

225229142

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Importing csv file**STEP1:**In [1]: `import pandas as pd`

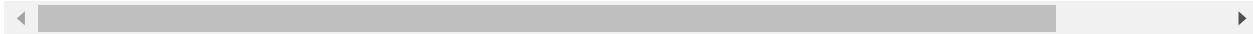
In [2]: `data=pd.read_csv('diabetes.csv')`
`data`

Out[2]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	
0	6	148	72	35	0	33.6	0.627	
1	1	85	66	29	0	26.6	0.351	
2	8	183	64	0	0	23.3	0.672	
3	1	89	66	23	94	28.1	0.167	
4	0	137	40	35	168	43.1	2.288	
5	5	116	74	0	0	25.6	0.201	
6	3	78	50	32	88	31.0	0.248	
7	10	115	0	0	0	35.3	0.134	
8	2	197	70	45	543	30.5	0.158	
9	8	125	96	0	0	0.0	0.232	
10	4	110	92	0	0	37.6	0.191	
11	10	168	74	0	0	38.0	0.537	
12	10	139	80	0	0	27.1	1.441	
13	1	189	60	23	846	30.1	0.398	
14	5	166	72	19	175	25.8	0.587	
15	7	100	0	0	0	30.0	0.484	
16	0	118	84	47	230	45.8	0.551	
17	7	107	74	0	0	29.6	0.254	
18	1	103	30	38	83	43.3	0.183	
19	1	115	70	30	96	34.6	0.529	
20	3	126	88	41	235	39.3	0.704	
21	8	99	84	0	0	35.4	0.388	
22	7	196	90	0	0	39.8	0.451	
23	9	119	80	35	0	29.0	0.263	
24	11	143	94	33	146	36.6	0.254	
25	10	125	70	26	115	31.1	0.205	
26	7	147	76	0	0	39.4	0.257	
27	1	97	66	15	140	23.2	0.487	
28	13	145	82	19	110	22.2	0.245	
29	5	117	92	0	0	34.1	0.337	
...	
738	2	99	60	17	160	36.6	0.453	
739	1	102	74	0	0	39.5	0.293	

Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	Diabetes	Pedigree	Function
740	11	120	80	37	150	42.3		0.785
741	3	102	44	20	94	30.8		0.400
742	1	109	58	18	116	28.5		0.219
743	9	140	94	0	0	32.7		0.734
744	13	153	88	37	140	40.6		1.174
745	12	100	84	33	105	30.0		0.488
746	1	147	94	41	0	49.3		0.358
747	1	81	74	41	57	46.3		1.096
748	3	187	70	22	200	36.4		0.408
749	6	162	62	0	0	24.3		0.178
750	4	136	70	0	0	31.2		1.182
751	1	121	78	39	74	39.0		0.261
752	3	108	62	24	0	26.0		0.223
753	0	181	88	44	510	43.3		0.222
754	8	154	78	32	0	32.4		0.443
755	1	128	88	39	110	36.5		1.057
756	7	137	90	41	0	32.0		0.391
757	0	123	72	0	0	36.3		0.258
758	1	106	76	0	0	37.5		0.197
759	6	190	92	0	0	35.5		0.278
760	2	88	58	26	16	28.4		0.766
761	9	170	74	31	0	44.0		0.403
762	9	89	62	0	0	22.5		0.142
763	10	101	76	48	180	32.9		0.171
764	2	122	70	27	0	36.8		0.340
765	5	121	72	23	112	26.2		0.245
766	1	126	60	0	0	30.1		0.349
767	1	93	70	31	0	30.4		0.315

768 rows × 9 columns



In [3]: `data.head()`

Out[3]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age
0	6	148	72	35	0	33.6		0.627
1	1	85	66	29	0	26.6		0.351
2	8	183	64	0	0	23.3		0.672
3	1	89	66	23	94	28.1		0.167
4	0	137	40	35	168	43.1		2.288



In [5]: `data.shape`

Out[5]: (768, 9)

In [6]: `data.columns`

Out[6]: Index(['Pregnancies', 'Glucose', 'BloodPressure', 'SkinThickness', 'Insulin', 'BMI', 'DiabetesPedigreeFunction', 'Age', 'Outcome'], dtype='object')

In [7]: `data.dtypes`

Out[7]: Pregnancies int64
Glucose int64
BloodPressure int64
SkinThickness int64
Insulin int64
BMI float64
DiabetesPedigreeFunction float64
Age int64
Outcome int64
dtype: object

In [8]: `data.info()`

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 768 entries, 0 to 767
Data columns (total 9 columns):
Pregnancies           768 non-null int64
Glucose              768 non-null int64
BloodPressure        768 non-null int64
SkinThickness        768 non-null int64
Insulin              768 non-null int64
BMI                 768 non-null float64
DiabetesPedigreeFunction 768 non-null float64
Age                  768 non-null int64
Outcome              768 non-null int64
dtypes: float64(2), int64(7)
memory usage: 54.1 KB
```

```
In [12]: data.BloodPressure.value_counts
```

```
Out[12]: <bound method IndexOpsMixin.value_counts of 0      72
1      66
2      64
3      66
4      40
5      74
6      50
7      0
8      70
9      96
10     92
11     74
12     80
13     60
14     72
15     0
16     84
17     74
18     30
19     70
20     88
21     84
22     90
23     80
24     94
25     70
26     76
27     66
28     82
29     92
...
738    60
739    74
740    80
741    44
742    58
743    94
744    88
745    84
746    94
747    74
748    70
749    62
750    70
751    78
752    62
753    88
754    78
755    88
756    90
757    72
758    76
759    92
760    58
761    74
```

```
762    62
763    76
764    70
765    72
766    60
767    70
Name: BloodPressure, Length: 768, dtype: int64>
```

Step-2.[Build Logistic Regression model]

```
In [13]: X=data[['Pregnancies','Glucose','BloodPressure','SkinThickness','Insulin','BMI','I
In [15]: Y=data[['Outcome']]
In [16]: from sklearn.model_selection import train_test_split
In [18]: X_train,X_test,y_train,y_test=train_test_split(X,Y,test_size=0.25,random_state=42)
```

In [19]: X_train

Out[19]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	
357	13	129	0	30	0	39.9	0.569	
73	4	129	86	20	270	35.1	0.231	
352	3	61	82	28	0	34.4	0.243	
497	2	81	72	15	76	30.1	0.547	
145	0	102	75	23	0	0.0	0.572	
514	3	99	54	19	86	25.6	0.154	
291	0	107	62	30	74	36.6	0.757	
132	3	170	64	37	225	34.5	0.356	
559	11	85	74	0	0	30.1	0.300	
631	0	102	78	40	90	34.5	0.238	
719	5	97	76	27	0	35.6	0.378	
395	2	127	58	24	275	27.7	1.600	
41	7	133	84	0	0	40.2	0.696	
637	2	94	76	18	66	31.6	0.649	
108	3	83	58	31	18	34.3	0.336	
481	0	123	88	37	0	35.2	0.197	
56	7	187	68	39	304	37.7	0.254	
323	13	152	90	33	29	26.8	0.731	
685	2	129	74	26	205	33.2	0.591	
758	1	106	76	0	0	37.5	0.197	
572	3	111	58	31	44	29.5	0.430	
529	0	111	65	0	0	24.6	0.660	
24	11	143	94	33	146	36.6	0.254	
465	0	124	56	13	105	21.8	0.452	
247	0	165	90	33	680	52.3	0.427	
443	8	108	70	0	0	30.5	0.955	
351	4	137	84	0	0	31.2	0.252	
327	10	179	70	0	0	35.1	0.200	
110	3	171	72	33	135	33.3	0.199	
82	7	83	78	26	71	29.3	0.767	
...	
21	8	99	84	0	0	35.4	0.388	
313	3	113	50	10	85	29.5	0.626	
459	9	134	74	33	60	25.9	0.460	

Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	Diabetes	Pedigree	Function
160	4	151	90	38	0	29.7		0.294
276	7	106	60	24	0	26.5		0.296
191	9	123	70	44	94	33.1		0.374
385	1	119	54	13	50	22.3		0.205
413	1	143	74	22	61	26.2		0.256
491	2	89	90	30	0	33.5		0.292
343	5	122	86	0	0	34.7		0.290
308	0	128	68	19	180	30.5		1.391
661	1	199	76	43	0	42.9		1.394
130	4	173	70	14	168	29.7		0.361
663	9	145	80	46	130	37.9		0.637
99	1	122	90	51	220	49.7		0.325
372	0	84	64	22	66	35.8		0.545
87	2	100	68	25	71	38.5		0.324
458	10	148	84	48	237	37.6		1.001
330	8	118	72	19	0	23.1		1.476
214	9	112	82	32	175	34.2		0.260
466	0	74	52	10	36	27.8		0.269
121	6	111	64	39	0	34.2		0.260
614	11	138	74	26	144	36.1		0.557
20	3	126	88	41	235	39.3		0.704
700	2	122	76	27	200	35.9		0.483
71	5	139	64	35	140	28.6		0.411
106	1	96	122	0	0	22.4		0.207
270	10	101	86	37	0	45.6		1.136
435	0	141	0	0	0	42.4		0.205
102	0	125	96	0	0	22.5		0.262

576 rows × 8 columns



In [20]: X_test

Out[20]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction
668	6	98	58	33	190	34.0	0.430
324	2	112	75	32	0	35.7	0.148
624	2	108	64	0	0	30.8	0.158
690	8	107	80	0	0	24.6	0.856
473	7	136	90	0	0	29.9	0.210
204	6	103	72	32	190	37.7	0.324
97	1	71	48	18	76	20.4	0.323
336	0	117	0	0	0	33.8	0.932
568	4	154	72	29	126	31.3	0.338
148	5	147	78	0	0	33.7	0.218
667	10	111	70	27	0	27.5	0.141
212	7	179	95	31	0	34.2	0.164
199	4	148	60	27	318	30.9	0.150
265	5	96	74	18	67	33.6	0.997
760	2	88	58	26	16	28.4	0.766
356	1	125	50	40	167	33.3	0.962
501	3	84	72	32	0	37.2	0.267
457	5	86	68	28	71	30.2	0.364
604	4	183	0	0	0	28.4	0.212
213	0	140	65	26	130	42.6	0.431
636	5	104	74	0	0	28.8	0.153
544	1	88	78	29	76	32.0	0.365
86	13	106	72	54	0	36.6	0.178
208	1	96	64	27	87	33.2	0.289
281	10	129	76	28	122	35.9	0.280
209	7	184	84	33	0	35.5	0.355
581	6	109	60	27	0	25.0	0.206
639	1	100	74	12	46	19.5	0.149
328	2	102	86	36	120	45.5	0.127
431	3	89	74	16	85	30.4	0.551
...
718	1	108	60	46	178	35.5	0.415
90	1	80	55	0	0	19.1	0.258
377	1	87	60	37	75	37.2	0.509

Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction
235	4	171	72	0	0	43.6
158	2	88	74	19	53	29.0
69	4	146	85	27	100	28.9
260	3	191	68	15	130	30.9
131	9	122	56	0	0	33.3
44	7	159	64	0	0	27.4
70	2	100	66	20	90	32.9
264	4	123	62	0	0	32.0
673	3	123	100	35	240	57.3
286	5	155	84	44	545	38.7
640	0	102	86	17	105	29.3
135	2	125	60	20	140	33.8
745	12	100	84	33	105	30.0
165	6	104	74	18	156	29.9
164	0	131	88	0	0	31.6
28	13	145	82	19	110	22.2
608	0	152	82	39	272	41.5
583	8	100	76	0	0	38.7
746	1	147	94	41	0	49.3
292	2	128	78	37	182	43.3
136	0	100	70	26	50	30.8
432	1	80	74	11	60	30.0
554	1	84	64	23	115	36.9
319	6	194	78	0	0	23.5
594	6	123	72	45	230	33.6
6	3	78	50	32	88	31.0
615	3	106	72	0	0	25.8

192 rows × 8 columns



In [21]: `from sklearn import linear_model`

```
In [23]: logr = linear_model.LogisticRegression()
logr.fit(X,Y)
```

```
C:\Program Files (x86)\Microsoft Visual Studio\Shared\Anaconda3_64\lib\site-packages\sklearn\utils\validation.py:578: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
y = column_or_1d(y, warn=True)
```

```
Out[23]: LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
                           intercept_scaling=1, max_iter=100, multi_class='ovr', n_jobs=1,
                           penalty='l2', random_state=None, solver='liblinear', tol=0.0001,
                           verbose=0, warm_start=False)
```

```
In [24]: y_pred=logr.predict(X_test)
y_pred
```

```
Out[24]: array([0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
 1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0,
 0, 1, 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0,
 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0,
 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0,
 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1,
 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0,
```

Step-3. [Predict on a new sample]

```
In [28]: new=logr.predict([[6,200,90,10,25,23.3,.672,42]])
if new==0:
    print("Non-diabetic patient",new)
else:
    print("Diabetic patient",new)
```

```
Diabetic patient [1]
```

Precision

```
In [31]: from sklearn.metrics import precision_score
print(precision_score(y_test,y_pred))
```

```
0.7
```

Recall

```
In [32]: from sklearn.metrics import recall_score
print(recall_score(y_test,y_pred))
```

```
0.6086956521739131
```

AUC Scores

```
In [33]: from sklearn.metrics import roc_auc_score
print(roc_auc_score(y_test,y_pred))
```

0.7311770943796395

```
In [37]: from sklearn import metrics
from sklearn.linear_model import LogisticRegression
```

```
In [39]: model = LogisticRegression(random_state=0, solver='lbfgs',multi_class='multinomial')
model.fit(X_train,y_train)
prediction=model.predict(X_test)
print('The accuracy of the Logistic Regression is', metrics.accuracy_score(prediction,y_test))
```

C:\Program Files (x86)\Microsoft Visual Studio\Shared\Anaconda3_64\lib\site-packages\sklearn\utils\validation.py:578: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().
y = column_or_1d(y, warn=True)

The accuracy of the Logistic Regression is 0.7291666666666666

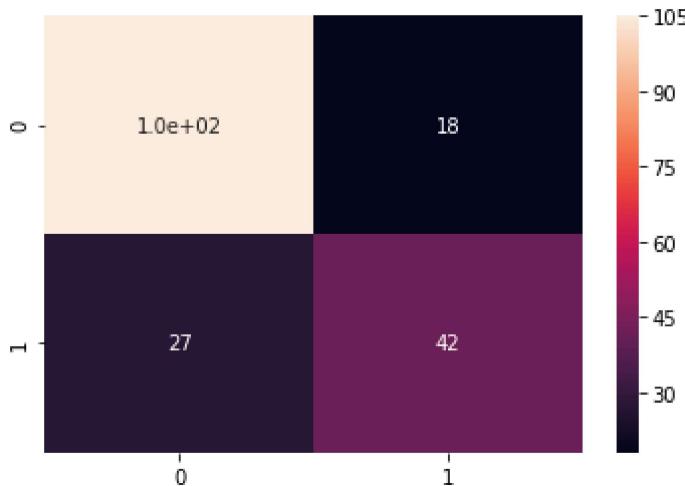
Step-4. [Understand Correlation]

```
In [34]: from sklearn.metrics import confusion_matrix
cfm=confusion_matrix(y_test,y_pred)
cfm
```

```
Out[34]: array([[105,  18],
       [ 27,  42]], dtype=int64)
```

```
In [36]: import seaborn as sns
sns.heatmap(cfm, annot=True)
```

```
Out[36]: <matplotlib.axes._subplots.AxesSubplot at 0x2d4d7f94cf8>
```



Step-5. [Normalization using MinMaxScaler and rebuild LOR]

```
In [40]: #Normalizing using MinMaxScaler
from sklearn.preprocessing import MinMaxScaler
mm=MinMaxScaler()
mm_X_train=mm.fit_transform(X_train)
mm_X_train
```

Out[40]: array([[0.76470588, 0.64824121, 0. , ..., 0.59463487, 0.20964987, 0.38333333], [0.23529412, 0.64824121, 0.70491803, ..., 0.52309985, 0.06532878, 0.03333333], [0.17647059, 0.30653266, 0.67213115, ..., 0.51266766, 0.0704526 , 0.41666667], ..., [0.58823529, 0.50753769, 0.70491803, ..., 0.67958271, 0.45175064, 0.28333333], [0. , 0.70854271, 0. , ..., 0.6318927 , 0.05422716, 0.13333333], [0. , 0.6281407 , 0.78688525, ..., 0.33532042, 0.07856533, 0.]])

```
In [41]: mm_X_test=mm.transform(X_test)
mm_X_test
```

Out[41]: array([[0.35294118, 0.49246231, 0.47540984, ..., 0.50670641, 0.15029889, 0.36666667], [0.11764706, 0.56281407, 0.6147541 , ..., 0.53204173, 0.02988898, 0.], [0.11764706, 0.54271357, 0.52459016, ..., 0.45901639, 0.03415884, 0.], ..., [0.35294118, 0.61809045, 0.59016393, ..., 0.50074516, 0.27967549, 0.21666667], [0.17647059, 0.3919598 , 0.40983607, ..., 0.46199702, 0.07258753, 0.08333333], [0.17647059, 0.53266332, 0.59016393, ..., 0.38450075, 0.05508113, 0.1]])

```
In [42]: #ReBuild LOR Model
mm_lor=LogisticRegression()
mm_lor=mm_lor.fit(mm_X_train,y_train)
```

C:\Program Files (x86)\Microsoft Visual Studio\Shared\Anaconda3_64\lib\site-packages\sklearn\utils\validation.py:578: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().
y = column_or_1d(y, warn=True)

```
In [43]: mm_y_pred=mm_lor.predict(mm_X_test)
mm_y_pred
```

```
Out[43]: array([0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 1, 1, 0,
0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 1, 1,
0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
```

Accuracy

```
In [44]: model = LogisticRegression(random_state=0, solver='lbfgs',multi_class='multinomial')
model.fit(X_train,y_train)
prediction=model.predict(X_test)
print('The accuracy of the Logistic Regression is', metrics.accuracy_score(y_test))
```

The accuracy of the Logistic Regression is 0.7239583333333334

```
C:\Program Files (x86)\Microsoft Visual Studio\Shared\Anaconda3_64\lib\site-packages\sklearn\utils\validation.py:578: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
y = column_or_1d(y, warn=True)
```

Precision

```
In [45]: print(precision_score(y_test,mm_y_pred))
```

0.6538461538461539

Recall

```
In [46]: print(recall_score(y_test,mm_y_pred))
```

0.4927536231884058

AUC scores

```
In [47]: mm_auc=print(roc_auc_score(y_test,mm_y_pred))
mm_auc
```

0.6732060798868859

Step-6: [Normalization using StandardScaler and rebuild LOR]

```
In [48]: from sklearn.preprocessing import StandardScaler
ss=StandardScaler()
ss_X_train=ss.fit_transform(X_train)
ss_X_train
```

```
Out[48]: array([[ 2.80346794,  0.25977903, -3.78077929, ... ,  1.03974028,
   0.29608546,  0.96352088], [ 0.07832678,  0.25977903,  0.89724451, ... ,  0.40945373,
  -0.70087555, -0.86295593], [-0.22446668, -1.85825286,  0.67966201, ... ,  0.31753694,
  -0.66548048,  1.13747105], ... , [ 1.89508755, -0.61235174,  0.89724451, ... ,  1.78820556,
  1.96850229,  0.44167036], [-1.13284707,  0.63354937, -3.78077929, ... ,  1.36801453,
  -0.77756486, -0.34110542], [-1.13284707,  0.13518892,  1.44120077, ... , -1.24504846,
  -0.6094383 , -1.03690611]])
```

```
In [49]: ss_X_test=ss.transform(X_test)
ss_X_test
```

```
Out[49]: array([[ 0.6839137 , -0.70579433, -0.625833 , ... ,  0.26501306,
  -0.11390738,  0.87654579], [-0.52726014, -0.26972894,  0.29889263, ... ,  0.48823955,
  -0.94569142, -1.03690611], [-0.52726014, -0.39431905, -0.29945925, ... , -0.15517797,
  -0.91619553, -1.03690611], ... , [ 0.6839137 ,  0.07289387,  0.13570575, ... ,  0.21248918,
  0.77981801,  0.09377001], [-0.22446668, -1.32874488, -1.06099801, ... , -0.12891603,
  -0.65073254, -0.60203068], [-0.22446668, -0.45661411,  0.13570575, ... , -0.81172646,
  -0.77166568, -0.51505559]])
```

```
In [50]: #Rebuild LOR
ss_lor=LogisticRegression()
ss_lor.fit(ss_X_train,y_train)
ss_y_pred=ss_lor.predict(ss_X_test)
```

```
C:\Program Files (x86)\Microsoft Visual Studio\Shared\Anaconda3_64\lib\site-packages\sklearn\utils\validation.py:578: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
y = column_or_1d(y, warn=True)
```

Accuracy

```
In [51]: model = LogisticRegression(random_state=0, solver='lbfgs',multi_class='multinomial')
model.fit(X_train,y_train)
prediction=model.predict(X_test)
print('The accuracy of the Logistic Regression is', metrics.accuracy_score(y_test))
```

The accuracy of the Logistic Regression is 0.7291666666666666

```
C:\Program Files (x86)\Microsoft Visual Studio\Shared\Anaconda3_64\lib\site-packages\sklearn\utils\validation.py:578: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
y = column_or_1d(y, warn=True)
```

Precision

```
In [52]: print(precision_score(y_test,ss_y_pred))
```

0.6164383561643836

Recall

```
In [53]: print(recall_score(y_test,ss_y_pred))
```

0.6521739130434783

AUC scores

```
In [54]: auc_ss=print(roc_auc_score(y_test,ss_y_pred))
auc_ss
```

0.7122658183103571

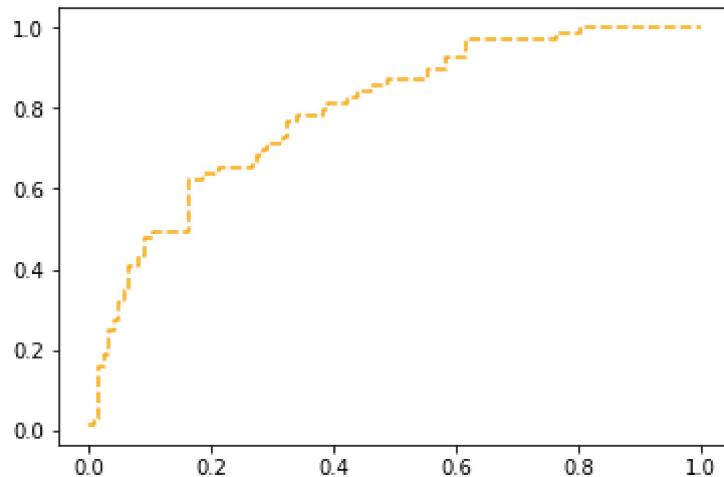
Step-7. [Plot ROC Curve]

```
In [55]: pred_prob1=mm_lor.predict_proba(mm_X_test)
```

```
In [56]: from sklearn.metrics import roc_curve
fpr1, tpr1, thresh1 = roc_curve(y_test, pred_prob1[:,1], pos_label=1)
```

```
In [57]: import matplotlib.pyplot as plt  
plt.plot(fpr1,tpr1,linestyle='--',color='orange',label='MinMaxScaler values')
```

```
Out[57]: [<matplotlib.lines.Line2D at 0x2d4d805d0f0>]
```



Step-8. [Comparison with KNN classifier]

```
In [58]: from sklearn.neighbors import KNeighborsClassifier  
knn=KNeighborsClassifier(n_neighbors=4)  
knn=knn.fit(X_train,y_train)
```

C:\Program Files (x86)\Microsoft Visual Studio\Shared\Anaconda3_64\lib\site-packages\ipykernel_launcher.py:3: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().

This is separate from the ipykernel package so we can avoid doing imports until

```
In [59]: knn_y_pred=knn.predict(X_test)
```

```
In [60]: from sklearn.preprocessing import MinMaxScaler
m=MinMaxScaler()
m_X_train=m.fit_transform(X_train)
m_X_train
```

```
Out[60]: array([[0.76470588, 0.64824121, 0.38333333, 0.23529412, 0.64824121, 0.70491803, 0.52309985, 0.06532878, 0.17647059, 0.30653266, 0.67213115, 0.51266766, 0.0704526, 0.41666667, 0.58823529, 0.50753769, 0.70491803, 0.67958271, 0.45175064, 0.28333333], [0., 0.70854271, 0.13333333], [0., 0.6281407, 0.78688525, 0.33532042, 0.07856533, 0.]])
```

```
In [61]: m_X_test=m.transform(X_test)
m_X_test
```

```
Out[61]: array([[0.35294118, 0.49246231, 0.47540984, 0.50670641, 0.15029889, 0.36666667], [0.11764706, 0.56281407, 0.6147541, 0.53204173, 0.02988898, 0.], [0.11764706, 0.54271357, 0.52459016, 0.45901639, 0.03415884, 0.], 0.35294118, 0.61809045, 0.59016393, 0.50074516, 0.27967549, 0.21666667], [0.17647059, 0.3919598, 0.40983607, 0.46199702, 0.07258753, 0.08333333], [0.17647059, 0.53266332, 0.59016393, 0.38450075, 0.05508113, 0.1]])
```

```
In [62]: m_knn=KNeighborsClassifier()
m_knn=m_knn.fit(m_X_train,y_train)
```

```
C:\Program Files (x86)\Microsoft Visual Studio\Shared\Anaconda3_64\lib\site-packages\ipykernel_launcher.py:2: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().
```

In [63]: `m_y_pred=m_knn.predict(m_X_test)`
`m_y_pred`

Out[63]: `array([0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0,`
`0, 0, 1, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1, 1, 0,`
`0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 1, 0, 0,`
`0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0,`
`0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0,`
`0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0,`
`0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 1, 1,`
`0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1,`
`0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 1, 1, 0, 1, 0, 1, 0,`
`0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 1, 0, 0, 1, 0]`, `dtype=int64)`

Classification Metrics

Accuracy

In [64]: `model = LogisticRegression(random_state=0, solver='lbfgs',multi_class='multinomial')`
`model.fit(X_train,y_train)`
`prediction=model.predict(X_test)`
`print('The accuracy of the Logistic Regression is', metrics.accuracy_score(y_test`

The accuracy of the Logistic Regression is 0.6770833333333334

C:\Program Files (x86)\Microsoft Visual Studio\Shared\Anaconda3_64\lib\site-packages\sklearn\utils\validation.py:578: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().

`y = column_or_1d(y, warn=True)`

Precision

In [65]: `print(precision_score(y_test,m_y_pred))`

0.5522388059701493

Recall

In [66]: `print(recall_score(y_test,m_y_pred))`

0.5362318840579711

AUC Scores

In [67]: `knn_auc=print(roc_auc_score(y_test,m_y_pred))`
`knn_auc`

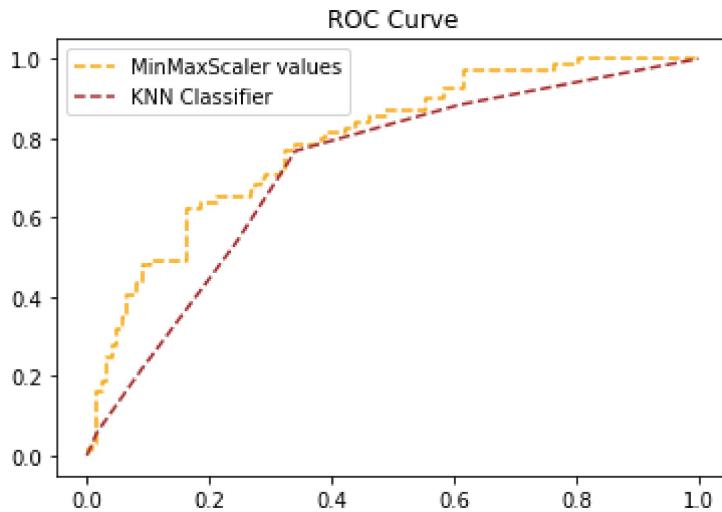
0.6461647225167905

Step-9. [Update ROC Curve]

```
In [68]: pred_prob2=m_knn.predict_proba(m_X_test)
```

```
In [69]: from sklearn.metrics import roc_curve
fpr2,tpr2,thresh2=roc_curve(y_test,pred_prob2[:,1],pos_label=1)
```

```
In [70]: import matplotlib.pyplot as plt
plt.plot(fpr1,tpr1,linestyle='--',color='orange',label='MinMaxScaler values')
plt.plot(fpr2,tpr2,linestyle='--',color='brown',label='KNN Classifier')
plt.title('ROC Curve')
plt.legend(loc='best')
plt.savefig('ROC',dpi=300)
plt.show()
```



Step-10. [Regularization]

```
In [71]: from sklearn.linear_model import LogisticRegressionCV
model1=LogisticRegressionCV(Cs=10,cv=4,penalty='l1',solver='liblinear')
model2=LogisticRegressionCV(Cs=10,cv=4,penalty='l2')
```

```
In [72]: model1.fit(mm_X_train,y_train)
model2.fit(mm_X_train,y_train)
```

```
C:\Program Files (x86)\Microsoft Visual Studio\Shared\Anaconda3_64\lib\site-packages\sklearn\utils\validation.py:578: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
y = column_or_1d(y, warn=True)
```

```
Out[72]: LogisticRegressionCV(Cs=10, class_weight=None, cv=4, dual=False,
fit_intercept=True, intercept_scaling=1.0, max_iter=100,
multi_class='ovr', n_jobs=1, penalty='l2', random_state=None,
refit=True, scoring=None, solver='lbfgs', tol=0.0001, verbose=0)
```

```
In [74]: rg_y_pred1 = model1.predict(mm_X_test)
rg_y_pred2 = model2.predict(mm_X_test)
```

AUC SCORE OF L1

```
In [75]: from sklearn.metrics import roc_auc_score
l1_auc = roc_auc_score(y_test, rg_y_pred1)
l1_auc = (' LOR L1 MINMAX AUC', l1_auc)
l1_auc
```

```
Out[75]: (' LOR L1 MINMAX AUC', 0.694591728525981)
```

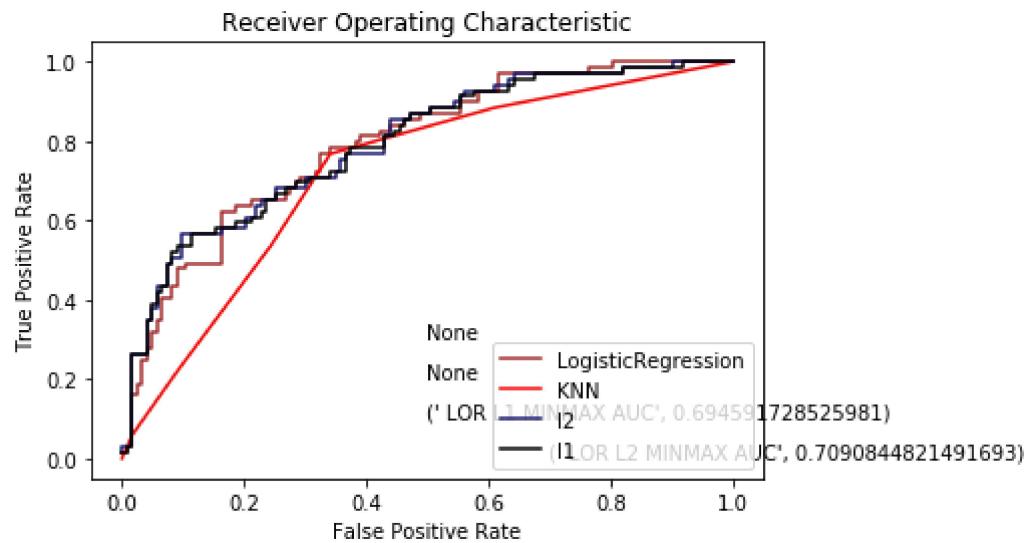
AUC SCORE OF L2

```
In [76]: from sklearn.metrics import roc_auc_score
l2_auc = roc_auc_score(y_test, rg_y_pred2)
l2_auc = (' LOR L2 MINMAX AUC', l2_auc)
l2_auc
```

```
Out[76]: (' LOR L2 MINMAX AUC', 0.7090844821491693)
```

STEP 12 : UPDATE ROC CURVE

```
In [77]: pred_prb7 = model1.predict_proba(mm_X_test)
pred_prb8 = model2.predict_proba(mm_X_test)
fpr,tbr,threshold = roc_curve(y_test, pred_prob1[:,1],pos_label=1)
fpr1,tbr1,threshold1 = roc_curve(y_test, pred_prob2[:,1],pos_label=1)
fpr2,tbr2,threshold2= roc_curve(y_test, pred_prb7[:,1],pos_label=1)
fpr3,tbr3,threshold3 = roc_curve(y_test, pred_prb8[:,1],pos_label=1)
plt.plot(fpr, tbr, linestyle='--', color='brown', label='LogisticRegression')
plt.plot(fpr1, tbr1, linestyle='--', color='red', label='KNN')
plt.plot(fpr3, tbr3, linestyle='--', color='midnightblue', label='l2')
plt.plot(fpr2, tbr2, linestyle='--', color='black', label='l1')
plt.annotate(xy=[0.5,0.3],s= auc_ss)
plt.annotate(xy=[0.5,0.2],s= knn_auc)
plt.annotate(xy=[0.5,0.1],s= l1_auc)
plt.annotate(xy=[0.7,0],s= l2_auc)
plt.title('Receiver Operating Characteristic')
plt.legend(loc = 'best')
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()
```



```
In [ ]:
```