Car Performance Prediction

Using IBM Watson Machine Learning

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Smart Bridge Project Report - Applied Data Science

1. INTRODUCTION

1.1 OVERVIEW:

We are undertaking a project to leverage Machine Learning techniques in order to predict and enhance the performance of a car, thereby improving its overall efficiency. Our analysis considers various factors such as engine type, number of cylinders, fuel type, horsepower, and more, to accurately forecast the condition of the vehicle. Through an ongoing process of data collection, investigation, analysis, and documentation, we aim to gain a comprehensive understanding of the car's health based on these key elements.

Our prediction model focuses on the engine and engine management system, with performance goals encompassing mileage, dependability, flexibility, and cost-effectiveness. By consolidating these objectives, we establish a crucial foundation for comprehending and optimizing the vehicle's performance. Through the utilization of advanced Machine Learning algorithms, we aim to provide valuable insights and recommendations to enhance the car's performance. This project aligns with our commitment to leverage cutting-edge technologies in the automotive industry, driving innovation, and delivering tangible benefits to vehicle owners.

1.2 PURPOSE:

Considering recent developments regarding fuel scarcity and the increased awareness of environmental concerns, researchers have turned their attention towards exploring alternative fuels, hybrid vehicles, and other sustainable fuel options. This shift in focus stems from the historical abundance of petrol, which led to the construction of cars optimized for high-speed operation, comfort, and safety. As the automotive industry evolves, there is a growing need to address the challenges posed by fuel scarcity and reduce the excessive reliance on gasoline. One area of exploration involves redesigning the car's body to minimize aerodynamic losses. Spoilers are employed to mitigate these losses, necessitating the optimization of their shape.

This study aims to identify the most efficient spoiler design for automobiles, considering factors such as strength, aerodynamics, mass reduction, and fuel consumption. To evaluate changes in the aerodynamic properties of the spoiler's cross-section, a Computational Fluid Dynamics (CFD) analysis is conducted on a two-dimensional spoiler model. The findings of this analysis serve as a validation mechanism for understanding the impact of various design modifications on the spoiler's aerodynamic performance.

By leveraging advanced computational techniques and conducting rigorous analyses, this research endeavours to contribute to the development of optimal spoiler designs that enhance both the vehicle's aerodynamic efficiency and fuel consumption. These efforts align with the broader objective of fostering sustainable practices within the automotive industry and reducing the ecological footprint of automobiles.

2. LITERATURE SURVEY

2.1 EXISTING PROBLEM:

[1] The Make, Model, Type, Origin, DriveTrain, MSRP, and other classifications of automobiles, as well as their locations and various manufacturers, were recognised by the car dealers using an artificial neural network (ANN) model.

EngineSize, Cylinders, Horsepower, MPG_Highway, Weight, Wheelbase, and Length are the key metrics. The number of miles per gallon the car will get while driven in the city (MPG_City) was predicted using an ANN. The outcomes demonstrated that the ANN model has a 97.50% accuracy rate in predicting MPG_City. The DriveTrain element has the biggest impact on how MPG_City is evaluated. For the examination of other automotive attributes, similar research can be done.

2.2 PROPOSED SOLUTION:

[2] The optimization of vehicle fuel economy and the prevention of fleet management fraud heavily rely on the ability to model and predict fuel usage. Numerous factors, both internal and external, influence a vehicle's fuel consumption, including distance travelled, load capacity, vehicle specifications, and driver behaviour. However, it is not always possible to monitor or have access to all these factors for analysis.

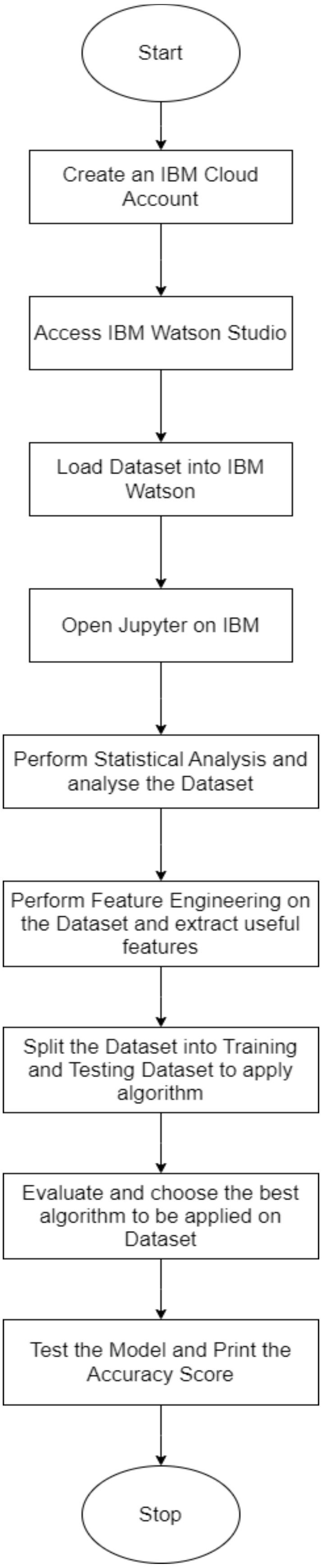
In this study, we investigate a specific scenario where only a subset of these components is available as a multivariate time series for a long-distance public bus. Thus, it becomes essential to develop a model or prediction method for fuel consumption using the limited available data while accounting for as many indirect impacts from other factors as practically possible.

Machine Learning (ML) techniques are particularly suitable for this type of analysis since they can learn patterns from data and build models accordingly. In this study, we assess the predictive capabilities of three ML algorithms in estimating bus fuel consumption using all relevant characteristics as a time series. Through our analysis, we compare the performance of gradient boosting, neural networks, and random forest techniques in generating accurate forecasts.

Based on the findings of our analysis, the random forest technique outperforms both gradient boosting and neural networks in terms of forecasting accuracy. This indicates that the random forest model provides the most reliable estimates for bus fuel consumption, considering the available data and its temporal nature.

3. THEORITICAL ANALYSIS

3.1 BLOCK DIAGRAM:



3.2 HARDWARE/SOFTWARE DESIGNING:

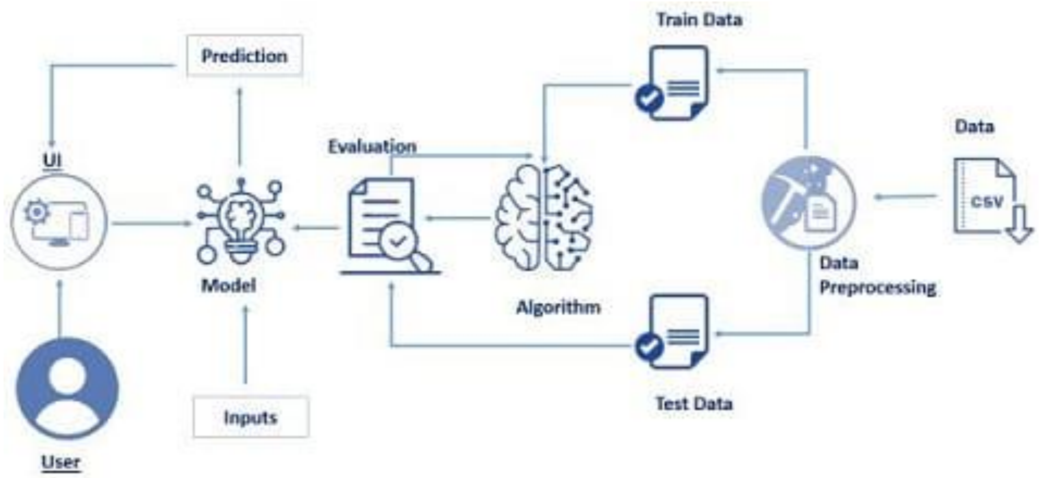
To ensure smooth execution of machine learning models, it is recommended to have a system with a minimum of 16 GB RAM and a powerful processor to handle the computational requirements. Additionally, the following software requirements are necessary:

1. **Jupyter Notebook:** Jupyter Notebook is a popular programming environment for data analysis and machine learning. It is recommended to install Jupyter Notebook as part of the Anaconda distribution, which provides a comprehensive package manager and simplifies the installation process.
2. **Python Packages:** Python is the programming language commonly used for machine learning. Ensure that the required Python packages are installed, such as NumPy, Pandas, Scikit-learn, TensorFlow, or PyTorch, depending on the specific requirements of your project. These packages provide essential functionalities for data manipulation, model training, and evaluation.
3. **Integrated Development Environment (IDE):** Spyder is a popular IDE for scientific computing with features like code editing, debugging, and variable exploration. It can be a suitable choice for your application building phase.
4. **HTML and CSS Tools:** Spyder itself provides an integrated web browser that can be used for this purpose. Alternatively, you can use other web browsers like Google Chrome, Mozilla Firefox, or Microsoft Edge to open and view your HTML and CSS files during the application development phase.

4. EXPERIMENTAL INVESTIGATIONS

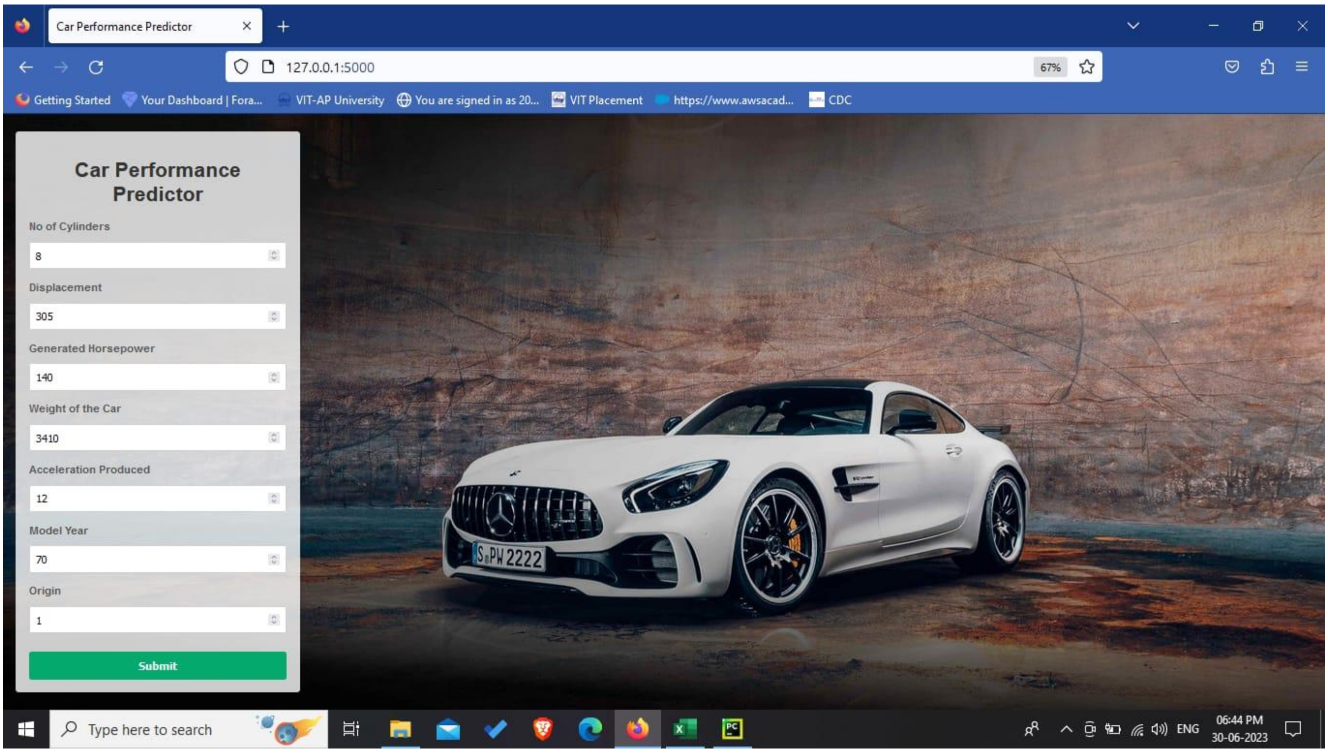
- Determine whether the dataset has any null values.
- Determine whether it contains numerical or categorical features.
- Dataset segmentation into dependent and independent features
- Find out the Correlation between the features
- Split the dataset into Training and Testing data

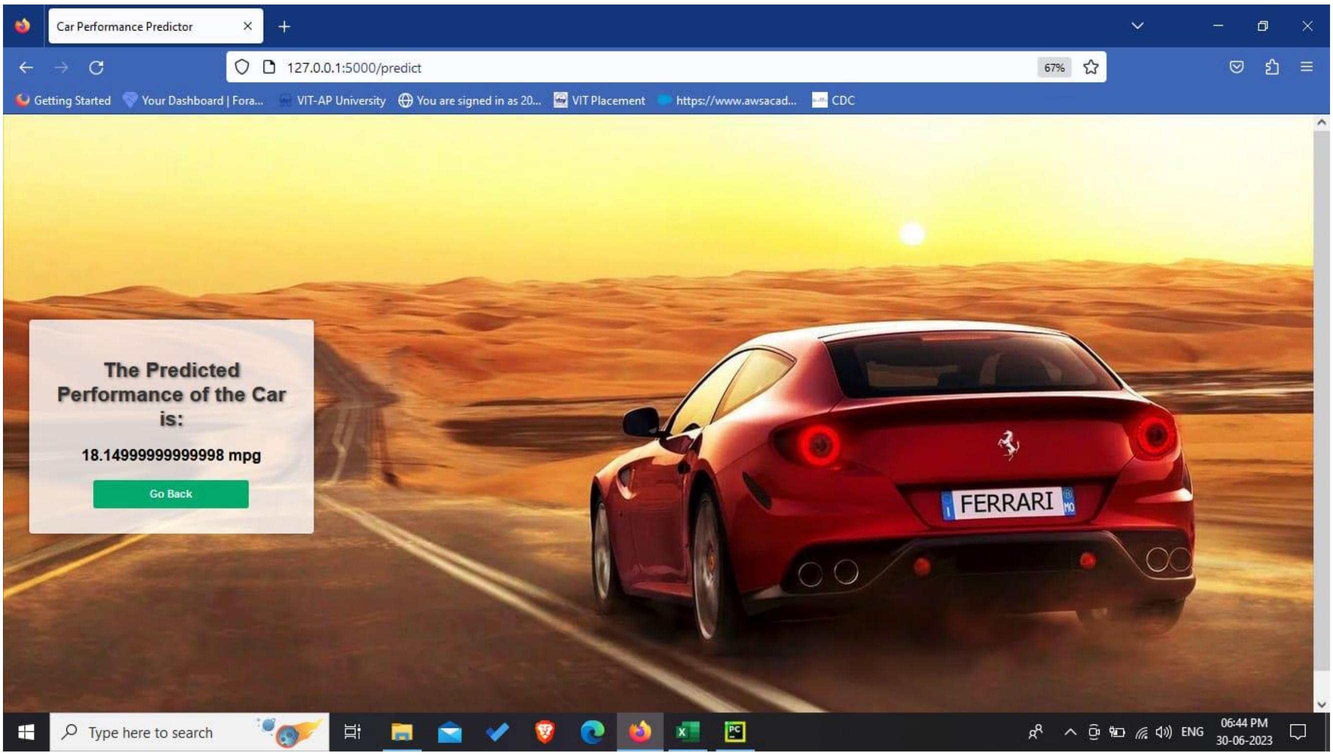
5. FLOWCHART



6. RESULT

Final Output of the above Project are :-





7. ADVANTAGES & DISADVANTAGES

Advantages of the above project:

1. **Improved vehicle performance:** By leveraging machine learning techniques to predict and optimize various aspects of a car's performance, such as fuel efficiency, mileage, and engine management, the project can lead to improved vehicle performance and overall efficiency.
2. **Cost savings:** By optimizing fuel consumption and identifying areas for improvement, the project can help reduce operational costs associated with fuel usage. This can be particularly beneficial for fleet management, where even small improvements in fuel efficiency can result in significant cost savings.
3. **Environmental sustainability:** The focus on alternative fuels, hybrid vehicles, and optimizing aerodynamics aligns with the goal of reducing environmental impact. By promoting sustainable practices and exploring fuel alternatives, the project contributes to mitigating the ecological footprint of automobiles.
4. **Data-driven decision-making:** The use of machine learning models enables data-driven decision-making by analysing large volumes of data and extracting valuable insights. This can inform design choices, maintenance schedules, and other factors that affect vehicle performance, leading to more informed and effective decision-making processes.

Disadvantages of the above project:

1. **Data limitations:** The project acknowledges that not all factors influencing fuel consumption may be available or monitored. This can introduce limitations in accurately modelling and predicting fuel usage. Incomplete or limited data can impact the performance and reliability of machine learning models.
2. **Complexity and resource requirements:** Implementing machine learning models for performance prediction and optimization requires expertise in data analysis, modelling, and computational resources. Acquiring and maintaining the necessary hardware, software, and skilled personnel can be resource-intensive.
3. **Generalization challenges:** The models developed for one specific car or dataset may not generalize well to other vehicles or scenarios. The project's effectiveness may depend on the availability of representative and diverse data for training the models to ensure they can be applied to different situations.
4. **Ethical considerations:** While the project focuses on performance improvement and efficiency, it is essential to consider the ethical implications related to the data collected and the potential impact on driver privacy and autonomy. Proper data handling practices, privacy protection measures, and transparent communication with stakeholders are crucial to address these concerns.

8. APPLICATIONS

The above project on predicting and improving car performance using machine learning techniques has several practical applications in the automotive industry. Some of the key applications include:

1. **Fuel efficiency optimization:** By accurately predicting fuel consumption and identifying factors that influence it, the project can help optimize fuel efficiency in vehicles. This is particularly valuable for fleet management companies, transportation companies, and individual vehicle owners looking to minimize fuel costs and reduce environmental impact.
2. **Performance enhancement:** The project can contribute to improving various performance aspects of vehicles, such as engine efficiency, horsepower, and overall reliability. By analysing the relationships between different variables and their impact on performance, it becomes possible to identify areas for improvement and optimize the vehicle's behaviour accordingly.
3. **Eco-friendly vehicle development:** The focus on alternative fuels, hybrid vehicles, and aerodynamics aligns with the objective of developing eco-friendly vehicles. The project can provide insights for designing more sustainable and energy-efficient cars, contributing to the ongoing efforts towards reducing greenhouse gas emissions and promoting environmental sustainability.
4. **Fleet management and maintenance:** Machine learning models developed through this project can assist fleet management companies in optimizing vehicle maintenance schedules, predicting maintenance needs, and identifying potential issues before they lead to breakdowns or costly repairs. This helps minimize downtime, improve fleet performance, and reduce overall maintenance costs.
5. **Vehicle design and engineering:** The project's insights can influence the design and engineering of future vehicles, considering factors like engine type, cylinder configuration, and aerodynamics. By understanding the correlation between these variables and performance goals, car manufacturers can make informed decisions during the design phase, leading to more efficient and reliable vehicles.

9. CONCLUSION

In conclusion, the project focused on leveraging machine learning techniques to predict and enhance the performance of cars, with a particular emphasis on fuel efficiency, engine management, and overall optimization. Through thorough data analysis, modelling, and predictive algorithms, the project aimed to provide valuable insights and recommendations to improve vehicle performance and efficiency.

By accurately predicting fuel consumption, optimizing aerodynamics, and considering alternative fuels and hybrid technologies, the project contributes to addressing the challenges posed by fuel scarcity and environmental concerns in the automotive industry. The applications of this project range from cost savings and improved fuel economy to reduced environmental impact and enhanced fleet management practices. The project's findings and models have implications for various stakeholders, including individual vehicle owners, fleet management companies, and car manufacturers. The insights gained from the project can inform decision-making processes related to vehicle design, maintenance schedules, driving habits, and overall operational efficiency.

10. FUTURE SCOPE

The future scope of this project is promising and opens several avenues for further exploration and advancements. Some potential areas for future development and expansion include:

1. **Advanced predictive models:** The project can be extended to develop more sophisticated predictive models by incorporating additional variables and considering more complex interactions between different factors influencing car performance. This can lead to even more accurate predictions and optimization strategies.
2. **Real-time performance monitoring:** Integrating real-time data collection and analysis capabilities can enable continuous monitoring of vehicle performance. This can facilitate proactive maintenance scheduling, early detection of anomalies or malfunctions, and dynamic adjustments to optimize performance on the go.
3. **Integration with connected vehicle technologies:** The project can be integrated with connected vehicle technologies, such as Internet of Things (IoT) devices and vehicle-to-vehicle (V2V) communication, to gather real-time data on vehicle performance, traffic conditions, and environmental factors. This integration can further enhance the accuracy of predictions and optimization strategies.
4. **Personalized recommendations for drivers:** By incorporating driver behaviour analysis and preferences, the project can provide personalized recommendations to drivers for improving fuel efficiency, enhancing driving habits, and optimizing vehicle performance based on individual driving patterns.
5. **Integration with autonomous vehicles:** As autonomous vehicles become more prevalent, the project can adapt to address the unique challenges and requirements of self-driving cars. This may include developing predictive models specifically tailored for autonomous driving scenarios and optimizing performance for autonomous vehicle fleets.

11. BIBILOGRAPHY

[1] Artificial Neural Network for Forecasting Car Mileage per Gallon in the City Afana, Mohsen; Ahmed, Jomana; Harb, Bayan; Abu-Nasser, Bassem S.; Abu-Naser, Samy S.

[2] Fuel consumption prediction of fleet vehicles using Machine Learning: A comparative study by Sandareka Wickramanayake; H.M.N. Dilum Bandara.

Appendix:-

App.py

```
from flask import Flask, request, render_template
#from flask_cors import CORS
import joblib
```

```python
app = Flask(__name__)


@app.route('/', methods=['GET'])
def sendHomePage():
    return render_template('index.html')

@app.route('/predict', methods=['POST'])
def predictPerformance():
    cylinders = float(request.form['cylinders'])
    displacement = float(request.form['displacement'])
    horsepower = float(request.form['horsepower'])
    weight = float(request.form['weight'])
    acceleration = float(request.form['acceleration'])
    modelyear = float(request.form['modelyear'])
    origin = float(request.form['origin'])

    X = [[cylinders,displacement,horsepower,
          weight,acceleration,modelyear,origin]]

    model = joblib.load('model.pkl')

    rating = model.predict(X)[0]
    return render_template('predict.html',predict=rating)

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

Index.html

```html
<!DOCTYPE html>
<html lang="en">
<head>
  <style>
    body {
      background-image:
url('https://getwallpapers.com/wallpaper/full/0/f/7/1348227-very-
cool-car-wallpapers-3400x1440-for-mac.jpg');
      background-size: cover;
      background-repeat: no-repeat;
```

```css
  font-family: Arial, sans-serif;
  margin: 0;
  display: flex;
  justify-content: flex-start; /* Align to the left side */
  align-items: center;
  height: 100vh;
}

.container {
  max-width: 400px;
  padding: 20px;
  background-color: rgba(255, 255, 255, 0.8);
  border-radius: 5px;
  box-shadow: 0 0 10px rgba(0, 0, 0, 0.1);
  margin-left: 20px; /* Add left margin for spacing */
}

h1 {
  text-align: center;
  color: #333;
}

form p {
  font-weight: bold;
  margin: 10px 0;
  color: #555;
}

input[type="number"],
select,
textarea {
  width: 100%;
  padding: 10px;
  border: 1px solid #ccc;
  border-radius: 4px;
  box-sizing: border-box;
  margin-top: 4px;
  margin-bottom: 8px;
  resize: vertical;
  font-size: 16px;
}

button[type="submit"] {
  width: 100%;
  background-color: #04AA6D;
  color: white;
  padding: 12px 20px;
  border: none;
```

```html
      border-radius: 4px;
      cursor: pointer;
      font-size: 16px;
      font-weight: bold;
      transition: background-color 0.3s ease;
    }

    button[type="submit"]:hover {
      background-color: #45a049;
    }
  </style>
  <meta charset="UTF-8">
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
  <meta name="viewport" content="width=device-width, initial-
scale=1.0">
  <title>Car Performance Predictor</title>
</head>
<body>
  <div class="container">
    <h1>Car Performance Predictor</h1>
    <form method="POST" action="/predict">
      <p>No of Cylinders</p>
      <input type="number" name="cylinders" required>
      <p>Displacement</p>
      <input type="number" name="displacement" required>
      <p>Generated Horsepower</p>
      <input type="number" name="horsepower" required>
      <p>Weight of the Car</p>
      <input type="number" name="weight" required>
      <p>Acceleration Produced</p>
      <input type="number" name="acceleration" required>
      <p>Model Year</p>
      <input type="number" name="modelyear" required>
      <p>Origin</p>
      <input type="number" name="origin" required>
      <br>
      <br>
      <button type="submit">Submit</button>
    </form>
  </div>
</body>
</html>
```

Predict.html

```
<!DOCTYPE html>
<html lang="en">
<head>
  <style>
    body {
      background-image:
url('https://image.winudf.com/v2/image/cGljdHVyZS53YWxscGFwZXIuZmVyc
mFyaV9zY3JlZW5fMV8xNTIwODk5NjM2XzAwNA/screen-
1.webp?fakeurl=1&type=.webp');
      background-size: cover;
      background-repeat: no-repeat;
      font-family: Arial, sans-serif;
      margin: 0;
      display: flex;
      justify-content: flex-start;
      align-items: center;
      height: 100vh;
      padding: 20px; /* Add some padding for spacing */
    }

    .result-box {
      max-width: 400px;
      margin-left: 20px; /* Adjust the margin as needed */
      padding: 20px;
      background-color: rgba(255, 255, 255, 0.8);
      border-radius: 5px;
      box-shadow: 0 0 10px rgba(0, 0, 0, 0.3);
    }

    h1 {
      text-align: center;
      margin-top: 40px;
      color: #333;
      text-shadow: 2px 2px 4px rgba(0, 0, 0, 0.5);
    }

    p {
      text-align: center;
      font-size: 24px;
      font-weight: bold;
    }

    a[type="submit"] {
      display: block;
      max-width: 200px;
```

```
      margin: 20px auto;
      text-align: center;
      background-color: #04AA6D;
      color: white;
      padding: 12px 20px;
      border: none;
      border-radius: 4px;
      text-decoration: none;
      font-weight: bold;
      transition: background-color 0.3s ease;
    }

    a[type="submit"]:hover {
      background-color: #045D42;
    }
  </style>
  <meta charset="UTF-8">
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
  <meta name="viewport" content="width=device-width, initial-
scale=1.0">
  <title>Car Performance Predictor</title>
</head>
<body>
  <div class="result-box">
    <h1>The Predicted Performance of the Car is:</h1>
    <p>{{predict}} mpg</p>
    <a href="/" type="submit">Go Back</a>
  </div>
</body>
</html>
```