

**Ex. No.: 8 a.**

**Date: 11/10/24**

### **A PYTHON PROGRAM TO IMPLEMENT ADA BOOSTING**

**Aim:**

To implement a python program for Ada Boosting.

**Algorithm:**

**Step 1: Import Necessary Libraries Import**

numpy as np.

Import pandas as pd.

Import DecisionTreeClassifier from sklearn.tree.

Import train\_test\_split from sklearn.model\_selection.

Import accuracy\_score from sklearn.metrics.

**Step 2: Load and Prepare Data**

Load your dataset using pd.read\_csv() (e.g., df = pd.read\_csv('data.csv')).

Separate features (X) and target (y).

Split the dataset into training and testing sets using train\_test\_split().

**Step 3: Initialize Parameters**

Set the number of weak classifiers n\_estimators.

Initialize an array weights for instance weights, setting each weight to 1 / number\_of\_samples.

**Step 4: Train Weak Classifiers**

Loop for n\_estimators iterations:

Train a weak classifier using DecisionTreeClassifier(max\_depth=1) on the training data weighted by weights.

Predict the target values using the trained weak classifier.

Calculate the error rate err as the sum of weights of misclassified samples divided by the sum of all weights.

Compute the classifier's weight alpha using  $0.5 * \log((1 - \text{err}) / \text{err})$ .

Update the weights: multiply the weights of misclassified samples by  $\text{np.exp}(\alpha)$  and the weights of correctly classified samples by  $\text{np.exp}(-\alpha)$ .

Normalize the weights so that they sum to 1.

Append the trained classifier and its weight to lists classifiers and alphas.

#### Step 5: Make Predictions

For each sample in the testing set:

Initialize a prediction score to 0.

For each trained classifier and its weight:

Add the classifier's prediction (multiplied by its weight) to the prediction score.

Take the sign of the prediction score as the final prediction.

#### Step 6: Evaluate the Model

Compute the accuracy of the AdaBoost model on the testing set using `accuracy_score()`.

#### Step 7: Output Results

Print or plot the final accuracy and possibly other evaluation metrics.

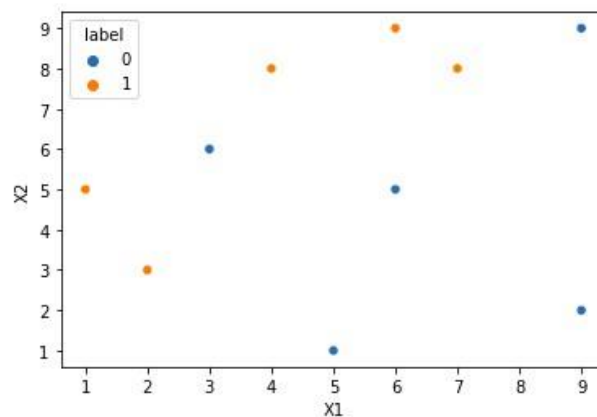
### **PROGRAM:**

```
import pandas as pd  import numpy as np from
mlxtend.plotting import plot_decision_regions df =
pd.DataFrame()      df['X1']=[1,2,3,4,5,6,6,7,9,9]
df['X2']=[5,3,6,8,1,9,5,8,9,2]
df['label']=[1,1,0,1,0,1,0,1,0,0]
```

	X1	X2	label
0	1	5	1
1	2	3	1
2	3	6	0
3	4	8	1
4	5	1	0
5	6	9	1
6	6	5	0
7	7	8	1
8	9	9	0
9	9	2	0

```
import seaborn as sns
sns.scatterplot(x=df['X1'],y=df['X2'],hue=df['label'])
```

```
<AxesSubplot:xlabel='X1', ylabel='X2'>
```



```
df['weights']=1/df.shape[0]
```

	X1	X2	label	weights
0	1	5	1	0.1
1	2	3	1	0.1
2	3	6	0	0.1
3	4	8	1	0.1
4	5	1	0	0.1
5	6	9	1	0.1
6	6	5	0	0.1
7	7	8	1	0.1
8	9	9	0	0.1
9	9	2	0	0.1

```
from sklearn.tree import DecisionTreeClassifier
```

```
dt1 = DecisionTreeClassifier(max_depth=1)
```

```
x = df.iloc[:,0:2].values y =
```

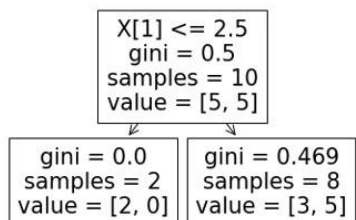
```
df.iloc[:,2].values # Step 2 - Train 1st Model
```

```
dt1.fit(x,y)
```

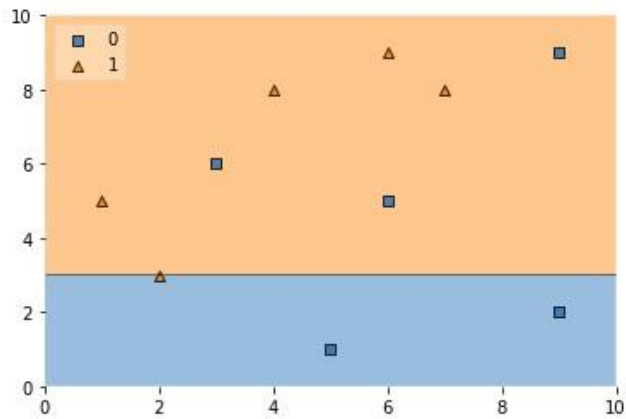
```
from sklearn.tree import plot_tree
```

```
plot_tree(dt1)
```

```
[Text(0.5, 0.75, 'X[1] <= 2.5\ngini = 0.5\nsamples = 10\nvalue = [5, 5]'),  
Text(0.25, 0.25, 'gini = 0.0\nsamples = 2\nvalue = [2, 0]'),  
Text(0.75, 0.25, 'gini = 0.469\nsamples = 8\nvalue = [3, 5]')]
```



```
plot_decision_regions(x,yclf=dt1, legend=2)
```



```
df['y_pred'] = dt1.predict(x)
```

	X1	X2	label	weights	y_pred
0	1	5	1	0.1	1
1	2	3	1	0.1	1
2	3	6	0	0.1	1
3	4	8	1	0.1	1
4	5	1	0	0.1	0
5	6	9	1	0.1	1
6	6	5	0	0.1	1
7	7	8	1	0.1	1
8	9	9	0	0.1	1
9	9	2	0	0.1	0

```
def calculate_model_weight(error):
    return 0.5*np.log((1-error)/(error))
```

```
# Step - 3 Calculate model weight
alpha1 = calculate_model_weight(0.3)
alpha1
```

**0.42364893019360184**

```
# Step -4 Update weights def
update_row_weights(row,alpha=0.423): if
row['label'] == row['y_pred']:
```

```
        return row['weights']* np.exp(-alpha)
    else:
        return row['weights']* np.exp(alpha)

df['updated_weights'] = df.apply(update_row_weights,axis=1)
```

	X1	X2	label	weights	y_pred	updated_weights
0	1	5	1	0.1	1	0.065508
1	2	3	1	0.1	1	0.065508
2	3	6	0	0.1	1	0.152653
3	4	8	1	0.1	1	0.065508
4	5	1	0	0.1	0	0.065508
5	6	9	1	0.1	1	0.065508
6	6	5	0	0.1	1	0.152653
7	7	8	1	0.1	1	0.065508
8	9	9	0	0.1	1	0.152653
9	9	2	0	0.1	0	0.065508

```
df['updated_weights'].sum()
```

```
0.9165153319682015
```

```
df['normalized_weights']=df['updated_weights']/df['updated_weights'].sum()
```

	X1	X2	label	weights	y_pred	updated_weights	normalized_weights
0	1	5	1	0.1	1	0.065508	0.071475
1	2	3	1	0.1	1	0.065508	0.071475
2	3	6	0	0.1	1	0.152653	0.166559
3	4	8	1	0.1	1	0.065508	0.071475
4	5	1	0	0.1	0	0.065508	0.071475
5	6	9	1	0.1	1	0.065508	0.071475
6	6	5	0	0.1	1	0.152653	0.166559
7	7	8	1	0.1	1	0.065508	0.071475
8	9	9	0	0.1	1	0.152653	0.166559
9	9	2	0	0.1	0	0.065508	0.071475

```
df['normalized_weights'].sum()
```

```
|:
```

```
1.0
```

```
df['cumsum_upper'] = np.cumsum(df['normalized_weights'])
```

```
df['cumsum_lower']=df['cumsum_upper'] - df['normalized_weights']
```

```
df[['X1','X2','label','weights','y_pred','updated_weights','cumsum_lower','cumsum_upper'
```

	X1	X2	label	weights	y_pred	updated_weights	cumsum_lower	cumsum_upper
0	1	5	1	0.1	1	0.065508	0.000000	0.071475
1	2	3	1	0.1	1	0.065508	0.071475	0.142950
2	3	6	0	0.1	1	0.152653	0.142950	0.309508
3	4	8	1	0.1	1	0.065508	0.309508	0.380983
4	5	1	0	0.1	0	0.065508	0.380983	0.452458
5	6	9	1	0.1	1	0.065508	0.452458	0.523933
6	6	5	0	0.1	1	0.152653	0.523933	0.690492
7	7	8	1	0.1	1	0.065508	0.690492	0.761967
8	9	9	0	0.1	1	0.152653	0.761967	0.928525
9	9	2	0	0.1	0	0.065508	0.928525	1.000000

```
def create_new_dataset(df):
    indices= []
    for i in range(df.shape[0]):
        a = np.random.random()
        for index,row in df.iterrows():
            if row['cumsum_upper']>a
            and a>row['cumsum_lower']:
                indices.append(index)
    return indices
```

```
index_values = create_new_dataset(df)
index_values
```

```
[6, 6, 0, 6, 7, 5, 1, 8, 4, 6]
```

```
second_df= df.iloc[index_values,[0,1,2,3]]
second_df
```



	X1	X2	label	weights
6	6	5	0	0.1
6	6	5	0	0.1
0	1	5	1	0.1
6	6	5	0	0.1
7	7	8	1	0.1
5	6	9	1	0.1
1	2	3	1	0.1
8	9	9	0	0.1
4	5	1	0	0.1
6	6	5	0	0.1

```
dt2 = DecisionTreeClassifier(max_depth=1)
```

```
x = second_df.iloc[:,0:2].values
```

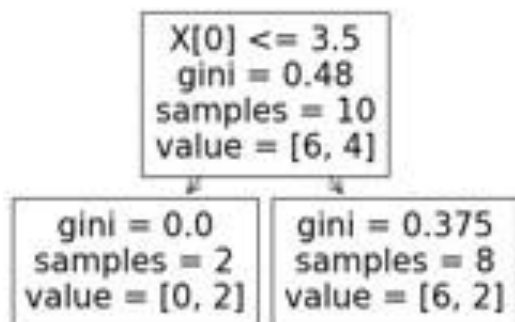
```
y = second_df.iloc[:,2].values
```

```
dt2.fit(x,y)
```

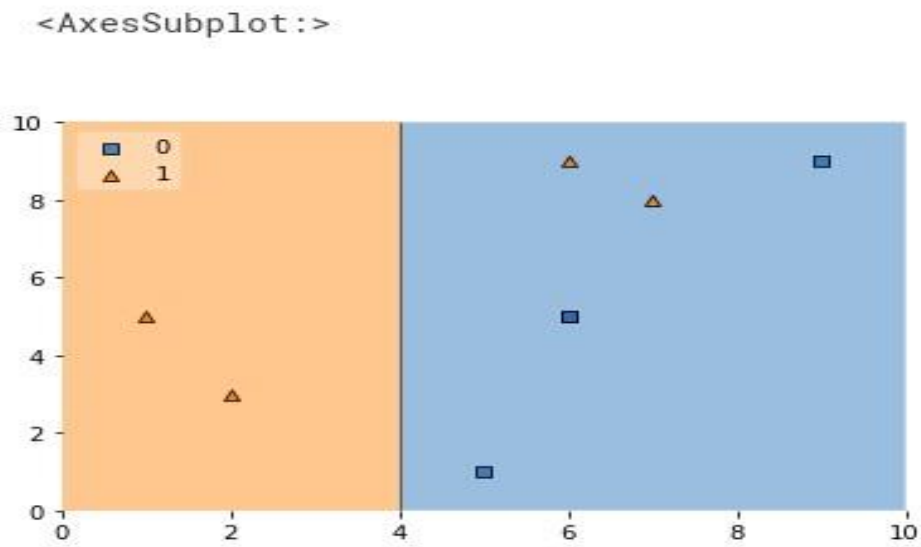
```
DecisionTreeClassifier(max_depth=1)
```

```
plot_tree(dt2)
```

```
[Text(0.5, 0.75, 'X[0] <= 3.5\ngini = 0.48\nsamples = 10\nvalue = [6, 4]'),
 Text(0.25, 0.25, 'gini = 0.0\nsamples = 2\nvalue = [0, 2]'),
 Text(0.75, 0.25, 'gini = 0.375\nsamples = 8\nvalue = [6, 2]')]
```



```
plot_decision_regions(x, y, clf=dt2, legend=2)
```



```
second_df['y_pred'] = dt2.predict(x) second_df
```

```
alpha2 = calculate_model_weight(0.1)
```

	X1	X2	label	weights	y_pred
6	6	5	0	0.1	0
6	6	5	0	0.1	0
0	1	5	1	0.1	1
6	6	5	0	0.1	0
7	7	8	1	0.1	0
5	6	9	1	0.1	0
1	2	3	1	0.1	1
8	9	9	0	0.1	0
4	5	1	0	0.1	0
6	6	5	0	0.1	0

alpha2

1.0986122886681098

**# Step 4 - Update weights** def

update\_row\_weights(row,alpha=1.09): if

row['label'] == row['y\_pred']:

return row['weights'] \* np.exp(-alpha)

else:

return row['weights'] \* np.exp(alpha)

second\_df['updated\_weights'] = second\_df.apply(update\_row\_weights,axis=1)

second\_df second\_df['nomalized\_weights'].sum()

	X1	X2	label	weights	y_pred	updated_weights
6	6	5	0	0.1	0	0.033622
6	6	5	0	0.1	0	0.033622
0	1	5	1	0.1	1	0.033622
6	6	5	0	0.1	0	0.033622
7	7	8	1	0.1	0	0.297427
5	6	9	1	0.1	0	0.297427
1	2	3	1	0.1	1	0.033622
8	9	9	0	0.1	0	0.033622
4	5	1	0	0.1	0	0.033622
6	6	5	0	0.1	0	0.033622

second\_df['nomalized\_weights'].sum()

0.9999999999999999

```

second_df['cumsum_upper'] = np.cumsum(second_df['normalized_weights'])
second_df['cumsum_lower'] = second_df['cumsum_upper'] - second_df['normalized_weights']
second_df[['X1','X2','label','weights','y_pred','normalized_weights','cumsum_lower','cumsum_
upper']]

```

	X1	X2	label	weights	y_pred	normalized_weights	cumsum_lower	cumsum_upper
6	6	5	0	0.1	0	0.038922	0.000000	0.038922
6	6	5	0	0.1	0	0.038922	0.038922	0.077843
0	1	5	1	0.1	1	0.038922	0.077843	0.116765
6	6	5	0	0.1	0	0.038922	0.116765	0.155687
7	7	8	1	0.1	0	0.344313	0.155687	0.500000
5	6	9	1	0.1	0	0.344313	0.500000	0.844313
1	2	3	1	0.1	1	0.038922	0.844313	0.883235
8	9	9	0	0.1	0	0.038922	0.883235	0.922157
4	5	1	0	0.1	0	0.038922	0.922157	0.961078
6	6	5	0	0.1	0	0.038922	0.961078	1.000000

```

index_values = create_new_dataset(second_df)
third_df = second_df.iloc[index_values[0,1,2,3]]
third_df

```

	X1	X2	label	weights
1	2	3	1	0.1
6	6	5	0	0.1
5	6	9	1	0.1
1	2	3	1	0.1
5	6	9	1	0.1
8	9	9	0	0.1
8	9	9	0	0.1
8	9	9	0	0.1
5	6	9	1	0.1
8	9	9	0	0.1

```

y = second_df.iloc[:,2].values
dt3.fit(X,y)

```

```

DecisionTreeClassifier(max_depth=1)

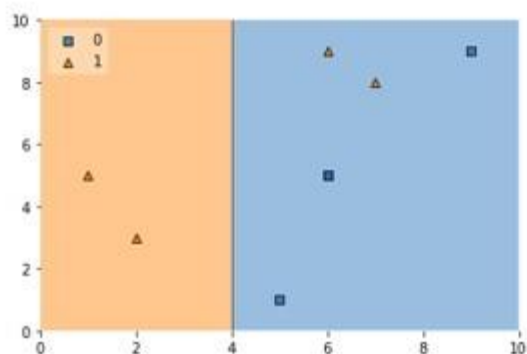
```

```

plot_decision_regions(X, y, clf=dt3, legend=2)

```

<AxesSubplot:>



```

third_df['y_pred'] = dt.predict(X)

```

```

alpha3 = calculate_model_weight(0.7) alpha3

```

```
-0.4236489301936017
```

```
print(alpha1,alpha2,alpha3)
```

```
0.42364893019360184 1.0986122886681098 -0.4236489301936017
```

```
query = np.array([1,5]).reshape(1,2) dt1.predict(query)
```

```
array([1])
```

```
dt2.predict(query)
```

```
array([1])
```

```
dt3.predict(query)
```

```
array([1])
```

```
alpha1*1 + alpha2*(1) + alpha3*(1)
```

```
1.09861228866811
```

```
np.sign(1.09)
```

```
1.0
```

```
query = np.array([9,9]).reshape(1,2) dt1.predict(query)
```

```
array([1])
```

```
dt2.predict(query)
```

```
array([0])
```

```
dt3.predict(query)
```

```
array([0])
```

```
alpha1*(1) + alpha2*(-1) + alpha3*(-1)
```

```
-0.2513144282809062
```

```
np.sign(-0.25)
```

'J' -1.0

### **RESULT:**

Thus the python program to implement Adaboosting has been executed successfully and the results have been verified and analyzed.