classification-regression-1

February 6, 2024

[82]:
```python
import pandas as pd

github_url = 'https://raw.githubusercontent.com/aniruddhachoudhury/
 ↪Red-Wine-Quality/master/winequality-red.csv'
wine_data = pd.read_csv(github_url)
print('Wine Quality Dataset:')
print(wine_data.head())
display(wine_data)
```

```
Wine Quality Dataset:
   fixed acidity  volatile acidity  citric acid  residual sugar  chlorides  \
0            7.4              0.70         0.00             1.9      0.076
1            7.8              0.88         0.00             2.6      0.098
2            7.8              0.76         0.04             2.3      0.092
3           11.2              0.28         0.56             1.9      0.075
4            7.4              0.70         0.00             1.9      0.076

   free sulfur dioxide  total sulfur dioxide  density    pH  sulphates  \
0                 11.0                  34.0   0.9978  3.51       0.56
1                 25.0                  67.0   0.9968  3.20       0.68
2                 15.0                  54.0   0.9970  3.26       0.65
3                 17.0                  60.0   0.9980  3.16       0.58
4                 11.0                  34.0   0.9978  3.51       0.56

   alcohol  quality
0      9.4        5
1      9.8        5
2      9.8        5
3      9.8        6
4      9.4        5
```

```
      fixed acidity  volatile acidity  citric acid  residual sugar  chlorides  \
0               7.4             0.700         0.00             1.9      0.076
1               7.8             0.880         0.00             2.6      0.098
2               7.8             0.760         0.04             2.3      0.092
3              11.2             0.280         0.56             1.9      0.075
4               7.4             0.700         0.00             1.9      0.076
…               …               …             …               …          …
```

```
1594            6.2             0.600          0.08              2.0        0.090
1595            5.9             0.550          0.10              2.2        0.062
1596            6.3             0.510          0.13              2.3        0.076
1597            5.9             0.645          0.12              2.0        0.075
1598            6.0             0.310          0.47              3.6        0.067

      free sulfur dioxide  total sulfur dioxide  density    pH  sulphates  \
0                    11.0                  34.0  0.99780  3.51       0.56
1                    25.0                  67.0  0.99680  3.20       0.68
2                    15.0                  54.0  0.99700  3.26       0.65
3                    17.0                  60.0  0.99800  3.16       0.58
4                    11.0                  34.0  0.99780  3.51       0.56
…                     …                   …       …     …        …
1594                 32.0                  44.0  0.99490  3.45       0.58
1595                 39.0                  51.0  0.99512  3.52       0.76
1596                 29.0                  40.0  0.99574  3.42       0.75
1597                 32.0                  44.0  0.99547  3.57       0.71
1598                 18.0                  42.0  0.99549  3.39       0.66

      alcohol  quality
0         9.4        5
1         9.8        5
2         9.8        5
3         9.8        6
4         9.4        5
…        …       …
1594     10.5        5
1595     11.2        6
1596     11.0        6
1597     10.2        5
1598     11.0        6

[1599 rows x 12 columns]
```

[83]:
```python
import pandas as pd

# Assuming redWine is a pandas DataFrame that has been previously loaded
quality_counts = wine_data['quality'].value_counts()
print(quality_counts)

wine_data['quality_binary'] = wine_data['quality'].apply(lambda x: 0 if x in␣
↪[3, 4, 5] else (1 if x in [6, 7, 8] else None))

quality_binary_counts = wine_data['quality_binary'].value_counts()
print(quality_binary_counts)
```

```
quality
5    681
```

```
6    638
7    199
4     53
8     18
3     10
Name: count, dtype: int64
quality_binary
1    855
0    744
Name: count, dtype: int64
```

[84]:
```
pip install scikit-learn
```

```
Requirement already satisfied: scikit-learn in /opt/conda/lib/python3.11/site-
packages (1.4.0)
Requirement already satisfied: numpy<2.0,>=1.19.5 in
/opt/conda/lib/python3.11/site-packages (from scikit-learn) (1.26.2)
Requirement already satisfied: scipy>=1.6.0 in /opt/conda/lib/python3.11/site-
packages (from scikit-learn) (1.12.0)
Requirement already satisfied: joblib>=1.2.0 in /opt/conda/lib/python3.11/site-
packages (from scikit-learn) (1.3.2)
Requirement already satisfied: threadpoolctl>=2.0.0 in
/opt/conda/lib/python3.11/site-packages (from scikit-learn) (3.2.0)
Note: you may need to restart the kernel to use updated packages.
```

[85]:
```
pip install matplotlib
```

```
Requirement already satisfied: matplotlib in /opt/conda/lib/python3.11/site-
packages (3.8.2)
Requirement already satisfied: contourpy>=1.0.1 in
/opt/conda/lib/python3.11/site-packages (from matplotlib) (1.2.0)
Requirement already satisfied: cycler>=0.10 in /opt/conda/lib/python3.11/site-
packages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in
/opt/conda/lib/python3.11/site-packages (from matplotlib) (4.47.2)
Requirement already satisfied: kiwisolver>=1.3.1 in
/opt/conda/lib/python3.11/site-packages (from matplotlib) (1.4.5)
Requirement already satisfied: numpy<2,>=1.21 in /opt/conda/lib/python3.11/site-
packages (from matplotlib) (1.26.2)
Requirement already satisfied: packaging>=20.0 in
/opt/conda/lib/python3.11/site-packages (from matplotlib) (23.2)
Requirement already satisfied: pillow>=8 in /opt/conda/lib/python3.11/site-
packages (from matplotlib) (10.2.0)
Requirement already satisfied: pyparsing>=2.3.1 in
/opt/conda/lib/python3.11/site-packages (from matplotlib) (3.1.1)
Requirement already satisfied: python-dateutil>=2.7 in
/opt/conda/lib/python3.11/site-packages (from matplotlib) (2.8.2)
Requirement already satisfied: six>=1.5 in /opt/conda/lib/python3.11/site-
```

```
packages (from python-dateutil>=2.7->matplotlib) (1.16.0)
Note: you may need to restart the kernel to use updated packages.
```

[86]:
```
pip install seaborn
```

```
Requirement already satisfied: seaborn in /opt/conda/lib/python3.11/site-
packages (0.13.2)
Requirement already satisfied: numpy!=1.24.0,>=1.20 in
/opt/conda/lib/python3.11/site-packages (from seaborn) (1.26.2)
Requirement already satisfied: pandas>=1.2 in /opt/conda/lib/python3.11/site-
packages (from seaborn) (2.0.3)
Requirement already satisfied: matplotlib!=3.6.1,>=3.4 in
/opt/conda/lib/python3.11/site-packages (from seaborn) (3.8.2)
Requirement already satisfied: contourpy>=1.0.1 in
/opt/conda/lib/python3.11/site-packages (from matplotlib!=3.6.1,>=3.4->seaborn)
(1.2.0)
Requirement already satisfied: cycler>=0.10 in /opt/conda/lib/python3.11/site-
packages (from matplotlib!=3.6.1,>=3.4->seaborn) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in
/opt/conda/lib/python3.11/site-packages (from matplotlib!=3.6.1,>=3.4->seaborn)
(4.47.2)
Requirement already satisfied: kiwisolver>=1.3.1 in
/opt/conda/lib/python3.11/site-packages (from matplotlib!=3.6.1,>=3.4->seaborn)
(1.4.5)
Requirement already satisfied: packaging>=20.0 in
/opt/conda/lib/python3.11/site-packages (from matplotlib!=3.6.1,>=3.4->seaborn)
(23.2)
Requirement already satisfied: pillow>=8 in /opt/conda/lib/python3.11/site-
packages (from matplotlib!=3.6.1,>=3.4->seaborn) (10.2.0)
Requirement already satisfied: pyparsing>=2.3.1 in
/opt/conda/lib/python3.11/site-packages (from matplotlib!=3.6.1,>=3.4->seaborn)
(3.1.1)
Requirement already satisfied: python-dateutil>=2.7 in
/opt/conda/lib/python3.11/site-packages (from matplotlib!=3.6.1,>=3.4->seaborn)
(2.8.2)
Requirement already satisfied: pytz>=2020.1 in /opt/conda/lib/python3.11/site-
packages (from pandas>=1.2->seaborn) (2023.3.post1)
Requirement already satisfied: tzdata>=2022.1 in /opt/conda/lib/python3.11/site-
packages (from pandas>=1.2->seaborn) (2023.4)
Requirement already satisfied: six>=1.5 in /opt/conda/lib/python3.11/site-
packages (from python-dateutil>=2.7->matplotlib!=3.6.1,>=3.4->seaborn) (1.16.0)
Note: you may need to restart the kernel to use updated packages.
```

[87]:
```python
import numpy as np
import pandas as pd
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
```

```python
# Assuming 'redWine' is a pandas DataFrame and 'quality_binary' is a column in␣
↪it
# Set the random seed
np.random.seed(123)

# Split the data into training and test sets
train_data, test_data = train_test_split(wine_data, test_size=0.3)

# Prepare the data for logistic regression
# Assuming 'quality' is a column to be excluded from the model
X_train = train_data.drop(columns=['quality', 'quality_binary'])
y_train = train_data['quality_binary']
X_test = test_data.drop(columns=['quality', 'quality_binary'])
y_test = test_data['quality_binary']

# Create and fit the logistic regression model
logistic_model_no_quality = LogisticRegression(max_iter=1000)
logistic_model_no_quality.fit(X_train, y_train)

# Print the summary of the model
# Note: There's no direct equivalent of R's summary function in sklearn; we␣
↪print the coefficients instead
#print(logistic_model_no_quality.coef_)

# Make predictions on the test data
predictions_no_quality = logistic_model_no_quality.predict_proba(X_test)[:, 1]

# Convert probabilities to class predictions
predicted_classes_no_quality = (predictions_no_quality > 0.5).astype(int)

from sklearn.metrics import confusion_matrix, accuracy_score, precision_score,␣
↪recall_score, f1_score

# Assuming test_data['quality_binary'] and predicted_classes_no_quality are␣
↪defined
conf_matrix_no_quality = confusion_matrix(test_data['quality_binary'],␣
↪predicted_classes_no_quality)
print(conf_matrix_no_quality)

accuracy_no_quality = accuracy_score(test_data['quality_binary'],␣
↪predicted_classes_no_quality)
precision_no_quality = precision_score(test_data['quality_binary'],␣
↪predicted_classes_no_quality)
recall_no_quality = recall_score(test_data['quality_binary'],␣
↪predicted_classes_no_quality)
```

```python
f1_score_no_quality = f1_score(test_data['quality_binary'],␣
 ↪predicted_classes_no_quality)

print("Model without 'quality' - Accuracy:", accuracy_no_quality)
print("Model without 'quality' - Precision:", precision_no_quality)
print("Model without 'quality' - Recall:", recall_no_quality)
print("Model without 'quality' - F1 Score:", f1_score_no_quality)
```

```
[[158  74]
 [ 62 186]]
Model without 'quality' - Accuracy: 0.7166666666666667
Model without 'quality' - Precision: 0.7153846153846154
Model without 'quality' - Recall: 0.75
Model without 'quality' - F1 Score: 0.7322834645669292
```

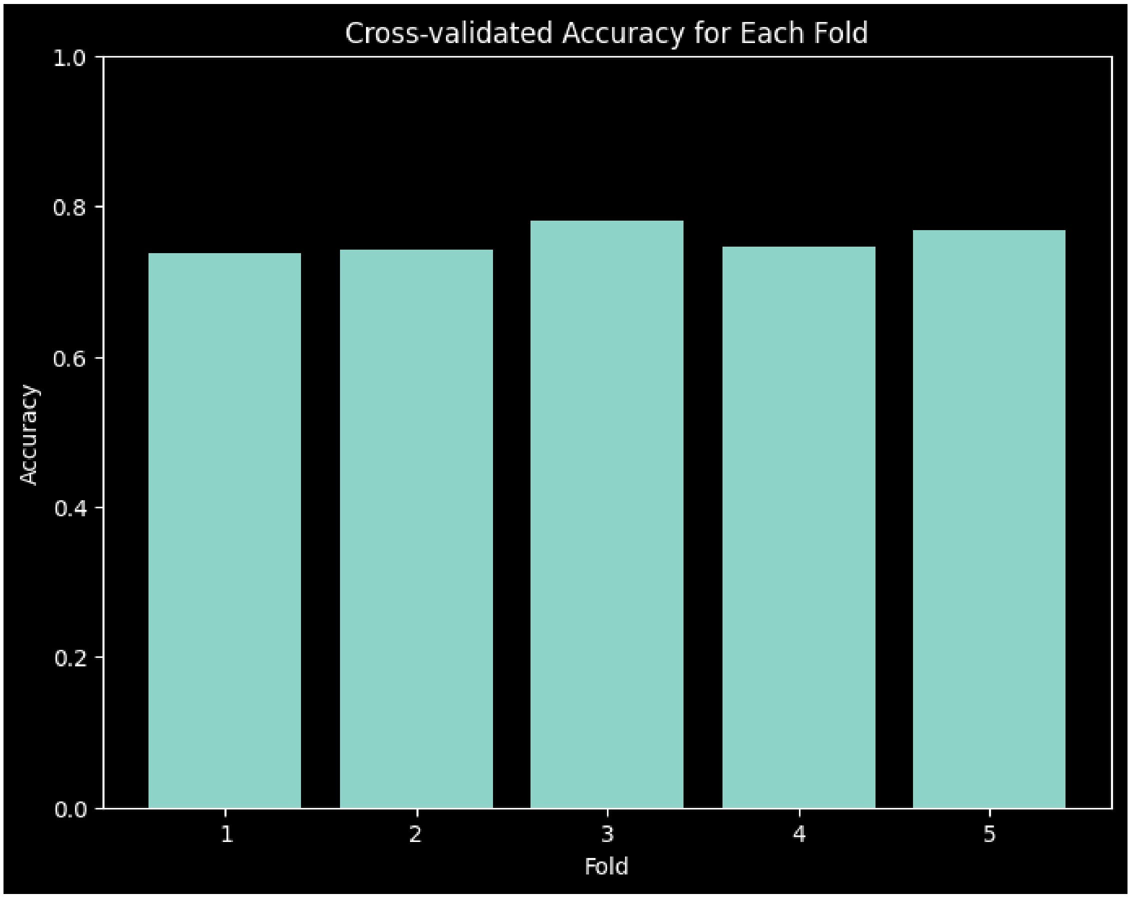
[88]:

```python
from sklearn.model_selection import cross_val_score

scores = cross_val_score(logistic_model_no_quality, X_train, y_train, cv=5,␣
 ↪scoring='accuracy')
print("Cross-validated Accuracy:", np.mean(scores))
```

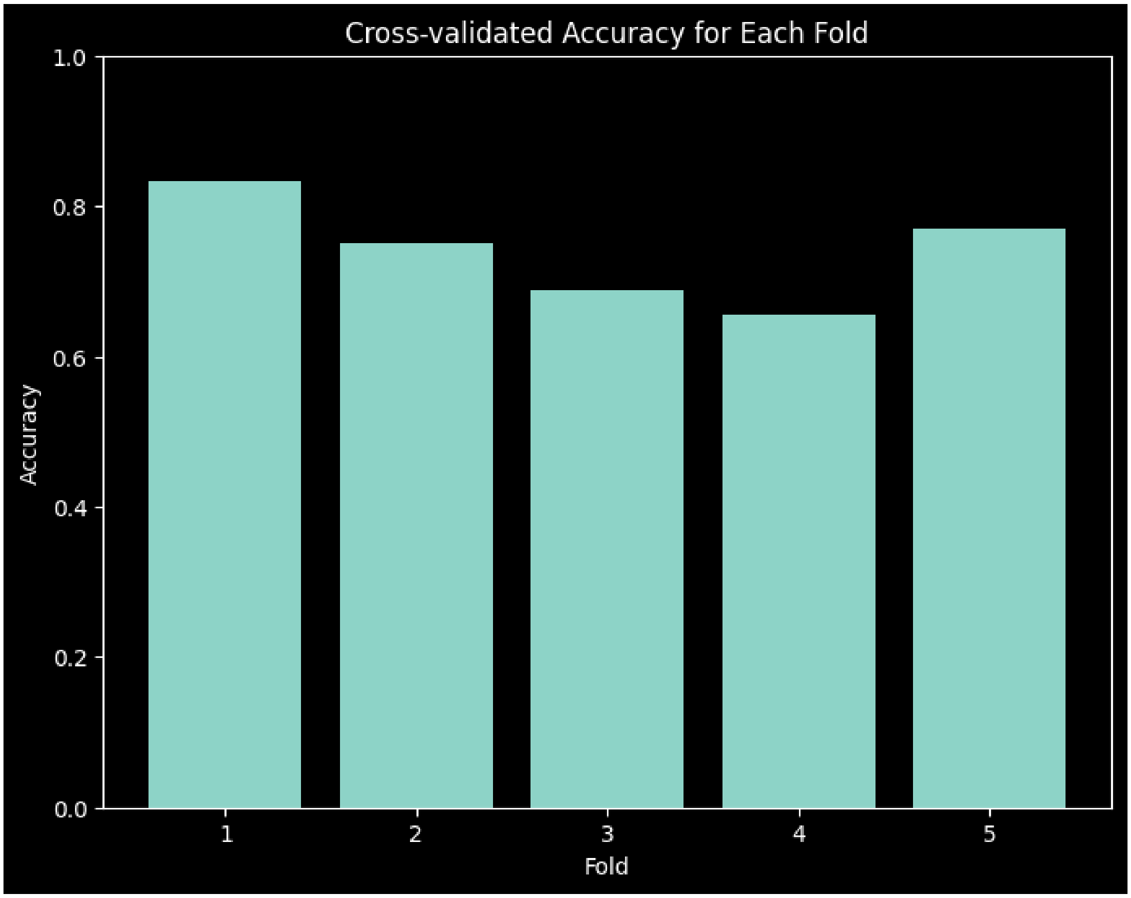
```
Cross-validated Accuracy: 0.7542560858424088
```

[469]:

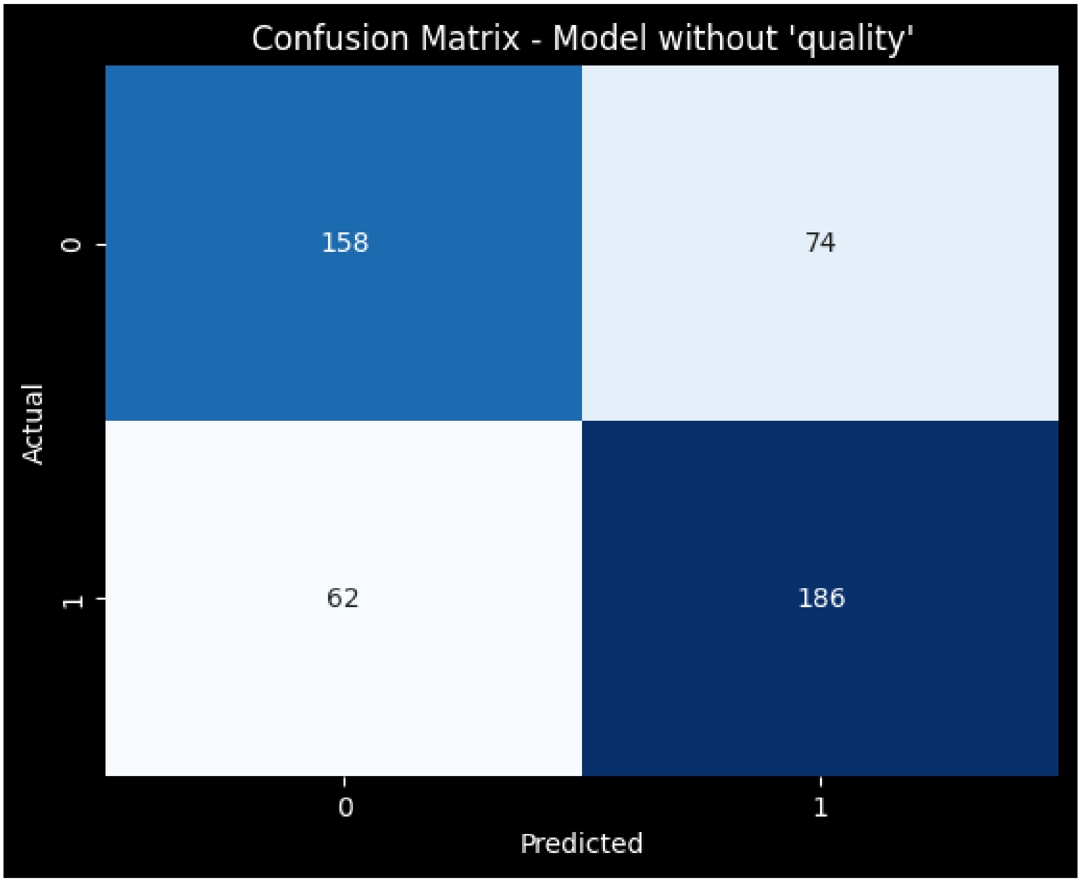
```python
import matplotlib.pyplot as plt

# Perform cross-validation
scores = cross_val_score(logistic_model_no_quality, X_train, y_train, cv=5,␣
 ↪scoring='accuracy')

# Create a bar plot of cross-validated accuracy for each fold
plt.figure(figsize=(8, 6))
plt.bar(range(1, len(scores) + 1), scores)
plt.title('Cross-validated Accuracy for Each Fold')
plt.xlabel('Fold')
plt.ylabel('Accuracy')
plt.ylim([0, 1])
plt.show()
```



[468]:
```
import matplotlib.pyplot as plt

# Perform cross-validation
scores = cross_val_score(logistic_model_no_quality, X_test, y_test, cv=5,␣
↪scoring='accuracy')

# Create a bar plot of cross-validated accuracy for each fold
plt.figure(figsize=(8, 6))
plt.bar(range(1, len(scores) + 1), scores)
plt.title('Cross-validated Accuracy for Each Fold')
plt.xlabel('Fold')
plt.ylabel('Accuracy')
plt.ylim([0, 1])
plt.show()
```

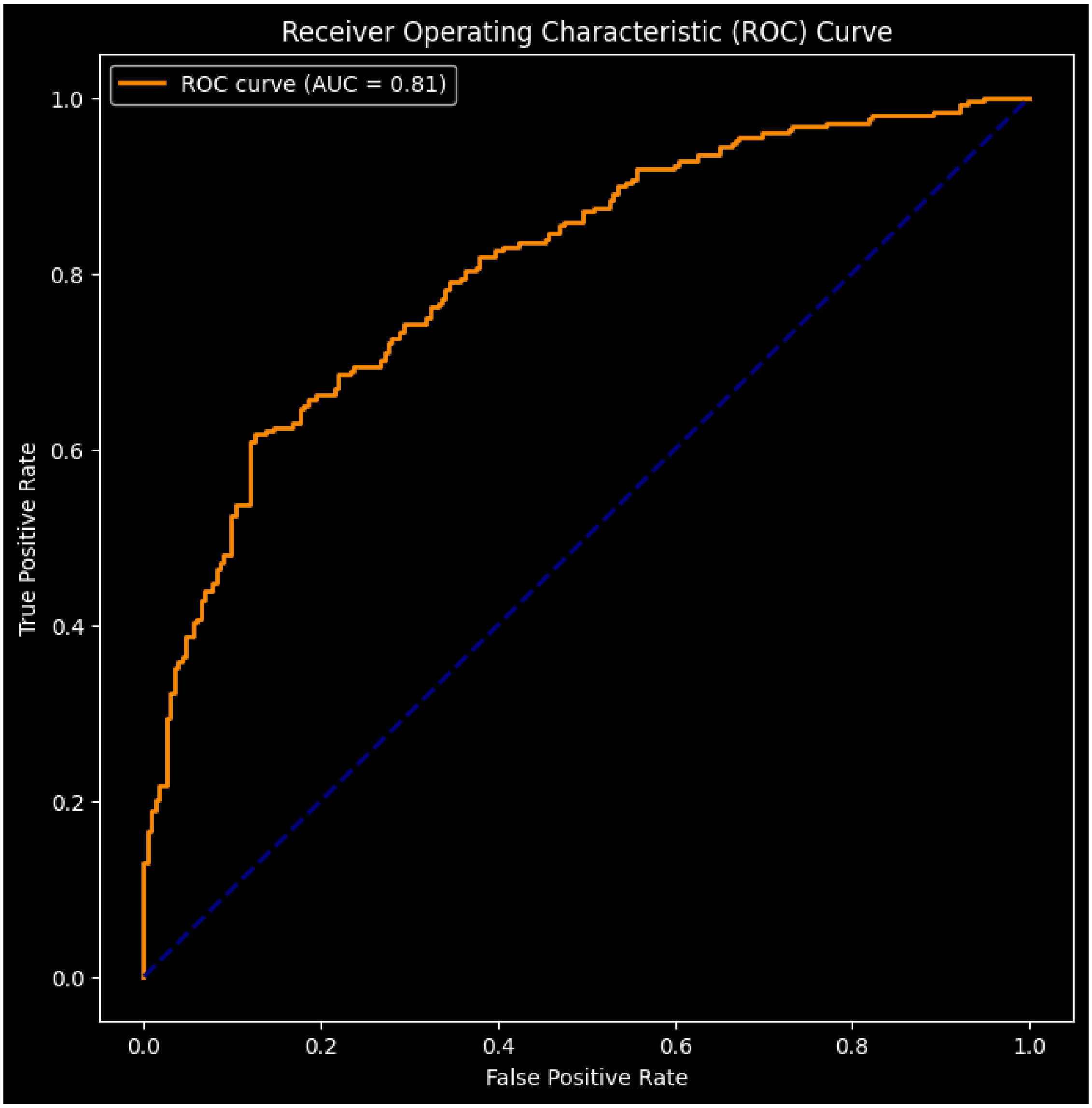


[89]:
```
sns.heatmap(conf_matrix_no_quality, annot=True, fmt='d', cmap='Blues',␣
  ↪cbar=False)
plt.title('Confusion Matrix - Model without \'quality\'')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.show()
```



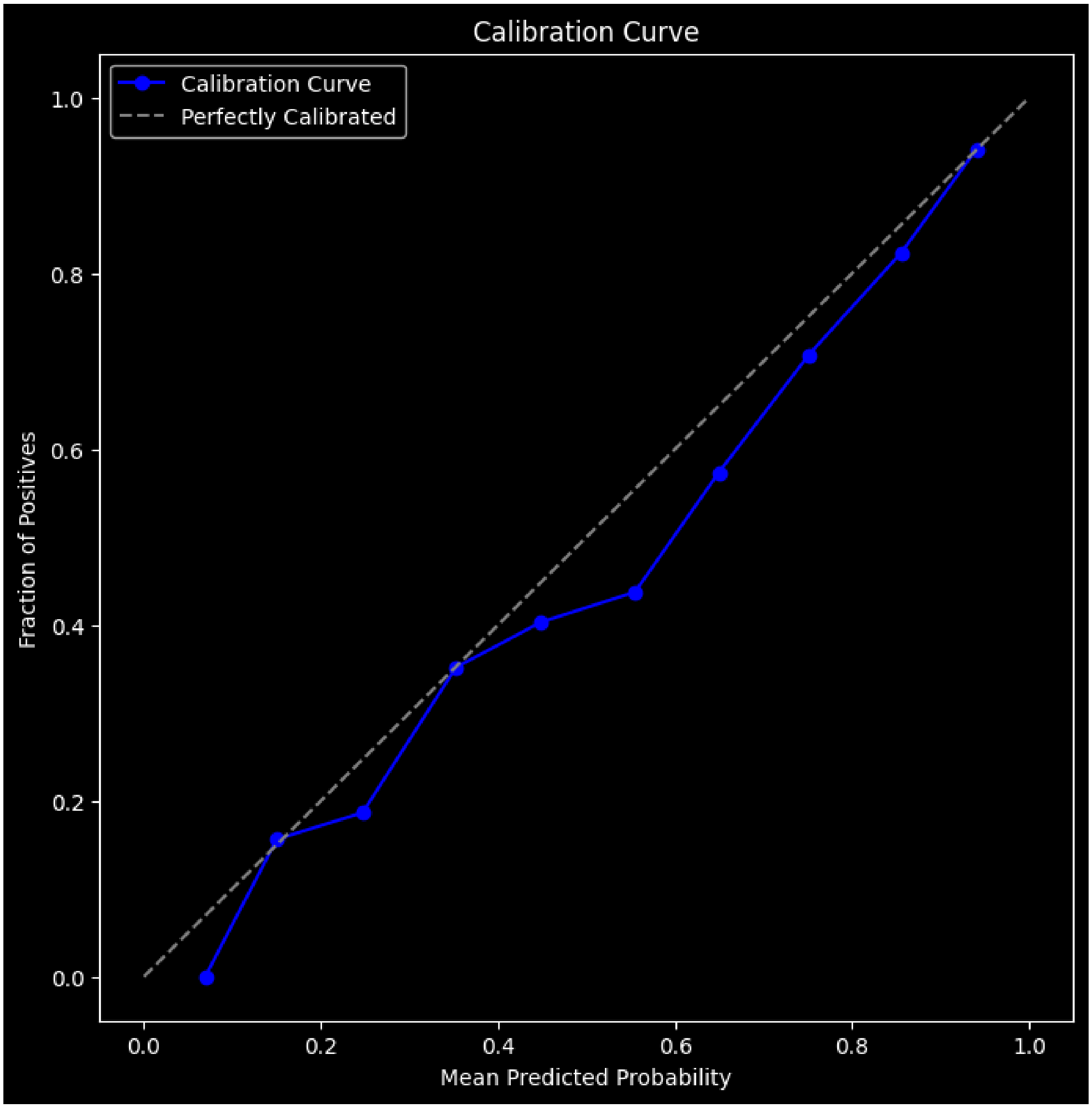
[90]:
```
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import roc_curve, roc_auc_score

# Assuming logistic_model is your fitted scikit-learn LogisticRegression model
# Assuming X_test is your test data and y_test is the corresponding true labels

# Predict probabilities
probabilities = logistic_model_no_quality.predict_proba(X_test)[:, 1]

# ROC curve
fpr, tpr, thresholds = roc_curve(y_test, probabilities)
roc_auc = roc_auc_score(y_test, probabilities)

plt.figure(figsize=(8, 8))
plt.plot(fpr, tpr, color='darkorange', lw=2, label='ROC curve (AUC = {:.2f})'.
  ↪format(roc_auc))
plt.plot([0, 1], [0, 1], color='navy', lw=2, linestyle='--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
```

```
plt.title('Receiver Operating Characteristic (ROC) Curve')
plt.legend()
plt.show()
```



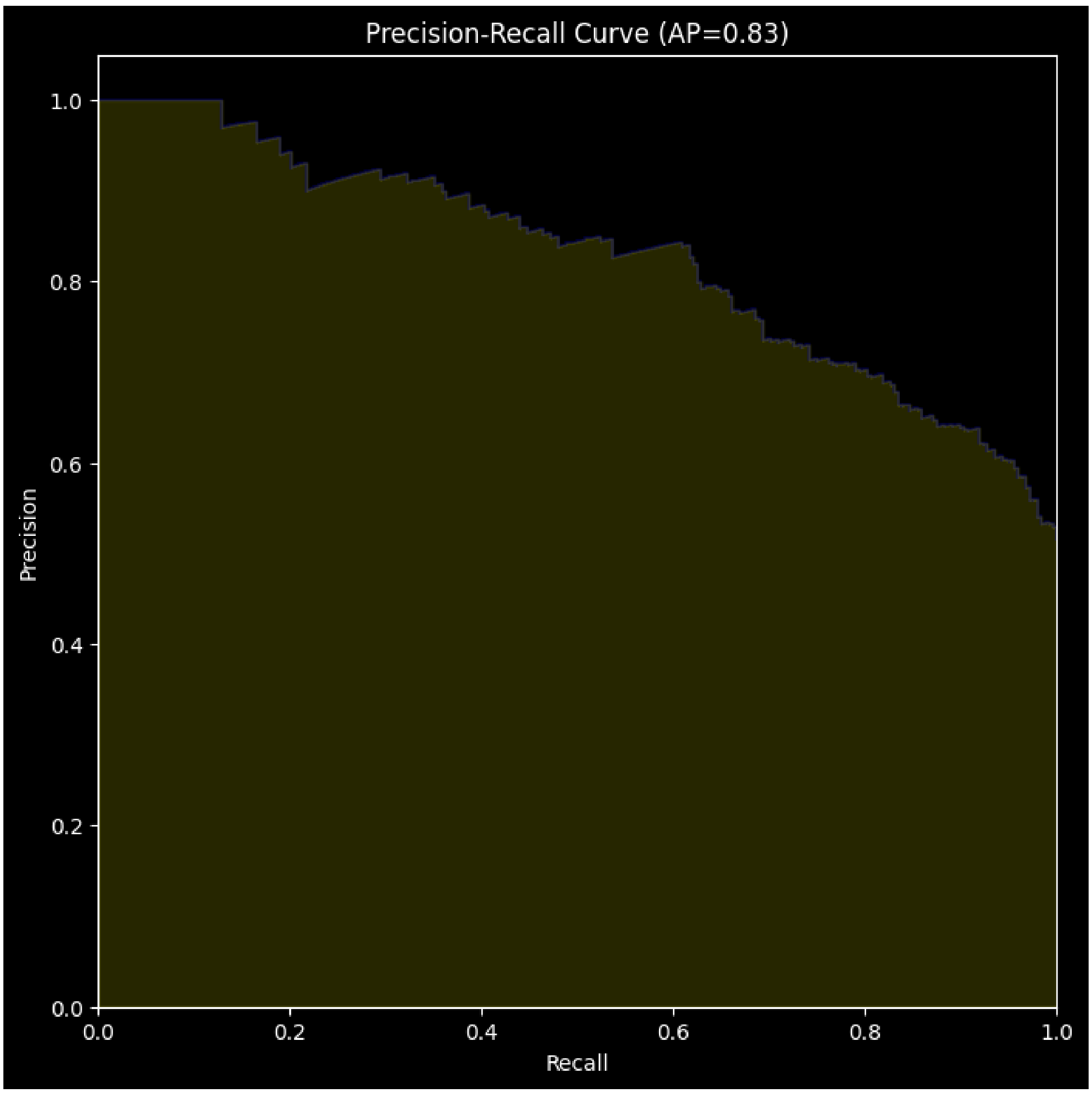
[91]:
```
from sklearn.calibration import calibration_curve

# Compute calibration curve
prob_true, prob_pred = calibration_curve(y_test, predictions_no_quality,
  ↪n_bins=10)

# Plot calibration curve
plt.figure(figsize=(8, 8))
```

```
plt.plot(prob_pred, prob_true, marker='o', linestyle='-', color='b',␣
 ↪label='Calibration Curve')
plt.plot([0, 1], [0, 1], linestyle='--', color='gray', label='Perfectly␣
 ↪Calibrated')
plt.xlabel('Mean Predicted Probability')
plt.ylabel('Fraction of Positives')
plt.title('Calibration Curve')
plt.legend()
plt.show()
```



[92]:
```
from sklearn.metrics import precision_recall_curve, average_precision_score
```

```python
# Compute precision-recall curve and area the curve
precision, recall, _ = precision_recall_curve(y_test, predictions_no_quality)
average_precision = average_precision_score(y_test, predictions_no_quality)

# Plot precision-recall curve
plt.figure(figsize=(8, 8))
plt.step(recall, precision, color='b', alpha=0.2, where='post')
plt.fill_between(recall, precision, step='post', alpha=0.2, color='y')
plt.xlabel('Recall')
plt.ylabel('Precision')
plt.ylim([0.0, 1.05])
plt.xlim([0.0, 1.0])
plt.title('Precision-Recall Curve (AP={:.2f})'.format(average_precision))
plt.show()
```



```
[ ]:
```