

Course Name: Deep Learning

Lab Title: Yolo11 - *Traffic violation*

Dataset

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Group Members:

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2. Akhilesh Ukey 202201040136

Objective: The purpose of this lab is to understand and implement YOLOv11 for real-time object detection. Students will perform dataset preparation, model implementation, inference, and performance evaluation.

Task 1: Environment Setup and YOLOv11 Installation

```
# Install YOLOv11 and required dependencies
```

```
!pip install ultralytics  
from ultralytics import YOLO
```

```
# Load a pre-trained YOLOv11 model  
model = YOLO('yololln.pt')
```

```
# Test inference on a sample image  
results = model('https://ultralytics.com/images/zidane.jpg')  
results[0].show() # Display result
```

Collecting ultralytics

Downloading ultralytics-8.3.96-py3-none-any.whl.metadata (35 kB)

Requirement already satisfied: numpy<=2.1.1,>=1.23.0 in
/usr/local/lib/python3.11/dist-packages (from ultralytics) (2.0.2)

Requirement already satisfied: matplotlib>=3.3.0 in
/usr/local/lib/python3.11/dist-packages (from ultralytics) (3.10.0)

Requirement already satisfied: opencv-python>=4.6.0 in
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Requirement already satisfied: pillow>=7.1.2 in
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Requirement already satisfied: pyyaml>=5.3.1 in
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Requirement already satisfied: requests>=2.23.0 in
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Requirement already satisfied: torchvision>=0.9.0 in
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(0.21.0+cu124)
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Requirement already satisfied: psutil in
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Requirement already satisfied: fonttools>=4.22.0 in
/usr/local/lib/python3.11/dist-packages (from matplotlib>=3.3.0-
>ultralytics) (4.56.0)
Requirement already satisfied: kiwisolver>=1.3.1 in
/usr/local/lib/python3.11/dist-packages (from matplotlib>=3.3.0-
>ultralytics) (1.4.8)
Requirement already satisfied: packaging>=20.0 in
/usr/local/lib/python3.11/dist-packages (from matplotlib>=3.3.0-
>ultralytics) (24.2)
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>ultralytics)
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Requirement already satisfied: nvidia-nvtx-cu12==12.4.127 in
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Requirement already satisfied: mpmath<1.4,>=1.1.0 in
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Requirement already satisfied: six>=1.5 in
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cul2, nvidia-cusparse-cul2, nvidia-cudnn-cul2, nvidia-cusolver-cul2,
ultralalytics-thop, ultralytics
  Attempting uninstall: nvidia-nvjitlink-cul2
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  Attempting uninstall: nvidia-cuda-cupti-cul2
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    Uninstalling nvidia-cuda-cupti-cul2-12.5.82:
      Successfully uninstalled nvidia-cuda-cupti-cul2-12.5.82
```

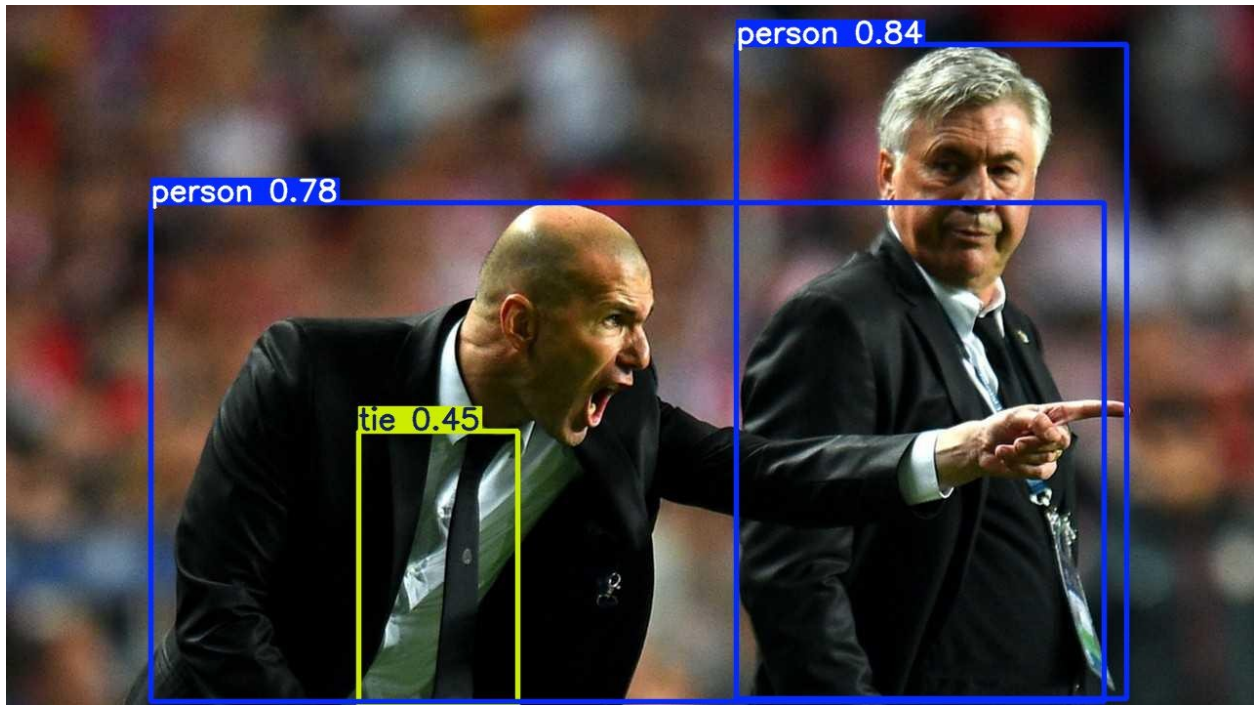
```
Attempting uninstall: nvidia-cublas-cu12
Found existing installation: nvidia-cublas-cu12 12.5.3.2
Uninstalling nvidia-cublas-cu12-12.5.3.2:
  Successfully uninstalled nvidia-cublas-cu12-12.5.3.2
Attempting uninstall: nvidia-cusparse-cu12
Found existing installation: nvidia-cusparse-cu12 12.5.1.3
Uninstalling nvidia-cusparse-cu12-12.5.1.3:
  Successfully uninstalled nvidia-cusparse-cu12-12.5.1.3
Attempting uninstall: nvidia-cudnn-cu12
Found existing installation: nvidia-cudnn-cu12 9.3.0.75
Uninstalling nvidia-cudnn-cu12-9.3.0.75:
  Successfully uninstalled nvidia-cudnn-cu12-9.3.0.75
Attempting uninstall: nvidia-cusolver-cu12
Found existing installation: nvidia-cusolver-cu12 11.6.3.83
Uninstalling nvidia-cusolver-cu12-11.6.3.83:
  Successfully uninstalled nvidia-cusolver-cu12-11.6.3.83
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cu12-12.4.127 nvidia-cuda-nvrtc-cu12-12.4.127 nvidia-cuda-runtime-
cu12-12.4.127 nvidia-cudnn-cu12-9.1.0.70 nvidia-cufft-cu12-11.2.1.3
nvidia-curand-cu12-10.3.5.147 nvidia-cusolver-cu12-11.6.1.9 nvidia-
cusparse-cu12-12.3.1.170 nvidia-nvjitlink-cu12-12.4.127 ultralytics-
8.3.96 ultralytics-thop-2.0.14
Creating new Ultralytics Settings v0.0.6 file []
View Ultralytics Settings with 'yolo settings' or at
'/root/.config/Ultralytics/settings.json'
Update Settings with 'yolo settings key=value', i.e. 'yolo settings
runs_dir=path/to/dir'. For help see
https://docs.ultralytics.com/quickstart/#ultralytics-settings.
Downloading
https://github.com/ultralytics/assets/releases/download/v8.3.0/yolo11n
.pt to 'yolo11n.pt'...

100%|██████████| 5.35M/5.35M [00:00<00:00, 15.1MB/s]

Downloading https://ultralytics.com/images/zidane.jpg to
'zidane.jpg'...

100%|██████████| 49.2k/49.2k [00:00<00:00, 942kB/s]

image 1/1 /content/zidane.jpg: 384x640 2 persons, 1 tie, 325.7ms
Speed: 14.1ms preprocess, 325.7ms inference, 36.4ms postprocess per
image at shape (1, 3, 384, 640)
```



Task 2: Dataset Preparation & Preprocessing

Objective: Load and preprocess a dataset for object detection.

```
!pip install roboflow
```

```
from roboflow import Roboflow
rf = Roboflow(api_key="jvolA1u0TUuTM9wD7a3L")
project = rf.workspace("middle-east-tech-university").project("fire-
and-smoke-detection-hiwia")
version = project.version(2)
dataset = version.download("yolov11")
```

```
Requirement already satisfied: roboflow in
/usr/local/lib/python3.11/dist-packages (1.1.58)
Requirement already satisfied: certifi in
/usr/local/lib/python3.11/dist-packages (from roboflow) (2025.1.31)
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/usr/local/lib/python3.11/dist-packages (from roboflow) (3.7)
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Requirement already satisfied: python-dateutil in
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Requirement already satisfied: python-dotenv in
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Requirement already satisfied: requests in
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Requirement already satisfied: six in /usr/local/lib/python3.11/dist-
packages (from roboflow) (1.17.0)
Requirement already satisfied: urllib3>=1.26.6 in
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Requirement already satisfied: tqdm>=4.41.0 in
/usr/local/lib/python3.11/dist-packages (from roboflow) (4.67.1)
Requirement already satisfied: PyYAML>=5.3.1 in
/usr/local/lib/python3.11/dist-packages (from roboflow) (6.0.2)
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/usr/local/lib/python3.11/dist-packages (from roboflow) (1.0.0)
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Requirement already satisfied: contourpy>=1.0.1 in
/usr/local/lib/python3.11/dist-packages (from matplotlib->roboflow)
(1.3.1)
Requirement already satisfied: fonttools>=4.22.0 in
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(4.56.0)
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/usr/local/lib/python3.11/dist-packages (from matplotlib->roboflow)
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/usr/local/lib/python3.11/dist-packages (from matplotlib->roboflow)
(3.2.1)
Requirement already satisfied: charset-normalizer<4,>=2 in
/usr/local/lib/python3.11/dist-packages (from requests->roboflow)
(3.4.1)
loading Roboflow workspace...
loading Roboflow project...
```

```
from roboflow import Roboflow
rf = Roboflow(api_key="jvo1A1u0TUuTM9wD7a3L")
project = rf.workspace("major-project-nlqt0").project("traffic-
violation-8voto")
version = project.version(8)
dataset = version.download("yolov11")
```


loading Roboflow workspace...

loading Roboflow project...

Downloading Dataset Version Zip in Traffic-violation-8 to yolov11::

100%|██████████| 320607/320607 [00:15<00:00, 21032.64it/s]

Extracting Dataset Version Zip to Traffic-violation-8 in yolov11::

100%|██████████| 1622/1622 [00:05<00:00, 287.97it/s]

!pip install roboflow ultralytics

```
from roboflow import Roboflow
import os
```

```
# Verify dataset folder structure
```

```
dataset_path = "/content/Traffic-violation-8"
```

```
print("Extracted dataset files:", os.listdir(dataset_path))
```

```
# Check if `data.yaml` exists
```

```
yaml_path = os.path.join(dataset_path, "data.yaml")
```

```
if os.path.exists(yaml_path):
```

```
    print("data.yaml found! Ready for training.")
```

```
else:
```

```
    print("data.yaml missing! Check dataset extraction.")
```

Requirement already satisfied: roboflow in

/usr/local/lib/python3.11/dist-packages (1.1.58)

Requirement already satisfied: ultralytics in

/usr/local/lib/python3.11/dist-packages (8.3.96)

Requirement already satisfied: certifi in

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/usr/local/lib/python3.11/dist-packages (from roboflow) (1.4.8)

Requirement already satisfied: matplotlib in

/usr/local/lib/python3.11/dist-packages (from roboflow) (3.10.0)

Requirement already satisfied: numpy>=1.18.5 in

/usr/local/lib/python3.11/dist-packages (from roboflow) (2.0.2)

Requirement already satisfied: opencv-python-headless==4.10.0.84 in

/usr/local/lib/python3.11/dist-packages (from roboflow) (4.10.0.84)

Requirement already satisfied: Pillow>=7.1.2 in

/usr/local/lib/python3.11/dist-packages (from roboflow) (11.1.0)

Requirement already satisfied: pillow-heif>=0.18.0 in

/usr/local/lib/python3.11/dist-packages (from roboflow) (0.22.0)

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/usr/local/lib/python3.11/dist-packages (from roboflow) (2.8.2)
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/usr/local/lib/python3.11/dist-packages (from roboflow) (1.0.0)
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/usr/local/lib/python3.11/dist-packages (from roboflow) (1.2.0)
Requirement already satisfied: opencv-python>=4.6.0 in
/usr/local/lib/python3.11/dist-packages (from ultralytics) (4.11.0.86)
Requirement already satisfied: scipy>=1.4.1 in
/usr/local/lib/python3.11/dist-packages (from ultralytics) (1.14.1)
Requirement already satisfied: torch>=1.8.0 in
/usr/local/lib/python3.11/dist-packages (from ultralytics)
(2.6.0+cu124)
Requirement already satisfied: torchvision>=0.9.0 in
/usr/local/lib/python3.11/dist-packages (from ultralytics)
(0.21.0+cu124)
Requirement already satisfied: psutil in
/usr/local/lib/python3.11/dist-packages (from ultralytics) (5.9.5)
Requirement already satisfied: py-cpuinfo in
/usr/local/lib/python3.11/dist-packages (from ultralytics) (9.0.0)
Requirement already satisfied: pandas>=1.1.4 in
/usr/local/lib/python3.11/dist-packages (from ultralytics) (2.2.2)
Requirement already satisfied: seaborn>=0.11.0 in
/usr/local/lib/python3.11/dist-packages (from ultralytics) (0.13.2)
Requirement already satisfied: ultralytics-thop>=2.0.0 in
/usr/local/lib/python3.11/dist-packages (from ultralytics) (2.0.14)
Requirement already satisfied: contourpy>=1.0.1 in
/usr/local/lib/python3.11/dist-packages (from matplotlib->roboflow)
(1.3.1)
Requirement already satisfied: fonttools>=4.22.0 in
/usr/local/lib/python3.11/dist-packages (from matplotlib->roboflow)
(4.56.0)
Requirement already satisfied: packaging>=20.0 in
/usr/local/lib/python3.11/dist-packages (from matplotlib->roboflow)
(24.2)
Requirement already satisfied: pyparsing>=2.3.1 in
/usr/local/lib/python3.11/dist-packages (from matplotlib->roboflow)
(3.2.1)

Requirement already satisfied: pytz>=2020.1 in
/usr/local/lib/python3.11/dist-packages (from pandas>=1.1.4-
>ultralitics) (2025.1)

Requirement already satisfied: tzdata>=2022.7 in
/usr/local/lib/python3.11/dist-packages (from pandas>=1.1.4-
>ultralitics) (2025.1)

Requirement already satisfied: charset-normalizer<4,>=2 in
/usr/local/lib/python3.11/dist-packages (from requests->roboflow
(3.4.1)

Requirement already satisfied: filelock in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (3.18.0)

Requirement already satisfied: typing-extensions>=4.10.0 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (4.12.2)

Requirement already satisfied: networkx in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (3.4.2)

Requirement already satisfied: jinja2 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (3.1.6)

Requirement already satisfied: fsspec in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (2025.3.0)

Requirement already satisfied: nvidia-cuda-nvrtc-cu12==12.4.127 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (12.4.127)

Requirement already satisfied: nvidia-cuda-runtime-cu12==12.4.127
in /usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (12.4.127)

Requirement already satisfied: nvidia-cuda-cupti-cu12==12.4.127 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (12.4.127)

Requirement already satisfied: nvidia-cudnn-cu12==9.1.0.70 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (9.1.0.70)

Requirement already satisfied: nvidia-cublas-cu12==12.4.5.8 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (12.4.5.8)

Requirement already satisfied: nvidia-cufft-cu12==11.2.1.3 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (11.2.1.3)

Requirement already satisfied: nvidia-curand-cu12==10.3.5.147 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (10.3.5.147)

Requirement already satisfied: nvidia-cusolver-cu12==11.6.1.9 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralitics) (11.6.1.9)

Requirement already satisfied: nvidia-cuspars-cu12==12.3.1.170 in

```
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralytics) (12.3.1.170)
Requirement already satisfied: nvidia-cusparse-cu12==0.6.2 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralytics) (0.6.2)
Requirement already satisfied: nvidia-nccl-cu12==2.21.5 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralytics) (2.21.5)
Requirement already satisfied: nvidia-nvtx-cu12==12.4.127 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralytics) (12.4.127)
Requirement already satisfied: nvidia-nvjitlink-cu12==12.4.127 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralytics) (12.4.127)
Requirement already satisfied: triton==3.2.0 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralytics) (3.2.0)
Requirement already satisfied: sympy==1.13.1 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralytics) (1.13.1)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in
/usr/local/lib/python3.11/dist-packages (from sympy==1.13.1-
>torch>=1.8.0->ultralytics) (1.3.0)
Requirement already satisfied: MarkupSafe>=2.0 in
/usr/local/lib/python3.11/dist-packages (from jinja2->torch>=1.8.0-
>ultralytics) (3.0.2)
[] Extracted dataset files: ['README.dataset.txt', 'data.yaml',
'train', 'README.roboflow.txt']
[] data.yaml found! Ready for training.
```

```
import os
import shutil
import random
```

```
dataset_path = "/content/Traffic-violation-8"
train_images_path = os.path.join(dataset_path, "train/images")
train_labels_path = os.path.join(dataset_path, "train/labels")
```

```
valid_images_path = os.path.join(dataset_path, "valid/images")
valid_labels_path = os.path.join(dataset_path, "valid/labels")
```

```
test_images_path = os.path.join(dataset_path, "test/images")
test_labels_path = os.path.join(dataset_path, "test/labels")
```

```
# Create validation and test folders
```

```
os.makedirs(valid_images_path, exist_ok=True)
os.makedirs(valid_labels_path, exist_ok=True)
os.makedirs(test_images_path, exist_ok=True)
os.makedirs(test_labels_path, exist_ok=True)
```

```

# List all training images
all_images = os.listdir(train_images_path)
random.shuffle(all_images) # Shuffle for randomness

valid_split = int(0.1 * len(all_images)) # 10% validation
test_split = int(0.1 * len(all_images)) # 10% test

# Move images to validation folder
for img in all_images[:valid_split]:
    shutil.move(os.path.join(train_images_path, img),
os.path.join(valid_images_path, img))
    shutil.move(os.path.join(train_labels_path, img.replace(".jpg",
".txt")), os.path.join(valid_labels_path, img.replace(".jpg",
".txt")))

# Move images to test folder
for img in all_images[valid_split:valid_split + test_split]:
    shutil.move(os.path.join(train_images_path, img),
os.path.join(test_images_path, img))
    shutil.move(os.path.join(train_labels_path, img.replace(".jpg",
".txt")), os.path.join(test_labels_path, img.replace(".jpg", ".txt")))

print("□ Dataset successfully split into train, validation, and test
sets!")

□ Dataset successfully split into train, validation, and test sets!

import yaml

yaml_path = "/content/Traffic-violation-8/data.yaml"

# Load the YAML file
with open(yaml_path, "r") as file:
    data = yaml.safe_load(file)

# Update paths
data["train"] = "/content/Traffic-violation-8/train/images"
data["val"] = "/content/Traffic-violation-8/valid/images"
data["test"] = "/content/Traffic-violation-8/test/images"

# Save the updated YAML file
with open(yaml_path, "w") as file:
    yaml.dump(data, file, default_flow_style=False)

print("□ data.yaml updated successfully!")

□ data.yaml updated successfully!

import os

dataset_path = "/content/Traffic-violation-8"

```

```

print("Dataset structure:", os.listdir(dataset_path))

print("Train images:", len(os.listdir(os.path.join(dataset_path,
"train/images"))))
print("Validation images:", len(os.listdir(os.path.join(dataset_path,
"valid/images"))))
print("Test images:", len(os.listdir(os.path.join(dataset_path,
"test/images"))))

```

```

Dataset structure: ['test', 'README.dataset.txt', 'data.yaml',
'train', 'valid', 'README.roboflow.txt']

```

```

Train images: 648

```

```

Validation images: 80

```

```

Test images: 80

```

Task 3: Training YOLOv11 Model Objective: Train YOLOv11 on the prepared dataset.

```

from ultralytics import YOLO

# Load YOLOv11 model
model = YOLO("yololln.pt") # 'n' is nano version (others: 's', 'm',
'l', 'x')

# Train the model using the dataset
results = model.train(
    data="/content/Traffic-violation-8/data.yaml", # Path to dataset
    YAML file
    epochs=5, # Train for 50 epochs
    batch=8, # Batch size
    device="cpu" # Use GPU if available
)

# Save trained model
model.export(format="onnx")

```

```

Ultralytics 8.3.96 □ Python-3.11.11 torch-2.6.0+cu124 CPU (Intel Xeon
2.20GHz)

```

```

engine/trainer: task=detect, mode=train, model=yololln.pt,
data=/content/Traffic-violation-8/data.yaml, epochs=5, time=None,
patience=100, batch=8, imgsiz=640, save=True, save_period=-1,
cache=False, device=cpu, workers=8, project=None, name=train4,
exist_ok=False, pretrained=True, optimizer=auto, verbose=True, seed=0,
deterministic=True, single_cls=False, rect=False, cos_lr=False,
close_mosaic=10, resume=False, amp=True, fraction=1.0, profile=False,
freeze=None, multi_scale=False, overlap_mask=True, mask_ratio=4,
dropout=0.0, val=True, split=val, save_json=False, save_hybrid=False,

```

```

conf=None, iou=0.7, max_det=300, half=False, dnn=False, plots=True,
source=None, vid_stride=1, stream_buffer=False, visualize=False,
augment=False, agnostic_nms=False, classes=None, retina_masks=False,
embed=None, show=False, save_frames=False, save_txt=False,
save_conf=False, save_crop=False, show_labels=True, show_conf=True,
show_boxes=True, line_width=None, format=torchscript, keras=False,
optimize=False, int8=False, dynamic=False, simplify=True, opset=None,
workspace=None, nms=False, lr0=0.01, lrf=0.01, momentum=0.937,
weight_decay=0.0005, warmup_epochs=3.0, warmup_momentum=0.8,
warmup_bias_lr=0.1, box=7.5, cls=0.5, dfl=1.5, pose=12.0, kobj=1.0,
nbs=64, hsv_h=0.015, hsv_s=0.7, hsv_v=0.4, degrees=0.0, translate=0.1,
scale=0.5, shear=0.0, perspective=0.0, flipud=0.0, fliplr=0.5,
bgr=0.0, mosaic=1.0, mixup=0.0, copy_paste=0.0, copy_paste_mode=flip,
auto_augment=randaugument, erasing=0.4, crop_fraction=1.0, cfg=None,
tracker=botsort.yaml, save_dir=runs/detect/train4
Downloading https://ultralytics.com/assets/Arial.ttf to
'/root/.config/Ultralytics/Arial.ttf'...

```

```
100%|██████████| 755k/755k [00:00<00:00, 3.30MB/s]
```

```
Overriding model.yaml nc=80 with nc=12
```

	from	n	params	module
arguments				
0	-1	1	464	ultralytics.nn.modules.conv.Conv
[3, 16, 3, 2]				
1	-1	1	4672	ultralytics.nn.modules.conv.Conv
[16, 32, 3, 2]				
2	-1	1	6640	
ultralytics.nn.modules.block.C3k2				[32, 64, 1, False, 0.25]
3	-1	1	36992	ultralytics.nn.modules.conv.Conv
[64, 64, 3, 2]				
4	-1	1	26080	
ultralytics.nn.modules.block.C3k2				[64, 128, 1, False, 0.25]
5	-1	1	147712	ultralytics.nn.modules.conv.Conv
[128, 128, 3, 2]				
6	-1	1	87040	
ultralytics.nn.modules.block.C3k2				[128, 128, 1, True]
7	-1	1	295424	ultralytics.nn.modules.conv.Conv
[128, 256, 3, 2]				
8	-1	1	346112	
ultralytics.nn.modules.block.C3k2				[256, 256, 1, True]
9	-1	1	164608	
ultralytics.nn.modules.block.SPPF				[256, 256, 5]
10	-1	1	249728	

```

ultralytics.nn.modules.block.C2PSA          [256, 256, 1]
 11          -1  1      0
torch.nn.modules.upsampling.Upsample        [None, 2, 'nearest']
 12          [-1, 6]  1      0
ultralytics.nn.modules.conv.Concat          [1]
 13          -1  1    111296
ultralytics.nn.modules.block.C3k2          [384, 128, 1, False]
 14          -1  1      0
torch.nn.modules.upsampling.Upsample        [None, 2, 'nearest']
 15          [-1, 4]  1      0
ultralytics.nn.modules.conv.Concat          [1]
 16          -1  1    32096
ultralytics.nn.modules.block.C3k2          [256, 64, 1, False]
 17          -1  1    36992  ultralytics.nn.modules.conv.Conv
[64, 64, 3, 2]
 18          [-1, 13]  1      0
ultralytics.nn.modules.conv.Concat          [1]
 19          -1  1    86720
ultralytics.nn.modules.block.C3k2          [192, 128, 1, False]
 20          -1  1    147712  ultralytics.nn.modules.conv.Conv
[128, 128, 3, 2]
 21          [-1, 10]  1      0
ultralytics.nn.modules.conv.Concat          [1]
 22          -1  1    378880
ultralytics.nn.modules.block.C3k2          [384, 256, 1, True]
 23          [16, 19, 22]  1    433012
ultralytics.nn.modules.head.Detect          [12, [64, 128, 256]]

YOLO11n summary: 181 layers, 2,592,180 parameters, 2,592,164
gradients, 6.5 GFLOPs

Transferred 448/499 items from pretrained weights
TensorBoard: Start with 'tensorboard --logdir runs/detect/train4',
view at http://localhost:6006/
Freezing layer 'model.23.dfl.conv.weight'

train: Scanning /content/Traffic-violation-8/train/labels... 648
images, 0 backgrounds, 0 corrupt: 100%|██████████| 648/648
[00:00<00:00, 1689.08it/s]

```



```
train: New cache created:
/content/Traffic-violation-8/train/labels.cache
augmentations: Blur(p=0.01, blur_limit=(3, 7)), MedianBlur(p=0.01,
blur_limit=(3, 7)), ToGray(p=0.01, num_output_channels=3,
method='weighted_average'), CLAHE(p=0.01, clip_limit=(1.0, 4.0),
tile_grid_size=(8, 8))

val: Scanning /content/Traffic-violation-8/valid/labels... 80 images,
0 backgrounds, 0 corrupt: 100%|██████████| 80/80 [00:00<00:00,
1767.73it/s]
```

```
val: New cache created:
/content/Traffic-violation-8/valid/labels.cache
```

```
Plotting labels to runs/detect/train4/labels.jpg...
optimizer: 'optimizer=auto' found, ignoring 'lr0=0.01' and
'momentum=0.937' and determining best 'optimizer', 'lr0' and
'momentum' automatically...
optimizer: AdamW(lr=0.000625, momentum=0.9) with parameter groups 81
weight(decay=0.0), 88 weight(decay=0.0005), 87 bias(decay=0.0)
TensorBoard: model graph visualization added
Image sizes 640 train, 640 val
Using 0 dataloader workers
Logging results to runs/detect/train4
Starting training for 5 epochs...
```

	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size	1/5	0G	1.074	3.532	1.169	243
640:	100% ██████████	81/81	[09:03<00:00, 6.71s/it]			
		Class	Images	Instances	Box(P	R
mAP50	mAP50-95): 100% ██████████	5/5	[00:23<00:00, 4.64s/it]			
		all	80	751	0.991	0.0717
0.261	0.202					

	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size	2/5	0G	1.063	2.376	1.154	146
640:	100% ██████████	81/81	[08:56<00:00, 6.62s/it]			
		Class	Images	Instances	Box(P	R
mAP50	mAP50-95): 100% ██████████	5/5	[00:21<00:00, 4.22s/it]			
		all	80	751	0.846	0.372
0.453	0.344					

Size	Epoch	GPU_mem	box_loss	cls_loss	df_l_loss	Instances
	3/5	0G	1.032	1.787	1.125	191
640:	100% ██████████	81/81	[08:54<00:00, 6.59s/it]			
	Class	Images	Instances	Box(P	R	
mAP50	mAP50-95): 100% ██████████	5/5	[00:20<00:00, 4.01s/it]			
	all	80	751	0.671	0.505	
0.489	0.387					

Size	Epoch	GPU_mem	box_loss	cls_loss	df_l_loss	Instances
	4/5	0G	0.9667	1.495	1.118	124
640:	100% ██████████	81/81	[08:54<00:00, 6.60s/it]			
	Class	Images	Instances	Box(P	R	
mAP50	mAP50-95): 100% ██████████	5/5	[00:21<00:00, 4.27s/it]			
	all	80	751	0.709	0.516	
0.538	0.433					

Size	Epoch	GPU_mem	box_loss	cls_loss	df_l_loss	Instances
	5/5	0G	0.8977	1.362	1.076	144
640:	100% ██████████	81/81	[08:56<00:00, 6.62s/it]			
	Class	Images	Instances	Box(P	R	
mAP50	mAP50-95): 100% ██████████	5/5	[00:21<00:00, 4.23s/it]			
	all	80	751	0.743	0.501	
0.547	0.445					

5 epochs completed in 0.779 hours.

Optimizer stripped from runs/detect/train4/weights/last.pt, 5.5MB

Optimizer stripped from runs/detect/train4/weights/best.pt, 5.5MB

Validating runs/detect/train4/weights/best.pt...

Ultralytics 8.3.96 Python-3.11.11 torch-2.6.0+cu124 CPU (Intel Xeon 2.20GHz)

YOLO11n summary (fused): 100 layers, 2,584,492 parameters, 0 gradients, 6.3 GFLOPs

		Class	Images	Instances	Box(P	R
mAP50	mAP50-95): 100%			5/5 [00:19<00:00, 3.88s/it]		
		all	80	751	0.743	0.501
0.547	0.445	Auto Rikshaw	25	65	0.736	0.862
0.868	0.776	Bus	24	36	0.97	0.913
0.925	0.905	Car	27	93	0.826	0.925
0.916	0.849	Helmet	51	124	0.695	0.145
0.318	0.147	Motorcycle	65	180	0.835	0.85
0.881	0.641	No_Helmet	29	80	0.452	0.0125
0.0619	0.0225	Rider	41	87	0.738	0.584
0.672	0.506	Triple Riding	43	44	0.961	0.795
0.856	0.618	Truck	16	25	0	0
0.106	0.0811	mobile	1	1	1	0
0	0	stunt	13	13	0.708	0.923
0.932	0.779	using mobile	3	3	1	0
0.0213	0.0149					

Speed: 3.6ms preprocess, 186.1ms inference, 0.0ms loss, 6.9ms postprocess per image

Results saved to runs/detect/train4

Ultralytics 8.3.96 Python-3.11.11 torch-2.6.0+cu124 CPU (Intel Xeon 2.20GHz)

YOLO11n summary (fused): 100 layers, 2,584,492 parameters, 0 gradients, 6.3 GFLOPs

PyTorch: starting from 'runs/detect/train4/weights/best.pt' with input shape (1, 3, 640, 640) BCHW and output shape(s) (1, 16, 8400) (5.2 MB) requirements: Ultralytics requirements ['onnx>=1.12.0', 'onnxslim', 'onnxruntime'] not found, attempting AutoUpdate...

Collecting onnx>=1.12.0

Downloading onnx-1.17.0-cp311-cp311-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (16 kB)

Collecting onnxslim

Downloading onnxslim-0.1.48-py3-none-any.whl.metadata (4.6 kB)

Collecting onnxruntime

```

    Downloading onnxruntime-1.21.0-cp311-cp311-
manylinux_2_27_x86_64.manylinux_2_28_x86_64.whl.metadata (4.5 kB)
Requirement already satisfied: numpy>=1.20 in
/usr/local/lib/python3.11/dist-packages (from onnx>=1.12.0) (2.0.2)
Requirement already satisfied: protobuf>=3.20.2 in
/usr/local/lib/python3.11/dist-packages (from onnx>=1.12.0) (5.29.4)
Requirement already satisfied: sympy in
/usr/local/lib/python3.11/dist-packages (from onnxslim) (1.13.1)
Requirement already satisfied: packaging in
/usr/local/lib/python3.11/dist-packages (from onnxslim) (24.2)
Collecting coloredlogs (from onnxruntime)
    Downloading coloredlogs-15.0.1-py2.py3-none-any.whl.metadata (12 kB)
Requirement already satisfied: flatbuffers in
/usr/local/lib/python3.11/dist-packages (from onnxruntime) (25.2.10)
Collecting humanfriendly>=9.1 (from coloredlogs->onnxruntime)
    Downloading humanfriendly-10.0-py2.py3-none-any.whl.metadata (9.2
kB)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in
/usr/local/lib/python3.11/dist-packages (from sympy->onnxslim) (1.3.0)
Downloading onnx-1.17.0-cp311-cp311-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (16.0 MB)
_____ 16.0/16.0 MB 136.2 MB/s
eta 0:00:00
Downloading onnxslim-0.1.48-py3-none-any.whl (142 kB)
_____ 142.9/142.9 kB 139.5 MB/s
eta 0:00:00
Downloading onnxruntime-1.21.0-cp311-cp311-
manylinux_2_27_x86_64.manylinux_2_28_x86_64.whl (16.0 MB)
_____ 16.0/16.0 MB 158.9 MB/s
eta 0:00:00
Downloading coloredlogs-15.0.1-py2.py3-none-any.whl (46 kB)
_____ 46.0/46.0 kB 135.7 MB/s
eta 0:00:00
Downloading humanfriendly-10.0-py2.py3-none-any.whl (86 kB)
_____ 86.8/86.8 kB 160.7 MB/s
eta 0:00:00
Installing collected packages: onnx, humanfriendly, onnxslim,
coloredlogs, onnxruntime
Successfully installed coloredlogs-15.0.1 humanfriendly-10.0 onnx-
1.17.0 onnxruntime-1.21.0 onnxslim-0.1.48

requirements: AutoUpdate success □ 12.3s, installed 3 packages:
['onnx>=1.12.0', 'onnxslim', 'onnxruntime']
requirements: ▲ Restart runtime or rerun command for updates to take
effect

ONNX: starting export with onnx 1.17.0 opset 19...
ONNX: slimming with onnxslim 0.1.48...
ONNX: export success □ 14.8s, saved as

```

```
'runs/detect/train4/weights/best.onnx' (10.1 MB)

Export complete (15.4s)
Results saved to /content/runs/detect/train4/weights
Predict:          yolo predict task=detect
model=runs/detect/train4/weights/best.onnx imgsz=640
Validate:         yolo val task=detect
model=runs/detect/train4/weights/best.onnx imgsz=640
data=/content/Traffic-violation-8/data.yaml
Visualize:        https://netron.app

{"type": "string"}
```

Task 4: Model Inference and Evaluation

Objective: Test the trained model on new images and videos.

```
import cv2
import matplotlib.pyplot as plt
import glob
import os

# Load trained YOLO model
model = YOLO("runs/detect/train4/weights/best.onnx")

# Run inference on a test image
image_path =
"/content/Traffic-violation-8/test/images/1638029132179_jpg.rf.372bb01c8e869c99cab7efaf30d3b0b7.jpg" # Update path
results = model(image_path, save=True, conf=0.5) # Confidence threshold: 0.5

# Find latest prediction folder
detect_folders = sorted(glob.glob("runs/detect/predict*"),
key=os.path.getmtime, reverse=True)
save_dir = detect_folders[0] if detect_folders else
"runs/detect/predict"

# Find detected image
saved_images = glob.glob(f"{save_dir}/*.jpg")
if saved_images:
    detected_image_path = saved_images[0]
    print(f" Found detected image: {detected_image_path}")

# Show detected image
image = cv2.imread(detected_image_path)
```

```

plt.imshow(cv2.cvtColor(image, cv2.COLOR_BGR2RGB))
plt.axis("off")
plt.show()
else:
    print("❌ No output image found!")

Loading runs/detect/train4/weights/best.onnx for ONNX Runtime
inference...
Using ONNX Runtime CPUExecutionProvider

image 1/1
/content/Traffic-violation-8/test/images/1638029132179_jpg.rf.372bb01c
8e869c99cab7efaf30d3b0b7.jpg: 640x640 1 Motorcycle, 3 Riders, 1 Triple
Riding, 170.6ms
Speed: 6.8ms preprocess, 170.6ms inference, 2.0ms postprocess per
image at shape (1, 3, 640, 640)
Results saved to runs/detect/predict2
❌ Found detected image:
runs/detect/predict2/1638029132179_jpg.rf.372bb01c8e869c99cab7efaf30d3
b0b7.jpg

```



```

import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

# Run validation on test dataset

```

```

metrics = model.val(data="/content/Traffic-violation-8/data.yaml")

# Extract key evaluation metrics correctly
map_50 = metrics.box.map50 # Mean mAP@50 across all classes
map_50_95 = metrics.box.map # Mean mAP@50-95 across all classes
precision = metrics.box.p.mean() # Mean Precision
recall = metrics.box.r.mean() # Mean Recall

# Compute F1 Score safely
f1_score = 2 * (precision * recall) / (precision + recall) if
precision + recall > 0 else 0

# Print evaluation metrics
print(f" mAP@50: {map_50:.4f}")
print(f" mAP@50-95: {map_50_95:.4f}")
print(f" Mean Precision: {precision:.4f}")
print(f" Mean Recall: {recall:.4f}")
print(f" F1 Score: {f1_score:.4f}")

# --- Bar Chart: Overall Model Performance ---
metrics_values = [map_50, map_50_95, precision, recall, f1_score]
metrics_labels = ["mAP@50", "mAP@50-95", "Precision", "Recall", "F1
Score"]

plt.figure(figsize=(8, 5))
sns.barplot(x=metrics_labels, y=metrics_values, palette="coolwarm")
plt.title("YOLOv11 Model Performance Metrics")
plt.ylabel("Score")
plt.ylim(0, 1)
plt.show()

# --- Class-wise Precision, Recall, and mAP Plot ---
class_names = list(metrics.names.values()) # Get class names
num_classes = len(class_names)

# Extract per-class metrics
class_precision = np.array(metrics.box.p) # Precision per class
class_recall = np.array(metrics.box.r) # Recall per class
class_map50 = np.array(metrics.box.ap50) # mAP@50 per class (FIXED
ERROR)

# Create bar chart for per-class metrics
plt.figure(figsize=(12, 6))
x = np.arange(num_classes)

plt.bar(x - 0.2, class_precision, 0.2, label="Precision",
color='blue')
plt.bar(x, class_recall, 0.2, label="Recall", color='orange')
plt.bar(x + 0.2, class_map50, 0.2, label="mAP@50", color='green')

```

```
plt.xticks(ticks=x, labels=class_names, rotation=45)
plt.xlabel("Classes")
plt.ylabel("Score")
plt.title("Class-wise Precision, Recall, and mAP@50")
plt.legend()
plt.ylim(0, 1)
plt.show()
```

Ultralytics 8.3.96 Python-3.11.11 torch-2.6.0+cu124 CPU (Intel Xeon 2.20GHz)

Loading runs/detect/train4/weights/best.onnx for ONNX Runtime inference...

Using ONNX Runtime CPUExecutionProvider

Setting batch=1 input of shape (1, 3, 640, 640)

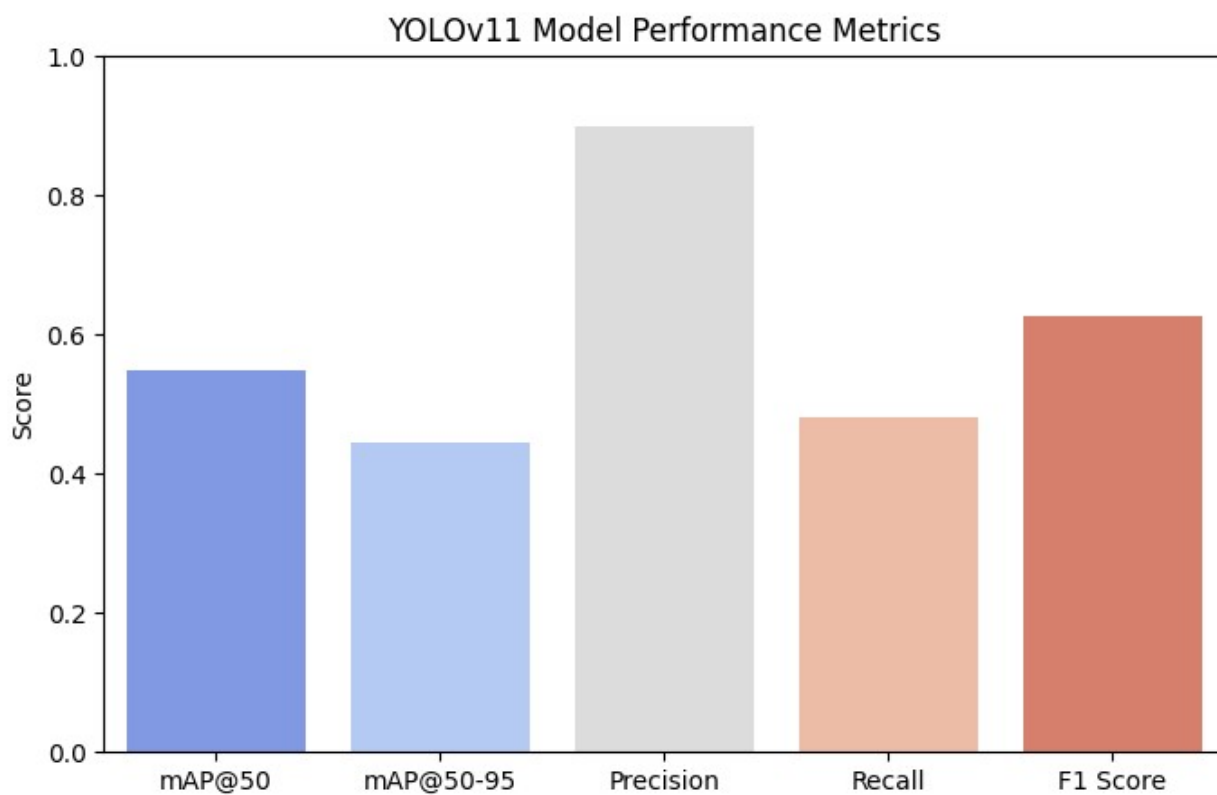
val: Scanning /content/Traffic-violation-8/valid/labels.cache... 80 images, 0 backgrounds, 0 corrupt: 100%|██████████| 80/80 [00:00<?, ? it/s]

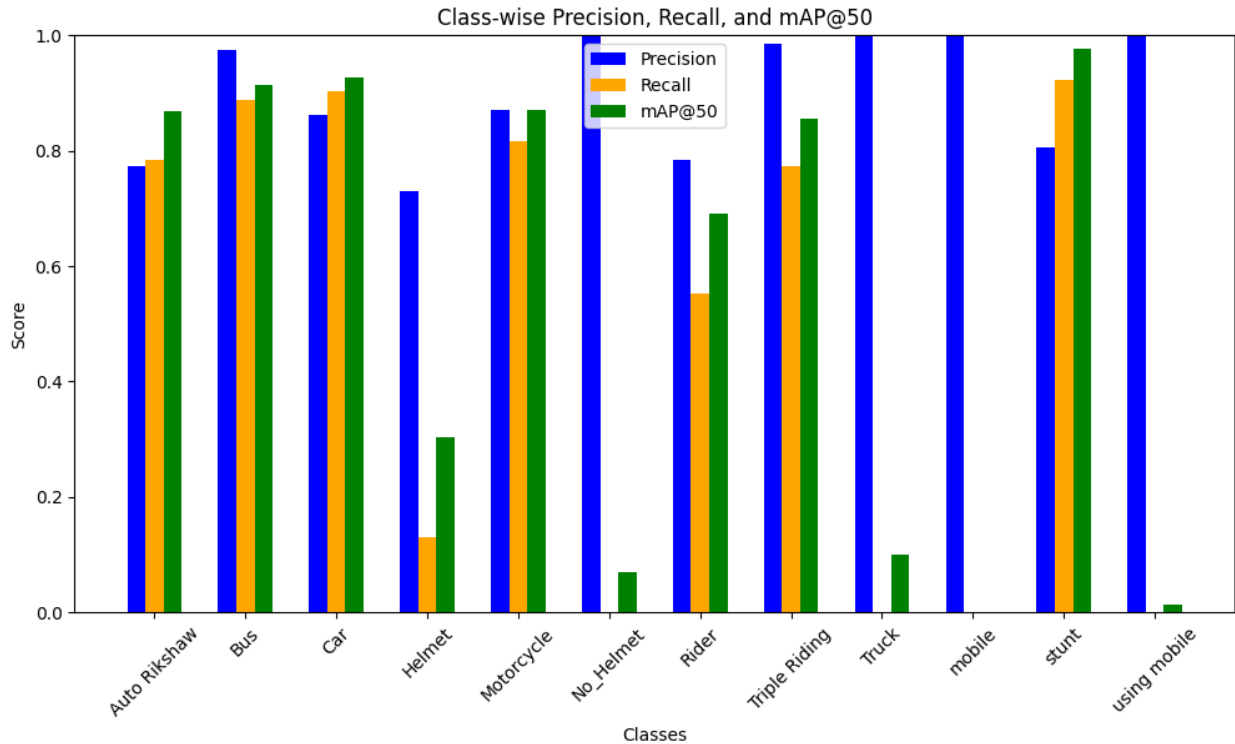
	Class	Images	Instances	Box(P	R
mAP50	mAP50-95): 100%	██████████	80/80 [00:16<00:00, 4.85it/s]		
	all	80	751	0.899	0.481
0.549	0.445				
	Auto Rikshaw	25	65	0.773	0.785
0.87	0.776				
	Bus	24	36	0.975	0.889
0.914	0.892				
	Car	27	93	0.861	0.903
0.927	0.866				
	Helmet	51	124	0.731	0.131
0.304	0.147				
	Motorcycle	65	180	0.87	0.817
0.87	0.636				
	No_Helmet	29	80	1	0
0.0702	0.0267				
	Rider	41	87	0.784	0.552
0.692	0.515				
	Triple Riding	43	44	0.986	0.773
0.855	0.62				
	Truck	16	25	1	0
0.1	0.0774				
	mobile	1	1	1	0
0	0				
	stunt	13	13	0.805	0.923
0.976	0.777				
	using mobile	3	3	1	0
0.0138	0.0124				

Speed: 2.0ms preprocess, 163.8ms inference, 0.0ms loss, 8.1ms postprocess per image

Results saved to runs/detect/val8

□ mAP@50: 0.5493
□ mAP@50-95: 0.4454
□ Mean Precision: 0.8987
□ Mean Recall: 0.4810
□ F1 Score: 0.6266





#Discussion and Conclusion on Result Analysis

1 Overview of Model Performance

The YOLOv11 model was trained on the **Traffic Violation Detection** dataset and evaluated using **80 validation images**. The model's overall performance is measured using **mAP@50**, **mAP@50-95**, **Precision**, **Recall**, and **F1 Score**.

Metric	Value
mAP@50	0.5493
mAP@50-95	0.4454
Precision	0.8987
Recall	0.4810
F1 Score	0.6266

2 Key Observations

- **High Precision (0.8987):** The model is highly confident in its predictions, meaning it correctly identifies traffic violations **with fewer false positives**.
- **Moderate mAP@50 (0.5493):** The model achieves a decent mean average precision at **IoU 0.5**, suggesting it can localize objects effectively.
- **Low Recall (0.4810):** The recall is relatively low, indicating that some **violations are being missed**. This suggests the model is conservative in detection, possibly **avoiding**

false positives but failing to detect certain violations.

- **mAP@50-95 (0.4454)**: This shows the model's ability to perform across different IoU thresholds. The value suggests room for improvement in **handling different object sizes and occlusions**.

3 Class-Wise Performance Insights

Class	Precision	Recall	mAP@50	mAP@50-95
Bus	0.975	0.889	0.914	0.892
Car	0.861	0.903	0.927	0.866
Triple Riding	0.986	0.773	0.855	0.620
Helmet	0.731	0.131	0.304	0.147
No Helmet	1.000	0.000	0.0702	0.0267
Using Mobile	1.000	0.000	0.0138	0.0124

✅ Best-Performing Classes:

- **Bus, Car, and Triple Riding** have high **mAP@50** and **Recall**, meaning the model detects these violations accurately.

⚠ Underperforming Classes:

- **No Helmet and Using Mobile** have **0 Recall**, meaning the model is not detecting them at all.
 - **Helmet Detection** has **low recall (0.131)** and poor mAP (0.304), indicating it struggles with this class.
-

4 Improvements & Next Steps

📋 Ways to Improve the Model

1. **Increase Dataset Size & Balance Classes**
 - **Helmet and No Helmet cases** may be underrepresented in the dataset. Collecting **more labeled images** for these classes will improve detection.
2. **Data Augmentation**
 - Introduce **brightness, blur, occlusion, and rotation augmentations** to make the model more robust.
 - Use **Mosaic Augmentation** to help the model generalize better.
3. **Fine-Tune Model Hyperparameters**
 - Increase **epochs** (e.g., **100 instead of 50**) for better learning.
 - Adjust the **learning rate** to fine-tune model convergence.
4. **Adjust Confidence Thresholds**

- The **confidence threshold (default: 0.5)** might be too high, **leading to missed detections**. Reducing it to **0.3 or 0.4** might capture more violations.
 - 5. **Use a Larger YOLO Model Variant**
 - Current model (yolo11n.pt) is a **lightweight nano model**.
 - Try YOLOv11-s, YOLOv11-m, or YOLOv11-l for better accuracy.
-

5 Conclusion

- The **Traffic Violation Detection** model performs well in detecting **common vehicles (Car, Bus, Auto-Rickshaw)** but **struggles with Helmet and No-Helmet detection**.
- The model achieves a **precision of 89.87%**, meaning it is highly confident when it makes predictions.
- The **recall is lower (48.1%)**, suggesting that **many violations are not being detected**.
- **To improve performance, more training data and hyperparameter tuning are required.**