In [1]:
```
# HEL 8048 UiT Exam
# Candidate No: 19

# GitHub repository: https://github.com/nikitamitkin/Exam-HEL8048.git

# License: MIT
```

In [2]:
```
# Data used:

# Dataset 'Alcohol Consumption by Country'
# Source: https://www.kaggle.com/datasets/pralabhpoudel/alcohol-consumption-by-c
```

In [3]:
```
# About dataset:

# Total alcohol per capita consumption is defined as the total (sum of recorded
# amount of alcohol consumed per person (15 years of age or older)
# over a calendar year, in litres of pure alcohol, adjusted for tourist consumpt

# Statistical concept and methodology:
# The estimates for the total alcohol consumption are produced by summing up the
# recorded alcohol consumption and an estimate of per capita (15+) unrecorded al

# Tourist consumption takes into account tourists visiting the country and inhab

# Variable time span: 2000 - 2018

# Original data taken from: https://ourworldindata.org/alcohol-consumption
```

In [4]:
```
# Objectives of this project are:
# 1) to assess the change in global alcohol consumption level around the world
# 2) to investagete the contruies and regions that made the highest impact to th
# 3) to add data from external source
# 4) to investigate association between drinking and GDP per capita
```

In [5]:
```
# Libraries importing:

import pandas as pd
import numpy as np
```

In [6]:
```
# Lets make a function for data loading

def load_data(source, file_path=None, url=None):
    """
    Load data from a file or a URL.

    Parameters:
    - source (str): Type of source 'file' or 'url'
    - file_path (str): Path to the file if source is 'file'.
    - url (str): URL to the file if source is 'url'.

    Returns:
    - df (DataFrame): Loaded data as a pandas DataFrame.
    """
    if source == 'file':
        df = pd.read_csv(file_path)
    elif source == 'url':
        df = pd.read_csv(url)
    else:
        raise ValueError("Source must be 'file' or 'url'")

    return df
```

In [7]:
```
# Using function to read the data:
# This function assumes CSV format and expects a path to the CSV file as input
# It returns a pandas DataFrame loaded with the CSV data


df = load_data('file', file_path=r"C:\Users\NikitaMitkin\Documents\GitHub\HEL804
```

In [8]:
```
# Let's look at our data:

df
```

Out[8]:

	Entity	Code	Year	Total alcohol consumption per capita (liters of pure alcohol, projected estimates, 15+ years of age)	GDP per capita, PPP (constant 2017 international $)	Population (historical estimates)	Continen
0	Abkhazia	OWID_ABK	2015	NaN	NaN	NaN	Asi
1	Afghanistan	AFG	2010	0.21	1957.029070	29185511.0	Na
2	Afghanistan	AFG	2015	0.21	2068.265904	34413603.0	Asi
3	Afghanistan	AFG	2018	0.21	2033.804389	37171922.0	Na
4	Afghanistan	AFG	2002	NaN	1189.784668	22600774.0	Na
...	...	...	...	...	...	...	.
57079	Zimbabwe	ZWE	1987	NaN	NaN	9527202.0	Na
57080	Zimbabwe	ZWE	1988	NaN	NaN	9849129.0	Na
57081	Zimbabwe	ZWE	1989	NaN	NaN	10153852.0	Na
57082	Zimbabwe	ZWE	2021	NaN	NaN	15092171.0	Na
57083	Åland Islands	ALA	2015	NaN	NaN	NaN	Europ

57084 rows × 7 columns

In [9]:
```
df.shape
```

Out[9]:
```
(57084, 7)
```

In [10]:
```
# We have 57 084 observations and 7 variables
```

In [11]:
```
# Ok. Our variables' names looks too large and awful for further analysis,
# Let's rename them:
```

```
df.rename(columns={
    'Entity': 'country',
    'Code': 'country_Code',
    'Year': 'year',
    'Total alcohol consumption per capita (liters of pure alcohol, projected est
    'GDP per capita, PPP (constant 2017 international $)': 'gdp_per_capita_ppp',
    'Population (historical estimates)': 'population',
    'Continent': 'continent'
}, inplace=True)

df
```

Out[11]:

	country	country_Code	year	alcohol_consumption_per_capita	gdp_per_capita
0	Abkhazia	OWID_ABK	2015	NaN	
1	Afghanistan	AFG	2010	0.21	1957.0
2	Afghanistan	AFG	2015	0.21	2068.2
3	Afghanistan	AFG	2018	0.21	2033.8
4	Afghanistan	AFG	2002	NaN	1189.7
...	...	...	...	...	
57079	Zimbabwe	ZWE	1987	NaN	
57080	Zimbabwe	ZWE	1988	NaN	
57081	Zimbabwe	ZWE	1989	NaN	
57082	Zimbabwe	ZWE	2021	NaN	
57083	Åland Islands	ALA	2015	NaN	

57084 rows × 7 columns

In [12]:
```
# Nice!

# Let's look at data types:

df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 57084 entries, 0 to 57083
Data columns (total 7 columns):
 #   Column                          Non-Null Count  Dtype  
---  ------                          --------------  -----  
 0   country                         57084 non-null  object 
 1   country_Code                    54099 non-null  object 
 2   year                            57084 non-null  int64  
 3   alcohol_consumption_per_capita  1164 non-null   float64
 4   gdp_per_capita_ppp              7109 non-null   float64
 5   population                      55656 non-null  float64
 6   continent                       285 non-null    object 
dtypes: float64(3), int64(1), object(3)
memory usage: 3.0+ MB
```

In [13]:
```
# Let's look at summary statistis for numerical variables:

df.describe()
```

Out[13]:

	year	alcohol_consumption_per_capita	gdp_per_capita_ppp	populatior
count	57084.000000	1164.000000	7109.000000	5.565600e+04
mean	1613.923324	6.041385	16938.108581	3.246352e+07
std	1400.177983	4.080525	19167.650695	2.503028e+08
min	-10000.000000	0.000000	1.960152	1.000000e+00
25%	1833.000000	2.545000	3560.617694	1.338740e+05
50%	1903.000000	5.655406	9948.266898	1.218570e+06
75%	1969.000000	9.190000	23194.223956	5.396250e+06
max	2021.000000	20.500000	161971.034870	7.874966e+09

In [14]:
```
# Ok. Global alcohol consumption is 6.08 L per year per capita.

# Now, let's look at summary for categorical variables:

df.describe(include=['O'])
```

Out[14]:

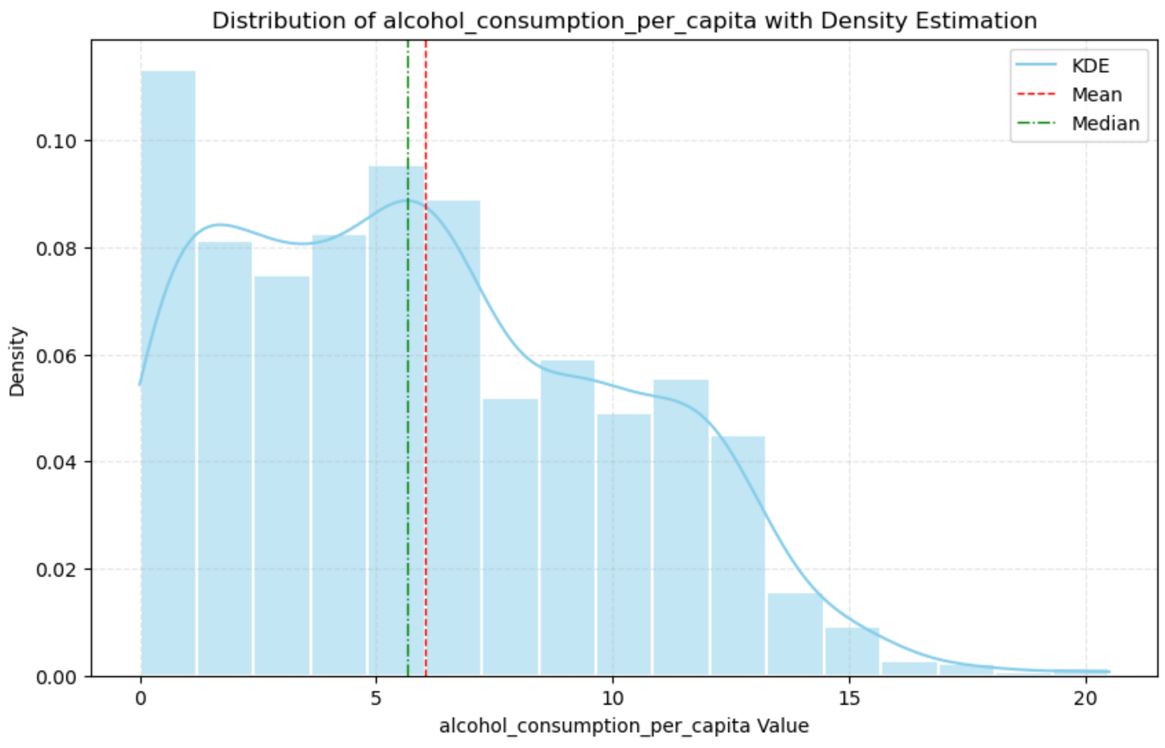
	country	country_Code	continent
count	57084	54099	285
unique	339	286	7
top	Lithuania	MWI	Europe
freq	259	259	75

In [15]:
```
# Ensure the directory exists
graphs_dir = "graphs"
```

In [16]:
```
# Make a Class to briefly see summary statistics for variable and its distributi

import matplotlib.pyplot as plt
import seaborn as sns

import warnings
warnings.simplefilter(action='ignore', category=FutureWarning)

class DataAnalyzer:
    def __init__(self, dataframe):
        """
        Initialize the DataAnalyzer with a pandas DataFrame.

        Parameters:
        - dataframe (DataFrame): A pandas DataFrame to analyze.
        """
        self.df = dataframe.replace([np.inf, -np.inf], np.nan)
    def summarize_data(self, column):
        """
        Generate summary statistics for a specified column in the dataframe.

        Parameters:
        - column (str): Column name for which to generate summary statistics.

        Returns:
        - (Series): Summary statistics of the specified column.
        """
        return self.df[column].describe()

    def plot_histogram_with_kde(self, column, color='skyblue', edge_color='white
        """
        Plot histogram with KDE overlay for the specified column and display sum

        Parameters:
        - column (str): Column name for which to plot the histogram with KDE.
        - color (str): Color of the histogram bars.
        - edge_color (str): Color of the edges of the histogram bars.
        """
        # Display summary statistics
        print(f"Summary Statistics for {column}:\n{self.summarize_data(column)}\

        # Plot histogram with KDE overlay
        plt.figure(figsize=(10, 6))
        sns.histplot(self.df[column], kde=True, color=color, edgecolor=edge_colo
        plt.title(f'Distribution of {column} with Density Estimation')
        plt.xlabel(f'{column} Value')
        plt.ylabel('Density')
        plt.grid(True, linestyle='--', alpha=0.3)
        plt.axvline(self.df[column].mean(), color='red', linestyle='dashed', lin
        plt.axvline(self.df[column].median(), color='green', linestyle='dashdot'
        plt.legend(['KDE', 'Mean', 'Median'])
        plt.savefig(f"{graphs_dir}/class_plot.png")
        plt.show()
```

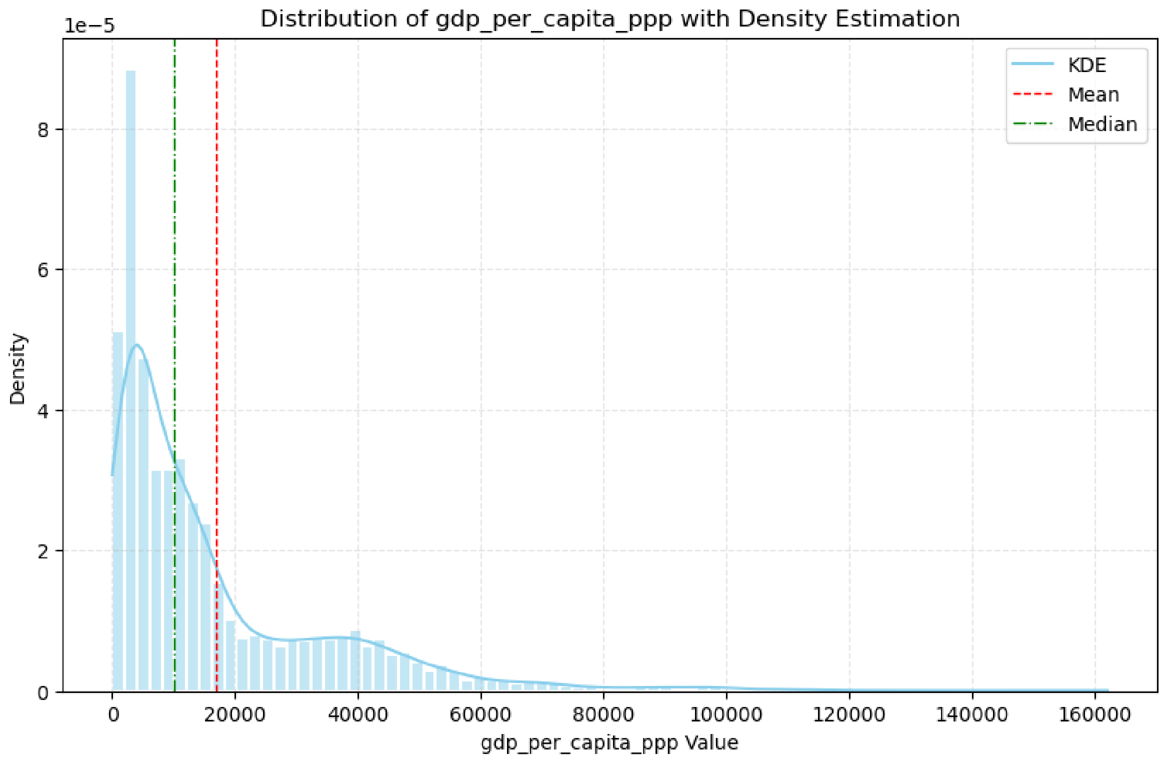
In [17]:
```
# Example usage
analyzer = DataAnalyzer(df)
analyzer.plot_histogram_with_kde('alcohol_consumption_per_capita')
```

```
Summary Statistics for alcohol_consumption_per_capita:
count    1164.000000
mean        6.041385
std         4.080525
min         0.000000
25%         2.545000
50%         5.655406
75%         9.190000
max        20.500000
Name: alcohol_consumption_per_capita, dtype: float64
```



```
In [18]: analyzer.plot_histogram_with_kde('gdp_per_capita_ppp')
```

```
Summary Statistics for gdp_per_capita_ppp:
count       7109.000000
mean       16938.108581
std        19167.650695
min            1.960152
25%         3560.617694
50%         9948.266898
75%        23194.223956
max       161971.034870
Name: gdp_per_capita_ppp, dtype: float64
```



In [19]:
```
# Remove duplicate rows for the same 'country' and 'year' and keep only the firs
df = df.drop_duplicates(subset=['country', 'year'], keep='first')
```

In [20]:
```
# check for duplicates
duplicates = df.duplicated(subset=['country', 'year'], keep=False)
print(f"Duplicate entries still present: {duplicates.any()}")

# ok. no duplicates
```

```
Duplicate entries still present: False
```

In [21]:
```
# See missed values:

df.isna().mean()
```

Out[21]:
```
country                             0.000000
country_Code                        0.052291
year                                0.000000
alcohol_consumption_per_capita      0.979609
gdp_per_capita_ppp                  0.875464
population                          0.025016
continent                           0.995007
dtype: float64
```

In [22]:
```
# Wow! We see huge (99.5%) missed data on continent for our contries.
# let's deal with it:
```

In [23]:
```
# Fill missing continent data based on known values for the same country
df['continent'] = df.groupby('country_Code')['continent'].transform(lambda x: x.

df.isna().mean()
# Nice! Only 5% missed now
```

Out[23]:
```
country                             0.000000
country_Code                        0.052291
year                                0.000000
alcohol_consumption_per_capita      0.979609
gdp_per_capita_ppp                  0.875464
population                          0.025016
continent                           0.056829
dtype: float64
```

In [24]:
```
# check:

df
```

Out[24]:

	country	country_Code	year	alcohol_consumption_per_capita	gdp_per_capita
0	Abkhazia	OWID_ABK	2015	NaN	
1	Afghanistan	AFG	2010	0.21	1957.0
2	Afghanistan	AFG	2015	0.21	2068.2
3	Afghanistan	AFG	2018	0.21	2033.8
4	Afghanistan	AFG	2002	NaN	1189.7
...	...	...	...	...	
57079	Zimbabwe	ZWE	1987	NaN	
57080	Zimbabwe	ZWE	1988	NaN	
57081	Zimbabwe	ZWE	1989	NaN	
57082	Zimbabwe	ZWE	2021	NaN	
57083	Åland Islands	ALA	2015	NaN	

57084 rows × 7 columns

In [25]:
```
# Display unique countries that still have undefined continent
countries_with_undefined_continent = df[df['continent'].isna()]['country'].uniqu
print("Countries with undefined continent:")
print(countries_with_undefined_continent)
```

```
Countries with undefined continent:
['Africa' 'Africa Eastern and Southern' 'Africa Western and Central'
 'Arab World' 'Asia' 'Caribbean Small States'
 'Central Europe and the Baltics' 'Early-demographic dividend'
 'East Asia & Pacific' 'East Asia & Pacific (IDA & IBRD)'
 'East Asia & Pacific (excluding high income)' 'Euro area' 'Europe'
 'Europe & Central Asia' 'Europe & Central Asia (IDA & IBRD)'
 'Europe & Central Asia (excluding high income)' 'European Union'
 'Fragile and conflict affected situations'
 'Heavily indebted poor countries (HIPC)' 'High income' 'IBRD only'
 'IDA & IBRD total' 'IDA blend' 'IDA only' 'IDA total'
 'Late-demographic dividend' 'Latin America & Caribbean'
 'Latin America & Caribbean (IDA & IBRD)'
 'Latin America & Caribbean (excluding high income)'
 'Least developed countries: UN classification' 'Low & middle income'
 'Low income' 'Lower middle income' 'Middle East & North Africa'
 'Middle East & North Africa (IDA & IBRD)'
 'Middle East & North Africa (excluding high income)' 'Middle income'
 'North America' 'OECD members' 'Oceania' 'Other small states'
 'Pacific island small states' 'Post-demographic dividend'
 'Pre-demographic dividend' 'Saint Barthlemy' 'Small states'
 'South America' 'South Asia' 'South Asia (IDA & IBRD)'
 'Sub-Saharan Africa' 'Sub-Saharan Africa (IDA & IBRD)'
 'Sub-Saharan Africa (excluding high income)' 'Upper middle income'
 'World']
```

In [26]:
```
# We can see that rows with missed continents data = regional aggregations like
# Let's drop these observations to focus only on countries:

df = df.dropna(subset=['continent'])
df.isna().mean()
```

Out[26]:
```
country                             0.000000
country_Code                        0.000000
year                                0.000000
alcohol_consumption_per_capita      0.982838
gdp_per_capita_ppp                  0.894168
population                          0.001282
continent                           0.000000
dtype: float64
```

In [27]:
```
# Ok. We also remember that our 'year' variable has some problems
# Specifically, it has minimum of -1000 which cannot be.


# Display original min and max years to understand the initial range
print(f"Original Year range: min={df['year'].min()}, max={df['year'].max()}")
```

```
Original Year range: min=-10000, max=2021
```

In [28]:
```
# Step 1: Remove rows where 'year' is outside the reasonable range
# We now that the dataset should only contain data from 2000 to the 2018
df = df[(df['year'] >= 2000) & (df['year'] <= 2018)]
```

In [29]:
```
# Step 2: Verify the cleaning by checking the new min and max of 'year'
print(f"Cleaned Year range: min={df['year'].min()}, max={df['year'].max()}")
```

```
Cleaned Year range: min=2000, max=2018
```

In [30]:
```
print(df['year'].describe())
```

```
count    4549.000000
mean     2009.059354
std         5.481238
min      2000.000000
25%      2004.000000
50%      2009.000000
75%      2014.000000
max      2018.000000
Name: year, dtype: float64
```

In [31]:
```
# Well done!

# Now, what we will need to to with missed alcohol use data and GDP data?

# Usually, we do not fill them with imputations in EDA,
# because it can distort our data and hide potentially important patterns and as

# But here I decided to use temporal interpolation method:
for column in ['alcohol_consumption_per_capita', 'gdp_per_capita_ppp']:
    df[column] = df.groupby('country_Code')[column].transform(lambda x: x.interp
```

In [32]:
```
# Check for remaining NaNs and fill them using the mean of each country
# for column in ['alcohol_consumption_per_capita', 'gdp_per_capita_ppp']:
   # df[column] = df.groupby('country_Code')[column].transform(lambda x: x.filln
```

In [33]:
```
df.isna().mean()
```

Out[33]:
```
country                            0.000000
country_Code                       0.000000
year                               0.000000
alcohol_consumption_per_capita     0.218949
gdp_per_capita_ppp                 0.191471
population                         0.014729
continent                          0.000000
dtype: float64
```

In [34]:
```python
# See rows where 'alcohol_consumption_per_capita' is NaN
missing_alcohol_df = df[df['alcohol_consumption_per_capita'].isna()]

# Get the unique list of countries with missing alcohol consumption data
countries_with_missing_alcohol = missing_alcohol_df['country'].unique()

# Print the list of countries
print("Countries with missing alcohol consumption data:")
print(countries_with_missing_alcohol)
```

```
Countries with missing alcohol consumption data:
['Abkhazia' 'Akrotiri and Dhekelia' 'American Samoa' 'Anguilla'
 'Antarctica' 'Aruba' 'Austria-Hungary' 'Baden' 'Bavaria' 'Bermuda'
 'Bonaire Sint Eustatius and Saba' 'Bouvet Island'
 'British Indian Ocean Territory' 'British Virgin Islands'
 'Cayman Islands' 'Channel Islands' 'Christmas Island' 'Cocos Islands'
 'Cook Islands' 'Curacao' 'Czechoslovakia' 'East Germany'
 'Eritrea and Ethiopia' 'Faeroe Islands' 'Falkland Islands'
 'French Guiana' 'French Polynesia' 'French Southern Territories'
 'Gibraltar' 'Greenland' 'Guadeloupe' 'Guam' 'Guernsey' 'Hanover'
 'Heard Island and McDonald Islands' 'Hesse Electoral' 'Hesse Grand Ducal'
 'Hong Kong' 'Isle of Man' 'Jersey' 'Kosovo' 'Liechtenstein' 'Macao'
 'Marshall Islands' 'Martinique' 'Mayotte' 'Mecklenburg Schwerin' 'Modena'
 'Monaco' 'Montserrat' 'Nagorno-Karabakh' 'Netherlands Antilles'
 'New Caledonia' 'Niue' 'Norfolk Island' 'Northern Cyprus'
 'Northern Mariana Islands' 'Palau' 'Palestine' 'Parma' 'Pitcairn'
 'Puerto Rico' 'Republic of Vietnam' 'Reunion' 'Saint Barthélemy'
 'Saint Helena' 'Saint Martin (French part)' 'Saint Pierre and Miquelon'
 'San Marino' 'Saxony' 'Serbia and Montenegro' 'Serbia excluding Kosovo'
 'Sint Maarten (Dutch part)' 'Somaliland'
 'South Georgia and the South Sandwich Islands' 'South Ossetia'
 'South Sudan' 'Svalbard and Jan Mayen' 'Taiwan' 'Tokelau' 'Transnistria'
 'Turks and Caicos Islands' 'Tuscany' 'Two Sicilies' 'USSR' 'United Korea'
 'United States Minor Outlying Islands' 'United States Virgin Islands'
 'Vatican' 'Wallis and Futuna' 'West Germany' 'Western Sahara'
 'Wuerttemburg' 'Yemen Arab Republic' "Yemen People's Republic"
 'Yugoslavia' 'Zanzibar' 'Åland Islands']
```

In [35]:
```python
# Hahaha!!! Countries like "USSR","Austria-Hungary," "Czechoslovakia," "East Ger
# Places like "American Samoa," "Bermuda," and "Cayman Islands" might not have r
# "Hong Kong," "Macao," "Northern Cyprus," and "Taiwan" have unique political st
# "Monaco," "San Marino," "Vatican," and others are very small and might not hav
```

In [36]:
```python
# List of historical or non-existent countries to drop
non_existent_countries = [
    'Austria-Hungary', 'Baden', 'Bavaria', 'Czechoslovakia', 'East Germany',
    'Eritrea and Ethiopia', 'Hanover', 'Hesse Electoral', 'Hesse Grand Ducal',
    'Mecklenburg Schwerin', 'Modena', 'Nagorno-Karabakh', 'Netherlands Antilles'
    'Northern Cyprus', 'Parma', 'Republic of Vietnam', 'Saxony',
    'Serbia and Montenegro', 'Serbia excluding Kosovo', 'South Sudan',
    'Two Sicilies', 'USSR', 'United Korea', 'West Germany',
    'Yemen Arab Republic', "Yemen People's Republic", 'Yugoslavia', 'Zanzibar'
]

# Drop rows where 'country' is in the list of non-existent countries
df.drop(df[df['country'].isin(non_existent_countries)].index, inplace=True)

# Check the number of rows to see how many were removed
print("Updated number of rows in DataFrame:", df.shape[0])
```

```
Updated number of rows in DataFrame: 4486
```

In [37]:
```
df
```

Out[37]:

	country	country_Code	year	alcohol_consumption_per_capita	gdp_per_capit
0	Abkhazia	OWID_ABK	2015	NaN	
1	Afghanistan	AFG	2010	0.21	1957.0
2	Afghanistan	AFG	2015	0.21	2068.2
3	Afghanistan	AFG	2018	0.21	2033.8
4	Afghanistan	AFG	2002	0.21	1189.7
...	...	...	...	...	
56849	Zimbabwe	ZWE	2013	4.67	3176.8
56850	Zimbabwe	ZWE	2014	4.67	3195.7
56851	Zimbabwe	ZWE	2016	4.67	3173.6
56852	Zimbabwe	ZWE	2017	4.67	3274.6
57083	Åland Islands	ALA	2015	NaN	

4486 rows × 7 columns

In [38]:
```
df.isna().mean()
```

Out[38]:
```
country                           0.000000
country_Code                      0.000000
year                              0.000000
alcohol_consumption_per_capita    0.207980
gdp_per_capita_ppp                0.180116
population                        0.009140
continent                         0.000000
dtype: float64
```

In [39]:
```
df.describe()
```

Out[39]:

	year	alcohol_consumption_per_capita	gdp_per_capita_ppp	population
count	4486.000000	3553.000000	3678.000000	4.445000e+03
mean	2009.027419	6.022354	19436.879179	2.936488e+07
std	5.479416	4.185311	21394.310813	1.233576e+08
min	2000.000000	0.000000	630.701614	7.830000e+02
25%	2004.000000	2.250000	3908.783919	3.657300e+05
50%	2009.000000	5.700000	11403.513587	4.632359e+06
75%	2014.000000	9.270000	28242.821287	1.796545e+07
max	2018.000000	20.500000	161971.034870	1.427648e+09

In [40]:
```
# Ok. Well done!

# We significantly improved the shape of our data.

# Let's move forward!
```

In [41]:
```
# Global levels of drinkings on the world map:

! pip install geopandas
```

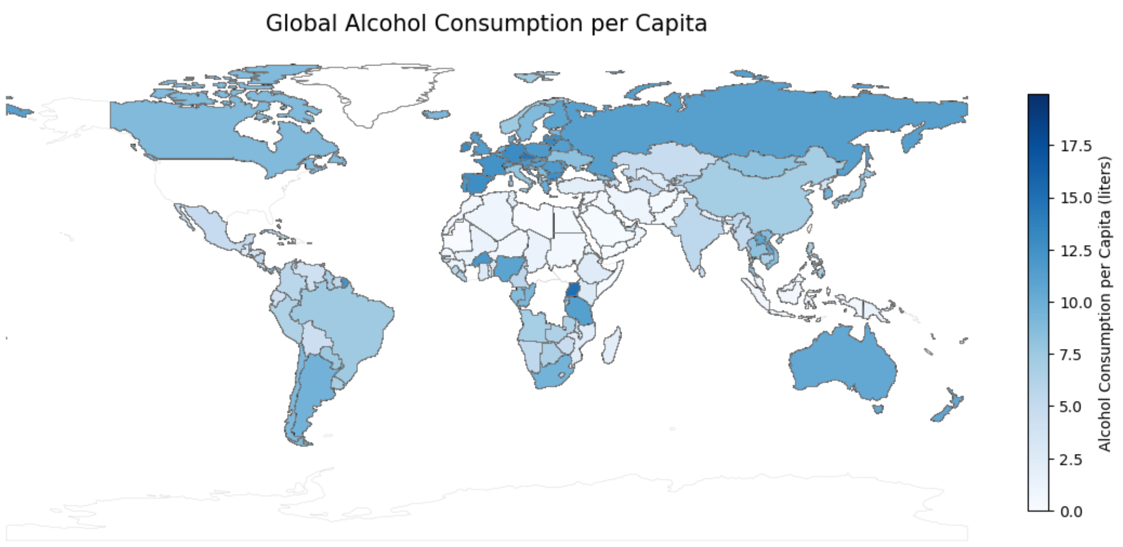
```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: geopandas in c:\users\nikitamitkin\appdata\roaming
\python\python311\site-packages (0.14.3)
Requirement already satisfied: fiona>=1.8.21 in c:\users\nikitamitkin\appdata\roa
ming\python\python311\site-packages (from geopandas) (1.9.6)
Requirement already satisfied: packaging in c:\programdata\anaconda3\lib\site-pac
kages (from geopandas) (23.1)
Requirement already satisfied: pandas>=1.4.0 in c:\programdata\anaconda3\lib\site
-packages (from geopandas) (2.1.4)
Requirement already satisfied: pyproj>=3.3.0 in c:\users\nikitamitkin\appdata\roa
ming\python\python311\site-packages (from geopandas) (3.6.1)
Requirement already satisfied: shapely>=1.8.0 in c:\users\nikitamitkin\appdata\ro
aming\python\python311\site-packages (from geopandas) (2.0.4)
Requirement already satisfied: attrs>=19.2.0 in c:\programdata\anaconda3\lib\site
-packages (from fiona>=1.8.21->geopandas) (23.1.0)
Requirement already satisfied: certifi in c:\programdata\anaconda3\lib\site-packa
ges (from fiona>=1.8.21->geopandas) (2024.2.2)
Requirement already satisfied: click~=8.0 in c:\programdata\anaconda3\lib\site-pa
ckages (from fiona>=1.8.21->geopandas) (8.1.7)
Requirement already satisfied: click-plugins>=1.0 in c:\users\nikitamitkin\appdat
a\roaming\python\python311\site-packages (from fiona>=1.8.21->geopandas) (1.1.1)
Requirement already satisfied: cligj>=0.5 in c:\users\nikitamitkin\appdata\roamin
g\python\python311\site-packages (from fiona>=1.8.21->geopandas) (0.7.2)
Requirement already satisfied: six in c:\programdata\anaconda3\lib\site-packages
(from fiona>=1.8.21->geopandas) (1.16.0)
Requirement already satisfied: numpy<2,>=1.23.2 in c:\programdata\anaconda3\lib\s
ite-packages (from pandas>=1.4.0->geopandas) (1.26.4)
Requirement already satisfied: python-dateutil>=2.8.2 in c:\programdata\anaconda3
\lib\site-packages (from pandas>=1.4.0->geopandas) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in c:\programdata\anaconda3\lib\site-
packages (from pandas>=1.4.0->geopandas) (2023.3.post1)
Requirement already satisfied: tzdata>=2022.1 in c:\programdata\anaconda3\lib\sit
e-packages (from pandas>=1.4.0->geopandas) (2023.3)
Requirement already satisfied: colorama in c:\programdata\anaconda3\lib\site-pack
ages (from click~=8.0->fiona>=1.8.21->geopandas) (0.4.6)
```

In [42]:
```python
import geopandas as gpd
```

In [43]:
```python
world = gpd.read_file(gpd.datasets.get_path('naturalearth_lowres'))
```

In [44]:
```python
# Merge the alcohol data onto the world DataFrame
world = world.merge(df, how="left", left_on="name", right_on="country")
```

In [45]:
```python
# Set up the plot with specified figure size
fig, ax = plt.subplots(1, figsize=(15, 10))

# Plotting the world boundaries
world.boundary.plot(ax=ax, linewidth=0.10, color='grey')

# Plotting the choropleth map with the alcohol consumption data
choropleth = world.dropna(subset=['alcohol_consumption_per_capita']).plot(
    column='alcohol_consumption_per_capita',
    ax=ax,
    legend=True,
    cmap='Blues',
    edgecolor='black',
    linewidth=0.25,
    legend_kwds={
        'label': "Alcohol Consumption per Capita (liters)",
        'orientation': "vertical",
        'shrink': 0.5,
        'pad': 0.01
    }
)

plt.title('Global Alcohol Consumption per Capita', fontdict={'fontsize': '15', '
ax.set_axis_off()
plt.savefig(f"{graphs_dir}/world_consumption.png")
plt.show()
```



Global Alcohol Consumption per Capita
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
Alcohol Consumption per Capita (liters)

In [46]:
```
#  See Global Trends Over Time in ALcohol Use

# Group by year and calculate mean, standard deviation (SD), and standard error
grouped = df.groupby('year')['alcohol_consumption_per_capita'].agg(['mean', 'std
grouped['se'] = grouped['std'] / np.sqrt(grouped['mean'].count())

# Calculate the 95% confidence interval (CI) with 1.96 as the z-score for 95% co
grouped['ci_lower'] = grouped['mean'] - 1.96 * grouped['se']
grouped['ci_upper'] = grouped['mean'] + 1.96 * grouped['se']

# Reset index to turn 'year' into a column
pivot_table = grouped.reset_index()

# Display the pivot table
pivot_table
```

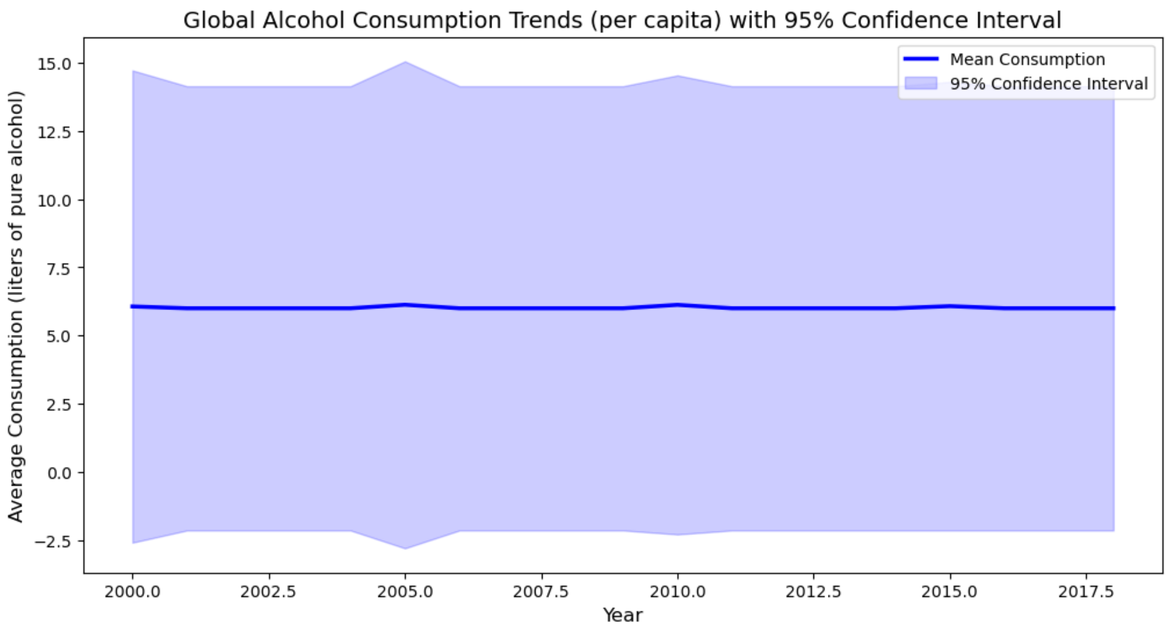
Out[46]:

	year	mean	std	se	ci_lower	ci_upper
0	2000	6.068219	4.411837	1.012145	4.084416	8.052023
1	2001	6.001267	4.150199	0.952121	4.135110	7.867424
2	2002	6.001267	4.150199	0.952121	4.135110	7.867424
3	2003	6.001267	4.150199	0.952121	4.135110	7.867424
4	2004	6.001267	4.150199	0.952121	4.135110	7.867424
5	2005	6.130428	4.549673	1.043767	4.084645	8.176210
6	2006	6.001267	4.150199	0.952121	4.135110	7.867424
7	2007	6.001267	4.150199	0.952121	4.135110	7.867424
8	2008	6.001267	4.150199	0.952121	4.135110	7.867424
9	2009	6.001267	4.150199	0.952121	4.135110	7.867424
10	2010	6.127198	4.288738	0.983904	4.198746	8.055649
11	2011	6.001267	4.150199	0.952121	4.135110	7.867424
12	2012	6.001267	4.150199	0.952121	4.135110	7.867424
13	2013	6.001267	4.150199	0.952121	4.135110	7.867424
14	2014	6.001267	4.150199	0.952121	4.135110	7.867424
15	2015	6.079861	4.190538	0.961375	4.195565	7.964157
16	2016	6.001267	4.150199	0.952121	4.135110	7.867424
17	2017	6.001267	4.150199	0.952121	4.135110	7.867424
18	2018	6.001267	4.150199	0.952121	4.135110	7.867424

In [47]:

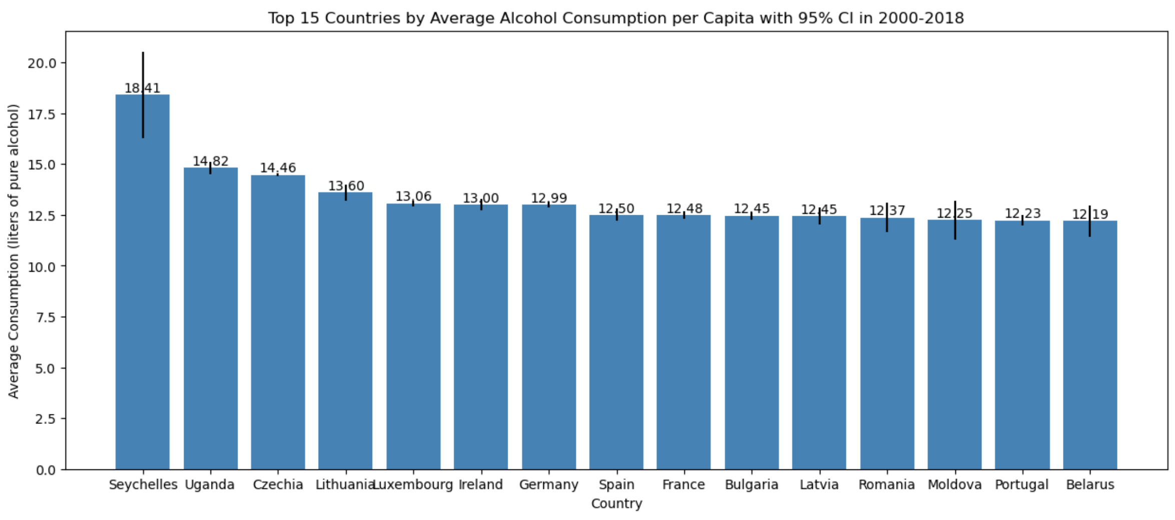
```python
# Hmmm. It seems that global alcohol use did not changed over time.
# Let's visualize it:

import seaborn as sns
import matplotlib.pyplot as plt

# Calculate global yearly averages and standard deviation for confidence interva
global_yearly_mean = df.groupby('year')['alcohol_consumption_per_capita'].mean()
global_yearly_std = df.groupby('year')['alcohol_consumption_per_capita'].std()

# Calculate the 95% confidence interval (1.96 is the z-score for 95% confidence)
ci_upper = global_yearly_mean + (1.96 * global_yearly_std)
ci_lower = global_yearly_mean - (1.96 * global_yearly_std)

# Create the plot with confidence interval
plt.figure(figsize=(12, 6))
plt.plot(global_yearly_mean.index, global_yearly_mean, marker='', color='blue',
plt.fill_between(global_yearly_mean.index, ci_lower, ci_upper, color='blue', alp

# Enhance the plot with titles and labels
plt.title('Global Alcohol Consumption Trends (per capita) with 95% Confidence In
plt.xlabel('Year', fontsize=12)
plt.ylabel('Average Consumption (liters of pure alcohol)', fontsize=12)
```

```
# Show the legend
plt.legend()

plt.savefig(f"{graphs_dir}/global_consumption_over_2000_2018.png")
plt.show()
```



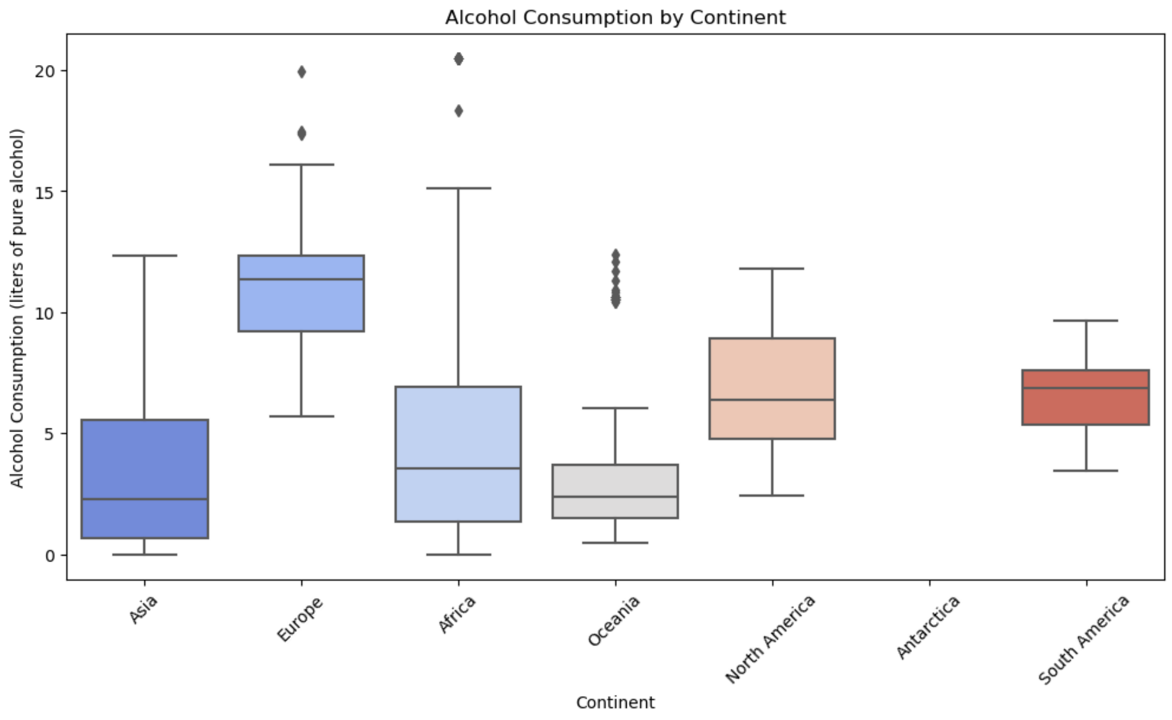
In [48]:
```
# Ok. Global alcohol use remains stable in 2000-2021 years.
# it is in line with WHO data.
```

In [49]:
```
# See contries with highest overall consumption 2000-2018:

# Calculate country means and standard deviation
country_stats = df.groupby('country')['alcohol_consumption_per_capita'].agg(['me
top_countries_stats = country_stats.nlargest(15, 'mean')

# Calculate the 95% confidence intervals
ci_95 = 1.96 * (top_countries_stats['std'] / np.sqrt(top_countries_stats['count'

# Plotting
plt.figure(figsize=(15, 6))
barplot = plt.bar(x=top_countries_stats.index, height=top_countries_stats['mean'

# Add average level numbers on top of each bar
for bar in barplot:
    plt.text(bar.get_x() + bar.get_width() / 2, bar.get_height(), f'{bar.get_hei
             ha='center', va='bottom')

plt.title('Top 15 Countries by Average Alcohol Consumption per Capita with 95% C
plt.xlabel('Country')
plt.ylabel('Average Consumption (liters of pure alcohol)')
plt.savefig(f"{graphs_dir}/top15_consumers.png")
plt.show()
```



In [50]:
```
# Ok. Nice. Our data are in line with WHO data on alcohol consumption.
# Seychelles and Uganda really have the highest drinking levels

# https://movendi.ngo/news/2023/05/27/uganda-new-who-data-reveal-worryingly-high
```

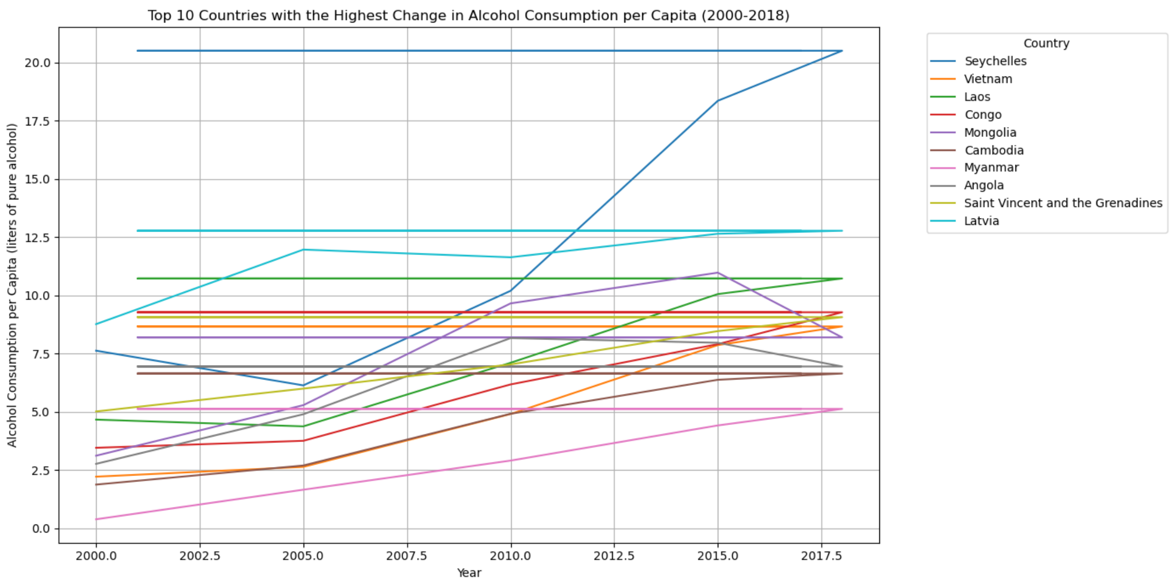
In [51]:
```
plt.figure(figsize=(12, 6))
sns.boxplot(x='continent', y='alcohol_consumption_per_capita', data=df, palette=
plt.title('Alcohol Consumption by Continent')
plt.xlabel('Continent')
plt.ylabel('Alcohol Consumption (liters of pure alcohol)')
plt.xticks(rotation=45)
plt.savefig(f"{graphs_dir}/consumption_by_continents.png")
plt.show()
```



In [52]:
```
# Yep. Europe has the highest overall level of drinking.

# Box plot clearly illustrates it.
```

In [53]:
```
# Calculate the first and last recorded consumption per country
first_year_consumption = df.groupby('country')['alcohol_consumption_per_capita']
last_year_consumption = df.groupby('country')['alcohol_consumption_per_capita'].
```

```
# Merge the first and last year data
consumption_change = pd.merge(first_year_consumption, last_year_consumption, on=

# Calculate the absolute change in consumption
consumption_change['abs_change'] = consumption_change['alcohol_consumption_per_c

# Sort the countries by the highest absolute change
top_changes = consumption_change.nlargest(10, 'abs_change')

# Now plot the countries with the highest change in alcohol consumption
plt.figure(figsize=(14, 7))

# We will draw one line per country
for country in top_changes['country']:
    country_data = df[df['country'] == country]
    plt.plot(country_data['year'], country_data['alcohol_consumption_per_capita'

plt.title('Top 10 Countries with the Highest Change in Alcohol Consumption per C
plt.xlabel('Year')
plt.ylabel('Alcohol Consumption per Capita (liters of pure alcohol)')
plt.legend(title='Country', bbox_to_anchor=(1.05, 1), loc='upper left')
plt.grid(True)
plt.tight_layout()  # Adjust the plot to ensure everything fits without overlapp
plt.show()
```



In [54]:
```
# Oooops!

# having multiple lines for the same country within the same year—suggests that

# Find entries with more than one record for the same country and year
duplicates = df[df.duplicated(subset=['country', 'year'], keep=False)]
```

In [55]:
```
df
```

Out[55]:

	country	country_Code	year	alcohol_consumption_per_capita	gdp_per_capit
0	Abkhazia	OWID_ABK	2015	NaN	
1	Afghanistan	AFG	2010	0.21	1957.0
2	Afghanistan	AFG	2015	0.21	2068.2
3	Afghanistan	AFG	2018	0.21	2033.8
4	Afghanistan	AFG	2002	0.21	1189.7
...	...	...	...	...	
56849	Zimbabwe	ZWE	2013	4.67	3176.8
56850	Zimbabwe	ZWE	2014	4.67	3195.7
56851	Zimbabwe	ZWE	2016	4.67	3173.6
56852	Zimbabwe	ZWE	2017	4.67	3274.6
57083	Åland Islands	ALA	2015	NaN	

4486 rows × 7 columns

In [56]:

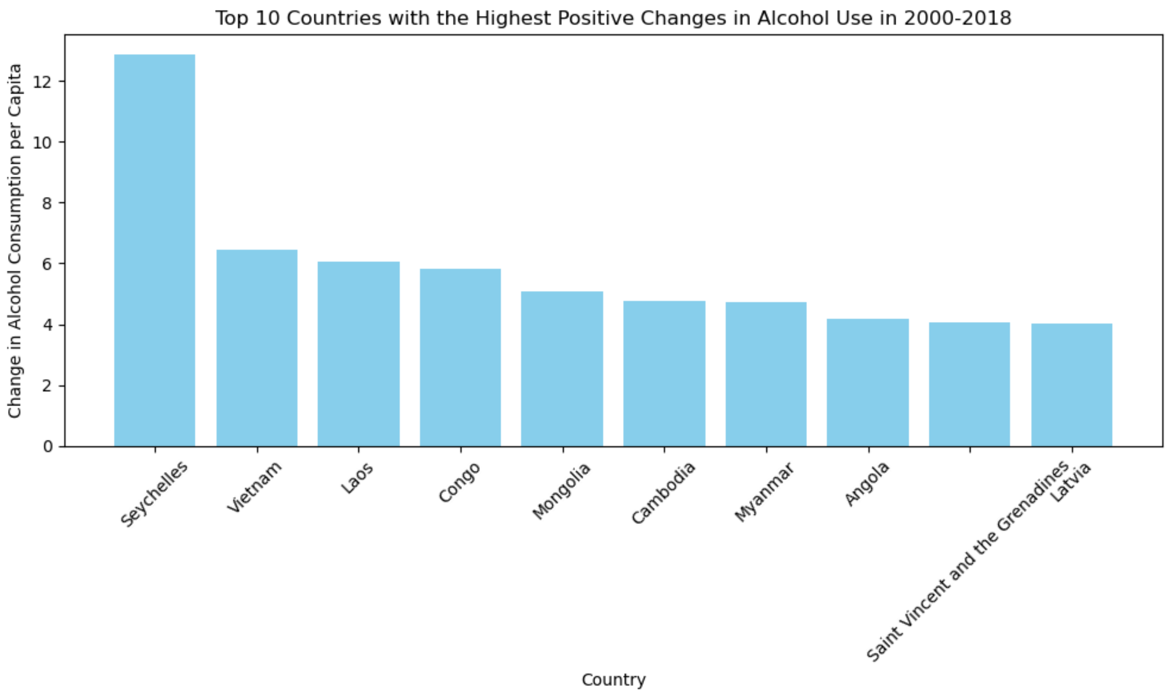
```
# Hmmmm there are no duplicates.

# Lets see Table for Seychelles:
df.query('country == "Seychelles" ')
```

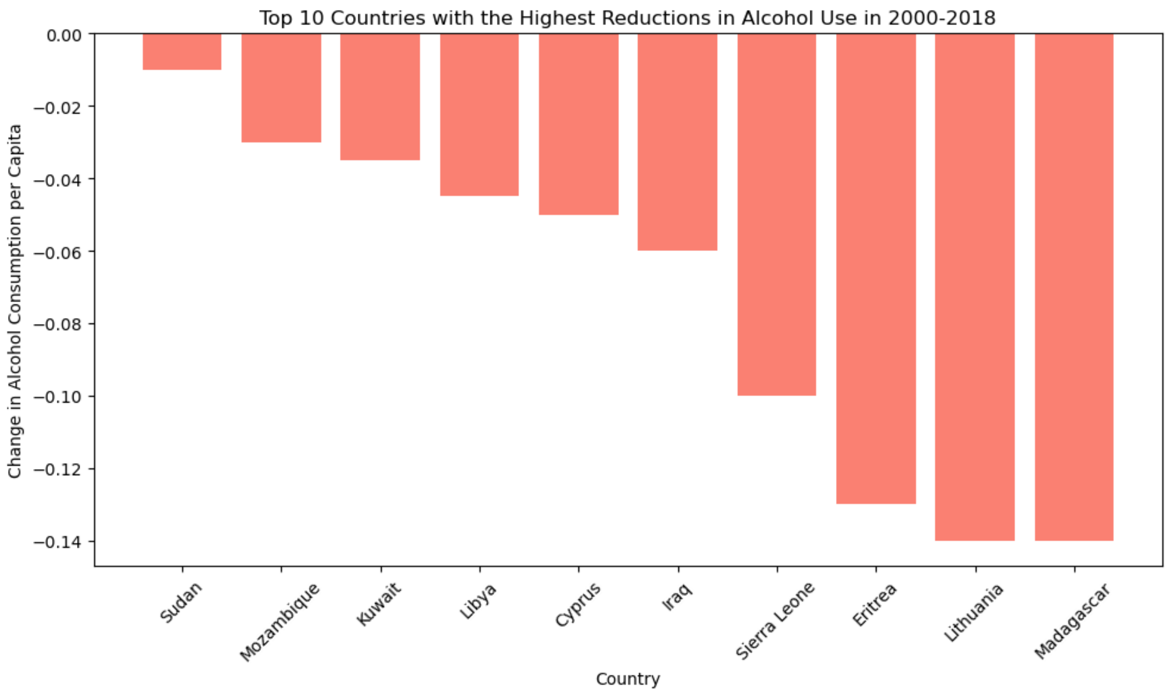
Out[56]:

	country	country_Code	year	alcohol_consumption_per_capita	gdp_per_capita_
44808	Seychelles	SYC	2000	7.62	18931.150
44809	Seychelles	SYC	2005	6.13	18273.719
44810	Seychelles	SYC	2010	10.19	20892.691
44811	Seychelles	SYC	2015	18.35	25500.486
44812	Seychelles	SYC	2018	20.50	27342.161
44823	Seychelles	SYC	2001	20.50	18485.016
44824	Seychelles	SYC	2002	20.50	18145.851
44825	Seychelles	SYC	2003	20.50	17271.915
44826	Seychelles	SYC	2004	20.50	16841.843
44827	Seychelles	SYC	2006	20.50	19580.901
44828	Seychelles	SYC	2007	20.50	21511.413
44829	Seychelles	SYC	2008	20.50	20584.082
44830	Seychelles	SYC	2009	20.50	20276.828
44831	Seychelles	SYC	2011	20.50	23140.926
44832	Seychelles	SYC	2012	20.50	23203.947
44833	Seychelles	SYC	2013	20.50	24150.210
44834	Seychelles	SYC	2014	20.50	24848.610
44835	Seychelles	SYC	2016	20.50	26309.685
44836	Seychelles	SYC	2017	20.50	27242.656

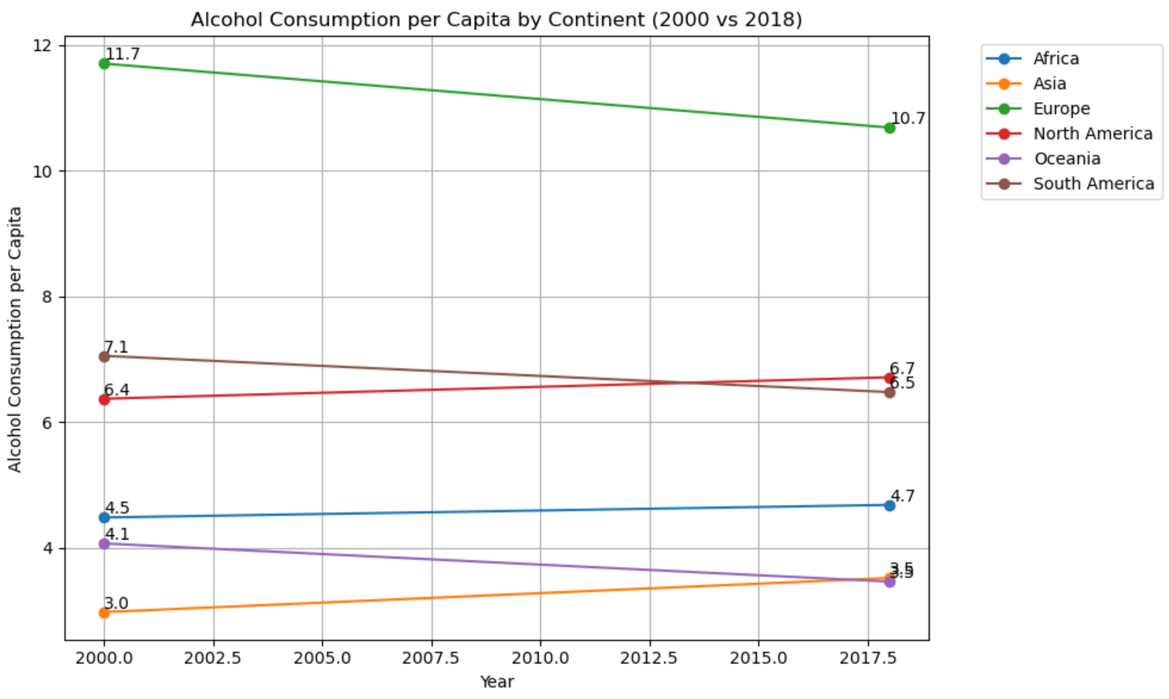
In [57]:
```
# There are still no duplicates.

# Let's try another approach for visualization:
```

In [58]:
```
# Let's look at countries with highest changes in drinking levels over the years



# Calculate the difference in alcohol consumption per capita between the first a
df_diff = df.groupby('country')['alcohol_consumption_per_capita'].apply(lambda x

# Sort countries based on the difference in alcohol consumption per capita
df_diff_sorted = df_diff.sort_values(by='alcohol_consumption_per_capita', ascend

# Separate positive and negative changes
positive_changes = df_diff_sorted[df_diff_sorted['alcohol_consumption_per_capita
negative_changes = df_diff_sorted[df_diff_sorted['alcohol_consumption_per_capita

# Plot countries with highest positive changes
plt.figure(figsize=(10, 6))
plt.bar(positive_changes['country'], positive_changes['alcohol_consumption_per_c
plt.xlabel('Country')
plt.ylabel('Change in Alcohol Consumption per Capita')
plt.title('Top 10 Countries with the Highest Positive Changes in Alcohol Use in
plt.xticks(rotation=45)
plt.tight_layout()
plt.savefig(f"{graphs_dir}/countries_with_highest_changes1.png")
plt.show()

# Plot countries with highest reductions
plt.figure(figsize=(10, 6))
plt.bar(negative_changes['country'], negative_changes['alcohol_consumption_per_c
plt.xlabel('Country')
plt.ylabel('Change in Alcohol Consumption per Capita')
plt.title('Top 10 Countries with the Highest Reductions in Alcohol Use in 2000-2
plt.xticks(rotation=45)
plt.tight_layout()
plt.savefig(f"{graphs_dir}/countries_with_highest_changes2.png")
plt.show()
```





In [59]:
```python
# See changes by continents


df_filtered = df[df['year'].isin([2000, 2018])]
colors = sns.color_palette('tab10', n_colors=len(df['continent'].unique()))
pivot_df = df_filtered.pivot_table(index='continent', columns='year', values='al
plt.figure(figsize=(10, 6))
for i, continent in enumerate(pivot_df.index):
    plt.plot(pivot_df.columns, pivot_df.loc[continent], marker='o', color=colors
    plt.text(pivot_df.columns[0], pivot_df.loc[continent, 2000], f'{pivot_df.loc
    plt.text(pivot_df.columns[-1], pivot_df.loc[continent, 2018], f'{pivot_df.lo

plt.xlabel('Year')
plt.ylabel('Alcohol Consumption per Capita')
plt.title('Alcohol Consumption per Capita by Continent (2000 vs 2018)')
plt.legend(bbox_to_anchor=(1.05, 1), loc='upper left')
plt.grid(True)
plt.tight_layout()
plt.savefig(f"{graphs_dir}/change_by_continents.png")
plt.show()
```



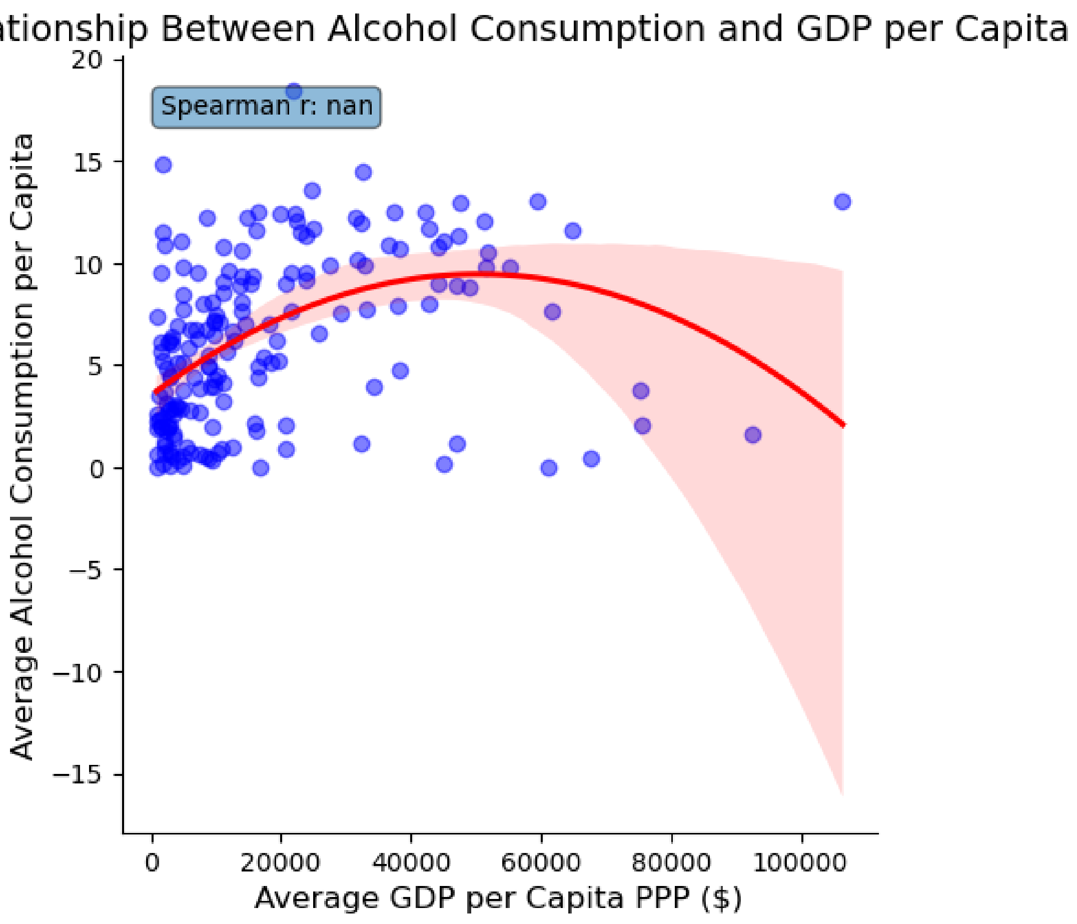
In [60]:
```python
# Nice! European Region reduced alcohol consumption by 10%, but Africa, Asia and
```

In [99]:
```python
# Ok. Now, Lets do an interactive plot.
# We can visualize relationship between alcohol use level and GDP per capita.

import plotly.express as px

# Calculate average consumption and GDP per capita for each country
avg_consumption = df.groupby('country')['alcohol_consumption_per_capita'].mean()
avg_gdp = df.groupby('country')['gdp_per_capita_ppp'].mean()

# Create a new df with average values
avg_df = pd.DataFrame({'country': avg_consumption.index, 'avg_consumption': avg_

# Plot the average consumption vs. average GDP per capita
fig = px.scatter(avg_df, x="avg_gdp", y="avg_consumption", color="country")
```

```
fig.update_layout(
    title="Alcohol Consumption vs. GDP per Capita over 2000-2018",
    xaxis_title="Average GDP per Capita (constant 2017 international $)",
    yaxis_title="Average Alcohol Consumption per Capita (liters of pure alcohol)
    width=1000,
    height=700
)

fig.write_html("graphs/alcohol_consumption_vs_gdp.html")

fig.show()
```

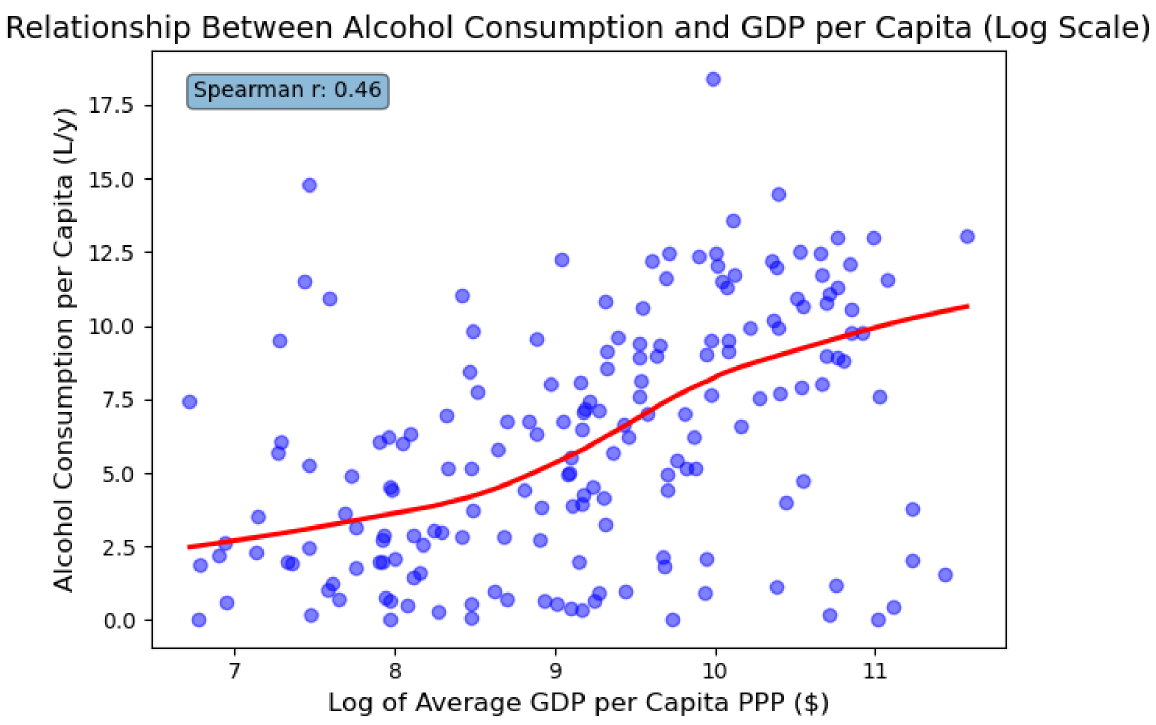
In [62]:
```
# Ok. Nice. We can interact with this plot above.
# Now, let's see correlation between drinking level and GDP per capita.
# here we need to use Spearman correlation because of non-linear association.
```

```
In [63]: from scipy.stats import spearmanr

         # Compute the mean alcohol consumption per capita and GDP per capita for each co
         country_means = df.groupby('country').agg({
             'alcohol_consumption_per_capita': 'mean',
             'gdp_per_capita_ppp': 'mean'
         }).reset_index()

         # Calculate the Spearman correlation coefficient
         spearman_coef, _ = spearmanr(country_means['alcohol_consumption_per_capita'], co

         # Create a scatter plot with a non-linear regression model fit
         sns.lmplot(x='gdp_per_capita_ppp', y='alcohol_consumption_per_capita', data=coun
                    order=2,  # This specifies a non-linear regression (quadratic fit)
                    ci=95,  # Confidence interval for the fit set to 95%
                    scatter_kws={'alpha':0.5, 'color':'blue'}, line_kws={'color':'red'})

         # Annotate the plot with the Spearman correlation coefficient
         plt.annotate(f'Spearman r: {spearman_coef:.1f}', xy=(0.05, 0.95), xycoords='axes
                      ha='left', va='top', fontsize=10, bbox=dict(boxstyle='round,pad=0.3

         # Set the plot titles and labels
         plt.title('Relationship Between Alcohol Consumption and GDP per Capita', fontsiz
         plt.xlabel('Average GDP per Capita PPP ($)', fontsize=12)
         plt.ylabel('Average Alcohol Consumption per Capita', fontsize=12)



         plt.show()
```



```
In [64]: # Hmmm. It is not bad. But we can improve this plot:


         # 1) do not account NaNs
         # 2) using a log scale may help to visualize the relationship
         # 3) confidence interval (the shaded area) dips into negative values, which may
```

```
In [65]: # Compute the mean alcohol consumption per capita and GDP per capita for each co
         country_means = df.groupby('country').agg({
             'alcohol_consumption_per_capita': 'mean',
             'gdp_per_capita_ppp': 'mean'
         }).dropna()  # Dropping NaNs

         # Calculate the Spearman correlation coefficient again after cleaning data
         spearman_coef, _ = spearmanr(country_means['alcohol_consumption_per_capita'], co

         # Log transformation for GDP per capita
         country_means['gdp_per_capita_ppp_log'] = np.log1p(country_means['gdp_per_capita

         # Create a scatter plot with a non-linear regression model fit using the log of
         sns.regplot(x='gdp_per_capita_ppp_log', y='alcohol_consumption_per_capita', data
                     scatter_kws={'alpha':0.5, 'color':'blue'}, line_kws={'color':'red'},

         # Spearman correlation coefficient, checking for NaN
         if not np.isnan(spearman_coef):
             plt.annotate(f'Spearman r: {spearman_coef:.2f}', xy=(0.05, 0.95), xycoords='
                          ha='left', va='top', fontsize=10, bbox=dict(boxstyle='round,pad

         # Set the plot titles and labels
         plt.title('Relationship Between Alcohol Consumption and GDP per Capita (Log Scal
         plt.xlabel('Log of Average GDP per Capita PPP ($)', fontsize=12)
         plt.ylabel('Alcohol Consumption per Capita (L/y)', fontsize=12)

         plt.savefig(f"{graphs_dir}/correlation_alcohol_GDP")
         plt.tight_layout()
         plt.show()
```



In [66]:
```
# Wonderful!

# A curved line (polynomial fit) is fitted to the data points,
# indicating a non-linear relationship between GDP and alcohol consumption.
# The trend suggests that as GDP per capita increases, alcohol consumption also
# but not at a constant rate. Interesting...
```

In [67]:
```
# Now, let's append our data with external part -- World Health Organization (WH
```

In [68]:
```
# Indicator: Alcohol use disorders (12-month prevalence)

# Adults (15+ years) who suffer from disorders attributable to the consumption o
# during a given calendar year.
# Numerator: Number of adults (15+ years) with a diagnosis of F10.1, F10.2 durin
# Denominator: Midyear resident population (15+ years) over the same calendar ye

# Source: World Health Organization
# Link: https://www.who.int/data/gho/data/indicators/indicator-details/GHO/alcoh
```

In [69]:
```
def load_who_data(filepath):
    """
    Load and preprocess the WHO data with the correct delimiter.

    Parameters:
    - filepath (str): Path to the downloaded WHO data file.

    Returns:
    - DataFrame: Preprocessed WHO data.
    """
    # Specify the delimiter as semicolon
    df = pd.read_csv(filepath, delimiter=';')
    # Rename columns if necessary and convert data types
    df.rename(columns=lambda x: x.strip(), inplace=True)  # Strip any extra spac
    df['year'] = pd.to_numeric(df['year'], errors='coerce')  # Convert year to n
    return df
```

In [70]:
```
# Loading new data:
who_df = load_who_data(r"C:\Users\NikitaMitkin\Documents\GitHub\HEL8048\data\who
```

In [71]:
```
# Display the column names for both DataFrames
print("Columns in main DataFrame:", df.columns)
print("Columns in WHO DataFrame:", who_df.columns)
```

```
Columns in main DataFrame: Index(['country', 'country_Code', 'year', 'alcohol_con
sumption_per_capita',
       'gdp_per_capita_ppp', 'population', 'continent'],
      dtype='object')
Columns in WHO DataFrame: Index(['country', 'year', 'aud_prevalence'], dtype='obj
ect')
```

In [72]:
```
def merge_datasets(df1, df2):
    """
    Merge two datasets on 'country' and 'year' columns ensuring only matched dat

    Parameters:
    - df1 (DataFrame): Primary dataset.
    - df2 (DataFrame): WHO data on AUD prevalence.

    Returns:
    - DataFrame: Merged dataset with matched records only.
    """
    # Ensure column names are correctly set for merging
    df1['year'] = pd.to_numeric(df1['year'], errors='coerce')  # Convert year to
    merged_df = pd.merge(df1, df2, on=['country', 'year'], how='inner')
    return merged_df
```

In [73]:
```
# Perform the merge and see output:

final_df = merge_datasets(df, who_df)
final_df
```

Out[73]:

	country	country_Code	year	alcohol_consumption_per_capita	gdp_per_capita_p
0	Afghanistan	AFG	2016	0.210	2057.067
1	Albania	ALB	2016	7.170	12291.873
2	Algeria	DZA	2016	0.950	11826.166
3	Andorra	AND	2016	11.020	N
4	Angola	AGO	2016	6.940	7568.998
...	...	...	...	...	
167	Uzbekistan	UZB	2016	2.590	6346.334
168	Vanuatu	VUT	2016	2.250	2973.467
169	Yemen	YEM	2016	0.051	N
170	Zambia	ZMB	2016	6.540	3467.887
171	Zimbabwe	ZWE	2016	4.670	3173.610

172 rows × 8 columns

In [74]:
```
# Nice! Now we have data on AUD prevalence with alcohol level use and GDP per ca
```

In [75]:
```
final_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 172 entries, 0 to 171
Data columns (total 8 columns):
 #   Column                          Non-Null Count  Dtype  
---  ------                          --------------  -----  
 0   country                         172 non-null    object 
 1   country_Code                    172 non-null    object 
 2   year                            172 non-null    int64  
 3   alcohol_consumption_per_capita  166 non-null    float64
 4   gdp_per_capita_ppp              165 non-null    float64
 5   population                      172 non-null    float64
 6   continent                       172 non-null    object 
 7   aud_prevalence                  172 non-null    object 
dtypes: float64(3), int64(1), object(4)
memory usage: 10.9+ KB
```

In [76]:
```
# Transform prevalence from object to float:

final_df['aud_prevalence'] = pd.to_numeric(final_df['aud_prevalence'], errors='c
```

In [77]:
```
# Missed values:

final_df.isnull().sum() # ok
```

Out[77]:

```
country                           0
country_Code                      0
year                              0
alcohol_consumption_per_capita    6
gdp_per_capita_ppp                7
population                        0
continent                         0
aud_prevalence                    3
dtype: int64
```

In [78]:

```
# Dropping rows with missing 'aud_prevalence'

final_df.dropna(subset=['aud_prevalence'], inplace=True)
```

In [79]:

```
final_df.describe()
```

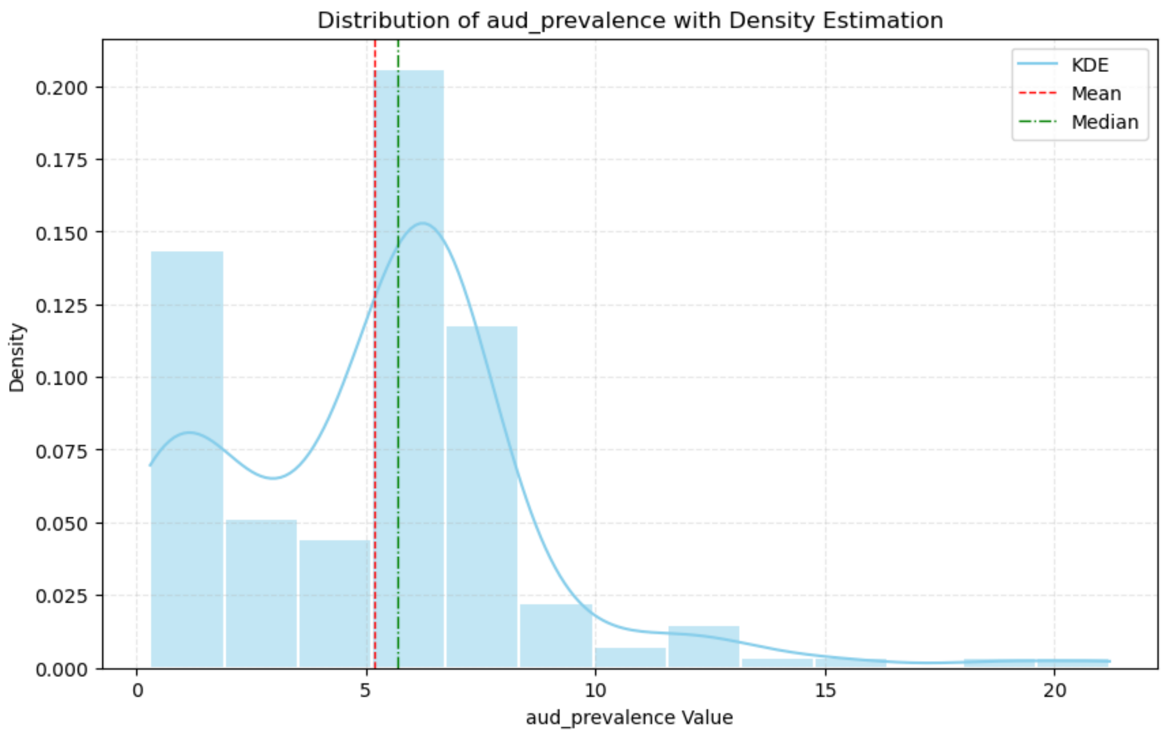
Out[79]:

	year	alcohol_consumption_per_capita	gdp_per_capita_ppp	population	aud_
count	169.0	166.000000	163.000000	1.690000e+02	
mean	2016.0	6.028054	19437.476464	3.737159e+07	
std	0.0	4.165412	20025.247372	1.515283e+08	
min	2016.0	0.003000	794.604271	1.611000e+03	
25%	2016.0	2.315000	4452.254364	2.007882e+06	
50%	2016.0	5.785000	12403.687142	8.108984e+06	
75%	2016.0	9.202500	27392.517778	2.392655e+07	
max	2016.0	20.500000	113035.834714	1.414049e+09	

In [80]:

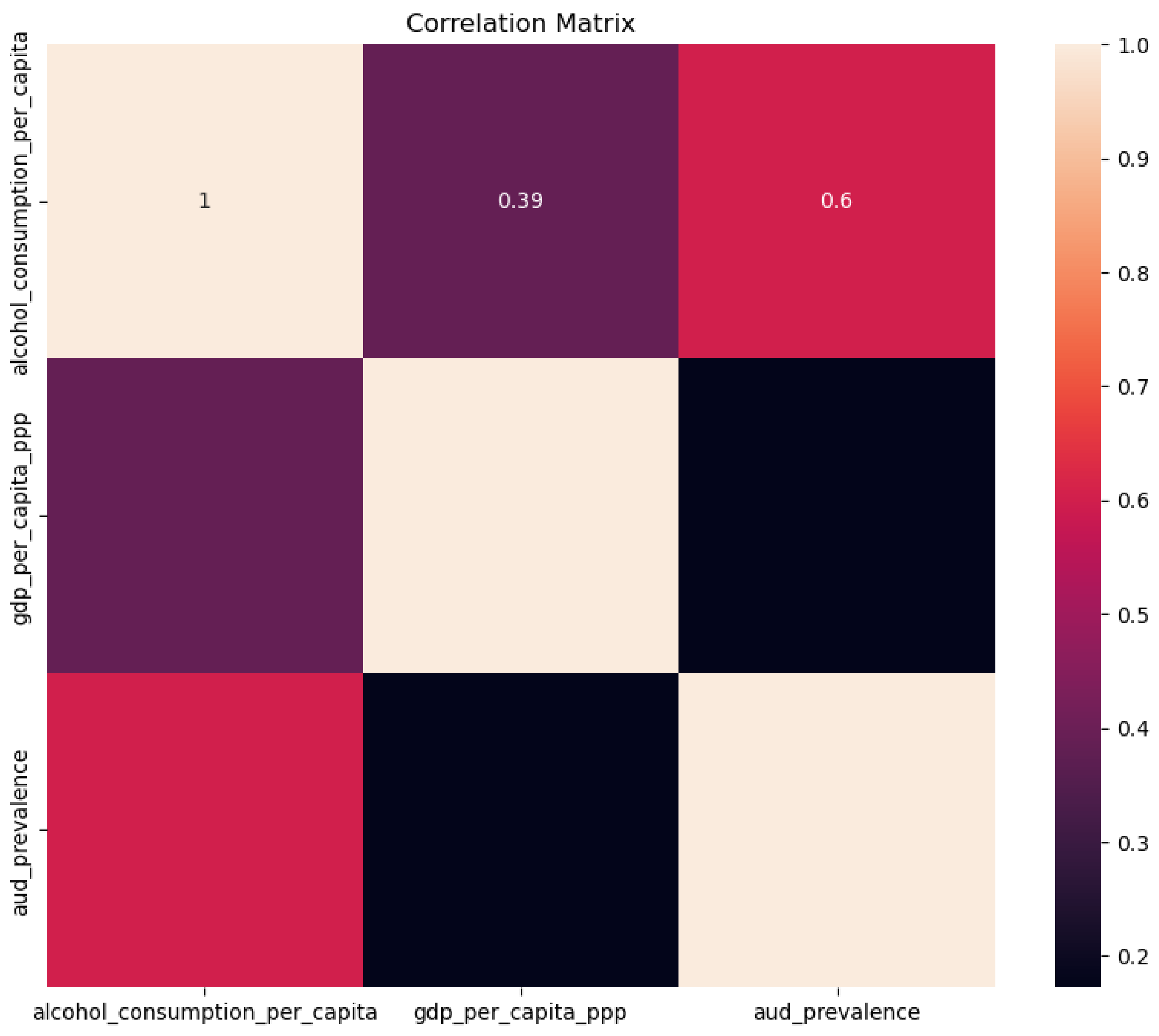
```
analyzer_who = DataAnalyzer(final_df)
analyzer_who.plot_histogram_with_kde('aud_prevalence')
```

```
Summary Statistics for aud_prevalence:
count    169.000000
mean       5.179882
std        3.444467
min        0.300000
25%        2.300000
50%        5.700000
75%        6.800000
max       21.200000
Name: aud_prevalence, dtype: float64
```



In [81]:

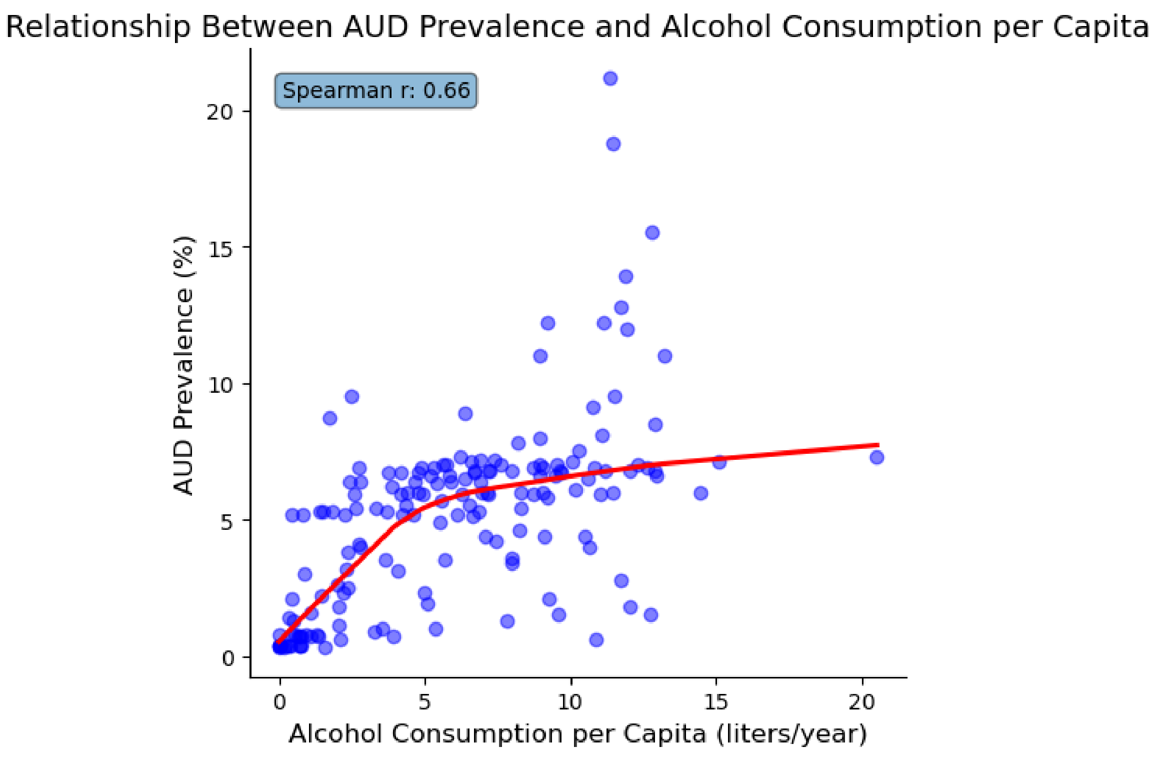
```
# See correlations:

plt.figure(figsize=(10, 8))
sns.heatmap(final_df[['alcohol_consumption_per_capita', 'gdp_per_capita_ppp', 'a
plt.title('Correlation Matrix')
plt.show()
```



In [82]:
```
# Compute the mean alcohol consumption per capita and AUD prevalence for each co
country_means = final_df.groupby('country').agg({
    'alcohol_consumption_per_capita': 'mean',
    'aud_prevalence': 'mean'
}).dropna()  # Dropping NaNs

# Calculate the Spearman correlation coefficient
spearman_coef, _ = spearmanr(country_means['alcohol_consumption_per_capita'], co

print(f"Spearman correlation coefficient: {spearman_coef:.2f}")
```

```
Spearman correlation coefficient: 0.66
```

In [83]:
```
# Create a scatter plot with a non-linear regression model fit (using LOWESS)
sns.lmplot(x='alcohol_consumption_per_capita', y='aud_prevalence', data=country_
           scatter_kws={'alpha':0.5, 'color':'blue'}, line_kws={'color':'red'},

if not np.isnan(spearman_coef):
    plt.annotate(f'Spearman r: {spearman_coef:.2f}', xy=(0.05, 0.95), xycoords='
                 ha='left', va='top', fontsize=10, bbox=dict(boxstyle='round,pad

# Set the plot titles and labels
plt.title('Relationship Between AUD Prevalence and Alcohol Consumption per Capit
plt.xlabel('Alcohol Consumption per Capita (liters/year)', fontsize=12)
plt.ylabel('AUD Prevalence (%)', fontsize=12)
plt.tight_layout()
plt.savefig(f"{graphs_dir}/correlation_alcohol_AUDprevalence")
plt.show()
```



```
In [84]: # While a positive correlation might indicate that higher alcohol consumption is
         # the causality cannot be inferred directly from the analysis
```

```
In [85]: # Ok. Nice.

         # Now, let's do some analysis.
```

```
In [86]: # Ensure all data is in the correct format
         final_df['aud_prevalence'] = pd.to_numeric(final_df['aud_prevalence'], errors='c
         final_df['alcohol_consumption_per_capita'] = pd.to_numeric(final_df['alcohol_con
         final_df['gdp_per_capita_ppp'] = pd.to_numeric(final_df['gdp_per_capita_ppp'], e
```

```
In [87]: # Drop  rows with missing data for simplicity in this initial model
         analysis_df = final_df.dropna(subset=['aud_prevalence', 'alcohol_consumption_per
```

```
In [88]: #  Simple Linear Regression to Explore Initial Associations
         import statsmodels.api as sm

         # Fit a simple linear regression model
         X_simple = sm.add_constant(analysis_df['alcohol_consumption_per_capita'])  # add
         y = analysis_df['aud_prevalence']

         model_simple = sm.OLS(y, X_simple).fit()
         print(model_simple.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:          aud_prevalence   R-squared:                       0.356
Model:                             OLS   Adj. R-squared:                  0.352
Method:                  Least Squares   F-statistic:                     88.37
Date:                 Wed, 17 Apr 2024   Prob (F-statistic):           5.50e-17
Time:                         14:26:02   Log-Likelihood:                -396.14
No. Observations:                  162   AIC:                             796.3
Df Residuals:                      160   BIC:                             802.4
Df Model:                            1
Covariance Type:             nonrobust
=================================================================================
=================
                                    coef    std err          t      P>|t|
[0.025      0.975]
---------------------------------------------------------------------------------
-----------------
const                             2.1768      0.391      5.566      0.000
1.404       2.949
alcohol_consumption_per_capita    0.5006      0.053      9.401      0.000
0.395       0.606
==============================================================================
Omnibus:                        39.457   Durbin-Watson:                   1.739
Prob(Omnibus):                   0.000   Jarque-Bera (JB):              119.203
Skew:                            0.929   Prob(JB):                     1.30e-26
Kurtosis:                        6.769   Cond. No.                         13.2
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
```

In [89]:
```
# Nice. But what does it mean?

# R-squared (0.356): Explains 35.6% of the variance in AUD prevalence, indicatin
# Adjusted R-squared (0.352): Slightly lower than R-squared, adjusted for the nu
# F-statistic (88.37): The model fit is statistically significant, with a very l
# coef for alcohol_consumption_per_capita (0.5006): For every one liter increase
# P-value for alcohol_consumption_per_capita (<0.001): The effect of alcohol con
# Confidence Interval: Indicates that we are 95% confident that the interval [0.
# Durbin-Watson (1.739): The value is close to 2, suggesting minimal autocorrela
# Omnibus/Prob(Omnibus): Test for the normality of the residuals; the low p-valu
# Jarque-Bera: Another test indicating non-normality in the residuals.
# Skew (0.929): Positive skew indicates a long tail on the right side of the dis
# Kurtosis (6.769): Indicates heavy tails compared to a normal distribution, sug
```

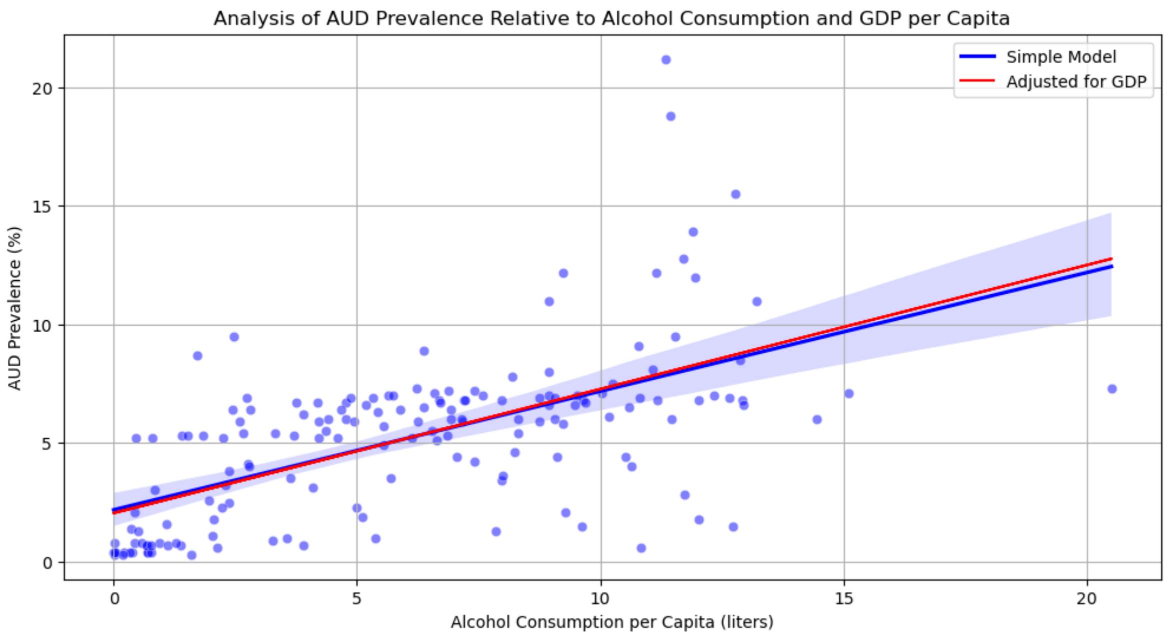
In [90]:
```
# Adding GDP per capita to the model
X_adjusted = sm.add_constant(analysis_df[['alcohol_consumption_per_capita', 'gdp
model_adjusted = sm.OLS(y, X_adjusted).fit()
print(model_adjusted.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:         aud_prevalence   R-squared:                       0.360
Model:                            OLS   Adj. R-squared:                  0.352
Method:                 Least Squares   F-statistic:                     44.71
Date:                Wed, 17 Apr 2024   Prob (F-statistic):           3.93e-16
Time:                        14:26:02   Log-Likelihood:                -395.62
No. Observations:                 162   AIC:                             797.2
Df Residuals:                     159   BIC:                             806.5
Df Model:                           2
Covariance Type:            nonrobust
=================================================================================
=================
                                   coef    std err          t      P>|t|
[0.025      0.975]
---------------------------------------------------------------------------------
-----------------
const                            2.2745      0.403      5.647      0.000
1.479       3.070
alcohol_consumption_per_capita   0.5233      0.058      9.058      0.000
0.409       0.637
gdp_per_capita_ppp            -1.21e-05    1.2e-05     -1.012      0.313   -3.5
7e-05    1.15e-05
==============================================================================
Omnibus:                       39.250   Durbin-Watson:                   1.731
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              121.800
Skew:                           0.913   Prob(JB):                     3.56e-27
Kurtosis:                       6.835   Cond. No.                     5.12e+04
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The condition number is large, 5.12e+04. This might indicate that there are
strong multicollinearity or other numerical problems.
```

In [91]:
```
# Output interpretation for Model 2:

# R-squared (0.360): Only a slight improvement in variance explanation compared
# Adjusted R-squared (0.352): Adjusted for two predictors, showing a stable expl
# F-statistic (44.71): The model remains significant, although the statistic has
# coef for alcohol_consumption_per_capita (0.5233): A slightly higher coefficien
# coef for gdp_per_capita_ppp (-1.21e-05): The effect is minimal and not statist
# Confidence Interval for gdp_per_capita_ppp: Includes zero, confirming the non-
# Durbin-Watson (1.731): Similar interpretation as in Model 1, with minimal auto
# Condition Number (5.12e+04): High, indicating potential multicollinearity issu
```

In [92]:
```
# Visualization of our regression:

analysis_df = final_df.dropna(subset=['aud_prevalence', 'alcohol_consumption_per

# Define a function to calculate the adjusted predictions
def adjusted_pred(x, avg_gdp):
    return model_adjusted.params[0] + model_adjusted.params[1] * x + model_adjus

# Calculate the average GDP per capita
avg_gdp_per_capita = analysis_df['gdp_per_capita_ppp'].mean()

# Calculate adjusted predictions using .loc to ensure direct modification
analysis_df.loc[:, 'adjusted_pred'] = analysis_df['alcohol_consumption_per_capit
```

```
# Plotting as before
plt.figure(figsize=(12, 6))
sns.scatterplot(data=analysis_df, x='alcohol_consumption_per_capita', y='aud_pre
sns.regplot(data=analysis_df, x='alcohol_consumption_per_capita', y='aud_prevale
plt.plot(analysis_df['alcohol_consumption_per_capita'], analysis_df['adjusted_pr
plt.xlabel('Alcohol Consumption per Capita (liters)')
plt.ylabel('AUD Prevalence (%)')
plt.title('Analysis of AUD Prevalence Relative to Alcohol Consumption and GDP pe
plt.legend()
plt.grid(True)
plt.savefig(f"{graphs_dir}/linear_regression")
plt.show()
```



In [93]:
```
# Well done!
# It was an interesting trip.

# We cleaned and processed the dataset,
# then we visualized alcohol level use in global, continent and country perspect
# We also illustrated countries with highest change in drinking levels (positive
# The notebook uses functions and classess as well.
# We observed changed in drinking levels over time by continents.
# Then we loaded external dataset, and merged two data frames
# We used linear regression to assess associations between drinking volume, GPD

# Conclusions:
# 1) global alcohol consumption level remained stable over 2000-2018 at around 6
# 2) European Region reduced alcohol consumption by 10%, but Africa, Asia and No
# 3) Alcohol drinking level has mild but signficant correaltion with alcohol-use
# 4) GDP per capita doesnt play a signficiant role in relationship between AUD p

# We sucessfully completed our initial objectivess.
```

In [1]:
```
!conda env export > environment.yml
```