BMS Institute of Technology and Management

(An Autonomous Institution, Affiliated to VTU, Belagavi)

Department of Master of Computer Applications

(Accredited by NBA, New Delhi)

Alternate Assessment Tool (AAT)

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AAT Question or Topic or Problem Statement

Implement Decision Tree Algorithm (ID3) using Python for the given Dataset

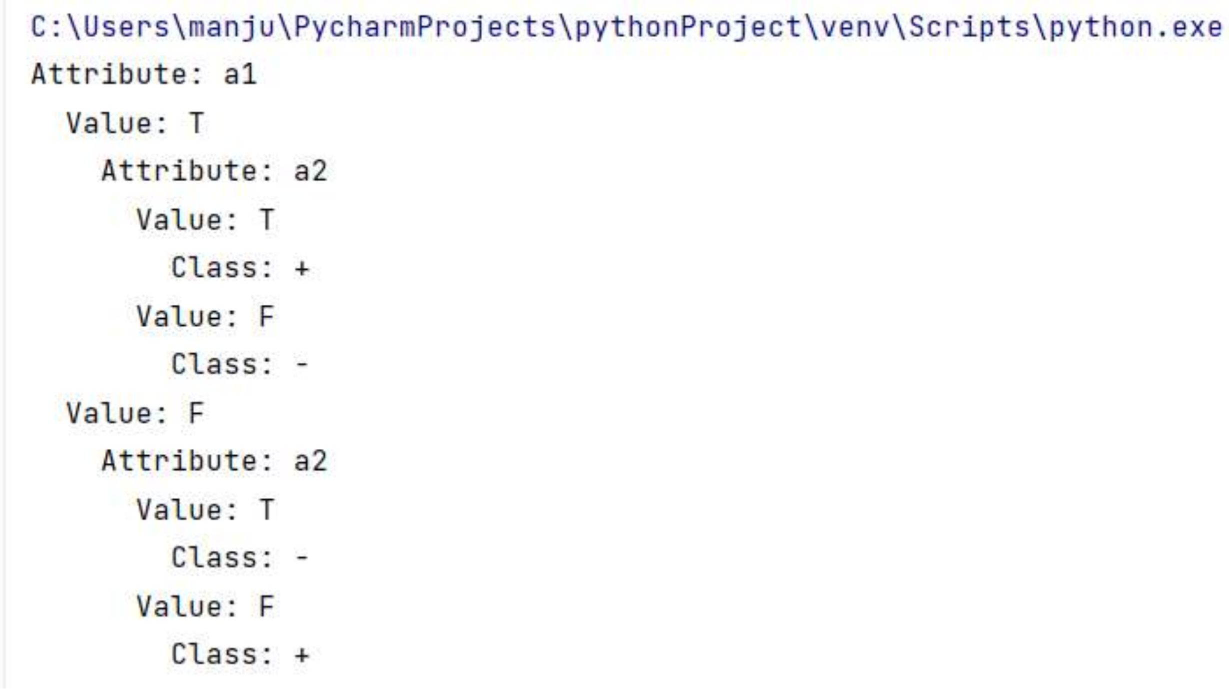
Solution / Answer

Data-Set

Instance	Classification	a1	a2
1	+	T	T
2	+	T	T
3	-	T	F
4	+	F	F
5	-	F	T
6	-	F	T

```
from graphviz import Digraph


class Node:
    def __init__(self, data=None, attribute=None, branches=None, classification=None):
        self.data = data  # Training data at this node
        self.attribute = attribute  # Attribute to split on
        self.branches = branches  # Subtrees (child nodes)
        self.classification = classification  # Class label (if leaf node)


def calculate_entropy(labels):
    from math import log2

    unique_labels = set(labels)
    entropy = 0.0

    for label in unique_labels:
        probability = list(labels).count(label) / len(labels)  # Convert set to list before counting
        entropy -= probability * log2(probability)

    return entropy


def id3(data, attributes, target_attribute):
    if len(set(data[target_attribute])) == 1:
        # If all instances have the same classification, return a leaf node
        return Node(classification=data[target_attribute].iloc[0])

    if len(attributes) == 0:
        # If no attributes left, return a leaf node with the majority class
        majority_class = data[target_attribute].mode()[0]
        return Node(classification=majority_class)

    # Calculate the entropy of the current data
    current_entropy = calculate_entropy(data[target_attribute])
    # Find the attribute with the highest information gain
    max_info_gain = 0
    best_attribute = None

    for attribute in attributes:
        values = set(data[attribute])
        new_entropy = 0.0

        for value in values:
            subset = data[data[attribute] == value]
            subset_entropy = calculate_entropy(subset[target_attribute])
            new_entropy += len(subset) / len(data) * subset_entropy

        info_gain = current_entropy - new_entropy

        if info_gain > max_info_gain:
            max_info_gain = info_gain
            best_attribute = attribute

    if best_attribute is None:
        # If no attribute provides information gain, return a leaf node with the majority class
        majority_class = data[target_attribute].mode()[0]
        return Node(classification=majority_class)

    # Split the data based on the best attribute
    branches = {}
    values = set(data[best_attribute])

    for value in values:
        subset = data[data[best_attribute] == value]
        branches[value] = id3(subset, attributes - {best_attribute}, target_attribute)

    return Node(attribute=best_attribute, branches=branches)


def visualize_tree(node, dot=None, parent_value=None):
    if dot is None:
        dot = Digraph(comment='Decision Tree')

    if node.classification is not None:
        dot.node(str(id(node)), f'Class: {node.classification}\n(for Value: {parent_value})')
    else:
        if parent_value is not None:
            dot.node(str(id(node)), f'Value: {parent_value}\nAttribute: {node.attribute}')
        else:
            dot.node(str(id(node)), f'Attribute: {node.attribute}')

        for value, branch in node.branches.items():
            visualize_tree(branch, dot, value)
            dot.edge(str(id(node)), str(id(branch)), label=str(value))
    return dot


# Example usage
import pandas as pd

# Creating a DataFrame from the provided data
data = {
    'Instance': [1, 2, 3, 4, 5, 6],
    'Classification': ['+', '+', '-', '+', '-', '-'],
    'a1': ['T', 'T', 'T', 'F', 'F', 'F'],
    'a2': ['T', 'T', 'F', 'F', 'T', 'T']
}

df = pd.DataFrame(data)

# Specify the target attribute (Classification) and the attributes to consider for splitting
target_attribute = 'Classification'
attributes = {'a1', 'a2'}

# Build the decision tree
root_node = id3(df, attributes, target_attribute)

# Visualize the decision tree using graphviz
dot = visualize_tree(root_node)
dot.render('decision_tree', format='png', cleanup=True)
```

Out-put:



```
C:\Users\manju\PycharmProjects\pythonProject\venv\Scripts\python.exe
Attribute: a1
  Value: T
    Attribute: a2
      Value: T
        Class: +
      Value: F
        Class: -
  Value: F
    Attribute: a2
      Value: T
        Class: -
      Value: F
        Class: +
```