wine-quality-prediction

February 19, 2024

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
```

[2]:
```
data = pd.read_csv("/content/WineQT.csv")
data.head()
```

[2]:

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

Data Preprocessing:

[3]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1143 entries, 0 to 1142
Data columns (total 13 columns):
 #   Column                Non-Null Count  Dtype
---  ------                --------------  -----
```

```
 0   fixed acidity         1143 non-null   float64
 1   volatile acidity      1143 non-null   float64
 2   citric acid           1143 non-null   float64
 3   residual sugar        1143 non-null   float64
 4   chlorides             1143 non-null   float64
 5   free sulfur dioxide   1143 non-null   float64
 6   total sulfur dioxide  1143 non-null   float64
 7   density               1143 non-null   float64
 8   pH                    1143 non-null   float64
 9   sulphates             1143 non-null   float64
 10  alcohol               1143 non-null   float64
 11  quality               1143 non-null   int64
 12  Id                    1143 non-null   int64
dtypes: float64(11), int64(2)
memory usage: 116.2 KB
```

[4]:
```
data.describe()
```

[4]:

	fixed acidity	volatile acidity	citric acid	residual sugar	\
count	1143.000000	1143.000000	1143.000000	1143.000000	
mean	8.311111	0.531339	0.268364	2.532152	
std	1.747595	0.179633	0.196686	1.355917	
min	4.600000	0.120000	0.000000	0.900000	
25%	7.100000	0.392500	0.090000	1.900000	
50%	7.900000	0.520000	0.250000	2.200000	
75%	9.100000	0.640000	0.420000	2.600000	
max	15.900000	1.580000	1.000000	15.500000	

	chlorides	free sulfur dioxide	total sulfur dioxide	density	\
count	1143.000000	1143.000000	1143.000000	1143.000000	
mean	0.086933	15.615486	45.914698	0.996730	
std	0.047267	10.250486	32.782130	0.001925	
min	0.012000	1.000000	6.000000	0.990070	
25%	0.070000	7.000000	21.000000	0.995570	
50%	0.079000	13.000000	37.000000	0.996680	
75%	0.090000	21.000000	61.000000	0.997845	
max	0.611000	68.000000	289.000000	1.003690	

	pH	sulphates	alcohol	quality	Id
count	1143.000000	1143.000000	1143.000000	1143.000000	1143.000000
mean	3.311015	0.657708	10.442111	5.657043	804.969379
std	0.156664	0.170399	1.082196	0.805824	463.997116
min	2.740000	0.330000	8.400000	3.000000	0.000000
25%	3.205000	0.550000	9.500000	5.000000	411.000000
50%	3.310000	0.620000	10.200000	6.000000	794.000000
75%	3.400000	0.730000	11.100000	6.000000	1209.500000
max	4.010000	2.000000	14.900000	8.000000	1597.000000

[5]:
```
data.isnull().sum()
```

[5]:
```
fixed acidity           0
volatile acidity        0
citric acid             0
residual sugar          0
chlorides               0
free sulfur dioxide     0
total sulfur dioxide    0
density                 0
pH                      0
sulphates               0
alcohol                 0
quality                 0
Id                      0
dtype: int64
```

Feature Selection:

[6]:
```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
```

[7]:
```
# Split the dataset into features (X) and target variable (y)
X = data.drop(["quality", "Id"], axis=1)
y = data["quality"]
```

[8]:
```
# Split the dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)
```

[9]:
```
# Feature Scaling
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)
```

Model Building:

[10]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.linear_model import SGDClassifier
from sklearn.svm import SVC
```

[11]:
```
# Initialize classifier models
rf_model = RandomForestClassifier()
sgd_model = SGDClassifier()
svc_model = SVC()
```

[12]:
```
# Train the random forest model
rf_model.fit(X_train_scaled, y_train)
```

[12]:
```
RandomForestClassifier()
```

[13]:
```
# Train the sgd model
sgd_model.fit(X_train_scaled, y_train)
```

[13]:
```
SGDClassifier()
```

[14]:
```
# Train the svc model
svc_model.fit(X_train_scaled, y_train)
```

[14]:
```
SVC()
```

Model Evaluation:

[15]:
```
from sklearn.metrics import classification_report
```

[16]:
```
# Evaluate Random Forest model
rf_predictions = rf_model.predict(X_test_scaled)
print("\033[1mRandom Forest Classifier:\033[0m")
print(classification_report(y_test, rf_predictions))
```

```
Random Forest Classifier:
              precision    recall  f1-score   support

           4       0.00      0.00      0.00         6
           5       0.71      0.80      0.75        96
           6       0.67      0.65      0.66        99
           7       0.69      0.69      0.69        26
           8       0.00      0.00      0.00         2

    accuracy                           0.69       229
   macro avg       0.42      0.43      0.42       229
weighted avg       0.67      0.69      0.68       229


/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
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UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
```

```
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

[17]:
```python
# Evaluate SGD model
sgd_predictions = sgd_model.predict(X_test_scaled)
print("\033[1mStochastic Gradient Descent Classifier:\033[0m")
print(classification_report(y_test, sgd_predictions))
```

```
Stochastic Gradient Descent Classifier:
              precision    recall  f1-score   support

           3       0.00      0.00      0.00         0
           4       0.00      0.00      0.00         6
           5       0.57      0.72      0.64        96
           6       0.48      0.26      0.34        99
           7       0.17      0.23      0.19        26
           8       0.00      0.00      0.00         2

    accuracy                           0.44       229
   macro avg       0.20      0.20      0.19       229
weighted avg       0.47      0.44      0.44       229


/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Recall and F-score are ill-defined and being set to 0.0
in labels with no true samples. Use `zero_division` parameter to control this
behavior.
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UndefinedMetricWarning: Recall and F-score are ill-defined and being set to 0.0
in labels with no true samples. Use `zero_division` parameter to control this
behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

[18]:
```python
# Evaluate SVC model
svc_predictions = svc_model.predict(X_test_scaled)
print("\033[1mSupport Vector Classifier:\033[0m")
print(classification_report(y_test, svc_predictions))
```

```
Support Vector Classifier:
              precision    recall  f1-score   support

           4       0.00      0.00      0.00         6
```

```
           5       0.70      0.74      0.72        96
           6       0.59      0.69      0.64        99
           7       0.54      0.27      0.36        26
           8       0.00      0.00      0.00         2

    accuracy                           0.64       229
   macro avg       0.37      0.34      0.34       229
weighted avg       0.61      0.64      0.62       229
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
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0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

[19]:

```
# Define classes and models
classes = np.unique(y_test)
models = ['Random Forest', 'Stochastic Gradient Descent', 'Support Vector␣
↪Classifier']
```

[20]:

```
# Initialize empty lists to store F1-scores for each class and model
f1_scores = {model: [] for model in models}
```

[21]:

```
# Calculate F1-score for each model
for model_name, predictions in zip(models, [rf_predictions, sgd_predictions,␣
↪svc_predictions]):
    report = classification_report(y_test, predictions, output_dict=True)
    for class_label in classes:
        f1_scores[model_name].append(report[str(class_label)]['f1-score'])
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
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UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
```

```
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/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```
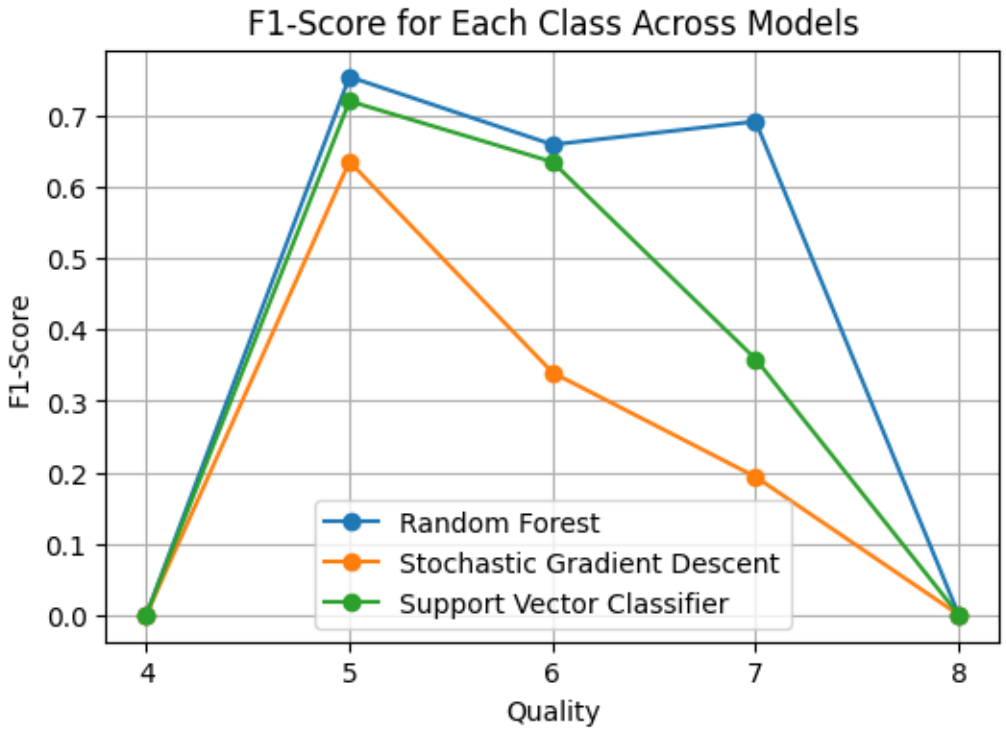

[22]:

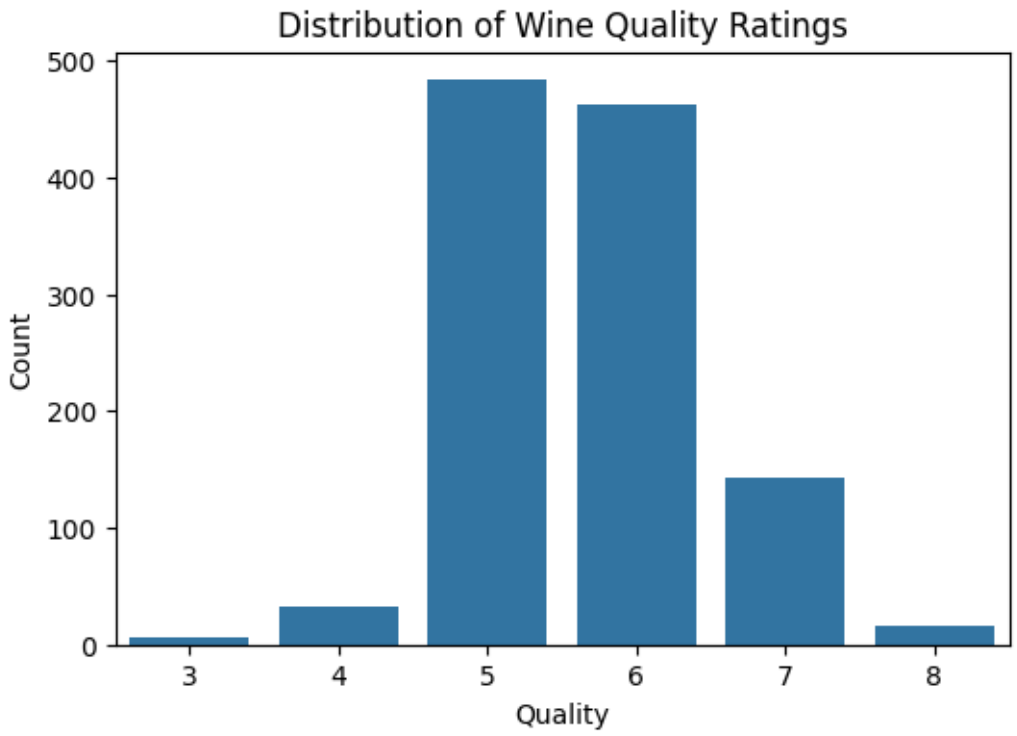
```
# Plot F1-scores for each class across models
plt.figure(figsize=(6, 4))
for model_name in models:
    plt.plot(classes, f1_scores[model_name], marker='o', label=model_name)
plt.title('F1-Score for Each Class Across Models')
plt.xlabel('Quality')
plt.ylabel('F1-Score')
plt.legend()
```

```
plt.xticks(classes)
plt.grid(True)
plt.show()
```

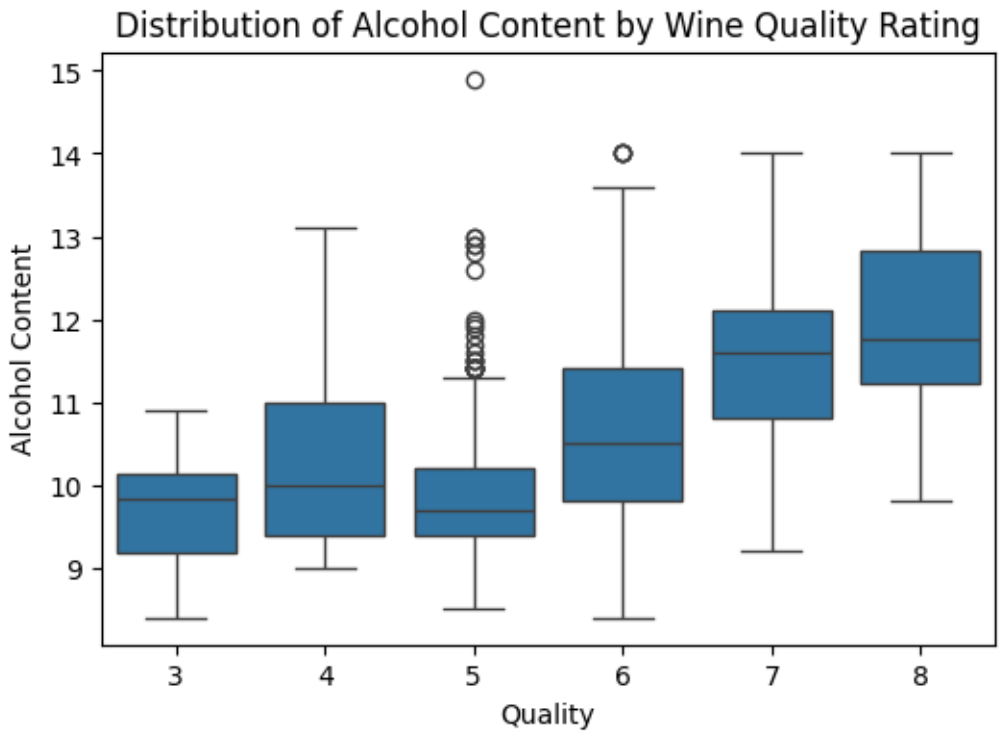


Visualizations:

[23]:
```
# Visualize the distribution of wine quality ratings
plt.figure(figsize=(6, 4))
sns.countplot(x='quality', data=data)
plt.title('Distribution of Wine Quality Ratings')
plt.xlabel('Quality')
plt.ylabel('Count')
plt.show()
```

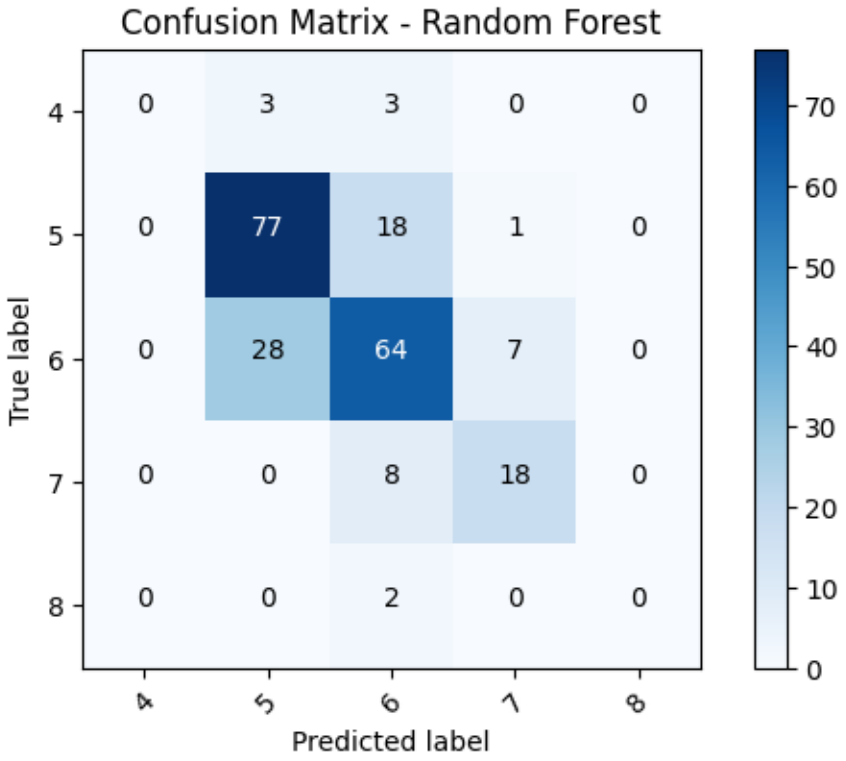


[24]:
```
# Boxplot to visualize distribution of features by quality rating
plt.figure(figsize=(6, 4))
sns.boxplot(x='quality', y='alcohol', data=data)
plt.title('Distribution of Alcohol Content by Wine Quality Rating')
plt.xlabel('Quality')
plt.ylabel('Alcohol Content')
plt.show()
```

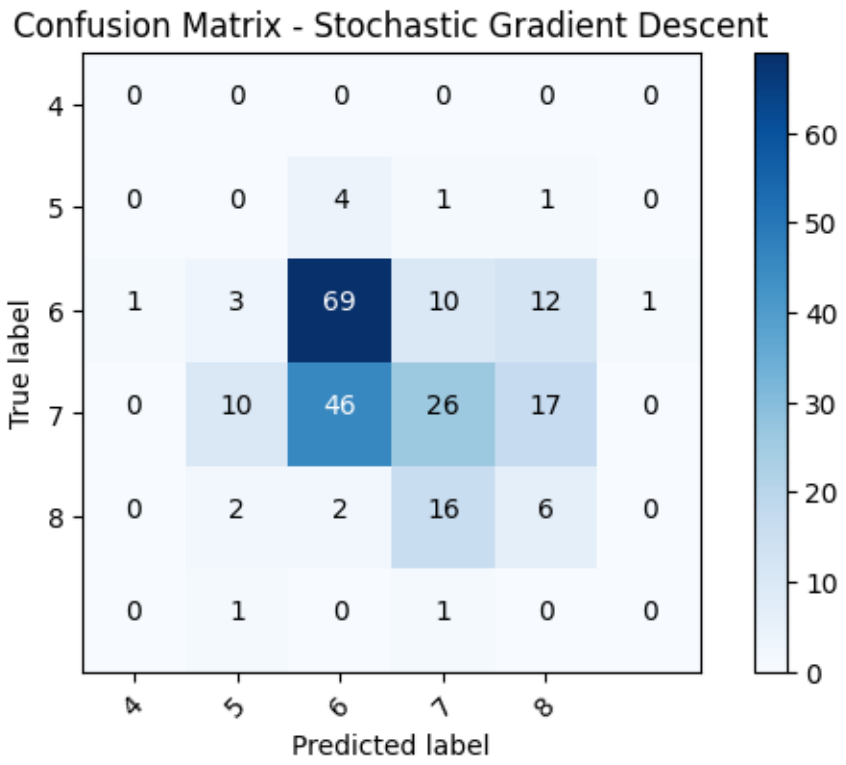


[25]:
```
from sklearn.metrics import confusion_matrix
import itertools

# Function to plot confusion matrix
def plot_confusion_matrix(cm, classes, title='Confusion matrix', cmap=plt.cm.
 ↪Blues):
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=45)
    plt.yticks(tick_marks, classes)

    fmt = 'd'
    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, format(cm[i, j], fmt),
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
```

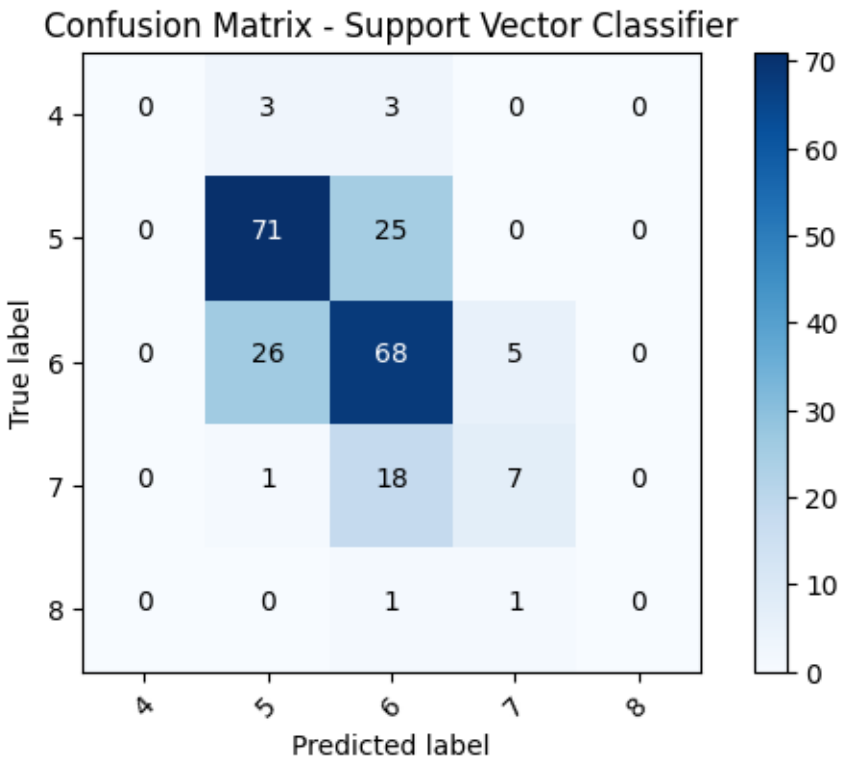
[26]:
```
# Calculate confusion matrix for Random Forest model
rf_cm = confusion_matrix(y_test, rf_predictions)

# Plot confusion matrix
plt.figure(figsize=(6, 4))
plot_confusion_matrix(rf_cm, classes=np.unique(y_test), title='Confusion Matrix␣
 ↪- Random Forest')
plt.show()
```



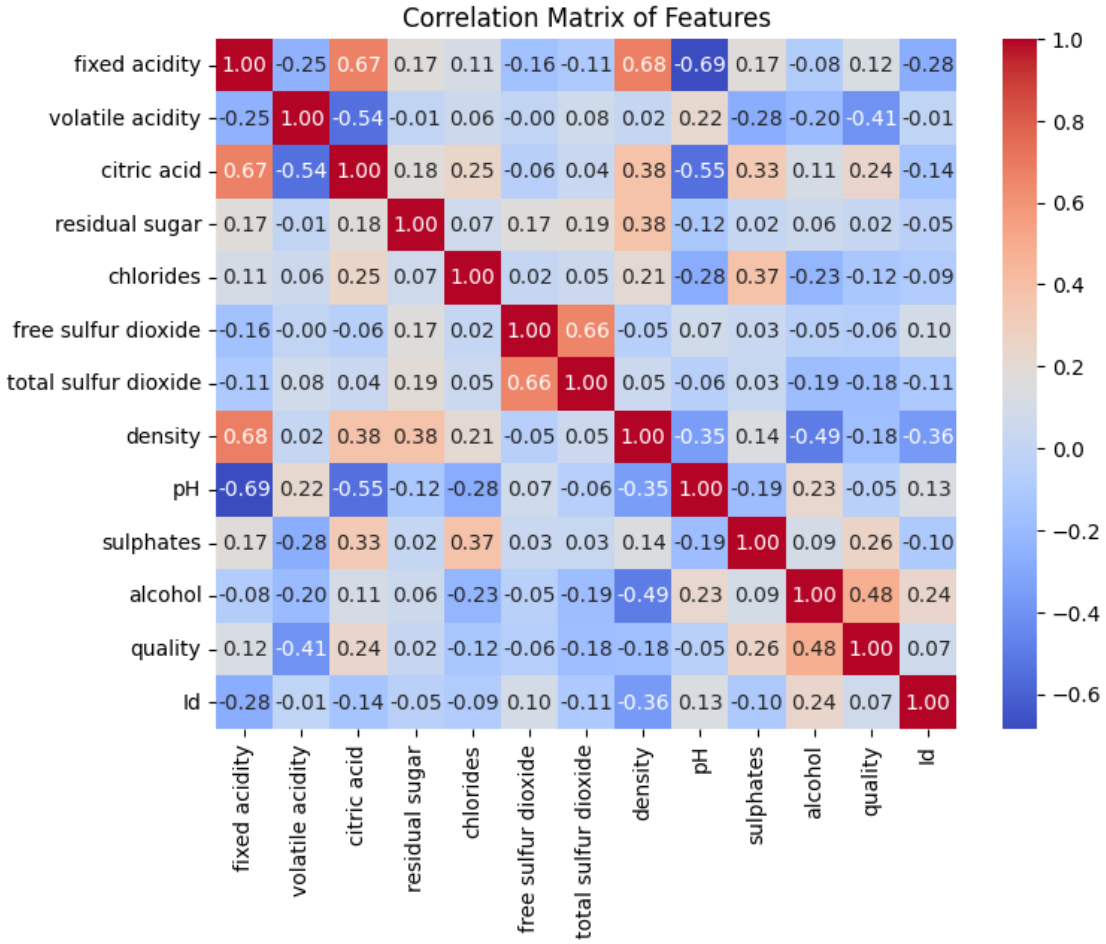
[27]:
```
# Calculate confusion matrix for SGD model
sgd_cm = confusion_matrix(y_test, sgd_predictions)

# Plot confusion matrix
plt.figure(figsize=(6, 4))
plot_confusion_matrix(sgd_cm, classes=np.unique(y_test), title='Confusion␣
 ↪Matrix - Stochastic Gradient Descent')
plt.show()
```



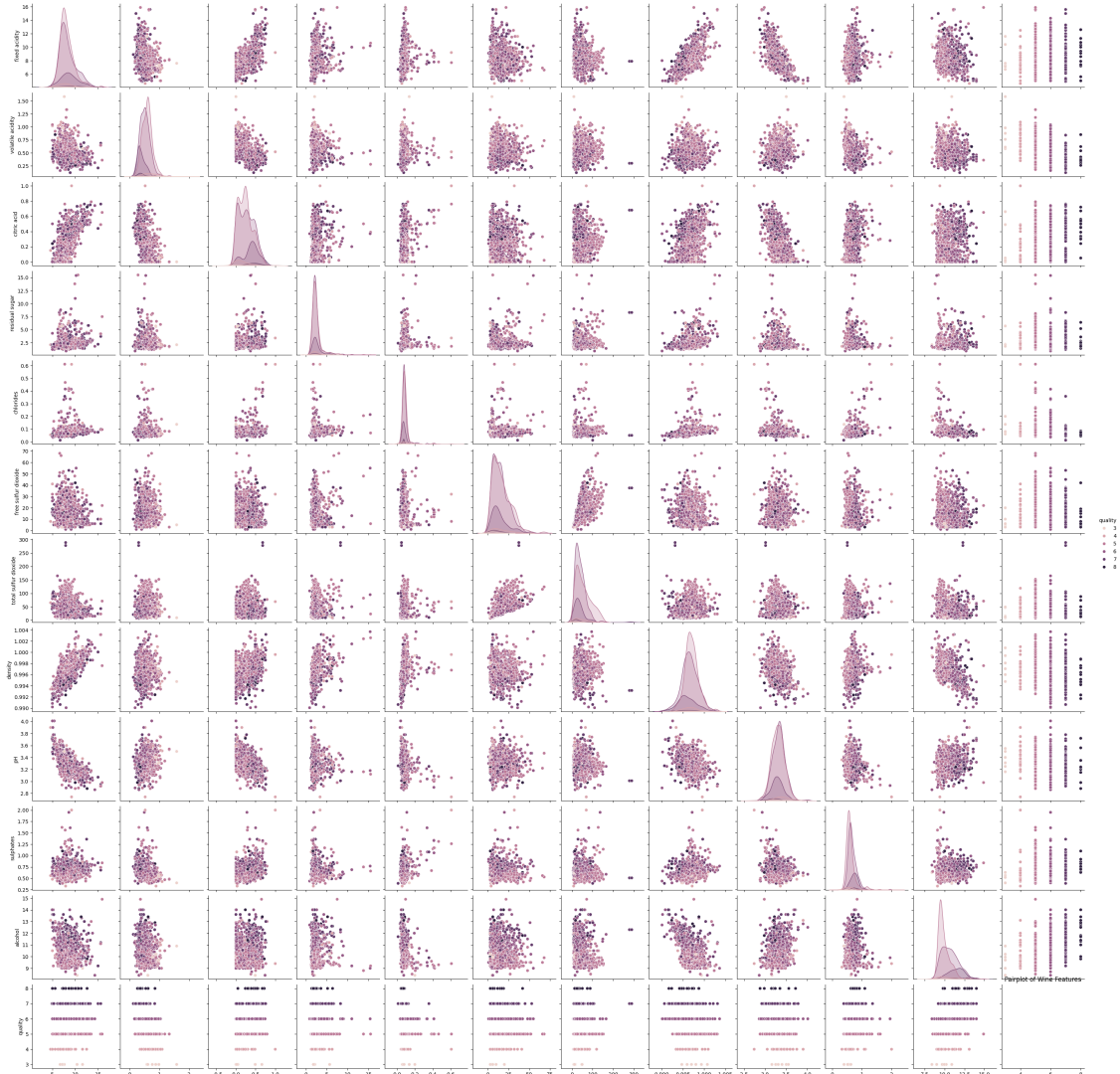
[28]:
```
# Calculate confusion matrix for SVC model
svc_cm = confusion_matrix(y_test, svc_predictions)

# Plot confusion matrix
plt.figure(figsize=(6, 4))
plot_confusion_matrix(svc_cm, classes=np.unique(y_test), title='Confusion␣
 ↪Matrix - Support Vector Classifier')
plt.show()
```



[29]:
```
# Visualize the correlation matrix of features
plt.figure(figsize=(8, 6))
sns.heatmap(data.corr(), annot=True, cmap='coolwarm', fmt=".2f")
plt.title('Correlation Matrix of Features')
plt.show()
```



[30]:
```
# Pairplot to visualize relationships between features
sns.pairplot(data=data, vars=['fixed acidity', 'volatile acidity', 'citric␣
 ↪acid', 'residual sugar',
                              'chlorides', 'free sulfur dioxide', 'total sulfur␣
 ↪dioxide', 'density', 'pH',
                              'sulphates', 'alcohol', 'quality'], hue='quality')
plt.title('Pairplot of Wine Features')
plt.show()
```


fixed acidity
volatile acidity
citric acid
residual sugar
chlorides
free sulfur dioxide
total sulfur dioxide
density
pH
sulphates
alcohol
quality
quality
3
4
5
6
7
8
Pairplot of Wine Features