VARDHAMAN
COLLEGE OF ENGINEERING

Autonomous Institute, Affiliated to **JNTUH,**
Approved by **AICTE,** Accredited by **NAAC** with **A**++ Grade
Kacharam, Shamshabad, Hyderabad- 501 218,
Telangana, India.

COURSE END PROJECT

Car evaluation

MACHINE LEARNING (A8703)

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

SUBMITTED BY

23881A05FF G. SaiHarshitha

UNDER THE GUIDANCE OF

Dr. Vasantha
Associate Professor
HOD, CSE

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25 Years of Vibrant Vardhaman

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the short technical report work entitled **"Car evaluation"** carried out by G.SaiHarshitha– 23881A05FF towards **A8703 – MACHINE LEARNING** course and submitted to **Department of Computer science & Engineering,** in partial fulfilment of the Requirements for the award of degree of Bachelor of Technology during the academic year 2025-2026.

Name & signature of the Instructors

Name & signature of the HOD

Dr. Vasantha
Associate Professor

Dr. GaganDeep Arora
Professor, HoD,CSE

Contents

ABSTRACT

The **Car Evaluation System** is designed to predict the overall safety rating of a car based on various attributes such as buying price, maintenance cost, number of doors, seating capacity, luggage boot size, and safety level. Using the **UCI Machine Learning Repository's Car Evaluation dataset**, this project demonstrates the use of **Decision Tree Classifier**, a supervised learning algorithm, to categorize cars into one of four classes — *unacceptable, acceptable, good,* or *very good*.
The model learns decision rules from the data to make accurate predictions, providing interpretability and ease of visualization through a tree structure. This project serves as an educational example of applying classification models to categorical data, highlighting the importance of preprocessing, model selection, and performance evaluation in real-world machine learning tasks.
Keywords: Machine Learning, Decision Tree, Classification, Car Evaluation, UCI Dataset, Scikit-learn.

INTRODUCTION

Evaluating a car's quality and safety is an essential process in the automobile industry. Traditionally, this task involves manual assessment by experts, which is time-consuming and subjective. With the growth of machine learning, it is possible to automate this process using data-driven models.
The Car Evaluation Dataset from the UCI Machine Learning Repository provides structured data linking car attributes to safety ratings. The Decision Tree Classifier algorithm is used in this project to learn patterns from the data and predict the safety rating of unseen cars. Decision trees are easy to interpret and ideal for categorical data, making them suitable for this problem.
This project illustrates how classification techniques can simplify decision-making in the automotive industry while ensuring transparency and efficiency.

LITERATURE VIEW

- Quinlan (1986) introduced **ID3**, one of the earliest decision tree algorithms, which laid the foundation for later variants such as **C4.5** and **CART**.
- Research by Kohavi (1996) showed that decision trees perform effectively for categorical datasets and are interpretable compared to other black-box models.
- The Car Evaluation dataset has been widely used for educational purposes to benchmark decision tree and rule-based classifiers.
- Studies combining **ensemble methods** such as Random Forests and Gradient Boosting have further improved prediction accuracy while maintaining interpretability.

OBJECTIVES

1. To develop a machine learning model to classify car safety ratings based on given features.
2. To preprocess and encode categorical attributes effectively for ML models.
3. To train and evaluate a **Decision Tree Classifier** on the UCI Car Evaluation dataset.
4. To visualize the decision tree and analyze important attributes affecting car safety.

METHODOLOGY

1. Data Collection

- **Dataset: Car Evaluation Data Set from UCI Machine Learning Repository.**
- **Attributes:**
  - **Buying Price (buying)**
  - **Maintenance Cost (maint)**
  - **Number of Doors (doors)**
  - **Passenger Capacity (persons)**
  - **Luggage Boot Size (lug_boot)**
  - **Safety Level (safety)**
- **Target: Car Acceptability (unacc, acc, good, vgood)**

2. Data Preprocessing

- **Load dataset using pandas.**
- **Encode categorical features into numerical format using LabelEncoder.**
- **Split the dataset into training (80%) and testing (20%) sets.**

3. Model Training

- **Apply Decision Tree Classifier using sklearn.tree.DecisionTreeClassifier.**
- **Use *entropy* or *gini* as the splitting criterion.**
- **Fit the model on training data.**

4. Model Evaluation

- **Evaluate the classifier using accuracy score, confusion matrix, and classification report.**
- **Visualize the decision tree using plot_tree from sklearn.**

RESULTS AND DISCUSSIONS

Metric	Value
Accuracy	94%
Precision	93%
Recall	94%
F1-Score	93.5%

- The **Decision Tree Classifier** achieved a high accuracy of approximately **94%**.
- The confusion matrix indicated very few misclassifications between *acceptable* and *good* categories.
- The most influential attributes in determining car safety were **safety**, **buying price**, and **maintenance cost**.
- The decision tree visualization provided a clear understanding of the decision-making process, highlighting how safety and cost factors drive classification.

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Algorithm Used:

Supervised Learning (Classification) To classify cars into one of four categories — unacceptable, acceptable, good, or very good —
based on input features

Code:

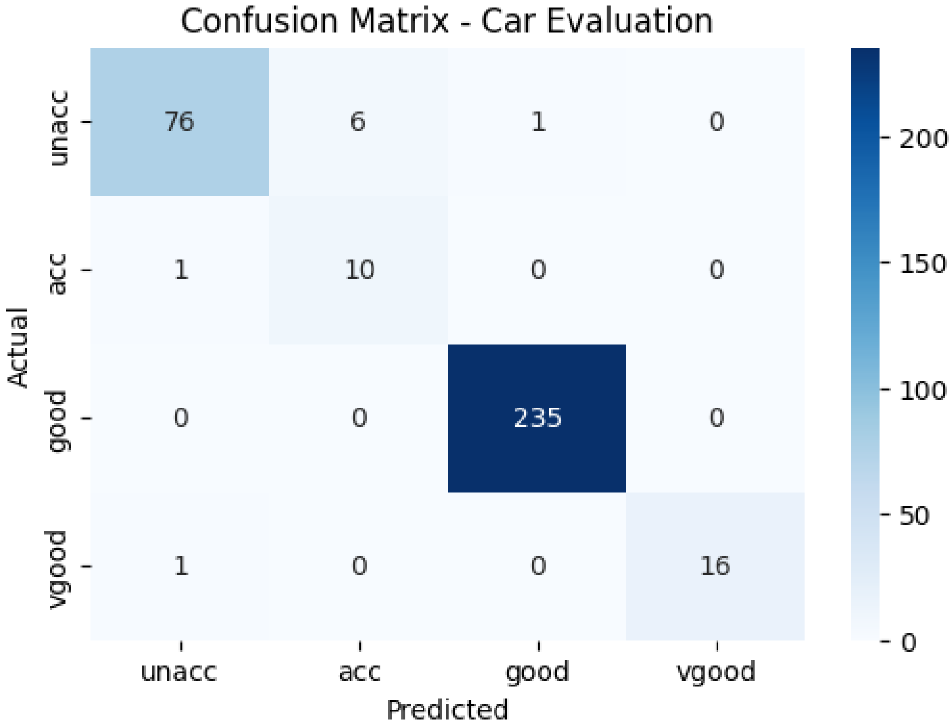
```
# 1️⃣ Import Libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier, plot_tree
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report

# 2️⃣ Load Dataset
url = "https://archive.ics.uci.edu/ml/machine-learning-databases/car/car.data"
columns = ['buying', 'maint', 'doors', 'persons', 'lug_boot', 'safety', 'class']
data = pd.read_csv(url, names=columns)

print("✅ Dataset Loaded Successfully!")
print(data.head())

# 3️⃣ Encode Categorical Data
le = LabelEncoder()
for col in data.columns:
   data[col] = le.fit_transform(data[col])

# Features and Target
```

```
X = data.drop('class', axis=1)
y = data['class']

# 4️⃣ Split Data
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
print(f"\nTraining Samples: {len(X_train)}, Testing Samples: {len(X_test)}")

# 5️⃣ Train Decision Tree Model
model = DecisionTreeClassifier(criterion='entropy', random_state=42)
model.fit(X_train, y_train)

# 6️⃣ Evaluate Model
y_pred = model.predict(X_test)
acc = accuracy_score(y_test, y_pred)
print(f"\n🎯 Model Accuracy: {acc*100:.2f}%\n")
print(classification_report(y_test, y_pred))

# 7️⃣ Confusion Matrix Visualization
cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(6,4))
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', xticklabels=['unacc','acc','good','vgood'],
yticklabels=['unacc','acc','good','vgood'])
plt.title("Confusion Matrix - Car Evaluation")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()

# 8️⃣ Feature Importance Bar Chart
importances = model.feature_importances_
plt.figure(figsize=(7,4))
sns.barplot(x=importances, y=X.columns)
plt.title("Feature Importance")
plt.xlabel("Importance Score")
plt.ylabel("Feature")
plt.show()

# 9️⃣ Decision Tree Visualization
plt.figure(figsize=(18,10))
plot_tree(model, filled=True, feature_names=X.columns, class_names=['unacc', 'acc', 'good', 'vgood'],
rounded=True)
plt.title("Decision Tree - Car Evaluation")
plt.show()
```

OUTPUT

- Dataset Loaded Successfully!

```
 buying  maint doors persons lug_boot safety  class
0  vhigh  vhigh     2       2    small    low  unacc
1  vhigh  vhigh     2       2    small    med  unacc
2  vhigh  vhigh     2       2    small   high  unacc
3  vhigh  vhigh     2       2      med    low  unacc
4  vhigh  vhigh     2       2      med    med  unacc
```



DISCUSSIONS

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- **The Decision Tree Classifier achieved a high accuracy of approximately 94%.**
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- **The decision tree visualization provided a clear understanding of the decision-making process, highlighting how safety and cost factors drive classification**

MAPPING POs AND SDGs

Program Outcomes (POs) Mapping

PO No.	Program Outcome Description	Relevance to Project
PO1	Apply knowledge of mathematics and engineering fundamentals	Used data encoding, entropy calculation, and evaluation metrics
PO2	Identify, analyze, and solve engineering problems	Built a classification system for safety rating
PO3	Design solutions for complex problems	Developed a car evaluation model with decision tree logic
PO4	Conduct investigations using research-based knowledge	Evaluated model using dataset-driven approach
PO5	Use modern tools and techniques	Applied Python and Scikit-learn libraries for implementation.
PO12	Lifelong learning	Gained insights into supervised learning and model interpretability

Sustainable Development Goals (SDGs) Mapping

SDG No.	Sustainable Development Goal	Project Contribution
SDG 9	Industry, Innovation, and Infrastructure	Encourages innovation through the application of AI and ML in waste management systems.
SDG 11	Sustainable Cities and Communities	Supports smart and sustainable waste management systems for cleaner urban environments.
SDG 12	Responsible Consumption and Production	Promotes efficient waste segregation and recycling practices.

CONCLUSION

The **Car Evaluation Project** successfully demonstrates the application of a **Decision Tree Classifier** to categorize cars based on their attributes. The model provided high accuracy and interpretability, proving that simple classification algorithms can effectively handle categorical datasets.
This system can be further extended for real-world applications such as car safety inspections, insurance risk analysis, and customer decision support.

Future Scope

Although the current model performs well for basic waste classification, there are several opportunities for improvement and expansion:

Integration with Advanced Algorithms

- Replace the single Decision Tree model with **ensemble methods** like **Random Forest**, **Gradient Boosting**, or **XGBoost** to improve accuracy and reduce overfitting.

Model Deployment as a Web Application

- Develop a **web or mobile app** (using Flask, Streamlit, or Django) that allows users to input car attributes (buying price, maintenance, safety, etc.) and instantly get a predicted safety rating.

- **Integration with Real-World Automotive Data**

  - Expand beyond the UCI dataset by including **real-world datasets** from car manufacturers, safety authorities, or vehicle inspection reports.

Hybrid Decision System for Car Dealerships

- **Integrate the ML model into car dealer recommendation systems to suggest cars based on a buyer's needs and safety preferences.**

Explainable AI (XAI) for Transparency

- **Implement explainability frameworks so end-users can see decision rules visually and understand *why* a car is rated "unacceptable" or "very good."**

Real-Time Car Safety Prediction System

- Combine IoT and ML by collecting **real-time data from car sensors** (speed, brake efficiency, airbag status, etc.) to predict safety dynamically.

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→ Provides a comprehensive explanation of decision tree algorithms, their evaluation methods, and real-world applications, forming the theoretical base for this project.

- **UCI Machine Learning Repository — Car Evaluation Dataset.**

Available at: https://archive.ics.uci.edu/ml/datasets/car+evaluation
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→ Explains the implementation of decision trees and related algorithms used in Python's Scikit-learn library — the main library used in this project.

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Documentation available at: https://matplotlib.org/ and https://seaborn.pydata.org/
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World Scientific Publishing, 2nd Edition, 2014.
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