In [24]:
```
import time
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error
from sklearn.model_selection import RepeatedStratifiedKFold
from sklearn.model_selection import RandomizedSearchCV,KFold, GridSearchCV, StratifiedKFold
from sklearn.model_selection import cross_val_score
from xgboost import XGBRegressor
from sklearn.tree import DecisionTreeRegressor
from sklearn.gaussian_process import GaussianProcessRegressor
from sklearn.linear_model import LinearRegression
from sklearn.linear_model import Ridge, Lasso
from sklearn.linear_model import Lars
from sklearn.linear_model import TheilSenRegressor
from sklearn.linear_model import HuberRegressor
from sklearn.linear_model import PassiveAggressiveRegressor
from sklearn.linear_model import ARDRegression
from sklearn.linear_model import BayesianRidge
from sklearn.linear_model import ElasticNet
from sklearn.linear_model import OrthogonalMatchingPursuit
from sklearn.svm import SVR
from sklearn.svm import NuSVR
from sklearn.preprocessing import PolynomialFeatures
from sklearn.svm import LinearSVR
from sklearn.kernel_ridge import KernelRidge
from sklearn.isotonic import IsotonicRegression
from sklearn.ensemble import RandomForestRegressor
from sklearn import metrics
from sklearn.metrics import mean_squared_error
from sklearn.metrics import mean_absolute_error
from math import sqrt
from sklearn.metrics import r2_score
import warnings
warnings.filterwarnings('ignore')
```

In [2]:
```
df = pd.read_csv("sdg_index_2000-2022.csv")
df
```

Out [2]:

	country_code	country	year	goal_1_score	goal_2_score	goal_3_score	goal_4_score	goal_5_score	goal_6_score	goal_7_s
0	AFG	Afghanistan	2000	28.8	27.3	19.2	1.6	20.8	32.4	21.0
1	AFG	Afghanistan	2001	28.8	30.6	19.4	1.6	20.8	32.4	22.3
2	AFG	Afghanistan	2002	28.8	30.7	19.7	1.6	20.8	32.7	21.5
3	AFG	Afghanistan	2003	28.8	32.5	19.9	1.6	20.8	33.0	24.5
4	AFG	Afghanistan	2004	28.8	32.1	21.1	1.6	20.8	33.3	28.0
...	...	...	...	...	...	...	...	...	...	...
4135	ZWE	Zimbabwe	2018	26.4	46.6	39.8	57.9	76.7	51.6	40.6
4136	ZWE	Zimbabwe	2019	21.4	46.0	40.6	60.6	77.0	51.3	39.9
4137	ZWE	Zimbabwe	2020	20.1	47.2	41.5	62.0	77.0	51.1	41.6
4138	ZWE	Zimbabwe	2021	20.8	48.4	41.9	62.5	77.1	51.1	41.6
4139	ZWE	Zimbabwe	2022	21.5	48.5	41.9	62.5	77.2	51.1	41.6

4140 rows × 21 columns

Column names and descriptions

Column Name Description country_code A unique identifier that links to the primary dataset. country The name of the country. year The year of the data entry. sdg_index_score The overall SDG (Sustainable Development Goals) index score of the country. goal_1_score The score for Goal 1: No Poverty. goal_2_score The score for Goal 2: Zero Hunger. goal_3_score The score for Goal 3: Good Health and Wellbeing. goal_4_score The score for Goal 4: Quality Education. goal_5_score The score for Goal 5: Gender Equality. goal_6_score The score for Goal 6: Clean Water and Sanitation. goal_7_score The score for Goal 7: Affordable and Clean Energy. goal_8_score The score for Goal 8: Decent Work and Economic Growth. goal_9_score The score for Goal 9: Industry, Innovation and Infrastructure. goal_10_score The score for Goal 10: Reduced Inequalities. goal_11_score The score for Goal 11: Sustainable Cities and Communities. goal_12_score The score for Goal 12: Responsible Consumption and Production. goal_13_score The score for Goal 13: Climate Action. goal_14_score The score for

Goal 14: Life Below Water. goal_15_score The score for Goal 15: Life on Land. goal_16_score The score for Goal 16: Peace, Justice and Strong Institutions. goal_17_score The score for Goal 17: Partnerships for the Goals.

In [3]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4140 entries, 0 to 4139
Data columns (total 21 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   country_code     4140 non-null   object 
 1   country          4140 non-null   object 
 2   year             4140 non-null   int64  
 3   goal_1_score     4140 non-null   float64
 4   goal_2_score     4140 non-null   float64
 5   goal_3_score     4140 non-null   float64
 6   goal_4_score     4140 non-null   float64
 7   goal_5_score     4140 non-null   float64
 8   goal_6_score     4140 non-null   float64
 9   goal_7_score     4140 non-null   float64
 10  goal_8_score     4140 non-null   float64
 11  goal_9_score     4140 non-null   float64
 12  goal_10_score    4140 non-null   float64
 13  goal_11_score    4140 non-null   float64
 14  goal_12_score    4140 non-null   float64
 15  goal_13_score    4140 non-null   float64
 16  goal_14_score    4140 non-null   float64
 17  goal_15_score    4140 non-null   float64
 18  goal_16_score    4140 non-null   float64
 19  goal_17_score    4140 non-null   float64
 20  sdg_index_score  4140 non-null   float64
dtypes: float64(18), int64(1), object(2)
memory usage: 679.3+ KB
```

In [4]:
```
df.isnull().sum()
```

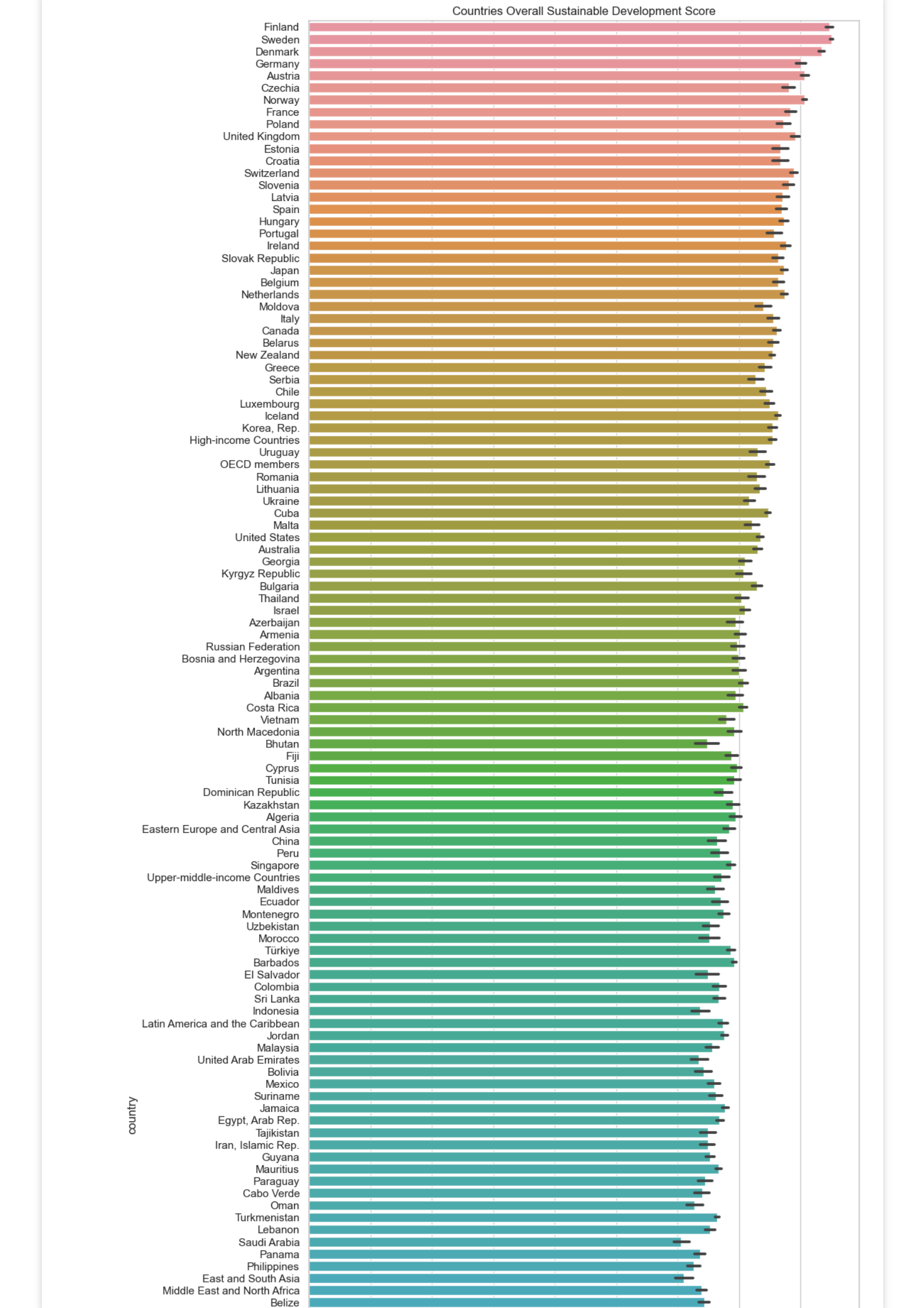
Out [4]:
```
country_code       0
country            0
year               0
goal_1_score       0
goal_2_score       0
goal_3_score       0
goal_4_score       0
goal_5_score       0
goal_6_score       0
goal_7_score       0
goal_8_score       0
goal_9_score       0
goal_10_score      0
goal_11_score      0
goal_12_score      0
goal_13_score      0
goal_14_score      0
goal_15_score      0
goal_16_score      0
goal_17_score      0
sdg_index_score    0
dtype: int64
```

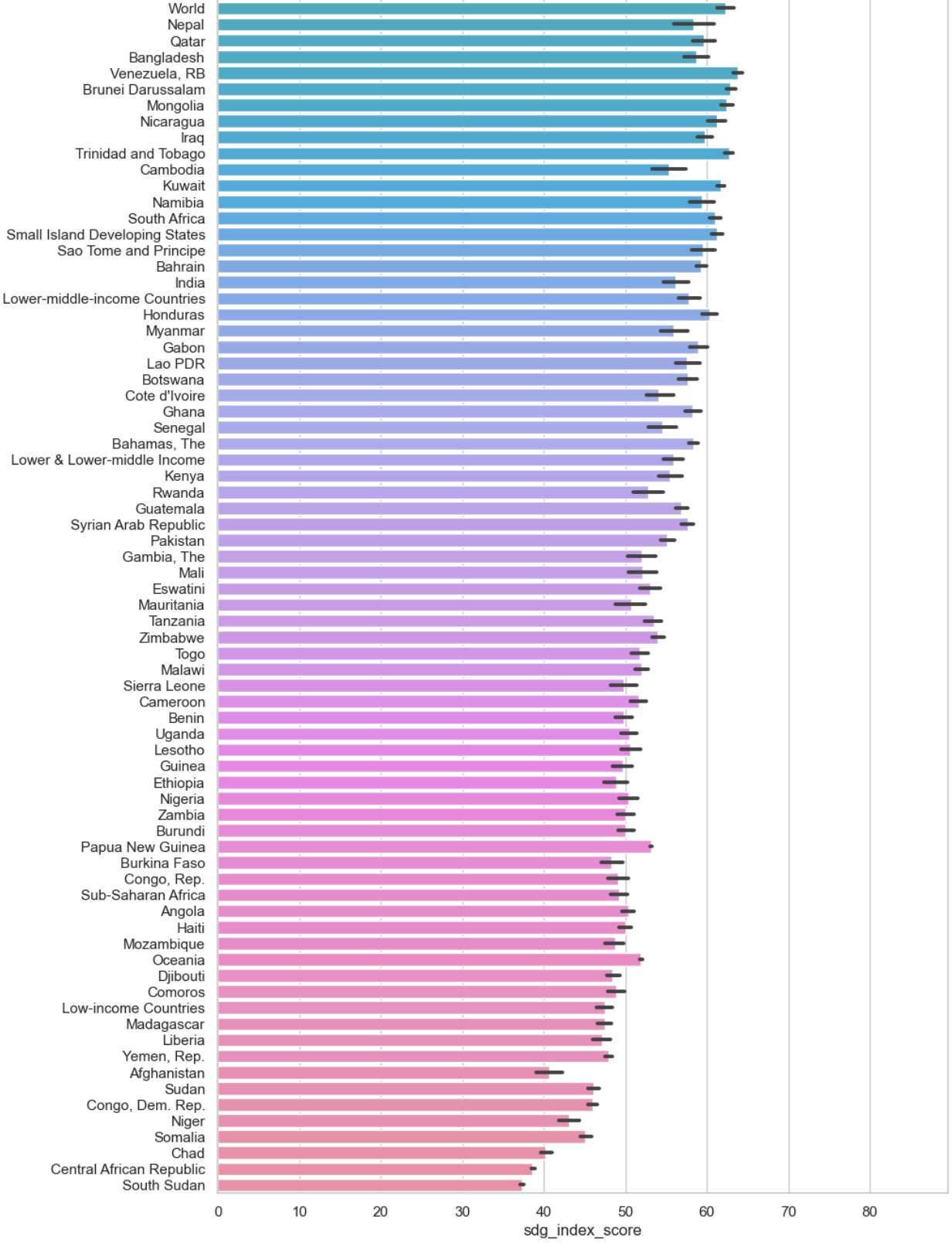
Exploratory Data Analysis (EDA)

In [5]:
```
print(("*")*120)
print("\t\t\t\t**************ANALYSIS***************\n\n~~ 1)Finland and Sweden Highest Overall score in o
print(("*")*120)
plt.figure(figsize = (10,40))
sns.set_theme(style="whitegrid")
sns.set_color_codes("pastel")
sns.barplot(data = df.sort_values(by = 'sdg_index_score', ascending = False), x = 'sdg_index_score', y = '
plt.title('Countries Overall Sustainable Development Score')
plt.show()
```

```
************************************************************************************************************************
                                **************ANALYSIS***************

~~ 1)Finland and Sweden Highest Overall score in overall SDG. 2)South Sudan is lowest in overall score of SDG.
************************************************************************************************************************
```


Countries Overall Sustainable Development Score
country
Finland
Sweden
Denmark
Germany
Austria
Czechia
Norway
France
Poland
United Kingdom
Estonia
Croatia
Switzerland
Slovenia
Latvia
Spain
Hungary
Portugal
Ireland
Slovak Republic
Japan
Belgium
Netherlands
Moldova
Italy
Canada
Belarus
New Zealand
Greece
Serbia
Chile
Luxembourg
Iceland
Korea, Rep.
High-income Countries
Uruguay
OECD members
Romania
Lithuania
Ukraine
Cuba
Malta
United States
Australia
Georgia
Kyrgyz Republic
Bulgaria
Thailand
Israel
Azerbaijan
Armenia
Russian Federation
Bosnia and Herzegovina
Argentina
Brazil
Albania
Costa Rica
Vietnam
North Macedonia
Bhutan
Fiji
Cyprus
Tunisia
Dominican Republic
Kazakhstan
Algeria
Eastern Europe and Central Asia
China
Peru
Singapore
Upper-middle-income Countries
Maldives
Ecuador
Montenegro
Uzbekistan
Morocco
Türkiye
Barbados
El Salvador
Colombia
Sri Lanka
Indonesia
Latin America and the Caribbean
Jordan
Malaysia
United Arab Emirates
Bolivia
Mexico
Suriname
Jamaica
Egypt, Arab Rep.
Tajikistan
Iran, Islamic Rep.
Guyana
Mauritius
Paraguay
Cabo Verde
Oman
Turkmenistan
Lebanon
Saudi Arabia
Panama
Philippines
East and South Asia
Middle East and North Africa
Belize



Split dataset

In [43]:
```
import sklearn.model_selection as ms
import sklearn.linear_model as lm
from sklearn.model_selection import train_test_split
linreg = lm.LinearRegression()
x = df.iloc[:,3:-1]
y = df.iloc[:,-1]
xtrain,xtest,ytrain,ytest = train_test_split(x,y,test_size = 0.2,random_state = 1)
```

In [60]:
```
### Linear Regression ###

def linear_reg(input_x, input_y, cv=5):
    ## Defining parameters
    model_LR= LinearRegression()

    parameters = {'fit_intercept':[True,False], 'copy_X':[True, False]}
```

```
    ## Building Grid Search algorithm with cross-validation and Mean Squared Error score.

    grid_search_LR = GridSearchCV(estimator=model_LR,
                          param_grid=parameters,
                          scoring='neg_mean_squared_error',
                          cv=cv,
                          n_jobs=-1)

    ## Lastly, finding the best parameters.

    grid_search_LR.fit(input_x, input_y)
    best_parameters_LR = grid_search_LR.best_params_
    best_score_LR = grid_search_LR.best_score_
    print(best_parameters_LR)
    print(best_score_LR)
```

In [61]:
```
linear_reg(x,y)
```

```
{'copy_X': True, 'fit_intercept': True}
-1.683280356121474
```

In [55]:
```
### Ridge Regression ###

def ridge_reg(input_x, input_y, cv=5):
    ## Defining parameters
    model_Ridge= Ridge()

    # prepare a range of alpha values to test
    alphas = np.array([1,0.1,0.01,0.001,0.0001,0,1000])

    ## Building Grid Search algorithm with cross-validation and Mean Squared Error score.

    grid_search_Ridge = GridSearchCV(estimator=model_Ridge,
                          param_grid=(dict(alpha=alphas)),
                          scoring='neg_mean_squared_error',
                          cv=cv,
                          n_jobs=-1)

    ## Lastly, finding the best parameters.

    grid_search_Ridge.fit(input_x, input_y)
    best_parameters_Ridge = grid_search_Ridge.best_params_
    best_score_Ridge = grid_search_Ridge.best_score_
    print(best_parameters_Ridge)
    print(best_score_Ridge)

ridge_reg(x, y)
```

```
{'alpha': 1000.0}
-1.6797784047222777
```

In [65]:
```
### Lasso Regression ###

def lasso_reg(input_x, input_y, cv=5):
    ## Defining parameters
    model_Lasso= Lasso()

    # prepare a range of alpha values to test
    alphas = np.array([1,0.1,0.01,0.001,0.0001,0,1000])

    ## Building Grid Search algorithm with cross-validation and Mean Squared Error score.

    grid_search_lasso = GridSearchCV(estimator=model_Lasso,
                          param_grid=(dict(alpha=alphas)),
                          scoring='neg_mean_squared_error',
                          cv=cv,
                          n_jobs=-1)

    ## Lastly, finding the best parameters.

    grid_search_lasso.fit(input_x, input_y)
    best_parameters_lasso = grid_search_lasso.best_params_
    best_score_lasso = grid_search_lasso.best_score_
```

```
    print(best_parameters_lasso)
    print(best_score_lasso)

lasso_reg(x,y)
```

```
{'alpha': 0.1}
-1.679020249990169
```

In [64]:
```
### ElasticNet Regression ###

def elastic_reg(input_x, input_y,cv=5):
    ## Defining parameters
    model_grid_Elastic= ElasticNet()

    # prepare a range of alpha values to test
    alphas = np.array([1,0.1,0.01,0.001,0.0001,0,1000])

    ## Building Grid Search algorithm with cross-validation and Mean Squared Error score.

    grid_search_elastic = GridSearchCV(estimator=model_grid_Elastic,
                          param_grid=(dict(alpha=alphas)),
                          scoring='neg_mean_squared_error',
                          cv=cv,
                          n_jobs=-1)

    ## Lastly, finding the best parameters.

    grid_search_elastic.fit(input_x, input_y)
    best_parameters_elastic = grid_search_elastic.best_params_
    best_score_elastic = grid_search_elastic.best_score_
    print(best_parameters_elastic)
    print(best_score_elastic)

elastic_reg(x, y)
```

```
{'alpha': 1.0}
-1.6801391768858842
```

In [45]:
```
Poly = PolynomialFeatures(degree=2, interaction_only=True, include_bias=False)
X_train = Poly.fit_transform(xtrain)
X_test = Poly.fit_transform(xtest)
```

In [66]:
```
##Linear Regression
lr = LinearRegression(copy_X= True, fit_intercept = True)
lr.fit(X_train, ytrain)
lr_pred= lr.predict(X_test)

#Ridge Model
ridge_model = Ridge(alpha = 1000)
ridge_model.fit(X_train, ytrain)
pred_ridge = ridge_model.predict(X_test)

#Lasso Model
Lasso_model = Lasso(alpha = 0.1)
Lasso_model.fit(X_train, ytrain)
pred_Lasso = Lasso_model.predict(X_test)

#ElasticNet Model
model_enet = ElasticNet(alpha = 1.0)
model_enet.fit(X_train, ytrain)
pred_test_enet= model_enet.predict(X_test)
```

In [67]:
```
print('-------------Lineer Regression-----------')

print('MAE: %f'% mean_absolute_error(ytest, lr_pred))
print('RMSE: %f'% np.sqrt(mean_squared_error(ytest, lr_pred)))
print('R2 %f' % r2_score(ytest, lr_pred))

print('---------------Ridge ----------------------')

print('MAE: %f'% mean_absolute_error(ytest, pred_ridge))
print('RMSE: %f'% np.sqrt(mean_squared_error(ytest, pred_ridge)))
print('R2 %f' % r2_score(ytest, pred_ridge))

print('---------------Lasso-----------------------')
```

```
print('MAE: %f' % mean_absolute_error(ytest, pred_Lasso))
print('RMSE: %f' % np.sqrt(mean_squared_error(ytest, pred_Lasso)))
print('R2 %f' % r2_score(ytest, pred_Lasso))

print('---------------ElasticNet-------------------')

print('MAE: %f' % mean_absolute_error(ytest,pred_test_enet)) #RMSE
print('RMSE: %f' % np.sqrt(mean_squared_error(ytest,pred_test_enet))) #RMSE
print('R2 %f' % r2_score(ytest, pred_test_enet))
```

```
------------Lineer Regression-----------
MAE: 0.449444
RMSE: 0.589586
R2 0.996940
---------------Ridge ----------------------
MAE: 0.462797
RMSE: 0.603696
R2 0.996792
---------------Lasso-----------------------
MAE: 0.484652
RMSE: 0.629469
R2 0.996512
---------------ElasticNet-------------------
MAE: 0.539638
RMSE: 0.685610
R2 0.995862
```

In [ ]: