data_analysis

February 21, 2019

```
In [1]: cd
```

```
C:\Users\an-user
```

```
In [4]: cd C:\Users\an-user\Desktop\data study\graduate-admissions
```

```
C:\Users\an-user\Desktop\data study\graduate-admissions
```

1 Basic Data Information & Correction

```
In [40]: import pandas as pd
         import numpy as np
         import matplotlib.pyplot as plt
         import statsmodels.api as sm
```

```
In [40]: df = pd.read_csv('Admission_Predict_Ver1.1.csv')
```

```
In [41]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 500 entries, 0 to 499
Data columns (total 9 columns):
Serial No.           500 non-null int64
GRE Score            500 non-null int64
TOEFL Score          500 non-null int64
University Rating    500 non-null int64
SOP                  500 non-null float64
LOR                  500 non-null float64
CGPA                 500 non-null float64
Research             500 non-null int64
Chance of Admit      500 non-null float64
dtypes: float64(4), int64(5)
memory usage: 35.2 KB
```

1.1 Two main Problems to be fixed.

1. column names are not neat
2. data types for serial number and research are not accurate.

```
In [42]: list1 = df.columns.tolist()
         print(list1)

         university_rating
         UniversityRating
```

```
['Serial No.', 'GRE Score', 'TOEFL Score', 'University Rating', 'SOP', 'LOR ', 'CGPA', 'Researc
```

```
In [43]: new_columns = []
         for i in range(0, len(list1)):
             new_column_name = list1[i].replace(' ', '_').lower()
             if new_column_name[-1] == '_' or new_column_name[-1] == '.':
                 new_column_name = new_column_name[0:-1]
             else:
                 new_column_name = new_column_name
             new_columns.append(new_column_name)
```

```
In [44]: print(new_columns)
```

```
['serial_no', 'gre_score', 'toefl_score', 'university_rating', 'sop', 'lor', 'cgpa', 'research
```

```
In [45]: df.columns = new_columns
```

```
In [69]: df['serial_no'] = df['serial_no'].astype('object')
         df['research'] = df['research'].astype('int')
```

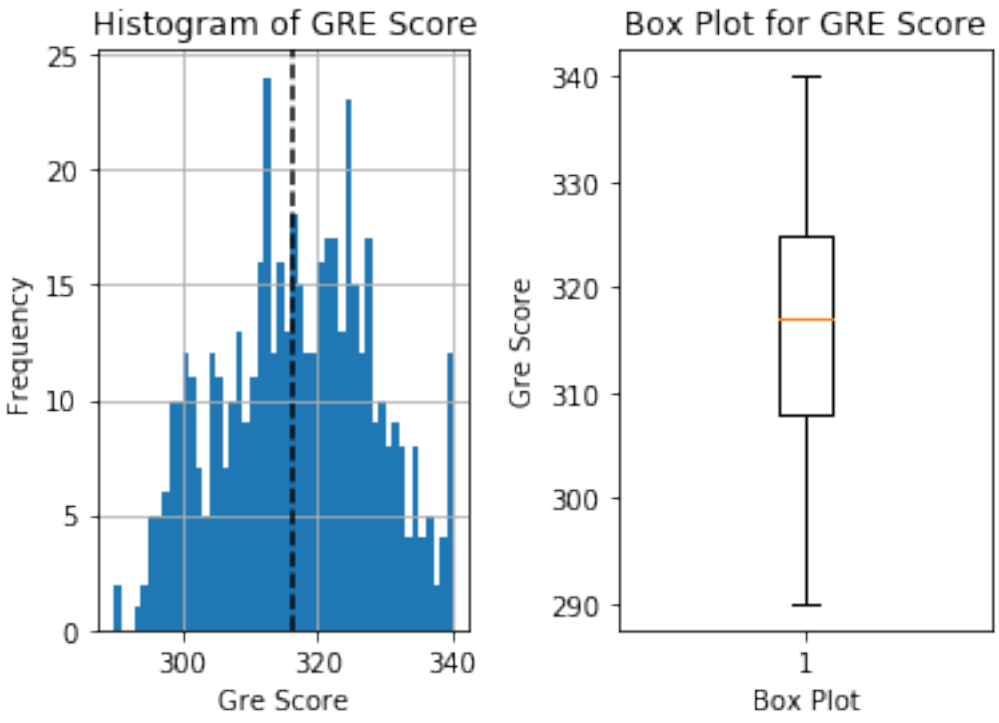
```
In [70]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 500 entries, 0 to 499
Data columns (total 10 columns):
serial_no            500 non-null object
gre_score            500 non-null int64
toefl_score          500 non-null int64
university_rating    500 non-null int64
sop                  500 non-null float64
lor                  500 non-null float64
cgpa                 500 non-null float64
research             500 non-null int32
chance_of_admit      500 non-null float64
intercept            500 non-null int64
dtypes: float64(4), int32(1), int64(4), object(1)
memory usage: 37.2+ KB
```

```
In [33]: df.to_csv('clean_data.csv')
```

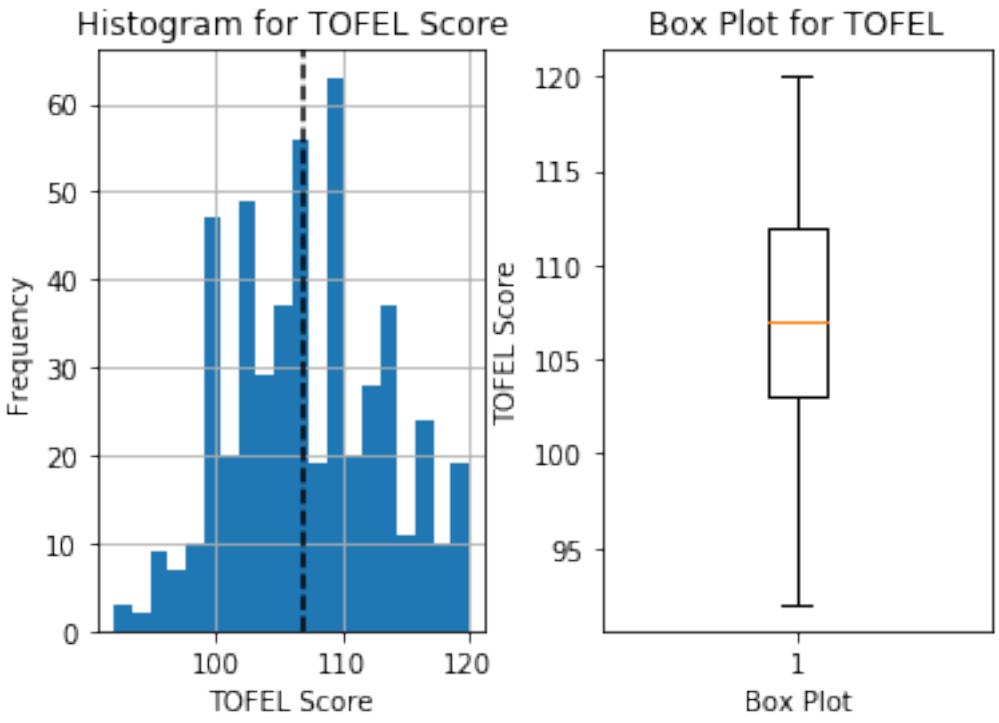
2 Univariate Analysis

In [19]:
```
##Univariate Analysis of GRE Score

        plt.subplot(1,2,1)

        plt.hist(x = df.gre_score, bins = 50)
        plt.xlabel('Gre Score')
        plt.ylabel('Frequency')
        plt.title('Histogram of GRE Score')
        plt.grid(True)
        plt.axvline(df.gre_score.mean(), color = 'k', linestyle = 'dashed')

        plt.subplot(1,2,2)
        plt.boxplot(df.gre_score)
        plt.xlabel('Box Plot')
        plt.ylabel('Gre Score')
        plt.title('Box Plot for GRE Score');

        plt.subplots_adjust(wspace=0.4);
```



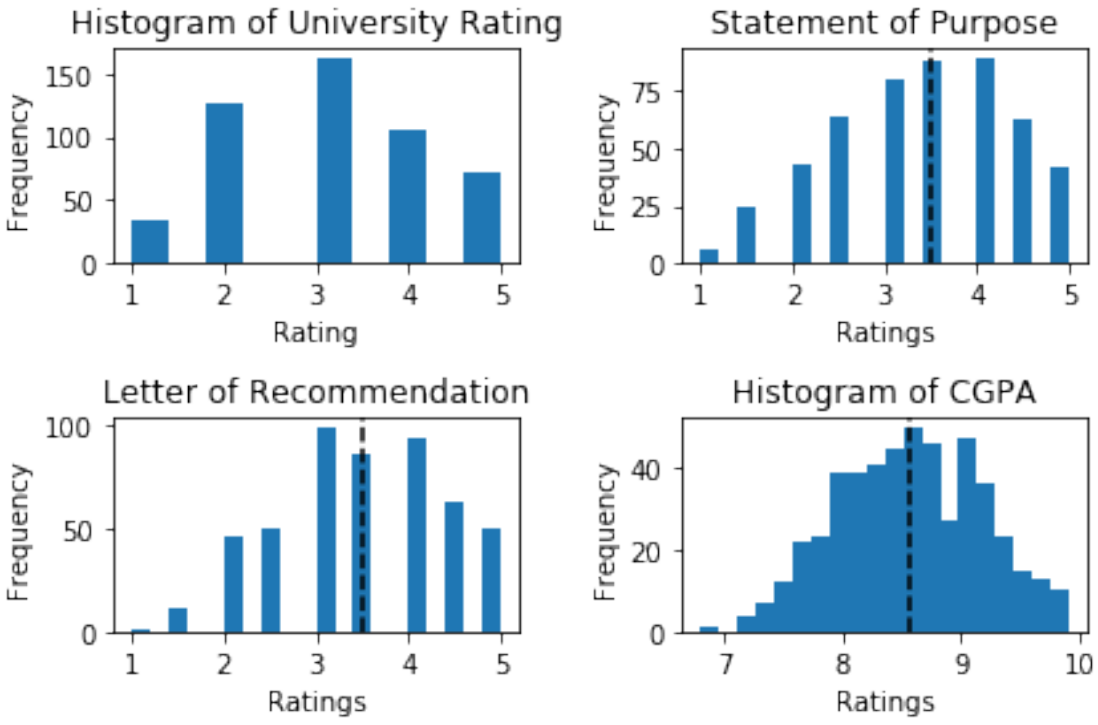
In [32]:
```
##Univariate Analysis of TOFEL Score

        plt.subplot(1,2,1)
```

```
plt.hist(x = df.toefl_score, bins = 20)
plt.xlabel('TOFEL Score')
plt.ylabel('Frequency')
plt.title('Histogram for TOFEL Score')
plt.grid(True)
plt.axvline(df.toefl_score.median(), color = 'k', linestyle = 'dashed')

plt.subplot(1,2,2)
plt.boxplot(df.toefl_score)
plt.xlabel('Box Plot')
plt.ylabel('TOFEL Score')
plt.title('Box Plot for TOFEL')

plt.subplots_adjust(wspace = 0.3);
```



In [34]:
```
'university_rating', 'sop', 'lor', 'cgpa'

plt.subplot(2, 2, 1)
plt.hist(df.university_rating)
plt.title('Histogram of University Rating')
plt.xlabel('Rating')
plt.ylabel('Frequency')
```

```
plt.subplot(2, 2, 2)
plt.hist(x = df.sop, bins = 20)
plt.title('Statement of Purpose')
plt.xlabel('Ratings')
plt.ylabel('Frequency')
plt.axvline(df.sop.quantile(0.5), color = 'k', linestyle = 'dashed')


plt.subplot(2, 2, 3)
plt.hist(x = df.lor, bins = 20)
plt.title('Letter of Recommendation')
plt.xlabel('Ratings')
plt.ylabel('Frequency')
plt.axvline(df.lor.quantile(0.5), color = 'k', linestyle = 'dashed')


plt.subplot(2, 2, 4)
plt.hist(x = df.cgpa, bins = 20)
plt.title('Histogram of CGPA')
plt.xlabel('Ratings')
plt.ylabel('Frequency')
plt.axvline(df.cgpa.quantile(0.5), color = 'k', linestyle = 'dashed')


plt.tight_layout();
```



3 Multivariate Analysis

```
In [6]: df = pd.read_csv('clean_data.csv')
```

3.0.1 Hypotheses Testing

H0. Chance of admit for research group is as same as chance for research group
H1. Chance of admit for research group will be higher than chance for no research group

```
In [33]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 500 entries, 0 to 499
Data columns (total 10 columns):
Unnamed: 0           500 non-null int64
serial_no            500 non-null int64
gre_score            500 non-null int64
toefl_score          500 non-null int64
university_rating    500 non-null int64
sop                  500 non-null float64
lor                  500 non-null float64
cgpa                 500 non-null float64
research             500 non-null int64
chance_of_admit      500 non-null float64
dtypes: float64(4), int64(6)
memory usage: 39.1 KB
```

```
In [7]: re = df.query('research == 1')
        nore = df.query('research == 0')
```

```
In [8]: re_mean = re.chance_of_admit.mean()
        nore_mean = nore.chance_of_admit.mean()
        print(re_mean, nore_mean)
```

```
0.7899642857142857 0.6349090909090905
```

```
In [9]: obs_p_diff = re_mean - nore_mean
        print(obs_p_diff)
```

```
0.15505519480519514
```

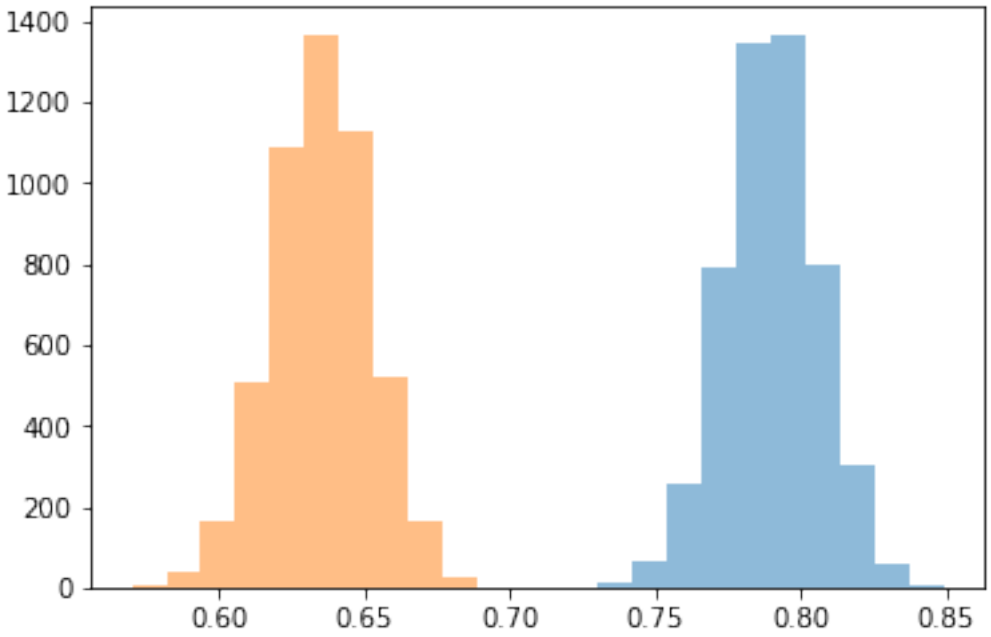
```
In [10]: research_means, no_research_means, diffs = [], [], []

         for i in range(5000):
             bootsamp = df.sample(100, replace = True)
             research_mean = bootsamp[bootsamp['research'] == 1]['chance_of_admit'].mean()
             no_research_mean = bootsamp[bootsamp['research'] == 0]['chance_of_admit'].mean()
             research_means.append(research_mean)
             no_research_means.append(no_research_mean)
             diffs.append(research_mean - no_research_mean)
```

```
In [11]: np.std(research_means)

Out[11]: 0.01627556659521142
```

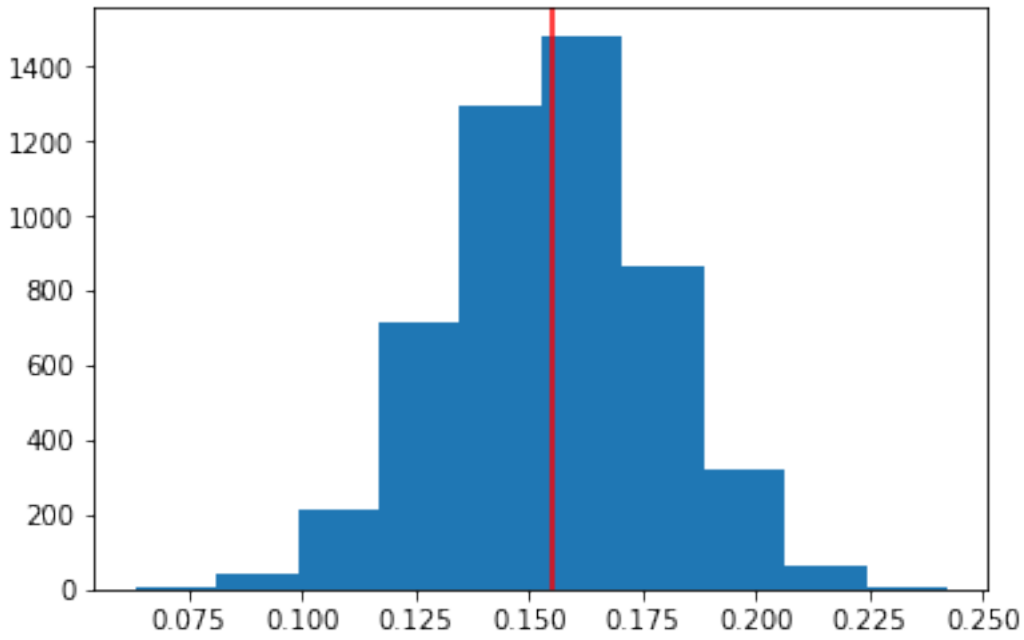
```
In [14]: np.std(no_research_means)

Out[14]: 0.01676103758712193
```

```
In [15]: np.std(diffs)

Out[15]: 0.023452616189278852
```

```
In [16]: plt.hist(research_means, alpha = 0.5);
         plt.hist(no_research_means, alpha = 0.5);
```

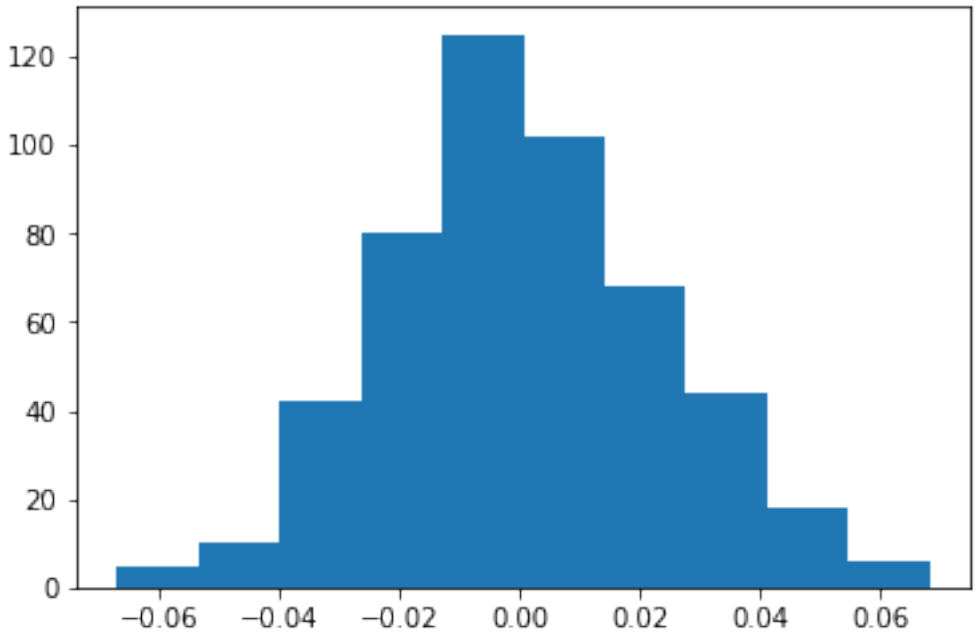



```
In [29]: plt.hist(diffs)
         plt.axvline(obs_p_diff, color = 'red');
```



In [31]:
```
null_vals = np.random.normal(0, np.std(diffs), 500)
```

In [32]:
```
plt.hist(null_vals);
```



```
In [33]: ##Creating the P-value
         (null_vals > obs_p_diff).mean()

Out[33]: 0.0
```

3.1 Result Summary

Since the P-value is 0.0, it is reasonable to conclude that null hypothesis is wrong. In other words, the mean of adimission rate for research group is higher than no research group. As a result, alternative hypothesis should be selected.

3.1.1 Model Development

For the next step, it is important to verity if effects of variables might be different based on research or no research group. For instance, effect size of letter of recommendation could not be the same. In this point of view, every possible variables is going to be taken into account.

```
In [51]: ##Multiple Regression Model for Research Group

         re_lm = sm.OLS(re['chance_of_admit'], re[['intercept', 'university_rating','gre_score
         result = re_lm.fit()
         result.summary()

Out[51]: <class 'statsmodels.iolib.summary.Summary'>
         """
                                     OLS Regression Results
         ==============================================================================
         Dep. Variable:        chance_of_admit   R-squared:                       0.840
         Model:                            OLS   Adj. R-squared:                  0.837
         Method:                 Least Squares   F-statistic:                     239.1
         Date:                Thu, 21 Feb 2019   Prob (F-statistic):          1.42e-105
         Time:                        16:29:15   Log-Likelihood:                 446.14
         No. Observations:                 280   AIC:                            -878.3
         Df Residuals:                     273   BIC:                            -852.8
         Df Model:                           6
         Covariance Type:            nonrobust
         ==============================================================================
                              coef    std err          t      P>|t|      [0.025      0.975]
         ------------------------------------------------------------------------------
         intercept           -1.2292      0.123    -10.004      0.000      -1.471      -0.987
         university_rating    0.0123      0.004      2.822      0.005       0.004       0.021
         gre_score            0.0018      0.001      3.014      0.003       0.001       0.003
         toefl_score          0.0029      0.001      2.921      0.004       0.001       0.005
         sop                  0.0034      0.006      0.610      0.542      -0.008       0.015
         lor                  0.0133      0.005      2.902      0.004       0.004       0.022
         cgpa                 0.1147      0.011     10.434      0.000       0.093       0.136
         ==============================================================================
         Omnibus:                       60.498   Durbin-Watson:                   1.204
         Prob(Omnibus):                  0.000   Jarque-Bera (JB):              130.720
```

```
Skew:                          -1.065   Prob(JB):                     4.12e-29
Kurtosis:                       5.582   Cond. No.                     1.41e+04
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly speci
[2] The condition number is large, 1.41e+04. This might indicate that there are
strong multicollinearity or other numerical problems.
"""
```

In [52]:
```
##Multiple Regression Model for No Research Group

nore_lm = sm.OLS(nore['chance_of_admit'], nore[['intercept', 'university_rating','gre
result = nore_lm.fit()
result.summary()
```

Out[52]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:        chance_of_admit   R-squared:                       0.610
Model:                            OLS   Adj. R-squared:                  0.599
Method:                 Least Squares   F-statistic:                     55.48
Date:                Thu, 21 Feb 2019   Prob (F-statistic):           6.53e-41
Time:                        16:29:35   Log-Likelihood:                 273.65
No. Observations:                 220   AIC:                            -533.3
Df Residuals:                     213   BIC:                            -509.5
Df Model:                           6
Covariance Type:            nonrobust
==============================================================================
                     coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
intercept          -1.2215      0.186     -6.570      0.000      -1.588      -0.855
university_rating  -0.0021      0.007     -0.322      0.748      -0.015       0.011
gre_score           0.0018      0.001      2.111      0.036       0.000       0.003
toefl_score         0.0027      0.002      1.715      0.088      -0.000       0.006
sop                 0.0002      0.007      0.021      0.983      -0.014       0.015
lor                 0.0218      0.008      2.890      0.004       0.007       0.037
cgpa                0.1183      0.017      6.931      0.000       0.085       0.152
==============================================================================
Omnibus:                       42.536   Durbin-Watson:                   0.866
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               69.744
Skew:                          -1.047   Prob(JB):                     7.17e-16
Kurtosis:                       4.794   Cond. No.                     1.27e+04
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly speci
```

```
[2] The condition number is large, 1.27e+04. This might indicate that there are
strong multicollinearity or other numerical problems.
"""
```

```
In [61]: from IPython.display import Image
         from IPython.display import display
         a = Image(filename='result for research.jpg')
         b = Image(filename = 'result for no research.jpg')
         display(a, b)
```

	coef	std err	t	P>|t|
intercept	-1.2292	0.123	-10.004	0.000
university_rating	0.0123	0.004	2.822	0.005
gre_score	0.0018	0.001	3.014	0.003
toefl_score	0.0029	0.001	2.921	0.004
sop	0.0034	0.006	0.610	0.542
lor	0.0133	0.005	2.902	0.004
cgpa	0.1147	0.011	10.434	0.000

	coef	std err	t	P>|t|
intercept	-1.2215	0.186	-6.570	0.000
university_rating	-0.0021	0.007	-0.322	0.748
gre_score	0.0018	0.001	2.111	0.036
toefl_score	0.0027	0.002	1.715	0.088
sop	0.0002	0.007	0.021	0.983
lor	0.0218	0.008	2.890	0.004
cgpa	0.1183	0.017	6.931	0.000

3.1.2 Point of Interest

1. Different P-value of University Rating column. University rating column's p-value for reserach group is 0.0005, whereas the same figure for no research group is 0.748. In other words, if one has academic research records, university's reputation might affect the chance of adimission. But if one does not have such history, university reputation does not count.

2. Coefficient Size Comparsion Among significant variables, when comparing the effect size, which is coefficient, the order is as follows on each group. Research Group: CGPA > LOR > SOP > TOFEL > GRE, No Research Group: CGPA > LOR > TOFEL > GRE > SOP.

This different orders imply that in order to be accepted by graduate schools that they admire, people with academic research record should focus on CGPA, LOR and SOP but people with no such history have to focus on CGPA, LOR and TOFEL.