

## Objective(s):

This activity aims to demonstrate how to apply simple linear regression analysis to solve regression problem

## Intended Learning Outcomes (ILOs):

- Demonstrate how to solve regression problems using simple linear regression
- Use the linear regression model to predict the target value

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## ▼ Data Wrangling

```
import numpy as np
import pandas as pd

life_expe = pd.read_csv('/content/Life_Expectancy_Data.csv')
life_expe
```

	Country	Year	Status	Life expectancy	Adult Mortality	infant deaths	Alcohol	percentage expenditure	Hepatitis B	Measles	...	Polio	Total expenditure	Diph
0	Afghanistan	2015	Developing	65.0	263.0	62	0.01	71.279624	65.0	1154	...	6.0	8.16	
1	Afghanistan	2014	Developing	59.9	271.0	64	0.01	73.523582	62.0	492	...	58.0	8.18	
2	Afghanistan	2013	Developing	59.9	268.0	66	0.01	73.219243	64.0	430	...	62.0	8.13	
3	Afghanistan	2012	Developing	59.5	272.0	69	0.01	78.184215	67.0	2787	...	67.0	8.52	
4	Afghanistan	2011	Developing	59.2	275.0	71	0.01	7.097109	68.0	3013	...	68.0	7.87	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2933	Zimbabwe	2004	Developing	44.3	723.0	27	4.36	0.000000	68.0	31	...	67.0	7.13	
2934	Zimbabwe	2003	Developing	44.5	715.0	26	4.06	0.000000	7.0	998	...	7.0	6.52	
2935	Zimbabwe	2002	Developing	44.8	73.0	25	4.43	0.000000	73.0	304	...	73.0	6.53	
2936	Zimbabwe	2001	Developing	45.3	686.0	25	1.72	0.000000	76.0	529	...	76.0	6.16	
2937	Zimbabwe	2000	Developing	46.0	665.0	24	1.68	0.000000	79.0	1483	...	78.0	7.10	

2938 rows x 22 columns

life\_expe.dtypes

Country	object
Year	int64
Status	object
Life expectancy	float64
Adult Mortality	float64
infant deaths	int64
Alcohol	float64
percentage expenditure	float64
Hepatitis B	float64
Measles	int64
BMI	float64
under-five deaths	int64
Polio	float64
Total expenditure	float64
Diphtheria	float64
HIV/AIDS	float64
GDP	float64
Population	float64
thinness 1-19 years	float64
thinness 5-9 years	float64
Income composition of resources	float64
Schooling	float64
	dtype: object

## ✓ Check for missing values

```
life_expe_null = life_expe.isnull().sum()
life_expe_null
```

Country	0
Year	0
Status	0
Life expectancy	10
Adult Mortality	10
infant deaths	0
Alcohol	194
percentage expenditure	0
Hepatitis B	553
Measles	0
BMI	34
under-five deaths	0
Polio	19
Total expenditure	226
Diphtheria	19
HIV/AIDS	0
GDP	448
Population	652
thinness 1-19 years	34
thinness 5-9 years	34
Income composition of resources	167
Schooling	163

dtype: int64

## ✓ Remove duplicates

```
# Check for duplicates
duplicate_rows = life_expe.duplicated()

# Count the number of duplicate rows
num_duplicates = duplicate_rows.sum()
print("Number of duplicate rows:", num_duplicates)

Number of duplicate rows: 0
```

## ✓ Summary statistics of numerical variables

```
life_expe.describe()
```

	Year	Life expectancy	Adult Mortality	infant deaths	Alcohol	percentage expenditure	Hepatitis B	Measles	BMI	under-five deaths
count	2938.000000	2928.000000	2928.000000	2938.000000	2744.000000	2938.000000	2385.000000	2938.000000	2904.000000	2938.000000
mean	2007.518720	69.224932	164.796448	30.303948	4.602861	738.251295	80.940461	2419.592240	38.321247	42.035739
std	4.613841	9.523867	124.292079	117.926501	4.052413	1987.914858	25.070016	11467.272489	20.044034	160.445548
min	2000.000000	36.300000	1.000000	0.000000	0.010000	0.000000	1.000000	0.000000	1.000000	0.000000
25%	2004.000000	63.100000	74.000000	0.000000	0.877500	4.685343	77.000000	0.000000	19.300000	0.000000
50%	2008.000000	72.100000	144.000000	3.000000	3.755000	64.912906	92.000000	17.000000	43.500000	4.000000
75%	2012.000000	75.700000	228.000000	22.000000	7.702500	441.534144	97.000000	360.250000	56.200000	28.000000
max	2015.000000	89.000000	723.000000	1800.000000	17.870000	19479.911610	99.000000	212183.000000	87.300000	2500.000000

## ✓ Remove extra whitespaces from column names

```
life_expe.columns
```

```
Index(['Country', 'Year', 'Status', 'Life expectancy ', 'Adult Mortality',
       'infant deaths', 'Alcohol', 'percentage expenditure', 'Hepatitis B',
       'Measles ', ' BMI ', 'under-five deaths ', 'Polio', 'Total expenditure',
       'Diphtheria ', ' HIV/AIDS', 'GDP', 'Population',
       ' thinness 1-19 years', ' thinness 5-9 years',
       'Income composition of resources', 'Schooling'],
      dtype='object')
```

```
life_expe.columns = life_expe.columns.str.strip()
life_expe.columns

Index(['Country', 'Year', 'Status', 'Life expectancy', 'Adult Mortality',
       'infant deaths', 'Alcohol', 'percentage expenditure', 'Hepatitis B',
       'Measles', 'BMI', 'under-five deaths', 'Polio', 'Total expenditure',
       'Diphtheria', 'HIV/AIDS', 'GDP', 'Population', 'thinness 1-19 years',
       'thinness 5-9 years', 'Income composition of resources', 'Schooling'],
      dtype='object')
```

## ▼ Categorical Variables

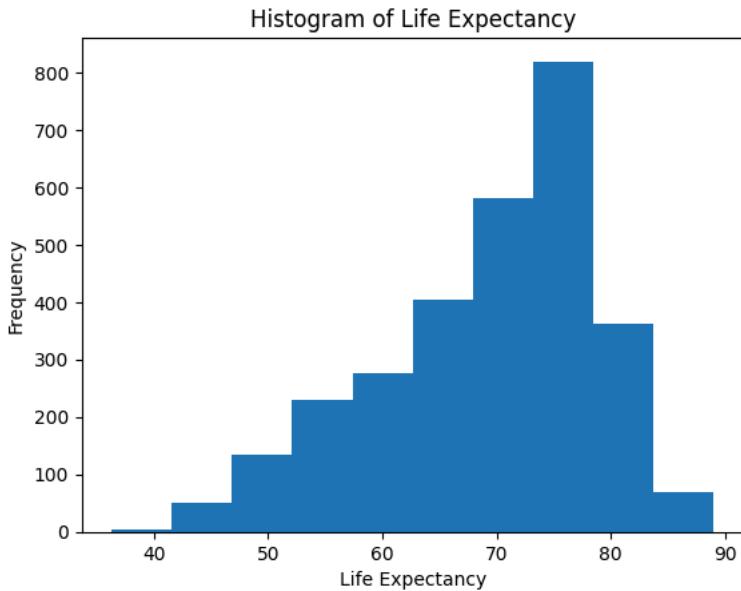
```
print("Unique countries:", life_expe['Country'].nunique())
print("Unique status:", life_expe['Status'].unique())
```

```
Unique countries: 193
Unique status: ['Developing' 'Developed']
```

## ▼ EDA

```
import matplotlib.pyplot as plt
import seaborn as sns

plt.hist(life_expe['Life expectancy'])
plt.xlabel('Life Expectancy')
plt.ylabel('Frequency')
plt.title('Histogram of Life Expectancy')
plt.show()
```

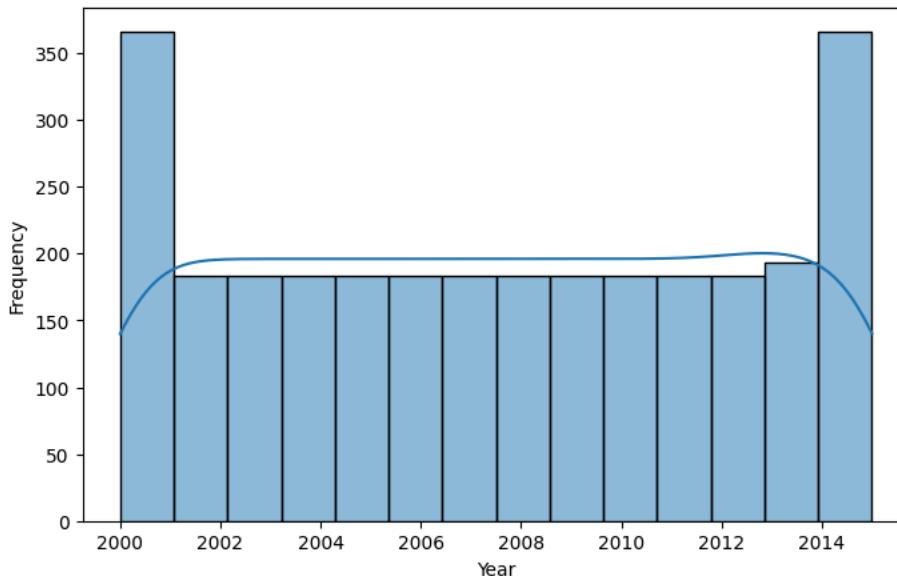


The most common life expectancy falls between 70 and 80 years, with over 700 occurrences. Fewer people live significantly shorter or longer than this range. Overall, reaching the 70s is quite common, while living into the late 80s or beyond is less usual.

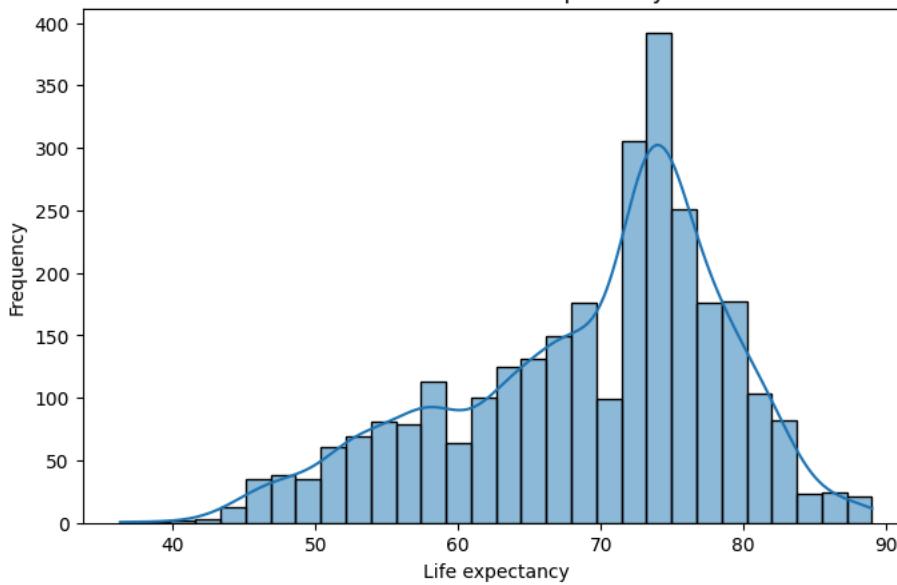
```
num_vars = life_expe.select_dtypes(include=['float64', 'int64']).columns
for var in num_vars:
    plt.figure(figsize=(8, 5))
    sns.histplot(data=life_expe, x=var, kde=True)
```

```
plt.title(f'Distribution of {var}')
plt.xlabel(var)
plt.ylabel('Frequency')
plt.show()
```

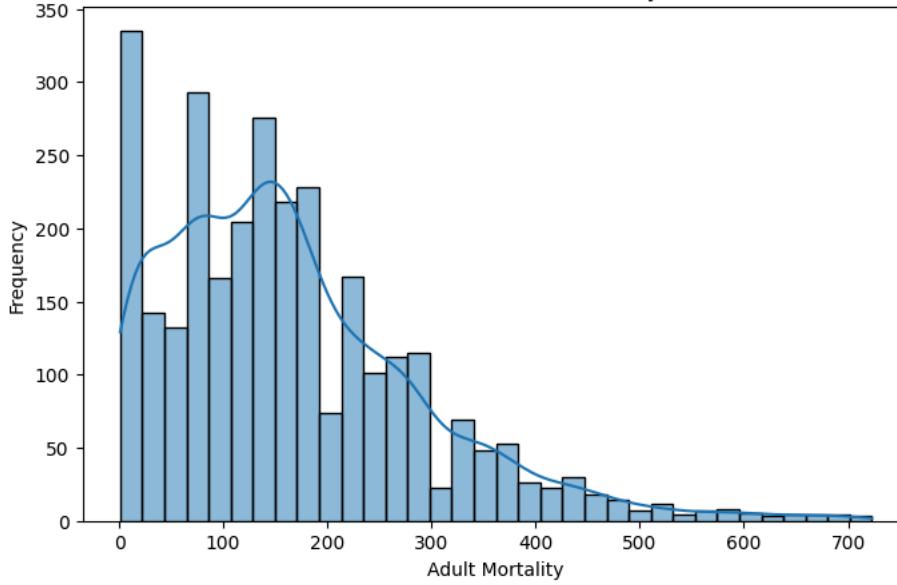
Distribution of Year



Distribution of Life expectancy

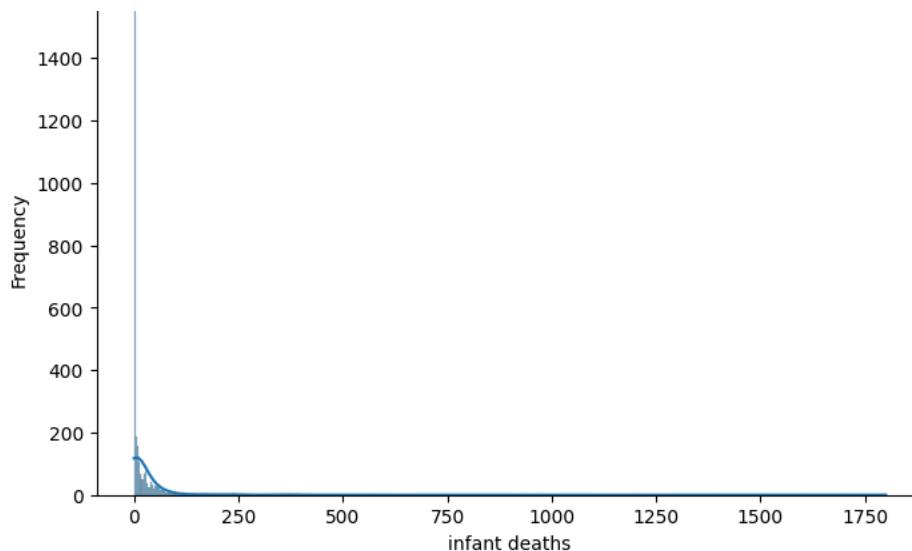


Distribution of Adult Mortality

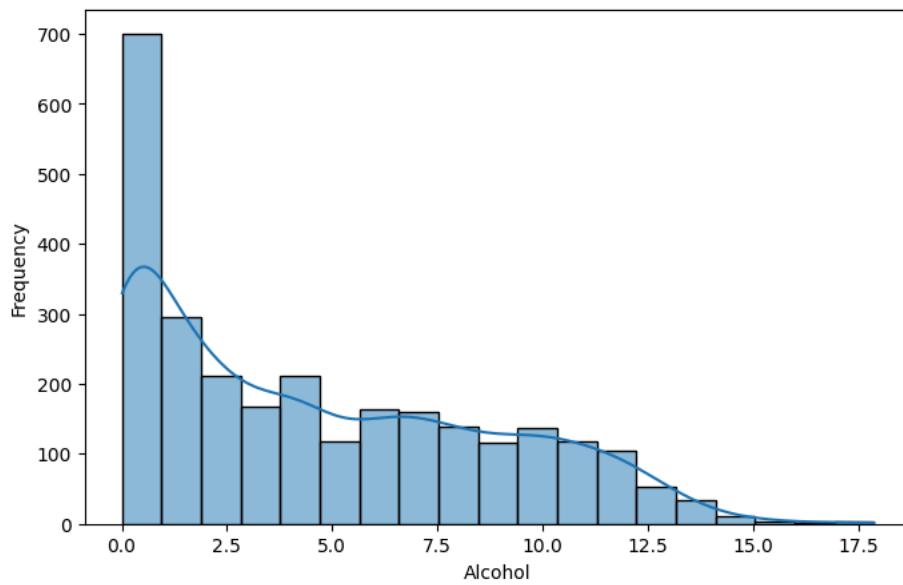


Distribution of infant deaths

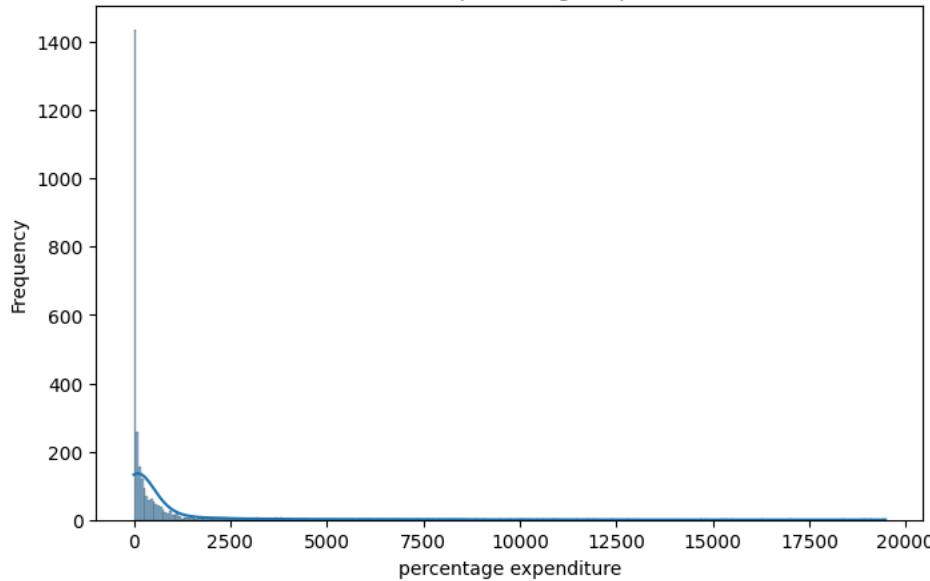




Distribution of Alcohol

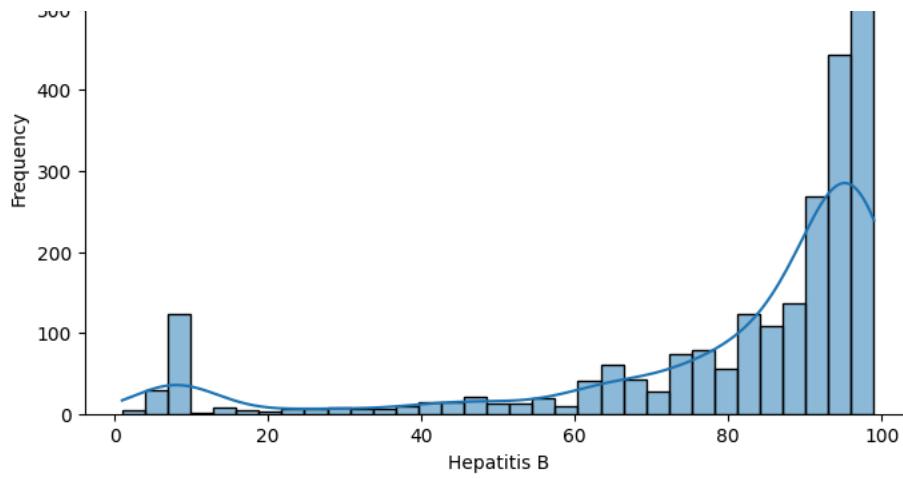


Distribution of percentage expenditure

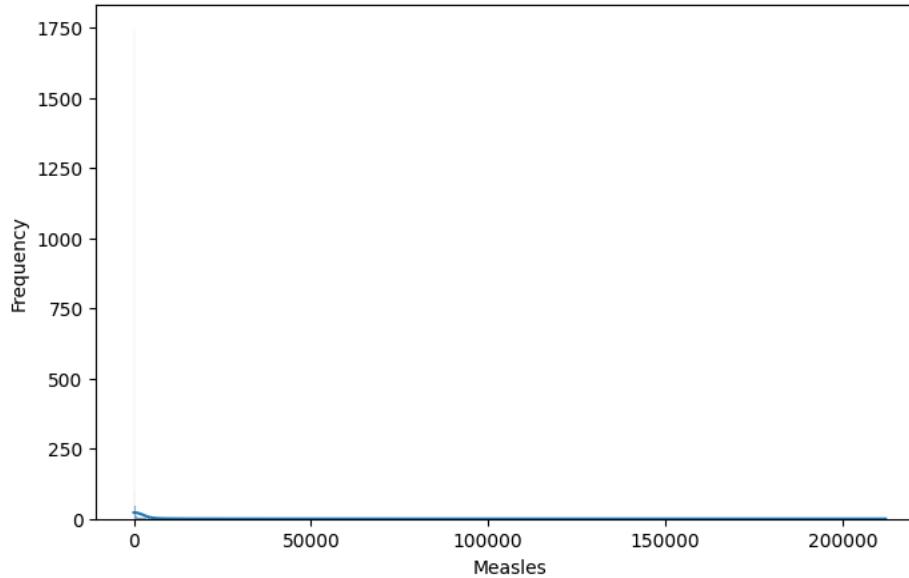


Distribution of Hepatitis B

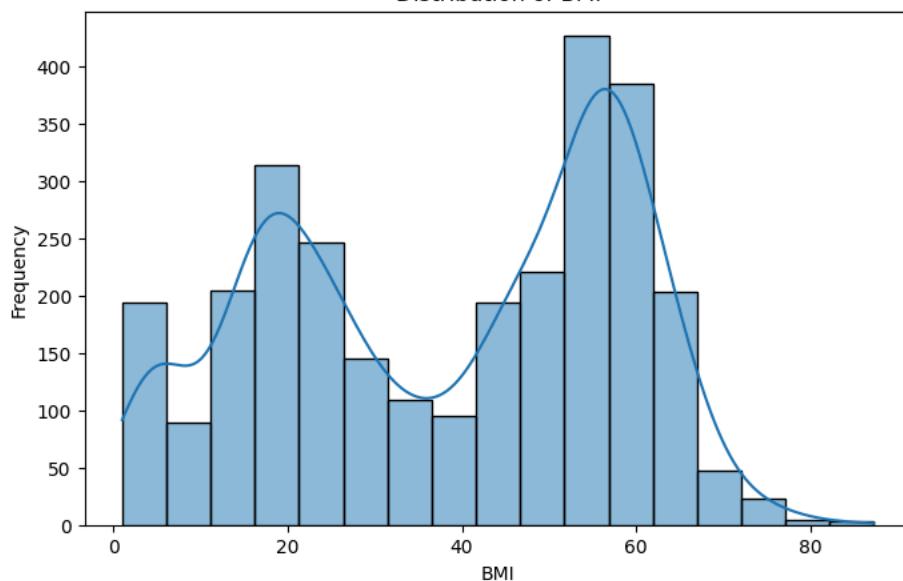




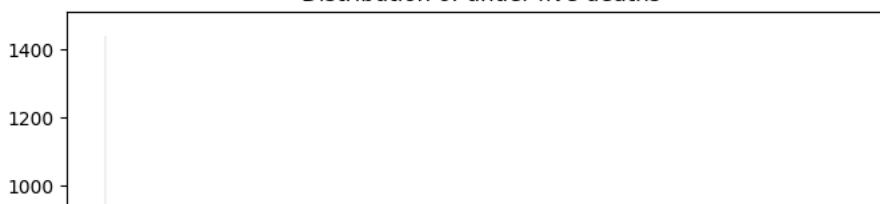
Distribution of Measles

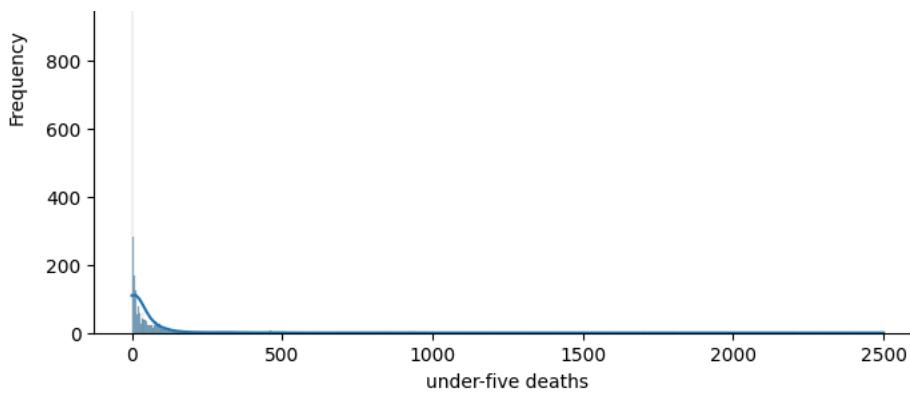


Distribution of BMI

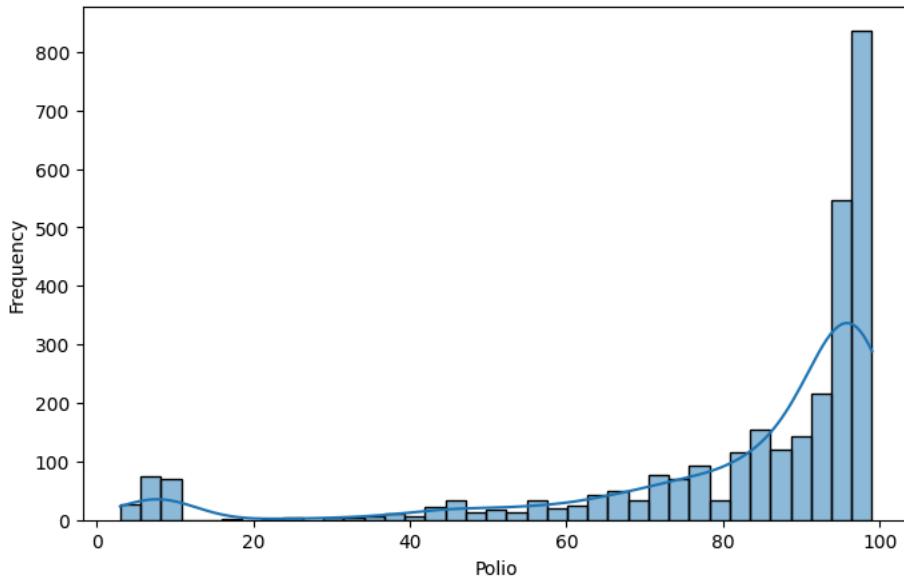


Distribution of under-five deaths

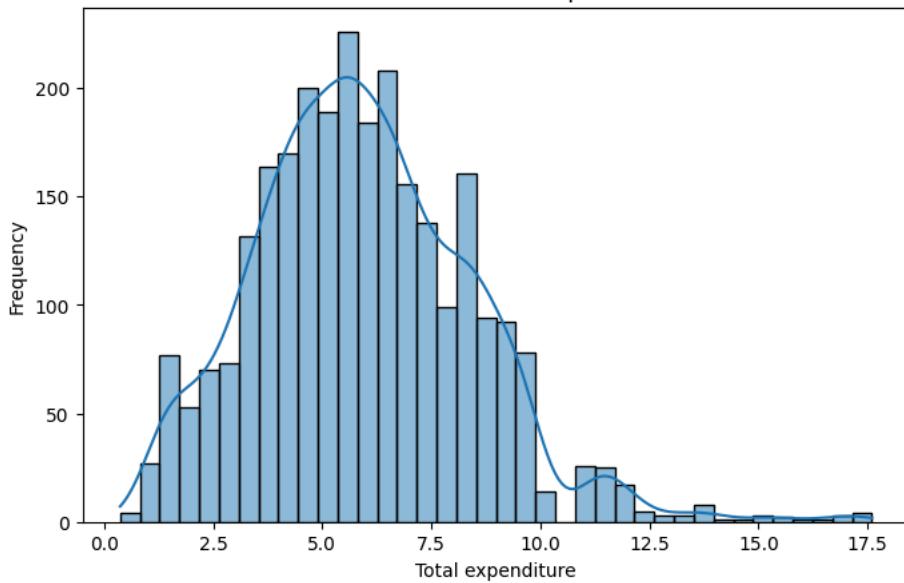




Distribution of Polio

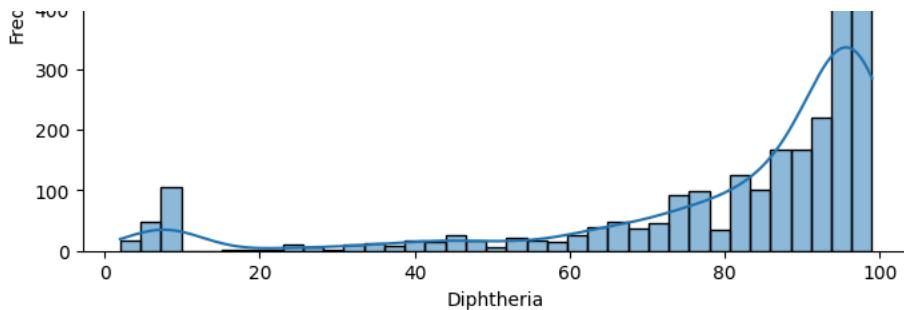


Distribution of Total expenditure

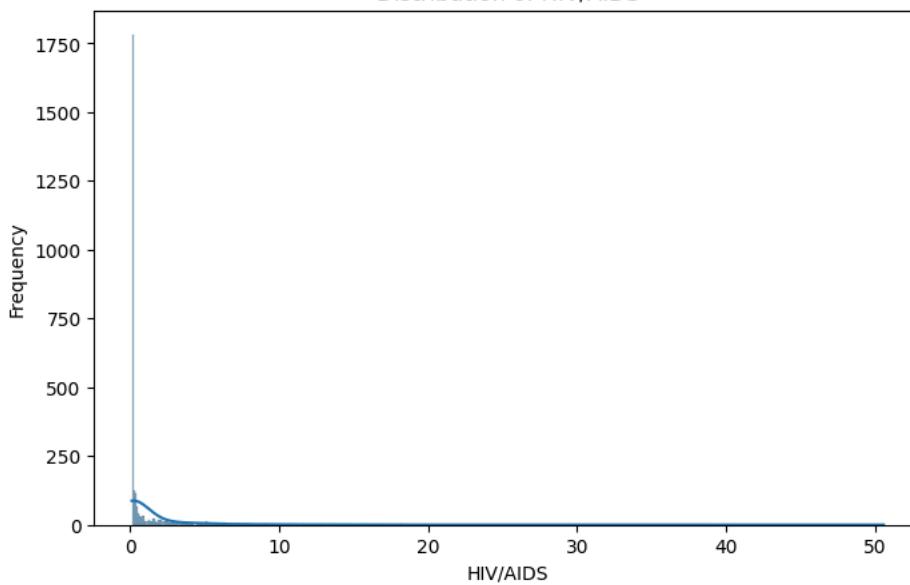


Distribution of Diphtheria

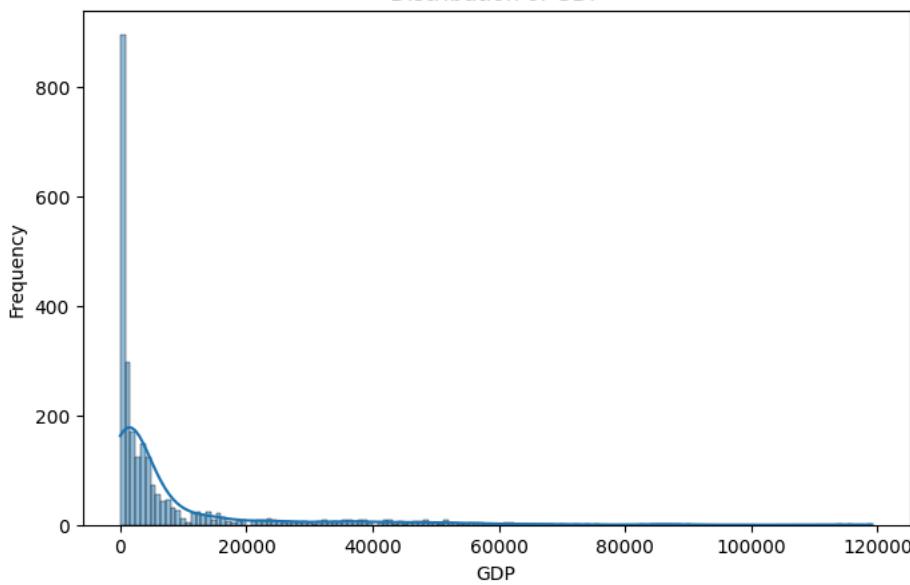




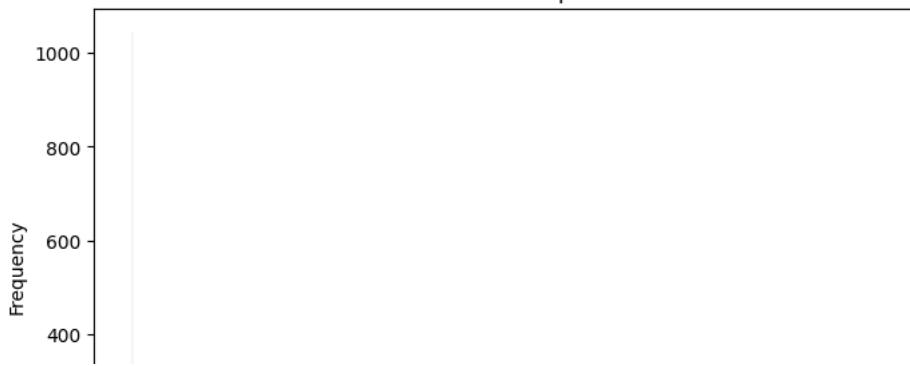
Distribution of HIV/AIDS

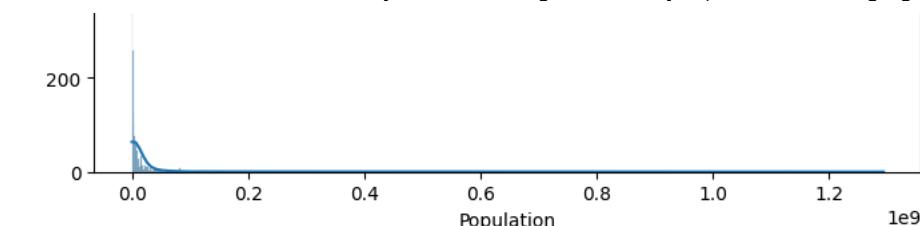


Distribution of GDP

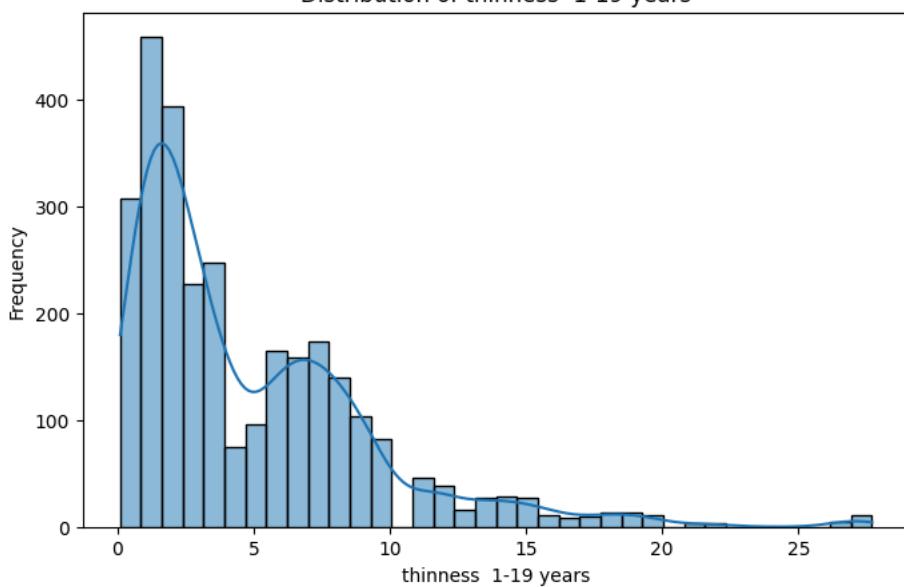


Distribution of Population

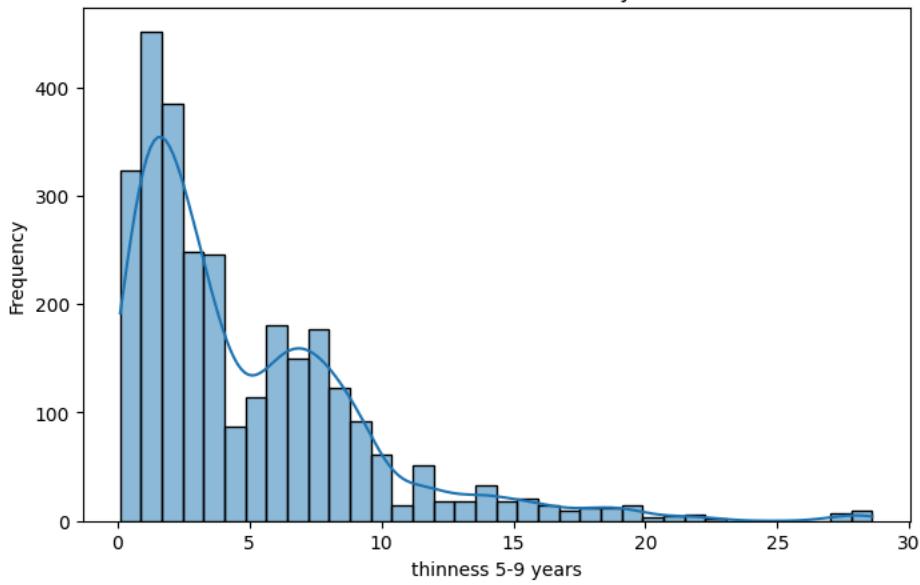




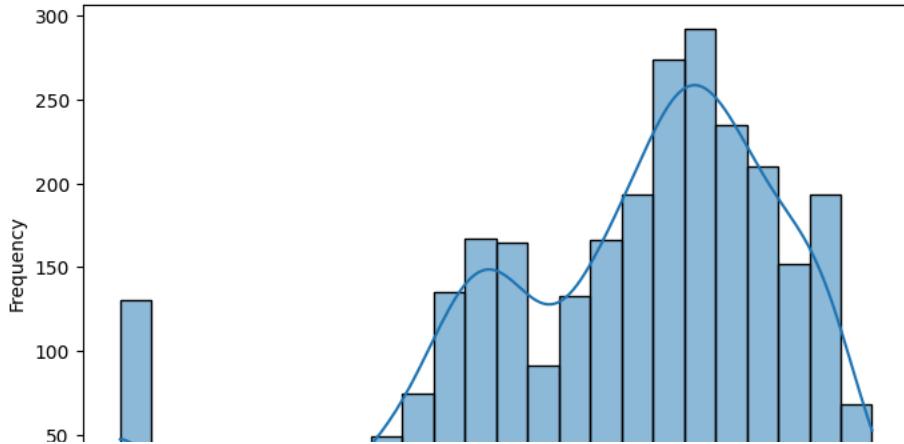
Distribution of thinness 1-19 years

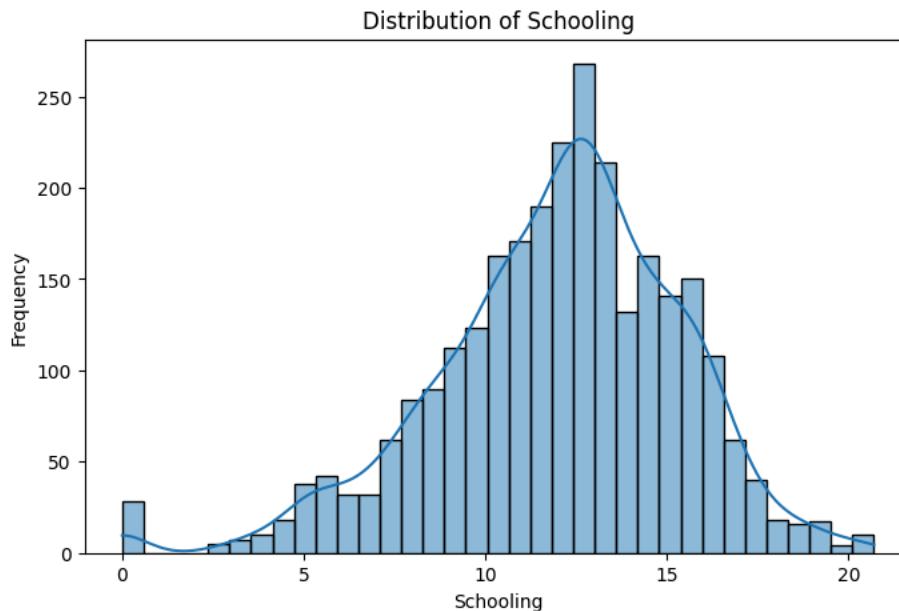
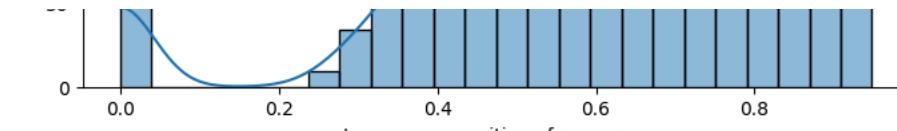


Distribution of thinness 5-9 years



Distribution of Income composition of resources





## ▼ Data Exploration by Country and Status

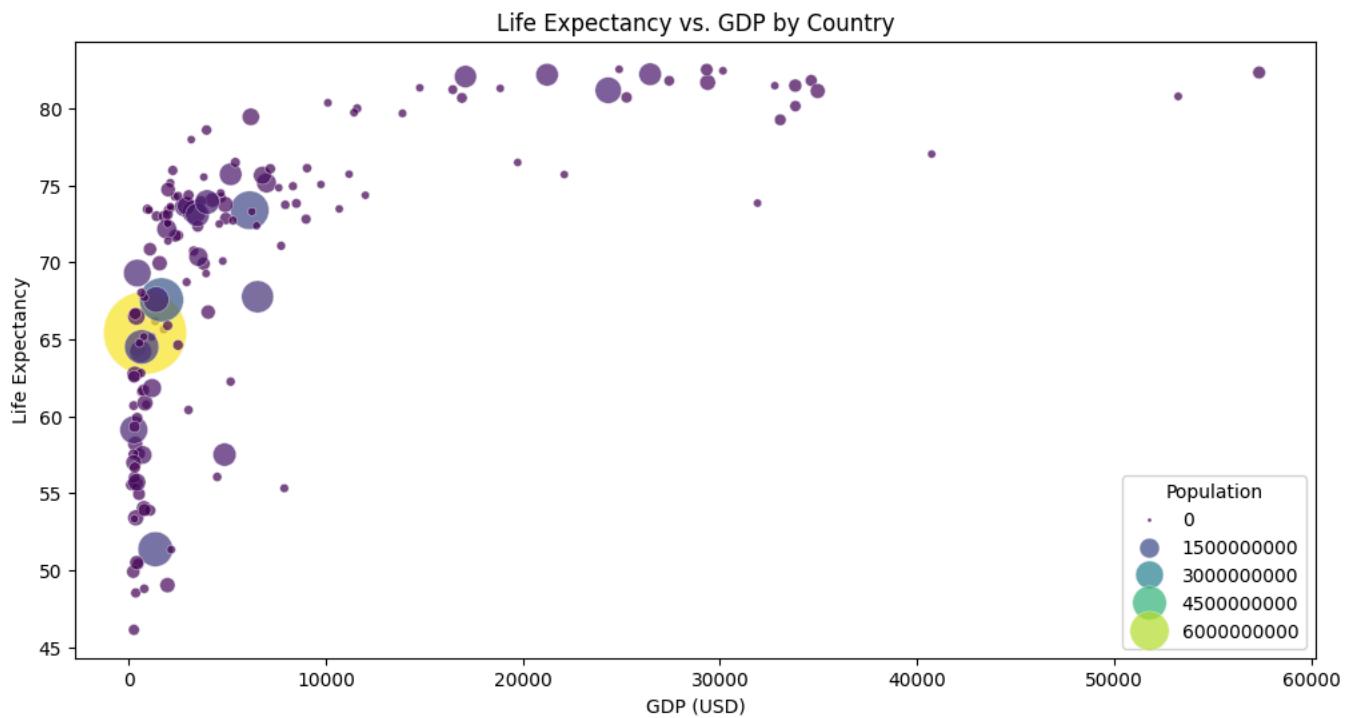
```
country_summary = life_expe.groupby('Country').agg({'Life expectancy': 'mean', 'GDP': 'mean', 'Population': 'sum'}).reset_index()
country_summary
```

	Country	Life expectancy	GDP	Population	
0	Afghanistan	58.19375	340.015425	159556157.0	
1	Albania	75.15625	2119.726679	11150586.0	
2	Algeria	73.61875	2847.853392	346397239.0	
3	Angola	49.01875	1975.143045	162353587.0	
4	Antigua and Barbuda	75.05625	9759.305728	0.0	
...	...	...	...	...	
188	Venezuela (Bolivarian Republic of)	73.38750	NaN	0.0	
189	Viet Nam	74.77500	NaN	0.0	
190	Yemen	63.86250	NaN	0.0	
191	Zambia	53.90625	811.811841	100163943.0	
192	Zimbabwe	50.48750	410.980194	128341489.0	

193 rows × 4 columns

Next steps: [View recommended plots](#)

```
plt.figure(figsize=(12, 6))
sns.scatterplot(data=country_summary, x='GDP', y='Life expectancy', size='Population', hue='Population', sizes=(20, 2000), palette='viridis'
plt.xlabel('GDP (USD)')
plt.ylabel('Life Expectancy')
plt.title('Life Expectancy vs. GDP by Country')
plt.legend(title='Population', loc='lower right', markerscale=0.5)
plt.show()
```

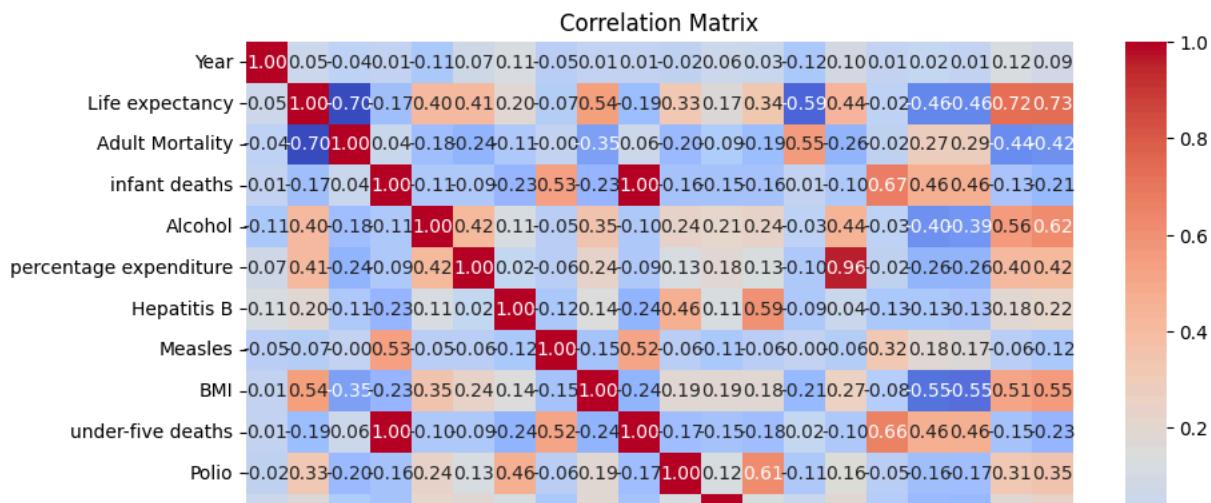


Life Expectancy vs. GDP by Country graph reveals a positive correlation between a country's GDP and the life expectancy of its citizens. As GDP increases, so does life expectancy. However, the effect diminishes with higher GDP levels. Countries with lower GDPs exhibit more variability in life expectancy. Overall, economic prosperity is associated with longer lifespans, but other factors also play a role in health outcomes

```
# Drop non-numeric columns before calculating the correlation matrix
numeric_cols = life_expe.select_dtypes(include=np.number).columns
numeric_data = life_expe[numeric_cols]

# Calculate correlation matrix
correlation_matrix = numeric_data.corr()

# Plot heatmap of correlation matrix
plt.figure(figsize=(10, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f")
plt.title('Correlation Matrix')
plt.show()
```



Scatter Plot (GDP vs. Life Expectancy): Positive correlation between GDP and life expectancy. Diminishing returns as GDP increases. Outliers at lower GDP levels suggest other factors impact life expectancy. Histogram (Life Expectancy Distribution): Most common life expectancy: 70–80 years. Fewer people live significantly shorter or longer. General trend: 70s are common, late 80s or beyond less usual. Correlation Matrix: Positive correlations: Life expectancy with schooling, income composition, and GDP. Negative correlations: Adult mortality and HIV/AIDS prevalence with life expectancy. These visualizations provide insights into the relationships between economic factors, health indicators, and life expectancy.

## Simple Linear Regression

```

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn import metrics
from sklearn.linear_model import LinearRegression

# Drop rows with missing values for simplicity (you may choose to handle missing values differently)
life_expe.dropna(inplace=True)

# Select the feature and target variables
X = life_expe[['GDP']] # Feature variable
y = life_expe['Life expectancy'] # Target variable

# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Create a linear regression model
model = LinearRegression()

```