In [2]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import preProcessing_uniTeh as pu
```

In [5]:
```
data = pd.read_excel('F:/O_C/T_U_C/dS_C9/7_Py(T)/3T/projects_classification/Diabet/cleanDiabetData.xlsx')
```

In [6]:
```
data
```

Out[6]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
0	0.461538	0.670968	0.463794	0.571429	0.580352	0.440000	0.458647	0.491525	1
1	0.076923	0.264516	0.381948	0.448980	0.082131	0.240000	0.228070	0.169492	0
2	0.615385	0.896774	0.354666	0.076420	0.425843	0.145714	0.496241	0.186441	1
3	0.076923	0.290323	0.381948	0.326531	0.231214	0.282857	0.074353	0.000000	0
4	0.000000	0.600000	0.027282	0.571429	0.445087	0.711429	0.158312	0.203390	1
...	...	...	...	...	...	...	...	...	...
763	0.769231	0.367742	0.518358	0.836735	0.479769	0.420000	0.077694	0.711864	0
764	0.153846	0.503226	0.436512	0.408163	0.163206	0.531429	0.218881	0.101695	0
765	0.384615	0.496774	0.463794	0.326531	0.283237	0.228571	0.139515	0.152542	0
766	0.076923	0.529032	0.300102	0.214309	0.858101	0.340000	0.226399	0.440678	1
767	0.076923	0.316129	0.436512	0.489796	0.920675	0.348571	0.197995	0.033898	0

768 rows × 9 columns

In [8]:
```
df = data.copy()
```

In [9]:
```
df
```

Out[9]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
0	0.461538	0.670968	0.463794	0.571429	0.580352	0.440000	0.458647	0.491525	1
1	0.076923	0.264516	0.381948	0.448980	0.082131	0.240000	0.228070	0.169492	0
2	0.615385	0.896774	0.354666	0.076420	0.425843	0.145714	0.496241	0.186441	1
3	0.076923	0.290323	0.381948	0.326531	0.231214	0.282857	0.074353	0.000000	0
4	0.000000	0.600000	0.027282	0.571429	0.445087	0.711429	0.158312	0.203390	1
...	...	...	...	...	...	...	...	...	...
763	0.769231	0.367742	0.518358	0.836735	0.479769	0.420000	0.077694	0.711864	0
764	0.153846	0.503226	0.436512	0.408163	0.163206	0.531429	0.218881	0.101695	0
765	0.384615	0.496774	0.463794	0.326531	0.283237	0.228571	0.139515	0.152542	0
766	0.076923	0.529032	0.300102	0.214309	0.858101	0.340000	0.226399	0.440678	1
767	0.076923	0.316129	0.436512	0.489796	0.920675	0.348571	0.197995	0.033898	0

768 rows × 9 columns

In [13]:
```
X = df.drop('Outcome', axis=1)
y = df.Outcome
```

In [14]:
```
X
```

Out[14]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age
0	0.461538	0.670968	0.463794	0.571429	0.580352	0.440000	0.458647	0.491525
1	0.076923	0.264516	0.381948	0.448980	0.082131	0.240000	0.228070	0.169492
2	0.615385	0.896774	0.354666	0.076420	0.425843	0.145714	0.496241	0.186441
3	0.076923	0.290323	0.381948	0.326531	0.231214	0.282857	0.074353	0.000000
4	0.000000	0.600000	0.027282	0.571429	0.445087	0.711429	0.158312	0.203390

...	...	...	...	...	...	...	...	...
763	0.769231	0.367742	0.518358	0.836735	0.479769	0.420000	0.077694	0.711864
764	0.153846	0.503226	0.436512	0.408163	0.163206	0.531429	0.218881	0.101695
765	0.384615	0.496774	0.463794	0.326531	0.283237	0.228571	0.139515	0.152542
766	0.076923	0.529032	0.300102	0.214309	0.858101	0.340000	0.226399	0.440678
767	0.076923	0.316129	0.436512	0.489796	0.920675	0.348571	0.197995	0.033898

768 rows × 8 columns

In [18]:
```
y
```

Out[18]:
```
0      1
1      0
2      1
3      0
4      1
      ..
763    0
764    0
765    0
766    1
767    0
Name: Outcome, Length: 768, dtype: int64
```

In [19]:
```
from sklearn.model_selection import train_test_split
```

In [22]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=.2, random_state=2020)

print(X_train.shape, X_test.shape)
```

```
(614, 8) (154, 8)
```

Tree

In [161…
```
from sklearn.tree import DecisionTreeClassifier
```

In [162…
```
DT = DecisionTreeClassifier()

DT.fit(X_train, y_train)

pred = DT.predict(X_test)

pred
```

Out[162…
```
array([1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 1, 0, 0, 1, 0, 1, 1, 0,
       1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0,
       1, 0, 1, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 1,
       1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0,
       1, 1, 1, 0, 1, 0, 0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 1, 1, 1, 0, 1,
       0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0],
      dtype=int64)
```

In [163…
```
(pred==y_test).mean()
```

Out[163…
```
0.7012987012987013
```

In [164…
```
from sklearn.metrics import accuracy_score, confusion_matrix, f1_score, precision_score, recall_score
```

In [166…
```
rec = recall_score(y_test, pred)
```

```
pre = precision_score(y_test, pred)
f1_scre = f1_score(y_test, pred)
acc_tree = accuracy_score(y_test, pred)

conf = confusion_matrix(y_test, pred)

print("accuracy is {}.".format(acc_tree))
print("\nf1-score is {}.".format(f1_scre))
print("recall is {}.".format(rec))
print("precision is {}.".format(pre))
print("\nconfusion matrix is:\n {}.".format(conf))
```

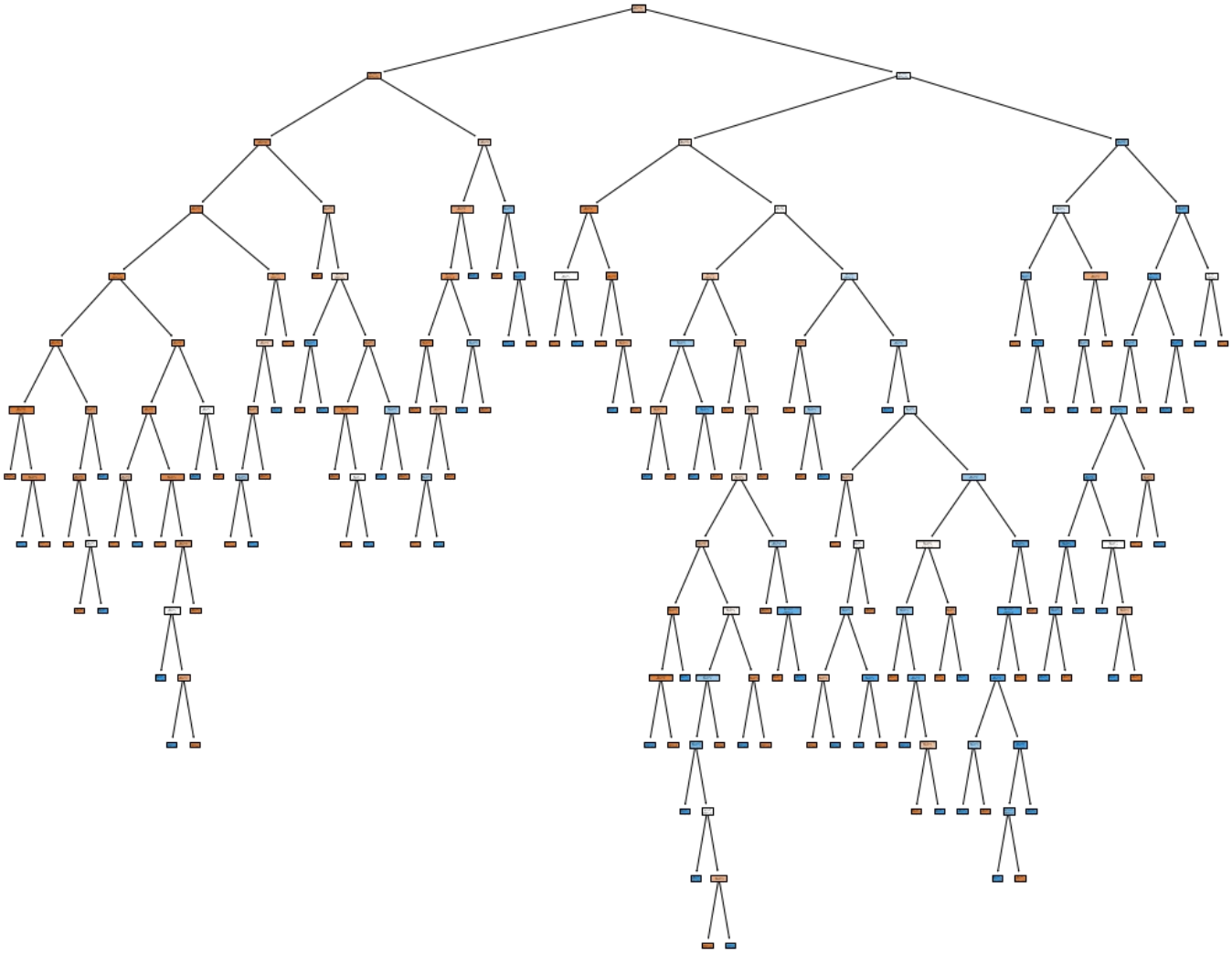
```
accuracy is 0.7012987012987013.

f1-score is 0.6034482758620691.
recall is 0.5737704918032787.
precision is 0.6363636363636364.

confusion matrix is:
 [[73 20]
 [26 35]].
```

In [34]:

```
from sklearn.tree import plot_tree
```

In [37]:

```
plt.figure(figsize=(18, 15))
plot_tree(DT, feature_names=df.columns, filled=True);
```



In [40]:

```
df['Outcome'].value_counts()
```

Out[40]:

```
0    500
1    268
Name: Outcome, dtype: int64
```

In [51]:
```
max_depth = 12

xx = []

for i in range(1, max_depth):
    DT = DecisionTreeClassifier(criterion='entropy',
                                max_depth=i,
                                min_samples_split=3,
                                class_weight={1:0.7, 0:0.3})

    xx.append([ i, DT.fit(X_train, y_train).score(X_train, y_train), accuracy_score(y_test, DT.predict(X_test)) ])

xx
```

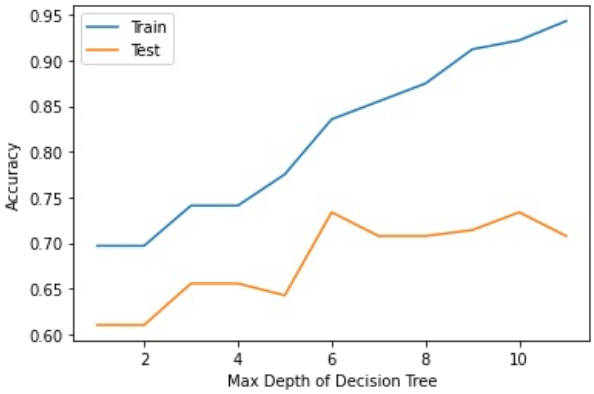
Out[51]:
```
[[1, 0.6970684039087948, 0.6103896103896104],
 [2, 0.6970684039087948, 0.6103896103896104],
 [3, 0.741042345276873, 0.6558441558441559],
 [4, 0.741042345276873, 0.6558441558441559],
 [5, 0.7752442996742671, 0.6428571428571429],
 [6, 0.8355048859934854, 0.7337662337662337],
 [7, 0.8550488599348535, 0.7077922077922078],
 [8, 0.8745928338762216, 0.7077922077922078],
 [9, 0.9120521172638436, 0.7142857142857143],
 [10, 0.9218241042345277, 0.7337662337662337],
 [11, 0.9429967426710097, 0.7077922077922078]]
```

In [52]:
```
tf = pd.DataFrame(data=xx, columns=['Depth', 'Train', 'Test'])
tf.set_index('Depth', inplace=True)
tf
```

Out[52]:

Depth	Train	Test
1	0.697068	0.610390
2	0.697068	0.610390
3	0.741042	0.655844
4	0.741042	0.655844
5	0.775244	0.642857
6	0.835505	0.733766
7	0.855049	0.707792
8	0.874593	0.707792
9	0.912052	0.714286
10	0.921824	0.733766
11	0.942997	0.707792

In [53]:
```
tf.plot(kind='line', xlabel='Max Depth of Decision Tree', ylabel = 'Accuracy');
```



In [62]:
```
from sklearn.model_selection import cross_val_predict, cross_val_score


DT = DecisionTreeClassifier(criterion='entropy', max_depth=4, min_samples_split=5,
                            min_samples_leaf=3, class_weight={0:0.3, 1:0.7})
```

```
acc = cross_val_score(DT, X, y ,cv=10, scoring='accuracy')

print("each fold accuracy :\n{}".format(acc))
print("\n\naccuracy : {}   -   acceptable error : {}".format(acc.mean()*100, 2*acc.std()*100))
```

```
each fold accuracy :
[0.72727273 0.68831169 0.75324675 0.62337662 0.68831169 0.81818182
 0.74025974 0.76623377 0.71052632 0.72368421]


accuracy : 72.39405331510595   -   acceptable error : 9.927406104408814
```

In [63]:
```
pred = cross_val_predict(DT, X, y, cv=10)

accuracy_score(y, pred)
```

Out[63]:
```
0.7200520833333334
```

In [64]:
```
from sklearn.model_selection import GridSearchCV
```

In [77]:
```
DT = DecisionTreeClassifier()

param = {'criterion':['gini', 'entropy'],
        'max_depth':[3, 4, 5, 6, 7, 8, 12],
        'min_samples_split':[2, 3, 4, 5, 6],
        'min_samples_leaf':[1, 2, 3, 4, 5],
        'class_weight':[{0:0.3, 1:0.7}, {0:0.4, 1:0.6}]}

GS = GridSearchCV(DT, param, cv=10, scoring='accuracy')

GS.fit(X, y)
```

Out[77]:
```
GridSearchCV(cv=10, estimator=DecisionTreeClassifier(),
             param_grid={'class_weight': [{0: 0.3, 1: 0.7}, {0: 0.4, 1: 0.6}],
                         'criterion': ['gini', 'entropy'],
                         'max_depth': [3, 4, 5, 6, 7, 8, 12],
                         'min_samples_leaf': [1, 2, 3, 4, 5],
                         'min_samples_split': [2, 3, 4, 5, 6]},
             scoring='accuracy')
```

In [167…
```
acc_tree = GS.best_score_
acc_tree
```

Out[167…
```
0.7708646616541354
```

In [79]:
```
GS.best_params_
```

Out[79]:
```
{'class_weight': {0: 0.4, 1: 0.6},
 'criterion': 'gini',
 'max_depth': 8,
 'min_samples_leaf': 5,
 'min_samples_split': 2}
```

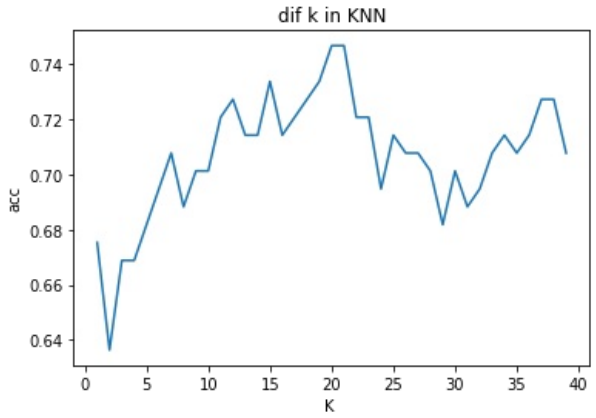
KNN

In [80]:
```
from sklearn.neighbors import KNeighborsClassifier
```

In [81]:
```
KNN = KNeighborsClassifier(n_neighbors=7, weights='distance')

acc = cross_val_score(KNN, X, y, cv=10, scoring='accuracy')

acc.mean()
```

Out[81]: 0.7383287764866713

In [87]:
```
k_range = list(range(1, 40))

scores = []

for i in k_range:
    knn = KNeighborsClassifier(n_neighbors=i)
    knn.fit(X_train, y_train)
    y_pred = knn.predict(X_test)
    scores.append(accuracy_score(y_test, y_pred))

plt.plot(k_range, scores)

plt.xlabel('K ')
plt.ylabel('acc')
plt.title('dif k in KNN')
plt.show()
```



In [89]:
```
KNN = KNeighborsClassifier()

k_range = list(range(1, 25))

param = {'weights':['uniform', 'distance'],
        'algorithm':['auto', 'ball_tree', 'kd_tree', 'brute'],
        'n_neighbors':k_range}

GS = GridSearchCV(KNN, param, cv=10, scoring='accuracy')

GS.fit(X, y)
```

Out[89]:
```
GridSearchCV(cv=10, estimator=KNeighborsClassifier(),
             param_grid={'algorithm': ['auto', 'ball_tree', 'kd_tree', 'brute'],
                         'n_neighbors': [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,
                                         13, 14, 15, 16, 17, 18, 19, 20, 21, 22,
                                         23, 24],
                         'weights': ['uniform', 'distance']},
             scoring='accuracy')
```

In [90]:
```
GS.best_params_
```

Out[90]:
```
{'algorithm': 'auto', 'n_neighbors': 18, 'weights': 'distance'}
```

In [168…
```
KNN = KNeighborsClassifier(n_neighbors=18, weights='distance')

acc = cross_val_score(KNN, X, y, cv=10, scoring='accuracy')

acc_KNN = acc.mean()
acc_KNN
```

Out[168… 0.753896103896104

Naive Bayes

Naive Bayes

In [92]:
```
from sklearn.naive_bayes import GaussianNB, MultinomialNB
```

In [171…
```
GNB = GaussianNB()
acc = cross_val_score(GNB, X, y, cv=10, scoring='accuracy')
acc_GaussianNB = acc.mean()
acc_GaussianNB
```

Out[171… 0.7410287081339713

In [94]:
```
MNB = MultinomialNB()
acc = cross_val_score(MNB, X, y, cv=10, scoring='accuracy')
acc.mean()
```

Out[94]: 0.6510594668489406

Logistic Regression

In [96]:
```
from sklearn.linear_model import LogisticRegression
```

In [172…
```
loreg = LogisticRegression(class_weight='balanced')

loreg.fit(X_train, y_train)

y_pred = loreg.predict(X_test)

acc_logreg = accuracy_score(y_test, y_pred)
acc_logreg
```

Out[172… 0.7662337662337663

In [103…
```
loreg = LogisticRegression()

param = {'class_weight':['balanced', {0:0.3, 1:0.7}, {0:0.4, 1:0.6}],
        'penalty':['l1', 'l2', 'elasticnet', 'none'],
        'solver':['newton-cg', 'lbfgs', 'liblinear', 'sag', 'saga']}

GS = GridSearchCV(loreg, param, cv=10, scoring='accuracy')

GS.fit(X, y)
```

```
C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: FitFailedWarning: Estimato
r fit failed. The score on this train-test partition for these parameters will be set to nan. Details:
Traceback (most recent call last):
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 598, in _fit_and
_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 443, in _check_solver
    raise ValueError("Solver %s supports only 'l2' or 'none' penalties, "
ValueError: Solver newton-cg supports only 'l2' or 'none' penalties, got l1 penalty.

  warnings.warn("Estimator fit failed. The score on this train-test"
C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: FitFailedWarning: Estimato
r fit failed. The score on this train-test partition for these parameters will be set to nan. Details:
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  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 598, in _fit_and
_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 443, in _check_solver
    raise ValueError("Solver %s supports only 'l2' or 'none' penalties, "
ValueError: Solver newton-cg supports only 'l2' or 'none' penalties, got l1 penalty.

  warnings.warn("Estimator fit failed. The score on this train-test"
```

```
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r fit failed. The score on this train-test partition for these parameters will be set to nan. Details:
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C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: FitFailedWarning: Estimato
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Traceback (most recent call last):
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  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
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ValueError: Solver newton-cg supports only 'l2' or 'none' penalties, got l1 penalty.

  warnings.warn("Estimator fit failed. The score on this train-test"
C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: FitFailedWarning: Estimato
r fit failed. The score on this train-test partition for these parameters will be set to nan. Details:
Traceback (most recent call last):
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 598, in _fit_and
_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 443, in _check_solver
    raise ValueError("Solver %s supports only 'l2' or 'none' penalties, "
ValueError: Solver newton-cg supports only 'l2' or 'none' penalties, got l1 penalty.

  warnings.warn("Estimator fit failed. The score on this train-test"
C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: FitFailedWarning: Estimato
r fit failed. The score on this train-test partition for these parameters will be set to nan. Details:
Traceback (most recent call last):
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 598, in _fit_and
_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
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ValueError: Solver newton-cg supports only 'l2' or 'none' penalties, got l1 penalty.

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ValueError: penalty='none' is not supported for the liblinear solver

  warnings.warn("Estimator fit failed. The score on this train-test"
C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: FitFailedWarning: Estimato
r fit failed. The score on this train-test partition for these parameters will be set to nan. Details:
Traceback (most recent call last):
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 598, in _fit_and
_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 454, in _check_solver
    raise ValueError(
ValueError: penalty='none' is not supported for the liblinear solver

  warnings.warn("Estimator fit failed. The score on this train-test"
C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: FitFailedWarning: Estimato
r fit failed. The score on this train-test partition for these parameters will be set to nan. Details:
Traceback (most recent call last):
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 598, in _fit_and
_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 454, in _check_solver
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ValueError: penalty='none' is not supported for the liblinear solver

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C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: FitFailedWarning: Estimato
r fit failed. The score on this train-test partition for these parameters will be set to nan. Details:
Traceback (most recent call last):
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 598, in _fit_and
_score
```

```
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 454, in _check_solver
    raise ValueError(
ValueError: penalty='none' is not supported for the liblinear solver

  warnings.warn("Estimator fit failed. The score on this train-test"
C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: FitFailedWarning: Estimato
r fit failed. The score on this train-test partition for these parameters will be set to nan. Details:
Traceback (most recent call last):
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 598, in _fit_and
_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
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    raise ValueError(
ValueError: penalty='none' is not supported for the liblinear solver

  warnings.warn("Estimator fit failed. The score on this train-test"
C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_search.py:922: UserWarning: One or more of th
e test scores are non-finite: [       nan        nan 0.74485646        nan 0.74485646 0.74618934
 0.74618934 0.74362611 0.74618934 0.74618934        nan        nan
        nan        nan        nan 0.74748804 0.74748804        nan
 0.74748804 0.74748804        nan        nan 0.72530759        nan
 0.73051948 0.73708134 0.73708134 0.72012987 0.73708134 0.73708134
        nan        nan        nan        nan        nan 0.72665755
 0.72665755        nan 0.72665755 0.72665755        nan        nan
 0.75266576        nan 0.75394737 0.75399863 0.75399863 0.75914217
 0.75399863 0.75399863        nan        nan        nan        nan
        nan 0.75268284 0.75268284        nan 0.75268284 0.75268284]
  warnings.warn(
```

Out[103…
```
GridSearchCV(cv=10, estimator=LogisticRegression(),
             param_grid={'class_weight': ['balanced', {0: 0.3, 1: 0.7},
                                          {0: 0.4, 1: 0.6}],
                         'penalty': ['l1', 'l2', 'elasticnet', 'none'],
                         'solver': ['newton-cg', 'lbfgs', 'liblinear', 'sag',
                                    'saga']},
             scoring='accuracy')
```

In [104…
```
GS.best_params_
```

Out[104…
```
{'class_weight': {0: 0.4, 1: 0.6}, 'penalty': 'l2', 'solver': 'liblinear'}
```

In [107…
```
loreg = LogisticRegression(class_weight = {0: 0.4, 1: 0.6},
                           penalty = 'l2',
                           solver = 'liblinear')

loreg.fit(X_train, y_train)

y_pred = loreg.predict(X_test)

accuracy_score(y_test, y_pred)
```

Out[107…
```
0.7597402597402597
```

In [108…
```
import statsmodels.api as sm
```

```
C:\Users\rouzn\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:7: FutureWarning: pandas.Int64Index
is deprecated and will be removed from pandas in a future version. Use pandas.Index with the appropriate dtype in
stead.
  from pandas import (to_datetime, Int64Index, DatetimeIndex, Period,
C:\Users\rouzn\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:7: FutureWarning: pandas.Float64Inde
x is deprecated and will be removed from pandas in a future version. Use pandas.Index with the appropriate dtype
instead.
  from pandas import (to_datetime, Int64Index, DatetimeIndex, Period,
```

In [111…
```
logit_model = sm.Logit(y, X)
```

```
resault = logit_model.fit()
print(resault.summary())
```

```
Optimization terminated successfully.
         Current function value: 0.606430
         Iterations 5
                           Logit Regression Results
==============================================================================
Dep. Variable:                Outcome   No. Observations:                  768
Model:                          Logit   Df Residuals:                      760
Method:                           MLE   Df Model:                            7
Date:                Fri, 28 Jan 2022   Pseudo R-squ.:                 0.06241
Time:                        10:17:30   Log-Likelihood:                -465.74
converged:                       True   LL-Null:                       -496.74
Covariance Type:            nonrobust   LLR p-value:                 5.989e-11
==============================================================================
                             coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
Pregnancies                0.2096      0.375      0.559      0.576      -0.525       0.944
Glucose                    2.3239      0.421      5.524      0.000       1.499       3.148
BloodPressure             -4.1825      0.524     -7.989      0.000      -5.209      -3.156
SkinThickness             -1.1288      0.390     -2.891      0.004      -1.894      -0.364
Insulin                   -0.4991      0.294     -1.700      0.089      -1.074       0.076
BMI                        1.7995      0.508      3.543      0.000       0.804       2.795
DiabetesPedigreeFunction  -0.5081      0.364     -1.397      0.163      -1.221       0.205
Age                        2.1799      0.531      4.105      0.000       1.139       3.221
==============================================================================
```

In [113…

```
X_new = X.drop('Pregnancies', axis=1)
```

In [115…

```
X_new
```

Out[115…

	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age
0	0.670968	0.463794	0.571429	0.580352	0.440000	0.458647	0.491525
1	0.264516	0.381948	0.448980	0.082131	0.240000	0.228070	0.169492
2	0.896774	0.354666	0.076420	0.425843	0.145714	0.496241	0.186441
3	0.290323	0.381948	0.326531	0.231214	0.282857	0.074353	0.000000
4	0.600000	0.027282	0.571429	0.445087	0.711429	0.158312	0.203390
...	...	...	...	...	...	...	...
763	0.367742	0.518358	0.836735	0.479769	0.420000	0.077694	0.711864
764	0.503226	0.436512	0.408163	0.163206	0.531429	0.218881	0.101695
765	0.496774	0.463794	0.326531	0.283237	0.228571	0.139515	0.152542
766	0.529032	0.300102	0.214309	0.858101	0.340000	0.226399	0.440678
767	0.316129	0.436512	0.489796	0.920675	0.348571	0.197995	0.033898

768 rows × 7 columns

In [116…

```
logit_model = sm.Logit(y, X_new)
resault = logit_model.fit()
print(resault.summary())
```

```
Optimization terminated successfully.
         Current function value: 0.606633
         Iterations 5
                           Logit Regression Results
==============================================================================
Dep. Variable:                Outcome   No. Observations:                  768
Model:                          Logit   Df Residuals:                      761
Method:                           MLE   Df Model:                            6
Date:                Fri, 28 Jan 2022   Pseudo R-squ.:                 0.06210
Time:                        10:19:40   Log-Likelihood:                -465.89
converged:                       True   LL-Null:                       -496.74
Covariance Type:            nonrobust   LLR p-value:                 2.035e-11
==============================================================================
                             coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
Glucose                    2.3269      0.421      5.530      0.000       1.502       3.152
BloodPressure             -4.1475      0.520     -7.981      0.000      -5.166      -3.129
SkinThickness             -1.1056      0.388     -2.848      0.004      -1.867      -0.345
Insulin                   -0.4906      0.293     -1.673      0.094      -1.065       0.084
```

```
BMI                          1.7928      0.507      3.534      0.000       0.799       2.787
DiabetesPedigreeFunction    -0.5040      0.364     -1.386      0.166      -1.217       0.209
Age                          2.3275      0.462      5.037      0.000       1.422       3.233
==============================================================================================
```

In [118…]
```
X_new = X.drop(['Pregnancies', 'DiabetesPedigreeFunction'], axis=1)
```

In [119…]
```
X_new
```

Out[119…]

	Glucose	BloodPressure	SkinThickness	Insulin	BMI	Age
0	0.670968	0.463794	0.571429	0.580352	0.440000	0.491525
1	0.264516	0.381948	0.448980	0.082131	0.240000	0.169492
2	0.896774	0.354666	0.076420	0.425843	0.145714	0.186441
3	0.290323	0.381948	0.326531	0.231214	0.282857	0.000000
4	0.600000	0.027282	0.571429	0.445087	0.711429	0.203390
...	...	...	...	...	...	...
763	0.367742	0.518358	0.836735	0.479769	0.420000	0.711864
764	0.503226	0.436512	0.408163	0.163206	0.531429	0.101695
765	0.496774	0.463794	0.326531	0.283237	0.228571	0.152542
766	0.529032	0.300102	0.214309	0.858101	0.340000	0.440678
767	0.316129	0.436512	0.489796	0.920675	0.348571	0.033898

768 rows × 6 columns

In [120…]
```
logit_model = sm.Logit(y, X_new)
resualt = logit_model.fit()
print(resualt.summary())
```

```
Optimization terminated successfully.
         Current function value: 0.607894
         Iterations 5
                           Logit Regression Results
==============================================================================
Dep. Variable:                Outcome   No. Observations:                  768
Model:                          Logit   Df Residuals:                      762
Method:                           MLE   Df Model:                            5
Date:                Fri, 28 Jan 2022   Pseudo R-squ.:                 0.06015
Time:                        10:20:50   Log-Likelihood:                -466.86
converged:                       True   LL-Null:                       -496.74
Covariance Type:            nonrobust   LLR p-value:                1.364e-11
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
Glucose          2.2211      0.413      5.377      0.000       1.412       3.031
BloodPressure   -4.2277      0.517     -8.174      0.000      -5.241      -3.214
SkinThickness   -1.0855      0.387     -2.802      0.005      -1.845      -0.326
Insulin         -0.5128      0.293     -1.753      0.080      -1.086       0.061
BMI              1.6671      0.498      3.349      0.001       0.692       2.643
Age              2.3162      0.462      5.016      0.000       1.411       3.221
==============================================================================
```

In [124…]
```
loreg = LogisticRegression()

param = {'class_weight':['balanced', {0:0.3, 1:0.7}, {0:0.4, 1:0.6}],
        'penalty':['l1', 'l2', 'elasticnet', 'none'],
        'solver':['newton-cg', 'lbfgs', 'liblinear', 'sag', 'saga']}

GS = GridSearchCV(loreg, param, cv=10, scoring='accuracy')

GS.fit(X_new, y)
```

```
C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: FitFailedWarning: Estimato
r fit failed. The score on this train-test partition for these parameters will be set to nan. Details:
Traceback (most recent call last):
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 598, in _fit_and
_score
    estimator.fit(X_train, y_train, **fit_params)
```

```
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 443, in _check_solver
    raise ValueError("Solver %s supports only 'l2' or 'none' penalties, "
ValueError: Solver newton-cg supports only 'l2' or 'none' penalties, got l1 penalty.

  warnings.warn("Estimator fit failed. The score on this train-test"
C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: FitFailedWarning: Estimato
r fit failed. The score on this train-test partition for these parameters will be set to nan. Details:
Traceback (most recent call last):
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 598, in _fit_and
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  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
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  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 598, in _fit_and
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Traceback (most recent call last):
  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py", line 598, in _fit_and
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  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
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ValueError: Solver newton-cg supports only 'l2' or 'none' penalties, got l1 penalty.

  warnings.warn("Estimator fit failed. The score on this train-test"
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ValueError: Solver newton-cg supports only 'l2' or 'none' penalties, got l1 penalty.
```

```
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  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
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  warnings.warn("Estimator fit failed. The score on this train-test"
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Traceback (most recent call last):
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  File "C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py", line 1306, in fit
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ValueError: Solver newton-cg supports only 'l2' or 'none' penalties, got l1 penalty.

  warnings.warn("Estimator fit failed. The score on this train-test"
C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_validation.py:615: FitFailedWarning: Estimato
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C:\Users\rouzn\anaconda3\lib\site-packages\sklearn\model_selection\_search.py:922: UserWarning: One or more of th
e test scores are non-finite: [       nan        nan 0.73831169        nan 0.73831169 0.72797334
 0.72797334 0.72925496 0.72797334 0.72797334        nan        nan
        nan        nan        nan 0.73832878 0.73832878        nan
 0.73832878 0.73832878        nan        nan 0.7213944         nan
 0.7213944  0.72004443 0.72004443 0.71093643 0.72004443 0.72004443
        nan        nan        nan        nan        nan 0.72271018
 0.72271018        nan 0.72271018 0.72271018        nan        nan
 0.74875256        nan 0.74745386 0.74878674 0.74878674 0.75140123
 0.74878674 0.74878674        nan        nan        nan        nan
        nan 0.75010253 0.75010253        nan 0.75010253 0.75010253]
  warnings.warn(
```

Out[124…

```
GridSearchCV(cv=10, estimator=LogisticRegression(),
             param_grid={'class_weight': ['balanced', {0: 0.3, 1: 0.7},
                                          {0: 0.4, 1: 0.6}],
                         'penalty': ['l1', 'l2', 'elasticnet', 'none'],
                         'solver': ['newton-cg', 'lbfgs', 'liblinear', 'sag',
                                    'saga']},
             scoring='accuracy')
```

In [125…

```
GS.best_params_
```

Out[125…

```
{'class_weight': {0: 0.4, 1: 0.6}, 'penalty': 'l2', 'solver': 'liblinear'}
```

In [126…

```
GS.best_score_
```

Out[126…

```
0.7514012303485987
```

فیچر دقت تکوارنخنفخورد2

In [127…

In [127…

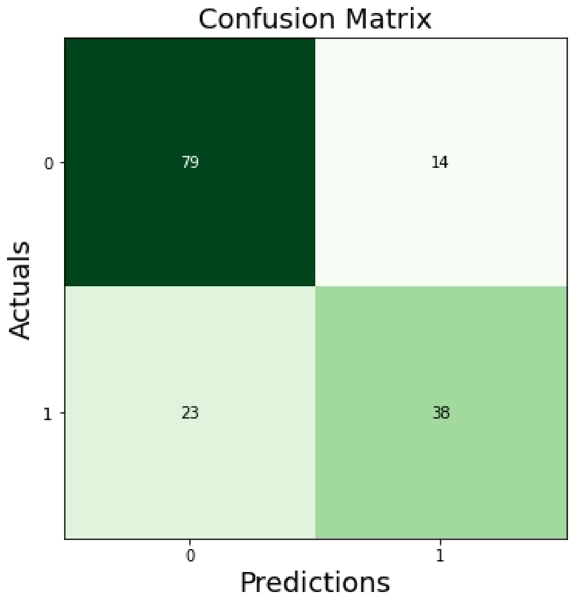
```
from mlxtend.plotting import plot_confusion_matrix
```

In [129…

```
cnf_matrix = confusion_matrix(y_test, y_pred)


fig, ax = plot_confusion_matrix(conf_mat= cnf_matrix, figsize=(6, 6), cmap=plt.cm.Greens)


plt.xlabel('Predictions', fontsize=18)
plt.ylabel('Actuals', fontsize=18)
plt.title('Confusion Matrix', fontsize=18)
plt.show()
```



Neural Network

In [130…

```
from sklearn.neural_network import MLPClassifier
```

In [131…

```
MLP = MLPClassifier()

acc = cross_val_score(MLP, X, y, cv=10, scoring='accuracy')

acc.mean()
```

```
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ng: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
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ng: Stochastic Optimizer: Maximum iterations (200) reached and the optimization hasn't converged yet.
```

```
  warnings.warn(
```

Out[131… 0.7642857142857143

In [138…
```python
MLP = MLPClassifier()

param = {"activation" : ["relu" , "logistic" , "tanh"],
         "hidden_layer_sizes":[(10), (20), (20,30)],
         "max_iter" : [100, 200],
         "solver": ["sgd", "adam"],
         "learning_rate_init": [0.01, 0.001, 0.0001, 0.025],
         "learning_rate":['invscaling'],
         "momentum":[0.9, 0.7, 0.5],
         'early_stopping': [True, False]}

GS = GridSearchCV(MLP, param, cv = 10)
GS.fit(X , y)
```

```
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ng: Stochastic Optimizer: Maximum iterations (100) reached and the optimization hasn't converged yet.
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  warnings.warn(
```

Out[138…

```
GridSearchCV(cv=10, estimator=MLPClassifier(),
             param_grid={'activation': ['relu', 'logistic', 'tanh'],
                         'early_stopping': [True, False],
                         'hidden_layer_sizes': [10, 20, (20, 30)],
                         'learning_rate': ['invscaling'],
                         'learning_rate_init': [0.01, 0.001, 0.0001, 0.025],
                         'max_iter': [100, 200], 'momentum': [0.9, 0.7, 0.5],
```

```
                          'solver': ['sgd', 'adam']})
```

In [139…
```
GS.best_params_
```

Out[139…
```
{'activation': 'tanh',
 'early_stopping': False,
 'hidden_layer_sizes': 20,
 'learning_rate': 'invscaling',
 'learning_rate_init': 0.025,
 'max_iter': 200,
 'momentum': 0.7,
 'solver': 'adam'}
```

In [173…
```
GS.best_score_
```

Out[173…
```
0.7708646616541354
```

In [147…
```
import warnings
warnings.filterwarnings("ignore")
```

In [174…
```
ML = MLPClassifier(activation= 'tanh',
                   early_stopping= False,
                   hidden_layer_sizes= 20,
                   learning_rate= 'invscaling',
                   learning_rate_init= 0.025,
                   max_iter= 200,
                   momentum= 0.7,
                   solver= 'adam')

acc = cross_val_score(MLP, X, y, cv=10, scoring='accuracy')
acc_MLP = acc.mean()
acc_MLP
```

Out[174…
```
0.7694976076555023
```

In [148…
```
X_new
```

Out[148…

	Glucose	BloodPressure	SkinThickness	Insulin	BMI	Age
0	0.670968	0.463794	0.571429	0.580352	0.440000	0.491525
1	0.264516	0.381948	0.448980	0.082131	0.240000	0.169492
2	0.896774	0.354666	0.076420	0.425843	0.145714	0.186441
3	0.290323	0.381948	0.326531	0.231214	0.282857	0.000000
4	0.600000	0.027282	0.571429	0.445087	0.711429	0.203390
...	...	...	...	...	...	...
763	0.367742	0.518358	0.836735	0.479769	0.420000	0.711864
764	0.503226	0.436512	0.408163	0.163206	0.531429	0.101695
765	0.496774	0.463794	0.326531	0.283237	0.228571	0.152542
766	0.529032	0.300102	0.214309	0.858101	0.340000	0.440678
767	0.316129	0.436512	0.489796	0.920675	0.348571	0.033898

768 rows × 6 columns

In [149…
```
ML = MLPClassifier(activation= 'tanh',
                   early_stopping= False,
                   hidden_layer_sizes= 20,
                   learning_rate= 'invscaling',
                   learning_rate_init= 0.025,
                   max_iter= 200,
                   momentum= 0.7,
```

```
                    solver= 'adam')

acc = cross_val_score(MLP, X_new, y, cv=10, scoring='accuracy')
acc.mean()
```

Out[149… 0.7708133971291866

SVM

In [151…
```
from sklearn.svm import SVC
```

In [152…
```
SVM = SVC()

acc = cross_val_score(SVM, X, y, cv=10, scoring='accuracy')

acc.mean()
```

Out[152… 0.7630382775119618

In [154…
```
SVM = SVC()

params = {"kernel":['linear', 'poly', 'rbf', 'sigmoid'],
          "class_weight":['balanced', {0:0.4, 1:0.6}],
          "gamma" : [0.01, 0.1, 0.2, 0.3, 0.5, 0.7],
          "C" : [0.01 , 0.1, 1, 10, 50, 100],
          "degree":[2, 3, 4]}

GS = GridSearchCV(SVM, params, cv=10, scoring='accuracy')

GS.fit(X, y)
```

Out[154…
```
GridSearchCV(cv=10, estimator=SVC(),
             param_grid={'C': [0.01, 0.1, 1, 10, 50, 100],
                         'class_weight': ['balanced', {0: 0.4, 1: 0.6}],
                         'degree': [2, 3, 4],
                         'gamma': [0.01, 0.1, 0.2, 0.3, 0.5, 0.7],
                         'kernel': ['linear', 'poly', 'rbf', 'sigmoid']},
             scoring='accuracy')
```

In [155…
```
GS.best_params_
```

Out[155…
```
{'C': 10,
 'class_weight': {0: 0.4, 1: 0.6},
 'degree': 2,
 'gamma': 0.5,
 'kernel': 'poly'}
```

In [156…
```
GS.best_score_
```

Out[156… 0.7708646616541354

In [157…
```
SVM = SVC(C = 10,
          class_weight = {0: 0.4, 1: 0.6},
          degree = 2,
          gamma = 0.5,
          kernel = 'poly')

acc = cross_val_score(SVM, X, y, cv=10, scoring='accuracy')
acc.mean()
```

Out[157… 0.7708646616541354

In [175…
```
SVM = SVC(C = 10
```

```
SVM = SVC(C = 10,
          class_weight = {0: 0.4, 1: 0.6},
          degree = 2,
          gamma = 0.5,
          kernel = 'poly')

acc = cross_val_score(SVM, X_new, y, cv=10, scoring='accuracy')
acc_SVM = acc.mean()
acc_SVM
```

Out[175… 0.7643711551606289

`DecisionTreeClassifier -> acc_tree` `KNeighborsClassifier -> acc_KNN` `naiveBayes_GaussianNB -> acc_GaussianNB` `LogisticRegression -> acc_logreg` `Neural Network -> acc_MLP` `SVM -> acc_SVM`

In [176…
```
method = ['DecisionTreeClassifier', 'KNeighborsClassifier', 'naiveBayes_GaussianNB',
          'LogisticRegression', 'Neural Network', 'SVM']
Accuracy = [acc_tree, acc_KNN, acc_GaussianNB, acc_logreg, acc_MLP, acc_SVM]
Resualt = pd.DataFrame({'Method':method, 'Accuracy': Accuracy})
```

In [177…
```
Resualt
```

Out[177…

	Method	Accuracy
0	DecisionTreeClassifier	0.770865
1	KNeighborsClassifier	0.753896
2	naiveBayes_GaussianNB	0.741029
3	LogisticRegression	0.766234
4	Neural Network	0.769498
5	SVM	0.764371

In [ ]:
```
```

Using Step Forward Selection (SFS)

Using Step Backward Selection (SBS)

Exhaustive Feature Selection (EFS): the most expensive Feature Selection

In [178…
```
from mlxtend.feature_selection import SequentialFeatureSelector as SFS
```

In [197…
```
from mlxtend.feature_selection import ExhaustiveFeatureSelector as EFS
```

In [179…
```
X.shape
```

Out[179… (768, 8)

In [183…
```
sfs = SFS(SVC(C = 10, class_weight = {0: 0.4, 1: 0.6}, degree = 2, gamma = 0.5, kernel = 'poly'),
          k_features = (1, 8),
           forward= True,
           floating = False,
           verbose= 2,
           scoring= 'accuracy',
           cv = 4,
           n_jobs= -1
          ).fit(X_train, y_train)

print(sfs.k_score_)
```

```
print(sfs.k_feature_names_)
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   5 out of   8 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=-1)]: Done   8 out of   8 | elapsed:    0.0s finished

[2022-01-28 12:19:05] Features: 1/8 -- score: 0.7475490196078431[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   4 out of   7 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=-1)]: Done   7 out of   7 | elapsed:    0.0s finished

[2022-01-28 12:19:05] Features: 2/8 -- score: 0.7605890841184959[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   3 out of   6 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=-1)]: Done   6 out of   6 | elapsed:    0.0s finished

[2022-01-28 12:19:05] Features: 3/8 -- score: 0.7670932009167303[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   3 out of   5 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=-1)]: Done   5 out of   5 | elapsed:    0.0s finished

[2022-01-28 12:19:05] Features: 4/8 -- score: 0.7687590187590188[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   2 out of   4 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=-1)]: Done   4 out of   4 | elapsed:    0.0s finished

[2022-01-28 12:19:05] Features: 5/8 -- score: 0.7687271878448348[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   3 out of   3 | elapsed:    0.0s finished

0.7703611747729394
('Pregnancies', 'Glucose', 'Insulin', 'BMI', 'DiabetesPedigreeFunction', 'Age')
[2022-01-28 12:19:05] Features: 6/8 -- score: 0.7703611747729394[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   2 out of   2 | elapsed:    0.0s finished

[2022-01-28 12:19:05] Features: 7/8 -- score: 0.7622442916560563[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    0.0s finished

[2022-01-28 12:19:05] Features: 8/8 -- score: 0.7557083439436381
```

In [188…

```
SFS_SVM_score = sfs.k_score_
SFS_SVM_feature_names = list(sfs.k_feature_names_)
SFS_SVM_features_num = len(sfs.k_feature_idx_)
print(SFS_SVM_score)
print(SFS_SVM_feature_names)
print(SFS_SVM_features_num)
```

```
0.7703611747729394
['Pregnancies', 'Glucose', 'Insulin', 'BMI', 'DiabetesPedigreeFunction', 'Age']
6
```

In [195…

```
sbs = SFS(SVC(C = 10, class_weight = {0: 0.4, 1: 0.6}, degree = 2, gamma = 0.5, kernel = 'poly'),
          k_features = (1, 8),
           forward= False,
           floating = False,
           verbose= 2,
           scoring= 'accuracy',
           cv = 4,
           n_jobs= -1
          ).fit(X_train, y_train)

print(sbs.k_score_)
print(sbs.k_feature_names_)
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   5 out of   8 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=-1)]: Done   8 out of   8 | elapsed:    0.0s finished

[2022-01-28 12:30:39] Features: 7/1 -- score: 0.7622442916560563[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   4 out of   7 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=-1)]: Done   7 out of   7 | elapsed:    0.0s finished
```

```
[2022-01-28 12:30:39] Features: 6/1 -- score: 0.7703611747729394[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   3 out of   6 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=-1)]: Done   6 out of   6 | elapsed:    0.0s finished

[2022-01-28 12:30:39] Features: 5/1 -- score: 0.7687271878448348[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   3 out of   5 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=-1)]: Done   5 out of   5 | elapsed:    0.0s finished

[2022-01-28 12:30:39] Features: 4/1 -- score: 0.7703611747729394[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   2 out of   4 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=-1)]: Done   4 out of   4 | elapsed:    0.0s finished

[2022-01-28 12:30:39] Features: 3/1 -- score: 0.7622230710466005[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   3 out of   3 | elapsed:    0.0s finished
```

```
0.7703611747729394
('Pregnancies', 'Glucose', 'Insulin', 'BMI', 'DiabetesPedigreeFunction', 'Age')
```

```
[2022-01-28 12:30:39] Features: 2/1 -- score: 0.7605890841184959[Parallel(n_jobs=-1)]: Using backend LokyBackend
with 12 concurrent workers.
[Parallel(n_jobs=-1)]: Done   2 out of   2 | elapsed:    0.0s finished

[2022-01-28 12:30:39] Features: 1/1 -- score: 0.7475490196078431
```

In [196…

```
SBS_SVM_score = sbs.k_score_
SBS_SVM_feature_names = list(sbs.k_feature_names_)
SBS_SVM_features_num = len(sbs.k_feature_idx_)
print(SBS_SVM_score)
print(SBS_SVM_feature_names)
print(SBS_SVM_features_num)
```

```
0.7703611747729394
['Pregnancies', 'Glucose', 'Insulin', 'BMI', 'DiabetesPedigreeFunction', 'Age']
6
```

In [207…

```
efs = EFS(SVC(C = 10, class_weight = {0: 0.4, 1: 0.6}, degree = 2, gamma = 0.5, kernel = 'poly'),
          min_features = 3,
          max_features=6,
          scoring= 'accuracy',
          cv = None,
          n_jobs= -1
         ).fit(X_train, y_train)
```

```
Features: 210/210
```

In [208…

```
EFS_SVM_score = efs.best_score_
EFS_SVM_feature_names = list(efs.best_feature_names_)
EFS_SVM_features_num = len(efs.best_idx_)
print(EFS_SVM_score)
print(EFS_SVM_feature_names)
print(EFS_SVM_features_num)
```

```
0.7833876221498371
['Pregnancies', 'Glucose', 'SkinThickness', 'Insulin', 'BMI', 'Age']
6
```

In [209…

```
from sklearn.ensemble import RandomForestClassifier
```

In [219…

```
efs = EFS(RandomForestClassifier(n_estimators=100, random_state=0, n_jobs = -1),
          min_features = 3,
          max_features=6,
          scoring= 'accuracy',
          cv = None,
          n_jobs= -1
         ).fit(X_train, y_train)
```

```
Features: 210/210
```

In [220…

```
EFS_RandomForest_score = efs.best_score_
EFS_RandomForest_feature_names = list(efs.best_feature_names_)
EFS_RandomForest_features_num = len(efs.best_idx_)
print(EFS_RandomForest_score)
print(EFS_RandomForest_feature_names)
print(EFS_RandomForest_features_num)
```

```
1.0
['Pregnancies', 'Glucose', 'Insulin']
3
```

In [212…

```
acc_RandomForest = EFS_RandomForest_score
```

In [216…

```
method = ['DecisionTreeClassifier', 'KNeighborsClassifier', 'naiveBayes_GaussianNB',
          'LogisticRegression', 'Neural Network', 'SVM', 'RandomForest']
Accuracy = [acc_tree, acc_KNN, acc_GaussianNB, acc_logreg, acc_MLP, acc_SVM, acc_RandomForest]
Resualt = pd.DataFrame({'Method':method, 'Accuracy': Accuracy})
```

In [214…

```
Resualt
```

Out[214…

	Method	Accuracy
0	DecisionTreeClassifier	0.770865
1	KNeighborsClassifier	0.753896
2	naiveBayes_GaussianNB	0.741029
3	LogisticRegression	0.766234
4	Neural Network	0.769498
5	SVM	0.764371
6	RandomForest	1.000000

In [221…

```
Resualt.to_csv('F:/O_C/T_U_C/dS_C9/7_Py(T)/3T/projects_classification/Diabet/resualt.csv')
```

In [ ]: