haberman-prediction

January 30, 2024

```
[47]: # Import necessary libraries
      import pandas as pd
      import numpy as np
      from sklearn.metrics import confusion_matrix,␣
       ↪accuracy_score,classification_report
      from sklearn.neighbors import KNeighborsClassifier
      from sklearn.model_selection import train_test_split
      from sklearn.preprocessing import StandardScaler
      import seaborn as sns
      import matplotlib.pyplot as plt
      from sklearn.decomposition import PCA
```

```
[2]: col_names=["patient_age", "year_of_operation", "positive_axillary_nodes",␣
      ↪"survival_status"];
     df=pd.read_csv('haberman kaggle.csv',names=col_names)
     df.head()
```

```
[2]:    patient_age  year_of_operation  positive_axillary_nodes  survival_status
     0           30                 64                        1                1
     1           30                 62                        3                1
     2           30                 65                        0                1
     3           31                 59                        2                1
     4           31                 65                        4                1
```

```
[3]: df.columns
```

```
[3]: Index(['patient_age', 'year_of_operation', 'positive_axillary_nodes',
            'survival_status'],
           dtype='object')
```

```
[4]: df.describe().transpose()
```

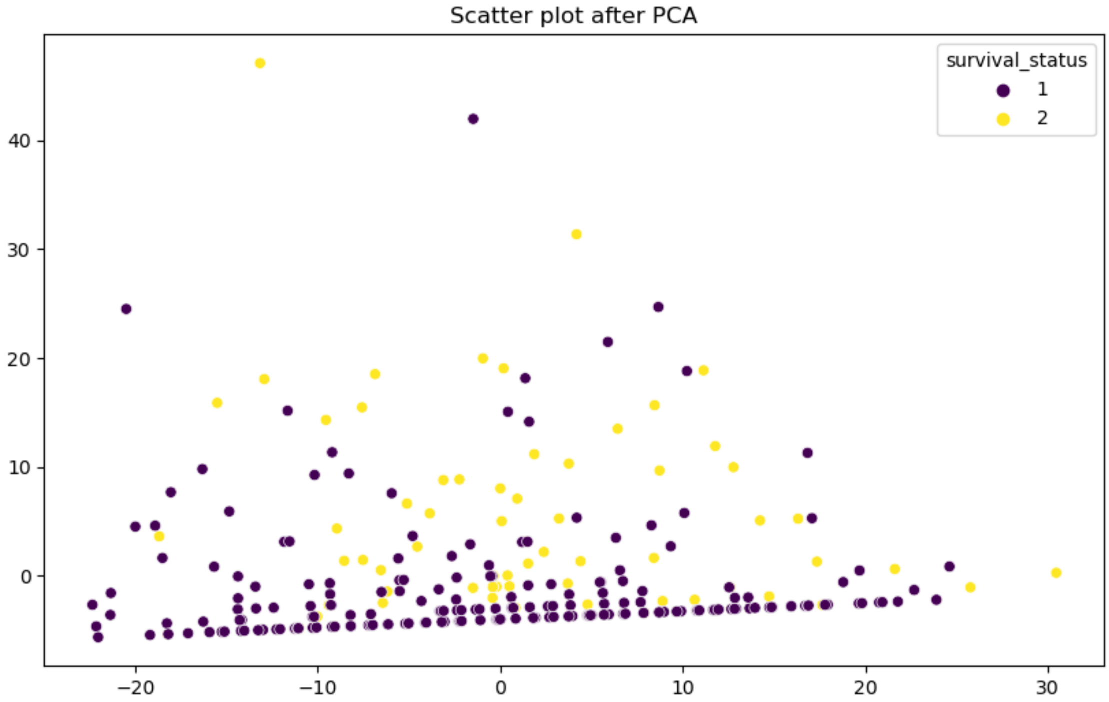
```
[4]:                          count       mean        std   min   25%   50%    75%  \
     patient_age              306.0  52.457516  10.803452  30.0  44.0  52.0  60.75
     year_of_operation        306.0  62.852941   3.249405  58.0  60.0  63.0  65.75
     positive_axillary_nodes  306.0   4.026144   7.189654   0.0   0.0   1.0   4.00
     survival_status          306.0   1.264706   0.441899   1.0   1.0   1.0   2.00
```

```
                           max
patient_age               83.0
year_of_operation         69.0
positive_axillary_nodes   52.0
survival_status            2.0
```

[5]:
```
x=df[['patient_age', 'year_of_operation', 'positive_axillary_nodes']]
y=df['survival_status']
```

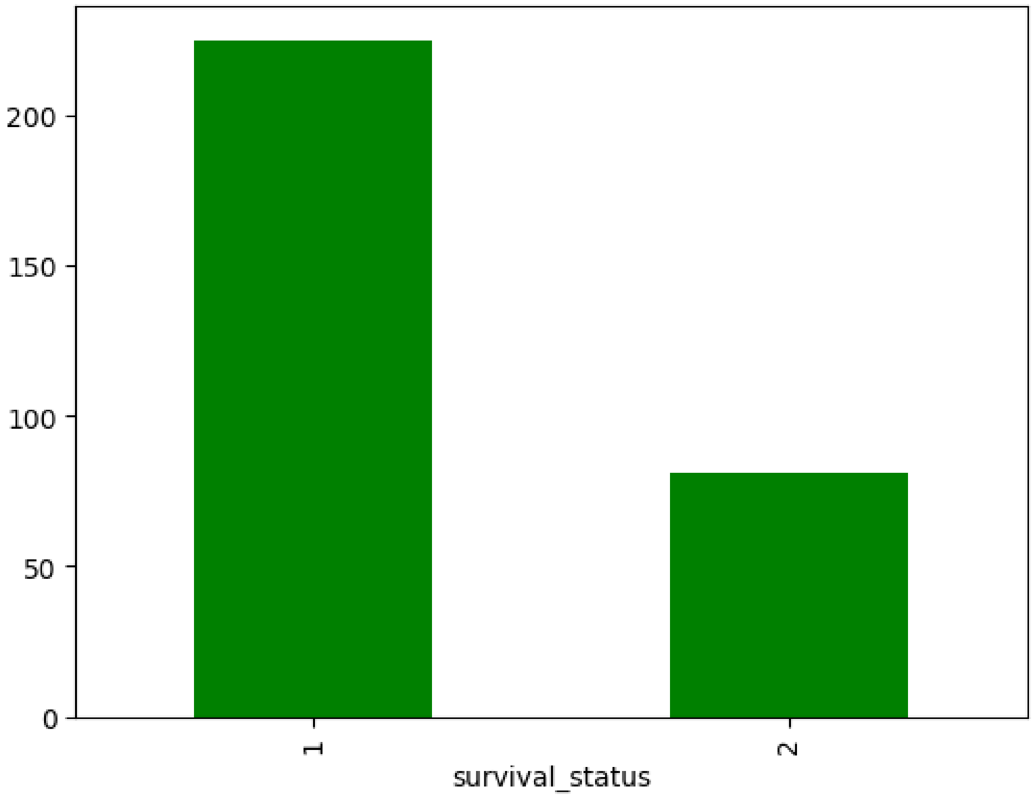
[6]:
```
pca = PCA(n_components=2)
x_pca = pca.fit_transform(x)
```

[7]:
```
plt.figure(figsize=(10, 6))
sns.scatterplot(x=x_pca[:, 0], y=x_pca[:, 1], hue=y, palette='viridis')
plt.title('Scatter plot after PCA')
plt.show()
```



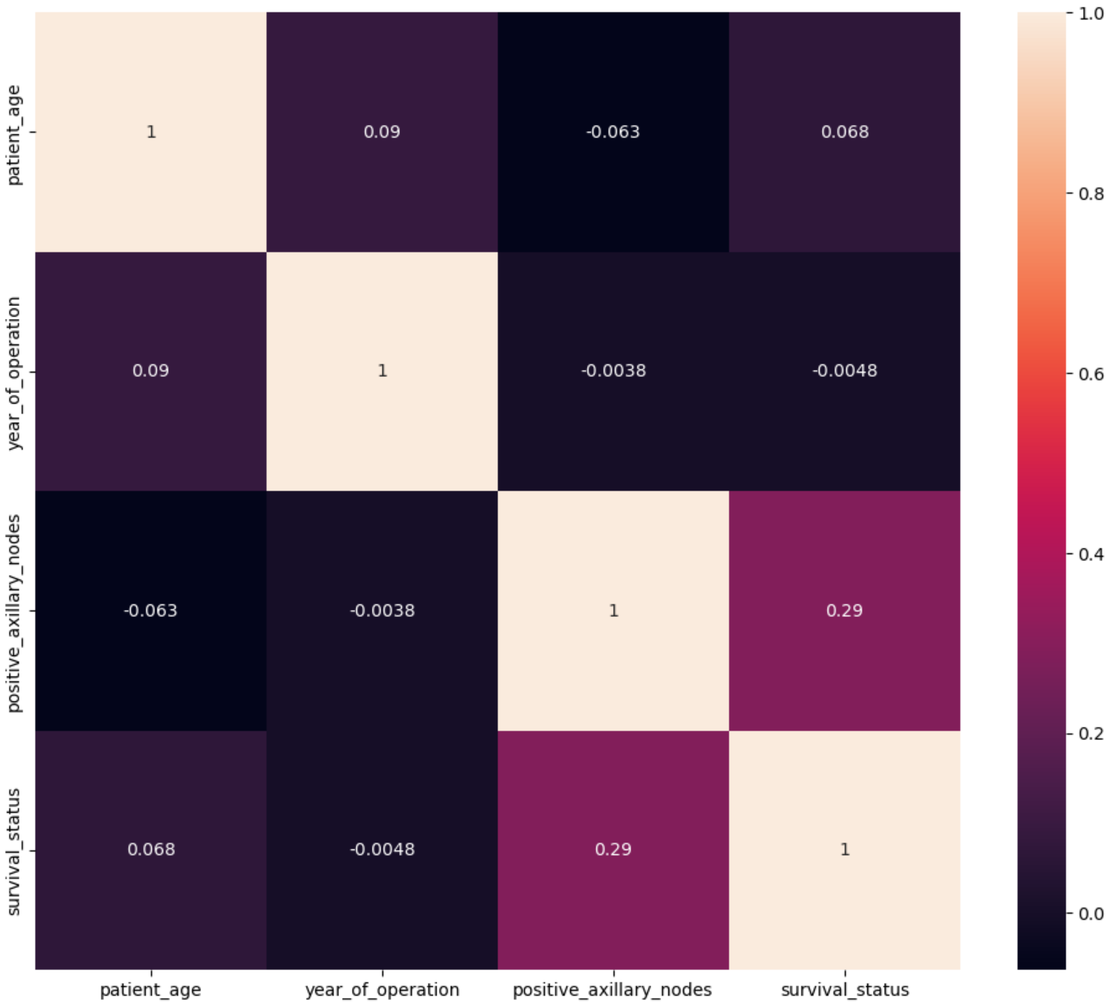
[33]:
```
df['survival_status'].value_counts().plot(kind='bar', color='green')
```

[33]:
```
<Axes: xlabel='survival_status'>
```



[34]:
```
plt.figure(figsize=(12, 10))
sns.heatmap(df.corr(),annot=True)
plt.show
```

[34]:
```
<function matplotlib.pyplot.show(close=None, block=None)>
```



[10]:
```
x_train,x_test,y_train,y_test,=train_test_split(x,y,test_size=0.
↪20,random_state=42)
```

[11]:
```
scaler=StandardScaler()
x_train=scaler.fit_transform(x_train)
x_test=scaler.fit_transform(x_test)
```

0.0.1 KNN

[12]:
```
# Hyperparameter tuning
best_accuracy = 0
best_k = 1
for k in range(1, 26):
    neigh = KNeighborsClassifier(n_neighbors=k)
    neigh.fit(x_train, y_train)
    y_pred = neigh.predict(x_test)
    accuracy = accuracy_score(y_test, y_pred)
    if accuracy > best_accuracy:
        best_accuracy = accuracy
        best_k = k
best_k
```

[12]:
```
4
```

[13]:
```
neigh=KNeighborsClassifier(n_neighbors=2, p= 3, weights='uniform')
neigh.fit(x_train,y_train)
```

[13]:
```
KNeighborsClassifier(n_neighbors=2, p=3)
```

[14]:
```
y_pred=neigh.predict(x_test)
y_pred=list(y_pred)
y_test=list(y_test)
```

[15]:
```
cm=confusion_matrix(y_test,y_pred)
cm
```

[15]:
```
array([[39,  5],
       [14,  4]], dtype=int64)
```

[16]:
```
score=accuracy_score(y_test,y_pred)
score
```

[16]:
```
0.6935483870967742
```

[17]:
```
neigh=KNeighborsClassifier(n_neighbors=4,weights='uniform')
neigh.fit(x_train,y_train)
y_pred_train=neigh.predict(x_train)
y_pred_test=neigh.predict(x_test)
from sklearn.metrics import accuracy_score
score_test=accuracy_score(y_pred_test,y_test)
print('test accuracy is ',score_test)
score_train=accuracy_score(y_pred_train,y_train)
print('train accuracy is ',score_train)
```

```
test accuracy is  0.7258064516129032
train accuracy is  0.7950819672131147
```

[18]:
```
for i in range(1,26):
    neigh=KNeighborsClassifier(n_neighbors=i,weights='uniform')
    neigh.fit(x_train,y_train)
    y_pred_train=neigh.predict(x_train)
    y_pred_test=neigh.predict(x_test)
    from sklearn.metrics import accuracy_score
    score_test=accuracy_score(y_pred_test,y_test)
    print('for',i,'test accuracy is ',score_test)
    score_train=accuracy_score(y_pred_train,y_train)
    print('for',i,' train accuracy is ',score_train)
```

```
for 1 test accuracy is  0.6451612903225806
for 1  train accuracy is  0.9836065573770492
for 2 test accuracy is  0.6935483870967742
for 2  train accuracy is  0.8237704918032787
for 3 test accuracy is  0.6451612903225806
for 3  train accuracy is  0.819672131147541
for 4 test accuracy is  0.7258064516129032
for 4  train accuracy is  0.7950819672131147
for 5 test accuracy is  0.7096774193548387
for 5  train accuracy is  0.8032786885245902
for 6 test accuracy is  0.6935483870967742
for 6  train accuracy is  0.7786885245901639
for 7 test accuracy is  0.6935483870967742
for 7  train accuracy is  0.7745901639344263
for 8 test accuracy is  0.6774193548387096
for 8  train accuracy is  0.7827868852459017
for 9 test accuracy is  0.6612903225806451
for 9  train accuracy is  0.7663934426229508
for 10 test accuracy is  0.6774193548387096
for 10  train accuracy is  0.7868852459016393
for 11 test accuracy is  0.6935483870967742
for 11  train accuracy is  0.7827868852459017
for 12 test accuracy is  0.7096774193548387
for 12  train accuracy is  0.7663934426229508
for 13 test accuracy is  0.6774193548387096
for 13  train accuracy is  0.7827868852459017
for 14 test accuracy is  0.6774193548387096
for 14  train accuracy is  0.7704918032786885
for 15 test accuracy is  0.6774193548387096
for 15  train accuracy is  0.7827868852459017
for 16 test accuracy is  0.6935483870967742
for 16  train accuracy is  0.7704918032786885
for 17 test accuracy is  0.6774193548387096
for 17  train accuracy is  0.7868852459016393
for 18 test accuracy is  0.6935483870967742
for 18  train accuracy is  0.7786885245901639
for 19 test accuracy is  0.6935483870967742
for 19  train accuracy is  0.7786885245901639
for 20 test accuracy is  0.7096774193548387
for 20  train accuracy is  0.7704918032786885
for 21 test accuracy is  0.6935483870967742
for 21  train accuracy is  0.7745901639344263
for 22 test accuracy is  0.7096774193548387
for 22  train accuracy is  0.7827868852459017
for 23 test accuracy is  0.7258064516129032
for 23  train accuracy is  0.7827868852459017
for 24 test accuracy is  0.6935483870967742
for 24  train accuracy is  0.7786885245901639
for 25 test accuracy is  0.6935483870967742
for 25  train accuracy is  0.7786885245901639
```

[19]:

```
from sklearn.model_selection import GridSearchCV
parameters = {'n_neighbors': [1,2,3,4], 'weights': ['uniform', 'distance'], 'p':
 ↪ [3, 4, 5]}

classifier = KNeighborsClassifier()
clf = GridSearchCV(classifier, parameters,cv=8)

clf.fit(x_train, y_train)
clf.best_params_
```

[19]:

```
{'n_neighbors': 2, 'p': 4, 'weights': 'uniform'}
```

[20]:

```
best_params = clf.best_params_
classifier_best = KNeighborsClassifier(**best_params)

# Fit the classifier with the best parameters on the training data
classifier_best.fit(x_train, y_train)

# Predictions on test and training sets
y_test_pred = classifier_best.predict(x_test)
y_train_pred = classifier_best.predict(x_train)

# Calculate accuracies
acc_test = accuracy_score(y_test_pred, y_test)
print('Test accuracy is ', acc_test)

acc_train = accuracy_score(y_train_pred, y_train)
print('Train accuracy is ', acc_train)
```

```
Test accuracy is  0.6774193548387096
Train accuracy is  0.8155737704918032
```

0.0.2 Decision Tree

[21]:

```
from sklearn.tree import DecisionTreeClassifier
```

[22]:

```
dt_classifier = DecisionTreeClassifier()
dt_classifier.fit(x_train, y_train)
```

[22]:
```
DecisionTreeClassifier()
```

[23]:
```python
dt_pred = dt_classifier.predict(x_test)
```

[24]:
```python
dt_accuracy = accuracy_score(y_test, dt_pred)
dt_accuracy
```

[24]:
```
0.6612903225806451
```

[25]:
```python
dt_param_grid = {'criterion': ['gini', 'entropy'], 'max_depth': [2, 5, 10, 15]}
dt_grid_search = GridSearchCV(dt_classifier, dt_param_grid, cv=5)
dt_grid_search.fit(x_train, y_train)
```

[25]:
```
GridSearchCV(cv=5, estimator=DecisionTreeClassifier(),
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': [2, 5, 10, 15]})
```

[26]:
```python
best_params = dt_grid_search.best_estimator_
best_params
```

[26]:
```
DecisionTreeClassifier(max_depth=2)
```

[27]:
```python
dt_pred_tuned = best_params.predict(x_test)
dt_accuracy_tuned = accuracy_score(y_test, dt_pred_tuned)
dt_accuracy_tuned
```

[27]:
```
0.7258064516129032
```

[28]:
```python
for i in range(1, 26):
    dt_classifier = DecisionTreeClassifier(max_depth=i, random_state=42)
    dt_classifier.fit(x_train, y_train)

    y_pred_train = dt_classifier.predict(x_train)
    score_train = accuracy_score(y_pred_train, y_train)
    print('For max_depth =', i, 'train accuracy is', score_train)

    y_pred_test = dt_classifier.predict(x_test)
    score_test = accuracy_score(y_pred_test, y_test)
    print('For max_depth =', i, 'test accuracy is', score_test)
```

```
For max_depth = 1 train accuracy is 0.7540983606557377
For max_depth = 1 test accuracy is 0.6935483870967742
For max_depth = 2 train accuracy is 0.7909836065573771
For max_depth = 2 test accuracy is 0.7258064516129032
For max_depth = 3 train accuracy is 0.8032786885245902
For max_depth = 3 test accuracy is 0.7258064516129032
For max_depth = 4 train accuracy is 0.8073770491803278
For max_depth = 4 test accuracy is 0.6935483870967742
For max_depth = 5 train accuracy is 0.8401639344262295
For max_depth = 5 test accuracy is 0.6774193548387096
For max_depth = 6 train accuracy is 0.8565573770491803
For max_depth = 6 test accuracy is 0.6612903225806451
For max_depth = 7 train accuracy is 0.8770491803278688
For max_depth = 7 test accuracy is 0.6774193548387096
For max_depth = 8 train accuracy is 0.9057377049180327
For max_depth = 8 test accuracy is 0.6774193548387096
For max_depth = 9 train accuracy is 0.9221311475409836
For max_depth = 9 test accuracy is 0.6774193548387096
For max_depth = 10 train accuracy is 0.9385245901639344
For max_depth = 10 test accuracy is 0.6129032258064516
For max_depth = 11 train accuracy is 0.9385245901639344
For max_depth = 11 test accuracy is 0.6451612903225806
For max_depth = 12 train accuracy is 0.9631147540983607
For max_depth = 12 test accuracy is 0.6451612903225806
For max_depth = 13 train accuracy is 0.9631147540983607
For max_depth = 13 test accuracy is 0.6451612903225806
For max_depth = 14 train accuracy is 0.9754098360655737
For max_depth = 14 test accuracy is 0.6129032258064516
For max_depth = 15 train accuracy is 0.9836065573770492
For max_depth = 15 test accuracy is 0.6129032258064516
For max_depth = 16 train accuracy is 0.9836065573770492
For max_depth = 16 test accuracy is 0.6129032258064516
For max_depth = 17 train accuracy is 0.9836065573770492
For max_depth = 17 test accuracy is 0.6129032258064516
For max_depth = 18 train accuracy is 0.9836065573770492
For max_depth = 18 test accuracy is 0.6129032258064516
For max_depth = 19 train accuracy is 0.9836065573770492
For max_depth = 19 test accuracy is 0.6129032258064516
For max_depth = 20 train accuracy is 0.9836065573770492
For max_depth = 20 test accuracy is 0.6129032258064516
For max_depth = 21 train accuracy is 0.9836065573770492
For max_depth = 21 test accuracy is 0.6129032258064516
For max_depth = 22 train accuracy is 0.9836065573770492
For max_depth = 22 test accuracy is 0.6129032258064516
For max_depth = 23 train accuracy is 0.9836065573770492
For max_depth = 23 test accuracy is 0.6129032258064516
For max_depth = 24 train accuracy is 0.9836065573770492
For max_depth = 24 test accuracy is 0.6129032258064516
For max_depth = 25 train accuracy is 0.9836065573770492
For max_depth = 25 test accuracy is 0.6129032258064516
```

[29]:

```
dt_classifier = DecisionTreeClassifier(max_depth=2)
dt_classifier.fit(x_train, y_train)
```

[29]:

```
DecisionTreeClassifier(max_depth=2)
```

```
[30]: dt_pred = dt_classifier.predict(x_test)
      dt_accuracy = accuracy_score(y_test, dt_pred)
      dt_accuracy
```

```
[30]: 0.7258064516129032
```

```
[51]: class_rep = classification_report(y_test, y_pred)
      class_rep
```

```
[51]: '              precision    recall  f1-score   support\n\n           1
      0.74      0.91      0.82        44\n           2       0.50      0.22      0.31
      18\n\n    accuracy                           0.71        62\n   macro avg
      0.62      0.57      0.56        62\nweighted avg       0.67      0.71      0.67
      62\n'
```

0.0.3 Random forest

```
[31]: from sklearn.ensemble import RandomForestClassifier
```

```
[32]: rf_classifier= RandomForestClassifier(random_state=42)
      rf_classifier.fit(x_train, y_train)
```

```
[32]: RandomForestClassifier(random_state=42)
```

```
[35]: y_pred = rf_classifier.predict(x_test)
      y_pred
```

```
[35]: array([1, 1, 1, 1, 1, 1, 1, 1, 2, 1, 1, 1, 1, 2, 1, 1, 1, 1, 1, 1, 1, 1,
             1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 1, 1, 1, 1, 1, 1, 1, 1, 2, 1, 2, 1,
             1, 1, 1, 1, 1, 1, 2, 1, 1, 1, 1, 2, 1, 1, 2, 1, 1, 1], dtype=int64)
```

```
[36]: accuracy = accuracy_score(y_test, y_pred)
      accuracy
```

```
[36]: 0.7096774193548387
```

```
[50]: class_rep = classification_report(y_test, y_pred)
      class_rep
```

```
[50]: '              precision    recall  f1-score   support\n\n           1
      0.74      0.91      0.82        44\n           2       0.50      0.22      0.31
      18\n\n    accuracy                           0.71        62\n   macro avg
      0.62      0.57      0.56        62\nweighted avg       0.67      0.71      0.67
      62\n'
```

0.0.4 Logistic regression

[52]:
```
from sklearn.linear_model import LogisticRegression
```

[53]:
```
logistic_model = LogisticRegression(random_state=42)
logistic_model.fit(x_train, y_train)
```

[53]:
```
LogisticRegression(random_state=42)
```

[54]:
```
y_pred = logistic_model.predict(x_test)
```

[55]:
```
accuracy = accuracy_score(y_test, y_pred)
accuracy
```

[55]:
```
0.7096774193548387
```

0.0.5 Naive Bayes

[56]:
```
from sklearn.naive_bayes import GaussianNB
from sklearn.datasets import make_classification
from sklearn.metrics import accuracy_score, confusion_matrix,␣
 ↪classification_report
```

[57]:
```
x, y = make_classification(n_samples=1000, n_features=20, n_classes=2,␣
 ↪random_state=42)
```

[58]:
```
X_train,X_test, y_train, y_test = train_test_split(x, y, test_size=0.2,␣
 ↪random_state=42)
```

[59]:
```
naive_bayes_classifier = GaussianNB()
naive_bayes_classifier.fit(X_train, y_train)
```

[59]:
```
GaussianNB()
```

[60]:
```
y_pred = naive_bayes_classifier.predict(X_test)
```

[61]:
```
accuracy = accuracy_score(y_test, y_pred)
accuracy
cm = confusion_matrix(y_test, y_pred)
cm
```

[61]:
```
'              precision    recall  f1-score   support\n\n           0
0.72      0.90      0.80        93\n           1       0.89      0.70      0.79
107\n\n    accuracy                           0.80       200\n   macro avg
0.81      0.80      0.79       200\nweighted avg       0.81      0.80      0.79
200\n'
```

[62]:

```
class_rep = classification_report(y_test, y_pred)
class_rep
```

[62]:

```
'              precision    recall  f1-score   support\n\n           0
0.72      0.90      0.80        93\n           1       0.89      0.70      0.79
107\n\n    accuracy                           0.80       200\n   macro avg
0.81      0.80      0.79       200\nweighted avg       0.81      0.80      0.79
200\n'
```

[ ]:

```
```