Practical 5

Aim: To implement a Machine Learning Classification model using a K Nearest Neighbors Classifier algorithm and enhance the model by K Fold and GridSearchCV cross-validation.

In [29]:
```
import numpy as np
import pandas as pd
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import train_test_split
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix,accuracy_score
from sklearn.metrics import precision_recall_fscore_support
from sklearn import metrics
import matplotlib.pyplot as plt
```

Loading dataset

specifying the x and y values

In [30]:
```
data = pd.read_csv(r"Practical5.csv")
X = data.iloc[:, [1, 2, 3, 4, 5, 6, 7]].values
y = data.iloc[:, -1].values
```

In [31]:
```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
X[:,0] = le.fit_transform(X[:,0])
```

splitting up the dataset

In [32]:
```
X_train, X_test, y_train, y_test = train_test_split(
            X, y, test_size = 0.2, random_state=42)
```

In [33]:
```
knn = KNeighborsClassifier(n_neighbors=7)
```

Training the model

In [34]:
```
knn.fit(X_train, y_train)
```

Out[34]:
```
KNeighborsClassifier(n_neighbors=7)
```

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Making the predictions

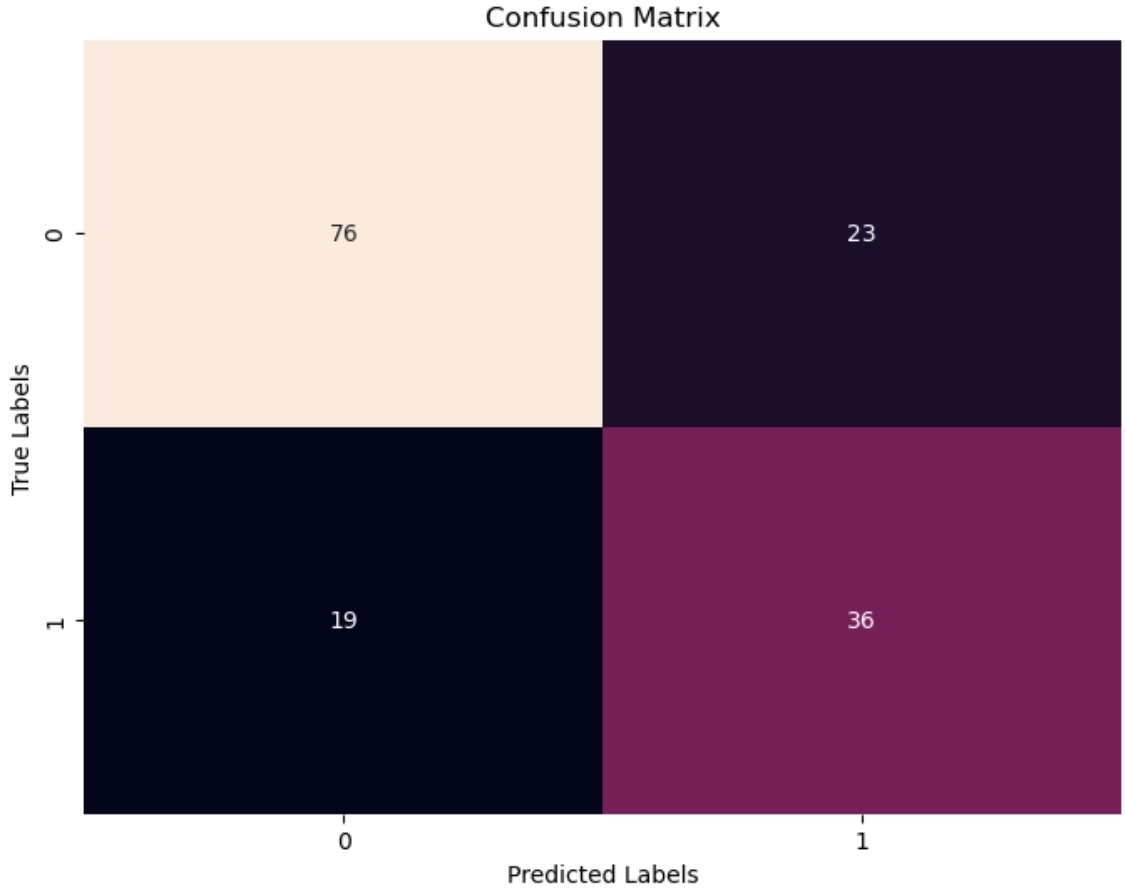
In [35]:
```
y_pred=knn.predict(X_test)
print(knn.predict(X_test))
```

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

In [36]:
```
from sklearn.metrics import confusion_matrix
cm= confusion_matrix(y_test,y_pred)
print(cm)
```

```
[[76 23]
 [19 36]]
```

In [37]:
```
import seaborn as sns
plt.figure(figsize=(8, 6))
sns.heatmap(cm, annot=True, fmt='d', cbar=False)
plt.title('Confusion Matrix')
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.show()
```



Use of KFold cross validation to find best input configuration

In [38]:
```
X_train, X_test, y_train, y_test = train_test_split(
            X, y, test_size = 0.2, random_state=1)
```

In [39]:
```
from sklearn.model_selection import KFold
from sklearn.metrics import precision_recall_fscore_support
from sklearn.metrics import confusion_matrix
#Data is splited into 10 same parts
cv = KFold(n_splits=10)
# perform cross-validation procedure
for train_ix, test_ix in cv.split(X):
    # split data
    X_train, X_test = X[train_ix, :], X[test_ix, :]
    y_train, y_test = y[train_ix], y[test_ix]
    # fit and evaluate a model
    knn = KNeighborsClassifier(n_neighbors=7)
    knn.fit(X_train, y_train)
    y_pred=knn.predict(X_test)
    print(knn.predict(X_test))
    #draw confusion matrix
    cm= confusion_matrix(y_test,y_pred)
    print(cm)
    #find metrices of evalution
    precision, recall, f1_score,_ = precision_recall_fscore_support(y_test,
    print("Precision:", precision)
    print("Recall:", recall)
    print("F1 Score:", f1_score)
```

```
[0 0 1 0 1 0 0 1 1 0 0 1 0 1 1 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 1 1 0 0 1 0 0
 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 1 1 0 1 0 1 0 0 0 0 1 1 0 0 0 0 1 0 0 1 0
 0 0 0]
[[35 10]
 [16 16]]
Precision: [0.68627451 0.61538462]
Recall: [0.77777778 0.5       ]
F1 Score: [0.72916667 0.55172414]
[0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 1 0 0 1 1 0 0
 1 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 1 0 0
 0 1 1]
[[50  5]
 [ 9 13]]
Precision: [0.84745763 0.72222222]
Recall: [0.90909091 0.59090909]
F1 Score: [0.87719298 0.65      ]
[1 1 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 1 0 1 1 0 0 0 0 0 0 1 1 0 0 1 0
 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 1 1 0 0 0 0 0 0 1 1 1 0 1 0 0 0 1
 1 0 0]
[[37  6]
 [17 17]]
Precision: [0.68518519 0.73913043]
Recall: [0.86046512 0.5       ]
F1 Score: [0.7628866  0.59649123]
[0 0 0 0 1 1 1 1 0 0 0 0 0 0 1 1 1 0 0 1 0 0 0 0 0 0 0 1 1 1 1 0 0 1 0 1 0
 0 1 0 0 1 0 0 0 0 0 0 0 0 0 1 1 1 0 1 1 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0
 0 1 0]
[[36 11]
 [17 13]]
Precision: [0.67924528 0.54166667]
Recall: [0.76595745 0.43333333]
F1 Score: [0.72       0.48148148]
[0 0 0 0 1 0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 1 0 0 1 0 1 0 0 1 1 1 0 1 0 0 0 1 0
 0 0 0 0 0 0 0 0 0 0 1 1 1 0 1 1 1 1 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 1 0 0 0
 0 0 0]
[[42  8]
 [12 15]]
Precision: [0.77777778 0.65217391]
Recall: [0.84       0.55555556]
F1 Score: [0.80769231 0.6       ]
[0 1 1 0 0 0 1 0 0 1 0 0 0 0 1 0 1 0 0 1 1 0 0 1 1 0 0 0 0 1 1 0 0 0 0 1 0
 0 0 0 1 0 1 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 1 0 1
 0 0 0]
[[43  4]
 [12 18]]
Precision: [0.78181818 0.81818182]
Recall: [0.91489362 0.6       ]
F1 Score: [0.84313725 0.69230769]
[0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 1 0 1 0 1 0 0 0 1 0 0 1
 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 1
 0 0 0]
[[53 10]
 [ 8  6]]
Precision: [0.86885246 0.375     ]
Recall: [0.84126984 0.42857143]
F1 Score: [0.85483871 0.4       ]
[1 0 0 0 0 0 1 1 1 0 1 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0
 0 0 1 1 1 0 0 0 1 0 1 0 1 0 1 0 1 0 1 1 0 0 1 0 0 0 1 1 1 0 1 0 0 0 0 1 1
 0 1 0]
[[45  7]
 [ 6 19]]
```

```
Precision: [0.88235294 0.73076923]
Recall: [0.86538462 0.76      ]
F1 Score: [0.87378641 0.74509804]
[0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0
 0 0 1 0 1 0 0 1 1 1 0 0 0 0 0 0 1 1 0 0 1 0 1 1 0 0 0 0 1 0 1 0 0 1 0 0 1
 0 1]
[[43  9]
 [10 14]]
Precision: [0.81132075 0.60869565]
Recall: [0.82692308 0.58333333]
F1 Score: [0.81904762 0.59574468]
[0 1 0 1 1 0 0 0 0 0 1 1 0 0 0 0 0 1 0 0 1 0 0 1 0 1 0 0 1 0 0 0 0 0 1 1 0 1
 0 0 0 1 0 0 0 0 0 0 0 1 1 0 0 1 1 0 0 0 1 0 0 0 0 0 1 0 1 0 1 0 1 0 1 0 1 0 0
 1 0]
[[38  8]
 [12 18]]
Precision: [0.76       0.69230769]
Recall: [0.82608696 0.6       ]
F1 Score: [0.79166667 0.64285714]
```

Applying The GridSearchCV for getting best classifier no. of neighbours

In [40]:
```
from sklearn.model_selection import KFold, GridSearchCV
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import confusion_matrix, precision_recall_fscore_suppo

# Define the KFold cross-validation
cv = KFold(n_splits=12)

param_grid = {'n_neighbors': list(range(1, 51, 2))}



# Initialize the KNN classifier
knn = KNeighborsClassifier()

# Initialize GridSearchCV
grid_search = GridSearchCV(estimator=knn, param_grid=param_grid, cv=cv, sco

# Perform cross-validation procedure with GridSearchCV
for train_ix, test_ix in cv.split(X):
    # Split data
    X_train, X_test = X[train_ix, :], X[test_ix, :]
    y_train, y_test = y[train_ix], y[test_ix]

    # Fit model using GridSearchCV
    grid_search.fit(X_train, y_train)

    # Get the best KNN model found by GridSearchCV
    best_knn = grid_search.best_estimator_

    # Predict
    y_pred = best_knn.predict(X_test)

    # Evaluate
    cm = confusion_matrix(y_test, y_pred)
    precision, recall, f1_score, _ = precision_recall_fscore_support(y_test

    # Print results
    print("Confusion Matrix:")
    print(cm)
    print("Precision:", precision)
    print("Recall:", recall)
    print("F1 Score:", f1_score)

    # You can also access the best hyperparameters found
    print("Best parameters found by GridSearchCV:", grid_search.best_params
```

```
Confusion Matrix:
[[29  7]
 [13 15]]
Precision: [0.69047619 0.68181818]
Recall: [0.80555556 0.53571429]
F1 Score: [0.74358974 0.6       ]
Best parameters found by GridSearchCV: {'n_neighbors': 15}
Confusion Matrix:
[[43  2]
 [12  7]]
Precision: [0.78181818 0.77777778]
Recall: [0.95555556 0.36842105]
F1 Score: [0.86 0.5 ]
Best parameters found by GridSearchCV: {'n_neighbors': 23}
Confusion Matrix:
[[35  7]
 [13  9]]
Precision: [0.72916667 0.5625    ]
Recall: [0.83333333 0.40909091]
F1 Score: [0.77777778 0.47368421]
Best parameters found by GridSearchCV: {'n_neighbors': 23}
Confusion Matrix:
[[27  8]
 [14 15]]
Precision: [0.65853659 0.65217391]
Recall: [0.77142857 0.51724138]
F1 Score: [0.71052632 0.57692308]
Best parameters found by GridSearchCV: {'n_neighbors': 9}
Confusion Matrix:
[[30  8]
 [15 11]]
Precision: [0.66666667 0.57894737]
Recall: [0.78947368 0.42307692]
F1 Score: [0.72289157 0.48888889]
Best parameters found by GridSearchCV: {'n_neighbors': 17}
Confusion Matrix:
[[35  8]
 [ 9 12]]
Precision: [0.79545455 0.6       ]
Recall: [0.81395349 0.57142857]
F1 Score: [0.8045977  0.58536585]
Best parameters found by GridSearchCV: {'n_neighbors': 13}
Confusion Matrix:
[[35  3]
 [11 15]]
Precision: [0.76086957 0.83333333]
Recall: [0.92105263 0.57692308]
F1 Score: [0.83333333 0.68181818]
Best parameters found by GridSearchCV: {'n_neighbors': 17}
Confusion Matrix:
[[42  8]
 [ 7  7]]
Precision: [0.85714286 0.46666667]
Recall: [0.84 0.5 ]
F1 Score: [0.84848485 0.48275862]
Best parameters found by GridSearchCV: {'n_neighbors': 15}
Confusion Matrix:
[[46  5]
 [ 4  9]]
Precision: [0.92       0.64285714]
Recall: [0.90196078 0.69230769]
```

```
F1 Score: [0.91089109 0.66666667]
Best parameters found by GridSearchCV: {'n_neighbors': 15}
Confusion Matrix:
[[41  2]
 [ 6 15]]
Precision: [0.87234043 0.88235294]
Recall: [0.95348837 0.71428571]
F1 Score: [0.91111111 0.78947368]
Best parameters found by GridSearchCV: {'n_neighbors': 15}
Confusion Matrix:
[[32  8]
 [ 9 15]]
Precision: [0.7804878  0.65217391]
Recall: [0.8   0.625]
F1 Score: [0.79012346 0.63829787]
Best parameters found by GridSearchCV: {'n_neighbors': 17}
Confusion Matrix:
[[34  5]
 [ 9 16]]
Precision: [0.79069767 0.76190476]
Recall: [0.87179487 0.64      ]
F1 Score: [0.82926829 0.69565217]
Best parameters found by GridSearchCV: {'n_neighbors': 17}
```

In [44]:
```
print("Best parameters found by GridSearchCV:", grid_search.best_params_)
```

```
Best parameters found by GridSearchCV: {'n_neighbors': 17}
```

In [46]:
```
knn = KNeighborsClassifier(n_neighbors=17)
```

In [47]:
```
knn.fit(X_train, y_train)
```

Out[47]:
```
KNeighborsClassifier(n_neighbors=17)
```

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On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [48]:
```
y_pred=knn.predict(X_test)
```

In [49]:
```
cm= confusion_matrix(y_test,y_pred)
print(cm)
```

```
[[34  5]
 [ 9 16]]
```

In [50]:
```
plt.figure(figsize=(8, 6))
sns.heatmap(cm, annot=True, fmt='d', cbar=False)
plt.title('Confusion Matrix')
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.show()
```