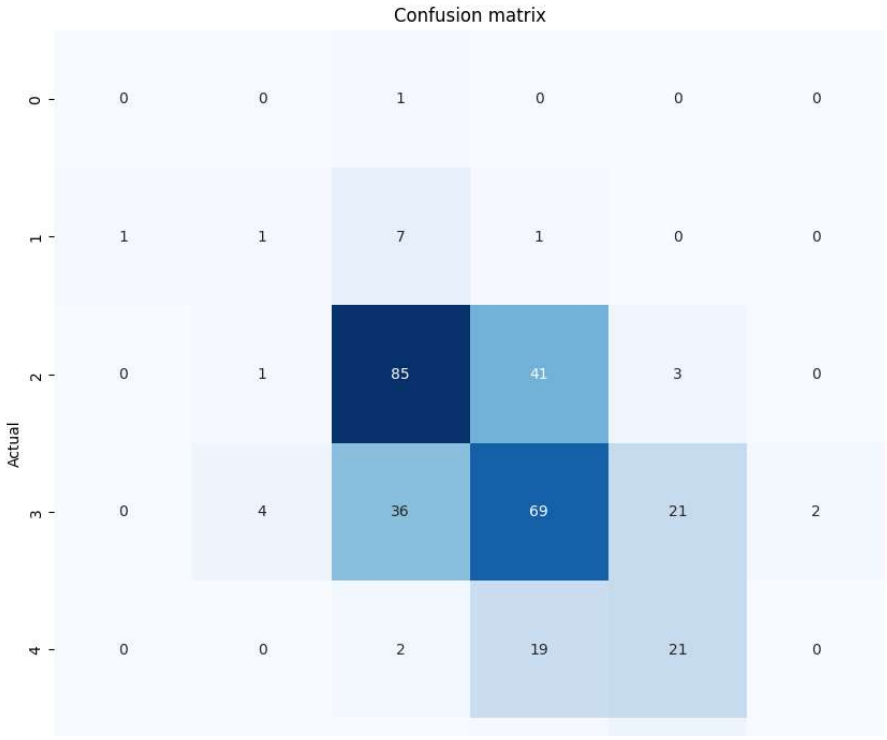
```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import classification_report, confusion_matrix
import matplotlib.pyplot as plt
import seaborn as sns


# Load winequality dataset
df = pd.read_csv("https://archive.ics.uci.edu/ml/machine-learning-databases/wine-quality/winequality-red.csv",sep=';')
df.head()
```

| | fixed acidity | volatile acidity | citric acid | residual sugar | chlorides | free sulfur dioxide | total sulfur dioxide | density | pH | sulphates | alcohol | quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 7.4 | 0.70 | 0.00 | 1.9 | 0.076 | 11.0 | 34.0 | 0.9978 | 3.51 | 0.56 | 9.4 | 5 |
| **1** | 7.8 | 0.88 | 0.00 | 2.6 | 0.098 | 25.0 | 67.0 | 0.9968 | 3.20 | 0.68 | 9.8 | 5 |
| **2** | 7.8 | 0.76 | 0.04 | 2.3 | 0.092 | 15.0 | 54.0 | 0.9970 | 3.26 | 0.65 | 9.8 | 5 |
| **3** | 11.2 | 0.28 | 0.56 | 1.9 | 0.075 | 17.0 | 60.0 | 0.9980 | 3.16 | 0.58 | 9.8 | 6 |
| **4** | 7.4 | 0.70 | 0.00 | 1.9 | 0.076 | 11.0 | 34.0 | 0.9978 | 3.51 | 0.56 | 9.4 | 5 |

```
# Split data into training and testing sets
X = df.drop(columns=['quality'])
y = df['quality']
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)


# Train Naive Bayes model
nb = GaussianNB()
nb.fit(X_train, y_train)
# Print classification report
y_pred = nb.predict(X_test)
print(classification_report(y_test, y_pred))
```

```
                   precision    recall  f1-score   support

                3       0.00      0.00      0.00         1
                4       0.17      0.10      0.12        10
                5       0.65      0.65      0.65       130
                6       0.53      0.52      0.52       132
                7       0.43      0.50      0.46        42
                8       0.00      0.00      0.00         5

         accuracy                           0.55       320
        macro avg       0.30      0.30      0.29       320
     weighted avg       0.54      0.55      0.55       320
```

```
# Plot confusion matrix
cm = confusion_matrix(y_test, y_pred)
fig, ax = plt.subplots(figsize=(10,10))
sns.heatmap(cm, annot=True, fmt='d', cmap=plt.cm.Blues, cbar=False)
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.title('Confusion matrix')
plt.show()
```




```
# Plot histogram of predicted class probabilities
proba = nb.predict_proba(X_test)
plt.hist(proba[:, 1], bins=50, alpha=0.5, label='Positive Class')
plt.hist(proba[:, 0], bins=50, alpha=0.5, label='Negative Class')
plt.xlabel('Predicted Probability')
plt.ylabel('Count')
plt.legend()
plt.title('Histogram of Predicted Class Probabilities')
plt.show()
```