Module 4 – Regression Part 1

To download the dataset, **Click Here!**

Dataset:

This dataset is created for prediction of graduate admissions for an Indian based on certain test scores. It contains the following attributes:

- GRE Scores (out of 340)
- TOEFL Scores (out of 120)
- University Rating (out of 5)
- Statement of Purpose (out of 5)
- 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)

```
!wget https://www.dropbox.com/s/f1x86l7xkdkz6ke/Admission_Predict.csv
#!wget https://www.dropbox.com/s/f1x86l7xkdkz6ke/Admission_Predict.csv
--no-check-certificate

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

df = pd.read_csv('Admission_Predict.csv')
print(df.shape)
df.head()
```

```
(500, 9)
```

```
   Serial No.  GRE Score  TOEFL Score  University Rating  SOP  LOR
CGPA  \
0           1        337          118                  4  4.5   4.5
9.65
1           2        324          107                  4  4.0   4.5
8.87
2           3        316          104                  3  3.0   3.5
8.00
3           4        322          110                  3  3.5   2.5
8.67
4           5        314          103                  2  2.0   3.0
8.21

   Research  Chance of Admit
0         1             0.92
```

```
1          1              0.76
2          1              0.72
3          1              0.80
4          0              0.65
```

```
## Analyzing the data using Pandas Profiling
# !pip install pandas-profiling==2.7.1

#Generating a Pandas Profiling Report

# import pandas_profiling
# from pandas_profiling import ProfileReport
# prof = ProfileReport(df)
# prof.to_file(output_file='output.html')
```

Let's drop the **Serial No.** column as it is of no use to us -

```
df.drop('Serial No.', inplace = True, axis = 1)
df.shape
```

```
(500, 8)
```

```
df.describe()
```

```
        GRE Score  TOEFL Score  University Rating         SOP
LOR   \
count  500.000000   500.000000         500.000000  500.000000
500.00000
mean   316.472000   107.192000           3.114000    3.374000
3.48400
std     11.295148     6.081868           1.143512    0.991004
0.92545
min    290.000000    92.000000           1.000000    1.000000
1.00000
25%    308.000000   103.000000           2.000000    2.500000
3.00000
50%    317.000000   107.000000           3.000000    3.500000
3.50000
75%    325.000000   112.000000           4.000000    4.000000
4.00000
max    340.000000   120.000000           5.000000    5.000000
5.00000

             CGPA    Research  Chance of Admit
count  500.000000  500.000000        500.00000
mean     8.576440    0.560000          0.72174
std      0.604813    0.496884          0.14114
min      6.800000    0.000000          0.34000
25%      8.127500    0.000000          0.63000
50%      8.560000    1.000000          0.72000
```

```
75%      9.040000    1.000000          0.82000
max      9.920000    1.000000          0.97000
```

```
df.isnull().sum()
```

```
GRE Score            0
TOEFL Score          0
University Rating    0
SOP                  0
LOR                  0
CGPA                 0
Research             0
Chance of Admit      0
dtype: int64
```

Cool! We do not have any Null Values in the Data set. This time, we are lucky but, this is not the case most of the times.

Simple Linear Regression

We obtain a relationship between 2 variables x & y by predicting the value of y based on x

x - Independent Variable (Feature)

y - Dependent Variable (Target Variable/ Output Variable)

It is called **Simple Linear Regression** because it examines relationship between 2 variables only

Why Linear?

When the Independent Variable increases (or decreases), the dependent variable increases or decreases in a Linear Fashion

```
x = df['GRE Score']
y = df['Chance of Admit'] #Target Variable
print(x.shape, y.shape)
```

```
(500,) (500,)
```

```
print(x.head())
print(y.head())
```

```
0    337
1    324
2    316
3    322
4    314
Name: GRE Score, dtype: int64
0    0.92
1    0.76
2    0.72
```

```
3    0.80
4    0.65
Name: Chance of Admit, dtype: float64

#Converting x & y into NumPy Arrays

x = np.array(x)
y = np.array(y)
x.shape, y.shape

((500,), (500,))

x = x.reshape(-1,1)
y = y.reshape(-1,1)
x.shape, y.shape

((500, 1), (500, 1))
```

Scaling the Data

```
x[0:5,0], y[0:5,0]

(array([337, 324, 316, 322, 314]), array([0.92, 0.76, 0.72, 0.8 ,
0.65]))

#Scaling the Data

from sklearn.preprocessing import StandardScaler

scaler1 = StandardScaler()
scaler2 = StandardScaler()
x = scaler1.fit_transform(x)
y = scaler2.fit_transform(y)

x[0:5,0], y[0:5,0]

(array([ 1.81923762,  0.66714832, -0.0418297 ,  0.48990382, -
0.21907421]),
 array([ 1.40610734,  0.27134907, -0.0123405 ,  0.55503864, -
0.50879724]))
```

Splitting the Data for training and testing

```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size =
0.25, random_state = 42)
print(x_train.shape, x_test.shape, y_train.shape, y_test.shape)

(375, 1) (125, 1) (375, 1) (125, 1)
```

Building a Simple Linear Regression Model

```
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, accuracy_score

lr_model = LinearRegression()
lr_model.fit(x_train, y_train)
```

```
LinearRegression()
```

```
lr_model.coef_, lr_model.intercept_
```

```
(array([[0.8424491]]), array([-0.00575213]))
```

Evaluating the Model

```
accuracy_lr = lr_model.score(x_test, y_test)
print(accuracy_lr)
```

```
0.6168905667479367
```

Oh. We could achieve an Accuracy of just **61.7%** on the testing data using a Simple Linear Regression Model which is very bad

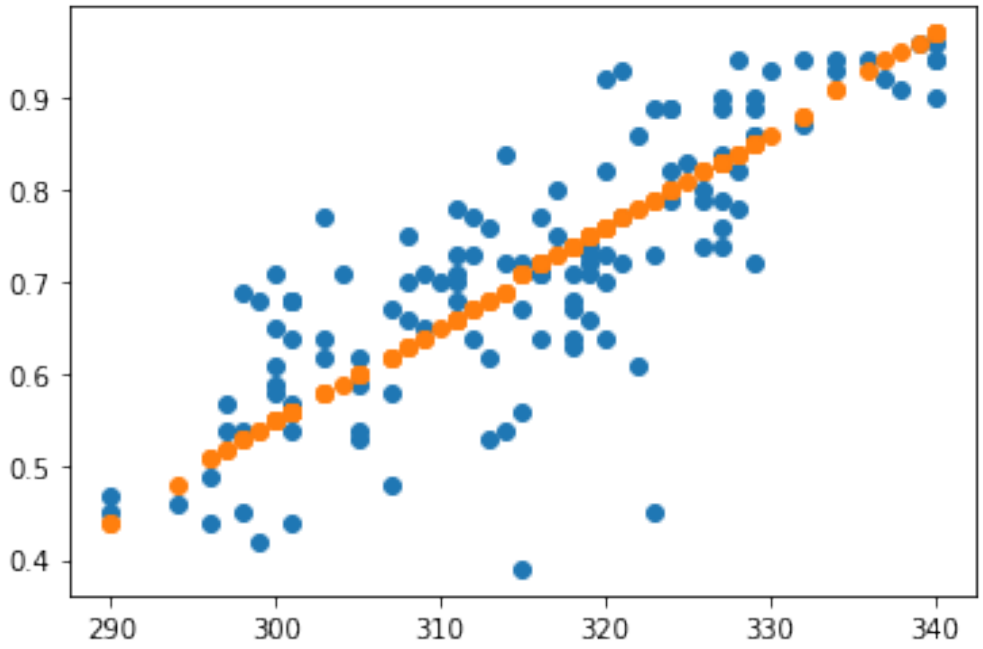
Let us check the correlation between the variables to understand how they affect the target variable (i.e., **Chance of Admit**)

```
y_pred = lr_model.predict(x_test)

x_test = scaler1.inverse_transform(x_test)
y_pred = scaler2.inverse_transform(y_pred).round(2)
y_test = scaler2.inverse_transform(y_test).round(2)
x_test[0:5,:], y_pred[0:5,0], y_test[0:5,0]
```

```
(array([[334.],
        [314.],
        [315.],
        [312.],
        [326.]]),
 array([0.91, 0.69, 0.71, 0.67, 0.82]),
 array([0.93, 0.84, 0.39, 0.77, 0.74]))
```

```
plt.scatter(x_test, y_test)
plt.scatter(x_test, y_pred)
plt.show()
```



Features correlation

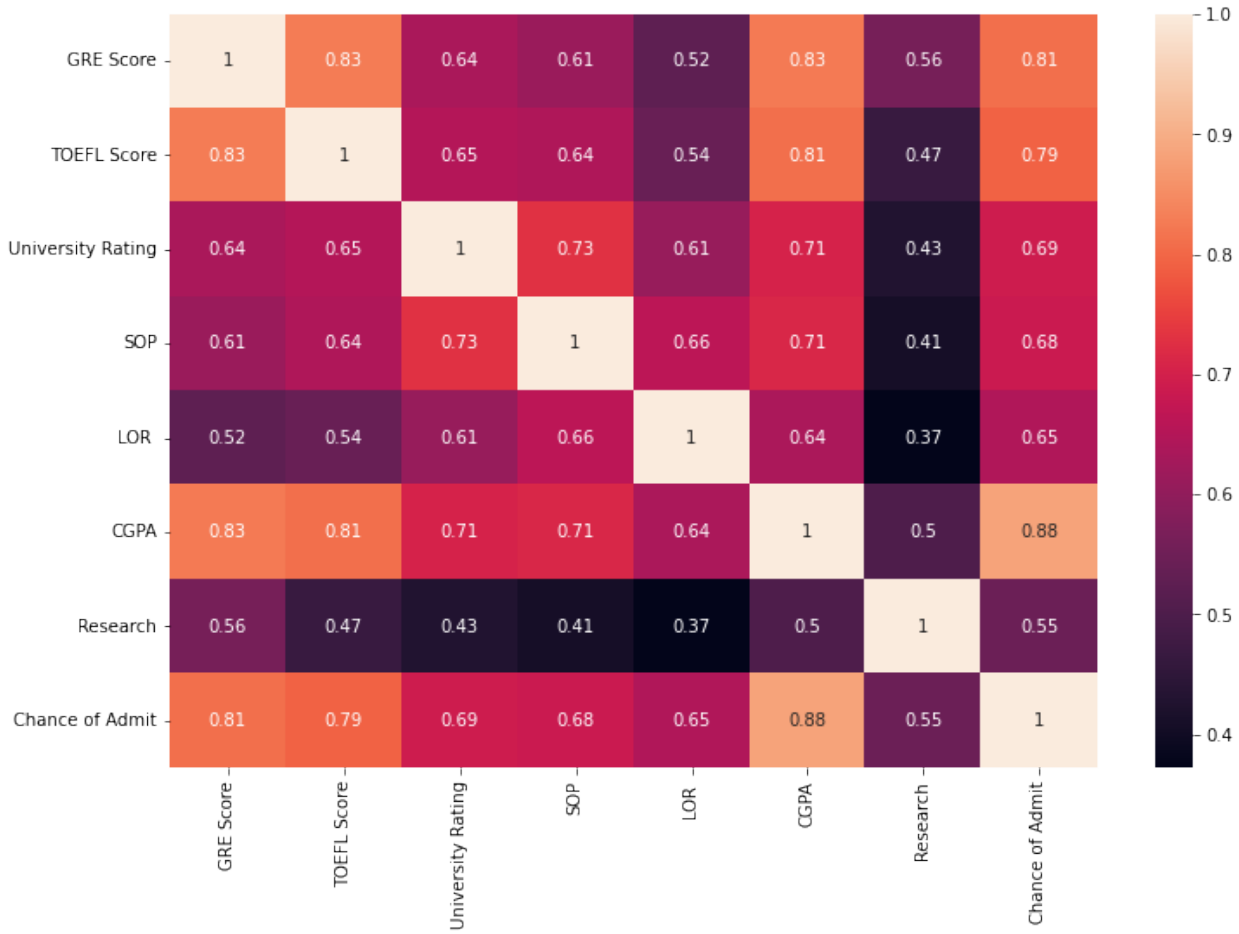
Pandas **df.corr()** is used to find the pairwise correlation of all columns in the dataframe

```
df.corr()
```

	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
GRE Score	1.000000	0.827200	0.635376	0.613498	0.524679	0.825878	0.563398	0.810351
TOEFL Score	0.827200	1.000000	0.649799	0.644410	0.541563	0.810574	0.467012	0.792228
University Rating	0.635376	0.649799	1.000000	0.728024	0.608651	0.705254	0.427047	0.690132
SOP	0.613498	0.644410	0.728024	1.000000	0.663707	0.712154	0.408116	0.684137
LOR	0.524679	0.541563	0.608651	0.663707	1.000000	0.637469	0.372526	0.645365
CGPA	0.825878	0.810574	0.705254	0.712154	0.637469	1.000000	0.501311	0.882413
Research	0.563398	0.467012	0.427047	0.408116	0.372526	0.501311	1.000000	0.545871
Chance of Admit	0.810351	0.792228	0.690132	0.684137	0.645365	0.882413	0.545871	1.000000

```
LOR                1.000000   0.637469   0.372526          0.645365
CGPA               0.637469   1.000000   0.501311          0.882413
Research           0.372526   0.501311   1.000000          0.545871
Chance of Admit    0.645365   0.882413   0.545871          1.000000
```

```
plt.figure(figsize=(12,8))
sns.heatmap(df.corr(), annot=True)
plt.show()
```



Observations:

- Students who have **High GRE** Score tend to also have high TOEFL Score. That means they are positively correlated
- **CGPA & TOEFL Score** and **Chance of Admit** is also highly correlated which suggests that CGPA & TOEFL Score are very important factors ___

Multiple Linear Regression

Now, let us try using **multiple features** (for e.g. **GRE Score, TOEFL Score, SOP, LOR, CGPA**, etc.) to predict the **Chance of Admit** using **Multiple Linear Regression**

Examines relationship between more than 2 variables

Whoa! This is what we are going to use because we have many dependent variables such as **GRE Score**, **TOEFL Score**, etc and one independent(or target varible) **Chance of Admit**

```
x = df.drop(columns = ['Chance of Admit']) # features
y = df['Chance of Admit'] #Target Variable

print(x.shape, y.shape)
print(type(x), type(y))
```

```
(500, 7) (500,)
<class 'pandas.core.frame.DataFrame'> <class
'pandas.core.series.Series'>
```

```
#Converting x & y into NumPy Arrays

x = np.array(x)
y = np.array(y)
y = y.reshape(-1,1)
print(x.shape, y.shape)
```

```
(500, 7) (500, 1)
```

Scaling the data

```
x[0:5,:], y[0:5,0]
```

```
(array([[337.  , 118.  ,   4.  ,   4.5 ,   4.5 ,   9.65,   1.  ],
        [324.  , 107.  ,   4.  ,   4.  ,   4.5 ,   8.87,   1.  ],
        [316.  , 104.  ,   3.  ,   3.  ,   3.5 ,   8.  ,   1.  ],
        [322.  , 110.  ,   3.  ,   3.5 ,   2.5 ,   8.67,   1.  ],
        [314.  , 103.  ,   2.  ,   2.  ,   3.  ,   8.21,   0.  ]]),
 array([0.92, 0.76, 0.72, 0.8 , 0.65]))
```

```
#Scaling the Data

from sklearn.preprocessing import StandardScaler

scaler1 = StandardScaler()
scaler2 = StandardScaler()

x = scaler1.fit_transform(x)
y = scaler2.fit_transform(y)

x[0:5,:], y[0:5,0]
```

```
(array([[ 1.81923762,  1.77886545,  0.77558214,  1.13735981,
1.09894429,
         1.77680627,  0.88640526],
        [ 0.66714832, -0.03160087,  0.77558214,  0.63231549,
1.09894429,
```

```
          0.48585943,  0.88640526],
        [-0.0418297 , -0.52536441, -0.09979274, -0.37777315,
0.01730621,
         -0.95404281,  0.88640526],
        [ 0.48990382,  0.46216267, -0.09979274,  0.12727117, -
1.06433187,
          0.15484742,  0.88640526],
        [-0.21907421, -0.68995225, -0.97516761, -1.3878618 , -
0.52351283,
         -0.6064802 , -1.12815215]]),
 array([ 1.40610734,  0.27134907, -0.0123405 ,  0.55503864, -
0.50879724]))
```

Splitting the data for training and testing

```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size =
0.2, random_state = 42)
print(x_train.shape, x_test.shape, y_train.shape, y_test.shape)
```

```
(400, 7) (100, 7) (400, 1) (100, 1)
```

Train & Evaluate a Linear Regression Model

```
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, accuracy_score

lr_model = LinearRegression()
lr_model.fit(x_train, y_train)
```

```
LinearRegression()
```

```
lr_model.coef_, lr_model.intercept_
```

```
(array([[0.19482262, 0.12909489, 0.02081226, 0.01273465, 0.11302848,
         0.48219942, 0.08458618]]), array([0.00773568]))
```

```
accuracy_lr = lr_model.score(x_test, y_test)
print(accuracy_lr)
```

```
0.8188432567829627
```

Okay, good! We achieved an Accuracy of **81.9%** on the testing data using a Multiple Linear Regression Model.

```
y_pred = lr_model.predict(x_test)

# x = scaler1.fit_transform(x)
# y = scaler2.fit_transform(y)
x_test = scaler1.inverse_transform(x_test)
y_pred = scaler2.inverse_transform(y_pred).round(2)
```

```
y_test = scaler2.inverse_transform(y_test).round(2)
x_test[0:5,:], y_pred[0:5,0], y_test[0:5,0]
```

```
(array([[334.  , 116.  ,   4.  ,   4.  ,   3.5 ,   9.54,   1.  ],
        [314.  , 108.  ,   4.  ,   4.5 ,   4.  ,   9.04,   1.  ],
        [315.  , 105.  ,   2.  ,   2.  ,   2.5 ,   7.65,   0.  ],
        [312.  , 109.  ,   3.  ,   3.  ,   3.  ,   8.69,   0.  ],
        [326.  , 112.  ,   3.  ,   3.5 ,   3.  ,   9.05,   1.  ]]),
 array([0.91, 0.8 , 0.57, 0.71, 0.82]),
 array([0.93, 0.84, 0.39, 0.77, 0.74]))
```