In [ ]:
```
import warnings
warnings.filterwarnings('ignore')

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.backends.backend_pdf import PdfPages
import seaborn as sns
from statsmodels.tsa.stattools import adfuller, coint
from statsmodels.tsa.stattools import grangercausalitytests
from hurst import compute_Hc
from sklearn.linear_model import LogisticRegression
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis, QuadraticDiscriminantAnalysis
from sklearn.svm import SVC
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.decomposition import PCA
from sklearn.metrics import confusion_matrix, classification_report, accuracy_score, precision_score, recall_score, f1_score
from reportlab.pdfgen import canvas
from reportlab.lib import colors
from reportlab.lib.pagesizes import letter
from reportlab.platypus import SimpleDocTemplate, Paragraph, Spacer, Table, TableStyle
from reportlab.lib.styles import getSampleStyleSheet
from reportlab.lib.units import inch
```

In [ ]:
```
class TradingAnalysis:
    def __init__(self, data_file):
        self.data = pd.read_csv(data_file, index_col=0)

    def plot_price_series(self):
        """
        Plot the price series for each asset.
        """
        plt.figure(figsize=(12, 6))
        for col in self.data.columns:
            plt.plot(self.data[col], label=col)
        plt.title("Price Series")
        plt.xlabel("Time")
        plt.ylabel("Price")
        plt.legend()
        plt.show()

    def plot_distributions(self):
        """
        Plot the distribution of prices for each asset using histograms and density plots.
        """
        for col in self.data.columns:
            fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(12, 4))
            sns.histplot(self.data[col], kde=True, ax=ax1)
            ax1.set_title(f"Distribution of {col} Prices")
            ax1.set_xlabel("Price")
            ax1.set_ylabel("Frequency")

            sns.kdeplot(self.data[col], ax=ax2)
            ax2.set_title(f"Density Plot of {col} Prices")
            ax2.set_xlabel("Price")
            ax2.set_ylabel("Density")

            plt.tight_layout()
            plt.show()

    def plot_correlation_matrix(self):
```

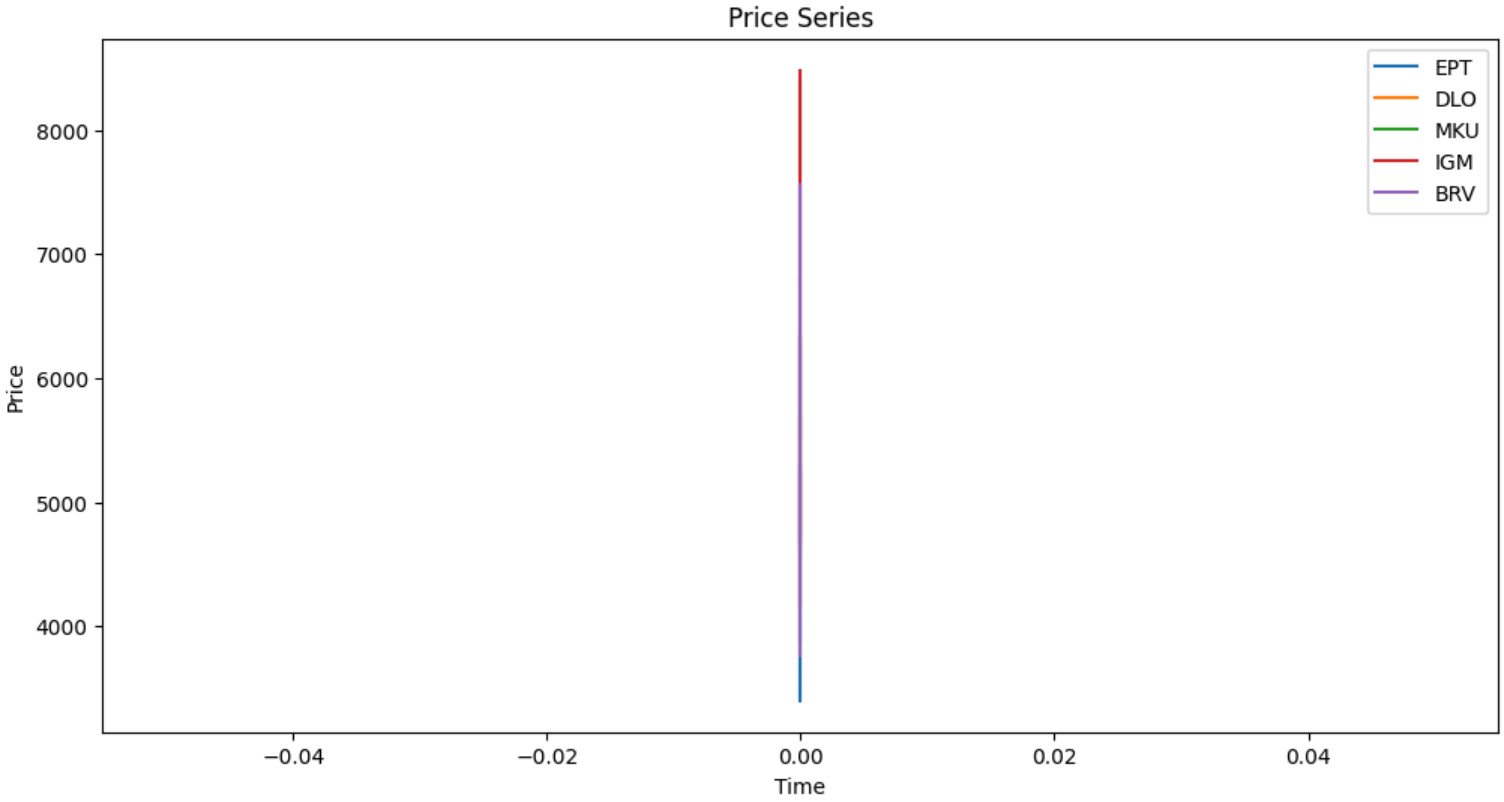
```
        """
        Plot the correlation matrix heatmap for the asset prices.
        """
        corr_matrix = self.data.corr()
        plt.figure(figsize=(8, 6))
        sns.heatmap(corr_matrix, annot=True, cmap='coolwarm', vmin=-1, vmax=1)
        plt.title("Correlation Matrix")
        plt.show()

    def augmented_dickey_fuller_test(self):
        """
        Perform the Augmented Dickey-Fuller test for stationarity on each asset's price series.
        The test checks if the series is stationary or if it has a unit root (non-stationary).
        """
        print("Augmented Dickey-Fuller Tests:")
        for col in self.data.columns:
            adf_result = adfuller(self.data[col])
            print(f"{col}: ADF Statistic = {adf_result[0]}, p-value = {adf_result[1] }")
            if adf_result[1] < 0.05:
                print(f"The price series of {col} is likely stationary.")
            else:
                print(f"The price series of {col} is likely non-stationary.")
            print()

    def hurst_exponent(self):
        """
        Calculate the Hurst Exponent for each asset's price series using the hurst library.
        The Hurst Exponent measures the degree of long-term memory or persistence in a time series.
        A value between 0 and 0.5 indicates mean reversion, while a value between 0.5 and 1 indicates trend persistence.
        """
        print("Hurst Exponents:")
        for col in self.data.columns:
            X = self.data[col].values
            H, _, _ = compute_Hc(X)
            print(f"{col}: Hurst Exponent = {H}")
            if H < 0.5:
                print(f"The price series of {col} exhibits mean reversion.")
            elif H > 0.5:
                print(f"The price series of {col} exhibits trend persistence.")
            else:
                print(f"The price series of {col} is similar to a random walk.")
            print()

    def cointegration_test(self):
        """
        Perform cointegration tests between pairs of asset price series.
        Cointegration suggests a long-term equilibrium relationship between two non-stationary series.
        """
        print("Cointegration Tests:")
        for i in range(len(self.data.columns)):
            for j in range(i+1, len(self.data.columns)):
                coint_result = coint(self.data.iloc[:,i], self.data.iloc[:,j])
                print(f"Pair: {self.data.columns[i]} and {self.data.columns[j]}")
                print(coint_result)
                if coint_result[1] < 0.05:
                    print(f"{self.data.columns[i]} and {self.data.columns[j]} are likely cointegrated (p-value = {coint_result[1]}).")
                else:
                    print(f"{self.data.columns[i]} and {self.data.columns[j]} are likely not cointegrated (p-value = {coint_result[1]}).")
                print()

    def granger_causality_test(self):
        """
        Perform Granger Causality tests between pairs of asset price series.
        Granger Causality tests if one time series is useful in predicting another.
```

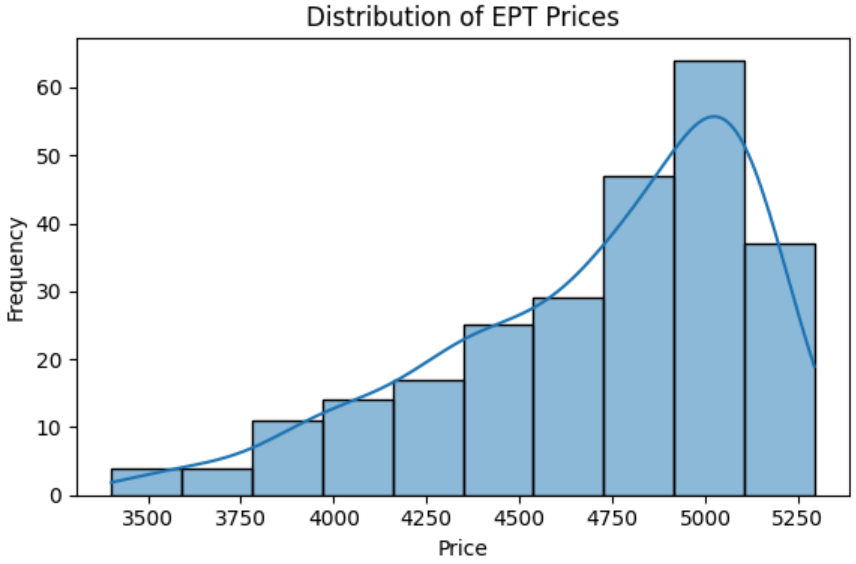
```
        """
        print("Granger Causality Tests:")
        for col1 in self.data.columns:
            for col2 in self.data.columns:
                if col1 != col2:
                    gc_result = grangercausalitytests(self.data[[col1, col2]], maxlag=5, verbose=False)
                    p_values = [gc_result[i+1][0]['ssr_ftest'][1] for i in range(5)]
                    min_p_value = min(p_values)
                    if min_p_value < 0.05:
                        print(f"{col2} Granger-causes {col1} (minimum p-value = {min_p_value} across 5 lags).")
                    else:
                        print(f"No significant Granger Causality found from {col2} to {col1} (minimum p-value = {min_p_value} across 5 lags).")
                    print()

    def predictive_modeling(self):
        """
        Perform predictive modeling on the asset returns using various classification algorithms.
        Visualize the prediction results using confusion matrices and evaluate the performance.
        """
        returns = self.data.pct_change().dropna()

        for col in returns.columns:
            print(f"\nPredictive Modeling for {col}:")
            X = returns.drop(columns=[col]).values[:-1]
            y = np.where(returns[col].values[1:] > 0, 1, 0)

            models = [
                LogisticRegression(),
                LinearDiscriminantAnalysis(),
                QuadraticDiscriminantAnalysis(),
                SVC(kernel='linear'),
                SVC(kernel='rbf'),
                DecisionTreeClassifier(),
                RandomForestClassifier(),
            ]

            for model in models:
                model.fit(X, y)
                y_pred = model.predict(X)
                print(f"\n{type(model).__name__} Results:")
                print(classification_report(y, y_pred))

                accuracy = accuracy_score(y, y_pred)
                precision = precision_score(y, y_pred)
                recall = recall_score(y, y_pred)
                f1 = f1_score(y, y_pred)

                print(f"Accuracy: {accuracy}")
                print(f"Precision: {precision}")
                print(f"Recall: {recall}")
                print(f"F1-score: {f1}")

                print("\nAnalysis:")
                print("- Accuracy measures the overall correctness of predictions.")
                print("- Precision indicates the proportion of true positive predictions among the positive predictions.")
                print("- Recall measures the proportion of actual positive instances that were correctly predicted.")
                print("- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.")

                cm = confusion_matrix(y, y_pred)
                plt.figure(figsize=(6, 4))
                sns.heatmap(cm, annot=True, fmt='d', cmap='Blues')
                plt.title(f"{type(model).__name__} Confusion Matrix for {col}")
                plt.xlabel("Predicted")
                plt.ylabel("Actual")
```

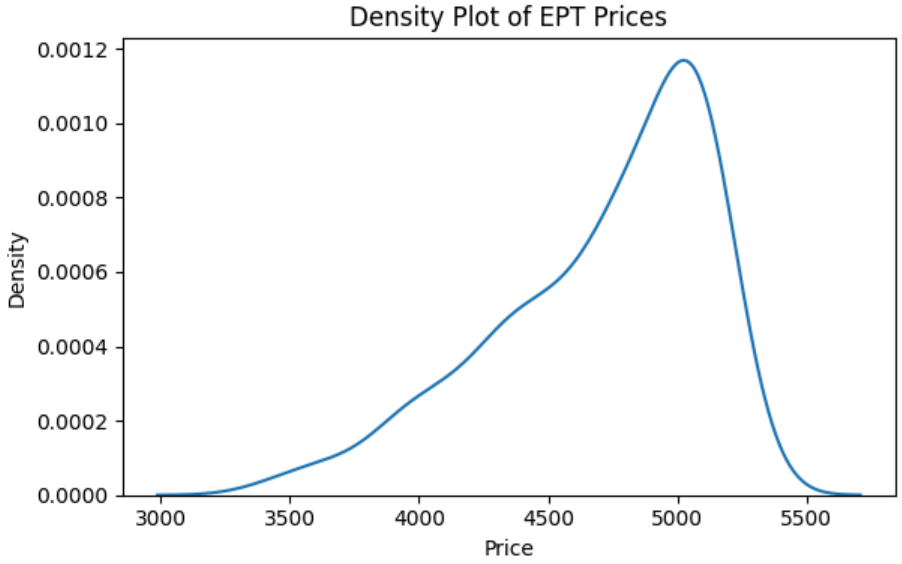
```
                plt.show()

    def principal_component_analysis(self):
        """
        Perform Principal Component Analysis (PCA) on the asset returns.
        Visualize the explained variance ratios and principal component loadings.
        """
        returns = self.data.pct_change().dropna()

        pca = PCA()
        pca.fit(returns)

        plt.figure(figsize=(8, 4))
        plt.bar(range(1, len(pca.explained_variance_ratio_) + 1), pca.explained_variance_ratio_)
        plt.xlabel("Principal Component")
        plt.ylabel("Explained Variance Ratio")
        plt.title("Scree Plot")
        plt.show()

        loadings = pd.DataFrame(pca.components_.T, columns=[f"PC{i+1}" for i in range(len(self.data.columns))], index=self.data.columns)
        plt.figure(figsize=(8, 6))
        sns.heatmap(loadings, annot=True, cmap='coolwarm', vmin=-1, vmax=1)
        plt.title("Principal Component Loadings")
        plt.show()
```

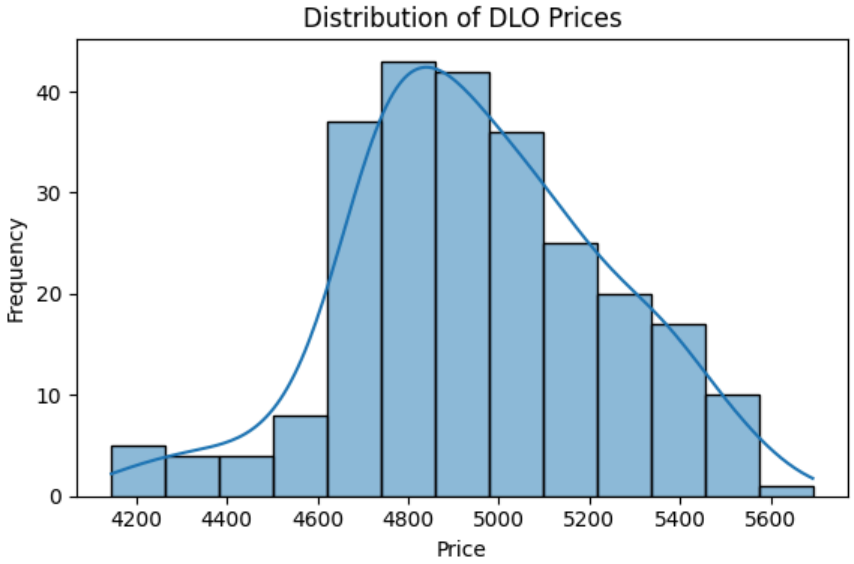
In [ ]:

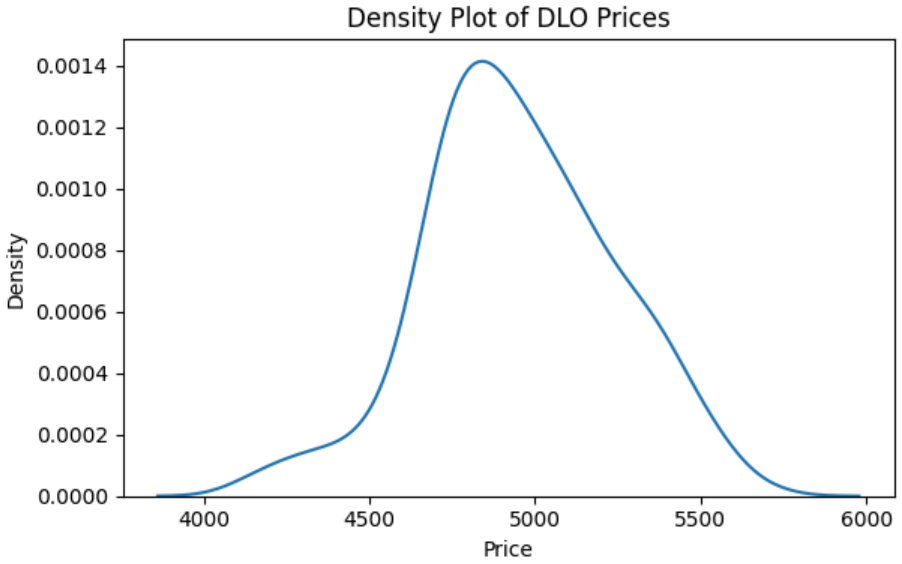
```
analysis = TradingAnalysis('Case1_Historical.csv')
analysis.plot_price_series()
analysis.plot_distributions()
analysis.plot_correlation_matrix()
analysis.augmented_dickey_fuller_test()
analysis.hurst_exponent()
analysis.cointegration_test()
analysis.granger_causality_test()
analysis.predictive_modeling()
analysis.principal_component_analysis()
```

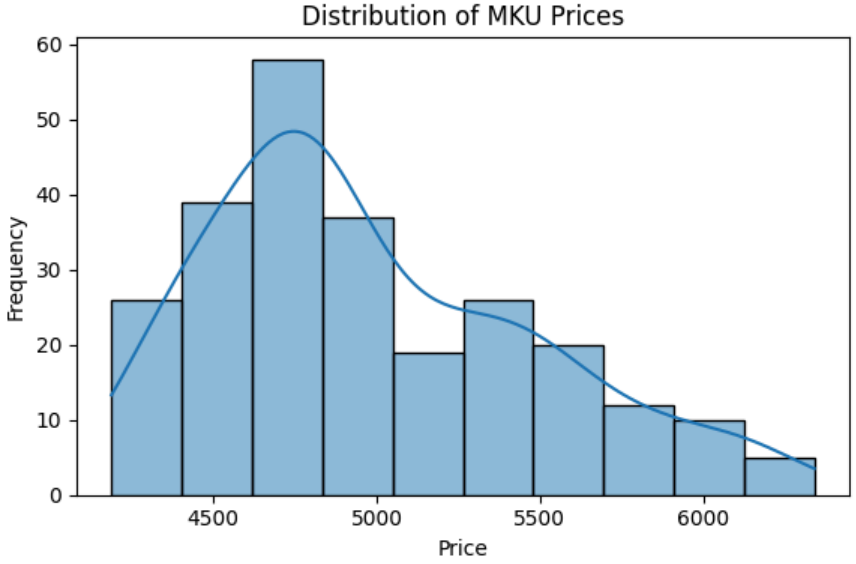

Price Series
EPT
DLO
MKU
IGM
BRV
8000
7000
6000
5000
4000
Price
−0.04
−0.02
0.00
0.02
0.04
Time

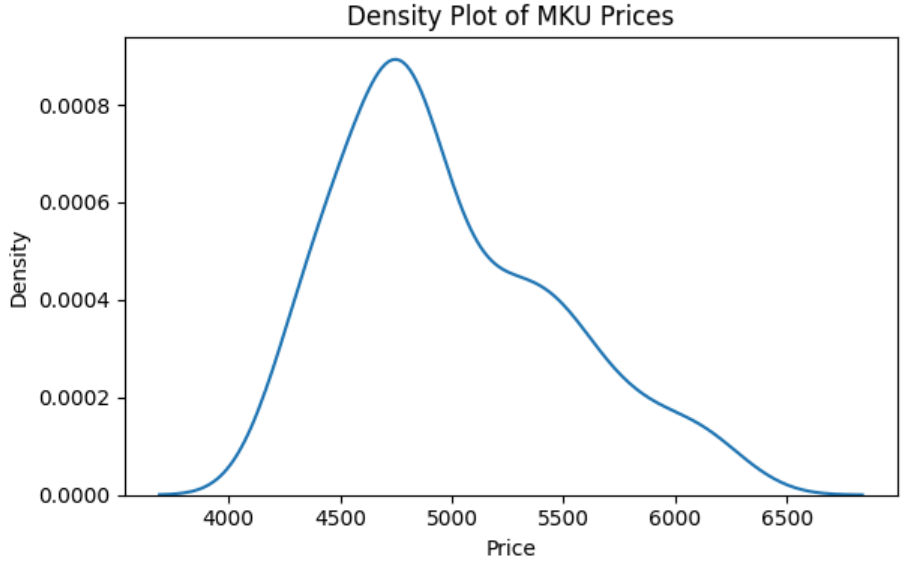

Distribution of EPT Prices
60
50
40
30
20
10
0
Frequency
3500
3750
4000
4250
4500
4750
5000
5250
Price

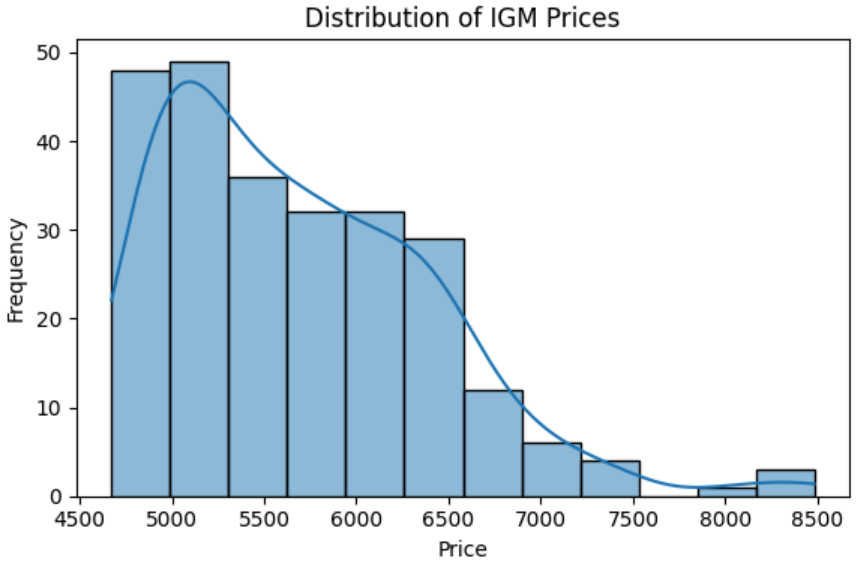

Density Plot of EPT Prices
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
Density
3000
3500
4000
4500
5000
5500
Price

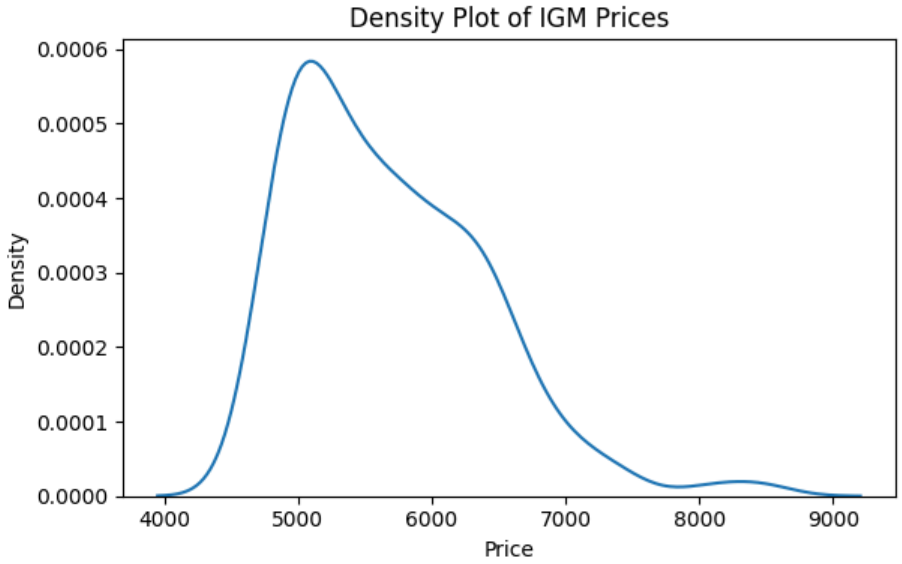

Distribution of DLO Prices
Frequency
Price
0
10
20
30
40
4200
4400
4600
4800
5000
5200
5400
5600

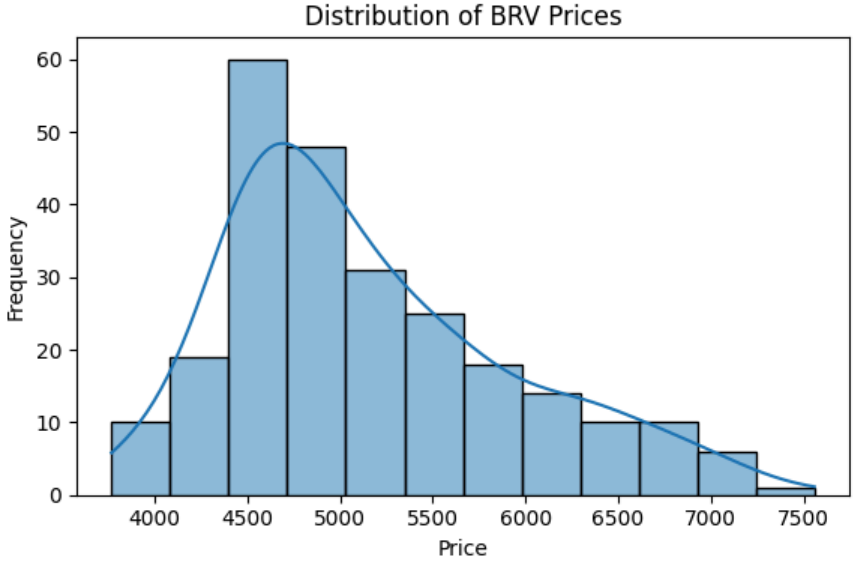

Density Plot of DLO Prices
Density
Price
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
0.0014
4000
4500
5000
5500
6000

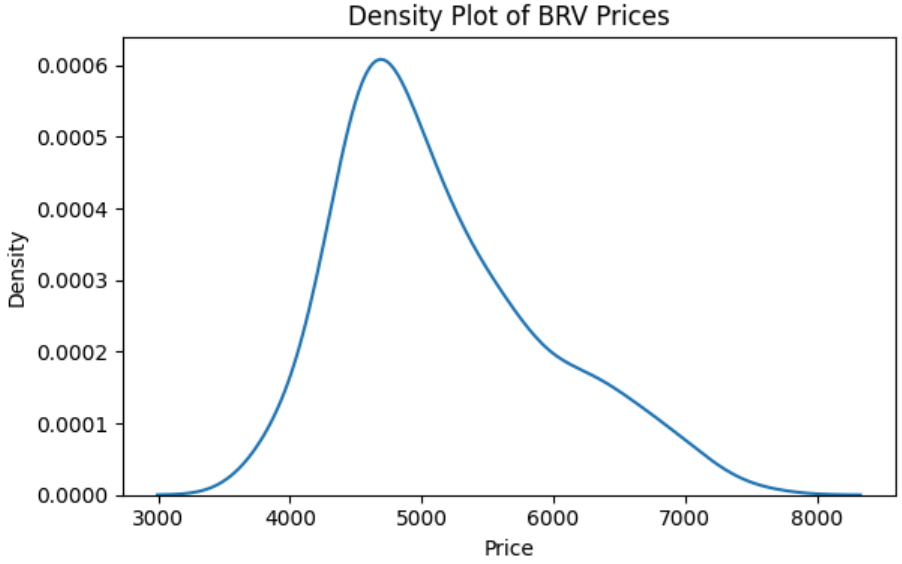

Distribution of MKU Prices
Frequency
Price
0
10
20
30
40
50
60
4500
5000
5500
6000

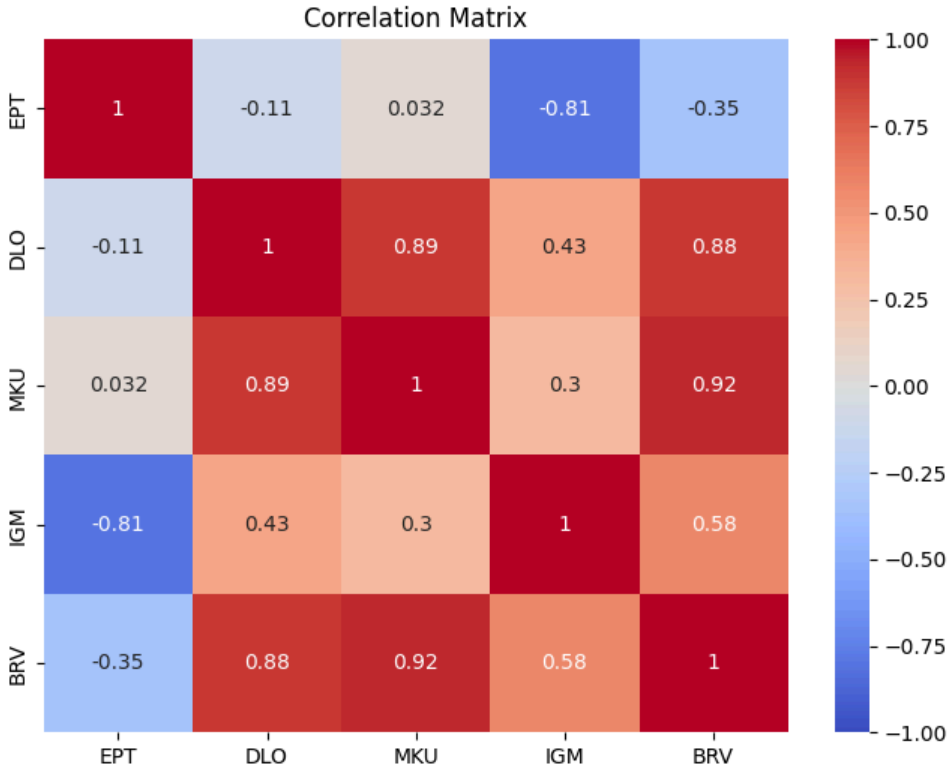

Density Plot of MKU Prices
Density
Price
0.0000
0.0002
0.0004
0.0006
0.0008
4000
4500
5000
5500
6000
6500


Distribution of IGM Prices
Frequency
Price
0
10
20
30
40
50
4500
5000
5500
6000
6500
7000
7500
8000
8500


Density Plot of IGM Prices
Density
Price
0.0000
0.0001
0.0002
0.0003
0.0004
0.0005
0.0006
4000
5000
6000
7000
8000
9000


Distribution of BRV Prices
Frequency
Price
0
10
20
30
40
50
60
4000
4500
5000
5500
6000
6500
7000
7500


Density Plot of BRV Prices
Density
Price
0.0000
0.0001
0.0002
0.0003
0.0004
0.0005
0.0006
3000
4000
5000
6000
7000
8000

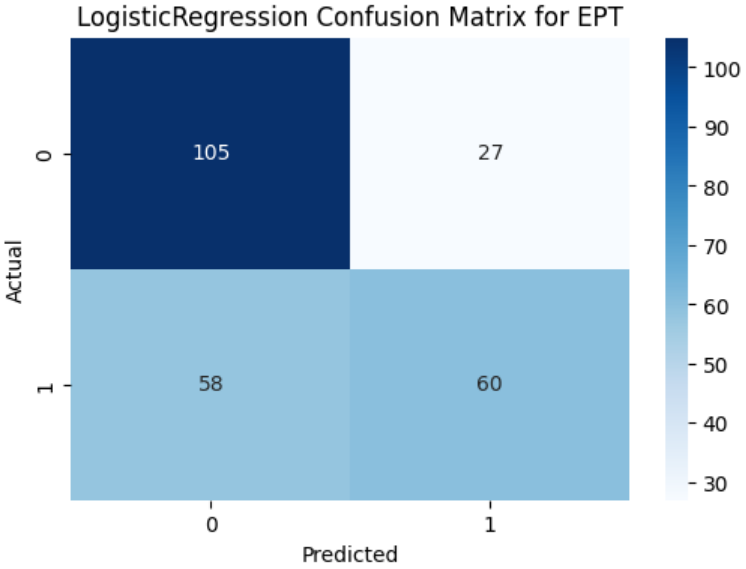

Correlation Matrix
EPT
DLO
MKU
IGM
BRV
1
-0.11
0.032
-0.81
-0.35
-0.11
1
0.89
0.43
0.88
0.032
0.89
1
0.3
0.92
-0.81
0.43
0.3
1
0.58
-0.35
0.88
0.92
0.58
1
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00

```
Augmented Dickey-Fuller Tests:
EPT: ADF Statistic = -7.851893522722521, p-value = 5.572592380682657e-12
The price series of EPT is likely stationary.

DLO: ADF Statistic = -16.663245075066392, p-value = 1.567566634525886e-29
The price series of DLO is likely stationary.

MKU: ADF Statistic = -15.772944473727156, p-value = 1.1551711911832044e-28
The price series of MKU is likely stationary.

IGM: ADF Statistic = -15.568353240953387, p-value = 2.0014151077994866e-28
The price series of IGM is likely stationary.

BRV: ADF Statistic = -15.859284315213147, p-value = 9.252444370068505e-29
The price series of BRV is likely stationary.

Hurst Exponents:
EPT: Hurst Exponent = 0.13916067212798686
The price series of EPT exhibits mean reversion.

DLO: Hurst Exponent = 0.16519771810614048
The price series of DLO exhibits mean reversion.

MKU: Hurst Exponent = 0.1101028201790881
The price series of MKU exhibits mean reversion.

IGM: Hurst Exponent = 0.1772151173580428
The price series of IGM exhibits mean reversion.

BRV: Hurst Exponent = 0.13516282806825455
The price series of BRV exhibits mean reversion.

Cointegration Tests:
Pair: EPT and DLO
(-7.757399243617282, 1.2210944722364674e-10, array([-3.94060523, -3.36058133, -3.06139039]))
EPT and DLO are likely cointegrated (p-value = 1.2210944722364674e-10).

Pair: EPT and MKU
(-7.870845471969408, 6.365827512170193e-11, array([-3.94060523, -3.36058133, -3.06139039]))
EPT and MKU are likely cointegrated (p-value = 6.365827512170193e-11).

Pair: EPT and IGM
(-8.586642363045538, 9.885360984292813e-13, array([-3.94060523, -3.36058133, -3.06139039]))
EPT and IGM are likely cointegrated (p-value = 9.885360984292813e-13).

Pair: EPT and BRV
(-7.891286950921868, 5.6590499878303844e-11, array([-3.94060523, -3.36058133, -3.06139039]))
EPT and BRV are likely cointegrated (p-value = 5.6590499878303844e-11).

Pair: DLO and MKU
(-11.00286727774287, 8.1971892197639245e-19, array([-3.94060523, -3.36058133, -3.06139039]))
DLO and MKU are likely cointegrated (p-value = 8.1971892197639245e-19).

Pair: DLO and IGM
(-16.32721699294808, 2.3406925078728252e-28, array([-3.94060523, -3.36058133, -3.06139039]))
DLO and IGM are likely cointegrated (p-value = 2.3406925078728252e-28).

Pair: DLO and BRV
(-16.43111142118745, 1.8645270390893522e-28, array([-3.94060523, -3.36058133, -3.06139039]))
DLO and BRV are likely cointegrated (p-value = 1.8645270390893522e-28).

Pair: MKU and IGM
(-15.765424290108259, 9.356523945219492e-28, array([-3.94060523, -3.36058133, -3.06139039]))
MKU and IGM are likely cointegrated (p-value = 9.356523945219492e-28).
```

```
Pair: MKU and BRV
(-8.130870355485088, 1.4154689344181896e-11, array([-3.94060523, -3.36058133, -3.06139039]))
MKU and BRV are likely cointegrated (p-value = 1.4154689344181896e-11).

Pair: IGM and BRV
(-8.115114461002667, 1.5510494253385756e-11, array([-3.94060523, -3.36058133, -3.06139039]))
IGM and BRV are likely cointegrated (p-value = 1.5510494253385756e-11).

Granger Causality Tests:
No significant Granger Causality found from DLO to EPT (minimum p-value = 0.17719051855906293 across 5 lags).

No significant Granger Causality found from MKU to EPT (minimum p-value = 0.11286547849459537 across 5 lags).

No significant Granger Causality found from IGM to EPT (minimum p-value = 0.3321457600734814 across 5 lags).

No significant Granger Causality found from BRV to EPT (minimum p-value = 0.11565754663342516 across 5 lags).

EPT Granger-causes DLO (minimum p-value = 0.04216788424975077 across 5 lags).

No significant Granger Causality found from MKU to DLO (minimum p-value = 0.1501002892474646 across 5 lags).

IGM Granger-causes DLO (minimum p-value = 0.049243382282821394 across 5 lags).

No significant Granger Causality found from BRV to DLO (minimum p-value = 0.6316020606718338 across 5 lags).

No significant Granger Causality found from EPT to MKU (minimum p-value = 0.05134271659853858 across 5 lags).

No significant Granger Causality found from DLO to MKU (minimum p-value = 0.25362144386139046 across 5 lags).

No significant Granger Causality found from IGM to MKU (minimum p-value = 0.11294380112933207 across 5 lags).

BRV Granger-causes MKU (minimum p-value = 0.03231300684193627 across 5 lags).

No significant Granger Causality found from EPT to IGM (minimum p-value = 0.38071671419123365 across 5 lags).

No significant Granger Causality found from DLO to IGM (minimum p-value = 0.10442261004085539 across 5 lags).

No significant Granger Causality found from MKU to IGM (minimum p-value = 0.20213693047700618 across 5 lags).

No significant Granger Causality found from BRV to IGM (minimum p-value = 0.2626562645390783 across 5 lags).

No significant Granger Causality found from EPT to BRV (minimum p-value = 0.051875820617634544 across 5 lags).

No significant Granger Causality found from DLO to BRV (minimum p-value = 0.5683062864218041 across 5 lags).

MKU Granger-causes BRV (minimum p-value = 0.04761976398307926 across 5 lags).

No significant Granger Causality found from IGM to BRV (minimum p-value = 0.08312059005115902 across 5 lags).


Predictive Modeling for EPT:

LogisticRegression Results:
              precision    recall  f1-score   support

           0       0.64      0.80      0.71       132
           1       0.69      0.51      0.59       118

    accuracy                           0.66       250
   macro avg       0.67      0.65      0.65       250
weighted avg       0.67      0.66      0.65       250

Accuracy: 0.66
```

Precision: 0.6896551724137931
Recall: 0.5084745762711864
F1-score: 0.5853658536585366

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

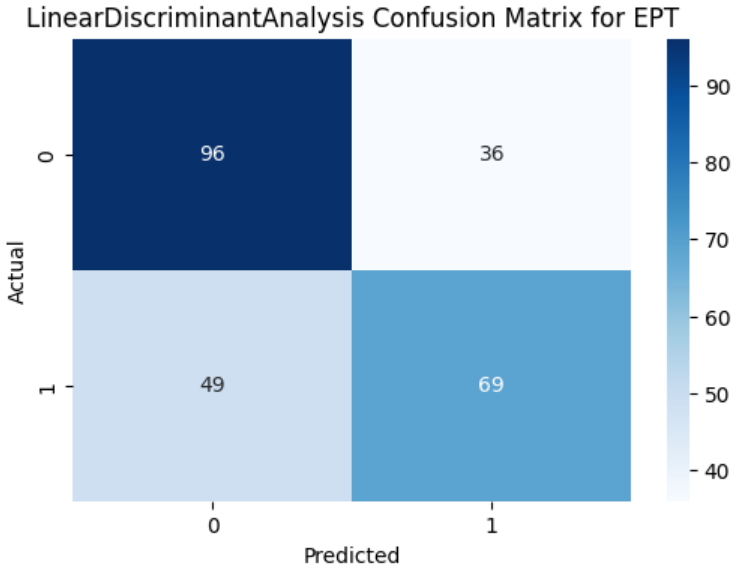


LinearDiscriminantAnalysis Results:

	precision	recall	f1-score	support
0	0.66	0.73	0.69	132
1	0.66	0.58	0.62	118
accuracy			0.66	250
macro avg	0.66	0.66	0.66	250
weighted avg	0.66	0.66	0.66	250

Accuracy: 0.66
Precision: 0.6571428571428571
Recall: 0.5847457627118644
F1-score: 0.6188340807174888

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

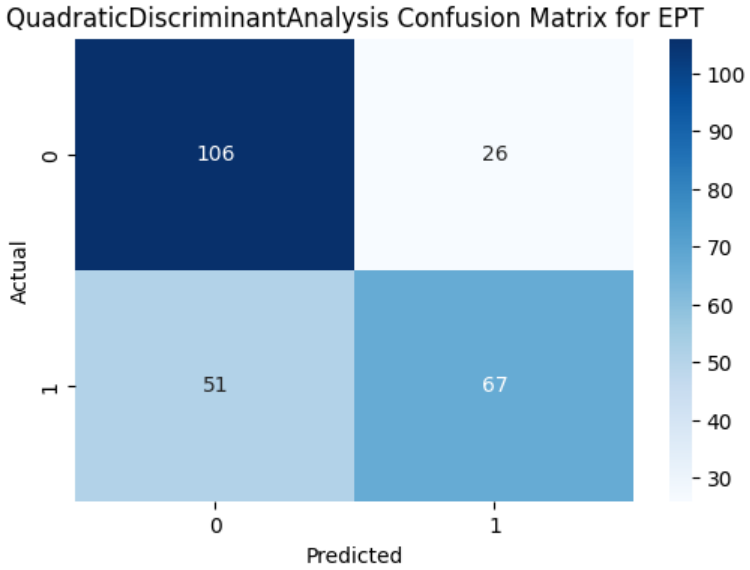


QuadraticDiscriminantAnalysis Results:

	precision	recall	f1-score	support
0	0.68	0.80	0.73	132
1	0.72	0.57	0.64	118
accuracy			0.69	250
macro avg	0.70	0.69	0.68	250
weighted avg	0.70	0.69	0.69	250

Accuracy: 0.692
Precision: 0.7204301075268817
Recall: 0.5677966101694916
F1-score: 0.6350710900473934

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

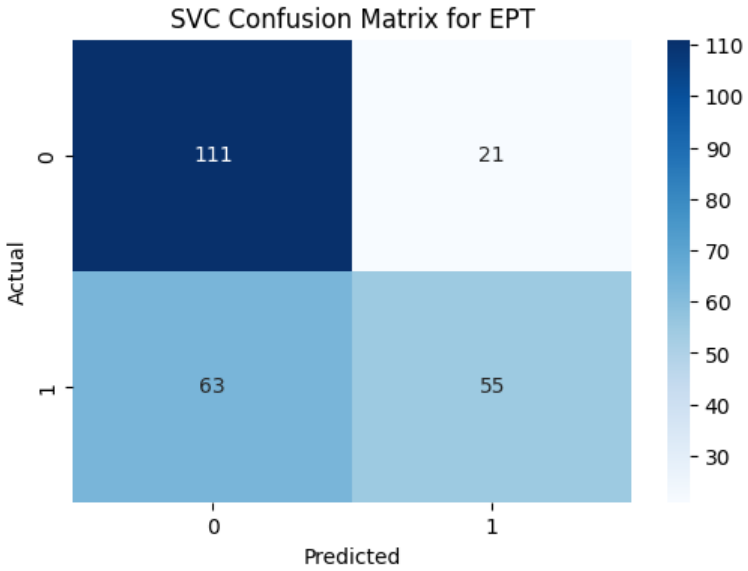


SVC Results:

	precision	recall	f1-score	support
0	0.64	0.84	0.73	132
1	0.72	0.47	0.57	118
accuracy			0.66	250
macro avg	0.68	0.65	0.65	250
weighted avg	0.68	0.66	0.65	250

Accuracy: 0.664
Precision: 0.7236842105263158
Recall: 0.4661016949152542
F1-score: 0.5670103092783505

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

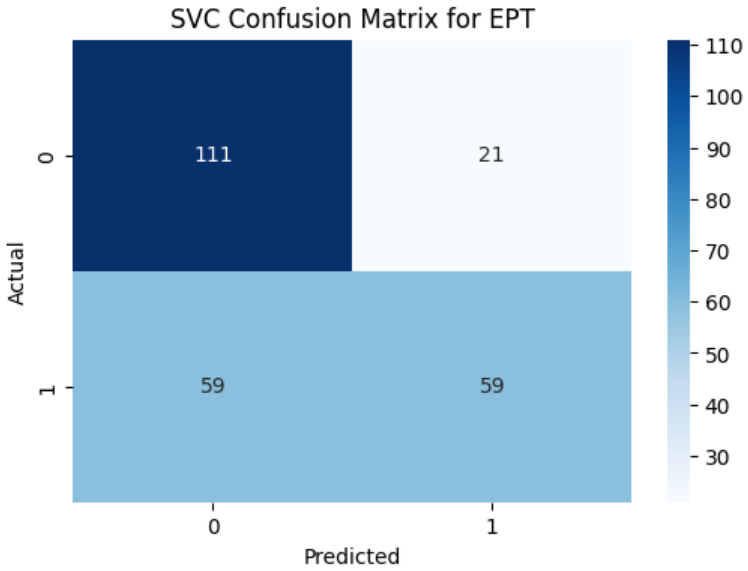


SVC Results:

	precision	recall	f1-score	support
0	0.65	0.84	0.74	132
1	0.74	0.50	0.60	118
accuracy			0.68	250
macro avg	0.70	0.67	0.67	250
weighted avg	0.69	0.68	0.67	250

Accuracy: 0.68
Precision: 0.7375
Recall: 0.5
F1-score: 0.5959595959595959

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

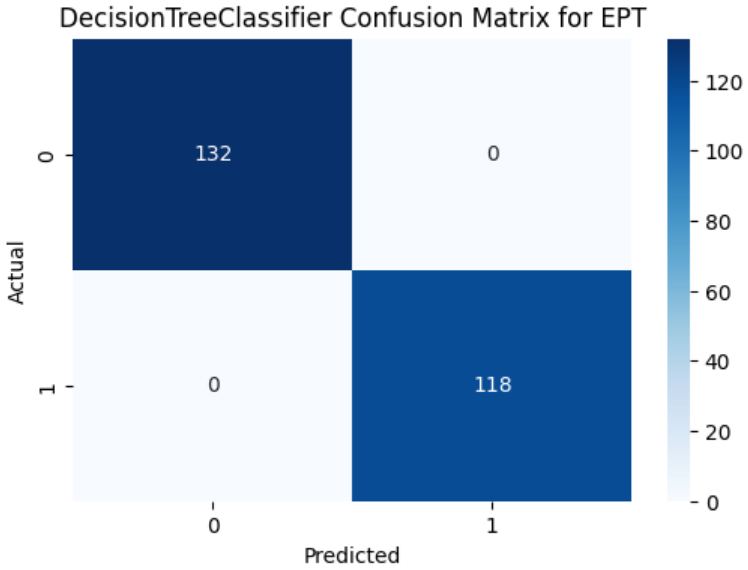


DecisionTreeClassifier Results:

	precision	recall	f1-score	support
0	1.00	1.00	1.00	132
1	1.00	1.00	1.00	118
accuracy			1.00	250
macro avg	1.00	1.00	1.00	250
weighted avg	1.00	1.00	1.00	250

Accuracy: 1.0
Precision: 1.0
Recall: 1.0
F1-score: 1.0

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

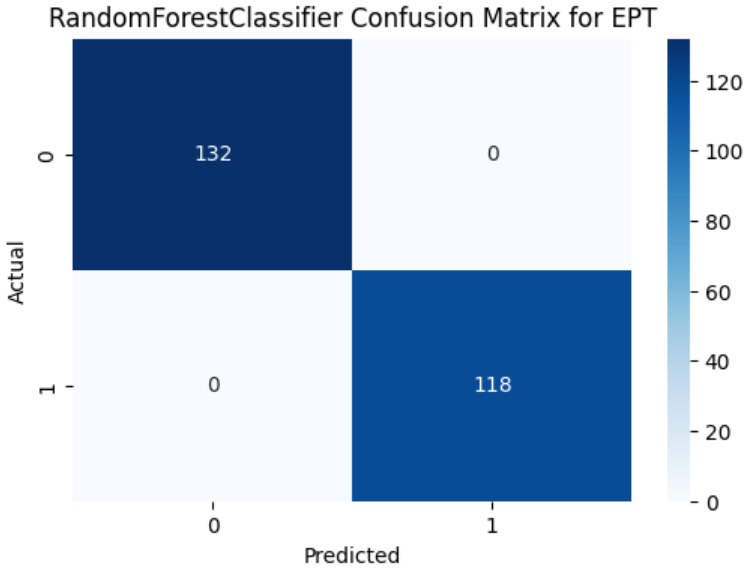


RandomForestClassifier Results:

	precision	recall	f1-score	support
0	1.00	1.00	1.00	132
1	1.00	1.00	1.00	118
accuracy			1.00	250
macro avg	1.00	1.00	1.00	250
weighted avg	1.00	1.00	1.00	250

Accuracy: 1.0
Precision: 1.0
Recall: 1.0
F1-score: 1.0

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.



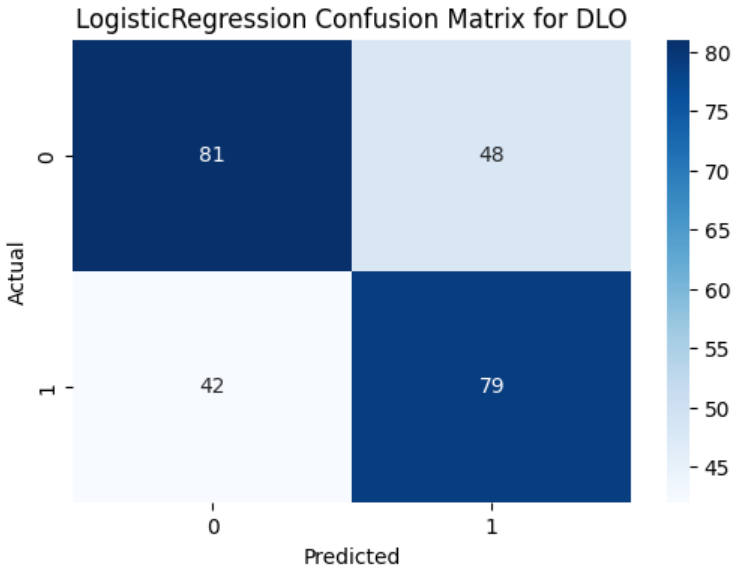
Predictive Modeling for DLO:

LogisticRegression Results:

	precision	recall	f1-score	support
0	0.66	0.63	0.64	129
1	0.62	0.65	0.64	121
accuracy			0.64	250
macro avg	0.64	0.64	0.64	250
weighted avg	0.64	0.64	0.64	250

Accuracy: 0.64
Precision: 0.6220472440944882
Recall: 0.6528925619834711
F1-score: 0.6370967741935484

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

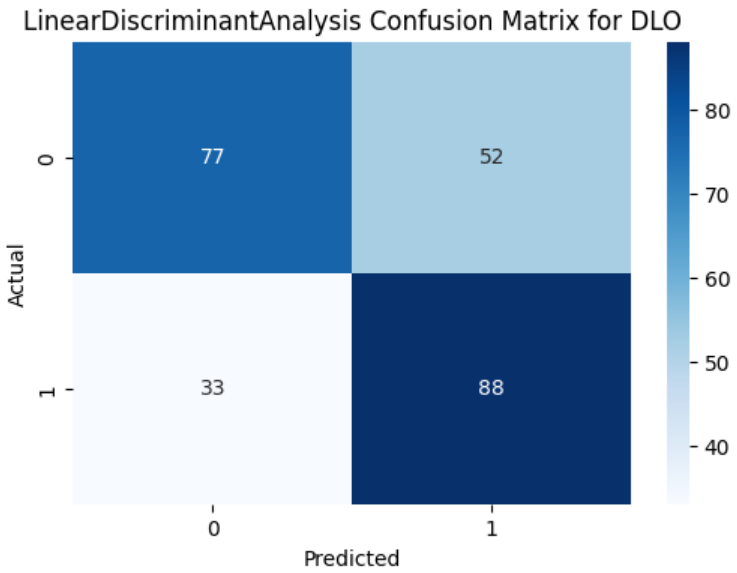


LinearDiscriminantAnalysis Results:

	precision	recall	f1-score	support
0	0.70	0.60	0.64	129
1	0.63	0.73	0.67	121
accuracy			0.66	250
macro avg	0.66	0.66	0.66	250
weighted avg	0.67	0.66	0.66	250

Accuracy: 0.66
Precision: 0.6285714285714286
Recall: 0.7272727272727273
F1-score: 0.6743295019157088

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

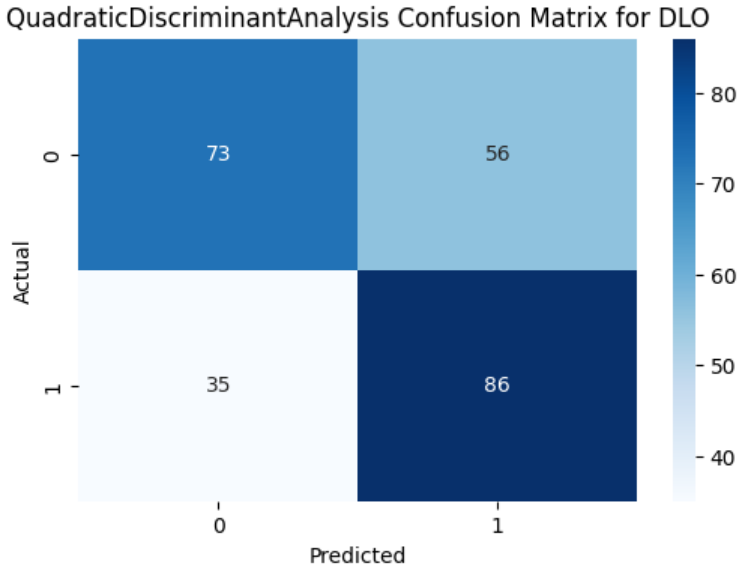


QuadraticDiscriminantAnalysis Results:

	precision	recall	f1-score	support
0	0.68	0.57	0.62	129
1	0.61	0.71	0.65	121
accuracy			0.64	250
macro avg	0.64	0.64	0.64	250
weighted avg	0.64	0.64	0.63	250

Accuracy: 0.636
Precision: 0.6056338028169014
Recall: 0.7107438016528925
F1-score: 0.6539923954372624

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

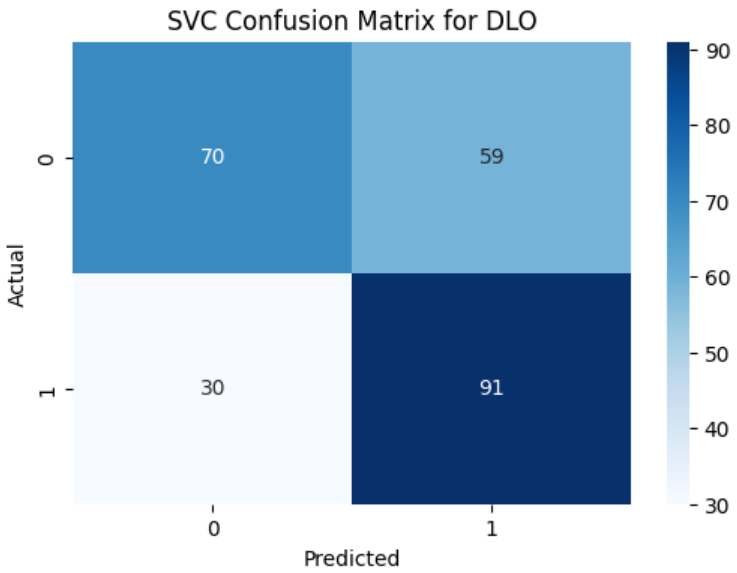


SVC Results:

	precision	recall	f1-score	support
0	0.70	0.54	0.61	129
1	0.61	0.75	0.67	121
accuracy			0.64	250
macro avg	0.65	0.65	0.64	250
weighted avg	0.65	0.64	0.64	250

Accuracy: 0.644
Precision: 0.6066666666666667
Recall: 0.7520661157024794
F1-score: 0.6715867158671587

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

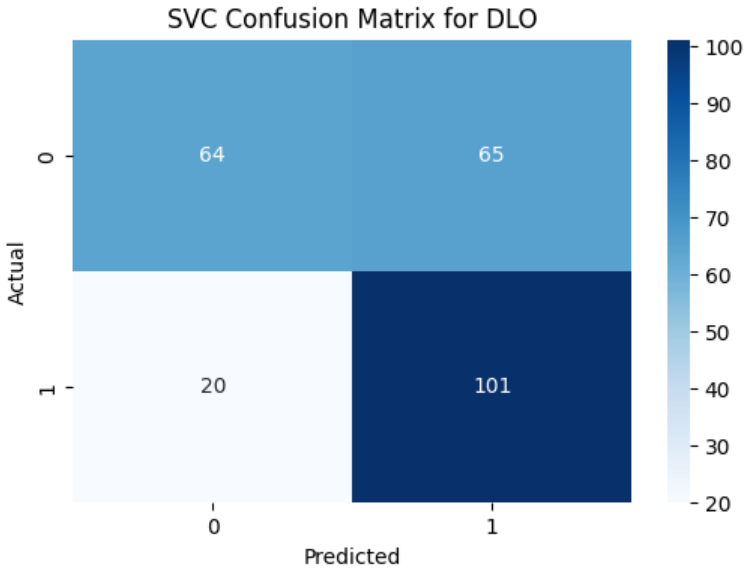


SVC Results:

	precision	recall	f1-score	support
0	0.76	0.50	0.60	129
1	0.61	0.83	0.70	121
accuracy			0.66	250
macro avg	0.69	0.67	0.65	250
weighted avg	0.69	0.66	0.65	250

Accuracy: 0.66
Precision: 0.608433734939759
Recall: 0.8347107438016529
F1-score: 0.7038327526132404

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

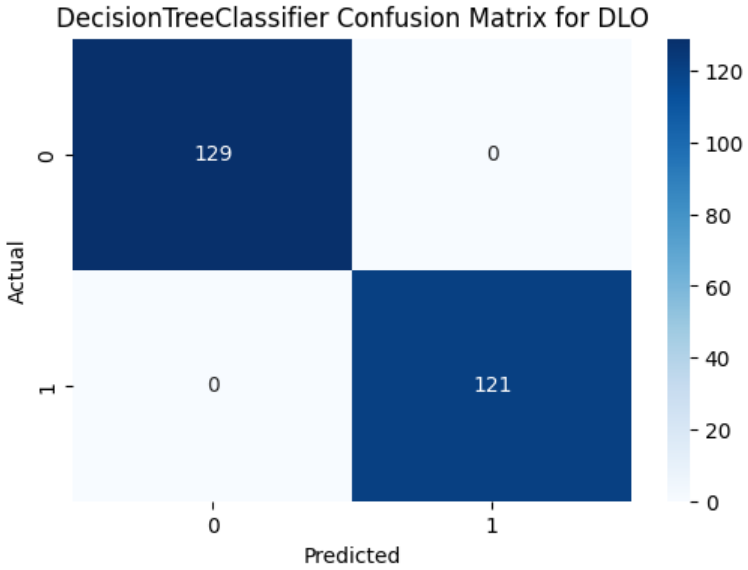


DecisionTreeClassifier Results:

	precision	recall	f1-score	support
0	1.00	1.00	1.00	129
1	1.00	1.00	1.00	121
accuracy			1.00	250
macro avg	1.00	1.00	1.00	250
weighted avg	1.00	1.00	1.00	250

Accuracy: 1.0
Precision: 1.0
Recall: 1.0
F1-score: 1.0

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

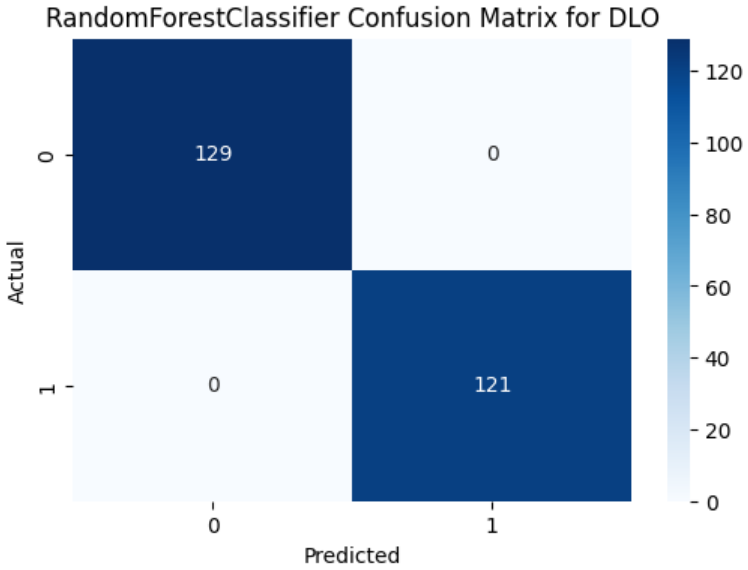


RandomForestClassifier Results:

	precision	recall	f1-score	support
0	1.00	1.00	1.00	129
1	1.00	1.00	1.00	121
accuracy			1.00	250
macro avg	1.00	1.00	1.00	250
weighted avg	1.00	1.00	1.00	250

Accuracy: 1.0
Precision: 1.0
Recall: 1.0
F1-score: 1.0

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.



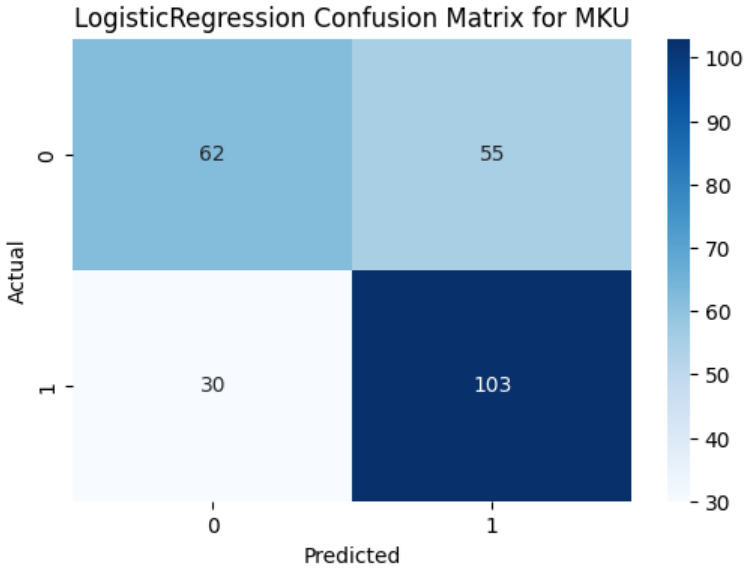
Predictive Modeling for MKU:

LogisticRegression Results:

	precision	recall	f1-score	support
0	0.67	0.53	0.59	117
1	0.65	0.77	0.71	133
accuracy			0.66	250
macro avg	0.66	0.65	0.65	250
weighted avg	0.66	0.66	0.65	250

Accuracy: 0.66
Precision: 0.6518987341772152
Recall: 0.7744360902255639
F1-score: 0.7079037800687286

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

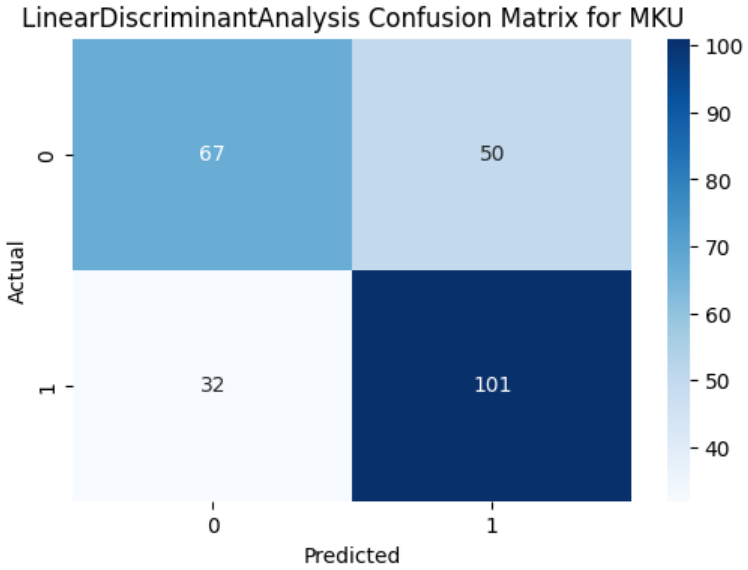


LinearDiscriminantAnalysis Results:

	precision	recall	f1-score	support
0	0.68	0.57	0.62	117
1	0.67	0.76	0.71	133
accuracy			0.67	250
macro avg	0.67	0.67	0.67	250
weighted avg	0.67	0.67	0.67	250

Accuracy: 0.672
Precision: 0.6688741721854304
Recall: 0.7593984962406015
F1-score: 0.7112676056338029

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

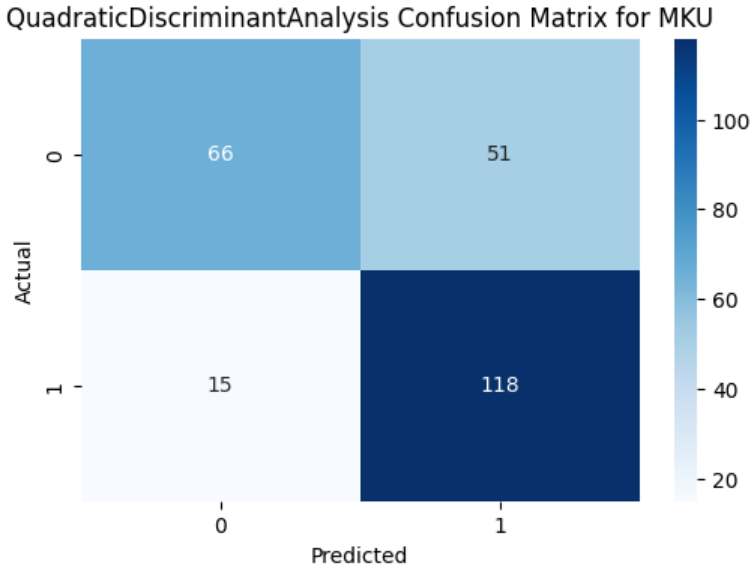


QuadraticDiscriminantAnalysis Results:

	precision	recall	f1-score	support
0	0.81	0.56	0.67	117
1	0.70	0.89	0.78	133
accuracy			0.74	250
macro avg	0.76	0.73	0.72	250
weighted avg	0.75	0.74	0.73	250

Accuracy: 0.736
Precision: 0.6982248520710059
Recall: 0.8872180451127819
F1-score: 0.7814569536423841

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

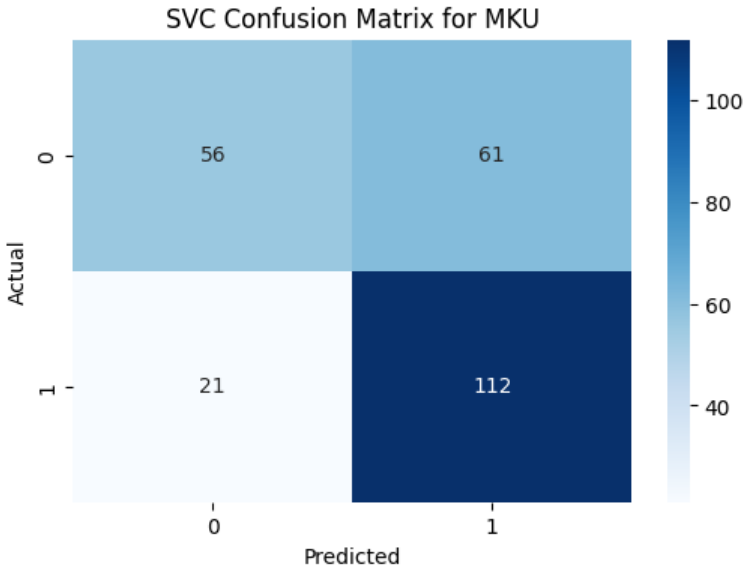


SVC Results:

	precision	recall	f1-score	support
0	0.73	0.48	0.58	117
1	0.65	0.84	0.73	133
accuracy			0.67	250
macro avg	0.69	0.66	0.65	250
weighted avg	0.68	0.67	0.66	250

Accuracy: 0.672
Precision: 0.6473988439306358
Recall: 0.8421052631578947
F1-score: 0.7320261437908496

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

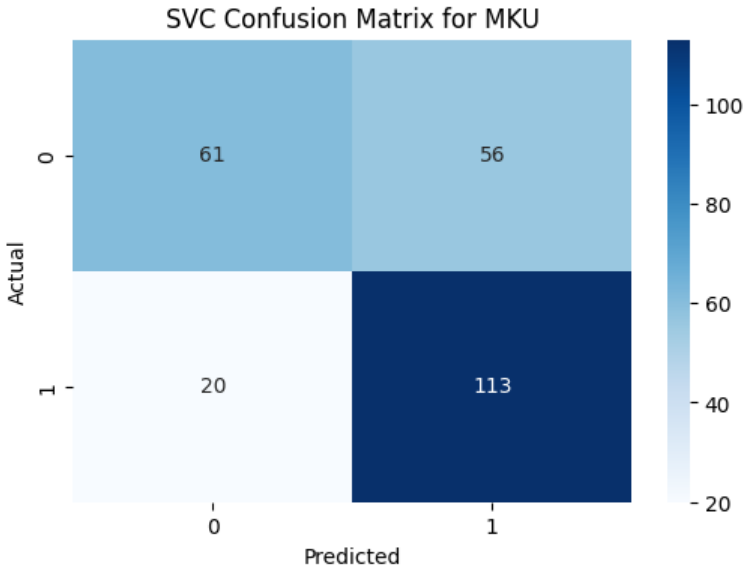


SVC Results:

	precision	recall	f1-score	support
0	0.75	0.52	0.62	117
1	0.67	0.85	0.75	133
accuracy			0.70	250
macro avg	0.71	0.69	0.68	250
weighted avg	0.71	0.70	0.69	250

Accuracy: 0.696
Precision: 0.6686390532544378
Recall: 0.849624060150376
F1-score: 0.7483443708609272

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

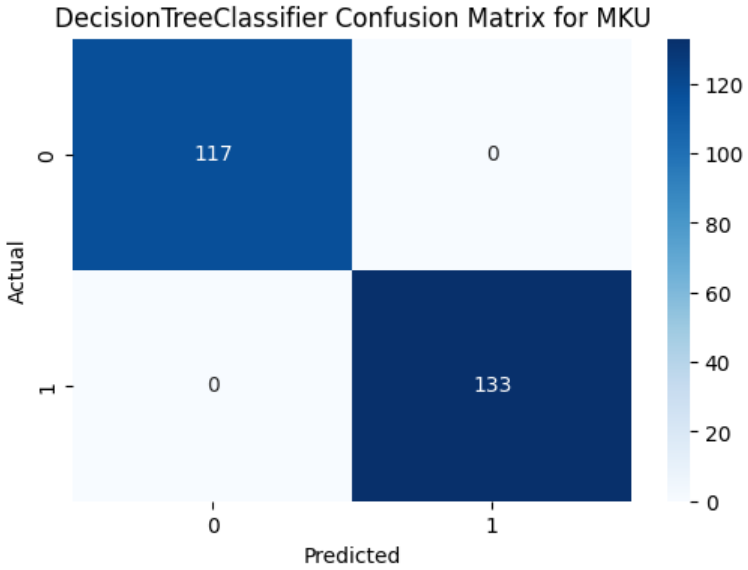


DecisionTreeClassifier Results:

	precision	recall	f1-score	support
0	1.00	1.00	1.00	117
1	1.00	1.00	1.00	133
accuracy			1.00	250
macro avg	1.00	1.00	1.00	250
weighted avg	1.00	1.00	1.00	250

Accuracy: 1.0
Precision: 1.0
Recall: 1.0
F1-score: 1.0

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

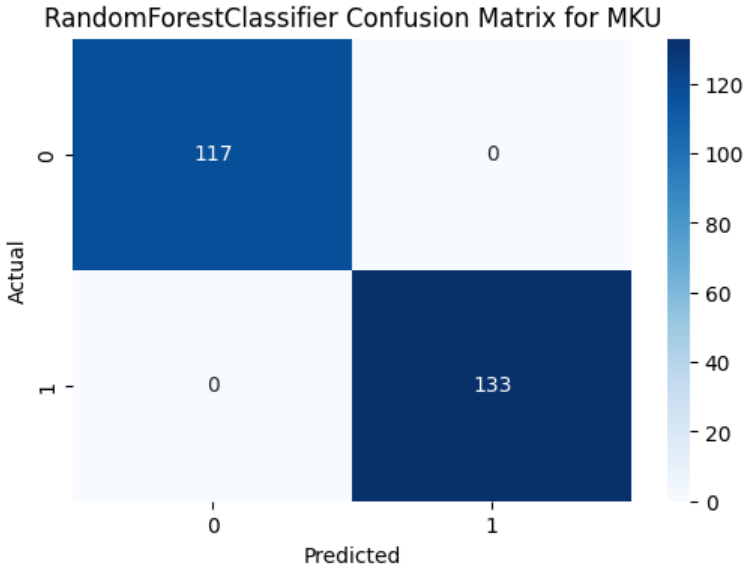


RandomForestClassifier Results:

	precision	recall	f1-score	support
0	1.00	1.00	1.00	117
1	1.00	1.00	1.00	133
accuracy			1.00	250
macro avg	1.00	1.00	1.00	250
weighted avg	1.00	1.00	1.00	250

Accuracy: 1.0
Precision: 1.0
Recall: 1.0
F1-score: 1.0

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.



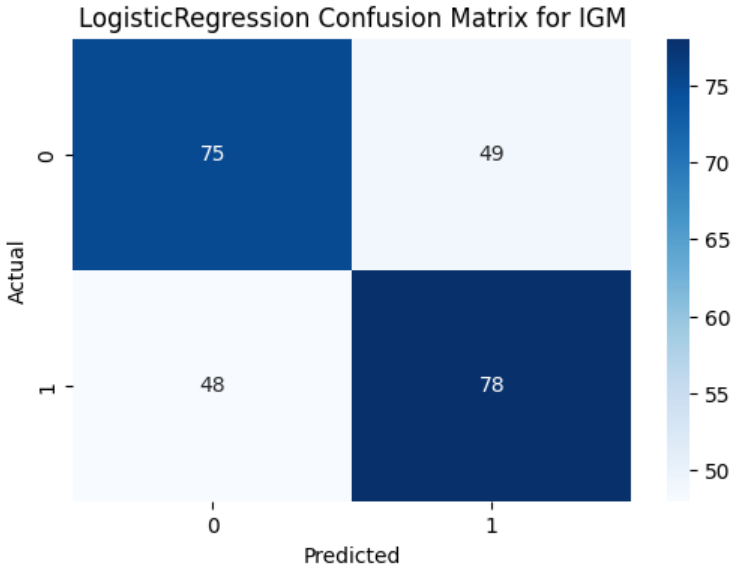
Predictive Modeling for IGM:

LogisticRegression Results:

	precision	recall	f1-score	support
0	0.61	0.60	0.61	124
1	0.61	0.62	0.62	126
accuracy			0.61	250
macro avg	0.61	0.61	0.61	250
weighted avg	0.61	0.61	0.61	250

Accuracy: 0.612
Precision: 0.6141732283464567
Recall: 0.6190476190476191
F1-score: 0.616600790513834

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

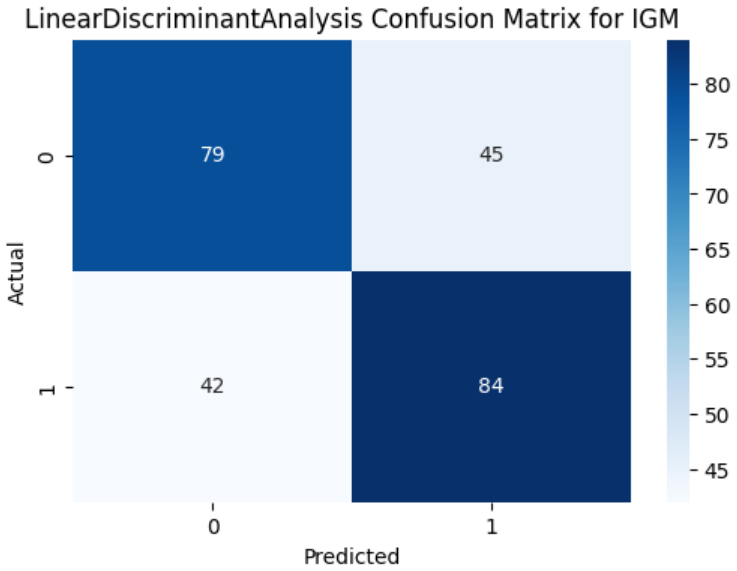


LinearDiscriminantAnalysis Results:

	precision	recall	f1-score	support
0	0.65	0.64	0.64	124
1	0.65	0.67	0.66	126
accuracy			0.65	250
macro avg	0.65	0.65	0.65	250
weighted avg	0.65	0.65	0.65	250

Accuracy: 0.652
Precision: 0.6511627906976745
Recall: 0.6666666666666666
F1-score: 0.6588235294117647

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

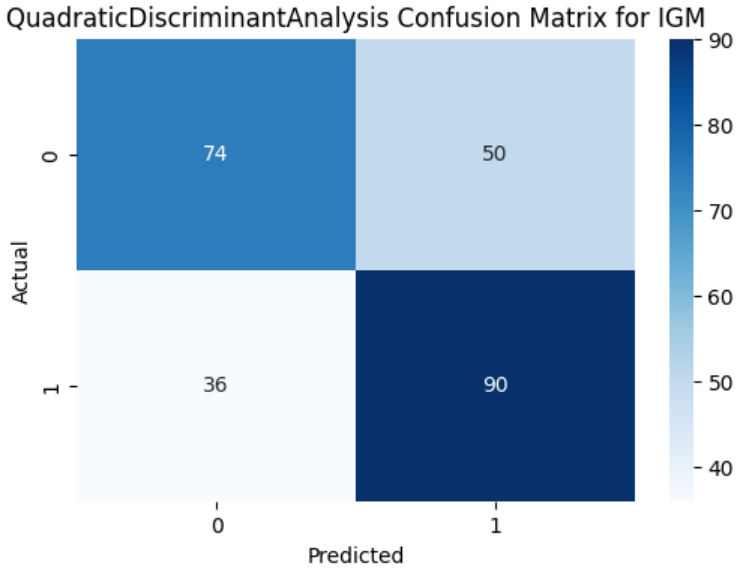


QuadraticDiscriminantAnalysis Results:

	precision	recall	f1-score	support
0	0.67	0.60	0.63	124
1	0.64	0.71	0.68	126
accuracy			0.66	250
macro avg	0.66	0.66	0.65	250
weighted avg	0.66	0.66	0.65	250

Accuracy: 0.656
Precision: 0.6428571428571429
Recall: 0.7142857142857143
F1-score: 0.6766917293233082

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

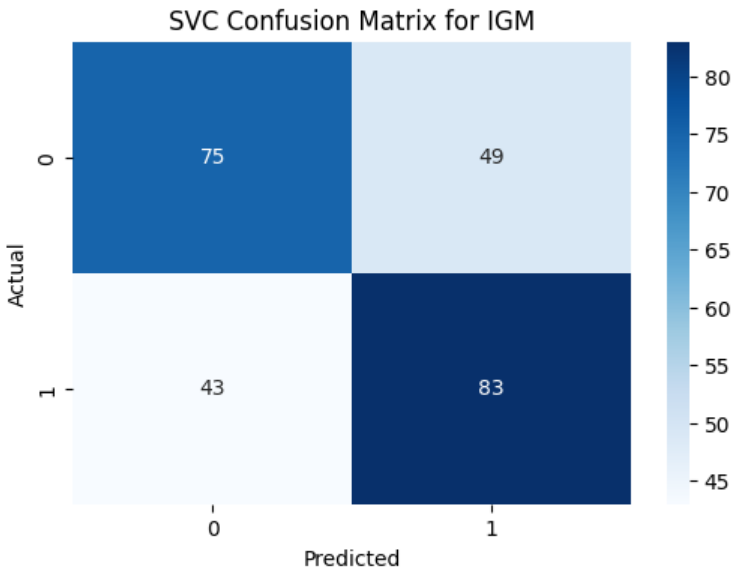


SVC Results:

	precision	recall	f1-score	support
0	0.64	0.60	0.62	124
1	0.63	0.66	0.64	126
accuracy			0.63	250
macro avg	0.63	0.63	0.63	250
weighted avg	0.63	0.63	0.63	250

Accuracy: 0.632
Precision: 0.6287878787878788
Recall: 0.6587301587301587
F1-score: 0.6434108527131783

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

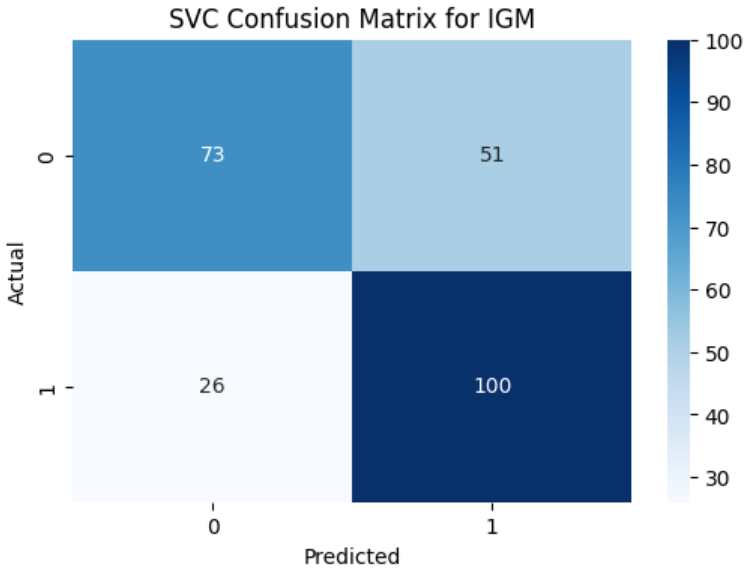


SVC Results:

	precision	recall	f1-score	support
0	0.74	0.59	0.65	124
1	0.66	0.79	0.72	126
accuracy			0.69	250
macro avg	0.70	0.69	0.69	250
weighted avg	0.70	0.69	0.69	250

Accuracy: 0.692
Precision: 0.6622516556291391
Recall: 0.7936507936507936
F1-score: 0.7220216606498195

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

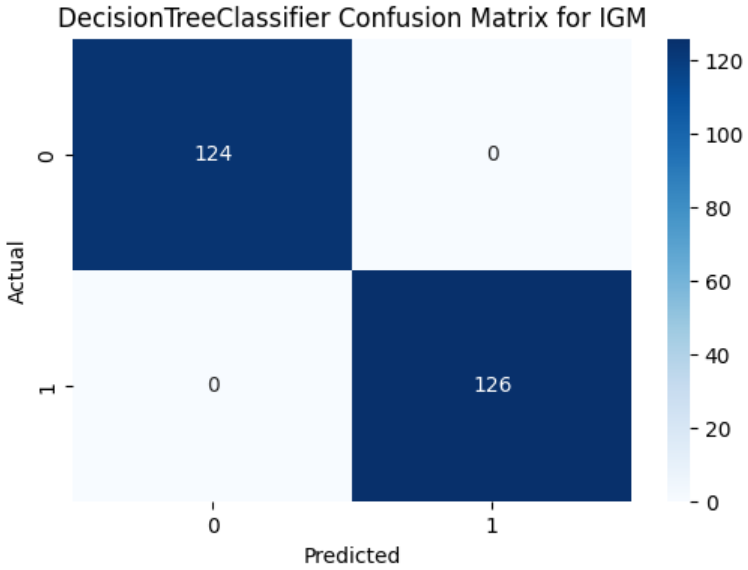


DecisionTreeClassifier Results:

	precision	recall	f1-score	support
0	1.00	1.00	1.00	124
1	1.00	1.00	1.00	126
accuracy			1.00	250
macro avg	1.00	1.00	1.00	250
weighted avg	1.00	1.00	1.00	250

Accuracy: 1.0
Precision: 1.0
Recall: 1.0
F1-score: 1.0

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

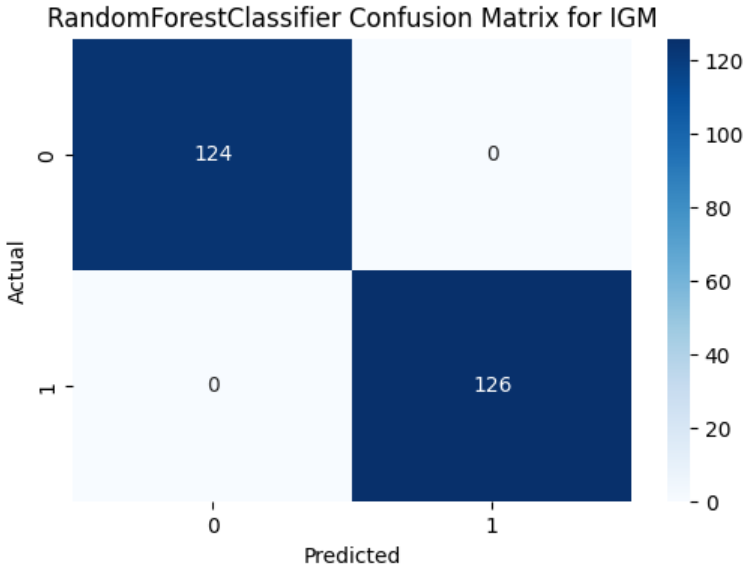


RandomForestClassifier Results:

	precision	recall	f1-score	support
0	1.00	1.00	1.00	124
1	1.00	1.00	1.00	126
accuracy			1.00	250
macro avg	1.00	1.00	1.00	250
weighted avg	1.00	1.00	1.00	250

Accuracy: 1.0
Precision: 1.0
Recall: 1.0
F1-score: 1.0

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.



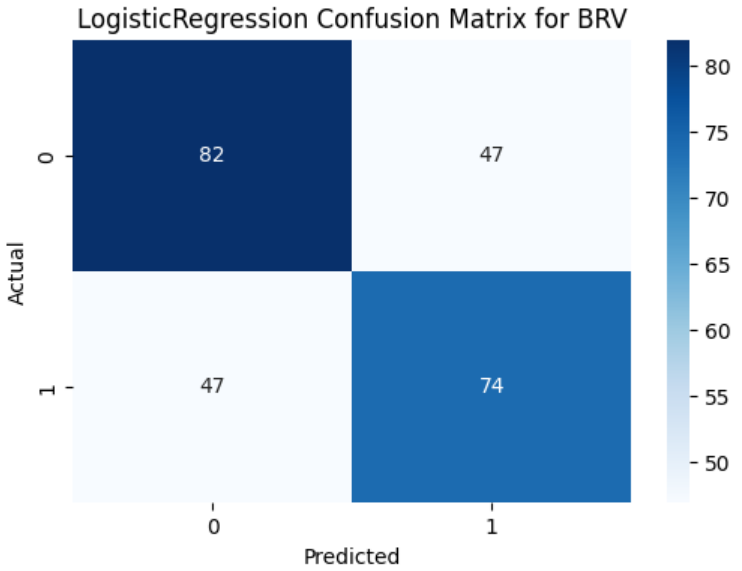
Predictive Modeling for BRV:

LogisticRegression Results:

	precision	recall	f1-score	support
0	0.64	0.64	0.64	129
1	0.61	0.61	0.61	121
accuracy			0.62	250
macro avg	0.62	0.62	0.62	250
weighted avg	0.62	0.62	0.62	250

Accuracy: 0.624
Precision: 0.6115702479338843
Recall: 0.6115702479338843
F1-score: 0.6115702479338843

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

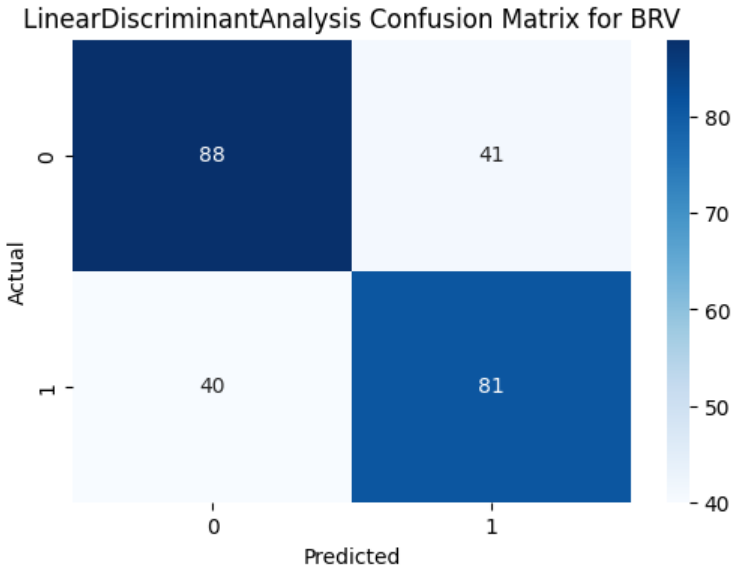


LinearDiscriminantAnalysis Results:

	precision	recall	f1-score	support
0	0.69	0.68	0.68	129
1	0.66	0.67	0.67	121
accuracy			0.68	250
macro avg	0.68	0.68	0.68	250
weighted avg	0.68	0.68	0.68	250

Accuracy: 0.676
Precision: 0.6639344262295082
Recall: 0.6694214876033058
F1-score: 0.6666666666666666

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

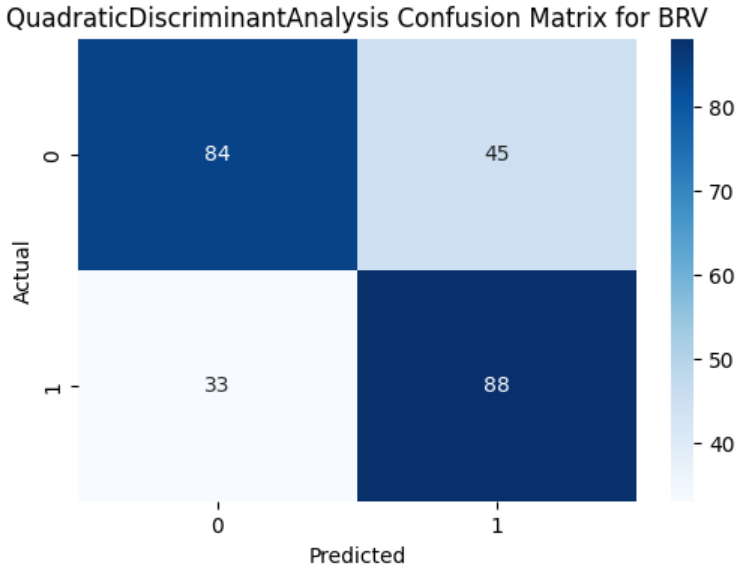


QuadraticDiscriminantAnalysis Results:

	precision	recall	f1-score	support
0	0.72	0.65	0.68	129
1	0.66	0.73	0.69	121
accuracy			0.69	250
macro avg	0.69	0.69	0.69	250
weighted avg	0.69	0.69	0.69	250

Accuracy: 0.688
Precision: 0.6616541353383458
Recall: 0.7272727272727273
F1-score: 0.6929133858267716

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

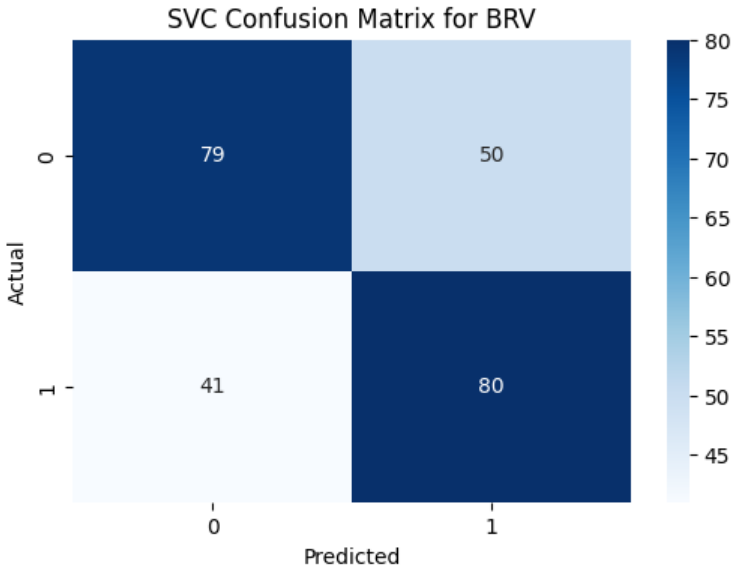


SVC Results:

	precision	recall	f1-score	support
0	0.66	0.61	0.63	129
1	0.62	0.66	0.64	121
accuracy			0.64	250
macro avg	0.64	0.64	0.64	250
weighted avg	0.64	0.64	0.64	250

Accuracy: 0.636
Precision: 0.6153846153846154
Recall: 0.6611570247933884
F1-score: 0.6374501992031872

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

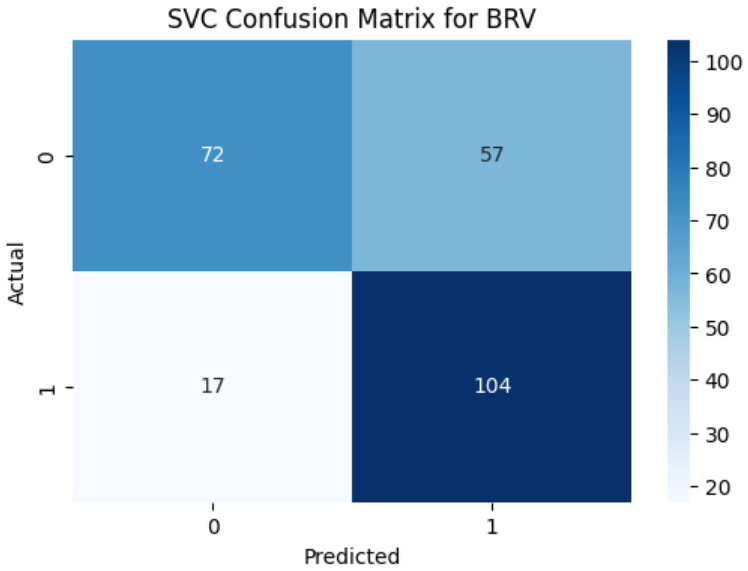


SVC Results:

	precision	recall	f1-score	support
0	0.81	0.56	0.66	129
1	0.65	0.86	0.74	121
accuracy			0.70	250
macro avg	0.73	0.71	0.70	250
weighted avg	0.73	0.70	0.70	250

Accuracy: 0.704
Precision: 0.6459627329192547
Recall: 0.859504132231405
F1-score: 0.7375886524822695

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

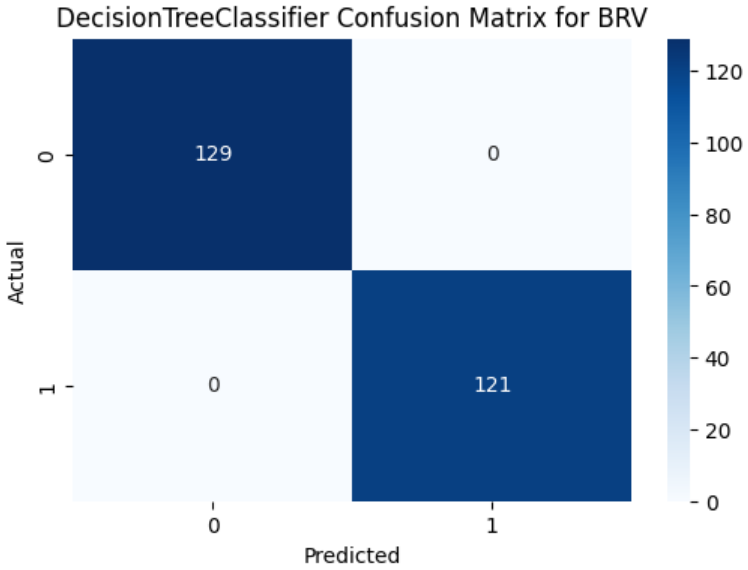


DecisionTreeClassifier Results:

	precision	recall	f1-score	support
0	1.00	1.00	1.00	129
1	1.00	1.00	1.00	121
accuracy			1.00	250
macro avg	1.00	1.00	1.00	250
weighted avg	1.00	1.00	1.00	250

Accuracy: 1.0
Precision: 1.0
Recall: 1.0
F1-score: 1.0

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.

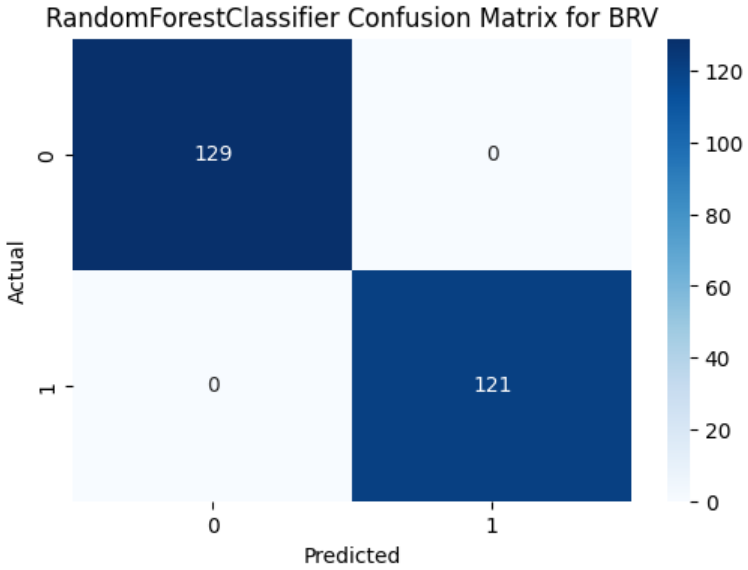


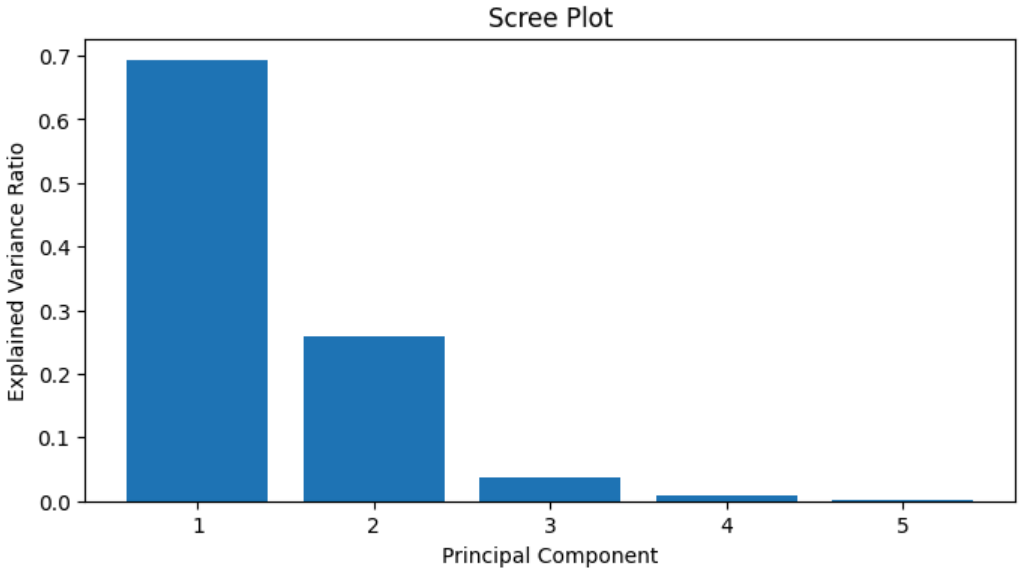
RandomForestClassifier Results:

	precision	recall	f1-score	support
0	1.00	1.00	1.00	129
1	1.00	1.00	1.00	121
accuracy			1.00	250
macro avg	1.00	1.00	1.00	250
weighted avg	1.00	1.00	1.00	250

Accuracy: 1.0
Precision: 1.0
Recall: 1.0
F1-score: 1.0

Analysis:
- Accuracy measures the overall correctness of predictions.
- Precision indicates the proportion of true positive predictions among the positive predictions.
- Recall measures the proportion of actual positive instances that were correctly predicted.
- F1-score is the harmonic mean of precision and recall, providing a balanced evaluation.


RandomForestClassifier Confusion Matrix for BRV
129
0
0
121
Actual
Predicted
0
1
120
100
80
60
40
20
0


Scree Plot
Explained Variance Ratio
Principal Component
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
1
2
3
4
5


Principal Component Loadings
EPT
DLO
MKU
IGM
BRV
-0.25
0.6
0.66
-0.041
0.36
0.25
0.17
0.12
0.91
-0.24
0.39
0.45
0.1
-0.39
-0.7
0.46
-0.57
0.67
-0.096
0.042
0.71
0.28
-0.3
-0.062
0.57
PC1
PC2
PC3
PC4
PC5
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00