MM20B007 DAL Assignment 6

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

from sklearn.experimental import enable_iterative_imputer
from sklearn.impute import SimpleImputer, IterativeImputer
from sklearn.metrics import mean_squared_error, precision_score,
accuracy_score, f1_score, roc_auc_score
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.preprocessing import StandardScaler
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score, confusion_matrix,
classification_report, roc_curve

train_data_path = '/content/drive/MyDrive/sem 7/EE5708/Assignment
6/pulsar_data_train.xlsx'
test_data_path = '/content/drive/MyDrive/sem 7/EE5708/Assignment
6/pulsar_data_test.xlsx'

train_data = pd.read_excel(train_data_path)

train_data.head()
```

```
    Mean of the integrated profile  \
0                       121.156250
1                        76.968750
2                       130.585938
3                       156.398438
4                        84.804688

    Standard deviation of the integrated profile  \
0                                      48.372971
1                                      36.175557
2                                      53.229534
3                                      48.865942
4                                      36.117659

    Excess kurtosis of the integrated profile  \
0                                    0.375485
1                                    0.712898
2                                    0.133408
3                                   -0.215989
4                                    0.825013

    Skewness of the integrated profile   Mean of the DM-SNR curve  \
```

```
0                               -0.013165                     3.168896
1                                3.388719                     2.399666
2                               -0.297242                     2.743311
3                               -0.171294                    17.471572
4                                3.274125                     2.790134

    Standard deviation of the DM-SNR curve  \
0                                 18.399367
1                                 17.570997
2                                 22.362553
3                                       NaN
4                                 20.618009

    Excess kurtosis of the DM-SNR curve   Skewness of the DM-SNR curve
\
0                                 7.449874                      65.159298

1                                 9.414652                     102.722975

2                                 8.508364                      74.031324

3                                 2.958066                       7.197842

4                                 8.405008                      76.291128


   target_class
0             0
1             0
2             0
3             0
4             0

train_data.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 12528 entries, 0 to 12527
Data columns (total 9 columns):
 #   Column                                            Non-Null Count
Dtype
---  ------                                            --------------
-----
 0    Mean of the integrated profile                   12528 non-null
float64
 1    Standard deviation of the integrated profile     12528 non-null
float64
 2    Excess kurtosis of the integrated profile        10793 non-null
float64
 3    Skewness of the integrated profile               12528 non-null
float64
```

```
 4    Mean of the DM-SNR curve                          12528 non-null
float64
 5    Standard deviation of the DM-SNR curve            11350 non-null
float64
 6    Excess kurtosis of the DM-SNR curve               12528 non-null
float64
 7    Skewness of the DM-SNR curve                      11903 non-null
float64
 8   target_class                                       12528 non-null
int64
dtypes: float64(8), int64(1)
memory usage: 881.0 KB

train_data.describe()

        Mean of the integrated profile  \
count                     12528.000000
mean                        111.041841
std                          25.672828
min                           5.812500
25%                         100.871094
50%                         115.183594
75%                         127.109375
max                         189.734375

        Standard deviation of the integrated profile  \
count                                     12528.000000
mean                                         46.521437
std                                           6.801077
min                                          24.772042
25%                                          42.362222
50%                                          46.931022
75%                                          50.979103
max                                          91.808628

        Excess kurtosis of the integrated profile  \
count                                   10793.000000
mean                                        0.478548
std                                         1.064708
min                                        -1.738021
25%                                         0.024652
50%                                         0.223678
75%                                         0.473125
max                                         8.069522

        Skewness of the integrated profile   Mean of the DM-SNR curve
\
count                           12528.000000                12528.000000

mean                                1.778431                   12.674758
```

```
std                                  6.208450                    29.613230

min                                 -1.791886                     0.213211

25%                                 -0.188142                     1.910535

50%                                  0.203317                     2.792642

75%                                  0.932374                     5.413253

max                                 68.101622                   222.421405


        Standard deviation of the DM-SNR curve  \
count                                11350.000000
mean                                    26.351318
std                                     19.610842
min                                      7.370432
25%                                     14.404353
50%                                     18.412402
75%                                     28.337418
max                                    110.642211

        Excess kurtosis of the DM-SNR curve   Skewness of the DM-SNR
curve  \
count                             12528.000000
11903.000000
mean                                  8.333489
105.525779
std                                   4.535783
107.399585
min                                  -3.139270                        -
1.976976
25%                                   5.803063
35.199899
50%                                   8.451097
83.126301
75%                                  10.727927
139.997850
max                                  34.539844
1191.000837

       target_class
count  12528.000000
mean       0.092034
std        0.289085
min        0.000000
25%        0.000000
50%        0.000000
```

```
75%         0.000000
max         1.000000
```

```
for cols in list(train_data.columns):
  s = train_data[cols].isna().sum()
  print(f'No. of missing values in {cols} are {s}')
```

```
No. of missing values in  Mean of the integrated profile are 0
No. of missing values in  Standard deviation of the integrated profile
are 0
No. of missing values in  Excess kurtosis of the integrated profile
are 1735
No. of missing values in  Skewness of the integrated profile are 0
No. of missing values in  Mean of the DM-SNR curve are 0
No. of missing values in  Standard deviation of the DM-SNR curve are
1178
No. of missing values in  Excess kurtosis of the DM-SNR curve are 0
No. of missing values in  Skewness of the DM-SNR curve are 625
No. of missing values in target_class are 0
```

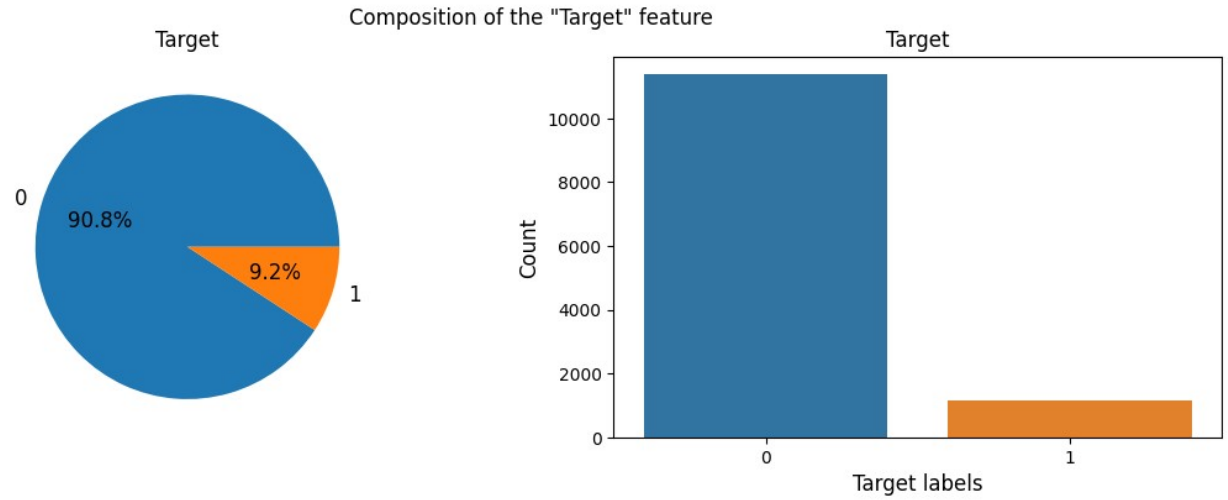
Observations

1. There are total of 12528 datapoints for each of 8 features and 1 target.
2. There are 3 features with missing data points
   - Excess kurtosis of the integrated profile - 1735
   - Standard deviation of the DM-SNR curve - 1178
   - Skewness of the DM-SNR curve - 625

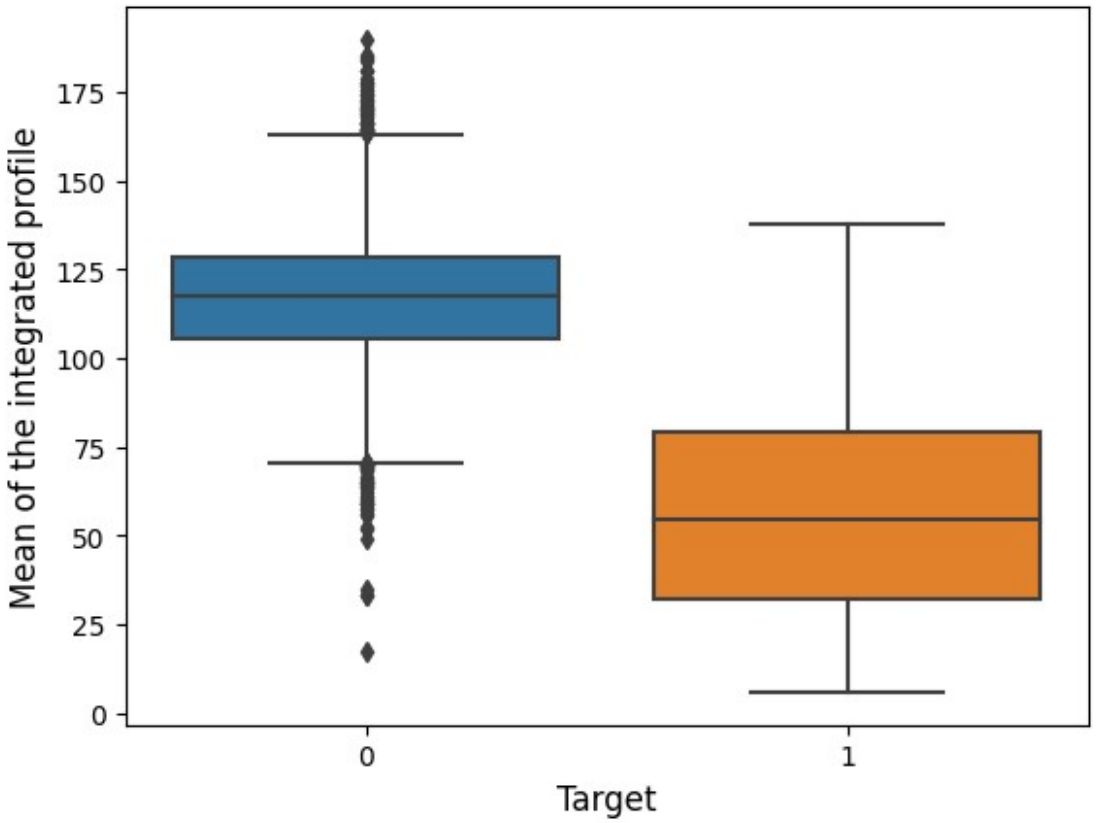
```
df = train_data.copy()
```

```
fig, ax = plt.subplots(1, 2, figsize = (14, 4))
fig.suptitle('Composition of the "Target" feature')
df['target_class'].value_counts().plot.pie(ax = ax[0],autopct='%1.1f%
%',shadow=False, textprops={'fontsize': 12})
ax[0].set_title('Target')
ax[0].set_ylabel(None)
sns.countplot(x = 'target_class', data = df, ax=ax[1])
ax[1].set_title('Target')
ax[1].set_ylabel('Count', fontsize = 12)
ax[1].set_xlabel('Target labels', fontsize = 12)
```

```
Text(0.5, 0, 'Target labels')
```

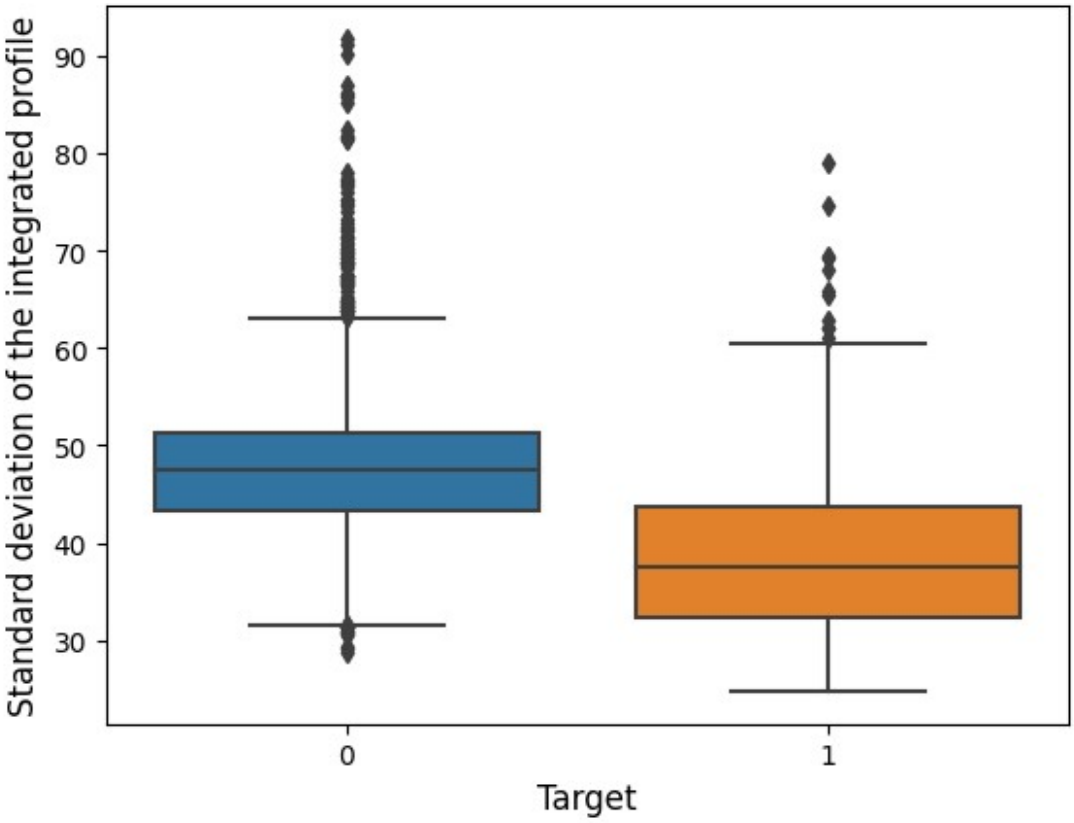



```
sns.boxplot(df, y = ' Mean of the integrated profile' ,x =
'target_class')
plt.ylabel('Mean of the integrated profile', fontsize = 12)
plt.xlabel('Target', fontsize = 12)

Text(0.5, 0, 'Target')
```



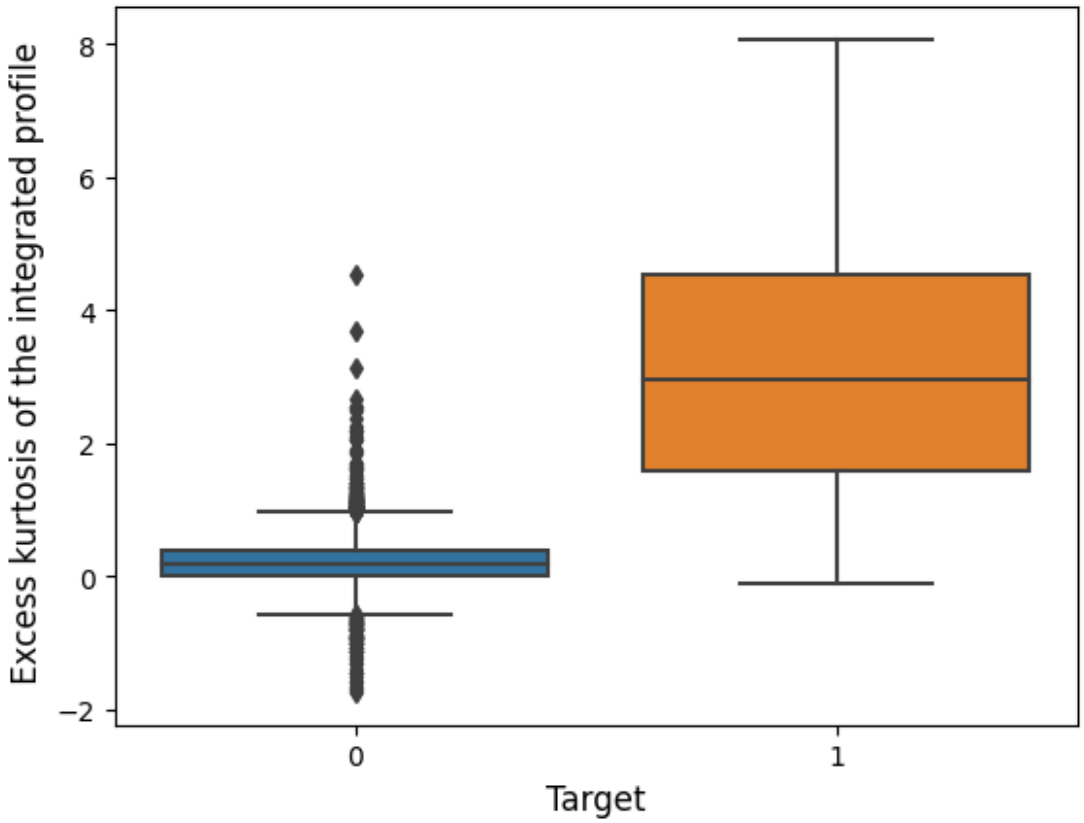
```
sns.boxplot(df, y = ' Standard deviation of the integrated profile' ,x
= 'target_class')
plt.ylabel('Standard deviation of the integrated profile', fontsize =
12)
plt.xlabel('Target', fontsize = 12)
```

```
Text(0.5, 0, 'Target')
```



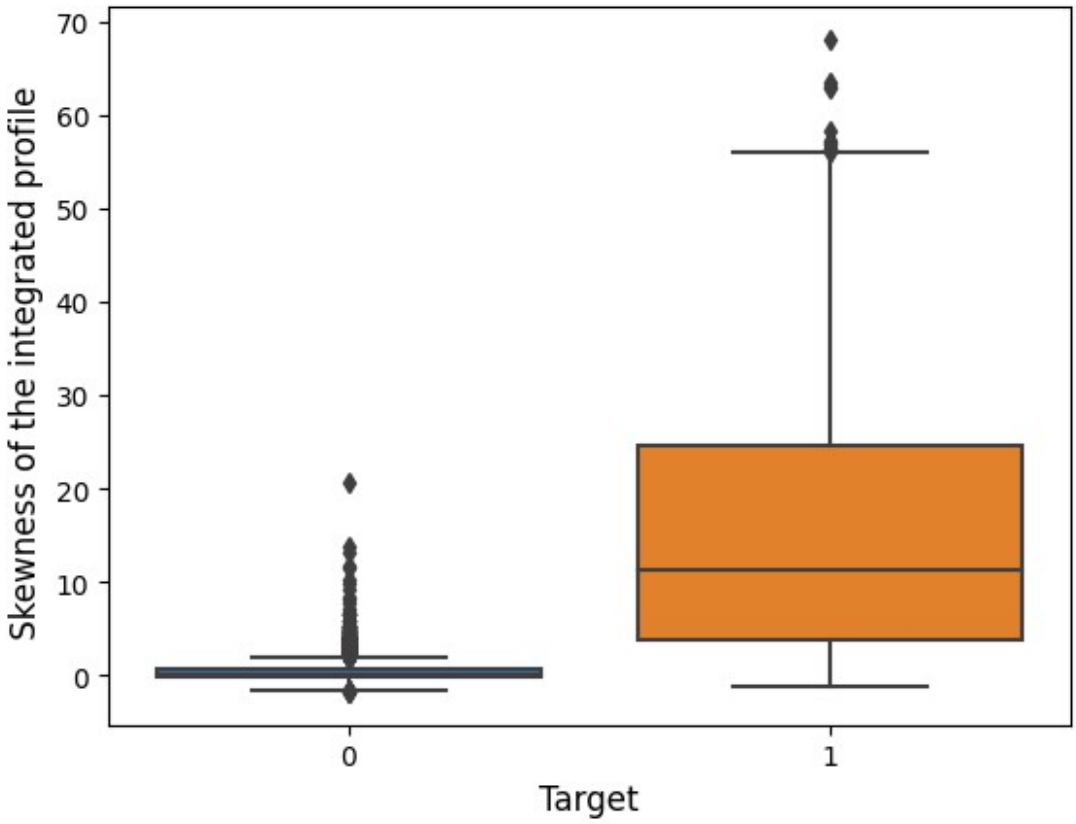

```
sns.boxplot(df, y = ' Excess kurtosis of the integrated profile' ,x =
'target_class')
plt.ylabel(' Excess kurtosis of the integrated profile', fontsize =
12)
plt.xlabel('Target', fontsize = 12)
```

```
Text(0.5, 0, 'Target')
```

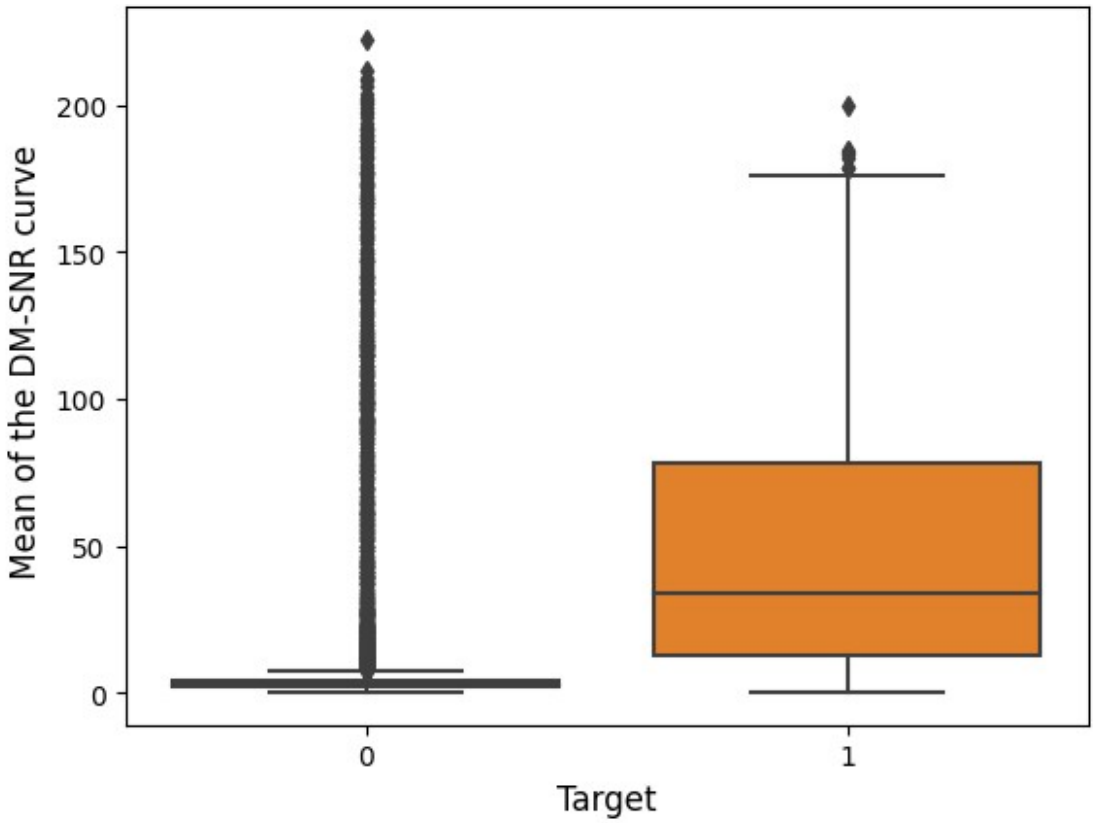



```
sns.boxplot(df, y = ' Skewness of the integrated profile' ,x =
'target_class')
plt.ylabel(' Skewness of the integrated profile', fontsize = 12)
plt.xlabel('Target', fontsize = 12)
```

```
Text(0.5, 0, 'Target')
```

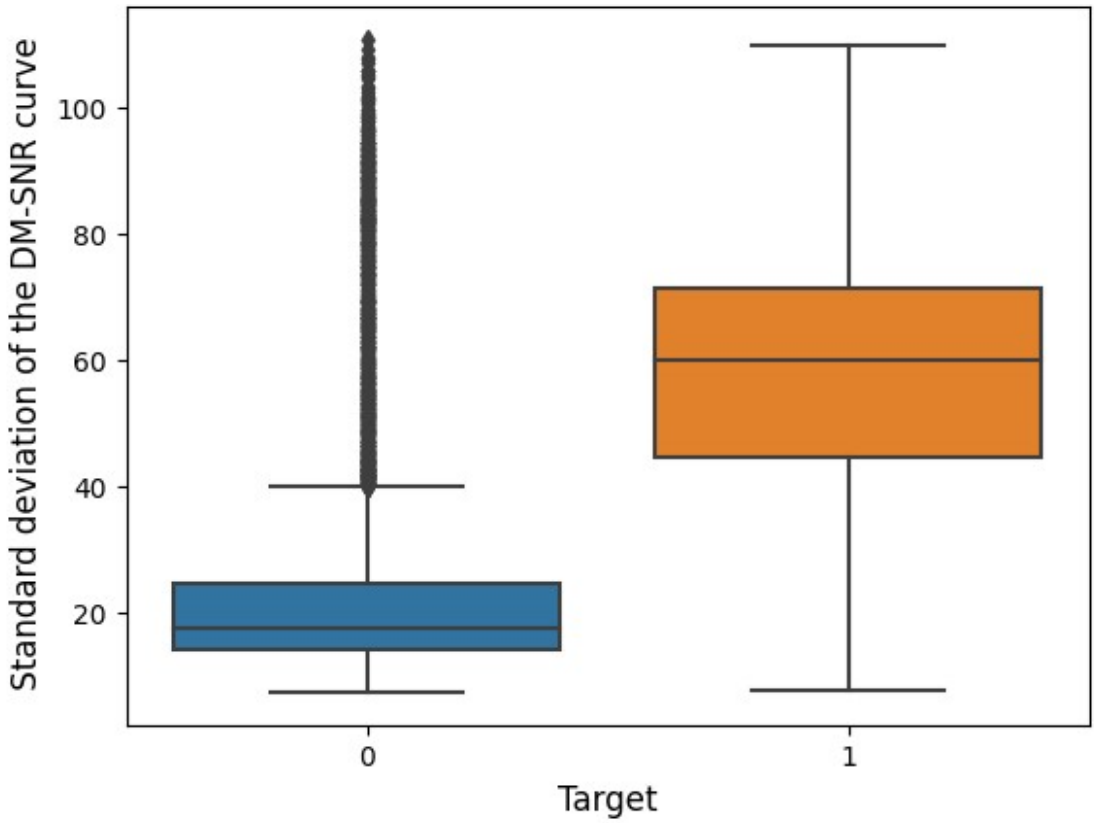



```
sns.boxplot(df, y = ' Mean of the DM-SNR curve' ,x = 'target_class')
plt.ylabel(' Mean of the DM-SNR curve', fontsize = 12)
plt.xlabel('Target', fontsize = 12)

Text(0.5, 0, 'Target')
```



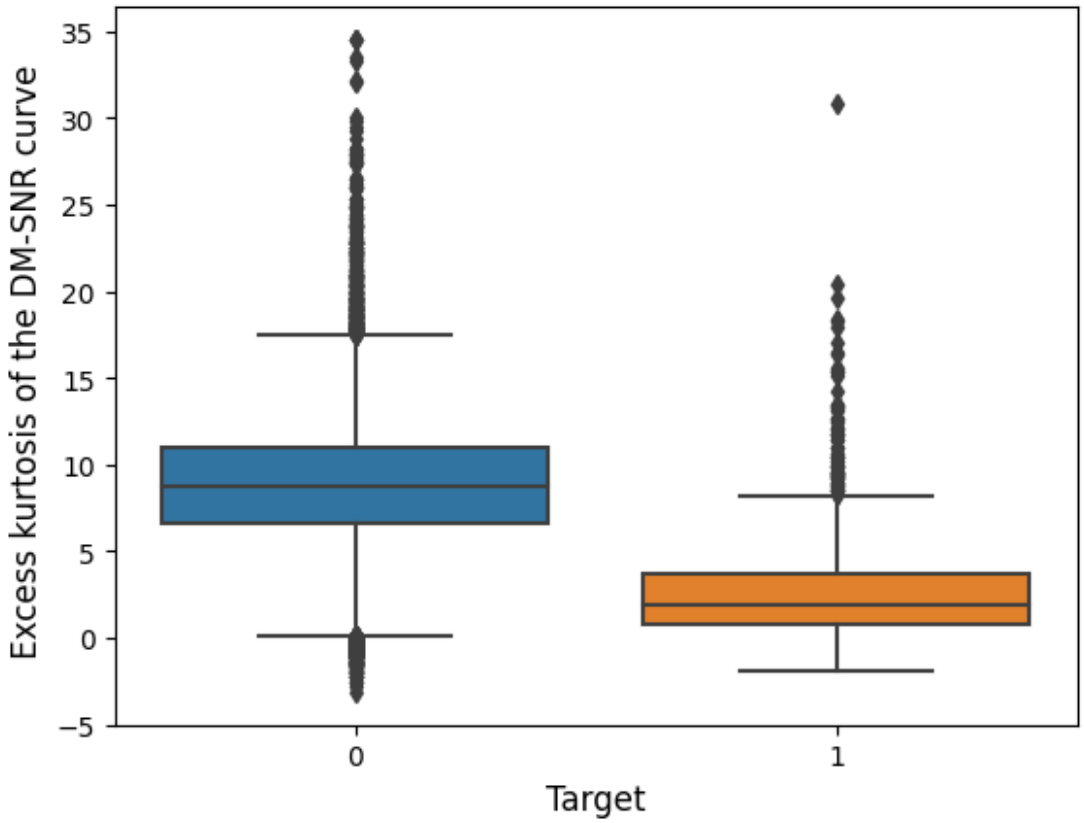

```
sns.boxplot(df, y = ' Standard deviation of the DM-SNR curve' ,x =
'target_class')
plt.ylabel(' Standard deviation of the DM-SNR curve', fontsize = 12)
plt.xlabel('Target', fontsize = 12)
```

```
Text(0.5, 0, 'Target')
```



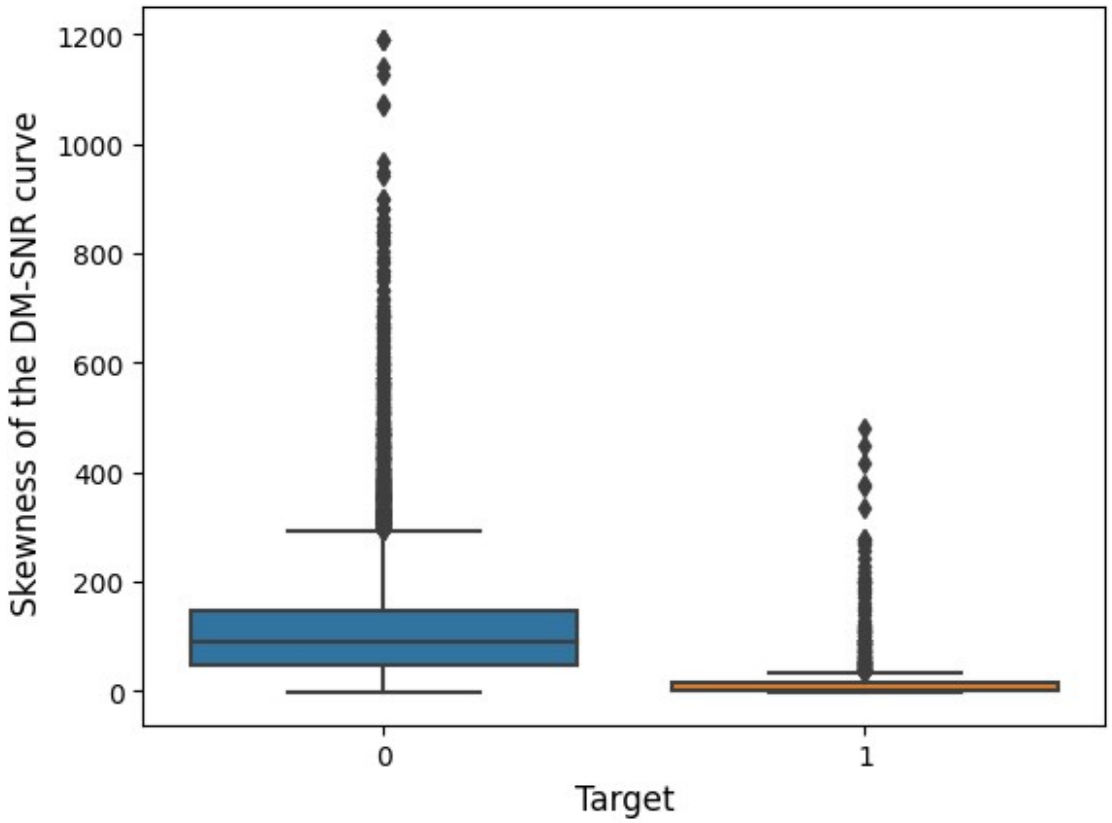

```
sns.boxplot(df, y = ' Excess kurtosis of the DM-SNR curve' ,x =
'target_class')
plt.ylabel(' Excess kurtosis of the DM-SNR curve', fontsize = 12)
plt.xlabel('Target', fontsize = 12)
```

```
Text(0.5, 0, 'Target')
```

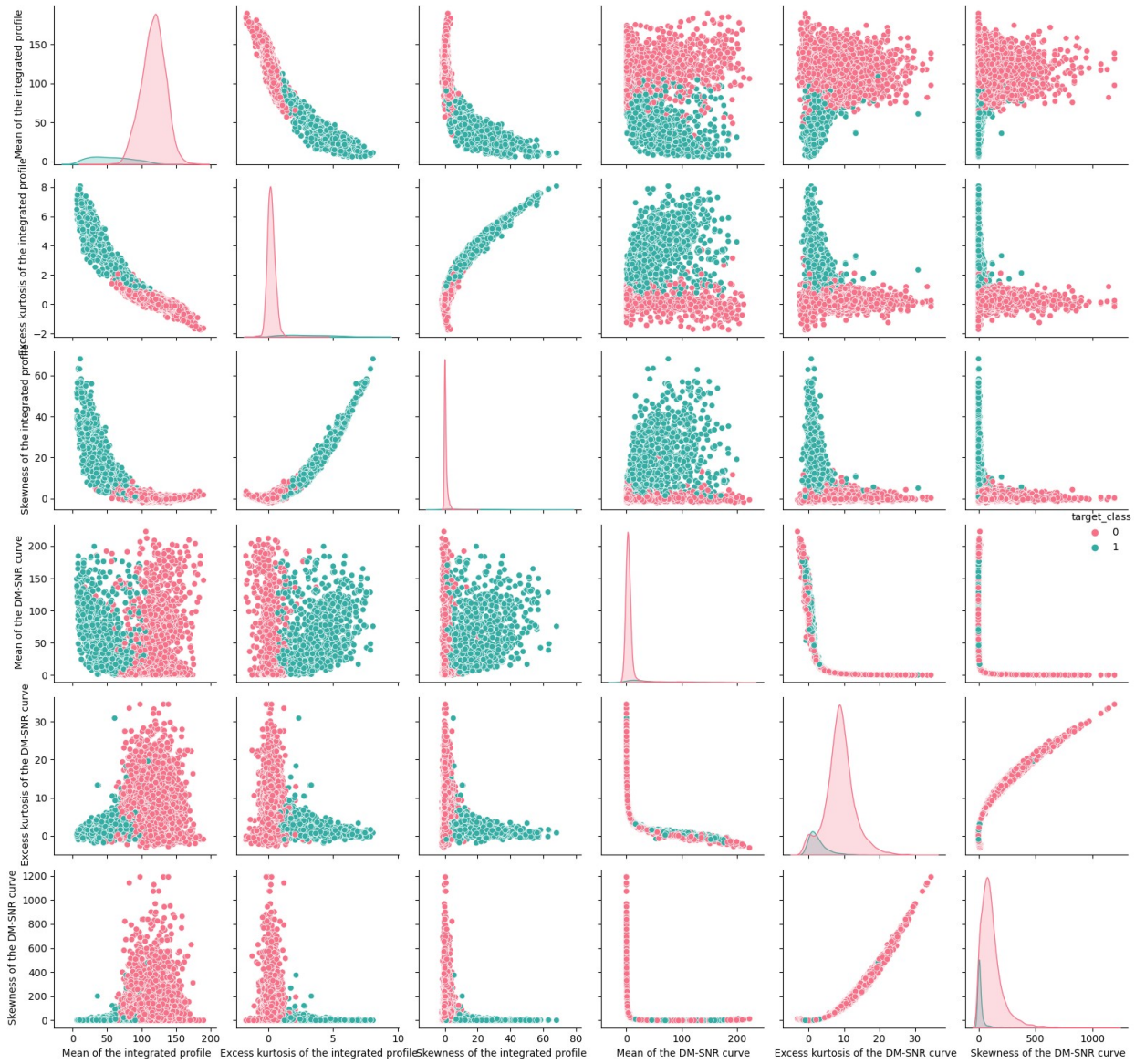



```
sns.boxplot(df, y = ' Skewness of the DM-SNR curve' ,x =
'target_class')
plt.ylabel(' Skewness of the DM-SNR curve', fontsize = 12)
plt.xlabel('Target', fontsize = 12)
```

```
Text(0.5, 0, 'Target')
```

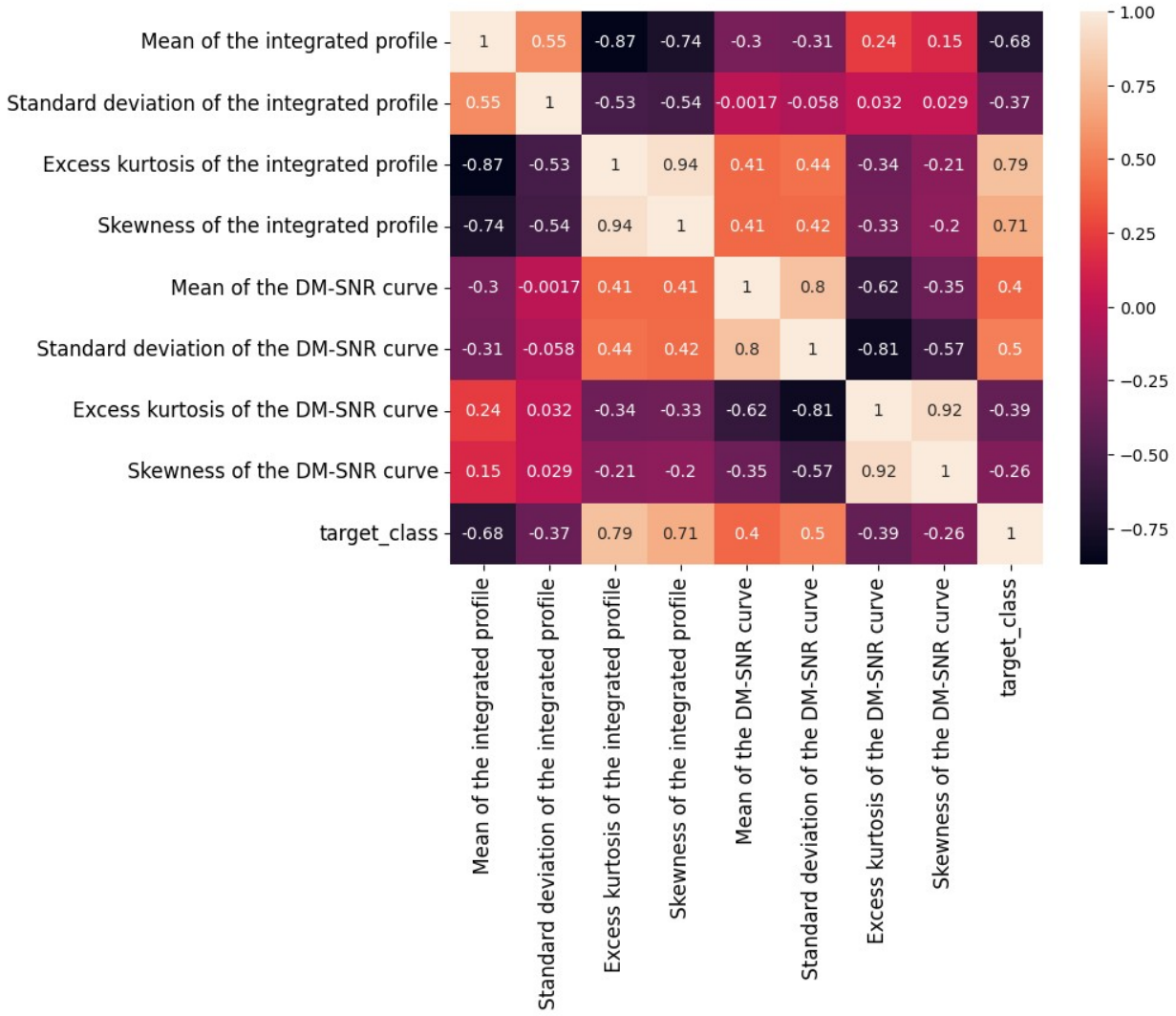



```
sns.pairplot(data=df,
             palette="husl",
             hue="target_class",
             vars=[" Mean of the integrated profile",
                   " Excess kurtosis of the integrated profile",
                   " Skewness of the integrated profile",
                   " Mean of the DM-SNR curve",
                   " Excess kurtosis of the DM-SNR curve",
                   " Skewness of the DM-SNR curve"])

# plt.suptitle("PairPlot of Data Without Std. Dev.
Fields",fontsize=18)

plt.tight_layout()
plt.show()
```




```
plt.figure(figsize = (8, 6))
sns.heatmap(df.corr(), annot = True)
plt.xticks(rotation = 90, fontsize = 12)
plt.yticks(rotation = 0, fontsize = 12)
```

```
(array([0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5, 7.5, 8.5]),
 [Text(0, 0.5, ' Mean of the integrated profile'),
  Text(0, 1.5, ' Standard deviation of the integrated profile'),
  Text(0, 2.5, ' Excess kurtosis of the integrated profile'),
  Text(0, 3.5, ' Skewness of the integrated profile'),
  Text(0, 4.5, ' Mean of the DM-SNR curve'),
  Text(0, 5.5, ' Standard deviation of the DM-SNR curve'),
  Text(0, 6.5, ' Excess kurtosis of the DM-SNR curve'),
  Text(0, 7.5, ' Skewness of the DM-SNR curve'),
  Text(0, 8.5, 'target_class')])
```



Observations

From the correlation heatmap it is clear that

1. Excess kurtosis of the integrated profile, Skewness of the integrated profile, and Standard deviation of the DM-SNR curve have high positive correlation (greater than 0.5) with the target class feature.
2. Apart from Mean of the DM-SNR curve, all reamining features have negative association with the target class feature.

Handling Missing Values

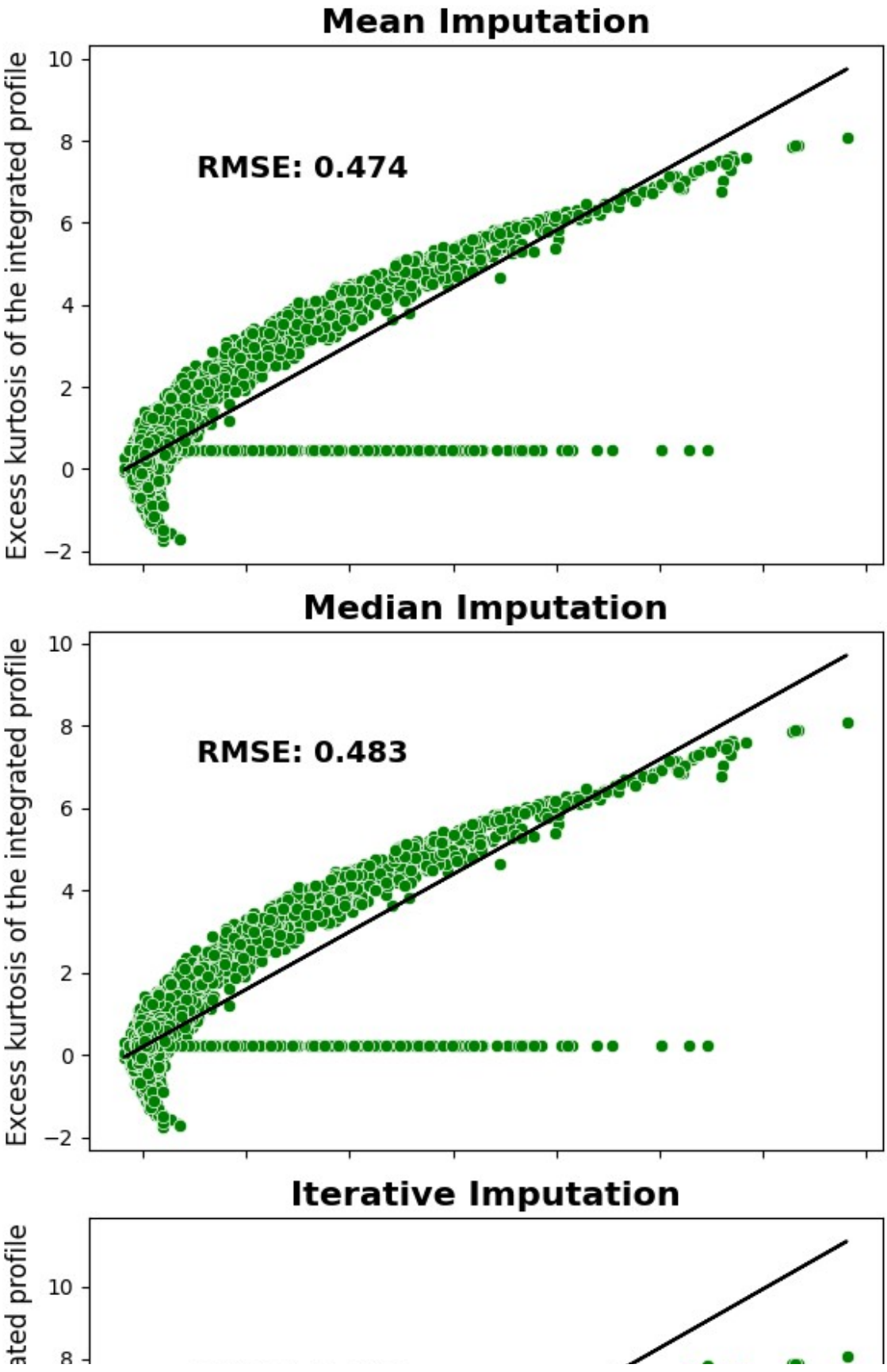
```
# Median Imputation
median_imputation = SimpleImputer(strategy = 'median')
median_imputed = median_imputation.fit_transform(df)
df_median_imputed = pd.DataFrame(median_imputed, columns = df.columns)
```

```
# Mean Imputation
mean_imputation = SimpleImputer(strategy = 'mean')
mean_imputed = mean_imputation.fit_transform(df)
df_mean_imputed = pd.DataFrame(mean_imputed, columns = df.columns)

# Iterative Imputation
iter_imputer = IterativeImputer(random_state=42)
iter_imputed = iter_imputer.fit_transform(df)
df_iter_imputed = pd.DataFrame(iter_imputed, columns = df.columns)
```

For verification of the imputations and plotting I have opted ' Excess kurtosis of the integrated profile' and ' Skewness of the integrated profile' because they have high positive association of 0.79, which can be seen in the plots.

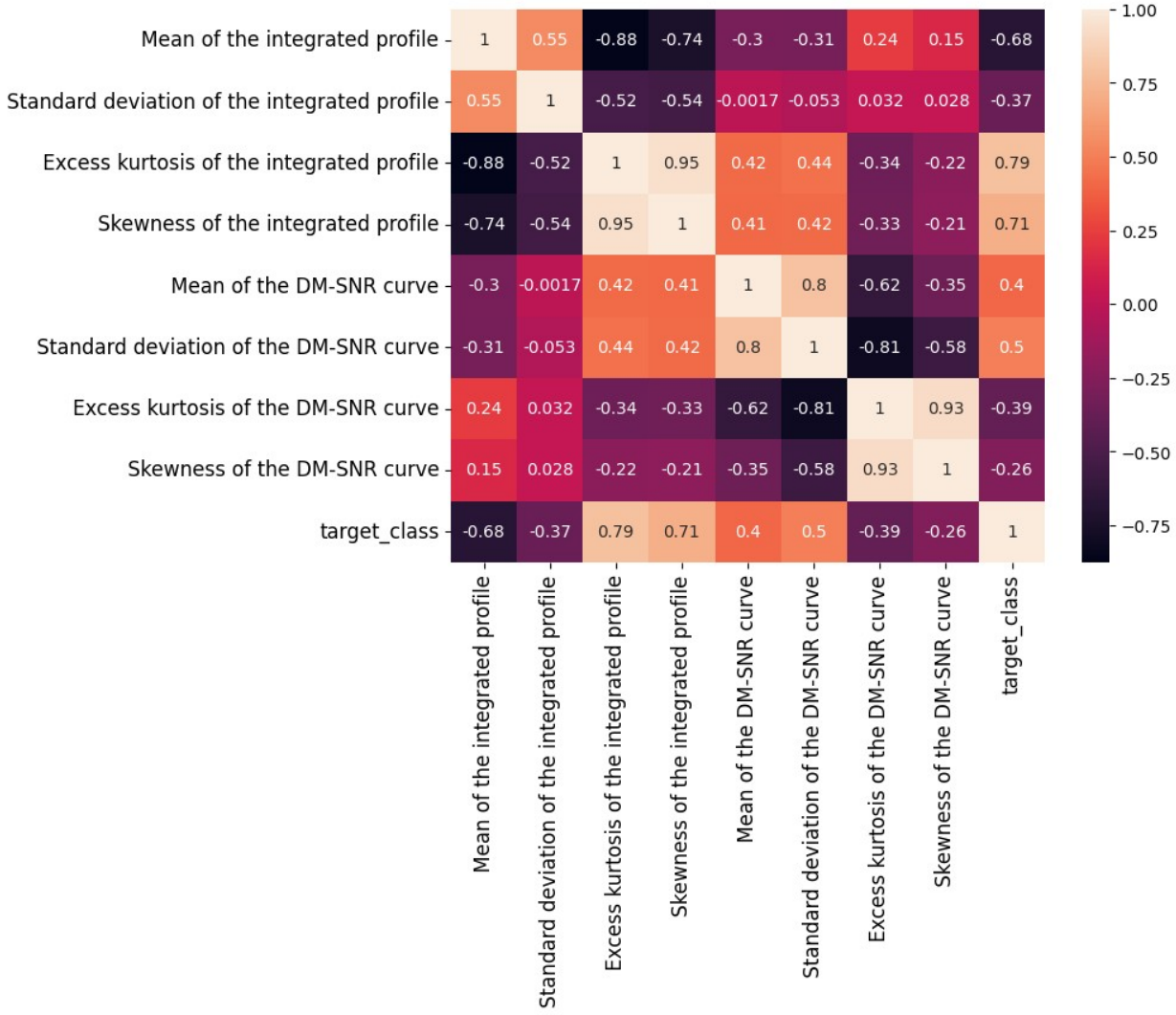
```
fig, axes = plt.subplots(nrows=3, ncols=1, sharex=True, figsize = (6,
12))
axes = np.reshape(axes, -1)

dfs = [df_mean_imputed, df_median_imputed, df_iter_imputed]
titles = ['Mean Imputation', 'Median Imputation', 'Iterative
Imputation']

for i, df in enumerate(dfs):
    # Plotting the data
    x = df[' Skewness of the integrated profile']
    y = df[' Excess kurtosis of the integrated profile']
    sns.scatterplot(x=x, y=y, ax=axes[i], color='green')

    # Fitting and plotting a linear regression line
    m, b = np.polyfit(x, y, 1)
    linreg = m * x + b
    axes[i].plot(x, linreg, color='black')

    # Setting the titles and including the RMSE values
    axes[i].set_title(titles[i], fontsize=16, fontweight='bold')
    rmse = round(mean_squared_error(y, linreg, squared=False), 3)
    text_x = min(x) + 0.1 * (max(x) - min(x))
    text_y = min(y) + 0.9 * (max(y) - min(y))
    axes[i].text(text_x, text_y, f'RMSE: {rmse}', fontsize=14,
fontweight='bold')

    # Set y-axis label
    axes[i].set_ylabel("Excess kurtosis of the integrated profile",
fontsize = 12)

# Set a common x-axis label
axes[-1].set_xlabel("Skewness of the integrated profile", fontsize =
12)
```

```
plt.tight_layout()
plt.show()
```


Mean Imputation
RMSE: 0.474
Excess kurtosis of the integrated profile
10
8
6
4
2
0
−2
Median Imputation
RMSE: 0.483
Excess kurtosis of the integrated profile
10
8
6
4
2
0
−2
Iterative Imputation
ated profile
10
8

```
plt.figure(figsize = (8, 6))
sns.heatmap(df_iter_imputed.corr(), annot = True)
plt.xticks(rotation = 90, fontsize = 12)
plt.yticks(rotation = 0, fontsize = 12)
```

```
(array([0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5, 7.5, 8.5]),
 [Text(0, 0.5, ' Mean of the integrated profile'),
  Text(0, 1.5, ' Standard deviation of the integrated profile'),
  Text(0, 2.5, ' Excess kurtosis of the integrated profile'),
  Text(0, 3.5, ' Skewness of the integrated profile'),
  Text(0, 4.5, ' Mean of the DM-SNR curve'),
  Text(0, 5.5, ' Standard deviation of the DM-SNR curve'),
  Text(0, 6.5, ' Excess kurtosis of the DM-SNR curve'),
  Text(0, 7.5, ' Skewness of the DM-SNR curve'),
  Text(0, 8.5, 'target_class')])
```



Train Validation split

```
X = df_iter_imputed.drop('target_class', axis = 1)
y = df_iter_imputed['target_class']

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size =
0.2, random_state = 42)

scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)

X_train = pd.DataFrame(X_train, columns = list(X.columns))
X_test = pd.DataFrame(X_test, columns = list(X.columns))

X_train.head()
```

```
    Mean of the integrated profile  \
0                         -0.014800
1                          0.656612
2                          0.519490
3                         -0.135008
4                          0.837226

    Standard deviation of the integrated profile  \
0                                       0.008072
1                                      -0.935945
2                                       0.077371
3                                      -0.117301
4                                      -0.515738

    Excess kurtosis of the integrated profile  \
0                                   -0.200569
1                                   -0.434856
2                                   -0.382747
3                                   -0.093828
4                                   -0.549088

    Skewness of the integrated profile   Mean of the DM-SNR curve  \
0                            -0.267138                  -0.327459
1                            -0.182541                  -0.269155
2                            -0.261074                  -0.384134
3                            -0.159627                  -0.362088
4                            -0.214350                  -0.351977

    Standard deviation of the DM-SNR curve  \
0                                -0.345614
1                                -0.141328
2                                -0.600240
```

```
3                                    -0.620212
4                                    -0.410801

    Excess kurtosis of the DM-SNR curve   Skewness of the DM-SNR curve

0                             -0.060276                      -0.265333

1                             -0.547480                      -0.631169

2                              1.028518                       0.732324

3                              0.469943                       0.272002

4                              0.208092                      -0.103956
```

SVM with Default Parameters

```
svc = SVC()
svc.fit(X_train, y_train)
y_pred = svc.predict(X_test)
print(f'The accuracy of the model with default parameters is:
{round(accuracy_score(y_test, y_pred), 4)}')
```

```
The accuracy of the model with default parameters is: 0.9816
```

```
# Checking for overfitting and underfitting
print(f'Training data score: {round(svc.score(X_train, y_train), 4)}')
print(f'Test data score: {round(svc.score(X_test, y_test), 4)}')
```

```
Training data score: 0.9796
Test data score: 0.9816
```

Since both the scores are comparable so there are no chance of overfitting or underfitting.

So, the models accuracy is 0.9816, let's very this score with null accuracy.

```
y_test.value_counts()
```

```
0.0    2279
1.0     227
Name: target_class, dtype: int64
```

```
y_test.size
```

```
2506
```

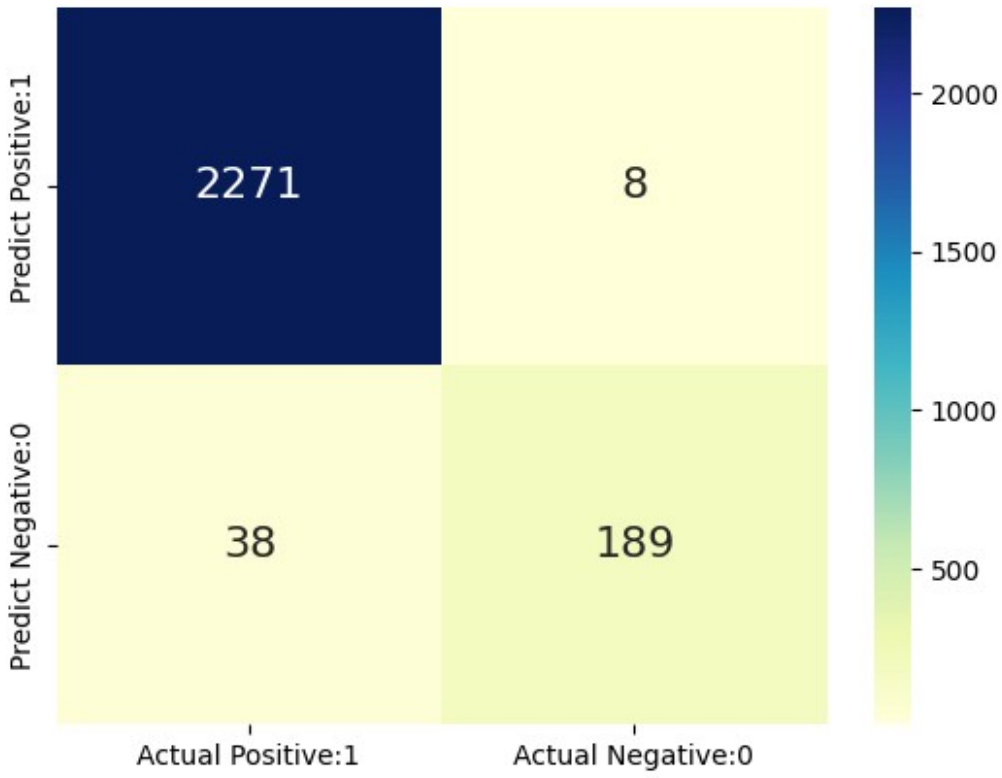
```
# Since 0 is the most frequent class

null_accuracy = (y_test == 0).sum() / y_test.size
print(f'The null accuracy of the model is: {round(null_accuracy, 4)}')
```

```
The null accuracy of the model is: 0.9094
```

So, the accuracy achieved by the model is greater than that of null accuracy hence our model is doing well.

```
cm = confusion_matrix(y_test, y_pred)
data_cm = pd.DataFrame(data=cm, columns=['Actual Positive:1', 'Actual
Negative:0'],
                                    index=['Predict Positive:1', 'Predict
Negative:0'])
sns.heatmap(data_cm, annot = True, fmt='d', cmap='YlGnBu', annot_kws =
{'size': 16})
```

```
<Axes: >
```

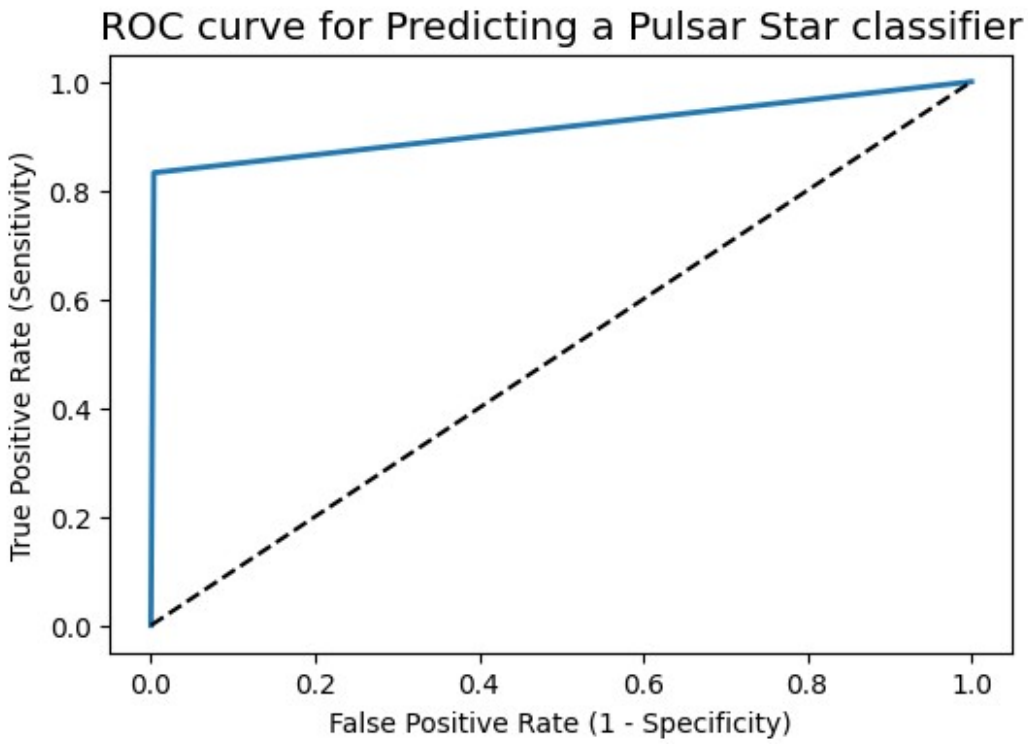



```
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

         0.0       0.98      1.00      0.99      2279
```

```
         1.0       0.96      0.83      0.89       227

    accuracy                           0.98      2506
   macro avg       0.97      0.91      0.94      2506
weighted avg       0.98      0.98      0.98      2506
```

```
fpr, tpr, thresholds = roc_curve(y_test, y_pred)

plt.figure(figsize=(6,4))
plt.plot(fpr, tpr, linewidth=2)
plt.plot([0,1], [0,1], 'k--' )
plt.rcParams['font.size'] = 12
plt.title('ROC curve for Predicting a Pulsar Star classifier')
plt.xlabel('False Positive Rate (1 - Specificity)')
plt.ylabel('True Positive Rate (Sensitivity)')
plt.show()
```




```
print(f'The accuracy of the model is: {round(accuracy_score(y_test,
y_pred), 4)}')
print(f'The precision of the model is: {round(precision_score(y_test,
y_pred), 4)}')
print(f'The f1 score of the model is: {round(f1_score(y_test, y_pred),
4)}')
print(f'The ROC AUC score of the model is:
{round(roc_auc_score(y_test, y_pred), 4)}')
```

```
The accuracy of the model is: 0.9816
The precision of the model is: 0.9594
The f1 score of the model is: 0.8915
The ROC AUC score of the model is: 0.9145
```

Hyper parameter tuning

```
parameters = [
    {'C': [1, 10, 100, 1000], 'kernel': ['linear']},
    {'C': [1, 10, 100, 1000], 'kernel': ['rbf'], 'gamma': [0.1, 0.2,
0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9]},
    {'C': [1, 10, 100, 1000], 'kernel': ['sigmoid'], 'gamma': [0.1,
0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9]},
    {'C': [1, 10, 100, 1000], 'kernel': ['poly'], 'degree': [2, 3, 4,
5], 'gamma': [0.01, 0.02, 0.03, 0.04, 0.05]}
]


grid_search = GridSearchCV(estimator = svc, param_grid = parameters,
scoring = 'accuracy')
grid_search.fit(X_train, y_train)
```

```
GridSearchCV(estimator=SVC(),
             param_grid=[{'C': [1, 10, 100, 1000], 'kernel':
['linear']},
                         {'C': [1, 10, 100, 1000],
                          'gamma': [0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7,
0.8,
                                    0.9],
                          'kernel': ['rbf']},
                         {'C': [1, 10, 100, 1000],
                          'gamma': [0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7,
0.8,
                                    0.9],
                          'kernel': ['sigmoid']},
                         {'C': [1, 10, 100, 1000], 'degree': [2, 3, 4,
5],
                          'gamma': [0.01, 0.02, 0.03, 0.04, 0.05],
                          'kernel': ['poly']}],
             scoring='accuracy')
```

```
# best score achieved during the GridSearchCV
print('GridSearch CV best score : {:.4f}\n\
n'.format(grid_search.best_score_))


# print parameters that give the best results
print('Parameters that give the best results :','\n\n',
(grid_search.best_params_))
```

```
# print estimator that was chosen by the GridSearch
print('\n\nEstimator that was chosen by the search :','\n\n',
(grid_search.best_estimator_))
```

```
GridSearch CV best score : 0.9816


Parameters that give the best results :

 {'C': 10, 'kernel': 'linear'}


Estimator that was chosen by the search :

 SVC(C=10, kernel='linear')
```

```
# calculate GridSearch CV score on test set

print('GridSearch CV score on test set:
{0:0.4f}'.format(grid_search.score(X_test, y_test)))
```

```
GridSearch CV score on test set: 0.9832
```

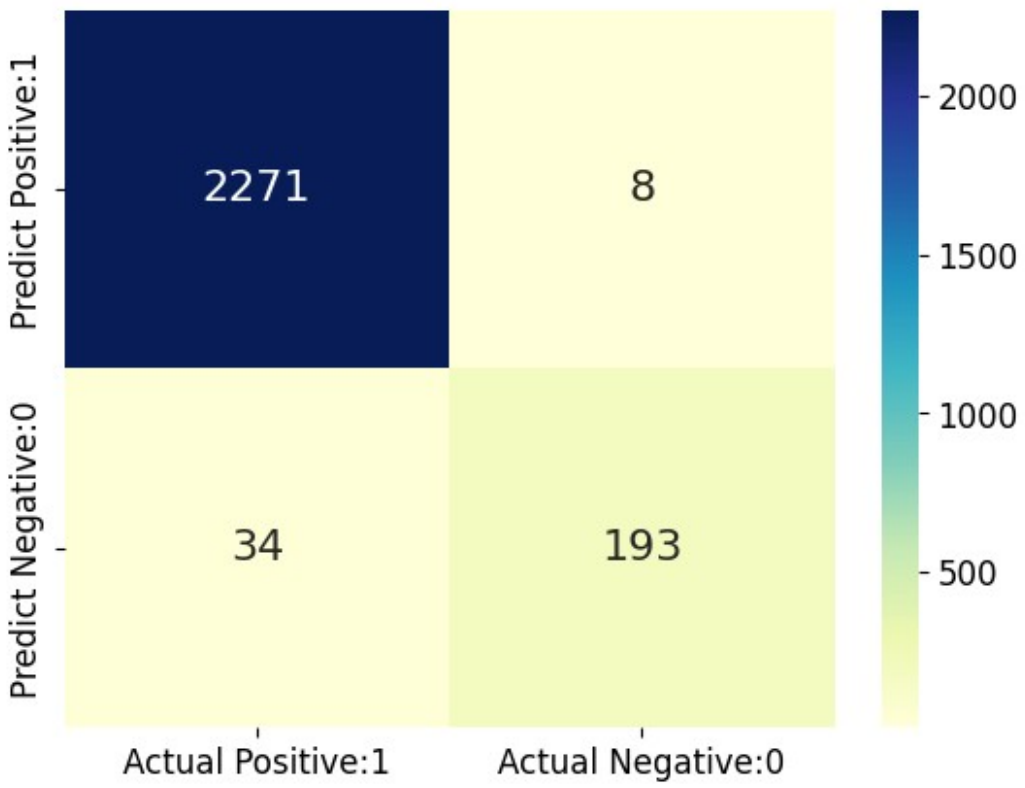
Making model with best estimators

```
svc_new = SVC(C = 10, kernel = 'linear')
svc_new.fit(X_train, y_train)
y_pred_new = svc_new.predict(X_test)
print(f'The accuracy of the model with default parameters is:
{round(accuracy_score(y_test, y_pred_new), 4)}')
```

```
The accuracy of the model with default parameters is: 0.9832
```

```
cm = confusion_matrix(y_test, y_pred_new)
data_cm = pd.DataFrame(data=cm, columns=['Actual Positive:1', 'Actual
Negative:0'],
                                  index=['Predict Positive:1', 'Predict
Negative:0'])
sns.heatmap(data_cm, annot = True, fmt='d', cmap='YlGnBu', annot_kws =
{'size': 16})
print(classification_report(y_test, y_pred))
```

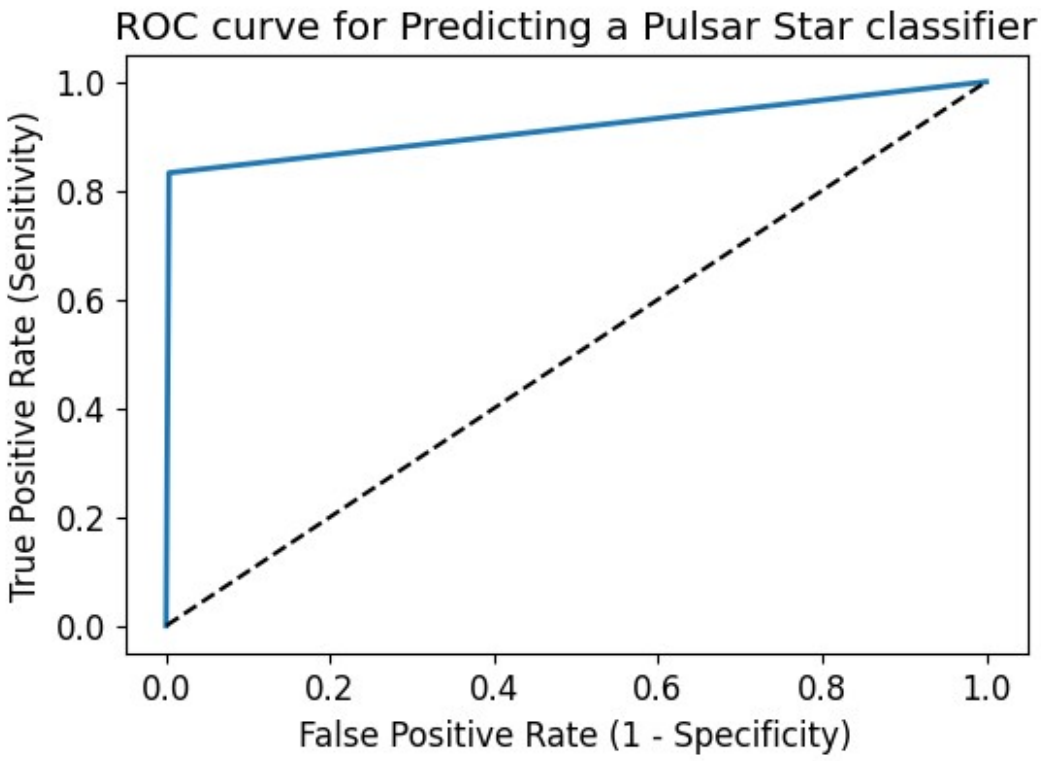
```
              precision    recall  f1-score   support

         0.0       0.98      1.00      0.99      2279
         1.0       0.96      0.83      0.89       227

    accuracy                           0.98      2506
   macro avg       0.97      0.91      0.94      2506
weighted avg       0.98      0.98      0.98      2506
```




```
print(f'The accuracy of the model is: {round(accuracy_score(y_test,
y_pred_new), 4)}')
print(f'The precision of the model is: {round(precision_score(y_test,
y_pred_new), 4)}')
print(f'The f1 score of the model is: {round(f1_score(y_test,
y_pred_new), 4)}')
print(f'The ROC AUC score of the model is:
{round(roc_auc_score(y_test, y_pred_new), 4)}')
```

```
The accuracy of the model is: 0.9832
The precision of the model is: 0.9602
The f1 score of the model is: 0.9019
The ROC AUC score of the model is: 0.9234
```

```
fpr, tpr, thresholds = roc_curve(y_test, y_pred)

plt.figure(figsize=(6,4))
plt.plot(fpr, tpr, linewidth=2)
plt.plot([0,1], [0,1], 'k--' )
plt.rcParams['font.size'] = 12
plt.title('ROC curve for Predicting a Pulsar Star classifier')
plt.xlabel('False Positive Rate (1 - Specificity)')
plt.ylabel('True Positive Rate (Sensitivity)')
plt.show()
```



Implementing the model to the test data

```
test_data = pd.read_excel(test_data_path)
test_data.head()
```

```
    Mean of the integrated profile  \
0                        116.906250
1                         75.585938
2                        103.273438
3                        101.078125
4                        113.226562

    Standard deviation of the integrated profile  \
0                                         48.920605
1                                         34.386254
2                                         46.996628
3                                         48.587487
4                                         48.608804
```

```
    Excess kurtosis of the integrated profile  \
0                                    0.186046
1                                    2.025498
2                                    0.504295
3                                    1.011427
4                                    0.291538

    Skewness of the integrated profile   Mean of the DM-SNR curve  \
0                            -0.129815                   3.037625
1                             8.652913                   3.765050
2                             0.821088                   2.244983
3                             1.151870                  81.887960
4                             0.292120                   6.291806

    Standard deviation of the DM-SNR curve  \
0                                17.737102
1                                21.897049
2                                15.622566
3                                81.464136
4                                26.585056

    Excess kurtosis of the DM-SNR curve   Skewness of the DM-SNR curve
\
0                              8.122621                      78.813405

1                              7.048189                      55.878791

2                              9.330498                     105.134941

3                              0.485105                      -1.117904

4                              4.540138                      21.708268


   target_class
0           NaN
1           NaN
2           NaN
3           NaN
4           NaN

test_data.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5370 entries, 0 to 5369
Data columns (total 9 columns):
 #   Column                                        Non-Null Count
Dtype
---  ------                                        --------------
-----
 0    Mean of the integrated profile               5370 non-null
```

```
float64
 1    Standard deviation of the integrated profile  5370 non-null
float64
 2    Excess kurtosis of the integrated profile     4603 non-null
float64
 3    Skewness of the integrated profile            5370 non-null
float64
 4    Mean of the DM-SNR curve                      5370 non-null
float64
 5    Standard deviation of the DM-SNR curve        4846 non-null
float64
 6    Excess kurtosis of the DM-SNR curve           5370 non-null
float64
 7    Skewness of the DM-SNR curve                  5126 non-null
float64
 8   target_class                                   0 non-null
float64
dtypes: float64(9)
memory usage: 377.7 KB
```

```
for items in list(test_data.columns):
  s = test_data[items].isna().sum()
  print(f'The number of missing values in {items} are {s}')
```

```
The number of missing values in  Mean of the integrated profile are 0
The number of missing values in  Standard deviation of the integrated
profile are 0
The number of missing values in  Excess kurtosis of the integrated
profile are 767
The number of missing values in  Skewness of the integrated profile
are 0
The number of missing values in  Mean of the DM-SNR curve are 0
The number of missing values in  Standard deviation of the DM-SNR
curve are 524
The number of missing values in  Excess kurtosis of the DM-SNR curve
are 0
The number of missing values in  Skewness of the DM-SNR curve are 244
The number of missing values in target_class are 5370
```

```
X_test_data = test_data.drop('target_class', axis = 1)

iter_imp = IterativeImputer(random_state = 42)
imputed = iter_imp.fit_transform(X_test_data)
df_iterative_imputed = pd.DataFrame(imputed, columns =
list(X.columns))

scaled = scaler.fit_transform(df_iterative_imputed)
df = pd.DataFrame(scaled, columns =
list(df_iterative_imputed.columns))
y_pred_test_data = svc_new.predict(df)
```

```
print(np.unique(y_pred_test_data))
```

```
[0. 1.]
```

```
print(f'The accuracy score is {svc.score(df, y_pred_test_data)}')
```

```
The accuracy score is 0.9945996275605214
```

```
df_iterative_imputed['target_class'] = pd.DataFrame(y_pred_test_data)
```

```
df_iterative_imputed.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5370 entries, 0 to 5369
Data columns (total 9 columns):
 #   Column                                            Non-Null Count
Dtype
---  ------                                            --------------
-----
 0    Mean of the integrated profile                   5370 non-null
float64
 1    Standard deviation of the integrated profile     5370 non-null
float64
 2    Excess kurtosis of the integrated profile        5370 non-null
float64
 3    Skewness of the integrated profile               5370 non-null
float64
 4    Mean of the DM-SNR curve                         5370 non-null
float64
 5    Standard deviation of the DM-SNR curve           5370 non-null
float64
 6    Excess kurtosis of the DM-SNR curve              5370 non-null
float64
 7    Skewness of the DM-SNR curve                     5370 non-null
float64
 8   target_class                                      5370 non-null
float64
dtypes: float64(9)
memory usage: 377.7 KB
```

```
df_iterative_imputed['target_class'].value_counts()
```

```
0.0    4944
1.0     426
Name: target_class, dtype: int64
```

```
null_accur = (df_iterative_imputed['target_class'] == 0.0).sum() /
df_iterative_imputed['target_class'].size
print(f'The null accuracy obtained by the model = {null_accur}')
```

```
The null accuracy obtained by the model = 0.9206703910614525
```