DSCI-6601-001 PRACTICAL MACHINE LEARNING

VEHICLE MAINTENANCE PREDICTION

Sahil Khan - 202482066

INTRODUCTION

The field of predictive maintenance is expanding quickly and has the potential to save costs, increase operational effectiveness, and improve safety in a variety of industries. The objective of this project is to create a machine learning model that can forecast whether maintenance is required for a vehicle based on a number of characteristics, such as component status, usage patterns, maintenance history, and vehicle specs. Accurately predicting future maintenance requirements enables fleet managers and car owners to plan maintenance in advance, reducing downtime, avoiding expensive malfunctions, and improving safety.

PROBLEM STATEMENT

- Implement AI predictive maintenance for vehicles.
- Utilize incoming data to anticipate and prevent disruptions.
- Minimize downtime and reduce maintenance costs.
- Enhance vehicle reliability for uninterrupted operations.
- Optimize maintenance schedules for efficient transportation.

OBJECTIVE

Predicting Maintenance Needs

- Build a classification model to identify whether a vehicle requires maintenance based on historical and operational data.

Optimizing Fuel Efficiency

- Develop a regression model to provide actionable insights for maintaining or improving vehicle fuel efficiency by analyzing key influencing factors.

DATASET

Dimension

- Columns: 20
- Samples: 5000

Distribution of Need_Maintenance

- False [0]: 9502 (19%)
- True [1]: 40,498 (81%)

Summary Stats: Fuel Efficiency

count	50000.000000
mean	14.990323
std	2.885583
min	10.000098
25%	12.489037
50%	14.986352
75%	17.474676
max	19.999968

Attributes

- Vehicle Model
- Mileage
- Maintenance History
- Reported Issues
- Vehicle Age
- Fuel Type
- Transmission Type
- Engine Size
- Odometer Reading
- Last Service Date
- Warranty Expiry Date
- Owner Type
- Insurance Premium
- Service History
- Accident History
- **Fuel Efficiency**
- Tire Condition
- Brake Condition
- Battery Status
- **Need Maintenance**

DATA PREPROCESSING

Key Features

- Step1: Handle Missing Values
- Step2: Drop Duplicates
- Step3: Feature Engineering
- Step4: Applying Feature Scaling for Numerical Features and One-Hot Encoding for Categorical Features
- Step5: Data Split in 75:25 ratio to train-test sets using StratifiedShuffleSplit to ensure balance and avoid skewness.

ML ALGORITHMS

CLASSIFIER

- Logistic Regression
- Random Forest Classifier
- SGD Classifier
- Decision Tree Classifier
- XGB Classifier

REGRESSOR

- Linear Regression
- Ridge Regression
- Random Forest Regressor
- Gradient Boosting Regressor
- XGB Regressor

MODEL METRICS

Classifiers

MODELS	ACCURACY	PRECISION	RECALL	F1 SCORE	TRAIN TIME(s)	PREDICT TIME(s)
DecisionTreeClassifier	0.958	0.958	0.958	0.958	5.328	0.006
LogisticRegression	0.929	0.929	0.929	0.929	2.829	0.004
RandomForestClassifier	0.958	0.958	0.958	0.958	99.297	0.115
SGDClassifier	0.929	0.929	0.929	0.929	1.808	0.004
XGBClassifier	0.958	0.958	0.958	0.958	14.168	0.042

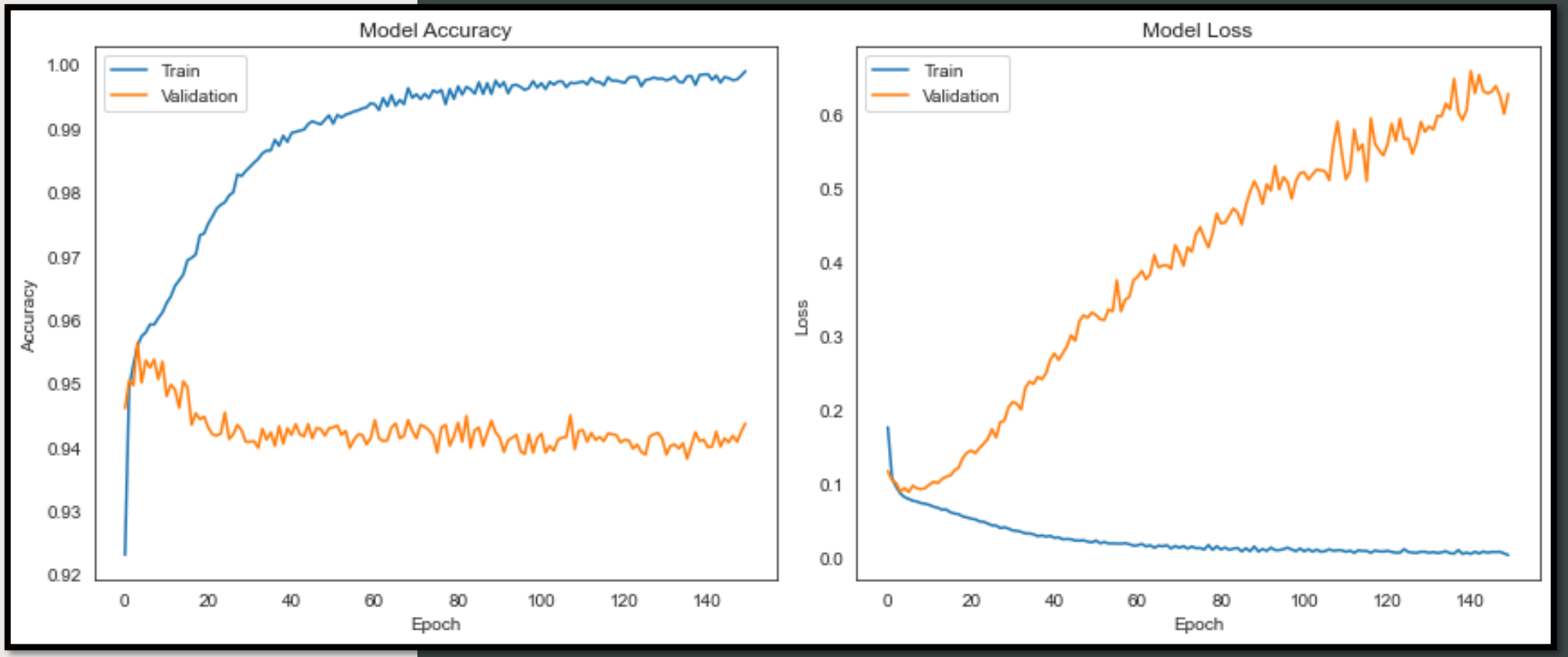
MODEL METRICS

Regressor

MODELS	RMSE	MAE	R2 SCORE	TRAIN TIME(s)	PREDICT TIME(s)
GradientBoostingRegressor	1.6993	2.5007	-0.0015	56.7979	0.0070
LinearRegression	1.6990	2.5008	-0.0008	2.1153	0.0025
RandomForestRegressor	1.6996	2.5012	-0.0021	202.4868	0.0722
Ridge	1.6990	2.5006	-0.0007	2.1027	0.0020
XGBRegressor	1.6991	2.4997	-0.0009	4.0592	0.0165

MODEL METRICS

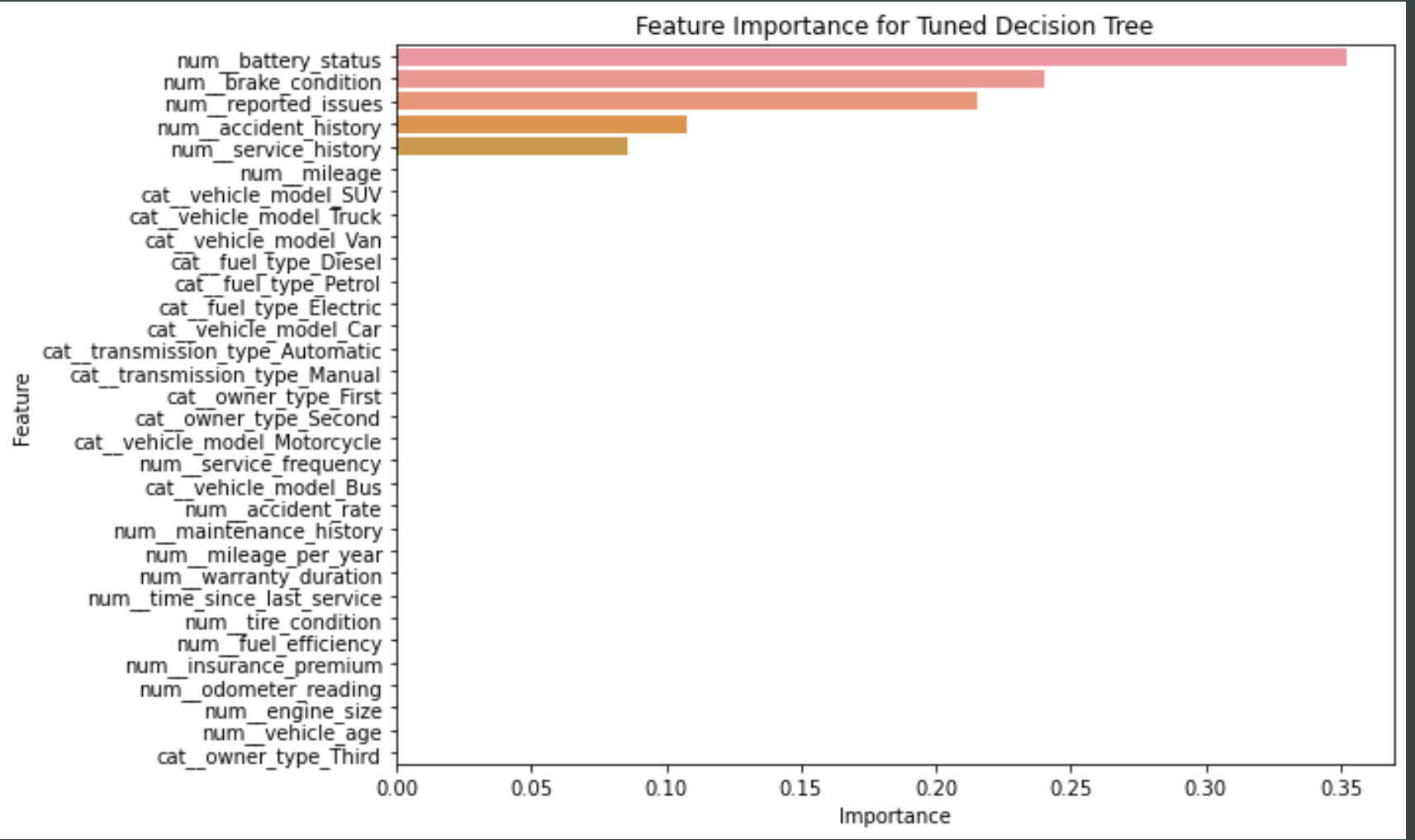
Neural Network Classifier



FEATURE IMPORTANCE

TOP FEATURES

- Battery Status
- Brake Condition
- Reported Issue
- Accident History
- Service History

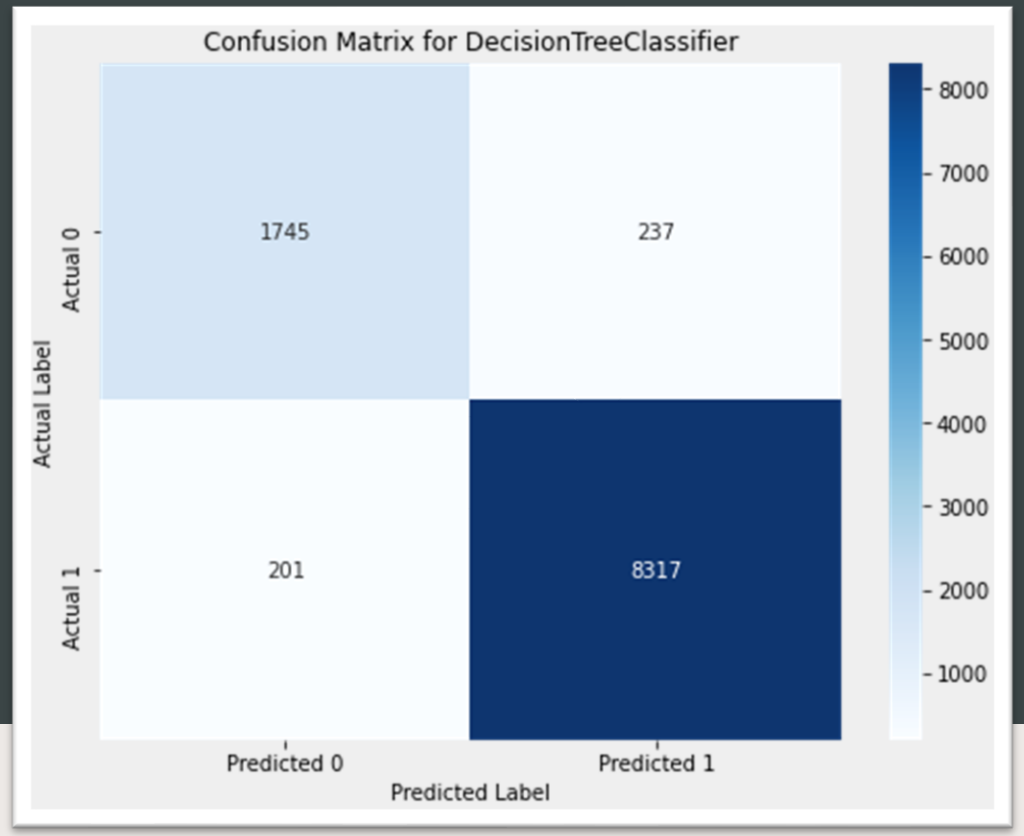


BEST MODELS

Classifier

Decision Tree

- Best Params: {'criterion': 'gini',
  'max_depth': 5,
  'min_samples_leaf': 1,
  'min_samples_split': 2}
- Accuracy: 0.958285714
- Precision: 0.958026574
- Recall: 0.958285714
- F1 Score: 0.958138541



BEST MODELS

Regressor

Ridge Regressor

- Best Params: {{'alpha': 10.0,
  'max_iter': 1000,
  'solver': 'auto’}
- RMSE: 1.698994548
- MAE: 2.500581049
- R2 Score: -0.000674967

PREDICTION: USER INPUT

THANK YOU

Sahil Khan

202482066

Project Link: https://github.com/sahil82764/Vehicle_Maintenance_Prediction