CONTENTS

- ABOUT PROJECT
- OBJECTIVE
- IMPORTING LIBRARIES
- IMPORTING DATA
- STATISTICAL ANALYSIS
  - 1. DATA DESCRIPTION
    - 1.1. DATASETS SUMMARY
    - 1.2. DATA INFORMATION / DESCRIPTION
    - 1.3. DATA DIMENSIONS
    - 1.4. DATA TYPES FULL VALUES
    - 1.5. DATA TYPES SUMMARY
  - 2. DATA EVALUATION
    - 2.1. DATA QUALITY ANALYSIS
    - 2.2. KPIS
      - 2.2.1. OVERARCHING ANALYSIS
      - 2.2.2. MORTALITY ANALYSIS
        - 2.2.2.1. MORTALITY
        - 2.2.2.2. TOTAL MORTALITY ON LIFEXPECTANCY
        - 2.2.2.3. TOTAL MORTALITY BY ADULT MORTALITY
        - 2.2.2.4. TOTAL MORTALITY BY INFANT DEATHS
        - 2.2.2.5. TOTAL MORTALITY BY STATUS AND COUNTRY AVERAGEMORTALITY
        - 2.2.2.6. TOTAL MORTALITY BY STATUS AND MEDIANLIFE EXPECTANCY
        - 2.2.2.7. TOTAL MORTALITY BY STATUS AND MEDIANADULT MORTALITY BY COUNTRY
        - 2.2.2.8. TOTAL MORTALITY BY STATUS AND HIVAIDS
      - 2.2.3. ECONOMIC ANALYSIS
        - 2.2.3.1. OVERARCHING ANALYSIS
        - 2.2.3.2. ANALYSIS OF MORTALITY BY GDP
        - 2.2.3.3. TOTAL MORTALITY BY STATUS AND COUNTRY
        - 2.2.3.4. ANALYSIS OF MORTALITY BY GDP BY STATUS
        - 2.2.3.5. ANALYSIS OF MORTALITY BY GDP BY STATUS AND COUNTRY
        - 2.2.3.6. ANALYSIS OF MORTALITY BY GDP BY STATUS
        - 2.2.3.7. ANALYSIS OF MORTALITY BY GDP BY STATUS AND COUNTRY
        - 2.2.3.8. POPULATION OF DEVELOPED AND DEVELOPING COUNTRIES
      - 2.2.4. DEMOGRAPHIC ANALYSIS
      - 2.2.5. OVERARCHING ANALYSIS
      - 2.2.6. ANALYSIS OF MORTALITY BY POPULATION
      - 2.2.7. LIFEXPECTANCY ANALYSIS AND ADULT MORTALITY
    - 2.3. ANALYSIS
      - 2.3.1. OVERARCHING ANALYSIS
      - 2.3.2. BORDERS ANALYSIS
      - 2.3.3. ANALYSIS OF HEALTHCARE CONSUMPTION
        - 2.3.3.1. ANALYSIS OF HEALTHCARE CONSUMPTION
        - 2.3.3.2. ANALYSIS OF HEALTHCARE CONSUMPTION
    - 2.4. REGIONS
      - 2.4.1. OVERARCHING ANALYSIS
      - 2.4.2. MORTALITY ANALYSIS
    - 2.5. COUNTRY STATUS
      - 2.5.1. OVERARCHING ANALYSIS
      - 2.5.2. MORTALITY ANALYSIS
    - 2.6. ADULT MORTALITY
      - 2.6.1. OVERARCHING ANALYSIS
      - 2.6.2. MORTALITY ANALYSIS
    - 2.7. TOTAL EXPENDITURE
      - 2.7.1. OVERARCHING ANALYSIS
      - 2.7.2. MORTALITY ANALYSIS
    - 2.8. CORRELATION
    - 2.9. DISTRIBUTIONS
    - 2.10. OUTLIER EXPLORATION
    - 2.11. CONCLUSION
  - 3. DATA PREPARATION
    - 3.1. DATA SELECTION
    - 3.2. DATA CLEANSING
    - 3.3. DATA TRANSFORMATION
    - 3.4. DATA REDUCTION
    - 3.5. DATA INTEGRATION
    - 3.6. DATA FORMATTING
    - 3.7. CONCLUSION
  - 4. MODELLING
    - 4.1. CONCLUSION EXPLORATION OF ASSUMPTIONS
      - 4.1.1. NORMALITY
      - 4.1.2. LINEARITY
      - 4.1.3. HOMOSCEDASTICITY
    - 4.2. DATA VARIATIONS
      - 4.2.1. CONCLUSION EXPLORATION OF ASSUMPTIONS
      - 4.2.2. NORMALITY
      - 4.2.3. LINEARITY
      - 4.2.4. HOMOSCEDASTICITY
    - 4.3. DATA REDUCTIONS
      - 4.3.1. CONCLUSION EXPLORATION OF ASSUMPTIONS
      - 4.3.2. NORMALITY
      - 4.3.3. LINEARITY
      - 4.3.4. HOMOSCEDASTICITY
    - 4.4. DATA TRANSFORMATIONS
      - 4.4.1. CONCLUSION EXPLORATION OF ASSUMPTIONS
      - 4.4.2. NORMALITY
      - 4.4.3. LINEARITY
      - 4.4.4. HOMOSCEDASTICITY
    - 4.5. CONCLUSION
    - 4.6. CONCLUSION EXPLORATION OF ASSUMPTIONS
      - 4.6.1. NORMALITY
      - 4.6.2. LINEARITY
      - 4.6.3. HOMOSCEDASTICITY
  - 5. CONCLUSION

ABOUT PROJECT

The concept of life expectancy serves as a pivotal indicator in the realm of global health and demographic analysis. It encapsulates the average number of years an individual can expect to live, offering profound insights into various factors influencing longevity. This project delves into a comprehensive analysis of life expectancy across different countries, leveraging machine learning techniques and statistical methods to uncover the intricate interplay of various factors that impact lifespan. The objective of this analysis is twofold: firstly, it aims to provide a detailed overview of life expectancy trends and patterns, highlighting disparities between developed and developing countries. Secondly, it seeks to identify the most significant factors that contribute to variations in life expectancy, such as economic indicators, healthcare expenditure, demographic factors, and mortality rates. The insights gleaned from this analysis will not only enhance our understanding of the complex dynamics at play but also inform policymakers and stakeholders about the critical areas where interventions can be most effective in improving overall population health outcomes.

OBJECTIVE

The overall objective of this project is to critically analyze and develop the relationships of various factors with life expectancy, with the ultimate goal of enhancing our understanding of the complex dynamics that influence lifespan across different countries. This analysis will not only shed light on the interplay of factors such as economic indicators, healthcare expenditure, demographic factors, and mortality rates with life expectancy, but also aims to provide a comprehensive overview of these relationships and their implications for global health and development.

The insights gleaned from this analysis will be instrumental in informing policy decisions and interventions aimed at improving overall population health outcomes. By identifying the most significant factors that contribute to variations in life expectancy, this project will provide valuable information for policymakers and stakeholders to prioritize resource allocation and develop targeted interventions that address the critical areas where improvements can be most effective.

IMPORTING LIBRARIES

```
import pandas
```

```
import numpy as np
```

```
import seaborn as sns
```

```
import matplotlib as mpl
```

```
import matplotlib.pyplot as plt
```

```
%matplotlib inline
```

```
from sklearn import preprocessing
```

```
exec(open('DataPrep.py').read())
```

```
from sklearn.preprocessing import StandardScaler
```

```
from sklearn.preprocessing import MinMaxScaler
```

```
from sklearn.preprocessing import PolynomialFeatures
```

```
from sklearn.preprocessing import LabelEncoder
```

```
pd.set_option('display.max_columns', None)
```

```
from sklearn.linear_model import LinearRegression, Ridge
```

```
from sklearn.model_selection import train_test_split, GridSearchCV, cross_val_score
```

```
from sklearn.metrics import mean_squared_error,r2_score, PredictionErrorDisplay, mean_absolute_error
```

```
from sklearn.decomposition import PCA
```

```
from sklearn.cluster import KMeans, AgglomerativeClustering, DBSCAN, MeanShift,estimate_bandwidth, Birch, SpectralClustering
```

```
from sklearn.preprocessing import LabelEncoder, OneHotEncoder, PolynomialFeatures, StandardScaler, LinearRegression, LogisticRegression
```

IMPORTING DATA

```
df = pd.read_csv('./Life Expectancy Data.csv')
```

```
df.columns = [c.lstrip() for c in df]
```

```
df
```

	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
0	Afghanistan	2015	Developing	65.0	263.0	62	0.01	71.279624	65.0	1154	19.1	83	6.0	8.16	65.0	0.1	584.259210	33736494.0	17.2	17.3	0.479	10.1
1	Afghanistan	2014	Developing	59.9	271.0	64	0.01	73.523582	62.0	492	18.6	86	58.0	8.18	62.0	0.1	612.696514	327582.0	17.5	17.7	0.476	10.0
2	Afghanistan	2013	Developing	59.9	268.0	66	0.01	73.219243	64.0	430	18.1	89	62.0	8.13	64.0	0.1	631.744976	31731688.0	17.7	17.9	0.470	9.9
3	Afghanistan	2012	Developing	59.5	272.0	69	0.01	78.184215	67.0	2787	17.6	91	67.0	8.52	67.0	0.1	669.959000	3696958.0	17.9	18.1	0.463	9.9
4	Afghanistan	2011	Developing	59.2	275.0	71	0.01	7.097109	68.0	3013	17.2	94	68.0	7.87	68.0	0.1	63537231.0	2978599.0	18.1	18.3	0.454	9.5
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2934	Zimbabwe	2004	Developing	44.3	723.0	27	4.36	0.000000	68.0	31	19.1	38	67.0	6.05	65.0	33.6	454.366654	12777511.0	9.4	9.4	0.407	9.3
2935	Zimbabwe	2003	Developing	44.5	715.0	26	4.06	0.000000	7.0	998	18.6	40	7.0	5.90	62.0	36.7	453.351651	12633897.0	9.8	9.8	0.418	9.0
2936	Zimbabwe	2002	Developing	44.8	73.0	25	4.43	0.000000	73.0	304	18.1	42	73.0	5.90	62.0	39.0	57.348340	12957499.0	10.2	10.3	0.427	8.7
2937	Zimbabwe	2001	Developing	45.3	686.0	24	1.72	0.000000	76.0	529	17.7	43	76.0	5.90	67.0	39.8	457.237068	13562942.0	10.6	10.7	0.436	8.3

2938 rows × 22 columns

STATISTICAL ANALYSIS

STATISTICAL SUMMARY

```
df.describe()
```

	Year	Life expectancy	Adult Mortality	infant deaths	Alcohol	percentage expenditure	Hepatitis B	Measles	BMI	under-five deaths	Polio
count	2938.000000	2928.000000	2928.000000	2938.000000	2744.000000	2938.000000	2357.000000	2938.000000	2904.000000	2938.000000	2919.000000
mean	2007.518720	69.224932	164.796448	30.303948	4.602861	738.251295	80.940461	2419.592240	38.321694	42.035739	82.550188
std	4.613841	9.523867	124.292079	117.926501	4.052413	1987.914858	25.070016	11467.272489	20.044034	160.445548	23.428046
min	2000.000000	36.300000	1.000000	0.000000	0.010000	0.000000	1.000000	0.000000	1.000000	0.000000	3.000000
25%	2003.750000	63.100000	74.000000	0.000000	0.877250	304.687193	77.000000	437.000000	19.300000	0.000000	78.000000
50%	2007.500000	72.100000	144.000000	3.000000	3.755000	73.026896	92.000000	17.000000	43.000000	4.000000	93.000000
75%	2011.250000	75.600000	228.000000	22.000000	7.754250	441.414410	97.000000	360.250000	56.200000	28.000000	97.000000
max	2015.000000	89.000000	723.000000	1800.000000	17.870000	19479.911602	99.000000	212480.000000	87.300000	2500.000000	99.000000

DATA INFORMATION / DESCRIPTION

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2938 entries, 0 to 2937
Data columns (total 22 columns):
 #   Country                          2938 non-null   object
 #   Year                             2938 non-null   int64
 #   Status                           2938 non-null   object
 #   Life expectancy                  2928 non-null   float64
 #   Adult Mortality                  2928 non-null   float64
 #   infant deaths                    2938 non-null   int64
 #   Alcohol                          2744 non-null   float64
 #   percentage expenditure           2938 non-null   float64
 #   Hepatitis B                      2357 non-null   float64
 #   Measles                          2938 non-null   int64
 #   BMI                              2904 non-null   float64
 #   under-five deaths                2938 non-null   int64
 #   Polio                            2919 non-null   float64
 #   Total expenditure                2827 non-null   float64
 #   Diphtheria                       2919 non-null   float64
 #   HIV/AIDS                         2938 non-null   float64
 #   GDP                              2490 non-null   float64
 #   Population                       2286 non-null   float64
 #   thinness 1-19 years              2904 non-null   float64
 #   thinness 5-9 years               2904 non-null   float64
 #   Income composition of resources  2771 non-null   float64
 #   Schooling                        2775 non-null   float64
dtypes: float64: 16, int64: 5, object: 1
memory usage: 1.1+ MB
```

DATA DESCRIPTION

Country: This column contains the names of the countries for which the data is recorded. Each row corresponds to a specific country.

Year: This column indicates the year for which the data was collected or recorded.

Status: This column specifies the status of the country, whether it is classified as "Developed" or "Developing".

Life expectancy: This column contains the life expectancy values, which represent the average number of years a person can expect to live in a specific country during the given year.

Adult Mortality: The "Adult Mortality" column represents the probability of death between the ages of 15 and 60 years per 1000 population. It provides insights into adult mortality rates.

Infant Deaths: This column records the number of infant deaths in a specific country during the given year.

Alcohol: The "Alcohol" column represents the average alcohol consumption per capita in a country, typically measured in liters of pure alcohol consumed per year.

Percentage Expenditure: This column quantifies the percentage of a country's total expenditure allocated to various healthcare services.

Hepatitis B: The "Hepatitis B" column represents the percentage of the population immunized against Hepatitis B in a specific country.

Measles: This column records the number of reported measles cases in a specific country during the given year.

BMI (Body Mass Index): The "BMI" column represents the average Body Mass Index for the population in a specific country.

Under-five Deaths: This column records the number of deaths among children under the age of five in a specific country during the given year.

Polio: This column contains the percentage of the population immunized against Polio.

Total Expenditure: This column represents the total healthcare expenditure as a percentage of a country's GDP.

Diphtheria: Similarly to the percentage of the population immunized against Diphtheria.

HIV/AIDS: This column represents the number of HIV/AIDS deaths in a specific country during the given year.

GDP: The "GDP" represents the Gross Domestic Product, which measures the economic output of a country. It's typically expressed in monetary terms (e.g., US dollars) and reflects a country's economic health.

Population: This column contains the population data for each country in the dataset for the given year.

Thinness 1-19 years: This column data represents the percentage of the population aged 1-19 years who are considered thin.

Thinness 5-9 years: Similar to the previous column, this key represents the percentage of the population aged 5-9 years who are considered thin.

Income Composition of Resources: This column likely represents a composite index reflecting a country's income composition, potentially considering factors like income distribution and sources of income.

Schooling: Indicating the average number of years of schooling or education received by individuals in a specific country, it's an indicator of educational attainment.

DETECTING NULLS

```
print("The total nulls in the data set: ")
df.isnull().sum()
```

```
The total nulls in the data set:
Country                             0
Year                                0
Status                              0
Life expectancy                    10
Adult Mortality                    10
infant deaths                       0
Alcohol                           194
percentage expenditure              0
Hepatitis B                       581
Measles                             0
BMI                                34
under-five deaths                   0
Polio                              19
Total expenditure                 111
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
```

FILLING IN NULL VALUES

```
for c in df.columns[3:-1]:
    mean = df[df.Status == 'Developing'][c].mean()
    print(c, mean)
    df[c].fillna(mean, inplace=True)
    mean = df[df.Status == 'Developed'][c].mean()
    print(c, mean)
    df[c].fillna(mean, inplace=True)
```

life expectancy

count	2.0
mean	72.5
std	0.0
min	72.5
25%	72.5
50%	72.5
75%	72.5
max	72.5

Dtype: float64, 8 statistics

life expectancy

count	2.0000000
mean	50.2000000
std	0.0000000
min	50.2000000
25%	50.2000000
50%	50.2000000
75%	50.2000000
max	50.2000000

Dtype: float64, 8 statistics

Land Mass(km)

count	2.0
mean	2.0
std	0.0
min	2.0
25%	2.0
50%	2.0
75%	2.0
max	2.0

Dtype: float64, 8 statistics

Land Mass(km)

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

Density

count	2.0
mean	2.0
std	0.0
min	2.0
25%	2.0
50%	2.0
75%	2.0
max	2.0

Dtype: float64, 8 statistics

Density

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

Agricultural Land(%)

count	2.0
mean	2.0
std	0.0
min	2.0
25%	2.0
50%	2.0
75%	2.0
max	2.0

Dtype: float64, 8 statistics

Agricultural Land(%)

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

Gross Domestic Product (GDP)

count	2.0
mean	2.0
std	0.0
min	2.0
25%	2.0
50%	2.0
75%	2.0
max	2.0

Dtype: float64, 8 statistics

Gross Domestic Product (GDP)

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

Exports

count	2.0
mean	2.0
std	0.0
min	2.0
25%	2.0
50%	2.0
75%	2.0
max	2.0

Dtype: float64, 8 statistics

Exports

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

Health Exp/Capita

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

Health Exp/Capita

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

HDI

count	2.0000000
mean	0.5215147
std	0.0000000
min	0.5215147
25%	0.5215147
50%	0.5215147
75%	0.5215147
max	0.5215147

Dtype: float64, 8 statistics

HDI

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

Mass

count	2.0000000
mean	2.0000000
std	0.0000000
min	2.0000000
25%	2.0000000
50%	2.0000000
75%	2.0000000
max	2.0000000

Dtype: float64, 8 statistics

Mass

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

Total expenditure

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

Total expenditure

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

Agriculture

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

Agriculture

count	2.0000000
mean	1.0000000
std	0.0000000
min	1.0000000
25%	1.0000000
50%	1.0000000
75%	1.0000000
max	1.0000000

Dtype: float64, 8 statistics

GDP

count	2.0000000
mean	2.5000000
std	0.7071068
min	2.0000000
25%	2.2500000
50%	2.5000000
75%	2.7500000
max	3.0000000

Dtype: float64, 8 statistics

GDP

count	2.0000000
mean	1.5000000
std	0.7071068
min	1.0000000
25%	1.2500000
50%	1.5000000
75%	1.7500000
max	2.0000000

Dtype: float64, 8 statistics

HALOTHER

count	0.0
mean	NaN
std	NaN
min	NaN
25%	NaN
50%	NaN
75%	NaN
max	NaN

Dtype: float64, 8 statistics

HALOTHER

count	0.0
mean	NaN
std	NaN
min	NaN
25%	NaN
50%	NaN
75%	NaN
max	NaN

Dtype: float64, 8 statistics

HALOTOTAL

count	0.0
mean	NaN
std	NaN
min	NaN
25%	NaN
50%	NaN
75%	NaN
max	NaN

Dtype: float64, 8 statistics

HALOTOTAL

count	0.0
mean	NaN
std	NaN
min	NaN
25%	NaN
50%	NaN
75%	NaN
max	NaN

Dtype: float64, 8 statistics

Population

count	2.0000000
mean	2.5000000
std	0.7071068
min	2.0000000
25%	2.2500000
50%	2.5000000
75%	2.7500000
max	3.0000000

Dtype: float64, 8 statistics

Population

count	2.0000000
mean	1.5000000
std	0.7071068
min	1.0000000
25%	1.2500000
50%	1.5000000
75%	1.7500000
max	2.0000000

Dtype: float64, 8 statistics

Area(km ^2) (Km)

count	2.0000000
mean	2.5000000
std	0.7071068
min	2.0000000
25%	2.2500000
50%	2.5000000
75%	2.7500000
max	3.0000000

Dtype: float64, 8 statistics

Area(km ^2) (Km)

count	2.0000000
mean	1.5000000
std	0.7071068
min	1.0000000
25%	1.2500000
50%	1.5000000
75%	1.7500000
max	2.0000000

Dtype: float64, 8 statistics

Income composition of resources

count	2.0000000
mean	2.5000000
std	0.7071068
min	2.0000000
25%	2.2500000
50%	2.5000000
75%	2.7500000
max	3.0000000

Dtype: float64, 8 statistics

Income composition of resources

count	2.0000000
mean	1.5000000
std	0.7071068
min	1.0000000
25%	1.2500000
50%	1.5000000
75%	1.7500000
max	2.0000000

Dtype: float64, 8 statistics

Schooling

count	2.0
mean	2.5
std	0.7
min	2.0
25%	2.2
50%	2.5
75%	2.8
max	3.0

Dtype: float64, 8 statistics

Schooling

count	2.0000000
mean	1.5000000
std	0.7071068
min	1.0000000
25%	1.2500000
50%	1.5000000
75%	1.7500000
max	2.0000000

Dtype: float64, 8 statistics

```
In [27]: Country = df['Country']
         Country.value_counts()
```

```
Out[27]: Country
         Afghanistan    1
         Albania        1
         Name: count, dtype: int64
```

```
In [28]: df.shape, df.columns, df.info(), df.describe(), df.head(), df.tail(), df.isna().sum(), df.dtypes, df.T.T.T.T
         df.nunique(), df.sample(), df.sample(2), df.sample(3), df.sample(4), df.sample(5), df.sample(6), df.sample(7)
```

```
Out[28]: (None,
          None,
          None,
          
```

```
Adult mortality rate
Number of patients drug between 15 - 60
in a certain year and area
Total number of population between 15 - 60
in the same year and same area
```

The Yearly Mortality ratio represents the probability of death between the ages of 15 and 60 per 1000 population.

It provides insights into adult mortality rates.

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pie chart [ by d Year ] [ "Male Mortality ratio" "Female Mortality ratio" ] pie1 [ "male" "female" ] colors [ "#ffc000" ] ;
pie colors [ "Male Mortality ratio" ] ;
pie size [ 7 ] ;
pie title [ "Female Mortality ratio" ] ;
pie dim
```

- INTERPRET -

1. The critical decrease in adult mortality rate from 2000 to 2001 suggests potential improvements in healthcare, sanitation, or other factors during that period.

2. The subsequent increase from 2001 to 2007 might indicate challenges or factors that led to a slight mortality rise.

3. The stabilization and continuous decline from 2008 onwards suggests positive changes or interventions that have been effective in lowering adult mortality rates.

4. Factors such as disease outbreaks, access to healthcare, socioeconomic conditions, and public health initiatives can significantly impact adult mortality rates.

5. The overall trend from 2000 to 2023 shows a significant decline, indicating a positive sign for public health and healthcare advancements.

6. It suggests that efforts to improve healthcare access and quality may have had a meaningful impact on reducing mortality.

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pie chart [ by d Year ] [ "Male Mortality ratio" "Female Mortality ratio" ] pie1 [ "male" "female" ] colors [ "#ffc000" ] ;
pie colors [ "Female Mortality ratio" ] ;
pie size [ 7 ] ;
pie dim
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- INTERPRET -

1. We can see a decreasing trend in the mortality of infants from the year 2000 (37.7) to 2021 (21.1)

2. The decrease in infant mortality over this 21 year period suggests improvements in healthcare care, sanitation, and overall health conditions.

3. Healthcare interventions and sanitation improvements could have contributed to a positive reduction of infant mortality.

4. The slight increase in infant mortality from 2021 to 2023 (21.1 to 2023 (21.2) suggests a potential slowdown in the rate of improvement.

5. The decrease in infant mortality over this 21 year period suggests improvements in healthcare care, sanitation, and overall health conditions.

6. Healthcare interventions and sanitation improvements could have contributed to a positive reduction of infant mortality.

7. The slight increase in infant mortality from 2021 to 2023 (21.1 to 2023 (21.2) suggests a potential slowdown in the rate of improvement.

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pie chart [ by d Year ] [ "Male Mortality ratio" "Female Mortality ratio" ] pie1 [ "male" "female" ] colors [ "#ffc000" ] ;
pie colors [ "Infant Mortality" ] ;
pie size [ 7 ] ;
pie dim
```

- INTERPRET -

1. We can see a decreasing trend in the mortality of infants from the year 2000 (37.7) to 2021 (21.1)

2. The decrease in infant mortality over this 21 year period suggests improvements in healthcare care, sanitation, and overall health conditions.

3. Healthcare interventions and sanitation improvements could have contributed to a positive reduction of infant mortality.

4. The slight increase in infant mortality from 2021 to 2023 (21.1 to 2023 (21.2) suggests a potential slowdown in the rate of improvement.

5. The decrease in infant mortality over this 21 year period suggests improvements in healthcare care, sanitation, and overall health conditions.

6. Healthcare interventions and sanitation improvements could have contributed to a positive reduction of infant mortality.

7. The slight increase in infant mortality from 2021 to 2023 (21.1 to 2023 (21.2) suggests a potential slowdown in the rate of improvement.

```
pie chart [ by d Year ] [ "Male Mortality ratio" "Female Mortality ratio" ] pie1 [ "male" "female" ] colors [ "#ffc000" ] ;
pie colors [ "Infant Mortality" ] ;
pie size [ 7 ] ;
pie dim
```

- INTERPRET -

1. Healthcare interventions in developed countries have been relatively stable, with occasional slight increases in the mortality rate.

2. The mortality rate has generally decreased in recent years, indicating improvements in healthcare access and quality.

3. In developed countries, the mortality rate has fluctuated slightly, with occasional slight increases and decreases.

4. The overall trend in developed countries has been relatively stable, with occasional slight increases and decreases.

5. In developing countries, the mortality rate has been relatively stable, with occasional slight increases and decreases.

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408. The overall trend in developed countries has been relatively stable, with occasional slight increases and decreases.

409. The mortality rate in developing countries

POPULATION OF DEVELOPED AND DEVELOPING COUNTRIES

```
>>> plot("Population", "Country")
>>> dev_countries = d.filter(d.Is_Developed == 1).select("Country")
>>> dev_pop = dev_countries.join(d, "Country").select("Country", "Population")
>>> dev_pop.show()
```

```
+--------+----------+
| Country|Population|
+--------+----------+
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
|Belgium|   11.4000|
+--------+----------+
only showing top 20 rows
```

```
>>> plot("Population", "Country")
>>> plot.show()
```

- INFERENCE -

1. Developing countries generally have a much larger and more varied population compared to developed countries.
2. Population differences in demographics and socio-economic factors.
   - The proportion of activities in developing countries, as indicated by a larger standard deviation, suggests a wider range of population sizes in these countries.

LIFE EXPECTANCY

UNIVARIATE ANALYSIS

```
>>> plot("Life_Expectancy", "Country")
>>> life_exp = d.filter(d.Life_Expectancy != 0).select("Country", "Life_Expectancy")
>>> life_exp.show()
```

MULTIVARIATE ANALYSIS

LIFE EXPECTANCY VARIATION AND ADULT MORTALITY

```
>>> plot("Country", "Life_Expectancy", "Adult_Mortality")
>>> life_exp_mortality = d.select("Life_Expectancy", "Adult_Mortality")
>>> life_exp_mortality.show()
```

- INFERENCE -

1. Strong negative correlation of -0.69624 exists between life expectancy and adult mortality.
   - This suggests that as adult mortality increases, adult mortality decreases, and vice versa.
2. Higher life expectancy in generally associated with lower adult mortality rates.
   - This correlation highlights the significant relationship between adult mortality and life expectancy rates.
   - Health challenges, limited access to healthcare, and factors that can lower life expectancy.

ALCOHOL

The "Alcohol" column represents the average yearly alcohol consumption per capita in a country, typically measured in liters.

- It covers all pure alcohol consumed per person per year.

UNIVARIATE ANALYSIS

```
>>> plot("Alcohol", "Country")
>>> alcohol = d.w.filter(d.Alcohol != 0).select("Country", "Alcohol")
>>> alcohol = alcohol.join(d.w, "Country").select("Country", "Alcohol", "Life_Expectancy")
>>> alcohol.show()
```

```
+-------+-------+----------------+
|Country|Alcohol|Life_Expectancy|
+-------+-------+----------------+
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
|Belgium|   0.01|            0.0|
+-------+-------+----------------+
only showing top 20 rows
```

```
>>> plot("Alcohol", "Life_Expectancy")
>>> plot.show()
```

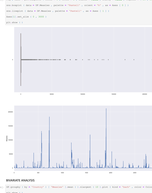
- INFERENCE -

1. On average, people in the dataset consume approximately 4.5 liters of pure alcohol per capita annually. The
   - The data shows a wide range of alcohol consumption, from as low as 0.01 liters to as high as 17.87 liters.
2. Higher alcohol consumption tends strongly higher levels of adult mortality and life expectancy.
   - The data shows that countries with higher alcohol consumption generally have higher adult mortality rates and lower life expectancy rates.
   - This suggests a potential correlation between alcohol consumption and various factors, including socio-economic factors, cultural norms, and economic factors.

BIVARIATE ANALYSIS

BMI AND ALCOHOL CONSUMPTION

```
>>> plot("Alcohol", "BMI")
>>> bmi_alcohol = d.filter(d.Alcohol != 0).select("Alcohol", "BMI")
>>> bmi_alcohol.show()
```




```
>>> plot("Alcohol", "BMI")
>>> plot.show()
```

- INFERENCE -

1. The correlation matrix reveals the relationship between BMI and alcohol consumption. The correlation coefficient
   - between BMI and alcohol is approximately 0.01, indicating a negligible correlation.
2. The data points exhibit a slight positive trend, suggesting that individuals who consume more alcohol tend to have
   - higher BMI. However, the correlation coefficient of 0.01 suggests that while there is a slight tendency for
   - BMI to increase with alcohol consumption, this implies that other factors likely have a significant influence on BMI.
3. The data points are concentrated in the lower left corner of the plot, indicating that the majority of individuals in the dataset have low alcohol consumption and low BMI. This concentration could
   - BMI values in the dataset exhibit a wide variability, as there might be a bias in the sample towards individuals with low alcohol consumption and low BMI.
4. There are also data points in the upper right side of the plot, representing individuals with high alcohol
   - consumption and high BMI. These data points could be considered outliers or might indicate a specific subgroup
   - within the dataset with distinct characteristics.
5. The high variability in the data emphasizes that individual choices and circumstances vary significantly. The
   - low correlation suggests that focusing solely on the relationship between alcohol consumption and BMI might be insufficient.

HEPATITIS AND ALCOHOL CONSUMPTION

```
>>> plot("Alcohol", "Hepatitis_B")
>>> hep_alcohol = d.w.filter(d.Alcohol != 0).select("Hepatitis_B", "Alcohol")
>>> hep_alcohol.show()
```

```
>>> plot("Alcohol", "Hepatitis_B")
>>> plot.show()
```

- INFERENCE -

1. Higher consumption suggests that countries with lower alcohol consumption per capita tend to have higher rates
   - of Hepatitis B immunization. This correlation can be attributed to factors such as healthcare
   - infrastructure, cultural practices, and socio-economic factors in these countries.
2. The data points are concentrated in the lower left corner of the plot, indicating that a
   - significant number of countries exhibit low alcohol consumption and low Hepatitis B immunization rates.
3. The presence of some outliers in the upper right corner suggests that countries with higher alcohol consumption and higher Hepatitis B immunization rates. This suggests that other factors may also influence Hepatitis B
   - immunization in these countries.

DIPHTERIA AND ALCOHOL CONSUMPTION

```
>>> plot("Alcohol", "Diphtheria")
>>> dip_alcohol = d.w.filter(d.Alcohol != 0).select("Diphtheria", "Alcohol")
>>> dip_alcohol.show()
```

```
>>> plot("Alcohol", "Diphtheria")
>>> plot.show()
```


- INFERENCE -

1. Higher consumption suggests that countries with lower alcohol consumption per capita tend to have higher rates
   - of Diphtheria immunization. This correlation can be attributed to factors such as healthcare
   - infrastructure, cultural practices, and socio-economic factors in these countries.
2. The data points are concentrated in the lower left corner of the plot, indicating that a
   - significant number of countries exhibit low alcohol consumption and low Diphtheria immunization rates.
3. The presence of some outliers in the upper right corner suggests that countries with higher alcohol consumption and higher Diphtheria immunization rates. This suggests that other factors may also influence Diphtheria
   - immunization in these countries.

MEASLES

This column records the number of reported measles cases in a specific country during the given year.

UNIVARIATE ANALYSIS

```
>>> plot("Measles", "Country")
>>> measles = d.filter(d.Measles != 0).select("Country", "Measles")
>>> measles.show()
```

```
+-------+--------+
|Country|Measles|
+-------+--------+
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
+-------+--------+
only showing top 20 rows
```

```
>>> plot("Measles", "Country")
>>> plot.show()
```


BIVARIATE ANALYSIS

```
>>> d1.groupBy("Country").sum("Measles").show(20,False)
>>> d1.filter("Country IN ('Angola', 'Bolivia', 'Brazil', 'Bulgaria', 'Cabo Verde', 'Cambodia', 'Chile', 'Colombia', 'Costa Rica', 'Croatia', 'Cuba', 'Dominica', 'Dominican Republic', 'Ecuador', 'El Salvador', 'Fiji', 'Gabon', 'Georgia', 'Grenada', 'Guatemala')").show()
```

```
+-----------+-----------+
|Country|sum(Measles)|
+-----------+-----------+
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
|Belgium|     1.0|
+-----------+-----------+
only showing top 20 rows
```


UNDER 5 DEATHS

The number of deaths among children under the age of five in a specific country during the given year.

UNIVARIATE ANALYSIS

```
>>> plot("Under_five_deaths", "Country")
>>> under_five = d.filter(d.Under_five_deaths != 0).select("Country", "Under_five_deaths")
>>> under_five.show()
```

```
+-------+-----------+
|Country|Under_five_deaths|
+-------+-----------+
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
+-------+-----------+
only showing top 20 rows
```

```
>>> plot("Under_five_deaths", "Country")
>>> plot.show()
```

BIVARIATE ANALYSIS

```
>>> d1.groupBy("Country").sum("Under_five_deaths").show(20,False)
>>> d1.filter("Country IN ('Angola', 'Bolivia', 'Brazil', 'Bulgaria', 'Cabo Verde', 'Cambodia', 'Chile', 'Colombia', 'Costa Rica', 'Croatia', 'Cuba', 'Dominica', 'Dominican Republic', 'Ecuador', 'El Salvador', 'Fiji', 'Gabon', 'Georgia', 'Grenada', 'Guatemala')").show()
```

```
+-----------+-----------+
|Country|sum(Under_five_deaths)|
+-----------+-----------+
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
|Belgium|        1.0|
+-----------+-----------+
only showing top 20 rows
```


- INFERENCE -

1. The data shows that higher average number of child deaths under the age of five, with approximately 1,000 deaths.
   - This suggests a wide range of child mortality rates in the dataset.
2. Countries with higher under five mortality rates indicates the need for improved healthcare, sanitation, and nutrition.
   - Addressing these factors is crucial to reduce child mortality and enhance child well-being.
3. Including data, Nigeria experiences a substantial number of child deaths under five, with an approximately 90,000 deaths.
   - This underscores the dire situation facing Nigeria with high child mortality.
   - Nigeria, and Pakistan like India, faces a critical issue of child mortality, emphasizing the urgent healthcare interventions and policies to address this challenge.

POLIO

Polio is the percentage of the population immunized against Polio. It's another measure of immunization coverage.

UNIVARIATE ANALYSIS

```
>>> plot("Polio", "Country")
>>> polio = d.filter(d.Polio != 0).select("Country", "Polio")
>>> polio.show()
```

```
+-------+----------+
|Country|Polio|
+-------+----------+
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
+-------+----------+
only showing top 20 rows
```


BIVARIATE ANALYSIS

```
>>> d1.groupBy("Country").sum("Polio").show(20,False)
>>> d1.filter("Country IN ('Angola', 'Bolivia', 'Brazil', 'Bulgaria', 'Cabo Verde', 'Cambodia', 'Chile', 'Colombia', 'Costa Rica', 'Croatia', 'Cuba', 'Dominica', 'Dominican Republic', 'Ecuador', 'El Salvador', 'Fiji', 'Gabon', 'Georgia', 'Grenada', 'Guatemala')").show()
```

```
+-----------+-----------+
|Country|sum(Polio)|
+-----------+-----------+
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
|Belgium|   99.0|
+-----------+-----------+
only showing top 20 rows
```


TOTAL EXPENDITURE

UNIVARIATE ANALYSIS

```
>>> plot("Total_Expenditure", "Country")
>>> total_exp = d.filter(d.Total_Expenditure != 0).select("Country", "Total_Expenditure")
>>> total_exp.show()
```

```
+-------+----------+
|Country|Total_Expenditure|
+-------+----------+
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
+-------+----------+
only showing top 20 rows
```

```
>>> plot("Total_Expenditure", "Country")
>>> plot.show()
```


BIVARIATE ANALYSIS

```
>>> d1.groupBy("Country").sum("Total_Expenditure").show(20,False)
>>> d1.filter("Country IN ('Angola', 'Bolivia', 'Brazil', 'Bulgaria', 'Cabo Verde', 'Cambodia', 'Chile', 'Colombia', 'Costa Rica', 'Croatia', 'Cuba', 'Dominica', 'Dominican Republic', 'Ecuador', 'El Salvador', 'Fiji', 'Gabon', 'Georgia', 'Grenada', 'Guatemala')").show()
```

```
+-----------+-----------+
|Country|sum(Total_Expenditure)|
+-----------+-----------+
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
|Belgium|      7.35|
+-----------+-----------+
only showing top 20 rows
```


POPULATION

```
In [1]: df.describe() # df.shape # df.T # ["Pneumonia"] ["Pneumonia"] [["Pneumonia"]] ["Age"] | [["Age"]] | [["Age", "Pneumonia"]]
Out[1]:  Pneumonia  Diabetes  COPD  Asthma  Infection  Hypertension  Cardiovascular  Obesity  Renal_failure  Tobacco  Age  Patient_id
count  10000.0  10000.0  10000.0  10000.0  10000.0  10000.0  10000.0  10000.0  10000.0  10000.0  10000.0  10000.0
mean  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
std  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
min  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
25%  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
50%  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
75%  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
max  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
```

```
In [2]: ["Pneumonia"] [["Pneumonia"]] ["Age"] | [["Age"]] | [["Age", "Pneumonia"]] ["Age"].describe()
Out[2]: count    10000.0
mean         0.0
std          0.0
min          0.0
25%          0.0
50%          0.0
75%          0.0
max          0.0
Name: Age, dtype: float64
```

```
In [3]: ["Pneumonia"].plot(kind="hist", figsize=(8,6))
```

The Frequency Distribution Curve
Pneumonia
Frequency
0.0
0.0
0.0

```
>>> [0] Shape = (1, 1) | [1] = (1, 1)
>>> output: [-0.0 0.0 0.0 
```

Residual Plot (Linear Regression - Test Set Predictions)
Residuals (Actual - Predicted)
Predicted Values
0
−5000
−10000
−15000
−20000
−25000
−30000
−35000
−40000
−45000
−50000
−55000
−60000
−65000
−70000
−75000
−80000
−85000
−90000
−95000
−100000
−105000
−110000
−115000
−120000
−125000
−130000
−135000
−140000
−145000
−150000
−155000
−160000
−165000
−170000
−175000
−180000
−185000
−190000
−195000
−200000