AUTONOMOUS VEHICLES

A PROJECT REPORT (PHASE 2)

submitted by

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In partial fulfilment of the requirements for

Bachelor of Engineering

in

COMPUTER SCIENCE AND ENGINEERING

Under the course of

ARTIFICIAL INTELLIGENCE

UNIVERSITY COLLEGE OF ENGINEERING,

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Introduction:

Phase 2 of our autonomous vehicle project embarks on a crucial endeavor dedicated solely to **data wrangling** and **analysis,** fundamental stages in refining the **raw dataset** essential for the development of our **AI-powered navigation system.** This phase constitutes a meticulous exploration of various data manipulation techniques, predominantly using **Python,** to **cleanse, transform,** and **scrutinize** the dataset. Within this context, we envision a scenario where the project aims to enhance the autonomy of vehicles by leveraging personalized content discovery techniques, thereby enriching the driving **experience** for passengers.

Objectives:

- **Data Cleansing:** Our primary objective is to ensure the integrity of the dataset by addressing **inconsistencies, errors,** and **missing values.** Through rigorous data **cleansing procedures,** we aim to enhance the reliability and accuracy of the dataset, laying a robust groundwork for subsequent analysis and modeling tasks.
- **Exploratory Data Analysis (EDA):** We strive to gain comprehensive insights into the dataset's characteristics through extensive **exploratory data analysis.** This involves unraveling intricate **distributions, correlations,** and **patterns** inherent within the dataset, providing valuable insights into the underlying data structure.
- **Feature Engineering:** Our focus extends to engineering relevant features tailored to augment the performance of our **AI-driven navigation system.** By identifying and incorporating pertinent features extracted from the dataset, we aim to optimize the **efficacy** and **adaptability** of the autonomous vehicle's **decision-making capabilities.**
- **Documentation:** Lastly, we prioritize the comprehensive documentation of the data wrangling process to ensure **transparency** and **reproducibility.** Through meticulous documentation, we aim to provide clarity on the methodologies employed during the data preparation phase, facilitating seamless collaboration and knowledge sharing among project stakeholders.

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.

Autonomous vehicles

- **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.

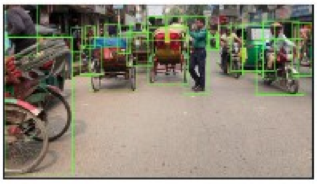
Test

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

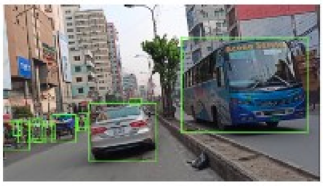
The test set has no provided annotations. Your task is to learn the bounding box from the train set and predict it for the test set images.

Sample Database:

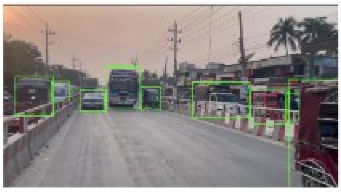
Sylhet



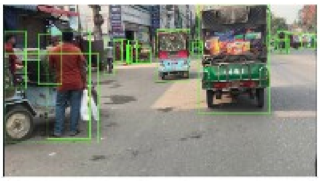
Dhaka



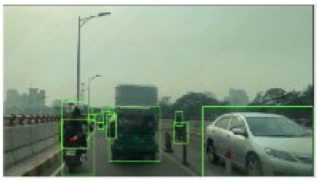
Rajshahi



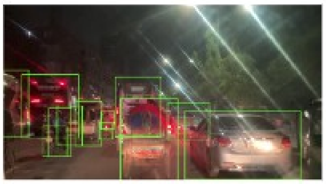
Mymensingh



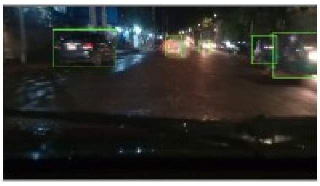
Maowa Expressway



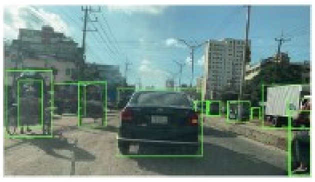
Dhaka Night



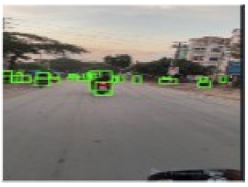
Chittagong Night



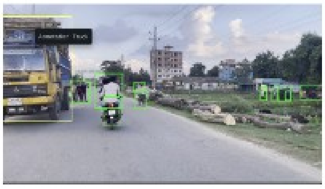
Chittagong Bohoddarhat



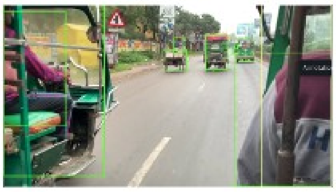
Chuadanga Sirajganj



Sherpur

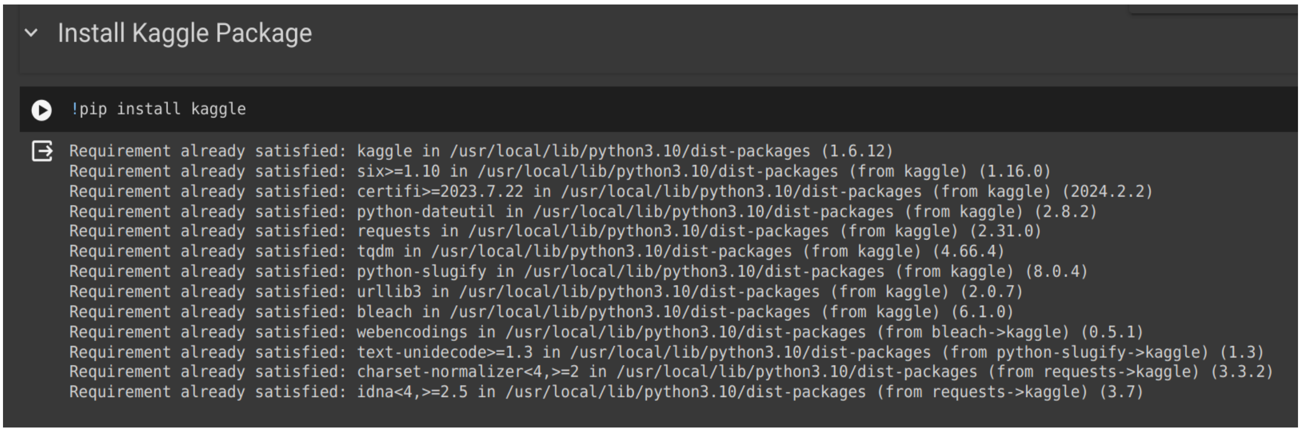


Khulna



Steps to be followed:

Step 1:

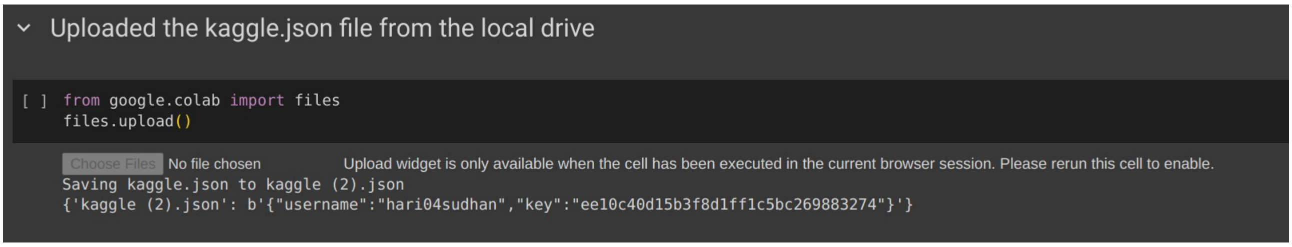


Install Kaggle Package

```
!pip install kaggle
```

```
Requirement already satisfied: kaggle in /usr/local/lib/python3.10/dist-packages (1.6.12)
Requirement already satisfied: six>=1.10 in /usr/local/lib/python3.10/dist-packages (from kaggle) (1.16.0)
Requirement already satisfied: certifi>=2023.7.22 in /usr/local/lib/python3.10/dist-packages (from kaggle) (2024.2.2)
Requirement already satisfied: python-dateutil in /usr/local/lib/python3.10/dist-packages (from kaggle) (2.8.2)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-packages (from kaggle) (2.31.0)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages (from kaggle) (4.66.4)
Requirement already satisfied: python-slugify in /usr/local/lib/python3.10/dist-packages (from kaggle) (8.0.4)
Requirement already satisfied: urllib3 in /usr/local/lib/python3.10/dist-packages (from kaggle) (2.0.7)
Requirement already satisfied: bleach in /usr/local/lib/python3.10/dist-packages (from kaggle) (6.1.0)
Requirement already satisfied: webencodings in /usr/local/lib/python3.10/dist-packages (from bleach->kaggle) (0.5.1)
Requirement already satisfied: text-unidecode>=1.3 in /usr/local/lib/python3.10/dist-packages (from python-slugify->kaggle) (1.3)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests->kaggle) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests->kaggle) (3.7)
```

Step 2:



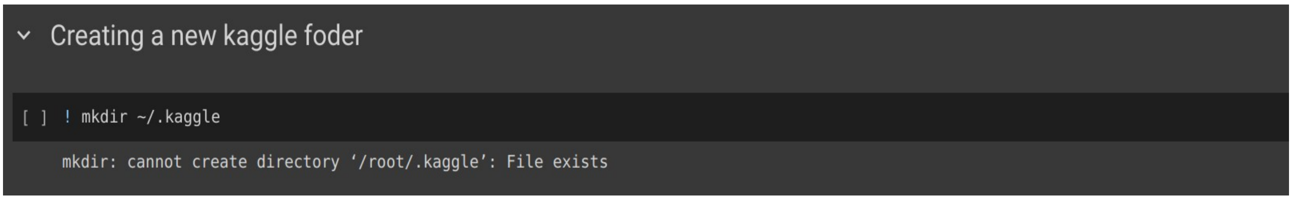
Uploaded the kaggle.json file from the local drive

```
[ ] from google.colab import files
    files.upload()
```

Choose Files No file chosen Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.

```
Saving kaggle.json to kaggle (2).json
{'kaggle (2).json': b'{"username":"hari04sudhan","key":"ee10c40d15b3f8d1ff1c5bc269883274"}'}
```

Step 3:

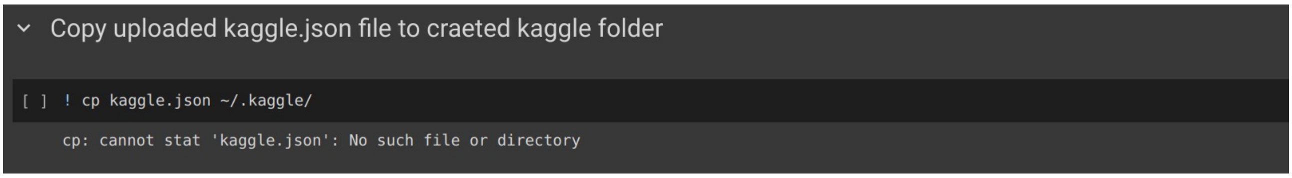


Creating a new kaggle foder

```
[ ] ! mkdir ~/.kaggle
```

```
mkdir: cannot create directory ‘/root/.kaggle’: File exists
```

Step 4:

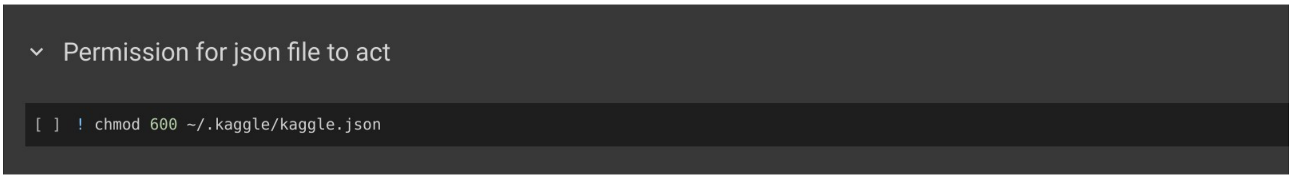


Copy uploaded kaggle.json file to craeted kaggle folder

```
[ ] ! cp kaggle.json ~/.kaggle/
```

```
cp: cannot stat 'kaggle.json': No such file or directory
```

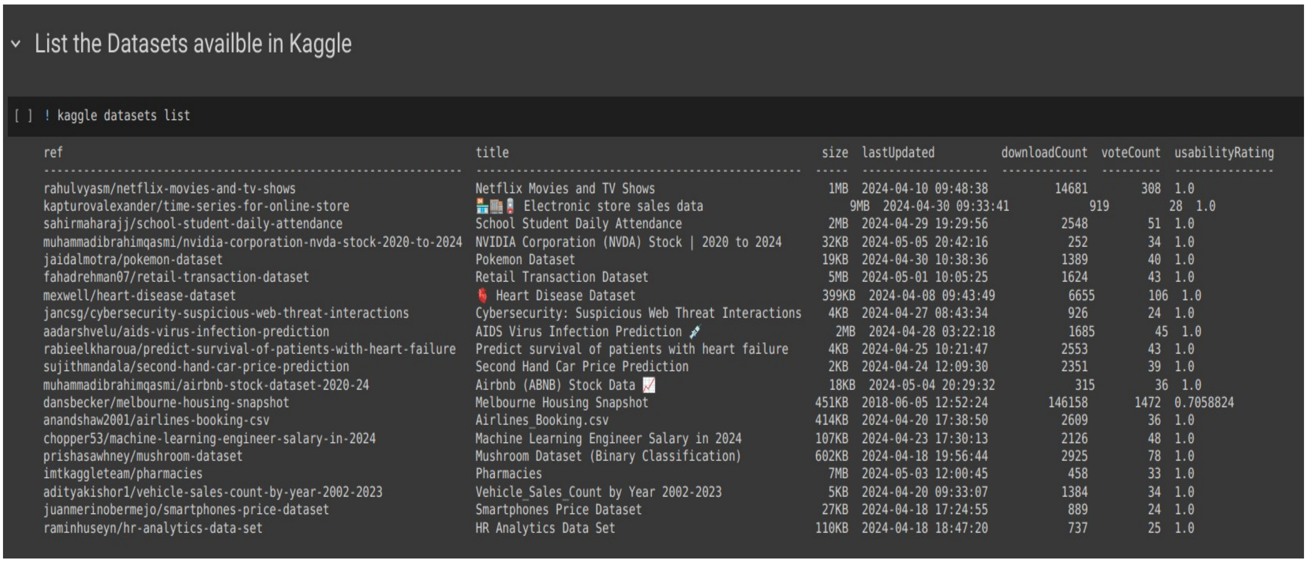
Step 5:



Permission for json file to act

```
[ ] ! chmod 600 ~/.kaggle/kaggle.json
```

Step 6:

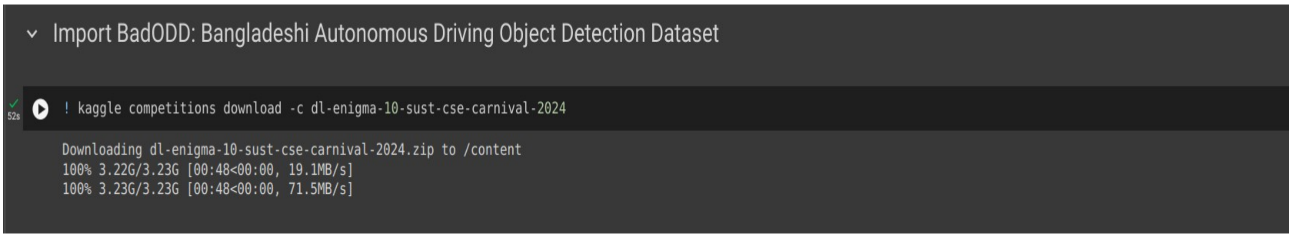


List the Datasets availble in Kaggle

```
[ ] ! kaggle datasets list
```

```
ref                                                           title                                          size  lastUpdated          downloadCount  voteCount  usabilityRating
------------------------------------------------------------  ---------------------------------------------  -----  -------------------  -------------  ---------  ---------------
rahulvyasm/netflix-movies-and-tv-shows                        Netflix Movies and TV Shows                      1MB  2024-04-10 09:48:38          14681        308  1.0
kapturovalexander/time-series-for-online-store                🏪🏬🚥 Electronic store sales data                   9MB  2024-04-30 09:33:41            919         28  1.0
sahirmaharajj/school-student-daily-attendance                 School Student Daily Attendance                  2MB  2024-04-29 19:29:56           2548         51  1.0
muhammadibrahimqasmi/nvidia-corporation-nvda-stock-2020-to-2024  NVIDIA Corporation (NVDA) Stock | 2020 to 2024  32KB  2024-05-05 20:42:16            252         34  1.0
jaidalmotra/pokemon-dataset                                   Pokemon Dataset                                 19KB  2024-04-30 10:38:36           1389         40  1.0
fahadrehman07/retail-transaction-dataset                      Retail Transaction Dataset                       5MB  2024-05-01 10:05:25           1624         43  1.0
mexwell/heart-disease-dataset                                 🫀 Heart Disease Dataset                        399KB  2024-04-08 09:43:49           6655        106  1.0
jancsg/cybersecurity-suspicious-web-threat-interactions       Cybersecurity: Suspicious Web Threat Interactions  4KB  2024-04-27 08:43:34            926         24  1.0
aadarshvelu/aids-virus-infection-prediction                   AIDS Virus Infection Prediction 💉                 2MB  2024-04-28 03:22:18           1685         45  1.0
rabieelkharoua/predict-survival-of-patients-with-heart-failure  Predict survival of patients with heart failure   4KB  2024-04-25 10:21:47           2553         43  1.0
sujithmandala/second-hand-car-price-prediction                Second Hand Car Price Prediction                 2KB  2024-04-24 12:09:30           2351         39  1.0
muhammadibrahimqasmi/airbnb-stock-dataset-2020-24             Airbnb (ABNB) Stock Data 📈                      18KB  2024-05-04 20:29:32            315         36  1.0
dansbecker/melbourne-housing-snapshot                         Melbourne Housing Snapshot                     451KB  2018-06-05 12:52:24         146158       1472  0.7058824
anandshaw2001/airlines-booking-csv                            Airlines_Booking.csv                           414KB  2024-04-20 17:38:50           2609         36  1.0
chopper53/machine-learning-engineer-salary-in-2024            Machine Learning Engineer Salary in 2024       107KB  2024-04-23 17:30:13           2126         48  1.0
prishasawhney/mushroom-dataset                                Mushroom Dataset (Binary Classification)       602KB  2024-04-18 19:56:44           2925         78  1.0
imtkaggleteam/pharmacies                                      Pharmacies                                       7MB  2024-05-03 12:00:45            458         33  1.0
adityakishor1/vehicle-sales-count-by-year-2002-2023           Vehicle_Sales_Count by Year 2002-2023            5KB  2024-04-20 09:33:07           1384         34  1.0
juanmerinobermejo/smartphones-price-dataset                   Smartphones Price Dataset                       27KB  2024-04-18 17:24:55            889         24  1.0
raminhuseyn/hr-analytics-data-set                             HR Analytics Data Set                          110KB  2024-04-18 18:47:20            737         25  1.0
```

Step 7:

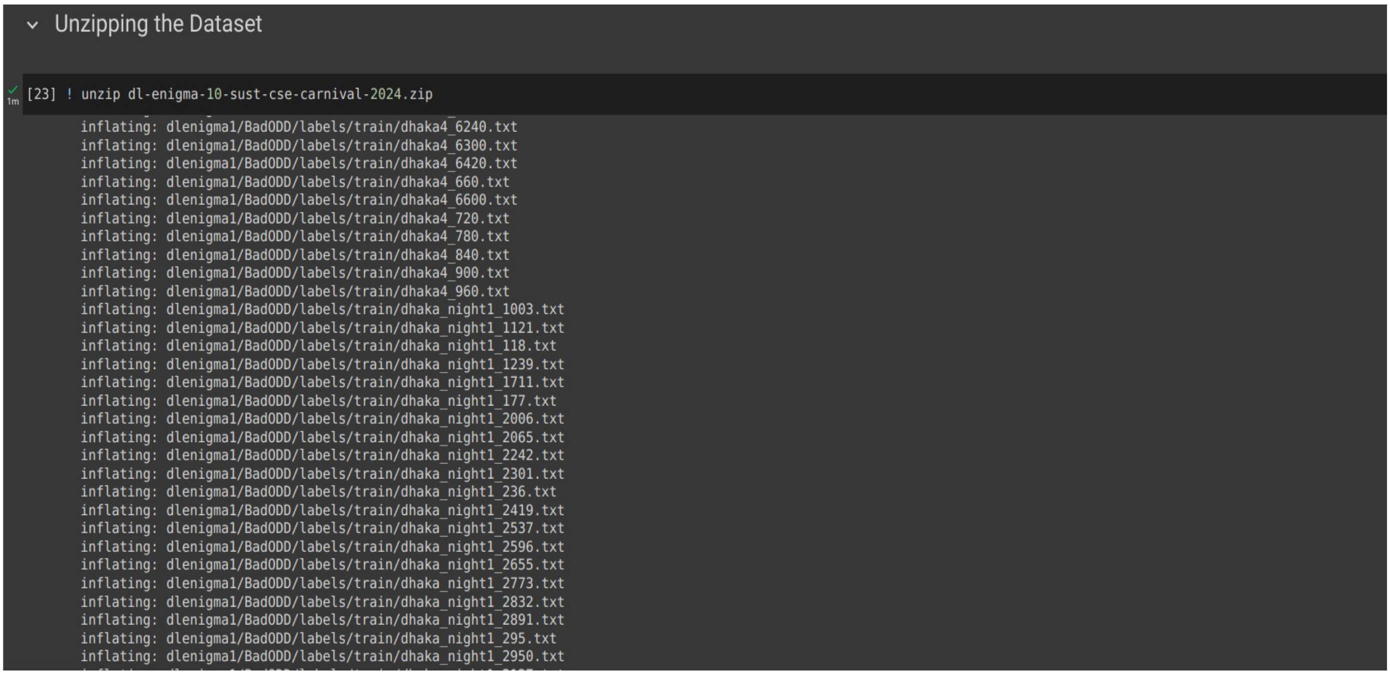


Import BadODD: Bangladeshi Autonomous Driving Object Detection Dataset

```
! kaggle competitions download -c dl-enigma-10-sust-cse-carnival-2024
```

```
Downloading dl-enigma-10-sust-cse-carnival-2024.zip to /content
100% 3.22G/3.23G [00:48<00:00, 19.1MB/s]
100% 3.23G/3.23G [00:48<00:00, 71.5MB/s]
```

Step 8:

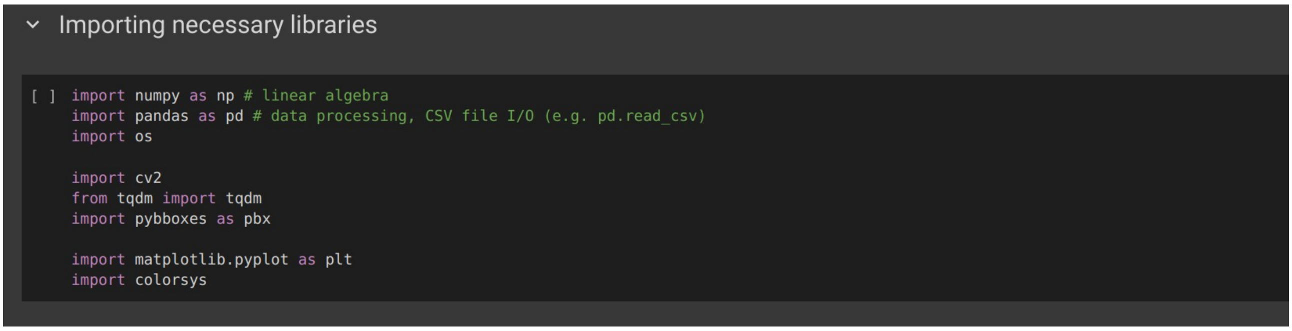


Unzipping the Dataset

```
[23] ! unzip dl-enigma-10-sust-cse-carnival-2024.zip
```

```
  inflating: dlenigma1/BadODD/labels/train/dhaka4_6240.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka4_6300.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka4_6420.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka4_660.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka4_6600.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka4_720.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka4_780.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka4_840.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka4_900.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka4_960.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_1003.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_1121.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_118.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_1239.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_1711.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_177.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_2006.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_2065.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_2242.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_2301.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_236.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_2419.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_2537.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_2596.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_2655.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_2773.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_2832.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_2891.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_295.txt
  inflating: dlenigma1/BadODD/labels/train/dhaka_night1_2950.txt
```

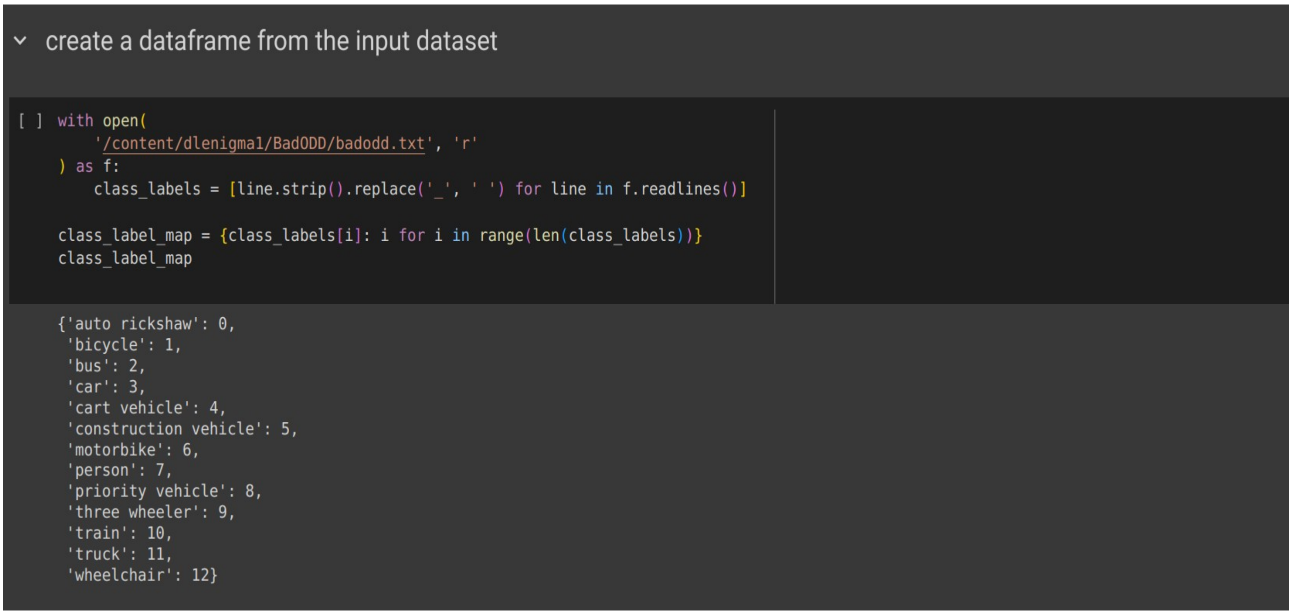
Step 9:



Importing necessary libraries

```
[ ] import numpy as np # linear algebra
    import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
    import os

    import cv2
    from tqdm import tqdm
    import pybboxes as pbx

    import matplotlib.pyplot as plt
    import colorsys
```

Step 10:



create a dataframe from the input dataset

```
[ ] with open(
        '/content/dlenigma1/BadODD/badodd.txt', 'r'
    ) as f:
        class_labels = [line.strip().replace('_', ' ') for line in f.readlines()]

    class_label_map = {class_labels[i]: i for i in range(len(class_labels))}
    class_label_map
```

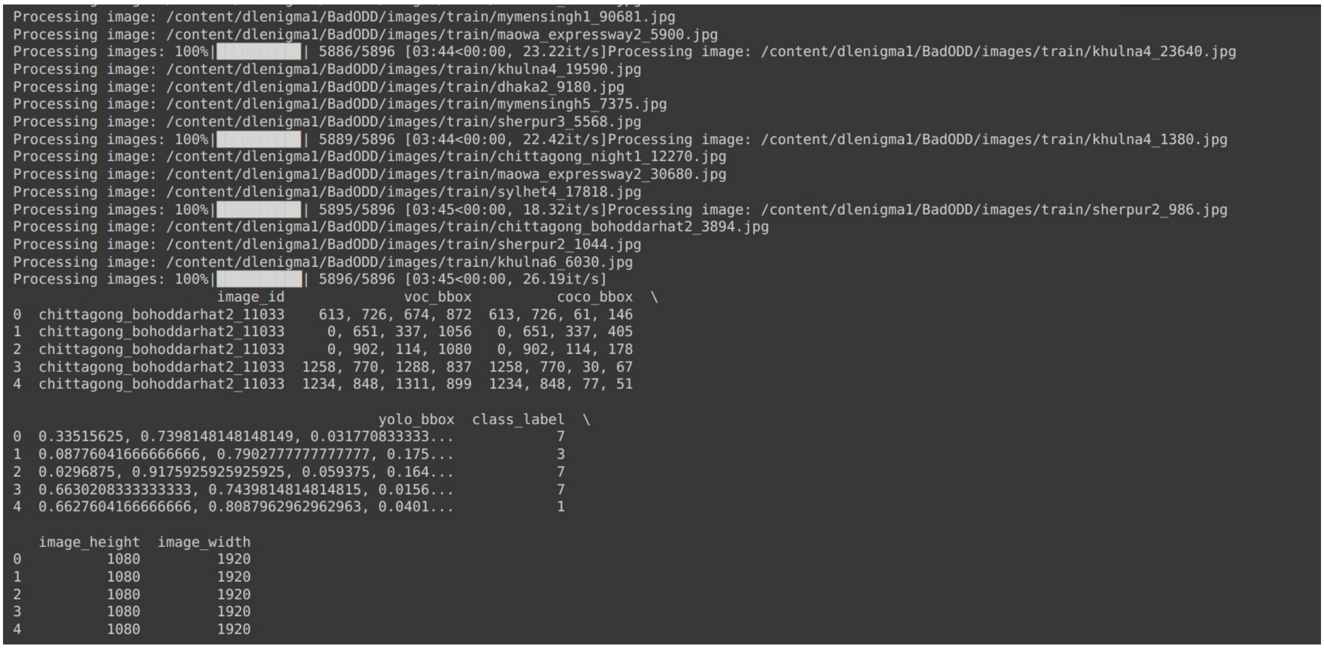
```
{'auto rickshaw': 0,
 'bicycle': 1,
 'bus': 2,
 'car': 3,
 'cart vehicle': 4,
 'construction vehicle': 5,
 'motorbike': 6,
 'person': 7,
 'priority vehicle': 8,
 'three wheeler': 9,
 'train': 10,
 'truck': 11,
 'wheelchair': 12}
```

Step 11: Training the data model

Code:

```
def get_possible_box_format(bbox, input_shape=None):
    if input_shape is None:
        return None, None, None


    voc_bbox = pbx.convert_bbox(
        bbox, from_type="yolo", to_type="voc", image_size=input_shape
    )
    coco_bbox = pbx.convert_bbox(
        bbox, from_type="yolo", to_type="coco", image_size=input_shape
    )
    yolo_bbox = ', '.join(map(str, bbox))
    return ', '.join(map(str, voc_bbox)), ', '.join(map(str, coco_bbox)), yolo_bbox


def prepare_dataframe(image_dir, label_dir):
    data = []
    for image_file in tqdm(os.listdir(image_dir), desc='Processing images'):
        img_path = os.path.join(image_dir, image_file)
        print(f"Processing image: {img_path}")
        img = cv2.imread(img_path)
        if img is None:
            print(f"Failed to read image: {img_path}. Skipping...")
            continue

        img_h, img_w = img.shape[:2]
        image_id = image_file.split('.')[0]
        label_file = os.path.join(label_dir, image_id + '.txt')

        if not os.path.exists(label_file):
            print(f"Label file not found for image: {image_file}. Skipping...")
            continue

        with open(label_file, 'r') as f:
            lines = f.readlines()
            for line in lines:
                class_label, *bbox = map(float, line.strip().split())
                class_label = int(class_label)
                voc_bbox, coco_bbox, yolo_bbox = get_possible_box_format(
                    bbox, input_shape=(img_w, img_h)
                )
                if voc_bbox is None or coco_bbox is None or yolo_bbox is None:
                    print(f"Failed to get box format for image: {image_file}. Skipping...")
                    continue
                data.append({
                    'image_id': image_id,
                    'voc_bbox': voc_bbox,
                    'coco_bbox': coco_bbox,
                    'yolo_bbox': yolo_bbox,
                    'class_label': class_label,
                    'image_height': img_h,
                    'image_width': img_w,
                })

    df = pd.DataFrame(data)
    return df

# Example usage:
image_dir = '/content/dlenigma1/BadODD/images/train'
label_dir = '/content/dlenigma1/BadODD/labels/train'
train_df = prepare_dataframe(image_dir, label_dir)
print(train_df.head())
```

Output:



```
Processing image: /content/dlenigma1/BadODD/images/train/mymensingh1_90681.jpg
Processing image: /content/dlenigma1/BadODD/images/train/maowa_expressway2_5900.jpg
Processing images: 100%|██████████| 5886/5896 [03:44<00:00, 23.22it/s]Processing image: /content/dlenigma1/BadODD/images/train/khulna4_23640.jpg
Processing image: /content/dlenigma1/BadODD/images/train/khulna4_19590.jpg
Processing image: /content/dlenigma1/BadODD/images/train/dhaka2_9180.jpg
Processing image: /content/dlenigma1/BadODD/images/train/mymensingh5_7375.jpg
Processing image: /content/dlenigma1/BadODD/images/train/sherpur3_5568.jpg
Processing images: 100%|██████████| 5889/5896 [03:44<00:00, 22.42it/s]Processing image: /content/dlenigma1/BadODD/images/train/khulna4_1380.jpg
Processing image: /content/dlenigma1/BadODD/images/train/chittagong_night1_12270.jpg
Processing image: /content/dlenigma1/BadODD/images/train/maowa_expressway2_30680.jpg
Processing image: /content/dlenigma1/BadODD/images/train/sylhet4_17818.jpg
Processing images: 100%|██████████| 5895/5896 [03:45<00:00, 18.32it/s]Processing image: /content/dlenigma1/BadODD/images/train/sherpur2_986.jpg
Processing image: /content/dlenigma1/BadODD/images/train/chittagong_bohoddarhat2_3894.jpg
Processing image: /content/dlenigma1/BadODD/images/train/sherpur2_1044.jpg
Processing image: /content/dlenigma1/BadODD/images/train/khulna6_6030.jpg
Processing images: 100%|██████████| 5896/5896 [03:45<00:00, 26.19it/s]
                        image_id             voc_bbox          coco_bbox  \
0  chittagong_bohoddarhat2_11033    613, 726, 674, 872  613, 726, 61, 146
1  chittagong_bohoddarhat2_11033     0, 651, 337, 1056   0, 651, 337, 405
2  chittagong_bohoddarhat2_11033     0, 902, 114, 1080   0, 902, 114, 178
3  chittagong_bohoddarhat2_11033  1258, 770, 1288, 837  1258, 770, 30, 67
4  chittagong_bohoddarhat2_11033  1234, 848, 1311, 899  1234, 848, 77, 51

                                           yolo_bbox  class_label  \
0  0.33515625, 0.7398148148148149, 0.031770833333...            7
1  0.08776041666666666, 0.7902777777777777, 0.175...            3
2  0.0296875, 0.9175925925925925, 0.059375, 0.164...            7
3  0.6630208333333333, 0.7439814814814815, 0.0156...            7
4  0.6627604166666666, 0.8087962962962963, 0.0401...            1

   image_height  image_width
0          1080         1920
1          1080         1920
2          1080         1920
3          1080         1920
4          1080         1920
```

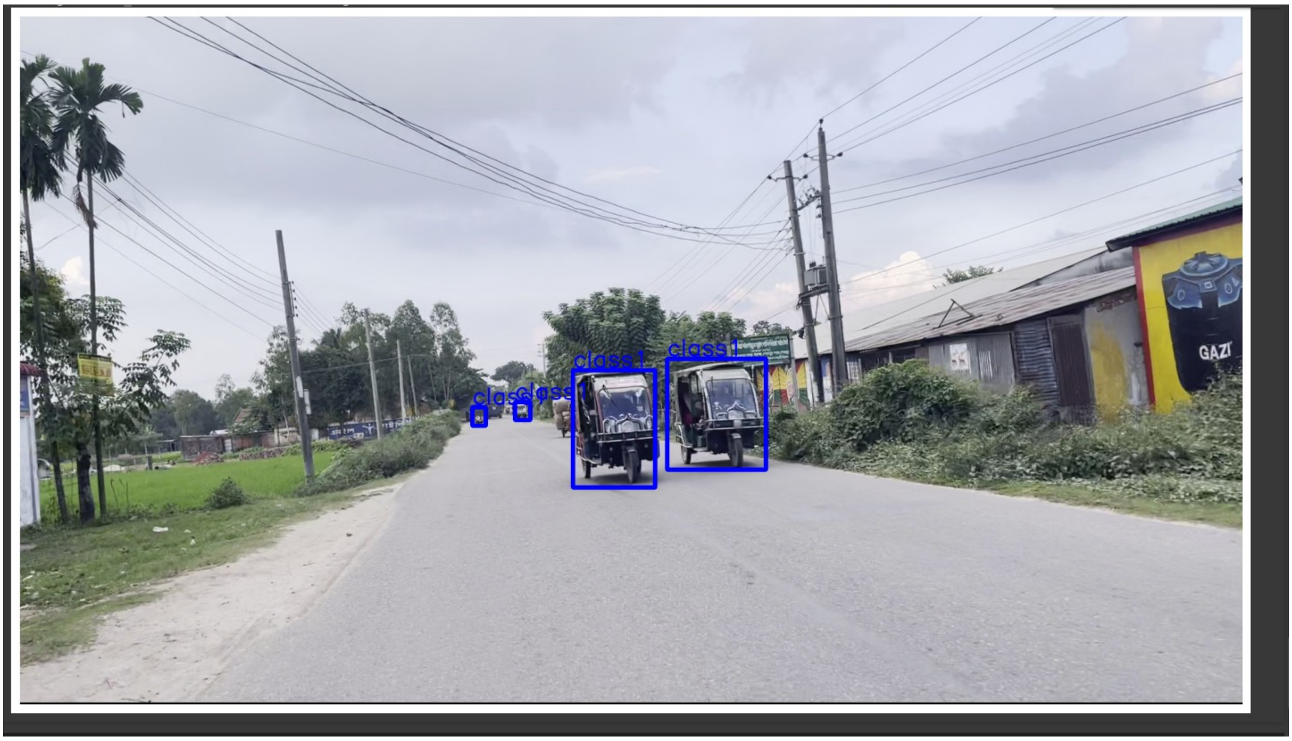
Step 12: Performing Visualizations

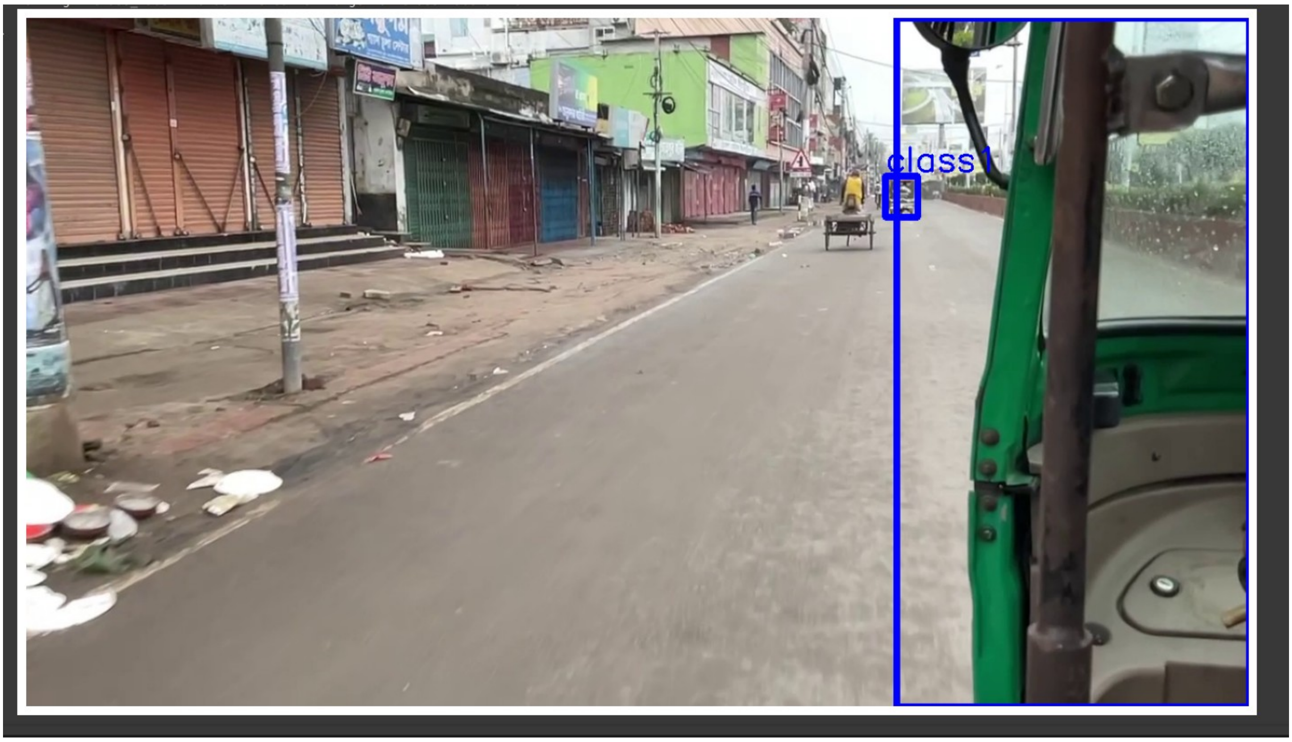
Code Snippet:

```
thickness = 5
font_scale = 1.2
font_thickness = 2

def generate_colors(num_classes):
    hsv_tuples = [(x / num_classes, 1., 1.) for x in range(num_classes)]
    colors = list(map(lambda x: colorsys.hsv_to_rgb(*x), hsv_tuples))
    colors = list(map(lambda x: (int(x[0] * 255), int(x[1] * 255), int(x[2] * 255)), colors))
    return colors

def draw_boxes(image_path, df, class_labels=None):
    image = cv2.imread(image_path)

    if class_labels is None:
        class_labels = ['class1', 'class2']  # Default class labels

    colors = generate_colors(len(class_labels))
    class_color_map = {class_labels[i]: colors[i] for i in range(len(class_labels))}

    if 'class_label' in df.columns:
        for _, row in df.iterrows():
            box = eval(row['voc_bbox'])
            class_label = row['class_label']
            if class_label < len(class_labels):
                color = class_color_map[class_labels[class_label]]
                box = [int(coord) for coord in box]

                cv2.rectangle(image, (box[0], box[1]), (box[2], box[3]), color, thickness)
                cv2.putText(
                    image,
                    class_labels[class_label],
                    (box[0], box[1] - 5),
                    cv2.FONT_HERSHEY_SIMPLEX,
                    font_scale,
                    color,
                    font_thickness
                )
            else:
                print(f"Warning: 'class_label' value {class_label} is out of range for class labels list.")
    else:
        print("Warning: 'class_label' column not found. Using default class labels.")

        for _, row in df.iterrows():
            box = eval(row['voc_bbox'])
            class_name = row['class_name'] if 'class_name' in df.columns else 'Unknown'
            color = class_color_map[class_name]
            box = [int(coord) for coord in box]

            cv2.rectangle(image, (box[0], box[1]), (box[2], box[3]), color, thickness)
            cv2.putText(
                image,
                class_name,
                (box[0], box[1] - 5),
                cv2.FONT_HERSHEY_SIMPLEX,
                font_scale,
                color,
                font_thickness
            )

    image_rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
```

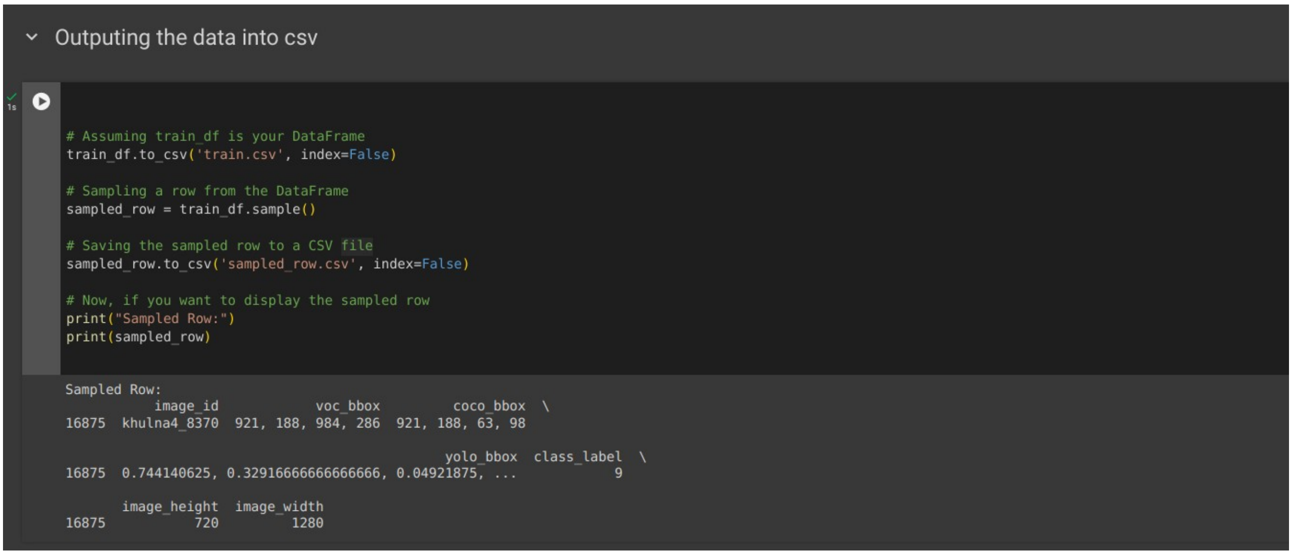
```
    plt.figure(figsize=(20,10))

    plt.imshow(image_rgb)

    plt.axis('off')

    plt.show()



image_id = train_df.sample().reset_index().loc[0, 'image_id']

image_path = '/content/dlenigma1/BadODD/images/train'

image_path = os.path.join(image_path, image_id + '.jpg')

df_image = train_df[train_df['image_id'] == image_id]

class_labels = ['class1', 'class2']

draw_boxes(image_path, df_image, class_labels)
```

Output:



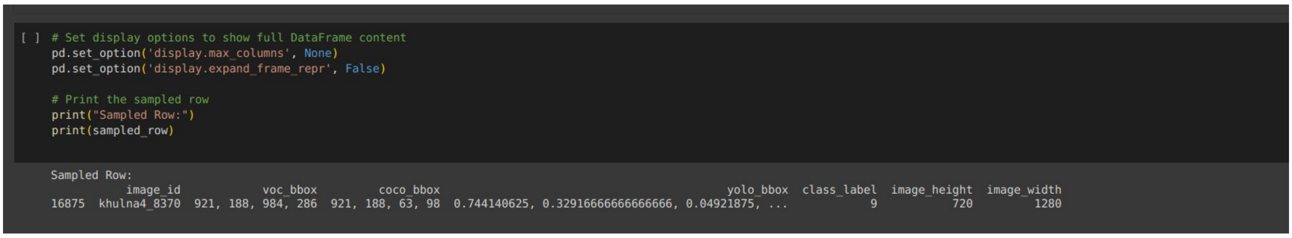


Step 13: Output into CSV


Outputting the data into csv

```
# Assuming train_df is your DataFrame
train_df.to_csv('train.csv', index=False)

# Sampling a row from the DataFrame
sampled_row = train_df.sample()

# Saving the sampled row to a CSV file
sampled_row.to_csv('sampled_row.csv', index=False)

# Now, if you want to display the sampled row
print("Sampled Row:")
print(sampled_row)
```

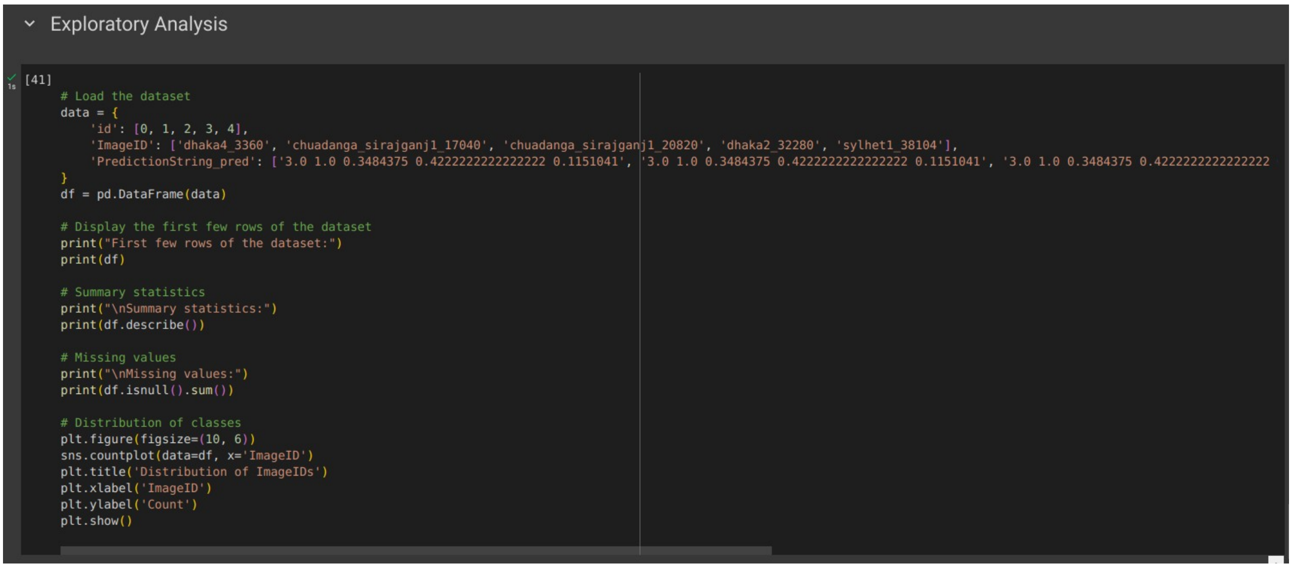
```
Sampled Row:
            image_id            voc_bbox         coco_bbox  \
16875  khulna4_8370  921, 188, 984, 286  921, 188, 63, 98

                                               yolo_bbox  class_label  \
16875  0.744140625, 0.32916666666666666, 0.04921875, ...            9

       image_height  image_width
16875           720         1280
```



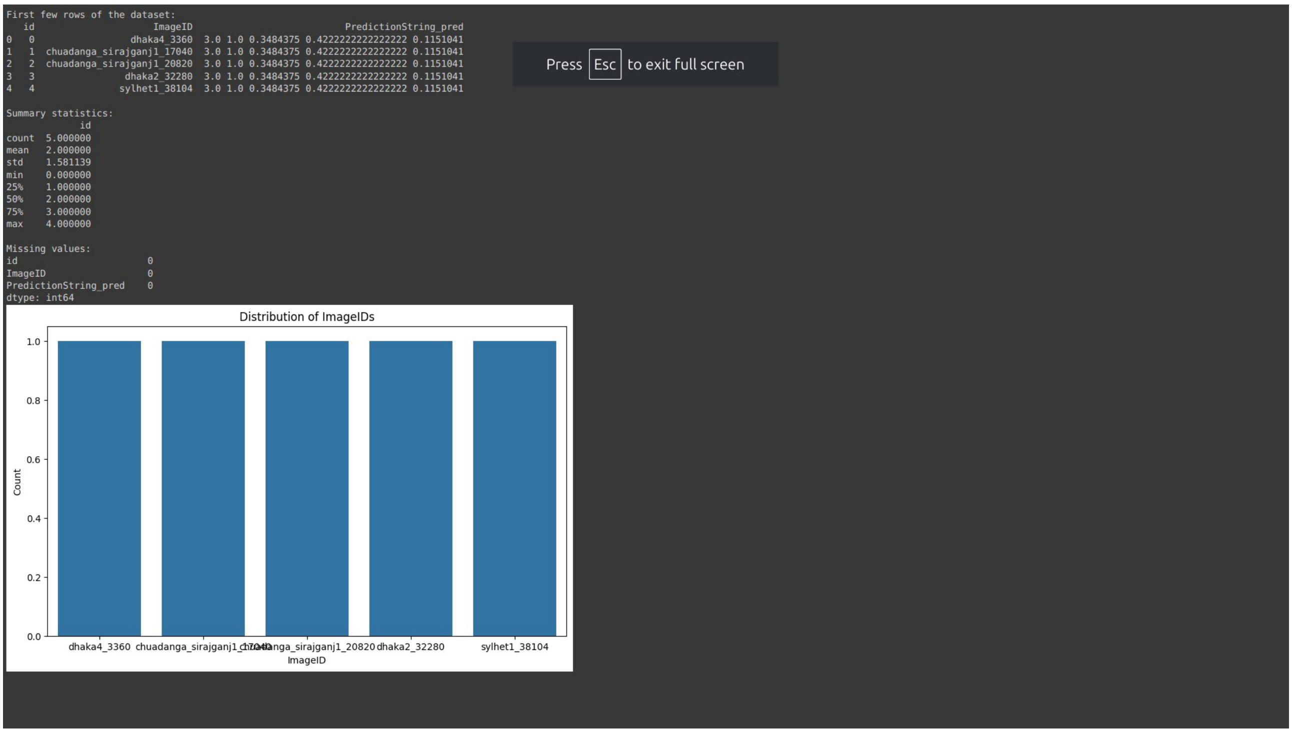
```
[ ] # Set display options to show full DataFrame content
    pd.set_option('display.max_columns', None)
    pd.set_option('display.expand_frame_repr', False)

    # Print the sampled row
    print("Sampled Row:")
    print(sampled_row)
```

```
Sampled Row:
            image_id            voc_bbox         coco_bbox                                          yolo_bbox  class_label  image_height  image_width
16875  khulna4_8370  921, 188, 984, 286  921, 188, 63, 98  0.744140625, 0.32916666666666666, 0.04921875, ...            9           720         1280
```

Step 14:



```
# Load the dataset
data = {
    'id': [0, 1, 2, 3, 4],
    'ImageID': ['dhaka4_3360', 'chuadanga_sirajganj1_17040', 'chuadanga_sirajganj1_20820', 'dhaka2_32280', 'sylhet1_38104'],
    'PredictionString_pred': ['3.0 1.0 0.3484375 0.4222222222222222 0.1151041', '3.0 1.0 0.3484375 0.4222222222222222 0.1151041', '3.0 1.0 0.3484375 0.4222222222222222
}
df = pd.DataFrame(data)

# Display the first few rows of the dataset
print("First few rows of the dataset:")
print(df)

# Summary statistics
print("\nSummary statistics:")
print(df.describe())

# Missing values
print("\nMissing values:")
print(df.isnull().sum())

# Distribution of classes
plt.figure(figsize=(10, 6))
sns.countplot(data=df, x='ImageID')
plt.title('Distribution of ImageIDs')
plt.xlabel('ImageID')
plt.ylabel('Count')
plt.show()
```



```
First few rows of the dataset:
   id                     ImageID                             PredictionString_pred
0   0                 dhaka4_3360  3.0 1.0 0.3484375 0.4222222222222222 0.1151041
1   1  chuadanga_sirajganj1_17040  3.0 1.0 0.3484375 0.4222222222222222 0.1151041
2   2  chuadanga_sirajganj1_20820  3.0 1.0 0.3484375 0.4222222222222222 0.1151041
3   3                dhaka2_32280  3.0 1.0 0.3484375 0.4222222222222222 0.1151041
4   4               sylhet1_38104  3.0 1.0 0.3484375 0.4222222222222222 0.1151041

Summary statistics:
             id
count  5.000000
mean   2.000000
std    1.581139
min    0.000000
25%    1.000000
50%    2.000000
75%    3.000000
max    4.000000

Missing values:
id                       0
ImageID                  0
PredictionString_pred    0
dtype: int64
```

Conclusion:

The journey into object detection across varied road conditions in **Bangladesh** commenced with a **meticulous exploration** of a dataset spanning nine districts, comprising 9,825 images meticulously annotated with rectangular bounding boxes. Representing a diverse array of road landscapes, from bustling towns to tranquil village roads, the dataset encapsulates **78,943 objects** across 1**3 distinct classes**, including vehicles such as **auto-rickshaws, buses, and bicycles,** as well as non-vehicle entities like **people and wheelchairs.** Ensuring authenticity, images were captured using smartphone cameras, replicating real-world driving scenarios and fostering the development of models with practical applicability. Implementation involved hands-on code development for drawing **bounding boxes** around **detected objects, navigating DataFrame** operations with **finesse,** and addressing common errors. This endeavor underscores the significance of realistic datasets and effective model implementations in advancing **computer vision,** particularly for autonomous driving systems, with the potential to enhance **road safety** and navigation not only in Bangladesh but also beyond.

LINKS:

Google colab:

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

Github link:

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