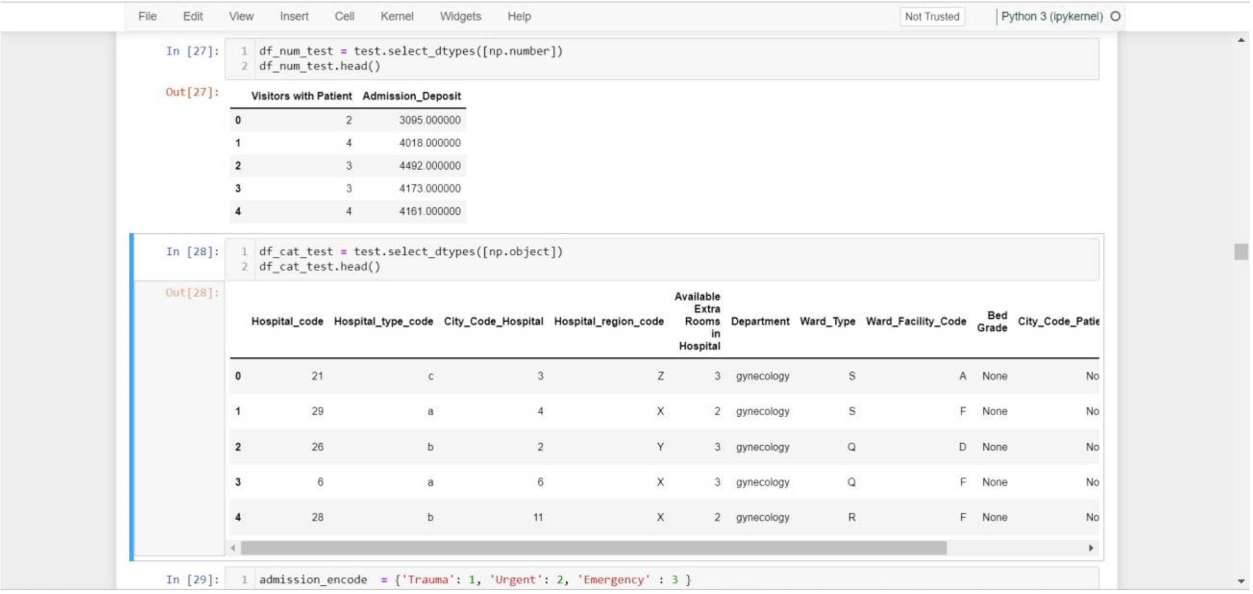
Analytics for Hospitals Health-Care Data

TEAM ID: PNT2022TMID16326

DATA ANALYSIS



In [27]:
```
df_num_test = test.select_dtypes([np.number])
df_num_test.head()
```

Out[27]:

	Visitors with Patient	Admission_Deposit
0	2	3095.000000
1	4	4018.000000
2	3	4492.000000
3	3	4173.000000
4	4	4161.000000

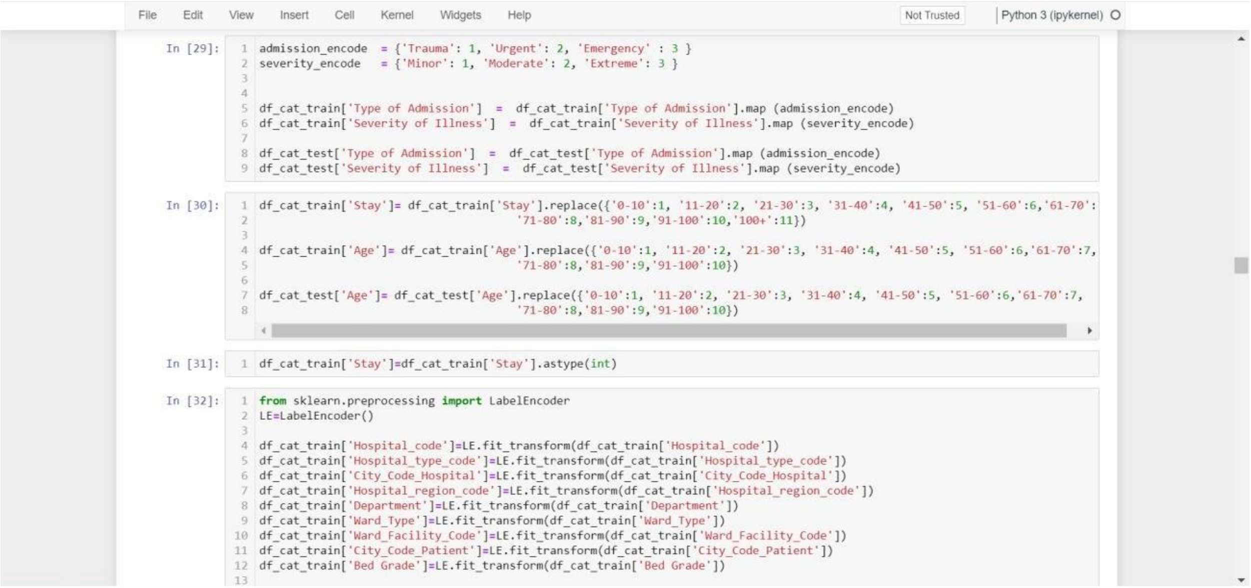
In [28]:
```
df_cat_test = test.select_dtypes([np.object])
df_cat_test.head()
```

Out[28]:

	Hospital_code	Hospital_type_code	City_Code_Hospital	Hospital_region_code	Available Extra Rooms in Hospital	Department	Ward_Type	Ward_Facility_Code	Bed Grade	City_Code_Patie
0	21	c	3	Z	3	gynecology	S	A	None	No
1	29	a	4	X	2	gynecology	S	F	None	No
2	26	b	2	Y	3	gynecology	Q	D	None	No
3	6	a	6	X	3	gynecology	Q	F	None	No
4	28	b	11	X	2	gynecology	R	F	None	No

In [29]:
```
admission_encode  = {'Trauma': 1, 'Urgent': 2, 'Emergency' : 3 }
```

ENCODING

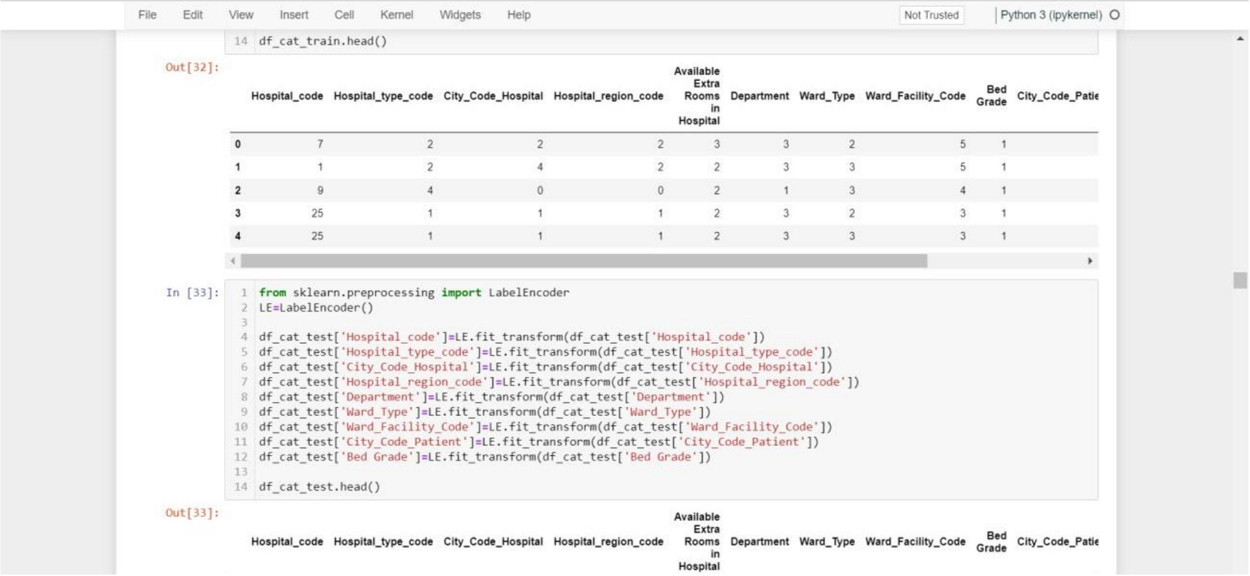


In [29]:
```
admission_encode  = {'Trauma': 1, 'Urgent': 2, 'Emergency' : 3 }
severity_encode   = {'Minor': 1, 'Moderate': 2, 'Extreme': 3 }


df_cat_train['Type of Admission']  =  df_cat_train['Type of Admission'].map (admission_encode)
df_cat_train['Severity of Illness']  =  df_cat_train['Severity of Illness'].map (severity_encode)

df_cat_test['Type of Admission']  =  df_cat_test['Type of Admission'].map (admission_encode)
df_cat_test['Severity of Illness']  =  df_cat_test['Severity of Illness'].map (severity_encode)
```

In [30]:
```
df_cat_train['Stay']= df_cat_train['Stay'].replace({'0-10':1, '11-20':2, '21-30':3, '31-40':4, '41-50':5, '51-60':6,'61-70':
                                   '71-80':8,'81-90':9,'91-100':10,'100+':11})

df_cat_train['Age']= df_cat_train['Age'].replace({'0-10':1, '11-20':2, '21-30':3, '31-40':4, '41-50':5, '51-60':6,'61-70':7,
                                   '71-80':8,'81-90':9,'91-100':10})

df_cat_test['Age']= df_cat_test['Age'].replace({'0-10':1, '11-20':2, '21-30':3, '31-40':4, '41-50':5, '51-60':6,'61-70':7,
                                   '71-80':8,'81-90':9,'91-100':10})
```

In [31]:
```
df_cat_train['Stay']=df_cat_train['Stay'].astype(int)
```

In [32]:
```
from sklearn.preprocessing import LabelEncoder
LE=LabelEncoder()

df_cat_train['Hospital_code']=LE.fit_transform(df_cat_train['Hospital_code'])
df_cat_train['Hospital_type_code']=LE.fit_transform(df_cat_train['Hospital_type_code'])
df_cat_train['City_Code_Hospital']=LE.fit_transform(df_cat_train['City_Code_Hospital'])
df_cat_train['Hospital_region_code']=LE.fit_transform(df_cat_train['Hospital_region_code'])
df_cat_train['Department']=LE.fit_transform(df_cat_train['Department'])
df_cat_train['Ward_Type']=LE.fit_transform(df_cat_train['Ward_Type'])
df_cat_train['Ward_Facility_Code']=LE.fit_transform(df_cat_train['Ward_Facility_Code'])
df_cat_train['City_Code_Patient']=LE.fit_transform(df_cat_train['City_Code_Patient'])
df_cat_train['Bed Grade']=LE.fit_transform(df_cat_train['Bed Grade'])

```



```
df_cat_train.head()
```

Out[32]:

	Hospital_code	Hospital_type_code	City_Code_Hospital	Hospital_region_code	Available Extra Rooms in Hospital	Department	Ward_Type	Ward_Facility_Code	Bed Grade	City_Code_Patie
0	7	2	2	2	3	3	2	5	1	
1	1	2	4	2	2	3	3	5	1	
2	9	4	0	0	2	1	3	4	1	
3	25	1	1	1	2	3	2	3	1	
4	25	1	1	1	2	3	3	3	1	

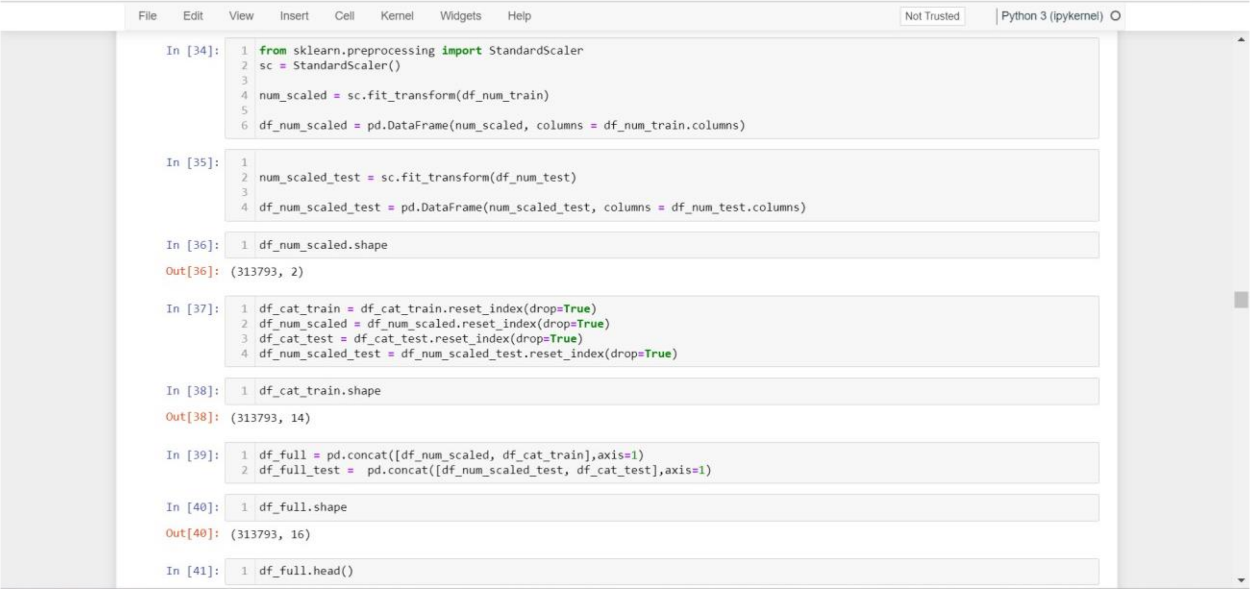
In [33]:

```
from sklearn.preprocessing import LabelEncoder
LE=LabelEncoder()

df_cat_test['Hospital_code']=LE.fit_transform(df_cat_test['Hospital_code'])
df_cat_test['Hospital_type_code']=LE.fit_transform(df_cat_test['Hospital_type_code'])
df_cat_test['City_Code_Hospital']=LE.fit_transform(df_cat_test['City_Code_Hospital'])
df_cat_test['Hospital_region_code']=LE.fit_transform(df_cat_test['Hospital_region_code'])
df_cat_test['Department']=LE.fit_transform(df_cat_test['Department'])
df_cat_test['Ward_Type']=LE.fit_transform(df_cat_test['Ward_Type'])
df_cat_test['Ward_Facility_Code']=LE.fit_transform(df_cat_test['Ward_Facility_Code'])
df_cat_test['City_Code_Patient']=LE.fit_transform(df_cat_test['City_Code_Patient'])
df_cat_test['Bed Grade']=LE.fit_transform(df_cat_test['Bed Grade'])

df_cat_test.head()
```

Out[33]:

Hospital_code	Hospital_type_code	City_Code_Hospital	Hospital_region_code	Available Extra Rooms in Hospital	Department	Ward_Type	Ward_Facility_Code	Bed Grade	City_Code_Patie

SCALE THE DATA



In [34]:

```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()

num_scaled = sc.fit_transform(df_num_train)

df_num_scaled = pd.DataFrame(num_scaled, columns = df_num_train.columns)
```

In [35]:

```

num_scaled_test = sc.fit_transform(df_num_test)

df_num_scaled_test = pd.DataFrame(num_scaled_test, columns = df_num_test.columns)
```

In [36]:

```
df_num_scaled.shape
```

Out[36]:

```
(313793, 2)
```

In [37]:

```
df_cat_train = df_cat_train.reset_index(drop=True)
df_num_scaled = df_num_scaled.reset_index(drop=True)
df_cat_test = df_cat_test.reset_index(drop=True)
df_num_scaled_test = df_num_scaled_test.reset_index(drop=True)
```

In [38]:

```
df_cat_train.shape
```

Out[38]:

```
(313793, 14)
```

In [39]:

```
df_full = pd.concat([df_num_scaled, df_cat_train],axis=1)
df_full_test =  pd.concat([df_num_scaled_test, df_cat_test],axis=1)
```

In [40]:

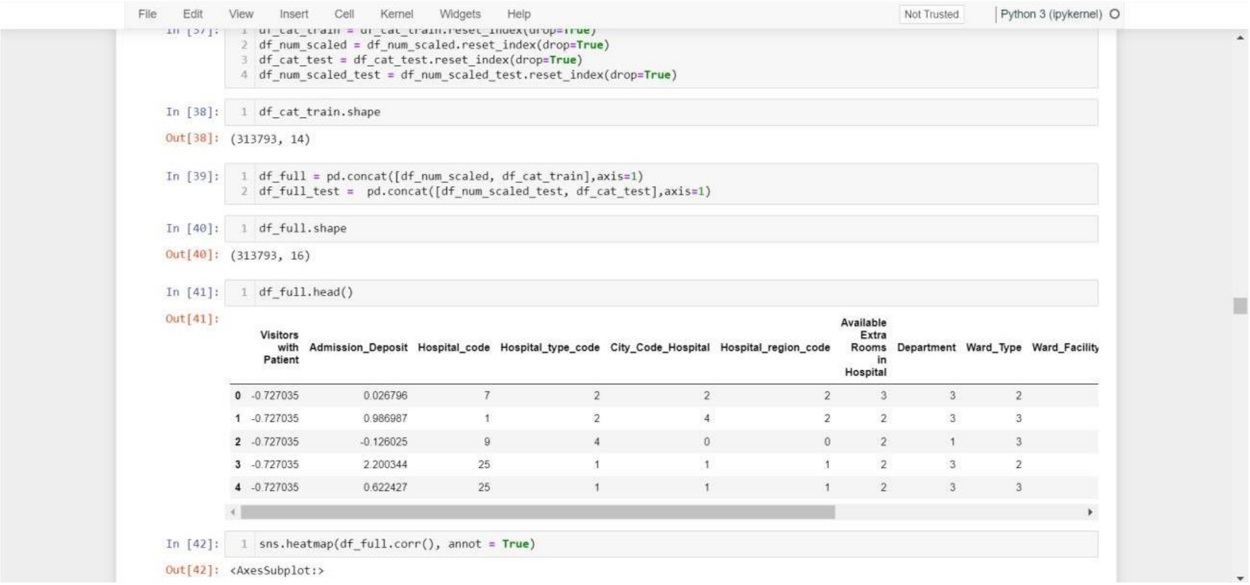
```
df_full.shape
```

Out[40]:

```
(313793, 16)
```

In [41]:

```
df_full.head()
```



```
In [37]: df_cat_train = df_cat_train.reset_index(drop=True)
         df_num_scaled = df_num_scaled.reset_index(drop=True)
         df_cat_test = df_cat_test.reset_index(drop=True)
         df_num_scaled_test = df_num_scaled_test.reset_index(drop=True)
```

```
In [38]: df_cat_train.shape
```

```
Out[38]: (313793, 14)
```

```
In [39]: df_full = pd.concat([df_num_scaled, df_cat_train],axis=1)
         df_full_test =  pd.concat([df_num_scaled_test, df_cat_test],axis=1)
```

```
In [40]: df_full.shape
```

```
Out[40]: (313793, 16)
```

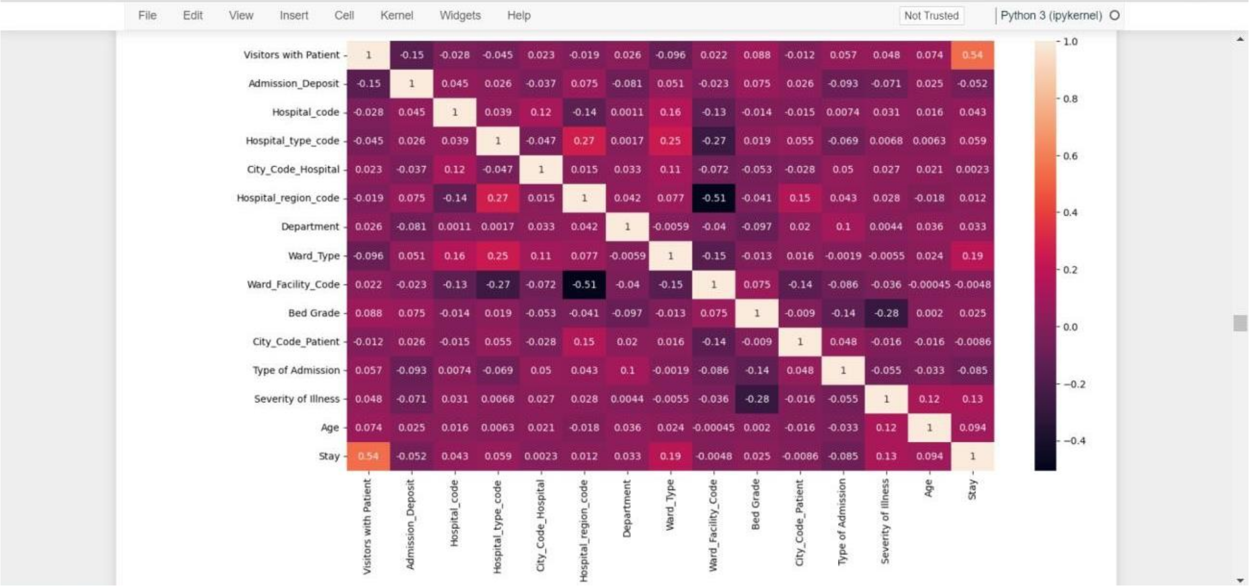
```
In [41]: df_full.head()
```

Out[41]:

	Visitors with Patient	Admission_Deposit	Hospital_code	Hospital_type_code	City_Code_Hospital	Hospital_region_code	Available Extra Rooms in Hospital	Department	Ward_Type	Ward_Facility
0	-0.727035	0.026796	7	2	2	2	3	3	2	
1	-0.727035	0.986987	1	2	4	2	2	3	3	
2	-0.727035	-0.126025	9	4	0	0	2	1	3	
3	-0.727035	2.200344	25	1	1	1	2	3	2	
4	-0.727035	0.622427	25	1	1	1	2	3	3	

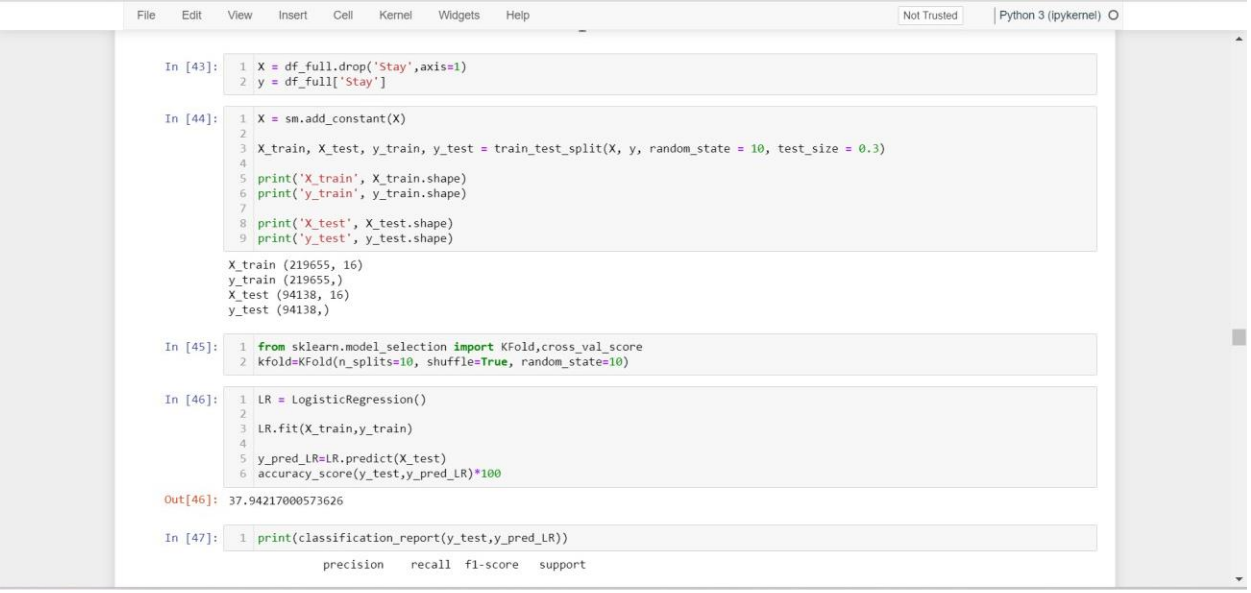
```
In [42]: sns.heatmap(df_full.corr(), annot = True)
```

```
Out[42]: <AxesSubplot:>
```



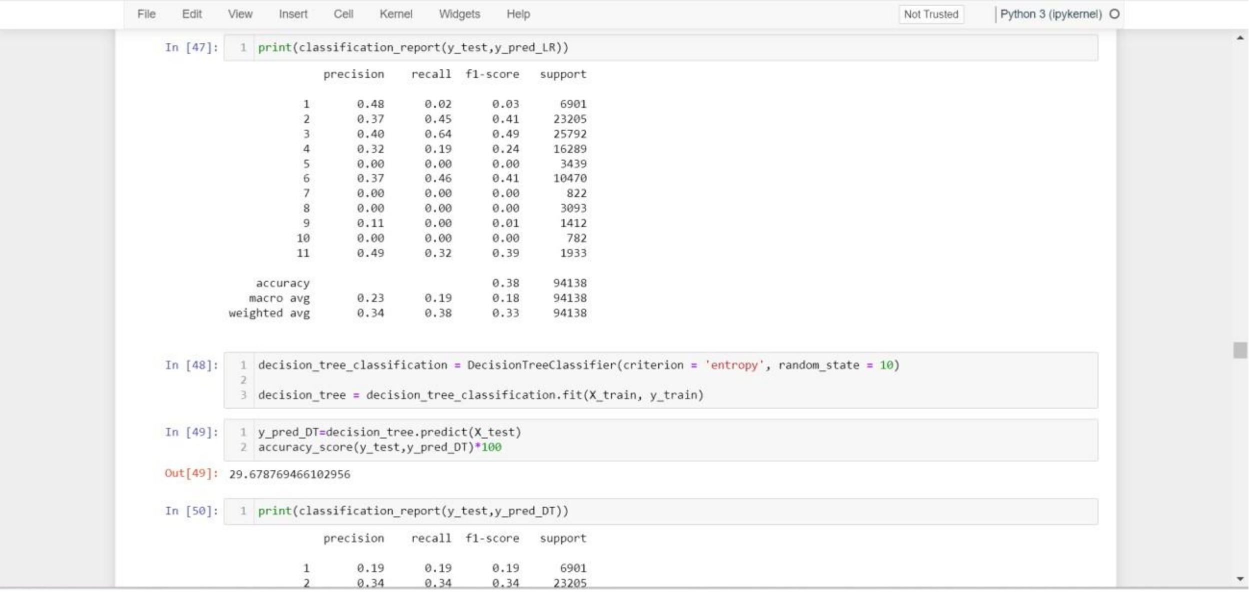
	Visitors with Patient	Admission_Deposit	Hospital_code	Hospital_type_code	City_Code_Hospital	Hospital_region_code	Department	Ward_Type	Ward_Facility_Code	Bed Grade	City_Code_Patient	Type of Admission	Severity of Illness	Age	Stay
Visitors with Patient	1	-0.15	-0.028	-0.045	0.023	-0.019	0.026	-0.096	0.022	0.088	-0.012	0.057	0.048	0.074	0.54
Admission_Deposit	-0.15	1	0.045	0.026	-0.037	0.075	-0.081	0.051	-0.023	0.075	0.026	-0.093	-0.071	0.025	-0.052
Hospital_code	-0.028	0.045	1	0.039	0.12	-0.14	0.0011	0.16	-0.13	-0.014	-0.015	0.0074	0.031	0.016	0.043
Hospital_type_code	-0.045	0.026	0.039	1	-0.047	0.27	0.0017	0.25	-0.27	0.019	0.055	-0.069	0.0068	0.0063	0.059
City_Code_Hospital	0.023	-0.037	0.12	-0.047	1	0.015	0.033	0.11	-0.072	-0.053	-0.028	0.05	0.027	0.021	0.0023
Hospital_region_code	-0.019	0.075	-0.14	0.27	0.015	1	0.042	0.077	-0.51	-0.041	0.15	0.043	0.028	-0.018	0.012
Department	0.026	-0.081	0.0011	0.0017	0.033	0.042	1	-0.0059	-0.04	-0.097	0.02	0.1	0.0044	0.036	0.033
Ward_Type	-0.096	0.051	0.16	0.25	0.11	0.077	-0.0059	1	-0.15	-0.013	0.016	-0.0019	-0.0055	0.024	0.19
Ward_Facility_Code	0.022	-0.023	-0.13	-0.27	-0.072	-0.51	-0.04	-0.15	1	0.075	-0.14	-0.086	-0.036	-0.00045	-0.0048
Bed Grade	0.088	0.075	-0.014	0.019	-0.053	-0.041	-0.097	-0.013	0.075	1	-0.009	-0.14	-0.28	0.002	0.025
City_Code_Patient	-0.012	0.026	-0.015	0.055	-0.028	0.15	0.02	0.016	-0.14	-0.009	1	0.048	-0.016	-0.016	-0.0086
Type of Admission	0.057	-0.093	0.0074	-0.069	0.05	0.043	0.1	-0.0019	-0.086	-0.14	0.048	1	-0.055	-0.033	-0.085
Severity of Illness	0.048	-0.071	0.031	0.0068	0.027	0.028	0.0044	-0.0055	-0.036	-0.28	-0.016	-0.055	1	0.12	0.13
Age	0.074	0.025	0.016	0.0063	0.021	-0.018	0.036	0.024	-0.00045	0.002	-0.016	-0.033	0.12	1	0.094
Stay	0.54	-0.052	0.043	0.059	0.0023	0.012	0.033	0.19	-0.0048	0.025	-0.0086	-0.085	0.13	0.094	1

TRAIN TEST SPLIT



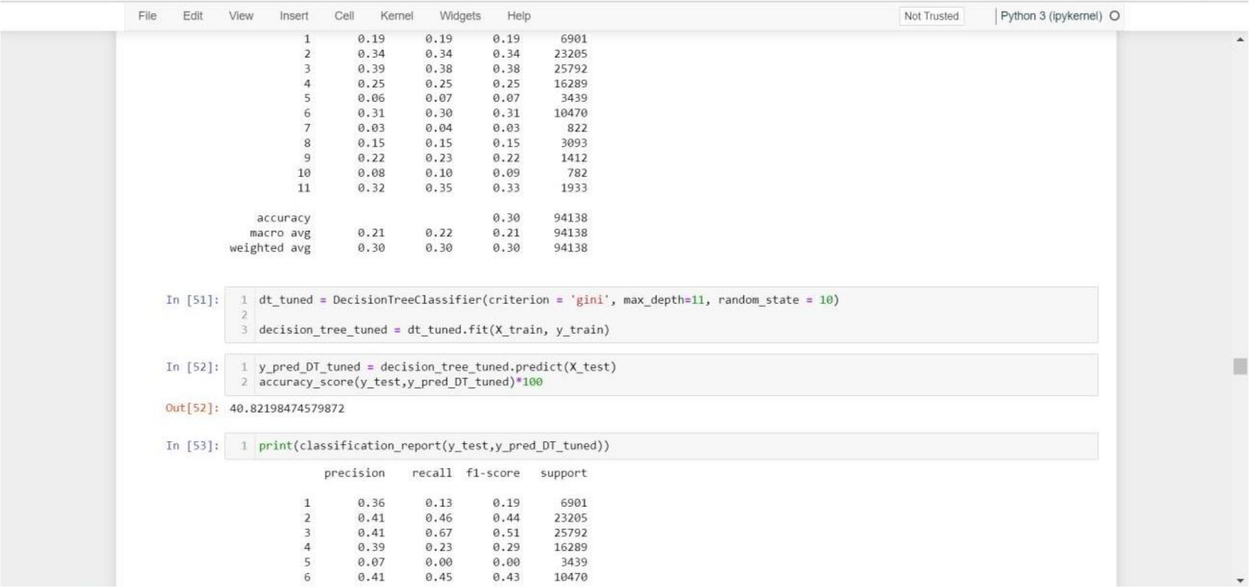
```
In [43]:  X = df_full.drop('Stay',axis=1)
          y = df_full['Stay']

In [44]:  X = sm.add_constant(X)

          X_train, X_test, y_train, y_test = train_test_split(X, y, random_state = 10, test_size = 0.3)

          print('X_train', X_train.shape)
          print('y_train', y_train.shape)

          print('X_test', X_test.shape)
          print('y_test', y_test.shape)

          X_train (219655, 16)
          y_train (219655,)
          X_test (94138, 16)
          y_test (94138,)

In [45]:  from sklearn.model_selection import KFold,cross_val_score
          kfold=KFold(n_splits=10, shuffle=True, random_state=10)

In [46]:  LR = LogisticRegression()

          LR.fit(X_train,y_train)

          y_pred_LR=LR.predict(X_test)
          accuracy_score(y_test,y_pred_LR)*100

Out[46]:  37.94217000573626

In [47]:  print(classification_report(y_test,y_pred_LR))

                       precision    recall  f1-score   support
```

FOLD CROSS VALIDATION AND LOGISTIC REGRESSION



```
In [47]:  print(classification_report(y_test,y_pred_LR))

                       precision    recall  f1-score   support

                    1       0.48      0.02      0.03      6901
                    2       0.37      0.45      0.41     23205
                    3       0.40      0.64      0.49     25792
                    4       0.32      0.19      0.24     16289
                    5       0.00      0.00      0.00      3439
                    6       0.37      0.46      0.41     10470
                    7       0.00      0.00      0.00       822
                    8       0.00      0.00      0.00      3093
                    9       0.11      0.00      0.01      1412
                   10       0.00      0.00      0.00       782
                   11       0.49      0.32      0.39      1933

             accuracy                           0.38     94138
            macro avg       0.23      0.19      0.18     94138
         weighted avg       0.34      0.38      0.33     94138


In [48]:  decision_tree_classification = DecisionTreeClassifier(criterion = 'entropy', random_state = 10)

          decision_tree = decision_tree_classification.fit(X_train, y_train)

In [49]:  y_pred_DT=decision_tree.predict(X_test)
          accuracy_score(y_test,y_pred_DT)*100

Out[49]:  29.678769466102956

In [50]:  print(classification_report(y_test,y_pred_DT))

                       precision    recall  f1-score   support

                    1       0.19      0.19      0.19      6901
                    2       0.34      0.34      0.34     23205
```

DECISION TREE



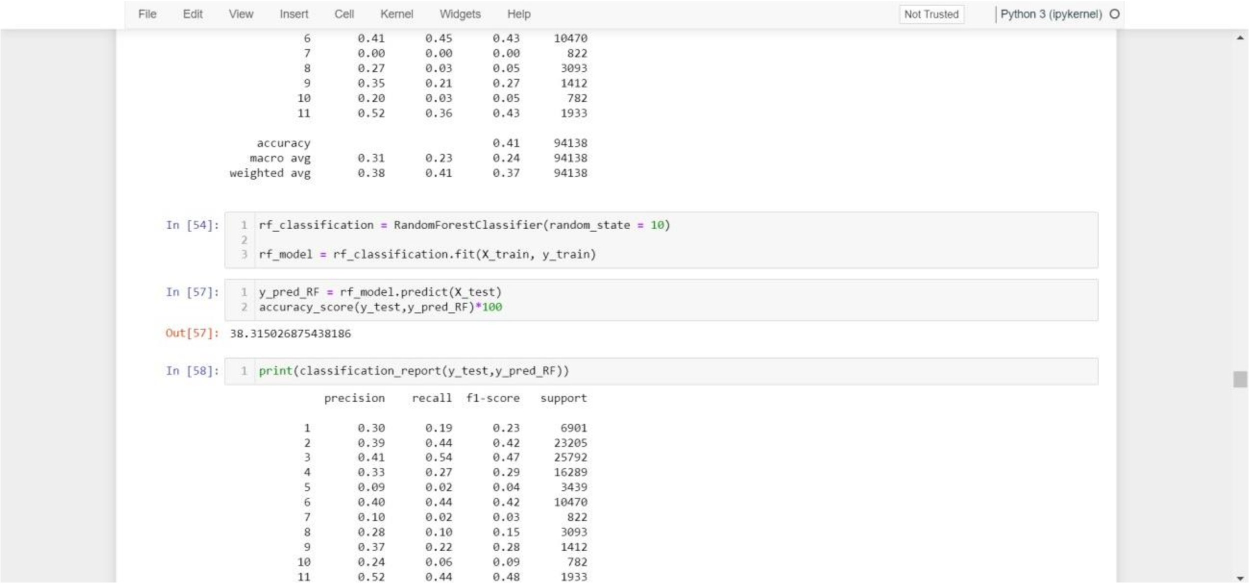
```
                   1       0.19      0.19      0.19      6901
                   2       0.34      0.34      0.34     23205
                   3       0.39      0.38      0.38     25792
                   4       0.25      0.25      0.25     16289
                   5       0.06      0.07      0.07      3439
                   6       0.31      0.30      0.31     10470
                   7       0.03      0.04      0.03       822
                   8       0.15      0.15      0.15      3093
                   9       0.22      0.23      0.22      1412
                  10       0.08      0.10      0.09       782
                  11       0.32      0.35      0.33      1933

            accuracy                           0.30     94138
           macro avg       0.21      0.22      0.21     94138
        weighted avg       0.30      0.30      0.30     94138
```

```
In [51]: dt_tuned = DecisionTreeClassifier(criterion = 'gini', max_depth=11, random_state = 10)

         decision_tree_tuned = dt_tuned.fit(X_train, y_train)
```

```
In [52]: y_pred_DT_tuned = decision_tree_tuned.predict(X_test)
         accuracy_score(y_test,y_pred_DT_tuned)*100

Out[52]: 40.82198474579872
```

```
In [53]: print(classification_report(y_test,y_pred_DT_tuned))

                      precision    recall  f1-score   support

                   1       0.36      0.13      0.19      6901
                   2       0.41      0.46      0.44     23205
                   3       0.41      0.67      0.51     25792
                   4       0.39      0.23      0.29     16289
                   5       0.07      0.00      0.00      3439
                   6       0.41      0.45      0.43     10470
```

TUNED HYPERPARAMETER DECISION TREE



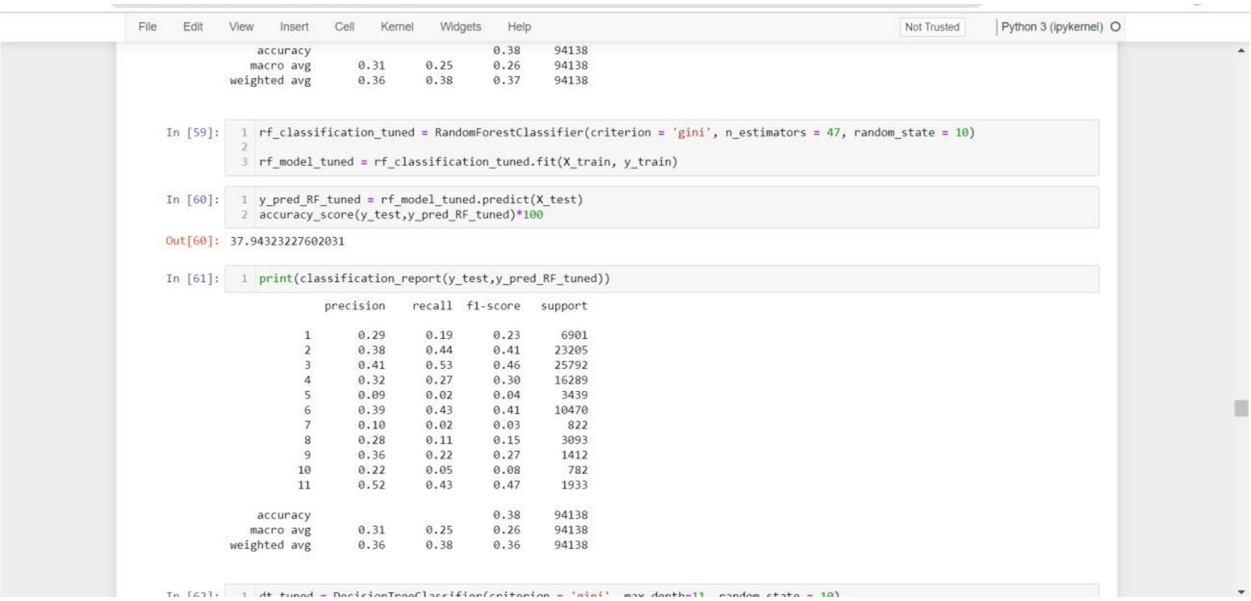
```
                   6       0.41      0.45      0.43     10470
                   7       0.00      0.00      0.00       822
                   8       0.27      0.03      0.05      3093
                   9       0.35      0.21      0.27      1412
                  10       0.20      0.03      0.05       782
                  11       0.52      0.36      0.43      1933

            accuracy                           0.41     94138
           macro avg       0.31      0.23      0.24     94138
        weighted avg       0.38      0.41      0.37     94138
```

```
In [54]: rf_classification = RandomForestClassifier(random_state = 10)

         rf_model = rf_classification.fit(X_train, y_train)
```

```
In [57]: y_pred_RF = rf_model.predict(X_test)
         accuracy_score(y_test,y_pred_RF)*100

Out[57]: 38.315026875438186
```

```
In [58]: print(classification_report(y_test,y_pred_RF))

                      precision    recall  f1-score   support

                   1       0.30      0.19      0.23      6901
                   2       0.39      0.44      0.42     23205
                   3       0.41      0.54      0.47     25792
                   4       0.33      0.27      0.29     16289
                   5       0.09      0.02      0.04      3439
                   6       0.40      0.44      0.42     10470
                   7       0.10      0.02      0.03       822
                   8       0.28      0.10      0.15      3093
                   9       0.37      0.22      0.28      1412
                  10       0.24      0.06      0.09       782
                  11       0.52      0.44      0.48      1933
```

RANDOM FOREST



```
    accuracy                           0.38     94138
   macro avg       0.31      0.25      0.26     94138
weighted avg       0.36      0.38      0.37     94138
```

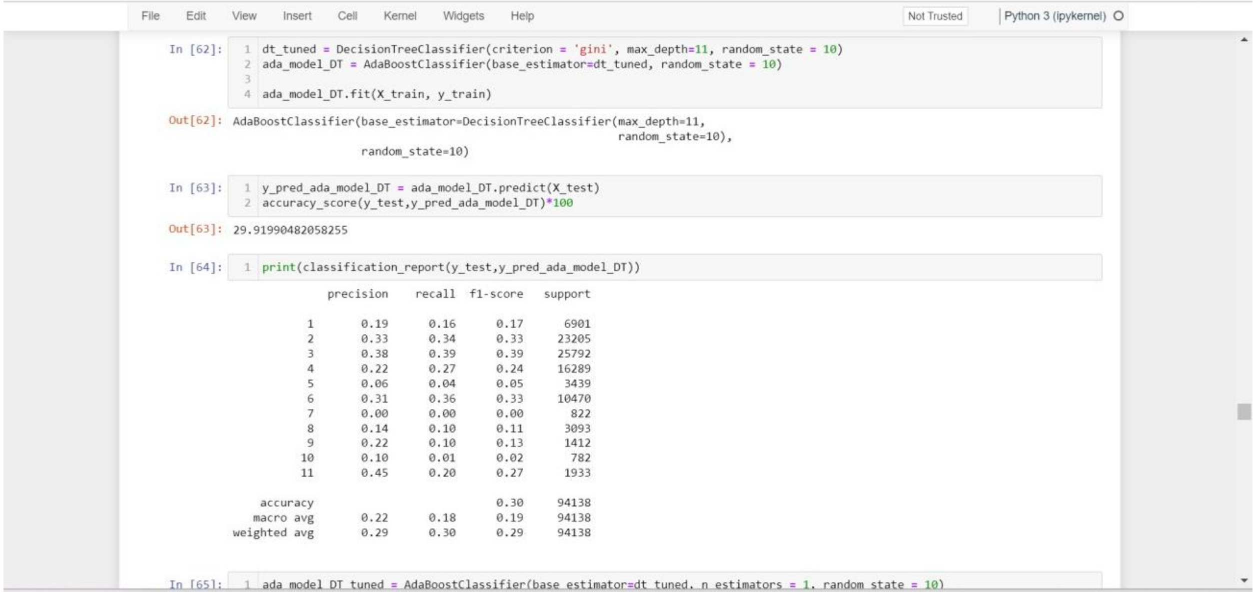
```
In [59]: rf_classification_tuned = RandomForestClassifier(criterion = 'gini', n_estimators = 47, random_state = 10)

         rf_model_tuned = rf_classification_tuned.fit(X_train, y_train)
```

```
In [60]: y_pred_RF_tuned = rf_model_tuned.predict(X_test)
         accuracy_score(y_test,y_pred_RF_tuned)*100

Out[60]: 37.94323227602031
```

```
In [61]: print(classification_report(y_test,y_pred_RF_tuned))

              precision    recall  f1-score   support

           1       0.29      0.19      0.23      6901
           2       0.38      0.44      0.41     23205
           3       0.41      0.53      0.46     25792
           4       0.32      0.27      0.30     16289
           5       0.09      0.02      0.04      3439
           6       0.39      0.43      0.41     10470
           7       0.10      0.02      0.03       822
           8       0.28      0.11      0.15      3093
           9       0.36      0.22      0.27      1412
          10       0.22      0.05      0.08       782
          11       0.52      0.43      0.47      1933

    accuracy                           0.38     94138
   macro avg       0.31      0.25      0.26     94138
weighted avg       0.36      0.38      0.36     94138
```

```
In [62]: dt_tuned = DecisionTreeClassifier(criterion = 'gini', max_depth=11, random_state = 10)
```

TUNED HYPERPARAMETER RANDOM FOREST AND ADA BOOST-DECISION TREE



```
In [62]: dt_tuned = DecisionTreeClassifier(criterion = 'gini', max_depth=11, random_state = 10)
         ada_model_DT = AdaBoostClassifier(base_estimator=dt_tuned, random_state = 10)

         ada_model_DT.fit(X_train, y_train)

Out[62]: AdaBoostClassifier(base_estimator=DecisionTreeClassifier(max_depth=11,
                                                                  random_state=10),
                            random_state=10)
```

```
In [63]: y_pred_ada_model_DT = ada_model_DT.predict(X_test)
         accuracy_score(y_test,y_pred_ada_model_DT)*100

Out[63]: 29.91990482058255
```

```
In [64]: print(classification_report(y_test,y_pred_ada_model_DT))

              precision    recall  f1-score   support

           1       0.19      0.16      0.17      6901
           2       0.33      0.34      0.33     23205
           3       0.38      0.39      0.39     25792
           4       0.22      0.27      0.24     16289
           5       0.06      0.04      0.05      3439
           6       0.31      0.36      0.33     10470
           7       0.00      0.00      0.00       822
           8       0.14      0.10      0.11      3093
           9       0.22      0.10      0.13      1412
          10       0.10      0.01      0.02       782
          11       0.45      0.20      0.27      1933

    accuracy                           0.30     94138
   macro avg       0.22      0.18      0.19     94138
weighted avg       0.29      0.30      0.29     94138
```

```
In [65]: ada_model_DT_tuned = AdaBoostClassifier(base_estimator=dt_tuned, n_estimators = 1, random_state = 10)
```