TRAFFICTELLIGENCE: ADVANCED TRAFFIC VOLUME ESTIMATION WITH MACHINE LEARNING

Done by :
R Sriram
D .Vishaal

CONTENTS

INTRODUCTION

PROJECT OVERVIEW:

Objective: The primary objective of this project is to develop an advanced traffic volume estimation system using machine learning techniques. This system will provide accurate and real-time predictions of traffic volume for various locations and times, enabling traffic management authorities to make data-driven decisions and alleviate traffic-related issues.

Key Components:

Data Collection: Gather a diverse range of data sources, including historical traffic data, weather information, road network details, and special event schedules. Real-time data streams from sensors and cameras will also be integrated.

Data Preprocessing: Clean and preprocess collected data, addressing issues such as missing values, outliers, and data quality. Create a comprehensive dataset with relevant features, including historical traffic volumes, weather conditions, time of day, and road attributes.

Traffic Volume Prediction: Utilize various machine learning models, such as time series forecasting (e.g., ARIMA, Prophet), regression models (e.g., XGBoost), and deep learning models (e.g., LSTM or CNN), to predict traffic volume. Evaluate model performance using metrics like Mean Absolute Error (MAE), Mean Squared Error (MSE), and Root Mean Squared Error (RMSE).
Optimize models for accuracy and adaptability to different locations and times.

Model Deployment: Deploy the integrated system on a scalable and reliable infrastructure.
Building a web application that is integrated to the model built. A UI is provided for the users where he/she has to enter the values for predictions. The enter values are given to the saved model and prediction is showcased on the UI.

PURPOSE:

Traffic problem is one of the major problem now a days, In the increase in no of vehicles and non –usage of public transport leading to traffic related issues, Making a eye on count of traffic at each level enables the government to take the further decisions such as building new roads, increasing infrastructure ,developing mutli-channel connectivity .To address such problems to tracking the vehicle count in each and every place AI-ML has given a solution to such kind of traffic related issues, which are able to measure the volume of traffic, identify the violations of traffic rules etc.ML models could give early alerts of severe traffic to help prevent issues related to traffic problems. Hence, there is needs to develop ML algorithms capable in predicting Traffic volume with acceptable level of precision and in reducing the error in the dataset of the projected Traffic volume from model with the expected observable Traffic volume.

LITERATURE SURVEY

EXISTING PROBLEM:

Traffic Congestion: Many cities and urban areas are plagued by severe traffic congestion, leading to increased travel times, fuel consumption, and frustration among commuters. Traffic congestion not only wastes time and energy but also has economic and environmental impacts.

Limited Infrastructure Planning: Inadequate infrastructure planning can exacerbate traffic issues. Without accurate traffic volume data, it's challenging for authorities to make informed decisions regarding road expansions, new construction, or the introduction of alternative transportation methods.

Safety Concerns: Traffic congestion can contribute to accidents, injuries, and fatalities on the road. Additionally, violations of traffic rules, such as speeding or running red lights, are common, posing significant safety risks.

Inefficient Resource Allocation: Traffic management resources are often allocated without real-time data. This can lead to inefficient traffic control, including poor signal timing, inadequate road maintenance, and ineffective traffic enforcement.

Data Fragmentation: Traffic data is often collected from various sources, leading to data fragmentation and inconsistency. Integrating and processing this data in a unified manner is a challenge.

Lack of Early Alerts: Currently, there is a lack of efficient systems that provide early alerts for severe traffic conditions. These alerts can help authorities take proactive measures to mitigate traffic issues.

Data Accuracy and Timeliness: The accuracy and timeliness of traffic data are crucial for effective traffic management. Traditional data collection methods may not provide real-time insights or the level of detail required for precise decision-making.

Manual Reporting: Many traffic-related processes, such as reporting traffic volume and violations, are manual and time-consuming, often relying on human observations.

Privacy Concerns: The use of traffic cameras and sensors for data collection raises privacy concerns. Balancing data collection for traffic management with individual privacy rights is a complex issue.

Data-Driven Decision-Making: Traditional traffic management practices often lack a strong data-driven approach. There is a need for more advanced and accurate methods to predict traffic patterns and optimize resources.

REFERENCES:

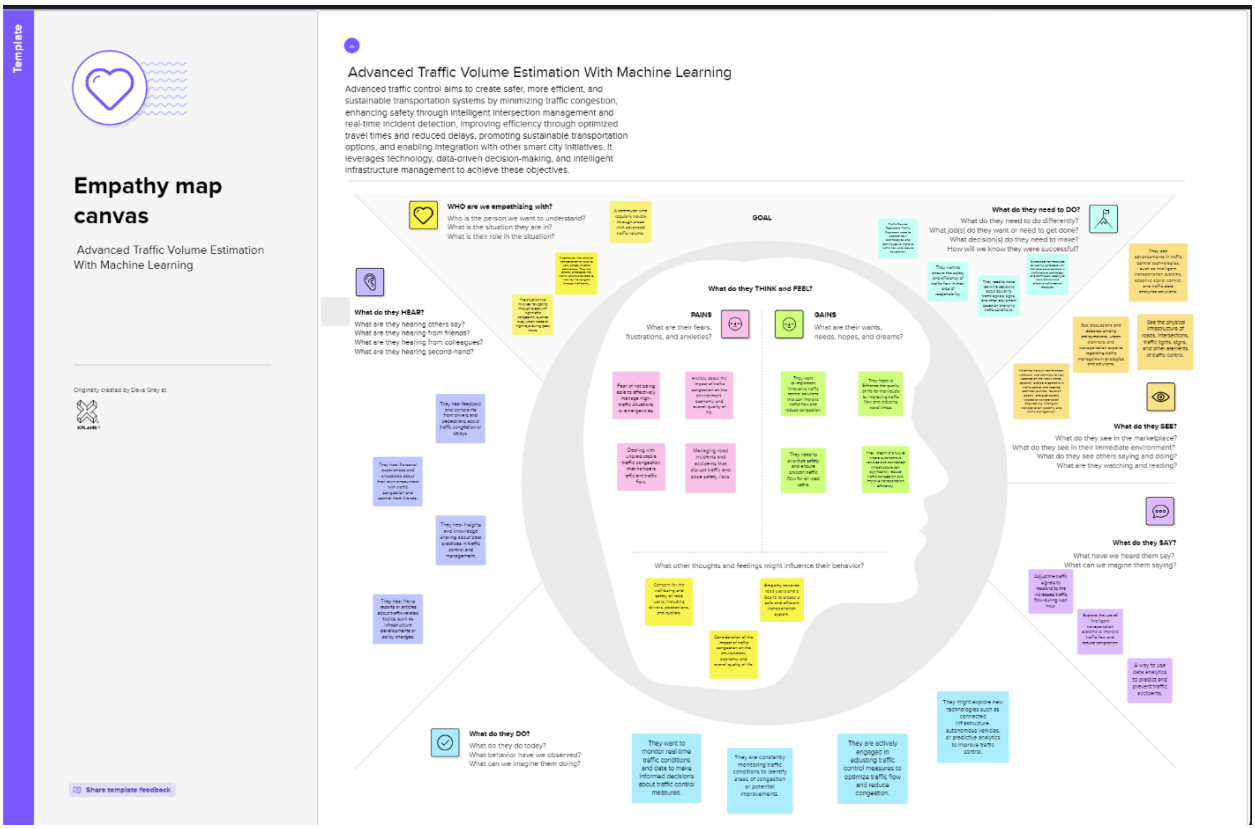
Ubiquitous Traffic Volume Estimation through Machine-Learning Procedure PI – Venu Garikapati Presenter – Yi Hou National Renewable Energy Laboratory June 3, 2020

PROBLEM STATEMENT DEFINATION:

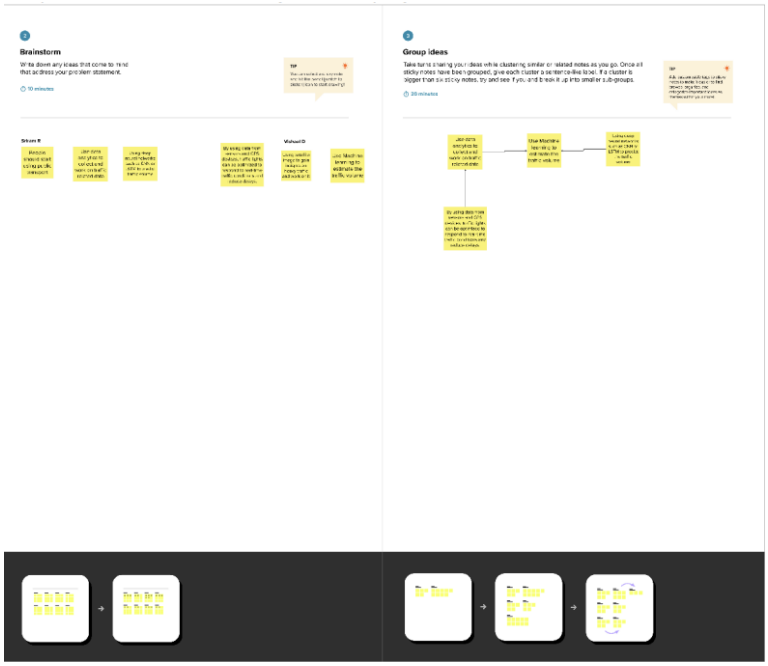
Traffic volume estimation is a crucial component of transportation planning and management. Accurate and reliable estimation of traffic volume is essential for optimizing traffic flow, reducing congestion, and improving safety on roadways. Machine learning (ML) techniques have been widely used in recent years for traffic volume estimation due to their ability to handle complex and large-scale data sets. In this literature survey, we will explore the various ML techniques used for traffic volume estimation

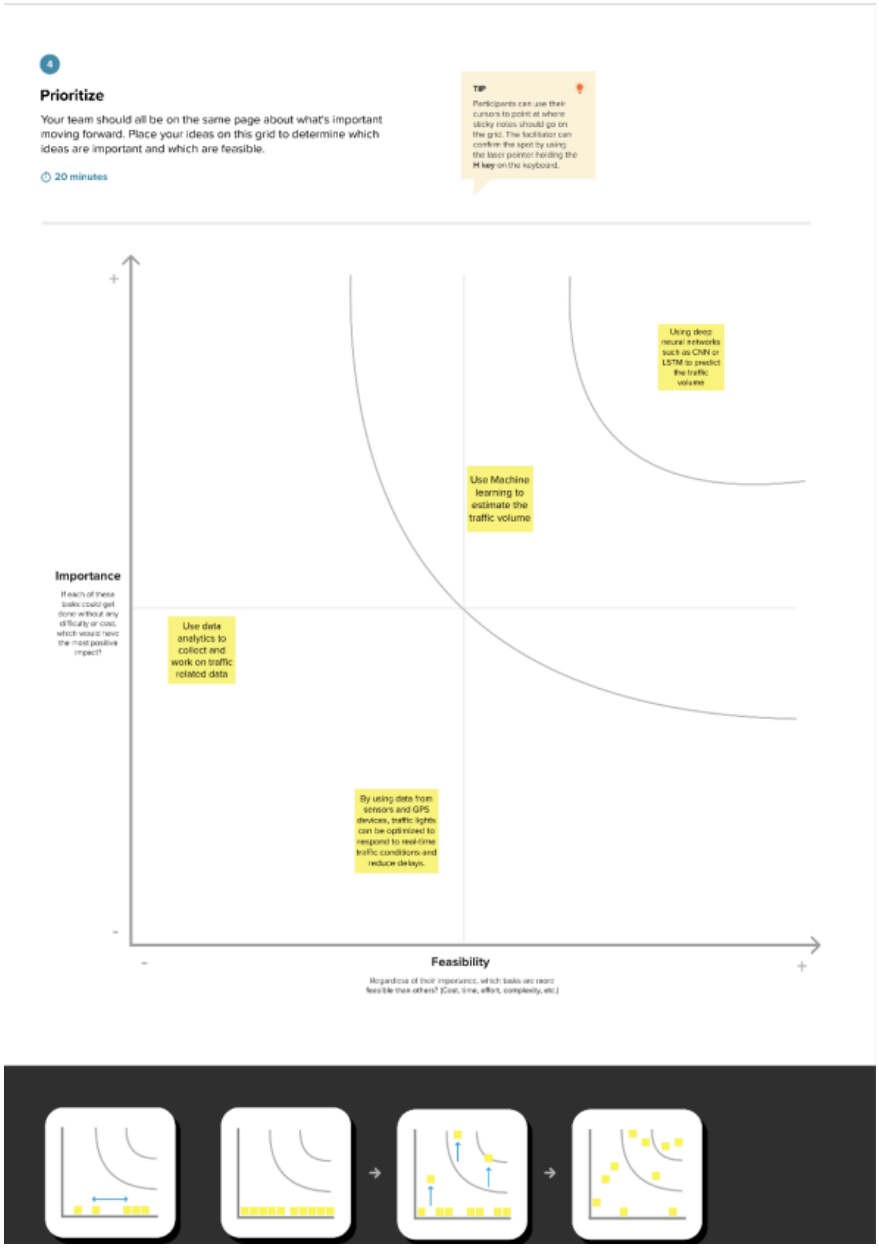
IDEATION & PROPOSED SOLUTION

EMPATHY MAP CANVAS:



IDEATION & BRAINSTORMING:




4
Prioritize
Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.
20 minutes
TIP
Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the H key on the keyboard.
Using deep neural networks such as CNN or LSTM to predict the traffic volume
Use Machine learning to estimate the traffic volume
Importance
If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?
Use data analytics to collect and work on traffic related data
By using data from sensors and GPS devices, traffic lights can be optimized to respond to real-time traffic conditions and reduce delays.
Feasibility
Regardless of their importance, which tasks are more feasible than others? (Cost, time, effort, complexity, etc.)

REQUIREMENT ANALYSIS

FUNCTIONAL REQUIREMENT:

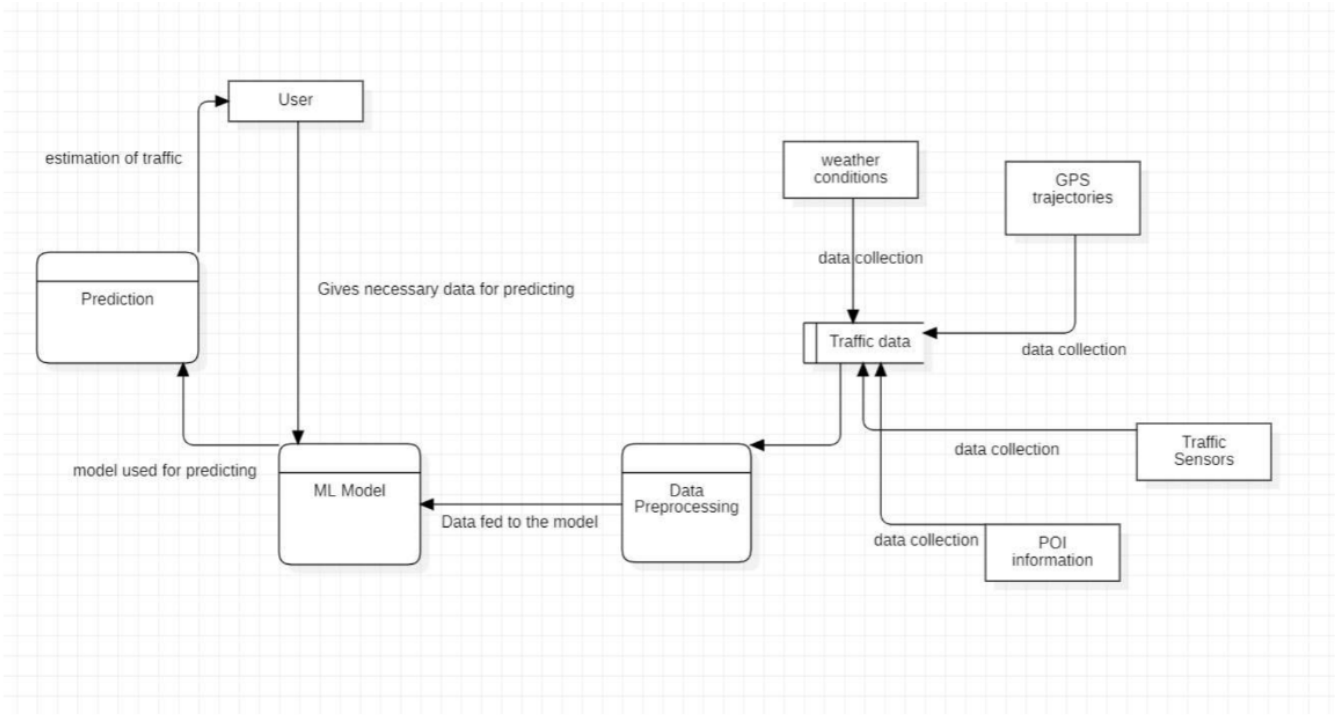
- Reporting and Visualization
- Accurate traffic measurement and prediction
- Traffic Rule Violation Identification
- API for Integration

NON-FUNCTIONAL REQUIREMENT:

- Response Time
- Scalability
- Availability
- Fault Tolerance
- Data Privacy
- Access Control
- Modularity
- Documentation
- Error Handling
- Regulatory Compliance
- Ethical Considerations

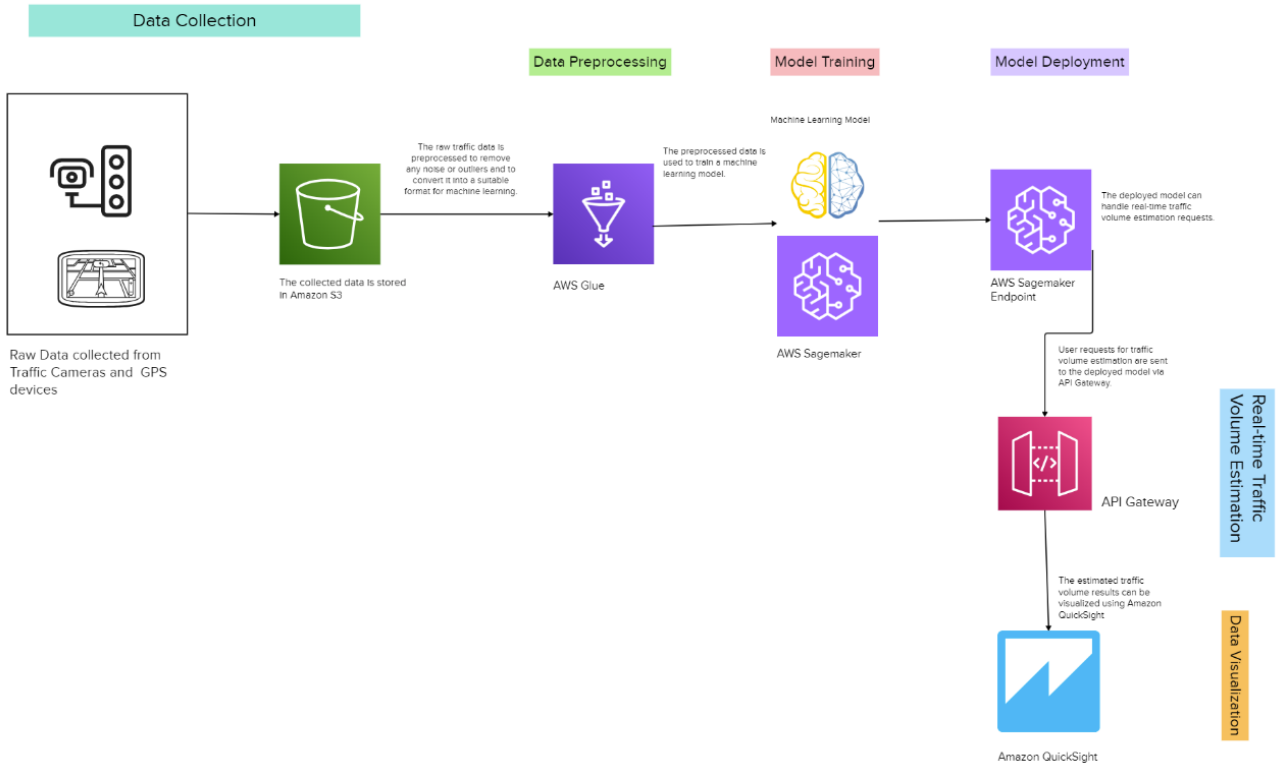
PROJECT DESIGN

DATA FLOW DIAGRAMS & USER STORIES:



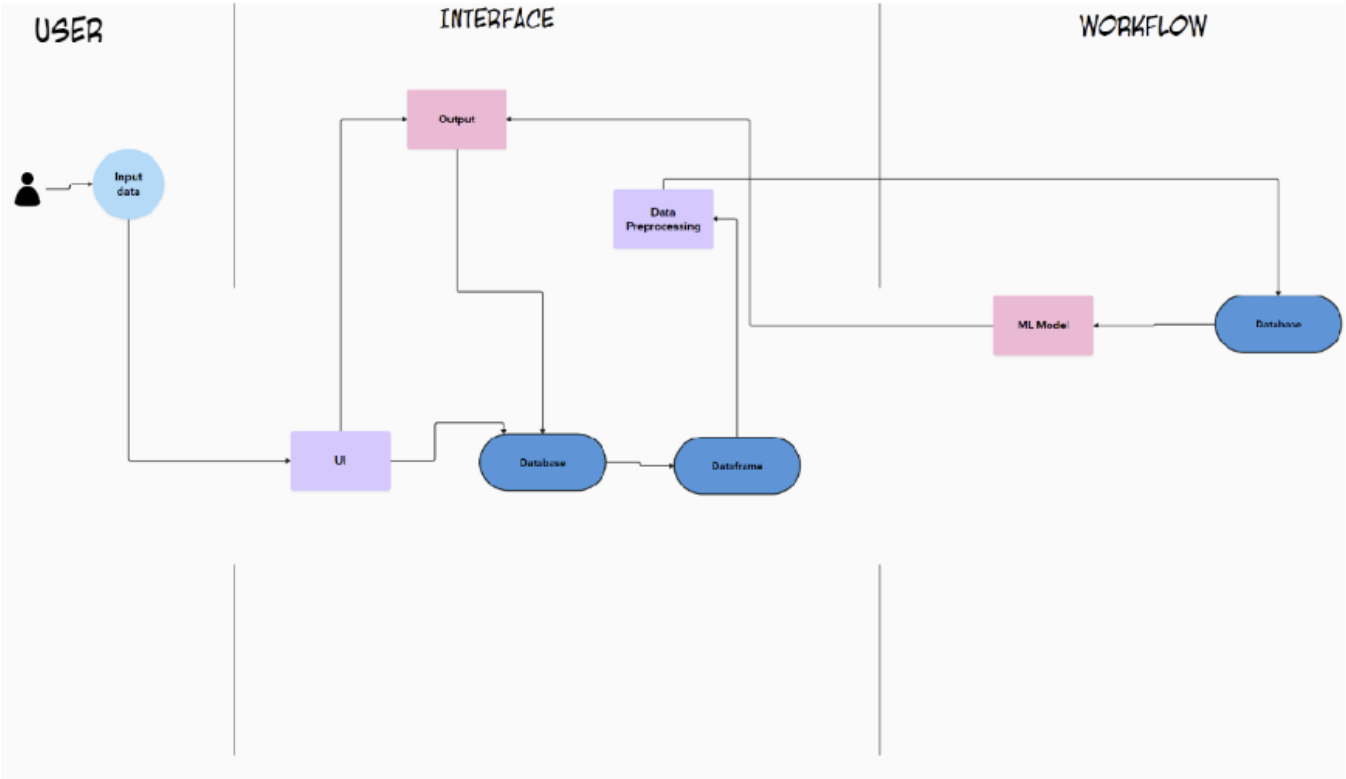
User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Administrator	Accurate traffic measurement and prediction	USN-1	As a government official, I want a system that can accurately measure and predict traffic volume at various locations, so I can make informed decisions regarding infrastructure development and traffic management.	I can access the volume of traffic at the locations needed	High	version-1
User		USN-2	As a commuter, I can receive real-time traffic updates and alerts on my mobile device, so I can plan my daily commute more efficiently and avoid severe traffic congestion.	I can receive traffic alerts as a notification	High	version-1
Officer	Traffic Rule Violation Identification	USN-3	As a traffic management officer, I need a tool that can identify violations of traffic rules, allowing us to take necessary enforcement actions to improve road safety.	I can capture the plate number of the vehicle that has violated the traffic rules	Medium	version-1
Developer	API for Integration	USN-4	As a software developer, I want access to a well-documented API that allows me to integrate traffic data into third-party applications or services, enhancing the accessibility of traffic information.	I can download API for integration to any software requirements	low	version-2
Official	Reporting and Visualization	USN-5	As a city official, I need the system to generate reports and visualizations that are easy to understand and share with the public, helping to increase awareness of traffic-related issues.	I can get reports of traffic related issues	low	version-2

SOLUTION ARCHITECTURE:



PROJECT PLANNING & SCHEDULING

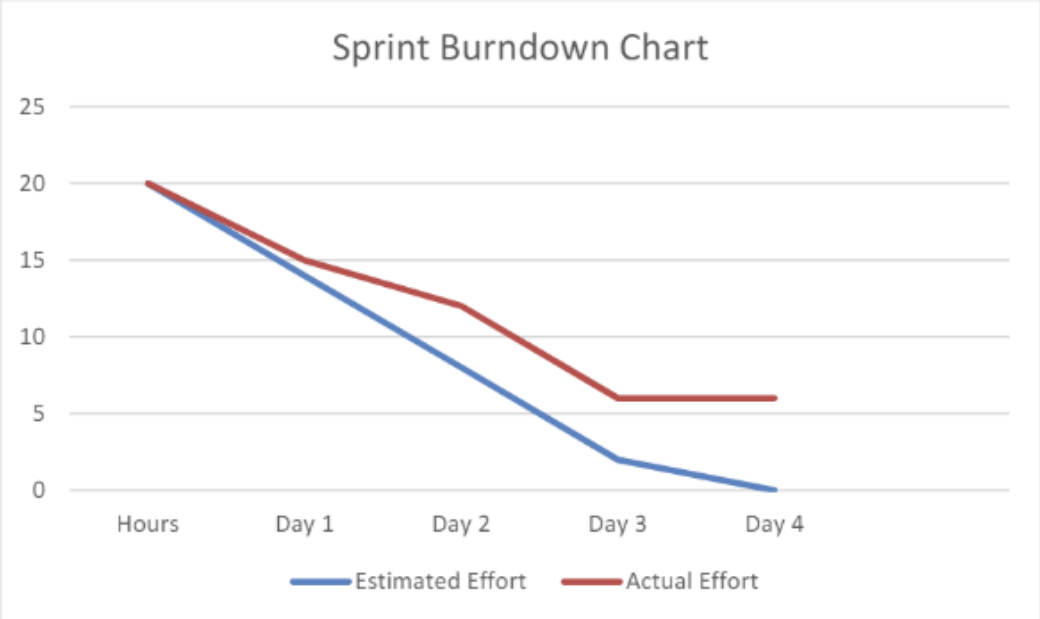
TECHNICAL ARCHITECTURE:



SPRINT PLANNING & ESTIMATION:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority
Sprint-1	Accurate traffic measurement and prediction	USN-1	As a government official, I want a system that can accurately measure and predict traffic volume at various locations, so I can make informed decisions regarding infrastructure development and traffic management.	2	High
Sprint-2		USN-2	As a commuter, I can receive real-time traffic updates and alerts on my mobile device, so I can plan my daily commute more efficiently and avoid severe traffic congestion.	1	High
Sprint-3	Traffic Rule Violation Identification	USN-3	As a traffic management officer, I need a tool that can identify violations of traffic rules, allowing us to take necessary enforcement actions to improve road safety.	2	Low
Sprint-4	API for Integration	USN-4	As a software developer, I want access to a well-documented API that allows me to integrate traffic data into third-party applications or services, enhancing the accessibility of traffic information.	2	Medium
Sprint-5	Reporting and Visualization	USN-5	As a city official, I need the system to generate reports and visualizations that are easy to understand and share with the public, helping to increase awareness of traffic-related issues.	1	High

SPRINT DELIVERY SCHEDULE:

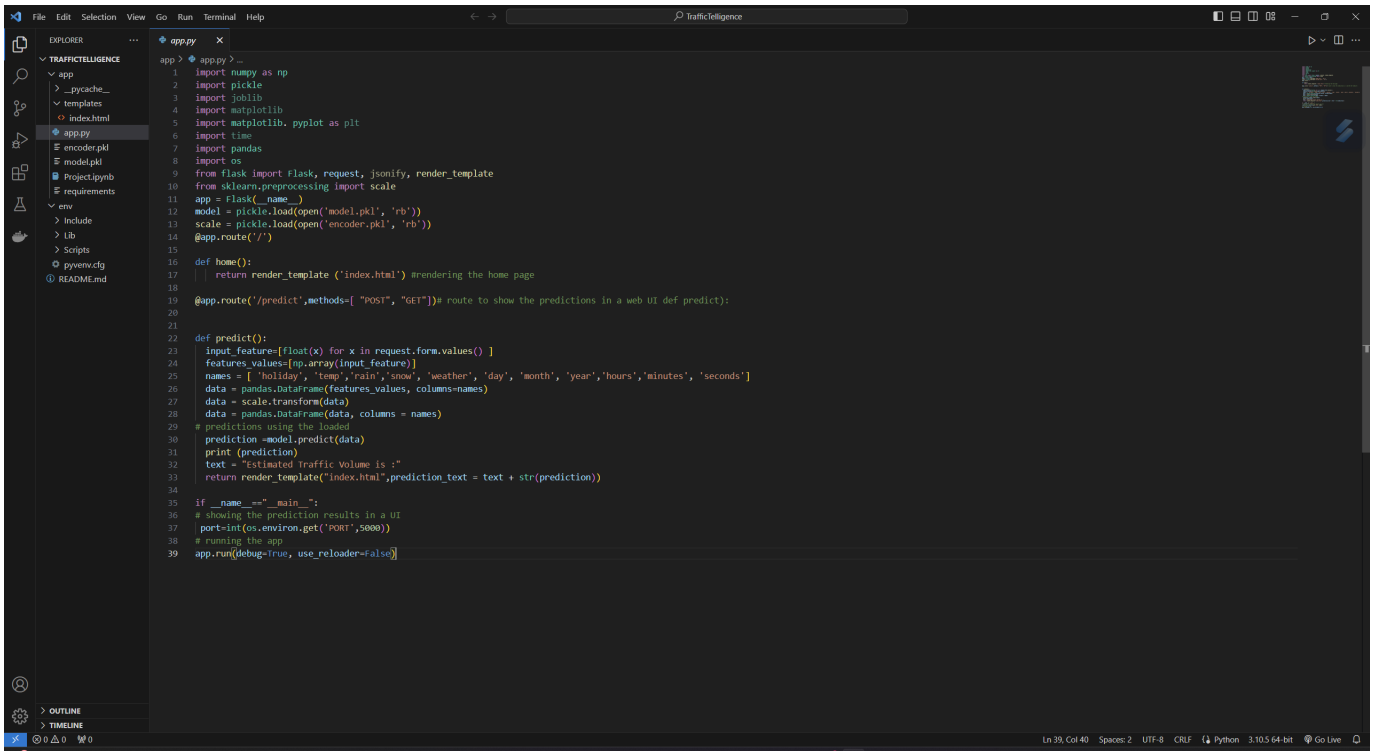


CODING & SOLUTIONING

FEATURE 1:

<u>WEB APPLICATION FOR TRAFFIC VOLUME PREDICTION:</u>

CODE:



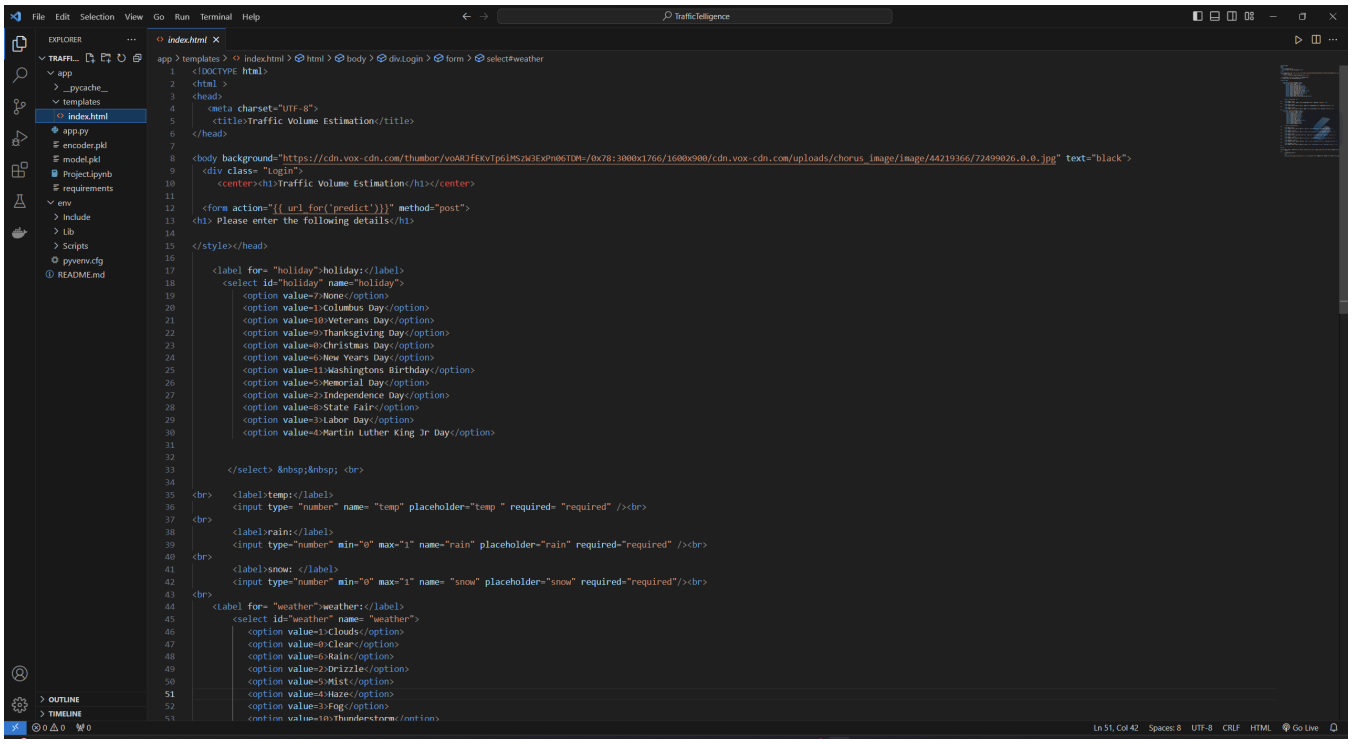
Explanation:

The above code is the main backend program for our web application. Flask is used in python for our web app, it is a widely used framework for integrating machine learning for web application. The model.pkl file contains the RandomForestRegressor model which was the best peforming model while testing with dataset. In the above code, app.route() is a decorator that allows us to assign a funtion to handle a request for a specific URL. There are two funtions home(), which is the home page of our website and predict(), which is the function that uses the ML model to predict for a particular input given in the website.

FEATURE 2:

USER INTERFACE FOR THE WEB APP:

CODE:



```
<!DOCTYPE html>
<html >
<head>
  <meta charset="UTF-8">
  <title>Traffic Volume Estimation</title>
</head>

<body background="https://cdn.vox-cdn.com/thumbor/voARJfEKvTp6iMSzW3ExPn06TDM=/0x78:3000x1766/1600x900/cdn.vox-cdn.com/uploads/chorus_image/image/44219366/72499026.0.0.jpg" text="black">
  <div class= "Login">
    <center><h1>Traffic Volume Estimation</h1></center>

  <form action="{{ url_for('predict')}}" method="post">
<h1> Please enter the following details</h1>

</style></head>

    <label for= "holiday">holiday:</label>
      <select id="holiday" name="holiday">
          <option value=7>None</option>
          <option value=1>Columbus Day</option>
          <option value=10>Veterans Day</option>
          <option value=9>Thanksgiving Day</option>
          <option value=0>Christmas Day</option>
          <option value=6>New Years Day</option>
          <option value=11>Washingtons Birthday</option>
          <option value=5>Memorial Day</option>
          <option value=2>Independence Day</option>
          <option value=8>State Fair</option>
          <option value=3>Labor Day</option>
          <option value=4>Martin Luther King Jr Day</option>


      </select>    <br>

<br>    <label>temp:</label>
        <input type= "number" name= "temp" placeholder="temp " required= "required" /><br>
<br>
        <label>rain:</label>
        <input type="number" min="0" max="1" name="rain" placeholder="rain" required="required" /><br>
<br>
        <label>snow: </label>
        <input type="number" min="0" max="1" name= "snow" placeholder="snow" required="required"/><br>
<br>
    <label for= "weather">weather:</label>
        <select id="weather" name= "weather">
            <option value=1>Clouds</option>
            <option value=0>Clear</option>
            <option value=6>Rain</option>
            <option value=2>Drizzle</option>
            <option value=5>Mist</option>
            <option value=4>Haze</option>
            <option value=3>Fog</option>
            <option value=10>Thunderstorm</option>
            <option value=8>Snow</option>
            <option value=9>Squall</option>
            <option value=7>Smoke</option>

        </select>   <br>
<br>
        <label>day:</label>
        <input type="number" min="1" max="31" name="day" placeholder="day" required="required" /><br>
<br>
        <label>month: </label>
        <input type="number" min="1" max="12" name="month" placeholder="month" required="required" /><br>
<br>
        <label>year:</label>
        <input type="number" min="2012" max="2022" name="year" placeholder="year" required="required"/><br>
<br>
        <label>hours: </label>
        <input type="number" min="0" max="24" name="hours" placeholder="hours"  required="required"/><br>
<br>
        <label>minutes:</label>
        <input type= "number" min="0" max="60" name= "minutes" placeholder="minutes" required="required"/><br>
<br>
        <label>seconds:</label>
        <input type="number" min="0" max="60" name="seconds" placelolder="seconds" required="required" /><br>
<br>


<br><br>

<button type="submit" class="btn btn-primary btn-block btn-Large" style="height:30px;width:200px">Predict</button>
        </form>
<br>
        {{ prediction_text }}
        <br>
        <br>
        <img src="data-image/nnn:base64 {{url_3 }}" alt="Submit Form" height="180" width="233" onerror="this.style.display='none'"/>
```

EXPLANATION:

This HTML code represents a webpage for estimating traffic volume. It includes a form where users can input details like the date, weather conditions, and temperature. After submitting the form, the page likely sends this data to the app.py for processing and displays the results on the page. The page has a background image and a title, and it allows users to visually select options for certain inputs. There's also a button to trigger the estimation, and a space for displaying the results and an image, which may change based on the input.

PERFORMANCE TESTING

PERFORMACE METRICS:

```
from sklearn import metrics
```

```
print(metrics.r2_score(p1,y_train))
print(metrics.r2_score(p2,y_train))
print(metrics.r2_score(p3,y_train))
print(metrics.r2_score(p4,y_train))
print(metrics.r2_score(p5,y_train))
```

```
-5.517383877973709
1.0
0.97505355935402
-12.186526578253414
0.8411290768657846
```

```
[ ] MSE= metrics.mean_squared_error(p3,y_train)
    MSE
```

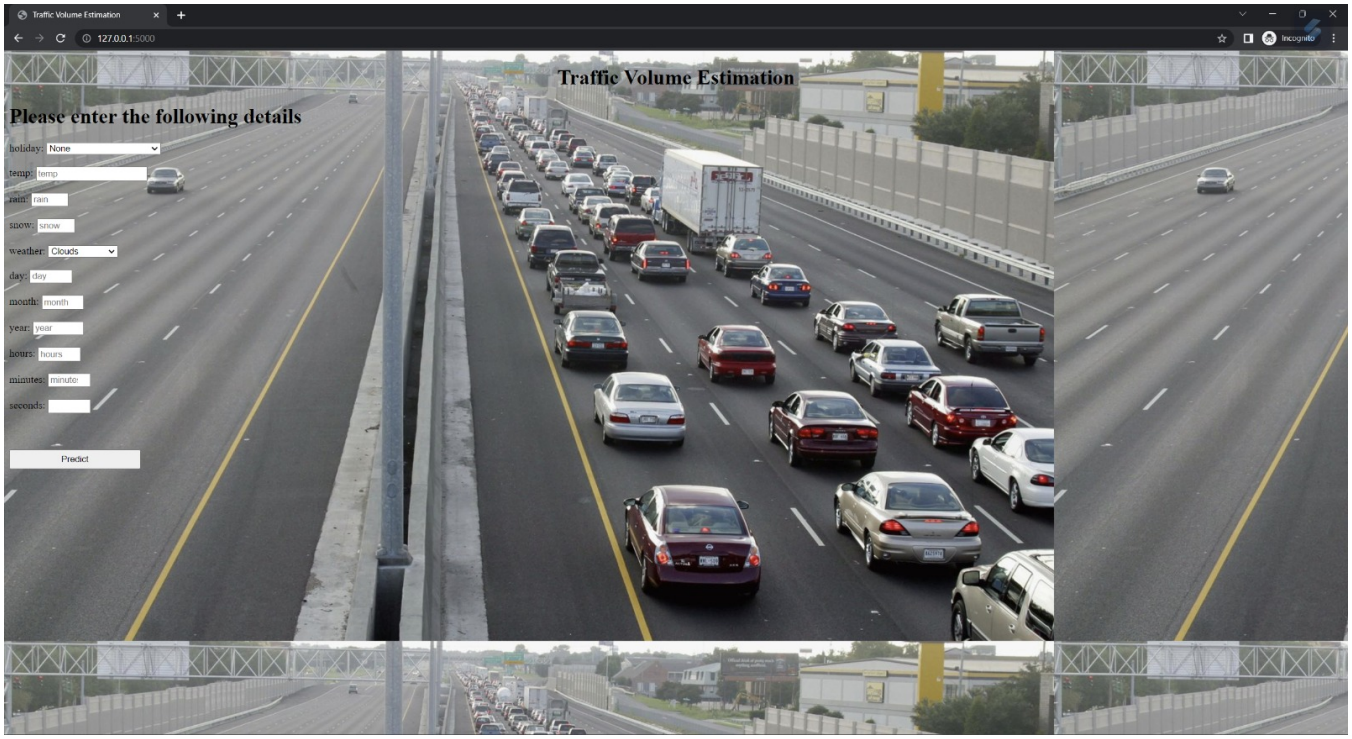
```
88733.31608997742
```

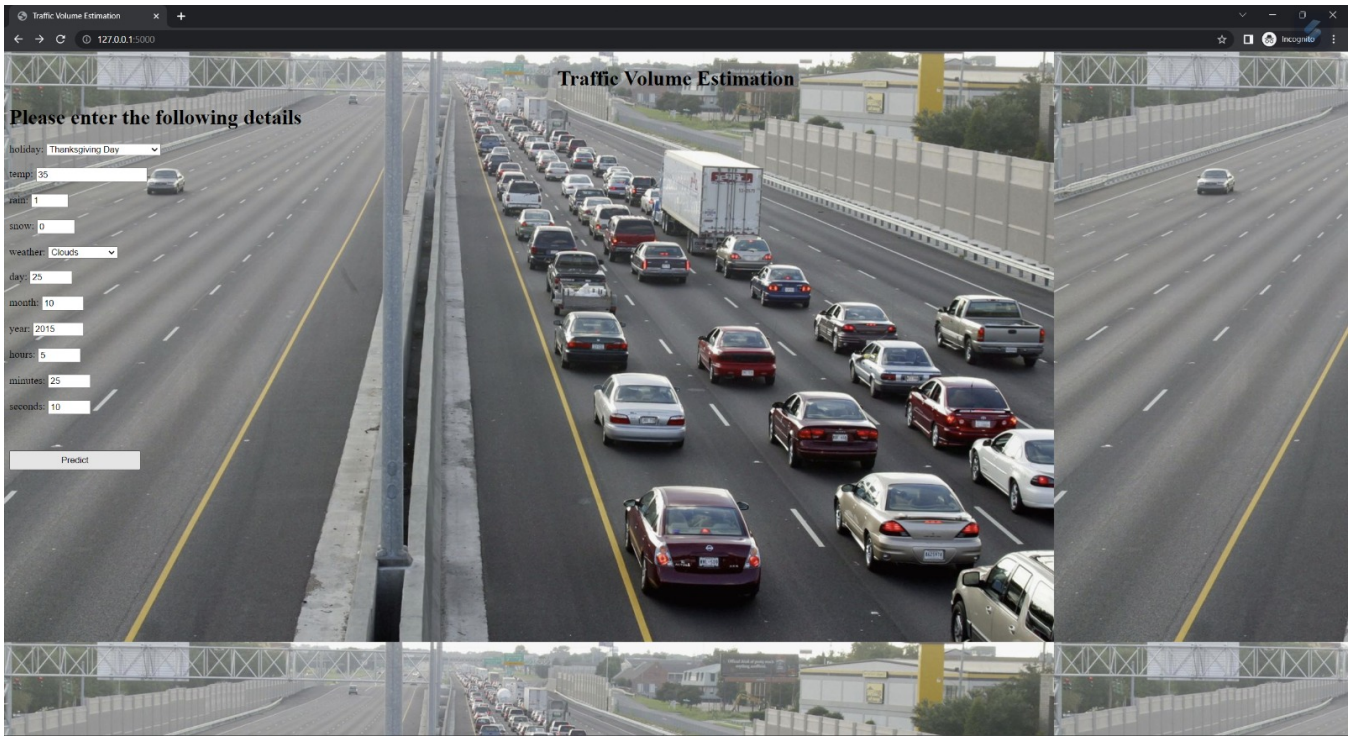
```
[ ] np.sqrt(MSE)
```

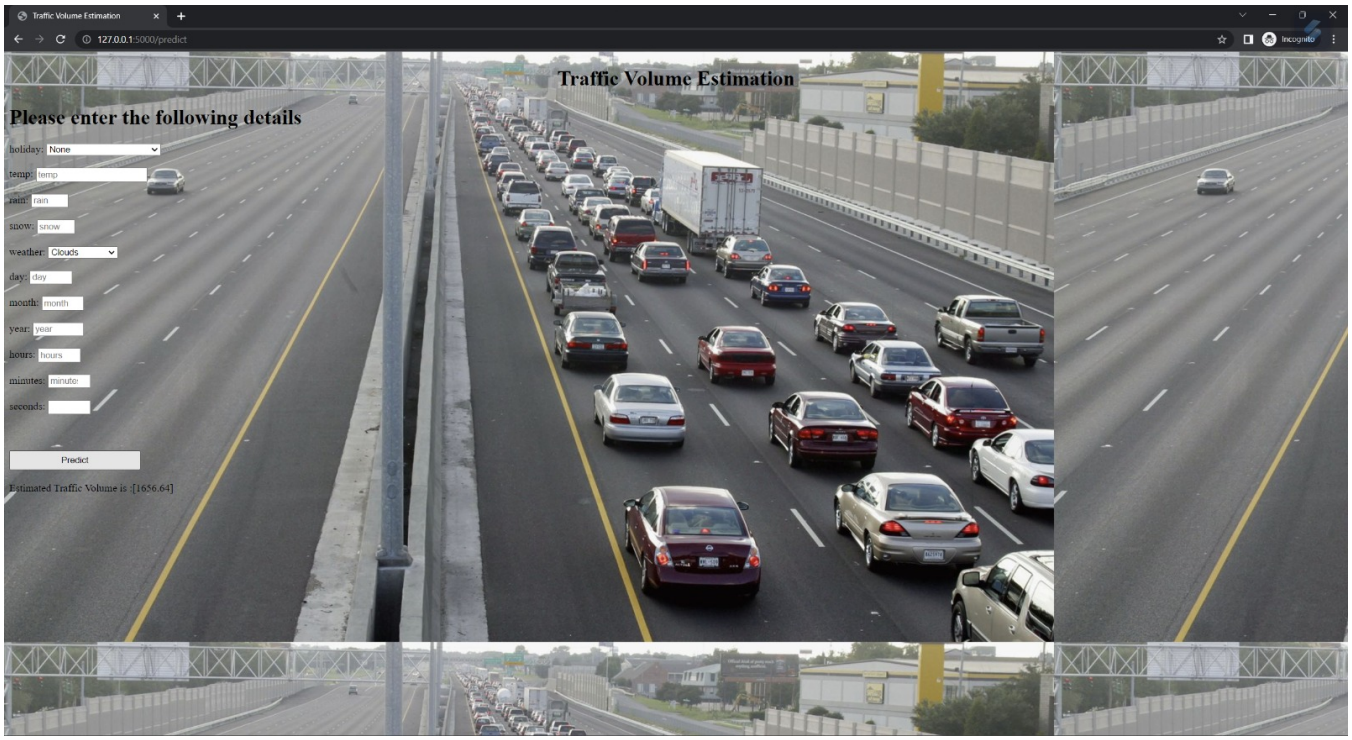
```
297.88137922666033
```

RESULTS

Output Screenshots:







ADVANTAGES & DISADVANTAGES

Advantages:

1. Accurate Traffic Management:
1. Real-time Monitoring
2. Proactive Issue Prevention
3. Optimized Resource Allocation
4. Data-Driven Decision Making
5. Enhanced Road Safety
6. Improved Infrastructure Planning
7. User-friendly Visualization

Disadvantages:

1. Data Privacy Concerns
2. Initial Implementation Costs
3. Model Training and Maintenance
4. Dependency on Data Quality
5. Potential for Technical Issues
6. Integration Challenges:
7. Ethical Consideration
8. Public Resistance
9. Regulatory Compliance

CONCLUSION

In summary, the implementation of an advanced system integrating machine learning for traffic management offers considerable potential for revolutionizing transportation strategies. The benefits of such a system include accurate traffic predictions, real-time monitoring, and data-driven decision-making, leading to improved traffic flow and resource allocation. However, challenges such as privacy concerns, initial implementation costs, and continuous model maintenance should be carefully addressed.

The integration of machine learning models into traffic management practices signifies a shift towards a more intelligent and responsive transportation system. Visualization and reporting tools contribute to user-friendly interfaces for efficient data interpretation by traffic management authorities. Successful implementation requires a focus on regulatory compliance, ethical considerations, and robust infrastructure.

In essence, the system represents a transformative approach to traffic management, leveraging cutting-edge technology for safer, more efficient, and smarter transportation networks. Addressing challenges and ensuring ethical practices are crucial for the system to make significant contributions to urban planning, infrastructure development, and overall road safety.

FUTURE SCOPE

Looking ahead, the future scope of an advanced traffic volume estimation system utilizing machine learning holds immense potential for further advancements in urban transportation. The integration of autonomous vehicles, multi-modal transportation modes, and environmental impact assessments could elevate the system to a holistic approach, providing comprehensive insights into dynamic traffic conditions. Predictive analytics for long-term traffic planning, real-time traffic signal control, and edge computing for faster processing are avenues for future exploration. Continuous enhancements to machine learning models, coupled with user engagement mechanisms and predictive maintenance for infrastructure, will contribute to the system's adaptability and efficiency. Moreover, global collaboration for traffic insights and advancements in privacy-preserving techniques will be crucial for ensuring widespread applicability and public trust. Embracing these future directions can transform the system into an intelligent, user-centric, and environmentally conscious solution, shaping the landscape of smart urban transportation.

APPENDIX

SOURCE CODE:

app.py code:

```
import numpy as np
import pickle
import joblib
import matplotlib
import matplotlib. pyplot as plt
import time
import pandas
import os
from flask import Flask, request, jsonify, render_template
from sklearn.preprocessing import scale
app = Flask(_name_)
model = pickle.load(open('model.pkl', 'rb'))
scale = pickle.load(open('encoder.pkl', 'rb'))
@app.route('/')

def home():
    return render_template ('index.html') #rendering the home page

@app.route('/predict',methods=[ "POST", "GET"])# route to show the predictions in a web UI def predict):


def predict():
  input_feature=[float(x) for x in request.form.values() ]
  features_values=[np.array(input_feature)]
  names = [ 'holiday', 'temp','rain','snow', 'weather', 'day', 'month', 'year','hours','minutes', 'seconds']
  data = pandas.DataFrame(features_values, columns=names)
  data = scale.transform(data)
  data = pandas.DataFrame(data, columns = names)
# predictions using the loaded
  prediction =model.predict(data)
  print (prediction)
  text = "Estimated Traffic Volume is :"
  return render_template("index.html",prediction_text = text + str(prediction))

if _name=="__main_":
# showing the prediction results in a UI
 port=int(os.environ.get('PORT',5000))
# running the app
app.run(debug=True, use_reloader=False)
```

index.html code:

```
<!DOCTYPE html>
<html >
<head>
  <meta charset="UTF-8">
   <title>Traffic Volume Estimation</title>
</head>

<body background="https://cdn.vox-
cdn.com/thumbor/voARJfEKvTp6iMSzW3ExPn06TDM=/0x78:3000x1766/1600x900/cdn.vox-
cdn.com/uploads/chorus_image/image/44219366/72499026.0.0.jpg" text="black">
 <div class= "Login">
   <center><h1>Traffic Volume Estimation</h1></center>

 <form action="{{ url_for('predict')}}" method="post">
<h1> Please enter the following details</h1>

</style></head>

   <label for= "holiday">holiday:</label>
    <select id="holiday" name="holiday">
       <option value=7>None</option>
       <option value=1>Columbus Day</option>
       <option value=10>Veterans Day</option>
       <option value=9>Thanksgiving Day</option>
       <option value=0>Christmas Day</option>
       <option value=6>New Years Day</option>
       <option value=11>Washingtons Birthday</option>
       <option value=5>Memorial Day</option>
       <option value=2>Independence Day</option>
       <option value=8>State Fair</option>
       <option value=3>Labor Day</option>
       <option value=4>Martin Luther King Jr Day</option>

     </select>    <br>

<br>   <label>temp:</label>
      <input type= "number" name= "temp" placeholder="temp " required= "required" /><br>
<br>
      <label>rain:</label>
      <input type="number" min="0" max="1" name="rain" placeholder="rain" required="required" /><br>
<br>
      <label>snow: </label>
      <input type="number" min="0" max="1" name= "snow" placeholder="snow" required="required"/><br>
<br>
   <Label for= "weather">weather:</label>
```

```
      <select id="weather" name= "weather">
        <option value=1>Clouds</option>
        <option value=0>Clear</option>
        <option value=6>Rain</option>
        <option value=2>Drizzle</option>
        <option value=5>Mist</option>
        <option value=4>Haze</option>
        <option value=3>Fog</option>
        <option value=10>Thunderstorm</option>
        <option value=8>Snow</option>
        <option value=9>Squall</option>
        <option value=7>Smoke</option>
      </select>   <br>
<br>
      <label>day:</label>
      <input type="number" min="1" max="31" name="day" placeholder="day" required="required" /><br>
<br>
      <label>month: </label>
      <input type="number" min="1" max="12" name="month" placeholder="month" required="required"
/><br>
<br>
      <label>year:</label>
      <input type="number" min="2012" max="2022" name="year" placeholder="year"
required="required"/><br>
<br>
      <Label>hours: </label>
      <input type="number" min="0" max="24" name="hours" placeholder="hours"
required="required"/><br>
<br>
      <label>minutes:</label>
      <input type= "number" min="0" max="60" name= "minutes" placeholder="minutes"
required="required"/><br>
<br>
      <label>seconds:</label>
      <input type="number" min="0" max="60" name="seconds" placelolder="seconds" required="required"
/><br>
<br>
<br><br>

<button type="submit" class="btn btn-primary btn-block btn-Large"
style="height:30px;width:200px">Predict</button>
      </form>
<br>
      {{ prediction_text }}
      <br>
      <br>
      <img src="data-image/nnn:base64 {{url_3 }}" alt="Submit Form" height="180" width="233"
onerror="this.style.display='none'"/>
```

GITHUB & PROJECT DEMO LINK:

https://github.com/smartinternz02/SI-GuidedProject-603591-1697644299
https://drive.google.com/file/d/1IaPDXrqhpmqGaUQ4WTAf4T9QFdb7mj4X/view?usp=sharing