MACHINE LEARNING BASED VEHICLE PERFORMANCE ANALYZER

PROJECT REPORT

Submitted by

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1.INTRODUCTION

1.1 Project Overview

With the increasing population the dependency of man on vehicles are the primary source of transportation, the number of motor vehicles being registered for commercial as well as non-commercial activities.This project is one such attempt at identifying the performance of small passenger cars in terms of fuel efficiency and map them with factors affecting it using machine learning techniques.The commencing activity while carrying out any such research activity will be the identification of the problem and all its possible sources.Machine learning techniques to predict the fuel efficiency of car.

1.2 Purpose

The purpose of the study is to address the research question “How well the machine learning technique predict the fuel efficiency of a car by considering both vehicle characteristics and driving data.The knowledge discovered from the research could be used by car manufacturers to design cars in future to mitigate the fuel consumption. Predicting the performance level of cars is an important and interesting problem. The main goal is to predict the performance of the car to improve certain behaviours of the vehicle. This can significantly help to improve the system's fuel consumption and increase efficiency.The performance analysis of the car is based on the engine type, no of engine cylinders, fuel type, horsepower, etc. These are the factors on which the health of the car can be predicted. It is an ongoing process of obtaining, researching, analyzing, and recording health based on the above three factors. The performance objectives like mileage, dependability, flexibility and cost can be grouped together to play a vital role in the prediction engine and engine management system. This approach is a very important step towards understanding the vehicle's performance.

2 LITERATURE SURVEY

2.1 Existing problem

Driving behavior is one of the most critical factors in traffic accidents. Accurate vehicle acceleration prediction approaches can promote the development of Advanced Driving Assistance Systems (ADAS) and improve traffic safety. However, few prediction models consider the characteristics of individual drivers, which may overlook the potential heterogeneity of driving behavior. In this study, a vehicle acceleration prediction model based on machine learning methods and driving behavior analysis is proposed. First, the driving behavior data are preprocessed, and the relative distance, relative speed, and acceleration of the subject vehicle are selected as feature variables to describe the driving behavior. Then, a finite Mixture of Hidden Markov Model (MHMM) is used to divide the driving behavior semantics. The model can divide heterogeneous data into different behavioral semantic fragments within different time lengths. Next, the similarity of different behavioral semantic fragments is evaluated using the Kolmogorov–Smirnov test. In total, 10 homogenous drivers are classified as the first group, and the remaining 20 drivers are classified as the second group.Long Short-Term Memory(LSTM) and Gate Recurrent Unit (GRU) are used to predict the vehicle acceleration for both groups. The prediction results show that the proposed method in this study can significantly improve the prediction accuracy of vehicle acceleration.

2.2 References

1.Title: Vehicle Acceleration Prediction Based on Machine Learning Models and Driving Behavior Analysis

Author: Yajie Zou , Lusa Ding , Hao Zhang , Ting Zhu and Lingtao Wu

Year:2022

2.Title: A systematic literature review of vehicle speed assistance in intelligent transportation system

Author: Mehrdad Asadi, Mahmood fathy, Hamidrreza Mahini, Amir masoud Rahmani

Year:2021

3.Title: Machine learning methods for vehicle predictive maintenance using off-board and on-board data

Author: Rune Prytz

Year:2021

4.Title: A Novel performance model based on machine learning

Author: Andrei Aksjonov Pavel Nedoma Valery Vodovozov Eduard Petlenkov PartinHerrman

Year:2019

5.Title: Vehicle Detection And Tracking Using Machine Learning Technique

Author: Sipan Masoud Mustafa

Year: 2019

2.3 Problem Statement Definition

A problem statement is the description of an issue currently existing which needs to be addressed. It provides the context for the research study and generates the questions which the research aims to answer. The statement of the problem is the focal point of any research.

First thing to mention in problem statement is to describe the problem clearly. After mentioning the problem, there is also a need to identify and describe the place where problem happened in a society or in an object. Problem statement is considered as most important part of the study. It is considered as base of the study which should be written properly and clearly. So it must be written with full of its extent and intensity that reveal study must be conducted on this problem.

At this point there is a need to mention how you know about the problem and extent of the problem, present references there. Present conceptual framework which you assumed in the light of above discussed problem. Also explain construct and variables and their relationships.

3. IDEATION &PROPOSED SOLUTION

3.1 Empathy Map Canvas

An empathy map is a collaborative visualization used to articulate what we know about a particular type of user.

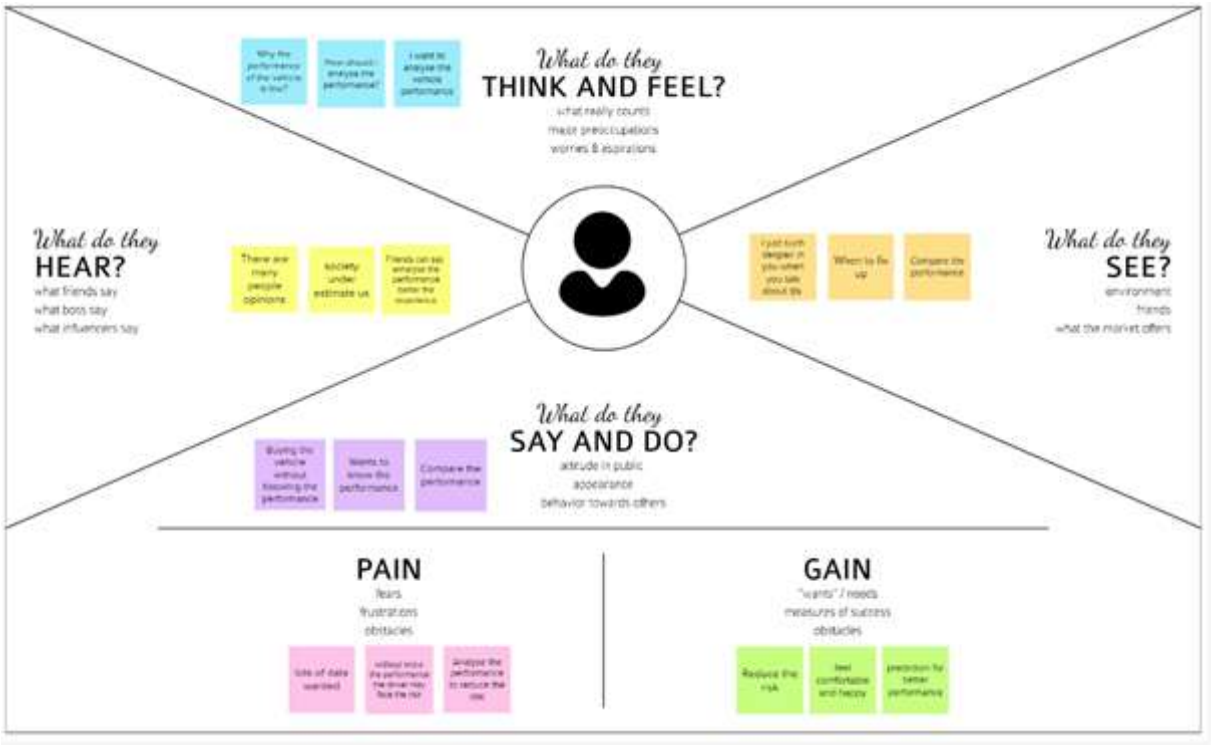
Empathy maps are split into four quadrants are:

1)Says

2)Thinks

3)Does

4)Feels



The Says quadrant contains what the user says out loud in an interview or some other usability study.

The thinks quadrant captures what the user is thinking through the experience.

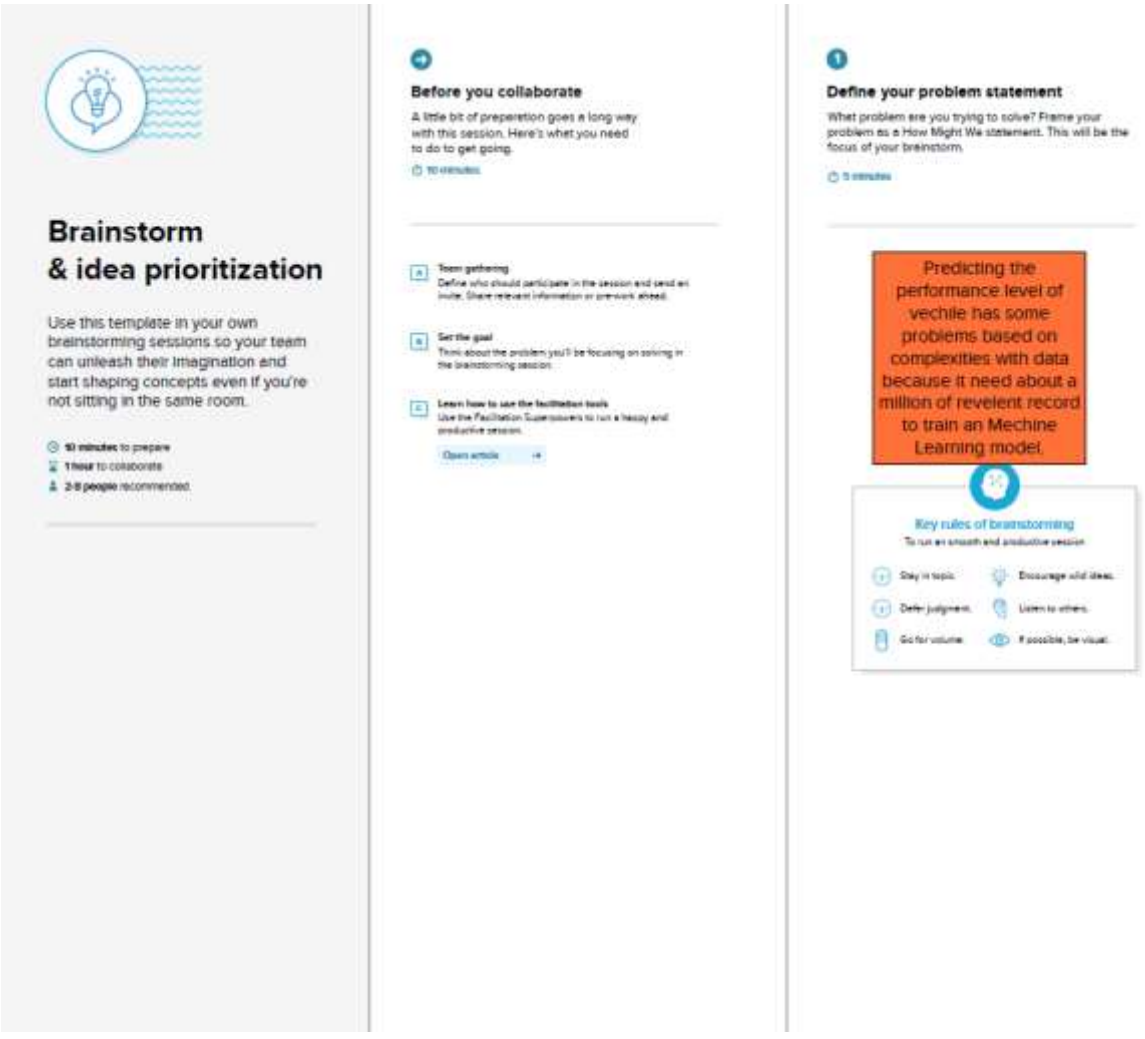
The Does quadrant encloses the action the user takes.

The Feels quadrant is the user’s emotional state, often represented as an adjective plus a short sentence for context.

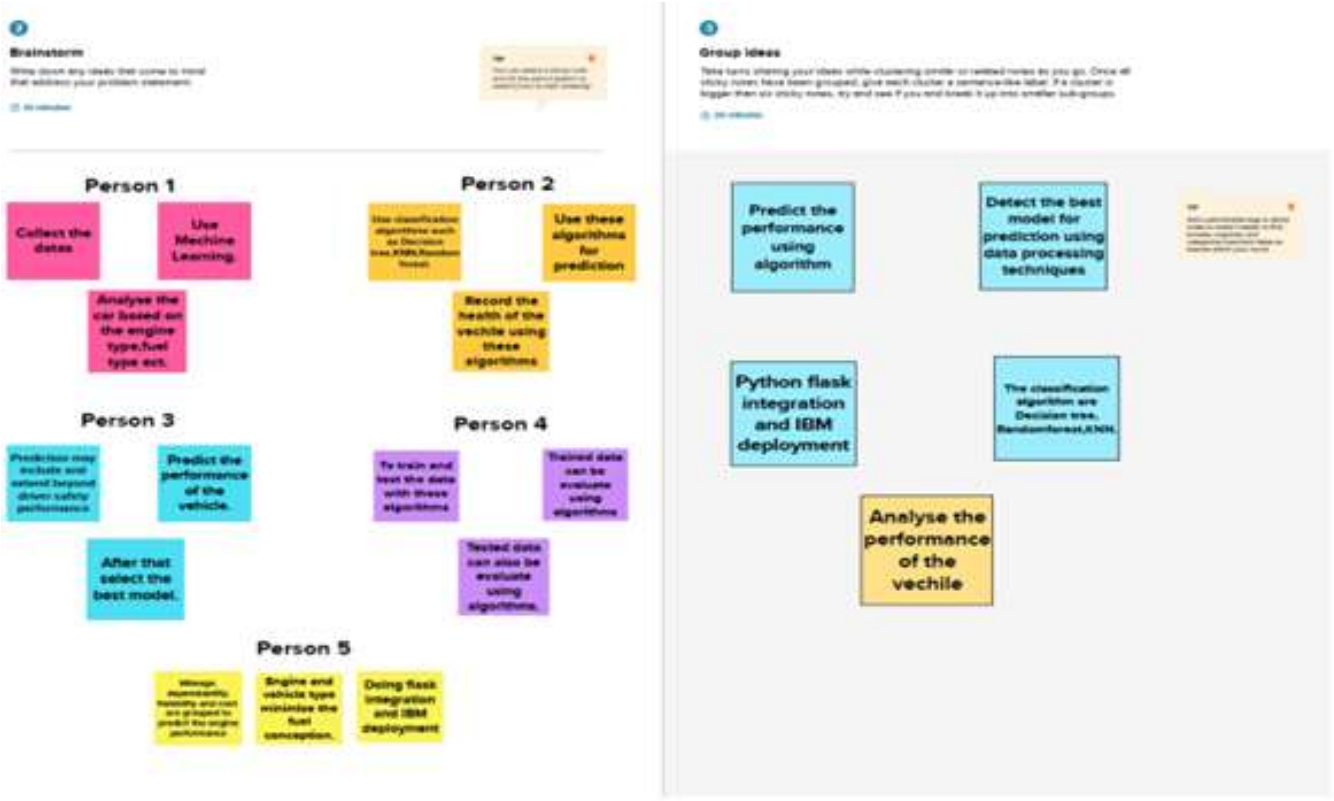
3.2 Ideation and Brainstorming

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions.

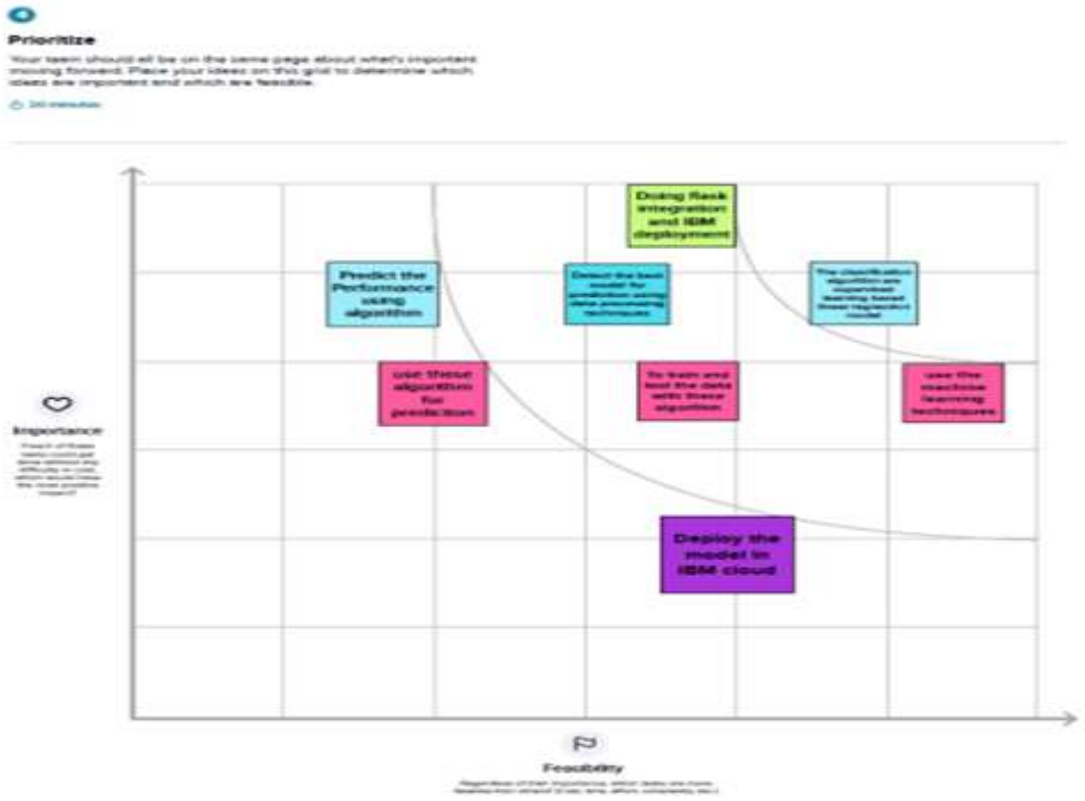
Step-1: Team Gathering, Collaboration and Select the Problem Statement



Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization



3.3 Proposed Solution

Having hooked your audience into the problem, now you want to paint a picture of what the world will be like when you solve the problem. The proposed solution should relate the current situation to a desired result and describe the benefits that will accrue when the desired result is achieved. So, begin your proposed solution by briefly describing this desired result.

S .No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Predicting the performance level of vehicle has some problems with based on complexities with data because it need about a million of relevant record to train an ML model
2.	Idea/ Solution description	Using Supervised Learning algorithm to know target value for the problem. In order to train such a model which can be identified as the vehicle parameters preferable with the variety of configuration are required as input variables.
3.	Novelty / Uniqueness	In Machine Learning the dataset which will be used in the training phase is a very important point to build successful prediction.
4.	Social Impact / Customer Satisfaction	Prediction may include and extend beyond drives safety performance, estimation of vehicle's life, fuel efficiency and long distance driving efficiency.
5.	Business Model (Revenue Model)	Vehicle's fuel consumption is influenced by external and internal factor. Although engine and vehicle type minimize the fuel consumption
6.	Scalability of the Solution	The study concluded that fuel consumption rate and vehicle driver index (VDI), measure of driving behaviour, were deeply related.

3.4 Proposed Solution Fit

Problem-solution fit is a term used to describe the point validating that the base problem resulting in a business idea really exists and the proposed solution actually solves that problem. Validate that the problem exists: When you validate your problem hypothesis using real-world data and feedback.

Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem. This occurs when you have evidence that customers cares about certain jobs, pains and gains.

4.REQUIREMENT ANALYSIS

4.1 Functional Requirement

A functional requirement defines a function of a system or its component, where a function is described as a specification of behaviour between inputs and outputs. It may involve calculations, technical details, data manipulation and processing, and other specific functionality that define what a system is supposed to accomplish.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through online
FR-2	User Confirmation	Confirmation via Email for new user Confirmation via OTP
FR-3	Vehicle Data Collection	User input through a Form Sending the data to the server
FR-4	Query Processing	Predict the expected mileage using the ML model
FR-5	Report Generation	Show the expected mileage, graph the expected mileage throughout time. Suggest similar car models from the database

Functional Requirements of a system should includes:

- Details of operations conducted in every screen.
- Data handling logic should be entered into the system.
- It should have descriptions of system reports or other output.
- Complete information about the workflows performed by the system.

4.2 Non-Functional Requirements

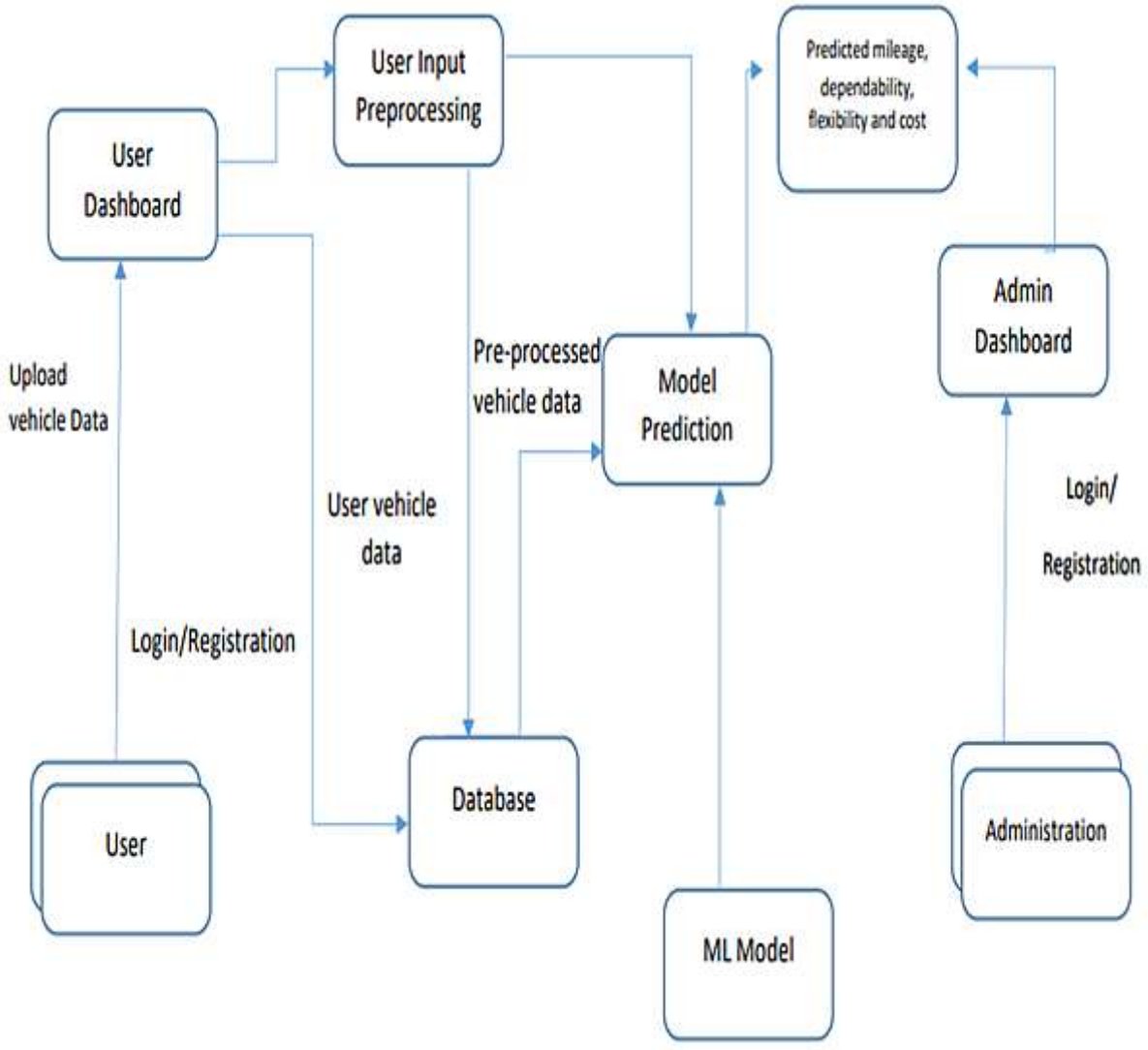
A Non-functional requirement (NFR) is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviours. They are contrasted with functional requirements that define specific behavior or functions.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Usability is the degree of ease with the car user interact with our application to know the efficiency. It tries to estimate mileage through data that the user can collect manually.
NFR-2	**Security**	Protect the performance analyser system from a cyber perspective. Protected against all forms of web-based threats.
NFR-3	**Reliability**	Relaiability of the car was based on the rate of reported problems like what type of problems and reports have been reported.
NFR-4	**Performance**	This can support a reasonably large number of users accessing the services simultaneously with little to no noticeble effect on the performance.
NFR-5	**Availability**	The availability of the prediction application when the user want.
NFR-6	**Scalability**	Need to grow the system can handle it includes features to install it in the future.

5.PROJECT DESIGN

5.1 Data Flow Diagram

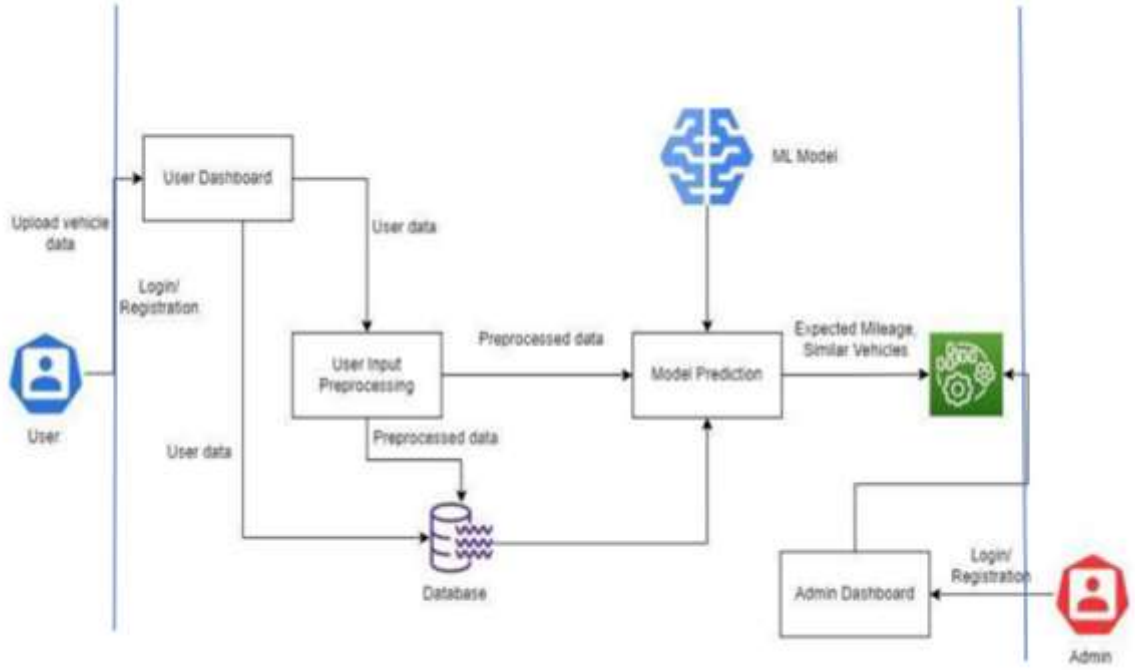
A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



5.2 Solution & Technical Architecture

Technical Architecture (TA) is a form of IT architecture that is used to design computer systems. It involves the development of a technical blueprint with regard to the arrangement, interaction, and interdependence of all elements so that system-relevant requirements are met.

User IBM Cloud Admin



The technical architect is responsible for building three primary types of architecture within an enterprise. These areas are application architecture, system architecture, and enterprise architecture

The architect has technology knowledge.

The architect has design skills.

The architect has programming skills.

The architect is a good communicator

5.3 User Stories

The purpose of a user story is to articulate how a piece of work will deliver a particular value back to the customer. Note that "customers" don't have to be external end users in the traditional sense, they can also be internal customers or colleagues within your organization who depend on your team.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Car user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Online	I can register & access the dashboard with Facebook Login	Medium	Sprint-1
	Login	USN-4	As a user, I can register for the application through Gmail	for vechile performance prediction	High	Sprint-1
	Dashboard	USN-5	As a user, I can log into the application by entering email & password	I will have knowledge about the vehicle performance	Medium	Sprint-2
Administrator	Login	USN-6	View vehicle performance	I can access my admin dashboard	High	Sprint-1
	Query Processing	USN-7	Try to rectify the query	Admin view the performance	Medium	Sprint-2

A user story is the smallest unit of work in an agile framework. It’s an end goal, not a feature, expressed from the software user’s perspective.

6. PROJECT PLANNING &SCHEDULING

6.1 Simple Planning & Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Visiting Webpage	USN-1	As a user, I can able to visit the website.	20	High	Deepika D
Sprint-1		USD-2	Enter the data of vehicle to know the performance.	10	low	Preethi K S
Sprint-2		USN-3	As a user, I can able to see the web page and enter the details of the vehicle for analyse the performance.	20	High	Mukesh D
Sprint-2		USN-4	enter the details like no.of cylinders, displacement, accleration, weight, origin and model number.	20	High	Gokul M
Sprint-2	Login	USN-5	As a user, I can able to submit the data to view the output as the performance of the vehicle	10	low	Rohit Jha D
Sprint-3	Dashboard		Fill the textbox in the output screen the text box is followed by the repreented lables.	20	High	Deepika D
Sprint-3		USD-6	With the help of the input the performance of the vehicle is analysed.	20	High	Preethi K S
Sprint-4	Output	USD-7	The performance of the vehicle is preddicted and that will be displayed in the output screen.	20	High	Rohit Jha

6.2 Sprint Delivery Schedule

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	30 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	07 Nov2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	15 Nov2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	22 Nov2022

The definition of a sprint is a dedicated period of time in which a set amount of work will be completed on a project. It's part of the agile methodology, and an Agile project will be broken down into a number of sprints, each sprint taking the project closer to completion.

Now that you have a clear understanding of what goes into sprint scheduling, we can jump into the process of assembling one. As time goes on, you will most likely form your unique approach to sprint scheduling.

When a sprint ends, the team shows their work to the project owner, who reviews it. If the project meets expectations, the team moves on to the next sprint.

6.3 Reports from JIRA

7. CODING & SOLUTION

7.1 Feature 1

In our project , we predict the performance of the vehicle with the help of inputs given by the car user. The inputs are

- Number of cylinders
- Displacement
- Horse power
- Weight
- Accelaration
- Model Year
- Origin

This lables and the text box below the lables are used to get the inputs from the car users who want to analyze the performance of the vehicle.

7.2 Feature 2

In this above picture shows How the Performance of the car was predicted by entering the inputs which was given by the user. The Data in the text box must be in the numeric form.

With the help of machine learning technique and algorithms the inputs given by user has analysed and the performance was predicted as an output. To predict the performance of the car we use many datas from the given dataset.

8. TESTING

8.1 Test Cases

A test case is a set of actions performed on a system to determine if it satisfies software requirements and functions correctly. The purpose of a test case is to determine if different features within a system are performing as expected and to confirm that the system satisfies all related standards, guidelines and customer requirements. The process of writing a test case can also help reveal errors or defects within the system.

Test cases are typically written by members of the quality assurance (QA) team or the testing team and can be used as step-by-step instructions for each system test. Testing begins once the development team has finished a system feature or set of features. A sequence or collection of test cases is called a test suite.

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	51	0	0	51
Security	2	0	0	2
Outsource Shipping	3	0	0	3
Exception Reporting	9	0	0	9
Final Report Output	5	0	0	5
Version Control	4	0	0	4

8.2 User Acceptance Testing

User Acceptance Testing (UAT), which is performed on most UIT projects, sometimes called beta testing or end-user testing, is a phase of software development in which the software is tested in the "real world" by the intended audience or business representative. This type of testing is not intended to be menu-driven, but rather to be performed by business users to verify that the application will meet the needs of the end-user, with scenarios and data representative of actual usage in the field.

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	4	2	3	20
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	11	2	4	20	37
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	24	14	13	26	77

9. RESULT

9.1 Performance Metrics

Performance metrics are used to measure the behaviour, activities, and performance of a business. This should be in the form of data that measures required data within a range, allowing a basis to be formed supporting the achievement of overall business goals. Measuring performance through metrics is key to seeing how employees are working, and whether targets are being met.

10 ADVANTAGES AND DISADVANTAGES

Advantages:

- Successfully handling today's vehicle design challenges, such as balancing fuel economy and energy efficiency with performance, requires innovative designs that are explored digitally and confirmed physically.
- To optimize safety and performance linked to ADAS by validating resulting behaviour when integrating active and passive safety systems.
- Offers best-in-class 3D CFD capability to help you understand the aerodynamic impact of design changes as you pursue increasingly toughperformance targets.
- Integrated and comprehensive solutions support the creation and implementation of mature product development processes that will enable the industry to move autonomous vehicles from concept to reality.
- Enable you to develop successful mechatronics systems that optimize mechanics, electronics and software simultaneously as an integrated system.
- Helps manufacturers to achieve outstanding vehicle handling performance by integrating test and simulation in the entire engineering process. Our tools and services enable car makers to ensure their vehicle has precisely the desired driving characteristics.

Disadvantages:

- The use of the automobile: some cars are required only for local driving; these cars may be capable of achieving good fuel economy on short trips, but they may be less comfortable to drive at high speeds.
- A sports car, built for speed, will have enhanced steering and handling abilities, but requires a stronger engine, more fuel, and a more sophisticated suspension system.
- Yet, an automobile must also be flexible enough to perform in every situation and use.
- Factors such as terrain, temperature, weather, trip length and environment, driving behaviour and load all affect the performance of a vehicle over time that is an challenging thing.
- Successfully handling today's vehicle design challenges, such as balancing fuel economy and energy efficiency with performance, requires innovative designs that are explored digitally and confirmed physically.
- There is the program pressure on emission friendly, lightweight and safe vehicles – with the strong trend of electrification and autonomous development.
- Frontloading performance engineering remains essential to support more efficient development for the many vehicle & architecture variants coming to market.
- At the same time, all of the different performances need to be balanced in order to meet requirements for customer brand experience.
- On top – the growing amount of ECU, controls, systems and sensors.

11. CONCLUSION

This is an important to analyse the factors using number of well-known approaches of machine learning algorithms like linear regression, decision tree and random forest to improve the vehicle performance efficiency.The range, durability and longevity of automotive traction batteries are ‘hot topics’ in automotive engineering. And here we consider a performance in mileage. To solve this problem, we will develop the models, using the different algorithms and neural networks. We will then see which algorithm predicts car performance(Mileage) with higher accuracy.

From these results we can analyze the different types of automobile are includes displacement, cylinder, horse power, acceleration, weight, model year and origin. A successful machine learning model depends on both the data and the performance of the learning algorithms. The sophisticated learning algorithms then need to be trained through the collected real-world data and knowledge related to the target application before the system can assist with intelligent decision-making.

Automobiles has become a virtual part of our daily life. Usage and demand of cars are getting increased day by day. Ten or twenty years back, a company used to produce various models at a rate of two or three per years. But now the things got changed. Companies are in a heavy contest to satisfy their customers and to increase their sales and profit. So now they release new models even on a monthly basis. So a review on their models can help the company to make improvement changes on their upcoming models. So in this project, a dataset which contain all details regarding various models and variants are used as input and then it is proceeds using various tools to obtain valuable results on various parameters output.

12. FUTURE SCOPE

- There is more scope in future for research and analysis of fuel efficiency by including other factors like the road condition and real-time traffic with the help of google maps, this would help in analysing much deeper.
- The knowledge discovered from the research and future work can be used by the car manufacturing companies to improve the fuel economy by considering the characteristics that substantially influence the fuel efficiency.
- The main Scope is to analyse the performance of the any type of vehicle, which can able to classification problem with the help of any algorithm such as Random Forest, Support Vector Machine, Neural Network by Machine Learning.
- It is needed to build the model that can be differentiate Between the Performance of Car such as very poor, poor, good, better, etc.
- Stricter regulations are planned well into the future, making it challenge for new competitive vehicle designs.
- Conventional combustion engines alone will not be able to achieve the future emission levels. By optimizing performance of the current combustion engines, we may be able to achieve target goals for the next generation vehicles. But to go beyond those limits, new innovate ideas need to be implemented to achieve future regulations.

One key, disruptive technology that will help meet those goals is vehicle electrification.

13. APPENDIX

SOURCE CODE

//index.html

```
<!DOCTYPE html>
<html lang="en">
<head>

    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <link rel="stylesheet" href="{{ url_for('static',filename='style.css') }}">
    <title>Car Performance Prediction</title>

</head>
<body>

    <h1><center><b>Car Performance Prediction</b></center></h1>
    <h2><center>ENTER THE BELOW DATA TO FIND THE CAR'S PERFORMANCE</center></h2></br></br>
    <center>
        <form action="http://localhost:5000/login" method="post" >

        <label for="noc">Enter No. of Cylinders </label><br>
            <input type="text" id="noc" name="noc" value=" "><br><br>
        <label for="dpm">Enter the Displacement</label><br>
            <input type="text" id="dpm" name="dpm" value=""><br><br>
        <label for="hp">Enter the Hourse Power </label><br>
            <input type="text" id="hp" name="hp" value=" "><br><br>
            <label for="w">Enter the Weight </label><br>
            <input type="text" id="w" name="w" value=" "><br><br>
        <label for="a">Enter the Acceleration</label><br>
            <input type="text" id="a" name="a" value=""><br><br>
        <label for="my">Enter the Model Year </label><br>
            <input type="text" id="my" name="my" value=" "><br><br>
        <label for="o">Enter the Origin </label><br>
            <input type="text" id="o" name="o" value=" "><br><br>

        <input type="submit"  value="Check the Performance"><br><br>

        {{ label }}
        {{ output }}

    </form></center>

</body>
</html>
```

//style.css

```
body{
    background-color: rgb(9, 0, 65);
    background-image: url(Car.png);
    background-repeat: no-repeat;
    background-size:cover;
}
h1 {
    color: rgb(255, 255, 255);
    font-size: 70px;
 }
 h2 {
    color: rgb(255, 255, 255);
    font-size: 30px;
 }
 form{
    color: rgb(255, 255, 255);
    font-size: 20px;

 }
 label{
    width: 70px;
 }
```

//app.py

```
from flask import Flask,render_template,request
import pickle
from sklearn.preprocessing import StandardScaler
sd = StandardScaler()

dbfile = open('regression.pkl','rb')
model = pickle.load(dbfile)

app = Flask(__name__)

@app.route('/')
def hello_world():
    return render_template('index.html')

@app.route('/login', methods = ['POST' , 'GET'])
def login():
    #mpg = request.form['mpg']
    cys = float(request.form["noc"])
    dis=float(request.form["dpm"])
    hp=float(request.form["hp"])
    w=float(request.form["w"])
    a=float(request.form["a"])
    my=float(request.form["my"])
    ori=float(request.form["o"])
    print(int(cys),int(dis),int(hp),int(w),int(a),int(my),int(ori))
    total=[[int(cys),int(dis),int(hp),int(w),int(a),int(my),int(ori)]]
    p=model.predict(total)
    p=p[0]
    print(p)


    return render_template('index.html',label="The performance of the car is "+str(p))



if __name__ == '__main__':
    app.run(debug=True)
```

GitHub & Project Demo Link

GitHub Link

https://github.com/IBM-EPBL/IBM-Project-39608-1660464149

Project Demo Link

https://github.com/IBM-EPBL/IBM-Project-39608-1660464149/blob/main/Final_Deliverables/Project_Demo.mp4