)
```

```
c:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning: KMeans is known to have a memory leak o
n Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
```

In [ ]:
```
preds = pd.DataFrame(kmeans.predict(X_scaled))
```

In [ ]:
```
output = pd.concat([preds,df],axis = 1)
```

In [ ]:
```
output
```

Out[ ]:

	0	country	child_mort	exports	health	imports	income	inflation	life_expec	total_fer	gdpp
0	0	Afghanistan	90.2	10.0	7.58	44.9	1610	9.44	56.2	5.82	553
1	1	Albania	16.6	28.0	6.55	48.6	9930	4.49	76.3	1.65	4090
2	1	Algeria	27.3	38.4	4.17	31.4	12900	16.10	76.5	2.89	4460
3	0	Angola	119.0	62.3	2.85	42.9	5900	22.40	60.1	6.16	3530
4	1	Antigua and Barbuda	10.3	45.5	6.03	58.9	19100	1.44	76.8	2.13	12200
...	...	...	...	...	...	...	...	...	...	...	...
162	0	Vanuatu	29.2	46.6	5.25	52.7	2950	2.62	63.0	3.50	2970
163	1	Venezuela	17.1	28.5	4.91	17.6	16500	45.90	75.4	2.47	13500
164	1	Vietnam	23.3	72.0	6.84	80.2	4490	12.10	73.1	1.95	1310
165	0	Yemen	56.3	30.0	5.18	34.4	4480	23.60	67.5	4.67	1310
166	0	Zambia	83.1	37.0	5.89	30.9	3280	14.00	52.0	5.40	1460

167 rows × 11 columns

In [ ]:
```
output
print('cluster 1:')
list(output.loc[output[0]==0,'country'])
```

```
cluster 1:
```

Out[ ]:
```
['Albania',
 'Algeria',
 'Antigua and Barbuda',
 'Argentina',
 'Armenia',
 'Australia',
 'Austria',
 'Azerbaijan',
 'Bahamas',
 'Bahrain',
 'Barbados',
 'Belarus',
 'Belgium',
 'Belize',
 'Bhutan',
 'Bosnia and Herzegovina',
 'Brazil',
 'Brunei',
 'Bulgaria',
 'Canada',
 'Cape Verde',
 'Chile',
 'China',
 'Colombia',
 'Costa Rica',
 'Croatia',
 'Cyprus',
 'Czech Republic',
 'Denmark',
 'Dominican Republic',
 'Ecuador',
 'El Salvador',
 'Estonia',
 'Fiji',
 'Finland',
 'France',
 'Georgia',
 'Germany',
 'Greece',
 'Grenada',
 'Hungary',
 'Iceland',
 'Iran',
 'Ireland',
 'Israel',
 'Italy',
 'Jamaica',
 'Japan',
 'Jordan',
 'Kazakhstan',
 'Kuwait',
 'Latvia',
 'Lebanon',
 'Libya',
 'Lithuania',
 'Luxembourg',
 'Macedonia, FYR',
 'Malaysia',
 'Maldives',
 'Malta',
 'Mauritius',
 'Moldova',
 'Montenegro',
 'Morocco',
 'Netherlands',
 'New Zealand',
 'Norway',
 'Oman',
 'Panama',
 'Paraguay',
 'Peru',
 'Poland',
 'Portugal',
 'Qatar',
 'Romania',
 'Russia',
 'Saudi Arabia',
 'Serbia',
 'Seychelles',
 'Singapore',
 'Slovak Republic',
 'Slovenia',
 'South Korea',
 'Spain',
 'Sri Lanka',
 'St. Vincent and the Grenadines',
 'Suriname',
 'Sweden',
 'Switzerland',
 'Thailand',
 'Tunisia',
```

```
 'Turkey',
 'Ukraine',
 'United Arab Emirates',
 'United Kingdom',
 'United States',
 'Uruguay',
 'Venezuela',
 'Vietnam']
```

In [ ]:
```
output
print('cluster 2:')
list(output.loc[output[0]==1,'country'])
```

```
cluster 2:
```

Out[ ]:
```
['Albania',
 'Algeria',
 'Antigua and Barbuda',
 'Argentina',
 'Armenia',
 'Australia',
 'Austria',
 'Azerbaijan',
 'Bahamas',
 'Bahrain',
 'Barbados',
 'Belarus',
 'Belgium',
 'Belize',
 'Bhutan',
 'Bosnia and Herzegovina',
 'Brazil',
 'Brunei',
 'Bulgaria',
 'Canada',
 'Cape Verde',
 'Chile',
 'China',
 'Colombia',
 'Costa Rica',
 'Croatia',
 'Cyprus',
 'Czech Republic',
 'Denmark',
 'Dominican Republic',
 'Ecuador',
 'El Salvador',
 'Estonia',
 'Fiji',
 'Finland',
 'France',
 'Georgia',
 'Germany',
 'Greece',
 'Grenada',
 'Hungary',
 'Iceland',
 'Iran',
 'Ireland',
 'Israel',
 'Italy',
 'Jamaica',
 'Japan',
 'Jordan',
 'Kazakhstan',
 'Kuwait',
 'Latvia',
 'Lebanon',
 'Libya',
 'Lithuania',
 'Luxembourg',
 'Macedonia, FYR',
 'Malaysia',
 'Maldives',
 'Malta',
 'Mauritius',
 'Moldova',
 'Montenegro',
 'Morocco',
 'Netherlands',
 'New Zealand',
 'Norway',
 'Oman',
 'Panama',
 'Paraguay',
 'Peru',
 'Poland',
 'Portugal',
 'Qatar',
 'Romania',
 'Russia',
 'Saudi Arabia',
 'Serbia',
 'Seychelles',
 'Singapore',
 'Slovak Republic',
 'Slovenia',
 'South Korea',
 'Spain',
 'Sri Lanka',
 'St. Vincent and the Grenadines',
 'Suriname',
 'Sweden',
 'Switzerland',
 'Thailand',
 'Tunisia',
```

```
'Turkey',
'Ukraine',
'United Arab Emirates',
'United Kingdom',
'United States',
'Uruguay',
'Venezuela',
'Vietnam']
```

In [ ]:
```
#### Write an observation
```

8.) Create a table of Descriptive Statistics. Rows being the Cluster number and columns being all the features. Values being the mean of the centroid. Use the nonscaled X values for interprotation

In [ ]:
```
q8df = pd.concat([preds, X], axis = 1)
```

In [ ]:
```
q8df
```

Out[ ]:

	0	child_mort	exports	health	imports	income	inflation	life_expec	total_fer	gdpp
0	0	90.2	10.0	7.58	44.9	1610	9.44	56.2	5.82	553
1	1	16.6	28.0	6.55	48.6	9930	4.49	76.3	1.65	4090
2	1	27.3	38.4	4.17	31.4	12900	16.10	76.5	2.89	4460
3	0	119.0	62.3	2.85	42.9	5900	22.40	60.1	6.16	3530
4	1	10.3	45.5	6.03	58.9	19100	1.44	76.8	2.13	12200
...	...	...	...	...	...	...	...	...	...	...
162	0	29.2	46.6	5.25	52.7	2950	2.62	63.0	3.50	2970
163	1	17.1	28.5	4.91	17.6	16500	45.90	75.4	2.47	13500
164	1	23.3	72.0	6.84	80.2	4490	12.10	73.1	1.95	1310
165	0	56.3	30.0	5.18	34.4	4480	23.60	67.5	4.67	1310
166	0	83.1	37.0	5.89	30.9	3280	14.00	52.0	5.40	1460

167 rows × 10 columns

In [ ]:
```
q8df.groupby(0).mean()
```

Out[ ]:

0	child_mort	exports	health	imports	income	inflation	life_expec	total_fer	gdpp
0	76.280882	30.198515	6.090147	43.642146	4227.397059	11.098750	61.910294	4.413824	1981.235294
1	12.161616	48.603030	7.314040	49.121212	26017.171717	5.503545	76.493939	1.941111	20507.979798

In [ ]:
```
q8df.groupby(0).std()
```

Out[ ]:

0	child_mort	exports	health	imports	income	inflation	life_expec	total_fer	gdpp
0	38.076068	18.201742	2.645319	19.323451	4890.581414	13.682630	6.897418	1.285590	2528.509189
1	8.523122	30.116032	2.716652	26.928785	20441.749847	6.957187	3.735757	0.486744	20578.727127

9.) Write an observation about the descriptive statistics.

- The child mortality of group 0 is higher than that of group 1, on an average level
- The health spending in group 0 is lower, correspondingly
- Group 1 has higher means in economic activities such as exports, income, and GDP. They are more economically developed
- Group 1's life expectancy is higher on average

In [ ]:
```
```