DV0101EN-3-4-1-Waffle-Charts-Word-Clouds-and-Regression-Plots-py-v2.0

April 2, 2019

Waffle Charts, Word Clouds, and Regression Plots

0.1 Introduction

In this lab, we will learn how to create word clouds and waffle charts. Furthermore, we will start learning about additional visualization libraries that are based on Matplotlib, namely the library *seaborn*, and we will learn how to create regression plots using the *seaborn* library.

0.2 Table of Contents

1 Exploring Datasets with *pandas* and Matplotlib

Toolkits: The course heavily relies on *pandas* and **Numpy** for data wrangling, analysis, and visualization. The primary plotting library we will explore in the course is Matplotlib.

Dataset: Immigration to Canada from 1980 to 2013 - International migration flows to and from selected countries - The 2015 revision from United Nation's website

The dataset contains annual data on the flows of international migrants 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. In this lab, we will focus on the Canadian Immigration data.

2 Downloading and Prepping Data

Import Primary Modules:

```
In [1]: import numpy as np  # useful for many scientific computing in Python
        import pandas as pd # primary data structure library
        from PIL import Image # converting images into arrays
```

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
```

Download the dataset and read it into a *pandas* dataframe:

```
In [2]: df_can = pd.read_excel('https://ibm.box.com/shared/static/lw190pt9zpy5bd1ptyg2aw15awomz9
                               sheet_name='Canada by Citizenship',
                               skiprows=range(20),
                               skipfooter=2)

        print('Data downloaded and read into a dataframe!')
```

```
Data downloaded and read into a dataframe!
```

Let's take a look at the first five items in our dataset

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

```
Out[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]
```

Let's find out how many entries there are in our dataset

```
In [4]: # print the dimensions of the dataframe
        print(df_can.shape)
```

```
(195, 43)
```

Clean up data. We will make some modifications to the original dataset to make it easier to create our visualizations. Refer to *Introduction to Matplotlib and Line Plots* and *Area Plots, Histograms, and Bar Plots* for a detailed description of this preprocessing.

```
In [5]: # clean up the dataset to remove unnecessary columns (eg. REG)
        df_can.drop(['AREA','REG','DEV','Type','Coverage'], axis = 1, inplace = True)

        # let's rename the columns so that they make sense
        df_can.rename (columns = {'OdName':'Country', 'AreaName':'Continent','RegName':'Region'}

        # for sake of consistency, let's also make all column labels of type string
        df_can.columns = list(map(str, df_can.columns))

        # set the country name as index - useful for quickly looking up countries using .loc met
        df_can.set_index('Country', inplace = True)

        # add total column
        df_can['Total'] =  df_can.sum (axis = 1)

        # years that we will be using in this lesson - useful for plotting later on
        years = list(map(str, range(1980, 2014)))
        print ('data dimensions:', df_can.shape)
```

```
data dimensions: (195, 38)
```

3 Visualizing Data using Matplotlib

Import `matplotlib`:

```
In [6]: %matplotlib inline

        import matplotlib as mpl
        import matplotlib.pyplot as plt
        import matplotlib.patches as mpatches # needed for waffle Charts

        mpl.style.use('ggplot') # optional: for ggplot-like style

        # check for latest version of Matplotlib
        print ('Matplotlib version: ', mpl.__version__) # >= 2.0.0
```

```
Matplotlib version:  3.0.2
```

4 Waffle Charts

A `waffle chart` is an interesting visualization that is normally created to display progress toward goals. It is commonly an effective option when you are trying to add interesting visualization features to a visual that consists mainly of cells, such as an Excel dashboard.

Let's revisit the previous case study about Denmark, Norway, and Sweden.

In [7]:
```python
# let's create a new dataframe for these three countries
df_dsn = df_can.loc[['Denmark', 'Norway', 'Sweden'], :]

# let's take a look at our dataframe
df_dsn
```

Out[7]:
```
         Continent           Region             DevName  1980  1981  1982  1983  \
Country
Denmark     Europe  Northern Europe  Developed regions   272   293   299   106
Norway      Europe  Northern Europe  Developed regions   116    77   106    51
Sweden      Europe  Northern Europe  Developed regions   281   308   222   176

         1984  1985  1986  ...   2005  2006  2007  2008  2009  2010  2011  \
Country                    ...
Denmark    93    73    93  ...     62   101    97   108    81    92    93
Norway     31    54    56  ...     57    53    73    66    75    46    49
Sweden    128   158   187  ...    205   139   193   165   167   159   134

         2012  2013  Total
Country
Denmark    94    81   3901
Norway     53    59   2327
Sweden    140   140   5866

[3 rows x 38 columns]
```

Unfortunately, unlike R, `waffle` charts are not built into any of the Python visualization libraries. Therefore, we will learn how to create them from scratch.

Step 1. The first step into creating a waffle chart is determing the proportion of each category with respect to the total.

In [8]:
```python
# compute the proportion of each category with respect to the total
total_values = sum(df_dsn['Total'])
category_proportions = [(float(value) / total_values) for value in df_dsn['Total']]

# print out proportions
for i, proportion in enumerate(category_proportions):
    print (df_dsn.index.values[i] + ': ' + str(proportion))
```

```
Denmark: 0.32255663965602777
Norway: 0.1924094592359848
Sweden: 0.48503390110798744
```

Step 2. The second step is defining the overall size of the `waffle` chart.

```
In [10]: width = 40 # width of chart
         height = 10 # height of chart

         total_num_tiles = width * height # total number of tiles

         print ('Total number of tiles is ', total_num_tiles)
```

```
Total number of tiles is  400
```

Step 3. The third step is using the proportion of each category to determe it respective number of tiles

```
In [11]: # compute the number of tiles for each catagory
         tiles_per_category = [round(proportion * total_num_tiles) for proportion in category_pr

         # print out number of tiles per category
         for i, tiles in enumerate(tiles_per_category):
             print (df_dsn.index.values[i] + ': ' + str(tiles))
```

```
Denmark: 129
Norway: 77
Sweden: 194
```

Based on the calculated proportions, Denmark will occupy 129 tiles of the `waffle` chart, Norway will occupy 77 tiles, and Sweden will occupy 194 tiles.

Step 4. The fourth step is creating a matrix that resembles the `waffle` chart and populating it.

```
In [12]: # initialize the waffle chart as an empty matrix
         waffle_chart = np.zeros((height, width))

         # define indices to loop through waffle chart
         category_index = 0
         tile_index = 0

         # populate the waffle chart
         for col in range(width):
             for row in range(height):
                 tile_index += 1

                 # if the number of tiles populated for the current category is equal to its cor
                 if tile_index > sum(tiles_per_category[0:category_index]):
                     # ...proceed to the next category
                     category_index += 1

                 # set the class value to an integer, which increases with class
```

```
                waffle_chart[row, col] = category_index

        print ('Waffle chart populated!')
```

```
Waffle chart populated!
```

Let's take a peek at how the matrix looks like.

```
In [13]: waffle_chart
```

```
Out[13]: array([[1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 2., 2., 2.,
                 2., 2., 2., 2., 2., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3.,
                 3., 3., 3., 3., 3., 3., 3., 3.],
                [1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 2., 2., 2.,
                 2., 2., 2., 2., 2., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3.,
                 3., 3., 3., 3., 3., 3., 3., 3.],
                [1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 2., 2., 2.,
                 2., 2., 2., 2., 2., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3.,
                 3., 3., 3., 3., 3., 3., 3., 3.],
                [1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 2., 2., 2.,
                 2., 2., 2., 2., 2., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3.,
                 3., 3., 3., 3., 3., 3., 3., 3.],
                [1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 2., 2., 2.,
                 2., 2., 2., 2., 2., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3.,
                 3., 3., 3., 3., 3., 3., 3., 3.],
                [1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 2., 2., 2.,
                 2., 2., 2., 2., 2., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3.,
                 3., 3., 3., 3., 3., 3., 3., 3.],
                [1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 2., 2., 2.,
                 2., 2., 2., 2., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3.,
                 3., 3., 3., 3., 3., 3., 3., 3.],
                [1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 2., 2., 2.,
                 2., 2., 2., 2., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3.,
                 3., 3., 3., 3., 3., 3., 3., 3.],
                [1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 2., 2., 2.,
                 2., 2., 2., 2., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3.,
                 3., 3., 3., 3., 3., 3., 3., 3.],
                [1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 2., 2., 2., 2.,
                 2., 2., 2., 2., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3.,
                 3., 3., 3., 3., 3., 3., 3., 3.]])
```

As expected, the matrix consists of three categories and the total number of each category's instances matches the total number of tiles allocated to each category.

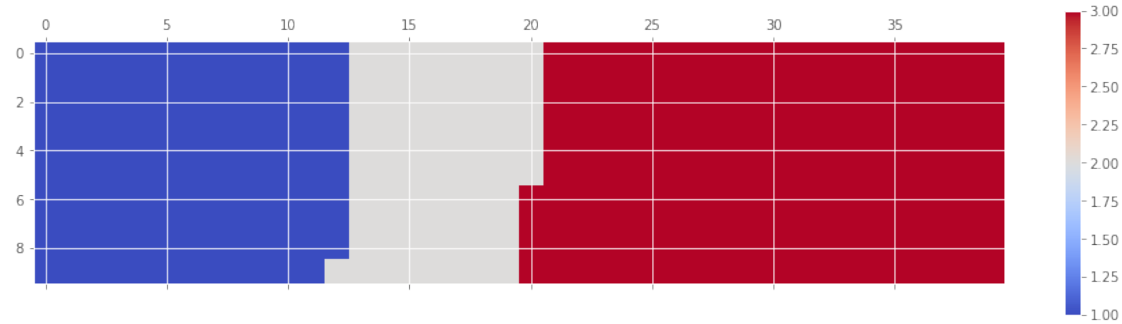
Step 5. Map the `waffle` chart matrix into a visual.

```
In [14]: # instantiate a new figure object
         fig = plt.figure()
```

```
# use matshow to display the waffle chart
colormap = plt.cm.coolwarm
plt.matshow(waffle_chart, cmap=colormap)
plt.colorbar()
```

Out[14]: <matplotlib.colorbar.Colorbar at 0x7f65d0ad7e80>

<Figure size 432x288 with 0 Axes>

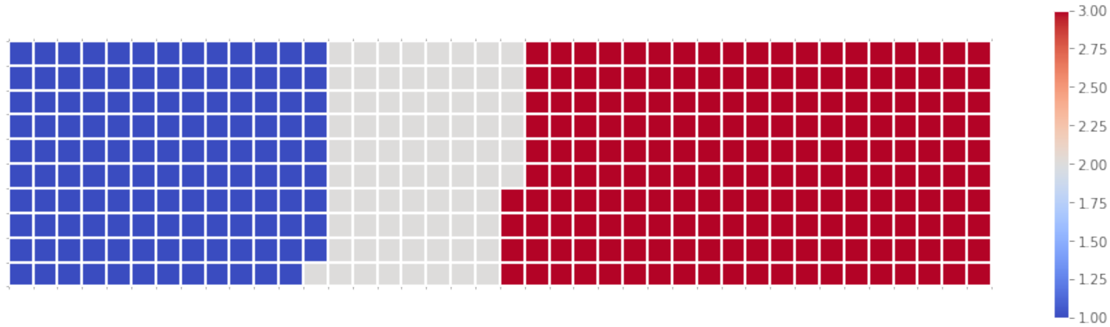


Step 6. Prettify the chart.

```
In [15]: # instantiate a new figure object
fig = plt.figure()

# use matshow to display the waffle chart
colormap = plt.cm.coolwarm
plt.matshow(waffle_chart, cmap=colormap)
plt.colorbar()

# get the axis
ax = plt.gca()

# set minor ticks
ax.set_xticks(np.arange(-.5, (width), 1), minor=True)
ax.set_yticks(np.arange(-.5, (height), 1), minor=True)

# add gridlines based on minor ticks
ax.grid(which='minor', color='w', linestyle='-', linewidth=2)

plt.xticks([])
plt.yticks([])
```

Out[15]: ([], <a list of 0 Text yticklabel objects>)

<Figure size 432x288 with 0 Axes>



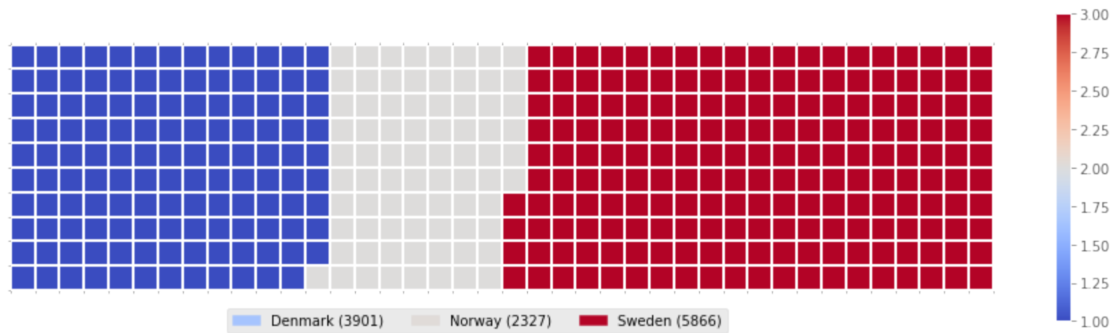
Step 7. Create a legend and add it to chart.

In [16]:
```
# instantiate a new figure object
fig = plt.figure()

# use matshow to display the waffle chart
colormap = plt.cm.coolwarm
plt.matshow(waffle_chart, cmap=colormap)
plt.colorbar()

# get the axis
ax = plt.gca()

# set minor ticks
ax.set_xticks(np.arange(-.5, (width), 1), minor=True)
ax.set_yticks(np.arange(-.5, (height), 1), minor=True)

# add gridlines based on minor ticks
ax.grid(which='minor', color='w', linestyle='-', linewidth=2)

plt.xticks([])
plt.yticks([])

# compute cumulative sum of individual categories to match color schemes between chart
values_cumsum = np.cumsum(df_dsn['Total'])
total_values = values_cumsum[len(values_cumsum) - 1]

# create legend
legend_handles = []
for i, category in enumerate(df_dsn.index.values):
    label_str = category + ' (' + str(df_dsn['Total'][i]) + ')'
    color_val = colormap(float(values_cumsum[i])/total_values)
    legend_handles.append(mpatches.Patch(color=color_val, label=label_str))

# add legend to chart
plt.legend(handles=legend_handles,
```

```
                  loc='lower center',
                  ncol=len(df_dsn.index.values),
                  bbox_to_anchor=(0., -0.2, 0.95, .1)
                 )
```

Out[16]:
```
<matplotlib.legend.Legend at 0x7f65d1ddf358>
```

```
<Figure size 432x288 with 0 Axes>
```



And there you go! What a good looking *delicious* `waffle` chart, don't you think?

Now it would very inefficient to repeat these seven steps every time we wish to create a `waffle` chart. So let's combine all seven steps into one function called *create_waffle_chart*. This function would take the following parameters as input:

1. **categories**: Unique categories or classes in dataframe.
2. **values**: Values corresponding to categories or classes.
3. **height**: Defined height of waffle chart.
4. **width**: Defined width of waffle chart.
5. **colormap**: Colormap class
6. **value_sign**: In order to make our function more generalizable, we will add this parameter to address signs that could be associated with a value such as %, $, and so on. **value_sign** has a default value of empty string.

In [17]:
```python
def create_waffle_chart(categories, values, height, width, colormap, value_sign=''):

    # compute the proportion of each category with respect to the total
    total_values = sum(values)
    category_proportions = [(float(value) / total_values) for value in values]

    # compute the total number of tiles
    total_num_tiles = width * height # total number of tiles
    print ('Total number of tiles is', total_num_tiles)

    # compute the number of tiles for each catagory
    tiles_per_category = [round(proportion * total_num_tiles) for proportion in categor
```

```
# print out number of tiles per category
for i, tiles in enumerate(tiles_per_category):
    print (df_dsn.index.values[i] + ': ' + str(tiles))

# initialize the waffle chart as an empty matrix
waffle_chart = np.zeros((height, width))

# define indices to loop through waffle chart
category_index = 0
tile_index = 0

# populate the waffle chart
for col in range(width):
    for row in range(height):
        tile_index += 1

        # if the number of tiles populated for the current category
        # is equal to its corresponding allocated tiles...
        if tile_index > sum(tiles_per_category[0:category_index]):
            # ...proceed to the next category
            category_index += 1

        # set the class value to an integer, which increases with class
        waffle_chart[row, col] = category_index

# instantiate a new figure object
fig = plt.figure()

# use matshow to display the waffle chart
colormap = plt.cm.coolwarm
plt.matshow(waffle_chart, cmap=colormap)
plt.colorbar()

# get the axis
ax = plt.gca()

# set minor ticks
ax.set_xticks(np.arange(-.5, (width), 1), minor=True)
ax.set_yticks(np.arange(-.5, (height), 1), minor=True)

# add dridlines based on minor ticks
ax.grid(which='minor', color='w', linestyle='-', linewidth=2)

plt.xticks([])
plt.yticks([])

# compute cumulative sum of individual categories to match color schemes between ch
```

```
    values_cumsum = np.cumsum(values)
    total_values = values_cumsum[len(values_cumsum) - 1]

    # create legend
    legend_handles = []
    for i, category in enumerate(categories):
        if value_sign == '%':
            label_str = category + ' (' + str(values[i]) + value_sign + ')'
        else:
            label_str = category + ' (' + value_sign + str(values[i]) + ')'

        color_val = colormap(float(values_cumsum[i])/total_values)
        legend_handles.append(mpatches.Patch(color=color_val, label=label_str))

    # add legend to chart
    plt.legend(
        handles=legend_handles,
        loc='lower center',
        ncol=len(categories),
        bbox_to_anchor=(0., -0.2, 0.95, .1)
    )
```

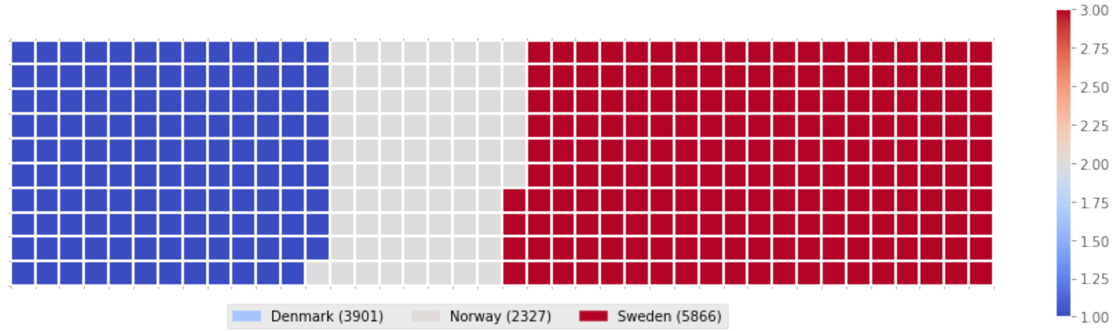
Now to create a `waffle` chart, all we have to do is call the function `create_waffle_chart`. Let's define the input parameters:

```
In [18]: width = 40 # width of chart
         height = 10 # height of chart

         categories = df_dsn.index.values # categories
         values = df_dsn['Total'] # correponding values of categories

         colormap = plt.cm.coolwarm # color map class
```

And now let's call our function to create a `waffle` chart.

```
In [19]: create_waffle_chart(categories, values, height, width, colormap)
```

```
Total number of tiles is 400
Denmark: 129
Norway: 77
Sweden: 194


<Figure size 432x288 with 0 Axes>
```



There seems to be a new Python package for generating `waffle charts` called PyWaffle, but it looks like the repository is still being built. But feel free to check it out and play with it.

5 Word Clouds

`Word` clouds (also known as text clouds or tag clouds) work in a simple way: the more a specific word appears in a source of textual data (such as a speech, blog post, or database), the bigger and bolder it appears in the word cloud.

Luckily, a Python package already exists in Python for generating `word` clouds. The package, called `word_cloud` was developed by **Andreas Mueller**. You can learn more about the package by following this link.

Let's use this package to learn how to generate a word cloud for a given text document.

First, let's install the package.

```
In [20]: # install wordcloud
         !conda install -c conda-forge wordcloud==1.4.1 --yes

         # import package and its set of stopwords
         from wordcloud import WordCloud, STOPWORDS

         print ('Wordcloud is installed and imported!')
```

```
Collecting package metadata: done
Solving environment: /
The environment is inconsistent, please check the package plan carefully
The following packages are causing the inconsistency:

  - defaults/linux-64::anaconda==5.3.1=py37_0
  - defaults/linux-64::astropy==3.0.4=py37h14c3975_0
  - defaults/linux-64::bkcharts==0.2=py37_0
  - defaults/linux-64::blaze==0.11.3=py37_0
  - defaults/linux-64::bokeh==0.13.0=py37_0
  - defaults/linux-64::bottleneck==1.2.1=py37h035aef0_1
  - defaults/linux-64::dask==0.19.1=py37_0
  - defaults/linux-64::datashape==0.5.4=py37_1
```

```
  - defaults/linux-64::mkl-service==1.1.2=py37h90e4bf4_5
  - defaults/linux-64::numba==0.39.0=py37h04863e7_0
  - defaults/linux-64::numexpr==2.6.8=py37hd89afb7_0
  - defaults/linux-64::odo==0.5.1=py37_0
  - defaults/linux-64::pytables==3.4.4=py37ha205bf6_0
  - defaults/linux-64::pytest-arraydiff==0.2=py37h39e3cac_0
  - defaults/linux-64::pytest-astropy==0.4.0=py37_0
  - defaults/linux-64::pytest-doctestplus==0.1.3=py37_0
  - defaults/linux-64::pywavelets==1.0.0=py37hdd07704_0
  - defaults/linux-64::scikit-image==0.14.0=py37hf484d3e_1
done

## Package Plan ##

  environment location: /home/jupyterlab/conda

  added / updated specs:
    - wordcloud==1.4.1


The following packages will be downloaded:

    package                    |            build
    ---------------------------|-----------------
    wordcloud-1.4.1            |           py36_0         324 KB  conda-forge
    ------------------------------------------------------------
                                           Total:         324 KB

The following NEW packages will be INSTALLED:

  wordcloud          conda-forge/linux-64::wordcloud-1.4.1-py36_0



Downloading and Extracting Packages
wordcloud-1.4.1      | 324 KB    | ##################################### | 100%
Preparing transaction: done
Verifying transaction: done
Executing transaction: done
Wordcloud is installed and imported!
```

`Word` clouds are commonly used to perform high-level analysis and visualization of text data. Accordinly, let's digress from the immigration dataset and work with an example that involves analyzing text data. Let's try to analyze a short novel written by **Lewis Carroll** titled *Alice's Adventures in Wonderland*. Let's go ahead and download a *.txt* file of the novel.

```
In [25]: # download file and save as alice_novel.txt
         !wget --quiet https://ibm.box.com/shared/static/m54sjtrshpt5su20dzesl5en9xa5vfz1.txt -O
```

```
# open the file and read it into a variable alice_novel
alice_novel = open('alice_novel.txt', 'r').read()

print ('File downloaded and saved!')
```

```
File downloaded and saved!
```

Next, let's use the stopwords that we imported from `word_cloud`. We use the function *set* to remove any redundant stopwords.

```
In [26]: stopwords = set(STOPWORDS)
```

Create a word cloud object and generate a word cloud. For simplicity, let's generate a word cloud using only the first 2000 words in the novel.

```
In [27]: # instantiate a word cloud object
         alice_wc = WordCloud(
             background_color='white',
             max_words=2000,
             stopwords=stopwords
         )

         # generate the word cloud
         alice_wc.generate(alice_novel)
```

```
Out[27]: <wordcloud.wordcloud.WordCloud at 0x7f65c8b45e10>
```

Awesome! Now that the `word` cloud is created, let's visualize it.

```
In [28]: # display the word cloud
         plt.imshow(alice_wc, interpolation='bilinear')
         plt.axis('off')
         plt.show()
```

Interesting! So in the first 2000 words in the novel, the most common words are **Alice**, **said**, **little**, **Queen**, and so on. Let's resize the cloud so that we can see the less frequent words a little better.

In [29]:
```
fig = plt.figure()
fig.set_figwidth(14) # set width
fig.set_figheight(18) # set height

# display the cloud
plt.imshow(alice_wc, interpolation='bilinear')
plt.axis('off')
plt.show()
```

Much better! However, **said** isn't really an informative word. So let's add it to our stopwords and re-generate the cloud.

In [30]:
```
stopwords.add('said') # add the words said to stopwords

# re-generate the word cloud
alice_wc.generate(alice_novel)

# display the cloud
fig = plt.figure()
fig.set_figwidth(14) # set width
fig.set_figheight(18) # set height

plt.imshow(alice_wc, interpolation='bilinear')
```

```
plt.axis('off')
plt.show()
```

Excellent! This looks really interesting! Another cool thing you can implement with the `word_cloud` package is superimposing the words onto a mask of any shape. Let's use a mask of Alice and her rabbit. We already created the mask for you, so let's go ahead and download it and call it *alice_mask.png*.

```
In [31]: # download image
         !wget --quiet https://ibm.box.com/shared/static/3mpxgaf6muer6af7t1nvqkw9cqj85ibm.png -O

         # save mask to alice_mask
         alice_mask = np.array(Image.open('alice_mask.png'))

         print('Image downloaded and saved!')
```

```
Image downloaded and saved!
```

Let's take a look at how the mask looks like.

```
In [32]: fig = plt.figure()
         fig.set_figwidth(14) # set width
         fig.set_figheight(18) # set height

         plt.imshow(alice_mask, cmap=plt.cm.gray, interpolation='bilinear')
         plt.axis('off')
         plt.show()
```

Shaping the word cloud according to the mask is straightforward using word_cloud package. For simplicity, we will continue using the first 2000 words in the novel.

```
In [33]: # instantiate a word cloud object
         alice_wc = WordCloud(background_color='white', max_words=2000, mask=alice_mask, stopwor

         # generate the word cloud
         alice_wc.generate(alice_novel)

         # display the word cloud
         fig = plt.figure()
         fig.set_figwidth(14) # set width
         fig.set_figheight(18) # set height

         plt.imshow(alice_wc, interpolation='bilinear')
```

```
plt.axis('off')
plt.show()
```

Really impressive!

Unfortunately, our immmigration data does not have any text data, but where there is a will there is a way. Let's generate sample text data from our immigration dataset, say text data of 90 words.

Let's recall how our data looks like.

```
In [34]: df_can.head()
```

```
Out[34]:             Continent           Region             DevName  1980  1981  \
         Country
         Afghanistan      Asia    Southern Asia  Developing regions    16    39
         Albania        Europe  Southern Europe   Developed regions     1     0
```

```
Algeria           Africa  Northern Africa  Developing regions    80    67
American Samoa   Oceania        Polynesia  Developing regions     0     1
Andorra           Europe  Southern Europe   Developed regions     0     0

                1982  1983  1984  1985  1986  ...  2005  2006  2007  2008  \
Country                                       ...
Afghanistan       39    47    71   340   496  ...  3436  3009  2652  2111
Albania            0     0     0     0     1  ...  1223   856   702   560
Algeria           71    69    63    44    69  ...  3626  4807  3623  4005
American Samoa     0     0     0     0     0  ...     0     1     0     0
Andorra            0     0     0     0     2  ...     0     1     1     0

                2009  2010  2011  2012  2013  Total
Country
Afghanistan     1746  1758  2203  2635  2004  58639
Albania          716   561   539   620   603  15699
Algeria         5393  4752  4325  3774  4331  69439
American Samoa     0     0     0     0     0      6
Andorra            0     0     0     1     1     15

[5 rows x 38 columns]
```

And what was the total immigration from 1980 to 2013?

```
In [35]: total_immigration = df_can['Total'].sum()
         total_immigration
```

```
Out[35]: 6409153
```

Using countries with single-word names, let's duplicate each country's name based on how much they contribute to the total immigration.

```
In [36]: max_words = 90
         word_string = ''
         for country in df_can.index.values:
             # check if country's name is a single-word name
             if len(country.split(' ')) == 1:
                 repeat_num_times = int(df_can.loc[country, 'Total']/float(total_immigration)*ma
                 word_string = word_string + ((country + ' ') * repeat_num_times)

         # display the generated text
         word_string
```

```
Out[36]: 'China China China China China China China China China Colombia Egypt France Guyana Hai
```

We are not dealing with any stopwords here, so there is no need to pass them when creating the word cloud.

```
In [37]: # create the word cloud
         wordcloud = WordCloud(background_color='white').generate(word_string)

         print('Word cloud created!')
```

```
Word cloud created!
```

```
In [38]: # display the cloud
         fig = plt.figure()
         fig.set_figwidth(14)
         fig.set_figheight(18)

         plt.imshow(wordcloud, interpolation='bilinear')
         plt.axis('off')
         plt.show()
```

According to the above word cloud, it looks like the majority of the people who immigrated came from one of 15 countries that are displayed by the word cloud. One cool visual that you could build, is perhaps using the map of Canada and a mask and superimposing the word cloud on top of the map of Canada. That would be an interesting visual to build!

6 Regression Plots

Seaborn is a Python visualization library based on matplotlib. It provides a high-level interface for drawing attractive statistical graphics. You can learn more about *seaborn* by following this link and more about *seaborn* regression plots by following this link.

In lab *Pie Charts, Box Plots, Scatter Plots, and Bubble Plots*, we learned how to create a scatter plot and then fit a regression line. It took ~20 lines of code to create the scatter plot along with the regression fit. In this final section, we will explore *seaborn* and see how efficient it is to create regression lines and fits using this library!

Let's first install *seaborn*

In [39]:
```
# install seaborn
!pip install seaborn

# import library
import seaborn as sns

print('Seaborn installed and imported!')
```

```
Requirement already satisfied: seaborn in /home/jupyterlab/conda/lib/python3.6/site-packages (0.
Requirement already satisfied: scipy>=0.14.0 in /home/jupyterlab/conda/lib/python3.6/site-packag
Requirement already satisfied: numpy>=1.9.3 in /home/jupyterlab/conda/lib/python3.6/site-package
Requirement already satisfied: matplotlib>=1.4.3 in /home/jupyterlab/conda/lib/python3.6/site-pa
Requirement already satisfied: pandas>=0.15.2 in /home/jupyterlab/conda/lib/python3.6/site-packa
Requirement already satisfied: cycler>=0.10 in /home/jupyterlab/conda/lib/python3.6/site-package
Requirement already satisfied: kiwisolver>=1.0.1 in /home/jupyterlab/conda/lib/python3.6/site-pa
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /home/jupyterlab/cond
Requirement already satisfied: python-dateutil>=2.1 in /home/jupyterlab/conda/lib/python3.6/site
Requirement already satisfied: pytz>=2011k in /home/jupyterlab/conda/lib/python3.6/site-packages
Requirement already satisfied: six in /home/jupyterlab/conda/lib/python3.6/site-packages (from c
Requirement already satisfied: setuptools in /home/jupyterlab/conda/lib/python3.6/site-packages
Seaborn installed and imported!
```

Create a new dataframe that stores that total number of landed immigrants to Canada per year from 1980 to 2013.

In [40]:
```
# we can use the sum() method to get the total population per year
df_tot = pd.DataFrame(df_can[years].sum(axis=0))

# change the years to type float (useful for regression later on)
df_tot.index = map(float,df_tot.index)

# reset the index to put in back in as a column in the df_tot dataframe
df_tot.reset_index(inplace = True)

# rename columns
df_tot.columns = ['year', 'total']

# view the final dataframe
df_tot.head()
```

Out[40]:

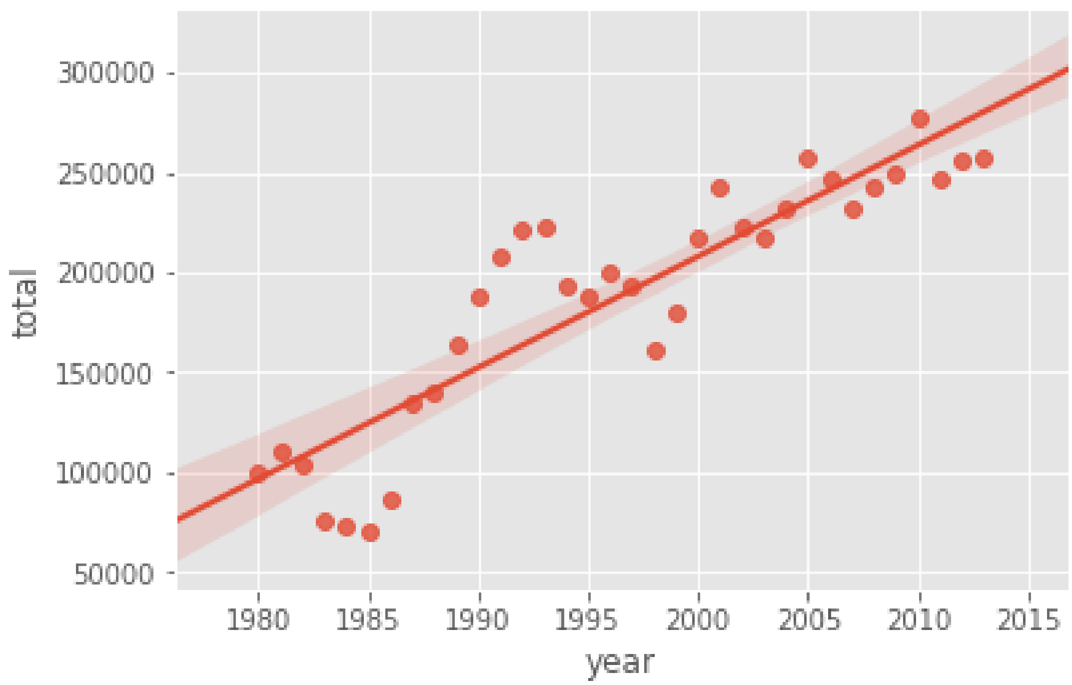
	year	total
0	1980.0	99137

```
1  1981.0  110563
2  1982.0  104271
3  1983.0   75550
4  1984.0   73417
```

With *seaborn*, generating a regression plot is as simple as calling the **regplot** function.

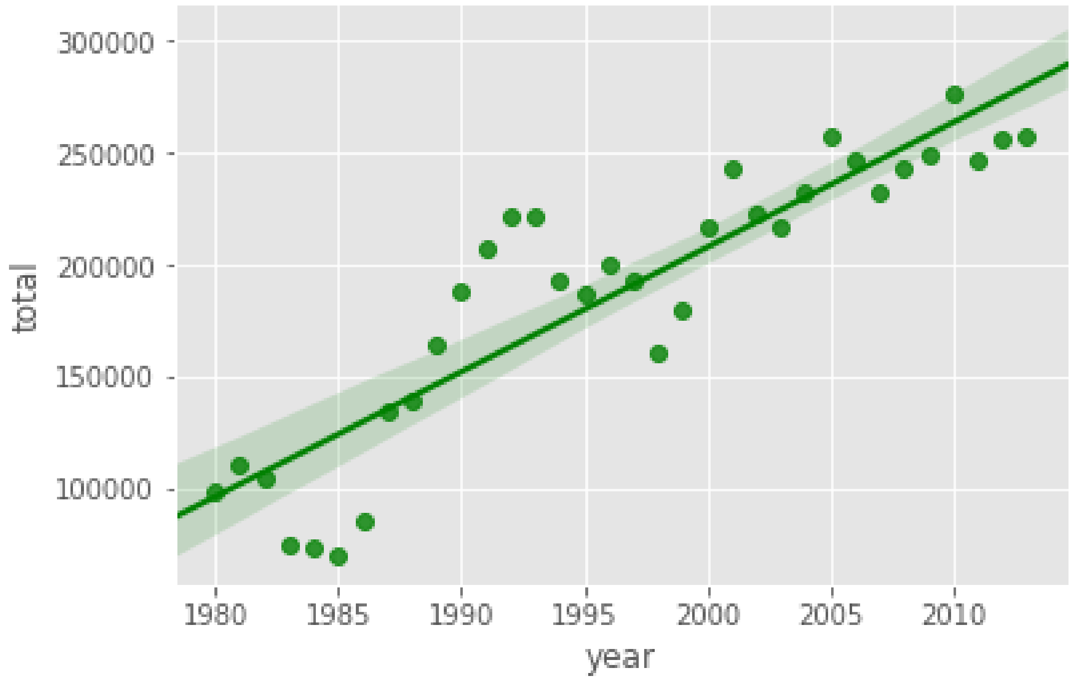
```
In [41]: import seaborn as sns
         ax = sns.regplot(x='year', y='total', data=df_tot)
```

```
/home/jupyterlab/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Usi
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```



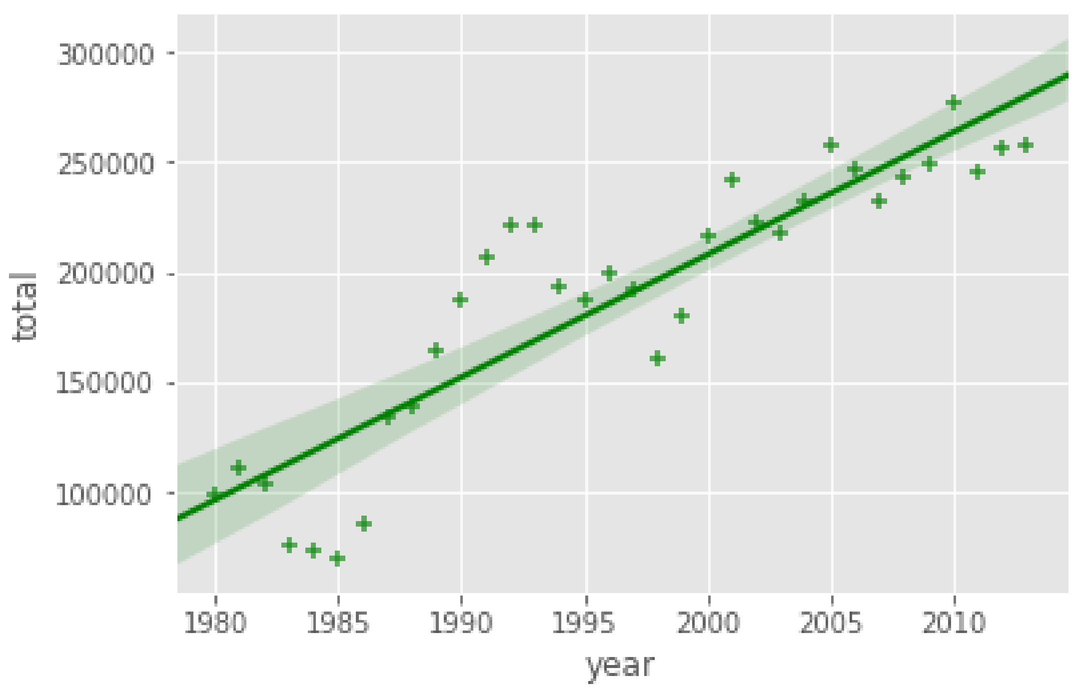
This is not magic; it is *seaborn*! You can also customize the color of the scatter plot and regression line. Let's change the color to green.

```
In [42]: import seaborn as sns
         ax = sns.regplot(x='year', y='total', data=df_tot, color='green')
```



You can always customize the marker shape, so instead of circular markers, let's use '+'.

```
In [43]: import seaborn as sns
         ax = sns.regplot(x='year', y='total', data=df_tot, color='green', marker='+')
```



Let's blow up the plot a little bit so that it is more appealing to the sight.

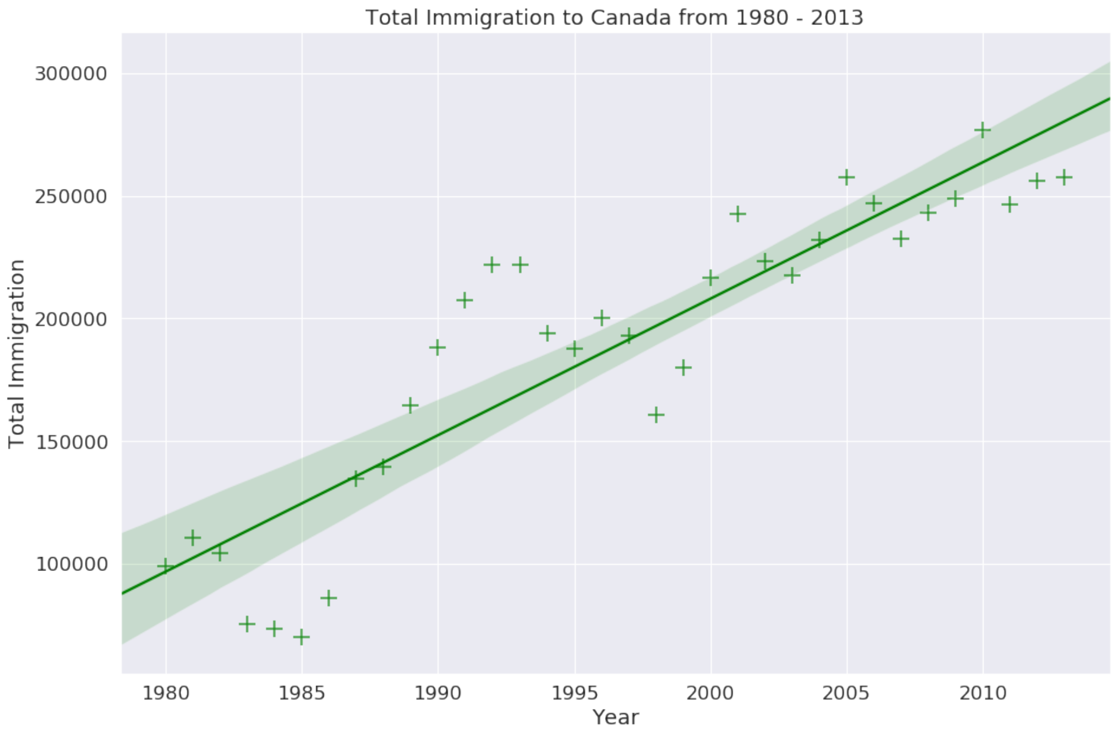
```
In [44]: plt.figure(figsize=(15, 10))
         ax = sns.regplot(x='year', y='total', data=df_tot, color='green', marker='+')
```

And let's increase the size of markers so they match the new size of the figure, and add a title and x- and y-labels.

```
In [45]: plt.figure(figsize=(15, 10))
         ax = sns.regplot(x='year', y='total', data=df_tot, color='green', marker='+', scatter_k

         ax.set(xlabel='Year', ylabel='Total Immigration') # add x- and y-labels
         ax.set_title('Total Immigration to Canada from 1980 - 2013') # add title

Out[45]: Text(0.5, 1.0, 'Total Immigration to Canada from 1980 - 2013')
```

And finally increase the font size of the tickmark labels, the title, and the x- and y-labels so they don't feel left out!

```
In [46]: plt.figure(figsize=(15, 10))

         sns.set(font_scale=1.5)

         ax = sns.regplot(x='year', y='total', data=df_tot, color='green', marker='+', scatter_k
         ax.set(xlabel='Year', ylabel='Total Immigration')
         ax.set_title('Total Immigration to Canada from 1980 - 2013')

Out[46]: Text(0.5, 1.0, 'Total Immigration to Canada from 1980 - 2013')
```

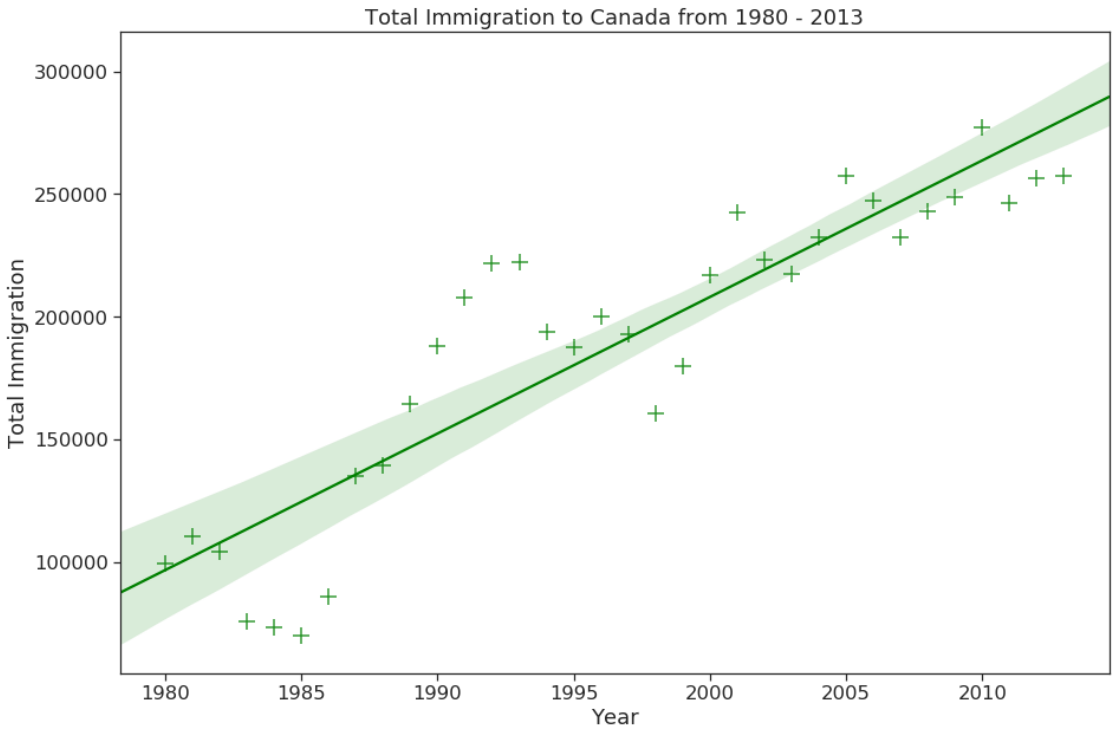


Amazing! A complete scatter plot with a regression fit with 5 lines of code only. Isn't this really amazing?

If you are not a big fan of the purple background, you can easily change the style to a white plain background.

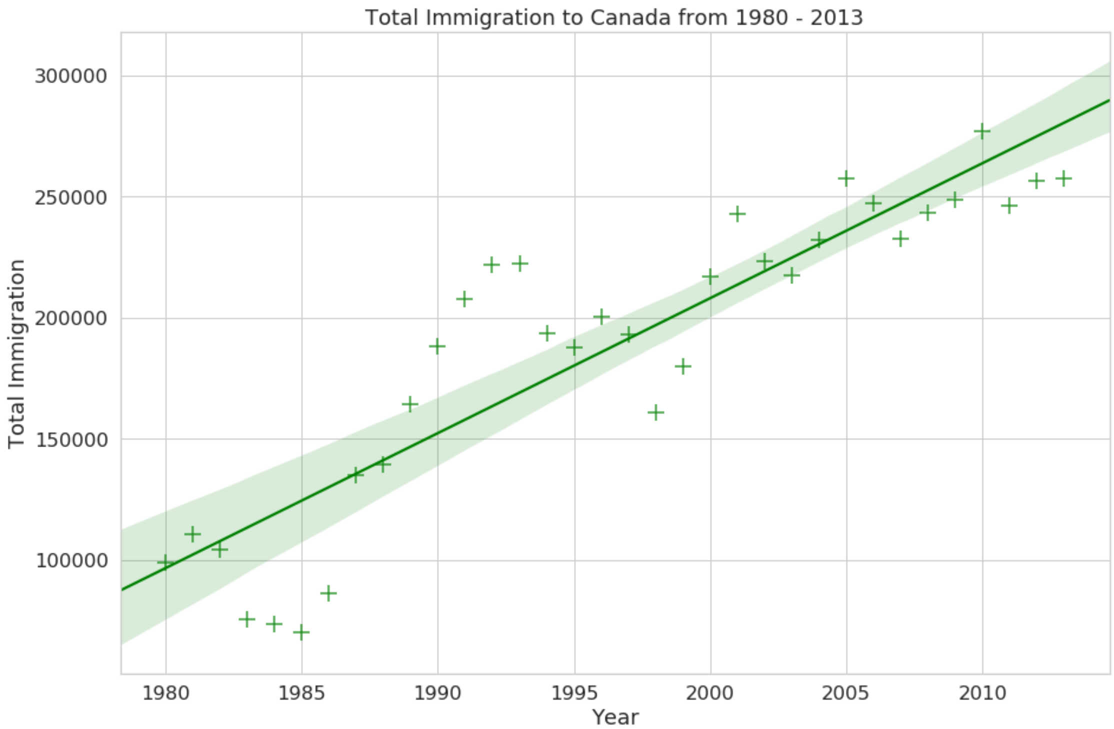
```
In [47]: plt.figure(figsize=(15, 10))

         sns.set(font_scale=1.5)
         sns.set_style('ticks') # change background to white background

         ax = sns.regplot(x='year', y='total', data=df_tot, color='green', marker='+', scatter_k
         ax.set(xlabel='Year', ylabel='Total Immigration')
         ax.set_title('Total Immigration to Canada from 1980 - 2013')
```

```
Out[47]: Text(0.5, 1.0, 'Total Immigration to Canada from 1980 - 2013')
```



Or to a white background with gridlines.

```
In [48]: plt.figure(figsize=(15, 10))

         sns.set(font_scale=1.5)
         sns.set_style('whitegrid')

         ax = sns.regplot(x='year', y='total', data=df_tot, color='green', marker='+', scatter_k
         ax.set(xlabel='Year', ylabel='Total Immigration')
         ax.set_title('Total Immigration to Canada from 1980 - 2013')

Out[48]: Text(0.5, 1.0, 'Total Immigration to Canada from 1980 - 2013')
```



Question: Use seaborn to create a scatter plot with a regression line to visualize the total immigration from Denmark, Sweden, and Norway to Canada from 1980 to 2013.

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

```
In [ ]:
```

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

6.0.1 Thank you for completing this lab!

This notebook was created by Alex Aklson. I hope you found this lab interesting and educational. 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.