Appendix: Homework 2

September 11, 2020

1 SSIE 500 Homework 2 (Playing with Python)

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[1]:
```
# Imported Packages for the Project
import pandas as pd
import string
import numpy as np
from collections import Counter, OrderedDict
import matplotlib.pyplot as plt
import copy
import requests as r
import seaborn as sns
%matplotlib inline

# URL to the text file of Pride and Prejudice that was downloaded from http://
 ↪www.gutenberg.org/ebooks/1342
# This code fulfills the requirements outlined in 1 of the homework instructions.
url = 'https://raw.githubusercontent.com/grantaguinaldo/mcmc/master/
 ↪pride_prejudice.txt'
```

[2]:
```
# Set of User-Defined Functions

def load_data(url):
    '''
    This function downloads a text document from a url
    and does transforms the text into a python list that
    can be loaded into a Pandas DataFrame.

    This code fulfills the requirements outlined in 2(a) of the homework␣
 ↪instructions.
    '''
    string_punctuation = '!"#$%&\'()*+,-./:;<=>?@[\\]^_`{|}~‘êàé-’’“‘'
    url = url
    data = r.get(url)

    # This code fulfills the requirements outlined in 2(a) of the homework␣
 ↪instructions.
```

```
    f = data.text
    print('Text File Has Been Downloaded')
    print('---')
    print('This Text File Contains: {} Characters'.format(len(f)))
    remove_bom = f.replace('\ufeff', '###')
    comma_delimit = remove_bom.replace('\n', ',').strip().lower().replace('\r',␣
 ↪'').split(',')
    clean_text = [each for each in comma_delimit if (str.rstrip(each) != '') or\
                  (str.rstrip(each) not in string_punctuation)]
    return pd.DataFrame({'text': clean_text})

def clean(s):
    '''
    This function takes in a string and remove punctuation, numeric values
    and all extra spaces from string.
    '''
    string_punctuation = '!"#$%&\'()*+,-./:;<=>?@[\\]^_`{|}~‘êàé-’”“'
    # remove punctuation
    no_punc = s.translate(str.maketrans('', '', string_punctuation))
    # remove num
    no_num = ''.join([each for each in no_punc if not each.isdigit()])
    # remove extra spaces
    return ' '.join(no_num.split())


def count_alpha(x):
    '''
    This function takes in a string and returns the occurances of each letter
    in the string.
    '''
    return Counter(x)

def count(s):
    '''
    This function takes in a string and manually counts the occurances
    of each letter in  the string.
    '''
    count_a = s.count('a')
    count_b = s.count('b')
    count_c = s.count('c')
    count_d = s.count('d')
    count_e = s.count('e')
    count_f = s.count('f')
    count_g = s.count('g')
    count_h = s.count('h')
    count_i = s.count('i')
    count_j = s.count('j')
    count_k = s.count('k')
    count_l = s.count('l')
    count_m = s.count('m')
    count_n = s.count('n')
    count_o = s.count('o')
    count_p = s.count('p')
    count_q = s.count('q')
    count_r = s.count('r')
    count_s = s.count('s')
    count_t = s.count('t')
    count_u = s.count('u')
    count_v = s.count('v')
    count_w = s.count('w')
    count_x = s.count('x')
    count_y = s.count('y')
    count_z = s.count('z')
    count_space = s.count(' ')

    return {'a': count_a, 'b': count_b, 'c': count_c,
            'd': count_d, 'e': count_e, 'f': count_f,
            'g': count_g, 'h': count_h, 'i': count_i,
            'j': count_j, 'k': count_k, 'l': count_l,
            'm': count_m, 'n': count_n, 'o': count_o,
            'p': count_p, 'q': count_q, 'r': count_r,
            's': count_s, 't': count_t, 'u': count_u,
            'v': count_v, 'w': count_w, 'x': count_x,
            'y': count_y, 'z': count_z, 'space': count_space}

def markov(s):
    '''
    This is a helper function that takes in dict and returns
    the value of the argument.
    '''
    return markov_pred_dict[s]

def markov_sampler(char_init, n_iter, markov_dict):
    '''
    This function takes in a series of initial parameters
    and recursively generates a string based on the most
    common letter transitions from the text.
    '''
    char_now = char_init
    markov_str = []
    n_iter = n_iter
    for i in range(n_iter):
        char_now = markov(char_now)
        markov_str.append(char_now)
    return ''.join(markov_str)

def generate_kgram(s, n):
    '''
    This function takes in a string and counts all of the possible
    k-grams found in  the string.
    '''
    return Counter([s[i:i+n] for i in range(0, len(s), 1)])

def graph(x, y, data, ylabel, xlabel, title):
    '''
    This is a helper function that is used to create the bar charts
    needed to show the distribution of letters in  the text.
    '''
    sns.set(rc={'figure.figsize':(15,5)})
    sns.barplot(x=x, y=y, data=data)
    plt.ylabel(ylabel, fontsize=16)
    plt.xlabel(xlabel, fontsize=16)
    plt.ylim(0, 0.180, 0.025)
    plt.xticks(fontsize=15)
    plt.yticks(fontsize=15)
    plt.title(title, fontsize=17)
    return plt.show()

idx_list = ['space', 'a', 'b', 'c',
            'd', 'e', 'f', 'g', 'h',
            'i', 'j', 'k', 'l', 'm',
            'n', 'o', 'p', 'q', 'r',
            's', 't', 'u', 'v', 'w',
            'x', 'y', 'z']

new_col_list = ['first_pos', ' ', 'a', 'b', 'c',
                'd', 'e', 'f', 'g', 'h', 'i',
                'j', 'k', 'l', 'm', 'n', 'o',
                'p', 'q', 'r', 's', 't', 'u',
                'v', 'w', 'x', 'y', 'z']

idx_list_2 = ['first_pos', 'a', 'b', 'c',
            'd', 'e', 'f', 'g', 'h',
            'i', 'j', 'k', 'l', 'm',
            'n', 'o', 'p', 'q', 'r',
            's', 't', 'u', 'v', 'w',
            'x', 'y', 'z']

df = load_data(url)
df.shape
```

```
Text File Has Been Downloaded
---
This Text File Contains: 790332 Characters
```

```
[2]: (20804, 1)
```

```
[3]: '''
     This code applies the user-defined cleaning function and
     adds the clean text to a  new Pandas column. The function
     also inserts a np.nan each time that there is a null value.
     '''
     df_clean = copy.deepcopy(df)
     df_clean.loc[:, 'clean_string'] = df_clean['text'].apply(clean)
     df_clean.replace('', np.nan, inplace=True)
     df_clean.describe()
```

```
[3]:          text clean_string
     count   20804        20782
     unique  18816        18197
     top       and          and
     freq      177          191
```

```
[4]: '''
     This code returns all of the rows that does not have a null.
     and returns the summary statistics.
     '''
     df_clean = df_clean[~df_clean['clean_string'].isna()]
     df_clean.describe()
```

```
[4]:          text clean_string
     count   20782        20782
     unique  18810        18197
     top       and          and
     freq      177          191
```

```
[5]: '''
     This code creates a dict of all of the occurances of the string and
     inserts the results into a new column using two methods. The first method
     manually counts the occurances and the second uses the built in Python method
     to count the occurances.
     '''
     df_clean.loc[:, 'clean_string_count'] = df_clean['clean_string'].
       ↪apply(count_alpha)
     df_clean.loc[:, 'clean_string_count_py'] = df_clean['clean_string'].apply(count)

     '''
     This code summarizes all of the counts from the list of dict and returns a
```

```
final dict that has the final counts of letters in the body of text.
'''
list_dict = [dict(each) for each in df_clean.clean_string_count.tolist()]
final_dist = {}
for d in list_dict:
    for k in d.keys():
        final_dist[k] = final_dist.get(k, 0) + d[k]

list_dict_py = [dict(each) for each in df_clean.clean_string_count_py.tolist()]
final_dist_py = {}
for d in list_dict_py:
    for k in d.keys():
        final_dist_py[k] = final_dist_py.get(k, 0) + d[k]
```

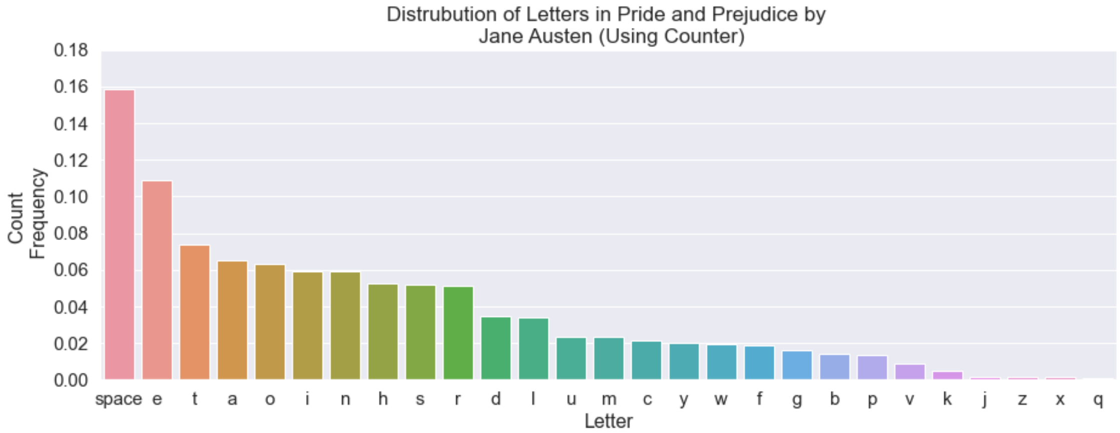
[6]:

```
'''
Create df_freq DataFrame of letter occurances from the manual counts.

This code fulfills the requirements outlined in 2(b) of the homework␣
 ↪instructions.
'''
df_freq = pd.DataFrame(final_dist.items(), columns=['letter', 'count'])
df_freq['freq'] = df_freq['count'] / df_freq['count'].sum()
df_freq.at[3, 'letter'] = 'space'
df_freq.sort_values(by='count', ascending=False, inplace=True)
df_freq.reset_index(drop=True, inplace=True)
df_freq['rank'] = df_freq.index + 1



'''
Create df_freq_py DataFrame of letter occurances from the built-in library.
'''
df_freq_py = pd.DataFrame(final_dist_py.items(), columns=['letter', 'count'])
df_freq_py['freq'] = df_freq_py['count'] / df_freq_py['count'].sum()
#df_freq_py.at[3, 'letter'] = 'space'
df_freq_py.sort_values(by='count', ascending=False, inplace=True)
df_freq_py.reset_index(drop=True, inplace=True)
df_freq_py['rank'] = df_freq_py.index + 1

'''
Check if both df are the same. A True suggests that both
methods produce the same results and that the results of the
manual counts match those produced by the built in counter.
'''
df_freq_py.equals(df_freq)
```

[6]:

```
True
```

[7]:
```python
'''
Uses the user defined function to print a histogram of the letter counts.
'''
graph(x='letter',
      y='freq',
      data=df_freq,
      ylabel='Count \n Frequency',
      xlabel='Letter',
      title='Distrubution of Letters in Pride and Prejudice by \n Jane Austen␣
 ↪(Using Counter)')
```



[8]:
```python
'''
Applies the user-defined function to produce the k-grams
from the text and stores the results as a dict in a new column.
'''
df_clean.loc[:, 'kgrams'] = df_clean['clean_string'].apply(generate_kgram,␣
 ↪args=[2])
df_clean.head()
```

[8]:
```
                                                text  \
0  the project gutenberg ebook of pride and preju...
1                                     by jane austen
2  this ebook is for the use of anyone anywhere a...
3  almost no restrictions whatsoever.  you may co...
4                                    give it away or

                                        clean_string  \
0  the project gutenberg ebook of pride and preju...
1                                     by jane austen
2  this ebook is for the use of anyone anywhere a...
3  almost no restrictions whatsoever you may copy it
4                                    give it away or
```

```
                                 clean_string_count  \
0  {'t': 3, 'h': 1, 'e': 8, ' ': 7, 'p': 3, 'r': ...
1  {'b': 1, 'y': 1, ' ': 2, 'j': 1, 'a': 2, 'n': ...
2  {'t': 5, 'h': 4, 'i': 3, 's': 4, ' ': 13, 'e':...
3  {'a': 3, 'l': 1, 'm': 2, 'o': 6, 's': 4, 't': ...
4  {'g': 1, 'i': 2, 'v': 1, 'e': 1, ' ': 3, 't': ...

                              clean_string_count_py  \
0  {'a': 1, 'b': 2, 'c': 2, 'd': 3, 'e': 8, 'f': ...
1  {'a': 2, 'b': 1, 'c': 0, 'd': 0, 'e': 2, 'f': ...
2  {'a': 4, 'b': 1, 'c': 1, 'd': 1, 'e': 6, 'f': ...
3  {'a': 3, 'b': 0, 'c': 2, 'd': 0, 'e': 3, 'f': ...
4  {'a': 2, 'b': 0, 'c': 0, 'd': 0, 'e': 1, 'f': ...

                                             kgrams
0  {'th': 1, 'he': 1, 'e ': 2, ' p': 3, 'pr': 3, ...
1  {'by': 1, 'y ': 1, ' j': 1, 'ja': 1, 'an': 1, ...
2  {'th': 3, 'hi': 1, 'is': 2, 's ': 2, ' e': 1, ...
3  {'al': 1, 'lm': 1, 'mo': 1, 'os': 1, 'st': 2, ...
4  {'gi': 1, 'iv': 1, 've': 1, 'e ': 1, ' i': 1, ...
```

[9]:

```
'''
This code summarizes all of the counts from the list of dict and returns a
final dict that has the final counts of letters in the body of text.
'''
kgram_list_dict_py = [dict(each) for each in df_clean.kgrams.tolist()]
kgram_dist= {}
for d in kgram_list_dict_py:
    for k in d.keys():
        kgram_dist[k] = kgram_dist.get(k, 0) + d[k]

'''
This code creates a DataFrame containing the kgrams and splits them up
so that we can see the first and second letters of the k-gram as well as
the counts.
'''
df_kgram = pd.DataFrame(kgram_dist.items(), columns=['kgram', 'count'])
df_kgram['kgram_len'] = df_kgram['kgram'].str.split(' ').str.len()
two_grams = df_kgram[df_kgram.kgram_len == 1]

two_grams = copy.deepcopy(two_grams)

two_grams.loc[:, 'first_pos'] = two_grams['kgram'].str[0]
two_grams.loc[:, 'second_pos'] = two_grams['kgram'].str[1]

df = two_grams[['kgram', 'count', 'first_pos', 'second_pos']]
```

```
df.head()
```

```
[9]:   kgram  count first_pos second_pos
     0    th  14098         t          h
     1    he  15044         h          e
     4    pr   1494         p          r
     5    ro   2060         r          o
     6    oj     89         o          j
```

```
[10]: '''
      This code creates a square adjacency matrix of the letter occurances found in␣
       ↪the text.
      '''
      df_trans = df.pivot_table(index=['first_pos'], columns='second_pos',␣
       ↪values='count')
      df_trans['first_pos'] = df_trans.index
      df_trans.reset_index(drop=True, inplace=True)
      df_reorder = df_trans.reindex(columns=idx_list_2)
      df_reorder.head()
```

```
[10]: second_pos first_pos       a       b       c       d       e      f      g  \
      0                  a     7.0  1562.0  1160.0  2447.0     8.0  473.0  899.0
      1                  b   292.0     7.0     NaN     1.0  4290.0    NaN    NaN
      2                  c  1441.0     1.0   344.0     3.0  2575.0    NaN    NaN
      3                  d  1114.0     8.0     1.0   215.0  2623.0   25.0  124.0
      4                  e  3165.0    78.0  1802.0  5544.0  1960.0  709.0  333.0

      second_pos       h       i  ...      q        r       s       t       u  \
      0              6.0  1610.0  ...    NaN   4270.0  4903.0  5818.0   517.0
      1              7.0   435.0  ...    NaN    325.0   156.0   111.0  1144.0
      2           2371.0   551.0  ...  100.0    331.0     7.0  1440.0   375.0
      3             12.0  2019.0  ...    1.0    244.0   428.0    21.0   240.0
      4            154.0  1087.0  ...  198.0  11652.0  3739.0  2624.0    23.0

      second_pos       v      w      x       y     z
      0           1371.0  348.0   11.0  1229.0  23.0
      1              1.0    NaN    NaN   692.0   NaN
      2              NaN    NaN    NaN   509.0   NaN
      3            100.0   22.0    NaN   407.0   NaN
      4           1430.0  389.0  745.0  1171.0   NaN

      [5 rows x 27 columns]
```

```
[11]: '''
      This code find the maximum value in each row (letter) and returns the␣
       ↪corresponding
```

```
letter that represents the highest co-occuring letter in the given the first␣
 ↪letter.
As an example, the entry "a": "n" means that for the letter 'a', the most common␣
 ↪letter
that follows is 'n'. These data only includes the 26 letters of the alphabet (no␣
 ↪space).

This code fulfills the requirements outlined in 2(c) of the homework␣
 ↪instructions.
'''

df_reorder['idxmax'] = df_reorder.iloc[:, 1:-1].idxmax(axis=1)
markov_pred_dict = dict(zip(df_reorder['first_pos'].tolist(),␣
 ↪df_reorder['idxmax'].tolist()))
markov_pred_dict
```

```
[11]: {'a': 'n',
       'b': 'e',
       'c': 'o',
       'd': 'e',
       'e': 'r',
       'f': 'o',
       'g': 'h',
       'h': 'e',
       'i': 'n',
       'j': 'e',
       'k': 'e',
       'l': 'e',
       'm': 'e',
       'n': 'd',
       'o': 'u',
       'p': 'e',
       'q': 'u',
       'r': 'e',
       's': 'e',
       't': 'h',
       'u': 'r',
       'v': 'e',
       'w': 'a',
       'x': 'p',
       'y': 'o',
       'z': 'a'}
```

```
[12]: '''
      Uses the dict showing the most common transistion letter, this code produces a␣
       ↪3,000 character
```

```
string starting with the letter 't'.

This code fulfills the requirements outlined in 2(e) of the homework␣
 ↪instructions.
'''
markov_string = markov_sampler(char_init='t', n_iter=3000,␣
 ↪markov_dict=markov_pred_dict)
markov_string
```

```
[12]: 'herererererererererererererererererererererererererererererererererererererererer
      erererererererererererererererererererererererererererererererererererererererer
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      ererererererererererererererererererererererere'
```
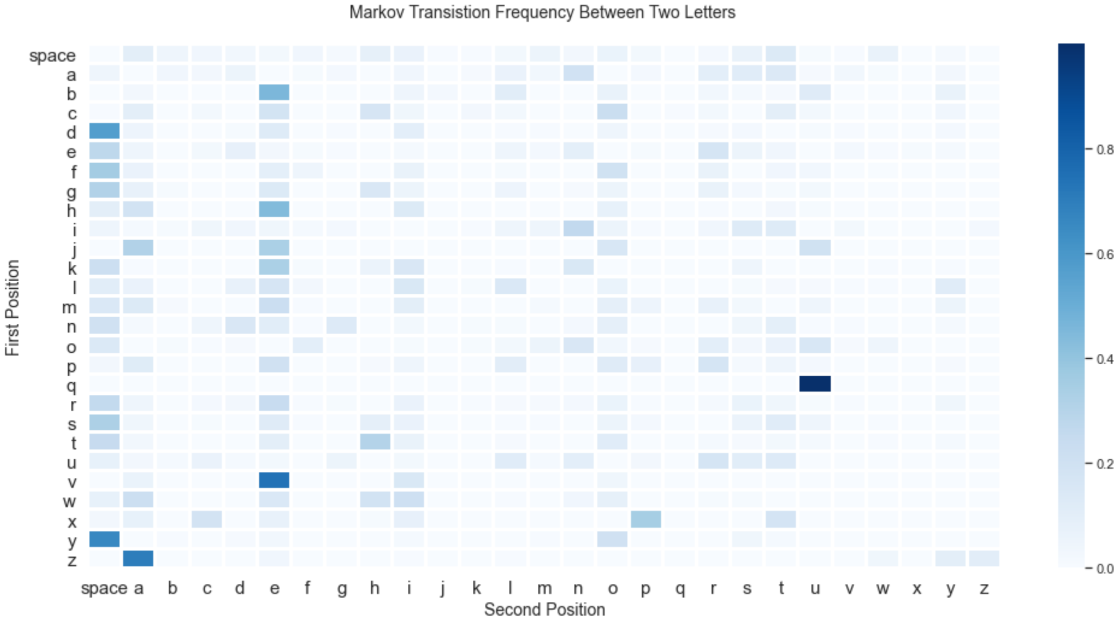

[13]:
```
'''
This code creates a square adjacency matrix of the letter occurances found
in the text and includes the space.
'''
df_kgram = copy.deepcopy(df_kgram)
df_kgram.loc[:, 'first_pos'] = df_kgram['kgram'].str[0]
df_kgram.loc[:, 'second_pos'] = df_kgram['kgram'].str[1]
df_k = df_kgram[['kgram', 'count', 'first_pos', 'second_pos']]
df_ktrans = df_k.pivot_table(index=['first_pos'], columns='second_pos',␣
 ↪values='count')
df_ktrans['first_pos'] = df_ktrans.index
df_ktrans.reset_index(drop=True, inplace=True)
df_ktrans.fillna(0, inplace=True)

df_ktrans = df_ktrans.reindex(columns=new_col_list).fillna(0)
df_ktrans.rename(columns={' ': 'space'}, inplace=True)
df_ktrans.loc[0, 'first_pos'] = 'space'
df_ktrans['total'] = df_ktrans.iloc[:, 0:].sum(axis=1)
df_ktrans.head()
```

[13]:
```
second_pos first_pos    space        a       b       c       d       e  \
0              space      0.0  10684.0  5187.0  4012.0  3368.0  2701.0
1                  a   1981.0      7.0  1562.0  1160.0  2447.0     8.0
2                  b     13.0    292.0     7.0     0.0     1.0  4290.0
3                  c     78.0   1441.0     1.0   344.0     3.0  2575.0
4                  d  11770.0   1114.0     8.0     1.0   215.0  2623.0

second_pos       f       g       h  ...       r       s        t       u  \
0           3645.0  1675.0  9233.0  ...  2049.0  7289.0  13894.0   894.0
1            473.0   899.0     6.0  ...  4270.0  4903.0   5818.0   517.0
2              0.0     0.0     7.0  ...   325.0   156.0    111.0  1144.0
3              0.0     0.0  2371.0  ...   331.0     7.0   1440.0   375.0
4             25.0   124.0    12.0  ...   244.0   428.0     21.0   240.0

second_pos       v       w     x       y     z     total
0            791.0  7469.0   0.0  1915.0   1.0  103750.0
1           1371.0   348.0  11.0  1229.0  23.0   42456.0
2              1.0     0.0   0.0   692.0   0.0    9363.0
3              0.0     0.0   0.0   509.0   0.0   14101.0
4            100.0    22.0   0.0   407.0   0.0   20646.0

[5 rows x 29 columns]
```

[14]:
```
'''
This code creates a square adjacency matrix of the letter occurances found
in the text and includes the space.
'''
```

```
df_ktrans_freq = df_ktrans.iloc[:, 1:].div(df_ktrans['total'] , axis=0)
df_ktrans_freq_2 = df_ktrans_freq.iloc[:, 0:27]
df_ktrans_freq_2['idx'] = idx_list
df_ktrans_freq_2.set_index('idx', inplace=True)
```

```
[15]: '''
Creates a heatmap using the data in the adjacency matrix that shows
the most common letter transistion in the text.

This code fulfills the requirements outlined in 2(d) of the homework␣
 ↪instructions.
'''
sns.set(rc={'figure.figsize':(17,8)})
sns.heatmap(df_ktrans_freq_2.iloc[:, 0:27], linewidths=2, yticklabels=1,␣
 ↪cmap='Blues')
plt.ylabel('First Position', fontsize=14)
plt.xlabel('Second Position', fontsize=14)
plt.yticks(fontsize=15)
plt.xticks(fontsize=15)
plt.title('Markov Transistion Frequency Between Two Letters \n', fontsize=14)
plt.show()
```


Markov Transistion Frequency Between Two Letters
First Position
space
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
q
r
s
t
u
v
w
x
y
z
Second Position
space a b c d e f g h i j k l m n o p q r s t u v w x y z