Lab2_js85773_asm3539

February 5, 2018

0.1 Problem 1

0.1.1 Part A Scatter Matrix

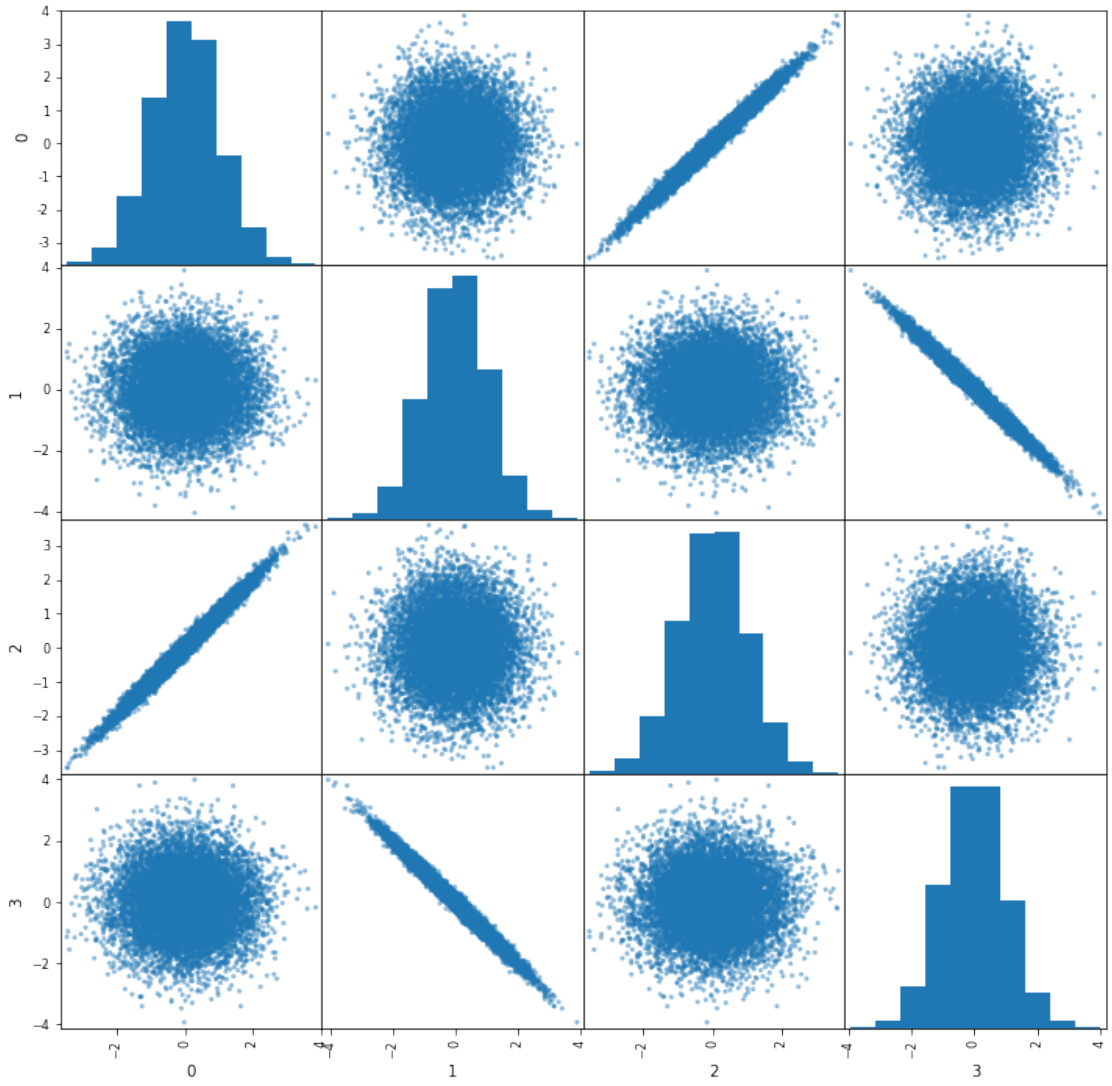
In [3]:
```
# Load libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from pandas.plotting import scatter_matrix
```

In [4]:
```
# Load data
file_path = 'DF1'
df1 = pd.read_csv(file_path)
```

In [3]:
```
# Print some different descriptions
#df1.describe()
#df1.shape
#print(df1)
```

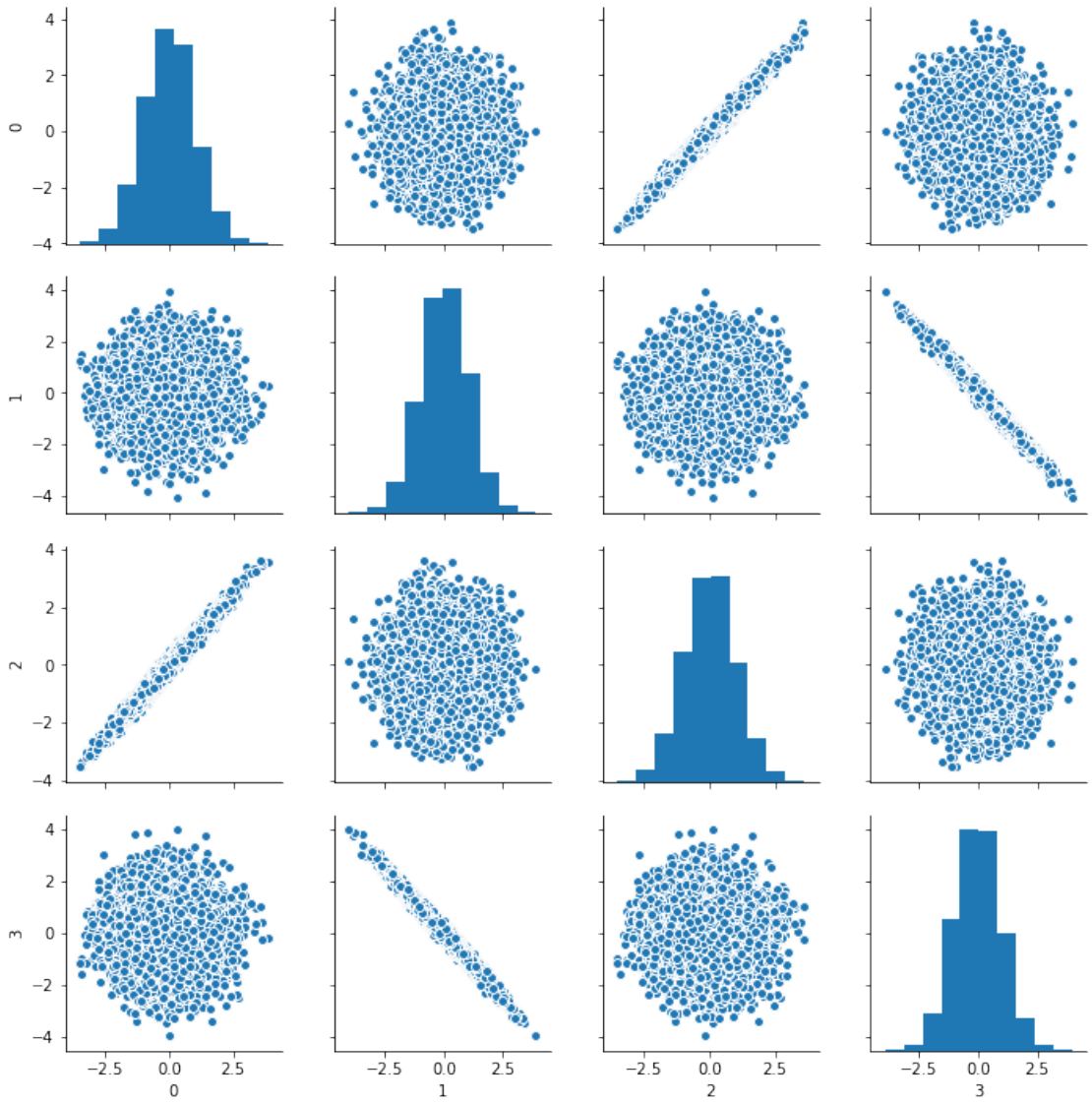
Pandas Scatter

In [4]:
```
# Scatter matrix for the columns. Output is assigned to temporary
# variable not to be used again due to jupyter notebook outputting
# each object otherwise.
_ = scatter_matrix(df1.iloc[:,1:], figsize=(12,12))
```



Seaborn Scatter

```
In [5]: import seaborn as sns
        _ = sns.pairplot(df1.iloc[:,1:])
```



0.1.2 Part B Covariance Matrix

The covariance matrix for the columns is given by:

```
In [5]: # Remove first column - "0 Unnamed"
        df_modified = df1.iloc[:,1:]
        cov_matrix = df_modified.cov()
        print(cov_matrix)
```

```
          0         1         2         3
0  1.001558 -0.004012  0.991624  0.004125
1 -0.004012  1.005378 -0.004099 -0.995457
2  0.991624 -0.004099  1.001589  0.004081
```

```
3  0.004125 -0.995457  0.004081  1.005168
```

Explanation

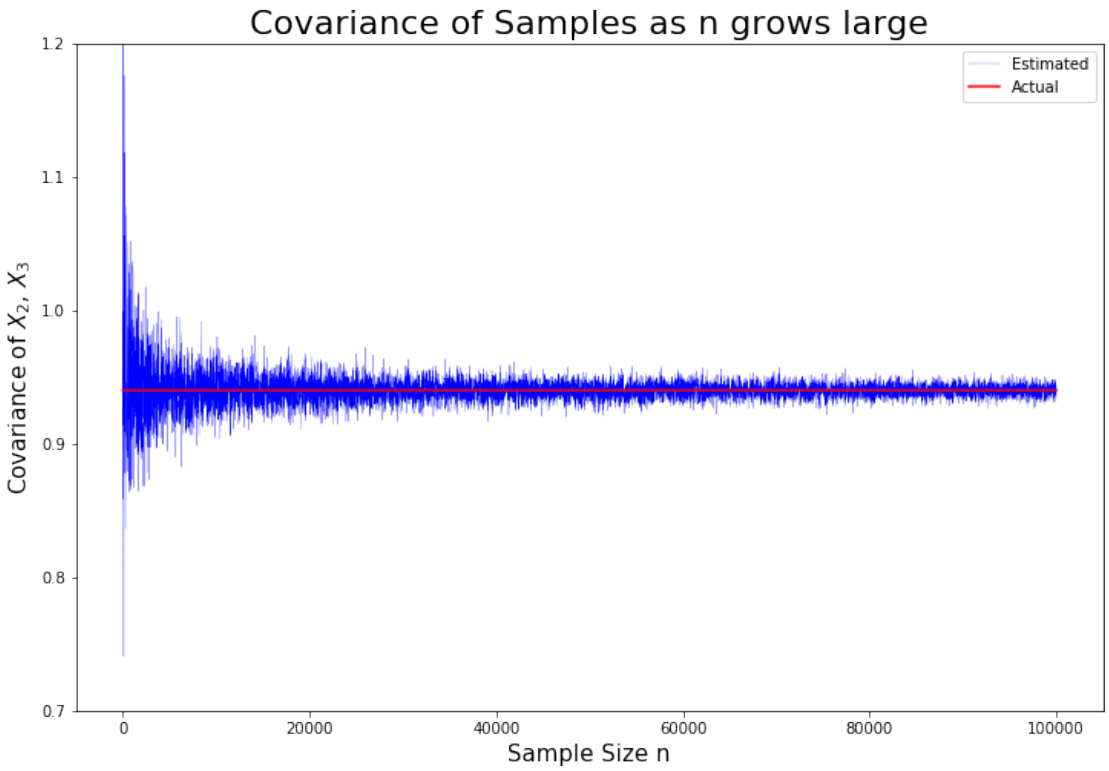
```
The covariance matrix matches the scatter plots because:
<ul>
  <li>Checking each entry of the matrix, we see the diagonal values are very close to 1. Since
      these are the correlation of a column with itself, they better be close to 1.</li>
  <li>For the scatter plots (0,2),(2,0), we see strong positive correlation, which is indicated
      by the corresponding matrix entries being near 1.</li>
  <li>For the scatter plots (3,1),(1,3), we see a strong negative correlation, which is
      indicated by the corresponding matrix entries being near -1.</li>
  <li>The remaining plots all appear to have no linear correlation, and so the corresponding
      matrices entries have values very close to zero, as expected.</li>
</ul>
```

0.1.3 Part C Reverse the problem

We chose a covariance matrix s.t. the problem definition was met. We chose a correlation for X_2, X_3 of 0.94, and zeros for the entries corresponding to the uncorrelated variables. The diagonals (variances) were all ones. We plotted the covariance for the correlated entries as n grows larger.

```
In [6]: mean_vector = [0,0,0]
        cov_matrix = [[1,0,0],[0,1,0.94],[0,0.94,1]]
        estimated = []
        x = []
        num_plots = 10000

        for i in range(1,num_plots):
                Z = np.random.multivariate_normal(mean_vector,cov_matrix,size=10*i)
                df = pd.DataFrame(Z)
                cov = df.cov()
                estimated.append(cov.iloc[1,2])
                x.append(10*i)

        actual = 0.94*np.ones(len(x))
```

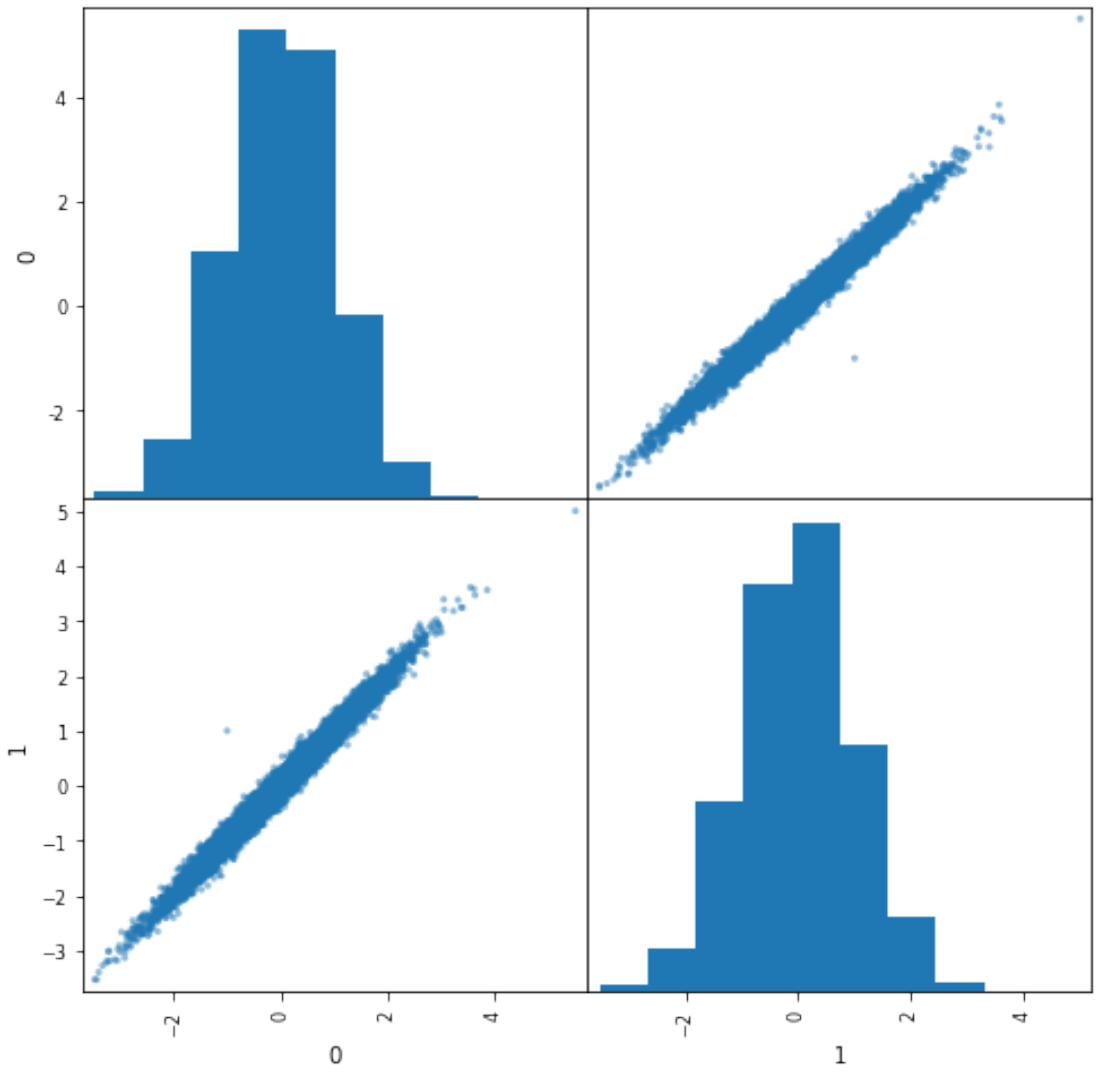
```
In [8]: plt.figure(figsize=(12,8))
        _ = plt.plot(x, estimated, 'b', linewidth=0.2, label='Estimated')
        _ = plt.plot(x, actual, 'r', label='Actual')
        _ = plt.title('Covariance of Samples as n grows large', FontSize=22)
        _ = plt.xlabel('Sample Size n', FontSize=15)
        _ = plt.ylabel('Covariance of $X_2$, $X_3$', FontSize=15)
        plt.ylim([0.7, 1.2])
        _ = plt.legend()
```



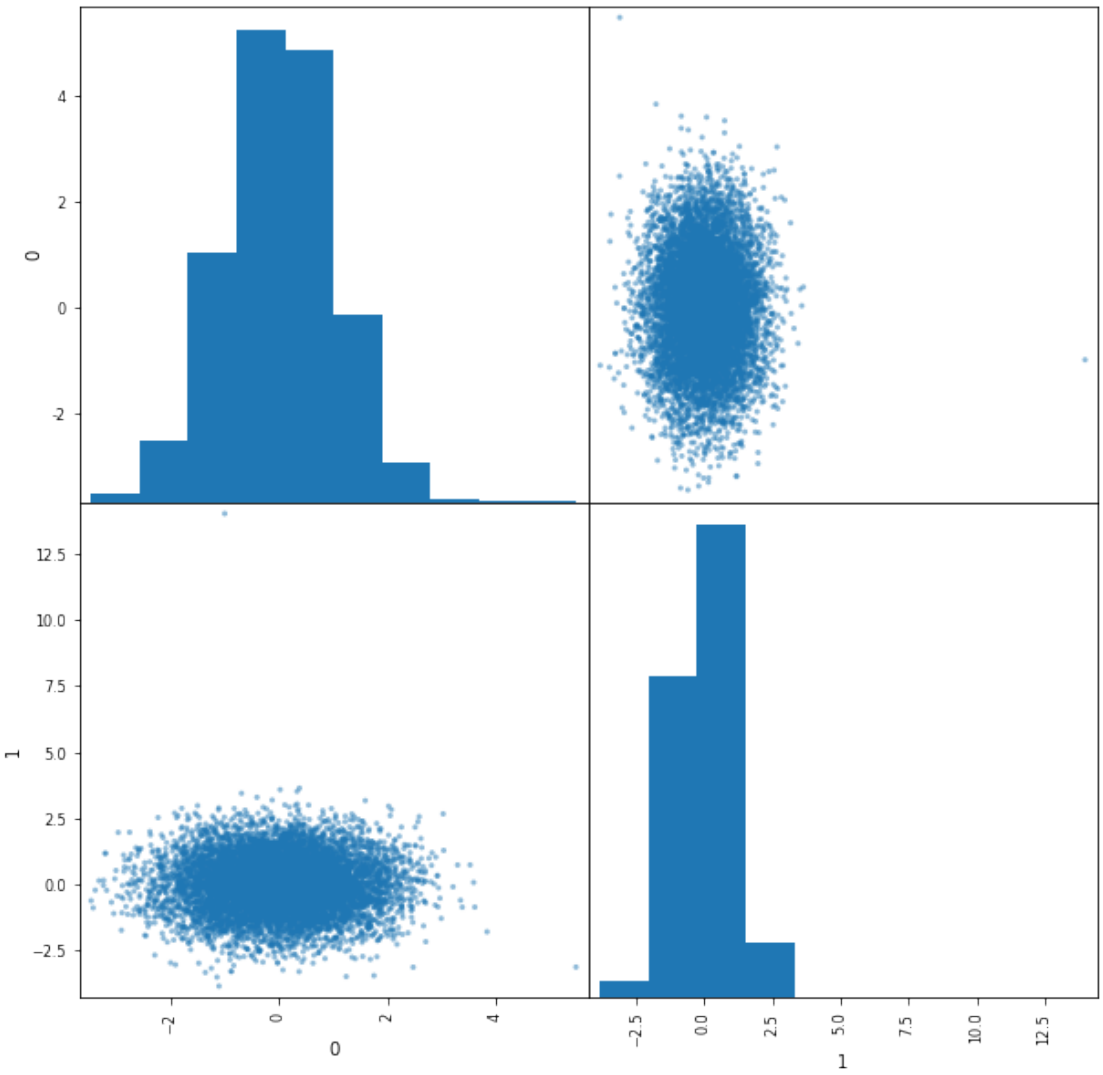
0.2 Problem 2

The most straightforward way to convert a bivariate normal with correlation to an uncorrelated s

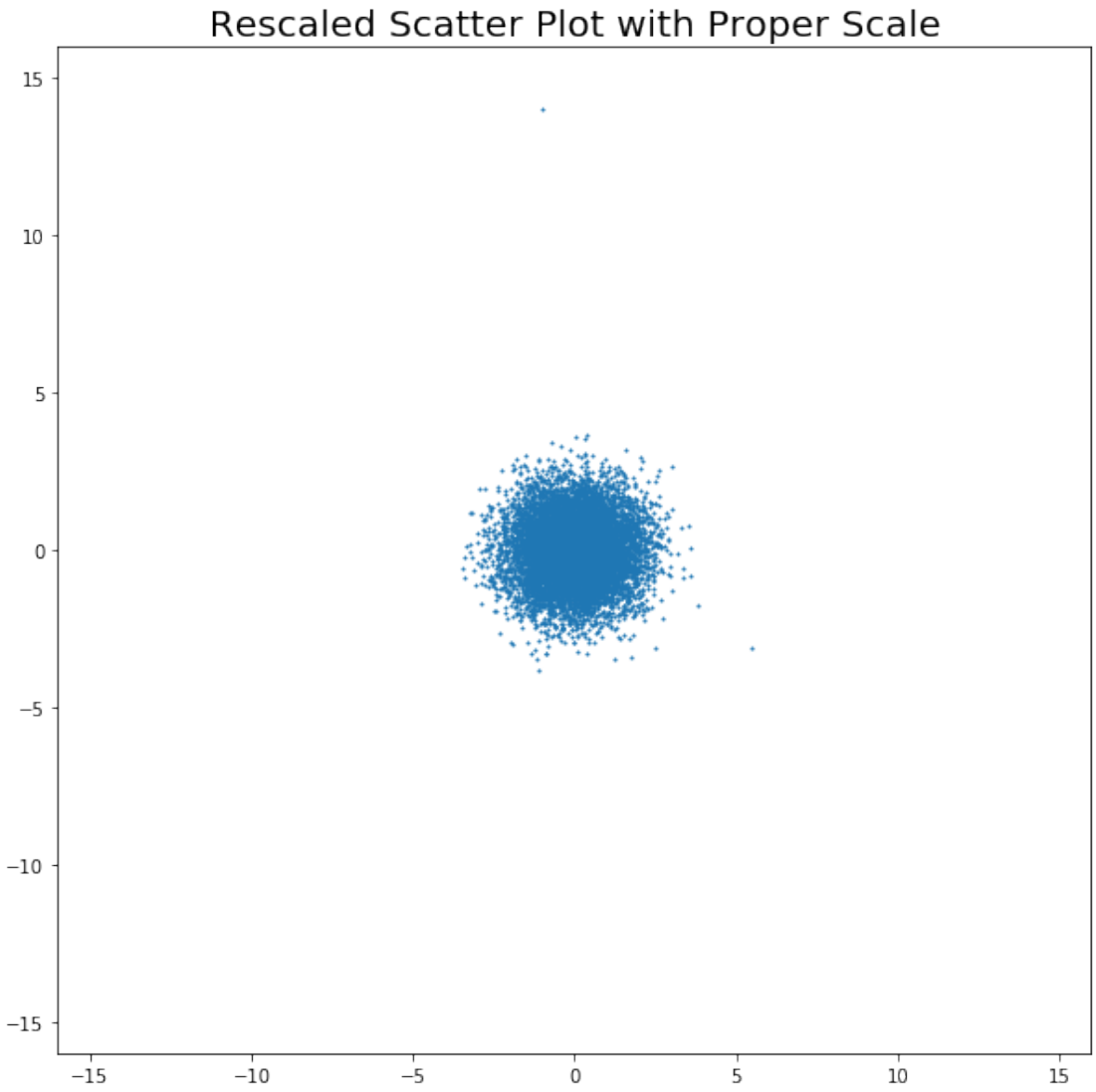
```
In [15]: # Load libraries
         import numpy as np
         import pandas as pd
         import matplotlib.pyplot as plt
         from pandas.plotting import scatter_matrix

In [16]: # Load data
         file_path = 'DF2'
         df = pd.read_csv(file_path)
         #print(np.std(df.iloc[:,1]))
         #print(np.std(df.iloc[:,2]))

In [17]: _ = scatter_matrix(df.iloc[:,1:], figsize=(8,8))
         _ = plt.suptitle('Scatter Plot of Covariance Matrix', FontSize=20)
```




```
In [18]: Z = np.array(df.iloc[:,1:])
         Q = np.linalg.cholesky(df.iloc[:,1:].cov())
         Q_inv = np.linalg.inv(Q.T)
         Y = np.dot(Z, Q_inv)
         Y = pd.DataFrame(Y)
         _ = scatter_matrix(Y, figsize=(10,10))
         _ = plt.suptitle('Scatter Plot of Transformed Data', FontSize=20)
```




```
In [19]: plt.figure(figsize=(10,10))
         plt.scatter(Y.iloc[:,0], Y.iloc[:,1], s=1.5, marker='*')
         _ = plt.xlim([-16,16])
         _ = plt.ylim([-16,16])
         _ = plt.title('Rescaled Scatter Plot with Proper Scale', FontSize=20)
```



0.3 Problem 3

```
In [1]: import numpy as np
        import matplotlib.pyplot as plt

        n = 150
        beta_one = 0
        beta_zero = -3
        beta = [beta_zero, beta_one]
        error = []
        #std_error = []
```

```
        # We want to use the normal equations to calculate beta_hat
        # Using a sample size of 150, we generate new data and record
        # the error every time
        for i in range(10):
            x = np.random.randn(n,)
            e = np.random.randn(n,)
            y = beta_zero + beta_one * x + e
            x_new = np.ones(len(x),)
            x_new = np.transpose(np.stack((x_new, x), axis=0))
            inv = np.linalg.inv(np.dot(x_new.T,x_new))
            beta_hat = np.dot(np.dot(inv, x_new.T), y)
            error.extend(abs(beta-beta_hat))

        std_dev_error = np.std(np.array(error))
```

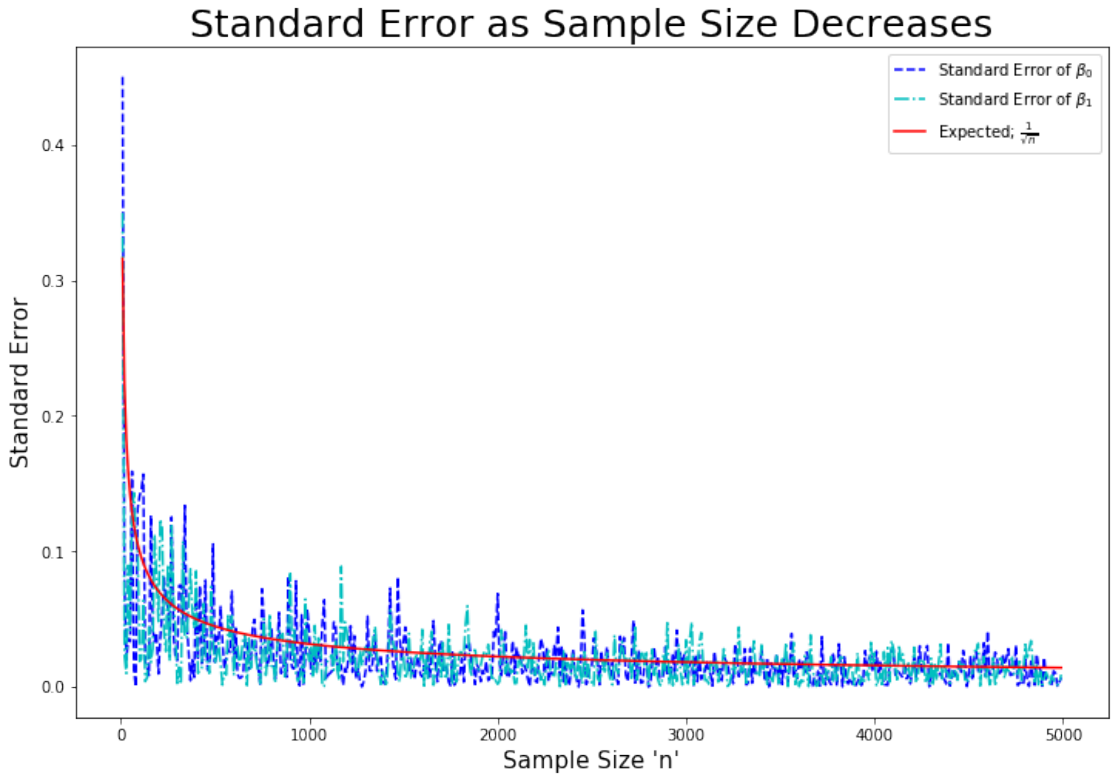
In [2]:
```
print(std_dev_error)
```

```
0.060995318674563793
```

We can see the empirical standard deviation of the error here is 0.06. This means our value -0.1

Next we reconstruct the experiment, and allow n to get larger. We plot the values with the expec

In [7]:
```
sample_sizes = 10*np.arange(1,500)
error_bo = []
error_b1 = []

for sample in sample_sizes:
    x = np.random.randn(sample,)
    e = np.random.randn(sample,)
    y = beta_zero + beta_one * x + e
    x_new = np.ones(len(x),)
    x_new = np.transpose(np.stack((x_new, x), axis=0))
    inv = np.linalg.inv(np.dot(x_new.T,x_new))
    beta_hat = np.dot(np.dot(inv, x_new.T), y)
    error_bo.append(abs(beta[0]-beta_hat[0]))
    error_b1.append(abs(beta[1]-beta_hat[1]))

fig = plt.figure(figsize=(12,8))
plt.plot(sample_sizes, error_bo, 'b--', label=r'Standard Error of $\beta_0$')
plt.plot(sample_sizes, error_b1, 'c-.', label=r'Standard Error of $\beta_1$')
plt.plot(sample_sizes, 1./np.sqrt(sample_sizes), 'r', label=r'Expected; $\frac{1}{\sqrt{
plt.xlabel('Sample Size \'n\'', FontSize = 15)
plt.ylabel('Standard Error', FontSize = 15)
plt.title('Standard Error as Sample Size Decreases', FontSize=25)
_ = plt.legend()
```



0.4 Problem 4

Write a program that on input k and XXXX, returns the top k names from year XXXX.

Write a program that on input Name returns the frequency for men and women of the name Name.

It could be that names are more diverse now than they were in 1880, so that a name may be relatively the most popular, though its frequency may have been decreasing over the years. Modify the above to return the relative frequency.

Find all the names that used to be more popular for one gender, but then became more popular for another gender.

(Optional) Find something cool about this data set.

```
In [1]: # Load libraries
        import numpy as np
        import pandas as pd
        import matplotlib.pyplot as plt
        from pandas.plotting import scatter_matrix
        import os
```

```
In [45]: # Load data
         file_path = "/home/humble-fool/school_work/Spring_18/Data-Science-Lab-ee379k/lab2/src/N
         #Getting data for first Data Frame
         file_name = "yob" + str(1880) + ".txt"
```

```
        names=pd.DataFrame(pd.read_csv((file_path + file_name), names = ["name", "sex","freq"])
        #adding year column
        names['year'] = 1880

        ## loading rest of the data, adding year column and appending it to names data frame
        for years in range(1881,2016):
            year = years
            new_df = pd.DataFrame(pd.read_csv((file_path+"yob"+str(year)+".txt"),names = ["name
            new_df['year'] = year
            names = names.append(new_df,ignore_index=True)
        print(names.head())
```

```
        name sex  freq  year
0       Mary   F  7065  1880
1       Anna   F  2604  1880
2       Emma   F  2003  1880
3  Elizabeth   F  1939  1880
4     Minnie   F  1746  1880
```

```
In [35]: # takes number as k from the problem description and year
         # returns the top k names from the particular year

         def top_k_names(num,year):
             temp_dataframe = names[names['year']==year]
             s = pd.Series(temp_dataframe.groupby('name')['freq'].sum())
             return s.nlargest(num)

         #testing top_k_names
         print(top_k_names(10,2015))
```

```
name
Emma        20365
Noah        19648
Olivia      19561
Liam        18302
Sophia      17341
Mason       16626
Ava         16305
Jacob       15838
William     15824
Isabella    15525
Name: freq, dtype: int64
```

```
In [66]: # This function takes name as input and calculates frequency of the particular name acr
         # returns the freq categorized by sex
         def freq_name(name):
             temp_data_frame = names[names['name']==name]
```

```
            #getting only males and summing up freq column
            temp_data_frame_male = temp_data_frame[temp_data_frame['sex']=="M"]
            male_freq = temp_data_frame_male['freq'].sum()

            #getting only females and summing up freq column
            temp_data_frame_female = temp_data_frame[temp_data_frame['sex']=="F"]
            female_freq = temp_data_frame_female['freq'].sum()

            dict_rt = {"Number of males" :male_freq, "Number of Females":female_freq}
            return dict_rt

        print(freq_name("Emma"))
```

```
{'Number of Females': 614505, 'Number of males': 1585}
```

In [44]:
```
        #This function takes name and year
        #Returns a dictionary containing relative frequency of the specified name in the year u
        def rel_freq(name,year):
            temp_dataframe_year = names[names['year']==year]
            print(temp_dataframe_year.shape)
            temp_df_name = temp_dataframe_year[temp_dataframe_year['name']==name]


            #getting only males and summing up freq column
            temp_df_male = temp_df_name[temp_df_name['sex']=="M"]
            male_freq = temp_df_male['freq'].sum()
            total_male_freq = temp_dataframe_year[temp_dataframe_year['sex']=='M']['freq'].sum(

            relative_male_freq = male_freq/total_male_freq

            #getting only females and summing up freq column

            temp_df_female = temp_df_name[temp_df_name['sex']=="F"]
            female_freq = temp_df_female['freq'].sum()

            total_freq_fem = temp_dataframe_year[temp_dataframe_year['sex']=='F']['freq'].sum()

            relative_fem_freq = female_freq/total_freq_fem
            dict_key1 = "Relative frequence of males with "+name+" in year "+str(year)
            dict_key2 = "Relative frequency of females with "+name+" in year "+str(year)
            dict_rt = {dict_key1 :relative_male_freq, dict_key2:relative_fem_freq}
            return dict_rt

        #testing for relative frequency
        print(rel_freq("Emma",2015))
```

```
(32952, 4)
```

```
{'Relative frequence of males with Emma in year 2015': 5.266323232174286e-06, 'Relative frequenc
```

```
In [51]: def rel_freq_list(name,year):
             temp_dataframe_year = names[names['year']==year]
             print(temp_dataframe_year.shape)
             temp_df_name = temp_dataframe_year[temp_dataframe_year['name']==name]


             #getting only males and summing up freq column
             temp_df_male = temp_df_name[temp_df_name['sex']=="M"]
             male_freq = temp_df_male['freq'].sum()
             total_male_freq = temp_dataframe_year[temp_dataframe_year['sex']=='M']['freq'].sum(

             relative_male_freq = male_freq/total_male_freq

             #getting only females and summing up freq column

             temp_df_female = temp_df_name[temp_df_name['sex']=="F"]
             female_freq = temp_df_female['freq'].sum()

             total_freq_fem = temp_dataframe_year[temp_dataframe_year['sex']=='F']['freq'].sum()

             relative_fem_freq = female_freq/total_freq_fem
             return [relative_fem_freq,relative_male_freq]
         rel_freq_list('Emma',2015)[0]
```

```
(32952, 4)
```

```
Out[51]: 0.011504387266330381
```

```
In [1]: # Algorithm
        # for each name
            # for each year
            # calculate rel freq for males
            # calculate rel freq for females
            # subract them and add it to a list called differences
        # check if differences has a root (goes from negative to positive or vice versa)
        # if yes, then add the name to a list
        # then go to next name

        # Commented out to supress output
        '''
        changing_popularity = []

        df_name = names.drop_duplicates('name')
        for name in df_name['name']:
            difference = []
```

```
        for year in range(1880,2016):
            relative_frequencies = rel_freq_list(name,year)
            fem_rel_freq = relative_frequencies[0]
            male_rel_freq = relative_frequencies[1]
            difference.append((fem_rel_freq-male_rel_freq))
        time = np.arange(0, len(difference))
        function = np.polyfit(time, difference,deg =2)
        roots = np.roots(function)
        real_roots = roots[np.isreal(roots)]
        if(len(real_roots) != 0):
            changing_popularity.append(name)

    print(changing_popularity)
    '''
```

```
Out[1]: "\nchanging_popularity = []\n\ndf_name = names.drop_duplicates('name')\nfor name in df_n
```

The cell above should return a list of the names that changed in popularity over time. Our algorithm took longer to run than we expected, and we did not start running it until it was too late. We had to compile the assignment and turn it in.

0.5 Problem 5

```
In [1]: import pandas as pd
```

```
In [16]: tweets = pd.read_csv("/home/humble-fool/school_work/Spring_18/Data-Science-Lab-ee379k/l
         tweets.head()
```

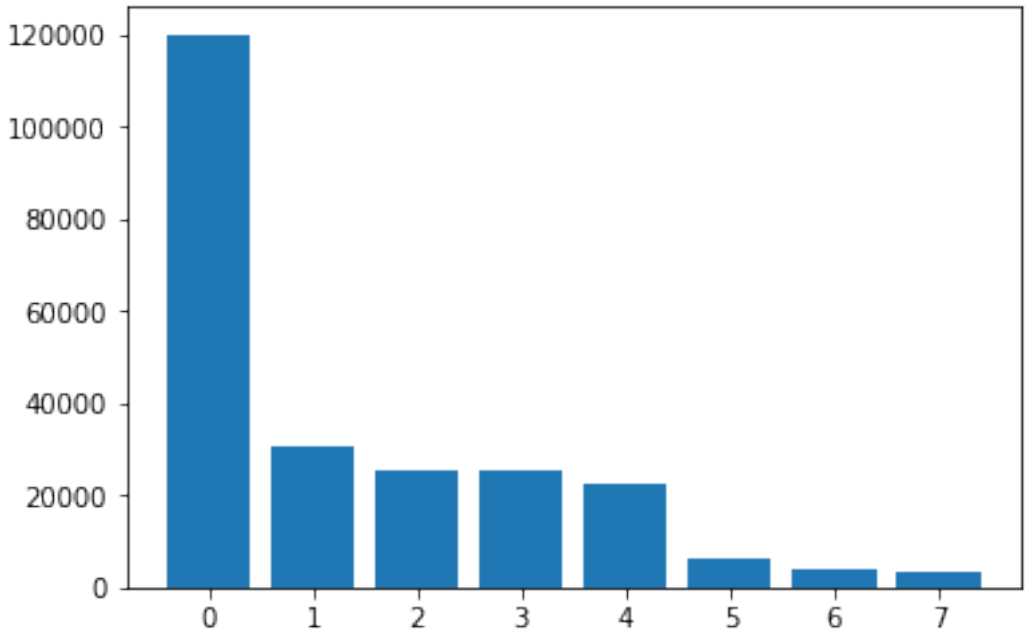
```
Out[16]:    id              id_str    user_location user_bg_color  retweet_count  \
         0   1  729828033092149248      Wheeling WV        022330              0
         1   2  729828033092161537              NaN        C0DEED              0
         2   3  729828033566224384              NaN        C0DEED              0
         3   4  729828033893302272           global        C0DEED              0
         4   5  729828034178482177  California, USA        131516              0

                user_name  polarity              created  geo  \
         0     Jaybo26003      0.00  2016-05-10T00:18:57  NaN
         1  brittttany_ns      0.15  2016-05-10T00:18:57  NaN
         2   JeffriesLori      0.00  2016-05-10T00:18:57  NaN
         3    WhorunsGOVs      0.00  2016-05-10T00:18:57  NaN
         4       BJCG0830      0.00  2016-05-10T00:18:57  NaN

                                          user_description         user_created  \
         0                                             NaN  2011-11-17T02:45:42
         1                                  18 // PSJAN  2012-12-24T17:33:12
```

```
2                                                  NaN  2012-10-11T14:29:59
3    Get Latest Global Political news as they unfold  2014-02-16T07:34:24
4  Queer Latino invoking his 1st amendment privil...  2009-03-21T01:43:26

   user_followers coordinates  subjectivity  \
0              39         NaN           0.0
1            1175         NaN           0.1
2              42         NaN           0.0
3             290         NaN           0.0
4             354         NaN           0.0

                                                text
0  Make a difference vote! WV Bernie Sanders Coul...
1  RT @HlPHOPNEWS: T.I. says if Donald Trump wins...
2  You have no one to blame but yourselves if Tru...
3  'Ruin the rest of their lives': Donald Trump c...
4  RT @elianayjohnson: Per source, GOP megadonor ...
```

In [3]:
```
def get_candidate(row):
    candidates = []
    text = row["text"].lower()
    if "clinton" in text or "hillary" in text:
        candidates.append("clinton")
    if "trump" in text or "donald" in text:
        candidates.append("trump")
    if "sanders" in text or "bernie"in text:
        candidates.append("sanders")
    return ",".join(candidates)

tweets["candidate"] = tweets.apply(get_candidate,axis=1)
```

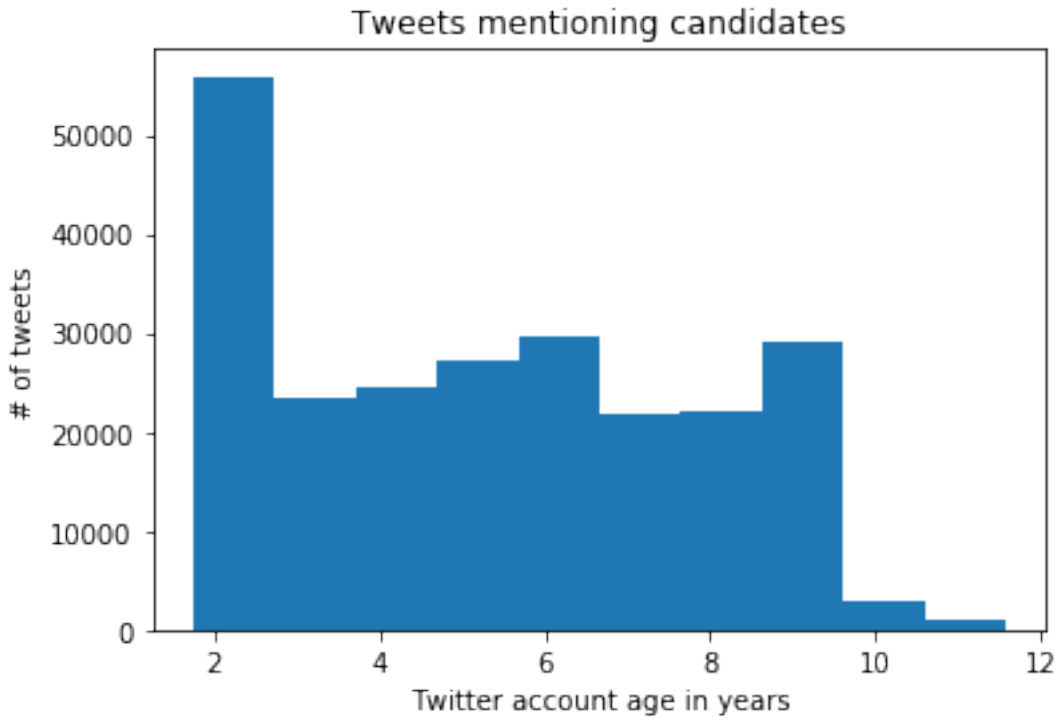
In [4]:
```
import matplotlib.pyplot as plt
import numpy as np
%matplotlib inline
```

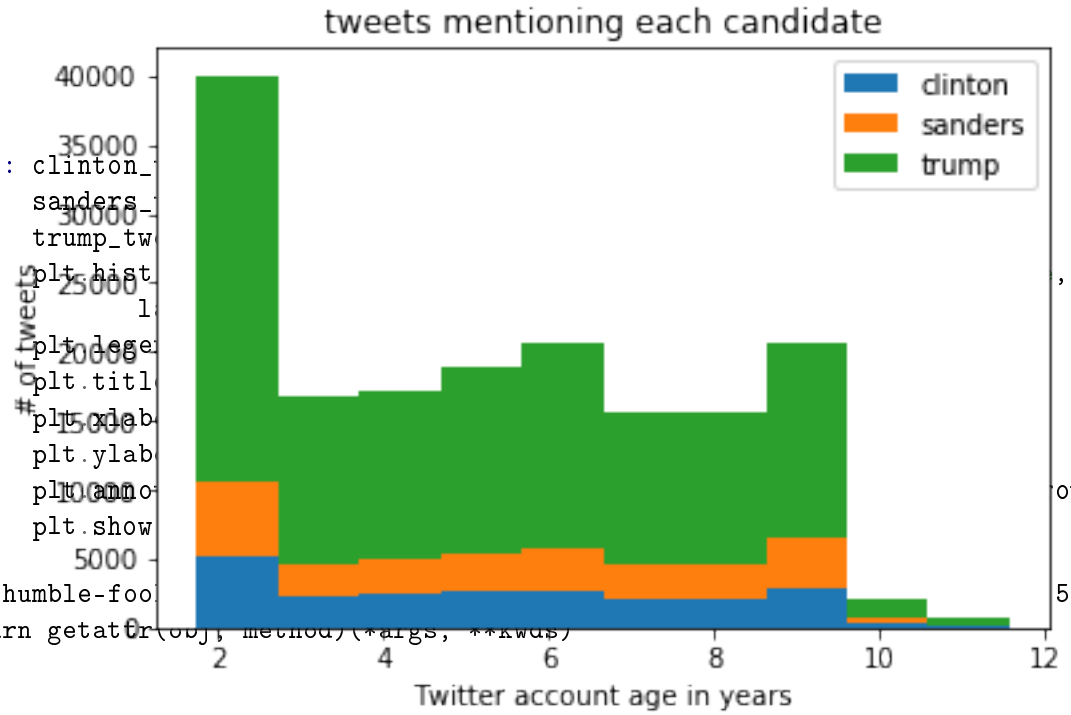
In [5]:
```
counts = tweets["candidate"].value_counts()
plt.bar(range(len(counts)),counts)
plt.show()
print(counts)
```




```
trump                    119998
clinton,trump             30521
                          25429
sanders                   25351
clinton                   22746
clinton,sanders            6044
clinton,trump,sanders      4219
trump,sanders              3172
Name: candidate, dtype: int64
```

```
In [6]: from datetime import datetime
        tweets["created"] = pd.to_datetime(tweets["created"])
        tweets["user_created"] = pd.to_datetime(tweets["user_created"])
        tweets["user_age"] = tweets["user_created"].apply(lambda x:(datetime.now()-x).total_seco
        plt.hist(tweets["user_age"])
        plt.title("Tweets mentioning candidates")
        plt.xlabel("Twitter account age in years")
        plt.ylabel("# of tweets")
        plt.show()
```

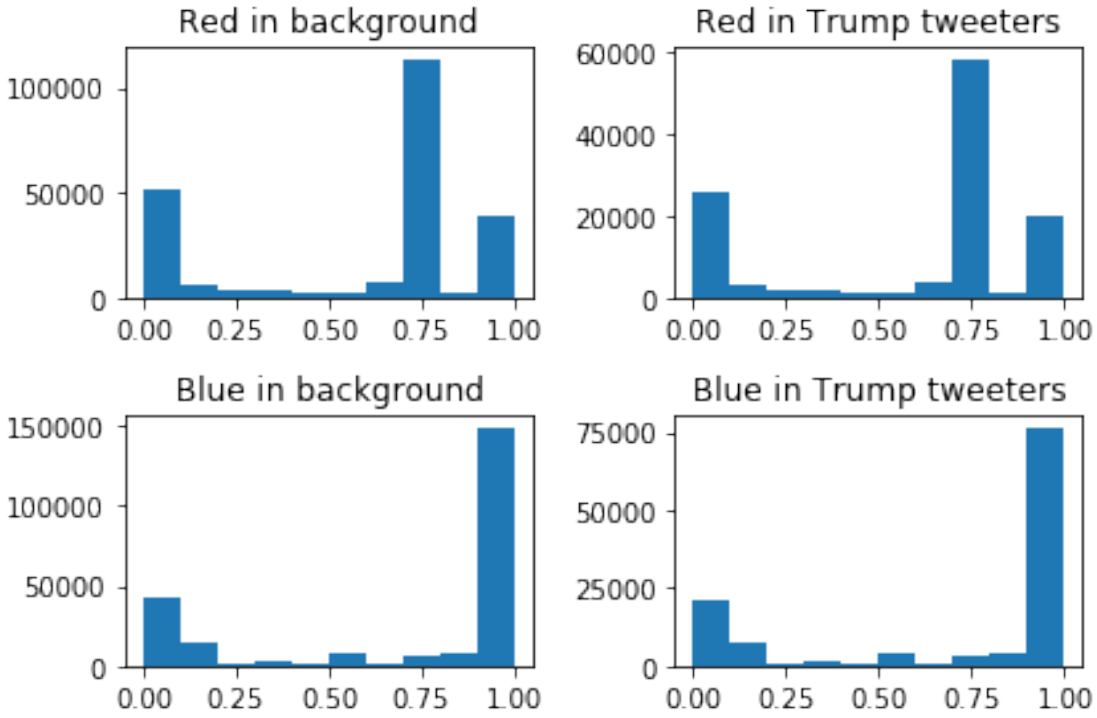





```
In [7]: clinton_
        sanders_
        trump_tw
        plt.hist                                                              ,
              la
        plt.lege
        plt.titl
        plt.xlab
        plt.ylab
        plt.ano                                                    owprops=dict(facecol
        plt.show
/home/humble-foo                                                   5/site-packages/nump
  return getattr(obj, method)(*args, **kwds)
```

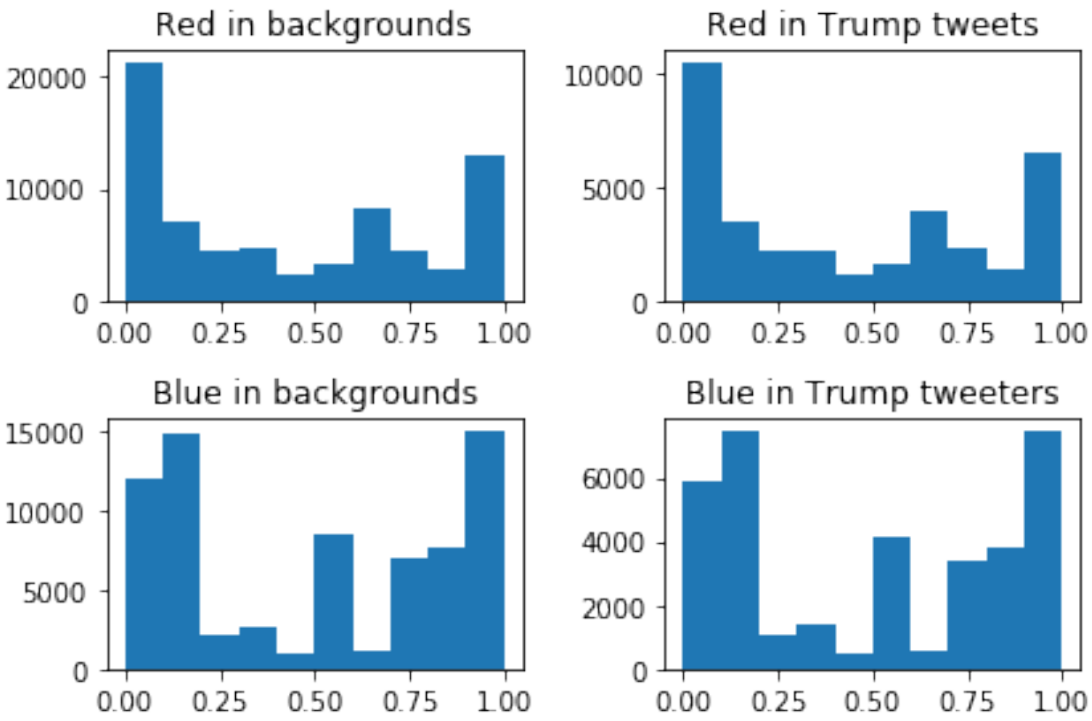
```
In [8]: import matplotlib.colors as colors
        tweets["red"] = tweets["user_bg_color"].apply(lambda x: colors.hex2color('#{0}'.format(x
        tweets["blue"] = tweets["user_bg_color"].apply(lambda x: colors.hex2color('#{0}'.format(
```

```
fig,axes = plt.subplots(nrows=2,ncols=2)
ax0, ax1, ax2, ax3 = axes.flat
ax0.hist(tweets["red"])
ax0.set_title("Red in background")

ax1.hist(tweets["red"][tweets["candidate"]=="trump"].values)
ax1.set_title('Red in Trump tweeters')

ax2.hist(tweets["blue"])
ax2.set_title("Blue in background")

ax3.hist(tweets["blue"][tweets["candidate"]=="trump"].values)
ax3.set_title("Blue in Trump tweeters")

plt.tight_layout()
plt.show()
```



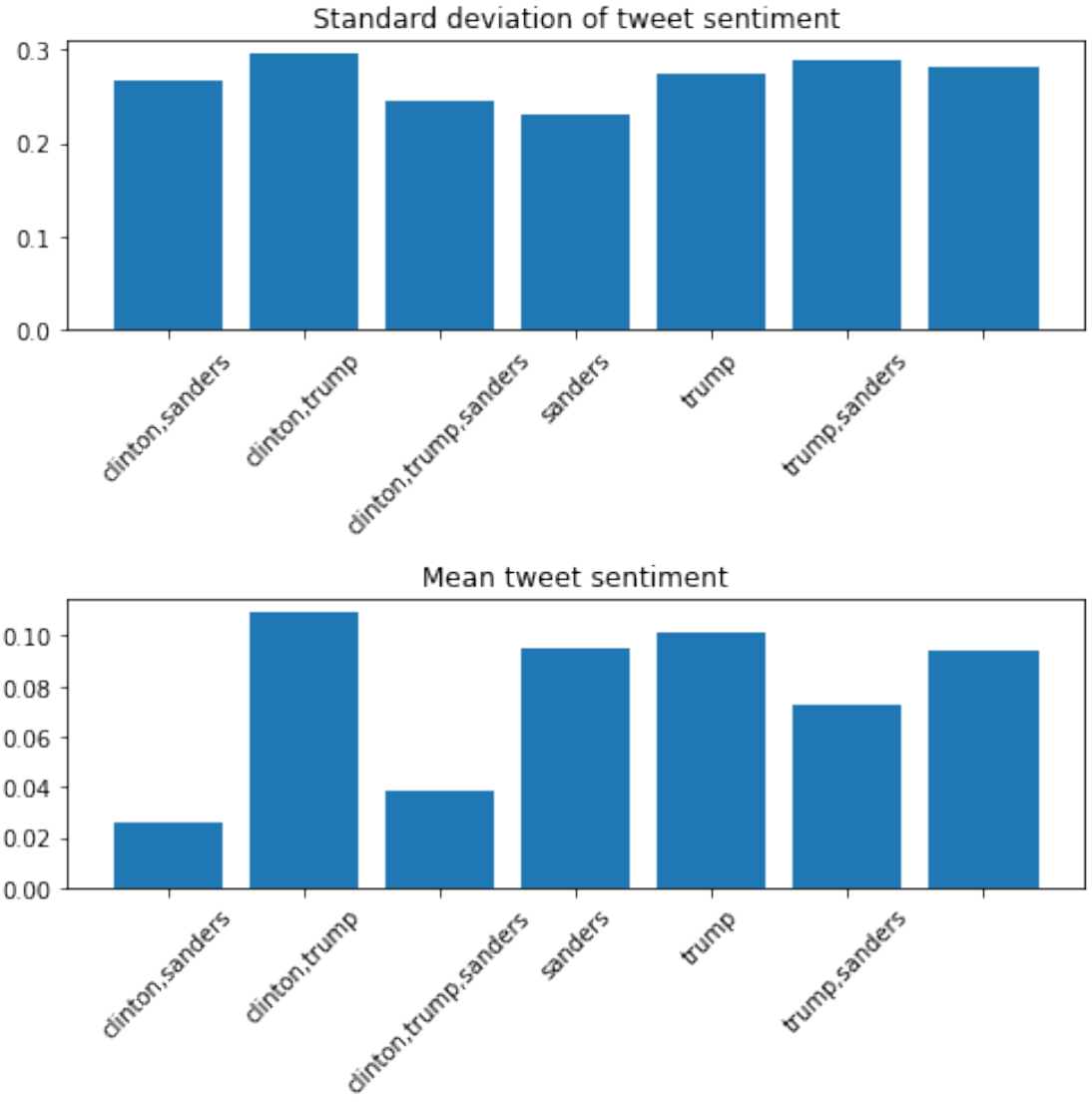
In [9]:
```
tweets["user_bg_color"].value_counts()
tc = tweets[~tweets["user_bg_color"].isin(['C0DEED','000000','F5F8FA'])]

def create_plot(data):
    fig, axes = plt.subplots(nrows=2, ncols=2)
    ax0, ax1, ax2, ax3 = axes.flat
```

```
        ax0.hist(data["red"])
        ax0.set_title('Red in backgrounds')

        ax1.hist(data["red"][data["candidate"] == "trump"].values)
        ax1.set_title('Red in Trump tweets')

        ax2.hist(data["blue"])
        ax2.set_title('Blue in backgrounds')

        ax3.hist(data["blue"][data["candidate"] == "trump"].values)
        ax3.set_title('Blue in Trump tweeters')

        plt.tight_layout()
        plt.show()

    create_plot(tc)
```




```
In [10]: gr = tweets.groupby("candidate").agg([np.mean, np.std])

         fig, axes = plt.subplots(nrows=2, ncols=1, figsize=(7, 7))
         ax0, ax1 = axes.flat

         std = gr["polarity"]["std"].iloc[1:]
         mean = gr["polarity"]["mean"].iloc[1:]
```

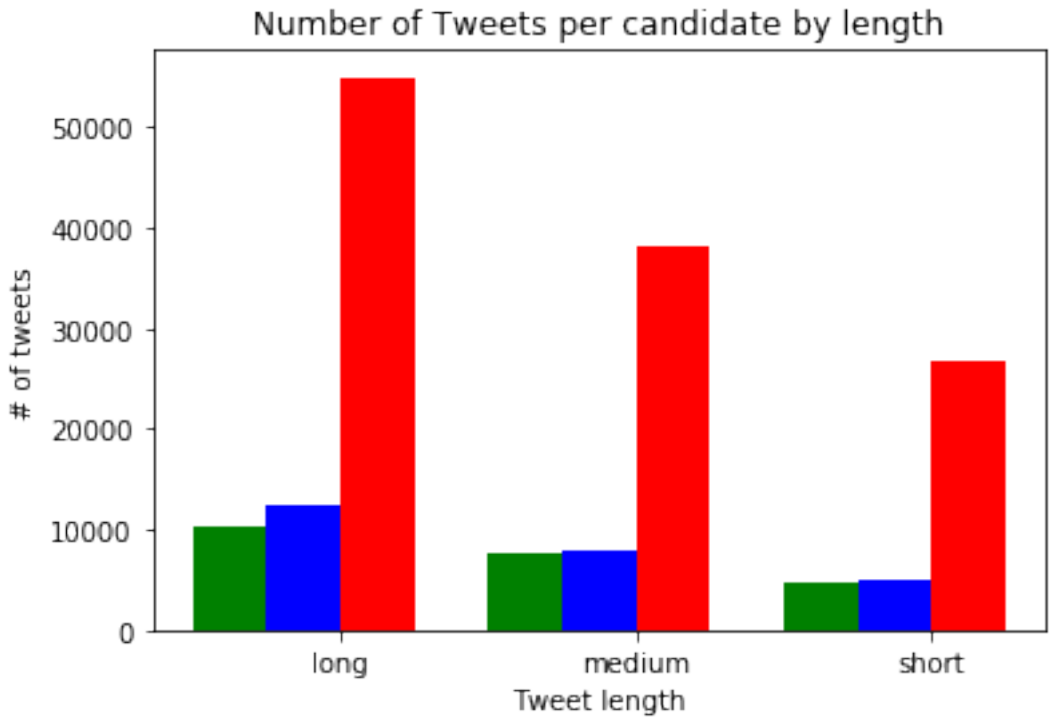
```
ax0.bar(range(len(std)), std)
ax0.set_xticklabels(std.index, rotation=45)
ax0.set_title('Standard deviation of tweet sentiment')

ax1.bar(range(len(mean)), mean)
ax1.set_xticklabels(mean.index, rotation=45)
ax1.set_title('Mean tweet sentiment')

plt.tight_layout()
plt.show()
```




```
In [11]: def tweet_lengths(text):
             if len(text) < 100:
```

```
            return "short"
        elif 100 <= len(text) <= 135:
            return "medium"
        else:
            return "long"

    tweets["tweet_length"] = tweets["text"].apply(tweet_lengths)

    tl = {}
    for candidate in ["clinton", "sanders", "trump"]:
        tl[candidate] = tweets["tweet_length"][tweets["candidate"] == candidate].value_coun
```

In [12]:
```
fig, ax = plt.subplots()
width = .5
x = np.array(range(0, 6, 2))
ax.bar(x, tl["clinton"], width, color='g')
ax.bar(x + width, tl["sanders"], width, color='b')
ax.bar(x + (width * 2), tl["trump"], width, color='r')

ax.set_ylabel('# of tweets')
ax.set_title('Number of Tweets per candidate by length')
ax.set_xticks(x + (width * 1.5))
ax.set_xticklabels(('long', 'medium', 'short'))
ax.set_xlabel('Tweet length')
plt.show()
```



```
In [15]: states = ['Alabama','Alaska','Arizona','Arkansas','California','Colorado','Connecticut'
                   'Hawaii','Idaho','Illinois','Indiana','Iowa','Kansas','Kentucky','Louisiana',
                   'Michigan','Minnesota','Mississippi','Missouri','Montana','Nebraska','Nevada'
                   'New Mexico','New York','North Carolina','North Dakota','Ohio','Oklahoma','Or
                   'South Carolina','South Dakota','Tennessee','Texas','Utah','Vermont','Virgini
                   'Wisconsin','Wyoming','al','ak','az','ar','ca','co','ct','de','fl','ga','hi',
                   'ky','la','me','md','ma','mi','mn','ms','mo','mt','ne','nv','nh','nj','nm','n
                   'pa','ri','sc','sd','tn','tx','ut','vt','va','wa','wv','wi','wy'
         ]
         states_lower=[]
         for state in states:
             states_lower.append(state.lower())
         print(states_lower)

['alabama', 'alaska', 'arizona', 'arkansas', 'california', 'colorado', 'connecticut', 'delaware'


In [18]: def get_state(row):
             state = []
             text = str(row["user_location"]).lower()
             if "alabama" in text or "al" in text:
                 state.append("alabama")
             if "alaska" in text or "ak" in text:
                 state.append("alaska")
             if "arizona" in text or "az"in text:
                 state.append("arizona")
             if "arkansas" in text or "ar"in text:
                 state.append("arkansas")
             if "california" in text or "ca"in text:
                 state.append("california")
             if "colorado" in text or "co"in text:
                 state.append("colorado")
             if "connecticut" in text or "ct"in text:
                 state.append("connecticut")
             if "delaware" in text or "de"in text:
                 state.append("delaware")
             if "florida" in text or "fl"in text:
                 state.append("florida")
             if "georgia" in text or "ga"in text:
                 state.append("georgia")
             if "hawaii" in text or "hi"in text:
                 state.append("arizona")
             if "idaho" in text or "id"in text:
                 state.append("idaho")
             if "illinois" in text or "il"in text:
                 state.append("illinois")
```

```
if "indiana" in text or "in"in text:
    state.append("indiana")
if "iowa" in text or "ia"in text:
    state.append("iowa")
if "kansas" in text or "ks"in text:
    state.append("kansas")
if "kentucky" in text or "ky"in text:
    state.append("ky")
if "louisiana" in text or "la"in text:
    state.append("louisiana")
if "maine" in text or "me"in text:
    state.append("maine")
if "maryland" in text or "md"in text:
    state.append("maryland")
if "massachusetts" in text or "ma"in text:
    state.append("massachusetts")
if "michigan" in text or "mi"in text:
    state.append("michigan")
if "minnesota" in text or "mn" in text:
    state.append("minnesota")
if "mississippi" in text or "ms"in text:
    state.append("mississipii")
if "missouri" in text or "mo"in text:
    state.append("missouri")
if "montana" in text or "mt"in text:
    state.append("montana")
if "nebraska" in text or "ne"in text:
    state.append("nebraska")

if "nevada" in text or "nv"in text:
    state.append("nevada")
if "new hampshire" in text or "nh"in text:
    state.append("new hampshire")
if "new jersey" in text or "nj"in text:
    state.append("new jersey")
if "new mexico" in text or "nm"in text:
    state.append("new mexico")
if "new york" in text or "ny"in text:
    state.append("new york")
if "north carolina" in text or "nc"in text:
    state.append("north carolina")
if "north dakota" in text or "nd"in text:
    state.append("north dakota")
if "ohio" in text or "oh"in text:
    state.append("ohio")
if "oklahoma" in text or "ok"in text:
    state.append("oklahoma")
if "oregon" in text or 'or' in text:
```

```
            state.append('oregon')
        if "pennsylvania" in text or "pa"in text:
            state.append("pennsylvania")
        if "rhode island" in text or "ri"in text:
            state.append("rhode island")
        if "south carolina" in text or "sc"in text:
            state.append("south carolina")
        if "south dakota" in text or "sd"in text:
            state.append("south dakota")
        if "tennessee" in text or "tn"in text:
            state.append("tennesse")
        if "texas" in text or 'tx' in text:
            state.append("texas")
        if "utah" in text or "ut"in text:
            state.append("utah")
        if "vermont" in text or "vt"in text:
            state.append("vermont")
        if "virginia" in text or "va"in text:
            state.append("virginia")
        if "washington" in text or "wa"in text:
            state.append("washington")
        if "west virginia" in text or "wv"in text:
            state.append("west virginia")
        if "wisconsin" in text or 'wi' in text:
            state.append('wisconsin')
        if "wyoming" in text or "wy"in text:
            state.append("wyoming")
        return ",".join(state)

tweets["state"] = tweets.apply(get_state,axis=1)
```

Other possible strategies are to inference state location using geographical co-ordinates and also compile data using cities and use some api to possibly check if it falls within any of the US states. Another possible strategy is to use hashtags to add data to the users for which location is missing

```
In [19]: print(tweets['state'].count())
```

```
237480
```

We were able to classify 237480 tweets with above written classifier

1 Written Problems

1.1 Problem 1

1.1.1 Part A

```
<h3>We want to calculate: </h3>
```

$$Pr\left(\bar{z} \geq c\right)$$

$$= Pr\left(\bar{z} - \mu \geq c - \mu\right)$$

$$= Pr\left(\frac{\bar{z} - \mu}{\sigma_{\bar{z}}} \geq \frac{c - \mu}{\sigma_{\bar{z}}}\right)$$

$$\sigma_{\bar{z}} = \frac{\sigma}{\sqrt{n}} = \frac{1}{\sqrt{n}}$$

$$= Pr\left(z_{avg} \geq c\sqrt{n}\right)$$

We want to calculate this probability for different values of c as given in the problem, namely:

$$c_1 = 0.1$$

$$c_2 = 0.01$$

$$c_3 = 0.001$$

We can use the cdf of the standard normal $\Phi(z)$. We know that $F_z(z) = \Phi(z) = Pr(Z \leq z)$
Therefore, we need to calculate $1 - \Phi(z)$ for $z = c_1\sqrt{n}$, etc.
Leaving them in "z-score" format:

```
<li>$$1\,\,-\,\,\Phi(10)$$</li>
<li>$$1\,\,-\,\,\Phi(1)$$</li>
<li>$$1\,\,-\,\,\Phi(0.1)$$</li>
```

1.1.2 Part B

$$Pr\left(\bar{z} \geq n^c\right)$$

$$= Pr\left(\bar{z} - \mu \geq n^c - \mu\right)$$

$$= Pr\left(\frac{\bar{z} - \mu}{\sigma_{\bar{z}}} \geq \frac{n^c - \mu}{\sigma_{\bar{z}}}\right)$$

$$\sigma_{\bar{z}} = \frac{\sigma}{\sqrt{n}}$$

$$= Pr\left(z_{avg} \geq \frac{n^c\sqrt{n}}{\sigma}\right)$$

We want to calculate this probability for different values of c as given in the problem, namely:

$$c_1 = \frac{-1}{3}$$

$$c_2 = \frac{-1}{2}$$