DV0101EN-1-1-1-Introduction-to-Matplotlib-and-Line-Plots-py-v2.0

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Introduction to Matplotlib and Line Plots

0.1 Introduction

The aim of these labs is to introduce you to data visualization with Python as concrete and as consistent as possible. Speaking of consistency, because there is no *best* data visualization library avaiblable for Python - up to creating these labs - we have to introduce different libraries and show their benefits when we are discussing new visualization concepts. Doing so, we hope to make students well-rounded with visualization libraries and concepts so that they are able to judge and decide on the best visualitzation technique and tool for a given problem *and* audience.

Please make sure that you have completed the prerequisites for this course, namely **Python for Data Science** and **Data Analysis with Python**, which are part of this specialization.

Note: The majority of the plots and visualizations will be generated using data stored in *pandas* dataframes. Therefore, in this lab, we provide a brief crash course on *pandas*. However, if you are interested in learning more about the *pandas* library, detailed description and explanation of how to use it and how to clean, munge, and process data stored in a *pandas* dataframe are provided in our course **Data Analysis with Python**, which is also part of this specialization.

0.2 Table of Contents

1 Exploring Datasets with *pandas*

pandas is an essential data analysis toolkit for Python. From their website: >*pandas* is a Python package providing fast, flexible, and expressive data structures designed to make working with "relational" or "labeled" data both easy and intuitive. It aims to be the fundamental high-level building block for doing practical, **real world** data analysis in Python.

The course heavily relies on *pandas* for data wrangling, analysis, and visualization. We encourage you to spend some time and familizare yourself with the *pandas* API Reference: http://pandas.pydata.org/pandas-docs/stable/api.html.

1.1 The Dataset: Immigration to Canada from 1980 to 2013

Dataset Source: International migration flows to and from selected countries - The 2015 revision.

The dataset contains annual data on the flows of international immigrants as recorded by the countries of destination. The data presents both inflows and outflows according to the place of birth, citizenship or place of previous / next residence both for foreigners and nationals. The current version presents data pertaining to 45 countries.

In this lab, we will focus on the Canadian immigration data.

For sake of simplicity, Canada's immigration data has been extracted and uploaded to one of IBM servers. You can fetch the data from here.

1.2 *pandas* Basics

The first thing we'll do is import two key data analysis modules: *pandas* and **Numpy**.

[1]:
```
import numpy as np  # useful for many scientific computing in Python
import pandas as pd # primary data structure library
```

Let's download and import our primary Canadian Immigration dataset using *pandas* `read_excel()` method. Normally, before we can do that, we would need to download a module which *pandas* requires to read in excel files. This module is **xlrd**. For your convenience, we have pre-installed this module, so you would not have to worry about that. Otherwise, you would need to run the following line of code to install the **xlrd** module:

```
!conda install -c anaconda xlrd --yes
```

Now we are ready to read in our data.

[2]:
```
df_can = pd.read_excel('https://s3-api.us-geo.objectstorage.softlayer.net/
 ↪cf-courses-data/CognitiveClass/DV0101EN/labs/Data_Files/Canada.xlsx',
                       sheet_name='Canada by Citizenship',
                       skiprows=range(20),
                       skipfooter=2)

print ('Data read into a pandas dataframe!')
```

```
Data read into a pandas dataframe!
```

Let's view the top 5 rows of the dataset using the `head()` function.

[3]:
```
df_can.head()
# tip: You can specify the number of rows you'd like to see as follows: df_can.
 ↪head(10)
```

[3]:
```
         Type    Coverage         OdName  AREA AreaName   REG  \
0  Immigrants  Foreigners    Afghanistan   935     Asia  5501
1  Immigrants  Foreigners        Albania   908   Europe   925
```

```
2  Immigrants  Foreigners         Algeria   903   Africa   912
3  Immigrants  Foreigners  American Samoa   909  Oceania   957
4  Immigrants  Foreigners         Andorra   908   Europe   925

           RegName  DEV             DevName  1980  …  2004  2005  2006  \
0    Southern Asia  902  Developing regions    16  …  2978  3436  3009
1  Southern Europe  901   Developed regions     1  …  1450  1223   856
2  Northern Africa  902  Developing regions    80  …  3616  3626  4807
3        Polynesia  902  Developing regions     0  …     0     0     1
4  Southern Europe  901   Developed regions     0  …     0     0     1

   2007  2008  2009  2010  2011  2012  2013
0  2652  2111  1746  1758  2203  2635  2004
1   702   560   716   561   539   620   603
2  3623  4005  5393  4752  4325  3774  4331
3     0     0     0     0     0     0     0
4     1     0     0     0     0     1     1

[5 rows x 43 columns]
```

We can also veiw the bottom 5 rows of the dataset using the `tail()` function.

[4]:
```
df_can.tail()
```

[4]:
```
           Type    Coverage          OdName  AREA AreaName  REG  \
190  Immigrants  Foreigners        Viet Nam   935     Asia  920
191  Immigrants  Foreigners  Western Sahara   903   Africa  912
192  Immigrants  Foreigners           Yemen   935     Asia  922
193  Immigrants  Foreigners          Zambia   903   Africa  910
194  Immigrants  Foreigners        Zimbabwe   903   Africa  910

                RegName  DEV             DevName  1980  …  2004  2005  2006  \
190  South-Eastern Asia  902  Developing regions  1191  …  1816  1852  3153
191     Northern Africa  902  Developing regions     0  …     0     0     1
192        Western Asia  902  Developing regions     1  …   124   161   140
193      Eastern Africa  902  Developing regions    11  …    56    91    77
194      Eastern Africa  902  Developing regions    72  …  1450   615   454

     2007  2008  2009  2010  2011  2012  2013
190  2574  1784  2171  1942  1723  1731  2112
191     0     0     0     0     0     0     0
192   122   133   128   211   160   174   217
193    71    64    60   102    69    46    59
194   663   611   508   494   434   437   407

[5 rows x 43 columns]
```

When analyzing a dataset, it's always a good idea to start by getting basic information about your dataframe. We can do this by using the `info()` method.

[5]:
```
df_can.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 195 entries, 0 to 194
Data columns (total 43 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   Type      195 non-null    object
 1   Coverage  195 non-null    object
 2   OdName    195 non-null    object
 3   AREA      195 non-null    int64
 4   AreaName  195 non-null    object
 5   REG       195 non-null    int64
 6   RegName   195 non-null    object
 7   DEV       195 non-null    int64
 8   DevName   195 non-null    object
 9   1980      195 non-null    int64
 10  1981      195 non-null    int64
 11  1982      195 non-null    int64
 12  1983      195 non-null    int64
 13  1984      195 non-null    int64
 14  1985      195 non-null    int64
 15  1986      195 non-null    int64
 16  1987      195 non-null    int64
 17  1988      195 non-null    int64
 18  1989      195 non-null    int64
 19  1990      195 non-null    int64
 20  1991      195 non-null    int64
 21  1992      195 non-null    int64
 22  1993      195 non-null    int64
 23  1994      195 non-null    int64
 24  1995      195 non-null    int64
 25  1996      195 non-null    int64
 26  1997      195 non-null    int64
 27  1998      195 non-null    int64
 28  1999      195 non-null    int64
 29  2000      195 non-null    int64
 30  2001      195 non-null    int64
 31  2002      195 non-null    int64
 32  2003      195 non-null    int64
 33  2004      195 non-null    int64
 34  2005      195 non-null    int64
 35  2006      195 non-null    int64
 36  2007      195 non-null    int64
 37  2008      195 non-null    int64
 38  2009      195 non-null    int64
 39   2010       195 non-null    int64
 40   2011       195 non-null    int64
 41   2012       195 non-null    int64
 42   2013       195 non-null    int64
dtypes: int64(37), object(6)
memory usage: 65.6+ KB
```

To get the list of column headers we can call upon the dataframe's `.columns` parameter.

```
[6]: df_can.columns.values
```

```
[6]: array(['Type', 'Coverage', 'OdName', 'AREA', 'AreaName', 'REG', 'RegName',
            'DEV', 'DevName', 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987,
            1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998,
            1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009,
            2010, 2011, 2012, 2013], dtype=object)
```

Similarly, to get the list of indicies we use the `.index` parameter.

```
[7]: df_can.index.values
```

```
[7]: array([  0,   1,   2,   3,   4,   5,   6,   7,   8,   9,  10,  11,  12,
             13,  14,  15,  16,  17,  18,  19,  20,  21,  22,  23,  24,  25,
             26,  27,  28,  29,  30,  31,  32,  33,  34,  35,  36,  37,  38,
             39,  40,  41,  42,  43,  44,  45,  46,  47,  48,  49,  50,  51,
             52,  53,  54,  55,  56,  57,  58,  59,  60,  61,  62,  63,  64,
             65,  66,  67,  68,  69,  70,  71,  72,  73,  74,  75,  76,  77,
             78,  79,  80,  81,  82,  83,  84,  85,  86,  87,  88,  89,  90,
             91,  92,  93,  94,  95,  96,  97,  98,  99, 100, 101, 102, 103,
            104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116,
            117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129,
            130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142,
            143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155,
            156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168,
            169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181,
            182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194])
```

Note: The default type of index and columns is NOT list.

```
[8]: print(type(df_can.columns))
     print(type(df_can.index))
```

```
<class 'pandas.core.indexes.base.Index'>
<class 'pandas.core.indexes.range.RangeIndex'>
```

To get the index and columns as lists, we can use the `tolist()` method.

```
[9]: df_can.columns.tolist()
     df_can.index.tolist()
```

```
print (type(df_can.columns.tolist()))
print (type(df_can.index.tolist()))
```

```
<class 'list'>
<class 'list'>
```

To view the dimensions of the dataframe, we use the `.shape` parameter.

```
[10]: # size of dataframe (rows, columns)
df_can.shape
```

```
[10]: (195, 43)
```

Note: The main types stored in *pandas* objects are *float*, *int*, *bool*, *datetime64[ns]* and *datetime64[ns, tz] (in >= 0.17.0)*, *timedelta[ns]*, *category (in >= 0.15.0)*, and *object* (string). In addition these dtypes have item sizes, e.g. int64 and int32.

Let's clean the data set to remove a few unnecessary columns. We can use *pandas* `drop()` method as follows:

```
[11]: # in pandas axis=0 represents rows (default) and axis=1 represents columns.
df_can.drop(['AREA','REG','DEV','Type','Coverage'], axis=1, inplace=True)
df_can.head(2)
```

```
[11]:         OdName AreaName          RegName             DevName  1980  1981  \
0  Afghanistan     Asia    Southern Asia  Developing regions    16    39
1      Albania   Europe  Southern Europe   Developed regions     1     0

   1982  1983  1984  1985  …  2004  2005  2006  2007  2008  2009  2010  \
0    39    47    71   340  …  2978  3436  3009  2652  2111  1746  1758
1     0     0     0     0  …  1450  1223   856   702   560   716   561

   2011  2012  2013
0  2203  2635  2004
1   539   620   603

[2 rows x 38 columns]
```

Let's rename the columns so that they make sense. We can use `rename()` method by passing in a dictionary of old and new names as follows:

```
[12]: df_can.rename(columns={'OdName':'Country', 'AreaName':'Continent', 'RegName':
 ↪'Region'}, inplace=True)
df_can.columns
```

```
[12]: Index([  'Country', 'Continent',    'Region',   'DevName',        1980,
                    1981,        1982,        1983,        1984,        1985,
                    1986,        1987,        1988,        1989,        1990,
                    1991,           1992,           1993,           1994,           1995,
                    1996,           1997,           1998,           1999,           2000,
                    2001,           2002,           2003,           2004,           2005,
                    2006,           2007,           2008,           2009,           2010,
                    2011,           2012,           2013],
            dtype='object')
```

We will also add a 'Total' column that sums up the total immigrants by country over the entire period 1980 - 2013, as follows:

[13]:
```
df_can['Total'] = df_can.sum(axis=1)
```

We can check to see how many null objects we have in the dataset as follows:

[14]:
```
df_can.isnull().sum()
```

[14]:
```
Country      0
Continent    0
Region       0
DevName      0
1980         0
1981         0
1982         0
1983         0
1984         0
1985         0
1986         0
1987         0
1988         0
1989         0
1990         0
1991         0
1992         0
1993         0
1994         0
1995         0
1996         0
1997         0
1998         0
1999         0
2000         0
2001         0
2002         0
2003         0
2004         0
2005         0
2006         0
2007         0
```

```
2008        0
2009        0
2010        0
2011        0
2012        0
2013        0
Total       0
dtype: int64
```

Finally, let's view a quick summary of each column in our dataframe using the `describe()` method.

[15]:
```
df_can.describe()
```

[15]:
```
               1980          1981          1982          1983          1984  \
count    195.000000    195.000000    195.000000    195.000000    195.000000
mean     508.394872    566.989744    534.723077    387.435897    376.497436
std     1949.588546   2152.643752   1866.997511   1204.333597   1198.246371
min        0.000000      0.000000      0.000000      0.000000      0.000000
25%        0.000000      0.000000      0.000000      0.000000      0.000000
50%       13.000000     10.000000     11.000000     12.000000     13.000000
75%      251.500000    295.500000    275.000000    173.000000    181.000000
max    22045.000000  24796.000000  20620.000000  10015.000000  10170.000000

              1985         1986          1987          1988          1989  \
count   195.000000   195.000000    195.000000    195.000000    195.000000
mean    358.861538   441.271795    691.133333    714.389744    843.241026
std    1079.309600  1225.576630   2109.205607   2443.606788   2555.048874
min       0.000000     0.000000      0.000000      0.000000      0.000000
25%       0.000000     0.500000      0.500000      1.000000      1.000000
50%      17.000000    18.000000     26.000000     34.000000     44.000000
75%     197.000000   254.000000    434.000000    409.000000    508.500000
max    9564.000000  9470.000000  21337.000000  27359.000000  23795.000000

       …          2005          2006          2007          2008  \
count  …    195.000000    195.000000    195.000000    195.000000
mean   …   1320.292308   1266.958974   1191.820513   1246.394872
std    …   4425.957828   3926.717747   3443.542409   3694.573544
min    …      0.000000      0.000000      0.000000      0.000000
25%    …     28.500000     25.000000     31.000000     31.000000
50%    …    210.000000    218.000000    198.000000    205.000000
75%    …    832.000000    842.000000    899.000000    934.500000
max    …  42584.000000  33848.000000  28742.000000  30037.000000

               2009          2010          2011          2012          2013  \
count    195.000000    195.000000    195.000000    195.000000    195.000000
mean    1275.733333   1420.287179   1262.533333   1313.958974   1320.702564
std     3829.630424   4462.946328   4030.084313   4247.555161   4237.951988
```

```
min       0.000000      0.000000      0.000000      0.000000      0.000000
25%      36.000000     40.500000     37.500000     42.500000     45.000000
50%     214.000000    211.000000    179.000000    233.000000    213.000000
75%     888.000000    932.000000    772.000000    783.000000    796.000000
max   29622.000000  38617.000000  36765.000000  34315.000000  34129.000000

               Total
count     195.000000
mean    32867.451282
std     91785.498686
min         1.000000
25%       952.000000
50%      5018.000000
75%     22239.500000
max    691904.000000

[8 rows x 35 columns]
```

1.3 *pandas* Intermediate: Indexing and Selection (slicing)

1.3.1 Select Column

There are two ways to filter on a column name:

Method 1: Quick and easy, but only works if the column name does NOT have spaces or special characters.

```
df.column_name
    (returns series)
```

Method 2: More robust, and can filter on multiple columns.

```
df['column']
    (returns series)
```

```
df[['column 1', 'column 2']]
    (returns dataframe)
```

Example: Let's try filtering on the list of countries ('Country').

```
[16]: df_can.Country  # returns a series
```

```
[16]: 0         Afghanistan
      1             Albania
      2             Algeria
      3      American Samoa
      4             Andorra
                 …
```

```
190           Viet Nam
191     Western Sahara
192              Yemen
193             Zambia
194           Zimbabwe
Name: Country, Length: 195, dtype: object
```

Let's try filtering on the list of countries ('OdName') and the data for years: 1980 - 1985.

```
[17]: df_can[['Country', 1980, 1981, 1982, 1983, 1984, 1985]] # returns a dataframe
      # notice that 'Country' is string, and the years are integers.
      # for the sake of consistency, we will convert all column names to string later␣
       ↪on.
```

```
[17]:            Country  1980  1981  1982  1983  1984  1985
      0       Afghanistan    16    39    39    47    71   340
      1           Albania     1     0     0     0     0     0
      2           Algeria    80    67    71    69    63    44
      3    American Samoa     0     1     0     0     0     0
      4           Andorra     0     0     0     0     0     0
      ..              …     …     …     …     …     …     …
      190        Viet Nam  1191  1829  2162  3404  7583  5907
      191  Western Sahara     0     0     0     0     0     0
      192           Yemen     1     2     1     6     0    18
      193          Zambia    11    17    11     7    16     9
      194        Zimbabwe    72   114   102    44    32    29

      [195 rows x 7 columns]
```

1.3.2 Select Row

There are main 3 ways to select rows:

```
df.loc[label]
    #filters by the labels of the index/column
df.iloc[index]
    #filters by the positions of the index/column
```

Before we proceed, notice that the defaul index of the dataset is a numeric range from 0 to 194. This makes it very difficult to do a query by a specific country. For example to search for data on Japan, we need to know the corressponding index value.

This can be fixed very easily by setting the 'Country' column as the index using `set_index()` method.

```
[18]: df_can.set_index('Country', inplace=True)
      # tip: The opposite of set is reset. So to reset the index, we can use df_can.
       ↪reset_index()
```

[19]:
```
df_can.head(3)
```

[19]:
```
                Continent           Region             DevName  1980  1981  1982  \
Country
Afghanistan          Asia    Southern Asia  Developing regions    16    39    39
Albania            Europe  Southern Europe   Developed regions     1     0     0
Algeria            Africa  Northern Africa  Developing regions    80    67    71

             1983  1984  1985  1986  …  2005  2006  2007  2008  2009  2010  \
Country                              …
Afghanistan    47    71   340   496  …  3436  3009  2652  2111  1746  1758
Albania         0     0     0     1  …  1223   856   702   560   716   561
Algeria        69    63    44    69  …  3626  4807  3623  4005  5393  4752

             2011  2012  2013  Total
Country
Afghanistan  2203  2635  2004  58639
Albania       539   620   603  15699
Algeria      4325  3774  4331  69439

[3 rows x 38 columns]
```

[20]:
```
# optional: to remove the name of the index
df_can.index.name = None
```

Example: Let's view the number of immigrants from Japan (row 87) for the following scenarios: 1. The full row data (all columns) 2. For year 2013 3. For years 1980 to 1985

[21]:
```
# 1. the full row data (all columns)
print(df_can.loc['Japan'])

# alternate methods
print(df_can.iloc[87])
print(df_can[df_can.index == 'Japan'].T.squeeze())
```

```
Continent                        Asia
Region                   Eastern Asia
DevName             Developed regions
1980                              701
1981                              756
1982                              598
1983                              309
1984                              246
1985                              198
1986                              248
1987                              422
1988                              324
1989                              494
```

```
1990                        379
1991                        506
1992                        605
1993                        907
1994                        956
1995                        826
1996                        994
1997                        924
1998                        897
1999                       1083
2000                       1010
2001                       1092
2002                        806
2003                        817
2004                        973
2005                       1067
2006                       1212
2007                       1250
2008                       1284
2009                       1194
2010                       1168
2011                       1265
2012                       1214
2013                        982
Total                     27707
Name: Japan, dtype: object
Continent                  Asia
Region             Eastern Asia
DevName       Developed regions
1980                        701
1981                        756
1982                        598
1983                        309
1984                        246
1985                        198
1986                        248
1987                        422
1988                        324
1989                        494
1990                        379
1991                        506
1992                        605
1993                        907
1994                        956
1995                        826
1996                        994
1997                        924
1998                        897
```

```
1999                       1083
2000                       1010
2001                       1092
2002                        806
2003                        817
2004                        973
2005                       1067
2006                       1212
2007                       1250
2008                       1284
2009                       1194
2010                       1168
2011                       1265
2012                       1214
2013                        982
Total                     27707
Name: Japan, dtype: object
Continent                  Asia
Region             Eastern Asia
DevName      Developed regions
1980                        701
1981                        756
1982                        598
1983                        309
1984                        246
1985                        198
1986                        248
1987                        422
1988                        324
1989                        494
1990                        379
1991                        506
1992                        605
1993                        907
1994                        956
1995                        826
1996                        994
1997                        924
1998                        897
1999                       1083
2000                       1010
2001                       1092
2002                        806
2003                        817
2004                        973
2005                       1067
2006                       1212
2007                       1250
```

```
2008                          1284
2009                          1194
2010                          1168
2011                          1265
2012                          1214
2013                           982
Total                        27707
Name: Japan, dtype: object
```

```
[22]: # 2. for year 2013
      print(df_can.loc['Japan', 2013])

      # alternate method
      print(df_can.iloc[87, 36]) # year 2013 is the last column, with a positional␣
       ↪index of 36
```

```
982
982
```

```
[23]: # 3. for years 1980 to 1985
      print(df_can.loc['Japan', [1980, 1981, 1982, 1983, 1984, 1984]])
      print(df_can.iloc[87, [3, 4, 5, 6, 7, 8]])
```

```
1980    701
1981    756
1982    598
1983    309
1984    246
1984    246
Name: Japan, dtype: object
1980    701
1981    756
1982    598
1983    309
1984    246
1985    198
Name: Japan, dtype: object
```

Column names that are integers (such as the years) might introduce some confusion. For example, when we are referencing the year 2013, one might confuse that when the 2013th positional index.

To avoid this ambuigity, let's convert the column names into strings: '1980' to '2013'.

```
[24]: df_can.columns = list(map(str, df_can.columns))
      # [print (type(x)) for x in df_can.columns.values] #<-- uncomment to check type␣
       ↪of column headers
```

Since we converted the years to string, let's declare a variable that will allow us to easily call upon the full range of years:

[25]:
```
# useful for plotting later on
years = list(map(str, range(1980, 2014)))
years
```

[25]:
```
['1980',
 '1981',
 '1982',
 '1983',
 '1984',
 '1985',
 '1986',
 '1987',
 '1988',
 '1989',
 '1990',
 '1991',
 '1992',
 '1993',
 '1994',
 '1995',
 '1996',
 '1997',
 '1998',
 '1999',
 '2000',
 '2001',
 '2002',
 '2003',
 '2004',
 '2005',
 '2006',
 '2007',
 '2008',
 '2009',
 '2010',
 '2011',
 '2012',
 '2013']
```

1.3.3 Filtering based on a criteria

To filter the dataframe based on a condition, we simply pass the condition as a boolean vector.

For example, Let's filter the dataframe to show the data on Asian countries (AreaName = Asia).

[26]:
```
# 1. create the condition boolean series
condition = df_can['Continent'] == 'Asia'
print(condition)
```

```
Afghanistan        True
Albania           False
Algeria           False
American Samoa    False
Andorra           False
                  …
Viet Nam           True
Western Sahara    False
Yemen              True
Zambia            False
Zimbabwe          False
Name: Continent, Length: 195, dtype: bool
```

[27]:
```
# 2. pass this condition into the dataFrame
df_can[condition]
```

[27]:
```
                                               Continent             Region  \
Afghanistan                                         Asia      Southern Asia
Armenia                                             Asia       Western Asia
Azerbaijan                                          Asia       Western Asia
Bahrain                                             Asia       Western Asia
Bangladesh                                          Asia      Southern Asia
Bhutan                                              Asia      Southern Asia
Brunei Darussalam                                   Asia South-Eastern Asia
Cambodia                                            Asia South-Eastern Asia
China                                               Asia       Eastern Asia
China, Hong Kong Special Administrative Region      Asia       Eastern Asia
China, Macao Special Administrative Region          Asia       Eastern Asia
Cyprus                                              Asia       Western Asia
Democratic People's Republic of Korea               Asia       Eastern Asia
Georgia                                             Asia       Western Asia
India                                               Asia      Southern Asia
Indonesia                                           Asia South-Eastern Asia
Iran (Islamic Republic of)                          Asia      Southern Asia
Iraq                                                Asia       Western Asia
Israel                                              Asia       Western Asia
Japan                                               Asia       Eastern Asia
Jordan                                              Asia       Western Asia
Kazakhstan                                          Asia       Central Asia
Kuwait                                              Asia       Western Asia
Kyrgyzstan                                          Asia       Central Asia
Lao People's Democratic Republic                    Asia South-Eastern Asia
Lebanon                                             Asia       Western Asia
Malaysia                                            Asia South-Eastern Asia
Maldives                                            Asia      Southern Asia
Mongolia                                            Asia       Eastern Asia
Myanmar                                             Asia South-Eastern Asia
```

```
Nepal                                                 Asia       Southern Asia
Oman                                                  Asia        Western Asia
Pakistan                                              Asia       Southern Asia
Philippines                                           Asia  South-Eastern Asia
Qatar                                                 Asia        Western Asia
Republic of Korea                                     Asia        Eastern Asia
Saudi Arabia                                          Asia        Western Asia
Singapore                                             Asia  South-Eastern Asia
Sri Lanka                                             Asia       Southern Asia
State of Palestine                                    Asia        Western Asia
Syrian Arab Republic                                  Asia        Western Asia
Tajikistan                                            Asia        Central Asia
Thailand                                              Asia  South-Eastern Asia
Turkey                                                Asia        Western Asia
Turkmenistan                                          Asia        Central Asia
United Arab Emirates                                  Asia        Western Asia
Uzbekistan                                            Asia        Central Asia
Viet Nam                                              Asia  South-Eastern Asia
Yemen                                                 Asia        Western Asia

                                                         DevName  1980  \
Afghanistan                                   Developing regions    16
Armenia                                       Developing regions     0
Azerbaijan                                    Developing regions     0
Bahrain                                       Developing regions     0
Bangladesh                                    Developing regions    83
Bhutan                                        Developing regions     0
Brunei Darussalam                             Developing regions    79
Cambodia                                      Developing regions    12
China                                         Developing regions  5123
China, Hong Kong Special Administrative Region  Developing regions     0
China, Macao Special Administrative Region    Developing regions     0
Cyprus                                        Developing regions   132
Democratic People's Republic of Korea         Developing regions     1
Georgia                                       Developing regions     0
India                                         Developing regions  8880
Indonesia                                     Developing regions   186
Iran (Islamic Republic of)                    Developing regions  1172
Iraq                                          Developing regions   262
Israel                                        Developing regions  1403
Japan                                          Developed regions   701
Jordan                                        Developing regions   177
Kazakhstan                                    Developing regions     0
Kuwait                                        Developing regions     1
Kyrgyzstan                                    Developing regions     0
Lao People's Democratic Republic              Developing regions    11
Lebanon                                       Developing regions  1409
```

```
Malaysia                                        Developing regions   786
Maldives                                        Developing regions     0
Mongolia                                        Developing regions     0
Myanmar                                         Developing regions    80
Nepal                                           Developing regions     1
Oman                                            Developing regions     0
Pakistan                                        Developing regions   978
Philippines                                     Developing regions  6051
Qatar                                           Developing regions     0
Republic of Korea                               Developing regions  1011
Saudi Arabia                                    Developing regions     0
Singapore                                       Developing regions   241
Sri Lanka                                       Developing regions   185
State of Palestine                              Developing regions     0
Syrian Arab Republic                            Developing regions   315
Tajikistan                                      Developing regions     0
Thailand                                        Developing regions    56
Turkey                                          Developing regions   481
Turkmenistan                                    Developing regions     0
United Arab Emirates                            Developing regions     0
Uzbekistan                                      Developing regions     0
Viet Nam                                        Developing regions  1191
Yemen                                           Developing regions     1

                                                1981  1982  1983  1984  1985  \
Afghanistan                                       39    39    47    71   340
Armenia                                            0     0     0     0     0
Azerbaijan                                         0     0     0     0     0
Bahrain                                            2     1     1     1     3
Bangladesh                                        84    86    81    98    92
Bhutan                                             0     0     0     1     0
Brunei Darussalam                                  6     8     2     2     4
Cambodia                                          19    26    33    10     7
China                                           6682  3308  1863  1527  1816
China, Hong Kong Special Administrative Region     0     0     0     0     0
China, Macao Special Administrative Region         0     0     0     0     0
Cyprus                                           128    84    46    46    43
Democratic People's Republic of Korea              1     3     1     4     3
Georgia                                            0     0     0     0     0
India                                           8670  8147  7338  5704  4211
Indonesia                                        178   252   115   123   100
Iran (Islamic Republic of)                      1429  1822  1592  1977  1648
Iraq                                             245   260   380   428   231
Israel                                          1711  1334   541   446   680
Japan                                            756   598   309   246   198
Jordan                                           160   155   113   102   179
Kazakhstan                                         0     0     0     0     0
```

```
Kuwait                                            0     8     2     1     4
Kyrgyzstan                                        0     0     0     0     0
Lao People's Democratic Republic                  6    16    16     7    17
Lebanon                                        1119  1159   789  1253  1683
Malaysia                                        816   813   448   384   374
Maldives                                          0     0     1     0     0
Mongolia                                          0     0     0     0     0
Myanmar                                          62    46    31    41    23
Nepal                                             1     6     1     2     4
Oman                                              0     0     8     0     0
Pakistan                                        972  1201   900   668   514
Philippines                                    5921  5249  4562  3801  3150
Qatar                                             0     0     0     0     0
Republic of Korea                              1456  1572  1081   847   962
Saudi Arabia                                      0     1     4     1     2
Singapore                                       301   337   169   128   139
Sri Lanka                                       371   290   197  1086   845
State of Palestine                                0     0     0     0     0
Syrian Arab Republic                            419   409   269   264   385
Tajikistan                                        0     0     0     0     0
Thailand                                         53   113    65    82    66
Turkey                                          874   706   280   338   202
Turkmenistan                                      0     0     0     0     0
United Arab Emirates                              2     2     1     2     0
Uzbekistan                                        0     0     0     0     0
Viet Nam                                       1829  2162  3404  7583  5907
Yemen                                             2     1     6     0    18

                                               1986  …   2005   2006  \
Afghanistan                                     496  …   3436   3009
Armenia                                           0  …    224    218
Azerbaijan                                        0  …    359    236
Bahrain                                           0  …     12     12
Bangladesh                                      486  …   4171   4014
Bhutan                                            0  …      5     10
Brunei Darussalam                                12  …      4      5
Cambodia                                          8  …    370    529
China                                          1960  …  42584  33518
China, Hong Kong Special Administrative Region    0  …    729    712
China, Macao Special Administrative Region        0  …     21     32
Cyprus                                           48  …      7      9
Democratic People's Republic of Korea             0  …     14     10
Georgia                                           0  …    114    125
India                                          7150  …  36210  33848
Indonesia                                       127  …    632    613
Iran (Islamic Republic of)                     1794  …   5837   7480
Iraq                                            265  …   2226   1788
```

```
Israel                                           1212  ...   2446   2625
Japan                                             248  ...   1067   1212
Jordan                                            181  ...   1940   1827
Kazakhstan                                          0  ...    506    408
Kuwait                                              4  ...     66     35
Kyrgyzstan                                          0  ...    173    161
Lao People's Democratic Republic                   21  ...     42     74
Lebanon                                          2576  ...   3709   3802
Malaysia                                          425  ...    593    580
Maldives                                            0  ...      0      0
Mongolia                                            0  ...     59     64
Myanmar                                            18  ...    210    953
Nepal                                              13  ...    607    540
Oman                                                0  ...     14     18
Pakistan                                          691  ...  14314  13127
Philippines                                      4166  ...  18139  18400
Qatar                                               1  ...     11      2
Republic of Korea                                1208  ...   5832   6215
Saudi Arabia                                        5  ...    198    252
Singapore                                         205  ...    392    298
Sri Lanka                                        1838  ...   4930   4714
State of Palestine                                  0  ...    453    627
Syrian Arab Republic                              493  ...   1458   1145
Tajikistan                                          0  ...     85     46
Thailand                                           78  ...    575    500
Turkey                                            257  ...   2065   1638
Turkmenistan                                        0  ...     40     26
United Arab Emirates                                5  ...     31     42
Uzbekistan                                          0  ...    330    262
Viet Nam                                         2741  ...   1852   3153
Yemen                                               7  ...    161    140

                                                  2007   2008   2009   2010  \
Afghanistan                                       2652   2111   1746   1758
Armenia                                            198    205    267    252
Azerbaijan                                         203    125    165    209
Bahrain                                             22      9     35     28
Bangladesh                                        2897   2939   2104   4721
Bhutan                                               7     36    865   1464
Brunei Darussalam                                   11     10      5     12
Cambodia                                           460    354    203    200
China                                            27642  30037  29622  30391
China, Hong Kong Special Administrative Region     674    897    657    623
China, Macao Special Administrative Region          16     12     21     21
Cyprus                                               4      7      6     18
Democratic People's Republic of Korea                7     19     11     45
Georgia                                            132    112    128    126
```

India	28742	28261	29456	34235
Indonesia	657	661	504	712
Iran (Islamic Republic of)	6974	6475	6580	7477
Iraq	2406	3543	5450	5941
Israel	2401	2562	2316	2755
Japan	1250	1284	1194	1168
Jordan	1421	1581	1235	1831
Kazakhstan	436	394	431	377
Kuwait	62	53	68	67
Kyrgyzstan	135	168	173	157
Lao People's Democratic Republic	53	32	39	54
Lebanon	3467	3566	3077	3432
Malaysia	600	658	640	802
Maldives	2	1	7	4
Mongolia	82	59	118	169
Myanmar	1887	975	1153	556
Nepal	511	581	561	1392
Oman	16	10	7	14
Pakistan	10124	8994	7217	6811
Philippines	19837	24887	28573	38617
Qatar	5	9	6	18
Republic of Korea	5920	7294	5874	5537
Saudi Arabia	188	249	246	330
Singapore	690	734	366	805
Sri Lanka	4123	4756	4547	4422
State of Palestine	441	481	400	654
Syrian Arab Republic	1056	919	917	1039
Tajikistan	44	15	50	52
Thailand	487	519	512	499
Turkey	1463	1122	1238	1492
Turkmenistan	37	13	20	30
United Arab Emirates	37	33	37	86
Uzbekistan	284	215	288	289
Viet Nam	2574	1784	2171	1942
Yemen	122	133	128	211

	2011	2012	2013	Total
Afghanistan	2203	2635	2004	58639
Armenia	236	258	207	3310
Azerbaijan	138	161	57	2649
Bahrain	21	39	32	475
Bangladesh	2694	2640	3789	65568
Bhutan	1879	1075	487	5876
Brunei Darussalam	6	3	6	600
Cambodia	196	233	288	6538
China	28502	33024	34129	659962
China, Hong Kong Special Administrative Region	591	728	774	9327

```
China, Macao Special Administrative Region          13     33     29     284
Cyprus                                               6     12     16    1126
Democratic People's Republic of Korea               97     66     17     388
Georgia                                            139    147    125    2068
India                                            27509  30933  33087  691904
Indonesia                                          390    395    387   13150
Iran (Islamic Republic of)                        7479   7534  11291  175923
Iraq                                              6196   4041   4918   69789
Israel                                            1970   2134   1945   66508
Japan                                             1265   1214    982   27707
Jordan                                            1635   1206   1255   35406
Kazakhstan                                         381    462    348    8490
Kuwait                                              58     73     48    2025
Kyrgyzstan                                         159    278    123    2353
Lao People's Democratic Republic                    22     25     15    1089
Lebanon                                           3072   1614   2172  115359
Malaysia                                           409    358    204   24417
Maldives                                             3      1      1      30
Mongolia                                           103     68     99     952
Myanmar                                            368    193    262    9245
Nepal                                             1129   1185   1308   10222
Oman                                                10     13     11     224
Pakistan                                          7468  11227  12603  241600
Philippines                                      36765  34315  29544  511391
Qatar                                                3     14      6     157
Republic of Korea                                 4588   5316   4509  142581
Saudi Arabia                                       278    286    267    3425
Singapore                                          219    146    141   14579
Sri Lanka                                         3309   3338   2394  148358
State of Palestine                                 555    533    462    6512
Syrian Arab Republic                              1005    650   1009   31485
Tajikistan                                          47     34     39     503
Thailand                                           396    296    400    9174
Turkey                                            1257   1068    729   31781
Turkmenistan                                        20     20     14     310
United Arab Emirates                                60     54     46     836
Uzbekistan                                         162    235    167    3368
Viet Nam                                          1723   1731   2112   97146
Yemen                                              160    174    217    2985

[49 rows x 38 columns]
```

[28]:
```
# we can pass mutliple criteria in the same line.
# let's filter for AreaNAme = Asia and RegName = Southern Asia

df_can[(df_can['Continent']=='Asia') & (df_can['Region']=='Southern Asia')]
```

```
# note: When using 'and' and 'or' operators, pandas requires we use '&' and '|'␣
↪instead of 'and' and 'or'
# don't forget to enclose the two conditions in parentheses
```

[28]:

```
                           Continent         Region             DevName  1980  \
Afghanistan                     Asia  Southern Asia  Developing regions    16
Bangladesh                      Asia  Southern Asia  Developing regions    83
Bhutan                          Asia  Southern Asia  Developing regions     0
India                           Asia  Southern Asia  Developing regions  8880
Iran (Islamic Republic of)      Asia  Southern Asia  Developing regions  1172
Maldives                        Asia  Southern Asia  Developing regions     0
Nepal                           Asia  Southern Asia  Developing regions     1
Pakistan                        Asia  Southern Asia  Developing regions   978
Sri Lanka                       Asia  Southern Asia  Developing regions   185

                            1981  1982  1983  1984  1985  1986  …   2005  \
Afghanistan                   39    39    47    71   340   496  …   3436
Bangladesh                    84    86    81    98    92   486  …   4171
Bhutan                         0     0     0     1     0     0  …      5
India                       8670  8147  7338  5704  4211  7150  …  36210
Iran (Islamic Republic of)  1429  1822  1592  1977  1648  1794  …   5837
Maldives                       0     0     1     0     0     0  …      0
Nepal                          1     6     1     2     4    13  …    607
Pakistan                     972  1201   900   668   514   691  …  14314
Sri Lanka                    371   290   197  1086   845  1838  …   4930

                             2006   2007   2008   2009   2010   2011   2012  \
Afghanistan                  3009   2652   2111   1746   1758   2203   2635
Bangladesh                   4014   2897   2939   2104   4721   2694   2640
Bhutan                         10      7     36    865   1464   1879   1075
India                       33848  28742  28261  29456  34235  27509  30933
Iran (Islamic Republic of)   7480   6974   6475   6580   7477   7479   7534
Maldives                        0      2      1      7      4      3      1
Nepal                         540    511    581    561   1392   1129   1185
Pakistan                    13127  10124   8994   7217   6811   7468  11227
Sri Lanka                    4714   4123   4756   4547   4422   3309   3338

                             2013   Total
Afghanistan                  2004   58639
Bangladesh                   3789   65568
Bhutan                        487    5876
India                       33087  691904
Iran (Islamic Republic of)  11291  175923
Maldives                        1      30
Nepal                        1308   10222
Pakistan                    12603  241600
Sri Lanka                    2394  148358
```

```
[9 rows x 38 columns]
```

Before we proceed: let's review the changes we have made to our dataframe.

```
[29]: print('data dimensions:', df_can.shape)
      print(df_can.columns)
      df_can.head(2)
```

```
data dimensions: (195, 38)
Index(['Continent', 'Region', 'DevName', '1980', '1981', '1982', '1983',
       '1984', '1985', '1986', '1987', '1988', '1989', '1990', '1991', '1992',
       '1993', '1994', '1995', '1996', '1997', '1998', '1999', '2000', '2001',
       '2002', '2003', '2004', '2005', '2006', '2007', '2008', '2009', '2010',
       '2011', '2012', '2013', 'Total'],
      dtype='object')
```

```
[29]:             Continent           Region             DevName  1980  1981  1982  \
      Afghanistan       Asia    Southern Asia  Developing regions    16    39    39
      Albania         Europe  Southern Europe   Developed regions     1     0     0

                   1983  1984  1985  1986  …  2005  2006  2007  2008  2009  2010  \
      Afghanistan    47    71   340   496  …  3436  3009  2652  2111  1746  1758
      Albania         0     0     0     1  …  1223   856   702   560   716   561

                   2011  2012  2013  Total
      Afghanistan  2203  2635  2004  58639
      Albania       539   620   603  15699

      [2 rows x 38 columns]
```

---

2 Visualizing Data using Matplotlib

2.1 Matplotlib: Standard Python Visualization Library

The primary plotting library we will explore in the course is Matplotlib. As mentioned on their website: >Matplotlib is a Python 2D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms. Matplotlib can be used in Python scripts, the Python and IPython shell, the jupyter notebook, web application servers, and four graphical user interface toolkits.

If you are aspiring to create impactful visualization with python, Matplotlib is an essential tool to have at your disposal.

2.1.1 Matplotlib.Pyplot

One of the core aspects of Matplotlib is `matplotlib.pyplot`. It is Matplotlib's scripting layer which we studied in details in the videos about Matplotlib. Recall that it is a collection of command style functions that make Matplotlib work like MATLAB. Each `pyplot` function makes some change to a figure: e.g., creates a figure, creates a plotting area in a figure, plots some lines in a plotting area, decorates the plot with labels, etc. In this lab, we will work with the scripting layer to learn how to generate line plots. In future labs, we will get to work with the Artist layer as well to experiment first hand how it differs from the scripting layer.

Let's start by importing `Matplotlib` and `Matplotlib.pyplot` as follows:

[30]:
```
# we are using the inline backend
%matplotlib inline

import matplotlib as mpl
import matplotlib.pyplot as plt
```

*optional: check if Matplotlib is loaded.

[31]:
```
print ('Matplotlib version: ', mpl.__version__) # >= 2.0.0
```

```
Matplotlib version:  3.1.1
```

*optional: apply a style to Matplotlib.

[32]:
```
print(plt.style.available)
mpl.style.use(['ggplot']) # optional: for ggplot-like style
```

```
['seaborn-notebook', 'seaborn-deep', 'seaborn-colorblind', 'seaborn-ticks',
'seaborn-bright', 'seaborn-whitegrid', 'bmh', 'seaborn-darkgrid', 'seaborn-
poster', 'tableau-colorblind10', 'Solarize_Light2', 'classic', 'seaborn-paper',
'fast', '_classic_test', 'seaborn', 'ggplot', 'seaborn-pastel',
'dark_background', 'seaborn-dark-palette', 'seaborn-muted', 'seaborn-white',
'grayscale', 'seaborn-talk', 'fivethirtyeight', 'seaborn-dark']
```

2.1.2 Plotting in *pandas*

Fortunately, pandas has a built-in implementation of Matplotlib that we can use. Plotting in *pandas* is as simple as appending a `.plot()` method to a series or dataframe.

Documentation: - Plotting with Series - Plotting with Dataframes

3 Line Pots (Series/Dataframe)

What is a line plot and why use it?

A line chart or line plot is a type of plot which displays information as a series of data points called 'markers' connected by straight line segments. It is a basic type of chart common in many fields. Use line plot when you have a continuous data set. These are best suited for trend-based visualizations of data over a period of time.

Let's start with a case study:

In 2010, Haiti suffered a catastrophic magnitude 7.0 earthquake. The quake caused widespread devastation and loss of life and aout three million people were affected by this natural disaster. As part of Canada's humanitarian effort, the Government of Canada stepped up its effort in accepting refugees from Haiti. We can quickly visualize this effort using a `Line` plot:

Question: Plot a line graph of immigration from Haiti using `df.plot()`.

First, we will extract the data series for Haiti.

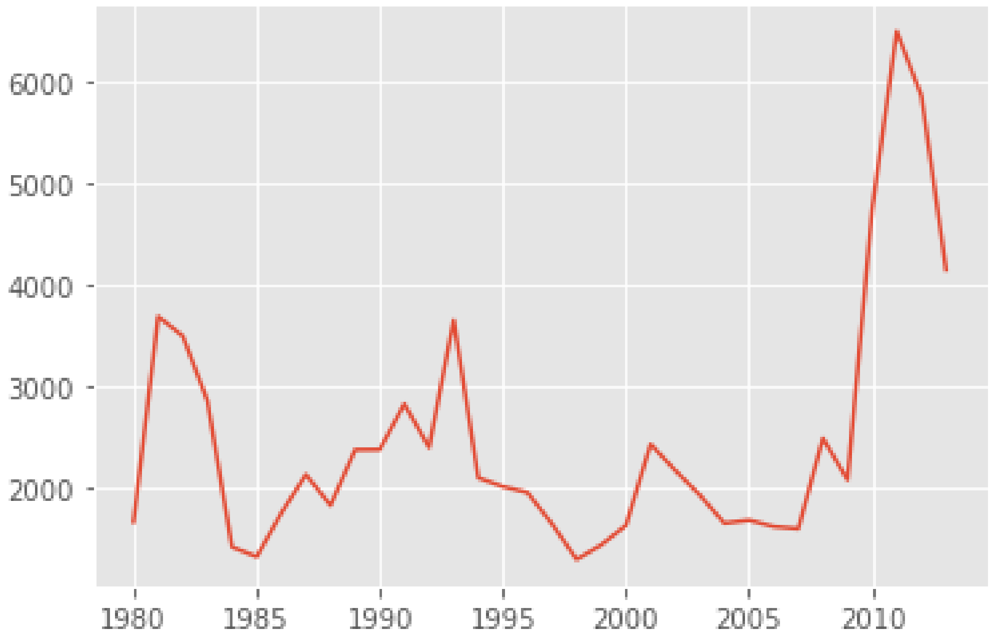
[33]:
```
haiti = df_can.loc['Haiti', years] # passing in years 1980 - 2013 to exclude␣
↪the 'total' column
haiti.head()
```

[33]:
```
1980    1666
1981    3692
1982    3498
1983    2860
1984    1418
Name: Haiti, dtype: object
```

Next, we will plot a line plot by appending `.plot()` to the `haiti` dataframe.

[34]:
```
haiti.plot()
```

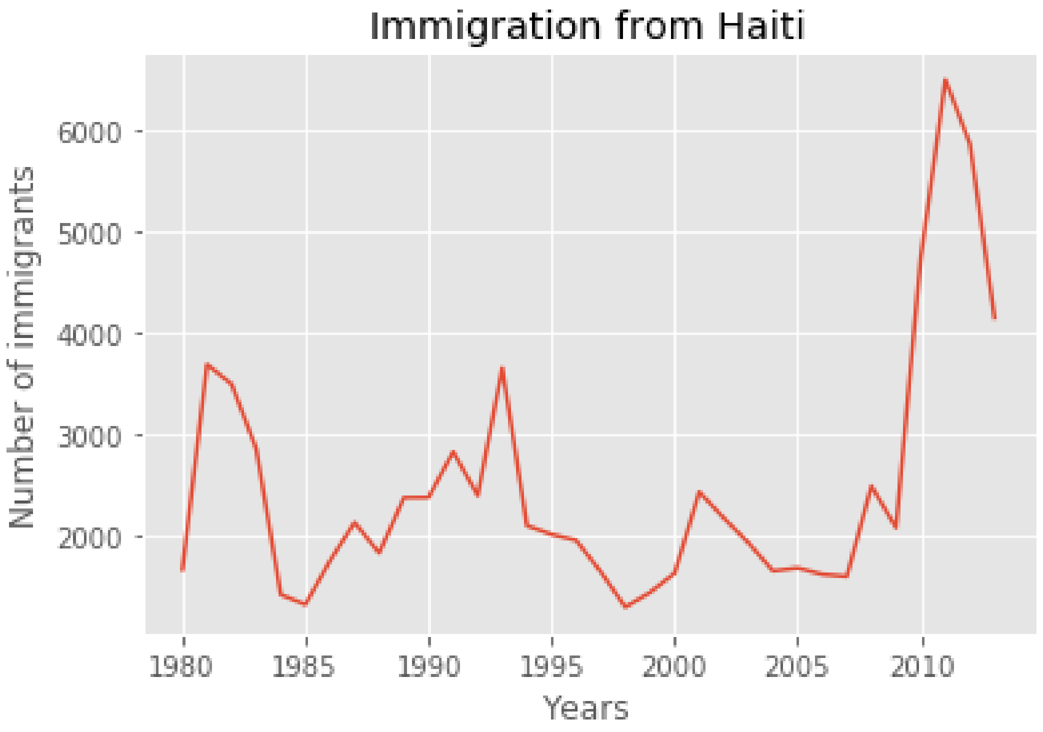
[34]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f3d6b007828>
```



pandas automatically populated the x-axis with the index values (years), and the y-axis with the column values (population). However, notice how the years were not displayed because they are of type *string*. Therefore, let's change the type of the index values to *integer* for plotting.

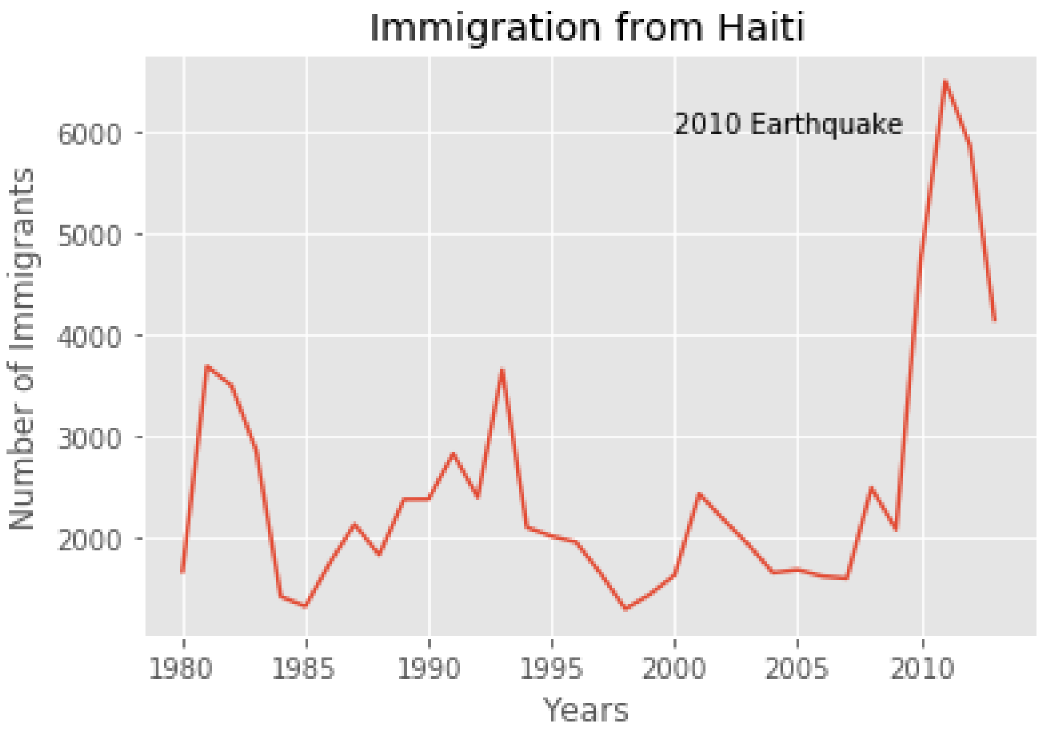
Also, let's label the x and y axis using `plt.title()`, `plt.ylabel()`, and `plt.xlabel()` as follows:

[35]:
```
haiti.index = haiti.index.map(int) # let's change the index values of Haiti to␣
 ↪type integer for plotting
haiti.plot(kind='line')

plt.title('Immigration from Haiti')
plt.ylabel('Number of immigrants')
plt.xlabel('Years')

plt.show() # need this line to show the updates made to the figure
```



We can clearly notice how number of immigrants from Haiti spiked up from 2010 as Canada stepped up its efforts to accept refugees from Haiti. Let's annotate this spike in the plot by using the `plt.text()` method.

[36]:
```
haiti.plot(kind='line')

plt.title('Immigration from Haiti')
plt.ylabel('Number of Immigrants')
plt.xlabel('Years')

# annotate the 2010 Earthquake.
# syntax: plt.text(x, y, label)
plt.text(2000, 6000, '2010 Earthquake') # see note below

plt.show()
```



With just a few lines of code, you were able to quickly identify and visualize the spike in immigration!

Quick note on x and y values in `plt.text(x, y, label)`:

```
 Since the x-axis (years) is type 'integer', we specified x as a year. The y axis (number of i
```

```
    plt.text(2000, 6000, '2010 Earthquake') # years stored as type int
```

```
If the years were stored as type 'string', we would need to specify x as the index position of
```

```
    plt.text(20, 6000, '2010 Earthquake') # years stored as type int
```

```
We will cover advanced annotation methods in later modules.
```

We can easily add more countries to line plot to make meaningful comparisons immigration from different countries.

Question: Let's compare the number of immigrants from India and China from 1980 to 2013.

Step 1: Get the data set for China and India, and display dataframe.

```
[37]: ### type your answer here

      df_CI = df_can.loc[['India', 'China'], years]
      df_CI.head()
```

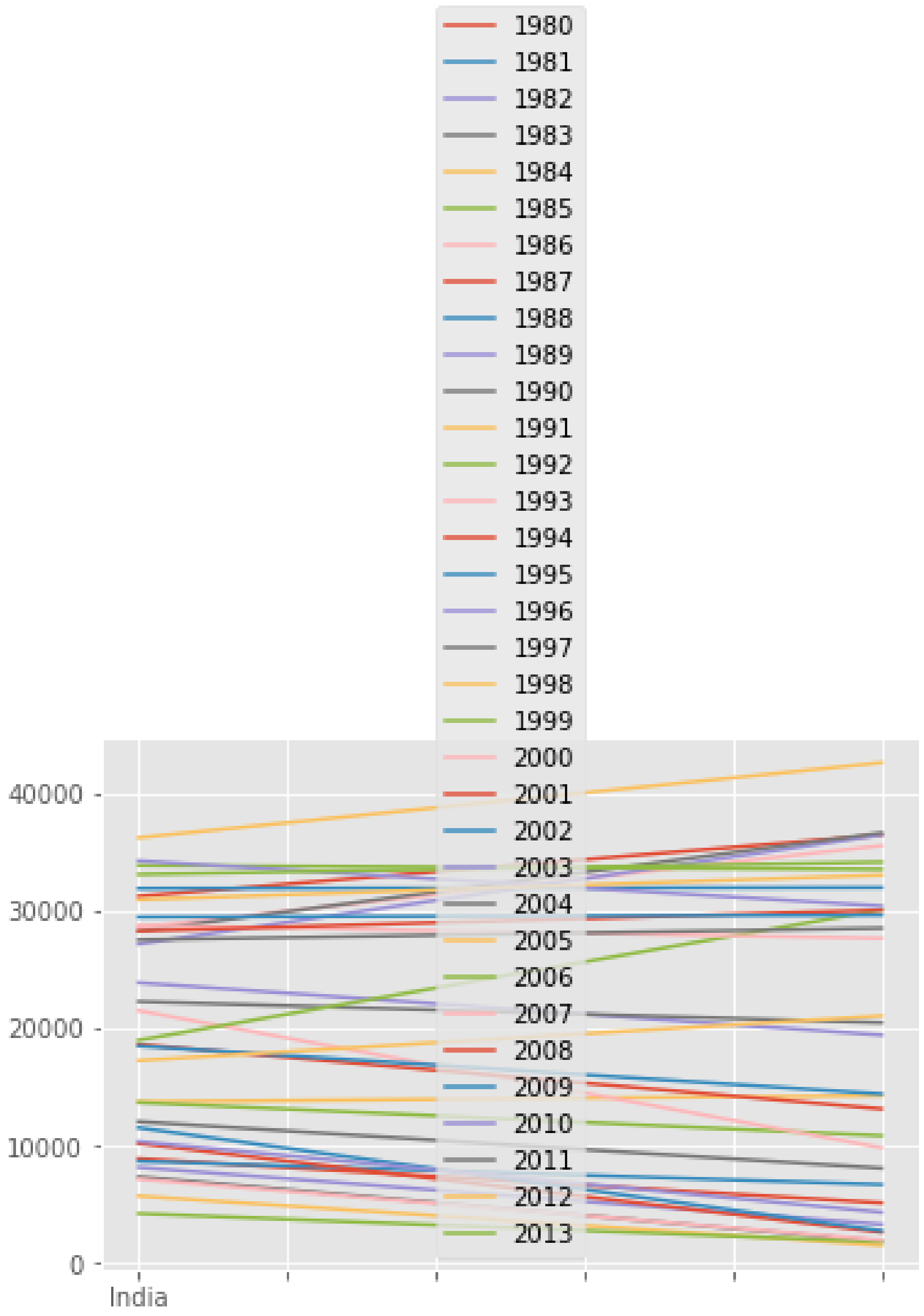
```
[37]:        1980  1981  1982  1983  1984  1985  1986   1987   1988   1989  …  \
      India  8880  8670  8147  7338  5704  4211  7150  10189  11522  10343  …
      China  5123  6682  3308  1863  1527  1816  1960   2643   2758   4323  …

              2004   2005   2006   2007   2008   2009   2010   2011   2012   2013
      India  28235  36210  33848  28742  28261  29456  34235  27509  30933  33087
      China  36619  42584  33518  27642  30037  29622  30391  28502  33024  34129

      [2 rows x 34 columns]
```

Double-click **here** for the solution.

Step 2: Plot graph. We will explicitly specify line plot by passing in `kind` parameter to `plot()`.

```
[38]: ### type your answer here
      df_CI.plot(kind='line')
```

```
[38]: <matplotlib.axes._subplots.AxesSubplot at 0x7f3d718d7d30>
```



Double-click **here** for the solution.

That doesn't look right...

Recall that *pandas* plots the indices on the x-axis and the columns as individual lines on the y-axis.

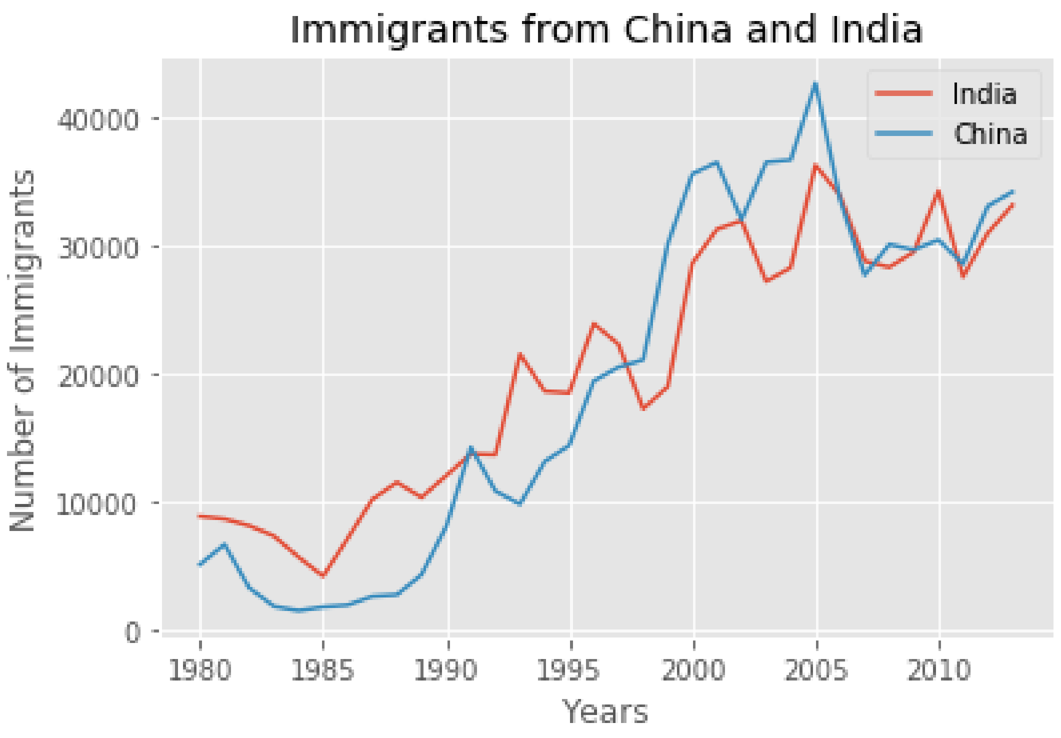
Since `df_CI` is a dataframe with the `country` as the index and `years` as the columns, we must first transpose the dataframe using `transpose()` method to swap the row and columns.

[39]:
```
df_CI = df_CI.transpose()
df_CI.head()
```

[39]:
```
      India  China
1980   8880   5123
1981   8670   6682
1982   8147   3308
1983   7338   1863
1984   5704   1527
```

pandas will auomatically graph the two countries on the same graph. Go ahead and plot the new transposed dataframe. Make sure to add a title to the plot and label the axes.

[40]:
```
### type your answer here



df_CI.index = df_CI.index.map(int)
df_CI.plot(kind='line')
plt.title('Immigrants from China and India')
plt.ylabel('Number of Immigrants')
plt.xlabel('Years')
plt.show()
```



Double-click **here** for the solution.

From the above plot, we can observe that the China and India have very similar immigration trends through the years.

Note: How come we didn't need to transpose Haiti's dataframe before plotting (like we did for df_CI)?

That's because `haiti` is a series as opposed to a dataframe, and has the years as its indices as shown below.

```
print(type(haiti))
print(haiti.head(5))
```

class 'pandas.core.series.Series' 1980 1666 1981 3692 1982 3498 1983 2860 1984 1418 Name: Haiti, dtype: int64

Line plot is a handy tool to display several dependent variables against one independent variable. However, it is recommended that no more than 5-10 lines on a single graph; any more than that and it becomes difficult to interpret.

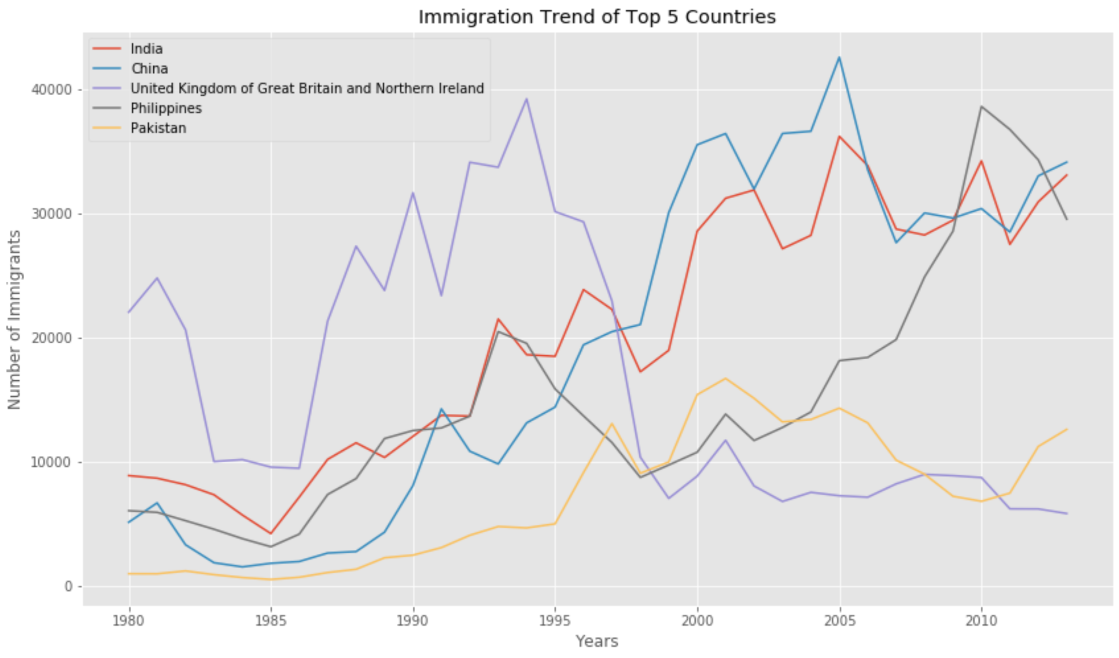
Question: Compare the trend of top 5 countries that contributed the most to immigration to Canada.

```
[43]: df_can.sort_values(by='Total', ascending=False, axis=0, inplace=True)
      df_top5 = df_can.head(5)
      df_top5 = df_top5[years].transpose()
      print(df_top5)
      df_top5.plot(kind='line', figsize=(14, 8))
      plt.title('Immigration Trend of Top 5 Countries')
      plt.ylabel('Number of Immigrants')
      plt.xlabel('Years')
      plt.show()
```

```
      India  China  United Kingdom of Great Britain and Northern Ireland  \
1980   8880   5123                                              22045
1981   8670   6682                                              24796
1982   8147   3308                                              20620
1983   7338   1863                                              10015
1984   5704   1527                                              10170
1985   4211   1816                                               9564
1986   7150   1960                                               9470
1987  10189   2643                                              21337
1988  11522   2758                                              27359
1989  10343   4323                                              23795
1990  12041   8076                                              31668
1991  13734  14255                                              23380
1992  13673  10846                                              34123
1993  21496   9817                                              33720
1994  18620  13128                                              39231
```

```
1995  18489  14398                                              30145
1996  23859  19415                                              29322
1997  22268  20475                                              22965
1998  17241  21049                                              10367
1999  18974  30069                                               7045
2000  28572  35529                                               8840
2001  31223  36434                                              11728
2002  31889  31961                                               8046
2003  27155  36439                                               6797
2004  28235  36619                                               7533
2005  36210  42584                                               7258
2006  33848  33518                                               7140
2007  28742  27642                                               8216
2008  28261  30037                                               8979
2009  29456  29622                                               8876
2010  34235  30391                                               8724
2011  27509  28502                                               6204
2012  30933  33024                                               6195
2013  33087  34129                                               5827

      Philippines  Pakistan
1980         6051       978
1981         5921       972
1982         5249      1201
1983         4562       900
1984         3801       668
1985         3150       514
1986         4166       691
1987         7360      1072
1988         8639      1334
1989        11865      2261
1990        12509      2470
1991        12718      3079
1992        13670      4071
1993        20479      4777
1994        19532      4666
1995        15864      4994
1996        13692      9125
1997        11549     13073
1998         8735      9068
1999         9734      9979
2000        10763     15400
2001        13836     16708
2002        11707     15110
2003        12758     13205
2004        14004     13399
2005        18139     14314
2006        18400     13127
```

```
2007          19837     10124
2008          24887      8994
2009          28573      7217
2010          38617      6811
2011          36765      7468
2012          34315     11227
2013          29544     12603
```



Double-click **here** for the solution.

3.0.1 Other Plots

Congratulations! you have learned how to wrangle data with python and create a line plot with Matplotlib. There are many other plotting styles available other than the default Line plot, all of which can be accessed by passing `kind` keyword to `plot()`. The full list of available plots are as follows:

- `bar` for vertical bar plots
- `barh` for horizontal bar plots
- `hist` for histogram
- `box` for boxplot
- `kde` or `density` for density plots
- `area` for area plots
- `pie` for pie plots
- `scatter` for scatter plots
- `hexbin` for hexbin plot

3.0.2 Thank you for completing this lab!

This notebook was originally created by Jay Rajasekharan with contributions from Ehsan M. Kermani, and Slobodan Markovic.

This notebook was recently revised by Alex Aklson. I hope you found this lab session interesting. Feel free to contact me if you have any questions!

This notebook is part of a course on **Coursera** called *Data Visualization with Python*. If you accessed this notebook outside the course, you can take this course online by clicking here.