EXPERIMENT : 8(a)

A python program to implement ada boost

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 * np.log((1 - err) / err).
Update the weights: multiply the weights of misclassified samples by np.exp(alpha) and the weights of correctly classified samples by 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.

CODE 1:

```
import pandas as pd
import numpy as np
import seaborn as sns
from sklearn.tree import DecisionTreeClassifier, plot_tree
from mlxtend.plotting import plot_decision_regions
import matplotlib.pyplot as plt

# Create dataset
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]
display(df)
```

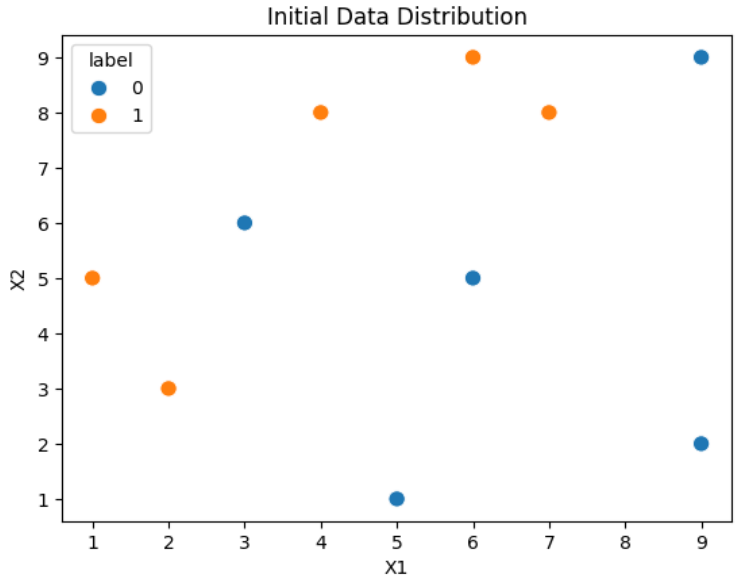
OUTPUT1:

	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

CODE 2:

```
sns.scatterplot(x=df['X1'], y=df['X2'], hue=df['label'], s=80)
plt.title("Initial Data Distribution")
plt.show()
```

OUTPUT 2:



CODE 3:

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

display(df)
```

OUTPUT 3:

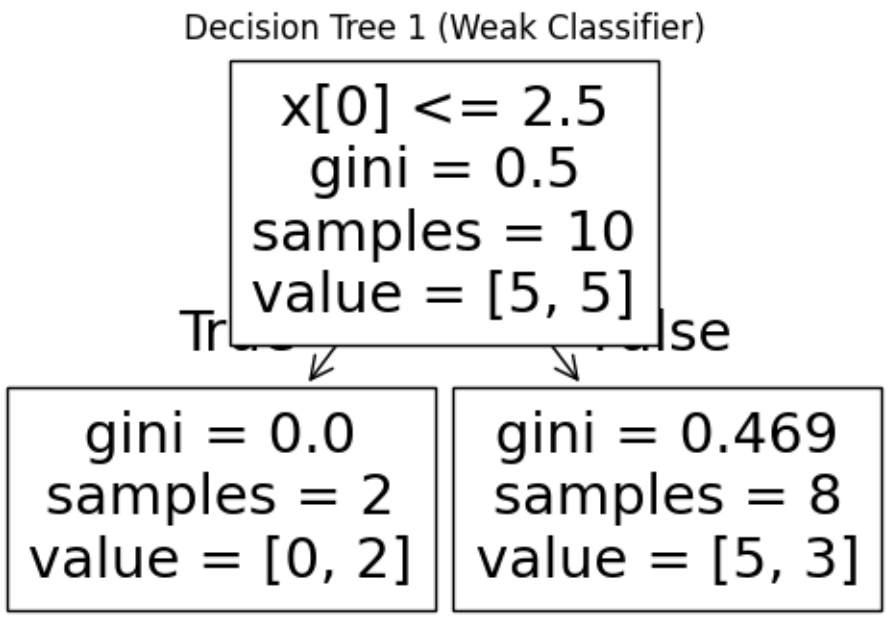
	X1	X2	label	weights
0	1	5	1	0.1
1	2	3	1	0.1
2	3	6	0	0.1
3	4	8	1	0.1
4	5	1	0	0.1
5	6	9	1	0.1
6	6	5	0	0.1

	X1	X2	label	weights
7	7	8	1	0.1
8	9	9	0	0.1
9	9	2	0	0.1

CODE 4:

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

y = df.iloc[:, 2].values

dt1 = DecisionTreeClassifier(max_depth=1)

dt1.fit(x, y)


plt.figure(figsize=(6,4))

plot_tree(dt1)

plt.title("Decision Tree 1 (Weak Classifier)")

plt.show()
```

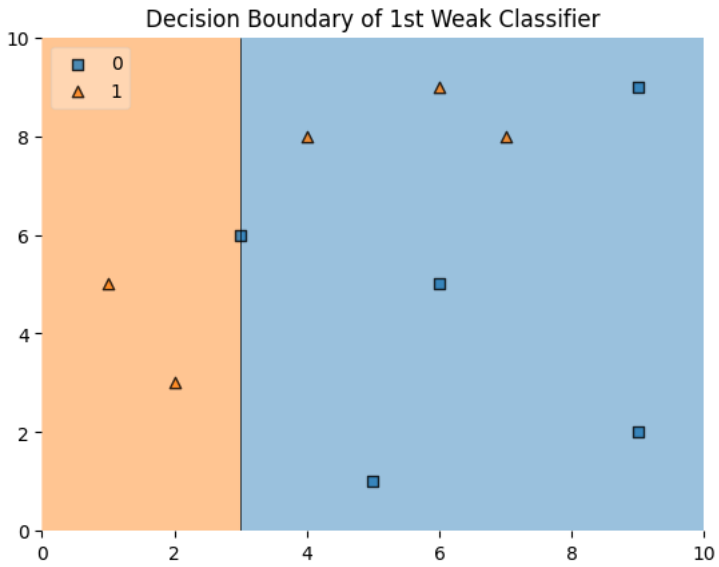
OUTPUT 4:



CODE 5:

```
plot_decision_regions(x, y, clf=dt1, legend=2)

plt.title("Decision Boundary of 1st Weak Classifier")

plt.show()
```

OUTPUT 5:



CODE 6:

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

display(df)


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


alpha1 = calculate_model_weight(0.3)


def update_row_weights(row, alpha):
   if row['label'] == row['y_pred']:
      return row['weights'] * np.exp(-alpha)
   else:
      return row['weights'] * np.exp(alpha)


df['updated_weights'] = df.apply(lambda r:
update_row_weights(r, alpha1), axis=1)

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

display(df[['X1','X2','label','weights','y_pred','normalized_weight
s']])

print("Sum of normalized weights:",
df['normalized_weights'].sum())
```

OUTPUT 6:

	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	0
3	4	8	1	0.1	0
4	5	1	0	0.1	0
5	6	9	1	0.1	0
6	6	5	0	0.1	0
7	7	8	1	0.1	0
8	9	9	0	0.1	0
9	9	2	0	0.1	0

	X1	X2	label	weights	y_pred	normalized_weights
0	1	5	1	0.1	1	0.071429
1	2	3	1	0.1	1	0.071429
2	3	6	0	0.1	0	0.071429
3	4	8	1	0.1	0	0.166667
4	5	1	0	0.1	0	0.071429
5	6	9	1	0.1	0	0.166667

	X1	X2	label	weights	y_pred	normalized_weights
6	6	5	0	0.1	0	0.071429
7	7	8	1	0.1	0	0.166667
8	9	9	0	0.1	0	0.071429
9	9	2	0	0.1	0	0.071429

Sum of normalized weights: 0.9999999999999999

CODE 7:

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

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

display(df[['X1','X2','label','weights','y_pred','normalized_weights','cumsum_lower','cumsum_upper']])
```

OUTPUT 7:

	X1	X2	label	weights	y_pred	normalized_weights	cumsum_lower	cumsum_upper
0	1	5	1	0.1	1	0.071429	0.000000	0.071429
1	2	3	1	0.1	1	0.071429	0.071429	0.142857
2	3	6	0	0.1	0	0.071429	0.142857	0.214286
3	4	8	1	0.1	0	0.166667	0.214286	0.380952
4	5	1	0	0.1	0	0.071429	0.380952	0.452381
5	6	9	1	0.1	0	0.166667	0.452381	0.619048

	X1	X2	label	weights	y_pred	normalized_weights	cumsum_lower	cumsum_upper
6	6	5	0	0.1	0	0.071429	0.619048	0.690476
7	7	8	1	0.1	0	0.166667	0.690476	0.857143
8	9	9	0	0.1	0	0.071429	0.857143	0.928571
9	9	2	0	0.1	0	0.071429	0.928571	1.000000

CODE 8:

```
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)
print("Sampled indices for next dataset:", index_values)


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

display(second_df)

OUTPUT 8:

Sampled indices for next dataset: [3, 2, 0, 2, 7, 9, 3, 7, 4, 7]

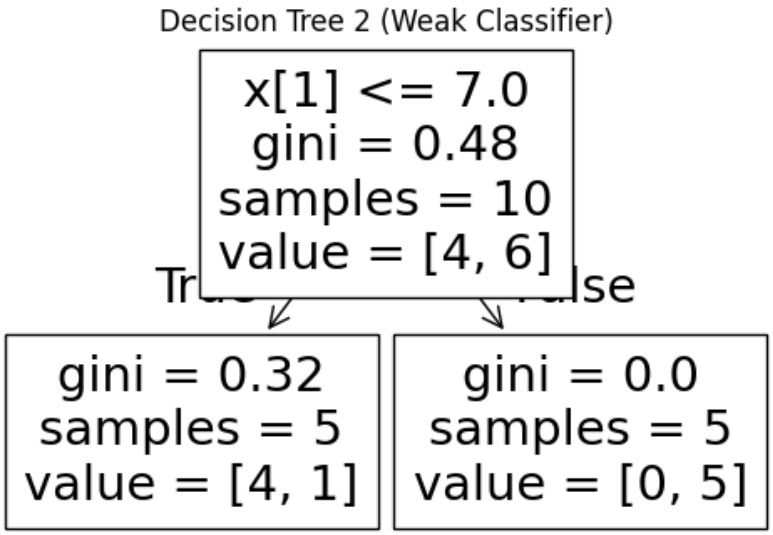
	X1	X2	label	weights
3	4	8	1	0.1
2	3	6	0	0.1
0	1	5	1	0.1
2	3	6	0	0.1
7	7	8	1	0.1
9	9	2	0	0.1
3	4	8	1	0.1
7	7	8	1	0.1
4	5	1	0	0.1
7	7	8	1	0.1

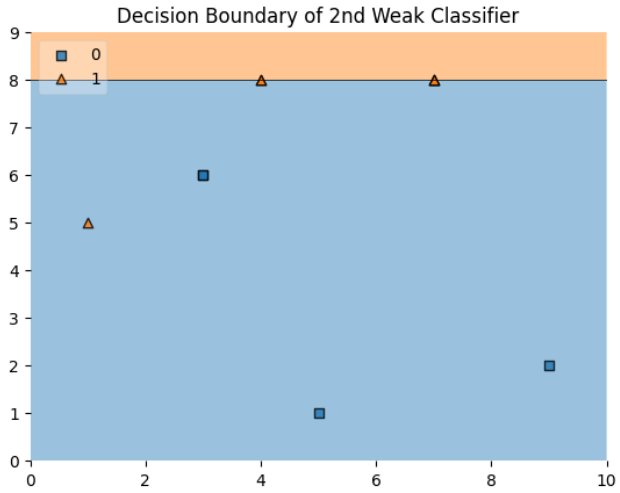
CODE 9:

```
x2 = second_df.iloc[:,0:2].values

y2 = second_df.iloc[:,2].values

dt2 = DecisionTreeClassifier(max_depth=1)

dt2.fit(x2, y2)
```

```
plt.figure(figsize=(6,4))
plot_tree(dt2)
plt.title("Decision Tree 2 (Weak Classifier)")
plt.show()

plot_decision_regions(x2, y2, clf=dt2, legend=2)
plt.title("Decision Boundary of 2nd Weak Classifier")
plt.show()

second_df['y_pred'] = dt2.predict(x2)
display(second_df)
alpha2 = calculate_model_weight(0.1)
print("Alpha 2 =", alpha2)
```

OUTPUT 9:





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

Alpha 2 = 1.0986122886681098

CODE 10:

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

```
print("\nQuery [1,5] predictions:")
print("dt1:", dt1.predict(query))
print("dt2:", dt2.predict(query))

query2 = np.array([9,9]).reshape(1,2)
print("\nQuery [9,9] predictions:")
print("dt1:", dt1.predict(query2))
print("dt2:", dt2.predict(query2))
```

OUTPUT 10:

Query [1,5] predictions:

dt1: [1]

dt2: [0]

Query [9,9] predictions:

dt1: [0]

dt2: [1]

RESULT:

Thus a python program to implement ada boost is written and the output is verified.