python-project-1

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1 Pandemic Impact: COVID-19 and World Happiness

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1.1 AIM

Investigating the relation Between Country-Specific COVID-19 Rates and World Happiness Index Scores to Understand the Impact of the Pandemic on Societal Well-being.

1.1.1 DATASET DESCRIPTION

This project combines two datasets: the COVID-19 dataset from the WHO website and the World Happiness Report dataset from Kaggle. The former provides COVID-19 rates for countries, while the latter offers happiness scores.

COVID-19 Dataset
World Happiness Report Dataset

[ ]:
```
#Importing necessary libraries
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
```

[ ]:
```
#Reading COVID-19 dataset
covid_data = pd.read_csv('covid_dataset.csv')
covid_data.head()
```

[ ]:
```
  Province/State Country/Region      Lat     Long  1/22/20  1/23/20  1/24/20  \
0            NaN    Afghanistan  33.0000  65.0000        0        0        0
1            NaN        Albania  41.1533  20.1683        0        0        0
2            NaN        Algeria  28.0339   1.6596        0        0        0
3            NaN        Andorra  42.5063   1.5218        0        0        0
```

```
4            NaN         Angola -11.2027  17.8739        0        0        0

   1/25/20  1/26/20  1/27/20  …  4/21/20  4/22/20  4/23/20  4/24/20  \
0        0        0        0  …     1092     1176     1279     1351
1        0        0        0  …      609      634      663      678
2        0        0        0  …     2811     2910     3007     3127
3        0        0        0  …      717      723      723      731
4        0        0        0  …       24       25       25       25

   4/25/20  4/26/20  4/27/20  4/28/20  4/29/20  4/30/20
0     1463     1531     1703     1828     1939     2171
1      712      726      736      750      766      773
2     3256     3382     3517     3649     3848     4006
3      738      738      743      743      743      745
4       25       26       27       27       27       27

[5 rows x 104 columns]
```

1.2 DATA PRE-PROCESSING

1.3 A. Pre-processing COVID-19 Dataset

[ ]:
```
#checking dataframe shape
covid_data.shape
```

[ ]:
```
(266, 104)
```

[ ]:
```
#Checking column names
columns = covid_data.columns
columns
```

[ ]:
```
Index(['Province/State', 'Country/Region', 'Lat', 'Long', '1/22/20', '1/23/20',
       '1/24/20', '1/25/20', '1/26/20', '1/27/20',
       …
       '4/21/20', '4/22/20', '4/23/20', '4/24/20', '4/25/20', '4/26/20',
       '4/27/20', '4/28/20', '4/29/20', '4/30/20'],
      dtype='object', length=104)
```

1. Checking Missing Values

[ ]:
```
covid_data.isna().sum()
```

[ ]:
```
Province/State    184
Country/Region      0
Lat                 0
Long                0
1/22/20             0
```

```
                  …
4/26/20           0
4/27/20           0
4/28/20           0
4/29/20           0
4/30/20           0
Length: 104, dtype: int64
```

Interpretation : There is no missing values in the dataset.

2. Checking Duplicate Rows

[ ]:
```
covid_data.duplicated().any()
```

[ ]:
```
False
```

Interpretation : Dataset does not have duplicate rows

3. Remove not required columns

[ ]:
```
#Remove not required columns
#Latitude and Longitude colums are irrelevent for the context.Hence this can be␣
↪removed.
covid_data.drop(['Lat','Long'],axis = 1, inplace=True)
print(covid_data.columns)
```

```
Index(['Province/State', 'Country/Region', '1/22/20', '1/23/20', '1/24/20',
       '1/25/20', '1/26/20', '1/27/20', '1/28/20', '1/29/20',
       …
       '4/21/20', '4/22/20', '4/23/20', '4/24/20', '4/25/20', '4/26/20',
       '4/27/20', '4/28/20', '4/29/20', '4/30/20'],
      dtype='object', length=102)
```

4. Grouping the records based on country name

[ ]:
```
covid_data_grouped = covid_data.groupby('Country/Region').sum()
covid_data_grouped.head()
```

```
<ipython-input-25-efa62008396f>:1: FutureWarning: The default value of
numeric_only in DataFrameGroupBy.sum is deprecated. In a future version,
numeric_only will default to False. Either specify numeric_only or select only
columns which should be valid for the function.
  covid_data_grouped = covid_data.groupby('Country/Region').sum()
```

[ ]:
```
                1/22/20  1/23/20  1/24/20  1/25/20  1/26/20  1/27/20  1/28/20  \
Country/Region
Afghanistan           0        0        0        0        0        0        0
Albania               0        0        0        0        0        0        0
Algeria               0        0        0        0        0        0        0
Andorra               0        0        0        0        0        0        0
```

```
Angola                 0        0        0        0        0        0        0

                 1/29/20  1/30/20  1/31/20  …  4/21/20  4/22/20  4/23/20  \
Country/Region                              …
Afghanistan            0        0        0  …     1092     1176     1279
Albania                0        0        0  …      609      634      663
Algeria                0        0        0  …     2811     2910     3007
Andorra                0        0        0  …      717      723      723
Angola                 0        0        0  …       24       25       25

                 4/24/20  4/25/20  4/26/20  4/27/20  4/28/20  4/29/20  4/30/20
Country/Region
Afghanistan         1351     1463     1531     1703     1828     1939     2171
Albania              678      712      726      736      750      766      773
Algeria             3127     3256     3382     3517     3649     3848     4006
Andorra              731      738      738      743      743      743      745
Angola                25       25       26       27       27       27       27

[5 rows x 100 columns]
```

[ ]:
```
#Checking shape of grouped dataframe
covid_data_grouped.shape
```

[ ]:
```
(187, 100)
```

5. Find total infections in all countries

[ ]:
```
countries = list(covid_data_grouped.index)
infection_count = []

for c in countries:
    infection_count.append(covid_data_grouped.loc[c].sum())

infection_count
```

[ ]:
```
[28462,
 17864,
 74325,
 21893,
 649,
 678,
 84105,
 40610,
 224354,
 502063,
 37281,
 1677,
```

56608,
70829,
2326,
150475,
1082648,
429,
1246,
213,
15387,
36234,
444,
1085638,
5777,
29366,
17131,
2463,
185,
1472,
4842,
31564,
982149,
485,
832,
282177,
6686938,
107654,
1,
3516,
9281,
20853,
21985,
56068,
26458,
21935,
209985,
236274,
53404,
16408,
539,
122072,
337630,
90542,
5489,
2997,
1092,
48428,
918,

2761,
511,
112892,
4132964,
3192,
268,
11027,
4531683,
25175,
77726,
481,
7645,
16059,
1541,
1703,
1461,
305,
14128,
52370,
61442,
457945,
176940,
2783401,
48863,
389169,
393611,
6139613,
5393,
282573,
14237,
48155,
7633,
572513,
11608,
55693,
13847,
553,
23426,
24136,
2097,
1213,
3065,
37109,
116527,
278,
3414,
528,

173243,
2808,
6004,
12806,
250,
9755,
237643,
65045,
3040,
934,
8890,
75625,
1118,
569,
884,
949574,
42498,
302,
15202,
20351,
31559,
251779,
33924,
245996,
120004,
151,
5592,
418646,
175219,
251454,
579961,
167128,
237705,
1141721,
4844,
410,
508,
347,
15518,
118,
274362,
13469,
145420,
436,
1109,
202073,
31703,

```
45214,
5343,
98217,
191,
5979474,
10572,
3062,
388,
422084,
922995,
973,
16433,
15,
4738,
91657,
375,
2591,
4072,
25532,
2156983,
20606211,
2008,
140485,
181619,
3206716,
17681,
36115,
8141,
10708,
11195,
142,
31,
1948,
671]
```

5. Adding new columns of highest and lowest infection rates for all countries

[ ]:
```
covid_data_grouped["Total Infections"] = infection_count
covid_data_grouped.head()
```

[ ]:
```
                1/22/20  1/23/20  1/24/20  1/25/20  1/26/20  1/27/20  1/28/20  \
Country/Region
Afghanistan           0        0        0        0        0        0        0
Albania               0        0        0        0        0        0        0
Algeria               0        0        0        0        0        0        0
Andorra               0        0        0        0        0        0        0
Angola                0        0        0        0        0        0        0
```

```
                 1/29/20  1/30/20  1/31/20  …  4/22/20  4/23/20  4/24/20  \
Country/Region                              …
Afghanistan            0        0        0  …     1176     1279     1351
Albania                0        0        0  …      634      663      678
Algeria                0        0        0  …     2910     3007     3127
Andorra                0        0        0  …      723      723      731
Angola                 0        0        0  …       25       25       25

                 4/25/20  4/26/20  4/27/20  4/28/20  4/29/20  4/30/20  \
Country/Region
Afghanistan         1463     1531     1703     1828     1939     2171
Albania              712      726      736      750      766      773
Algeria             3256     3382     3517     3649     3848     4006
Andorra              738      738      743      743      743      745
Angola                25       26       27       27       27       27

                 Total Infections
Country/Region
Afghanistan                 28462
Albania                     17864
Algeria                     74325
Andorra                     21893
Angola                        649

[5 rows x 101 columns]
```

6. Creating new dataframe with only required fields

[ ]:
```
country_covid_rate_df = pd.DataFrame(covid_data_grouped["Total Infections"])
country_covid_rate_df.head()
```

[ ]:
```
                 Total Infections
Country/Region
Afghanistan                 28462
Albania                     17864
Algeria                     74325
Andorra                     21893
Angola                        649
```

1.4 B. Pre-processing World Happiness Index Dataset

1.4.1 Importing happiness index dataset

[ ]:
```
happiness_index_data = pd.read_csv("happiness_index.csv")
happiness_index_data.head()
```

```
[ ]:    Overall rank Country or region  Score  GDP per capita  Social support  \
     0             1           Finland  7.769           1.340           1.587
     1             2           Denmark  7.600           1.383           1.573
     2             3            Norway  7.554           1.488           1.582
     3             4           Iceland  7.494           1.380           1.624
     4             5       Netherlands  7.488           1.396           1.522

        Healthy life expectancy  Freedom to make life choices  Generosity  \
     0                    0.986                         0.596       0.153
     1                    0.996                         0.592       0.252
     2                    1.028                         0.603       0.271
     3                    1.026                         0.591       0.354
     4                    0.999                         0.557       0.322

        Perceptions of corruption
     0                      0.393
     1                      0.410
     2                      0.341
     3                      0.118
     4                      0.298
```

1. Checking Missing Values

```
[ ]: happiness_index_data.isnull().sum()
```

```
[ ]: Overall rank                    0
     Country or region               0
     Score                           0
     GDP per capita                  0
     Social support                  0
     Healthy life expectancy         0
     Freedom to make life choices    0
     Generosity                      0
     Perceptions of corruption       0
     dtype: int64
```

Interpretation : There is no missing values in the dataset.

2. Checking Duplicate Rows

```
[ ]: happiness_index_data.duplicated().any()
```

```
[ ]: False
```

Interpretation : There is no duplicate rows in the dataset.

3. Removing not required Columns

[ ]:
```
remove_columns = ["Overall rank","Score","Generosity"]
happiness_index_data.drop(remove_columns, axis=1, inplace=True)
happiness_index_data.head()
```

[ ]:
```
  Country or region  GDP per capita  Social support  Healthy life expectancy  \
0           Finland           1.340           1.587                    0.986
1           Denmark           1.383           1.573                    0.996
2            Norway           1.488           1.582                    1.028
3           Iceland           1.380           1.624                    1.026
4       Netherlands           1.396           1.522                    0.999

   Freedom to make life choices  Perceptions of corruption
0                         0.596                      0.393
1                         0.592                      0.410
2                         0.603                      0.341
3                         0.591                      0.118
4                         0.557                      0.298
```

4. Changing dataframe index to country name

[ ]:
```
happiness_index_data.set_index("Country or region", inplace=True)
happiness_index_data.head()
```

[ ]:
```
                   GDP per capita  Social support  Healthy life expectancy  \
Country or region
Finland                     1.340           1.587                    0.986
Denmark                     1.383           1.573                    0.996
Norway                      1.488           1.582                    1.028
Iceland                     1.380           1.624                    1.026
Netherlands                 1.396           1.522                    0.999

                   Freedom to make life choices  Perceptions of corruption
Country or region
Finland                                   0.596                      0.393
Denmark                                   0.592                      0.410
Norway                                    0.603                      0.341
Iceland                                   0.591                      0.118
Netherlands                               0.557                      0.298
```

1.5 C. Joining Covid Dataset and Happiness Index Dataset

[ ]:
```
#COVID Dataset
country_covid_rate_df.head()
```

[ ]:
```
                Total Infections
Country/Region
Afghanistan                28462
```

```
Albania                      17864
Algeria                      74325
Andorra                      21893
Angola                         649
```

[ ]:
```python
#Shape of COVID dataset
country_covid_rate_df.shape
```

[ ]:
```
(187, 1)
```

[ ]:
```python
#World Happiness index dataset
happiness_index_data.head()
```

[ ]:
```
                   GDP per capita  Social support  Healthy life expectancy  \
Country or region
Finland                     1.340           1.587                    0.986
Denmark                     1.383           1.573                    0.996
Norway                      1.488           1.582                    1.028
Iceland                     1.380           1.624                    1.026
Netherlands                 1.396           1.522                    0.999

                   Freedom to make life choices  Perceptions of corruption
Country or region
Finland                                   0.596                      0.393
Denmark                                   0.592                      0.410
Norway                                    0.603                      0.341
Iceland                                   0.591                      0.118
Netherlands                               0.557                      0.298
```

[ ]:
```python
#Shape of happiness index data
happiness_index_data.shape
```

[ ]:
```
(156, 5)
```

[ ]:
```python
#Perform inner join to include the details of countries which appears in both␣
 ↪datasets
data = country_covid_rate_df.join(happiness_index_data,
                                  how = "inner"
                                  )
data.head()
```

[ ]:
```
             Total Infections  GDP per capita  Social support  \
Afghanistan             28462           0.350           0.517
Albania                 17864           0.947           0.848
Algeria                 74325           1.002           1.160
Argentina               84105           1.092           1.432
Armenia                 40610           0.850           1.055
```

```
              Healthy life expectancy  Freedom to make life choices  \
Afghanistan                     0.361                         0.000
Albania                         0.874                         0.383
Algeria                         0.785                         0.086
Argentina                       0.881                         0.471
Armenia                         0.815                         0.283

              Perceptions of corruption
Afghanistan                       0.025
Albania                           0.027
Algeria                           0.114
Argentina                         0.050
Armenia                           0.064
```

1.6 EXPLORATORY DATA ANALYSIS

1.7 1. Correlation matrix

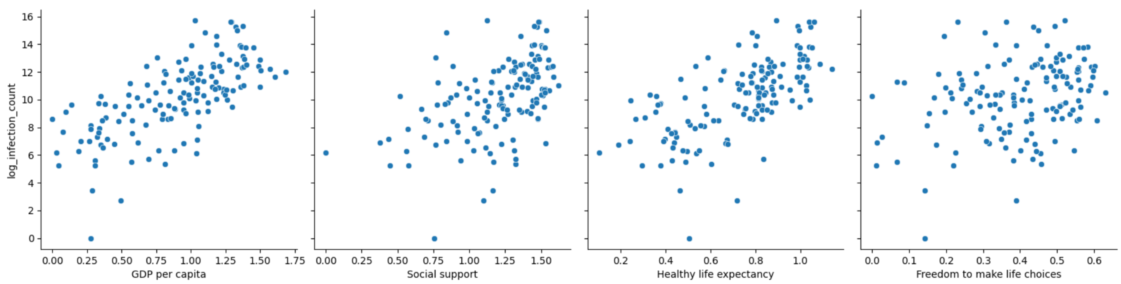
[ ]:
```
data.corr()
```

[ ]:
```
                              Total Infections  GDP per capita  \
Total Infections                      1.000000        0.280044
GDP per capita                        0.280044        1.000000
Social support                        0.183900        0.759468
Healthy life expectancy               0.316972        0.863062
Freedom to make life choices          0.043221        0.394603
Perceptions of corruption             0.108712        0.311577

                              Social support  Healthy life expectancy  \
Total Infections                    0.183900                 0.316972
GDP per capita                      0.759468                 0.863062
Social support                      1.000000                 0.765286
Healthy life expectancy             0.765286                 1.000000
Freedom to make life choices        0.456246                 0.427892
Perceptions of corruption           0.203225                 0.314811

                              Freedom to make life choices  \
Total Infections                                  0.043221
GDP per capita                                    0.394603
Social support                                    0.456246
Healthy life expectancy                           0.427892
Freedom to make life choices                      1.000000
Perceptions of corruption                         0.446677

                              Perceptions of corruption
Total Infections                               0.108712
```

```
GDP per capita                          0.311577
Social support                          0.203225
Healthy life expectancy                 0.314811
Freedom to make life choices            0.446677
Perceptions of corruption               1.000000
```

1.8 2. Pair Plot : How infection rate is correlated with other variables

[ ]:
```
#Pair Plot
data['log_infection_count'] = np.log(data['Total Infections'])
sns.pairplot(data, x_vars=['GDP per capita', 'Social support', 'Healthy life␣
↪expectancy','Freedom to make life choices'], y_vars='log_infection_count',␣
↪height=4, aspect=1, kind='scatter')
plt.show()
```

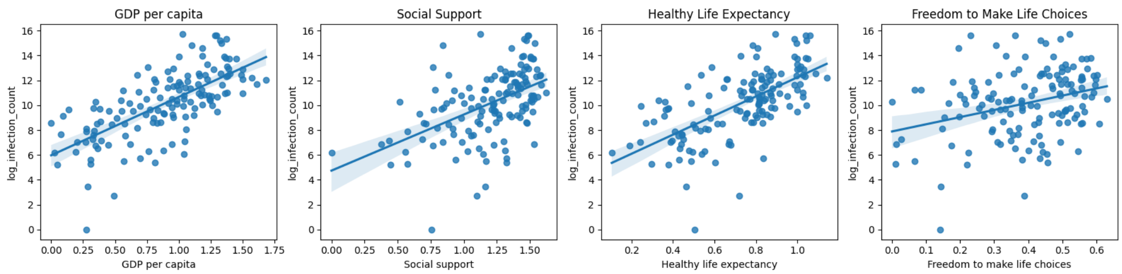


Interpretation : All the graphs are weakly positively correlated with target variable.

1.9 3. Regression Plot

[ ]:
```
#Regression Plot
# Set up a 1x4 grid of subplots
fig, axes = plt.subplots(1, 4, figsize=(16, 4))

# Plot each regression plot on a separate subplot
sns.regplot(x='GDP per capita', y='log_infection_count', data=data, ax=axes[0])
axes[0].set_title('GDP per capita')

sns.regplot(x='Social support', y='log_infection_count', data=data, ax=axes[1])
axes[1].set_title('Social Support')

sns.regplot(x='Healthy life expectancy', y='log_infection_count', data=data,␣
↪ax=axes[2])
axes[2].set_title('Healthy Life Expectancy')

sns.regplot(x='Freedom to make life choices', y='log_infection_count',␣
↪data=data, ax=axes[3])
```

```
axes[3].set_title('Freedom to Make Life Choices')

# Adjust layout for better spacing
plt.tight_layout()
plt.show()
```



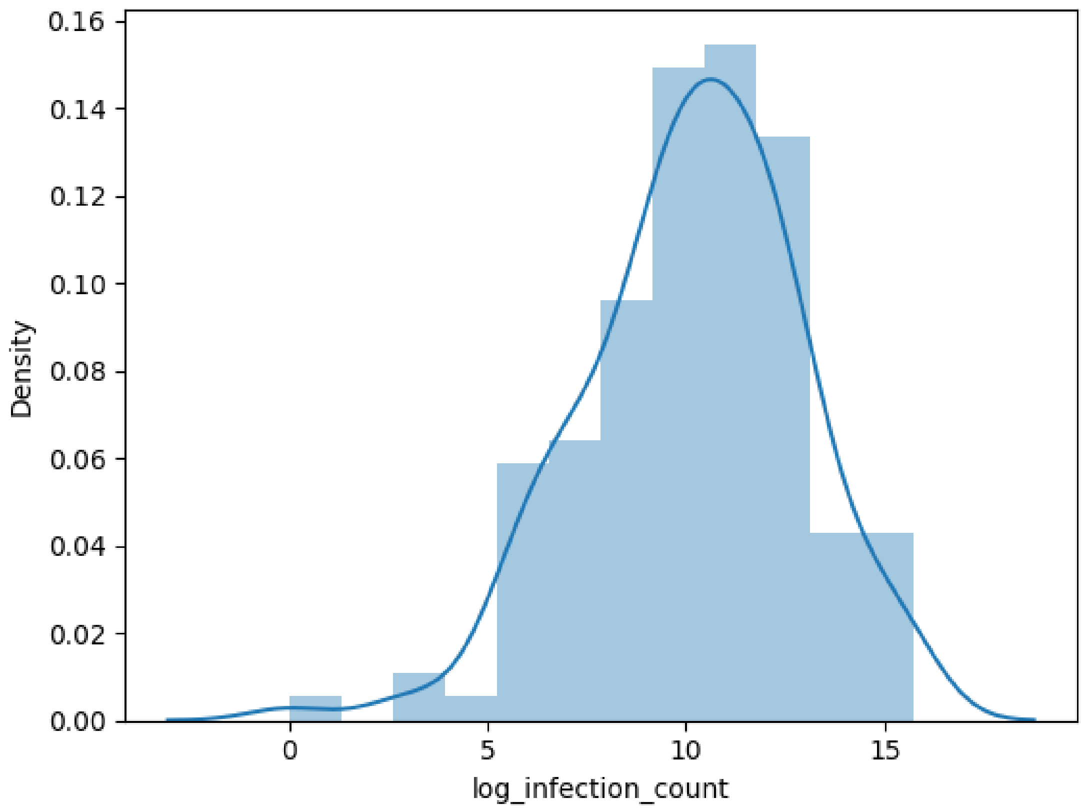
Interpretation : GDP per capita and Healthy life expectancy are weakly positively correlated with target variable.

1.10 4. Distribution of Target Variable

[ ]:
```
# Distribution of the target variable
data['log_infection_count'] = np.log(data['Total Infections'])
sns.distplot(data['log_infection_count'])
```

```
<ipython-input-43-94ef63c433b6>:3: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(data['log_infection_count'])
```

[ ]:
```
<Axes: xlabel='log_infection_count', ylabel='Density'>
```

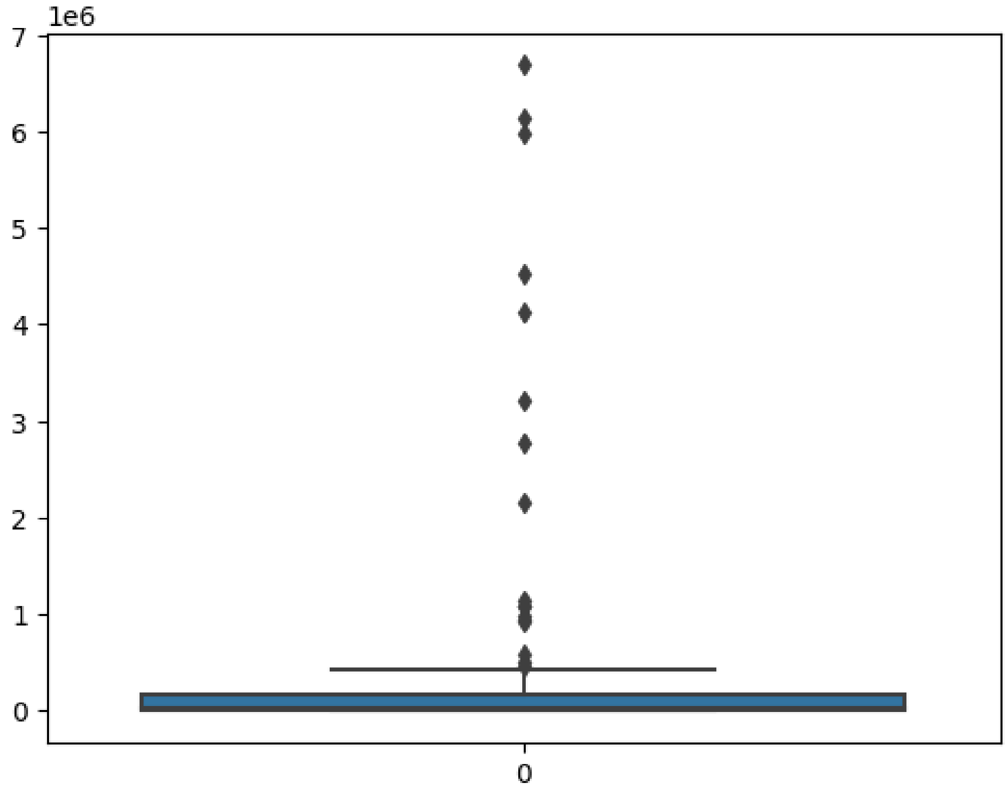


Interpretation : Distribution is slightly left skewed

1.11 5. Checking Outliers

[ ]:
```
# Checking Outliers
data.head()
sns.boxplot(data['Total Infections'])
```

[ ]: <Axes: >



Interpretation : There are many outliers present in the dataset

[ ]:
```
#Dropping irrelevent column
remove_columns = ["log_infection_count"]
data.drop(remove_columns, axis=1, inplace=True)
data.head()
```

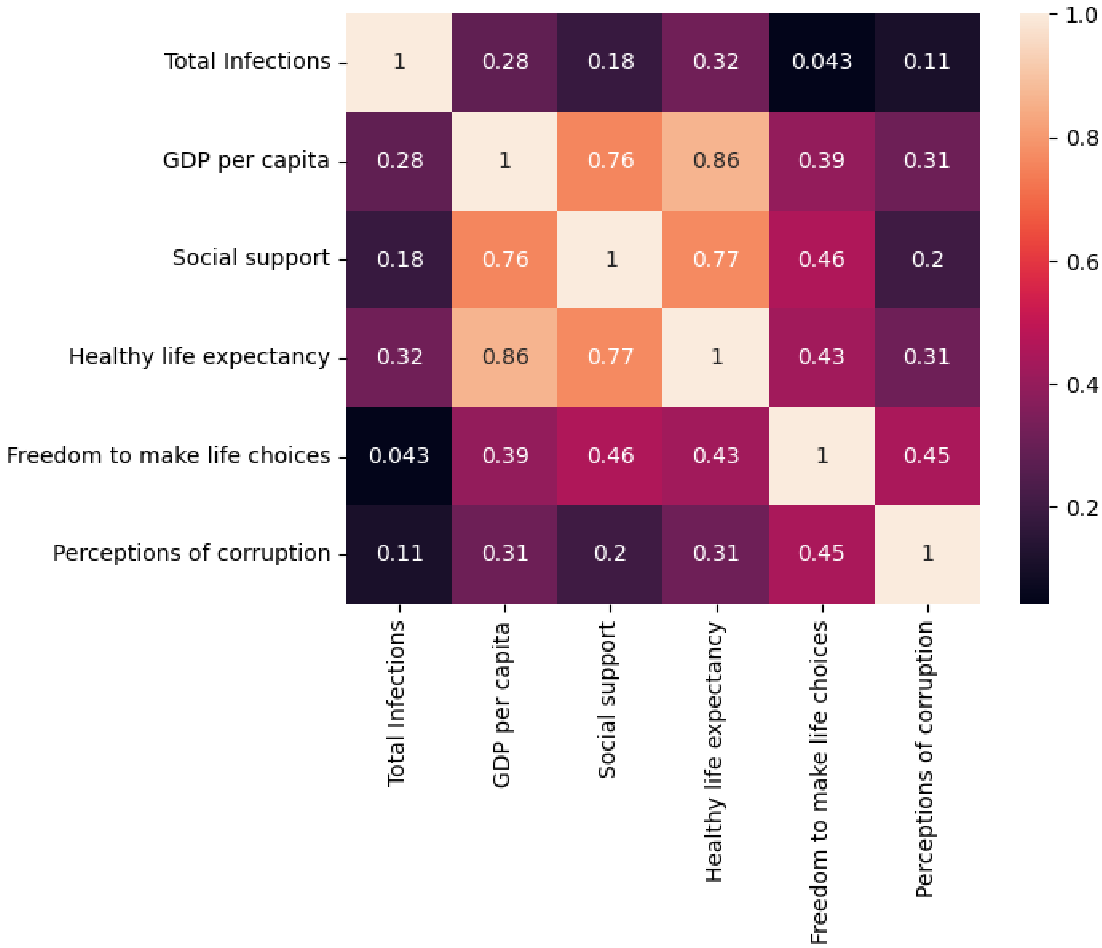
[ ]:
```
             Total Infections  GDP per capita  Social support  \
Afghanistan             28462           0.350           0.517
Albania                 17864           0.947           0.848
Algeria                 74325           1.002           1.160
Argentina               84105           1.092           1.432
Armenia                 40610           0.850           1.055

             Healthy life expectancy  Freedom to make life choices  \
Afghanistan                    0.361                         0.000
Albania                        0.874                         0.383
Algeria                        0.785                         0.086
Argentina                      0.881                         0.471
Armenia                        0.815                         0.283
```

```
               Perceptions of corruption
Afghanistan                        0.025
Albania                            0.027
Algeria                            0.114
Argentina                          0.050
Armenia                            0.064
```

1.12 6. Heatmap

[ ]:

```
#Heatmap
sns.heatmap(data.corr(), annot = True)
plt.show()
```



Interpretation: Healthy life expectancy seems to be most correlated(but weakly) with total infections compared to other independent variables.

2 STORING DATA IN DATABASE

[ ]:
```
import pandas as pd
import sqlite3
```

[ ]:
```
#Adding csv data into dataframe
csv_file_path1 = 'covid_dataset.csv'
csv_file_path2 = 'happiness_index.csv'
df1 = pd.read_csv(csv_file_path1)
df2= pd.read_csv(csv_file_path2)
```

[ ]:
```
#Database and table creation and data population
try:
  #create a database
  covid_db = 'covid_analysis.db'

  # Create a connection
  sqliteConnection = sqlite3.connect(covid_db)
  print("Connection Successful!!")

  # COnvert dataframe into table
  df1.to_sql('covid_table', sqliteConnection, index=False, if_exists='replace')
  df2.to_sql('happiness_table', sqliteConnection, index=False,␣
↪if_exists='replace')
  print("Tables created")

except sqlite3.Error as error:
    print("Error while creating table",error)

finally:
    #finally block will be executed always
    if sqliteConnection:
        sqliteConnection.close()
        print("Connection is closed")
```

```
Connection Successful!!
Tables created
Connection is closed
```

[ ]:
```
# READ covid TABLE
def readTable():
    try:
        sqliteConnection = sqlite3.connect(covid_db)
        cursor = sqliteConnection.cursor()
        print("Connection Successful!!")
        sqlite_create_table_query =  '''SELECT * FROM covid_table;'''
        cursor.execute(sqlite_create_table_query)
```

```python
        records = cursor.fetchall()
        print("length of records:",len(records))
        print(records)
        cursor.close()
    except sqlite3.Error as error:
        print("Error while deleting",error)
    finally:
        #finally block will be executed always
        if sqliteConnection:
            sqliteConnection.close()
            print("Connection is closed")
readTable()
```

```
Connection Successful!!
length of records: 266
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77, 83, 83, 83, 86, 86, 86, 86, 86, 96, 96, 96, 97, 97, 97, 107, 111, 111, 111,
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32, 32, 35, 35, 35, 37, 39, 39, 39, 48, 48, 48, 57, 57, 57, 81, 81, 83, 83, 86,

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19), (None, 'Libya', 26.3351, 17.228331, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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171, 216, 224, 246, 258, 293, 309, 325, 370, 389, 408, 424, 482, 490), (None,
'Saint Kitts and Nevis', 17.357822, -62.782998, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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'Canada', 64.8255, -124.8457, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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Kingdom', 18.4207, -64.64, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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6), ('Turks and Caicos Islands', 'United Kingdom', 21.694000000000001, -71.7979,
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(None, 'Sierra Leone', 8.460555000000001, -11.779889, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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Eustatius and Saba', 'Netherlands', 12.1784, -68.2385, 0, 0, 0, 0, 0, 0, 0, 0,
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36, 37), ('Falkland Islands (Malvinas)', 'United Kingdom', -51.7963, -59.5236,
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('Saint Pierre and Miquelon', 'France', 46.8852, -56.3159, 0, 0, 0, 0, 0, 0, 0,
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'Western Sahara', 24.2155, -12.8858, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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'Comoros', -11.6455, 43.3333, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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0, 0, 0, 0, 0, 0, 0, 0, 15)]
Connection is closed

3 BUILDING PREDICTIVE MODEL AND TESTING : MULTIPLE LINEAR REGRESSION

[ ]:
```
#Import required libraries
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn import metrics
```

3.1 Object Oriented Programming for Predictive Modelling

[ ]:
```
class LinearRegressionModel:
    def __init__(self, data):
        self.data = data
        self.x = data[['GDP per capita', 'Social support', 'Healthy life␣
 ↪expectancy', 'Freedom to make life choices']]
        self.y = data['Total Infections']
        self.x_train, self.x_test, self.y_train, self.y_test =␣
 ↪train_test_split(self.x, self.y, test_size=0.2, random_state=100)
        self.mlr = LinearRegression()

    def train_model(self):
        self.mlr.fit(self.x_train, self.y_train)

    def print_coefficients(self):
        print("Intercept Value:", self.mlr.intercept_)
        # pair the feature names with the coefficients
        print("Other Coefficients:", list(zip(self.x.columns, self.mlr.coef_)))

    def predict_test_set(self):
        y_pred_mlr = self.mlr.predict(self.x_test)
        print("Prediction for test set:", y_pred_mlr)

    def print_actual_vs_predicted(self):
        mlr_diff = pd.DataFrame({'Actual value': self.y_test, 'Predicted value':
 ↪ self.mlr.predict(self.x_test)})
        print("\n----------------Actual vs Predicted Value---------------")
        print(mlr_diff)

    def predict_for_values(self, values):
        pred_vals = self.mlr.predict([values])
        print(f'R Predicted Value: {pred_vals}')

    def print_r_squared_value(self):
        r_squared = self.mlr.score(self.x, self.y) * 100
        print('R squared value of the model: {:.2f}'.format(r_squared))
```

```
    def print_error_metrics(self):
        y_pred_mlr = self.mlr.predict(self.x_test)
        mean_absolute_error = metrics.mean_absolute_error(self.y_test,␣
 ↪y_pred_mlr)
        mean_squared_error = metrics.mean_squared_error(self.y_test, y_pred_mlr)
        root_mean_squared_error = np.sqrt(mean_squared_error)

        print('Mean Absolute Error:', mean_absolute_error)
        print('Mean Square Error:', mean_squared_error)
        print('Root Mean Square Error:', root_mean_squared_error)


linear_reg_model = LinearRegressionModel(data)
linear_reg_model.train_model()
linear_reg_model.print_coefficients()
linear_reg_model.predict_test_set()
linear_reg_model.print_actual_vs_predicted()
linear_reg_model.predict_for_values([0.9, 0.6, 0.55, 0.78])
linear_reg_model.print_r_squared_value()
linear_reg_model.print_error_metrics()
```

```
Intercept Value: -134524.67717574624
Other Coefficients: [('GDP per capita', 272329.25260819617), ('Social support',
-732709.7723702246), ('Healthy life expectancy', 1724646.3974207772), ('Freedom
to make life choices', -306889.91130496183)]
Prediction for test set: [ 516627.33696103  549742.57482286  627047.76705019
519714.3196811
 -280412.86639126  655140.23551356  382076.80776309  406788.21951885
  422413.86373857  688100.71152579  330893.86359747 -215106.22503947
  290206.00985003  731025.51202748  681229.93838944  -93601.014
  485980.81944443  809524.51378545  848613.27182111  314134.25214808
  539529.81085346  212800.30364683   79281.35781691   52911.35873529
  414019.42131276  496686.27698456  737916.99081618  576726.12682345
  699436.27084722]

----------------Actual vs Predicted Value---------------
                        Actual value  Predicted value
Poland                        251454    516627.336961
Kuwait                         55693    549742.574823
Bosnia and Herzegovina         36234    627047.767050
Slovakia                       31703    519714.319681
Mozambique                      1118   -280412.866391
Chile                         282177    655140.235514
Vietnam                        10708    382076.807763
Colombia                      107654    406788.219519
Venezuela                       8141    422413.863739
Belgium                      1082648    688100.711526
```

```
Rwanda                         4844    330893.863597
Zimbabwe                        671   -215106.225039
Ukraine                      140485    290206.009850
Morocco                       75625    731025.512027
United Kingdom              3206716    681229.938389
Guinea                        16059    -93601.014000
Sri Lanka                     10572    485980.819444
Georgia                       11027    809524.513785
Italy                       6139613    848613.271821
Tajikistan                       15    314134.252148
Mexico                       237643    539529.810853
Comoros                           1    212800.303647
Tanzania                       4738     79281.357817
Kyrgyzstan                    13847     52911.358735
Lithuania                     37109    414019.421313
Ecuador                      337630    496686.276985
Tunisia                       25532    737916.990816
Lebanon                       24136    576726.126823
Norway                       251779    699436.270847
R Predicted Value: [380127.17451305]
R squared value of the model: 11.24
Mean Absolute Error: 610685.4550839054
Mean Square Error: 1343126647727.9663
Root Mean Square Error: 1158933.4095313528

/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439: UserWarning: X does
not have valid feature names, but LinearRegression was fitted with feature names
  warnings.warn(
```

3.2 Interpretation:

- Intercept: The intercept represents the predicted value of the dependent variable when all predictor variables are zero. In your case, it's -134524.68.
- GDP per capita coefficient: A one-unit increase in GDP per capita is associated with an increase of approximately 272329.25 in the dependent variable.
- Social support coefficient: A one-unit increase in social support is associated with a decrease of approximately 732709.77 in the dependent variable.
- Healthy life expectancy coefficient: A one-unit increase in healthy life expectancy is associated with an increase of approximately 1724646.40 in the dependent variable.
- Freedom to make life choices coefficient: A one-unit increase in freedom to make life choices is associated with a decrease of approximately 306889.91 in the dependent variable.
- R Predicted Value: The predicted value of the dependent variable for the entire test set is 380127.17.
- R squared value: The R squared value of 11.24% indicates that approximately 11.24% of the variance in the dependent variable is explained by the independent variables in your model.

- Mean Absolute Error (MAE): The average absolute difference between the predicted and actual values is 610685.46.
- Mean Square Error (MSE): The average squared difference between the predicted and actual values is 1343126647727.97.
- Root Mean Square Error (RMSE): The square root of MSE is 1158933.41, representing the average magnitude of the errors in the predicted values.

4 CONCLUSION

In summary, the study on how COVID-19 rates relate to World happiness index shows that the response variable is very slightly positively dependent on chosen predictor variables and hence the model doesn't explain much (low R squared at 11.24%). The model's predictions differ a lot from the actual values, suggesting it might not be the best fit for our data. This could be because:

```
-Model not capturing genuine predictor relationships.
-Predictions stray, compromising accurate dependent variable forecasts.
-Negative predictions, a sign of model instability.
-High coefficient magnitudes suggest potential multicollinearity issues.
-Outliers significantly disrupt regression coefficients and prediction accuracy.
```