Dan_UK_Population_Study

April 3, 2019

1 Study of UK population dynamics

1.1 Introduction

In this document I will analyze evolution of UK population accross: * Time * Region * Gender * Age

1.2 Data Loading

First of all, I trasform data collected from the given url into a "tidy" dataframe where * Each variable forms a column * Each observation forms a row * Each measure forms a dataframe * There is not "Total" element and dimensions elements are partition of the total

```
In [1]: import requests
        import json
        import pandas as pd
        import numpy as np
        import matplotlib.pyplot as plt
```

```
In [2]: url="https://www.nomisweb.co.uk/api/v01/dataset/NM_31_1.jsonstat.json"
        r = requests.get(url)
        data_json = json.loads(r.content.decode())
        size=data_json['size']
```

```
In [3]: #initialize empty columns
        time=[]
        region=[]
        gender=[]
        age=[]
        meas=[]
```

```
In [4]: # create every column separately to have better performances
        for time_index in range(size[0]):
            time=time+[list(data_json['dimension']['time']['category']['label'].
                            values())[time_index]]*size[1]*size[2]*size[3]*size[4]
            for geo_index in range(size[1]):
                region=region+[list(data_json['dimension']['geography']['category']['label'].
                                    values())[geo_index]]*size[2]*size[3]*size[4]
                for sex_index in range(size[2]):
                    gender=gender+[list(data_json['dimension']['sex']['category']['label'].
                                        values())[sex_index]]*size[3]*size[4]
                    for age_index in range(size[3]):
                        age=age+[list(data_json['dimension']['age']['category']['label'].
                                      values())[age_index]]*size[4]
                        for meas_index in range(size[4]):
                            meas=meas+[list(data_json['dimension']['measures']['category']
                                            ['label'].values())[meas_index]]
```

```
In [5]: #create the complete DataFrame from json
        data_df=pd.DataFrame(
            {'Year':time,
             'Region':region,
             'Gender':gender,
             'Age':age,
             'Measure':meas,
             'Value':data_json['value']}
        )
```

```
In [6]: #delete "Total" values and all elements that
        #do not create a partition like "Aged 16 - 59/64"
        df_stage1=data_df[
            (data_df.Age!="All ages") &
            (data_df.Age!="Aged 16 - 59/64") &
            (data_df.Age!="Aged 18 - 24") &
            (data_df.Age!="Aged 16 - 64") &
            (data_df.Age!="Aged 0 - 15") &
            (data_df.Age!="Aged 65 and over") &
            (data_df.Gender!="Total") &
            (data_df.Measure=="Value")
        ][['Year','Region','Gender','Age','Value']]
        df_stage1=df_stage1.dropna() #remove NAN rows of NI from 1981 to 1991
        df_stage1['Value']=df_stage1['Value'].astype(int)
        df_stage1['Year']=df_stage1['Year'].astype(int)

        #create the England data by subtracting "Wales" from "England and Wales"
        df_wales=df_stage1[df_stage1.Region=="Wales"]
        df_engl_wales=df_stage1[df_stage1.Region=="England and Wales"]
        df_engl=pd.merge(df_wales,df_engl_wales,on=["Year","Gender","Age"],how="inner")
        df_engl['Value']=df_engl["Value_y"]-df_engl["Value_x"]
        df_engl["Region"]="England"
        df_engl=df_engl[["Year","Region","Gender","Age","Value"]]
        df_pop=pd.concat([df_stage1[df_stage1.Region!="England and Wales"],df_engl])

        #new age binning
        df_pop=df_pop.replace(df_pop.Age.unique(),
                              ["Aged 0-24"]*6+["Aged 25-50"]*5+
                         ["Aged 51-74"]*5+["Aged 75+"]*3
                        )
df_pop.head()
```

```
Out[6]:     Year Region Gender        Age   Value
        2   1981  Wales   Male  Aged 0-24   18300
        4   1981  Wales   Male  Aged 0-24   70200
        6   1981  Wales   Male  Aged 0-24   95300
        8   1981  Wales   Male  Aged 0-24  113500
        10  1981  Wales   Male  Aged 0-24  118700
```

1.3 Data Exploration

Starting from the created dataframe, I study the population progression by the following dimensions: * Number of people * Geographic distribution * Age distribution ### Table with gender distribution in the last year As requested I created a dataframe showing male, female and total population in columns, per UK region in rows, as well as the UK total, for the most recent year.

```
In [8]: most_recent_year=df_pop.Year.max() #compute the most recent year
        df_pop_ry=df_pop[df_pop.Year==most_recent_year].groupby(
            ['Region','Gender']).sum().reset_index()
        df_pop_ry=df_pop_ry.pivot_table(
            index='Region', columns='Gender', values='Value',aggfunc='sum',margins=True)
        df_pop_ry
```

```
Out[8]: Gender              Female      Male       All
        Region
        England           28138500  27481400  55619900
        Northern Ireland    950500    920400   1870900
        Scotland           2784800   2640400   5425200
        Wales              1584900   1540100   3125000
        All               33458700  32582300  66041000
```

1.3.1 Number of people analysis

I analize the number of people trend from 1991 to 2017 because we do not have data of Northern Ireland before 1991.

```
In [9]: df_pop_np=df_pop[df_pop.Year>1991].groupby(
            ['Year','Region']).sum().reset_index()
        df_pop_np=df_pop_np.pivot_table(
            index='Year',columns='Region', values='Value',aggfunc='sum',margins=False)
        df_pop_np.head()
```

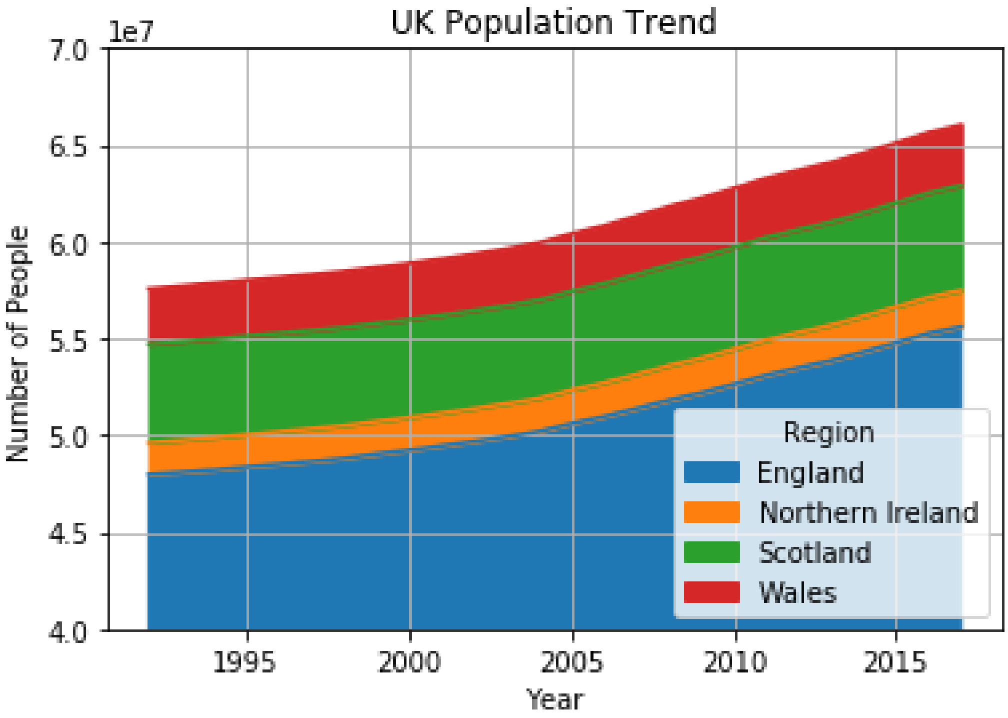
```
Out[9]: Region   England  Northern Ireland  Scotland    Wales
        Year
        1992    47998000           1623400   5085500  2877500
        1993    48102700           1635800   5092400  2883400
        1994    48228700           1643500   5102400  2887600
```

```
1995     48383400            1649100    5104000   2888600
1996     48519100            1661800    5092400   2891200
```

```
In [10]: pop_increase_rate=(df_pop_np.sum(axis=1)[2017]-df_pop_np.sum(axis=1)[2012])/5
         pop_increase_rate
```

```
Out[10]: 467180.0
```

```
In [11]: df_pop_np.plot(kind="area")
         plt.ylabel("Number of People")
         plt.title("UK Population Trend")
         plt.ylim([40000000,70000000])
         plt.grid()
         plt.savefig('np.png')
```



1.3.2 Region analysis

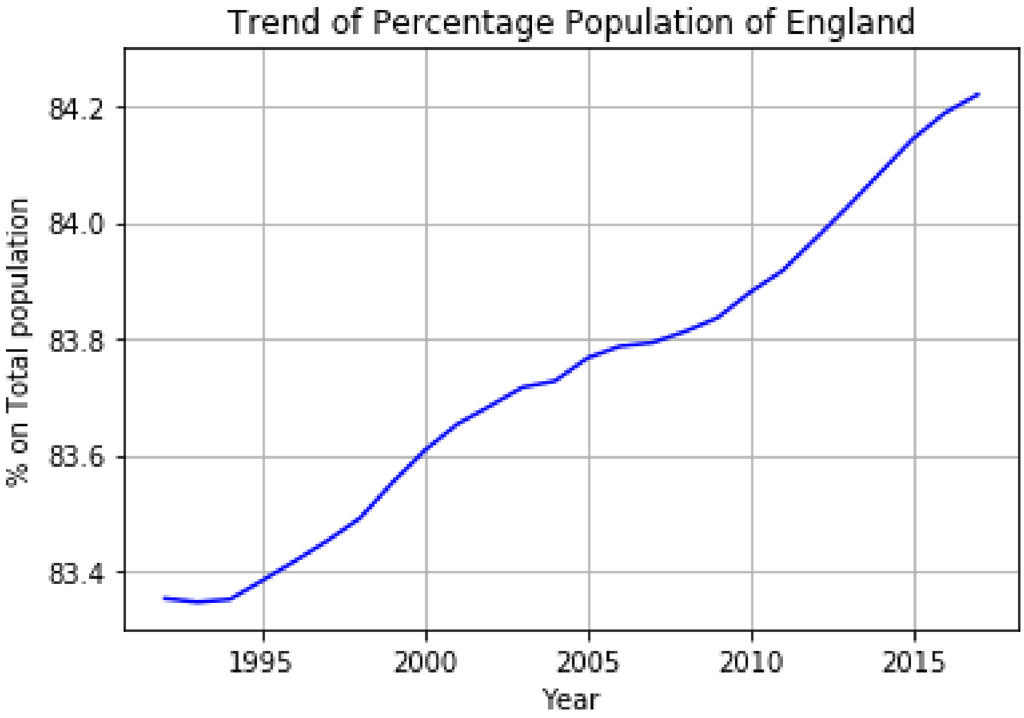
I analize the percentage of people in each region from 1991 to 2017.

```
In [12]: df_pop_reg=pd.merge(
             df_pop[df_pop.Year>1991].groupby(['Year','Region']).sum().reset_index(),
             df_pop[df_pop.Year>1991].groupby(['Year']).sum().reset_index(),
             on='Year',
             how='inner'
```

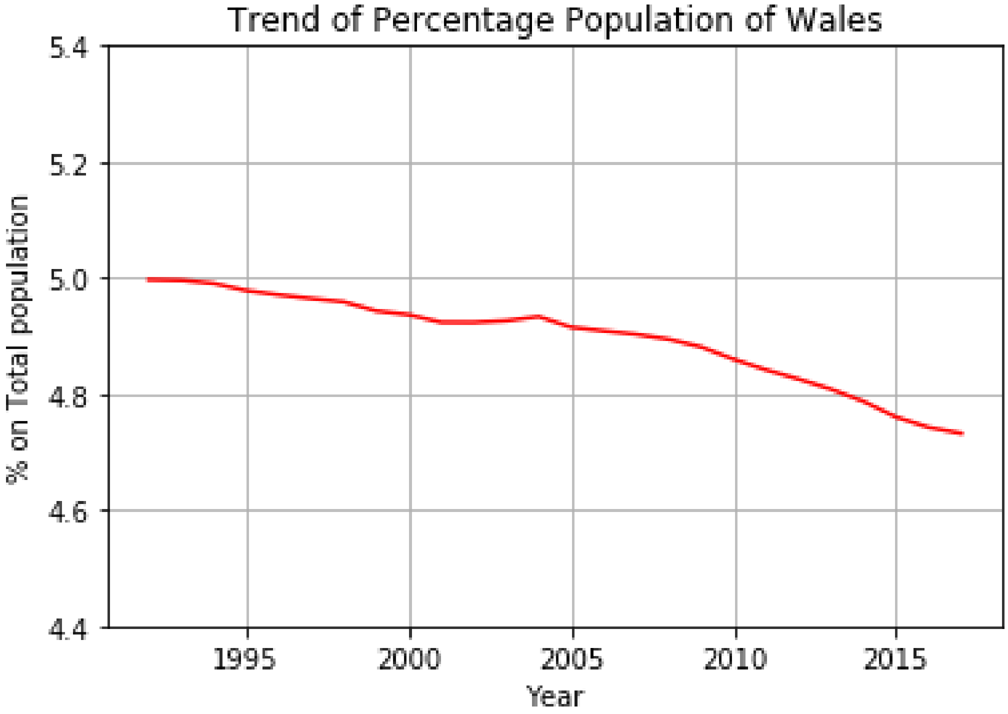
```
        )
        df_pop_reg['Percentage']=df_pop_reg.Value_x/df_pop_reg.Value_y*100
        df_pop_reg=df_pop_reg.pivot_table(
            index='Year',columns='Region', values='Percentage',aggfunc='sum',margins=False)
        df_pop_reg.head()
```

```
Out[12]: Region    England  Northern Ireland  Scotland     Wales
         Year
         1992    83.352436          2.819166  8.831385  4.997013
         1993    83.346242          2.834306  8.823463  4.995989
         1994    83.350961          2.840369  8.818192  4.990477
         1995    83.383570          2.842046  8.796193  4.978190
         1996    83.417033          2.857069  8.755169  4.970730
```

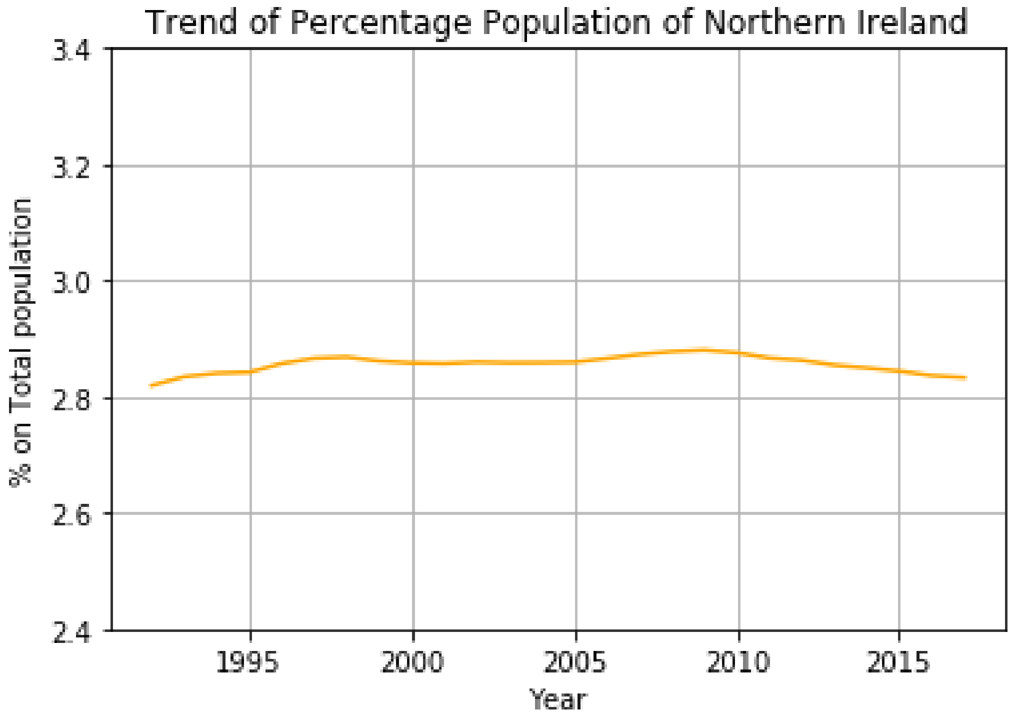
```
In [13]: df_pop_reg['England'].plot(kind="line",color="blue")
         plt.ylabel("% on Total population")
         plt.title("Trend of Percentage Population of England")
         plt.ylim([83.3,84.3]) #same scale for every chart (1%)
         plt.grid()
         plt.savefig('reg1.png')
```



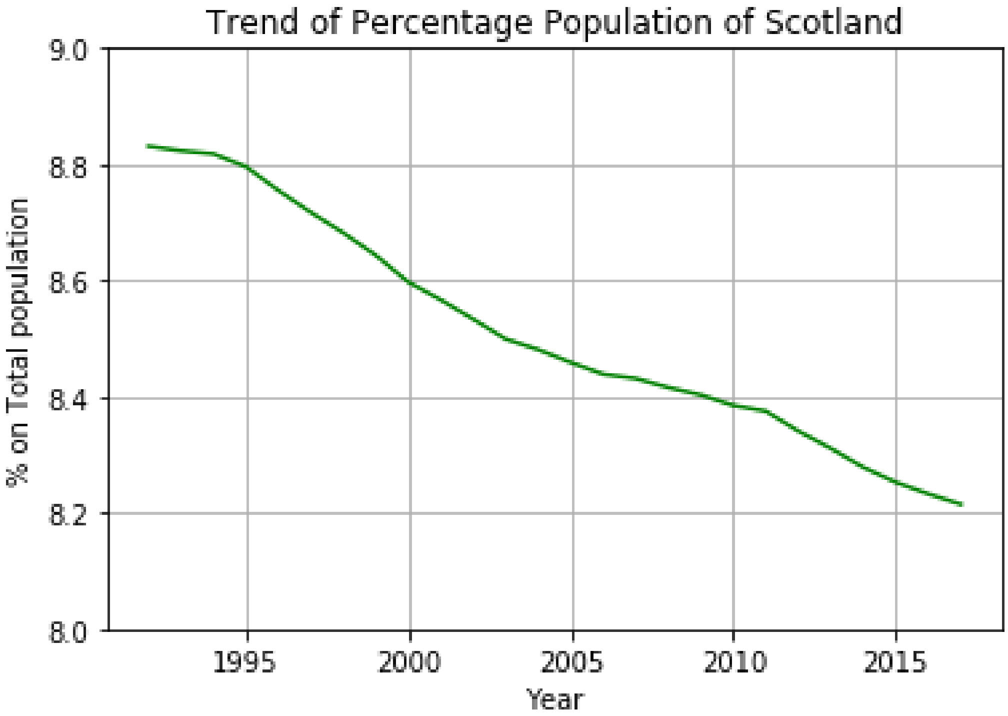
```
In [14]: df_pop_reg['Wales'].plot(kind="line",color="red")
         plt.ylabel("% on Total population")
         plt.title("Trend of Percentage Population of Wales")
         plt.ylim([4.4,5.4]) #same scale for every chart (1%)
         plt.grid()
         plt.savefig('reg2.png')
```



```
In [15]: df_pop_reg['Northern Ireland'].plot(kind="line",color="orange")
         plt.ylabel("% on Total population")
         plt.title("Trend of Percentage Population of Northern Ireland")
         plt.ylim([2.4,3.4]) #same scale for every chart (1%)
         plt.grid()
         plt.savefig('reg3.png')
```



```
In [16]: df_pop_reg['Scotland'].plot(kind="line",color="green")
         plt.ylabel("% on Total population")
         plt.title("Trend of Percentage Population of Scotland")
         plt.ylim([8,9]) #same scale for every chart (1%)
         plt.grid()
         plt.savefig('reg4.png')
```



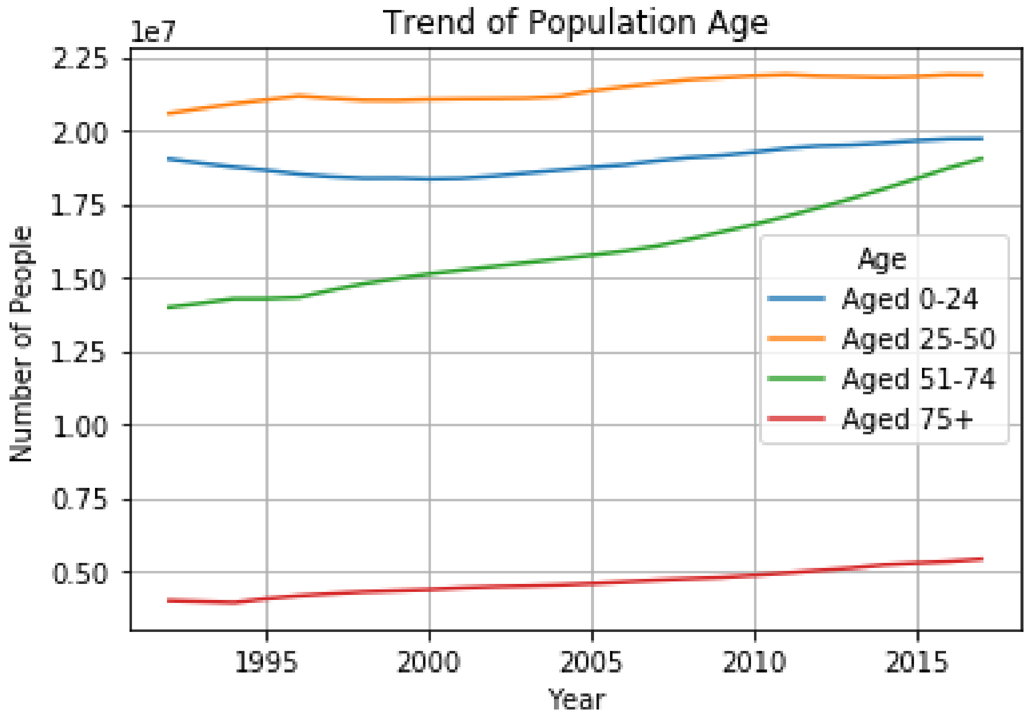
1.3.3 Region analysis

I analize the percentage of people in the group 0-25/ 25-50/ 50-75/ 75+ from 1991 to 2017.

```
In [17]: df_pop_age_abs=df_pop[df_pop.Year>1991].pivot_table(
             index='Year',columns='Age', values='Value',aggfunc='sum',margins=False)
         df_pop_age_abs.head()
```

```
Out[17]: Age    Aged 0-24  Aged 25-50  Aged 51-74  Aged 75+
         Year
         1992    19026200    20579800    13982800   3995600
         1993    18881400    20751500    14119700   3961700
         1994    18753000    20910100    14272200   3926900
         1995    18644300    21045000    14275700   4060100
         1996    18513300    21178300    14316000   4156900
```

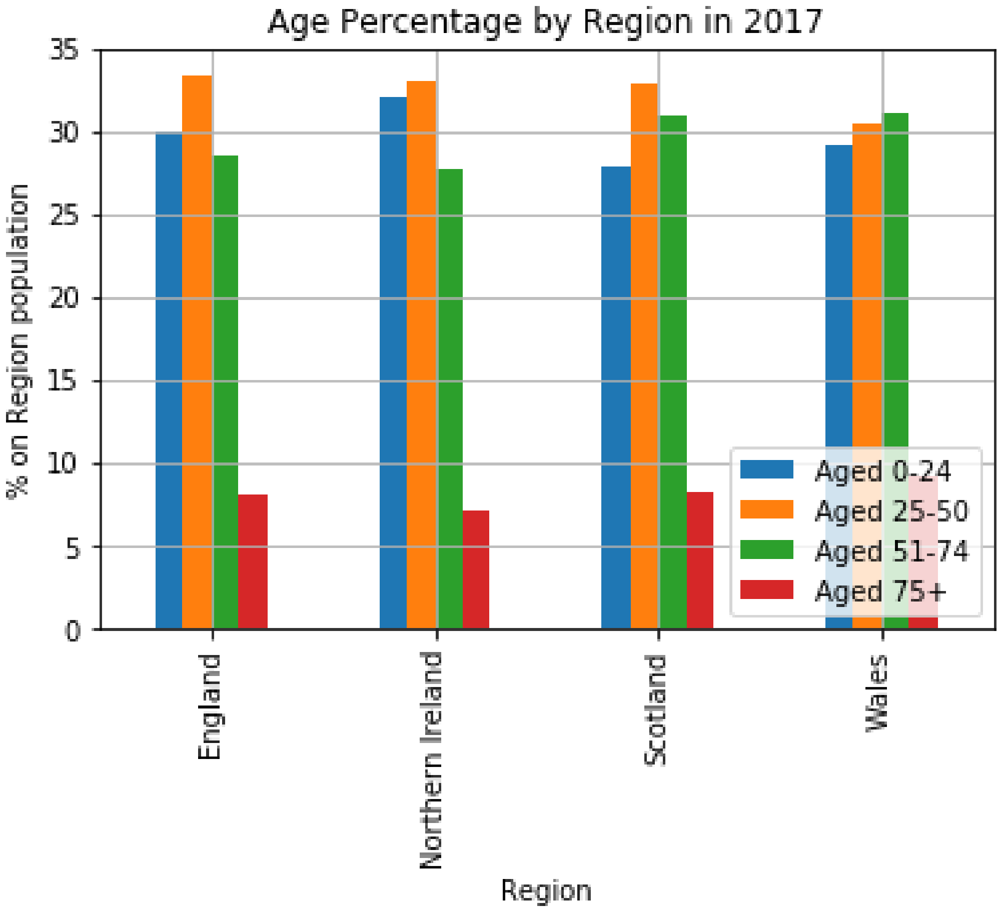
```
In [18]: df_pop_age_abs.plot(kind="line")
         plt.ylabel("Number of People")
         plt.title("Trend of Population Age")
         plt.grid()
         plt.savefig('age1.png')
```



```
In [19]: df_pop_perc=pd.merge(
             df_pop[df_pop.Year==2017].groupby(['Year','Age','Region']).sum().reset_index(),
             df_pop[df_pop.Year==2017].groupby(['Year','Region']).sum().reset_index(),
             on=['Year','Region'],
             how='inner'
         )
         df_pop_perc['Percentage']=df_pop_perc.Value_x/df_pop_perc.Value_y*100
         df_pop_perc=df_pop_perc.pivot_table(
             index='Region',columns='Age', values='Percentage',aggfunc='sum',margins=False)
         df_pop_perc
```

```
Out[19]: Age                Aged 0-24  Aged 25-50  Aged 51-74  Aged 75+
         Region
         England            30.017134   33.305526   28.523065  8.154276
         Northern Ireland   32.107542   32.968090   27.729970  7.194398
         Scotland           27.847821   32.931505   30.961071  8.259603
         Wales              29.190400   30.499200   31.142400  9.168000
```

```
In [20]: df_pop_perc.plot(kind="bar")
         plt.ylabel("% on Region population")
         plt.title("Age Percentage by Region in 2017")
         plt.grid()
         plt.legend(loc="lower right")
         plt.savefig('age2.png')
```


Age Percentage by Region in 2017
% on Region population
35
30
25
20
15
10
5
0
England
Northern Ireland
Scotland
Wales
Region
Aged 0-24
Aged 25-50
Aged 51-74
Aged 75+