Support Vector Machine (SVM) Implementation

Author: Srikar Kalle
Student ID: C00313529

Change Log:

SL No.	Change Category	Description	Duration (mins)	Difficulty (1-10)
1	Decision Boundary Visualization	Fixed visualization issue by training SVM with only **two features** (`bill_length_mm` , `bill_depth_mm`).	10	5
2	Dataset Handling	Updated dataset to use only **bill_length_mm and bill_depth_mm** for better boundary visualization.	8	4
3	Dataset Selection	Replaced **synthetic dataset** with a **real Kaggle dataset** for a more practical application.	15	6
4	Framework Integration	Implemented the **CRISP-DM framework** for structured analysis and documentation.	12	5
5	Hyperparameter Tuning	Used `GridSearchCV` to optimize **SVM hyperparameters**.	20	7
6	Decision Boundary Enhancement	Improved **decision boundary visualization** with better plotting techniques.	10	5
7	Logging Implementation	Introduced **structured logging** for tracking model performance and errors.	8	4
8	Initial Implementation	Basic SVM model setup and training.	5	3

In [3]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import logging
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.svm import SVC
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import classification_report, accuracy_score
```

In [4]:
```
# Configure logging
logging.basicConfig(level=logging.INFO, format='%(asctime)s - %(levelname)s - %(message)s')

# Step 1: Business Understanding
logging.info("Business Understanding: Classifying data using Support Vector Machines (SVM).")
```

```
2025-02-21 18:41:50,879 - INFO - Business Understanding: Classifying data using Support Vector
Machines (SVM).
```

In [5]:
```
# Step 2: Data Understanding
logging.info("Loading dataset...")
data = sns.load_dataset('penguins').dropna()
logging.info(f"Dataset loaded with shape {data.shape}")
```

```
2025-02-21 18:41:50,896 - INFO - Loading dataset...
2025-02-21 18:41:51,000 - INFO - Dataset loaded with shape (333, 7)
```

In [6]:

```
# Selecting numerical features & encoding target
X = data[['bill_length_mm', 'bill_depth_mm']]
y = data['species'].astype('category').cat.codes
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
```

In [7]:

```
# Splitting dataset
X_train, X_test, y_train, y_test = train_test_split(X_scaled, y, test_size=0.2, random_state=
logging.info("Data split into training and testing sets.")
```

```
2025-02-21 18:41:51,058 - INFO - Data split into training and testing sets.
```

In [8]:

```
# Step 3: Model Training & Hyperparameter Tuning
param_grid = {
    'C': [0.1, 1, 10],
    'kernel': ['linear', 'rbf', 'poly'],
    'gamma': ['scale', 'auto']
}
```

In [9]:

```
svc = SVC()
grid_search = GridSearchCV(svc, param_grid, cv=5, scoring='accuracy')
logging.info("Starting hyperparameter tuning...")
grid_search.fit(X_train, y_train)
best_model = grid_search.best_estimator_
logging.info("Best parameters found: %s", grid_search.best_params_)
```

```
2025-02-21 18:41:51,096 - INFO - Starting hyperparameter tuning...
2025-02-21 18:41:51,652 - INFO - Best parameters found: {'C': 10, 'gamma': 'scale', 'kernel':
'rbf'}
```

In [10]:

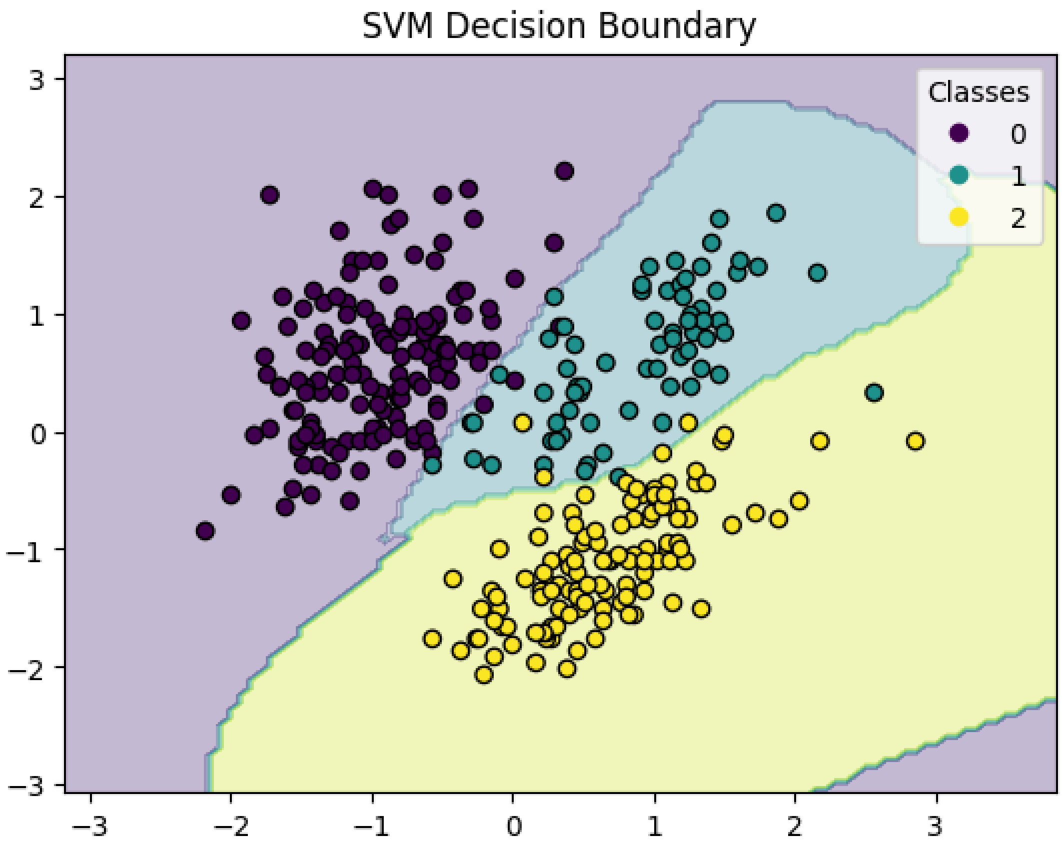
```
# Step 4: Model Evaluation
y_pred = best_model.predict(X_test)
accuracy = accuracy_score(y_test, y_pred)
logging.info(f"Model Accuracy: {accuracy:.4f}")
print(classification_report(y_test, y_pred))
```

```
2025-02-21 18:41:51,672 - INFO - Model Accuracy: 0.9552
              precision    recall  f1-score   support

           0       1.00      0.97      0.98        31
           1       0.86      0.92      0.89        13
           2       0.96      0.96      0.96        23

    accuracy                           0.96        67
   macro avg       0.94      0.95      0.94        67
weighted avg       0.96      0.96      0.96        67
```

In [11]:

```
# Step 5: Decision Boundary Visualization
def plot_decision_boundary(model, X, y):
    x_min, x_max = X[:, 0].min() - 1, X[:, 0].max() + 1
    y_min, y_max = X[:, 1].min() - 1, X[:, 1].max() + 1
    xx, yy = np.meshgrid(np.linspace(x_min, x_max, 100), np.linspace(y_min, y_max, 100))
    Z = model.predict(np.c_[xx.ravel(), yy.ravel()])
    Z = Z.reshape(xx.shape)
    plt.contourf(xx, yy, Z, alpha=0.3)
    scatter = plt.scatter(X[:, 0], X[:, 1], c=y, cmap='viridis', edgecolor='k')
    plt.legend(*scatter.legend_elements(), title="Classes")
    plt.title("SVM Decision Boundary")
    plt.show()
```

In [12]:
```
plot_decision_boundary(best_model, X_scaled, y)

logging.info("SVM model trained and evaluated successfully.")
```




```
2025-02-21 18:41:52,796 - INFO - SVM model trained and evaluated successfully.
```