worldPopAnalysis

February 11, 2024

1 MSDS 670 Midterm Project

Wiley Winters Regis University Anderson College of Business and Computing MSDS 670 Data Visualization Mr. John Koenig Febrary 11, 2024 ### Research Question: *Do birth and death rates affect total population in the top ten economies?*

Load required packages and libraries

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np

#
# Pandas has not been playing nice with this project
# Adding options to display numbers in float format
# and supress warnings on copy on write functions,
#
pd.options.display.float_format = '{:.0f}'.format
pd.options.mode.copy_on_write = True
#
# Make plots pretty
#
plt.style.use('ggplot')
```

Define path names

[2]:
```
homeDir = '/home/wiley/regis/dataScience/msds670'
data = homeDir+'/MidTermProject/MSDS-670-MidTerm-Project/data/
 ↪worldPopulationData.csv'
images = homeDir+'/MidTermProject/MSDS-670-MidTerm-Project/images/'
```

Load dataset into a dataframe and rename columns

[3]:
```
# Do not like the column names supplied by Data Bank.  Using shorter column␣
 ↪names
# to avoid confusion
columns = ['country','cntry_code','series','series_code','1960','1965','1970',
```

```
 ↪'1975','1980','1985','1990','1995','2000','2005','2010','2015','2020',
          '2022','2023','2024']
world_df = pd.read_csv(data, skiprows=1, names=columns,
                       na_values='..')
```

1.1 Basic EDA

[4]:
```
world_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 50 entries, 0 to 49
Data columns (total 20 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   country      50 non-null     object
 1   cntry_code   50 non-null     object
 2   series       50 non-null     object
 3   series_code  50 non-null     object
 4   1960         40 non-null     float64
 5   1965         50 non-null     float64
 6   1970         50 non-null     float64
 7   1975         50 non-null     float64
 8   1980         50 non-null     float64
 9   1985         50 non-null     float64
 10  1990         50 non-null     float64
 11  1995         50 non-null     float64
 12  2000         50 non-null     float64
 13  2005         50 non-null     float64
 14  2010         50 non-null     float64
 15  2015         50 non-null     float64
 16  2020         50 non-null     float64
 17  2022         30 non-null     float64
 18  2023         20 non-null     float64
 19  2024         20 non-null     float64
dtypes: float64(16), object(4)
memory usage: 7.9+ KB
```

[5]:
```
world_df.head(10)
```

[5]:

	country	cntry_code	series	series_code	\
0	Brazil	BRA	Birth rate, crude (per 1,000 people)	SP.DYN.CBRT.IN	
1	Brazil	BRA	Death rate, crude (per 1,000 people)	SP.DYN.CDRT.IN	
2	Brazil	BRA	Population ages 65 and above, total	SP.POP.65UP.TO	
3	Brazil	BRA	Population growth (annual %)	SP.POP.GROW	
4	Brazil	BRA	Population, total	SP.POP.TOTL	

```
5  Canada        CAN  Birth rate, crude (per 1,000 people)  SP.DYN.CBRT.IN
6  Canada        CAN  Death rate, crude (per 1,000 people)  SP.DYN.CDRT.IN
7  Canada        CAN   Population ages 65 and above, total  SP.POP.65UP.TO
8  Canada        CAN          Population growth (annual %)     SP.POP.GROW
9  Canada        CAN                       Population, total     SP.POP.TOTL

      1960     1965     1970      1975      1980      1985      1990  \
0       44       40       36        33        32        29        25
1       14       12       11        10         9         8         7
2  1921246  2437203  3066987   3795103   4642501   5558148   6729875
3      NaN        3        2         2         2         2         2
4 73092515 84623747 96369875 108700515 122288383 136783180 150706446
5       27       21       17        16        15        15        15
6        8        8        7         7         7         7         7
7  1373988  1519291  1702610   1960638   2302843   2644549   3108392
8      NaN        2        1         1         1         1         2
9 17909356 19678000 21324000  23143275  24515667  25842116  27691138

       1995      2000      2005      2010      2015      2020      2022  \
0        22        20        17        15        15        13       NaN
1         7         6         6         6         6         7       NaN
2   8134166   9679708  11461295  13563871  16222681  19807547  21265888
3         2         1         1         1         1         1         0
4 163515328 175873720 186797334 196353492 205188205 213196304 215313498
5        13        11        11        11        11        10       NaN
6         7         7         7         7         7         8       NaN
7   3493208   3831961   4190005   4782333   5715697   6848293   7410039
8         1         1         1         1         1         1         2
9  29302311  30685730  32243753  34004889  35702908  38007166  38929902

       2023      2024
0       NaN       NaN
1       NaN       NaN
2  22101851  23039580
3       NaN       NaN
4 216422446 217637297
5       NaN       NaN
6       NaN       NaN
7   7670567   7932928
8       NaN       NaN
9  39244168  39555364
```

[6]:
```
world_df.isna().sum()
```

[6]:
```
country         0
cntry_code      0
series          0
```

```
series_code     0
1960           10
1965            0
1970            0
1975            0
1980            0
1985            0
1990            0
1995            0
2000            0
2005            0
2010            0
2015            0
2020            0
2022           20
2023           30
2024           30
dtype: int64
```

1.2 Some basic data cleaning

The columns `cntry_code`, `series`, and `series_code` are not required for this study. `1960` column contained some null values in the % growth series. There is not enough data to extrapulate their values so I will just drop it. Should not make too much of a difference on the final product

[7]:
```
world_df.drop(['cntry_code','series','series_code'], inplace=True, axis=1)
```

1.3 Do some work

The format of the dataset is different from other timeseries studies I've worked with. The first four columns are the country's name and country code. The next two are the series and the series code. Rest of the columns are the years and values being studied.

Due to the number of plots to be created, I will make a list of countries in this study. The list is in order from the largest GDP to the lowest of the top ten economies.

[8]:
```
countries = ['United States','China','Germany','Japan','India','United Kingdom',
             'France','Italy','Brazil','Canada']
```

1.3.1 Define Functions

[9]:
```
# Function to create dataframes based on country, then drop
# column that is not used.
# Accepts country name and returns the country datafram (series)
def formatSeries(country):
    cntry = world_df[world_df['country'] == country]
    cntry.drop('country', inplace=True, axis=1)
    return cntry
```

[10]:
```
# Funtion to scale population data by millions.
# Accepts the population number and returns a scaled
# version of it
def scalePopulation(population):
    scaled = population.apply(lambda x: x/1000000)
    return scaled
```

[11]:
```
# Function to plot birth and death rates for each country
# Accepts country name, but does not return anything
def plotBirthDeath(country):
    cntry = formatSeries(country)
    birth = cntry.iloc[0]
    death = cntry.iloc[1]
    plt.figure(figsize=(10,6))
    title = 'Birth and Death Rates per 1000 ('+country+')'
    plt.title(title)
    plt.xlabel('Year')
    plt.ylabel('Rate/1000')
    plt.plot(birth, color='darkorange', label='Births', marker='o')
    plt.plot(death, color='blue', label='Deaths', marker='o')
    plt.legend()
    plt.plot()
    if country == 'United States':
        fileName = images+'usBirthDeathRate.png'
    elif country == 'United Kingdom':
        fileName = images+'ukBirthDeathRate.png'
    else:
        fileName = images+country+'BirthDeathRate.png'
    plt.savefig(fileName, format='png')
```

[12]:
```
# Function to plot the over 65 population of a country
# Accepts country name, but does not return anything
def plotOver65(country):
    cntry = formatSeries(country)
    over65 = cntry.iloc[2]
    total = cntry.iloc[4]
    # Scale populations to make graph easier to read
    over65_scaled = scalePopulation(over65)
```

```
    total_scaled = scalePopulation(total)
    plt.figure(figsize=(10,6))
    title = 'Total Population and Over 65 ('+country+')'
    plt.title(title)
    plt.xlabel('Year')
    plt.ylabel('Population in Millions')
    plt.plot(over65_scaled, color='black', label='Over 65', marker='o')
    plt.plot(total_scaled, color='blue', label='Total', marker='o')
    plt.legend()
    plt.plot()
    if country == 'United States':
        fileName = images+'usTotalandOver65.png'
    elif country == 'United Kingdom':
        fileName = images+'ukTotalandOver65.png'
    else:
        fileName = images+country+'TotalandOver65.png'
    plt.savefig(fileName, format='png')
```

[13]:
```
# Function to plot growth in percent
# Accepts country name and returns nothing
def plotGrowth(country):
    cntry = formatSeries(country)
    growth = cntry.iloc[3]
    plt.figure(figsize=(10,6))
    title = 'Growth in Percent ('+country+')'
    plt.title(title)
    plt.xlabel('Year')
    plt.ylabel('Percent of Growth')
    plt.plot(growth, color='black', label='Over 65', marker='o')
    plt.legend()
    plt.plot()
    if country == 'United States':
        fileName = images+'usGrowthPercent.png'
    elif country == 'United Kingdom':
        fileName = images+'ukGrowthPercent.png'
    else:
        fileName = images+country+'GrowthPercent.png'
    plt.savefig(fileName, format='png')
```

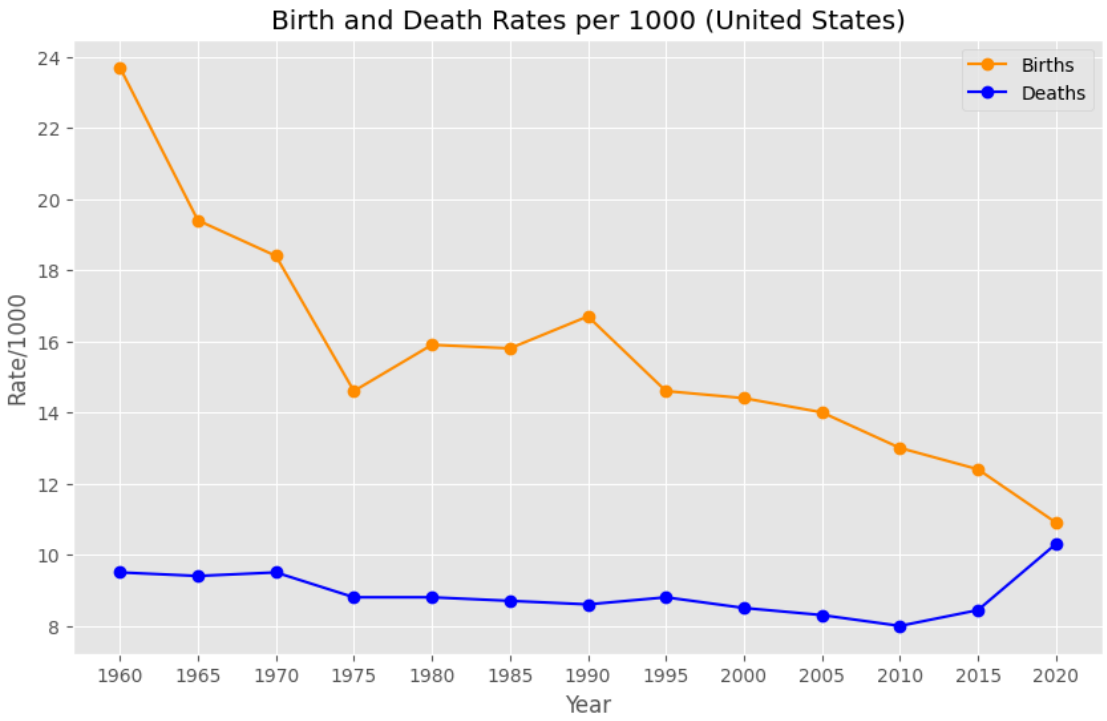
[14]:
```
# Function to extract the different series from the countries dataframe
# Accepts country name and returns series: birth, death, over65, and total
def getIndividual(country):
    cntry = formatSeries(country)
    birth = cntry.iloc[0]
    death = cntry.iloc[1]
    over65 = cntry.iloc[2]
    growth = cntry.iloc[3]
```

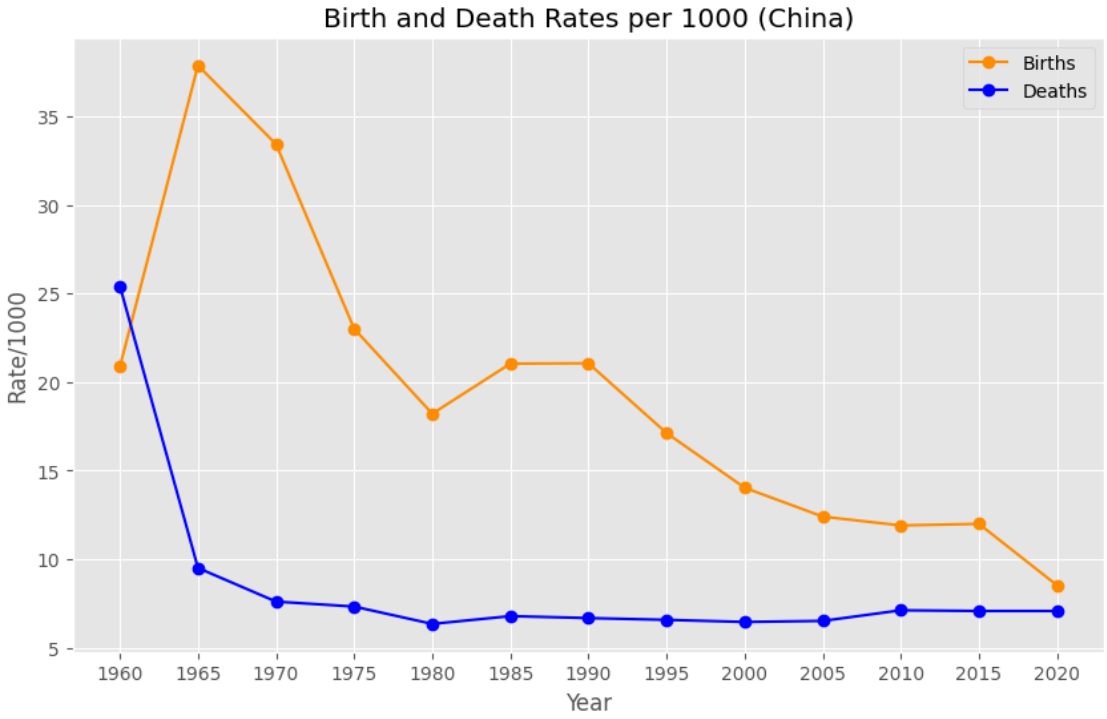
```
    total = cntry.iloc[4]
    return birth, death, over65, growth, total
```

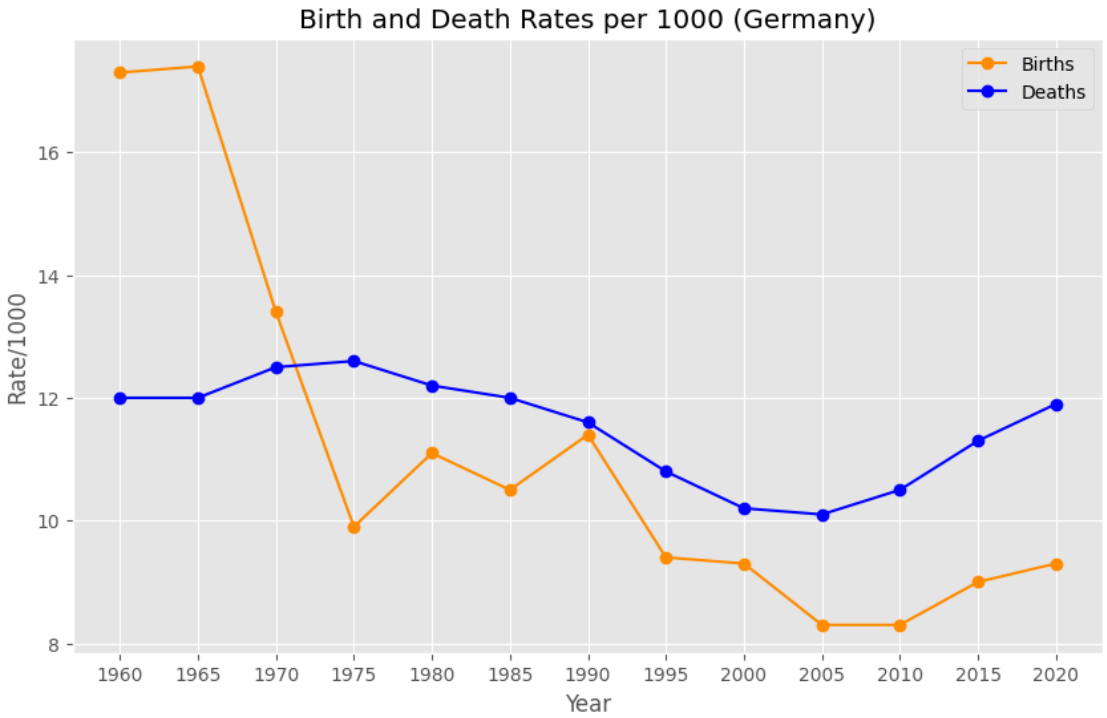
1.3.2 Create individual plots

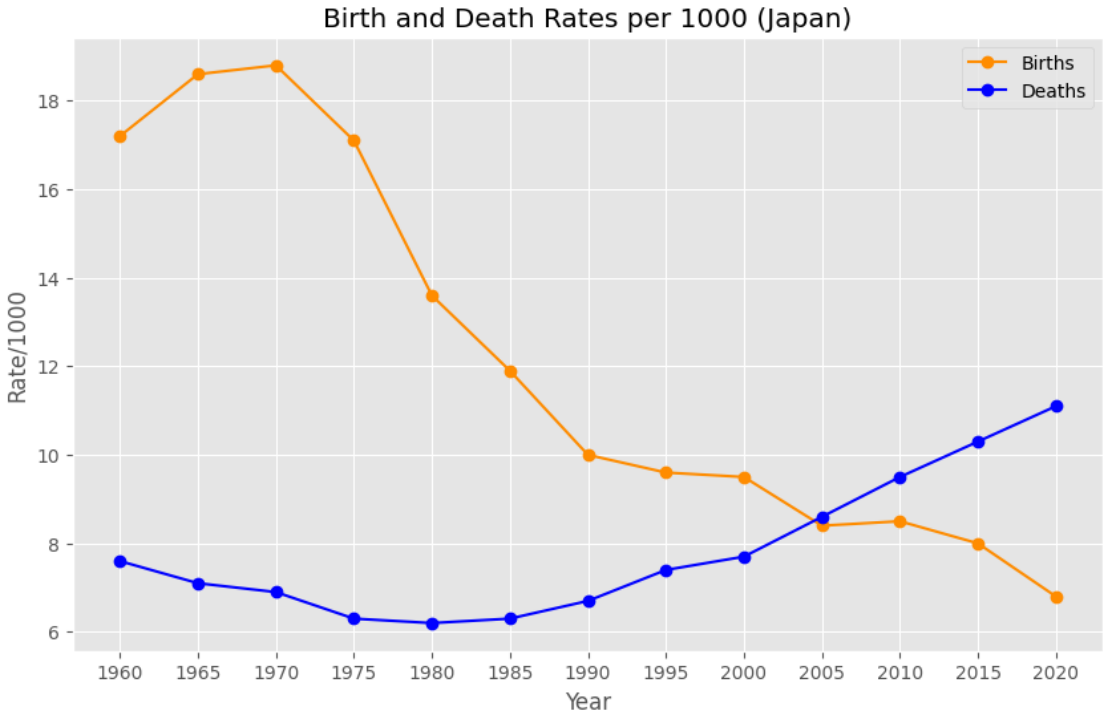
Plot birth and death rates

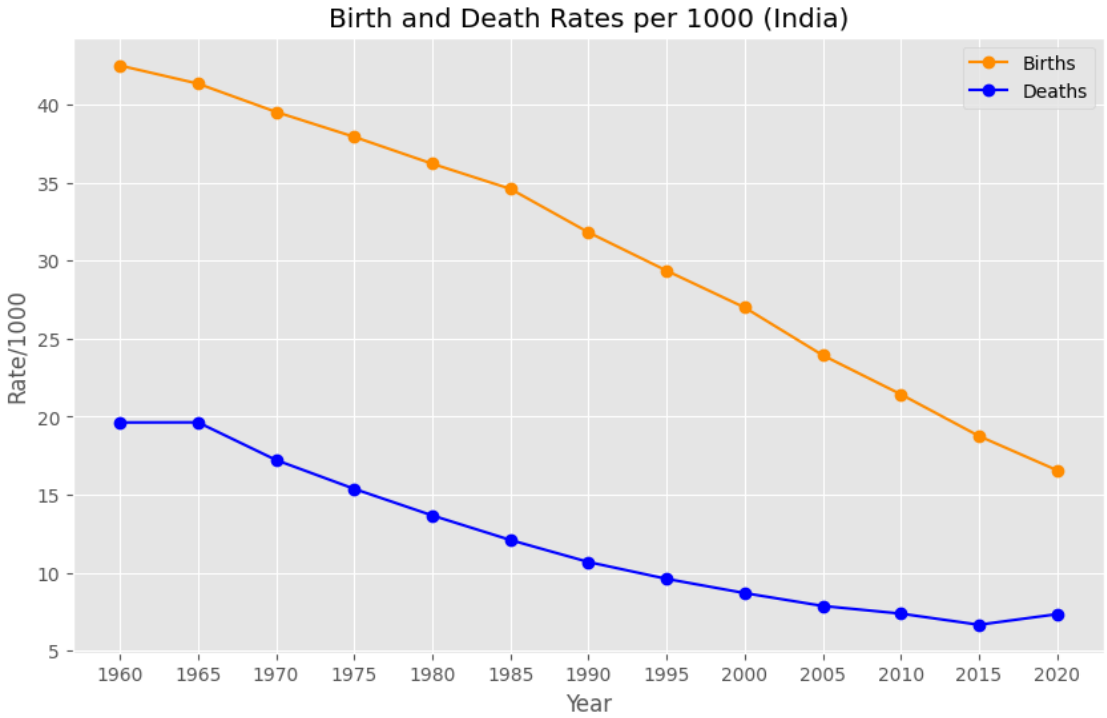
[15]:
```
for country in countries:
    plotBirthDeath(country)
```

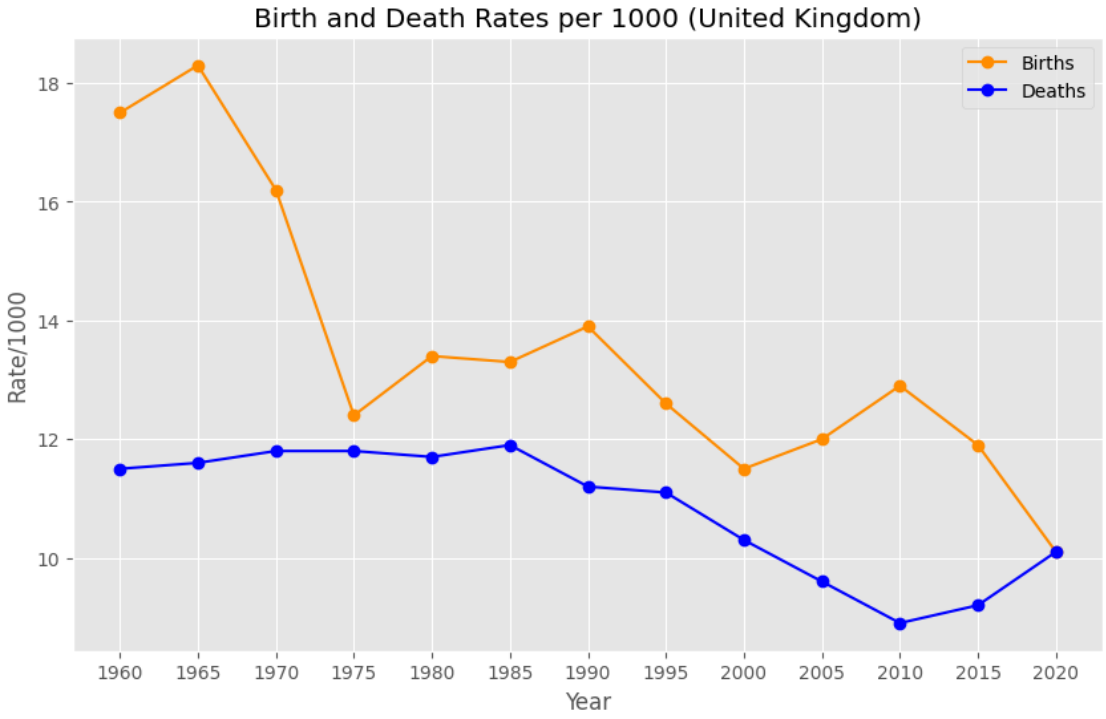


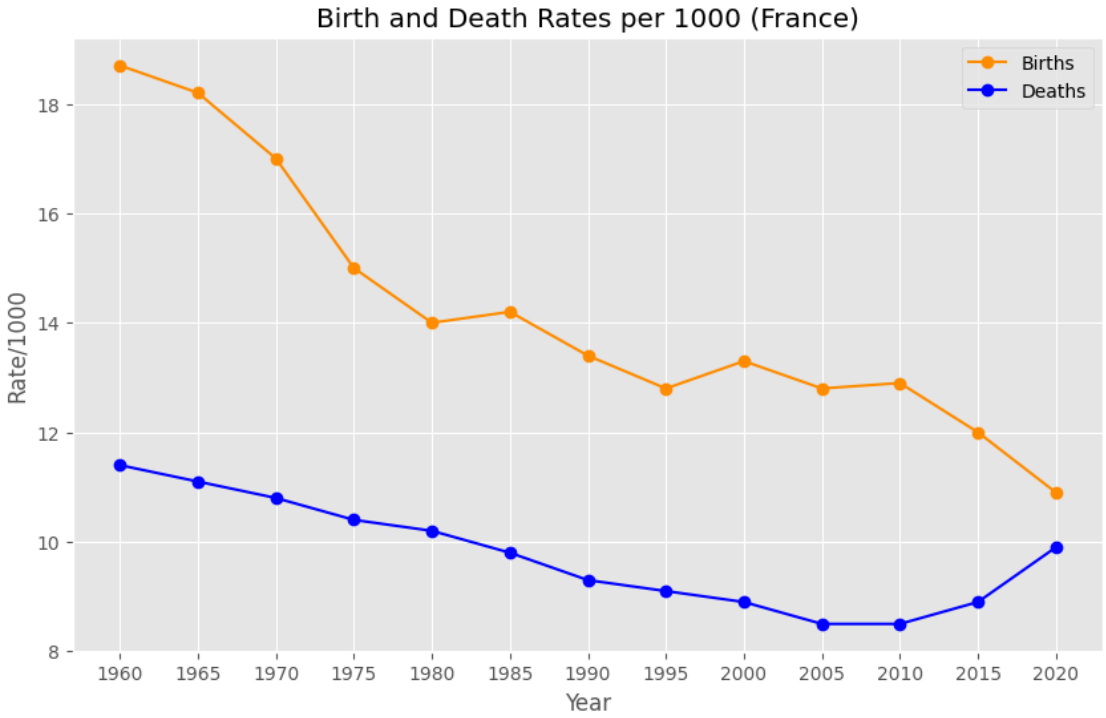

Birth and Death Rates per 1000 (China)
Births
Deaths
Rate/1000
Year
5
10
15
20
25
30
35
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

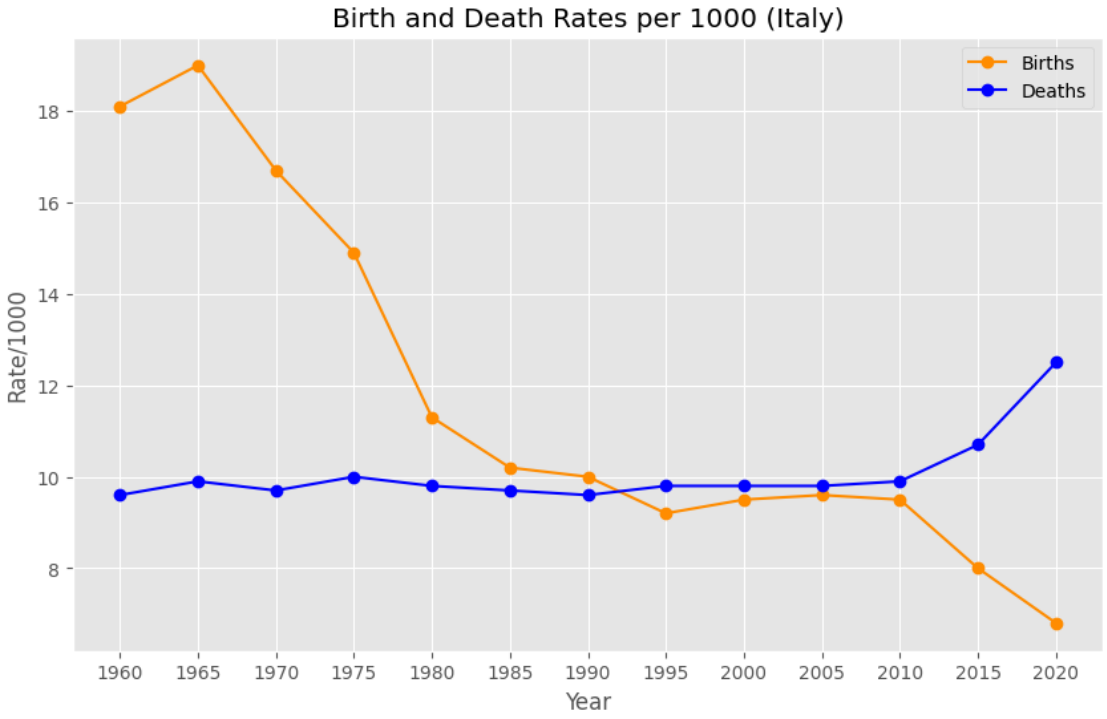

Birth and Death Rates per 1000 (Germany)
Births
Deaths
Rate/1000
Year
8
10
12
14
16
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

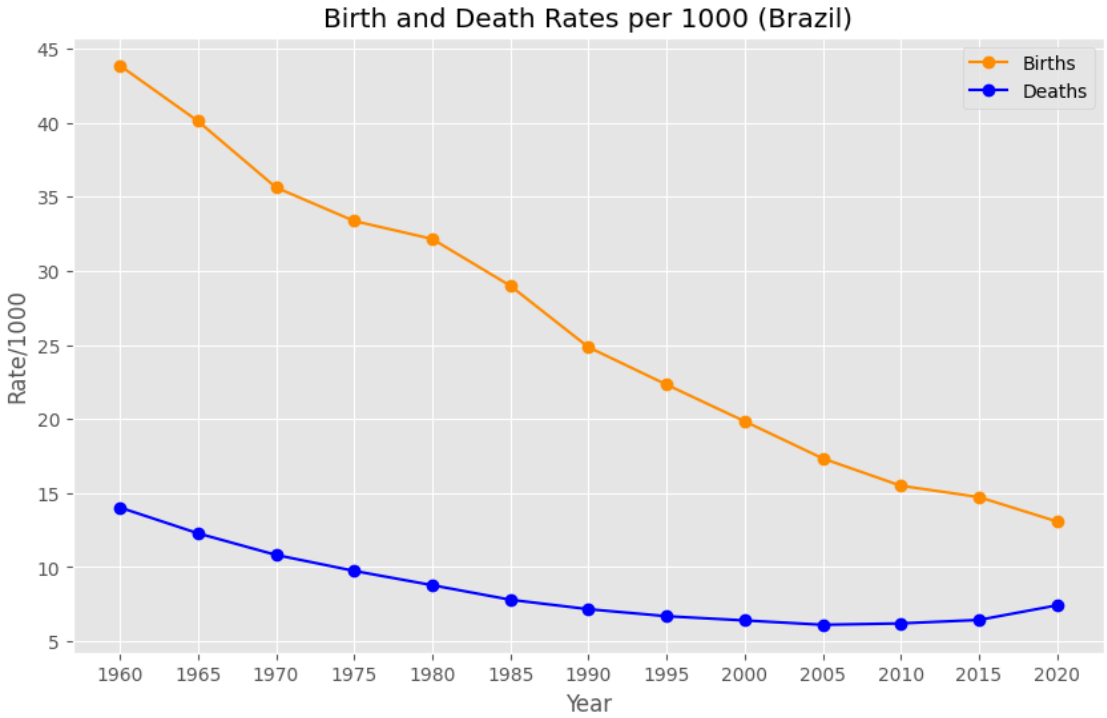

Birth and Death Rates per 1000 (Japan)
Births
Deaths
Rate/1000
Year
18
16
14
12
10
8
6
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

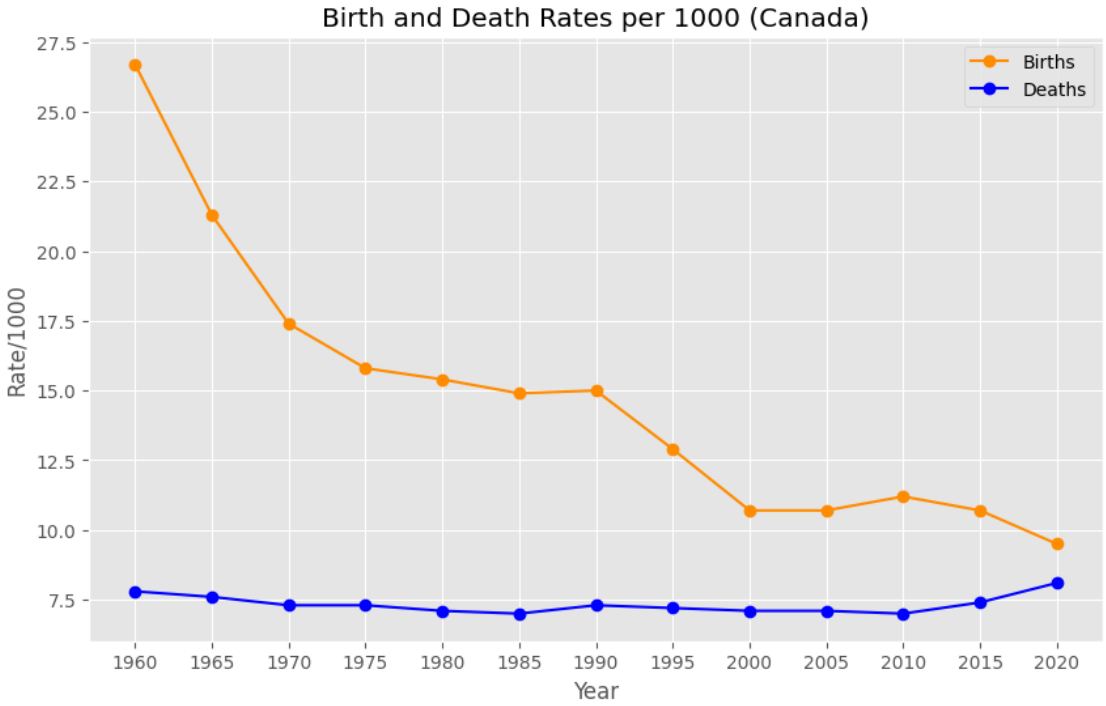

Birth and Death Rates per 1000 (India)
Births
Deaths
Rate/1000
Year
40
35
30
25
20
15
10
5
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


Birth and Death Rates per 1000 (United Kingdom)
Births
Deaths
Rate/1000
Year
18
16
14
12
10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


Birth and Death Rates per 1000 (France)
Births
Deaths
Rate/1000
Year
18
16
14
12
10
8
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

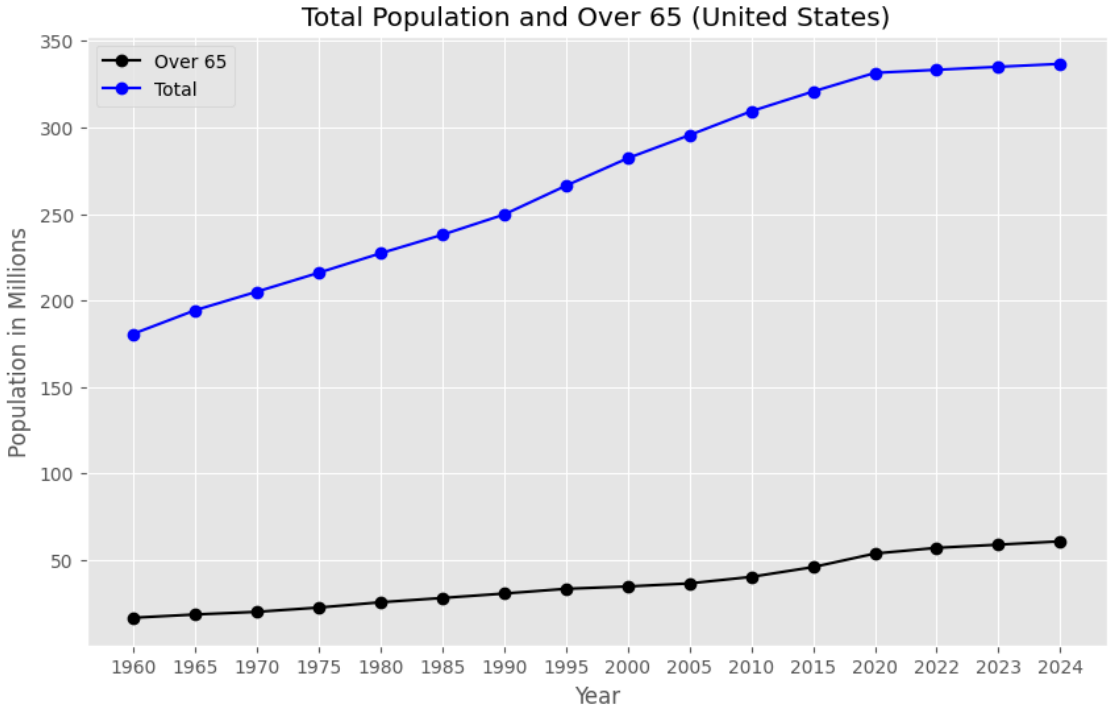

Birth and Death Rates per 1000 (Italy)
Births
Deaths
Rate/1000
18
16
14
12
10
8
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

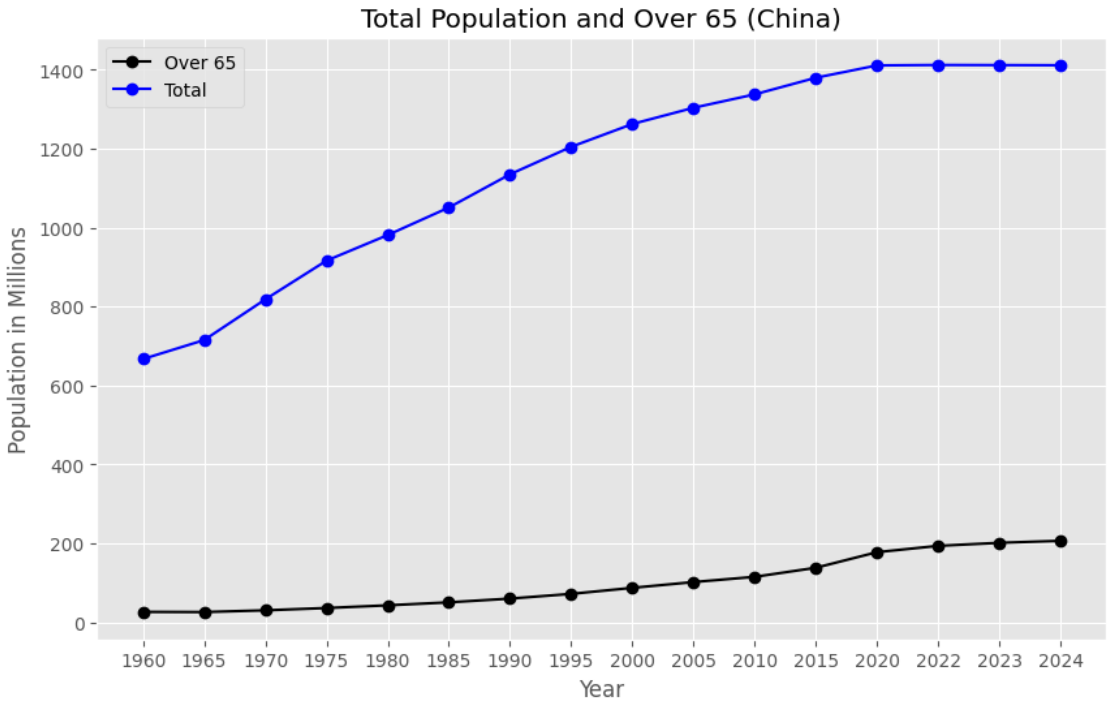

Birth and Death Rates per 1000 (Brazil)
Births
Deaths
Rate/1000
45
40
35
30
25
20
15
10
5
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

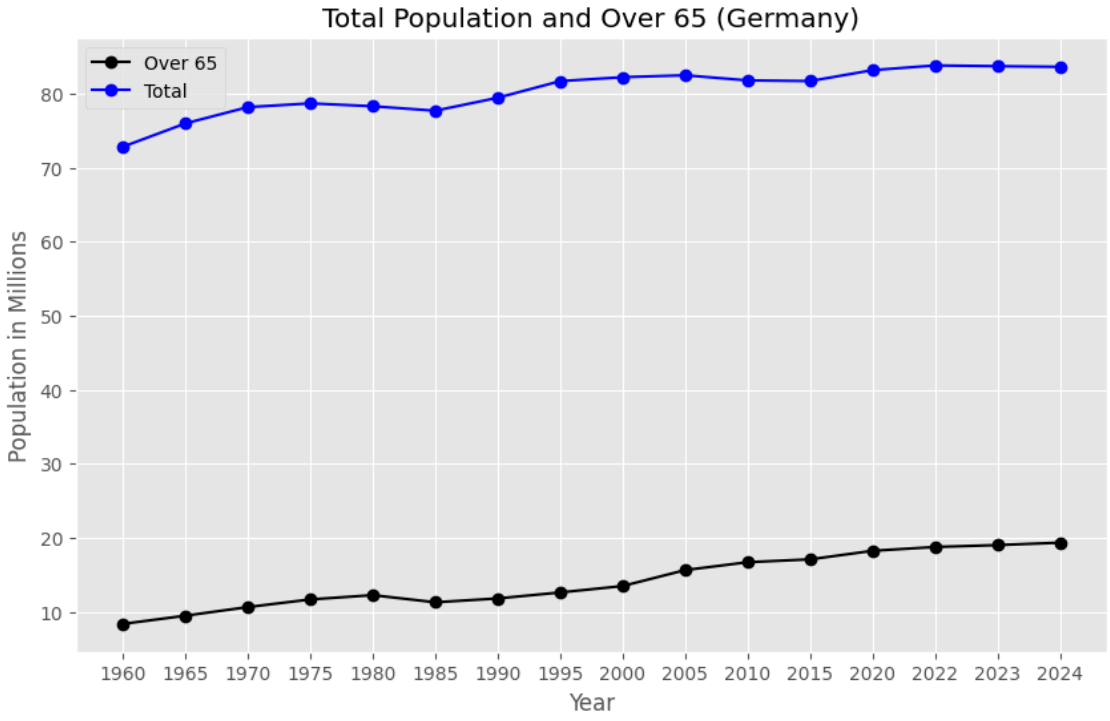


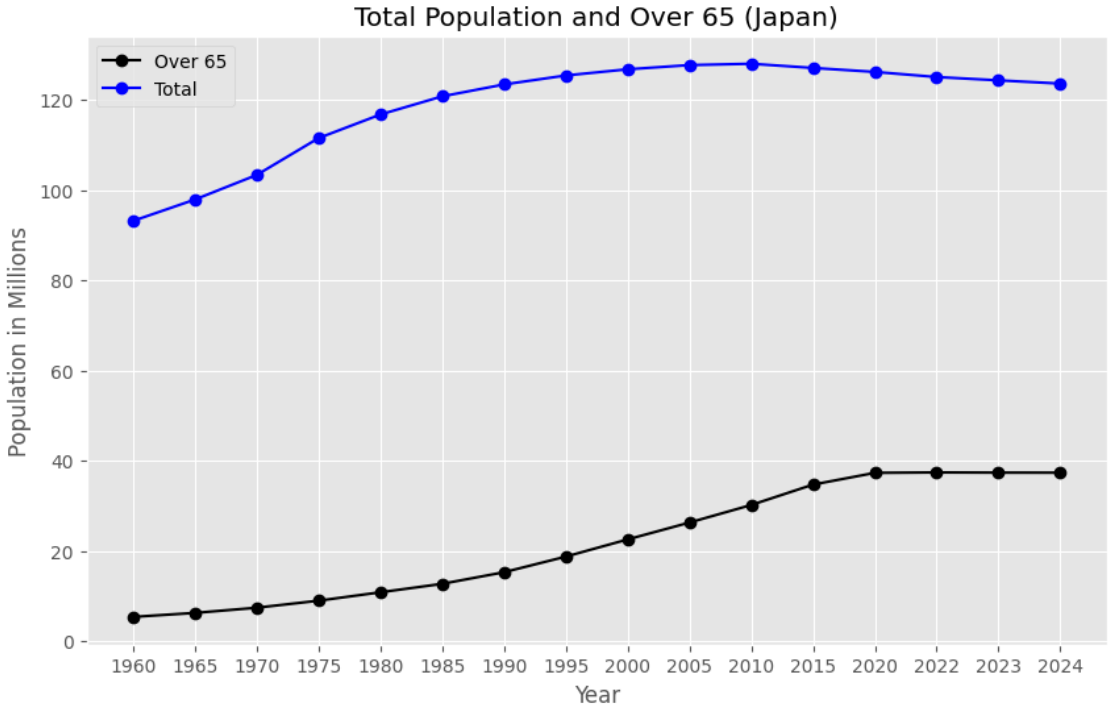
Plot total and over 65 population

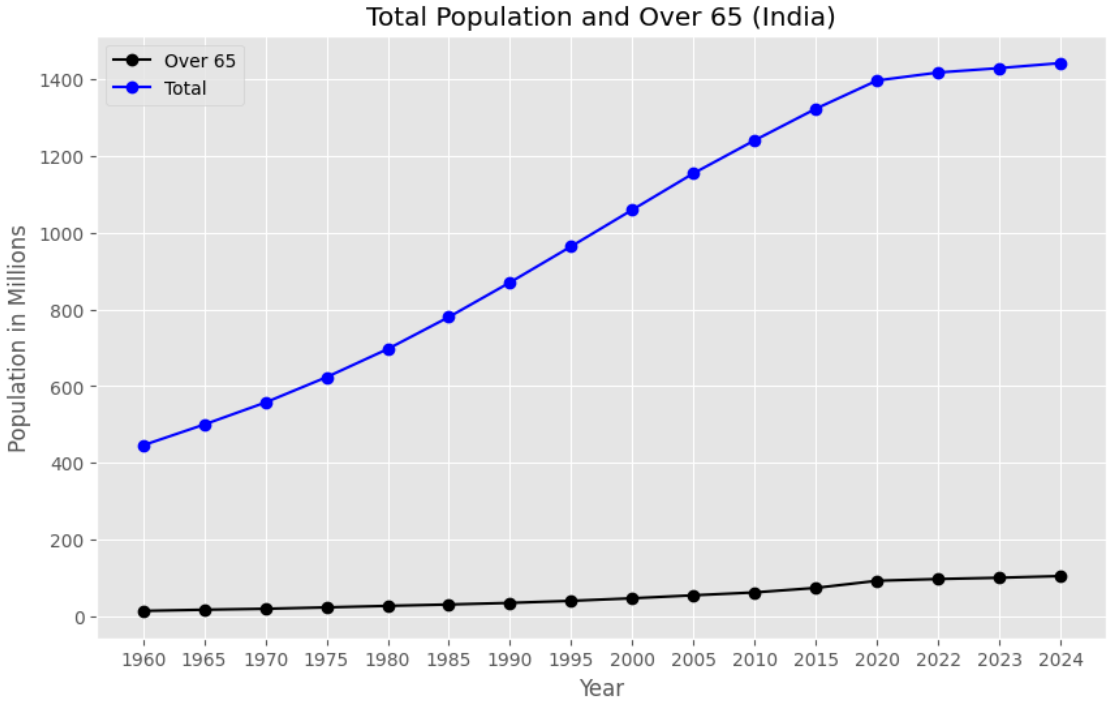
[16]:
```
for country in countries:
    plotOver65(country)
```

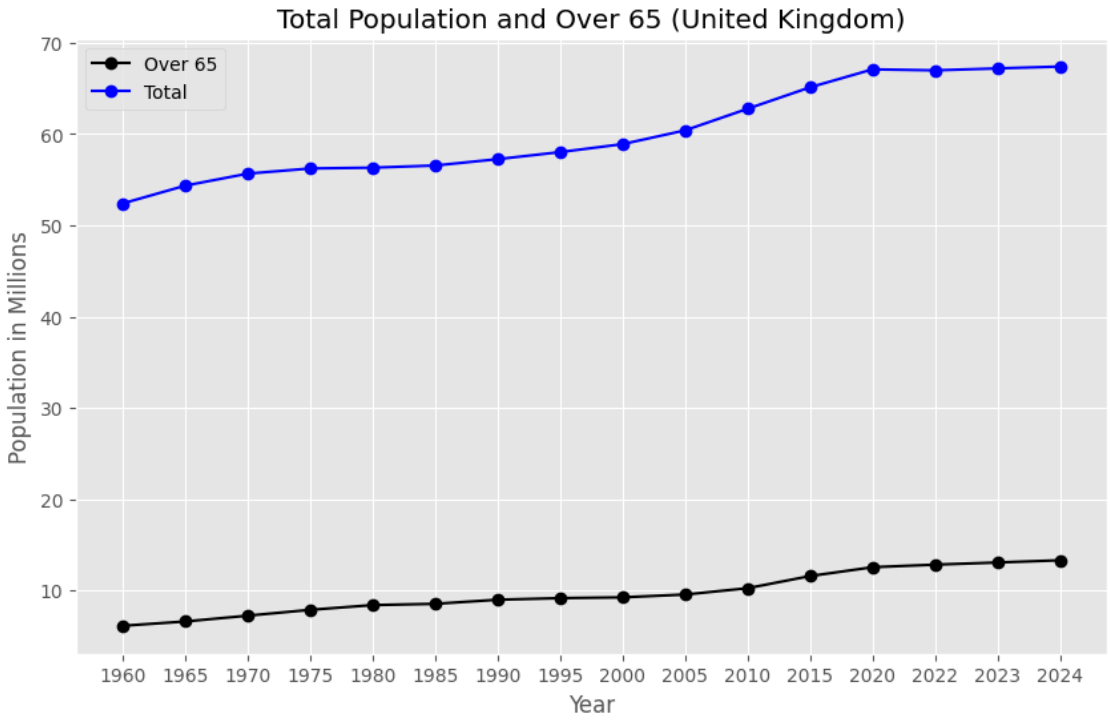

Total Population and Over 65 (United States)
Over 65
Total
Population in Millions
350
300
250
200
150
100
50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
2023
2024
Year

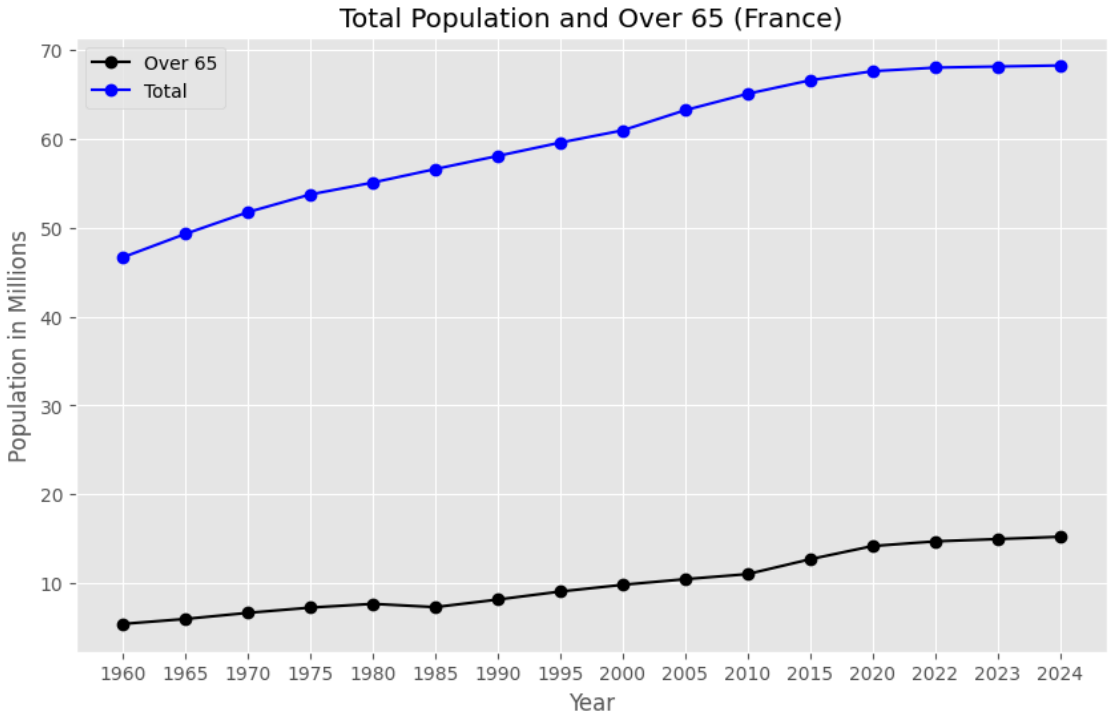

Total Population and Over 65 (China)
Over 65
Total
Population in Millions
1400
1200
1000
800
600
400
200
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
2023
2024
Year

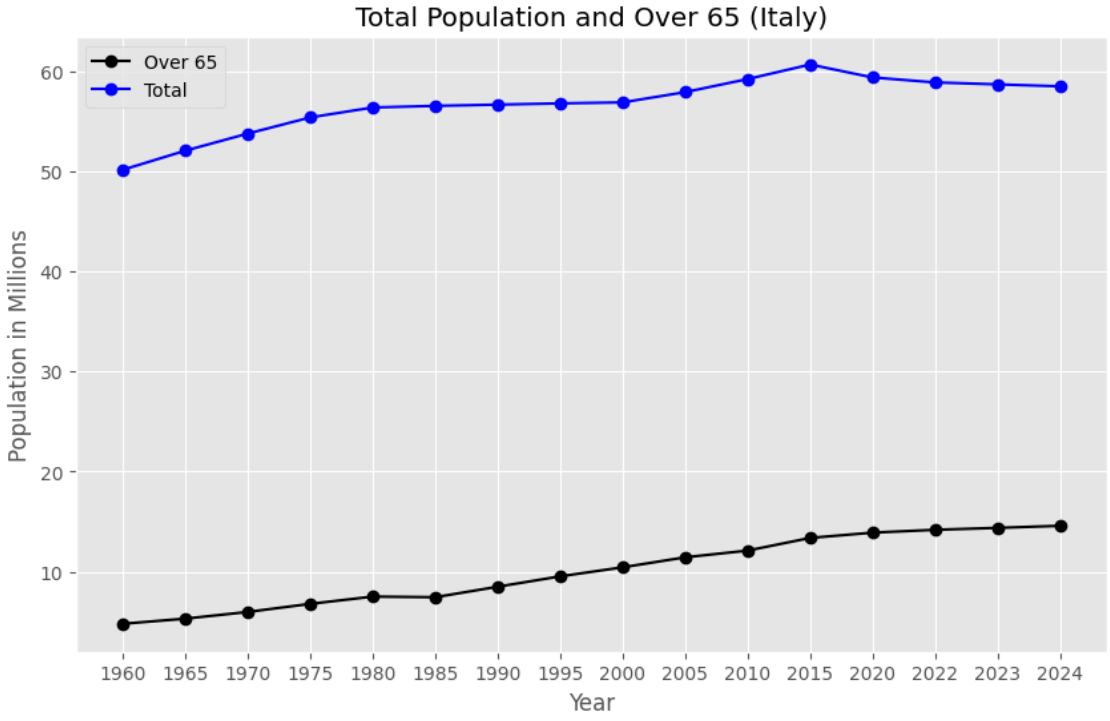

Total Population and Over 65 (Germany)
Over 65
Total
Population in Millions
10
20
30
40
50
60
70
80
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
2023
2024
Year

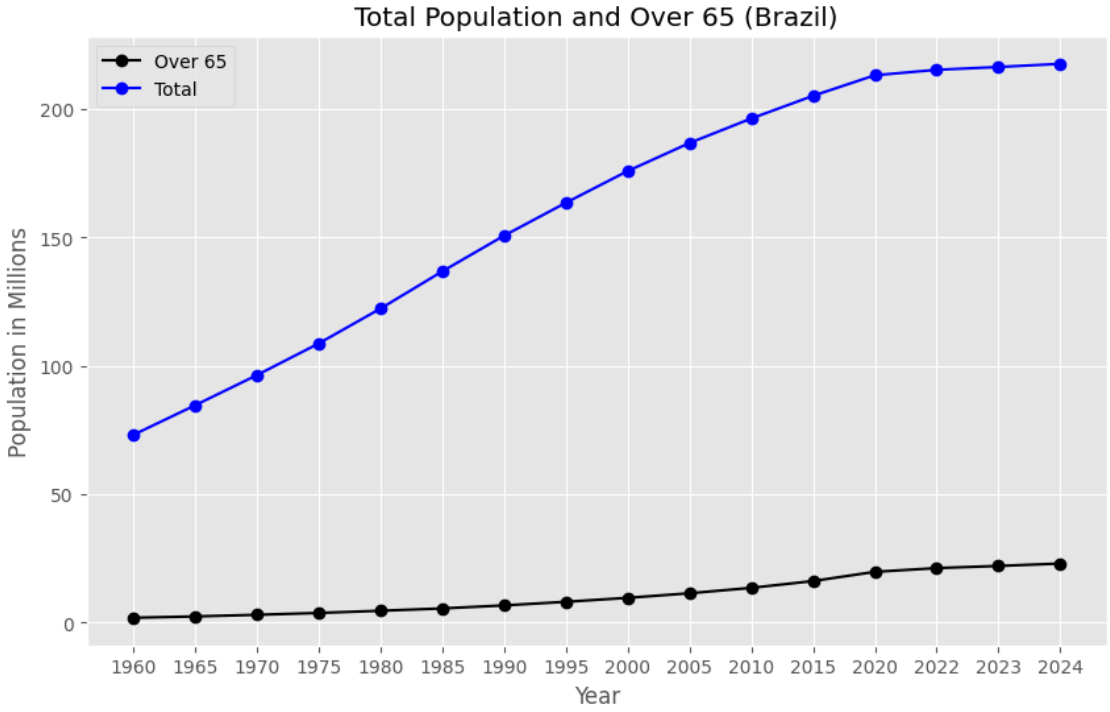

Total Population and Over 65 (Japan)
Over 65
Total
Population in Millions
0
20
40
60
80
100
120
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
2023
2024
Year

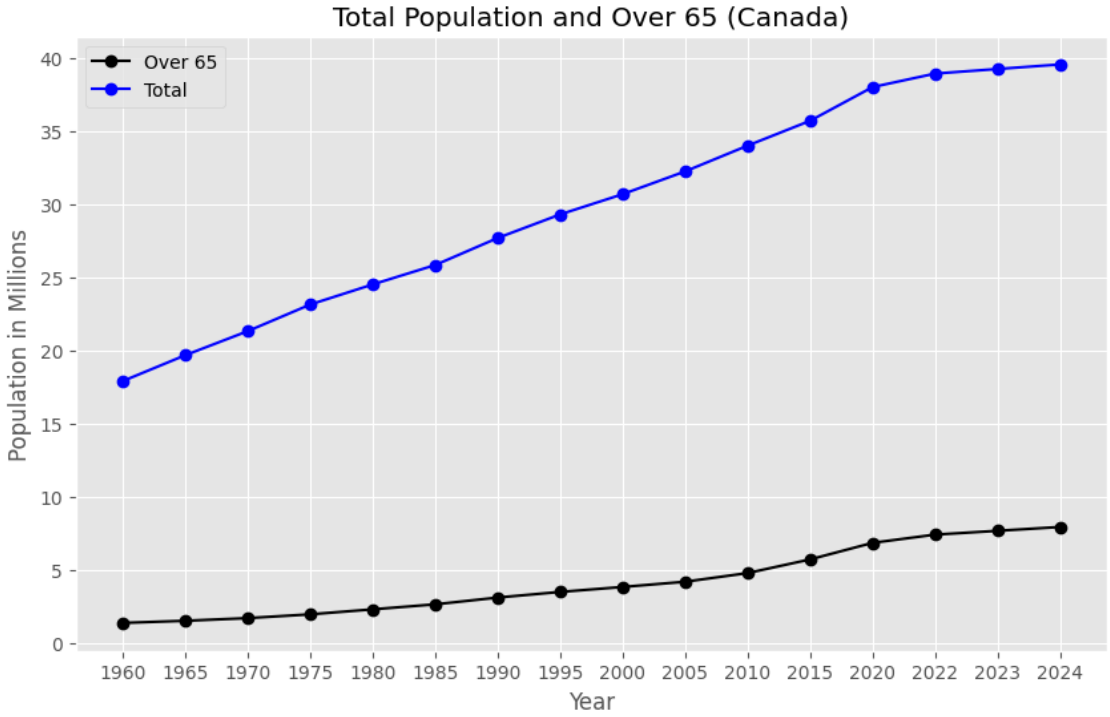

Total Population and Over 65 (India)
Over 65
Total
Population in Millions
0
200
400
600
800
1000
1200
1400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
2023
2024
Year


Total Population and Over 65 (United Kingdom)
Over 65
Total
Population in Millions
10
20
30
40
50
60
70
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
2023
2024
Year


Total Population and Over 65 (France)
Over 65
Total
Population in Millions
70
60
50
40
30
20
10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
2023
2024
Year

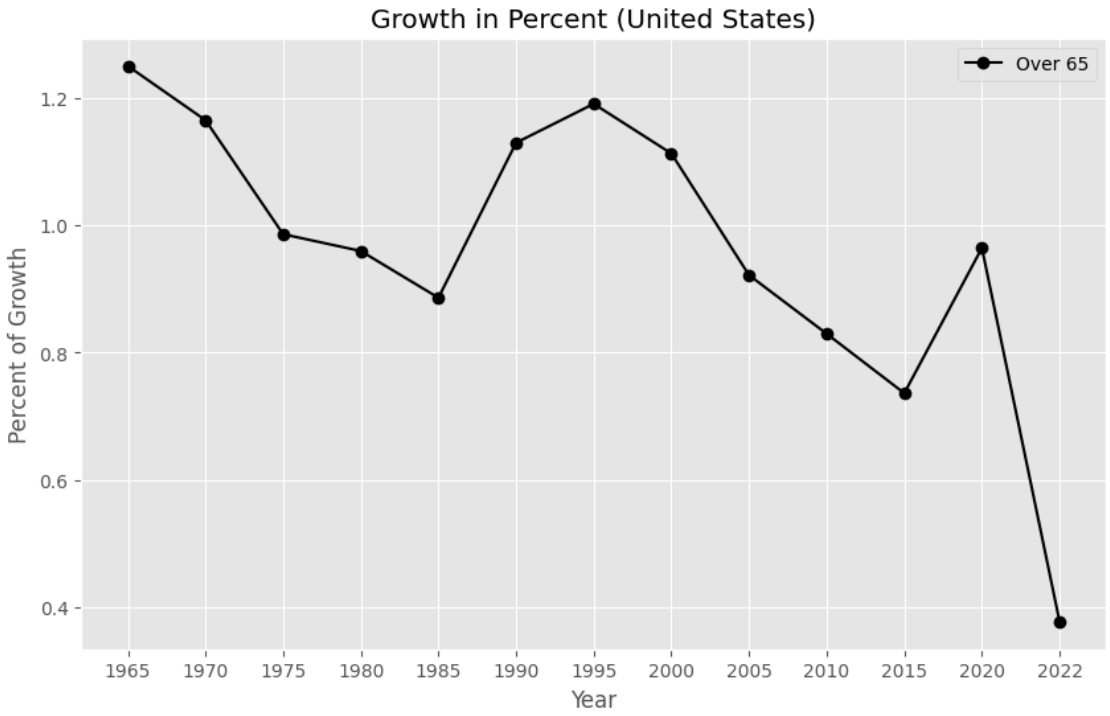

Total Population and Over 65 (Italy)
Over 65
Total
Population in Millions
60
50
40
30
20
10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
2023
2024
Year

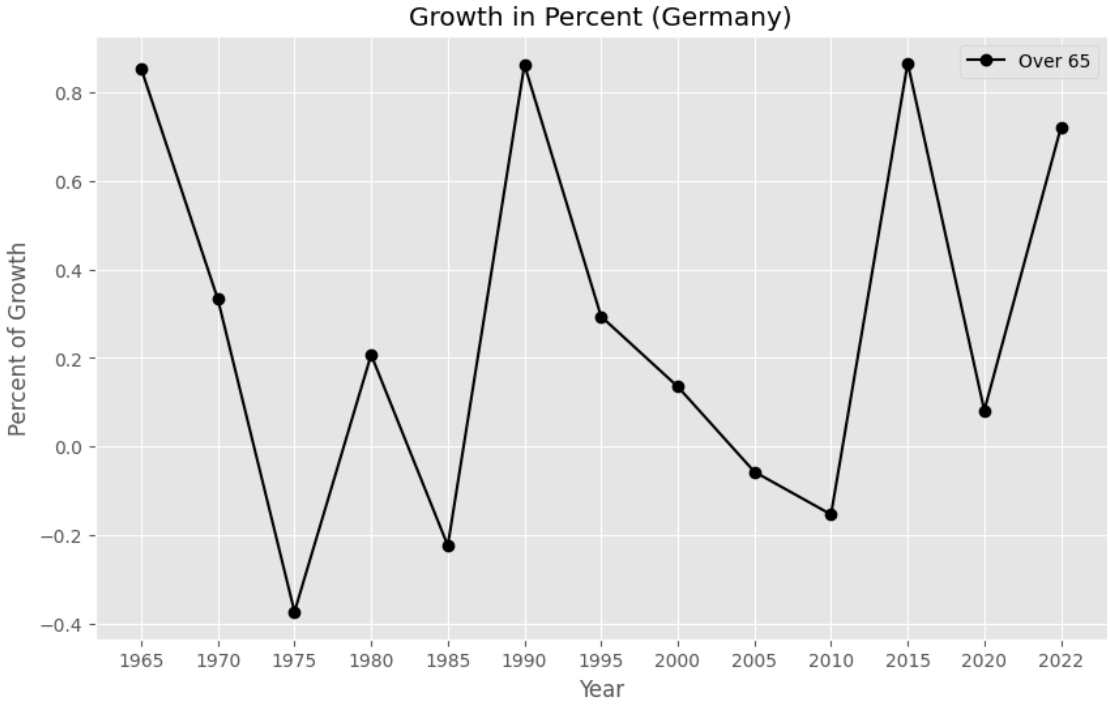


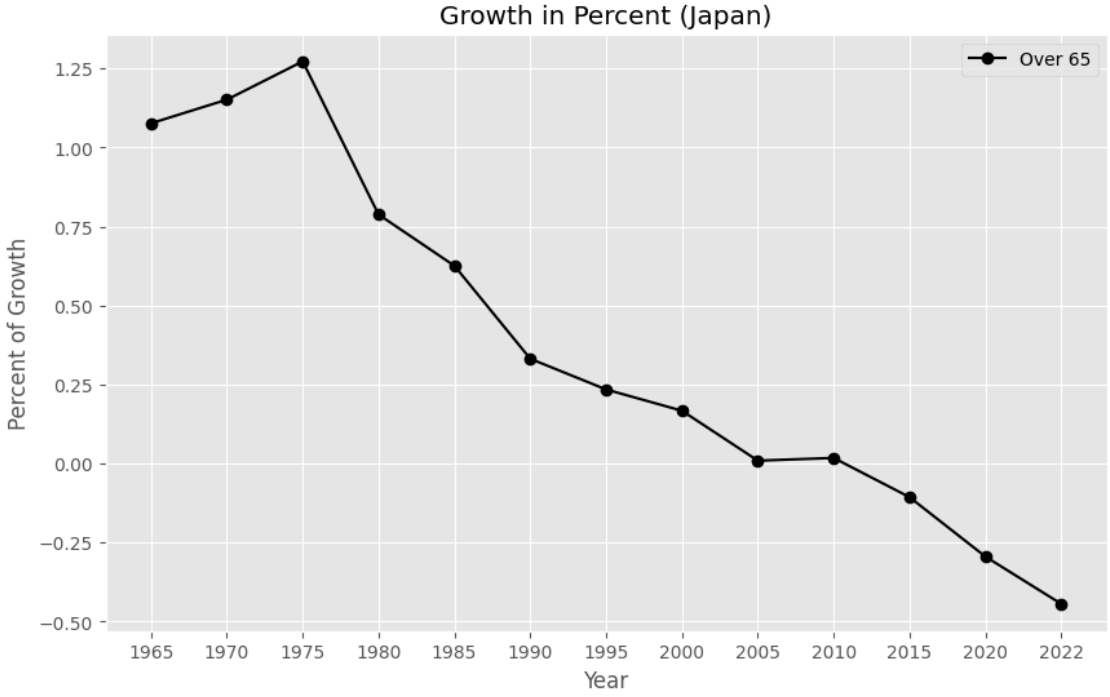


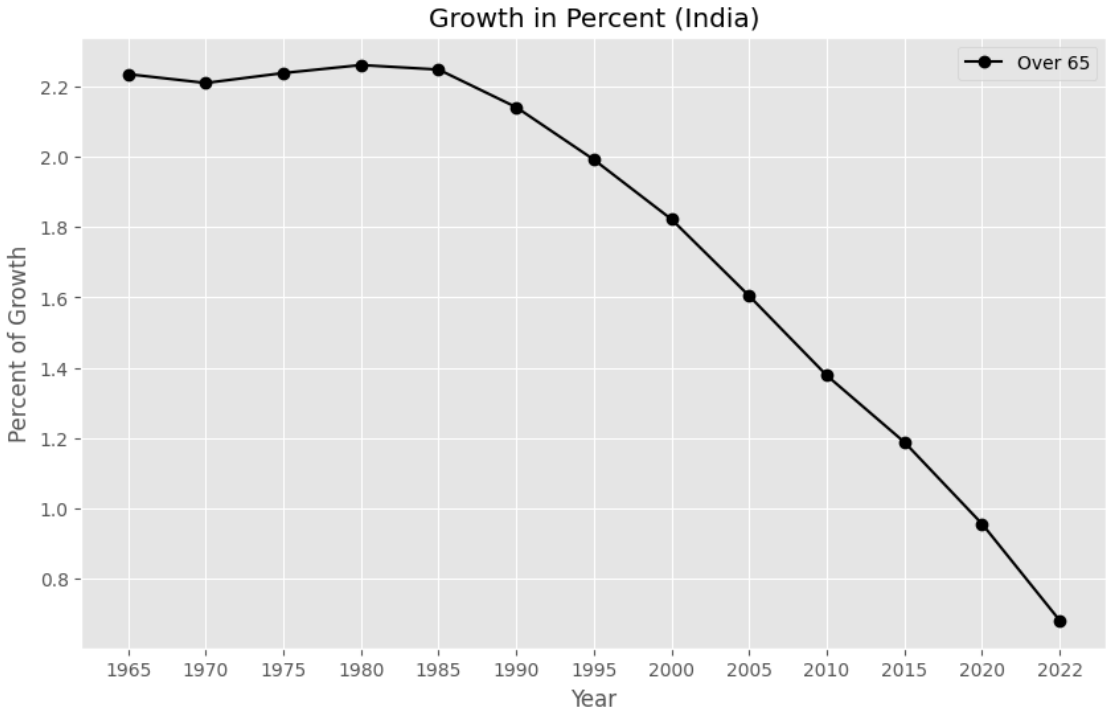
Plot growth rate

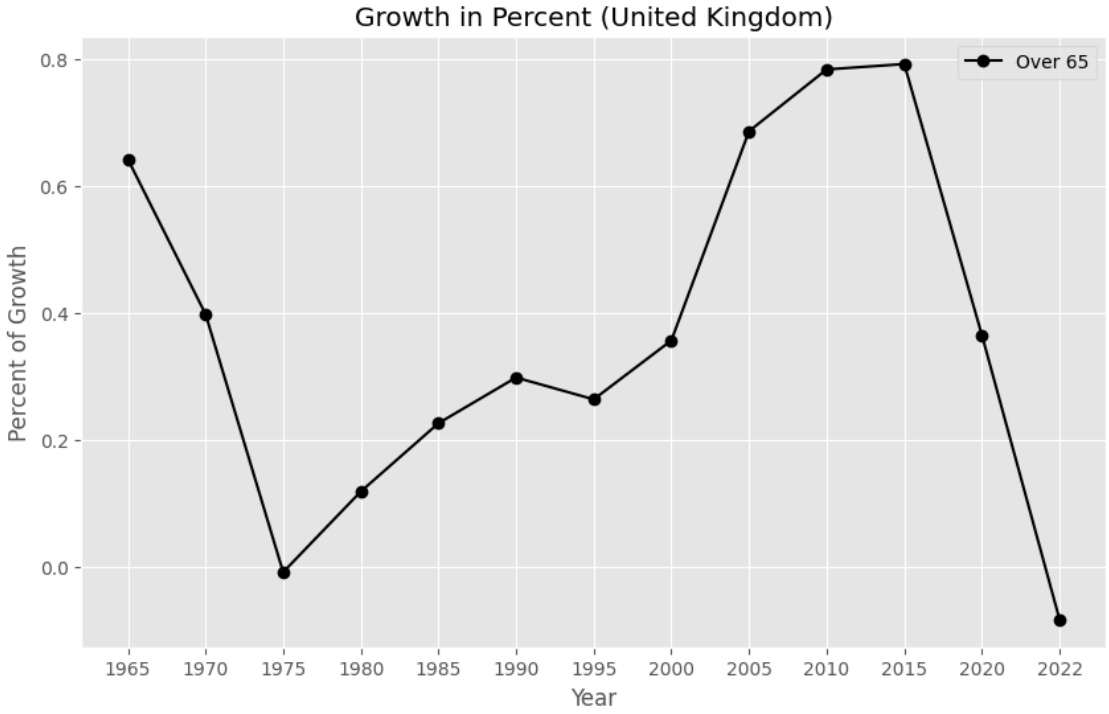
[17]:
```
for country in countries:
    plotGrowth(country)
```

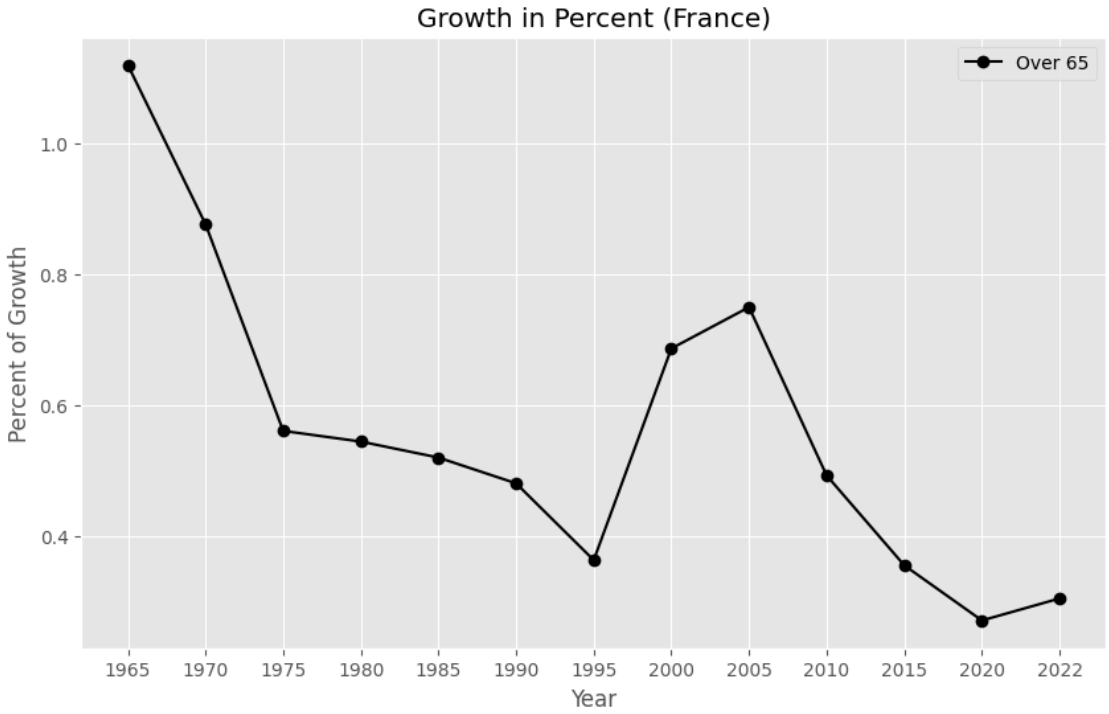


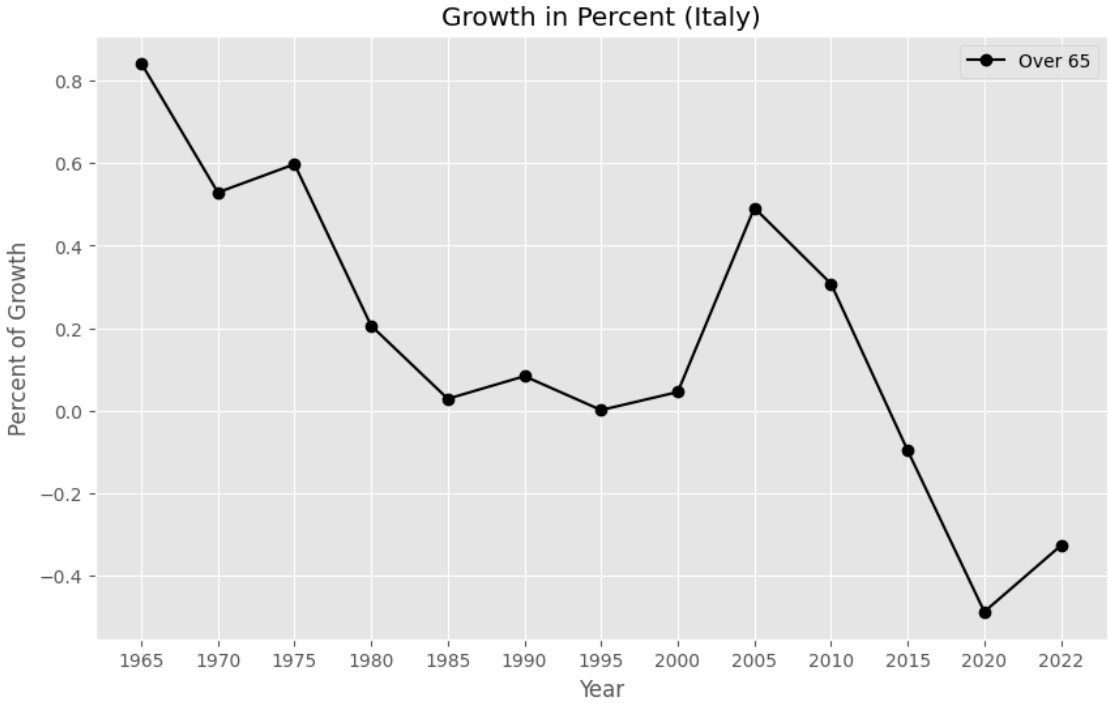

Growth in Percent (Germany)
Over 65
Percent of Growth
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
Year

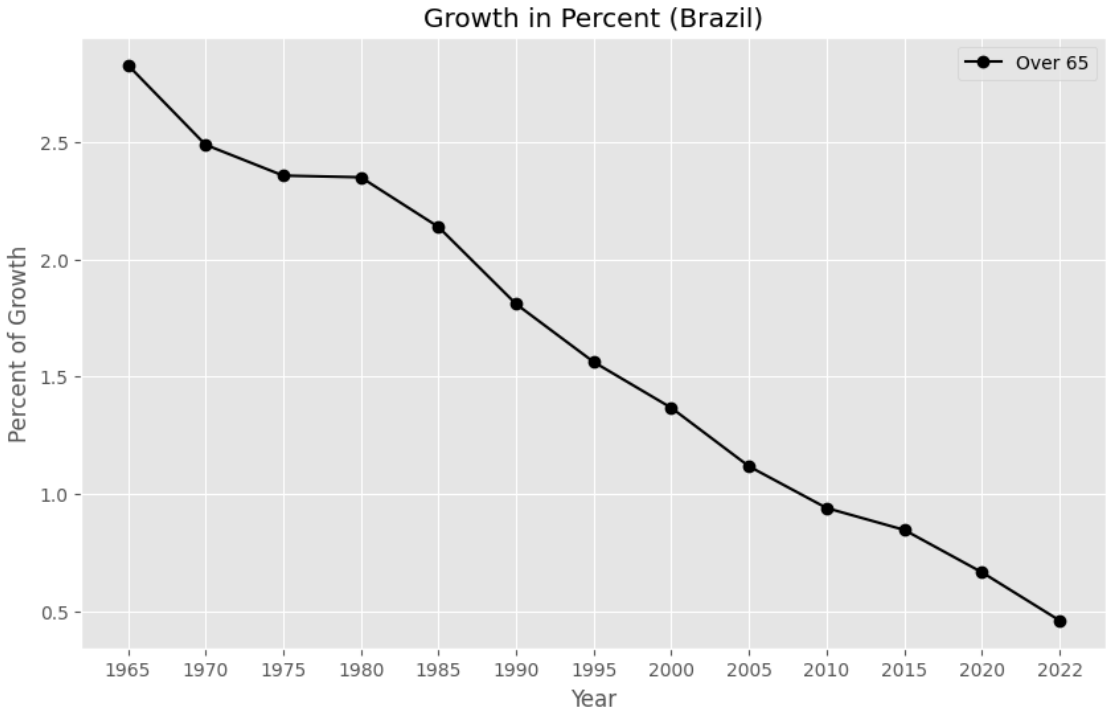

Growth in Percent (Japan)
Over 65
Percent of Growth
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
Year

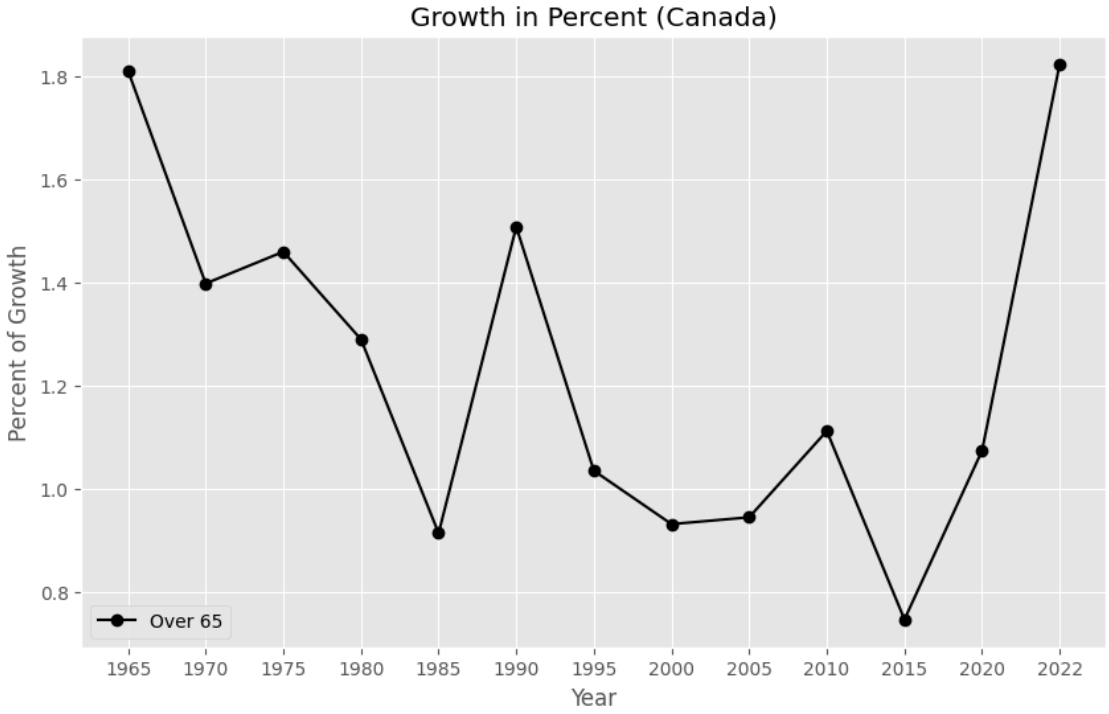

Growth in Percent (India)
Over 65
Percent of Growth
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
Year


Growth in Percent (United Kingdom)
Over 65
Percent of Growth
0.8
0.6
0.4
0.2
0.0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
Year


Growth in Percent (France)
Over 65
Percent of Growth
1.0
0.8
0.6
0.4
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
Year


Growth in Percent (Italy)
Over 65
Percent of Growth
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
Year


Growth in Percent (Brazil)
Over 65
Percent of Growth
2.5
2.0
1.5
1.0
0.5
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
Year


Growth in Percent (Canada)
Percent of Growth
1.8
1.6
1.4
1.2
1.0
0.8
Over 65
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
Year

1.3.3 Summary Charts of all Countries

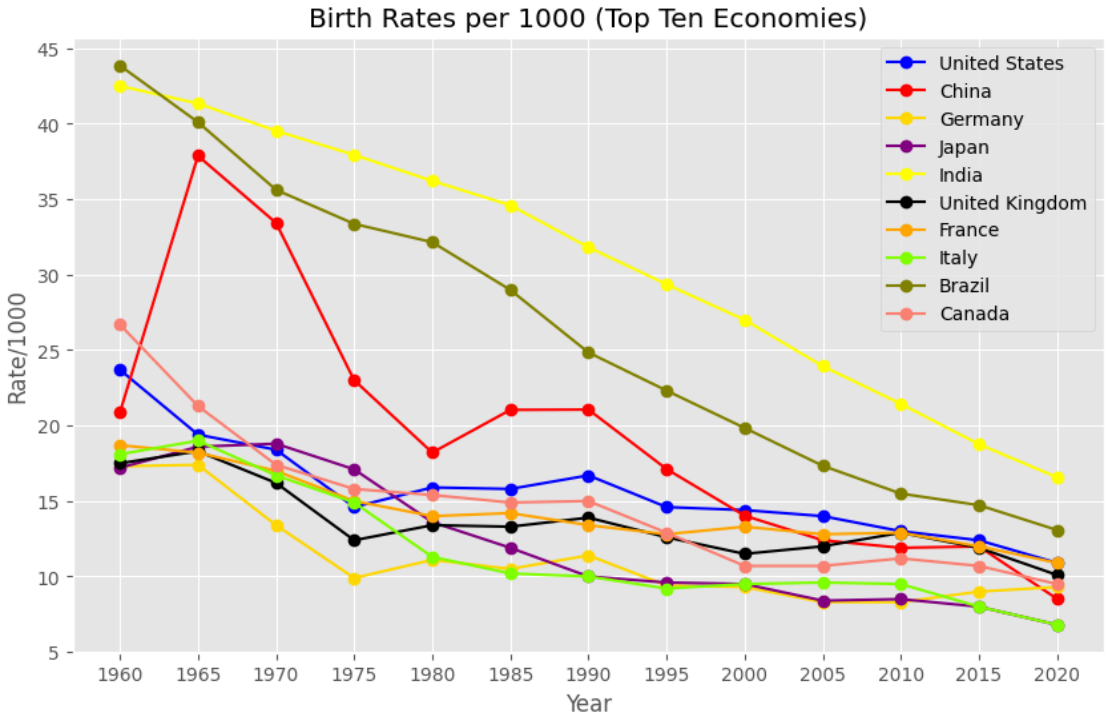
Extract and create the series to plot

[18]:
```
us_birth, us_death, us_over65, us_growth, us_total = getIndividual('United␣
↪States')
us_over65_scaled = scalePopulation(us_over65)
us_total_scaled = scalePopulation(us_total)
cn_birth, cn_death, cn_over65, cn_growth, cn_total = getIndividual('China')
cn_over65_scaled = scalePopulation(cn_over65)
cn_total_scaled = scalePopulation(cn_total)
de_birth, de_death, de_over65, de_growth, de_total = getIndividual('Germany')
de_over65_scaled = scalePopulation(de_over65)
de_total_scaled = scalePopulation(de_total)
jp_birth, jp_death, jp_over65, jp_growth, jp_total = getIndividual('Japan')
jp_over65_scaled = scalePopulation(jp_over65)
jp_total_scaled = scalePopulation(jp_total)
in_birth, in_death, in_over65, in_growth, in_total = getIndividual('India')
in_over65_scaled = scalePopulation(in_over65)
in_total_scaled = scalePopulation(in_total)
uk_birth, uk_death, uk_over65, uk_growth, uk_total = getIndividual('United␣
↪Kingdom')
uk_over65_scaled = scalePopulation(uk_over65)
uk_total_scaled = scalePopulation(uk_total)
fr_birth, fr_death, fr_over65, fr_growth, fr_total = getIndividual('France')
fr_over65_scaled = scalePopulation(fr_over65)
fr_total_scaled = scalePopulation(fr_total)
it_birth, it_death, it_over65, it_growth, it_total = getIndividual('Italy')
it_over65_scaled = scalePopulation(it_over65)
it_total_scaled = scalePopulation(it_total)
br_birth, br_death, br_over65, br_growth, br_total = getIndividual('Brazil')
br_over65_scaled = scalePopulation(br_over65)
br_total_scaled = scalePopulation(br_total)
ca_birth, ca_death, ca_over65, ca_growth, ca_total = getIndividual('Canada')
ca_over65_scaled = scalePopulation(ca_over65)
ca_total_scaled = scalePopulation(ca_total)
```

Plot birth rates for all countries

[19]:
```
plt.figure(figsize=(10,6))
plt.title('Birth Rates per 1000 (Top Ten Economies)')
plt.xlabel('Year')
plt.ylabel('Rate/1000')
plt.plot(us_birth, color='blue', label='United States', marker='o')
plt.plot(cn_birth, color='red', label='China', marker='o')
plt.plot(de_birth, color='gold', label='Germany', marker='o')
plt.plot(jp_birth, color='purple', label='Japan', marker='o')
plt.plot(in_birth, color='yellow', label='India', marker='o')
```

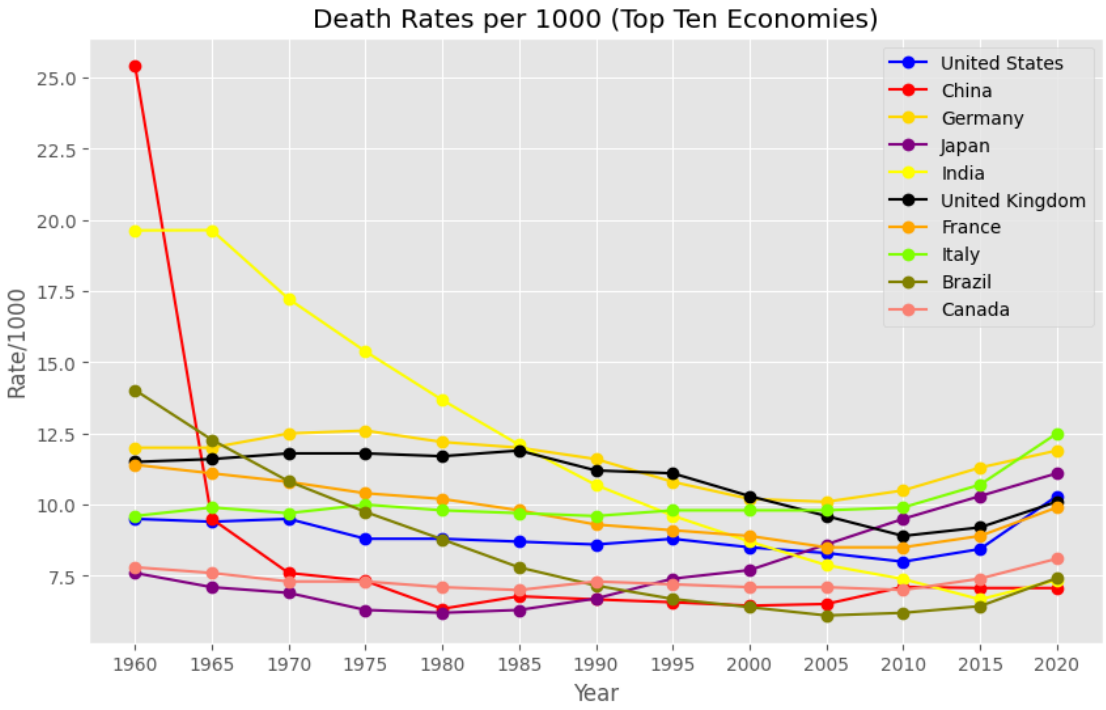
```
plt.plot(uk_birth, color='black', label='United Kingdom', marker='o')
plt.plot(fr_birth, color='orange', label='France', marker='o')
plt.plot(it_birth, color='chartreuse', label='Italy', marker='o')
plt.plot(br_birth, color='olive', label='Brazil', marker='o')
plt.plot(ca_birth, color='salmon', label='Canada', marker='o')
plt.legend()
plt.plot()
plt.savefig('../images/sumBirthRates.png', format='png')
```



Plot death rates for all countries

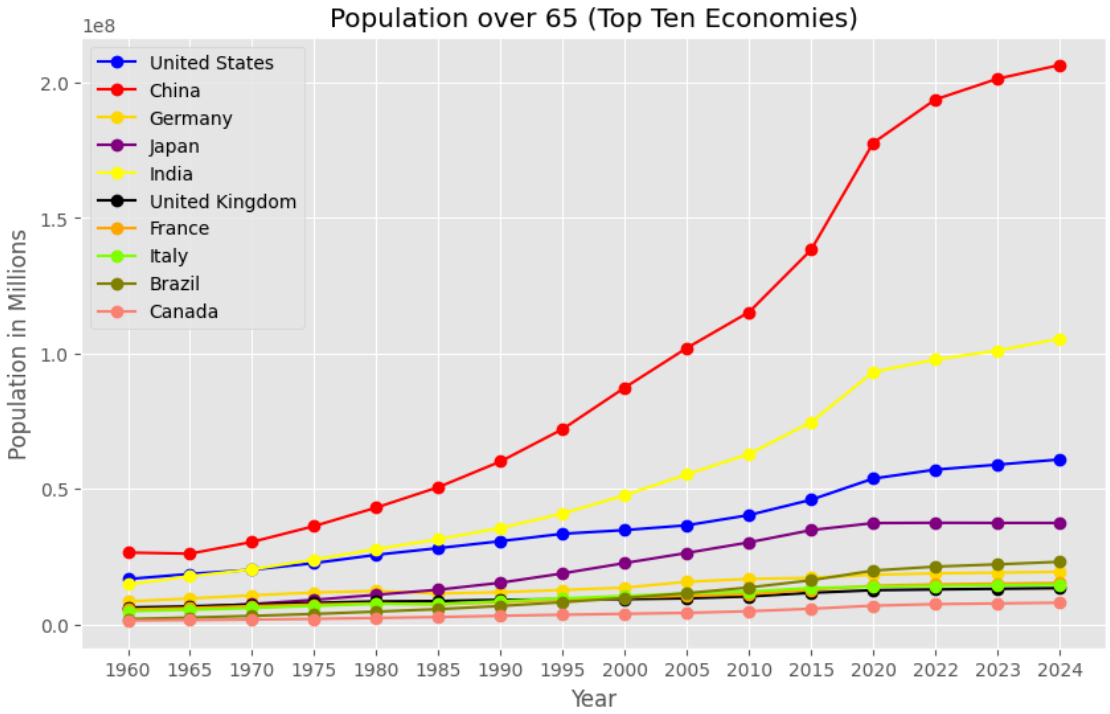
[20]:
```
plt.figure(figsize=(10,6))
plt.title('Death Rates per 1000 (Top Ten Economies)')
plt.xlabel('Year')
plt.ylabel('Rate/1000')
plt.plot(us_death, color='blue', label='United States', marker='o')
plt.plot(cn_death, color='red', label='China', marker='o')
plt.plot(de_death, color='gold', label='Germany', marker='o')
plt.plot(jp_death, color='purple', label='Japan', marker='o')
plt.plot(in_death, color='yellow', label='India', marker='o')
plt.plot(uk_death, color='black', label='United Kingdom', marker='o')
plt.plot(fr_death, color='orange', label='France', marker='o')
plt.plot(it_death, color='chartreuse', label='Italy', marker='o')
plt.plot(br_death, color='olive', label='Brazil', marker='o')
```

```
plt.plot(ca_death, color='salmon', label='Canada', marker='o')
plt.legend()
plt.plot()
plt.savefig('../images/sumDeathRates.png', format='png')
```

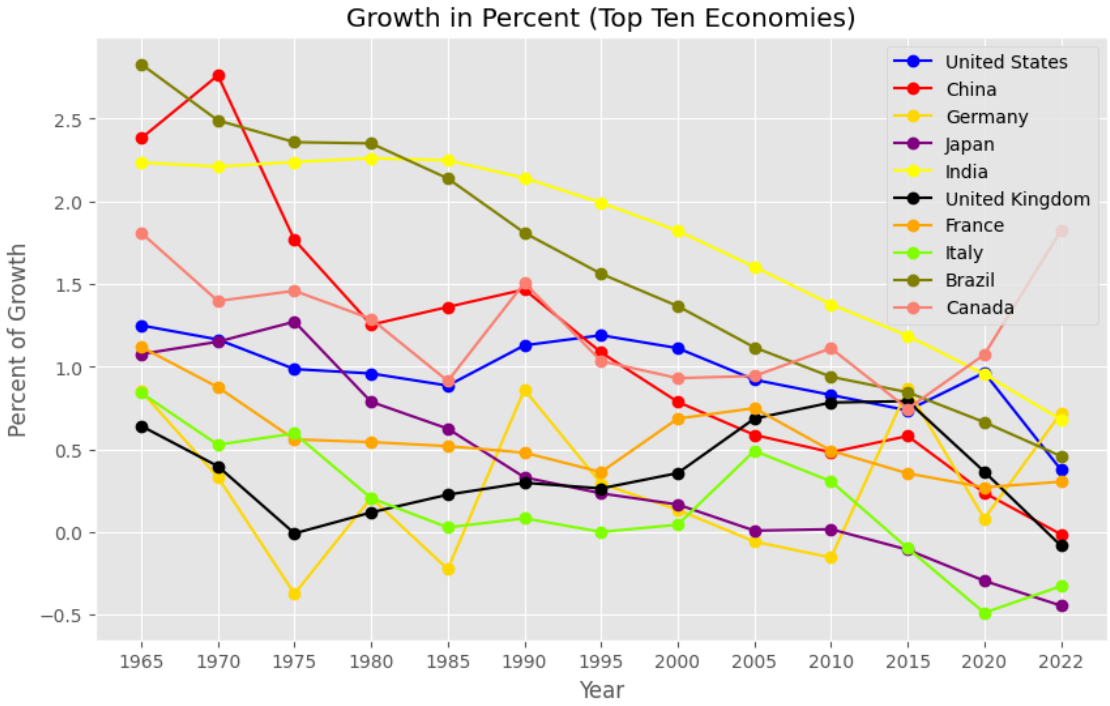


Plot population over 65 for all countries

[21]:
```
plt.figure(figsize=(10,6))
plt.title('Population over 65 (Top Ten Economies)')
plt.xlabel('Year')
plt.ylabel('Population in Millions')
plt.plot(us_over65, color='blue', label='United States', marker='o')
plt.plot(cn_over65, color='red', label='China', marker='o')
plt.plot(de_over65, color='gold', label='Germany', marker='o')
plt.plot(jp_over65, color='purple', label='Japan', marker='o')
plt.plot(in_over65, color='yellow', label='India', marker='o')
plt.plot(uk_over65, color='black', label='United Kingdom', marker='o')
plt.plot(fr_over65, color='orange', label='France', marker='o')
plt.plot(it_over65, color='chartreuse', label='Italy', marker='o')
plt.plot(br_over65, color='olive', label='Brazil', marker='o')
plt.plot(ca_over65, color='salmon', label='Canada', marker='o')
plt.legend()
plt.plot()
plt.savefig('../images/sumOver65.png', format='png')
```

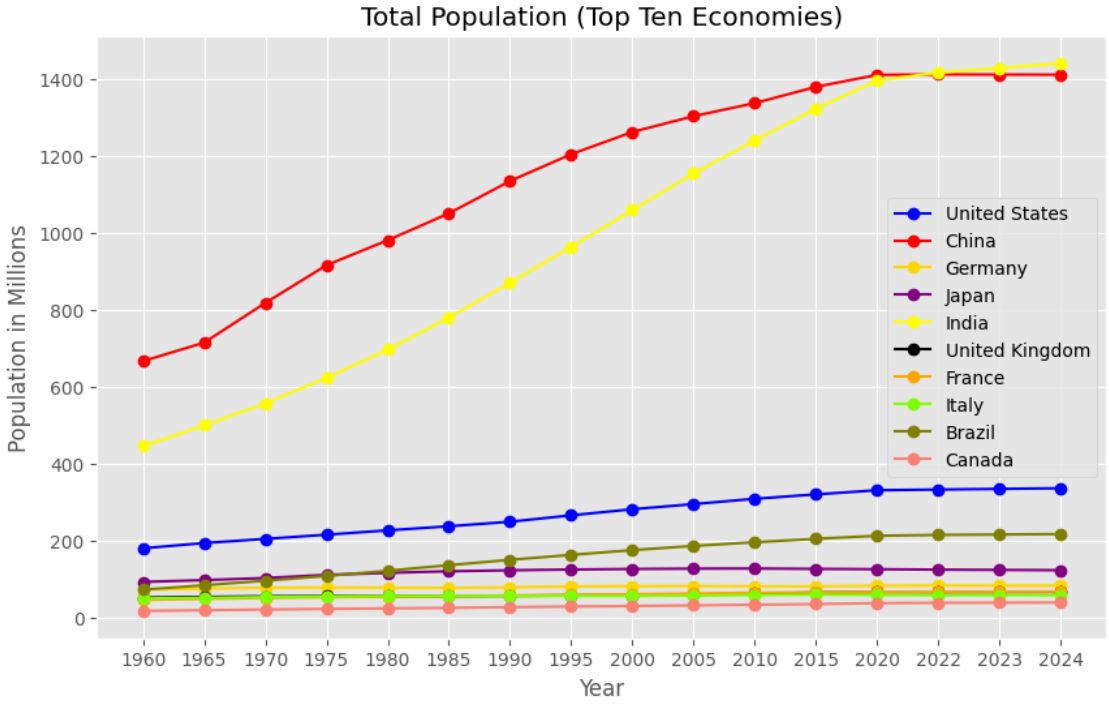


[22]:
```
plt.figure(figsize=(10,6))
plt.title('Growth in Percent (Top Ten Economies)')
plt.xlabel('Year')
plt.ylabel('Percent of Growth')
plt.plot(us_growth, color='blue', label='United States', marker='o')
plt.plot(cn_growth, color='red', label='China', marker='o')
plt.plot(de_growth, color='gold', label='Germany', marker='o')
plt.plot(jp_growth, color='purple', label='Japan', marker='o')
plt.plot(in_growth, color='yellow', label='India', marker='o')
plt.plot(uk_growth, color='black', label='United Kingdom', marker='o')
plt.plot(fr_growth, color='orange', label='France', marker='o')
plt.plot(it_growth, color='chartreuse', label='Italy', marker='o')
plt.plot(br_growth, color='olive', label='Brazil', marker='o')
plt.plot(ca_growth, color='salmon', label='Canada', marker='o')
plt.legend()
plt.plot()
plt.savefig('../images/sumGowthPercent.png', format='png')
```



Total Population Summary

[23]:
```
plt.figure(figsize=(10,6))
plt.title('Total Population (Top Ten Economies)')
plt.xlabel('Year')
plt.ylabel('Population in Millions')
plt.plot(us_total_scaled, color='blue', label='United States', marker='o')
plt.plot(cn_total_scaled, color='red', label='China', marker='o')
plt.plot(de_total_scaled, color='gold', label='Germany', marker='o')
plt.plot(jp_total_scaled, color='purple', label='Japan', marker='o')
plt.plot(in_total_scaled, color='yellow', label='India', marker='o')
plt.plot(uk_total_scaled, color='black', label='United Kingdom', marker='o')
plt.plot(fr_total_scaled, color='orange', label='France', marker='o')
plt.plot(it_total_scaled, color='chartreuse', label='Italy', marker='o')
plt.plot(br_total_scaled, color='olive', label='Brazil', marker='o')
plt.plot(ca_total_scaled, color='salmon', label='Canada', marker='o')
plt.legend()
plt.plot()
plt.savefig('../images/sumTotalPopulation.png', format='png')
```


Total Population (Top Ten Economies)
Population in Millions
Year
0
200
400
600
800
1000
1200
1400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2022
2023
2024
United States
China
Germany
Japan
India
United Kingdom
France
Italy
Brazil
Canada