BITS F464 - Semester 1 - MACHINE LEARNING

ASSIGNMENT 2 – DECISION TREES AND SUPPORT VECTOR MACHINES

Team number: 13

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This assignment aims to identify the differences between three Machine Learning models.

1. Preprocess and perform exploratory data analysis of the dataset obtained

Import Dependencies and Load Dataset

In [ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import plotly.graph_objs as go
```

In [ ]:
```
# Load the dataset

# Add column names
column_names = [
    "state", "county", "community", "communityname", "fold", "population"
    "racepctblack", "racePctWhite", "racePctAsian", "racePctHisp", "agePc
    "agePct12t29", "agePct16t24", "agePct65up", "numbUrban", "pctUrban",
    "pctWWage", "pctWFarmSelf", "pctWInvInc", "pctWSocSec", "pctWPubAsst"
    "medFamInc", "perCapInc", "whitePerCap", "blackPerCap", "indianPerCap
    "OtherPerCap", "HispPerCap", "NumUnderPov", "PctPopUnderPov", "PctLes
    "PctNotHSGrad", "PctBSorMore", "PctUnemployed", "PctEmploy", "PctEmpl
    "PctEmplProfServ", "PctOccupManu", "PctOccupMgmtProf", "MalePctDivorc
    "MalePctNevMarr", "FemalePctDiv", "TotalPctDiv", "PersPerFam", "PctFa
    "PctKids2Par", "PctYoungKids2Par", "PctTeen2Par", "PctWorkMomYoungKid
    "NumIlleg", "PctIlleg", "NumImmig", "PctImmigRecent", "PctImmigRec5",
    "PctImmigRec10", "PctRecentImmig", "PctRecImmig5", "PctRecImmig8", "P
    "PctSpeakEnglOnly", "PctNotSpeakEnglWell", "PctLargHouseFam", "PctLar
    "PersPerOccupHous", "PersPerOwnOccHous", "PersPerRentOccHous", "PctPe
    "PctPersDenseHous", "PctHousLess3BR", "MedNumBR", "HousVacant", "PctH
    "PctHousOwnOcc", "PctVacantBoarded", "PctVacMore6Mos", "MedYrHousBuil
```

```
    "PctHousNoPhone", "PctWOFullPlumb", "OwnOccLowQuart", "OwnOccMedVal",
    "RentLowQ", "RentMedian", "RentHighQ", "MedRent", "MedRentPctHousInc"
    "MedOwnCostPctInc", "MedOwnCostPctIncNoMtg", "NumInShelters", "NumStr
    "PctForeignBorn", "PctBornSameState", "PctSameHouse85", "PctSameCity8
    "PctSameState85", "LemasSwornFT", "LemasSwFTPerPop", "LemasSwFTFieldO
    "LemasSwFTFieldPerPop", "LemasTotalReq", "LemasTotReqPerPop", "PolicR
    "PolicPerPop", "RacialMatchCommPol", "PctPolicWhite", "PctPolicBlack"
    "PctPolicHisp", "PctPolicAsian", "PctPolicMinor", "OfficAssgnDrugUnit
    "NumKindsDrugsSeiz", "PolicAveOTWorked", "LandArea", "PopDens", "PctU
    "PolicCars", "PolicOperBudg", "LemasPctPolicOnPatr", "LemasGangUnitDe
    "LemasPctOfficDrugUn", "PolicBudgPerPop", "ViolentCrimesPerPop"
]

# Define missing values
missing_values = ['?']

# Read the dataset
data = pd.read_csv('communities.data', header=None, names=column_names, n

data.head()
```

Out[ ]:

	state	county	community	communityname	fold	population	householdsize	race
0	8	NaN	NaN	Lakewoodcity	1	0.19	0.33	
1	53	NaN	NaN	Tukwilacity	1	0.00	0.16	
2	24	NaN	NaN	Aberdeentown	1	0.00	0.42	
3	34	5.0	81440.0	Willingborotownship	1	0.04	0.77	
4	42	95.0	6096.0	Bethlehemtownship	1	0.01	0.55	

5 rows × 128 columns

In [ ]:
```
# Remove non-predictive columns
df = data.drop(["state", "county", "community", "communityname", "fold"],
df.head()
```

Out[ ]:

	population	householdsize	racepctblack	racePctWhite	racePctAsian	racePctHisp	ag
0	0.19	0.33	0.02	0.90	0.12	0.17	
1	0.00	0.16	0.12	0.74	0.45	0.07	
2	0.00	0.42	0.49	0.56	0.17	0.04	
3	0.04	0.77	1.00	0.08	0.12	0.10	
4	0.01	0.55	0.02	0.95	0.09	0.05	

5 rows × 123 columns

Exploratory Data Analysis

In [ ]:
```
samples, features = np.shape(df)
df.shape
```

Out[ ]: (1994, 123)

In [ ]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1994 entries, 0 to 1993
Columns: 123 entries, population to ViolentCrimesPerPop
dtypes: float64(123)
memory usage: 1.9 MB
```

In [ ]:
```
df.describe()
```

Out[ ]:

	population	householdsize	racepctblack	racePctWhite	racePctAsian	racePct
count	1994.000000	1994.000000	1994.000000	1994.000000	1994.000000	1994.000
mean	0.057593	0.463395	0.179629	0.753716	0.153681	0.144
std	0.126906	0.163717	0.253442	0.244039	0.208877	0.232
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000
25%	0.010000	0.350000	0.020000	0.630000	0.040000	0.010
50%	0.020000	0.440000	0.060000	0.850000	0.070000	0.040
75%	0.050000	0.540000	0.230000	0.940000	0.170000	0.160
max	1.000000	1.000000	1.000000	1.000000	1.000000	1.000

8 rows × 123 columns

In [ ]:
```
df['ViolentCrimesPerPop'].value_counts(normalize=True)
```

Out[ ]:
```
ViolentCrimesPerPop
0.03    0.052156
0.04    0.046138
0.06    0.043129
0.05    0.040120
0.02    0.037111
          ...
0.79    0.001003
0.77    0.000502
0.89    0.000502
0.94    0.000502
0.96    0.000502
Name: proportion, Length: 98, dtype: float64
```

In [ ]:
```
df.drop('ViolentCrimesPerPop', axis=1).skew()
```

Out[ ]:
```
population             5.063957
householdsize          0.981300
racepctblack           1.863340
racePctWhite          -1.300489
racePctAsian           2.604395
                          ...
PolicOperBudg          4.153317
LemasPctPolicOnPatr   -1.589877
LemasGangUnitDeploy    0.221361
LemasPctOfficDrugUn    2.554246
PolicBudgPerPop        3.222583
Length: 122, dtype: float64
```

In [ ]:
```
df.corr()
```

Out[ ]:

	population	householdsize	racepctblack	racePctWhite	racePctAsi
population	1.000000	-0.046148	0.231178	-0.300845	0.1816
householdsize	-0.046148	1.000000	-0.067109	-0.235907	0.2019
racepctblack	0.231178	-0.067109	1.000000	-0.794389	-0.1067
racePctWhite	-0.300845	-0.235907	-0.794389	1.000000	-0.2702
racePctAsian	0.181603	0.201996	-0.106738	-0.270266	1.0000
...	...	...	...	...	
LemasPctPolicOnPatr	-0.080482	-0.017972	-0.168434	0.125223	0.0690
LemasGangUnitDeploy	0.100012	-0.000784	0.022388	-0.078552	0.1395
LemasPctOfficDrugUn	0.466352	-0.094368	0.260793	-0.276234	0.1018
PolicBudgPerPop	-0.046494	-0.152603	0.045311	-0.014957	-0.0247
ViolentCrimesPerPop	0.367157	-0.034923	0.631264	-0.684770	0.0376

123 rows × 123 columns

In [ ]:
```
fig = go.Figure(go.Heatmap(z=df.corr(), x=df.corr().columns.tolist(), y=d
fig.show()
```

Data Preprocessing

In [ ]:
```
# Check if there are any missing values
missing_values = df.isnull().sum()
columns_with_missing_values = missing_values[missing_values > (samples //

# Print the number of missing values for each column
for column in columns_with_missing_values:
    print(f"{column}: {missing_values[column]} missing values")

# Drop columns with too many missing values
df = df.drop(columns=columns_with_missing_values)
```

```
LemasSwornFT: 1675 missing values
LemasSwFTPerPop: 1675 missing values
LemasSwFTFieldOps: 1675 missing values
LemasSwFTFieldPerPop: 1675 missing values
LemasTotalReq: 1675 missing values
LemasTotReqPerPop: 1675 missing values
PolicReqPerOffic: 1675 missing values
PolicPerPop: 1675 missing values
RacialMatchCommPol: 1675 missing values
PctPolicWhite: 1675 missing values
PctPolicBlack: 1675 missing values
PctPolicHisp: 1675 missing values
PctPolicAsian: 1675 missing values
PctPolicMinor: 1675 missing values
OfficAssgnDrugUnits: 1675 missing values
NumKindsDrugsSeiz: 1675 missing values
PolicAveOTWorked: 1675 missing values
PolicCars: 1675 missing values
PolicOperBudg: 1675 missing values
LemasPctPolicOnPatr: 1675 missing values
LemasGangUnitDeploy: 1675 missing values
PolicBudgPerPop: 1675 missing values
```

In [ ]:
```
# Handle missing values (if any) by replacing them with the mean
df.fillna(df.mean(), inplace=True)
df.head()
```

Out[ ]:

	population	householdsize	racepctblack	racePctWhite	racePctAsian	racePctHisp	ag
0	0.19	0.33	0.02	0.90	0.12	0.17	
1	0.00	0.16	0.12	0.74	0.45	0.07	
2	0.00	0.42	0.49	0.56	0.17	0.04	
3	0.04	0.77	1.00	0.08	0.12	0.10	
4	0.01	0.55	0.02	0.95	0.09	0.05	

5 rows × 101 columns

In [ ]:
```
df.describe()
```

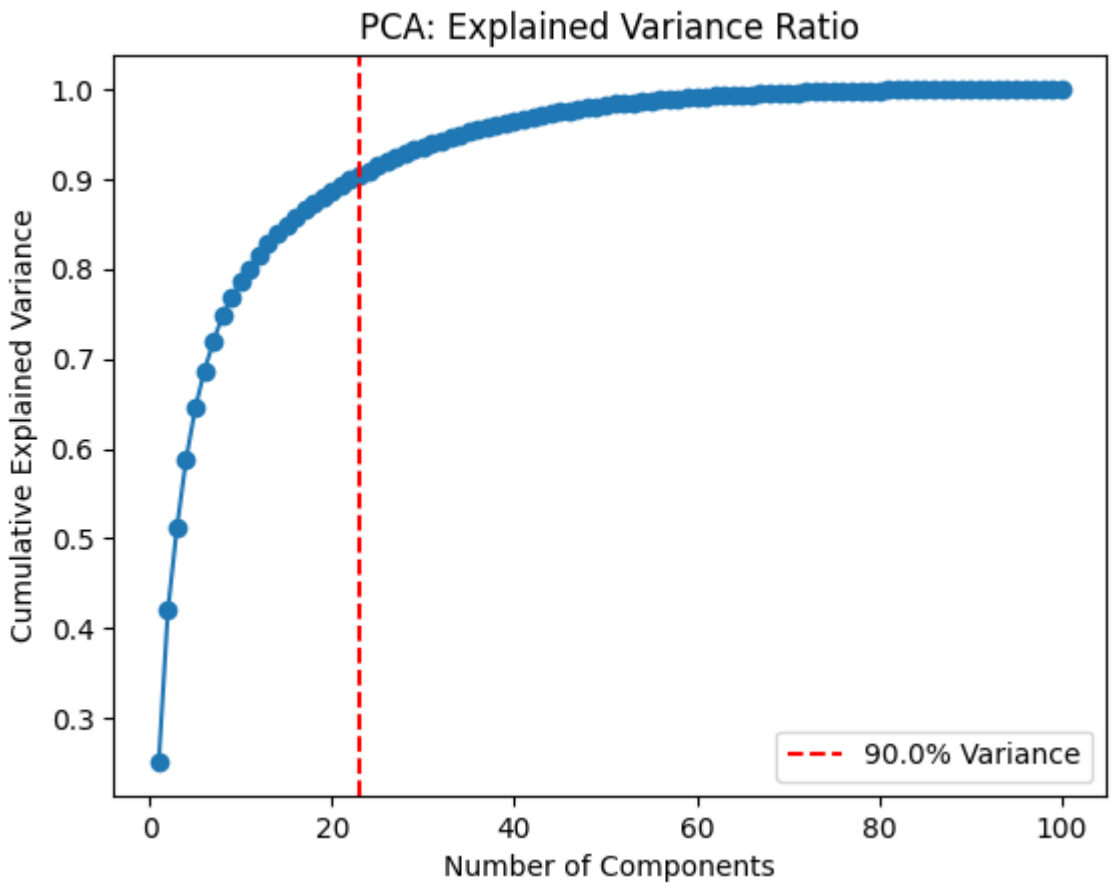
Out[ ]:

	population	householdsize	racepctblack	racePctWhite	racePctAsian	racePct
count	1994.000000	1994.000000	1994.000000	1994.000000	1994.000000	1994.000
mean	0.057593	0.463395	0.179629	0.753716	0.153681	0.144
std	0.126906	0.163717	0.253442	0.244039	0.208877	0.232
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000
25%	0.010000	0.350000	0.020000	0.630000	0.040000	0.010
50%	0.020000	0.440000	0.060000	0.850000	0.070000	0.040
75%	0.050000	0.540000	0.230000	0.940000	0.170000	0.160
max	1.000000	1.000000	1.000000	1.000000	1.000000	1.000

8 rows × 101 columns

In [ ]:
```
# Performing PCA on the dataset
target_variable = df['ViolentCrimesPerPop']
features = df.drop(['ViolentCrimesPerPop'], axis=1)

# Standardize the features
standardized_features = (features - features.mean()) / features.std()

# Calculate the covariance matrix
cov_matrix = np.cov(standardized_features, rowvar=False)

# Calculate the eigenvectors and eigenvalues
eigenvalues, eigenvectors = np.linalg.eigh(cov_matrix)

# Sort eigenvalues and corresponding eigenvectors in descending order
sorted_indices = np.argsort(eigenvalues)[::-1]
eigenvalues = eigenvalues[sorted_indices]
eigenvectors = eigenvectors[:, sorted_indices]
```

In [ ]:
```
# Calculate the explained variance ratio
explained_variance_ratio = eigenvalues / np.sum(eigenvalues)

# Cumulative explained variance
cumulative_explained_variance = np.cumsum(explained_variance_ratio)

# Find the number of components that explain at least 90% of the variance
desired_explained_variance = 0.90
num_components = np.argmax(cumulative_explained_variance >= desired_expla

# Plot the explained variance ratio
plt.plot(range(1, len(explained_variance_ratio) + 1), cumulative_explaine
plt.axvline(x=num_components, color='r', linestyle='--', label=f'{desired
plt.xlabel('Number of Components')
plt.ylabel('Cumulative Explained Variance')
plt.title('PCA: Explained Variance Ratio')
plt.legend()
plt.show()
```



In [ ]:
```
# Project the original data onto the selected number of components
selected_eigenvectors = eigenvectors[:, :num_components]
pca_result = np.dot(standardized_features, selected_eigenvectors)

# Create a DataFrame with the principal components and the target variabl
df_pca = pd.DataFrame(pca_result, columns=[f'PC{i + 1}' for i in range(nu
df_pca['ViolentCrimesPerPop'] = target_variable
df_pca.head()
df_pca.to_csv('crimes.csv', index=False)
```

Generate Random Test and Train Splits

In [ ]:
```
seed = 420
train_fraction = 0.8
train = df_pca.sample(frac=train_fraction, random_state=seed)
test = df_pca.drop(train.index)
```

In [ ]:
```
train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 1595 entries, 493 to 1405
Data columns (total 24 columns):
 #   Column               Non-Null Count  Dtype  
---  ------               --------------  -----  
 0   PC1                  1595 non-null   float64
 1   PC2                  1595 non-null   float64
 2   PC3                  1595 non-null   float64
 3   PC4                  1595 non-null   float64
 4   PC5                  1595 non-null   float64
 5   PC6                  1595 non-null   float64
 6   PC7                  1595 non-null   float64
 7   PC8                  1595 non-null   float64
 8   PC9                  1595 non-null   float64
 9   PC10                 1595 non-null   float64
 10  PC11                 1595 non-null   float64
 11  PC12                 1595 non-null   float64
 12  PC13                 1595 non-null   float64
 13  PC14                 1595 non-null   float64
 14  PC15                 1595 non-null   float64
 15  PC16                 1595 non-null   float64
 16  PC17                 1595 non-null   float64
 17  PC18                 1595 non-null   float64
 18  PC19                 1595 non-null   float64
 19  PC20                 1595 non-null   float64
 20  PC21                 1595 non-null   float64
 21  PC22                 1595 non-null   float64
 22  PC23                 1595 non-null   float64
 23  ViolentCrimesPerPop  1595 non-null   float64
dtypes: float64(24)
memory usage: 311.5 KB
```

In [ ]:
```
test.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 399 entries, 2 to 1989
Data columns (total 24 columns):
 #   Column               Non-Null Count  Dtype  
---  ------               --------------  -----  
 0   PC1                  399 non-null    float64
 1   PC2                  399 non-null    float64
 2   PC3                  399 non-null    float64
 3   PC4                  399 non-null    float64
 4   PC5                  399 non-null    float64
 5   PC6                  399 non-null    float64
 6   PC7                  399 non-null    float64
 7   PC8                  399 non-null    float64
 8   PC9                  399 non-null    float64
 9   PC10                 399 non-null    float64
 10  PC11                 399 non-null    float64
 11  PC12                 399 non-null    float64
 12  PC13                 399 non-null    float64
 13  PC14                 399 non-null    float64
 14  PC15                 399 non-null    float64
 15  PC16                 399 non-null    float64
 16  PC17                 399 non-null    float64
 17  PC18                 399 non-null    float64
 18  PC19                 399 non-null    float64
 19  PC20                 399 non-null    float64
 20  PC21                 399 non-null    float64
 21  PC22                 399 non-null    float64
 22  PC23                 399 non-null    float64
 23  ViolentCrimesPerPop  399 non-null    float64
dtypes: float64(24)
memory usage: 77.9 KB
```

In [ ]:
```python
# Assuming 'ViolentCrimesPerPop' is the column you want to predict
X_train = train.drop('ViolentCrimesPerPop', axis=1)  # Features for train
y_train = train['ViolentCrimesPerPop']  # Target for training

X_test = test.drop('ViolentCrimesPerPop', axis=1)  # Features for testing
y_test = test['ViolentCrimesPerPop']  # Target for testing

# Convert labels to numpy array for applying ML Models
y_train = y_train.to_numpy()
y_test = y_test.to_numpy()
```

In [ ]:
```python
def accuracy(pred, y_test, threshold=0.5):
    # Calculate the standard deviation of the true values
    y_std = np.std(y_test)

    # Check if the absolute difference is below the threshold (multiple o
    correct_predictions = np.abs(pred - y_test) < threshold * y_std

    # Calculate accuracy as the percentage of correct predictions
    accu = 100 * correct_predictions.mean()

    return accu
```

2. Decision tree model with entropy implementation

2.1 Implementation of the Model

In [ ]:

```
class Node():
    def __init__(self, feature_index=None, threshold=None, left=None, rig
        ''' constructor '''

        # for decision node
        self.feature_index = feature_index
        self.threshold = threshold
        self.left = left
        self.right = right
        self.info_gain = info_gain

        # for leaf node
        self.value = value

class DecisionTreeClassifier():
    def __init__(self, min_samples_split=2, max_depth=2):
        ''' constructor '''

        # initialize the root of the tree
        self.root = None

        # stopping conditions
        self.min_samples_split = min_samples_split
        self.max_depth = max_depth

    def build_tree(self, dataset, curr_depth=0):
        ''' recursive function to build the tree '''

        X, Y = dataset[:,:-1], dataset[:,-1]
        num_samples, num_features = np.shape(X)

        # split until stopping conditions are met
        if num_samples>=self.min_samples_split and curr_depth<=self.max_d
            # find the best split
            best_split = self.get_best_split(dataset, num_samples, num_fe
            # check if information gain is positive
            if best_split["info_gain"]>0:
                # recur left
                left_subtree = self.build_tree(best_split["dataset_left"]
                # recur right
                right_subtree = self.build_tree(best_split["dataset_right
                # return decision node
                return Node(best_split["feature_index"], best_split["thre
                            left_subtree, right_subtree, best_split["info

        # compute leaf node
        leaf_value = self.calculate_leaf_value(Y)
        # return leaf node
        return Node(value=leaf_value)

    def get_best_split(self, dataset, num_samples, num_features):
        ''' function to find the best split '''

        # dictionary to store the best split
        best_split = {}
        max_info_gain = -float("inf")
```

```
        # loop over all the features
        for feature_index in range(num_features):
            feature_values = dataset[:, feature_index]
            possible_thresholds = np.unique(feature_values)
            # loop over all the feature values present in the data
            for threshold in possible_thresholds:
                # get current split
                dataset_left, dataset_right = self.split(dataset, feature
                # check if childs are not null
                if len(dataset_left)>0 and len(dataset_right)>0:
                    y, left_y, right_y = dataset[:, -1], dataset_left[:,
                    # compute information gain
                    curr_info_gain = self.information_gain(y, left_y, rig
                    # update the best split if needed
                    if curr_info_gain>max_info_gain:
                        best_split["feature_index"] = feature_index
                        best_split["threshold"] = threshold
                        best_split["dataset_left"] = dataset_left
                        best_split["dataset_right"] = dataset_right
                        best_split["info_gain"] = curr_info_gain
                        max_info_gain = curr_info_gain

        # return best split
        return best_split

    def split(self, dataset, feature_index, threshold):
        ''' function to split the data '''

        dataset_left = np.array([row for row in dataset if row[feature_in
        dataset_right = np.array([row for row in dataset if row[feature_i
        return dataset_left, dataset_right

    def information_gain(self, parent, l_child, r_child, mode="entropy"):
        ''' function to compute information gain '''

        weight_l = len(l_child) / len(parent)
        weight_r = len(r_child) / len(parent)
        if mode=="gini":
            gain = self.gini_index(parent) - (weight_l*self.gini_index(l_
        else:
            gain = self.entropy(parent) - (weight_l*self.entropy(l_child)
        return gain

    def entropy(self, y):
        ''' function to compute entropy '''

        class_labels = np.unique(y)
        entropy = 0
        for cls in class_labels:
            p_cls = len(y[y == cls]) / len(y)
            entropy += -p_cls * np.log2(p_cls)
        return entropy

    def gini_index(self, y):
        ''' function to compute gini index '''

        class_labels = np.unique(y)
        gini = 0
        for cls in class_labels:
```

```
            p_cls = len(y[y == cls]) / len(y)
            gini += p_cls**2
        return 1 - gini

    def calculate_leaf_value(self, Y):
        ''' function to compute leaf node '''

        Y = list(Y)
        return max(Y, key=Y.count)

    def print_tree(self, tree=None, indent=""):
        ''' function to print the tree '''

        if not tree:
            tree = self.root

        if tree.value is not None:
            print(f"{indent}Leaf Node: Class {tree.value}")

        else:
            print(f"{indent}Node: PC{tree.feature_index} <= {tree.thresho
            print(f"{indent}left:")
            self.print_tree(tree.left, indent + "  ")
            print(f"{indent}right:")
            self.print_tree(tree.right, indent + "  ")

    def fit(self, X, Y):
        ''' function to train the tree '''

        dataset = np.concatenate((X, Y), axis=1)
        self.root = self.build_tree(dataset)

    def predict(self, X):
        ''' function to predict new dataset '''

        preditions = [self.make_prediction(x, self.root) for x in X.value
        return preditions

    def make_prediction(self, x, tree):
        ''' function to predict a single data point '''

        if (tree.value != None):
            return tree.value
        feature_val = x[tree.feature_index]
        if feature_val<=tree.threshold:
            return self.make_prediction(x, tree.left)
        else:
            return self.make_prediction(x, tree.right)

classifier = DecisionTreeClassifier(min_samples_split=2, max_depth=num_co
```

In [ ]:
```
classifier.fit(X_train,pd.DataFrame(y_train))
```

In [ ]:
```
Y_pred = np.array(classifier.predict(X_test))
acc = accuracy(y_test, Y_pred)
acc
```

Out[ ]: 57.89473684210527

2.2 Insights drawn (plots, markdown explanations)

Decision Tree Structure

Lets take a look at the decision tree structure.

In [ ]:
```
classifier.print_tree()
```

```
Node: PC0 <= -1.903406546494383 [Info Gain: 0.3068691753511583]
left:
  Node: PC0 <= -5.404072525388851 [Info Gain: 0.2795796614091701]
  left:
    Node: PC10 <= -0.622998399766284 [Info Gain: 0.5069499925013172]
    left:
      Node: PC6 <= 1.304111411122921 [Info Gain: 0.7324452692561572]
      left:
        Node: PC6 <= -0.5355053161787456 [Info Gain: 0.8429038335138657]
        left:
          Node: PC5 <= 0.5314709382419304 [Info Gain: 0.9656361333706105]
          left:
            Node: PC8 <= -0.723970264374518 [Info Gain: 1.000000000000000
4]
            left:
              Node: PC0 <= -6.139118842483037 [Info Gain: 0.59167277858232
73]
              left:
                Node: PC5 <= -0.5463861793856238 [Info Gain: 0.45914791702
72448]
                left:
                  Node: PC3 <= 1.684765404111435 [Info Gain: 0.91829583405
44896]
                  left:
                    Leaf Node: Class 0.66
                  right:
                    Leaf Node: Class 0.36
                right:
                  Leaf Node: Class 0.36
              right:
                Leaf Node: Class 0.93
            right:
              Node: PC0 <= -7.58865331960808 [Info Gain: 0.985228136034251
6]
              left:
                Node: PC0 <= -8.937900603459456 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.61
                right:
                  Node: PC0 <= -7.716220490292774 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.45
                  right:
                    Leaf Node: Class 0.33
              right:
                Node: PC0 <= -6.510808682197184 [Info Gain: 1.0]
                left:
                  Node: PC0 <= -6.8523344043417795 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.72
                  right:
                    Leaf Node: Class 0.54
                right:
                  Node: PC0 <= -5.8161357646481004 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.51
                  right:
                    Leaf Node: Class 0.16
          right:
```

```
            Node: PC3 <= 3.072044647597992 [Info Gain: 0.9910760598382224]
            left:
              Node: PC6 <= -2.633198169926147 [Info Gain: 1.0]
              left:
                Node: PC0 <= -10.915609147418284 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.94
                right:
                  Leaf Node: Class 0.71
              right:
                Leaf Node: Class 0.88
            right:
              Node: PC0 <= -10.216225011571394 [Info Gain: 0.9709505944546
687]
              left:
                Leaf Node: Class 1.0
              right:
                Node: PC0 <= -9.437005388212414 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.67
                right:
                  Node: PC0 <= -9.337322820817002 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.8
                  right:
                    Leaf Node: Class 0.83
        right:
          Node: PC19 <= -0.3838549175342491 [Info Gain: 0.918295834054489
1]
          left:
            Node: PC0 <= -6.539417934145353 [Info Gain: 0.999999999999999
8]
            left:
              Node: PC0 <= -8.203485018969511 [Info Gain: 0.91829583405448
94]
              left:
                Leaf Node: Class 0.44
              right:
                Node: PC0 <= -6.782991705075494 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.61
                right:
                  Leaf Node: Class 0.31
            right:
              Node: PC0 <= -5.854588224631723 [Info Gain: 0.91829583405448
96]
              left:
                Leaf Node: Class 0.54
              right:
                Leaf Node: Class 0.28
          right:
            Node: PC18 <= 0.3230221684027426 [Info Gain: 0.813202089984486
1]
            left:
              Node: PC2 <= -0.8257788876573482 [Info Gain: 0.8631205685666
308]
              left:
                Node: PC0 <= -6.979474764752912 [Info Gain: 0.721928094887
3623]
```

```
                left:
                  Leaf Node: Class 0.32
                right:
                  Leaf Node: Class 0.19
              right:
                Leaf Node: Class 0.69
            right:
              Node: PC0 <= -7.619349651347717 [Info Gain: 0.97095059445466
86]
              left:
                Node: PC0 <= -8.468170295070335 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.42
                right:
                  Leaf Node: Class 0.19
              right:
                Node: PC0 <= -6.673796598158362 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.23
                right:
                  Node: PC0 <= -6.035324304923927 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.59
                  right:
                    Leaf Node: Class 0.51
      right:
        Node: PC14 <= 0.8282369746687511 [Info Gain: 0.888399168955444]
        left:
          Node: PC2 <= -0.22630550443030775 [Info Gain: 0.949452015387947
3]
          left:
            Node: PC0 <= -7.1757596326202675 [Info Gain: 0.674988789175822
8]
            left:
              Node: PC0 <= -8.522960814404431 [Info Gain: 0.99999999999999
98]
              left:
                Node: PC0 <= -8.807711721053549 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.51
                right:
                  Node: PC0 <= -8.688357217808216 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.29
                  right:
                    Leaf Node: Class 0.22
              right:
                Node: PC0 <= -7.587281825025812 [Info Gain: 0.918295834054
4896]
                left:
                  Leaf Node: Class 0.41
                right:
                  Leaf Node: Class 0.12
            right:
              Node: PC0 <= -5.760829241776502 [Info Gain: 0.65002242164835
41]
              left:
                Leaf Node: Class 0.29
```

```
            right:
              Leaf Node: Class 0.4
          right:
            Node: PC0 <= -8.18258531571492 [Info Gain: 0.9852281360342516]
            left:
              Node: PC0 <= -13.870973853382605 [Info Gain: 0.9182958340544
894]
              left:
                Leaf Node: Class 1.0
              right:
                Node: PC0 <= -8.91949725668142 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.87
                right:
                  Leaf Node: Class 0.72
            right:
              Node: PC0 <= -6.376336409992102 [Info Gain: 1.0]
              left:
                Node: PC0 <= -7.0358608779297676 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.82
                right:
                  Leaf Node: Class 0.27
              right:
                Node: PC0 <= -6.271913367891829 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.15
                right:
                  Leaf Node: Class 0.36
        right:
          Node: PC4 <= 0.32881916384512294 [Info Gain: 0.9612366047228766]
          left:
            Node: PC7 <= 1.023260391078564 [Info Gain: 0.9709505944546685]
            left:
              Leaf Node: Class 0.13
            right:
              Node: PC0 <= -9.284541110993521 [Info Gain: 0.91829583405448
96]
              left:
                Leaf Node: Class 0.12
              right:
                Leaf Node: Class 0.2
          right:
            Node: PC15 <= -0.3703580145447534 [Info Gain: 0.99999999999999
98]
            left:
              Node: PC0 <= -10.07706307580513 [Info Gain: 0.81127812445913
28]
              left:
                Leaf Node: Class 0.17
              right:
                Leaf Node: Class 0.28
            right:
              Node: PC2 <= -8.856950900201525 [Info Gain: 1.0]
              left:
                Node: PC0 <= -9.531432643978837 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.39
                right:
                  Leaf Node: Class 0.1
```

```
              right:
                Leaf Node: Class 0.31
    right:
      Node: PC17 <= -0.1617952626269261 [Info Gain: 0.6332691989508161]
      left:
        Node: PC18 <= -0.05246782596530038 [Info Gain: 0.6195163733349176]
        left:
          Node: PC15 <= -0.3605514300909472 [Info Gain: 0.685689216830387
9]
          left:
            Node: PC1 <= -1.5829061197513556 [Info Gain: 1.000000000000000
4]
            left:
              Node: PC0 <= -7.848814763101196 [Info Gain: 1.0]
              left:
                Node: PC0 <= -9.081956281914422 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.25
                right:
                  Node: PC0 <= -8.191624358778771 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.73
                  right:
                    Leaf Node: Class 0.45
              right:
                Node: PC0 <= -6.885994848957439 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.18
                right:
                  Node: PC0 <= -6.289332675514985 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.24
                  right:
                    Leaf Node: Class 0.78
            right:
              Node: PC0 <= -7.254698479454201 [Info Gain: 0.999999999999999
98]
              left:
                Node: PC0 <= -9.449010279386744 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.36
                right:
                  Node: PC0 <= -9.328036994943256 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.23
                  right:
                    Leaf Node: Class 0.3
              right:
                Node: PC0 <= -6.775794562529487 [Info Gain: 0.918295834054
4896]
                left:
                  Leaf Node: Class 0.33
                right:
                  Leaf Node: Class 0.46
          right:
            Node: PC3 <= 1.2254721050235067 [Info Gain: 0.588589535846695
3]
```

```
            left:
              Node: PC18 <= -0.8016307948495061 [Info Gain: 0.936667381877
5624]
              left:
                Node: PC10 <= 0.3363057254130197 [Info Gain: 1.00000000000
00002]
                left:
                  Node: PC0 <= -8.272282811892111 [Info Gain: 0.9182958340
544894]
                  left:
                    Leaf Node: Class 0.77
                  right:
                    Node: PC0 <= -7.716034240237393 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.07
                    right:
                      Leaf Node: Class 0.36
                right:
                  Node: PC2 <= 0.7494015959362854 [Info Gain: 0.9182958340
544896]
                  left:
                    Leaf Node: Class 0.47
                  right:
                    Leaf Node: Class 0.15
              right:
                Node: PC2 <= -0.004216372626110277 [Info Gain: 0.994030211
4769568]
                left:
                  Node: PC9 <= -1.4232144688348816 [Info Gain: 1.0]
                  left:
                    Node: PC1 <= -0.9029565238300743 [Info Gain: 0.9182958
340544896]
                    left:
                      Leaf Node: Class 0.54
                    right:
                      Leaf Node: Class 0.25
                  right:
                    Leaf Node: Class 1.0
                right:
                  Node: PC10 <= 0.4830209899521175 [Info Gain: 0.970950594
4546687]
                  left:
                    Leaf Node: Class 0.4
                  right:
                    Node: PC0 <= -5.991409664926725 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.76
                    right:
                      Leaf Node: Class 0.7
            right:
              Node: PC7 <= -1.836845138156368 [Info Gain: 0.68939174674308
77]
              left:
                Node: PC0 <= -8.00621618317191 [Info Gain: 0.9852281360342
516]
                left:
                  Node: PC0 <= -9.912819315675792 [Info Gain: 0.9182958340
544894]
                  left:
                    Leaf Node: Class 0.53
```

```
                right:
                  Node: PC0 <= -9.246887876975222 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.4
                  right:
                    Leaf Node: Class 1.0
              right:
                Node: PC0 <= -7.626691732167419 [Info Gain: 0.8112781244
591328]
                left:
                  Leaf Node: Class 0.81
                right:
                  Leaf Node: Class 0.45
            right:
              Leaf Node: Class 1.0
      right:
        Node: PC9 <= -0.03426876189246329 [Info Gain: 0.834817485636019
1]
        left:
          Node: PC16 <= -0.2212684830275519 [Info Gain: 0.90312557735571
72]
          left:
            Node: PC4 <= -0.3421250039919825 [Info Gain: 0.8453509366224
374]
            left:
              Node: PC0 <= -6.749979635536684 [Info Gain: 0.749999999999
9998]
              left:
                Node: PC1 <= 6.581299894454629 [Info Gain: 0.81127812445
91328]
                left:
                  Leaf Node: Class 0.55
                right:
                  Leaf Node: Class 0.24
              right:
                Node: PC0 <= -6.524639102965642 [Info Gain: 1.0]
                left:
                  Node: PC0 <= -6.721391634631879 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.23
                  right:
                    Leaf Node: Class 0.6
                right:
                  Node: PC0 <= -6.452486647656389 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.4
                  right:
                    Leaf Node: Class 0.24
            right:
              Node: PC0 <= -7.548006695726908 [Info Gain: 0.918295834054
4894]
              left:
                Leaf Node: Class 0.63
              right:
                Node: PC0 <= -6.808630340925432 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.96
                right:
                  Leaf Node: Class 0.3
          right:
```

```
              Node: PC2 <= -0.6745407719674404 [Info Gain: 1.0]
              left:
                Node: PC0 <= -8.727359914140143 [Info Gain: 0.970950594454
6686]
                left:
                  Node: PC0 <= -9.763123153334636 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.53
                  right:
                    Leaf Node: Class 0.3
                right:
                  Node: PC0 <= -7.372435432163279 [Info Gain: 0.9182958340
544894]
                  left:
                    Leaf Node: Class 0.43
                  right:
                    Node: PC0 <= -7.158957968228151 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.86
                    right:
                      Leaf Node: Class 0.37
              right:
                Node: PC2 <= 0.48224667445276614 [Info Gain: 0.97095059445
46687]
                left:
                  Node: PC0 <= -6.586389119178553 [Info Gain: 0.9182958340
544894]
                  left:
                    Leaf Node: Class 0.03
                  right:
                    Node: PC0 <= -6.133694463870556 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.2
                    right:
                      Leaf Node: Class 0.51
                right:
                  Leaf Node: Class 0.59
          right:
            Node: PC6 <= -1.1743572844733765 [Info Gain: 0.999999999999999
1]
            left:
              Node: PC3 <= 1.041471222332018 [Info Gain: 1.0]
              left:
                Node: PC1 <= -2.139351840738459 [Info Gain: 0.970950594454
6686]
                left:
                  Leaf Node: Class 0.34
                right:
                  Leaf Node: Class 0.61
              right:
                Node: PC3 <= 2.206282844958867 [Info Gain: 0.9709505944546
687]
                left:
                  Node: PC0 <= -8.554057835132264 [Info Gain: 0.9182958340
544894]
                  left:
                    Leaf Node: Class 0.85
                  right:
                    Node: PC0 <= -7.860761121405422 [Info Gain: 1.0]
                    left:
```

```
                    Leaf Node: Class 0.31
                  right:
                    Leaf Node: Class 0.35
              right:
                Leaf Node: Class 1.0
          right:
            Node: PC10 <= 0.07619021038916515 [Info Gain: 1.0]
            left:
              Node: PC1 <= -0.8026603846098925 [Info Gain: 0.9709505944546687]
              left:
                Leaf Node: Class 0.12
              right:
                Node: PC0 <= -9.143626508457595 [Info Gain: 0.9182958340544894]
                left:
                  Leaf Node: Class 0.07
                right:
                  Node: PC0 <= -5.746381645013932 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.23
                  right:
                    Leaf Node: Class 0.36
            right:
              Node: PC11 <= -1.5917281735206286 [Info Gain: 0.9709505944546687]
              left:
                Leaf Node: Class 0.7
              right:
                Node: PC0 <= -6.7170062981364005 [Info Gain: 0.9182958340544894]
                left:
                  Leaf Node: Class 0.24
                right:
                  Node: PC0 <= -6.343267483443733 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.86
                  right:
                    Leaf Node: Class 0.18
      right:
        Node: PC11 <= -0.39118643343452303 [Info Gain: 0.6851059579769978]
        left:
          Node: PC1 <= -0.5200942582158068 [Info Gain: 0.9188455359952004]
          left:
            Node: PC5 <= 0.6824542323471203 [Info Gain: 0.995727452084926]
            left:
              Node: PC0 <= -6.657672333340107 [Info Gain: 1.0]
              left:
                Node: PC0 <= -9.33968903347888 [Info Gain: 0.9182958340544894]
                left:
                  Leaf Node: Class 0.66
                right:
                  Node: PC0 <= -7.095203694042585 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.49
                  right:
                    Leaf Node: Class 0.42
              right:
                Node: PC0 <= -6.388389244758954 [Info Gain: 0.918295834054
```

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4894]
                left:
                  Leaf Node: Class 0.57
                right:
                  Node: PC0 <= -5.876532499784787 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.2
                  right:
                    Leaf Node: Class 0.81
            right:
              Node: PC5 <= 1.6079867712919511 [Info Gain: 0.98522813603425
13]
              left:
                Node: PC4 <= -1.5494137538503254 [Info Gain: 0.91829583405
44896]
                left:
                  Leaf Node: Class 0.74
                right:
                  Leaf Node: Class 0.9
              right:
                Node: PC0 <= -8.767299102924865 [Info Gain: 0.811278124459
1328]
                left:
                  Leaf Node: Class 0.95
                right:
                  Leaf Node: Class 0.41
          right:
            Node: PC4 <= -0.47829817223989174 [Info Gain: 1.0]
            left:
              Node: PC17 <= 0.22879338574218896 [Info Gain: 0.999999999999
9998]
              left:
                Node: PC0 <= -7.058266590909577 [Info Gain: 0.918295834054
4896]
                left:
                  Leaf Node: Class 0.62
                right:
                  Leaf Node: Class 0.71
              right:
                Node: PC0 <= -8.15931289444374 [Info Gain: 0.9182958340544
896]
                left:
                  Leaf Node: Class 0.44
                right:
                  Leaf Node: Class 0.38
            right:
              Node: PC0 <= -7.250928117851399 [Info Gain: 1.0]
              left:
                Node: PC0 <= -13.63538757236279 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 1.0
                right:
                  Node: PC0 <= -8.228142040070294 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.54
                  right:
                    Leaf Node: Class 0.52
              right:
                Node: PC0 <= -7.115291416840174 [Info Gain: 0.918295834054
```

```
4894]
                left:
                  Leaf Node: Class 0.79
                right:
                  Node: PC0 <= -6.190061439325424 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.47
                  right:
                    Leaf Node: Class 0.57
        right:
          Node: PC10 <= 1.0639383838785534 [Info Gain: 0.7022899137532157]
          left:
            Node: PC18 <= 0.27158004773299577 [Info Gain: 0.66710186436848
98]
            left:
              Node: PC1 <= -1.7242414794351764 [Info Gain: 0.6766750008111
79]
              left:
                Node: PC13 <= 0.9935009247482555 [Info Gain: 0.98522813603
42514]
                left:
                  Node: PC2 <= -0.3039344783740332 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= -8.205185904493973 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.93
                    right:
                      Leaf Node: Class 0.97
                  right:
                    Leaf Node: Class 0.62
                right:
                  Node: PC0 <= -8.401334166139085 [Info Gain: 0.9182958340
544896]
                  left:
                    Leaf Node: Class 1.0
                  right:
                    Leaf Node: Class 0.16
              right:
                Node: PC3 <= -1.1181883173285763 [Info Gain: 0.56650950655
29054]
                left:
                  Node: PC0 <= -7.268012161721162 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.61
                  right:
                    Leaf Node: Class 0.39
                right:
                  Node: PC17 <= 0.8024089266547445 [Info Gain: 0.407467771
43542007]
                  left:
                    Leaf Node: Class 1.0
                  right:
                    Node: PC0 <= -9.208842339719231 [Info Gain: 0.91829583
40544894]
                    left:
                      Leaf Node: Class 0.87
                    right:
                      Node: PC0 <= -8.706031476756003 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.85
```

```
                    right:
                      Leaf Node: Class 1.0
            right:
              Node: PC0 <= -7.673008464080507 [Info Gain: 1.0]
              left:
                Node: PC0 <= -10.675116120382755 [Info Gain: 1.0]
                left:
                  Node: PC0 <= -10.73024873564328 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.89
                  right:
                    Leaf Node: Class 0.35
                right:
                  Node: PC0 <= -8.365955017330752 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.86
                  right:
                    Leaf Node: Class 0.68
              right:
                Node: PC0 <= -6.658825689247177 [Info Gain: 1.0]
                left:
                  Node: PC0 <= -7.08322142375553 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.64
                  right:
                    Leaf Node: Class 0.65
                right:
                  Node: PC0 <= -5.722388465038337 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 1.0
                  right:
                    Leaf Node: Class 0.54
          right:
            Node: PC7 <= 1.4663086009007744 [Info Gain: 1.0]
            left:
              Node: PC0 <= -6.453075482447042 [Info Gain: 0.99999999999999
98]
              left:
                Node: PC0 <= -9.634696236424093 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.67
                right:
                  Node: PC0 <= -7.4686394971776116 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.63
                  right:
                    Leaf Node: Class 0.21
              right:
                Node: PC1 <= -0.6090570685593496 [Info Gain: 0.91829583405
44896]
                left:
                  Leaf Node: Class 0.44
                right:
                  Leaf Node: Class 0.87
            right:
              Node: PC1 <= -1.130538105997903 [Info Gain: 0.99999999999999
98]
              left:
                Node: PC0 <= -6.281289894008711 [Info Gain: 0.918295834054
```

```
4894]
                left:
                  Leaf Node: Class 0.74
                right:
                  Node: PC0 <= -6.261213683575614 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.39
                  right:
                    Leaf Node: Class 0.81
              right:
                Node: PC0 <= -7.2125397204160375 [Info Gain: 0.91829583405
44896]
                left:
                  Leaf Node: Class 0.53
                right:
                  Leaf Node: Class 0.35
  right:
    Node: PC1 <= 0.5926784271658221 [Info Gain: 0.32809456278349014]
    left:
      Node: PC7 <= 0.6480428495572415 [Info Gain: 0.3241942055787419]
      left:
        Node: PC18 <= -0.26540583799867334 [Info Gain: 0.3279771762249082]
        left:
          Node: PC5 <= -0.507139533123593 [Info Gain: 0.6276506330626495]
          left:
            Node: PC4 <= -0.921315414452469 [Info Gain: 0.794697468055487
5]
            left:
              Node: PC21 <= 0.1692082954439116 [Info Gain: 0.9957274520849
26]
              left:
                Node: PC4 <= -1.0203873803902919 [Info Gain: 0.91829583405
44893]
                left:
                  Node: PC2 <= 1.9580293337109125 [Info Gain: 0.8112781244
591328]
                  left:
                    Leaf Node: Class 0.26
                  right:
                    Leaf Node: Class 0.78
                right:
                  Node: PC0 <= -4.782450585454311 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.2
                  right:
                    Leaf Node: Class 0.53
              right:
                Node: PC5 <= -1.8097823140902995 [Info Gain: 0.98522813603
42513]
                left:
                  Node: PC0 <= -2.9908621893848055 [Info Gain: 0.918295834
0544896]
                  left:
                    Leaf Node: Class 0.13
                  right:
                    Leaf Node: Class 0.54
                right:
                  Leaf Node: Class 0.12
            right:
              Node: PC20 <= -0.3207233906164885 [Info Gain: 0.998363672593
```

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8125]
              left:
                Node: PC1 <= -3.477276401586957 [Info Gain: 1.0]
                left:
                  Node: PC10 <= -0.33905545527428455 [Info Gain: 0.9709505
944546687]
                  left:
                    Leaf Node: Class 0.27
                  right:
                    Node: PC0 <= -4.0574991780813985 [Info Gain: 0.9182958
340544894]
                    left:
                      Leaf Node: Class 0.5
                    right:
                      Node: PC0 <= -1.9626852724279404 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.09
                      right:
                        Leaf Node: Class 0.41
                right:
                  Node: PC0 <= -3.899177582125395 [Info Gain: 0.9709505944
546685]
                  left:
                    Leaf Node: Class 0.24
                  right:
                    Node: PC0 <= -3.791382617726543 [Info Gain: 0.91829583
40544896]
                    left:
                      Leaf Node: Class 0.21
                    right:
                      Leaf Node: Class 0.3
              right:
                Node: PC19 <= -0.05726752154982611 [Info Gain: 0.945660304
6006402]
                left:
                  Node: PC0 <= -4.046289786981046 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= -4.209077125981044 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.12
                    right:
                      Leaf Node: Class 0.03
                  right:
                    Node: PC0 <= -3.9306728270492544 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.54
                    right:
                      Leaf Node: Class 0.45
                right:
                  Node: PC9 <= -1.5772108433923966 [Info Gain: 0.591672778
5823276]
                  left:
                    Leaf Node: Class 0.33
                  right:
                    Node: PC2 <= 0.4106969846942684 [Info Gain: 0.45914791
70272448]
                    left:
                      Node: PC2 <= -4.6743764548760485 [Info Gain: 0.81127
81244591328]
                        left:
```

```
                      Leaf Node: Class 0.29
                    right:
                      Leaf Node: Class 0.14
                  right:
                    Leaf Node: Class 0.29
          right:
            Node: PC11 <= -0.46134924760926305 [Info Gain: 0.6955420583457
554]
            left:
              Node: PC13 <= -0.4075360176034981 [Info Gain: 0.880419644636
2287]
              left:
                Node: PC21 <= 0.1752868669696099 [Info Gain: 0.99572745208
49257]
                left:
                  Node: PC20 <= -0.05109701981062329 [Info Gain: 0.9999999
999999998]
                  left:
                    Leaf Node: Class 0.1
                  right:
                    Node: PC0 <= -4.677387673810528 [Info Gain: 0.91829583
40544894]
                    left:
                      Leaf Node: Class 0.22
                    right:
                      Node: PC0 <= -3.4906922486516314 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.7
                      right:
                        Leaf Node: Class 0.03
                right:
                  Node: PC2 <= 1.1632414094488035 [Info Gain: 0.9852281360
342515]
                  left:
                    Node: PC0 <= -4.5362771372316555 [Info Gain: 0.9182958
340544896]
                    left:
                      Leaf Node: Class 0.21
                    right:
                      Leaf Node: Class 0.27
                  right:
                    Node: PC5 <= 2.3890127697389336 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.14
                    right:
                      Leaf Node: Class 0.06
              right:
                Node: PC17 <= 0.1309889054639388 [Info Gain: 0.99679163198
16363]
                left:
                  Node: PC1 <= -3.94345396829452 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= -2.348637955771475 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.09
                    right:
                      Node: PC0 <= -2.0604486313884647 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.38
                      right:
```

```
                        Leaf Node: Class 0.24
                  right:
                    Node: PC1 <= -0.3122782712378242 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.33
                    right:
                      Leaf Node: Class 0.15
                right:
                  Node: PC2 <= -1.1560484938162154 [Info Gain: 0.985228136
0342516]
                  left:
                    Node: PC0 <= -3.465070080942743 [Info Gain: 0.91829583
40544894]
                    left:
                      Leaf Node: Class 0.58
                    right:
                      Node: PC0 <= -2.8147253616736587 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.1
                      right:
                        Leaf Node: Class 0.39
                  right:
                    Node: PC1 <= -5.898825902907996 [Info Gain: 0.81127812
44591328]
                    left:
                      Leaf Node: Class 0.05
                    right:
                      Leaf Node: Class 0.07
            right:
              Node: PC16 <= 0.46121757772220046 [Info Gain: 0.870864469235
3649]
              left:
                Node: PC8 <= -0.9455215778193872 [Info Gain: 0.85977075870
46428]
                left:
                  Node: PC10 <= -0.14714742872118253 [Info Gain: 0.9852281
360342516]
                  left:
                    Node: PC2 <= -1.7107584785225172 [Info Gain: 0.8112781
244591328]
                    left:
                      Leaf Node: Class 0.0
                    right:
                      Leaf Node: Class 0.09
                  right:
                    Node: PC0 <= -3.89395131460086 [Info Gain: 0.918295834
0544894]
                    left:
                      Leaf Node: Class 0.03
                    right:
                      Node: PC0 <= -3.0302541078747867 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.19
                      right:
                        Leaf Node: Class 0.15
                right:
                  Node: PC2 <= 0.9108625453414426 [Info Gain: 0.9999999999
999998]
                  left:
                    Node: PC11 <= 0.06673789755771325 [Info Gain: 0.970950
```

```
5944546687]
                    left:
                      Leaf Node: Class 0.05
                    right:
                      Node: PC0 <= -5.354109926609575 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.5
                      right:
                        Leaf Node: Class 0.04
                  right:
                    Node: PC9 <= 0.006196228383762435 [Info Gain: 0.970950
5944546687]
                    left:
                      Node: PC0 <= -4.854747462859784 [Info Gain: 0.918295
8340544894]
                      left:
                        Leaf Node: Class 0.46
                      right:
                        Node: PC0 <= -3.9155169958256897 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.16
                        right:
                          Leaf Node: Class 0.19
                    right:
                      Leaf Node: Class 0.18
              right:
                Node: PC0 <= -4.183514394495789 [Info Gain: 0.985228136034
2514]
                left:
                  Node: PC2 <= -2.5683088412523114 [Info Gain: 0.918295834
0544896]
                  left:
                    Leaf Node: Class 0.13
                  right:
                    Leaf Node: Class 1.0
                right:
                  Node: PC0 <= -2.6083900737058916 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.22
                  right:
                    Node: PC0 <= -2.313229200522256 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.36
                    right:
                      Leaf Node: Class 0.2
        right:
          Node: PC14 <= -0.08580761042027996 [Info Gain: 0.452347193677383
96]
          left:
            Node: PC15 <= -0.0345216732250153 [Info Gain: 0.59284187656933
17]
            left:
              Node: PC22 <= 0.3520430501721663 [Info Gain: 0.8264991087674
094]
              left:
                Node: PC11 <= 0.11947842216872505 [Info Gain: 0.9967916319
816359]
                left:
                  Node: PC1 <= -4.842814980335978 [Info Gain: 0.9852281360
342516]
```

```
                  left:
                    Node: PC1 <= -4.853721535153986 [Info Gain: 0.91829583
40544896]
                    left:
                      Leaf Node: Class 0.03
                    right:
                      Leaf Node: Class 0.53
                  right:
                    Node: PC0 <= -2.982869500324575 [Info Gain: 1.0]
                    left:
                      Node: PC0 <= -3.74378390418361 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.35
                      right:
                        Leaf Node: Class 0.09
                    right:
                      Node: PC0 <= -2.442723615254615 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.07
                      right:
                        Leaf Node: Class 0.2
                right:
                  Node: PC6 <= -0.04476592821926807 [Info Gain: 0.95443400
29249647]
                  left:
                    Node: PC0 <= -4.257344499318379 [Info Gain: 0.91829583
40544894]
                    left:
                      Leaf Node: Class 0.32
                    right:
                      Node: PC0 <= -3.6054425998846797 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.43
                      right:
                        Leaf Node: Class 0.3
                  right:
                    Node: PC8 <= -0.37192741445200844 [Info Gain: 0.970950
5944546686]
                    left:
                      Leaf Node: Class 0.02
                    right:
                      Leaf Node: Class 0.17
              right:
                Node: PC21 <= 0.185434576203622 [Info Gain: 0.995727452084
926]
                left:
                  Node: PC7 <= -0.28093018201799586 [Info Gain: 0.99999999
99999998]
                  left:
                    Node: PC0 <= -3.789265306690374 [Info Gain: 0.91829583
40544896]
                    left:
                      Leaf Node: Class 0.37
                    right:
                      Leaf Node: Class 0.53
                  right:
                    Node: PC0 <= -3.8889908128714117 [Info Gain: 0.9182958
340544896]
                    left:
                      Leaf Node: Class 0.22
```

```
                    right:
                      Leaf Node: Class 0.18
                right:
                  Node: PC1 <= -3.6700751679703667 [Info Gain: 0.985228136
0342514]
                  left:
                    Node: PC3 <= 0.18342376951794973 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.08
                    right:
                      Node: PC0 <= -3.360446255325514 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.11
                      right:
                        Leaf Node: Class 0.02
                  right:
                    Node: PC1 <= -2.89306293203772 [Info Gain: 0.918295834
0544896]
                    left:
                      Leaf Node: Class 0.28
                    right:
                      Leaf Node: Class 0.34
            right:
              Node: PC14 <= -0.6959383059818535 [Info Gain: 0.632603065506
0446]
              left:
                Node: PC20 <= 0.5983934183485403 [Info Gain: 0.88654089282
20901]
                left:
                  Node: PC16 <= 0.03557988480027691 [Info Gain: 0.89603823
25345573]
                  left:
                    Node: PC10 <= -0.56120913527585 [Info Gain: 0.99403021
14769572]
                    left:
                      Node: PC7 <= -0.4558476974213674 [Info Gain: 0.99999
99999999998]
                      left:
                        Leaf Node: Class 0.07
                      right:
                        Node: PC0 <= -4.863805245432988 [Info Gain: 0.9182
958340544894]
                        left:
                          Leaf Node: Class 0.21
                        right:
                          Node: PC0 <= -4.435342842767719 [Info Gain: 1.0]
                          left:
                            Leaf Node: Class 0.36
                          right:
                            Leaf Node: Class 0.27
                    right:
                      Node: PC5 <= -1.5308939934467363 [Info Gain: 0.97095
05944546685]
                      left:
                        Leaf Node: Class 0.18
                      right:
                        Node: PC0 <= -4.485671186775648 [Info Gain: 0.9182
958340544896]
                        left:
                          Leaf Node: Class 0.12
```

```
                        right:
                          Leaf Node: Class 0.11
                  right:
                    Node: PC9 <= -0.016630904834219938 [Info Gain: 0.97095
05944546685]
                    left:
                      Leaf Node: Class 0.06
                    right:
                      Node: PC0 <= -4.632412650623374 [Info Gain: 0.918295
8340544896]
                      left:
                        Leaf Node: Class 0.14
                      right:
                        Leaf Node: Class 0.04
                right:
                  Node: PC4 <= -0.7770962165416996 [Info Gain: 0.985228136
0342516]
                  left:
                    Node: PC0 <= -4.980018638811385 [Info Gain: 0.91829583
40544894]
                    left:
                      Leaf Node: Class 0.42
                    right:
                      Node: PC0 <= -4.545292844042765 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.13
                      right:
                        Leaf Node: Class 0.08
                  right:
                    Node: PC1 <= -5.2837898930430285 [Info Gain: 0.8112781
244591328]
                    left:
                      Leaf Node: Class 0.31
                    right:
                      Leaf Node: Class 0.09
              right:
                Node: PC12 <= 0.08703274203950354 [Info Gain: 0.7319354494
159889]
                left:
                  Node: PC12 <= -0.1816050395759505 [Info Gain: 0.99999999
99999998]
                  left:
                    Node: PC0 <= -4.95195962051034 [Info Gain: 0.918295834
0544894]
                    left:
                      Leaf Node: Class 0.32
                    right:
                      Node: PC0 <= -3.1927415082074995 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.21
                      right:
                        Leaf Node: Class 0.47
                  right:
                    Node: PC1 <= -5.285280784226891 [Info Gain: 0.91829583
40544896]
                    left:
                      Leaf Node: Class 0.41
                    right:
                      Leaf Node: Class 0.11
                right:
```

```
                  Node: PC20 <= -0.2025179474912309 [Info Gain: 0.70195500
08653881]
                  left:
                    Node: PC20 <= -0.5662980477036307 [Info Gain: 0.799999
9999999998]
                    left:
                      Node: PC0 <= -3.716127733130453 [Info Gain: 0.970950
5944546686]
                      left:
                        Node: PC0 <= -4.508828770000216 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.21
                        right:
                          Leaf Node: Class 0.48
                      right:
                        Node: PC0 <= -3.13084269900106 [Info Gain: 0.91829
58340544894]
                        left:
                          Leaf Node: Class 0.1
                        right:
                          Node: PC0 <= -2.775307733375327 [Info Gain: 1.0]
                          left:
                            Leaf Node: Class 0.07
                          right:
                            Leaf Node: Class 0.03
                    right:
                      Node: PC5 <= -2.9206703268076097 [Info Gain: 0.72192
80948873623]
                      left:
                        Leaf Node: Class 0.21
                      right:
                        Leaf Node: Class 0.14
                  right:
                    Node: PC9 <= -0.1487741505160274 [Info Gain: 0.9709505
944546687]
                    left:
                      Leaf Node: Class 0.03
                    right:
                      Node: PC0 <= -3.395354112354287 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.08
                      right:
                        Leaf Node: Class 0.2
          right:
            Node: PC3 <= -0.4595054417049718 [Info Gain: 0.759664030463831
4]
            left:
              Node: PC8 <= 1.0822757398162137 [Info Gain: 1.0]
              left:
                Node: PC7 <= -0.5136592026139865 [Info Gain: 0.98522813603
42525]
                left:
                  Node: PC0 <= -2.453783501541174 [Info Gain: 0.9544340029
249652]
                  left:
                    Node: PC10 <= -0.10341414459057045 [Info Gain: 0.97095
05944546685]
                    left:
                      Leaf Node: Class 0.08
                    right:
```

```
                    Node: PC2 <= 0.9542426565840714 [Info Gain: 0.918295
8340544896]
                      left:
                        Leaf Node: Class 0.02
                      right:
                        Leaf Node: Class 0.1
                  right:
                    Node: PC1 <= -2.5000108914063177 [Info Gain: 0.9182958
340544896]
                    left:
                      Leaf Node: Class 0.0
                    right:
                      Leaf Node: Class 0.06
                right:
                  Node: PC0 <= -3.3913203938540524 [Info Gain: 1.000000000
0000002]
                  left:
                    Node: PC0 <= -4.988682732979826 [Info Gain: 0.91829583
40544896]
                    left:
                      Leaf Node: Class 0.13
                    right:
                      Leaf Node: Class 0.16
                  right:
                    Node: PC0 <= -3.355395467894789 [Info Gain: 0.91829583
40544894]
                    left:
                      Leaf Node: Class 0.21
                    right:
                      Node: PC0 <= -3.0799290769923995 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.03
                      right:
                        Leaf Node: Class 0.14
              right:
                Node: PC8 <= 1.954993884129743 [Info Gain: 1.0000000000000
009]
                left:
                  Node: PC0 <= -3.500408653428011 [Info Gain: 0.9852281360
342516]
                  left:
                    Leaf Node: Class 0.31
                  right:
                    Node: PC0 <= -2.795359815513299 [Info Gain: 1.0]
                    left:
                      Node: PC0 <= -3.2127084892187803 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.04
                      right:
                        Leaf Node: Class 0.36
                    right:
                      Node: PC0 <= -2.7812071830375746 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.25
                      right:
                        Leaf Node: Class 0.63
                right:
                  Node: PC5 <= -0.779971073737201 [Info Gain: 0.9852281360
342512]
                  left:
```

```
                    Node: PC0 <= -3.391886648531254 [Info Gain: 0.91829583
40544894]
                    left:
                      Leaf Node: Class 0.11
                    right:
                      Node: PC0 <= -3.1697549945723864 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.34
                      right:
                        Leaf Node: Class 0.23
                  right:
                    Node: PC0 <= -5.383113283894866 [Info Gain: 0.81127812
44591328]
                    left:
                      Leaf Node: Class 0.22
                    right:
                      Leaf Node: Class 0.24
              right:
                Node: PC18 <= 0.3632154037684077 [Info Gain: 0.9227701295331
636]
                left:
                  Node: PC10 <= -1.0034267315162118 [Info Gain: 1.0000000000
000009]
                  left:
                    Node: PC16 <= 0.01296787976174261 [Info Gain: 0.98522813
60342516]
                    left:
                      Node: PC0 <= -3.8319069814906594 [Info Gain: 0.9182958
340544894]
                      left:
                        Leaf Node: Class 0.24
                      right:
                        Node: PC0 <= -3.4809180601452145 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.53
                        right:
                          Leaf Node: Class 0.17
                    right:
                      Leaf Node: Class 0.15
                  right:
                    Node: PC0 <= -3.6570159924156687 [Info Gain: 0.985228136
0342516]
                    left:
                      Node: PC0 <= -5.281580771776835 [Info Gain: 0.91829583
40544894]
                      left:
                        Leaf Node: Class 0.7
                      right:
                        Node: PC0 <= -4.655166220424507 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 1.0
                        right:
                          Leaf Node: Class 0.52
                    right:
                      Node: PC0 <= -2.780051259668901 [Info Gain: 1.0]
                      left:
                        Node: PC0 <= -2.900952500333862 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.27
                        right:
```

```
                        Leaf Node: Class 0.36
                    right:
                      Node: PC0 <= -2.2578742164055114 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.71
                      right:
                        Leaf Node: Class 0.35
              right:
                Node: PC9 <= 1.2123397206566282 [Info Gain: 0.899743758698
262]
                left:
                  Node: PC19 <= 0.465800108043733 [Info Gain: 0.8418812982
387722]
                  left:
                    Node: PC10 <= 1.047250952111736 [Info Gain: 0.59167277
85823274]
                    left:
                      Node: PC22 <= -0.6807178934356481 [Info Gain: 0.6500
224216483541]
                      left:
                        Leaf Node: Class 0.24
                      right:
                        Leaf Node: Class 0.28
                    right:
                      Leaf Node: Class 0.45
                  right:
                    Node: PC2 <= -0.9914351004632425 [Info Gain: 0.9999999
999999998]
                    left:
                      Node: PC0 <= -4.618447208898383 [Info Gain: 0.918295
8340544896]
                      left:
                        Leaf Node: Class 0.26
                      right:
                        Leaf Node: Class 0.04
                    right:
                      Node: PC0 <= -3.275926613151522 [Info Gain: 0.918295
8340544896]
                      left:
                        Leaf Node: Class 0.23
                      right:
                        Leaf Node: Class 0.45
                right:
                  Node: PC0 <= -4.142282608810688 [Info Gain: 0.9999999999
999998]
                  left:
                    Node: PC0 <= -5.267813424914607 [Info Gain: 0.91829583
40544894]
                    left:
                      Leaf Node: Class 0.3
                    right:
                      Node: PC0 <= -4.376382004616319 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.12
                      right:
                        Leaf Node: Class 0.33
                  right:
                    Node: PC0 <= -3.5540917925553686 [Info Gain: 0.9182958
340544896]
                    left:
```

```
                    Leaf Node: Class 0.2
                  right:
                    Leaf Node: Class 0.22
      right:
        Node: PC9 <= 0.01871308447318168 [Info Gain: 0.748295756732146]
        left:
          Node: PC7 <= 1.3565300485538991 [Info Gain: 0.8656922636965514]
          left:
            Node: PC0 <= -3.7330691291865135 [Info Gain: 0.977417817528172
7]
            left:
              Node: PC16 <= -0.4724704762353502 [Info Gain: 1.0]
              left:
                Node: PC1 <= -4.096200033797079 [Info Gain: 0.970950594454
6687]
                left:
                  Leaf Node: Class 0.18
                right:
                  Node: PC0 <= -5.3809824683981855 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.57
                  right:
                    Node: PC0 <= -4.406059731352417 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.91
                    right:
                      Leaf Node: Class 0.65
              right:
                Node: PC0 <= -5.148230489640537 [Info Gain: 0.970950594454
6685]
                left:
                  Leaf Node: Class 0.53
                right:
                  Node: PC0 <= -4.879100491283899 [Info Gain: 0.9182958340
544896]
                  left:
                    Leaf Node: Class 0.28
                  right:
                    Leaf Node: Class 0.33
            right:
              Node: PC0 <= -3.5566725578437772 [Info Gain: 0.9852281360342
512]
              left:
                Node: PC0 <= -3.6964922090865544 [Info Gain: 0.91829583405
44894]
                left:
                  Leaf Node: Class 0.09
                right:
                  Node: PC0 <= -3.623677088632702 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.48
                  right:
                    Leaf Node: Class 0.27
              right:
                Node: PC5 <= -0.33296033387140467 [Info Gain: 1.0]
                left:
                  Node: PC0 <= -3.186796236464192 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.39
```

```
                right:
                  Leaf Node: Class 0.15
              right:
                Leaf Node: Class 0.37
          right:
            Node: PC8 <= 1.3367218682572222 [Info Gain: 0.949452015387947
8]
            left:
              Node: PC16 <= -0.41006288505136534 [Info Gain: 0.97986875665
11526]
              left:
                Node: PC1 <= -3.8446902954203637 [Info Gain: 0.97095059445
46687]
                left:
                  Leaf Node: Class 0.21
                right:
                  Node: PC0 <= -3.032955396998897 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.13
                  right:
                    Leaf Node: Class 0.33
              right:
                Node: PC1 <= -1.4636340968552917 [Info Gain: 0.98522813603
42514]
                left:
                  Node: PC5 <= -0.4732290899745259 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= -3.6093069860485336 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.16
                    right:
                      Leaf Node: Class 0.62
                  right:
                    Leaf Node: Class 0.1
                right:
                  Node: PC0 <= -4.598820038446831 [Info Gain: 0.9182958340
544896]
                  left:
                    Leaf Node: Class 0.34
                  right:
                    Leaf Node: Class 0.42
            right:
              Node: PC0 <= -4.381867473434011 [Info Gain: 0.98522813603425
12]
              left:
                Node: PC0 <= -4.802704373469222 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.48
                right:
                  Node: PC0 <= -4.435806661223447 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.3
                  right:
                    Leaf Node: Class 0.38
              right:
                Node: PC0 <= -4.068819157536804 [Info Gain: 1.0]
                left:
                  Node: PC0 <= -4.288988732481958 [Info Gain: 1.0]
                  left:
```

```
                    Leaf Node: Class 0.24
                  right:
                    Leaf Node: Class 0.12
                right:
                  Leaf Node: Class 1.0
        right:
          Node: PC7 <= 1.3964069197090974 [Info Gain: 0.8824322467024319]
          left:
            Node: PC0 <= -4.171503318488999 [Info Gain: 1.000000000000000
9]
            left:
              Node: PC9 <= 0.2676342985596167 [Info Gain: 0.98522813603425
14]
              left:
                Node: PC0 <= -5.170763219573042 [Info Gain: 0.918295834054
4896]
                left:
                  Leaf Node: Class 0.63
                right:
                  Leaf Node: Class 0.36
              right:
                Node: PC0 <= -4.420052323596199 [Info Gain: 1.0]
                left:
                  Node: PC0 <= -4.764538286604261 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.46
                  right:
                    Leaf Node: Class 0.24
                right:
                  Leaf Node: Class 0.45
            right:
              Node: PC0 <= -2.853443222392064 [Info Gain: 0.98522813603425
14]
              left:
                Node: PC4 <= -0.34081385908145007 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.56
                right:
                  Node: PC0 <= -4.093909786099723 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.47
                  right:
                    Leaf Node: Class 0.42
              right:
                Node: PC0 <= -2.612220171376995 [Info Gain: 0.918295834054
4896]
                left:
                  Leaf Node: Class 0.26
                right:
                  Leaf Node: Class 0.21
          right:
            Node: PC5 <= -1.0466142341423348 [Info Gain: 0.965636133370610
5]
            left:
              Node: PC5 <= -1.5349098909633527 [Info Gain: 0.9910760598382
224]
              left:
                Node: PC0 <= -3.7206764805938337 [Info Gain: 0.97095059445
46687]
                left:
```

```
                  Leaf Node: Class 0.59
                right:
                  Node: PC0 <= -3.671275592499995 [Info Gain: 0.9182958340
544894]
                  left:
                    Leaf Node: Class 0.38
                  right:
                    Node: PC0 <= -3.5597445928636238 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.76
                    right:
                      Leaf Node: Class 0.45
              right:
                Node: PC0 <= -4.33242443159697 [Info Gain: 1.0]
                left:
                  Node: PC0 <= -4.808050384322511 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.16
                  right:
                    Leaf Node: Class 0.67
                right:
                  Leaf Node: Class 0.39
            right:
              Node: PC6 <= -0.09899849427963908 [Info Gain: 0.940285958670
6311]
              left:
                Node: PC14 <= -0.1689487342130172 [Info Gain: 0.9910760598
382224]
                left:
                  Node: PC1 <= -3.5598542892101985 [Info Gain: 0.721928094
8873623]
                  left:
                    Leaf Node: Class 0.8
                  right:
                    Leaf Node: Class 0.6
                right:
                  Node: PC5 <= 0.20503879484652962 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= -5.274024260983364 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.5
                    right:
                      Leaf Node: Class 0.14
                  right:
                    Leaf Node: Class 0.52
              right:
                Node: PC8 <= 0.07081369375254574 [Info Gain: 0.97095059445
46687]
                left:
                  Leaf Node: Class 0.25
                right:
                  Node: PC0 <= -5.054749718927575 [Info Gain: 0.9182958340
544894]
                  left:
                    Leaf Node: Class 0.79
                  right:
                    Node: PC0 <= -4.543883492430707 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.54
                    right:
```

```
                    Leaf Node: Class 0.13
    right:
      Node: PC10 <= 0.3550800526126832 [Info Gain: 0.6650611381059308]
      left:
        Node: PC1 <= 2.93488944443981 [Info Gain: 0.8085516158268842]
        left:
          Node: PC3 <= -1.6447247901083542 [Info Gain: 0.7772754960916819]
          left:
            Node: PC15 <= -0.14296762507466398 [Info Gain: 1.0]
            left:
              Node: PC7 <= 0.9457805488570955 [Info Gain: 1.0]
              left:
                Node: PC8 <= 0.035884741137777856 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.2
                right:
                  Node: PC0 <= -5.13062802906984 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.58
                  right:
                    Leaf Node: Class 0.34
              right:
                Node: PC4 <= -0.8934258024839187 [Info Gain: 1.0]
                left:
                  Node: PC0 <= -4.16014293094226 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.43
                  right:
                    Leaf Node: Class 0.35
                right:
                  Leaf Node: Class 0.5
            right:
              Node: PC5 <= 2.298173731892406 [Info Gain: 0.954434002924964
7]
              left:
                Node: PC17 <= -0.44639088459820153 [Info Gain: 0.970950594
4546687]
                left:
                  Node: PC0 <= -4.712758974857766 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.27
                  right:
                    Leaf Node: Class 0.13
                right:
                  Leaf Node: Class 0.29
              right:
                Node: PC2 <= 1.8596802402602357 [Info Gain: 0.918295834054
4896]
                left:
                  Leaf Node: Class 0.16
                right:
                  Leaf Node: Class 0.19
          right:
            Node: PC11 <= -0.3763446595417178 [Info Gain: 0.80445793632671
37]
            left:
              Node: PC22 <= 0.12219271148240009 [Info Gain: 0.985228136034
2511]
              left:
                Node: PC3 <= 1.9936503996966493 [Info Gain: 0.918295834054
```

```
4896]
                left:
                  Leaf Node: Class 0.51
                right:
                  Leaf Node: Class 0.3
              right:
                Node: PC0 <= -4.449732774994189 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.76
                right:
                  Leaf Node: Class 0.19
            right:
              Node: PC20 <= -0.5285627102931951 [Info Gain: 0.979868756651
1526]
              left:
                Node: PC2 <= -5.0002923054282755 [Info Gain: 0.97095059445
46687]
                left:
                  Node: PC0 <= -5.297506511456442 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.19
                  right:
                    Leaf Node: Class 0.68
                right:
                  Leaf Node: Class 0.49
              right:
                Node: PC5 <= -0.7231867871010899 [Info Gain: 0.98522813603
42515]
                left:
                  Leaf Node: Class 0.66
                right:
                  Node: PC1 <= 1.3479493362617654 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= -3.9625446247695724 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.28
                    right:
                      Leaf Node: Class 0.2
                  right:
                    Leaf Node: Class 0.33
        right:
          Node: PC0 <= -2.910634192442635 [Info Gain: 0.9999999999999978]
          left:
            Node: PC3 <= 0.4373386946275401 [Info Gain: 0.994030211476957
7]
            left:
              Node: PC0 <= -4.179286108687132 [Info Gain: 0.97095059445466
86]
              left:
                Node: PC0 <= -5.0785047696350905 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.95
                right:
                  Leaf Node: Class 1.0
              right:
                Node: PC0 <= -3.6631497545222804 [Info Gain: 0.91829583405
44894]
                left:
                  Leaf Node: Class 0.42
                right:
```

```
                Node: PC0 <= -2.9623311729230752 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.36
                right:
                  Leaf Node: Class 0.15
            right:
              Node: PC2 <= 1.7908901880377972 [Info Gain: 0.99999999999999
98]
              left:
                Node: PC0 <= -5.1342542353995295 [Info Gain: 0.91829583405
44894]
                left:
                  Leaf Node: Class 0.53
                right:
                  Node: PC0 <= -4.635200200155772 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.5
                  right:
                    Leaf Node: Class 0.6
              right:
                Node: PC2 <= 7.909518330016069 [Info Gain: 0.9182958340544
896]
                left:
                  Leaf Node: Class 0.59
                right:
                  Leaf Node: Class 0.75
          right:
            Node: PC0 <= -2.641591735835773 [Info Gain: 0.994030211476957
7]
            left:
              Node: PC0 <= -2.862662879495574 [Info Gain: 0.97095059445466
86]
              left:
                Node: PC0 <= -2.9058178886291044 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.34
                right:
                  Leaf Node: Class 0.4
              right:
                Node: PC0 <= -2.769606471146024 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.58
                right:
                  Node: PC0 <= -2.662908498937192 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.35
                  right:
                    Leaf Node: Class 0.37
            right:
              Node: PC1 <= 6.385982449502619 [Info Gain: 0.999999999999999
8]
              left:
                Node: PC0 <= -2.2815667829100543 [Info Gain: 0.91829583405
44896]
                left:
                  Leaf Node: Class 0.32
                right:
                  Leaf Node: Class 0.38
              right:
```

```
                Node: PC0 <= -2.4447646113862933 [Info Gain: 0.91829583405
44894]
                left:
                  Leaf Node: Class 0.7
                right:
                  Node: PC0 <= -2.2884110949713925 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.22
                  right:
                    Leaf Node: Class 0.24
      right:
        Node: PC18 <= -0.13814027135548587 [Info Gain: 0.8910737158798137]
        left:
          Node: PC3 <= 0.35962425126079156 [Info Gain: 0.8885879664733682]
          left:
            Node: PC8 <= -0.6738953740724405 [Info Gain: 0.994030211476957
7]
            left:
              Node: PC1 <= 1.9240789186571303 [Info Gain: 0.97095059445466
87]
              left:
                Leaf Node: Class 0.15
              right:
                Node: PC0 <= -2.7973205096014992 [Info Gain: 0.91829583405
44894]
                left:
                  Leaf Node: Class 0.51
                right:
                  Node: PC0 <= -2.287807794287907 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.07
                  right:
                    Leaf Node: Class 0.45
            right:
              Node: PC4 <= -1.7666609228154675 [Info Gain: 0.9999999999999
998]
              left:
                Node: PC0 <= -4.501351301793505 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.27
                right:
                  Node: PC0 <= -3.6953121186246345 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.32
                  right:
                    Leaf Node: Class 0.41
              right:
                Node: PC0 <= -2.7399723630038832 [Info Gain: 0.91829583405
44896]
                left:
                  Leaf Node: Class 0.29
                right:
                  Leaf Node: Class 0.24
          right:
            Node: PC11 <= 0.030299347875579516 [Info Gain: 0.8799649487271
113]
            left:
              Node: PC6 <= 3.453346595549826 [Info Gain: 0.954434002924965
2]
```

```
            left:
              Node: PC0 <= -5.28069169972414 [Info Gain: 0.7219280948873
623]
              left:
                Leaf Node: Class 0.21
              right:
                Leaf Node: Class 0.69
            right:
              Node: PC0 <= -5.017764337969481 [Info Gain: 0.918295834054
4894]
              left:
                Leaf Node: Class 0.26
              right:
                Node: PC0 <= -5.000769972165587 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.22
                right:
                  Leaf Node: Class 0.52
          right:
            Node: PC16 <= -0.14294789704860822 [Info Gain: 1.0]
            left:
              Node: PC10 <= 0.5458105344552252 [Info Gain: 0.97095059445
46687]
              left:
                Node: PC0 <= -4.899868732142733 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.52
                right:
                  Leaf Node: Class 0.84
              right:
                Leaf Node: Class 0.48
            right:
              Node: PC0 <= -5.002850047834803 [Info Gain: 0.970950594454
6686]
              left:
                Node: PC0 <= -5.216434998794486 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.25
                right:
                  Leaf Node: Class 0.62
              right:
                Node: PC0 <= -3.5754522000948654 [Info Gain: 0.918295834
0544894]
                left:
                  Leaf Node: Class 0.86
                right:
                  Node: PC0 <= -3.0435998801513837 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.36
                  right:
                    Leaf Node: Class 0.41
      right:
        Node: PC17 <= -0.3155228409085067 [Info Gain: 0.991076059838222
4]
        left:
          Node: PC14 <= -0.5377383650036601 [Info Gain: 0.97095059445466
86]
          left:
            Node: PC3 <= 2.5347257882300727 [Info Gain: 0.81127812445913
28]
```

```
              left:
                Leaf Node: Class 0.54
              right:
                Leaf Node: Class 0.73
            right:
              Node: PC2 <= -4.609566602830822 [Info Gain: 0.99999999999999
98]
              left:
                Node: PC0 <= -2.1192669061196123 [Info Gain: 0.91829583405
44896]
                left:
                  Leaf Node: Class 0.57
                right:
                  Leaf Node: Class 0.55
              right:
                Node: PC0 <= -3.300328784258515 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.82
                right:
                  Node: PC0 <= -3.2944306106394343 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.48
                  right:
                    Leaf Node: Class 0.74
          right:
            Node: PC3 <= 0.7784160741874008 [Info Gain: 1.0]
            left:
              Node: PC0 <= -4.0352092404680295 [Info Gain: 1.0]
              left:
                Node: PC0 <= -4.668161664865398 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.75
                right:
                  Leaf Node: Class 0.65
              right:
                Node: PC0 <= -3.011518724780928 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.02
                right:
                  Leaf Node: Class 0.35
            right:
              Node: PC6 <= 1.6076118549864937 [Info Gain: 1.0]
              left:
                Leaf Node: Class 1.0
              right:
                Node: PC0 <= -5.322840361192098 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.37
                right:
                  Leaf Node: Class 0.34
right:
  Node: PC0 <= 3.6080803968714528 [Info Gain: 0.1832529430368277]
  left:
    Node: PC1 <= 0.12745212426571598 [Info Gain: 0.2372056929596118]
    left:
      Node: PC7 <= 0.07282481456327024 [Info Gain: 0.20739515709052014]
      left:
        Node: PC6 <= -0.6490347807459809 [Info Gain: 0.20023375616029426]
        left:
```

```
          Node: PC22 <= 0.10140032534702592 [Info Gain: 0.43908760173626504]
          left:
            Node: PC6 <= -1.3657223188081093 [Info Gain: 0.57912101104922]
            left:
              Node: PC14 <= -0.27969547750316015 [Info Gain: 0.7875311359020309]
              left:
                Node: PC0 <= 0.07403766220309894 [Info Gain: 0.9852281360342516]
                left:
                  Node: PC0 <= -1.3522833686881037 [Info Gain: 0.9182958340544894]
                  left:
                    Leaf Node: Class 0.53
                  right:
                    Node: PC0 <= -0.045697741594519684 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.09
                    right:
                      Leaf Node: Class 0.15
                right:
                  Node: PC2 <= -1.0858723517356859 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.13
                  right:
                    Node: PC0 <= 1.0743894779965975 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.18
                    right:
                      Leaf Node: Class 0.1
              right:
                Node: PC12 <= 0.19190938827368478 [Info Gain: 0.8739810481273582]
                left:
                  Node: PC9 <= -0.21525563901483358 [Info Gain: 0.7502947981375305]
                  left:
                    Node: PC12 <= -0.06545523203326473 [Info Gain: 0.9852281360342513]
                    left:
                      Leaf Node: Class 0.12
                    right:
                      Node: PC0 <= -0.16677779292155953 [Info Gain: 0.9182958340544896]
                      left:
                        Leaf Node: Class 0.14
                      right:
                        Leaf Node: Class 0.16
                  right:
                    Node: PC1 <= -2.361720925275842 [Info Gain: 0.9709505944546687]
                    left:
                      Leaf Node: Class 0.17
                    right:
                      Node: PC0 <= 1.141124330212697 [Info Gain: 0.9182958340544894]
                      left:
                        Leaf Node: Class 0.14
                      right:
```

```
                        Node: PC0 <= 2.0335478851893107 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.24
                        right:
                          Leaf Node: Class 0.06
                right:
                  Node: PC0 <= -0.23875738127947263 [Info Gain: 0.97095059
44546687]
                  left:
                    Leaf Node: Class 0.23
                  right:
                    Node: PC0 <= 2.288229615988096 [Info Gain: 0.918295834
0544894]
                    left:
                      Leaf Node: Class 0.18
                    right:
                      Node: PC0 <= 3.122453595648693 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.08
                      right:
                        Leaf Node: Class 0.04
            right:
              Node: PC1 <= -2.490120984591596 [Info Gain: 0.73583958321313
99]
              left:
                Node: PC2 <= -2.2933509534287335 [Info Gain: 0.67212115099
18934]
                left:
                  Node: PC0 <= 0.24396667828745625 [Info Gain: 0.970950594
4546686]
                  left:
                    Leaf Node: Class 0.03
                  right:
                    Leaf Node: Class 0.1
                right:
                  Node: PC10 <= 0.17467214478276763 [Info Gain: 0.84188129
82387722]
                  left:
                    Node: PC0 <= -1.8905739163311406 [Info Gain: 0.5916727
785823274]
                    left:
                      Leaf Node: Class 0.17
                    right:
                      Node: PC0 <= 2.36718897080547 [Info Gain: 0.65002242
16483541]
                      left:
                        Leaf Node: Class 0.05
                      right:
                        Leaf Node: Class 0.26
                  right:
                    Node: PC2 <= -0.3056010097564544 [Info Gain: 0.9999999
999999998]
                    left:
                      Node: PC0 <= 3.092635497058014 [Info Gain: 0.9182958
340544896]
                      left:
                        Leaf Node: Class 0.02
                      right:
                        Leaf Node: Class 0.14
                    right:
```

```
                    Node: PC0 <= -1.408161952477195 [Info Gain: 0.918295
8340544894]
                    left:
                      Leaf Node: Class 0.17
                    right:
                      Node: PC0 <= 0.41176258004707783 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.1
                      right:
                        Leaf Node: Class 0.32
            right:
              Node: PC6 <= -1.107059105459626 [Info Gain: 0.991076059838
2224]
              left:
                Node: PC7 <= -1.057231228058096 [Info Gain: 0.9544340029
249647]
                left:
                  Node: PC0 <= 0.2450672240532114 [Info Gain: 0.91829583
40544894]
                  left:
                    Leaf Node: Class 0.25
                  right:
                    Node: PC0 <= 1.393889926118681 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.04
                    right:
                      Leaf Node: Class 0.1
                right:
                  Node: PC21 <= 0.19449857296722314 [Info Gain: 0.970950
5944546687]
                  left:
                    Leaf Node: Class 0.09
                  right:
                    Node: PC0 <= 1.3658669708684579 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.05
                    right:
                      Leaf Node: Class 0.19
              right:
                Node: PC9 <= -0.1314313576554763 [Info Gain: 1.000000000
0000004]
                left:
                  Node: PC0 <= 1.4808428325885519 [Info Gain: 0.97095059
44546686]
                  left:
                    Node: PC0 <= -0.1372329941360343 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.14
                    right:
                      Leaf Node: Class 0.49
                  right:
                    Node: PC0 <= 2.0505838316908727 [Info Gain: 0.918295
8340544894]
                    left:
                      Leaf Node: Class 0.01
                    right:
                      Node: PC0 <= 2.4730669978287683 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.11
                      right:
```

```
                        Leaf Node: Class 0.13
                right:
                  Node: PC2 <= -0.7479539960605187 [Info Gain: 0.9709505
944546686]
                  left:
                    Leaf Node: Class 0.06
                  right:
                    Leaf Node: Class 0.2
          right:
            Node: PC7 <= -1.8626119696448638 [Info Gain: 0.769011948966094
5]
            left:
              Node: PC0 <= 0.1821129640794511 [Info Gain: 0.74610341378980
88]
              left:
                Node: PC0 <= -0.46886536633695036 [Info Gain: 0.9999999999
999998]
                left:
                  Node: PC0 <= -0.6273728062521198 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.05
                  right:
                    Node: PC0 <= -0.5878960662577075 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.01
                    right:
                      Leaf Node: Class 0.04
                right:
                  Node: PC1 <= -3.7396300922961827 [Info Gain: 0.918295834
0544896]
                  left:
                    Leaf Node: Class 0.08
                  right:
                    Leaf Node: Class 0.21
              right:
                Node: PC6 <= -1.2247925073902115 [Info Gain: 0.98522813603
42513]
                left:
                  Node: PC0 <= 2.1981806325470825 [Info Gain: 0.8112781244
591328]
                  left:
                    Leaf Node: Class 0.05
                  right:
                    Leaf Node: Class 0.03
                right:
                  Node: PC0 <= 0.6212081698899269 [Info Gain: 0.9182958340
544896]
                  left:
                    Leaf Node: Class 0.11
                  right:
                    Leaf Node: Class 0.17
            right:
              Node: PC9 <= -0.06479996713918092 [Info Gain: 0.970950594454
6692]
              left:
                Node: PC14 <= 0.5856602647759029 [Info Gain: 0.99107605983
8222]
                left:
                  Node: PC3 <= 0.7769871526161103 [Info Gain: 0.7219280948
```

```
873623]
                  left:
                    Leaf Node: Class 0.03
                  right:
                    Leaf Node: Class 0.23
                right:
                  Node: PC1 <= -0.8610168269794765 [Info Gain: 0.811278124
4591328]
                  left:
                    Leaf Node: Class 0.28
                  right:
                    Leaf Node: Class 0.24
              right:
                Node: PC3 <= -1.1532361474023007 [Info Gain: 0.99999999999
99998]
                left:
                  Node: PC2 <= -4.742261064889683 [Info Gain: 0.9182958340
544896]
                  left:
                    Leaf Node: Class 0.15
                  right:
                    Leaf Node: Class 0.11
                right:
                  Node: PC0 <= -1.6403861380636167 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.18
                  right:
                    Node: PC0 <= -0.6493151958363874 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.82
                    right:
                      Leaf Node: Class 0.31
        right:
          Node: PC21 <= 0.4841576681791785 [Info Gain: 0.2367279369876342
8]
          left:
            Node: PC16 <= -0.16417056206048872 [Info Gain: 0.2955206429681
9136]
            left:
              Node: PC14 <= 0.2667952991297372 [Info Gain: 0.4869227377060
3256]
              left:
                Node: PC21 <= 0.13197229504495697 [Info Gain: 0.5806903431
450121]
                left:
                  Node: PC11 <= 0.7975198103196246 [Info Gain: 0.603759374
819711]
                  left:
                    Node: PC14 <= -0.16005382267589846 [Info Gain: 0.91829
58340544898]
                    left:
                      Node: PC5 <= -1.4937108818273113 [Info Gain: 0.81127
81244591328]
                      left:
                        Leaf Node: Class 0.01
                      right:
                        Node: PC0 <= -0.2152797634813359 [Info Gain: 0.459
1479170272448]
                          left:
```

```
                        Node: PC0 <= -0.8440119771219661 [Info Gain: 0.9
182958340544896]
                        left:
                          Leaf Node: Class 0.1
                        right:
                          Leaf Node: Class 0.16
                      right:
                        Leaf Node: Class 0.1
                  right:
                    Node: PC1 <= -3.198321538097748 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.08
                    right:
                      Leaf Node: Class 0.05
                right:
                  Node: PC11 <= 1.4550995915239697 [Info Gain: 1.0]
                  left:
                    Node: PC3 <= 0.040450886712520194 [Info Gain: 1.0]
                    left:
                      Node: PC1 <= -5.5731515084950916 [Info Gain: 0.918
2958340544896]
                      left:
                        Leaf Node: Class 0.45
                      right:
                        Leaf Node: Class 0.04
                    right:
                      Leaf Node: Class 0.19
                  right:
                    Node: PC0 <= -0.49870747203077537 [Info Gain: 0.9999
999999999998]
                    left:
                      Node: PC1 <= -5.7412618033708975 [Info Gain: 0.918
2958340544896]
                      left:
                        Leaf Node: Class 0.05
                      right:
                        Leaf Node: Class 0.08
                    right:
                      Node: PC0 <= 0.8095588921383255 [Info Gain: 0.9182
958340544894]
                      left:
                        Leaf Node: Class 0.01
                      right:
                        Node: PC0 <= 0.8304933230221778 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.12
                        right:
                          Leaf Node: Class 0.25
            right:
              Node: PC2 <= -0.1609539012234352 [Info Gain: 0.841881298
2387722]
              left:
                Node: PC2 <= -0.7106108028962037 [Info Gain: 0.9852281
360342513]
                left:
                  Node: PC0 <= -0.8255044343461208 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.05
                  right:
                    Node: PC0 <= 0.8127999045724307 [Info Gain: 1.0]
```

```
                        left:
                          Leaf Node: Class 0.11
                        right:
                          Leaf Node: Class 0.15
                    right:
                      Leaf Node: Class 0.14
                  right:
                    Node: PC1 <= -2.9577905487961607 [Info Gain: 0.9999999
999999998]
                    left:
                      Node: PC0 <= 0.7004958267835039 [Info Gain: 0.918295
8340544896]
                      left:
                        Leaf Node: Class 0.1
                      right:
                        Leaf Node: Class 0.15
                    right:
                      Node: PC0 <= -0.7192726860365095 [Info Gain: 0.91829
58340544896]
                      left:
                        Leaf Node: Class 0.18
                      right:
                        Leaf Node: Class 0.12
              right:
                Node: PC21 <= -0.2548226334888967 [Info Gain: 0.8307516187
028985]
                left:
                  Node: PC13 <= 0.32978443425187903 [Info Gain: 1.0]
                  left:
                    Node: PC1 <= -5.478055165418591 [Info Gain: 0.72192809
48873623]
                    left:
                      Leaf Node: Class 0.04
                    right:
                      Leaf Node: Class 0.06
                  right:
                    Node: PC9 <= 1.3818431348564846 [Info Gain: 0.97095059
44546686]
                    left:
                      Leaf Node: Class 0.14
                    right:
                      Leaf Node: Class 0.18
                right:
                  Node: PC0 <= 1.7567457665744959 [Info Gain: 0.9612366047
228762]
                  left:
                    Node: PC0 <= -0.7807098706109566 [Info Gain: 0.9999999
999999998]
                    left:
                      Node: PC0 <= -1.4146861257878678 [Info Gain: 1.0]
                      left:
                        Node: PC0 <= -1.506974843925375 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.3
                        right:
                          Leaf Node: Class 0.02
                      right:
                        Leaf Node: Class 0.05
                    right:
                      Node: PC5 <= -2.609048754258615 [Info Gain: 0.811278
```

```
1244591328]
                    left:
                      Leaf Node: Class 0.01
                    right:
                      Leaf Node: Class 0.15
                right:
                  Node: PC5 <= -1.9359034896286436 [Info Gain: 0.9709505
944546687]
                  left:
                    Leaf Node: Class 0.11
                  right:
                    Node: PC0 <= 2.289910346284549 [Info Gain: 0.9182958
340544894]
                    left:
                      Leaf Node: Class 0.22
                    right:
                      Node: PC0 <= 3.2642582525202966 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.07
                      right:
                        Leaf Node: Class 0.06
            right:
              Node: PC19 <= 0.04582280533371007 [Info Gain: 0.391391177983
1958]
              left:
                Node: PC16 <= 0.13164748808197174 [Info Gain: 0.6447850000
105939]
                left:
                  Node: PC1 <= -1.050245342183495 [Info Gain: 0.9940302114
769577]
                  left:
                    Node: PC0 <= -0.86270378475428 [Info Gain: 0.999999999
9999998]
                    left:
                      Node: PC0 <= -1.271148208552464 [Info Gain: 0.918295
8340544896]
                      left:
                        Leaf Node: Class 0.02
                      right:
                        Leaf Node: Class 0.08
                    right:
                      Node: PC0 <= -0.03246165272443315 [Info Gain: 0.9182
958340544894]
                      left:
                        Leaf Node: Class 0.01
                      right:
                        Node: PC0 <= 0.42567620108689214 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.11
                        right:
                          Leaf Node: Class 0.35
                  right:
                    Node: PC1 <= -1.0198021252875111 [Info Gain: 0.9709505
944546687]
                    left:
                      Leaf Node: Class 0.2
                    right:
                      Node: PC0 <= -1.81309940476286 [Info Gain: 0.9182958
340544894]
                      left:
```

```
                        Leaf Node: Class 0.12
                      right:
                        Node: PC0 <= -1.2189238482577849 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.14
                        right:
                          Leaf Node: Class 0.09
                right:
                  Node: PC20 <= -0.13292267743625386 [Info Gain: 0.6330356
548861347]
                  left:
                    Node: PC15 <= -0.8633347942225268 [Info Gain: 0.811278
1244591329]
                    left:
                      Node: PC0 <= 2.007860509425437 [Info Gain: 0.9182958
340544894]
                      left:
                        Leaf Node: Class 0.04
                      right:
                        Node: PC0 <= 3.00860990779984 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.08
                        right:
                          Leaf Node: Class 0.06
                    right:
                      Node: PC6 <= 0.3451480604964926 [Info Gain: 0.557727
7787393193]
                      left:
                        Leaf Node: Class 0.07
                      right:
                        Node: PC0 <= 1.0021154598990412 [Info Gain: 1.0]
                        left:
                          Node: PC0 <= -1.2381773587385059 [Info Gain: 1.
0]
                            left:
                              Leaf Node: Class 0.07
                            right:
                              Leaf Node: Class 0.05
                        right:
                          Node: PC0 <= 2.620228114675936 [Info Gain: 1.0]
                          left:
                            Leaf Node: Class 0.1
                          right:
                            Leaf Node: Class 0.09
                  right:
                    Node: PC21 <= -0.4906673791093034 [Info Gain: 0.779349
8372920851]
                    left:
                      Leaf Node: Class 0.05
                    right:
                      Node: PC10 <= 0.8708554895238246 [Info Gain: 0.72192
80948873625]
                      left:
                        Node: PC2 <= -1.340777494501486 [Info Gain: 0.5612
781244591329]
                        left:
                          Node: PC0 <= 1.8580108810729874 [Info Gain: 1.0]
                          left:
                            Leaf Node: Class 0.12
                          right:
```

```
                          Leaf Node: Class 0.01
                      right:
                        Node: PC1 <= -6.07767806646685 [Info Gain: 0.650
0224216483541]
                        left:
                          Leaf Node: Class 0.01
                        right:
                          Leaf Node: Class 0.06
                    right:
                      Node: PC0 <= 1.921041266317173 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.13
                      right:
                        Leaf Node: Class 0.1
            right:
              Node: PC16 <= 0.6170496547309818 [Info Gain: 0.58755375166
35054]
              left:
                Node: PC1 <= -2.5766496330520035 [Info Gain: 0.614726638
5472814]
                left:
                  Node: PC18 <= 0.05977819828294077 [Info Gain: 0.590004
89601191]
                  left:
                    Node: PC11 <= -0.033857489656260197 [Info Gain: 0.81
12781244591329]
                    left:
                      Node: PC0 <= -0.9909592277166115 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.03
                      right:
                        Leaf Node: Class 0.06
                    right:
                      Node: PC1 <= -3.339660231651233 [Info Gain: 0.6500
224216483541]
                      left:
                        Leaf Node: Class 0.04
                      right:
                        Leaf Node: Class 0.18
                  right:
                    Node: PC0 <= -0.021252445269674642 [Info Gain: 0.970
9505944546687]
                    left:
                      Node: PC8 <= 0.8983381100631752 [Info Gain: 0.9182
958340544896]
                      left:
                        Leaf Node: Class 0.06
                      right:
                        Node: PC0 <= -1.8475780561444384 [Info Gain: 1.
0]
                        left:
                          Leaf Node: Class 0.23
                        right:
                          Leaf Node: Class 0.11
                    right:
                      Leaf Node: Class 0.03
                right:
                  Node: PC9 <= -0.5603259498715072 [Info Gain: 0.9940302
114769566]
                  left:
```

```
                    Node: PC4 <= 0.44055007407457825 [Info Gain: 1.0]
                    left:
                      Node: PC1 <= -1.6674215025791508 [Info Gain: 0.918
2958340544896]
                      left:
                        Leaf Node: Class 0.06
                      right:
                        Leaf Node: Class 0.04
                    right:
                      Leaf Node: Class 0.05
                  right:
                    Node: PC2 <= -0.03280919193187031 [Info Gain: 0.7219
280948873623]
                    left:
                      Leaf Node: Class 0.07
                    right:
                      Leaf Node: Class 0.25
                right:
                  Node: PC0 <= 1.6368374038875348 [Info Gain: 0.9957274520
84926]
                  left:
                    Node: PC0 <= -0.010313623613734444 [Info Gain: 1.0]
                    left:
                      Node: PC0 <= -1.3585574962509332 [Info Gain: 0.91829
58340544894]
                      left:
                        Leaf Node: Class 0.14
                      right:
                        Node: PC0 <= -0.15461556561726536 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.22
                        right:
                          Leaf Node: Class 0.12
                    right:
                      Node: PC0 <= 0.09277100631626777 [Info Gain: 0.91829
58340544894]
                      left:
                        Leaf Node: Class 0.65
                      right:
                        Node: PC0 <= 0.9488320253119406 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.37
                        right:
                          Leaf Node: Class 0.04
                  right:
                    Node: PC1 <= -3.9418279260992266 [Info Gain: 0.9852281
360342514]
                    left:
                      Node: PC1 <= -4.677659240120105 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.05
                      right:
                        Leaf Node: Class 0.09
                    right:
                      Node: PC0 <= 1.9354136781829057 [Info Gain: 0.918295
8340544894]
                      left:
                        Leaf Node: Class 0.15
                      right:
                        Node: PC0 <= 2.5359770212038364 [Info Gain: 1.0]
```

```
                        left:
                          Leaf Node: Class 0.27
                        right:
                          Leaf Node: Class 0.07
          right:
            Node: PC4 <= -0.7597054706266814 [Info Gain: 0.60039455809637
9]
            left:
              Node: PC9 <= -0.03864104224527476 [Info Gain: 0.890491640219
4916]
              left:
                Node: PC2 <= -1.0885511353576272 [Info Gain: 0.76420450650
86203]
                left:
                  Node: PC0 <= 1.1265779124873139 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.0
                  right:
                    Leaf Node: Class 0.05
                right:
                  Node: PC15 <= -0.25784156219362536 [Info Gain: 0.8631205
685666309]
                  left:
                    Node: PC0 <= -1.87186464788178 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.07
                    right:
                      Leaf Node: Class 0.32
                  right:
                    Leaf Node: Class 0.06
              right:
                Node: PC0 <= -1.7732731374961046 [Info Gain: 0.81127812445
91328]
                left:
                  Leaf Node: Class 0.23
                right:
                  Leaf Node: Class 0.09
            right:
              Node: PC19 <= -0.31409680101446935 [Info Gain: 0.60386724702
29351]
              left:
                Node: PC8 <= -1.6197949824763445 [Info Gain: 0.84535093662
24368]
                left:
                  Node: PC1 <= -3.0039385392920015 [Info Gain: 0.918295834
0544896]
                  left:
                    Leaf Node: Class 0.04
                  right:
                    Leaf Node: Class 0.17
                right:
                  Node: PC4 <= 0.20085545146857728 [Info Gain: 0.811278124
4591329]
                  left:
                    Node: PC6 <= -0.2900512268007052 [Info Gain: 0.9999999
999999998]
                    left:
                      Node: PC0 <= -1.4085281097997076 [Info Gain: 0.91829
58340544894]
                      left:
```

```
                        Leaf Node: Class 0.07
                      right:
                        Node: PC0 <= -1.0764075740896635 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.05
                        right:
                          Leaf Node: Class 0.08
                    right:
                      Leaf Node: Class 0.03
                  right:
                    Leaf Node: Class 0.19
              right:
                Node: PC12 <= -0.8590795932411477 [Info Gain: 0.6957171036
318397]
                left:
                  Node: PC10 <= 0.4474678039309885 [Info Gain: 0.999999999
9999998]
                  left:
                    Leaf Node: Class 0.06
                  right:
                    Node: PC0 <= -0.3841975420244387 [Info Gain: 0.9182958
340544894]
                    left:
                      Leaf Node: Class 0.13
                    right:
                      Node: PC0 <= 0.5402660999569263 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.08
                      right:
                        Leaf Node: Class 0.07
                right:
                  Node: PC6 <= -0.4107422617578707 [Info Gain: 0.863120568
5666309]
                  left:
                    Node: PC0 <= -1.6875957491504066 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.18
                    right:
                      Leaf Node: Class 0.03
                  right:
                    Leaf Node: Class 0.08
      right:
        Node: PC5 <= -1.5632922192336898 [Info Gain: 0.5143100838388452]
        left:
          Node: PC19 <= -0.020846568139983822 [Info Gain: 0.65394692858204
58]
          left:
            Node: PC3 <= -0.9252881607860596 [Info Gain: 0.934068055375490
8]
            left:
              Node: PC21 <= -0.35927313880255807 [Info Gain: 0.96123660472
28758]
              left:
                Node: PC4 <= 2.065461605299026 [Info Gain: 0.9709505944546
686]
                left:
                  Leaf Node: Class 0.19
                right:
                  Leaf Node: Class 0.07
              right:
```

```
                Node: PC2 <= -1.709627299814473 [Info Gain: 1.0]
                left:
                  Node: PC0 <= 0.7068760868689694 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.08
                  right:
                    Node: PC0 <= 0.9127343151213171 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.16
                    right:
                      Leaf Node: Class 0.11
                right:
                  Leaf Node: Class 0.15
            right:
              Node: PC4 <= -0.05009922590194252 [Info Gain: 0.985228136034
2513]
              left:
                Node: PC6 <= -0.6816761488081644 [Info Gain: 0.81127812445
91328]
                left:
                  Leaf Node: Class 0.09
                right:
                  Leaf Node: Class 0.14
              right:
                Node: PC0 <= 2.339395155767089 [Info Gain: 0.9182958340544
896]
                left:
                  Leaf Node: Class 0.17
                right:
                  Leaf Node: Class 0.1
          right:
            Node: PC0 <= -0.5776662491872273 [Info Gain: 0.768924327122470
6]
            left:
              Node: PC5 <= -2.3276387475754445 [Info Gain: 0.9612366047228
762]
              left:
                Node: PC15 <= -0.234109584696919 [Info Gain: 0.95443400292
49652]
                left:
                  Node: PC1 <= -1.7395739685285863 [Info Gain: 0.918295834
0544896]
                  left:
                    Leaf Node: Class 0.48
                  right:
                    Leaf Node: Class 0.6
                right:
                  Node: PC5 <= -2.8509811352615677 [Info Gain: 0.970950594
4546685]
                  left:
                    Leaf Node: Class 0.11
                  right:
                    Node: PC0 <= -1.5338083310813984 [Info Gain: 0.9182958
340544896]
                    left:
                      Leaf Node: Class 0.22
                    right:
                      Leaf Node: Class 0.34
              right:
                Node: PC2 <= -0.7473668871980071 [Info Gain: 0.97095059445
```

```
46687]
                left:
                  Leaf Node: Class 0.2
                right:
                  Node: PC0 <= -1.5056395128435394 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.23
                  right:
                    Node: PC0 <= -1.1200515160407072 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.41
                    right:
                      Leaf Node: Class 0.56
            right:
              Node: PC20 <= -0.16770798914325552 [Info Gain: 0.81287868934
20301]
              left:
                Node: PC16 <= -0.6340908503186047 [Info Gain: 0.9910760598
382222]
                left:
                  Node: PC5 <= -2.6852390295087343 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.21
                  right:
                    Leaf Node: Class 0.27
                right:
                  Node: PC1 <= -4.03524918192173 [Info Gain: 0.97095059445
46687]
                  left:
                    Node: PC0 <= -0.27163599293581225 [Info Gain: 0.918295
8340544894]
                    left:
                      Leaf Node: Class 0.4
                    right:
                      Node: PC0 <= 0.9920795238282835 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.08
                      right:
                        Leaf Node: Class 0.15
                  right:
                    Leaf Node: Class 0.26
              right:
                Node: PC16 <= -0.28333517392067925 [Info Gain: 0.738699408
2884972]
                left:
                  Node: PC1 <= -1.5737133890772796 [Info Gain: 0.918295834
0544896]
                  left:
                    Node: PC8 <= -1.4207339275674795 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.08
                    right:
                      Node: PC0 <= 2.4640039563535945 [Info Gain: 0.918295
8340544896]
                      left:
                        Leaf Node: Class 0.11
                      right:
                        Leaf Node: Class 0.23
                  right:
```

```
                    Node: PC1 <= -0.17998660262149657 [Info Gain: 0.918295
8340544896]
                    left:
                      Leaf Node: Class 0.13
                    right:
                      Leaf Node: Class 0.05
                  right:
                    Node: PC10 <= -0.7083699028781102 [Info Gain: 0.98522813
60342517]
                    left:
                      Leaf Node: Class 0.16
                    right:
                      Node: PC1 <= -2.6475943352135336 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.13
                      right:
                        Node: PC0 <= 0.9222936424500316 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.25
                        right:
                          Leaf Node: Class 0.29
          right:
            Node: PC14 <= -0.9190216112310594 [Info Gain: 0.663898608997828
7]
            left:
              Node: PC5 <= -0.6810116514201789 [Info Gain: 0.988699408288497
7]
              left:
                Node: PC21 <= -0.13639810971538663 [Info Gain: 0.99107605983
8222]
                left:
                  Node: PC0 <= 1.7745540940554916 [Info Gain: 0.811278124459
1328]
                  left:
                    Leaf Node: Class 0.06
                  right:
                    Leaf Node: Class 0.27
                right:
                  Node: PC7 <= 1.2944730154598643 [Info Gain: 0.970950594454
6687]
                  left:
                    Leaf Node: Class 0.03
                  right:
                    Node: PC0 <= 2.557252702670196 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.29
                    right:
                      Leaf Node: Class 0.05
              right:
                Node: PC5 <= 0.18826815476992045 [Info Gain: 0.9852281360342
514]
                left:
                  Node: PC0 <= -1.482831099687241 [Info Gain: 0.918295834054
4894]
                  left:
                    Leaf Node: Class 0.41
                  right:
                    Node: PC0 <= 0.6399047363408557 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.21
```

```
                right:
                  Leaf Node: Class 0.16
              right:
                Node: PC2 <= -1.6003938699811753 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.02
                right:
                  Leaf Node: Class 0.15
          right:
            Node: PC17 <= -0.19900016365261428 [Info Gain: 0.6358021801147
782]
            left:
              Node: PC8 <= -1.0827714531550447 [Info Gain: 0.9967916319816
368]
              left:
                Node: PC5 <= -0.9924112091381889 [Info Gain: 0.98522813603
42514]
                left:
                  Node: PC0 <= 0.06826342193899206 [Info Gain: 0.918295834
0544896]
                  left:
                    Leaf Node: Class 0.15
                  right:
                    Leaf Node: Class 0.06
                right:
                  Node: PC0 <= 2.164663994123494 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.04
                  right:
                    Node: PC0 <= 2.583645385162888 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.1
                    right:
                      Leaf Node: Class 0.11
              right:
                Node: PC5 <= -0.48007699680713767 [Info Gain: 0.9999999999
999998]
                left:
                  Node: PC3 <= -0.3512201978706827 [Info Gain: 0.811278124
4591328]
                  left:
                    Leaf Node: Class 0.19
                  right:
                    Leaf Node: Class 0.22
                right:
                  Node: PC0 <= 2.386421316127281 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= -1.4114885866827944 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.35
                    right:
                      Leaf Node: Class 0.36
                  right:
                    Node: PC0 <= 2.7833974102678614 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.07
                    right:
                      Leaf Node: Class 0.09
            right:
              Node: PC8 <= -0.8639511724736447 [Info Gain: 0.7098971440619
```

```
857]
              left:
                Node: PC15 <= 0.20317649770200688 [Info Gain: 0.8441888574
932115]
                left:
                  Node: PC8 <= -1.9818568512042425 [Info Gain: 0.918295834
0544891]
                  left:
                    Node: PC0 <= -0.2789741293105278 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.26
                    right:
                      Node: PC0 <= 0.1266387468954526 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.1
                      right:
                        Leaf Node: Class 0.55
                  right:
                    Node: PC2 <= 0.3618454639379422 [Info Gain: 0.70443400
29249652]
                    left:
                      Node: PC0 <= -1.4276819026325276 [Info Gain: 0.91829
58340544894]
                      left:
                        Leaf Node: Class 0.47
                      right:
                        Node: PC0 <= 2.472537646138551 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.37
                        right:
                          Leaf Node: Class 0.12
                    right:
                      Node: PC1 <= -4.868107982623153 [Info Gain: 0.721928
0948873623]
                      left:
                        Leaf Node: Class 0.12
                      right:
                        Leaf Node: Class 0.18
                right:
                  Node: PC2 <= 0.1014754580666866 [Info Gain: 0.9852281360
342514]
                  left:
                    Node: PC0 <= 0.5979280787585979 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.27
                    right:
                      Node: PC0 <= 0.5986773457995184 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.5
                      right:
                        Leaf Node: Class 0.23
                  right:
                    Node: PC1 <= -0.7562947825154013 [Info Gain: 0.9182958
340544896]
                    left:
                      Leaf Node: Class 0.37
                    right:
                      Leaf Node: Class 0.19
              right:
                Node: PC4 <= 0.6116438961686758 [Info Gain: 0.970950594454
```

```
6684]
                left:
                  Node: PC2 <= 1.4463318761620763 [Info Gain: 0.9182958340
544896]
                  left:
                    Leaf Node: Class 0.1
                  right:
                    Node: PC0 <= 1.365891879275244 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.14
                    right:
                      Leaf Node: Class 0.75
                right:
                  Node: PC0 <= 1.3677623623035764 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= -1.386073916175328 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.12
                    right:
                      Leaf Node: Class 0.39
                  right:
                    Leaf Node: Class 0.04
    right:
      Node: PC11 <= -0.550972812335622 [Info Gain: 0.3842384188587431]
      left:
        Node: PC13 <= -0.07283197008461768 [Info Gain: 0.6448561133513468]
        left:
          Node: PC11 <= -1.100169239884619 [Info Gain: 0.7771276076205429]
          left:
            Node: PC5 <= -1.502785194400241 [Info Gain: 0.799584371082960
2]
            left:
              Node: PC0 <= -0.2100071181227156 [Info Gain: 0.9852281360342
512]
              left:
                Node: PC0 <= -0.8641482864151508 [Info Gain: 0.91829583405
44894]
                left:
                  Leaf Node: Class 0.25
                right:
                  Node: PC0 <= -0.6937407649512228 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.11
                  right:
                    Leaf Node: Class 0.5
              right:
                Node: PC1 <= 1.465790111654305 [Info Gain: 1.0]
                left:
                  Node: PC0 <= 2.277461770276038 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.2
                  right:
                    Leaf Node: Class 0.06
                right:
                  Leaf Node: Class 0.36
            right:
              Node: PC0 <= 0.312995219296035 [Info Gain: 0.785879877173714
5]
              left:
                Node: PC0 <= -0.9129210947261452 [Info Gain: 0.98522813603
```

```
42516]
                left:
                  Node: PC0 <= -1.3061443768538272 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.16
                  right:
                    Node: PC0 <= -1.266399295165692 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.24
                    right:
                      Leaf Node: Class 0.49
                right:
                  Node: PC0 <= -0.626694052767975 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= -0.6666087873328898 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.1
                    right:
                      Leaf Node: Class 0.69
                  right:
                    Node: PC0 <= -0.36183597756815233 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.2
                    right:
                      Leaf Node: Class 0.09
              right:
                Node: PC19 <= -0.4654001192639103 [Info Gain: 0.7688538376
159997]
                left:
                  Node: PC1 <= 2.579620216860395 [Info Gain: 0.81127812445
91328]
                  left:
                    Leaf Node: Class 0.16
                  right:
                    Leaf Node: Class 0.37
                right:
                  Node: PC6 <= -1.3841437375860353 [Info Gain: 0.970950594
4546687]
                  left:
                    Node: PC0 <= 1.030621583615034 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.37
                    right:
                      Leaf Node: Class 0.21
                  right:
                    Leaf Node: Class 0.15
          right:
            Node: PC17 <= -0.7447820626216606 [Info Gain: 0.99679163198163
63]
            left:
              Node: PC0 <= 0.6653618962247889 [Info Gain: 0.98522813603425
14]
              left:
                Node: PC1 <= 0.532668522572015 [Info Gain: 0.9182958340544
896]
                left:
                  Leaf Node: Class 0.51
                right:
                  Leaf Node: Class 0.28
```

```
              right:
                Node: PC1 <= 0.5271981857110938 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.12
                right:
                  Node: PC0 <= 1.2348204088610295 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.5
                  right:
                    Leaf Node: Class 0.4
            right:
              Node: PC0 <= 1.6789433452168243 [Info Gain: 1.0]
              left:
                Node: PC0 <= -0.01978147693745221 [Info Gain: 1.0]
                left:
                  Node: PC0 <= -1.427296390651923 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.67
                  right:
                    Leaf Node: Class 0.15
                right:
                  Node: PC0 <= 0.9169507312701431 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.29
                  right:
                    Leaf Node: Class 0.31
              right:
                Node: PC5 <= -0.29443497614997277 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.18
                right:
                  Node: PC0 <= 2.5192884428626274 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.25
                  right:
                    Leaf Node: Class 0.32
        right:
          Node: PC12 <= -0.8337079551544778 [Info Gain: 0.781791522942594
7]
          left:
            Node: PC20 <= -0.2999299616440884 [Info Gain: 0.85545081056013
08]
            left:
              Node: PC13 <= 0.3573570899527336 [Info Gain: 0.9852281360342
513]
              left:
                Node: PC0 <= -1.3394323080384125 [Info Gain: 0.91829583405
44896]
                left:
                  Leaf Node: Class 0.3
                right:
                  Leaf Node: Class 0.13
              right:
                Node: PC1 <= 1.2377693715415703 [Info Gain: 0.811278124459
1328]
                left:
                  Leaf Node: Class 0.08
                right:
                  Leaf Node: Class 0.1
            right:
```

```
              Node: PC21 <= -0.7176532244868513 [Info Gain: 0.838026754162
474]
              left:
                Node: PC5 <= 0.032488957467928375 [Info Gain: 1.0]
                left:
                  Node: PC17 <= -0.5661291537016758 [Info Gain: 0.97095059
44546687]
                  left:
                    Leaf Node: Class 0.12
                  right:
                    Node: PC0 <= -0.027556091553619256 [Info Gain: 0.91829
58340544894]
                    left:
                      Leaf Node: Class 0.32
                    right:
                      Node: PC0 <= 0.9379199593665704 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.02
                      right:
                        Leaf Node: Class 0.09
                right:
                  Node: PC0 <= -0.9700737438119239 [Info Gain: 0.970950594
4546686]
                  left:
                    Leaf Node: Class 0.24
                  right:
                    Leaf Node: Class 0.05
              right:
                Node: PC6 <= 0.08900331197136775 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.18
                right:
                  Node: PC2 <= -0.8629346736031067 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= -1.5492675722171525 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.12
                    right:
                      Leaf Node: Class 0.17
                  right:
                    Leaf Node: Class 0.34
          right:
            Node: PC11 <= -1.2075254049065685 [Info Gain: 0.98869940828849
77]
            left:
              Node: PC6 <= 1.6783208403110728 [Info Gain: 0.91829583405448
93]
              left:
                Node: PC20 <= -0.5338079179111062 [Info Gain: 0.9182958340
544896]
                left:
                  Node: PC0 <= -0.9204143512791235 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.24
                  right:
                    Leaf Node: Class 0.19
                right:
                  Leaf Node: Class 0.11
              right:
                Leaf Node: Class 0.04
```

```
            right:
              Node: PC4 <= 0.30577205000390806 [Info Gain: 0.9852281360342
514]
              left:
                Node: PC4 <= -0.45233849390593883 [Info Gain: 1.0]
                left:
                  Node: PC0 <= 0.5210410079714489 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.22
                  right:
                    Leaf Node: Class 0.32
                right:
                  Leaf Node: Class 0.17
              right:
                Node: PC3 <= -5.210201901009882 [Info Gain: 0.918295834054
4896]
                left:
                  Leaf Node: Class 0.23
                right:
                  Leaf Node: Class 0.21
      right:
        Node: PC3 <= -0.6794400196306325 [Info Gain: 0.5871348292322898]
        left:
          Node: PC4 <= -0.5547597397024437 [Info Gain: 0.7216636723783942]
          left:
            Node: PC11 <= 0.5204555107664279 [Info Gain: 0.829012535866551
2]
            left:
              Node: PC3 <= -1.715024418561098 [Info Gain: 0.97095059445466
88]
              left:
                Node: PC4 <= -1.0356221135153028 [Info Gain: 0.76420450650
86203]
                left:
                  Node: PC21 <= 0.12778069193818256 [Info Gain: 0.86312056
85666308]
                  left:
                    Node: PC6 <= 2.489410875667545 [Info Gain: 0.721928094
8873623]
                    left:
                      Leaf Node: Class 0.09
                    right:
                      Leaf Node: Class 0.15
                  right:
                    Leaf Node: Class 0.07
                right:
                  Node: PC0 <= 0.49653579456622293 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.27
                  right:
                    Leaf Node: Class 0.13
              right:
                Node: PC3 <= -0.868910626086377 [Info Gain: 0.999999999999
9998]
                left:
                  Node: PC0 <= -0.6368295468902381 [Info Gain: 0.918295834
0544896]
                  left:
                    Leaf Node: Class 0.63
                  right:
```

```
                    Leaf Node: Class 0.19
                right:
                  Node: PC0 <= -1.3061965869932506 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.26
                  right:
                    Node: PC0 <= 2.534796004826298 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.41
                    right:
                      Leaf Node: Class 0.17
            right:
              Node: PC1 <= 3.89466317039241 [Info Gain: 0.994030211476957]
              left:
                Node: PC12 <= 0.0026158365109257907 [Info Gain: 0.97095059
44546687]
                left:
                  Node: PC0 <= -0.5361663946920823 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.29
                  right:
                    Node: PC0 <= 1.0815741185272665 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.28
                    right:
                      Leaf Node: Class 0.26
                right:
                  Leaf Node: Class 0.24
              right:
                Node: PC2 <= 1.9351782783298122 [Info Gain: 0.999999999999
9998]
                left:
                  Leaf Node: Class 0.14
                right:
                  Node: PC0 <= -0.0800442378957518 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.04
                  right:
                    Node: PC0 <= 1.5697672993167728 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.27
                    right:
                      Leaf Node: Class 0.23
          right:
            Node: PC8 <= -0.05797694813647314 [Info Gain: 0.87477784081074
98]
            left:
              Node: PC2 <= -0.1318393534974621 [Info Gain: 0.9940302114769
572]
              left:
                Node: PC1 <= 2.254416485225279 [Info Gain: 0.9709505944546
687]
                left:
                  Node: PC0 <= -0.18478670019707646 [Info Gain: 0.91829583
40544894]
                  left:
                    Leaf Node: Class 0.16
```

```
                  right:
                    Node: PC0 <= 0.6287138153143853 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.34
                    right:
                      Leaf Node: Class 0.31
                right:
                  Leaf Node: Class 0.39
              right:
                Node: PC4 <= 0.5037978312051251 [Info Gain: 0.999999999999
9998]
                left:
                  Node: PC2 <= 1.1875473353220658 [Info Gain: 0.9182958340
544896]
                  left:
                    Leaf Node: Class 0.22
                  right:
                    Leaf Node: Class 0.2
                right:
                  Node: PC3 <= -2.8100348603625025 [Info Gain: 0.918295834
0544896]
                  left:
                    Leaf Node: Class 0.13
                  right:
                    Leaf Node: Class 0.75
            right:
              Node: PC0 <= 0.7579394794948737 [Info Gain: 0.99403021147695
68]
              left:
                Node: PC1 <= 1.2619084933261713 [Info Gain: 0.999999999999
9998]
                left:
                  Node: PC2 <= -8.191606068902745 [Info Gain: 0.9182958340
544896]
                  left:
                    Leaf Node: Class 0.04
                  right:
                    Leaf Node: Class 0.11
                right:
                  Node: PC2 <= 3.3740054758847333 [Info Gain: 0.9182958340
544896]
                  left:
                    Leaf Node: Class 0.17
                  right:
                    Leaf Node: Class 0.35
              right:
                Node: PC0 <= 1.0569485791537825 [Info Gain: 0.970950594454
6687]
                left:
                  Leaf Node: Class 0.16
                right:
                  Node: PC0 <= 1.605408410759681 [Info Gain: 0.91829583405
44894]
                  left:
                    Leaf Node: Class 0.3
                  right:
                    Node: PC0 <= 1.962596631934473 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.29
                    right:
```

```
                    Leaf Node: Class 0.09
        right:
          Node: PC3 <= 1.245761035681095 [Info Gain: 0.6786649596542302]
          left:
            Node: PC9 <= 0.9625511853840639 [Info Gain: 0.769245207487798
2]
            left:
              Node: PC14 <= 0.2194489145522111 [Info Gain: 0.9587118829771
315]
              left:
                Node: PC1 <= 5.6403459469405 [Info Gain: 0.890491640219491
6]
                left:
                  Node: PC3 <= -0.05077823437082047 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= -1.7948034131042219 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.35
                    right:
                      Leaf Node: Class 0.25
                  right:
                    Leaf Node: Class 0.59
                right:
                  Node: PC14 <= -0.6695928220320617 [Info Gain: 0.99107605
9838222]
                  left:
                    Node: PC0 <= -0.9164926023749828 [Info Gain: 1.0]
                    left:
                      Node: PC0 <= -1.2305354609384298 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.42
                      right:
                        Leaf Node: Class 0.67
                    right:
                      Leaf Node: Class 0.23
                  right:
                    Node: PC1 <= 8.002815140803772 [Info Gain: 0.721928094
8873623]
                    left:
                      Leaf Node: Class 0.33
                    right:
                      Leaf Node: Class 0.32
              right:
                Node: PC12 <= 0.9070233240348259 [Info Gain: 0.99999999999
99998]
                left:
                  Node: PC0 <= -0.7272748428926483 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.39
                  right:
                    Node: PC0 <= 0.32944556764250227 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.37
                    right:
                      Leaf Node: Class 0.4
                right:
                  Node: PC0 <= 2.5790987692443053 [Info Gain: 0.8112781244
591328]
                  left:
                    Leaf Node: Class 0.2
```

```
                right:
                  Leaf Node: Class 0.16
            right:
              Node: PC16 <= 0.1233278994228081 [Info Gain: 0.9366673818775
633]
              left:
                Node: PC6 <= -1.0565936781727032 [Info Gain: 0.84535093662
24368]
                left:
                  Node: PC0 <= -1.3742387381681411 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.36
                  right:
                    Node: PC0 <= 1.3313532860409492 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.28
                    right:
                      Leaf Node: Class 0.02
                right:
                  Node: PC8 <= -0.9060294992497588 [Info Gain: 0.704434002
9249649]
                  left:
                    Node: PC1 <= 0.69269717975984 [Info Gain: 0.9182958340
544896]
                    left:
                      Leaf Node: Class 0.2
                    right:
                      Leaf Node: Class 0.3
                  right:
                    Node: PC9 <= 1.5513450014722492 [Info Gain: 0.72192809
48873623]
                    left:
                      Leaf Node: Class 0.25
                    right:
                      Leaf Node: Class 0.2
              right:
                Node: PC0 <= -0.6606981543707 [Info Gain: 0.99999999999999
98]
                left:
                  Node: PC0 <= -1.7084714305372608 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.68
                  right:
                    Node: PC0 <= -1.1907260518437366 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.46
                    right:
                      Leaf Node: Class 0.6
                right:
                  Node: PC1 <= 4.877253102487807 [Info Gain: 0.91829583405
44896]
                  left:
                    Leaf Node: Class 0.22
                  right:
                    Leaf Node: Class 0.26
          right:
            Node: PC15 <= -0.21228346627365854 [Info Gain: 0.9940302114769
564]
```

```
            left:
              Node: PC9 <= 0.7845195485030881 [Info Gain: 1.0000000000000
04]
              left:
                Node: PC5 <= -2.1512332665746388 [Info Gain: 0.97095059445
46685]
                left:
                  Leaf Node: Class 0.21
                right:
                  Node: PC1 <= 6.203317519345691 [Info Gain: 0.91829583405
44896]
                  left:
                    Leaf Node: Class 0.38
                  right:
                    Leaf Node: Class 0.16
              right:
                Node: PC3 <= 1.6054215257379558 [Info Gain: 0.970950594454
6687]
                left:
                  Node: PC0 <= -1.5935593528786316 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.34
                  right:
                    Node: PC0 <= -0.12163275160309142 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.52
                    right:
                      Leaf Node: Class 0.22
                right:
                  Leaf Node: Class 0.37
            right:
              Node: PC16 <= -0.47992880317699815 [Info Gain: 1.0]
              left:
                Node: PC0 <= 0.7108095751104396 [Info Gain: 1.0]
                left:
                  Node: PC0 <= -1.1387697702096768 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.27
                  right:
                    Node: PC0 <= 0.501455264862675 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.24
                    right:
                      Leaf Node: Class 0.2
                right:
                  Node: PC0 <= 1.0024237525277537 [Info Gain: 0.9182958340
544894]
                  left:
                    Leaf Node: Class 1.0
                  right:
                    Node: PC0 <= 1.7184568010832912 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.68
                    right:
                      Leaf Node: Class 0.23
              right:
                Node: PC7 <= -0.812389083907626 [Info Gain: 0.999999999999
9998]
```

```
                left:
                  Node: PC1 <= 4.791682125848387 [Info Gain: 0.91829583405
44896]
                  left:
                    Leaf Node: Class 0.19
                  right:
                    Leaf Node: Class 0.15
                right:
                  Node: PC0 <= -1.4791333181935662 [Info Gain: 0.918295834
0544896]
                  left:
                    Leaf Node: Class 0.58
                  right:
                    Leaf Node: Class 0.53
  right:
    Node: PC1 <= 3.159073196576443 [Info Gain: 0.16363493702588894]
    left:
      Node: PC0 <= 7.708695911956341 [Info Gain: 0.16496668798549008]
      left:
        Node: PC5 <= -1.1513935950316612 [Info Gain: 0.14964667407395904]
        left:
          Node: PC10 <= -0.5050756798531213 [Info Gain: 0.530614226937830
7]
          left:
            Node: PC7 <= 0.3524127515982179 [Info Gain: 0.888650035908662]
            left:
              Node: PC4 <= 1.2022777921996541 [Info Gain: 0.99999999999999
98]
              left:
                Node: PC19 <= -0.2059165509282852 [Info Gain: 1.0]
                left:
                  Node: PC0 <= 5.164170932036018 [Info Gain: 0.91829583405
44896]
                  left:
                    Leaf Node: Class 0.08
                  right:
                    Leaf Node: Class 0.14
                right:
                  Leaf Node: Class 0.06
              right:
                Node: PC1 <= -2.8587972700764412 [Info Gain: 0.91829583405
44896]
                left:
                  Node: PC0 <= 4.009541561080144 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.16
                  right:
                    Leaf Node: Class 0.19
                right:
                  Leaf Node: Class 0.09
            right:
              Node: PC5 <= -2.704172661275386 [Info Gain: 0.78381302884158
28]
              left:
                Node: PC5 <= -3.372555588174803 [Info Gain: 0.999999999999
9998]
                left:
                  Node: PC0 <= 4.381836685366007 [Info Gain: 0.91829583405
44894]
                  left:
```

```
                    Leaf Node: Class 0.12
                  right:
                    Node: PC0 <= 4.507715457989489 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.03
                    right:
                      Leaf Node: Class 0.08
                right:
                  Node: PC0 <= 6.522044608831767 [Info Gain: 0.91829583405
44896]
                  left:
                    Leaf Node: Class 0.07
                  right:
                    Leaf Node: Class 0.02
              right:
                Node: PC14 <= -0.8042655912260923 [Info Gain: 0.9852281360
342513]
                left:
                  Node: PC0 <= 6.00804898021848 [Info Gain: 0.918295834054
4896]
                  left:
                    Leaf Node: Class 0.12
                  right:
                    Leaf Node: Class 0.18
                right:
                  Node: PC0 <= 3.837371936818607 [Info Gain: 0.81127812445
91328]
                  left:
                    Leaf Node: Class 0.05
                  right:
                    Leaf Node: Class 0.13
          right:
            Node: PC5 <= -2.233011042054792 [Info Gain: 0.656798554484399
5]
            left:
              Node: PC5 <= -2.7737217738219453 [Info Gain: 0.8631205685666
312]
              left:
                Node: PC4 <= 3.6456104358252737 [Info Gain: 1.0]
                left:
                  Node: PC0 <= 4.399176859749965 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.06
                  right:
                    Leaf Node: Class 0.1
                right:
                  Leaf Node: Class 0.07
              right:
                Node: PC19 <= -0.6337416928259832 [Info Gain: 0.6954618442
383218]
                left:
                  Node: PC1 <= -1.0519238686097534 [Info Gain: 0.811278124
4591328]
                  left:
                    Leaf Node: Class 0.11
                  right:
                    Leaf Node: Class 0.14
                right:
                  Node: PC9 <= -0.8019672438304002 [Info Gain: 1.0]
                  left:
```

```
                    Leaf Node: Class 0.04
                  right:
                    Node: PC0 <= 5.088532926255175 [Info Gain: 0.9182958340544896]
                    left:
                      Leaf Node: Class 0.11
                    right:
                      Leaf Node: Class 0.22
            right:
              Node: PC14 <= -0.18086306970611518 [Info Gain: 0.8423709931771088]
              left:
                Node: PC9 <= -0.36083359842132173 [Info Gain: 0.9999999999999998]
                left:
                  Node: PC0 <= 5.266698583697762 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.09
                  right:
                    Node: PC0 <= 7.205543799331409 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.1
                    right:
                      Leaf Node: Class 0.01
                right:
                  Node: PC0 <= 3.6625068806955383 [Info Gain: 0.8112781244591328]
                  left:
                    Leaf Node: Class 0.21
                  right:
                    Leaf Node: Class 0.08
              right:
                Node: PC0 <= 4.13015985280581 [Info Gain: 0.9999999999999998]
                left:
                  Node: PC2 <= -0.26196138218338744 [Info Gain: 0.9182958340544896]
                  left:
                    Leaf Node: Class 0.06
                  right:
                    Leaf Node: Class 0.17
                right:
                  Node: PC0 <= 4.514174566855133 [Info Gain: 0.9182958340544896]
                  left:
                    Leaf Node: Class 0.21
                  right:
                    Leaf Node: Class 0.11
        right:
          Node: PC10 <= 0.8672314949665249 [Info Gain: 0.19418793459248018]
          left:
            Node: PC3 <= 0.8278671219993888 [Info Gain: 0.24607454638966875]
            left:
              Node: PC19 <= 0.7631091271310928 [Info Gain: 0.31358147246975054]
              left:
                Node: PC9 <= -0.0031027702992183514 [Info Gain: 0.41242038807330017]
```

```
                left:
                  Node: PC16 <= 0.41614440949981596 [Info Gain: 0.66811481
54558434]
                  left:
                    Node: PC16 <= -0.8671775823610954 [Info Gain: 0.741294
0675383672]
                    left:
                      Node: PC1 <= -0.9505602223888894 [Info Gain: 0.97095
05944546687]
                      left:
                        Leaf Node: Class 0.07
                      right:
                        Node: PC0 <= 5.74516778220235 [Info Gain: 0.918295
8340544894]
                        left:
                          Leaf Node: Class 0.04
                        right:
                          Node: PC0 <= 5.906568624885362 [Info Gain: 1.0]
                          left:
                            Leaf Node: Class 0.02
                          right:
                            Leaf Node: Class 0.11
                    right:
                      Node: PC22 <= -0.5698506373966136 [Info Gain: 0.7793
498372920853]
                      left:
                        Node: PC0 <= 4.567564701691208 [Info Gain: 0.91829
58340544894]
                        left:
                          Leaf Node: Class 0.03
                        right:
                          Node: PC0 <= 5.729621297610283 [Info Gain: 1.0]
                          left:
                            Leaf Node: Class 0.05
                          right:
                            Leaf Node: Class 0.09
                      right:
                        Node: PC2 <= 0.5721158764580845 [Info Gain: 0.4689
955935892811]
                        left:
                          Node: PC9 <= -2.809047900804363 [Info Gain: 0.50
32583347756457]
                          left:
                            Leaf Node: Class 0.02
                          right:
                            Leaf Node: Class 0.06
                        right:
                          Leaf Node: Class 0.13
                  right:
                    Node: PC14 <= -0.49587153946967394 [Info Gain: 0.99107
60598382224]
                    left:
                      Node: PC3 <= -0.6215017757912046 [Info Gain: 0.97095
05944546687]
                      left:
                        Leaf Node: Class 0.01
                      right:
                        Node: PC0 <= 4.05920240171008 [Info Gain: 0.918295
8340544894]
                        left:
```

```
                        Leaf Node: Class 0.08
                      right:
                        Node: PC0 <= 4.187264557288642 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.05
                        right:
                          Leaf Node: Class 0.03
                  right:
                    Node: PC0 <= 7.044365557941209 [Info Gain: 0.8112781
244591328]
                    left:
                      Leaf Node: Class 0.15
                    right:
                      Leaf Node: Class 0.07
              right:
                Node: PC16 <= -1.2955440151315285 [Info Gain: 0.49123734
182433365]
                left:
                  Node: PC0 <= 3.615698672647369 [Info Gain: 0.918295834
0544894]
                  left:
                    Leaf Node: Class 0.06
                  right:
                    Node: PC0 <= 6.390394160868752 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.0
                    right:
                      Leaf Node: Class 0.12
                right:
                  Node: PC14 <= -0.44534221989020867 [Info Gain: 0.41754
24759098896]
                  left:
                    Node: PC1 <= -2.017173155581013 [Info Gain: 0.970950
5944546685]
                    left:
                      Node: PC6 <= 0.04499816380686555 [Info Gain: 0.918
2958340544896]
                      left:
                        Leaf Node: Class 0.04
                      right:
                        Leaf Node: Class 0.07
                    right:
                      Leaf Node: Class 0.08
                  right:
                    Node: PC7 <= 0.47145951708705225 [Info Gain: 0.48743
029809272165]
                    left:
                      Node: PC4 <= 1.7709626090738753 [Info Gain: 0.4101
3588810847357]
                      left:
                        Node: PC4 <= 0.8636467157981892 [Info Gain: 0.43
35941172605444]
                        left:
                          Leaf Node: Class 0.04
                        right:
                          Node: PC13 <= -0.29579559697184943 [Info Gain:
0.5032583347756457]
                          left:
                            Leaf Node: Class 0.04
                          right:
```

```
                            Leaf Node: Class 0.03
                        right:
                          Node: PC11 <= 0.17829721694125297 [Info Gain: 0.
9709505944546687]
                          left:
                            Node: PC0 <= 5.0998402933799145 [Info Gain: 1.
0]
                              left:
                                Leaf Node: Class 0.03
                              right:
                                Leaf Node: Class 0.04
                            right:
                              Leaf Node: Class 0.05
                      right:
                        Node: PC2 <= 0.09189413292764993 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.08
                        right:
                          Node: PC0 <= 6.96961071836384 [Info Gain: 1.0]
                          left:
                            Leaf Node: Class 0.01
                          right:
                            Leaf Node: Class 0.03
              right:
                Node: PC11 <= 0.34346164855885236 [Info Gain: 0.9709505944
54669]
                left:
                  Node: PC12 <= -0.06689975578800603 [Info Gain: 0.9999999
999999998]
                  left:
                    Node: PC0 <= 4.689157229666703 [Info Gain: 0.918295834
0544896]
                    left:
                      Leaf Node: Class 0.16
                    right:
                      Leaf Node: Class 0.15
                  right:
                    Leaf Node: Class 0.02
                right:
                  Node: PC7 <= 0.37400055483370803 [Info Gain: 0.811278124
4591328]
                  left:
                    Leaf Node: Class 0.05
                  right:
                    Leaf Node: Class 0.04
            right:
              Node: PC0 <= 5.349866810660451 [Info Gain: 0.414533148956664
4]
              left:
                Node: PC19 <= 0.11885254107408556 [Info Gain: 0.5827902775
373919]
                left:
                  Node: PC1 <= -0.9602349223974951 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= 4.469504483098028 [Info Gain: 0.764204506
5086198]
                    left:
                      Node: PC7 <= -1.8635195977315737 [Info Gain: 0.86312
05685666311]
                        left:
```

```
                        Node: PC0 <= 3.7896448027339664 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.26
                        right:
                          Leaf Node: Class 0.03
                      right:
                        Node: PC1 <= -1.251687384903639 [Info Gain: 0.7219
280948873623]
                        left:
                          Leaf Node: Class 0.04
                        right:
                          Leaf Node: Class 0.18
                    right:
                      Node: PC0 <= 4.530628884606832 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.2
                      right:
                        Leaf Node: Class 0.17
                  right:
                    Node: PC8 <= -0.5192539306340657 [Info Gain: 0.7642045
065086203]
                    left:
                      Node: PC3 <= 1.4804727703052023 [Info Gain: 0.863120
5685666308]
                      left:
                        Leaf Node: Class 0.11
                      right:
                        Node: PC1 <= 1.9229162452381792 [Info Gain: 0.7219
280948873623]
                        left:
                          Leaf Node: Class 0.06
                        right:
                          Leaf Node: Class 0.05
                    right:
                      Leaf Node: Class 0.12
                right:
                  Node: PC19 <= 0.29132052910824313 [Info Gain: 0.76420450
65086198]
                  left:
                    Node: PC3 <= 1.315435967963122 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.13
                    right:
                      Leaf Node: Class 0.09
                  right:
                    Node: PC7 <= -1.6962884353649683 [Info Gain: 0.7495952
5725948]
                    left:
                      Node: PC0 <= 3.648923129637021 [Info Gain: 0.9182958
340544894]
                      left:
                        Leaf Node: Class 0.07
                      right:
                        Node: PC0 <= 3.956236491002127 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.02
                        right:
                          Leaf Node: Class 0.31
                    right:
                      Node: PC15 <= -1.0522218177182376 [Info Gain: 0.5949
```

```
066182439393]
                      left:
                        Node: PC0 <= 4.823454642645958 [Info Gain: 0.91829
58340544896]
                        left:
                          Leaf Node: Class 0.12
                        right:
                          Leaf Node: Class 0.1
                      right:
                        Node: PC21 <= -0.375527900717629 [Info Gain: 0.704
4340029249649]
                        left:
                          Node: PC0 <= 5.036533648857337 [Info Gain: 0.721
9280948873623]
                          left:
                            Leaf Node: Class 0.11
                          right:
                            Leaf Node: Class 0.1
                        right:
                          Node: PC3 <= 1.0677489928971078 [Info Gain: 0.91
82958340544896]
                          left:
                            Leaf Node: Class 0.1
                          right:
                            Leaf Node: Class 0.06
              right:
                Node: PC12 <= 0.5039321598342208 [Info Gain: 0.55559964527
7316]
                left:
                  Node: PC12 <= -1.451929311831761 [Info Gain: 0.579777846
4679282]
                  left:
                    Node: PC1 <= 0.22815977720271374 [Info Gain: 0.9999999
999999998]
                    left:
                      Node: PC0 <= 6.057439045045316 [Info Gain: 0.9182958
340544896]
                      left:
                        Leaf Node: Class 0.02
                      right:
                        Leaf Node: Class 0.17
                    right:
                      Node: PC0 <= 7.253944252164746 [Info Gain: 0.9182958
340544896]
                      left:
                        Leaf Node: Class 0.08
                      right:
                        Leaf Node: Class 0.09
                  right:
                    Node: PC6 <= 0.2700391449034675 [Info Gain: 0.65709141
61644228]
                    left:
                      Node: PC19 <= -0.15689378031436785 [Info Gain: 0.622
384751252099]
                      left:
                        Node: PC3 <= 1.0787780222652887 [Info Gain: 0.5612
781244591329]
                        left:
                          Node: PC0 <= 5.641807414409556 [Info Gain: 1.0]
                          left:
```

```
                          Leaf Node: Class 0.17
                        right:
                          Leaf Node: Class 0.12
                      right:
                        Node: PC1 <= 0.518595627209121 [Info Gain: 0.650
0224216483541]
                        left:
                          Leaf Node: Class 0.03
                        right:
                          Leaf Node: Class 0.12
                    right:
                      Node: PC2 <= -0.3671584909758784 [Info Gain: 0.466
91718668869925]
                      left:
                        Leaf Node: Class 0.04
                      right:
                        Node: PC0 <= 5.993020013277235 [Info Gain: 0.918
2958340544896]
                        left:
                          Leaf Node: Class 0.03
                        right:
                          Leaf Node: Class 0.04
                  right:
                    Node: PC12 <= -1.0559400518462683 [Info Gain: 0.9182
958340544896]
                    left:
                      Node: PC0 <= 6.769405147335451 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.04
                      right:
                        Leaf Node: Class 0.08
                    right:
                      Leaf Node: Class 0.05
                right:
                  Node: PC17 <= 0.2853565966833945 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.02
                  right:
                    Node: PC0 <= 5.7957931321400435 [Info Gain: 1.0]
                    left:
                      Node: PC0 <= 5.560036472868957 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.09
                      right:
                        Leaf Node: Class 0.14
                    right:
                      Node: PC0 <= 6.163394869960111 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.06
                      right:
                        Leaf Node: Class 0.1
          right:
            Node: PC2 <= 0.22462568818344172 [Info Gain: 0.505654001797868
8]
            left:
              Node: PC18 <= 0.5677484040815441 [Info Gain: 0.5124694044878
573]
              left:
                Node: PC13 <= -0.9239009613830405 [Info Gain: 0.5269453436
183462]
```

```
                left:
                  Node: PC9 <= 0.24021339332409786 [Info Gain: 0.985228136
0342516]
                  left:
                    Node: PC1 <= 0.06532236608536961 [Info Gain: 0.8112781
244591328]
                    left:
                      Leaf Node: Class 0.05
                    right:
                      Leaf Node: Class 0.09
                  right:
                    Node: PC0 <= 4.310713339496355 [Info Gain: 0.918295834
0544894]
                    left:
                      Leaf Node: Class 0.02
                    right:
                      Node: PC0 <= 6.39988766639496 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.18
                      right:
                        Leaf Node: Class 0.03
                right:
                  Node: PC19 <= 0.18724351595322788 [Info Gain: 0.46060577
99537937]
                  left:
                    Node: PC22 <= -0.34806053039744544 [Info Gain: 0.75162
91673878226]
                    left:
                      Node: PC0 <= 6.059855410851464 [Info Gain: 0.8112781
244591329]
                      left:
                        Node: PC1 <= -4.085049440270112 [Info Gain: 0.6500
224216483541]
                        left:
                          Leaf Node: Class 0.02
                        right:
                          Leaf Node: Class 0.08
                      right:
                        Node: PC0 <= 6.259965052748457 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.1
                        right:
                          Leaf Node: Class 0.16
                    right:
                      Node: PC1 <= 0.6407625633825937 [Info Gain: 0.811278
1244591328]
                      left:
                        Leaf Node: Class 0.03
                      right:
                        Leaf Node: Class 0.02
                  right:
                    Node: PC7 <= 0.4082214736453002 [Info Gain: 0.46899559
35892812]
                    left:
                      Leaf Node: Class 0.03
                    right:
                      Leaf Node: Class 0.1
              right:
                Node: PC2 <= -2.876512124896351 [Info Gain: 0.999999999999
9998]
```

```
                left:
                  Node: PC0 <= 4.171652760472645 [Info Gain: 0.91829583405
44894]
                  left:
                    Leaf Node: Class 0.0
                  right:
                    Node: PC0 <= 4.751834799158516 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.03
                    right:
                      Leaf Node: Class 0.01
                right:
                  Node: PC1 <= -1.6889755988999116 [Info Gain: 0.918295834
0544896]
                  left:
                    Leaf Node: Class 0.22
                  right:
                    Leaf Node: Class 0.17
            right:
              Node: PC7 <= -0.540122964165984 [Info Gain: 0.99403021147695
75]
              left:
                Node: PC9 <= 0.4153796711831864 [Info Gain: 0.999999999999
9998]
                left:
                  Leaf Node: Class 0.09
                right:
                  Node: PC0 <= 4.208750550813955 [Info Gain: 0.91829583405
44894]
                  left:
                    Leaf Node: Class 0.13
                  right:
                    Node: PC0 <= 5.051439635177789 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.17
                    right:
                      Leaf Node: Class 0.05
              right:
                Node: PC0 <= 4.586839392206997 [Info Gain: 0.9709505944546
687]
                left:
                  Node: PC0 <= 4.282162497791927 [Info Gain: 0.91829583405
44894]
                  left:
                    Leaf Node: Class 0.18
                  right:
                    Node: PC0 <= 4.5106815659873964 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.15
                    right:
                      Leaf Node: Class 0.22
                right:
                  Leaf Node: Class 0.07
      right:
        Node: PC4 <= 1.0897503914122886 [Info Gain: 0.27591345176422033]
        left:
          Node: PC6 <= -1.1080380889207184 [Info Gain: 0.3602118709049424
4]
          left:
            Node: PC6 <= -1.560253789039628 [Info Gain: 0.991076059838222
```

```
4]
            left:
              Node: PC4 <= -0.9228991907029963 [Info Gain: 0.9709505944546
687]
              left:
                Node: PC0 <= 8.009162401642138 [Info Gain: 0.9182958340544
894]
                left:
                  Leaf Node: Class 0.19
                right:
                  Node: PC0 <= 8.652702533551691 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.11
                  right:
                    Leaf Node: Class 0.12
              right:
                Leaf Node: Class 0.06
            right:
              Node: PC0 <= 8.596273822377213 [Info Gain: 1.0]
              left:
                Node: PC0 <= 8.412987931964079 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.07
                right:
                  Leaf Node: Class 0.05
              right:
                Leaf Node: Class 0.08
          right:
            Node: PC17 <= 0.5192493669875935 [Info Gain: 0.279264106541752
27]
            left:
              Node: PC7 <= 0.5539506969979311 [Info Gain: 0.30699855925878
25]
              left:
                Node: PC6 <= -0.4944799352565553 [Info Gain: 0.75161447181
01816]
                left:
                  Node: PC1 <= 0.4134589069421609 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.04
                  right:
                    Node: PC0 <= 8.350527097052245 [Info Gain: 0.918295834
0544896]
                    left:
                      Leaf Node: Class 0.06
                    right:
                      Leaf Node: Class 0.02
                right:
                  Node: PC10 <= -0.25704413487721806 [Info Gain: 0.7709505
944546686]
                  left:
                    Node: PC0 <= 8.185632830480827 [Info Gain: 0.811278124
4591328]
                    left:
                      Leaf Node: Class 0.08
                    right:
                      Leaf Node: Class 0.06
                  right:
                    Node: PC0 <= 7.799737495021942 [Info Gain: 0.918295834
0544896]
```

```
                    left:
                      Node: PC0 <= 7.781673707821537 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.08
                      right:
                        Leaf Node: Class 0.05
                    right:
                      Leaf Node: Class 0.03
                right:
                  Node: PC20 <= -0.3879802133816536 [Info Gain: 0.3568739866
6263004]
                  left:
                    Node: PC15 <= -1.4552036774923685 [Info Gain: 0.55677964
94470394]
                    left:
                      Node: PC5 <= 2.965278611138568 [Info Gain: 1.0]
                      left:
                        Node: PC0 <= 9.991192714226345 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.04
                        right:
                          Leaf Node: Class 0.02
                      right:
                        Leaf Node: Class 0.05
                    right:
                      Leaf Node: Class 0.02
                  right:
                    Node: PC20 <= 0.12007823196840786 [Info Gain: 0.68939174
67430879]
                    left:
                      Node: PC1 <= -1.0414488170571223 [Info Gain: 0.8631205
685666309]
                      left:
                        Node: PC0 <= 8.077138621540582 [Info Gain: 1.0]
                        left:
                          Leaf Node: Class 0.08
                        right:
                          Leaf Node: Class 0.02
                      right:
                        Leaf Node: Class 0.03
                    right:
                      Leaf Node: Class 0.02
            right:
              Node: PC8 <= 1.8498622725676794 [Info Gain: 0.74358589309845
96]
              left:
                Node: PC1 <= 0.13816420702740642 [Info Gain: 1.0]
                left:
                  Node: PC0 <= 9.926552383765598 [Info Gain: 0.91829583405
44896]
                  left:
                    Leaf Node: Class 0.06
                  right:
                    Leaf Node: Class 0.0
                right:
                  Node: PC2 <= 1.340367831121941 [Info Gain: 0.91829583405
44896]
                  left:
                    Leaf Node: Class 0.02
                  right:
```

```
                    Leaf Node: Class 0.01
                right:
                  Node: PC0 <= 12.635438119929793 [Info Gain: 0.721928094887
3623]
                  left:
                    Leaf Node: Class 0.04
                  right:
                    Leaf Node: Class 0.06
          right:
            Node: PC0 <= 10.259056996198794 [Info Gain: 0.4020784069005816]
            left:
              Node: PC13 <= 0.12735374833485616 [Info Gain: 0.40058006239993
16]
              left:
                Node: PC19 <= 0.5249463542750765 [Info Gain: 0.4506607463653
922]
                left:
                  Node: PC14 <= 0.5152862419735444 [Info Gain: 0.91829583405
44896]
                  left:
                    Node: PC5 <= 2.3105153441124613 [Info Gain: 0.6500224216
483541]
                    left:
                      Leaf Node: Class 0.01
                    right:
                      Leaf Node: Class 0.05
                  right:
                    Node: PC0 <= 10.026769199039355 [Info Gain: 0.9182958340
544896]
                    left:
                      Leaf Node: Class 0.02
                    right:
                      Leaf Node: Class 0.18
                right:
                  Node: PC14 <= -0.8531683759923684 [Info Gain: 0.9709505944
546687]
                  left:
                    Leaf Node: Class 0.02
                  right:
                    Node: PC0 <= 8.215204418431066 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.07
                    right:
                      Leaf Node: Class 0.05
              right:
                Node: PC1 <= -0.9444243506863026 [Info Gain: 0.5839204788510
35]
                left:
                  Node: PC0 <= 8.320885959312237 [Info Gain: 1.0]
                  left:
                    Node: PC0 <= 8.305612765204815 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.01
                    right:
                      Leaf Node: Class 0.0
                  right:
                    Node: PC0 <= 8.442332523797708 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.02
                    right:
```

```
                    Leaf Node: Class 0.07
                right:
                  Node: PC9 <= -0.7146689837291794 [Info Gain: 0.43983727721
99859]
                  left:
                    Node: PC11 <= -0.6719786918242545 [Info Gain: 1.0]
                    left:
                      Leaf Node: Class 0.02
                    right:
                      Leaf Node: Class 0.04
                  right:
                    Node: PC4 <= 1.1434961624915818 [Info Gain: 0.5612781244
591329]
                    left:
                      Node: PC0 <= 7.925050636550777 [Info Gain: 1.0]
                      left:
                        Leaf Node: Class 0.05
                      right:
                        Leaf Node: Class 0.09
                    right:
                      Node: PC1 <= 0.4103465392122052 [Info Gain: 0.65002242
16483541]
                      left:
                        Leaf Node: Class 0.05
                      right:
                        Leaf Node: Class 0.04
            right:
              Node: PC2 <= -1.4130445117765658 [Info Gain: 1.0]
              left:
                Node: PC0 <= 10.616819609551015 [Info Gain: 0.81127812445913
28]
                left:
                  Leaf Node: Class 0.01
                right:
                  Leaf Node: Class 0.04
              right:
                Node: PC0 <= 10.691655067374901 [Info Gain: 0.81127812445913
28]
                left:
                  Leaf Node: Class 0.03
                right:
                  Leaf Node: Class 0.1
    right:
      Node: PC5 <= 0.1048575731879691 [Info Gain: 0.5567164009818013]
      left:
        Node: PC13 <= -0.9636575910360118 [Info Gain: 0.6508125738878991]
        left:
          Node: PC13 <= -1.3660675568526817 [Info Gain: 0.841881298238772
7]
          left:
            Node: PC7 <= 1.0962974020057927 [Info Gain: 0.999999999999999
8]
            left:
              Node: PC0 <= 5.625580204141542 [Info Gain: 0.918295834054489
6]
              left:
                Leaf Node: Class 0.26
              right:
                Leaf Node: Class 0.1
            right:
```

```
              Node: PC0 <= 4.710113345642145 [Info Gain: 0.918295834054489
4]
              left:
                Leaf Node: Class 0.13
              right:
                Node: PC0 <= 5.287252151878695 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.2
                right:
                  Leaf Node: Class 0.16
          right:
            Node: PC13 <= -1.1441236396930299 [Info Gain: 0.98522813603425
15]
            left:
              Node: PC0 <= 5.319016103306107 [Info Gain: 0.918295834054489
6]
              left:
                Leaf Node: Class 0.18
              right:
                Leaf Node: Class 0.11
            right:
              Node: PC0 <= 5.945132109349853 [Info Gain: 0.811278124459132
8]
              left:
                Leaf Node: Class 0.25
              right:
                Leaf Node: Class 0.16
        right:
          Node: PC1 <= 5.894081510570722 [Info Gain: 0.868229793185122]
          left:
            Node: PC5 <= -2.2128319360579796 [Info Gain: 0.819020323054032
9]
            left:
              Node: PC20 <= -0.8446876034305578 [Info Gain: 1.0]
              left:
                Leaf Node: Class 0.22
              right:
                Node: PC0 <= 3.6814346664165556 [Info Gain: 0.918295834054
4894]
                left:
                  Leaf Node: Class 0.14
                right:
                  Node: PC0 <= 6.135172561229914 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.07
                  right:
                    Leaf Node: Class 0.03
            right:
              Node: PC14 <= 0.48641072242344474 [Info Gain: 0.994030211476
9568]
              left:
                Node: PC15 <= -0.10631855698161286 [Info Gain: 0.970950594
4546686]
                left:
                  Leaf Node: Class 0.09
                right:
                  Leaf Node: Class 0.12
              right:
                Node: PC0 <= 5.696808247346666 [Info Gain: 0.9999999999999
998]
```

```
                left:
                  Node: PC1 <= 4.08510115912032 [Info Gain: 0.918295834054
4896]
                  left:
                    Leaf Node: Class 0.15
                  right:
                    Leaf Node: Class 0.27
                right:
                  Node: PC0 <= 10.051913747165004 [Info Gain: 0.9182958340
544896]
                  left:
                    Leaf Node: Class 0.06
                  right:
                    Leaf Node: Class 0.14
          right:
            Node: PC19 <= -0.528135009125366 [Info Gain: 0.994030211476957
2]
            left:
              Node: PC4 <= -0.5340215765630351 [Info Gain: 0.9999999999999
998]
              left:
                Node: PC0 <= 4.826001004377214 [Info Gain: 0.9182958340544
896]
                left:
                  Leaf Node: Class 0.26
                right:
                  Leaf Node: Class 0.05
              right:
                Node: PC4 <= 0.517155855557664 [Info Gain: 0.9182958340544
896]
                left:
                  Leaf Node: Class 0.37
                right:
                  Leaf Node: Class 0.2
            right:
              Node: PC5 <= -2.690506896273039 [Info Gain: 0.97095059445466
87]
              left:
                Leaf Node: Class 0.1
              right:
                Node: PC0 <= 6.965897572242088 [Info Gain: 0.9182958340544
894]
                left:
                  Leaf Node: Class 0.11
                right:
                  Node: PC0 <= 9.25764132444283 [Info Gain: 1.0]
                  left:
                    Leaf Node: Class 0.08
                  right:
                    Leaf Node: Class 0.14
      right:
        Node: PC18 <= 0.19142995743130073 [Info Gain: 0.8251629167387828]
        left:
          Node: PC16 <= 0.3216746229957851 [Info Gain: 0.7367826633222951]
          left:
            Node: PC11 <= 0.7467826614728249 [Info Gain: 0.561278124459132
9]
            left:
              Node: PC5 <= 3.1880768089898597 [Info Gain: 0.65002242164835
41]
```

```
              left:
                Leaf Node: Class 0.04
              right:
                Leaf Node: Class 0.1
            right:
              Node: PC0 <= 8.38301924687949 [Info Gain: 1.0]
              left:
                Leaf Node: Class 0.1
              right:
                Leaf Node: Class 0.83
          right:
            Node: PC4 <= -0.7224071786200509 [Info Gain: 0.985228136034251
6]
            left:
              Node: PC0 <= 3.7185587056407656 [Info Gain: 0.81127812445913
28]
              left:
                Leaf Node: Class 0.21
              right:
                Leaf Node: Class 0.03
            right:
              Node: PC0 <= 7.911727432692058 [Info Gain: 0.918295834054489
4]
              left:
                Leaf Node: Class 0.28
              right:
                Node: PC0 <= 8.662396827548474 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.11
                right:
                  Leaf Node: Class 0.04
        right:
          Node: PC0 <= 6.362074616236452 [Info Gain: 0.9967916319816359]
          left:
            Node: PC0 <= 5.4309271286292935 [Info Gain: 0.985228136034251
6]
            left:
              Node: PC0 <= 4.686205708287726 [Info Gain: 0.918295834054489
4]
              left:
                Leaf Node: Class 0.4
              right:
                Node: PC0 <= 5.014932081338942 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.06
                right:
                  Leaf Node: Class 0.21
            right:
              Node: PC0 <= 5.718618878939599 [Info Gain: 1.0]
              left:
                Node: PC0 <= 5.4836129029369785 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.18
                right:
                  Leaf Node: Class 0.2
              right:
                Node: PC0 <= 5.752588946443799 [Info Gain: 1.0]
                left:
                  Leaf Node: Class 0.16
                right:
```

```
        Leaf Node: Class 0.0
    right:
      Node: PC1 <= 3.9984587146391304 [Info Gain: 1.0]
      left:
        Node: PC1 <= 3.7855241130784365 [Info Gain: 1.0]
        left:
          Leaf Node: Class 0.07
        right:
          Node: PC0 <= 11.788976055157395 [Info Gain: 1.0]
          left:
            Leaf Node: Class 0.05
          right:
            Leaf Node: Class 0.01
      right:
        Node: PC0 <= 8.440018853654108 [Info Gain: 1.0]
        left:
          Node: PC0 <= 7.792827973550439 [Info Gain: 1.0]
          left:
            Leaf Node: Class 0.45
          right:
            Leaf Node: Class 0.03
        right:
          Node: PC0 <= 8.885360375132475 [Info Gain: 1.0]
          left:
            Leaf Node: Class 0.17
          right:
            Leaf Node: Class 0.13
```

Decision Tree Implementation

1. `Node` Class

The `Node` class represents a node in the decision tree. It has attributes for decision nodes (`feature_index` , `threshold` , `left` , `right` , `info_gain`) and leaf nodes (`value`).

2. `DecisionTreeClassifier` Class

The Decision Tree Classifier is implemented with a recursive binary tree structure. It builds the tree by selecting the best feature and threshold for splitting based on information gain. The tree stops growing when a specified depth or minimum samples for splitting is reached. Leaf nodes represent the majority class, and the structure is printed for interpretability. The classifier is trained using the fit method and makes predictions for new datasets.

Initialization:

The class is initialized with parameters `min_samples_split` and `max_depth` to control the tree-building process.

Methods:

1. **`build_tree`** : Recursive tree construction.
2. **`get_best_split`** : Finds best split based on Entropy.

3. `split` : Divides data based on feature threshold.
4. `information_gain` : Computes information gain.
5. `calculate_leaf_value` : Determines leaf value.
6. `print_tree` : Prints tree structure.
7. `fit` : Trains the tree.
8. `predict` : Makes predictions.
9. `make_prediction` : Predicts a single data point.

Usage

- An instance of DecisionTreeClassifier is created with specified parameters.
- The fit method is called to train the tree on the training data.
- Predictions are made using the predict method on the test data.
- Accuracy is calculated using a simple accuracy calculating function.

Interpretation of Accuracy

In [ ]:
```
print(f"The Accuracy of the Decision Tree Classifier is: {acc}%")
```

```
The Accuracy of the Decision Tree Classifier is: 57.89473684210527%
```

Improvement Suggestions

- Tune hyperparameters.
- Analyze feature importance.
- Use cross-validation.
- Iteratively refine based on insights.
- Advanced Tree algorithms improve implementation and optimization

3. Adaboost

3.1 Implementation of the Model

In [ ]:
```
# Decision stump used as weak classifier
class DecisionStump():
    def __init__(self):
        self.polarity = 1
        self.feature_idx = None
        self.threshold = None
        self.alpha = None

    def predict(self, X):
        n_samples = X.shape[0]
        X_column = X[:, self.feature_idx]
        predictions = np.ones(n_samples)
```

```
        if self.polarity == 1:
            predictions[X_column < self.threshold] = -1
        else:
            predictions[X_column > self.threshold] = -1

        return predictions


class Adaboost():

    def __init__(self, n_clf=2):
        self.n_clf = n_clf

    def fit(self, X, y):
        n_samples, n_features = X.shape

        # Initialize weights to 1/N
        w = np.full(n_samples, (1 / n_samples))

        self.clfs = []
        # Iterate through classifiers
        for _ in range(self.n_clf):
            clf = DecisionStump()

            min_error = float('inf')
            # greedy search to find best threshold and feature
            for feature_i in range(n_features):
                X_column = X[:, feature_i]
                thresholds = np.unique(X_column)

                for threshold in thresholds:
                    # predict with polarity 1
                    p = 1
                    predictions = np.ones(n_samples)
                    predictions[X_column < threshold] = -1

                    # Error = sum of weights of misclassified samples
                    misclassified = w[y != predictions]
                    error = sum(misclassified)

                    if error > 0.5:
                        error = 1 - error
                        p = -1

                    # store the best configuration
                    if error < min_error:
                        clf.polarity = p
                        clf.threshold = threshold
                        clf.feature_idx = feature_i
                        min_error = error

            # calculate alpha
            EPS = 1e-10
            clf.alpha = 0.5 * np.log((1.0 - min_error + EPS) / (min_error

            # calculate predictions and update weights
            predictions = clf.predict(X)

            w *= np.exp(-clf.alpha * y * predictions)
            # Normalize to one
```

```
            w /= np.sum(w)

            # Save classifier
            self.clfs.append(clf)

    def predict(self, X):
        clf_preds = [clf.alpha * clf.predict(X) for clf in self.clfs]
        y_pred = np.sum(clf_preds, axis=0)
        y_pred = np.sign(y_pred)

        return y_pred

classifier = Adaboost()
```

In [ ]:
```
classifier.fit(X_train.values, y_train)

y_pred = classifier.predict(X_test.values)
```

In [ ]:
```
acc = accuracy(y_test, y_pred, threshold=1)
acc
```

Out[ ]:
```
56.390977443609025
```

3.2 Insights drawn (plots, markdown explanations)

AdaBoost Implementation

1. `DecisionStump` Class

The `DecisionStump` class represents a weak classifier (a decision stump). It has attributes for polarity, feature index, threshold, and alpha.

2. `Adaboost` Class

Adaboost, short for Adaptive Boosting, is an ensemble learning algorithm that combines weak classifiers to create a strong classifier. In this implementation, weak classifiers are decision stumps (simple decision trees with a single split). Adaboost iteratively trains decision stumps(`DecisionStump`), adjusting their weights based on their performance. The `Adaboost` Class iteratively selects the best feature and threshold for each weak classifier, assigning higher weights to misclassified samples. The final prediction is a weighted combination of individual weak classifiers. The algorithm adapts by adjusting weights and focuses on difficult-to-classify instances. The resulting ensemble achieves better accuracy than individual classifiers.

Initialization:

The class is initialized with the number of weak classifiers (`n_clf`).

Methods:

1. `fit` : Trains the AdaBoost ensemble by iteratively training weak classifiers.

2. `predict`: Makes predictions using the ensemble.

Usage

- An instance of the `AdaBoost` class is created with the specified number of weak classifiers.
- The `fit` method is called to train the AdaBoost ensemble on the training data.
- Predictions are made using the `predict` method on the test data.
- Accuracy is calculated using a simple accuracy calculating function.

Interpretation of Accuracy

In [ ]:
```
print(f"The Accuracy of the AdaBoost Classifier is: {acc}%")
```

```
The Accuracy of the AdaBoost Classifier is: 56.390977443609025%
```

Improvement Suggestions

- Experiment with different weak classifiers.
- Fine-tune hyperparameters, especially the learning rate.
- Consider increasing the number of weak classifiers.
- Evaluate performance on a variety of datasets to ensure generalization.
- Analyze misclassifications for further insights.

4. Multiclass SVM

4.1 Implementation of the Model

In [ ]:
```
class MultiClassSVM:
    def __init__(self, C=1.0, learning_rate=0.01, epochs=500):
        self.C = C  # Regularization parameter
        self.learning_rate = learning_rate
        self.epochs = epochs
        self.classifiers = []

    def fit(self, X, y):
        unique_classes = np.unique(y)

        for cls in unique_classes:
            binary_labels = np.where(y == cls, 1, -1)
            classifier = self.train_one_class(X, binary_labels)
            self.classifiers.append((cls, classifier))

    def train_one_class(self, X, y):
        m, n = X.shape
        weights = np.zeros(n)
        bias = 0

        for epoch in range(self.epochs):
            for i in range(m):
                if y[i] * (np.dot(X[i], weights) - bias) >= 1:
```

```
                    weights -= self.learning_rate * (2 * self.C * weights
                else:
                    weights -= self.learning_rate * (2 * self.C * weights
                    bias -= self.learning_rate * y[i]

        return (weights, bias)

    def predict(self, X):
        predictions = []

        for cls, classifier in self.classifiers:
            weights, bias = classifier
            decision = np.dot(X, weights) - bias
            predictions.append((cls, decision))

        # Choose the class with the highest decision value as the predict
        return max(predictions, key=lambda x: x[1])[0]

# Convert labels to binary for each class
def to_binary_labels(y, target_class):
    return np.where(y == target_class, 1, -1)

# Train the SVM classifier
classifier = MultiClassSVM()
classifier.fit(X_train.values, y_train)

# Make predictions
predictions = [classifier.predict(x) for x in X_test.values]
```

In [ ]:
```
acc = accuracy(y_test, predictions)
acc
```

Out[ ]:
```
58.64661654135338
```

4.2 Insights drawn (plots, markdown explanations)

Multi-Class SVM Implementation

`to_binary_labels` Function

The `to_binary_labels` function converts the multi-class labels to binary labels for each class, where the target class is assigned a label of 1 and all other classes are assigned a label of -1.

`MultiClassSVM` Class

The `MultiClassSVM` class implements a multi-class Support Vector Machine (SVM) using a **ONE-VS-ALL** strategy. It has attributes for the regularization parameter (`C`), learning rate (`learning_rate`), and number of epochs (`epochs`). The trained classifiers for each class are stored in the `classifiers` attribute.

Methods:

1. **`fit` Method:** Iterates over unique classes, converts labels to binary, and trains a binary SVM for each class. The trained classifiers are stored in the `classifiers` attribute.
2. **`train_one_class` Method:** Trains a binary SVM for one class using stochastic gradient descent (SGD) with hinge loss.
3. **`predict` Method:** Makes predictions by obtaining decision values for each class and selecting the class with the highest decision value as the prediction.

Usage

- An instance of the `MultiClassSVM` class is created with specified parameters.
- The `fit` method is called to train the multi-class SVM on the training data.
- Predictions are made using the `predict` method on the test data.
- Accuracy is calculated using a simple accuracy calculating function.

Interpretation of Accuracy

In [ ]:
```
print(f"The Accuracy of the Multi-Class SVM Classifier is: {acc}%")
```

```
The Accuracy of the Multi-Class SVM Classifier is: 58.64661654135338%
```

Improvement Suggestions

- Fine-tune hyperparameters (e.g., `C`, `learning_rate`, `epochs`).
- Evaluate performance on various datasets to ensure generalization.
- Implement kernelized SVM for non-linear decision boundaries.
- Explore additional multi-class SVM strategies (e.g., one-vs-one).
- Use Cross-validation strategy to evaluate the Model using standard SVM libraries.

5. References

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