AUTONOMOUS VEHICLES

A PROJECT REPORT (PHASE 3)

submitted by

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Bachelor of Engineering

in

COMPUTER SCIENCE AND ENGINEERING

Under the course of

ARTIFICIAL INTELLIGENCE

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Introduction:

Phase 3 of our project marks a significant shift towards **data visualization,** a critical aspect of **data analysis** and **interpretation.** Through the implementation of effective visualization techniques, we aim to visually communicate **insights, trends,** and **patterns** present within the dataset. By doing so, we facilitate stakeholders in making **informed decisions** and understanding complex relationships more intuitively. This phase emphasizes the power of visualization in aiding **comprehension** and fostering actionable insights, ultimately contributing to the success of our project.

Objectives:

- Develop visually **informative** and appealing **visualizations** to explore and effectively communicate key insights derived from the dataset.
- Employ a diverse range of visualization techniques tailored to represent various types of data comprehensively, ensuring **clarity** and **accuracy** in representation.
- Enhance user engagement and understanding through the implementation of interactive visualizations, fostering a **dynamic** and **immersive exploration** of the dataset.
- Document the data visualization process meticulously, ensuring **transparency** and **reproducibility,** thereby facilitating effective collaboration and future reference.

Dataset description:

Dataset Paper Link: https://arxiv.org/abs/2401.10659

- **Dataset Overview:**
  - Covers 9 districts in Bangladesh: Sylhet, Dhaka, Rajshahi, Mymensingh, Maowa, Chittagong, Sirajganj, Sherpur, and Khulna
  - Contains 9825 images.
  - Annotations for 78,943 objects.
  - Includes 13 different classes of objects.
  - Annotated with rectangular bounding boxes.

- **Data Collection:**
  - Images were collected using smartphone cameras.
  - Simulates real-world conditions faced by autonomous vehicles.
  - Absence of online images ensures dataset authenticity.
  - Represents actual driving scenarios in Bangladesh, promoting practical model development.

Main Goal:

- ✓ Develop solutions for detecting objects under diverse road conditions in Bangladesh.

Classes (13 in total):

1. Auto Rickshaw
2. Bicycle
3. Bus
4. Car
5. Cart Vehicle
6. Construction Vehicle
7. Motorbike
8. Person
9. Priority Vehicle
10. Three-Wheeler
11. Train
12. Truck
13. Wheelchair

Dataset Format:

This dataset is in Yolov5 format. The train and test images can be found in in `dlenigma1/BadODD/images/`, and the labels for the train dataset can be found in `dlenigma1/BadODD/labels/`directory.

- Train Image Count: 5896
- Test Image Count: 1964

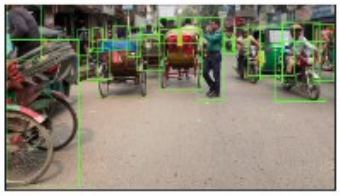
Each training image has a txt file of the same name in the labels directory.

Test
Test set images are in `dlenigma1/BadODD/images/test`.

The test set has no provided annotations. Your task is to learn the bounding box from the train set and predict it for the test set images.

Sample Database:

Sylhet



Dhaka

Rajshahi

Mymensingh

Maowa Expressway

Dhaka Night

Chittagong Night

Chittagong Bohoddarhat

Chuadanga Sirajganj

Sherpur

Khulna

Data Visualizations:

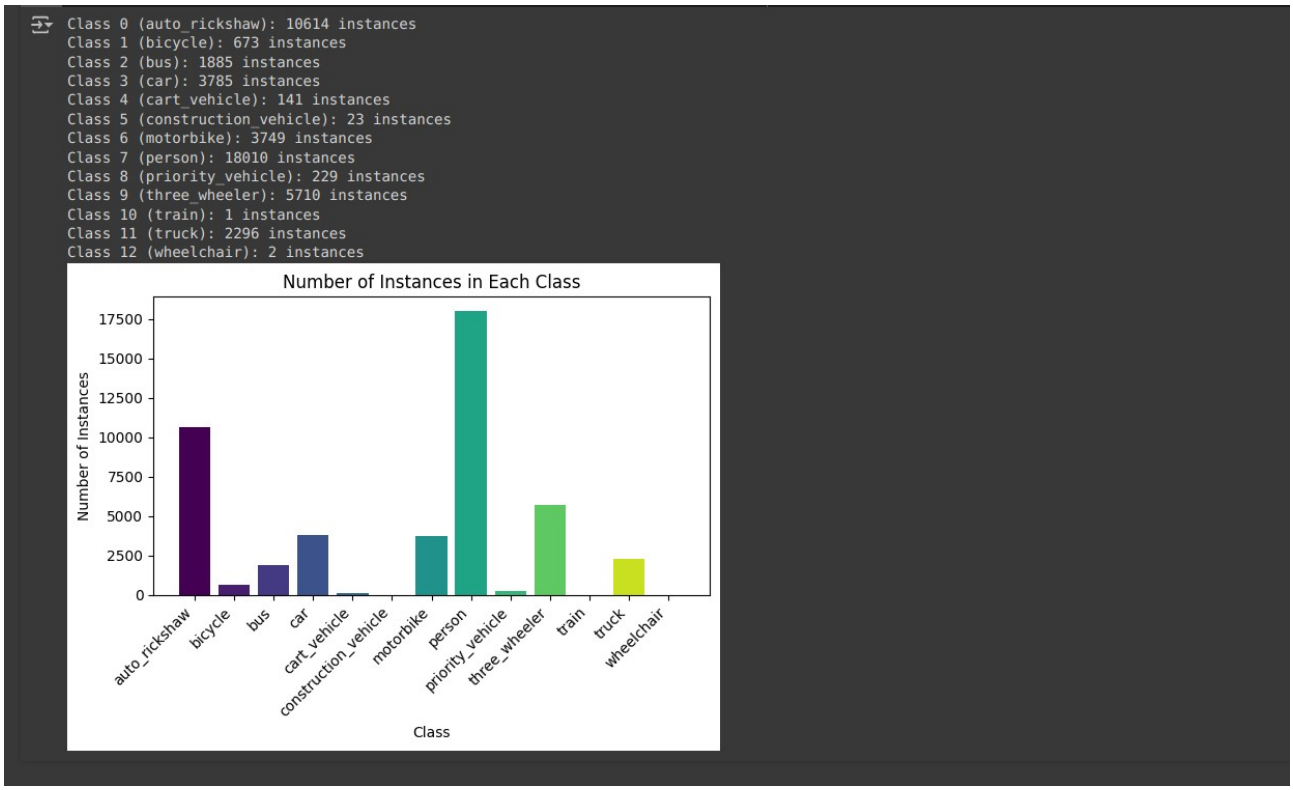
Data visualization is the art of representing **information** and **data** through visual elements like **charts, graphs,** and **maps.** It's a powerful tool to t**ransform raw data** into easily **digestible insights.**

Code snippet (Data Visualization):

```
import os

import matplotlib.pyplot as plt

import numpy as np

class_id_to_name = {
0: 'auto_rickshaw',
1: 'bicycle',
2: 'bus',
3: 'car',
4: 'cart_vehicle',
5: 'construction_vehicle',
6: 'motorbike',
7: 'person',
8: 'priority_vehicle',
9: 'three_wheeler',
10: 'train',
11: 'truck',
12: 'wheelchair'
}

# Define the label folder path
label_folder = "/content/dlenigma1/BadODD/labels/train"
# Initialize a dictionary to store class counts
class_counts = {class_id: 0 for class_id in class_id_to_name}

# Iterate through each text file in the label folder
for filename in os.listdir(label_folder):
if filename.endswith(".txt"):
file_path = os.path.join(label_folder, filename)

# Read the content of the label file and count class occurrences
with open(file_path, 'r') as file:
lines = file.readlines()

for line in lines:
parts = line.strip().split()
if parts: # Check if the line is not empty
class_id = int(parts[0])
if class_id in class_counts:
class_counts[class_id] += 1

# Print the class counts
for class_id, count in class_counts.items():
class_name = class_id_to_name[class_id]
print(f'Class {class_id} ({class_name}): {count} instances')

# Create a bar plot
class_ids = np.array(list(class_counts.keys()))
class_names = [class_id_to_name[class_id] for class_id in class_ids]
```

```
counts = np.array(list(class_counts.values()))
colors = plt.cm.viridis(np.linspace(0, 1, len(class_ids)))

plt.bar(class_names, counts, color=colors)
plt.xlabel('Class')
plt.ylabel('Number of Instances')
plt.title('Number of Instances in Each Class')
plt.xticks(rotation=45, ha="right") # Rotate x-axis labels for better visibility
plt.tight_layout()
plt.show()
```

Output:



➢ **Univariate Data Visualization:**

Univariate visualization is a way of using graphs and charts to understand the distribution of a **single variable** in your data set. This variable can be either categorical (like hair color or shoe size) or continuous (like weight or height).

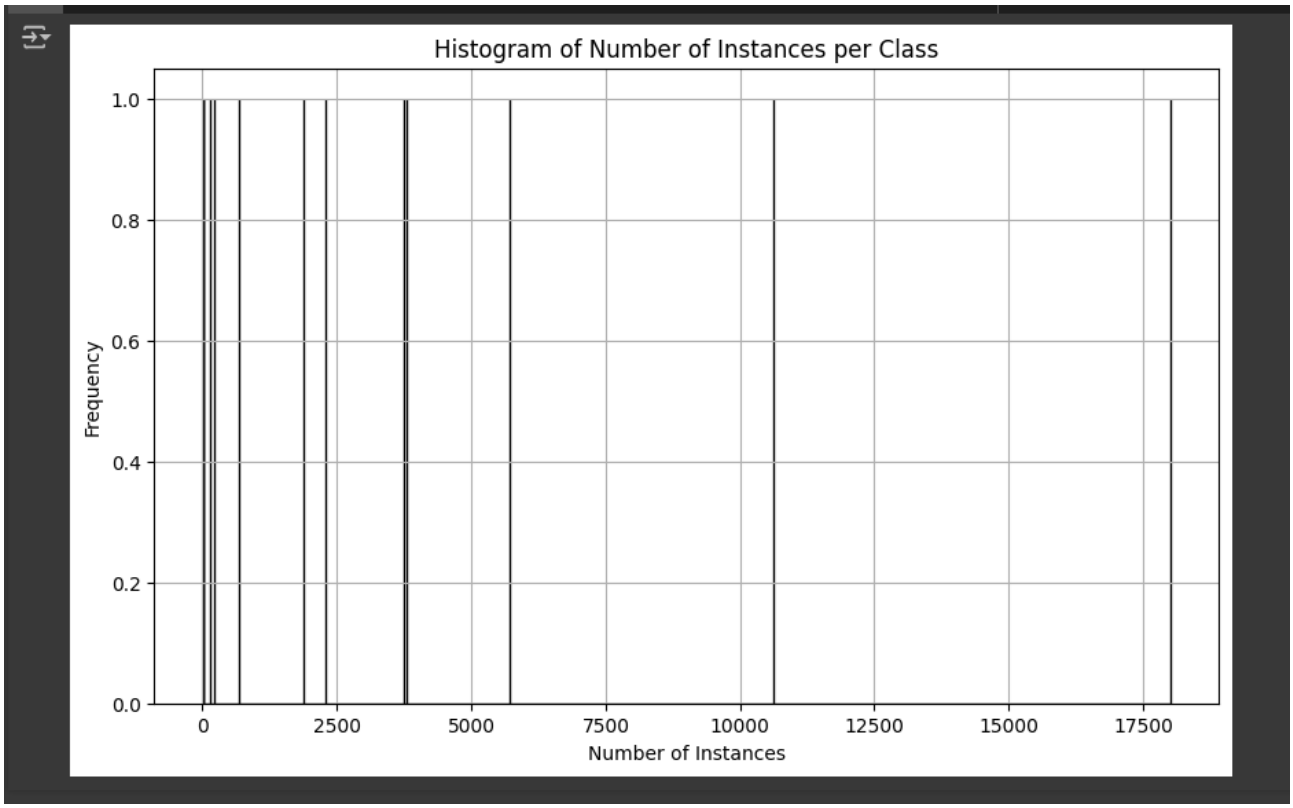
Code snippet for Univariate Data Visualization:

Histogram:

```
import matplotlib.pyplot as plt
import numpy as np

class_id_to_name = {
0: 'auto_rickshaw',
1: 'bicycle',
```

```
2: 'bus',
3: 'car',
4: 'cart_vehicle',
5: 'construction_vehicle',
6: 'motorbike',
7: 'person',
8: 'priority_vehicle',
9: 'three_wheeler',
10: 'train',
11: 'truck',
12: 'wheelchair'
}

# Define the label folder path
label_folder = "/content/dlenigma1/BadODD/labels/train"

# Initialize a dictionary to store class counts
class_counts = {class_id: 0 for class_id in class_id_to_name}

# Iterate through each text file in the label folder
for filename in os.listdir(label_folder):
if filename.endswith(".txt"):
file_path = os.path.join(label_folder, filename)

# Read the content of the label file and count class occurrences
with open(file_path, 'r') as file:
lines = file.readlines()

for line in lines:
parts = line.strip().split()
if parts: # Check if the line is not empty
class_id = int(parts[0])
if class_id in class_counts:
class_counts[class_id] += 1

# Univariate analysis
class_ids = np.array(list(class_counts.keys()))
counts = np.array(list(class_counts.values()))

# Plotting histogram
plt.figure(figsize=(10, 6))
plt.hist(counts, bins=range(min(counts), max(counts) + 1), edgecolor='black')
plt.xlabel('Number of Instances')
plt.ylabel('Frequency')
plt.title('Histogram of Number of Instances per Class')
plt.grid(True)
plt.show()
```

Output:

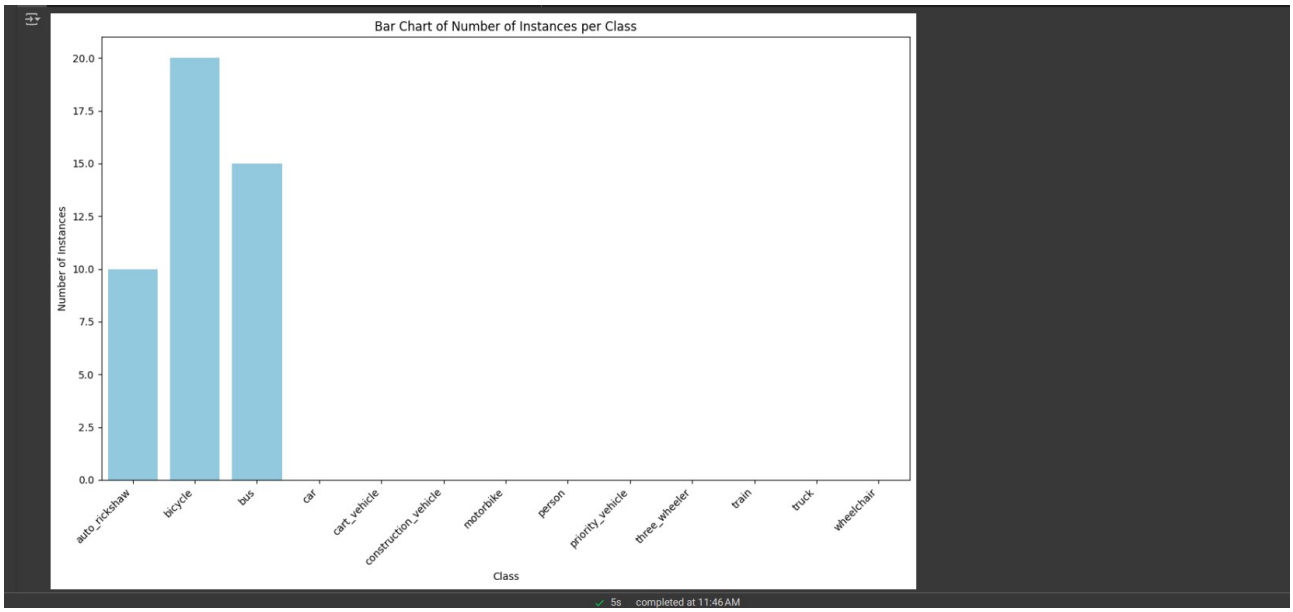


Barchart using Seaborn for Univariate visualizations:

code:

```
import seaborn as sns
import matplotlib.pyplot as plt

# Define class names and counts
class_names = list(class_id_to_name.values())
counts = [class_counts.get(class_id, 0) for class_id in class_id_to_name.keys()]

# Create a bar plot using Seaborn
plt.figure(figsize=(12, 8))
sns.barplot(x=class_names, y=counts, color='skyblue')
plt.xlabel('Class')
plt.ylabel('Number of Instances')
plt.title('Bar Chart of Number of Instances per Class')
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()
```

Output:



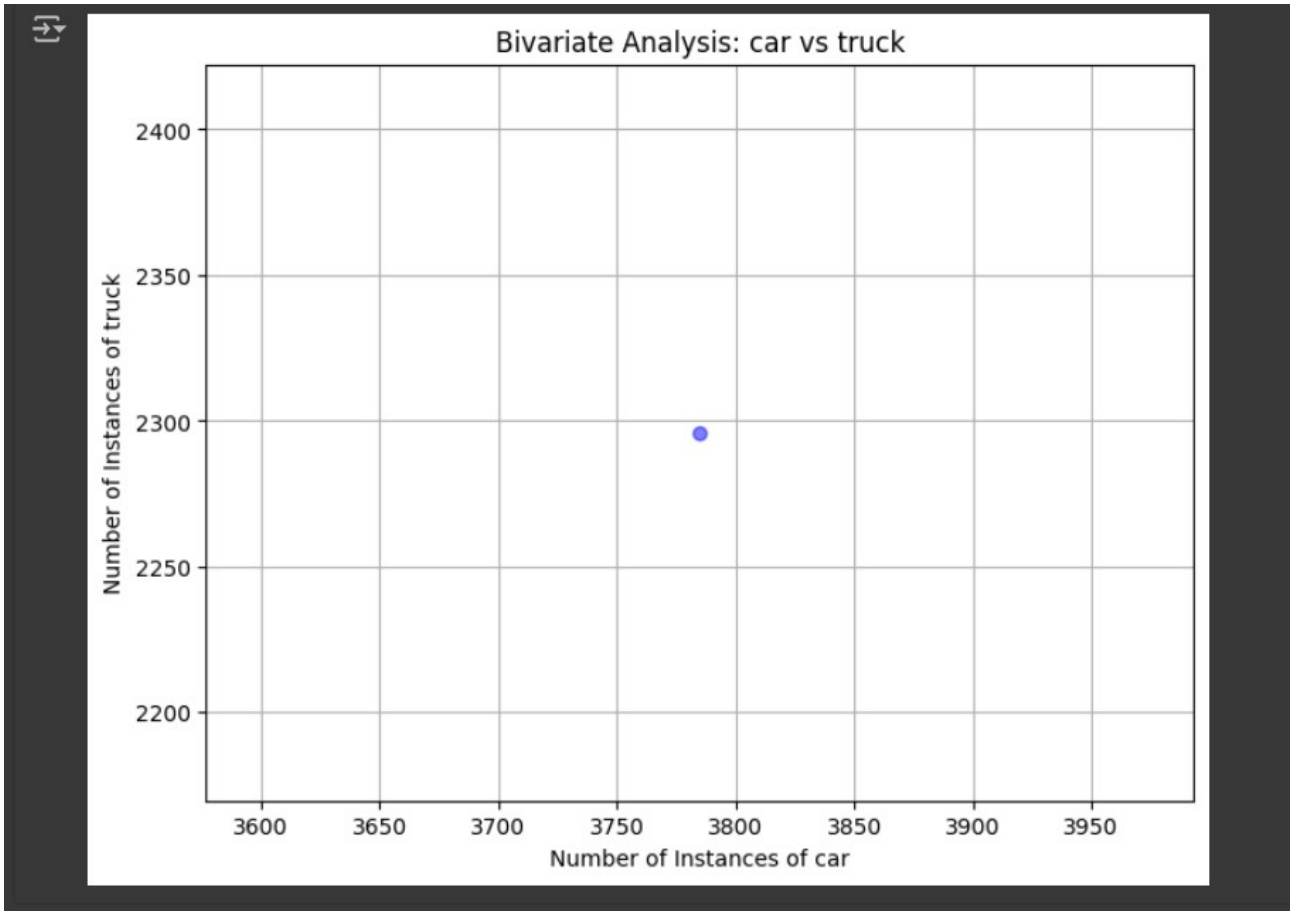
- **Bivariate Data Visualization:**
  - Bivariate visualization is a type of data visualization specifically designed to explore the relationship between **two variables** in your data set. These variables can be either **categorical** (like occupation and income level) or **continuous** (like hours studied and exam score).

Code snippet for Bivariate Data Visualization:

Histogram:

```
import matplotlib.pyplot as plt

# Define the classes you want to compare
class_id_1 = 3 # car
class_id_2 = 11 # truck

# Get the counts for the two classes
count_class_1 = class_counts[class_id_1]
count_class_2 = class_counts[class_id_2]

# Create a scatter plot
plt.figure(figsize=(8, 6))
plt.scatter(count_class_1, count_class_2, color='blue', alpha=0.5)
plt.title(f'Bivariate Analysis: {class_id_to_name[class_id_1]} vs {class_id_to_name[class_id_2]}')
plt.xlabel(f'Number of Instances of {class_id_to_name[class_id_1]}')
plt.ylabel(f'Number of Instances of {class_id_to_name[class_id_2]}')
plt.grid(True)
plt.show()
```

Output:



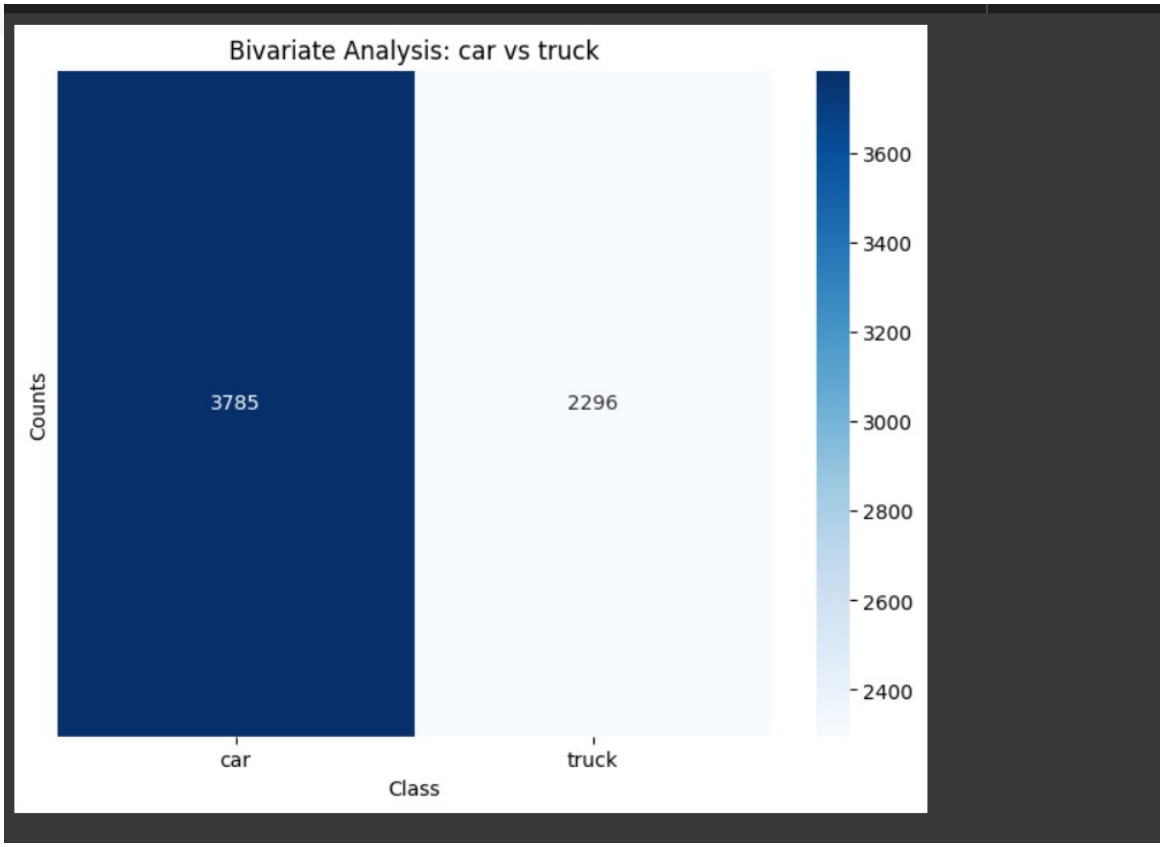
Code for Bivariate Data Visualization:

Heat map_visualization:

```
import seaborn as sns

# Define the classes you want to compare
class_id_1 = 3 # car
class_id_2 = 11 # truck

# Get the counts for the two classes
count_class_1 = class_counts[class_id_1]
count_class_2 = class_counts[class_id_2]

# Create a heatmap
plt.figure(figsize=(8, 6))
sns.heatmap([[count_class_1, count_class_2]], annot=True, fmt='d', cmap='Blues',
xticklabels=[class_id_to_name[class_id_1], class_id_to_name[class_id_2]],
yticklabels=False)
plt.title(f'Bivariate Analysis: {class_id_to_name[class_id_1]} vs {class_id_to_name[class_id_2]}')
plt.xlabel('Class')
```

```
plt.ylabel('Counts')
plt.show()
```

Output:



- **Multivariate Data Visualization:**
  - Multivariate variate data visualization involves visualizing **more than one data value in a single renderer.** This is done for many reasons, including to: View the relationship between two or more variables. Compare or contrast the difference between **two variables**.

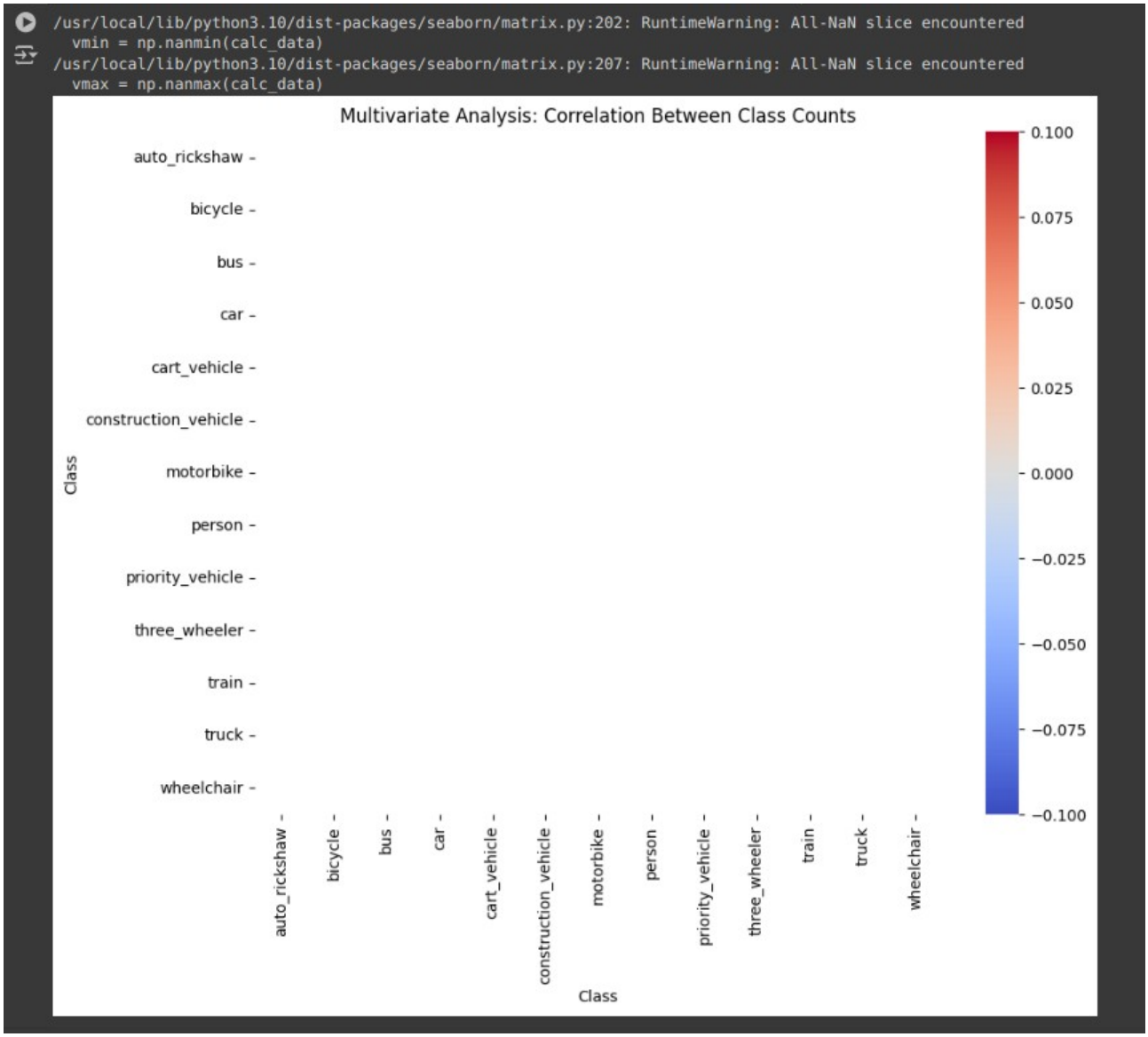
Code snippet for Multivariate Data visualization:

Code for Heat_map_visualization:

```
import pandas as pd
import seaborn as sns

# Create a DataFrame with class counts
counts_df = pd.DataFrame([class_counts.values()], columns=class_id_to_name.values())

# Calculate the correlation matrix
correlation_matrix = counts_df.corr()

# Create a heatmap
```

```
plt.figure(figsize=(10, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm',
xticklabels=correlation_matrix.columns, yticklabels=correlation_matrix.columns)
plt.title('Multivariate Analysis: Correlation Between Class Counts')
plt.xlabel('Class')
plt.ylabel('Class')
plt.show()
```

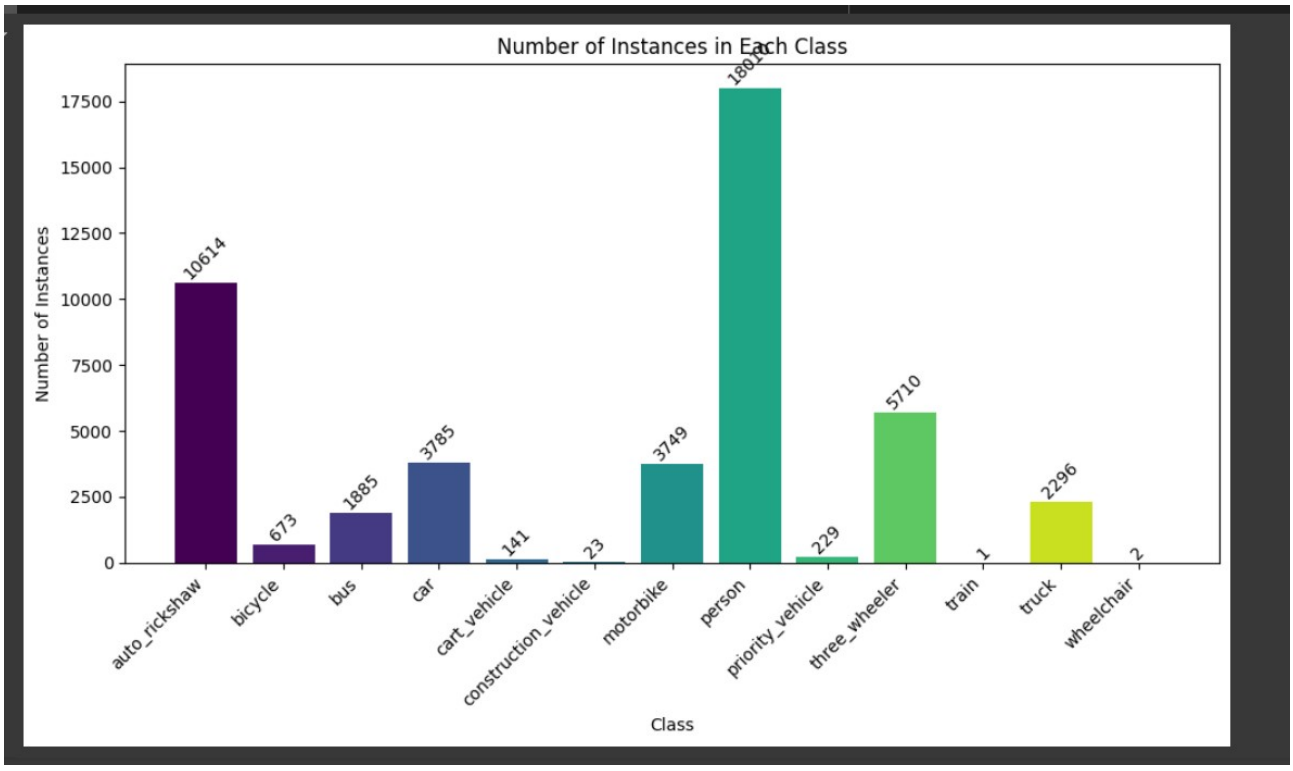
Output:



Code for Histogram (Multivariate):

```
# Create a bar plot
plt.figure(figsize=(10, 6))
bars = plt.bar(class_names, counts, color=colors)

# Add counts as annotations above each bar
for bar, count in zip(bars, counts):
plt.text(bar.get_x() + bar.get_width() / 2,
bar.get_height() + 5, # Adjust the position of the annotation
str(count),
ha='center', va='bottom', rotation=45)

plt.xlabel('Class')
plt.ylabel('Number of Instances')
plt.title('Number of Instances in Each Class')
plt.xticks(rotation=45, ha="right") # Rotate x-axis labels for better visibility
plt.tight_layout()
plt.show()
```

Output:



- **Interactive Visualizations:**

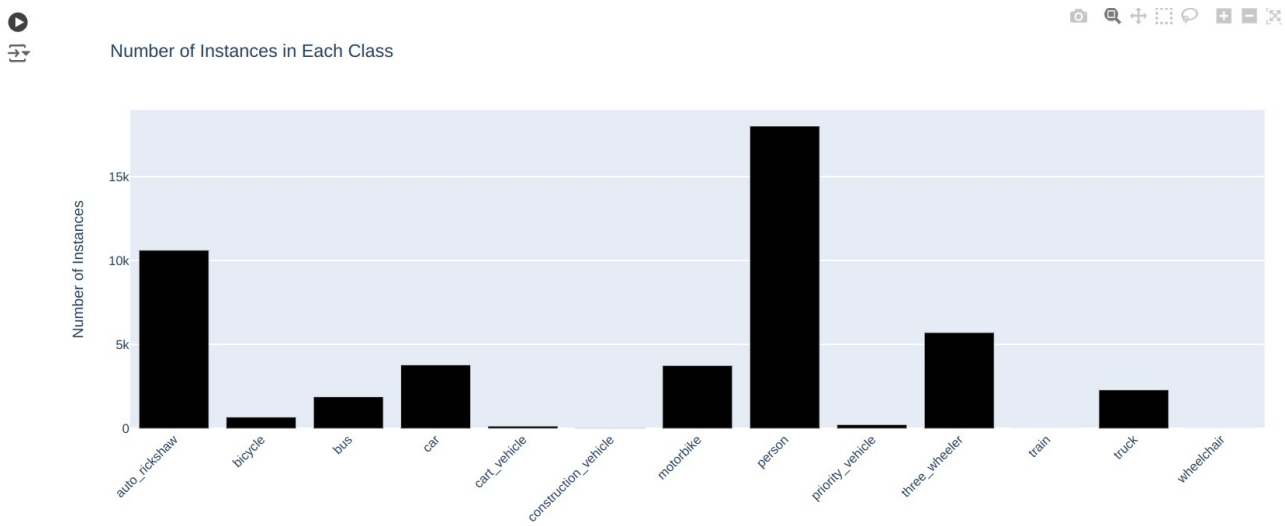
  - Interactive data visualization is the use of tools and processes to produce **a visual representation of data** which can be explored and analyzed directly within the visualization itself. This interaction can help **uncover insights** which lead to better, data-driven decisions.

Code snippet for Interactive Data Visualization:

Code:

```
import plotly.graph_objects as go

# Create a bar chart figure
fig = go.Figure(data=[go.Bar(
x=class_names,
y=counts,
marker=dict(color=colors)
)])

# Update the layout of the figure
fig.update_layout(
title='Number of Instances in Each Class',
xaxis=dict(title='Class'),
yaxis=dict(title='Number of Instances'),
xaxis_tickangle=-45 # Rotate x-axis labels for better visibility
)

# Show the interactive plot
fig.show()
```

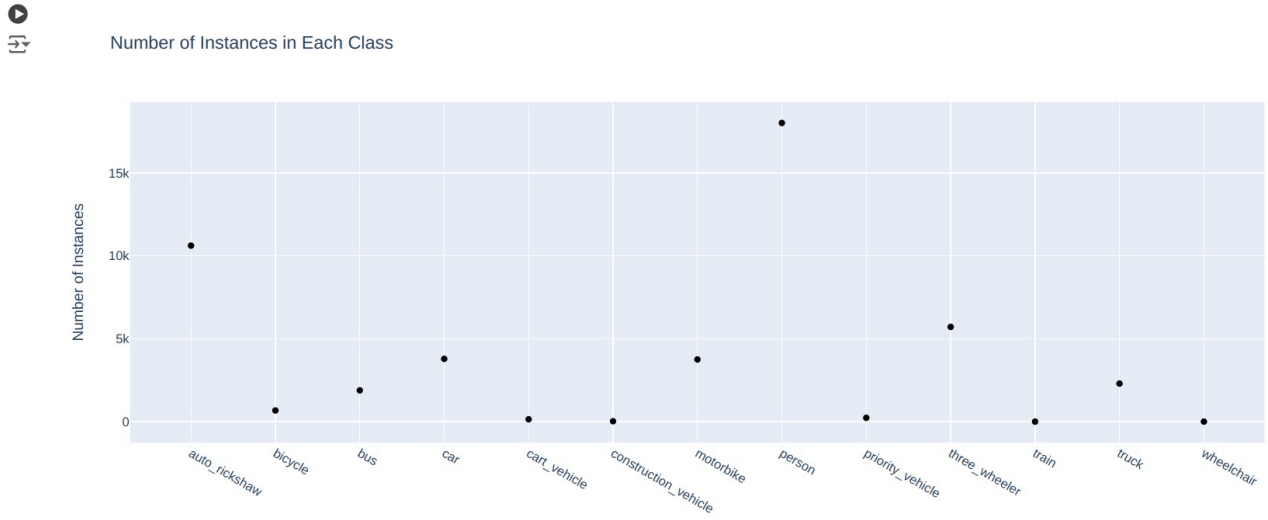
Output:



Code for Scatter plot:

```
import plotly.graph_objects as go

# Create a scatter plot figure
fig = go.Figure(data=go.Scatter(
x=class_names,
y=counts,
mode='markers',
marker=dict(color=colors)
))

# Update the layout of the figure
fig.update_layout(
title='Number of Instances in Each Class',
xaxis=dict(title='Class'),
yaxis=dict(title='Number of Instances')
)

# Show the interactive plot
fig.show()
```

Output:

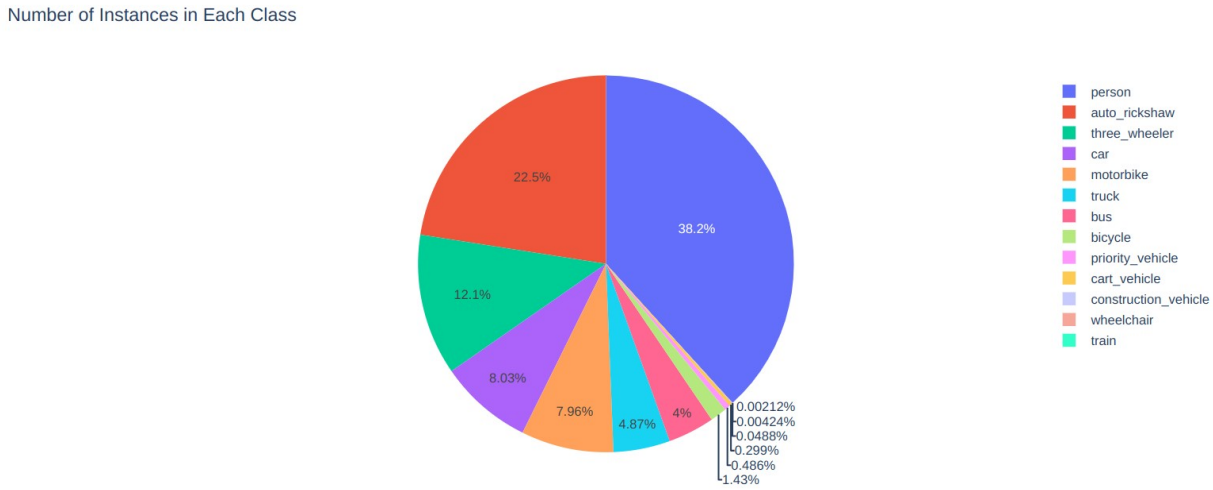


Code for Pie chart:

```
import plotly.graph_objects as go

# Create a pie chart figure
fig = go.Figure(data=[go.Pie(labels=class_names, values=counts)])

# Update the layout of the figure
fig.update_layout(title='Number of Instances in Each Class')
```

```
# Show the interactive plot
fig.show()
```

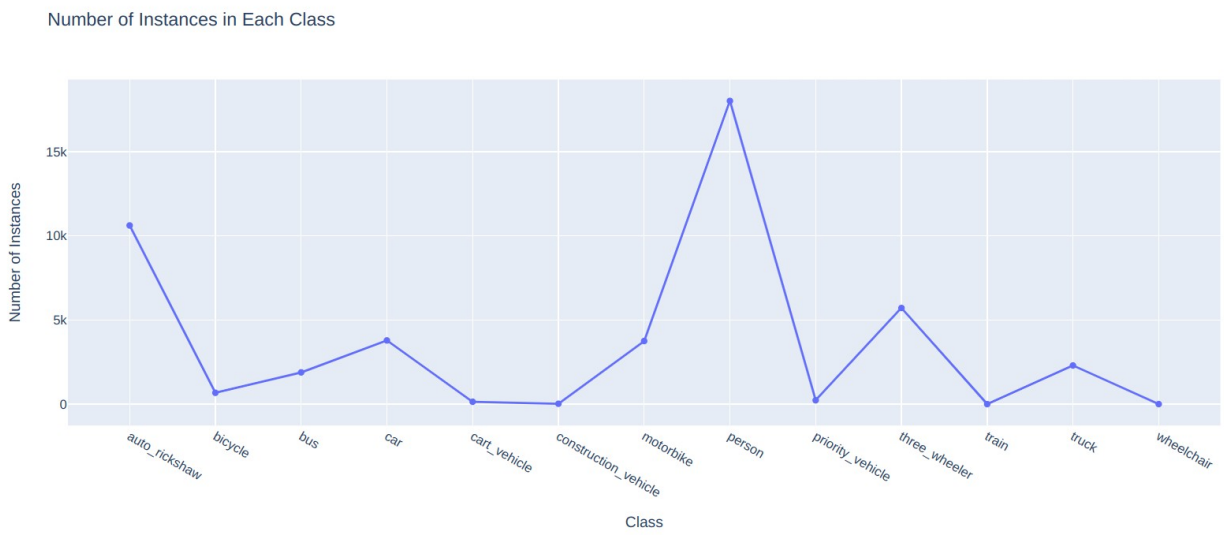
Output:



Code for line plot:

```
import plotly.graph_objects as go

# Create a line plot figure
fig = go.Figure(data=go.Scatter(
x=class_names,
y=counts,
mode='lines+markers'
))

# Update the layout of the figure
fig.update_layout(
title='Number of Instances in Each Class',
xaxis=dict(title='Class'),
yaxis=dict(title='Number of Instances')
)

# Show the interactive plot
fig.show()
```

Output:



Assumed Scenario:

- ➔ **Scenario:** The project focuses on **analyzing** and **visualizing** a dataset containing images of various road conditions in Bangladesh, annotated with **object bounding boxes.**
- ➔ **Objective:** The objective is to develop a **robust solution** for object detection in diverse road environments, **leveraging machine learning techniques.**
- ➔ **Target Audience:** The project is intended for **stakeholders** involved in road safety initiatives, **autonomous vehicle development,** and **traffic management,** seeking insights into road infrastructure and potential hazards.

Conclusion:

In the 3rd phase of the project, emphasis will be placed on employing **advanced data visualization techniques** to uncover meaningful insights and patterns within the dataset. Through the utilization of diverse visualization methods and assuming a scenario geared towards providing stakeholders with **interactive visualizations,** the goal is to facilitate **enhanced decision-making** and **comprehension of road conditions.** By presenting the data in intuitive and informative visual formats, the project aims to empower stakeholders with the tools necessary to make **informed decisions** and implement **effective strategies** for **road safety** and **traffic management** in Bangladesh.

LINKS:

Google colab:

https://colab.research.google.com/drive/1ByzXvGlofaDR4RgmKq2gQZ3ypwBSEQeN?usp=sharing

Github link:

https://github.com/Harihara04sudhan/naan-mudhalvan