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

June 17, 2020

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:

[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:

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

print('Data 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

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

[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

[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.

[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'}, inplace = True)

# 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 method
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`:

[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:  3.1.1
```

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.

[7]:
```
# 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
```

[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.

[8]:
```
# 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.

[9]:
```
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

[10]:
```
# compute the number of tiles for each catagory
tiles_per_category = [round(proportion * total_num_tiles) for proportion in␣
 ↪category_proportions]

# 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.

[11]:
```
# 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

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

```
Waffle chart populated!
```

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

[12]:
```
waffle_chart
```

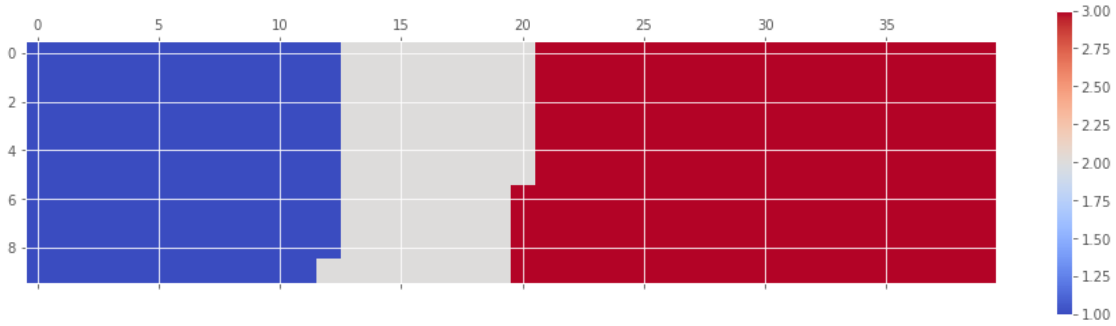
[12]:
```
array([[1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 2., 2., 2.,
        2., 2., 2., 2., 2., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3., 3.,
        3., 3., 3., 3., 3., 3., 3., 3.],
       [1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 2., 2., 2.,
        2., 2., 2., 2., 2., 3., 3., 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.

[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()
```

[15]:
```
<matplotlib.colorbar.Colorbar at 0x7fc4e16f2198>

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

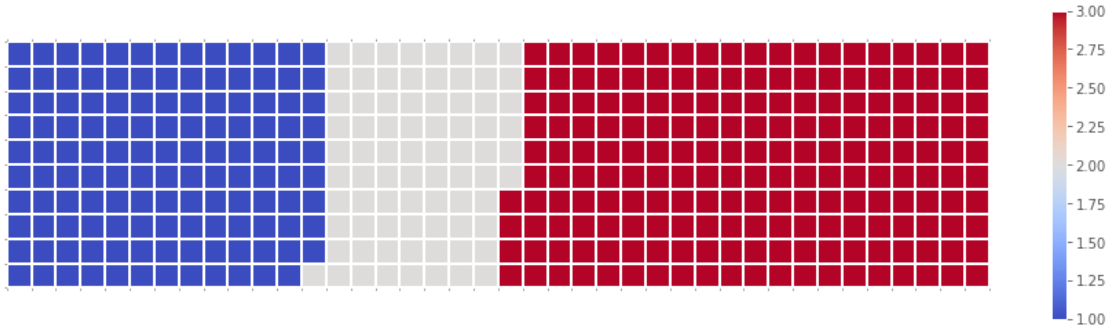


Step 6. Prettify the chart.

[22]:
```
# 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([])
```

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

<Figure size 432x288 with 0 Axes>



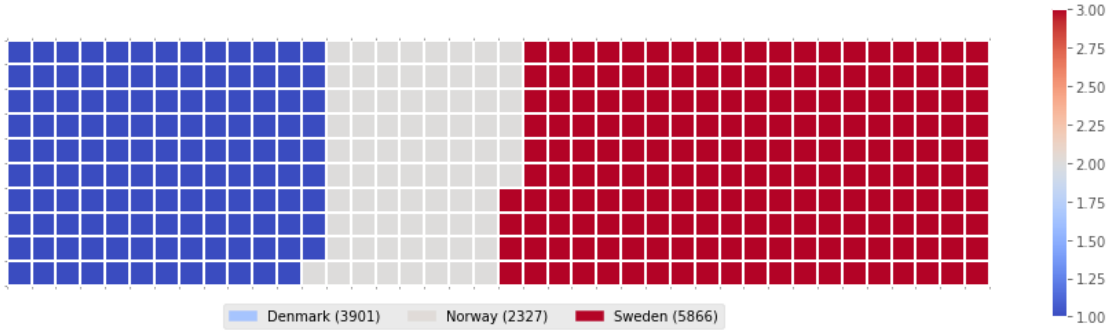
Step 7. Create a legend and add it to chart.

[24]:
```
# 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 and legend
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)
          )
```

[24]: <matplotlib.legend.Legend at 0x7fc4e11aceb8>

<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.

[25]:
```
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␣
↪category_proportions]

    # 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 chart and legend
    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:

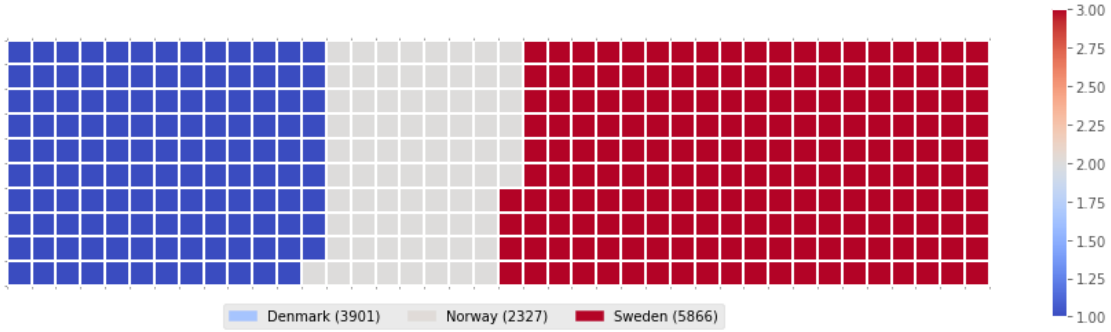
[26]:
```
width = 40 # width of chart
height = 10 # height of chart

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.

[27]:
```
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.

[28]:
```
# 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 (current_repodata.json): done
Solving environment: failed with initial frozen solve. Retrying with flexible
solve.
Collecting package metadata (repodata.json): done
```

```
Solving environment: done

## Package Plan ##

  environment location: /home/jupyterlab/conda/envs/python

  added / updated specs:
    - wordcloud==1.4.1


The following packages will be downloaded:

    package                    |            build
    ---------------------------|-----------------
    ca-certificates-2020.4.5.2 |       hecda079_0         147 KB  conda-forge
    certifi-2020.4.5.2         |   py36h9f0ad1d_0         152 KB  conda-forge
    olefile-0.46               |            py_0          31 KB  conda-forge
    pillow-7.1.2               |   py36h8328e55_0         656 KB  conda-forge
    wordcloud-1.4.1            |           py36_0         324 KB  conda-forge
    ------------------------------------------------------------
                                           Total:         1.3 MB

The following NEW packages will be INSTALLED:

  olefile            conda-forge/noarch::olefile-0.46-py_0
  pillow             conda-forge/linux-64::pillow-7.1.2-py36h8328e55_0
  wordcloud          conda-forge/linux-64::wordcloud-1.4.1-py36_0

The following packages will be UPDATED:

  ca-certificates                     2020.4.5.1-hecc5488_0 -->
2020.4.5.2-hecda079_0
  certifi                          2020.4.5.1-py36h9f0ad1d_0 -->
2020.4.5.2-py36h9f0ad1d_0



Downloading and Extracting Packages
pillow-7.1.2         | 656 KB    | ##################################### | 100%
certifi-2020.4.5.2   | 152 KB    | ##################################### | 100%
wordcloud-1.4.1      | 324 KB    | ##################################### | 100%
ca-certificates-2020 | 147 KB    | ##################################### | 100%
olefile-0.46         | 31 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.

[29]:
```
# download file and save as alice_novel.txt
!wget --quiet https://s3-api.us-geo.objectstorage.softlayer.net/cf-courses-data/
 ↪CognitiveClass/DV0101EN/labs/Data_Files/alice_novel.txt

# 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.

[30]:
```
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.

[31]:
```
# 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)
```

[31]:
```
<wordcloud.wordcloud.WordCloud at 0x7fc4e156a160>
```

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

[34]:
```
# 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.

[35]:
```
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.

[36]:
```
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*.

[37]:
```
# download image
!wget --quiet https://s3-api.us-geo.objectstorage.softlayer.net/cf-courses-data/
 ↪CognitiveClass/DV0101EN/labs/Images/alice_mask.png

# 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.

[38]:
```
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.

[39]:
```
# instantiate a word cloud object
alice_wc = WordCloud(background_color='white', max_words=2000, mask=alice_mask,␣
 ↪stopwords=stopwords)

# 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.

[40]:
```
df_can.head()
```

[40]:

Country	Continent	Region	DevName	1980	1981	\
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?

[41]:
```
total_immigration = df_can['Total'].sum()
total_immigration
```

[41]:
```
6409153
```

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

[42]:
```
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)*max_words)
        word_string = word_string + ((country + ' ') * repeat_num_times)

# display the generated text
word_string
```

[42]:
```
'China China China China China China China China China Colombia Egypt France
Guyana Haiti India India India India India India India India India Jamaica
Lebanon Morocco Pakistan Pakistan Pakistan Philippines Philippines Philippines
Philippines Philippines Philippines Philippines Poland Portugal Romania '
```

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

[43]:
```
# create the word cloud
wordcloud = WordCloud(background_color='white').generate(word_string)

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

```
Word cloud created!
```

[44]:
```
# 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*

[45]:
```
# install seaborn
!conda install -c anaconda seaborn --yes

# import library
import seaborn as sns

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

```
Collecting package metadata (current_repodata.json): done
Solving environment: done

## Package Plan ##

  environment location: /home/jupyterlab/conda/envs/python

  added / updated specs:
    - seaborn


The following packages will be downloaded:

    package                    |            build
    ---------------------------|-----------------
    blas-1.0                   |         openblas          48 KB  anaconda
    ca-certificates-2020.1.1   |                0         132 KB  anaconda
    certifi-2020.4.5.2         |           py36_0         160 KB  anaconda
    dbus-1.13.14               |       hb2f20db_0         590 KB  anaconda
    gst-plugins-base-1.14.0    |       hbbd80ab_1         4.8 MB
    gstreamer-1.14.0           |       hb453b48_1         3.1 MB
    matplotlib-3.1.3           |           py36_0          21 KB  anaconda
    matplotlib-base-3.1.3      |   py36hef1b27d_0         6.6 MB  anaconda
    openssl-1.1.1g             |       h7b6447c_0         3.8 MB  anaconda
    pandas-1.0.3               |   py36h0573a6f_0        11.1 MB  anaconda
    pyqt-5.9.2                 |   py36h22d08a2_1         5.6 MB  anaconda
    pytz-2020.1                |            py_0         239 KB  anaconda
    qt-5.9.7                   |       h5867ecd_1        68.5 MB
    scipy-1.4.1                |   py36habc2bb6_0        18.8 MB  anaconda
    seaborn-0.10.1             |            py_0         160 KB  anaconda
    sip-4.19.13                |   py36he6710b0_0         293 KB  anaconda
    ------------------------------------------------------------
                                           Total:       124.0 MB
```

```
The following NEW packages will be INSTALLED:

  blas               anaconda/linux-64::blas-1.0-openblas
  dbus               anaconda/linux-64::dbus-1.13.14-hb2f20db_0
  gst-plugins-base   pkgs/main/linux-64::gst-plugins-base-1.14.0-hbbd80ab_1
  gstreamer          pkgs/main/linux-64::gstreamer-1.14.0-hb453b48_1
  matplotlib         anaconda/linux-64::matplotlib-3.1.3-py36_0
  pandas             anaconda/linux-64::pandas-1.0.3-py36h0573a6f_0
  pyqt               anaconda/linux-64::pyqt-5.9.2-py36h22d08a2_1
  pytz               anaconda/noarch::pytz-2020.1-py_0
  qt                 pkgs/main/linux-64::qt-5.9.7-h5867ecd_1
  scipy              anaconda/linux-64::scipy-1.4.1-py36habc2bb6_0
  seaborn            anaconda/noarch::seaborn-0.10.1-py_0
  sip                anaconda/linux-64::sip-4.19.13-py36he6710b0_0

The following packages will be UPDATED:

  matplotlib-base    conda-forge::matplotlib-base-3.1.1-py~ -->
anaconda::matplotlib-base-3.1.3-py36hef1b27d_0

The following packages will be SUPERSEDED by a higher-priority channel:

  ca-certificates    conda-forge::ca-certificates-2020.4.5~ --> anaconda::ca-
certificates-2020.1.1-0
  certifi            conda-forge::certifi-2020.4.5.2-py36h~ -->
anaconda::certifi-2020.4.5.2-py36_0
  openssl            conda-forge::openssl-1.1.1g-h516909a_0 -->
anaconda::openssl-1.1.1g-h7b6447c_0



Downloading and Extracting Packages
sip-4.19.13          | 293 KB    | ##################################### | 100%
dbus-1.13.14         | 590 KB    | ##################################### | 100%
pyqt-5.9.2           | 5.6 MB    | ##################################### | 100%
pytz-2020.1          | 239 KB    | ##################################### | 100%
seaborn-0.10.1       | 160 KB    | ##################################### | 100%
certifi-2020.4.5.2   | 160 KB    | ##################################### | 100%
blas-1.0             | 48 KB     | ##################################### | 100%
matplotlib-base-3.1. | 6.6 MB    | ##################################### | 100%
openssl-1.1.1g       | 3.8 MB    | ##################################### | 100%
gst-plugins-base-1.1 | 4.8 MB    | ##################################### | 100%
pandas-1.0.3         | 11.1 MB   | ##################################### | 100%
ca-certificates-2020 | 132 KB    | ##################################### | 100%
scipy-1.4.1          | 18.8 MB   | ##################################### | 100%
gstreamer-1.14.0     | 3.1 MB    | ##################################### | 100%
matplotlib-3.1.3     | 21 KB     | ##################################### | 100%
```

```
qt-5.9.7              | 68.5 MB   | ##################################### | 100%
Preparing transaction: done
Verifying transaction: done
Executing transaction: done
Seaborn installed and imported!
```

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

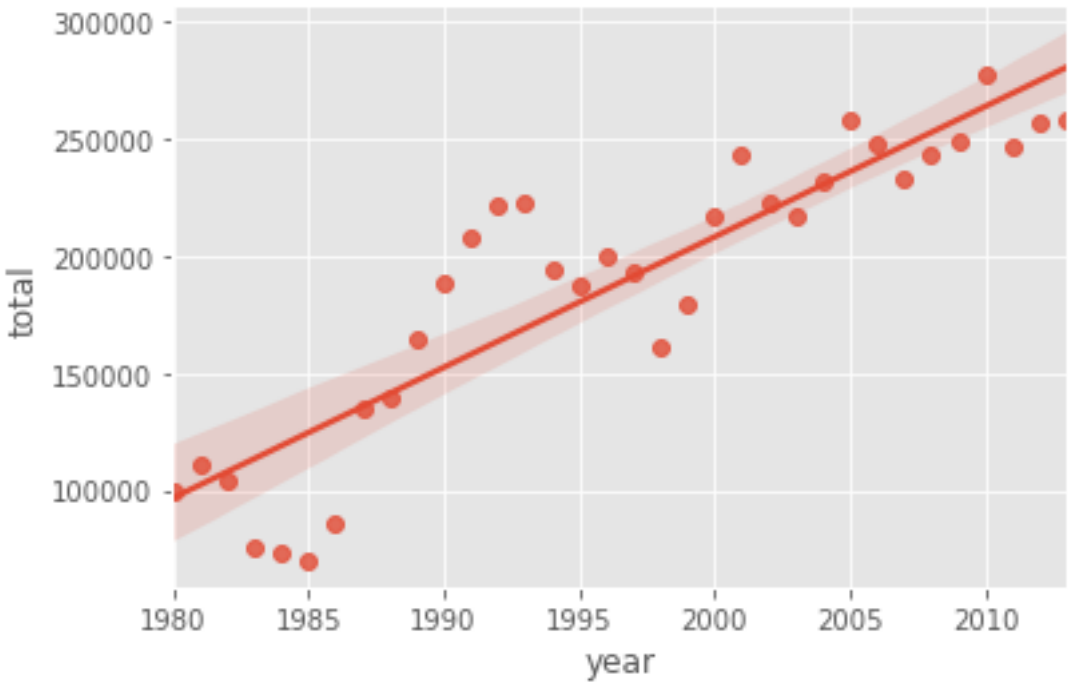
[47]:
```
# we can use the sum() method to get the total population per year
df_tot = pd.DataFrame(df_can[years].sum(axis=0))

# 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()
```

[47]:

	year	total
0	1980.0	99137
1	1981.0	110563
2	1982.0	104271
3	1983.0	75550
4	1984.0	73417

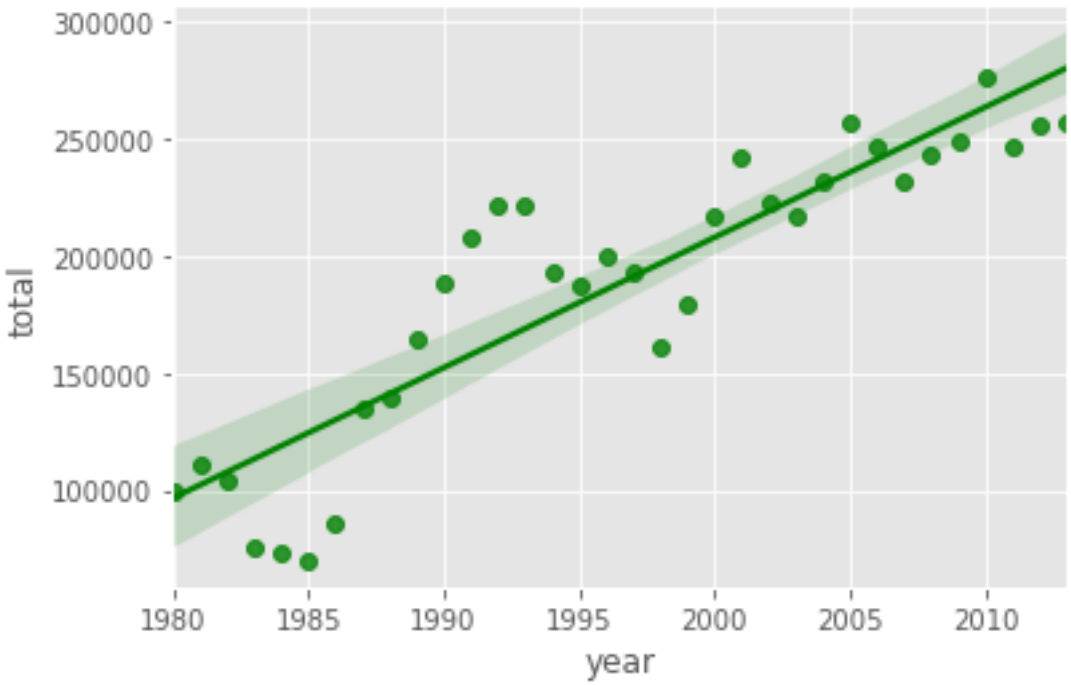
With *seaborn*, generating a regression plot is as simple as calling the **regplot** function.

[48]:
```
import seaborn as sns
ax = sns.regplot(x='year', y='total', data=df_tot)
```



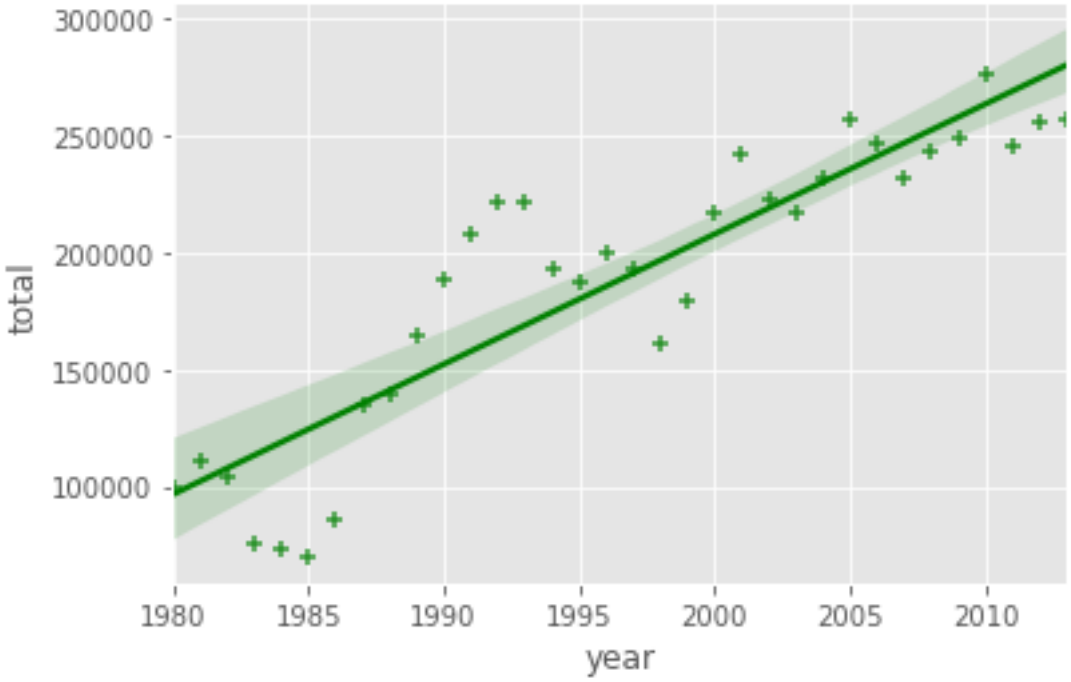
This is not magic; it is *seaborn*! You can also customize the color of the scatter plot and regression line. Let's change the color to green.

[49]:
```
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 '+'.

[50]:
```
import seaborn as sns
ax = sns.regplot(x='year', y='total', data=df_tot, color='green', marker='+')
```



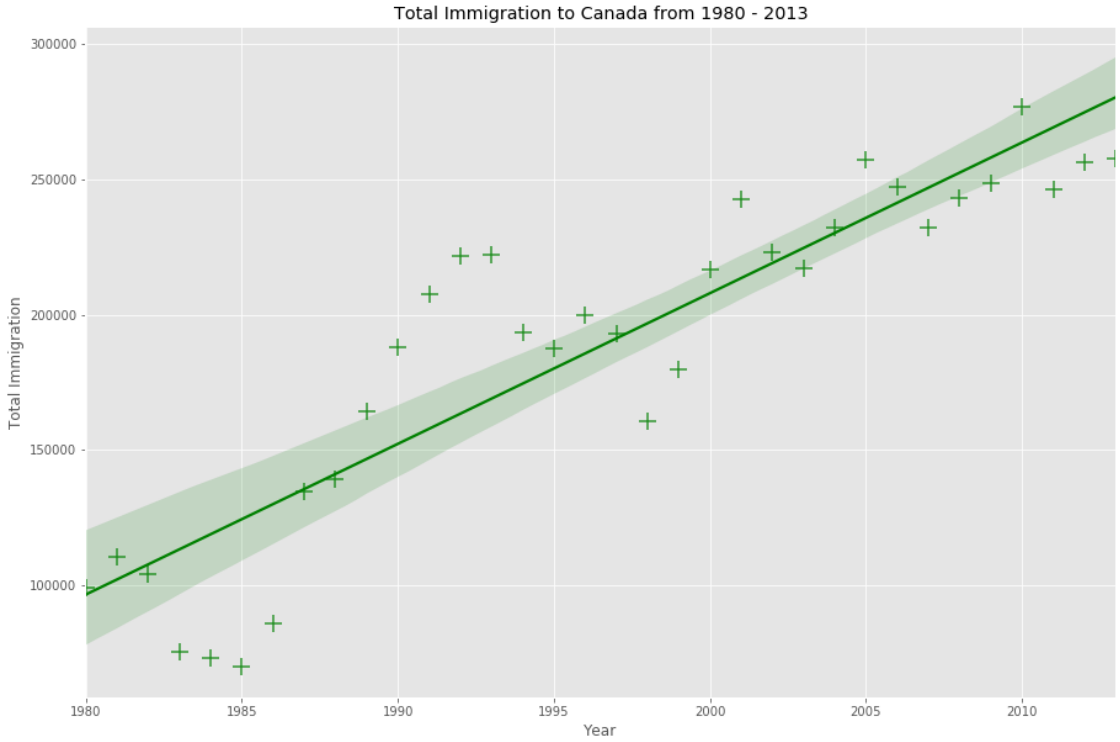
Let's blow up the plot a little bit so that it is more appealing to the sight.

[51]:
```
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.

[52]:
```
plt.figure(figsize=(15, 10))
ax = sns.regplot(x='year', y='total', data=df_tot, color='green', marker='+',␣
 ↪scatter_kws={'s': 200})

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

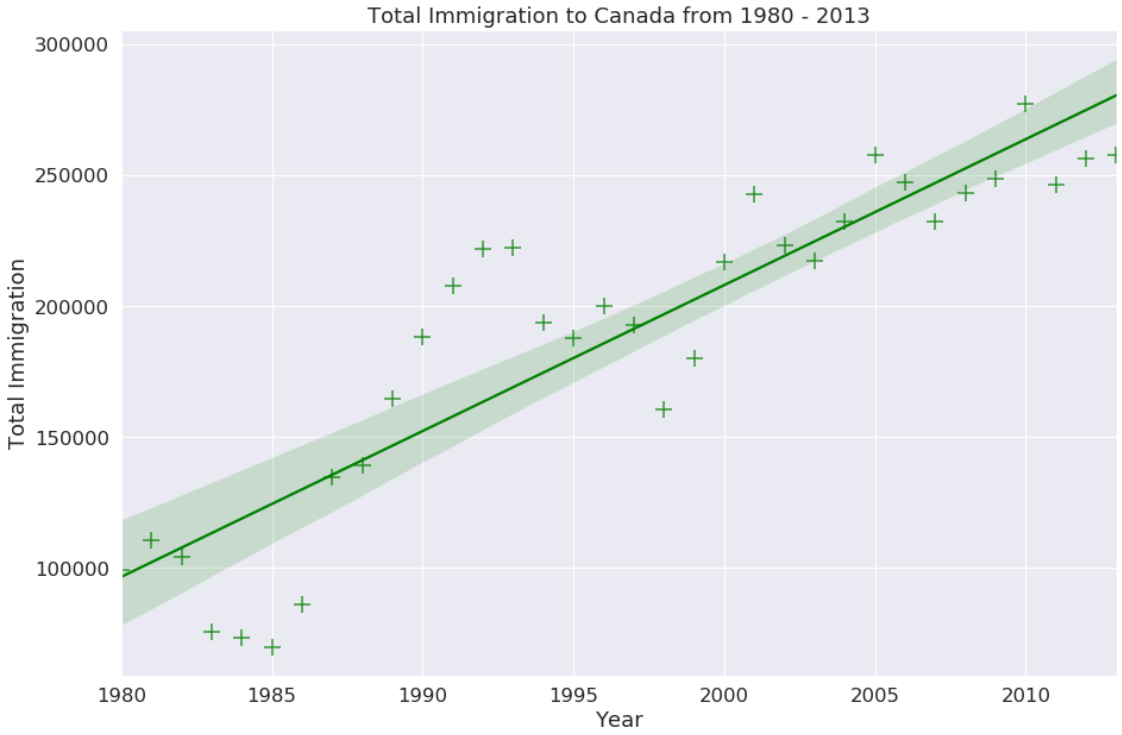
[52]:
```
Text(0.5, 1.0, 'Total Immigration to Canada from 1980 - 2013')
```



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!

[53]:
```
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_kws={'s': 200})
ax.set(xlabel='Year', ylabel='Total Immigration')
ax.set_title('Total Immigration to Canada from 1980 - 2013')
```

[53]:
```
Text(0.5, 1.0, 'Total Immigration to Canada from 1980 - 2013')
```

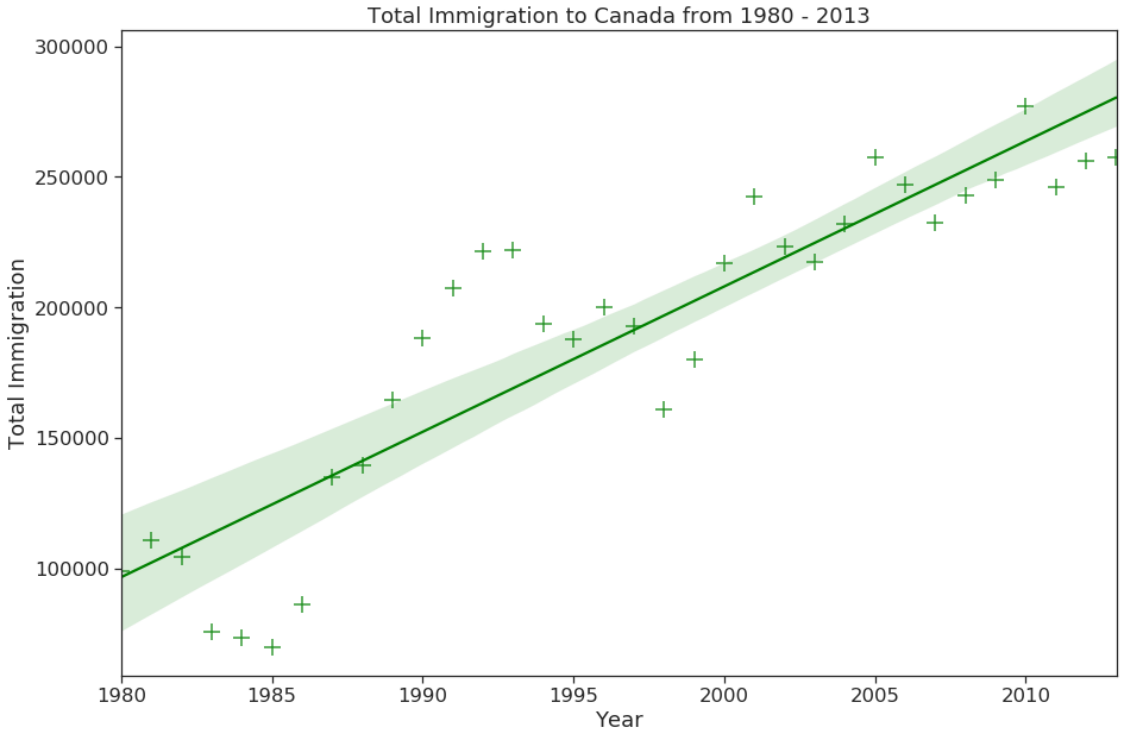


Amazing! A complete scatter plot with a regression fit with 5 lines of code only. Isn't this really amazing?

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

[54]:
```
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_kws={'s': 200})
ax.set(xlabel='Year', ylabel='Total Immigration')
ax.set_title('Total Immigration to Canada from 1980 - 2013')
```

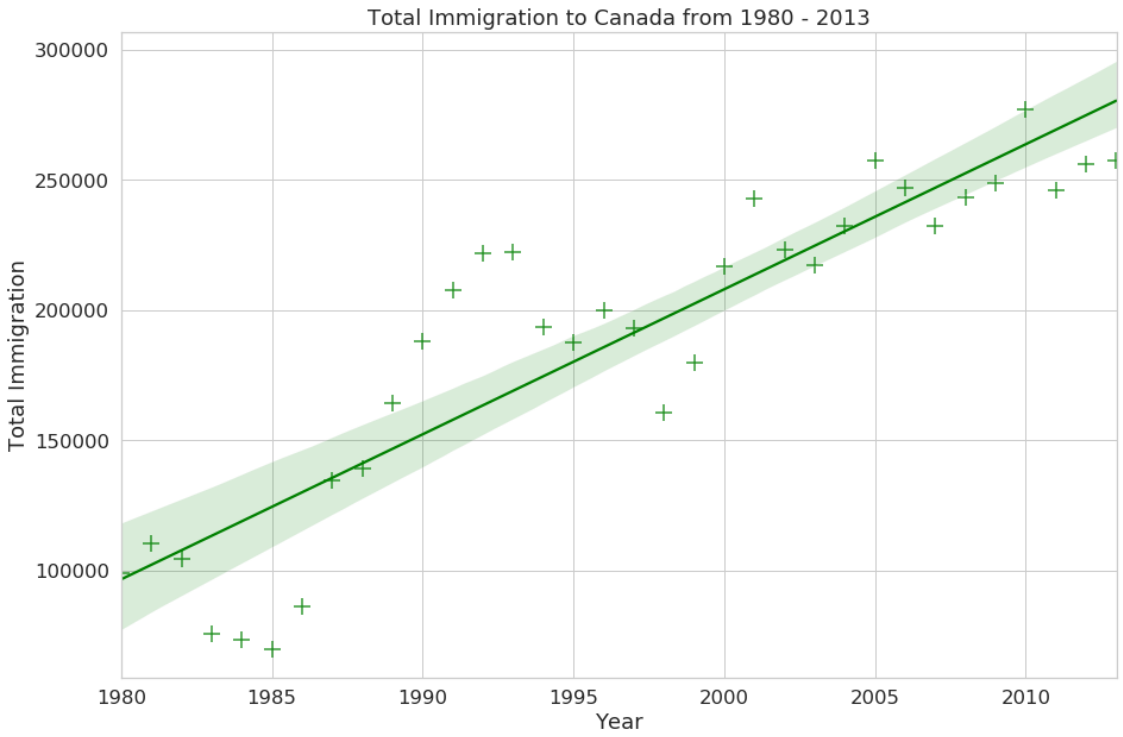
[54]:
```
Text(0.5, 1.0, 'Total Immigration to Canada from 1980 - 2013')
```



Or to a white background with gridlines.

[55]:
```
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_kws={'s': 200})
ax.set(xlabel='Year', ylabel='Total Immigration')
ax.set_title('Total Immigration to Canada from 1980 - 2013')
```

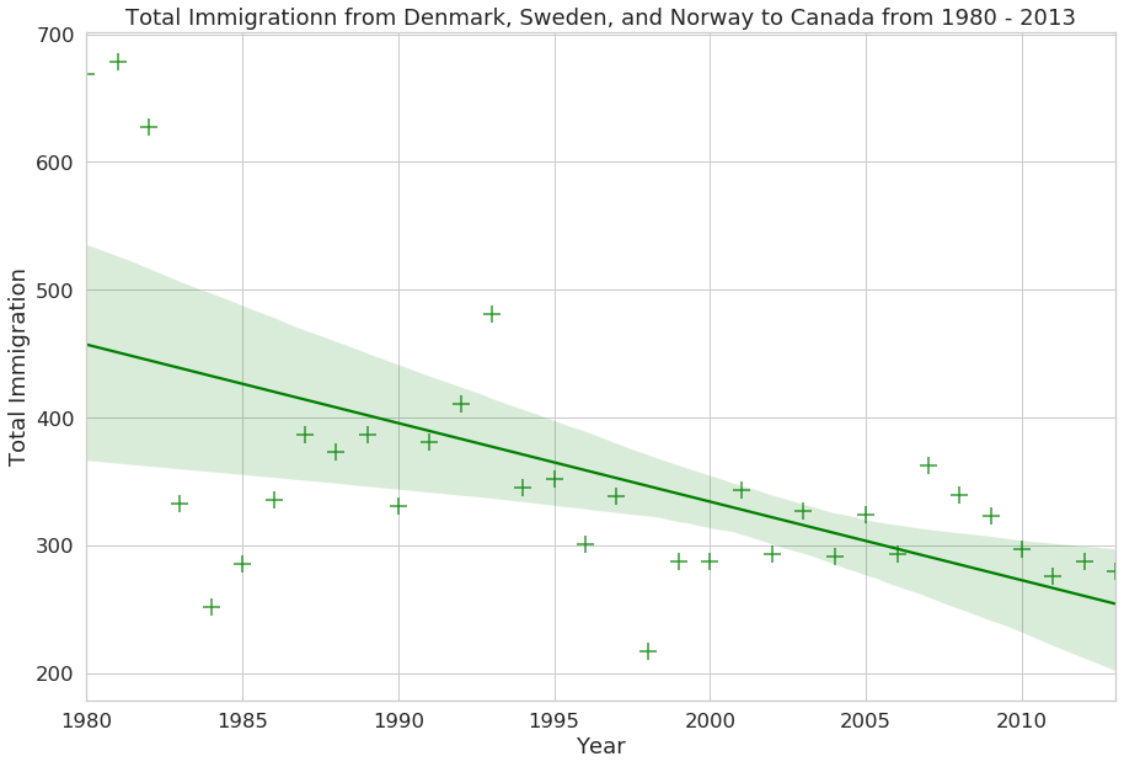
[55]:
```
Text(0.5, 1.0, 'Total Immigration to Canada from 1980 - 2013')
```



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.

[56]:
```
### type your answer here
df_countries = df_can.loc[['Denmark', 'Norway', 'Sweden'], years].transpose()

df_total = pd.DataFrame(df_countries.sum(axis=1))

df_total.reset_index(inplace=True)

df_total.columns = ['year', 'total']

df_total['year'] = df_total['year'].astype(int)

plt.figure(figsize=(15, 10))

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

ax = sns.regplot(x='year', y='total', data=df_total, color='green', marker='+',␣
↪scatter_kws={'s': 200})
ax.set(xlabel='Year', ylabel='Total Immigration')
ax.set_title('Total Immigrationn from Denmark, Sweden, and Norway to Canada␣
↪from 1980 - 2013')
```

[56]: `Text(0.5, 1.0, 'Total Immigrationn from Denmark, Sweden, and Norway to Canada from 1980 - 2013')`



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.