Line-Plots-Matplotlib

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Introduction to Matplotlib and Line Plots

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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)  #Number of lines at bottom of file to skip

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.

[8]:
```
df_can.columns.values
```

[8]:
```
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.

[9]:
```
df_can.index.values
```

[9]:
```
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.

[10]:
```
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.

[11]:
```
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.

[12]:
```
# size of dataframe (rows, columns)
df_can.shape
```

[12]:
```
(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:

[13]:
```
# 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)
```

[13]:
```
         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:

[14]:
```
df_can.rename(columns={'OdName':'Country', 'AreaName':'Continent', 'RegName':
 ↪'Region'}, inplace=True)
df_can.columns
```

[14]:
```
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:

[15]:
```
df_can['Total'] = df_can.sum(axis=1)
```

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

[16]:
```
df_can.isnull().sum()
```

[16]:
```
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.

[17]:
```
df_can.describe()
```

[17]:
```
              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').

[18]:
```
df_can.Country  # returns a series
```

[18]:
```
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.

[19]:
```
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.
```

[19]:

	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.

[20]:
```
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()
```

[21]:
```
df_can.head(3)
```

[21]:
```
           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]
```

[23]:
```
# optional: to remove the name of the index
df_can.index.name = None
df_can.head(3)
```

[23]:

	Continent	Region	DevName	1980	1981	1982	\
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	\
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
Afghanistan	2203	2635	2004	58639
Albania	539	620	603	15699
Algeria	4325	3774	4331	69439

```
[3 rows x 38 columns]
```

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

[25]:
```
# 1. the full row data (all columns)
print(df_can.loc['Japan'])
```

```
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
```

[29]:
```
# alternate methods
print(df_can.iloc[87])
print(df_can[df_can.index == 'Japan'].T.squeeze()) #.T()tranpose array;.
 ↪squeeze()delete sigle-dimension
```

```
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
```

[30]:
```
# 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
```

[32]:
```
# 3. for years 1980 to 1985
print(df_can.loc['Japan', [1980, 1981, 1982, 1983, 1984, 1985]])
print(df_can.iloc[87, [3, 4, 5, 6, 7, 8]])
```

```
1980    701
1981    756
1982    598
1983    309
1984    246
1985    198
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'.

[38]:
```
df_can.columns = list(map(str, df_can.columns))
```

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:

[39]:
```
# useful for plotting later on
years = list(map(str, range(1980, 2014)))
years
```

[39]:
```
['1980',
 '1981',
 '1982',
 '1983',
 '1984',
 '1985',
 '1986',
 '1987',
 '1988',
 '1989',
 '1990',
 '1991',
 '1992',
 '1993',
 '1994',
 '1995',
 '1996',
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 '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).

[40]:
```
# 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
```

[41]:
```
# 2. pass this condition into the dataFrame
df_can[condition]
```

[41]:

	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]

[42]:
```
# 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
```

[42]:

	Continent	Region	DevName	1980	1981	1982	1983	1984	1985	1986	…	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Afghanistan	Asia	Southern Asia	Developing regions	16	39	39	47	71	340	496	…	3436	3009	2652	2111	1746	1758	2203	2635	2004	58639
Bangladesh	Asia	Southern Asia	Developing regions	83	84	86	81	98	92	486	…	4171	4014	2897	2939	2104	4721	2694	2640	3789	65568
Bhutan	Asia	Southern Asia	Developing regions	0	0	0	0	1	0	0	…	5	10	7	36	865	1464	1879	1075	487	5876
India	Asia	Southern Asia	Developing regions	8880	8670	8147	7338	5704	4211	7150	…	36210	33848	28742	28261	29456	34235	27509	30933	33087	691904
Iran (Islamic Republic of)	Asia	Southern Asia	Developing regions	1172	1429	1822	1592	1977	1648	1794	…	5837	7480	6974	6475	6580	7477	7479	7534	11291	175923
Maldives	Asia	Southern Asia	Developing regions	0	0	0	1	0	0	0	…	0	0	2	1	7	4	3	1	1	30
Nepal	Asia	Southern Asia	Developing regions	1	1	6	1	2	4	13	…	607	540	511	581	561	1392	1129	1185	1308	10222
Pakistan	Asia	Southern Asia	Developing regions	978	972	1201	900	668	514	691	…	14314	13127	10124	8994	7217	6811	7468	11227	12603	241600
Sri Lanka	Asia	Southern Asia	Developing regions	185	371	290	197	1086	845	1838	…	4930	4714	4123	4756	4547	4422	3309	3338	2394	148358

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

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

[45]:
```
print('data dimensions:', df_can.shape)
print("")
print(df_can.columns)
print("")
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')
```

[45]:

	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:

[46]:
```
# we are using the inline backend
%matplotlib inline

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

*optional: check if Matplotlib is loaded.

[47]:
```
print ('Matplotlib version: ', mpl.__version__) # >= 2.0.0
```

```
Matplotlib version:  3.1.1
```

*optional: apply a style to Matplotlib.

[48]:
```
print(plt.style.available)
mpl.style.use(['ggplot']) # optional: for ggplot-like style
```

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

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.

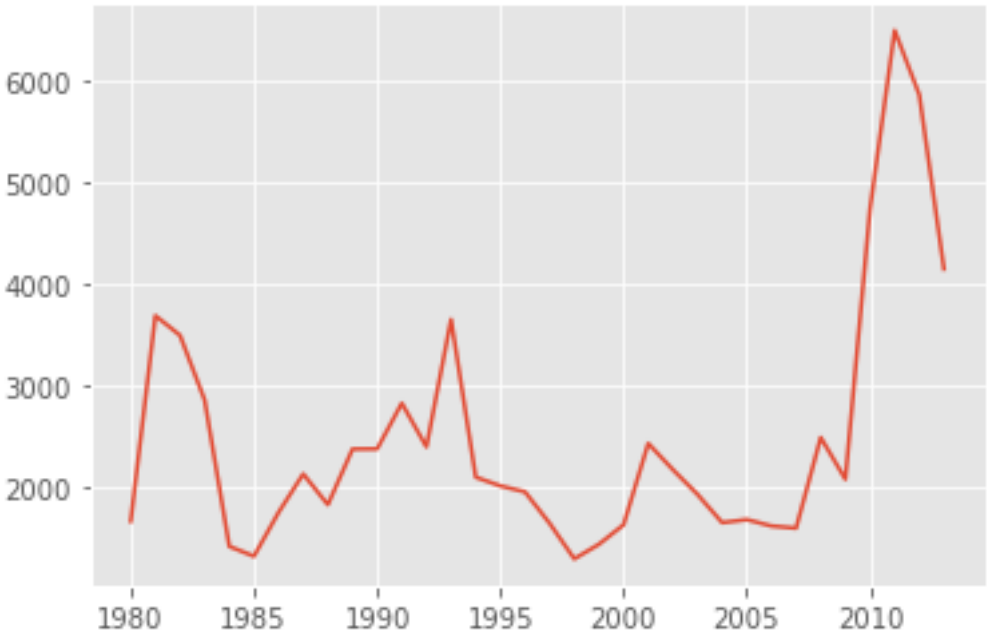
[58]:
```
years = list(map(str, range(1980, 2014)))
haiti = df_can.loc['Haiti', years] # passing in years 1980 - 2013 to exclude␣
↪the 'total' column
haiti.head()
```

[58]:
```
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.

[52]:
```
haiti.plot()
```

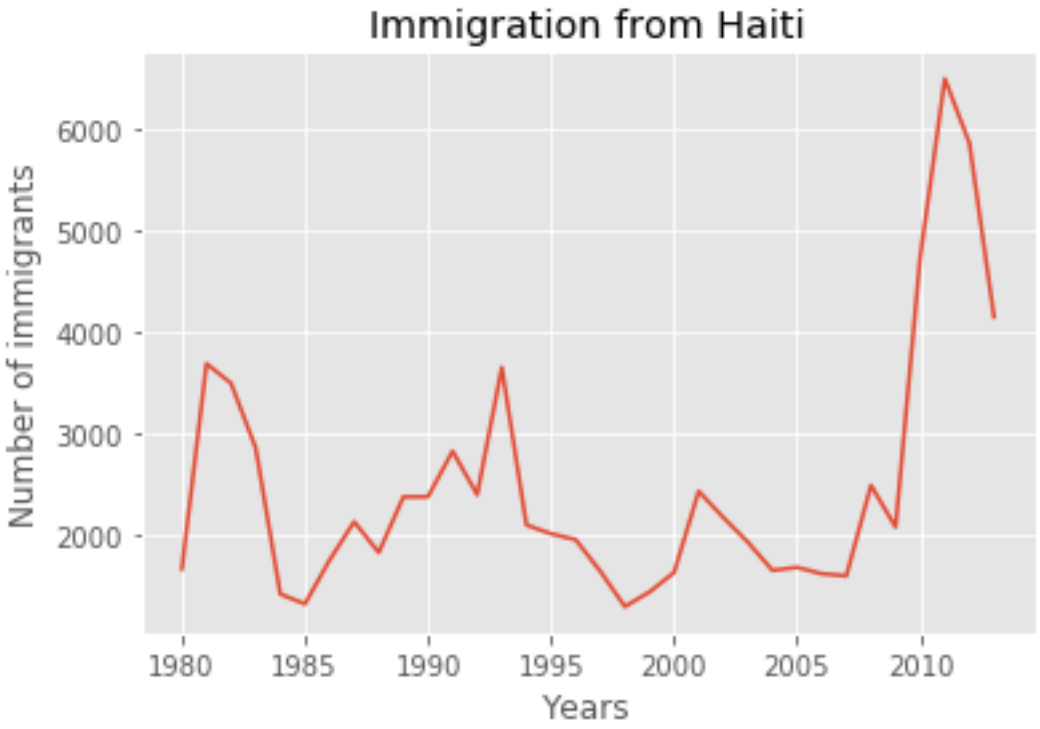
[52]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff284169e10>
```



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:

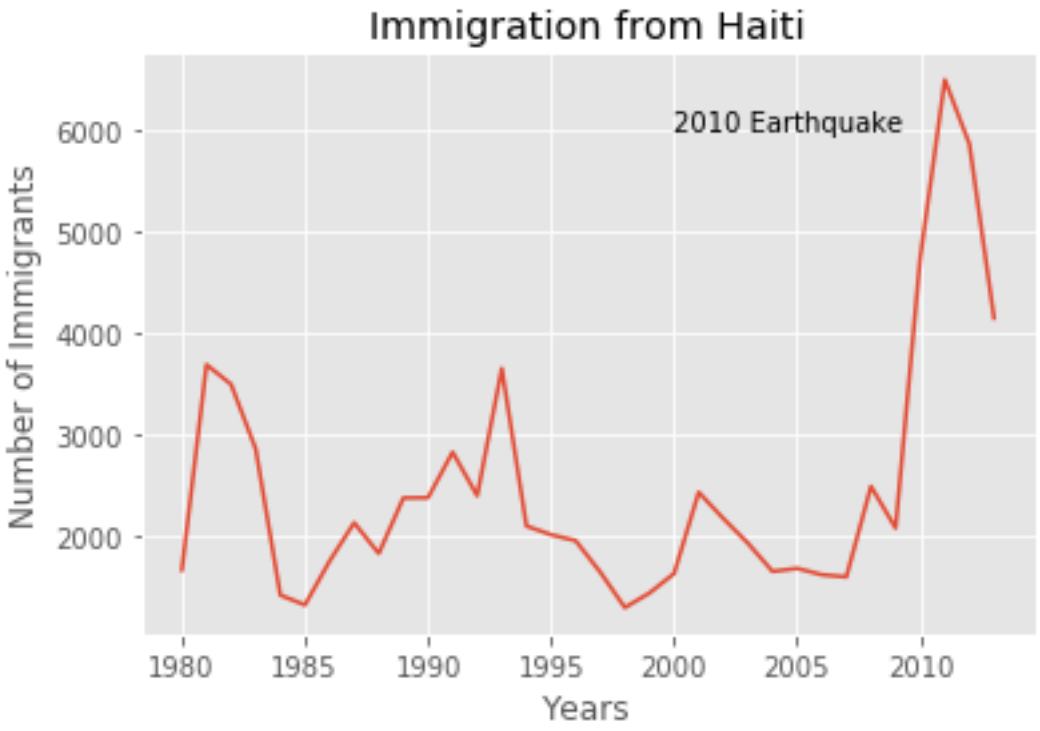
[72]:
```
# let's change the index values of Haiti to type integer for plotting
haiti.index = haiti.index.map(int)
haiti.plot(kind='line')

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.

[74]:
```
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 str
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.

[64]:
```
years = list(map(str, range(1980, 2014)))
df2 = df_can.loc[['China','India'], years]
df2.head()
```

[64]:

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

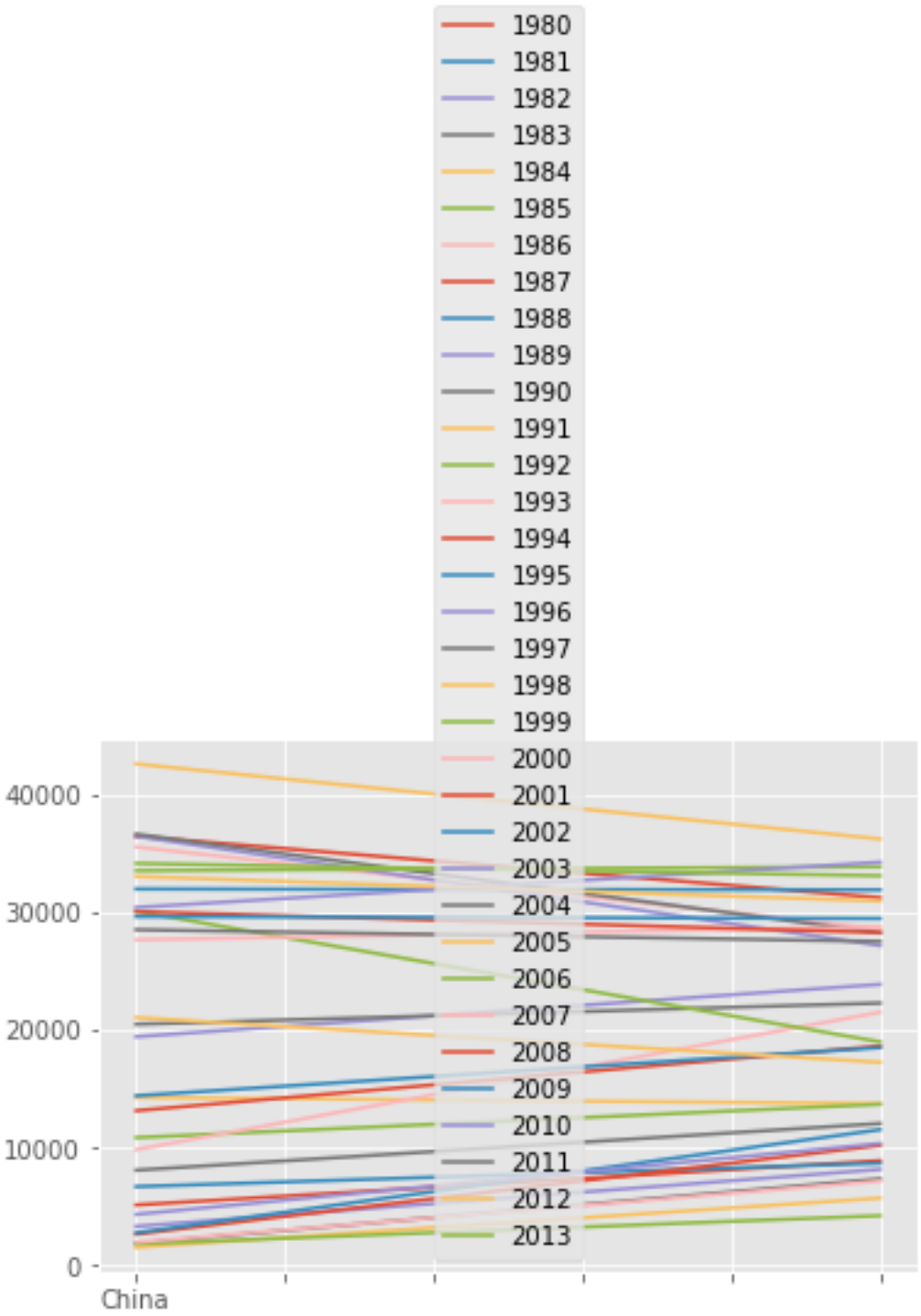
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
China	36619	42584	33518	27642	30037	29622	30391	28502	33024	34129
India	28235	36210	33848	28742	28261	29456	34235	27509	30933	33087

[2 rows x 34 columns]

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

[65]:
```
df2.plot(kind='line')
```

[65]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff27f200a58>
```



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.

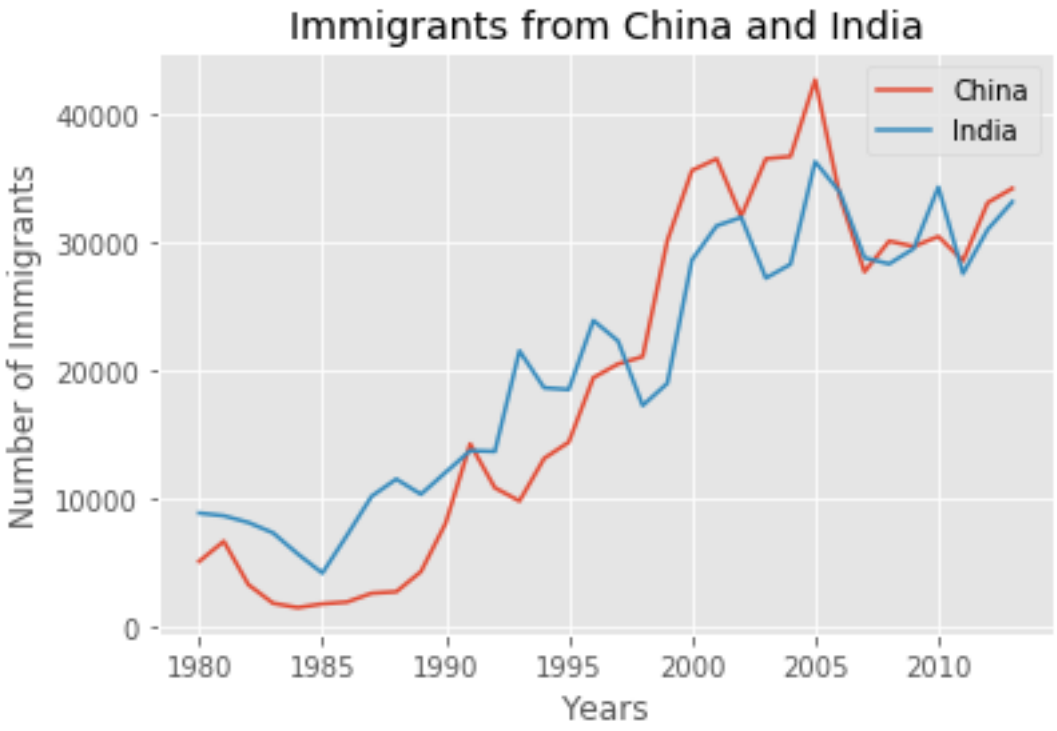
[66]:
```
df2 = df2.transpose()
df2.head()
```

[66]:

	China	India
1980	5123	8880
1981	6682	8670
1982	3308	8147
1983	1863	7338
1984	1527	5704

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.

[69]:
```
df2.index = df2.index.map(int)
df2.plot(kind='line')

plt.title('Immigrants from China and India')
plt.ylabel('Number of Immigrants')
plt.xlabel('Years')

plt.show()
```



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.

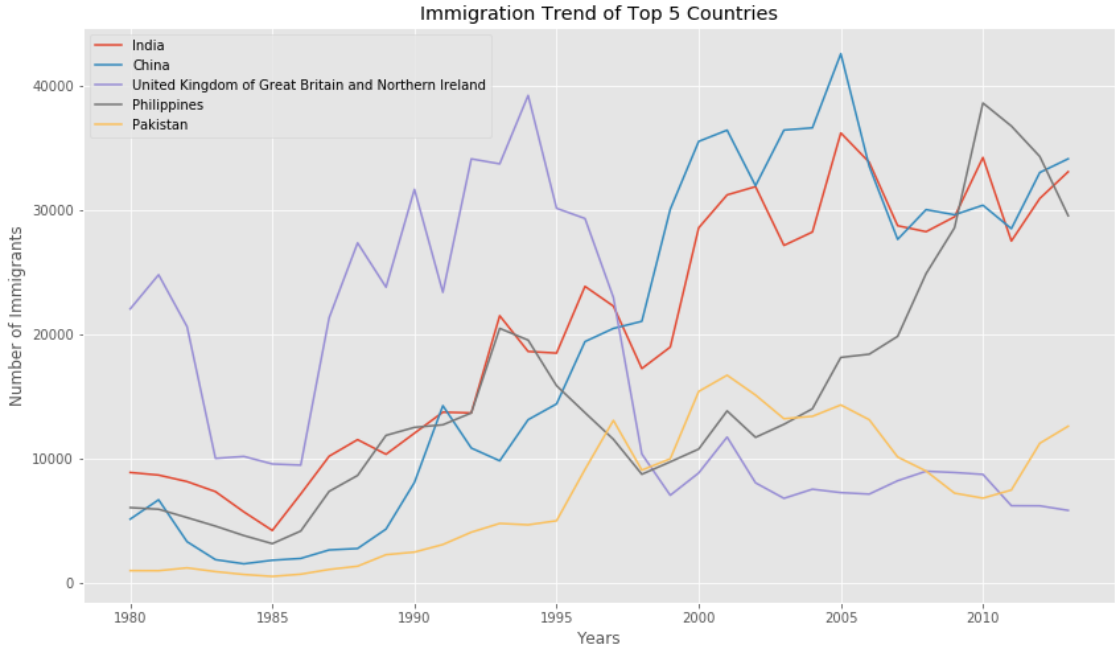
[71]:
```
df_can.sort_values(by='Total',ascending=False,axis=0,inplace=True)
df_top5 = df_can.head(5)
df_top5 = df_top5[years].transpose()
print(df_top5)

df_top5.index = df_top5.index.map(int)
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



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