JAMBOREE EDUCATION CASE STUDY

Jamboree has helped thousands of students like you make it to top colleges abroad. Be it GMAT, GRE or SAT, their unique problem-solving methods ensure maximum scores with minimum effort.They recently launched a feature where students/learners can come to their website and check their probability of getting into the IVY league college. This feature estimates the chances of graduate admission from an Indian perspective.

Problem Statement

What factors are important in graduate admissions and how these factors are interrelated among themselves. It will also help predict one's chances of admission given the rest of the variables.

Column Profiling:

Serial No. (Unique row ID)

GRE Scores (out of 340)

TOEFL Scores (out of 120)

University Rating (out of 5)

Statement of Purpose and Letter of Recommendation Strength (out of 5)

Undergraduate GPA (out of 10)

Research Experience (either 0 or 1)

Chance of Admit (ranging from 0 to 1)

Importing Libraries

In [1]:

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import numpy as np
```

In [114]:
```
%matplotlib inline
```

In [2]:
```
df = pd.read_csv("Jamboree_Admission.csv")
```

Statistical Summary

In [43]:
```
df.head()
```

Out[43]:

	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
0	1	337	118	4	4.5	4.5	9.65	1	0.92
1	2	324	107	4	4.0	4.5	8.87	1	0.76
2	3	316	104	3	3.0	3.5	8.00	1	0.72
3	4	322	110	3	3.5	2.5	8.67	1	0.80
4	5	314	103	2	2.0	3.0	8.21	0	0.65

In [45]:
```
df.shape
```

Out[45]:
```
(500, 9)
```

In [4]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 500 entries, 0 to 499
Data columns (total 9 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   Serial No.         500 non-null    int64  
 1   GRE Score          500 non-null    int64  
 2   TOEFL Score        500 non-null    int64  
 3   University Rating  500 non-null    int64  
 4   SOP                500 non-null    float64
 5   LOR                500 non-null    float64
 6   CGPA               500 non-null    float64
 7   Research           500 non-null    int64  
 8   Chance of Admit    500 non-null    float64
dtypes: float64(4), int64(5)
memory usage: 35.3 KB
```

In [54]:

```
df.describe()
```

Out[54]:

	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	R
count	500.000000	500.000000	500.000000	500.000000	500.000000	500.00000	500.000000	50(
mean	250.500000	316.472000	107.192000	3.114000	3.374000	3.48400	8.576440	(
std	144.481833	11.295148	6.081868	1.143512	0.991004	0.92545	0.604813	(
min	1.000000	290.000000	92.000000	1.000000	1.000000	1.00000	6.800000	(
25%	125.750000	308.000000	103.000000	2.000000	2.500000	3.00000	8.127500	(
50%	250.500000	317.000000	107.000000	3.000000	3.500000	3.50000	8.560000	-
75%	375.250000	325.000000	112.000000	4.000000	4.000000	4.00000	9.040000	-
max	500.000000	340.000000	120.000000	5.000000	5.000000	5.00000	9.920000	-

Non Graphical Analysis

In [37]:

```
for i in columns[1:]:
    print("Column Name :" , i)
    print(df[i].value_counts(normalize = True)*100)
    print("\n\n")
```

```
Column Name : GRE Score
312    4.8
324    4.6
316    3.6
321    3.4
322    3.4
327    3.4
314    3.2
311    3.2
320    3.2
317    3.0
325    3.0
315    2.6
308    2.6
323    2.6
318    2.4
319    2.4
326    2.4
304    2.4
```

In [42]:
```
for i in columns[1:]:
    print( i," : " , df[i].nunique())
```

```
GRE Score  :  49
TOEFL Score  :  29
University Rating  :  5
SOP  :  9
LOR   :  9
CGPA  :  184
Research  :  2
Chance of Admit   :  61
```

In [52]:
```
for i in columns[1:]:
    print( i," :" , df[i].unique())
    print("\n")
```

```
GRE Score  : [337 324 316 322 314 330 321 308 302 323 325 327 328 307
311 317 319 318
 303 312 334 336 340 298 295 310 300 338 331 320 299 304 313 332 326
329
 339 309 315 301 296 294 306 305 290 335 333 297 293]


TOEFL Score  : [118 107 104 110 103 115 109 101 102 108 106 111 112 1
05 114 116 119 120
  98  93  99  97 117 113 100  95  96  94  92]


University Rating  : [4 3 2 5 1]


SOP  : [4.5 4.  3.  3.5 2.  5.  1.5 1.  2.5]


LOR   : [4.5 3.5 2.5 3.  4.  1.5 2.  5.  1. ]


CGPA  : [9.65 8.87 8.   8.67 8.21 9.34 8.2  7.9  8.6  8.4  9.   9.1
8.3  8.7
 8.8  8.5  9.5  9.7  9.8  9.6  7.5  7.2  7.3  8.1  9.4  9.2  7.8  7.7
 9.3  8.85 7.4  7.6  6.8  8.92 9.02 8.64 9.22 9.16 9.64 9.76 9.45 9.0
4
 8.9  8.56 8.72 8.22 7.54 7.36 8.02 9.36 8.66 8.42 8.28 8.14 8.76 7.9
2
 7.66 8.03 7.88 7.84 8.96 9.24 8.88 8.46 8.12 8.25 8.47 9.05 8.78 9.1
8
 9.46 9.38 8.48 8.68 8.34 8.45 8.62 7.46 7.28 8.84 9.56 9.48 8.36 9.3
2
 8.71 9.35 8.65 9.28 8.77 8.16 9.08 9.12 9.15 9.44 9.92 9.11 8.26 9.4
3
 9.06 8.75 8.89 8.69 7.86 9.01 8.97 8.33 8.27 7.98 8.04 9.07 9.13 9.2
3
 8.32 8.98 8.94 9.53 8.52 8.43 8.54 9.91 9.87 7.65 7.89 9.14 9.66 9.7
8
 9.42 9.26 8.79 8.23 8.53 8.07 9.31 9.17 9.19 8.37 7.68 8.15 8.73 8.8
3
 8.57 9.68 8.09 8.17 7.64 8.01 7.95 8.49 7.87 7.97 8.18 8.55 8.74 8.1
3
 8.44 9.47 8.24 7.34 7.43 7.25 8.06 7.67 9.54 9.62 7.56 9.74 9.82 7.9
6
 7.45 7.94 8.35 7.42 8.95 9.86 7.23 7.79 9.25 9.67 8.86 7.57 7.21 9.2
7
 7.81 7.69]


Research  : [1 0]


Chance of Admit   : [0.92 0.76 0.72 0.8  0.65 0.9  0.75 0.68 0.5  0.4
5 0.52 0.84 0.78 0.62
 0.61 0.54 0.66 0.63 0.64 0.7  0.94 0.95 0.97 0.44 0.46 0.74 0.91 0.8
8
 0.58 0.48 0.49 0.53 0.87 0.86 0.89 0.82 0.56 0.36 0.42 0.47 0.55 0.5
7
 0.96 0.93 0.38 0.34 0.79 0.71 0.69 0.59 0.85 0.77 0.81 0.83 0.67 0.7
3
 0.6  0.43 0.51 0.39 0.37]
```

Insight :

Categorical columns : 'University Rating', 'SOP', 'LOR ', 'Research'

Continous Columns :'GRE Score', 'TOEFL Score', 'CGPA', 'Chance of Admit '

In [58]:
```
df.isnull().sum()
```

Out[58]:
```
Serial No.           0
GRE Score            0
TOEFL Score          0
University Rating    0
SOP                  0
LOR                  0
CGPA                 0
Research             0
Chance of Admit      0
dtype: int64
```

There are no Null Values

In [64]:
```
df.describe()
```

Out[64]:

	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	R
count	500.000000	500.000000	500.000000	500.000000	500.000000	500.00000	500.000000	50(
mean	250.500000	316.472000	107.192000	3.114000	3.374000	3.48400	8.576440	(
std	144.481833	11.295148	6.081868	1.143512	0.991004	0.92545	0.604813	(
min	1.000000	290.000000	92.000000	1.000000	1.000000	1.00000	6.800000	(
25%	125.750000	308.000000	103.000000	2.000000	2.500000	3.00000	8.127500	(
50%	250.500000	317.000000	107.000000	3.000000	3.500000	3.50000	8.560000	-
75%	375.250000	325.000000	112.000000	4.000000	4.000000	4.00000	9.040000	-
max	500.000000	340.000000	120.000000	5.000000	5.000000	5.00000	9.920000	-

Graphical Analysis

Univariate Analysis

In [65]:
```
df.head()
```

Out[65]:

	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
0	1	337	118	4	4.5	4.5	9.65	1	0.92
1	2	324	107	4	4.0	4.5	8.87	1	0.76
2	3	316	104	3	3.0	3.5	8.00	1	0.72
3	4	322	110	3	3.5	2.5	8.67	1	0.80
4	5	314	103	2	2.0	3.0	8.21	0	0.65

In [89]:
```
cat_columns = columns[3:6]
```

In [90]:
```
cat_columns = list(cat_columns)
```

In [91]:
```
cat_columns.append("Research")
```

In [98]:
```
continous_columns = columns.copy()
```

In [103]:
```
continous_columns = list(continous_columns)
```

In [108]:
```
continous_columns = [i for i in continous_columns if i not in cat_colu
```

In [109]:
```
cat_columns
```

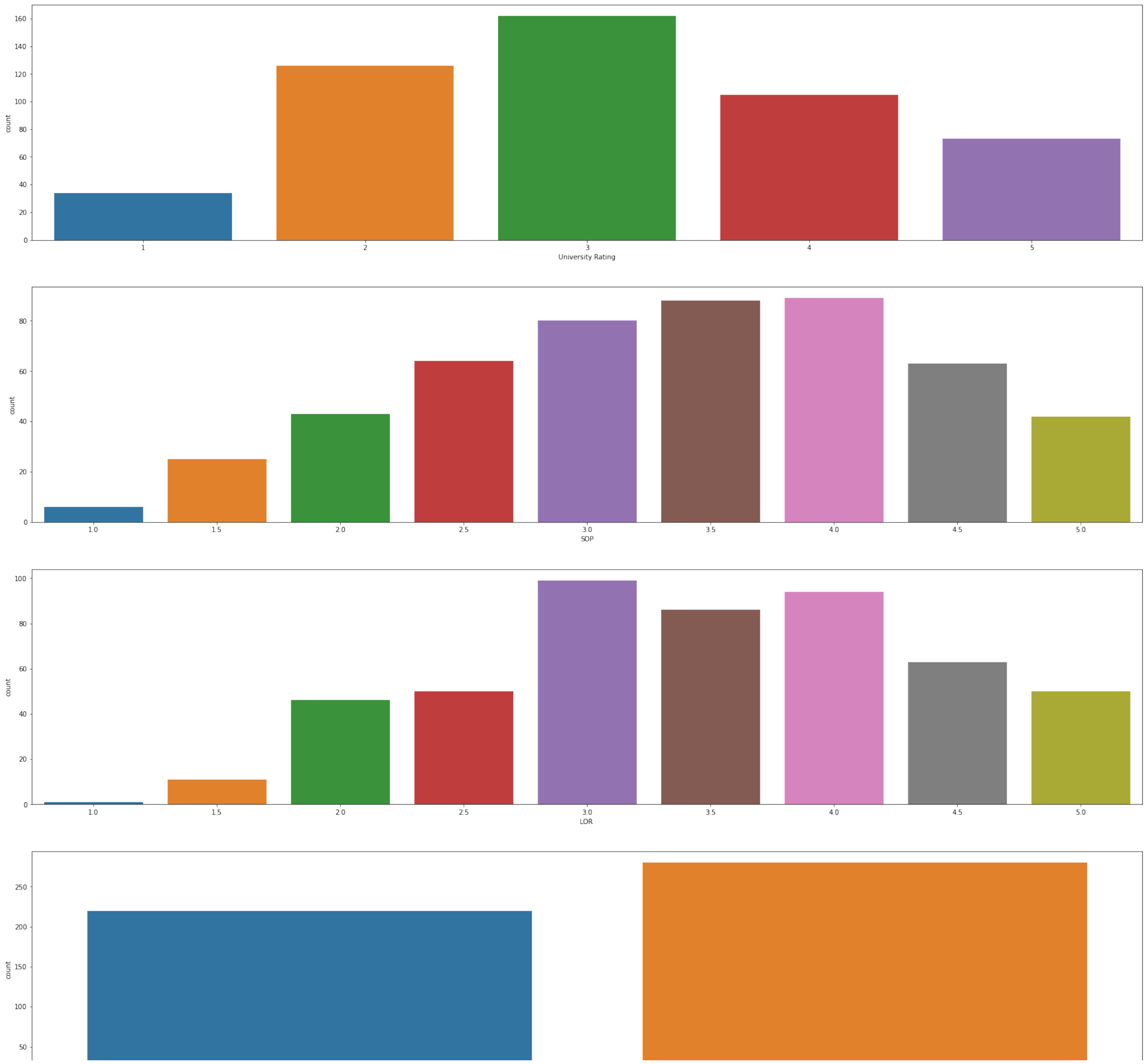
Out[109]:
```
['University Rating', 'SOP', 'LOR ', 'Research']
```

In [111]:
```
continous_columns
```

Out[111]:
```
['Serial No.', 'GRE Score', 'TOEFL Score', 'CGPA', 'Chance of Admit '
]
```

In [184]:
```
fig, ax = plt.subplots(len(cat_columns) , 1 , figsize = (30,30))
for i in range(len(cat_columns)):
    sns.countplot(df[cat_columns[i]] ,ax  = ax[i])
```

```
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
```



Insight :

32% of students have got 3 in the university Rating section

6.8% of students have got 1 in University Rating

Almost 34% of students have recieved 3.5 and 4 in SOP Section, only a few students have got 1

56% of students have research experience

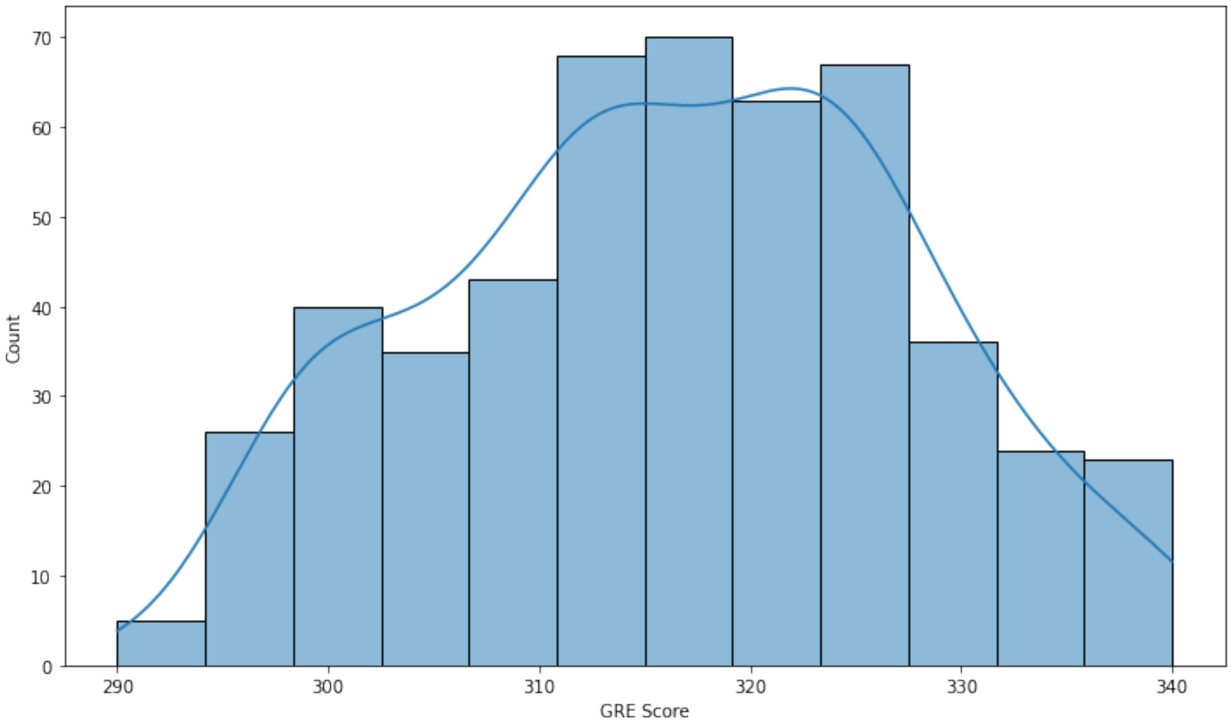
In [181]:

```
for i in cat_columns:
    print("Column Name :" , i)
    print(df[i].value_counts(normalize = True)*100)
```

```
Column Name : University Rating
3    32.4
2    25.2
4    21.0
5    14.6
1     6.8
Name: University Rating, dtype: float64
Column Name : SOP
4.0    17.8
3.5    17.6
3.0    16.0
2.5    12.8
4.5    12.6
2.0     8.6
5.0     8.4
1.5     5.0
1.0     1.2
Name: SOP, dtype: float64
Column Name : LOR
3.0    19.8
4.0    18.8
3.5    17.2
4.5    12.6
5.0    10.0
2.5    10.0
2.0     9.2
1.5     2.2
1.0     0.2
Name: LOR , dtype: float64
Column Name : Research
1    56.0
0    44.0
Name: Research, dtype: float64
```

```
In [173]: plt.figure(figsize = (12,7))
          sns.histplot(df["GRE Score"], kde = True)

Out[173]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbbf9127d30>
```

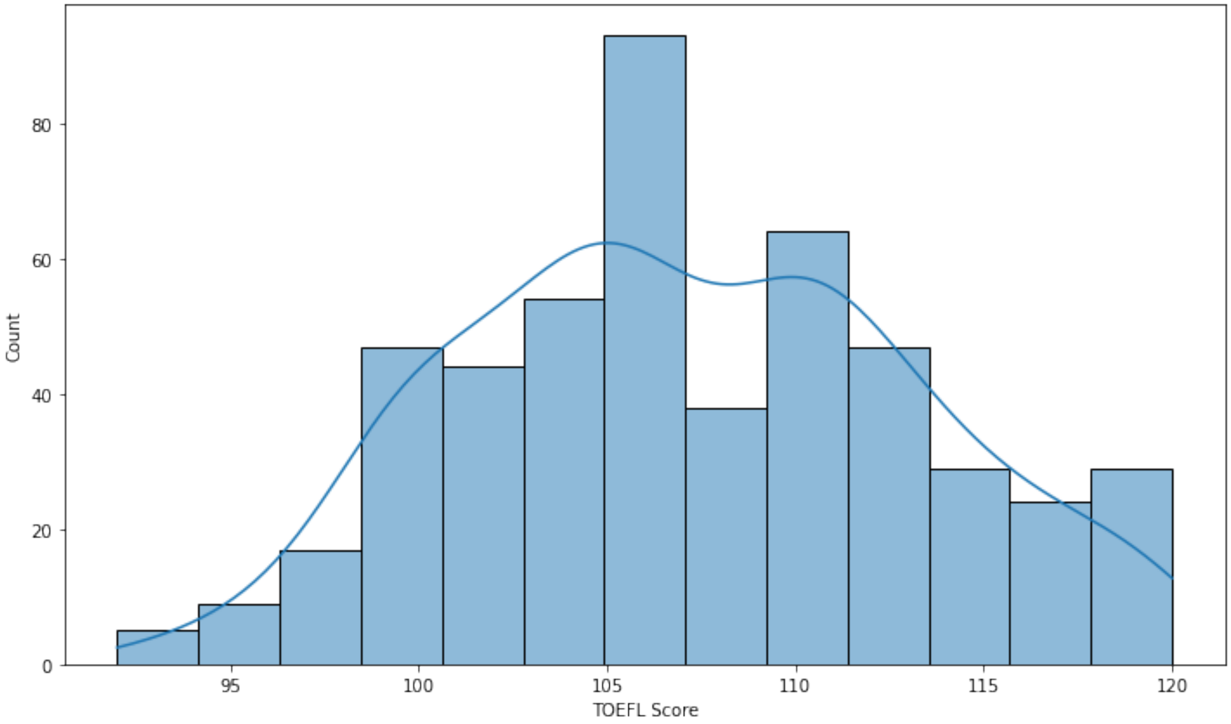


```
In [165]: continous_columns

Out[165]: ['Serial No.', 'GRE Score', 'TOEFL Score', 'CGPA', 'Chance of Admit '
          ]
```

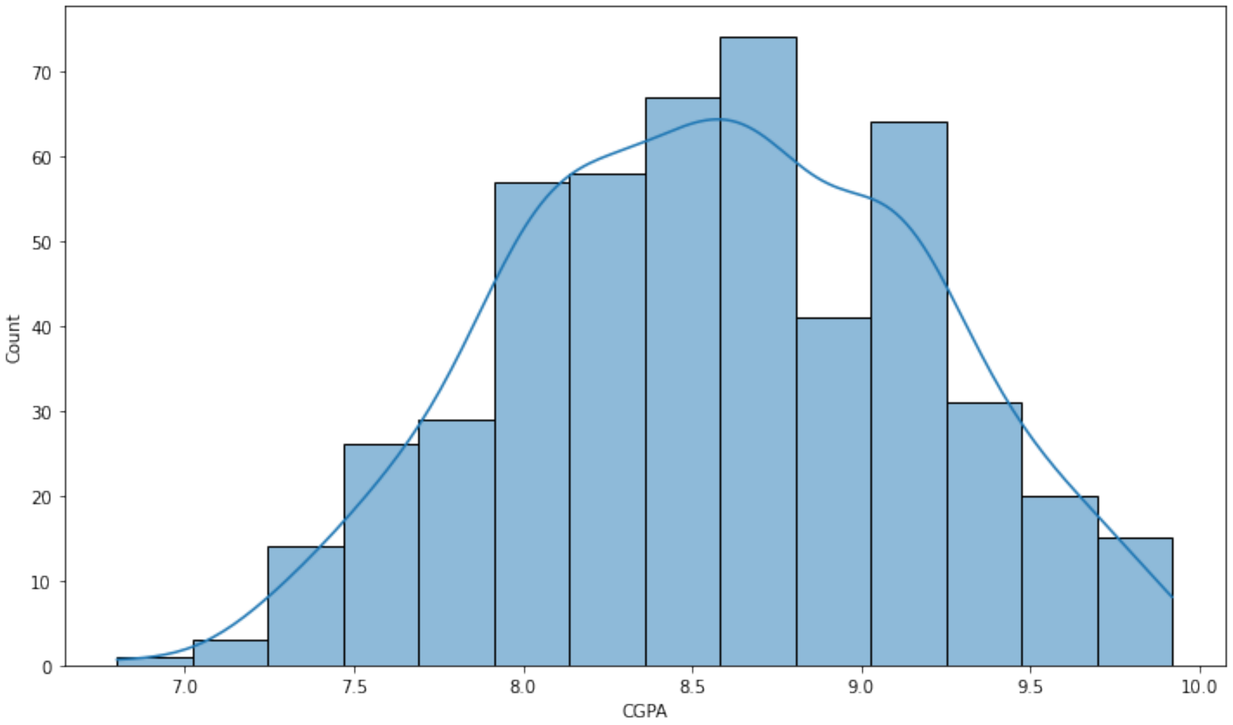
In [177]:
```
plt.figure(figsize = (12,7))
sns.histplot(df["TOEFL Score"], kde = True)
```

Out[177]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbbdb7690d0>
```



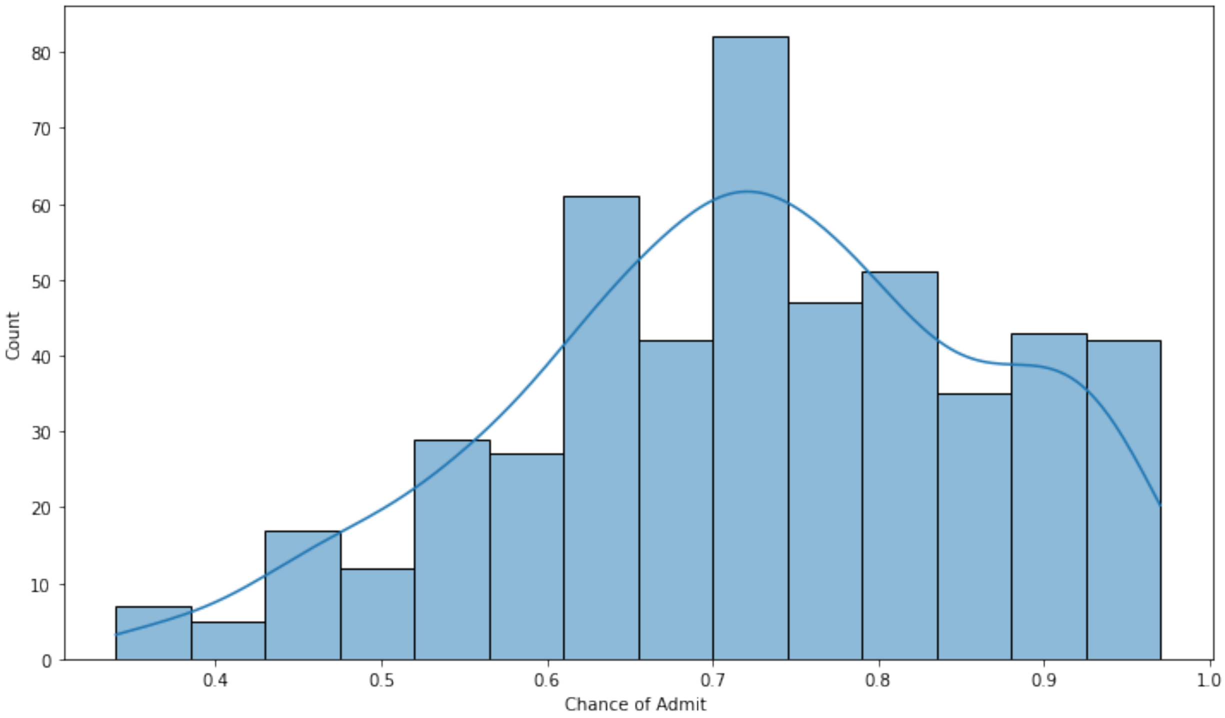
```
In [176]: plt.figure(figsize = (12,7))
          sns.histplot(df["CGPA"], kde = True)

Out[176]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbbda17e9d0>
```



In [179]:
```
plt.figure(figsize = (12,7))
sns.histplot(df["Chance of Admit "], kde = True)
```

Out[179]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbbf83cb430>
```



Insight : There is a variety of distributions for the continuous columns.

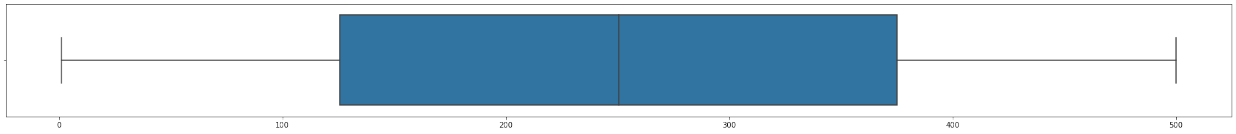
This infers that merits of student vary in the data set.

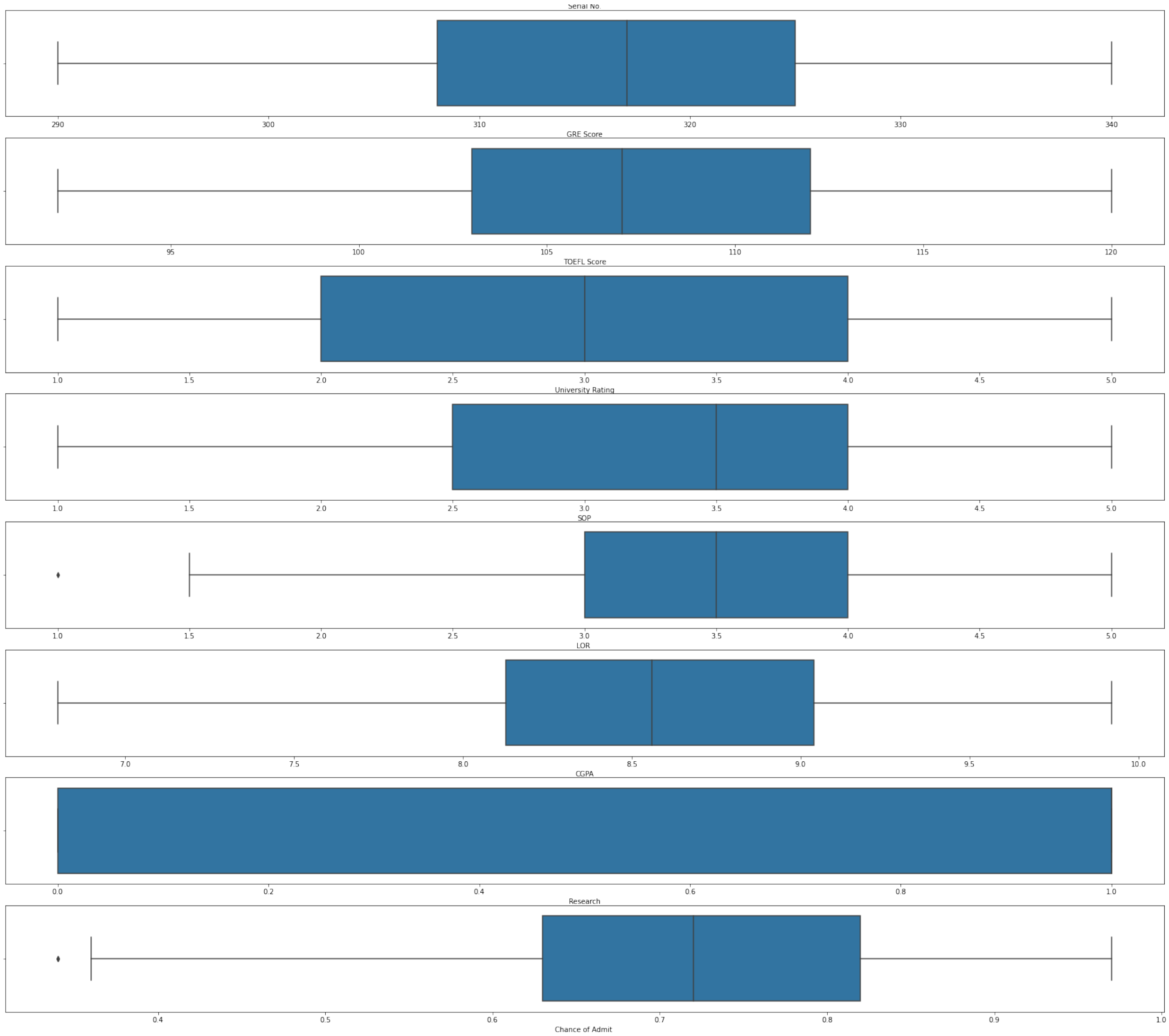
Outlier Detection

In [203]:
```
fig, ax = plt.subplots(len(columns) , 1 , figsize = (30,30))
for i in range(len(columns)):
    sns.boxplot(df[columns[i]] , ax  = ax[i])
```

```
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
```

```
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
```

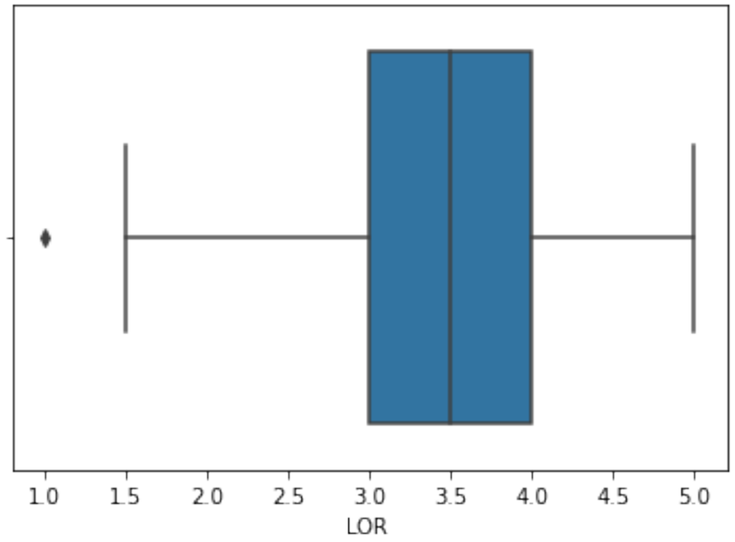



Serial No
290
300
310
320
330
340
GRE Score
95
100
105
110
115
120
TOEFL Score
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
University Rating
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
SOP
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
LOR
7.0
7.5
8.0
8.5
9.0
9.5
10.0
CGPA
0.0
0.2
0.4
0.6
0.8
1.0
Research
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Chance of Admit

In [190]:
```
sns.boxplot(df["LOR "])
```

```
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
```

Out[190]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbbc4788460>
```



In [193]:
```
df[df["LOR "]<1.5]
```

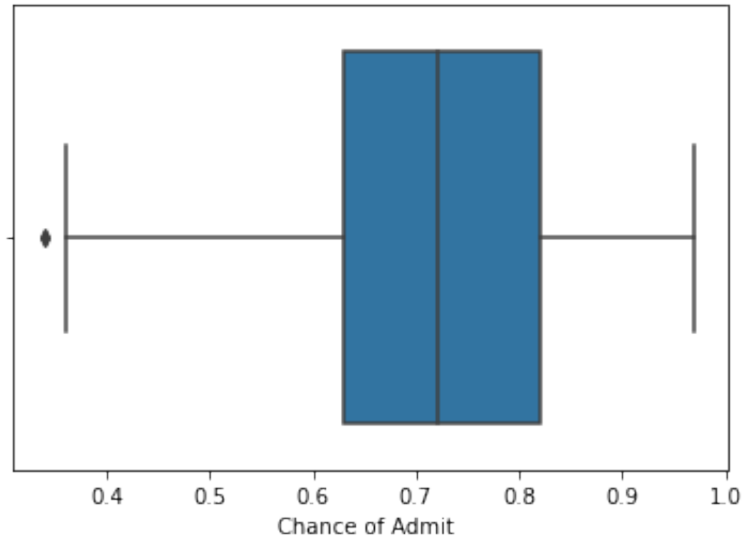
Out[193]:

	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
347	348	299	94	1	1.0	1.0	7.34	0	0.42

```
In [204]: sns.boxplot(df["Chance of Admit "])
```

```
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variable as a key
word arg: x. From version 0.12, the only valid positional argument wi
ll be `data`, and passing other arguments without an explicit keyword
will result in an error or misinterpretation.
  warnings.warn(
```

```
Out[204]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbbbc528340>
```



Inights : There were no outliers in the columns.

```
In [ ]:
```

Bivariate Analysis

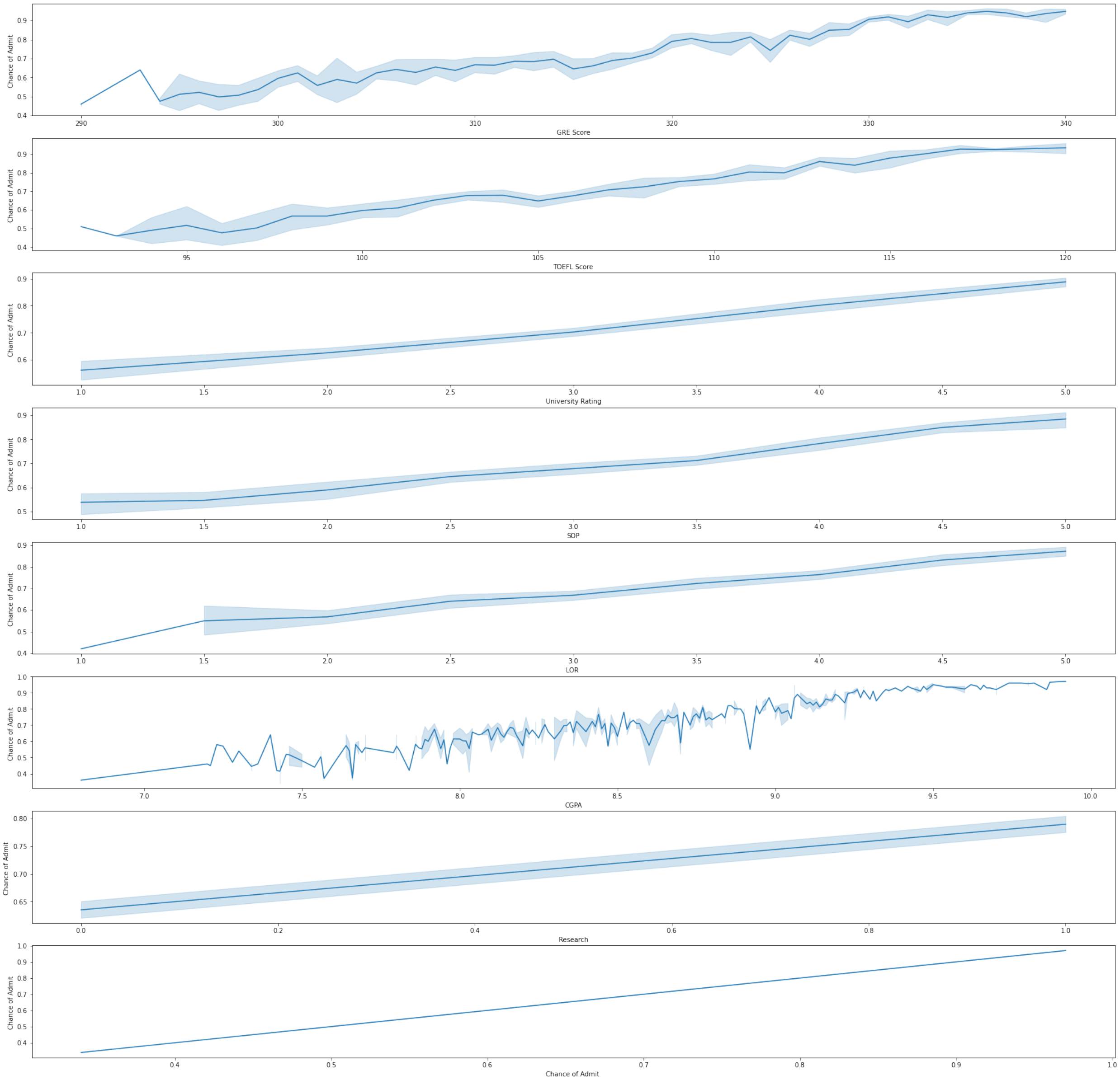
In [198]:

```
df.head()
```

Out[198]:

	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
0	1	337	118	4	4.5	4.5	9.65	1	0.92
1	2	324	107	4	4.0	4.5	8.87	1	0.76
2	3	316	104	3	3.0	3.5	8.00	1	0.72
3	4	322	110	3	3.5	2.5	8.67	1	0.80
4	5	314	103	2	2.0	3.0	8.21	0	0.65

In [209]:
```
fig, ax = plt.subplots(len(columns[1:]) , 1 , figsize = (30,30))
for i in range(len(columns[1:])):
    sns.lineplot(x = df[columns[1+i]], y = df["Chance of Admit "] , ax
```



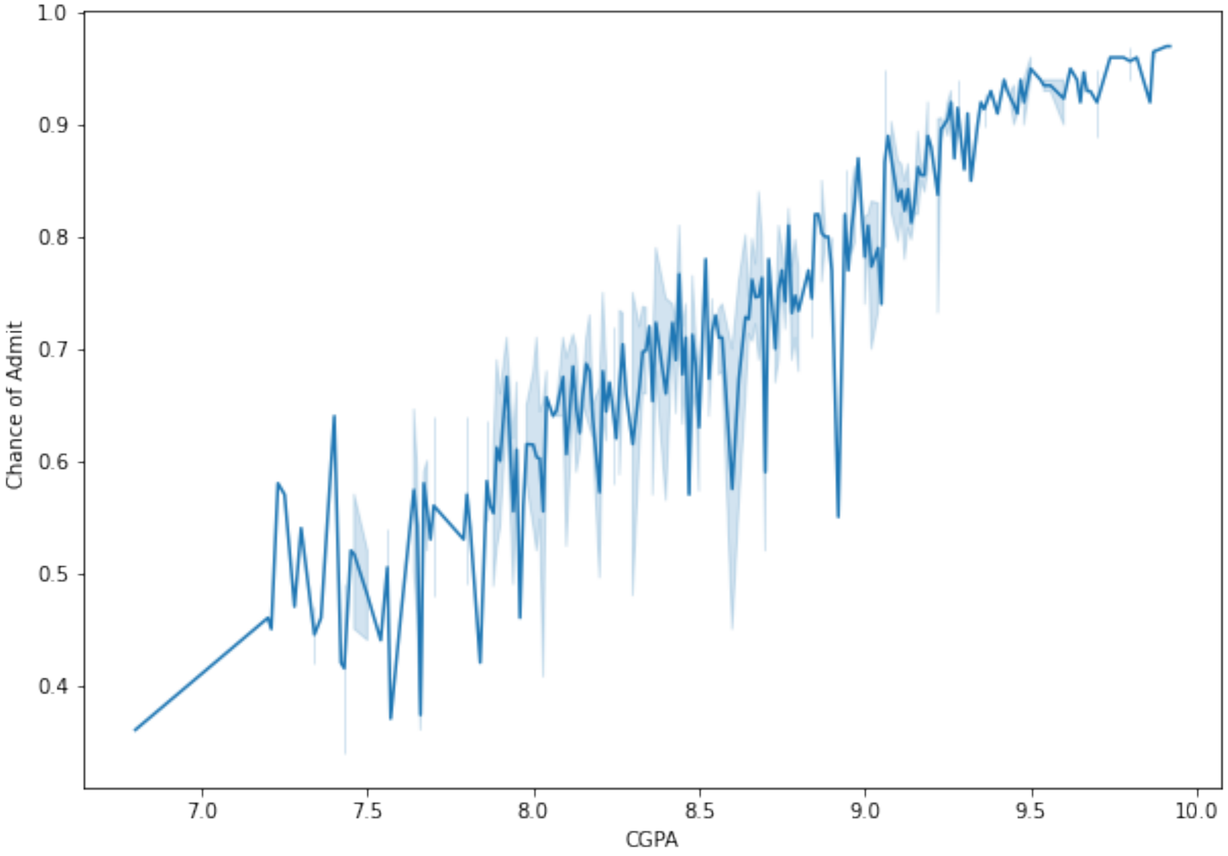
Insights : All the columns show linear relationship with the Target Variable.

In [213]:

```
plt.figure(figsize=(10,7))
sns.lineplot(x = df["CGPA"] , y = df["Chance of Admit "])
```

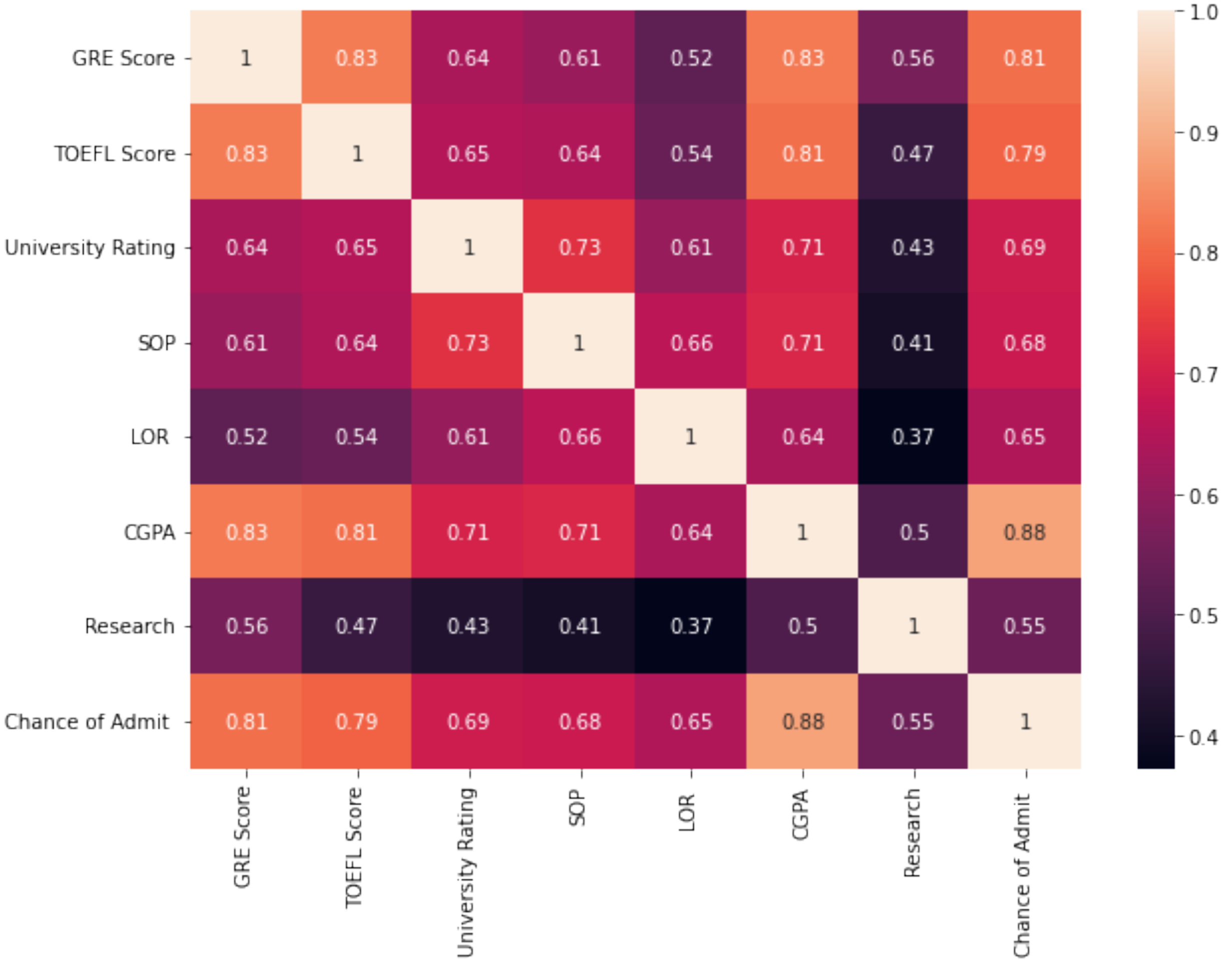
Out[213]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbbc3fb7fa0>
```



```
In [290]: plt.figure(figsize = (10,7))
          sns.heatmap(df[columns[1:]].corr(),annot=True)
```

```
Out[290]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbbc3db8a30>
```

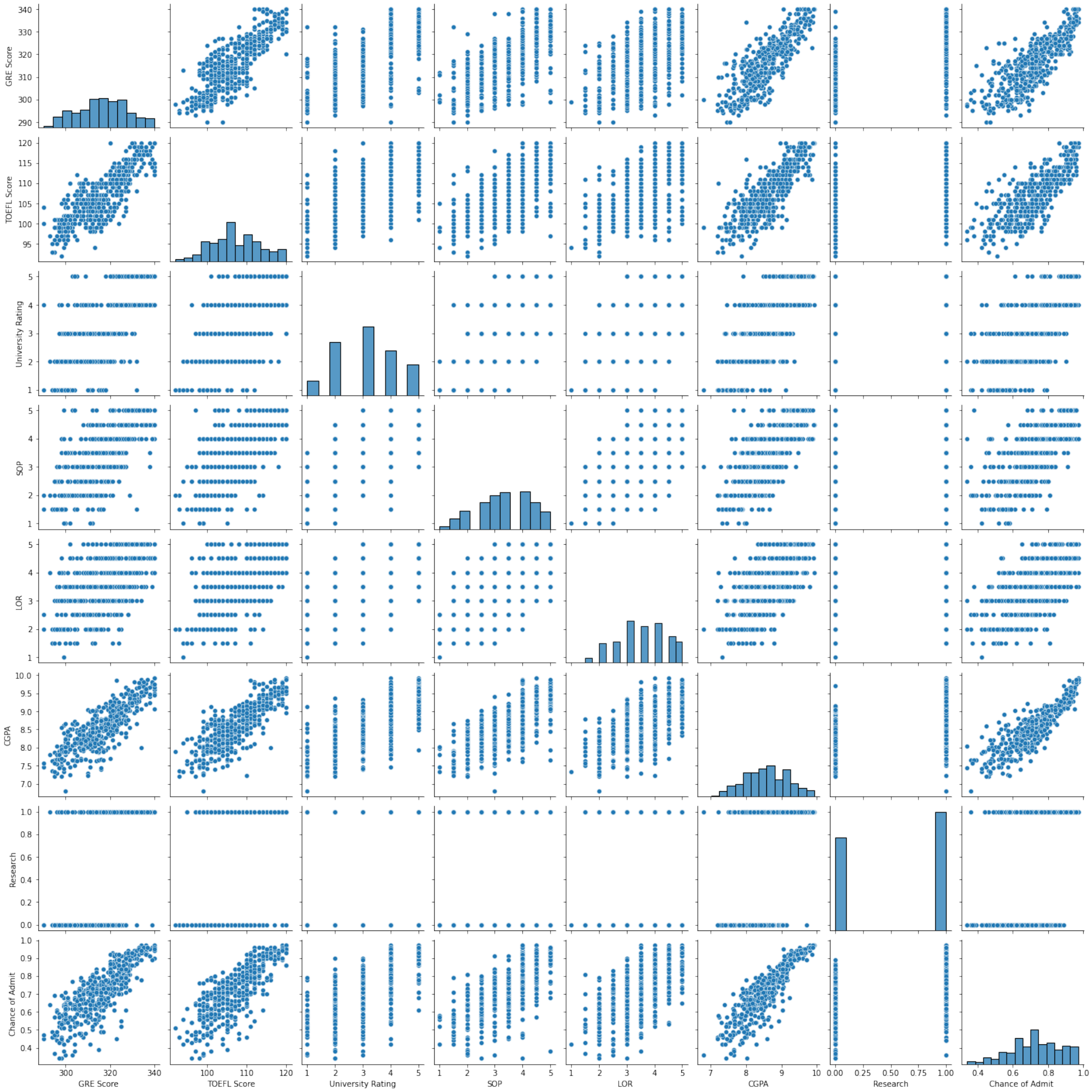


In [214]:

```
sns.pairplot(df[columns[1:]])
```

Out[214]:

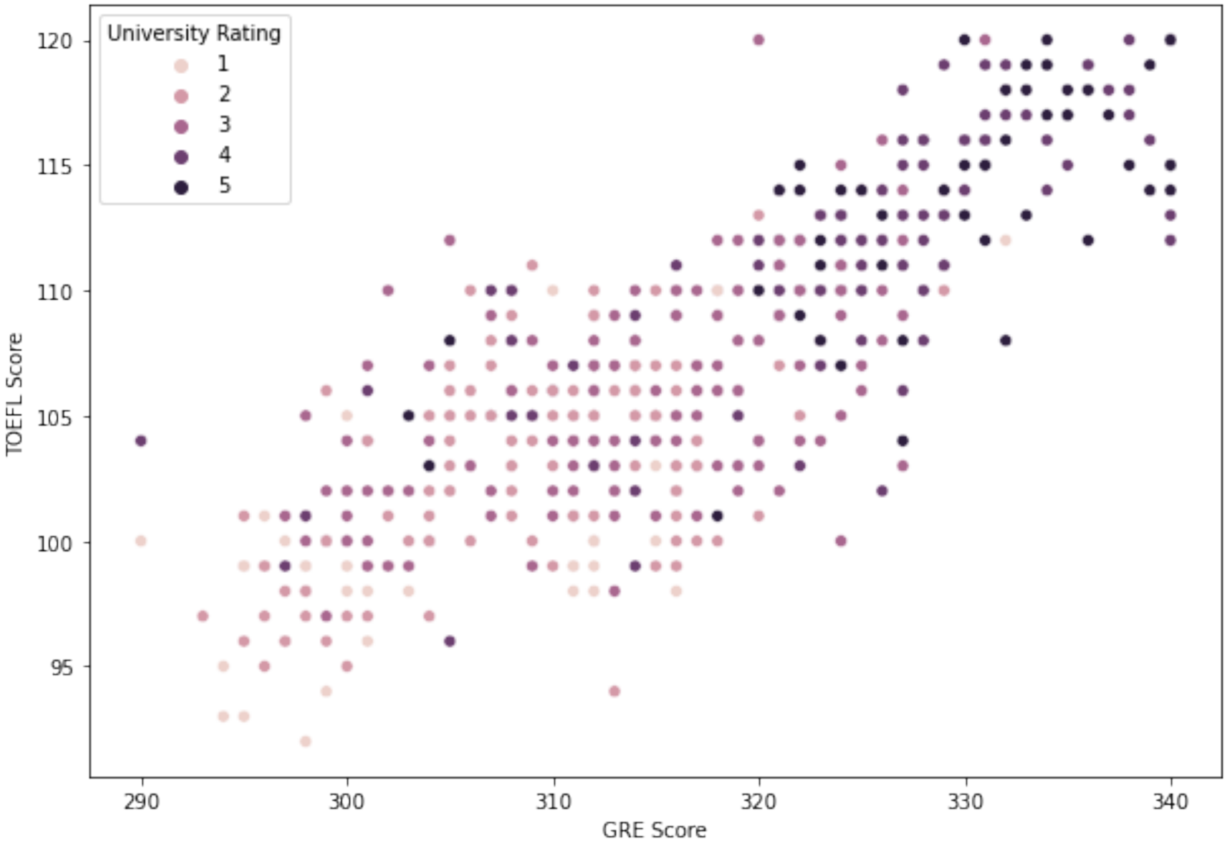
```
<seaborn.axisgrid.PairGrid at 0x7fbbc4f43640>
```



It is observed that there is high co-relation among the columns

```
In [456]: plt.figure(figsize=(10,7))
          sns.scatterplot(x = df["GRE Score"] , y = df["TOEFL Score"] , hue = df
```

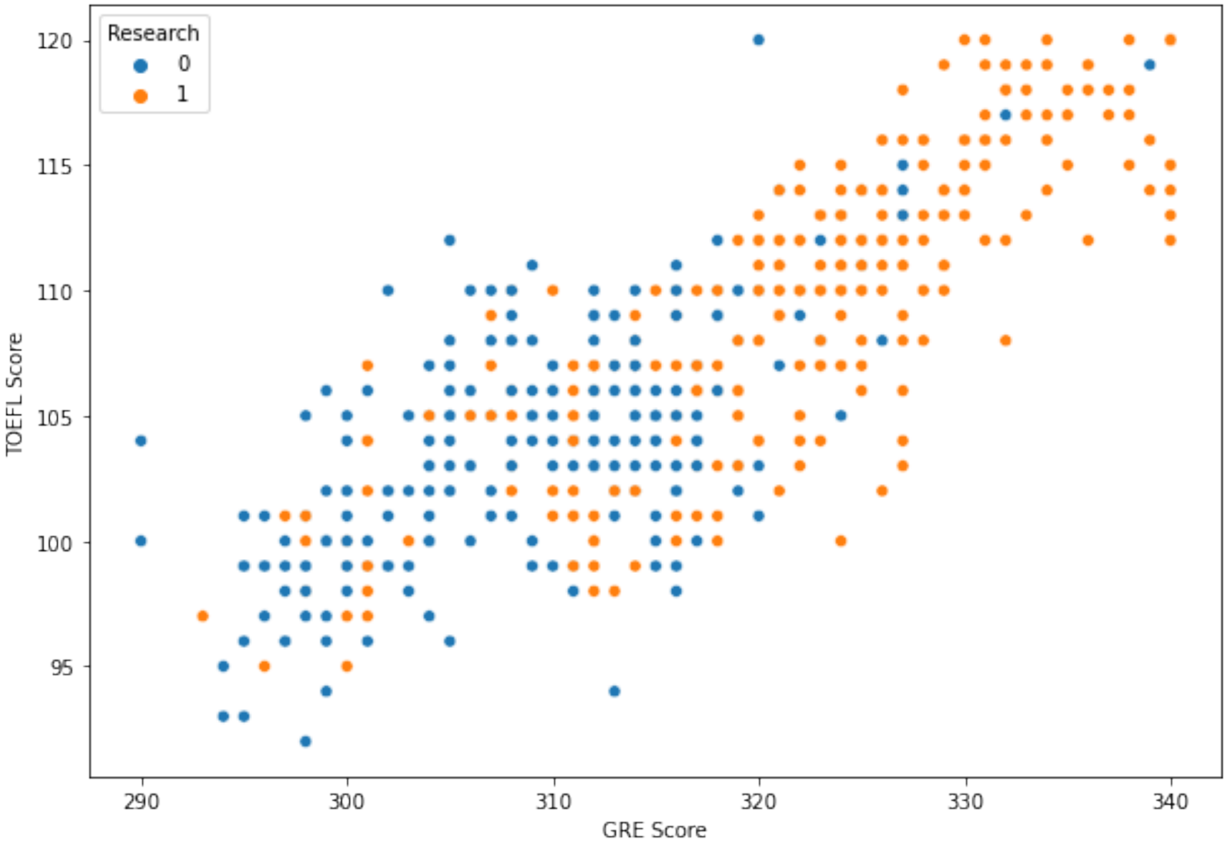
```
Out[456]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbbd8c60190>
```



Applicants with high TOEFL and GRE score have got highest university ratings

```
In [226]: plt.figure(figsize=(10,7))
          sns.scatterplot(x = df["GRE Score"] , y = df["TOEFL Score"] , hue = df
```

```
Out[226]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbbc4145160>
```



Applicants with high TOEFL and GRE score have higher research experience

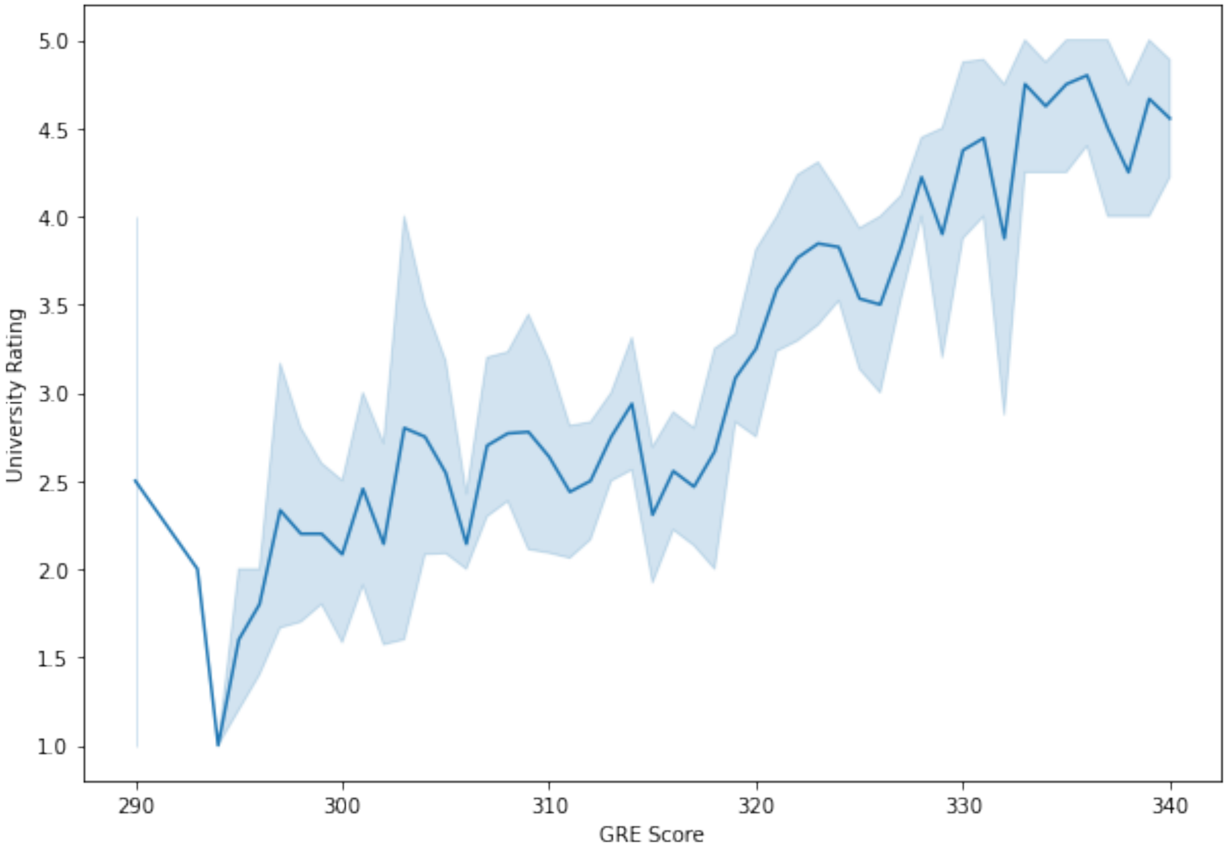
In [233]:

```
plt.figure(figsize=(10,7))


sns.lineplot(x = df["GRE Score"] , y = df["University Rating"])
```

Out[233]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbbbbd017f0>
```



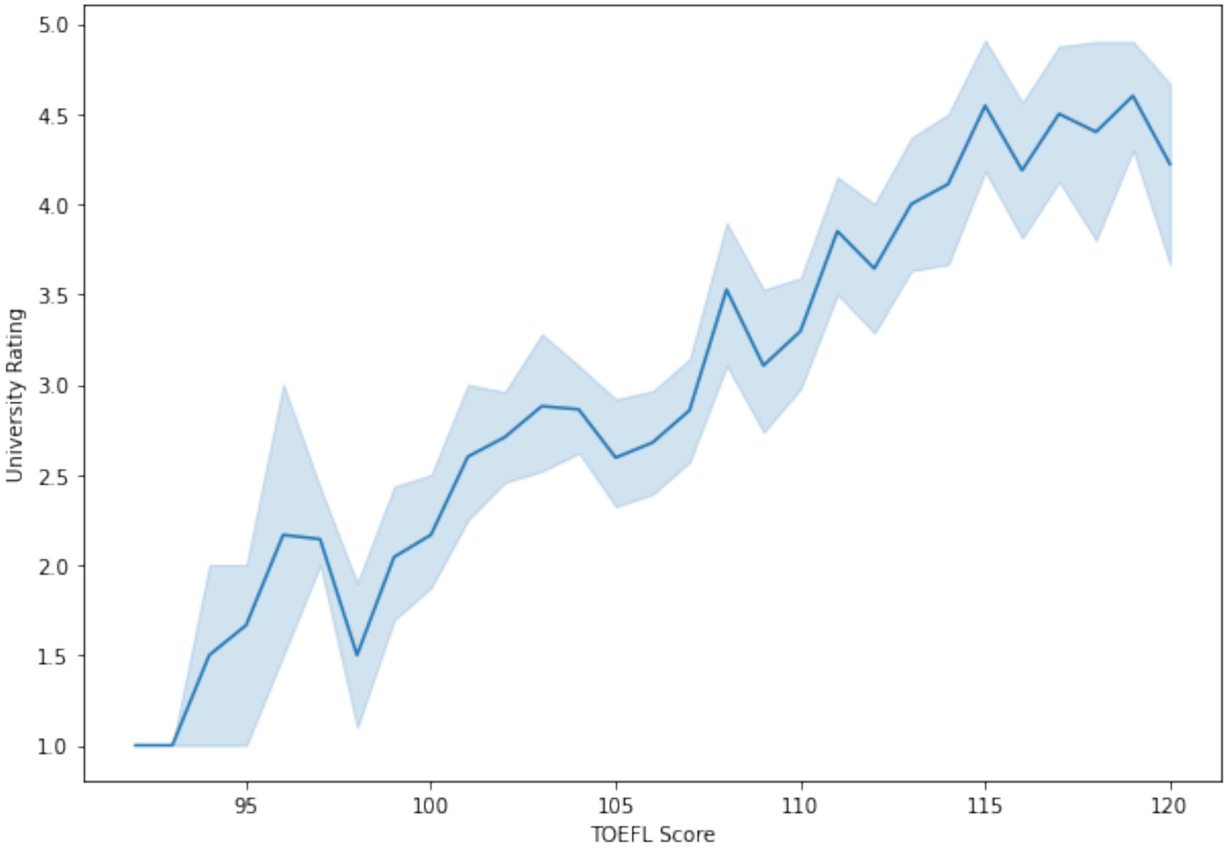
In [234]:

```
plt.figure(figsize=(10,7))


sns.lineplot(x = df["TOEFL Score"] , y = df["University Rating"])
```

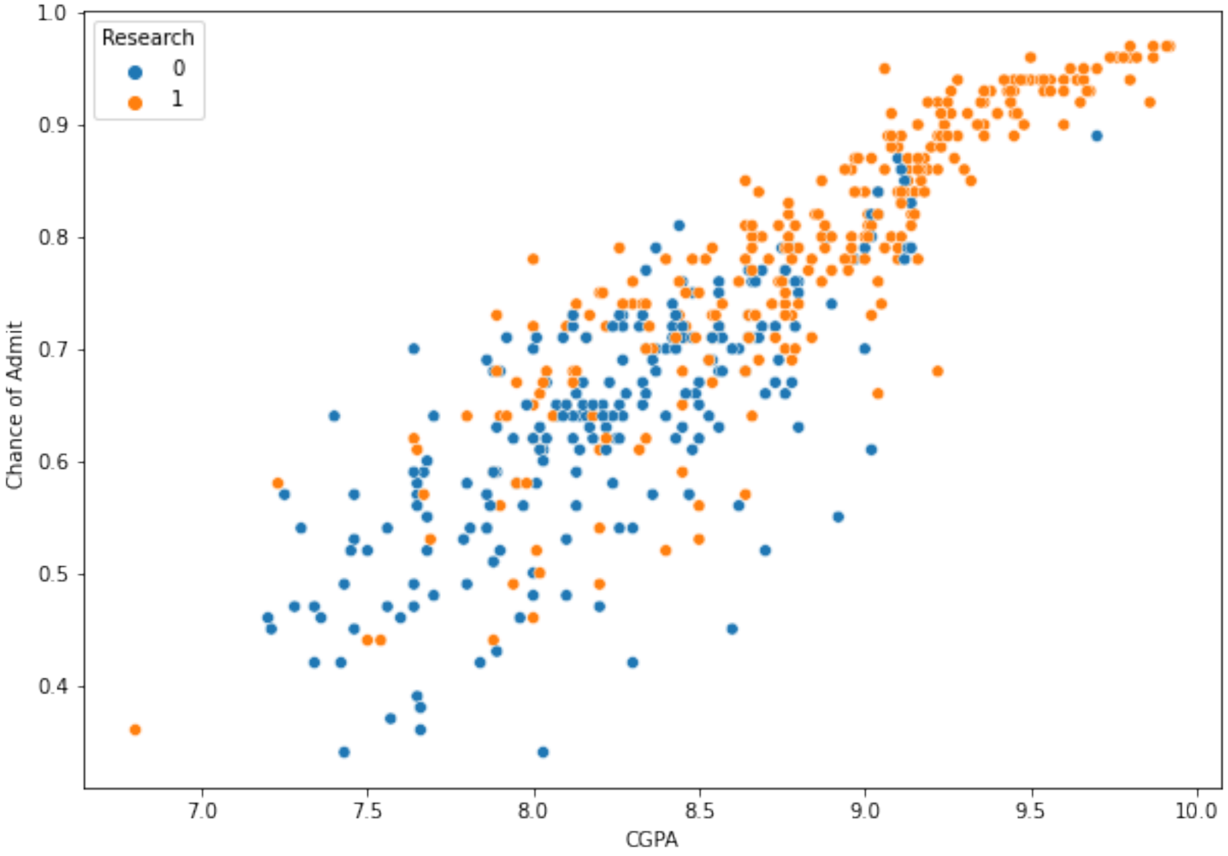
Out[234]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbbc31640d0>
```



```
In [229]: plt.figure(figsize=(10,7))
          sns.scatterplot(x = df["CGPA"] , y = df["Chance of Admit "] , hue = df
```

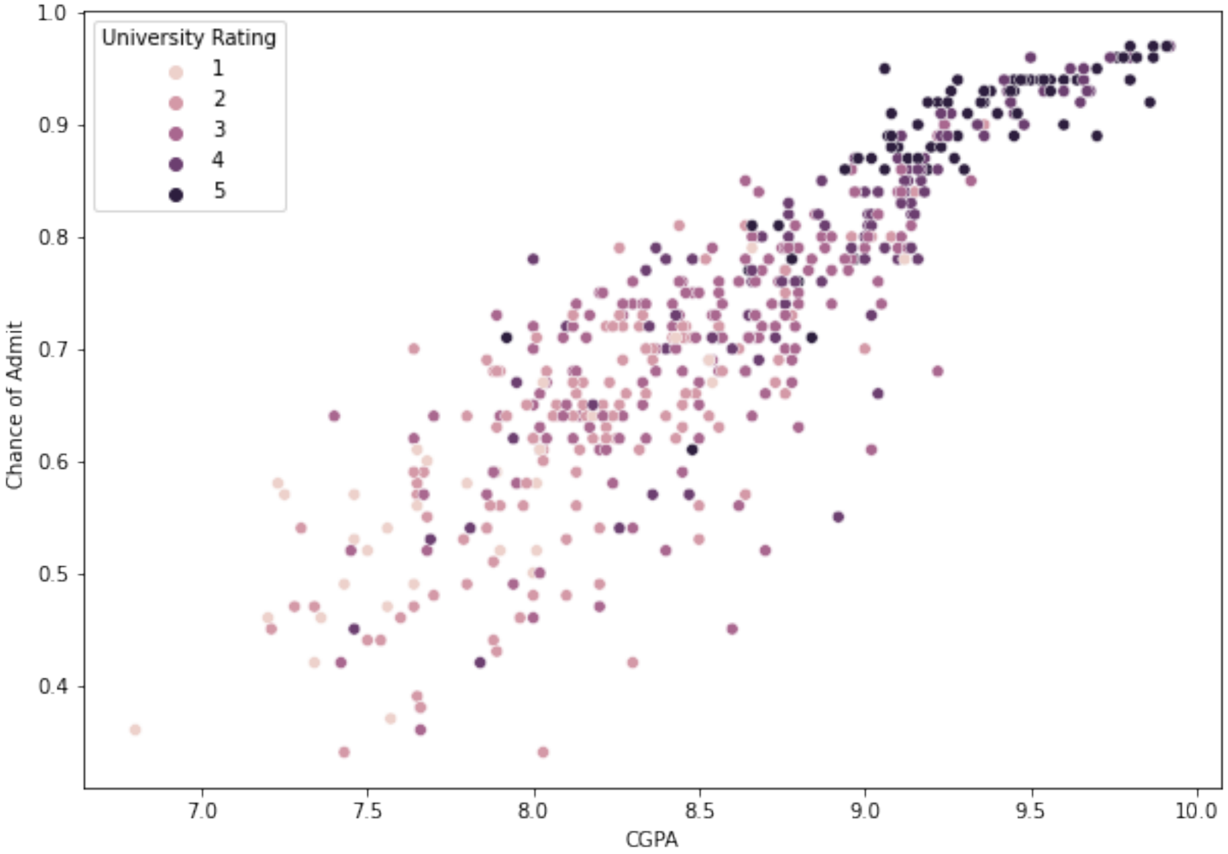
```
Out[229]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbbbb897250>
```



Higher probability of students to crack universities , when the cgpa is high and they have research experience

```
In [230]: plt.figure(figsize=(10,7))
          sns.scatterplot(x = df["CGPA"] , y = df["Chance of Admit "] , hue = df
```

```
Out[230]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbbc30f8bb0>
```



In [231]:

Out[231]:

	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
0	1	337	118	4	4.5	4.5	9.65	1	0.92
1	2	324	107	4	4.0	4.5	8.87	1	0.76
2	3	316	104	3	3.0	3.5	8.00	1	0.72
3	4	322	110	3	3.5	2.5	8.67	1	0.80
4	5	314	103	2	2.0	3.0	8.21	0	0.65
...	...	...	...	...	...	...	...	...	...
495	496	332	108	5	4.5	4.0	9.02	1	0.87
496	497	337	117	5	5.0	5.0	9.87	1	0.96
497	498	330	120	5	4.5	5.0	9.56	1	0.93
498	499	312	103	4	4.0	5.0	8.43	0	0.73
499	500	327	113	4	4.5	4.5	9.04	0	0.84

500 rows × 9 columns

In [241]:

```
pd.crosstab(index = df["University Rating"] , columns=df["Research"] ,
```

Out[241]:

Research	**0**	**1**	**All**
University Rating			
1	4.8	2.0	6.8
2	17.8	7.4	25.2
3	15.0	17.4	32.4
4	4.6	16.4	21.0
5	1.8	12.8	14.6
All	44.0	56.0	100.0

In [244]:
```
pd.crosstab(index = df["University Rating"] , columns=df["LOR "] , nor
```

Out[244]:

LOR	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
University Rating									
1	0.2	1.0	2.2	1.0	1.4	0.6	0.4	0.0	0.0
2	0.0	1.0	4.4	3.8	6.8	5.4	3.4	0.4	0.0
3	0.0	0.2	2.0	3.2	9.6	6.8	6.4	2.6	1.6
4	0.0	0.0	0.6	2.0	1.4	2.8	5.2	6.2	2.8
5	0.0	0.0	0.0	0.0	0.6	1.6	3.4	3.4	5.6

DATA PROCESSING

Data Duplication Check

In [251]:
```
df[df.duplicated()]
```

Out[251]:

Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit

Missing Value Treatment

In [249]:
```
df.isnull().sum()
```

Out[249]:
```
Serial No.           0
GRE Score            0
TOEFL Score          0
University Rating    0
SOP                  0
LOR                  0
CGPA                 0
Research             0
Chance of Admit      0
dtype: int64
```

Preparing Data for Modelling

```
In [281]: new_df = df.copy()
```

```
In [282]: new_df
```

```
Out[282]:
       Serial    GRE    TOEFL    University   SOP   LOR   CGPA   Research    Chance
          No.  Score    Score        Rating                                of Admit
  0         1    337      118             4   4.5   4.5   9.65          1      0.92
  1         2    324      107             4   4.0   4.5   8.87          1      0.76
  2         3    316      104             3   3.0   3.5   8.00          1      0.72
  3         4    322      110             3   3.5   2.5   8.67          1      0.80
  4         5    314      103             2   2.0   3.0   8.21          0      0.65
...       ...    ...      ...           ...   ...   ...    ...        ...       ...
495       496    332      108             5   4.5   4.0   9.02          1      0.87
496       497    337      117             5   5.0   5.0   9.87          1      0.96
497       498    330      120             5   4.5   5.0   9.56          1      0.93
498       499    312      103             4   4.0   5.0   8.43          0      0.73
499       500    327      113             4   4.5   4.5   9.04          0      0.84

500 rows × 9 columns
```

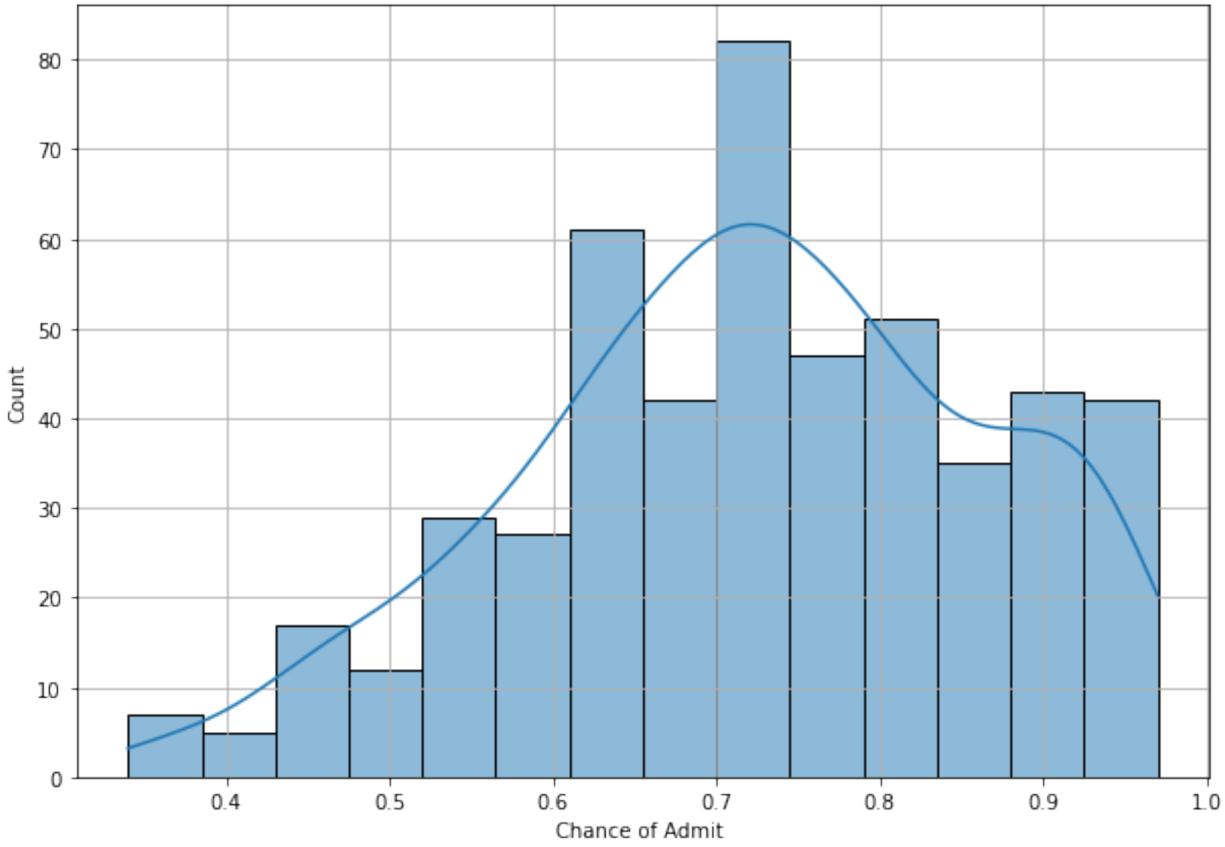
ASSUMPTIONS FOR LINEAR REGRESSION

1. Linearity

As we have already seen, all the columns show linearity with the target column i.e Chance of Admit.

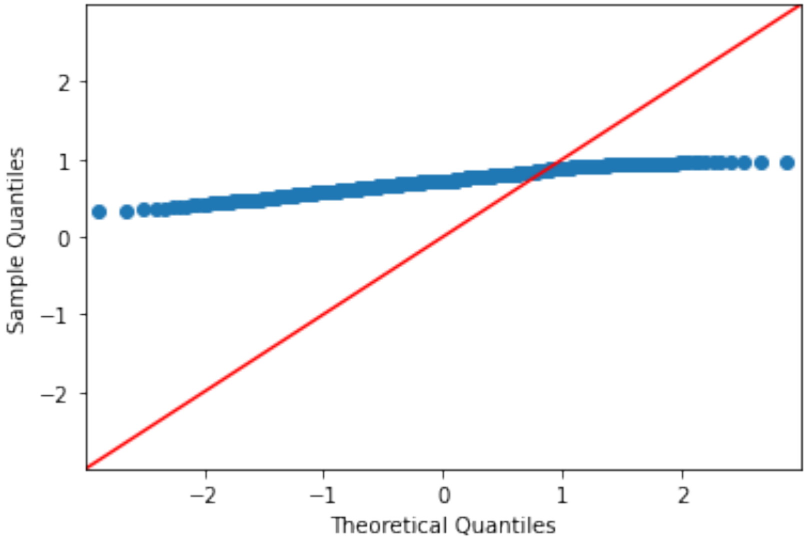
2. Normality of the Target Variable

In [287]:
```
plt.figure(figsize = (10,7))
sns.histplot(df["Chance of Admit "] , kde = True)
plt.grid()
```



In [288]:

```
import statsmodels.api as sm
import pylab as py
sm.qqplot(df["Chance of Admit "], line ='45')
py.show()
```



In [ ]:

```
#how to plot qqplot
```

Performing Shapiro-Wilk Test

Ho : Distribution is Normal

Ha : Distribution is not Normal

In [291]:

```
from scipy.stats import shapiro
shapiro(df["Chance of Admit "])
```

Out[291]:

```
ShapiroResult(statistic=0.9802490472793579, pvalue=2.654237050592201e
-06)
```

Since the Pvalue is greater then 0.05 , we fail to reject the null hypothesis.

Conclusion:

Target variable is normally distributed.

In [ ]:

```
```

Splitting the data for Test and Train

In [349]:

```
X = new_df.drop(["Serial No." , "Chance of Admit "] , axis = 1)
```

In [350]:

```
y = new_df["Chance of Admit "]
```

In [351]:

```
X.head()
```

Out[351]:

	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research
0	337	118	4	4.5	4.5	9.65	1
1	324	107	4	4.0	4.5	8.87	1
2	316	104	3	3.0	3.5	8.00	1
3	322	110	3	3.5	2.5	8.67	1
4	314	103	2	2.0	3.0	8.21	0

In [352]:

```
y.head()
```

Out[352]:

```
0    0.92
1    0.76
2    0.72
3    0.80
4    0.65
Name: Chance of Admit , dtype: float64
```

In [393]:

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, train_size=0
```

In [394]:

```
from sklearn.preprocessing import StandardScaler
standard = StandardScaler()
x_columns =X_train.columns
X_train =standard.fit_transform(X_train)
```

In [395]:

```
X_train = pd.DataFrame(X_train , columns= x_columns)
```

```
In [396]: X_test = standard.fit_transform(X_test)
          X_test
```

```
Out[396]: array([[ 1.02731163,  1.28491463,  0.74437783, ...,  0.57766723,
                   1.00801211,  0.92295821],
                 [-0.56313642, -1.2700109 , -0.97341717, ..., -1.47322233,
                  -1.9087622 , -1.08347268],
                 [-0.4747782 , -0.63127952, -0.11451967, ...,  0.57766723,
                  -0.6699172 , -1.08347268],
                 ...,
                 [-1.8885098 , -1.2700109 , -1.83231467, ..., -1.98594472,
                  -1.48535948, -1.08347268],
                 [ 1.11566986,  1.12523179, -0.97341717, ...,  0.57766723,
                   0.06711717,  0.92295821],
                 [ 1.02731163,  0.16713471,  0.74437783, ...,  0.57766723,
                   1.03937528,  0.92295821]])
```

Performing Linear Regression

```
In [397]: from sklearn.metrics import mean_squared_error,r2_score
```

```
In [398]: from sklearn.linear_model import LinearRegression
          lr= LinearRegression()
```

```
In [399]: lr.fit(X_train, y_train.values)
```

```
Out[399]: LinearRegression()
```

```
In [400]: y_pred = lr.predict(X_test)
```

```
In [401]: print(r2_score(y_test, y_pred))
```

```
0.8429230560323886
```

```
In [402]: print(mean_squared_error(y_test, y_pred))
```

```
0.003256725845782807
```

```
In [403]: lr.coef_,lr.intercept_
```

```
Out[403]: (array([0.01273122, 0.02104744, 0.00593204, 0.000534  , 0.01552633,
                  0.07488036, 0.01366563]),
           0.7224285714285718)
```

```
In [404]: import statsmodels.api as sm
          X_train = sm.add_constant(X_train)
          X_train = sm.add_constant(X_train)
          model = sm.OLS(y_train.values, X_train).fit()
          print(model.summary())
```

```
                            OLS Regression Results                            
=====================================================================
=========
Dep. Variable:                      y   R-squared:                       
0.813
Model:                            OLS   Adj. R-squared:                  
0.809
Method:                 Least Squares   F-statistic:                     
212.8
Date:                Fri, 06 Jan 2023   Prob (F-statistic):          
1.71e-120
Time:                        23:03:20   Log-Likelihood:                 
485.93
No. Observations:                 350   AIC:                            
-955.9
Df Residuals:                     342   BIC:                            
-925.0
Df Model:                           7                                         
Covariance Type:            nonrobust                                         
=====================================================================
================
                        coef    std err          t      P>|t|      [0
.025      0.975]
---------------------------------------------------------------------
----------------
const                 0.7224      0.003    221.313      0.000       0
.716       0.729
GRE Score             0.0127      0.007      1.788      0.075      -0
.001       0.027
TOEFL Score           0.0210      0.006      3.340      0.001       0
.009       0.033
University Rating     0.0059      0.005      1.153      0.250      -0
.004       0.016
SOP                   0.0005      0.005      0.099      0.921      -0
.010       0.011
LOR                   0.0155      0.005      3.389      0.001       0
.007       0.025
CGPA                  0.0749      0.007     10.575      0.000       0
.061       0.089
Research              0.0137      0.004      3.433      0.001       0
.006       0.021
=====================================================================
=========
Omnibus:                       84.653   Durbin-Watson:                   
2.105
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              
202.880
```

```
Skew:                          -1.181   Prob(JB):
8.81e-45
Kurtosis:                       5.887   Cond. No.
5.81
==============================================================================
=========

Notes:
[1] Standard Errors assume that the covariance matrix of the errors i
s correctly specified.
```

In [383]:

```
# This gives us an insight where SOP is insignificant for the Target V
```

In [405]:

```
from statsmodels.stats.outliers_influence import variance_inflation_fa

vif_data = pd.DataFrame()
vif_data["feature"] = X_train.columns
vif_data["VIF"] = [variance_inflation_factor(X_train.values, i)for i i
vif_data
```

Out[405]:

	feature	VIF
0	const	1.000000
1	GRE Score	4.758360
2	TOEFL Score	3.726722
3	University Rating	2.482060
4	SOP	2.733400
5	LOR	1.970183
6	CGPA	4.705215
7	Research	1.486937

In [406]:

```
X_train.drop("SOP" , axis = 1 , inplace = True)
```

In [418]:

```
import statsmodels.api as sm
X_train = sm.add_constant(X_train)
model_new = sm.OLS(y_train.values, X_train).fit()
print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
=========
Dep. Variable:                      y   R-squared:
```

```
0.813
Model:                            OLS   Adj. R-squared:
0.810
Method:                 Least Squares   F-statistic:
248.9
Date:                Fri, 06 Jan 2023   Prob (F-statistic):
1.05e-121
Time:                        23:06:30   Log-Likelihood:
485.93
No. Observations:                 350   AIC:
-957.9
Df Residuals:                     343   BIC:
-930.8
Df Model:                           6
Covariance Type:            nonrobust
=====================================================================
================
                        coef    std err          t      P>|t|      [0
.025      0.975]
---------------------------------------------------------------------
----------------
const                 0.7224      0.003    221.634      0.000       0
.716       0.729
GRE Score             0.0127      0.007      1.789      0.074      -0
.001       0.027
TOEFL Score           0.0211      0.006      3.361      0.001       0
.009       0.033
University Rating     0.0061      0.005      1.272      0.204      -0
.003       0.016
LOR                   0.0157      0.004      3.594      0.000       0
.007       0.024
CGPA                  0.0750      0.007     10.801      0.000       0
.061       0.089
Research              0.0137      0.004      3.445      0.001       0
.006       0.021
=====================================================================
=========
Omnibus:                       84.490   Durbin-Watson:
2.105
Prob(Omnibus):                  0.000   Jarque-Bera (JB):
202.210
Skew:                          -1.179   Prob(JB):
1.23e-44
Kurtosis:                       5.882   Cond. No.
5.37
=====================================================================
=========

Notes:
[1] Standard Errors assume that the covariance matrix of the errors i
```

```
s correctly specified.
```

In [409]:

```
from statsmodels.stats.outliers_influence import variance_inflation_fa

vif_data = pd.DataFrame()
vif_data["feature"] = X_train.columns
vif_data["VIF"] = [variance_inflation_factor(X_train.values, i)for i i
vif_data
```

Out[409]:

	feature	VIF
0	const	1.000000
1	GRE Score	4.757002
2	TOEFL Score	3.706181
3	University Rating	2.172865
4	LOR	1.787886
5	CGPA	4.539564
6	Research	1.484278

In [413]:

```
len(x_columns)
```

Out[413]:

```
7
```

In [414]:

```
X_test = pd.DataFrame(X_test , columns = x_columns)
```

In [416]:

```
X_test.drop("SOP" , axis  =1 , inplace = True)
```

In [422]:

```
X_test = sm.add_constant(X_test)
```

In [423]:

```
y_pred_new = model_new.predict(X_test)
```

In [424]:

```
r2_score(y_test.values, y_pred_new)
```

Out[424]:

```
0.8428631061667798
```

In [425]:

```
mean_squared_error(y_test.values, y_pred_new)
```

Out[425]:

```
0.0032579688052639865
```

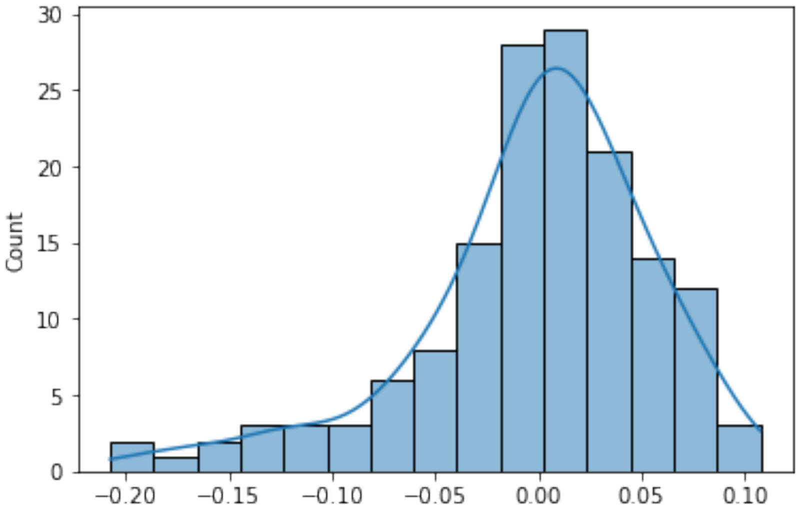
In [428]:

```
residual = y_test.values - y_pred_new
```

Residual Normality

```
In [431]: sns.histplot(residual , kde = True)
```

```
Out[431]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbbc9acdb80>
```



```
In [435]: np.mean(residual)
```

```
Out[435]: -0.002295238095238117
```

Test Homoscadicity

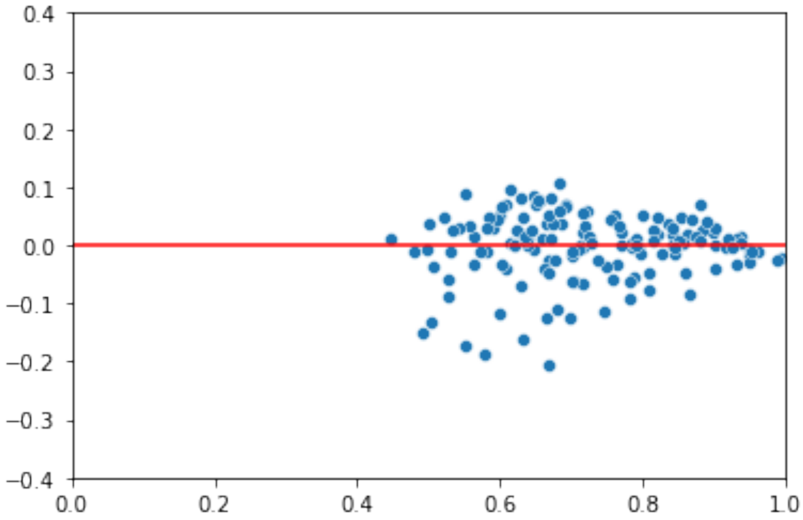
In [449]:

```
sns.scatterplot(x = y_pred_new , y = residual)
plt.ylim(-0.4,0.4)
plt.xlim(0,1)
sns.lineplot(x= [0,10] , y = [0,0], c = "r")
```

```
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/r
elational.py:514: MatplotlibDeprecationWarning: Saw kwargs ['c', 'col
or'] which are all aliases for 'color'.  Kept value from 'color'.  Pa
ssing multiple aliases for the same property will raise a TypeError i
n 3.3.
  line, = ax.plot([], [], **kws)
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/r
elational.py:529: MatplotlibDeprecationWarning: Saw kwargs ['c', 'col
or'] which are all aliases for 'color'.  Kept value from 'color'.  Pa
ssing multiple aliases for the same property will raise a TypeError i
n 3.3.
  line, = ax.plot(x, y, **kws)
```

Out[449]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fbbd85ad490>
```

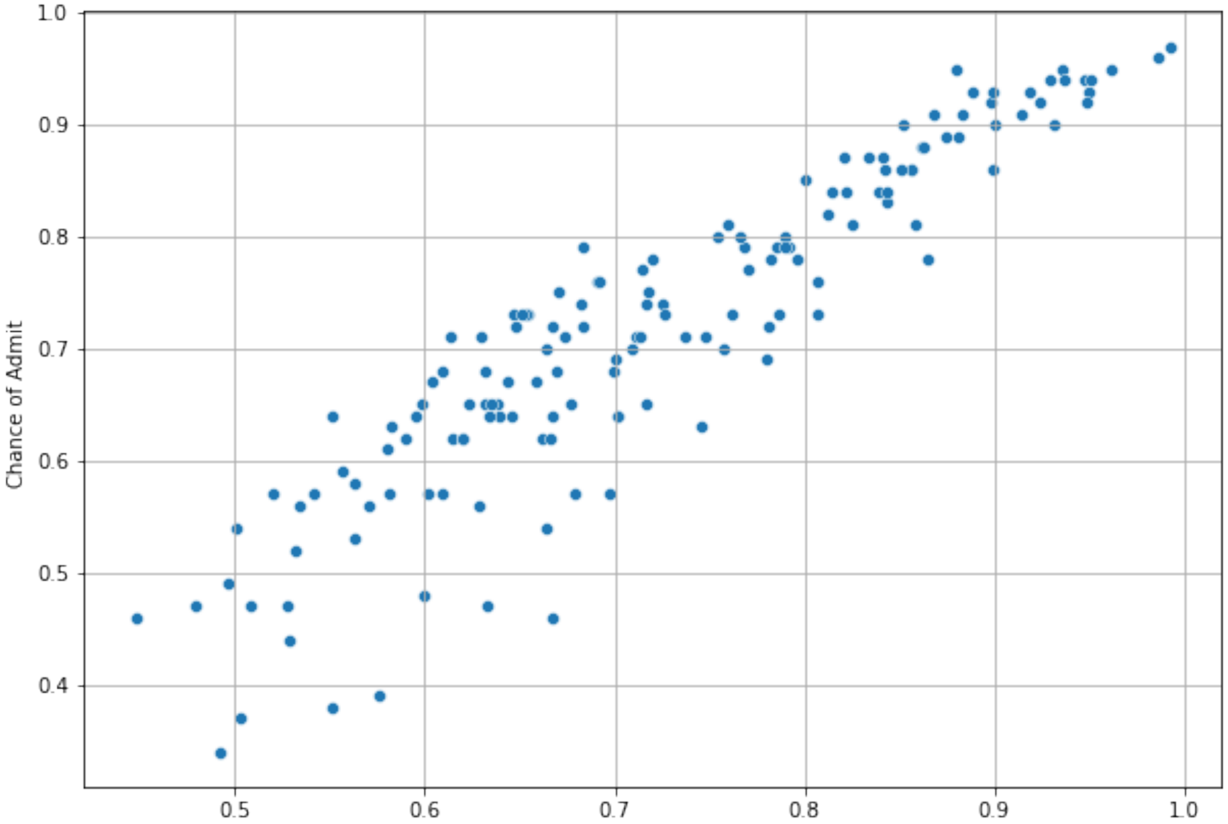


The figure implies that it is Hetroscadastic

In [451]:

```
plt.figure(figsize = (10,7))
sns.scatterplot(y_pred, y_test)
plt.grid()
```

```
/Users/arjunarora/opt/anaconda3/lib/python3.8/site-packages/seaborn/_
decorators.py:36: FutureWarning: Pass the following variables as keyw
ord args: x, y. From version 0.12, the only valid positional argument
will be `data`, and passing other arguments without an explicit keywo
rd will result in an error or misinterpretation.
  warnings.warn(
```



Please refer to the word documents for all insights and recommendations