CS156 (Introduction to AI), Fall 2022

Final Term Project

Roster Name: Anh Dinh

Preferred Name (if different): Anh Dinh

Student ID: 015583620

Email address: anh.dinh@sjsu.edu

Project description/introduction text (the background information)

On November 15th, 2022, the global population reached 8 billion, which marked 11 years ever since the population hit the 7 billion milestone. This raises the question as to whether if overpopulation is a problem or not. For example, China and India have been the two countries with most population as they both have at least 1 billion individuals, so it is clear that overpopulation has been an issue there. As for the Singapore, its population is not as high as many countries, but in terms of density, it is third in line for the countries with the highest density. Therefore, it might not be an overpopulation issue globally but locally.

Without these knowledges about the population and density, we will not be able to understand which part of the world actually has overpopulation issue or just only has this problem but in a local scale. However, with this project, not only it will show the world's population overall, it will also allow us to see the growth scale.

Machine learning algorithm selected for this project

Because of time shortage, this project contains variations of plotly, seaborn, and country converter to describe the dataset. I choose plotly as it has different way to distribute data and for better data visualization.

Dataset source

https://www.kaggle.com/datasets/whenamancodes/world-population-live-dataset

References and sources

https://www.un.org/en/desa/world-population-reach-8-billion-15-november-2022#:~:text=The%20global%20population%20is%20projected,today%20on%20World%20Populati
https://pypi.org/project/country-converter/ https://plotly.com/python/plotly-express/
https://plotly.com/python/choropleth-maps/
https://www.w3schools.com/python/matplotlib_plotting.asp https://plotly.com/python/builtin-colorscales/ https://machinelearningmastery.com/seaborn-data-visualization-for-machine-learning/

Solution

Load libraries and set random number generator seed

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px
import os
import country_converter
from plotly.subplots import make_subplots
import plotly.graph_objects as go
```

In [2]:
```
np.random.seed(42)
import warnings
warnings.filterwarnings('ignore')
```

Code

In [3]:
```
df = pd.read_csv('World Population Live Dataset.csv')
df_copy = df.copy()
```

In [4]:
```
df['CCA3'] = country_converter.convert(names=df['Name'], to="ISO3")
df1 = (df.set_index(["Name","CCA3",'Area (km²)','Density (per km²)','GrowthRate','Worl
         .stack()
         .reset_index(name='Population')
         .rename(columns={'level_7':'Year'}))
df1.Population = df1.Population*1000
```

In [5]:
```
px.choropleth(df1.sort_values('Year'),
              locations = 'CCA3',
              color="Population",
              animation_frame='Year',
              color_continuous_scale ='mint',
              title='World population through years' ,
              height=800)
```

World population through years

5 countries with the most population

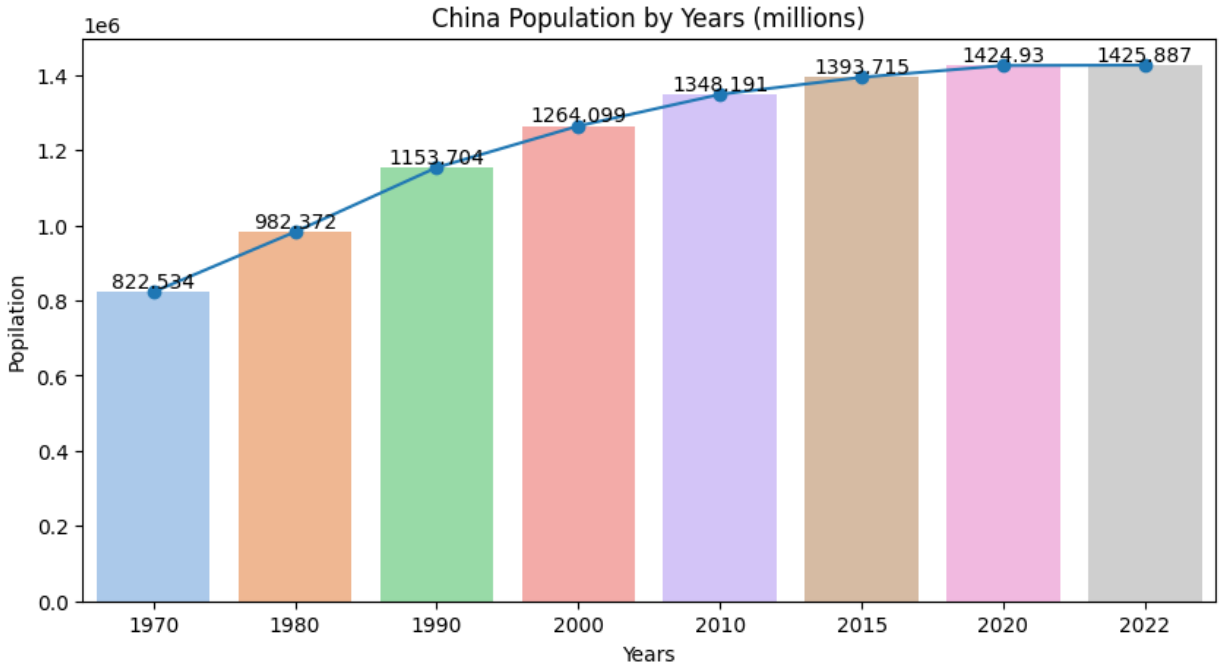
In [6]:
```
df.head()
```

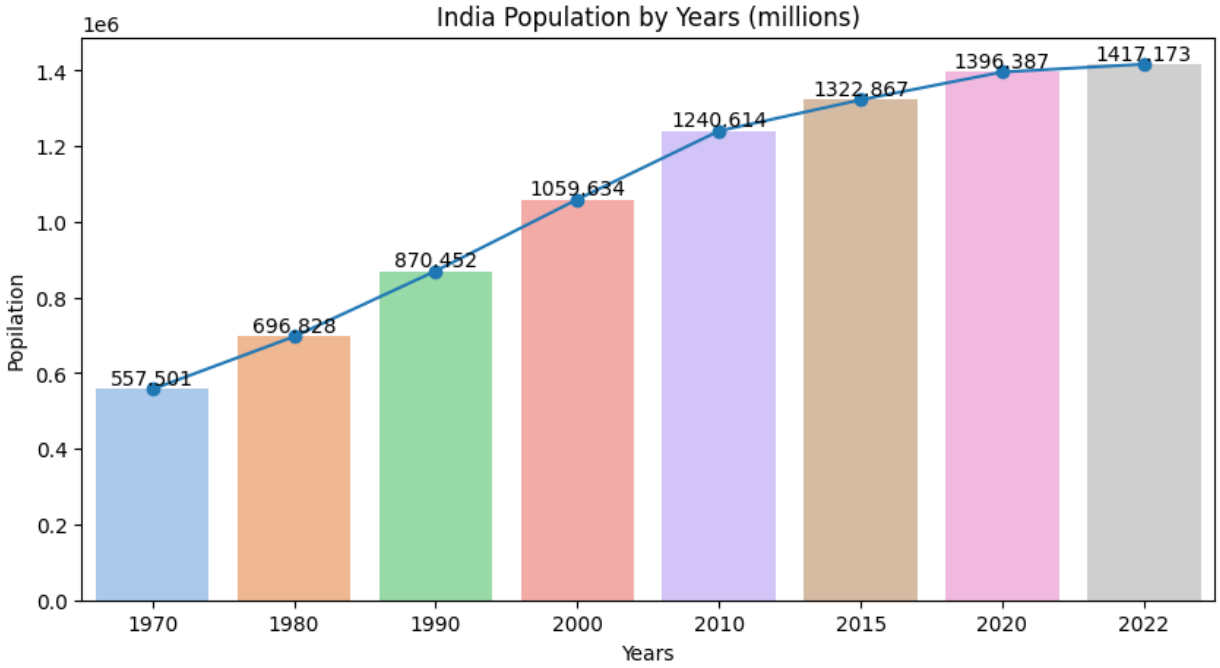
Out[6]:

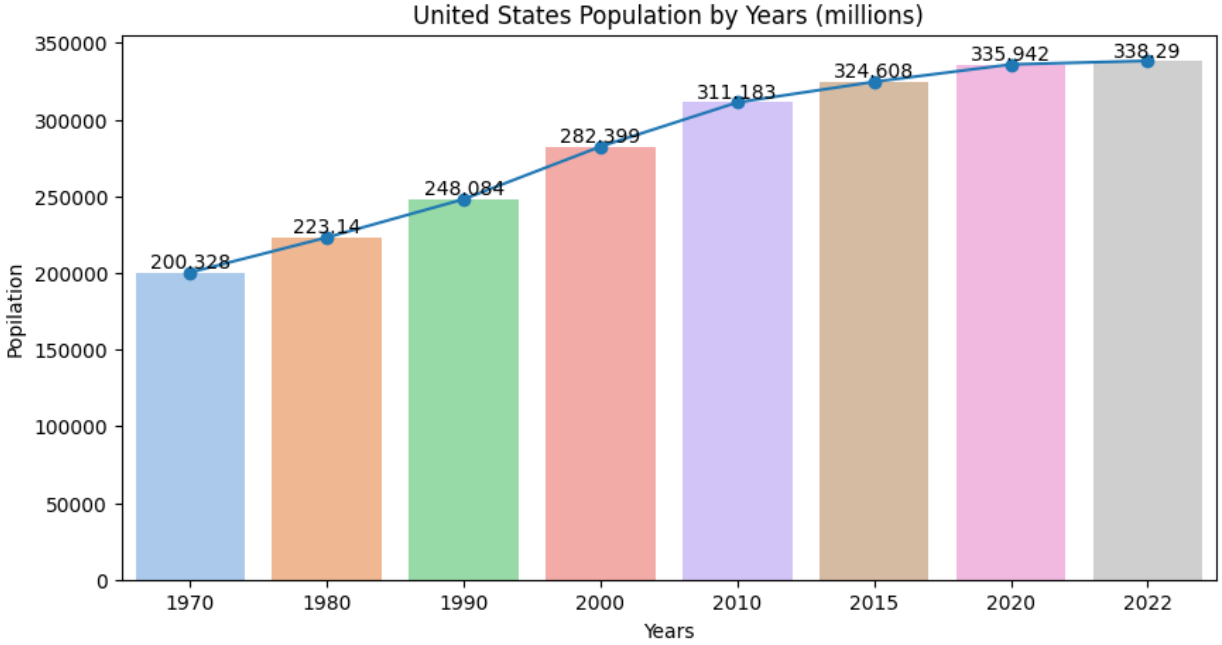
	CCA3	Name	2022	2020	2015	2010	2000	1990	1980	1970	Are (km
0	CHN	China	1425887	1424930	1393715	1348191	1264099	1153704	982372	822534	970696
1	IND	India	1417173	1396387	1322867	1240614	1059634	870452	696828	557501	328759
2	USA	United States	338290	335942	324608	311183	282399	248084	223140	200328	937261
3	IDN	Indonesia	275501	271858	259092	244016	214072	182160	148177	115228	190456
4	PAK	Pakistan	235825	227197	210969	194454	154370	115414	80624	59291	88191

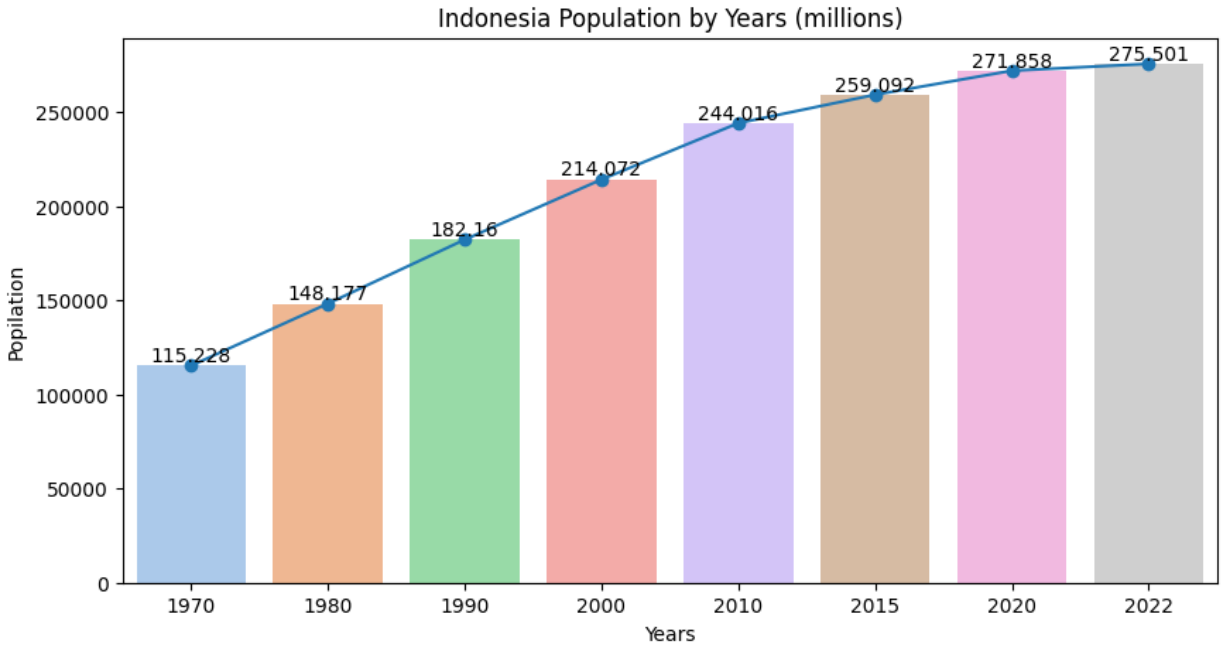
In [7]:

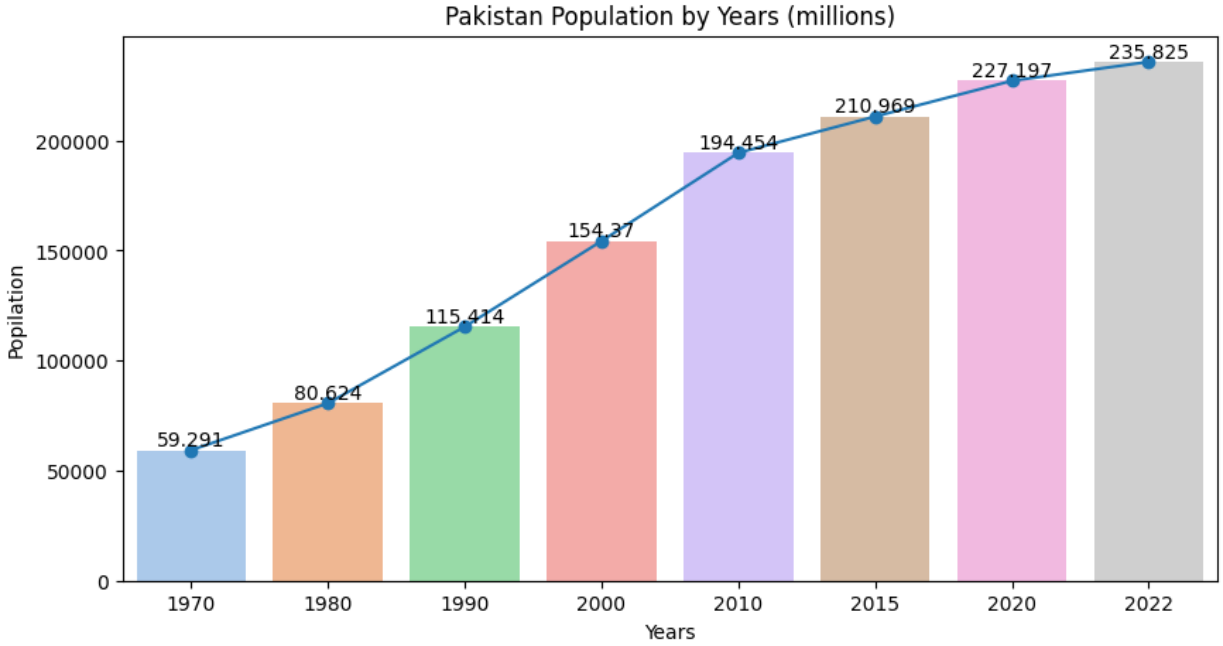
```
def plotting(df):
    for i in range(len(df.index)):
        country = df.iloc[i][2:10].sort_values()
        name = df.iloc[i][1]
        growth_rate = df.iloc[i][12]
        fig = plt.figure(figsize = (10, 5))
        ax = plt.plot(country,  '-o')
        ax = sns.barplot(x = country.index, y = country,  palette = 'pastel')
        ax.bar_label(ax.containers[0], fmt='%g', label_type = 'edge', labels = country
        plt.title(str(name)+' Population by Years (millions)')
        plt.xlabel('Years')
        plt.ylabel('Popilation')
        plt.show()
plotting(df.head())
```




India Population by Years (millions)
1e6
Popilation
Years
557,501
696,828
870,452
1059,634
1240,614
1322,867
1396,387
1417,173
1970
1980
1990
2000
2010
2015
2020
2022


United States Population by Years (millions)
Popilation
Years
200,328
223,14
248,084
282,399
311,183
324,608
335,942
338,29
1970
1980
1990
2000
2010
2015
2020
2022



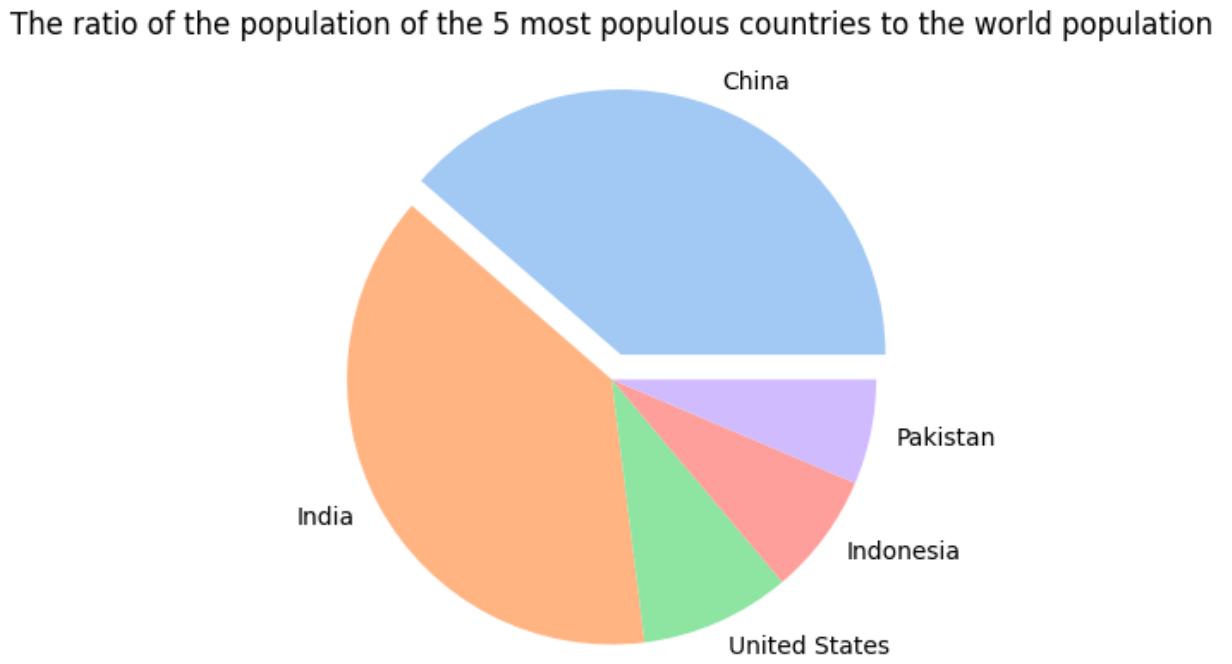


In [8]:
```
df_copy['World Population Percentage'] = df_copy['World Population Percentage'].str.re
df_copy['World Population Percentage'] = df_copy['World Population Percentage'].astype
df_copy.head()
```

Out[8]:

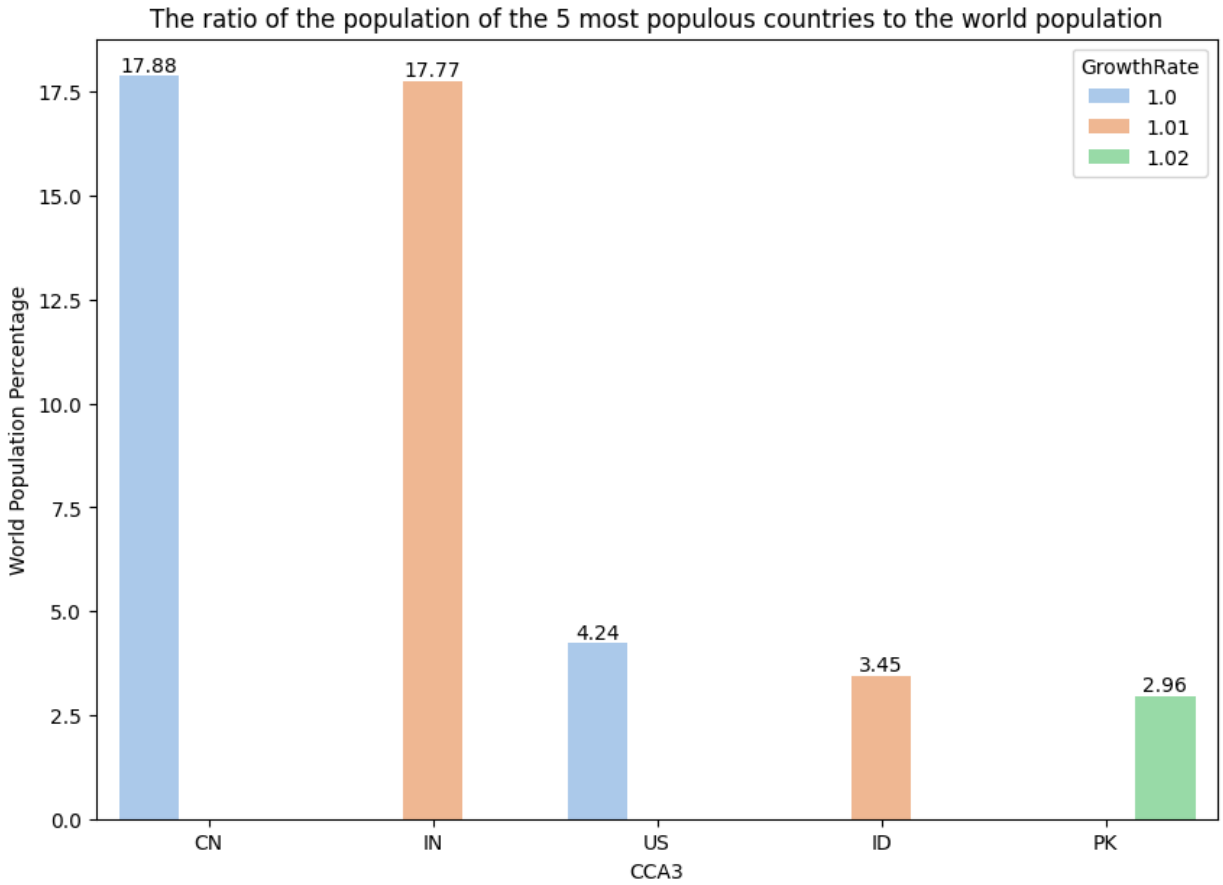
	CCA3	Name	2022	2020	2015	2010	2000	1990	1980	1970	Are (km
0	CN	China	1425887	1424930	1393715	1348191	1264099	1153704	982372	822534	970696
1	IN	India	1417173	1396387	1322867	1240614	1059634	870452	696828	557501	328759
2	US	United States	338290	335942	324608	311183	282399	248084	223140	200328	937261
3	ID	Indonesia	275501	271858	259092	244016	214072	182160	148177	115228	190456
4	PK	Pakistan	235825	227197	210969	194454	154370	115414	80624	59291	88191

In [9]:
```
fig = plt.figure(figsize = (7,5))
explode = [0.1, 0, 0, 0, 0]
ax = plt.pie(df_copy['World Population Percentage'][:5], labels = df_copy['Name'][:5],
plt.title('The ratio of the population of the 5 most populous countries to the world p
plt.show()
```



In [10]:
```
fig = plt.figure(figsize = (10,7))
ax = sns.barplot(x = df_copy['CCA3'][:5], y = df_copy['World Population Percentage'][:
for i in range(len(ax.containers)):
    ax.bar_label(ax.containers[i], fmt='%g', label_type = 'edge')

plt.title('The ratio of the population of the 5 most populous countries to the world p
plt.show()
```



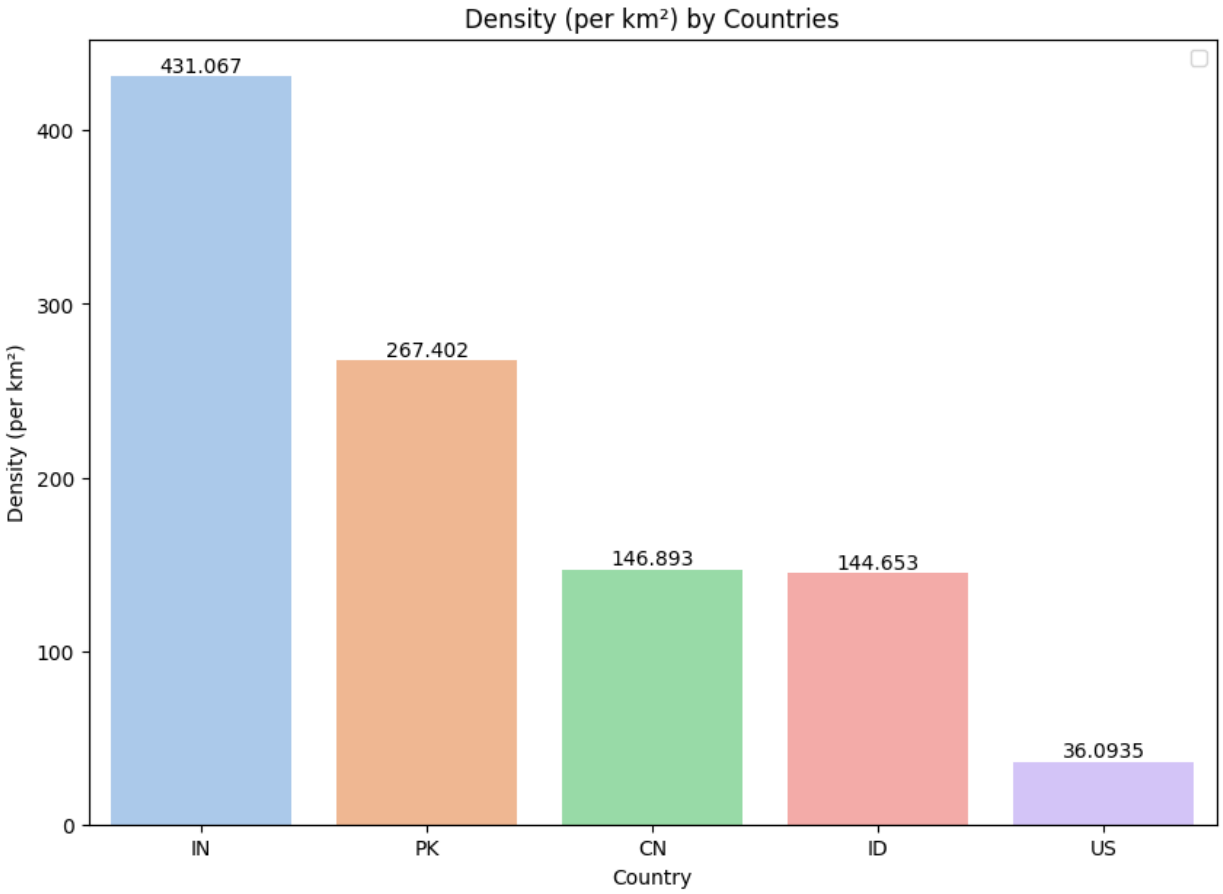
In [11]:
```
df_copy[:5].sort_values(['Density (per km²)'])
```

Out[11]:

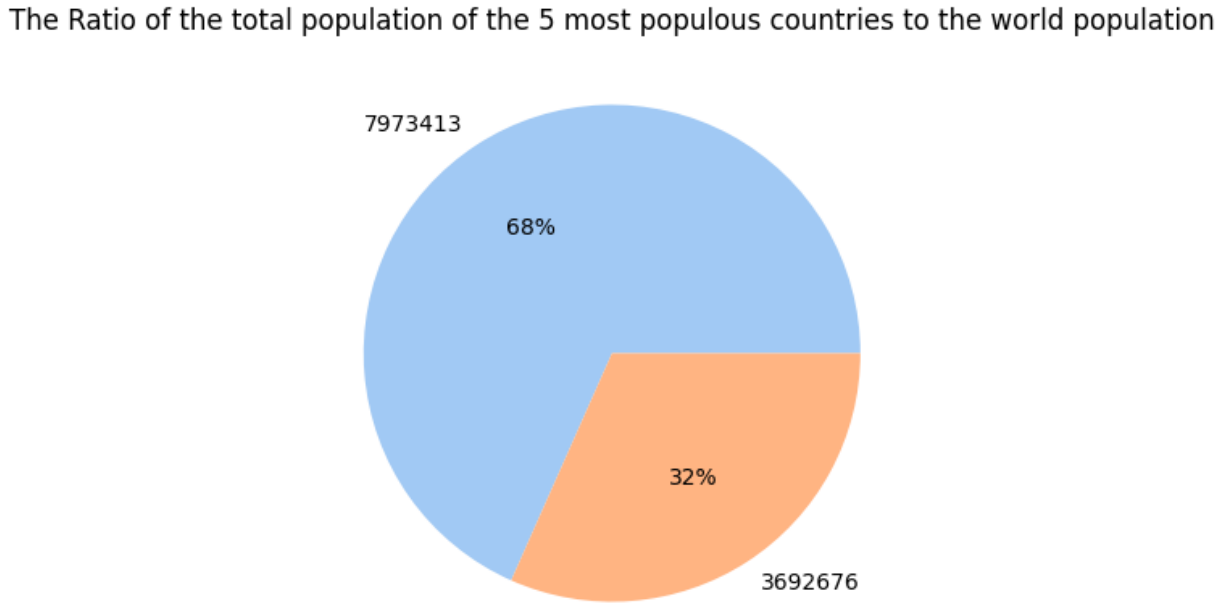
	CCA3	Name	2022	2020	2015	2010	2000	1990	1980	1970	Are (km
2	US	United States	338290	335942	324608	311183	282399	248084	223140	200328	937261
3	ID	Indonesia	275501	271858	259092	244016	214072	182160	148177	115228	190456
0	CN	China	1425887	1424930	1393715	1348191	1264099	1153704	982372	822534	970696
4	PK	Pakistan	235825	227197	210969	194454	154370	115414	80624	59291	88191
1	IN	India	1417173	1396387	1322867	1240614	1059634	870452	696828	557501	328759

In [12]:
```
destiny = df_copy[:5].sort_values(['Density (per km²)'], ascending = False)
fig = plt.figure(figsize = (10,7))
ax = sns.barplot(x = destiny['CCA3'] , y = destiny['Density (per km²)'],
            palette = 'pastel')
ax.bar_label(ax.containers[0])
plt.title('Density (per km²) by Countries')
plt.xlabel('Country')
plt.legend()
plt.show()
```

```
No artists with labels found to put in legend.  Note that artists whose label start w
ith an underscore are ignored when legend() is called with no argument.
```



In [13]:
```
liste = [df_copy['2022'].sum(), df_copy['2022'][:5].sum()]
palette_color = sns.color_palette('pastel')
fig = plt.figure(figsize = (7,5))
explode = [0, 0]
ax = plt.pie(liste, labels = liste, colors=palette_color, explode=explode, autopct='%.
plt.xticks(rotation=45)
plt.title('The Ratio of the total population of the 5 most populous countries to the w
plt.show()
```



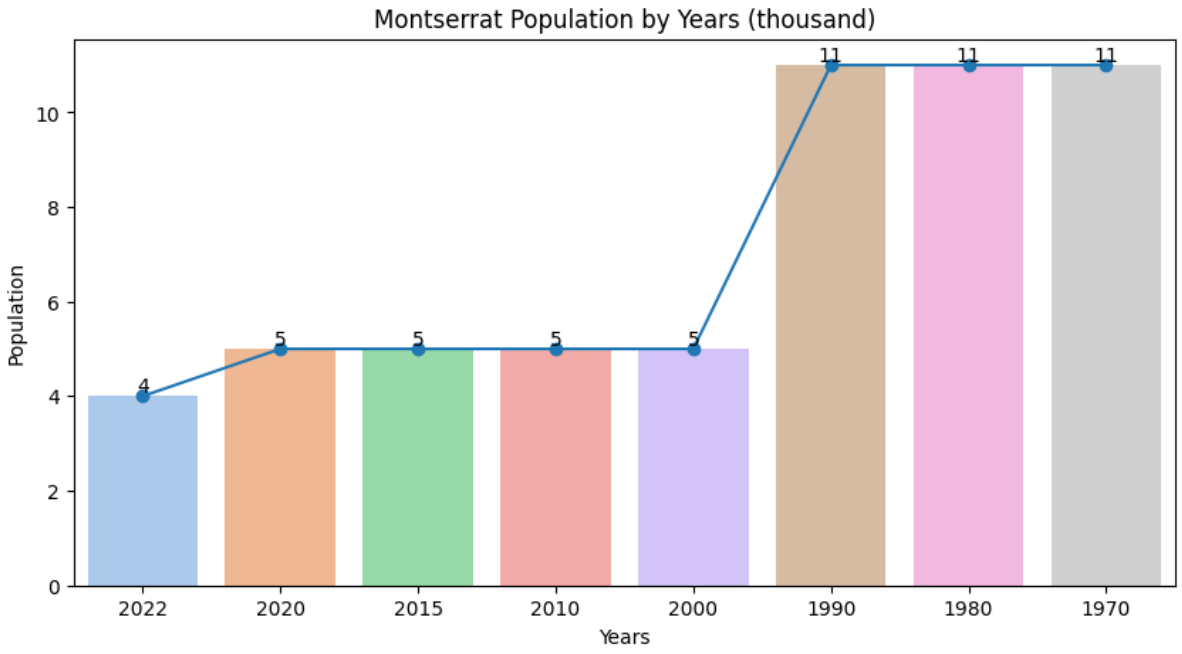
5 countries with the least population

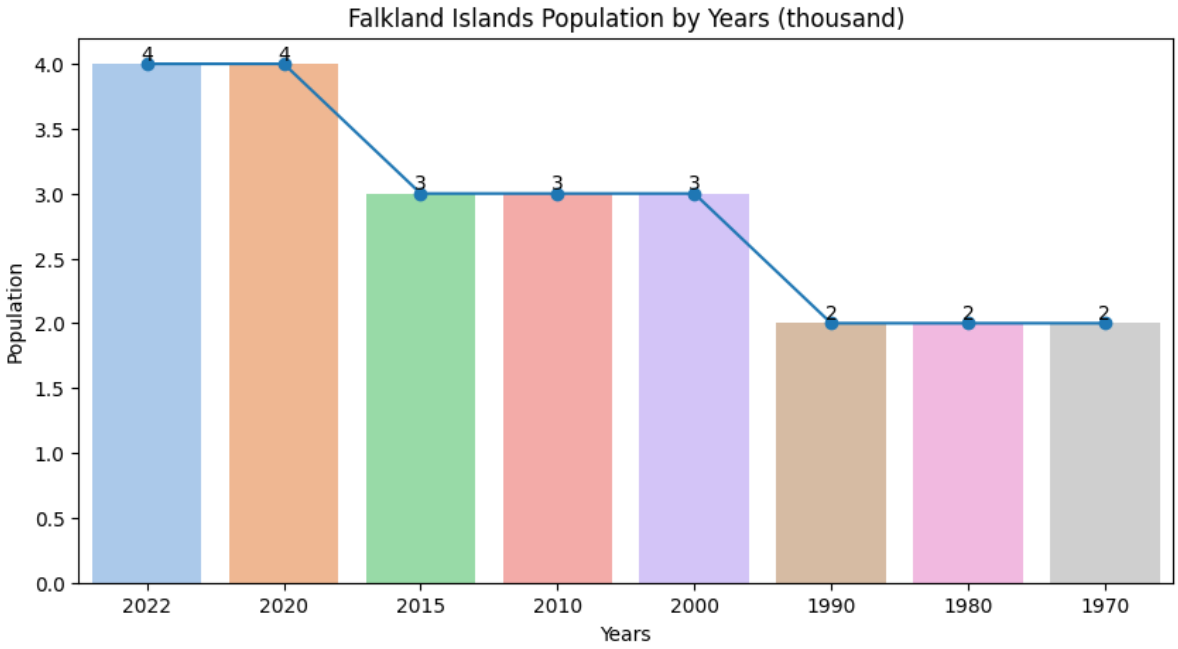
In [14]:
```
df_copy.tail()
```

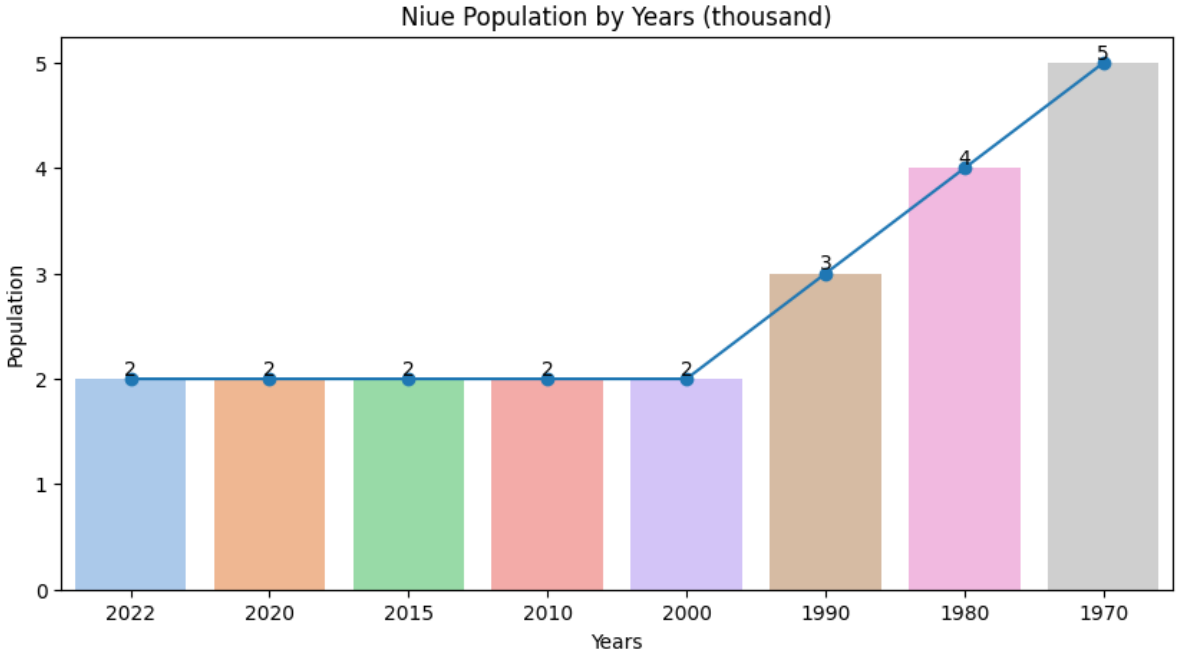
Out[14]:

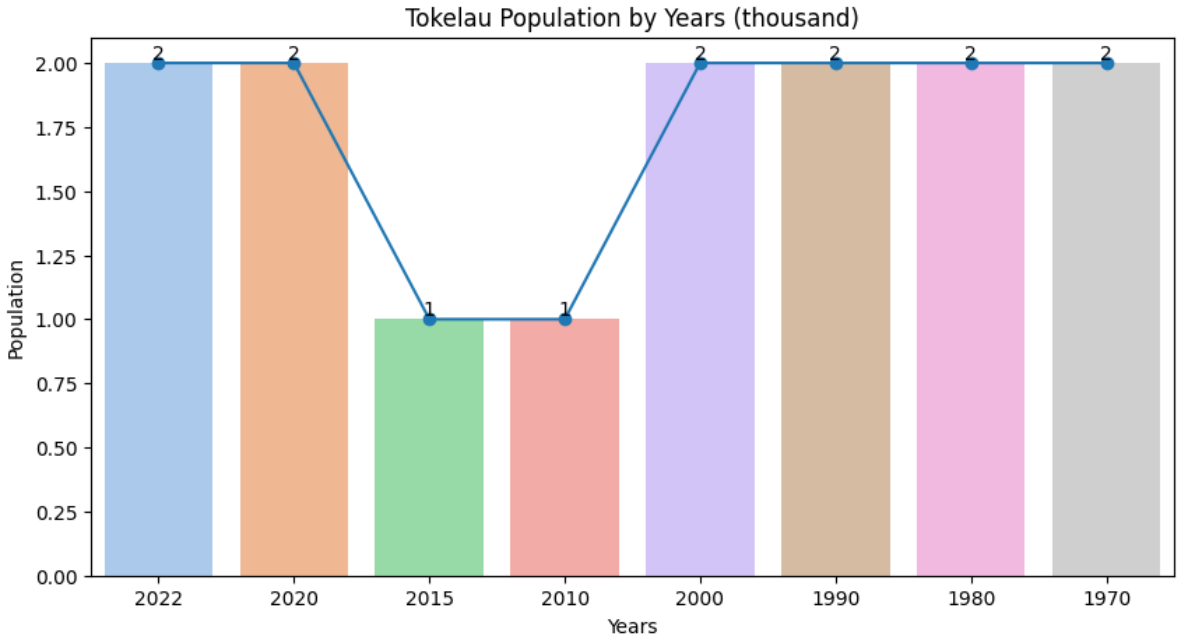
	CCA3	Name	2022	2020	2015	2010	2000	1990	1980	1970	Area (km²)	Density (per km²)	Growth
229	MS	Montserrat	4	5	5	5	5	11	11	11	102	43.0392	
230	FK	Falkland Islands	4	4	3	3	3	2	2	2	12173	0.3105	
231	NU	Niue	2	2	2	2	2	3	4	5	260	7.4385	
232	TK	Tokelau	2	2	1	1	2	2	2	2	12	155.9167	
233	VA	Vatican City	1	1	1	1	1	1	1	1	1	510.0000	

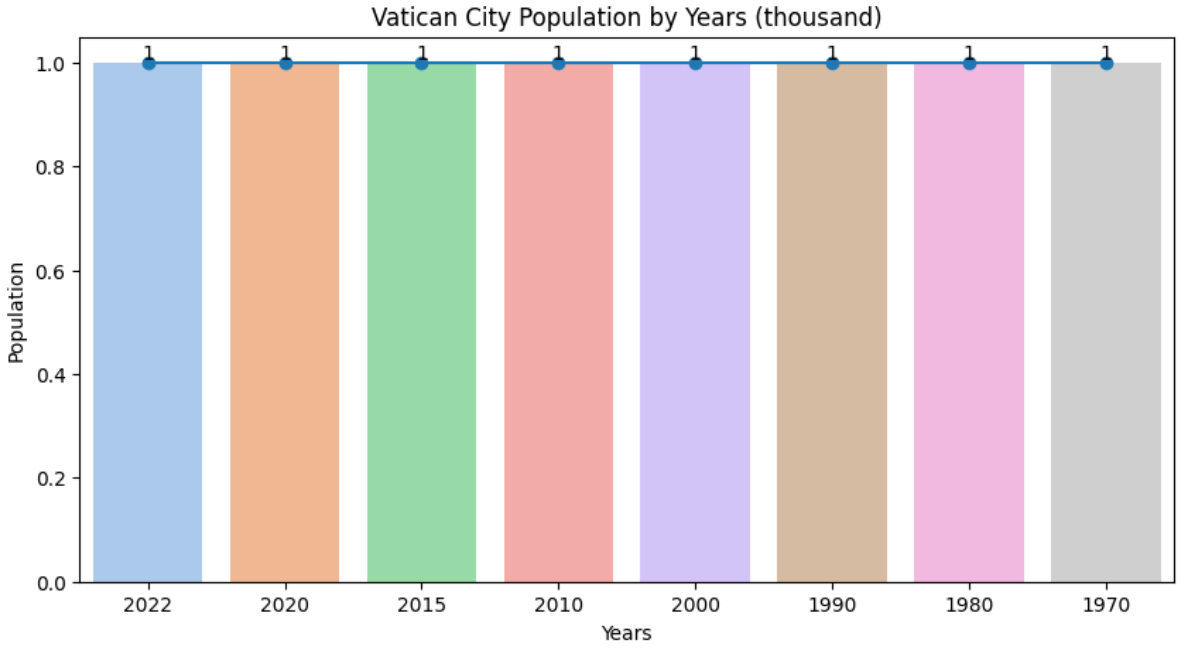
In [15]:
```
def plottting2(df):
    for i in range(len(df.index)):
        country = df.iloc[i][2:10]
        name = df.iloc[i][1]
        growth_rate = df.iloc[i][12]
        fig = plt.figure(figsize = (10, 5))
        ax = plt.plot(country,  '-o')
        ax = sns.barplot(x = country.index, y = country,  palette = 'pastel')
        ax.bar_label(ax.containers[0], fmt='%g', label_type = 'edge', labels = country
        plt.title(str(name)+' Population by Years (thousand)')
        plt.xlabel('Years')
        plt.ylabel('Population')
        plt.show()
plottting2(df_copy.tail())
```




Falkland Islands Population by Years (thousand)
Population
Years
2022
2020
2015
2010
2000
1990
1980
1970
4
4
3
3
3
2
2
2

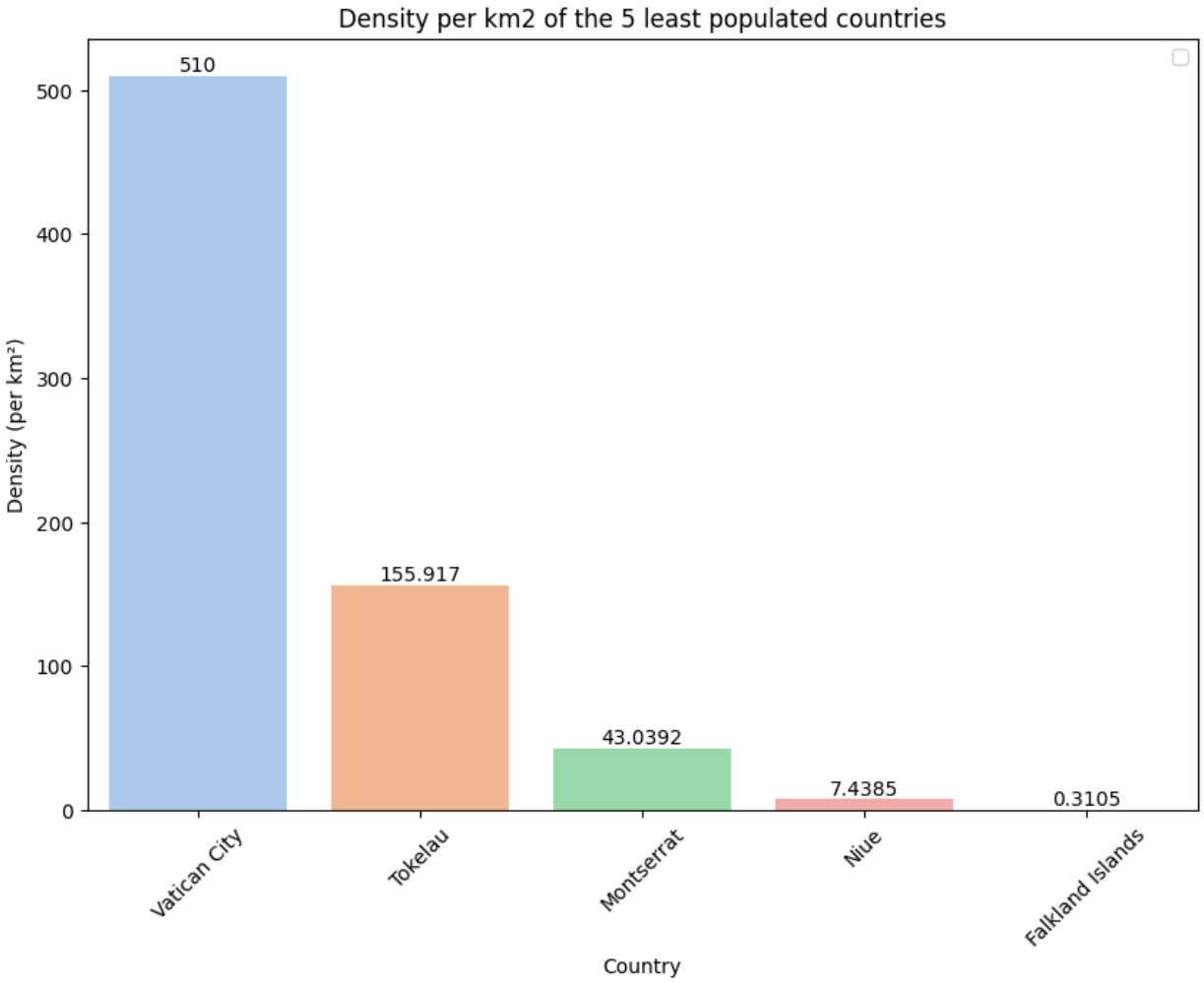

Niue Population by Years (thousand)
Population
Years
2022
2020
2015
2010
2000
1990
1980
1970
2
2
2
2
2
3
4
5



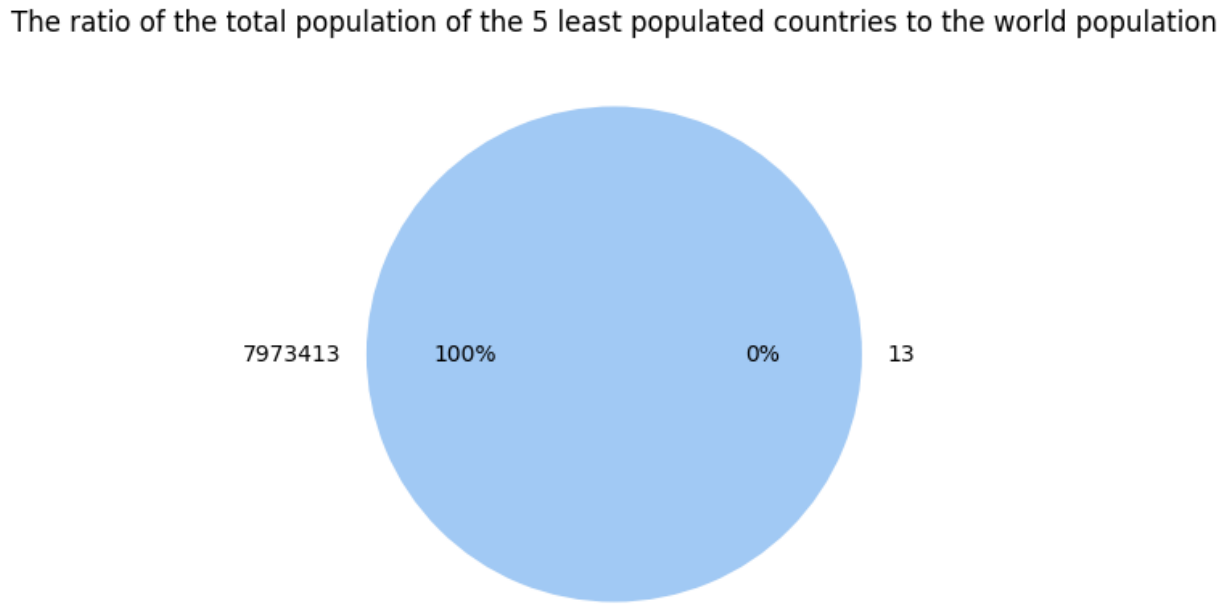


In [16]:
```
destiny = df_copy.tail().sort_values(['Density (per km²)'], ascending = False)
fig = plt.figure(figsize = (10,7))
ax = sns.barplot(x = destiny['Name'] , y = destiny['Density (per km²)'],
            palette = 'pastel')
ax.bar_label(ax.containers[0])
plt.xticks(rotation=45)
plt.title('Density per km2 of the 5 least populated countries')
plt.xlabel('Country')
plt.legend()
plt.show()
```

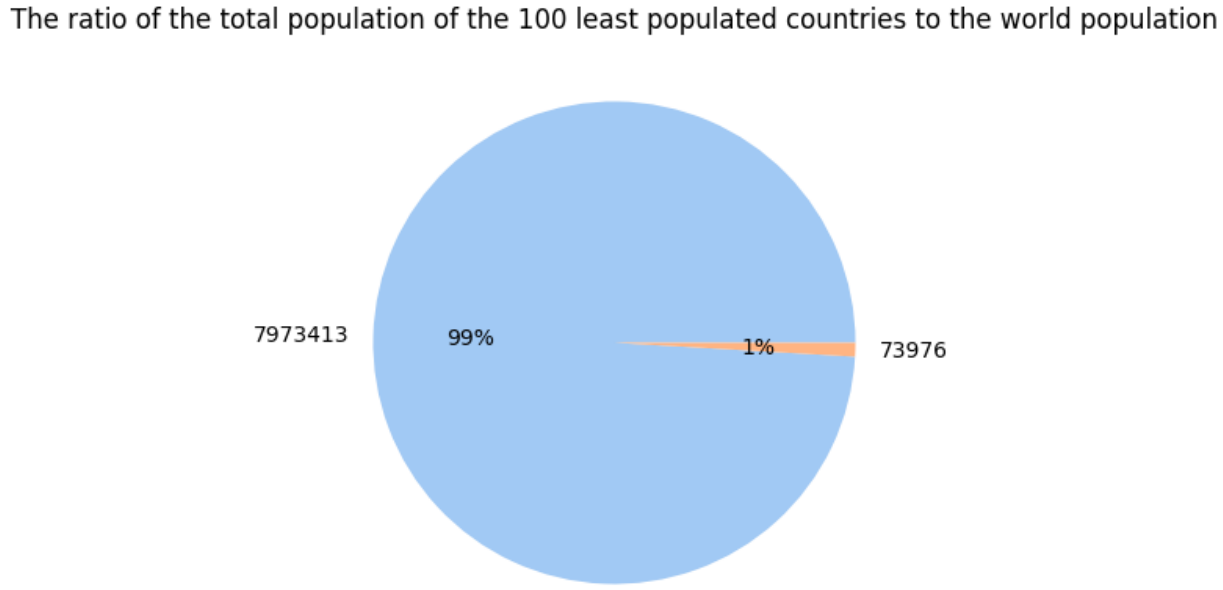
```
No artists with labels found to put in legend.  Note that artists whose label start w
ith an underscore are ignored when legend() is called with no argument.
```



In [17]:
```
liste = [df_copy['2022'].sum(), df_copy['2022'].tail().sum()]
fig = plt.figure(figsize = (7,5))
explode = [0, 0]
ax = plt.pie(liste, labels = liste, colors=sns.color_palette('pastel'), explode=explod
plt.xticks(rotation=45)
plt.title('The ratio of the total population of the 5 least populated countries to the
plt.show()
```



In [18]:
```
# I added the least 100 because the least 5 took almost 0%
liste = [df_copy['2022'].sum(), df_copy['2022'].tail(100).sum()]
fig = plt.figure(figsize = (7,5))
explode = [0, 0]
ax = plt.pie(liste, labels = liste, colors=sns.color_palette('pastel'), explode=explod
plt.xticks(rotation=45)
plt.title('The ratio of the total population of the 100 least populated countries to t
plt.show()
```



5 countries with the highest density and 5 countries with the lowest density

In [19]:
```
df2 = df.sort_values(by = 'Density (per km²)', ascending = False)
df2
```

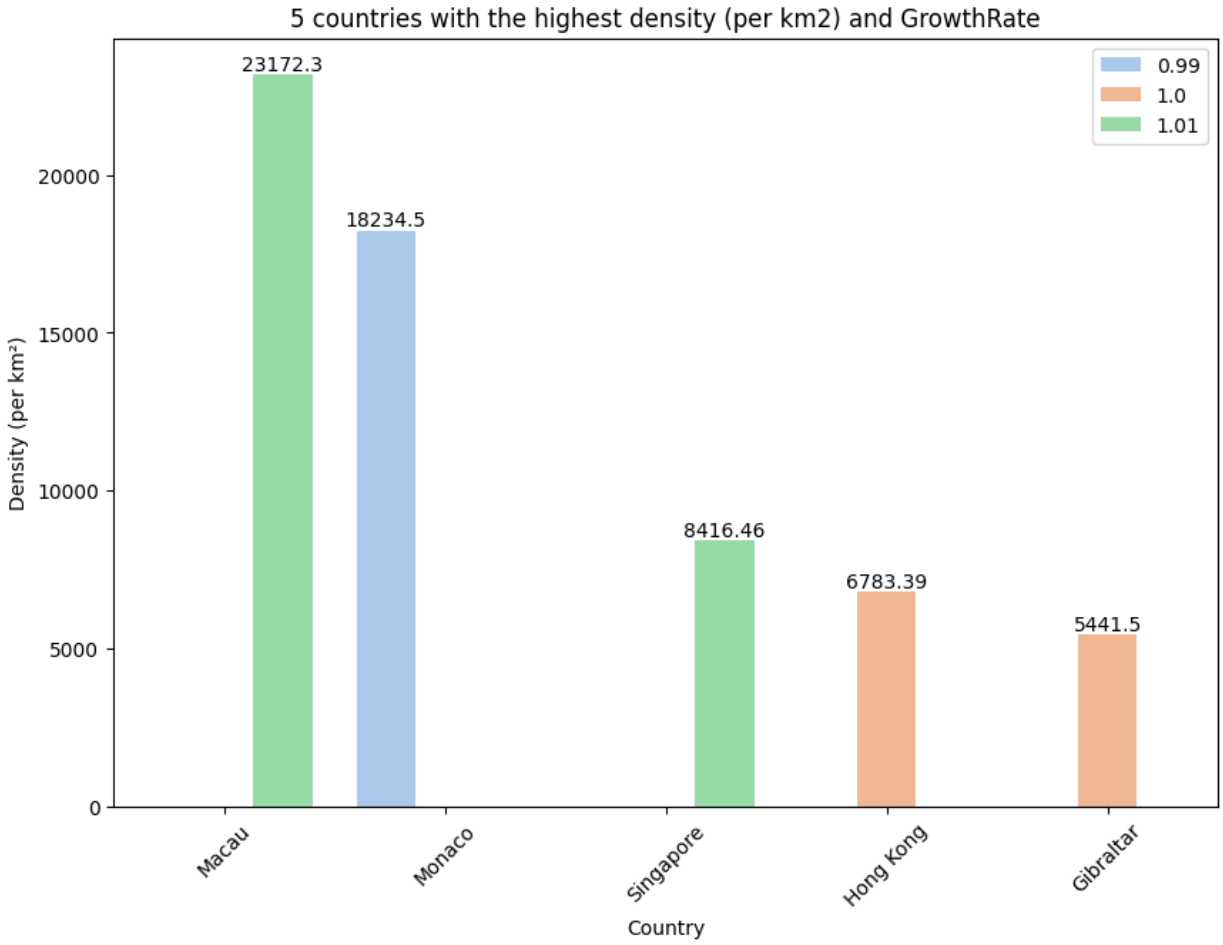
Out[19]:

	CCA3	Name	2022	2020	2015	2010	2000	1990	1980	1970	Area (km²)	Density (per km²)	Gro
166	MAC	Macau	695	676	615	557	432	350	245	247	30	23172.2667	
216	MCO	Monaco	36	37	37	33	32	30	27	24	2	18234.5000	
112	SGP	Singapore	5976	5910	5650	5164	4054	3022	2401	2062	710	8416.4634	
103	HKG	Hong Kong	7489	7501	7400	7132	6731	5839	4979	3955	1104	6783.3922	
218	GIB	Gibraltar	33	33	33	31	28	27	29	27	6	5441.5000	
...	...	...	...	...	...	...	...	...	...	...	...	...	
144	NAM	Namibia	2567	2489	2283	2099	1819	1369	976	754	825615	3.1092	
133	MNG	Mongolia	3398	3294	2965	2703	2451	2161	1698	1294	1564110	2.1727	
171	ESH	Western Sahara	576	556	492	413	270	179	117	76	266000	2.1654	
230	FLK	Falkland Islands	4	4	3	3	3	2	2	2	12173	0.3105	
207	GRL	Greenland	56	56	56	56	56	56	50	45	2166086	0.0261	

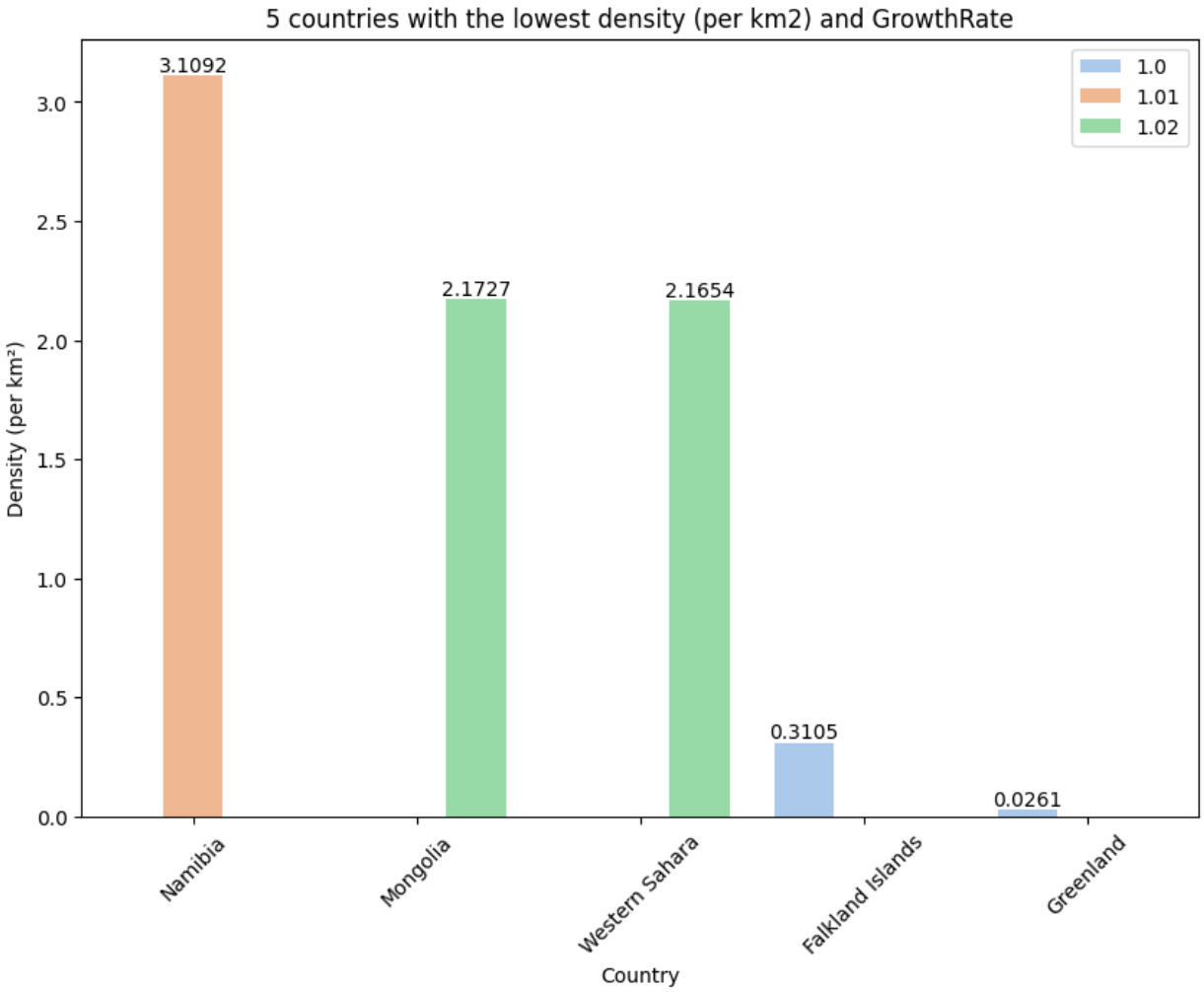
234 rows × 15 columns

In [20]:

```
fig = plt.figure(figsize = (10,7))
ax = sns.barplot(x = df2['Name'][:5] , y = df2['Density (per km²)'][:5],
            palette = 'pastel', hue = df2['GrowthRate'][:5])
ax.bar_label(ax.containers[0])
ax.bar_label(ax.containers[1])
ax.bar_label(ax.containers[2])
plt.xticks(rotation=45)
plt.title('5 countries with the highest density (per km2) and GrowthRate')
plt.xlabel('Country')
plt.legend(loc = 1)
plt.show()
```



In [21]:
```
fig = plt.figure(figsize = (10,7))
ax = sns.barplot(x = df2['Name'][-5:] , y = df2['Density (per km²)'][-5:],
            palette = 'pastel', hue = df2['GrowthRate'][-5:])
ax.bar_label(ax.containers[0])
ax.bar_label(ax.containers[1])
ax.bar_label(ax.containers[2])
plt.xticks(rotation=45)
plt.title('5 countries with the lowest density (per km2) and GrowthRate')
plt.xlabel('Country')
plt.legend( loc = 'upper right')
plt.show()
```

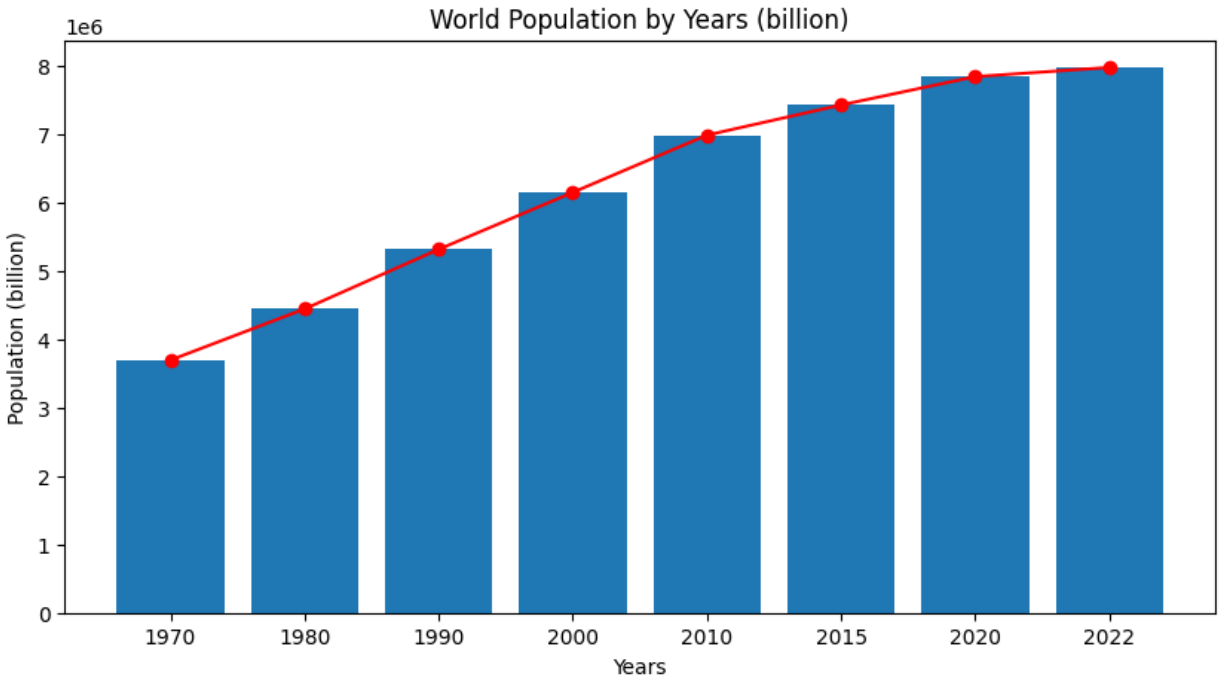


Total of the world population

In [22]:
```
total = df_copy[['1970', '1980', '1990', '2000', '2010', '2015', '2020', '2022']].sum(
total
```

Out[22]:
```
1970    3694129
1980    4442407
1990    5314196
2000    6147055
2010    6983783
2015    7424808
2020    7839255
2022    7973413
dtype: int64
```

In [23]:
```
plt.figure(figsize = (10, 5))
plt.plot(total,  '-o', color='red')
plt.bar(x = total.index, height = total)
#plt.fill_between(x = total.index, y1 = total)
plt.title('World Population by Years (billion)')
plt.ylabel('Population (billion)')
plt.xlabel('Years')
plt.show()
```


World Population by Years (billion)
1e6
Population (billion)
0
1
2
3
4
5
6
7
8
1970
1980
1990
2000
2010
2015
2020
2022
Years