FINAL

September 22, 2024

[1]:
```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler, OneHotEncoder
from sklearn.compose import ColumnTransformer
from sklearn.impute import SimpleImputer
from sklearn.pipeline import Pipeline
from sklearn.ensemble import RandomForestClassifier
from xgboost import XGBClassifier
from sklearn.metrics import accuracy_score, classification_report
```

[2]:
```
# Load the dataset
data = pd.read_csv(
    "/Users/gabrielmancillas/Documents/GitHub/StudentPerformancePrediction/
 ↪student_performance_prediction.csv"
)
```

[3]:
```
# Display the first few rows of the dataset to understand its structure
print(data.head())

# Get summary statistics for numerical columns
print(data.describe())

# Check for missing values
print(data.isnull().sum())
```

```
  Student ID  Study Hours per Week  Attendance Rate  Previous Grades  \
0     S00001                  12.5              NaN             75.0
1     S00002                   9.3             95.3             60.6
2     S00003                  13.2              NaN             64.0
3     S00004                  17.6             76.8             62.4
4     S00005                   8.8             89.3             72.7

  Participation in Extracurricular Activities Parent Education Level Passed
0                                         Yes                 Master    Yes
1                                          No            High School     No
2                                          No              Associate     No
3                                         Yes               Bachelor     No
4                                          No                 Master     No
```

```
       Study Hours per Week  Attendance Rate  Previous Grades
count          38005.000000     38008.000000     38006.000000
mean               9.962744        75.276323        65.440107
std                5.031154        20.393418        16.503119
min              -12.300000       -14.300000         8.300000
25%                6.600000        61.600000        55.100000
50%               10.000000        75.300000        65.200000
75%               13.400000        88.800000        75.200000
max               32.400000       150.200000       200.000000
Student ID                                            0
Study Hours per Week                                1995
Attendance Rate                                     1992
Previous Grades                                     1994
Participation in Extracurricular Activities         2000
Parent Education Level                              2000
Passed                                              2000
dtype: int64
```

[4]:
```python
# Percentage of missing data in each column
missing_data_percentage = data.isnull().mean() * 100
print(missing_data_percentage)
```

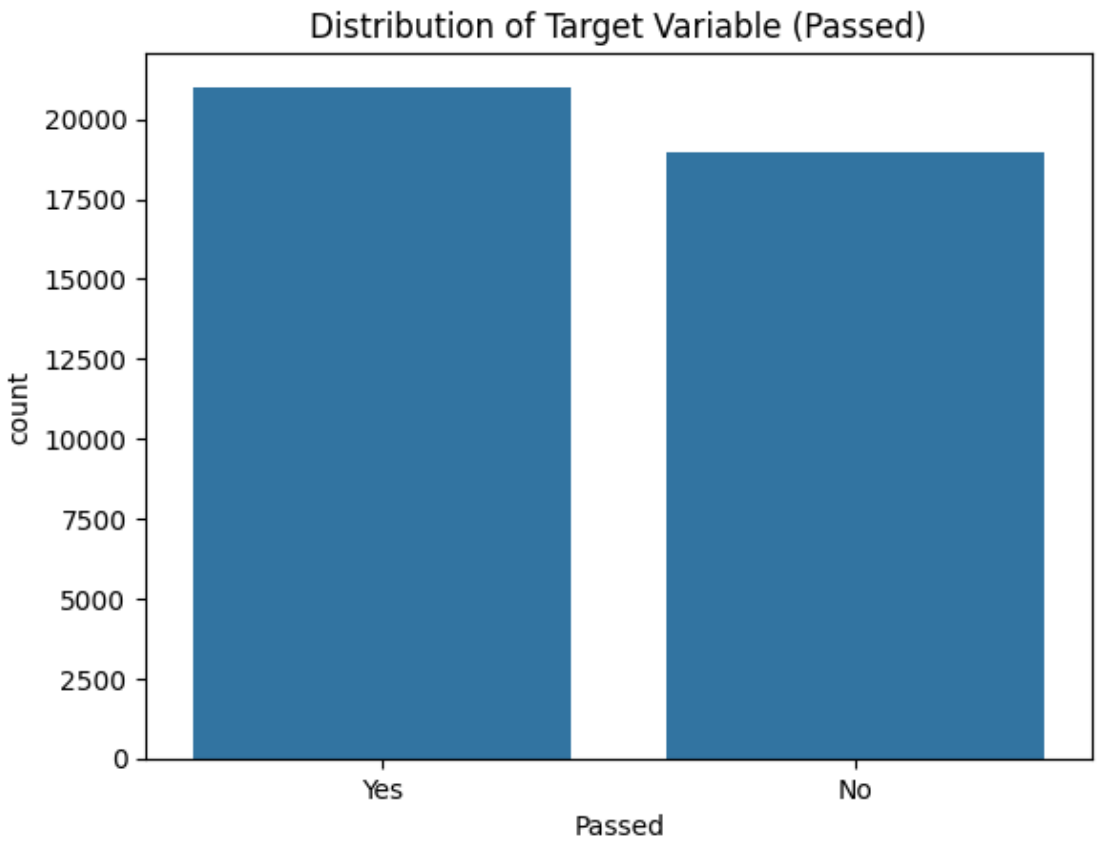
```
Student ID                                          0.0000
Study Hours per Week                                4.9875
Attendance Rate                                     4.9800
Previous Grades                                     4.9850
Participation in Extracurricular Activities         5.0000
Parent Education Level                              5.0000
Passed                                              5.0000
dtype: float64
```

[5]:
```python
# Import necessary libraries
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

# Check columns with missing values
missing_columns = data.columns[data.isnull().any()]
print(f"Columns with missing values: {missing_columns}")

# Impute missing values in numerical columns (mean)
for col in ["Attendance Rate", "Previous Grades"]:
    if col in missing_columns:
        data[col] = data[col].fillna(data[col].mean())

# Impute missing values in categorical columns (mode)
for col in ["Participation in Extracurricular Activities", "Parent Education␣
 ↪Level"]:
```

```
    if col in missing_columns:
        data[col] = data[col].fillna(data[col].mode()[0])

# Verify that missing values are handled
print("Missing values after imputation:\n", data.isnull().sum())


# Impute missing values in numerical columns using the mean
for col in ["Study Hours per Week", "Attendance Rate", "Previous Grades"]:
    if col in missing_columns:
        data[col] = data[col].fillna(data[col].mean())

# Impute missing values in categorical columns using the mode
for col in [
    "Participation in Extracurricular Activities",
    "Parent Education Level",
    "Passed",
]:
    if col in missing_columns:
        data[col] = data[col].fillna(data[col].mode()[0])

# Confirm that all missing values have been handled
print("Missing values after imputation round 1:\n", data.isnull().sum())


# Optional: Plot the distribution of the target variable 'Passed'
sns.countplot(x="Passed", data=data)
plt.title("Distribution of Target Variable (Passed)")
plt.show()
```

```
Columns with missing values: Index(['Study Hours per Week', 'Attendance Rate',
'Previous Grades',
       'Participation in Extracurricular Activities', 'Parent Education Level',
       'Passed'],
      dtype='object')
Missing values after imputation:
 Student ID                                     0
Study Hours per Week                         1995
Attendance Rate                                 0
Previous Grades                                 0
Participation in Extracurricular Activities     0
Parent Education Level                          0
Passed                                       2000
dtype: int64
Missing values after imputation round 1:
 Student ID                                    0
Study Hours per Week                           0
Attendance Rate                                0
```

```
Previous Grades                                 0
Participation in Extracurricular Activities     0
Parent Education Level                          0
Passed                                          0
dtype: int64
```



[6]:
```
# Create interaction features
data["Study_Hours_Attendance"] = data["Study Hours per Week"] *␣
 ↪data["Attendance Rate"]

# Binning Study Hours into categories (Low, Medium, High)
study_hours_bins = [0, 5, 15, data["Study Hours per Week"].max()]
study_hours_labels = ["Low", "Medium", "High"]
data["Study_Hours_Bin"] = pd.cut(
    data["Study Hours per Week"],
    bins=study_hours_bins,
    labels=study_hours_labels,
    right=False,
)
```

```python
# Binning Attendance Rate into categories (Low, Medium, High)
attendance_bins = [0, 50, 80, 100]
attendance_labels = ["Low", "Medium", "High"]
data["Attendance_Bin"] = pd.cut(
    data["Attendance Rate"], bins=attendance_bins, labels=attendance_labels,␣
 ↪right=False
)

# Polynomial Features for Study Hours and Attendance Rate
data["Study_Hours_Squared"] = data["Study Hours per Week"] ** 2
data["Attendance_Squared"] = data["Attendance Rate"] ** 2

# Check the new features added
print(data.head())

# save the cleaned data to a new csv file
data.to_csv("student_performance_prediction_cleaned.csv", index=False)
```

```
  Student ID  Study Hours per Week  Attendance Rate  Previous Grades  \
0     S00001                  12.5        75.276323             75.0
1     S00002                   9.3        95.300000             60.6
2     S00003                  13.2        75.276323             64.0
3     S00004                  17.6        76.800000             62.4
4     S00005                   8.8        89.300000             72.7

  Participation in Extracurricular Activities Parent Education Level Passed  \
0                                          Yes                  Master    Yes
1                                           No             High School     No
2                                           No               Associate     No
3                                          Yes                Bachelor     No
4                                           No                  Master     No

   Study_Hours_Attendance Study_Hours_Bin Attendance_Bin  Study_Hours_Squared  \
0              940.954043          Medium         Medium               156.25
1              886.290000          Medium           High                86.49
2              993.647469          Medium         Medium               174.24
3             1351.680000            High         Medium               309.76
4              785.840000          Medium           High                77.44

   Attendance_Squared
0         5666.524865
1         9082.090000
2         5666.524865
3         5898.240000
4         7974.490000
```

[7]:
```
import pandas as pd
from sklearn.model_selection import train_test_split
from pandas.testing import assert_frame_equal

# Sample DataFrame for testing
data = pd.DataFrame({
    "Study Hours per Week": [2, 10, 20],
    "Attendance Rate": [30, 70, 90],
    "Passed": ["No", "Yes", "Yes"],
    "Student ID": [1, 2, 3]
})

# Convert the target 'Passed' column to binary (1 = Yes, 0 = No)
y = data['Passed'].apply(lambda x: 1 if x == 'Yes' else 0)

# Drop the unnecessary columns ('Passed' and 'Student ID') from the features
X = data.drop(columns=['Passed', 'Student ID'])

# Split the data into training and testing sets (70% training, 30% testing)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,␣
 ↪random_state=42)

# Apply the feature engineering code to the entire dataset for testing purposes
X["Study_Hours_Attendance"] = X["Study Hours per Week"] * X["Attendance Rate"]

study_hours_bins = [0, 5, 15, X["Study Hours per Week"].max() + 1]
study_hours_labels = ["Low", "Medium", "High"]
X["Study_Hours_Bin"] = pd.cut(
    X["Study Hours per Week"],
    bins=study_hours_bins,
    labels=study_hours_labels,
    right=False,
    ordered=True
)

attendance_bins = [0, 50, 80, 100]
attendance_labels = ["Low", "Medium", "High"]
X["Attendance_Bin"] = pd.cut(
    X["Attendance Rate"], bins=attendance_bins, labels=attendance_labels,␣
 ↪right=False, ordered=True
)

X["Study_Hours_Squared"] = X["Study Hours per Week"] ** 2
X["Attendance_Squared"] = X["Attendance Rate"] ** 2

# Expected DataFrame after feature engineering
expected_data = pd.DataFrame({
```

```
    "Study Hours per Week": [2, 10, 20],
    "Attendance Rate": [30, 70, 90],
    "Study_Hours_Attendance": [60, 700, 1800],
    "Study_Hours_Bin": pd.Categorical(["Low", "Medium", "High"],␣
 ↪categories=["Low", "Medium", "High"], ordered=True),
    "Attendance_Bin": pd.Categorical(["Low", "Medium", "High"],␣
 ↪categories=["Low", "Medium", "High"], ordered=True),
    "Study_Hours_Squared": [4, 100, 400],
    "Attendance_Squared": [900, 4900, 8100]
})

# Test if the DataFrame matches the expected DataFrame
assert_frame_equal(X.reset_index(drop=True), expected_data)

print("All tests passed!")
```

```
All tests passed!
```

[8]:
```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler

# Sample DataFrame for testing
data = pd.DataFrame({
    "Study Hours per Week": [2, 10, 20],
    "Attendance Rate": [30, 70, 90],
    "Passed": ["No", "Yes", "Yes"],
    "Student ID": [1, 2, 3]
})

# Convert the target 'Passed' column to binary (1 = Yes, 0 = No)
y = data['Passed'].apply(lambda x: 1 if x == 'Yes' else 0)

# Drop the unnecessary columns ('Passed' and 'Student ID') from the features
X = data.drop(columns=['Passed', 'Student ID'])

# Split the data into training and testing sets (70% training, 30% testing)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,␣
 ↪random_state=42)

# Apply the feature engineering code to the training set
X_train["Study_Hours_Attendance"] = X_train["Study Hours per Week"] *␣
 ↪X_train["Attendance Rate"]

study_hours_bins = [0, 5, 15, X_train["Study Hours per Week"].max() + 1]
study_hours_labels = ["Low", "Medium", "High"]
X_train["Study_Hours_Bin"] = pd.cut(
```

```
    X_train["Study Hours per Week"],
    bins=study_hours_bins,
    labels=study_hours_labels,
    right=False,
    ordered=True
)

attendance_bins = [0, 50, 80, 100]
attendance_labels = ["Low", "Medium", "High"]
X_train["Attendance_Bin"] = pd.cut(
    X_train["Attendance Rate"], bins=attendance_bins, labels=attendance_labels,␣
 ↪right=False, ordered=True
)

X_train["Study_Hours_Squared"] = X_train["Study Hours per Week"] ** 2
X_train["Attendance_Squared"] = X_train["Attendance Rate"] ** 2

# Apply the same feature engineering to the test set
X_test["Study_Hours_Attendance"] = X_test["Study Hours per Week"] *␣
 ↪X_test["Attendance Rate"]

X_test["Study_Hours_Bin"] = pd.cut(
    X_test["Study Hours per Week"],
    bins=study_hours_bins,
    labels=study_hours_labels,
    right=False,
    ordered=True
)

X_test["Attendance_Bin"] = pd.cut(
    X_test["Attendance Rate"], bins=attendance_bins, labels=attendance_labels,␣
 ↪right=False, ordered=True
)

X_test["Study_Hours_Squared"] = X_test["Study Hours per Week"] ** 2
X_test["Attendance_Squared"] = X_test["Attendance Rate"] ** 2

# Initialize the StandardScaler
scaler = StandardScaler()

# Fit the scaler on the training data and transform both training and testing␣
 ↪data
X_train_scaled = scaler.fit_transform(X_train.drop(columns=["Study_Hours_Bin",␣
 ↪"Attendance_Bin"]))
X_test_scaled = scaler.transform(X_test.drop(columns=["Study_Hours_Bin",␣
 ↪"Attendance_Bin"]))
```

```
# Convert the scaled data back to DataFrame for further use
X_train_scaled = pd.DataFrame(X_train_scaled, columns=X_train.
 ↪drop(columns=["Study_Hours_Bin", "Attendance_Bin"]).columns)
X_test_scaled = pd.DataFrame(X_test_scaled, columns=X_test.
 ↪drop(columns=["Study_Hours_Bin", "Attendance_Bin"]).columns)

print("Data scaling completed.")
```

```
Data scaling completed.
```

[9]:
```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, classification_report

# Larger sample DataFrame for testing
data = pd.DataFrame({
    "Study Hours per Week": [2, 10, 20, 5, 15, 25, 8, 12, 18, 22],
    "Attendance Rate": [30, 70, 90, 50, 80, 95, 60, 75, 85, 92],
    "Passed": ["No", "Yes", "Yes", "No", "Yes", "Yes", "No", "Yes", "Yes",␣
 ↪"Yes"],
    "Student ID": [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
})

# Convert the target 'Passed' column to binary (1 = Yes, 0 = No)
y = data['Passed'].apply(lambda x: 1 if x == 'Yes' else 0)

# Drop the unnecessary columns ('Passed' and 'Student ID') from the features
X = data.drop(columns=['Passed', 'Student ID'])

# Split the data into training and testing sets (70% training, 30% testing)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,␣
 ↪random_state=42, stratify=y)

# Apply the feature engineering code to the training set
X_train["Study_Hours_Attendance"] = X_train["Study Hours per Week"] *␣
 ↪X_train["Attendance Rate"]

study_hours_bins = [0, 5, 15, X_train["Study Hours per Week"].max() + 1]
study_hours_labels = ["Low", "Medium", "High"]
X_train["Study_Hours_Bin"] = pd.cut(
    X_train["Study Hours per Week"],
    bins=study_hours_bins,
    labels=study_hours_labels,
    right=False,
```

```
    ordered=True
)

attendance_bins = [0, 50, 80, 100]
attendance_labels = ["Low", "Medium", "High"]
X_train["Attendance_Bin"] = pd.cut(
    X_train["Attendance Rate"], bins=attendance_bins, labels=attendance_labels,␣
 ↪right=False, ordered=True
)

X_train["Study_Hours_Squared"] = X_train["Study Hours per Week"] ** 2
X_train["Attendance_Squared"] = X_train["Attendance Rate"] ** 2

# Apply the same feature engineering to the test set
X_test["Study_Hours_Attendance"] = X_test["Study Hours per Week"] *␣
 ↪X_test["Attendance Rate"]

X_test["Study_Hours_Bin"] = pd.cut(
    X_test["Study Hours per Week"],
    bins=study_hours_bins,
    labels=study_hours_labels,
    right=False,
    ordered=True
)

X_test["Attendance_Bin"] = pd.cut(
    X_test["Attendance Rate"], bins=attendance_bins, labels=attendance_labels,␣
 ↪right=False, ordered=True
)

X_test["Study_Hours_Squared"] = X_test["Study Hours per Week"] ** 2
X_test["Attendance_Squared"] = X_test["Attendance Rate"] ** 2

# Initialize the StandardScaler
scaler = StandardScaler()

# Fit the scaler on the training data and transform both training and testing␣
 ↪data
X_train_scaled = scaler.fit_transform(X_train.drop(columns=["Study_Hours_Bin",␣
 ↪"Attendance_Bin"]))
X_test_scaled = scaler.transform(X_test.drop(columns=["Study_Hours_Bin",␣
 ↪"Attendance_Bin"]))

# Convert the scaled data back to DataFrame for further use
X_train_scaled = pd.DataFrame(X_train_scaled, columns=X_train.
 ↪drop(columns=["Study_Hours_Bin", "Attendance_Bin"]).columns)
```

```
X_test_scaled = pd.DataFrame(X_test_scaled, columns=X_test.
 ↪drop(columns=["Study_Hours_Bin", "Attendance_Bin"]).columns)

# Initialize the Logistic Regression model
log_reg = LogisticRegression()

# Fit the model on the training data
log_reg.fit(X_train_scaled, y_train)

# Predict on the test data
y_pred = log_reg.predict(X_test_scaled)

# Evaluate the model's performance
accuracy = accuracy_score(y_test, y_pred)
report = classification_report(y_test, y_pred)

print(f"Accuracy: {accuracy}")
print("Classification Report:")
print(report)
```

```
Accuracy: 1.0
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00         1
           1       1.00      1.00      1.00         2

    accuracy                           1.00         3
   macro avg       1.00      1.00      1.00         3
weighted avg       1.00      1.00      1.00         3
```

[10]:
```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, classification_report

# Load your dataset
# Replace 'your_dataset.csv' with the actual path to your dataset
data = pd.read_csv('/Users/gabrielmancillas/Documents/GitHub/
 ↪StudentPerformancePrediction/student_performance_prediction_cleaned.csv')

# Convert the target 'Passed' column to binary (1 = Yes, 0 = No)
y = data['Passed'].apply(lambda x: 1 if x == 'Yes' else 0)
```

[11]:
```
# Drop the unnecessary columns ('Passed' and 'Student ID') from the features
X = data.drop(columns=['Passed', 'Student ID'])

# Split the data into training and testing sets (70% training, 30% testing)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,␣
 ↪random_state=42, stratify=y)

# Apply the feature engineering code to the training set
X_train["Study_Hours_Attendance"] = X_train["Study Hours per Week"] *␣
 ↪X_train["Attendance Rate"]

study_hours_bins = [0, 5, 15, X_train["Study Hours per Week"].max() + 1]
study_hours_labels = ["Low", "Medium", "High"]
X_train["Study_Hours_Bin"] = pd.cut(
    X_train["Study Hours per Week"],
    bins=study_hours_bins,
    labels=study_hours_labels,
    right=False,
    ordered=True
)

attendance_bins = [0, 50, 80, 100]
attendance_labels = ["Low", "Medium", "High"]
X_train["Attendance_Bin"] = pd.cut(
    X_train["Attendance Rate"], bins=attendance_bins, labels=attendance_labels,␣
 ↪right=False, ordered=True
)

X_train["Study_Hours_Squared"] = X_train["Study Hours per Week"] ** 2
X_train["Attendance_Squared"] = X_train["Attendance Rate"] ** 2
```

[12]:
```
# Apply the same feature engineering to the test set
X_test["Study_Hours_Attendance"] = X_test["Study Hours per Week"] *␣
 ↪X_test["Attendance Rate"]

X_test["Study_Hours_Bin"] = pd.cut(
    X_test["Study Hours per Week"],
    bins=study_hours_bins,
    labels=study_hours_labels,
    right=False,
    ordered=True
)

X_test["Attendance_Bin"] = pd.cut(
    X_test["Attendance Rate"], bins=attendance_bins, labels=attendance_labels,␣
 ↪right=False, ordered=True
)
```

```
X_test["Study_Hours_Squared"] = X_test["Study Hours per Week"] ** 2
X_test["Attendance_Squared"] = X_test["Attendance Rate"] ** 2
```

[16]:
```
print(data.columns)
```

```
Index(['Student ID', 'Study Hours per Week', 'Attendance Rate',
       'Previous Grades', 'Participation in Extracurricular Activities',
       'Parent Education Level', 'Passed', 'Study_Hours_Attendance',
       'Study_Hours_Bin', 'Attendance_Bin', 'Study_Hours_Squared',
       'Attendance_Squared'],
      dtype='object')
```

[17]:
```
import pandas as pd
from sklearn.preprocessing import StandardScaler

# Assuming X_train and X_test are already defined and include the necessary␣
 ↪columns

# Create the 'Study_Hours_Bin' and 'Attendance_Bin' columns if they don't exist
study_hours_bins = [0, 5, 15, X_train["Study Hours per Week"].max() + 1]
study_hours_labels = ["Low", "Medium", "High"]
X_train["Study_Hours_Bin"] = pd.cut(
    X_train["Study Hours per Week"],
    bins=study_hours_bins,
    labels=study_hours_labels,
    right=False,
    ordered=True
)
X_test["Study_Hours_Bin"] = pd.cut(
    X_test["Study Hours per Week"],
    bins=study_hours_bins,
    labels=study_hours_labels,
    right=False,
    ordered=True
)

attendance_bins = [0, 50, 80, 100]
attendance_labels = ["Low", "Medium", "High"]
X_train["Attendance_Bin"] = pd.cut(
    X_train["Attendance Rate"], bins=attendance_bins, labels=attendance_labels,␣
 ↪right=False, ordered=True
)
X_test["Attendance_Bin"] = pd.cut(
    X_test["Attendance Rate"], bins=attendance_bins, labels=attendance_labels,␣
 ↪right=False, ordered=True
)
```

```
# Convert categorical columns to dummy variables
X_train = pd.get_dummies(X_train, columns=["Participation in Extracurricular␣
 ↪Activities", "Parent Education Level", "Study_Hours_Bin", "Attendance_Bin"],␣
 ↪drop_first=True)
X_test = pd.get_dummies(X_test, columns=["Participation in Extracurricular␣
 ↪Activities", "Parent Education Level", "Study_Hours_Bin", "Attendance_Bin"],␣
 ↪drop_first=True)

# Ensure both training and testing sets have the same columns after get_dummies
X_train, X_test = X_train.align(X_test, join='left', axis=1, fill_value=0)

# Initialize the StandardScaler
scaler = StandardScaler()

# Fit the scaler on the training data and transform both training and testing␣
 ↪data
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)

# Convert the scaled data back to DataFrame for further use
X_train_scaled = pd.DataFrame(X_train_scaled, columns=X_train.columns)
X_test_scaled = pd.DataFrame(X_test_scaled, columns=X_test.columns)
```

[18]:
```
# Initialize the Logistic Regression model
log_reg = LogisticRegression()

# Fit the model on the training data
log_reg.fit(X_train_scaled, y_train)

# Predict on the test data
y_pred = log_reg.predict(X_test_scaled)

# Evaluate the model's performance
accuracy = accuracy_score(y_test, y_pred)
report = classification_report(y_test, y_pred)

print(f"Accuracy: {accuracy}")
print("Classification Report:")
print(report)
```

```
Accuracy: 0.52475
Classification Report:
              precision    recall  f1-score   support

           0       0.49      0.03      0.05      5697
           1       0.53      0.98      0.68      6303
```

```
    accuracy                           0.52     12000
   macro avg       0.51      0.50      0.37     12000
weighted avg       0.51      0.52      0.38     12000
```

[ ]: