Skills Network

Introduction to Matplotlib and Line Plots

Estimated time needed: **20** minutes

Objectives

After completing this lab you will be able to:

- Create Data Visualization with Python
- Use various Python libraries for visualization

Introduction

The aim of these labs is to introduce you to introduction you to Matplotlib and creating Line Plots. Please make sure that you have completed the previous courses based on python.

Table of Contents

pandas Refresher

The course heavily relies on *pandas* for data wrangling, analysis. Refresh your Panads skill quickly with the lab on Data pre-processing with Pandas

pandas is an essential data analysis toolkit for Python.

We encourage you to spend some time and familiarize yourself with the *pandas* from the website

The Dataset: Immigration to Canada from 1980 to 2013

Dataset Source: International migration flows to and from selected countries - The 2015 revision. In this lab, we will focus on the Canadian immigration data.

We have already **pre-processed** the data, we will use the **clean data** saved in the csv format for this lab. The Canada Immigration dataset can be fetched from here

---

Next, we'll do is install and import two key data analysis modules: *pandas*, *numpy* and *matplotlib*

In [ ]:
```
!pip install pandas
!pip install numpy
!pip install matplotlib
import pandas as pd # primary data structure library
```

Let's download and import our primary Canadian Immigration dataset using *pandas*'s `read_csv ()` method.

In [3]:
```
df_can = pd.read_csv('https://cf-courses-data.s3.us.cloud-object-storage.appdomain.cloud/IBMDeveloperSkillsNetwork-DV0101EN-SkillsNetwork/Data%20Files

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.

In [4]:
```
df_can.head()
# tip: You can specify the number of rows you'd like to see as follows: df_can.head(10)
```

Out[4]:

	Country	Continent	Region	DevName	1980	1981	1982	1983	1984	1985	...	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
0	Afghanistan	Asia	Southern Asia	Developing regions	16	39	39	47	71	340	...	3436	3009	2652	2111	1746	1758	2203	2635	2004	58639
1	Albania	Europe	Southern Europe	Developed regions	1	0	0	0	0	0	...	1223	856	702	560	716	561	539	620	603	15699
2	Algeria	Africa	Northern Africa	Developing regions	80	67	71	69	63	44	...	3626	4807	3623	4005	5393	4752	4325	3774	4331	69439
3	American Samoa	Oceania	Polynesia	Developing regions	0	1	0	0	0	0	...	0	1	0	0	0	0	0	0	0	6
4	Andorra	Europe	Southern Europe	Developed regions	0	0	0	0	0	0	...	0	1	1	0	0	0	0	1	1	15

5 rows × 39 columns

Let's set Country as the index, it will help you to plot the charts easily, by refering to the country names as index value

In [5]:
```
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()
```

In [6]:
```
#let's check
df_can.head(3)
```

Out[6]:

	Continent	Region	DevName	1980	1981	1982	1983	1984	1985	1986	...	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Country																					
Afghanistan	Asia	Southern Asia	Developing regions	16	39	39	47	71	340	496	...	3436	3009	2652	2111	1746	1758	2203	2635	2004	58639
Albania	Europe	Southern Europe	Developed regions	1	0	0	0	0	0	1	...	1223	856	702	560	716	561	539	620	603	15699
Algeria	Africa	Northern Africa	Developing regions	80	67	71	69	63	44	69	...	3626	4807	3623	4005	5393	4752	4325	3774	4331	69439

3 rows × 38 columns

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

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:

In [8]:
```
# useful for plotting later on
years = list(map(str, range(1980, 2014)))
print(years)
```

```
['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']
```

Visualizing Data using Matplotlib

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.

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:

In [9]:
```
# we are using the inline backend
%matplotlib inline

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

*optional: check if Matplotlib is loaded.

```
In [10]: print('Matplotlib version: ', mpl.__version__)  # >= 2.0.0
```

```
Matplotlib version:  3.10.0
```

*optional: apply a style to Matplotlib.

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

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

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 about 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.

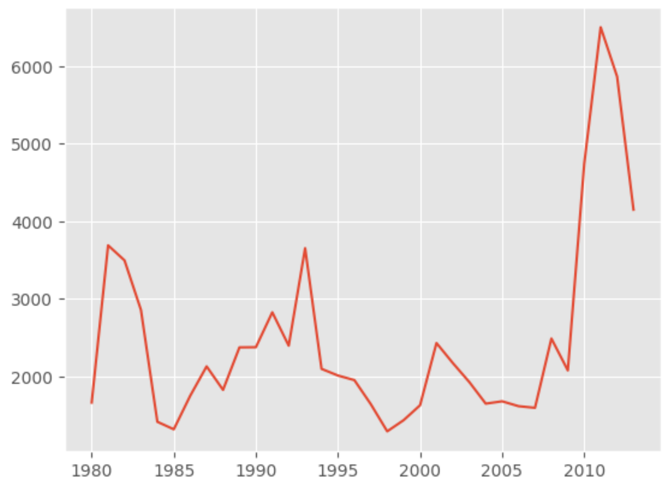
```
In [12]: #Since we converted the years to string,
         #let's declare a variable that will allow us to easily call upon the full range of years:
         years = list(map(str, range(1980, 2014)))
         #creating data series
         haiti = df_can.loc['Haiti', years] # passing in years 1980 - 2013 to exclude the 'total' column
         haiti.head()
```

```
Out[12]: 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.

```
In [13]: haiti.plot()
```

```
Out[13]: <Axes: >
```



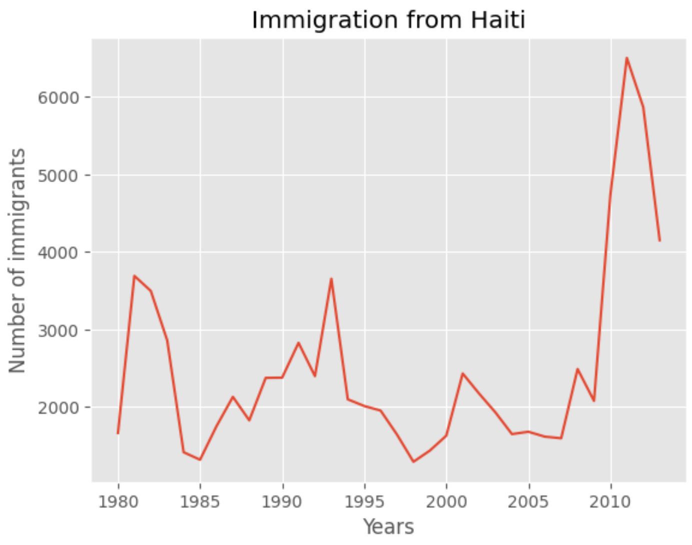
pandas automatically populated the x-axis with the index values (years), and the y-axis with the column values (population).

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

```
In [14]: 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.

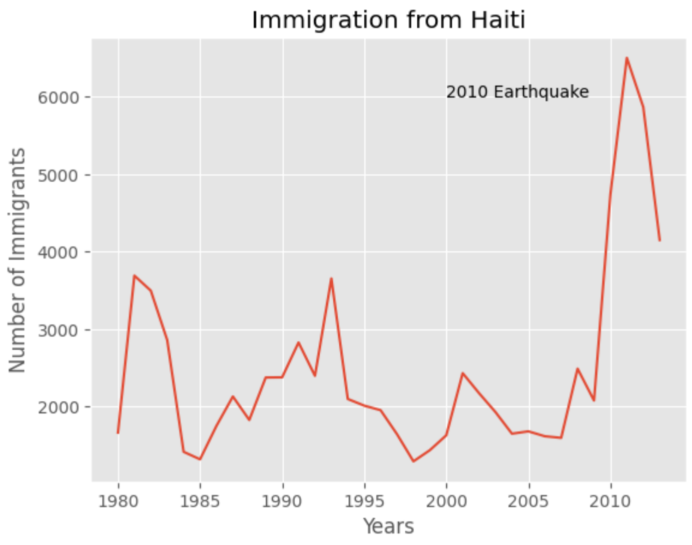
However, notice that years are of type *string*. Let's change the type of the index values to *integer* first.

In [15]:
```
haiti.index = haiti.index.map(int)
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 immigrants) is type 'integer', so we
can just specify the value y = 6000.
```

```
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 the year. Eg 20th index is year
2000 since it is the 20th year with a base year of 1980.
```

```
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 the dataframe.

In [17]:
```
### type your answer here
df_ci = df_can.loc[['China','India'],years]
df_ci
```

Out[17]:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	...	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Country																					
China	5123	6682	3308	1863	1527	1816	1960	2643	2758	4323	...	36619	42584	33518	27642	30037	29622	30391	28502	33024	34129
India	8880	8670	8147	7338	5704	4211	7150	10189	11522	10343	...	28235	36210	33848	28742	28261	29456	34235	27509	30933	33087

2 rows × 34 columns

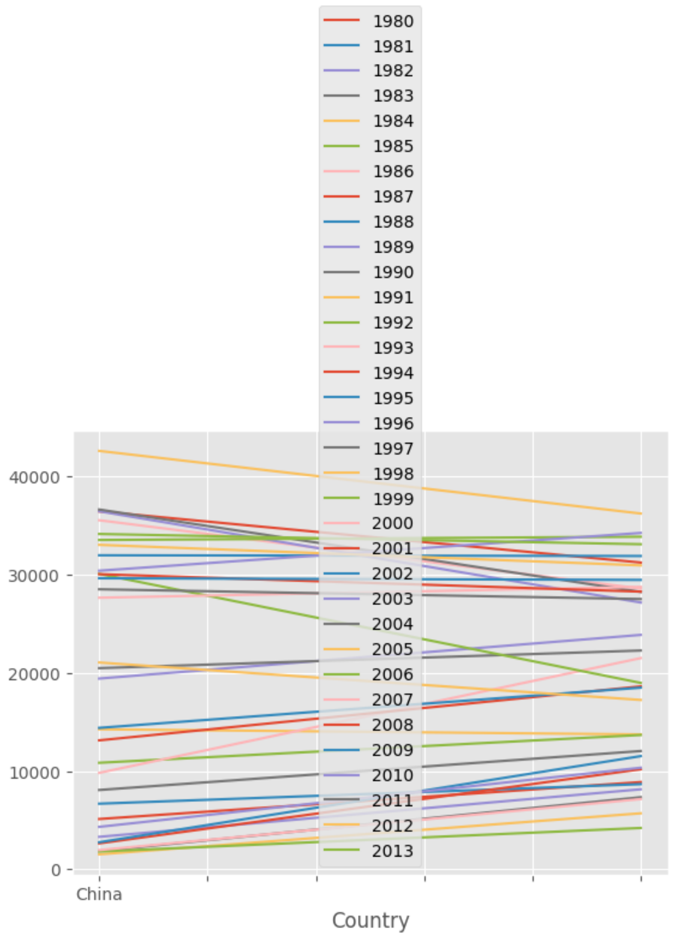
▸ Click here for a sample python solution

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

In [18]:
```
### type your answer here

df_ci.plot(kind='line')
```

Out[18]:
```
<Axes: xlabel='Country'>
```



▸ Click here for a sample python 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.

```
In [19]: df_ci = df_ci.transpose()
         df_ci.head()
```

Out[19]:

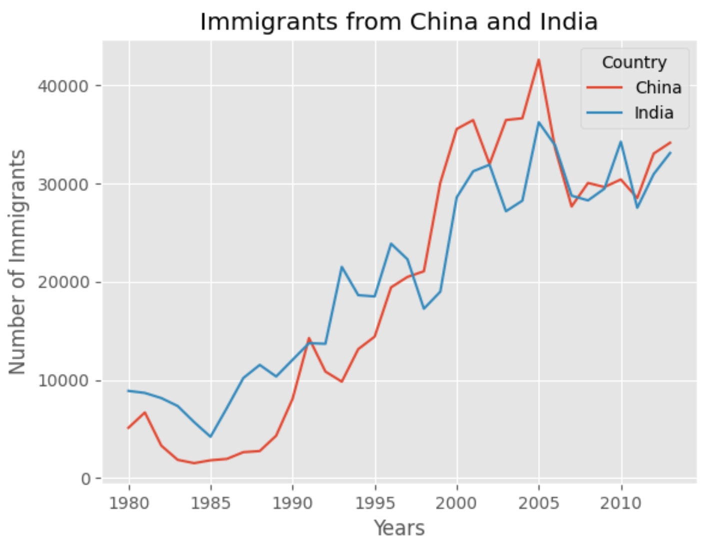
Country	China	India
1980	5123	8880
1981	6682	8670
1982	3308	8147
1983	1863	7338
1984	1527	5704

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.

```
In [20]: ### 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()
```



▸ Click here for a sample python 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

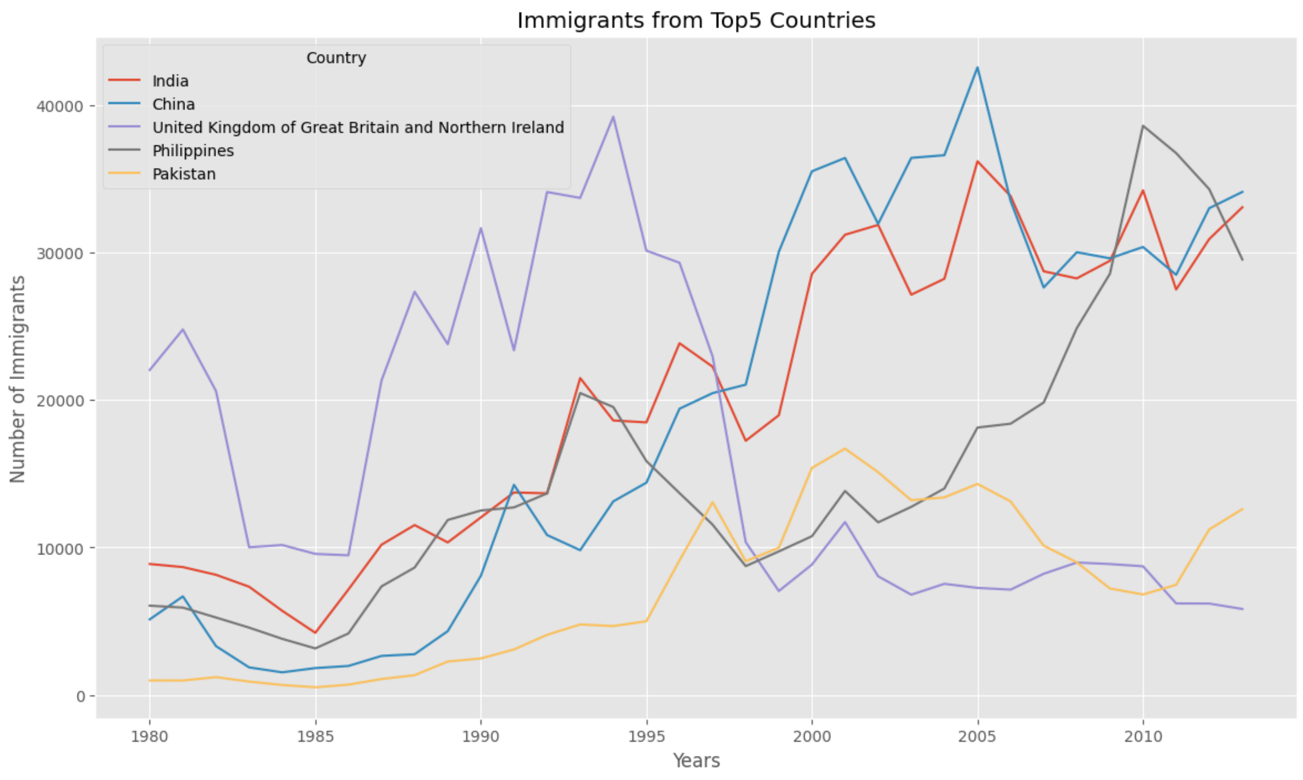
Line plot is a handy tool to display several dependent variables against one independent variable. However, it is recommended that no more than 5-10 lines on a single graph; any more than that and it becomes difficult to interpret.

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

```
In [28]: ### type your answer here
         df_can.sort_values(by='Total', ascending=False, axis=0, inplace=True)
         df_top5 = df_can.head(5).loc[:,years]
         df_top5 = df_top5.transpose()
         df_top5.index = df_top5.index.map(int)
         df_top5.plot(kind='line',figsize=(14,8))
```

```
plt.title('Immigrants from Top5 Countries')
plt.ylabel('Number of Immigrants')
plt.xlabel('Years')

plt.show()
```



▸ Click here for a sample python solution

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

Thank you for completing this lab!

Author

Alex Aklson

Other Contributors

Jay Rajasekharan, Ehsan M. Kermani, Slobodan Markovic, Weiqing Wang, Dr. Pooja