

Course Name: Deep Learning

Lab Title: Yolo11 - Traffic violation

Dataset

Group Members:

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Student ID: 202201040089

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('yolo11n.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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/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: tqdm>=4.64.0 in
/usr/local/lib/python3.11/dist-packages (from ultralytics) (4.67.1)
Requirement already satisfied: psutil in
/usr/local/lib/python3.11/dist-packages (from ultralytics) (5.9.5)
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Requirement already satisfied: contourpy>=1.0.1 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
/usr/local/lib/python3.11/dist-packages (from python-dateutil>=2.7-
>matplotlib>=3.3.0->ultralytics) (1.17.0)
Requirement already satisfied: MarkupSafe>=2.0 in
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cublascu12, nvidia-cusparse-cu12, nvidia-cudnn-cu12, nvidia-cusolver-
cu12,
ultralytics-thop, ultralytics
Attempting uninstall: nvidia-nvjitlink-cu12
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Uninstalling nvidia-nvjitlink-cu12-12.5.82:
    Successfully uninstalled nvidia-nvjitlink-cu12-12.5.82
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    Found existing installation: nvidia-curand-cu12 10.3.6.82
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Attempting uninstall: nvidia-cusparse-cu12
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Uninstalling nvidia-cusparse-cu12-12.5.1.3:
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Attempting uninstall: nvidia-cudnn-cu12
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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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cupticu12-12.4.127 nvidia-cuda-nvrtc-cu12-12.4.127 nvidia-cuda-
runtimecu12-12.4.127 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
nvidiacusparse-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/yolol1n.pt to 'yolol1n.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="jvo1Alu0TUuTM9wD7a3L")
project = rf.workspace("middle-east-tech-university").project("fireand-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)
Requirement already satisfied: idna==3.7 in
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Requirement already satisfied: cycler in
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Requirement already satisfied: kiwisolver>=1.3.1 in
/usr/local/lib/python3.11/dist-packages (from roboflow) (1.4.8)
Requirement already satisfied: matplotlib in
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/usr/local/lib/python3.11/dist-packages (from roboflow) (3.10.0)
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Requirement already satisfied: opencv-python-headless==4.10.0.84 in
/usr/local/lib/python3.11/dist-packages (from roboflow) (4.10.0.84)
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/usr/local/lib/python3.11/dist-packages (from roboflow) (11.1.0)
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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)
Requirement already satisfied: requests-toolbelt in
/usr/local/lib/python3.11/dist-packages (from roboflow) (1.0.0)
Requirement already satisfied: filetype in
/usr/local/lib/python3.11/dist-packages (from roboflow) (1.2.0)
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: 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="jvo1Alu0TUuTM9wD7a3L")
```

```
project = rf.workspace("major-project-nlqt0").project("trafficviolation-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
/usr/local/lib/python3.11/dist-packages (from roboflow) (2025.1.31)
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Requirement already satisfied: kiwisolver>=1.3.1 in
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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
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/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)
Requirement already satisfied: python-dotenv in
/usr/local/lib/python3.11/dist-packages (from roboflow) (1.1.0)
Requirement already satisfied: requests in
/usr/local/lib/python3.11/dist-packages (from roboflow) (2.32.3)
Requirement already satisfied: six in /usr/local/lib/python3.11/dist-
packages (from roboflow) (1.17.0)
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/usr/local/lib/python3.11/dist-packages (from roboflow) (2.3.0)
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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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/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-
>ultralytics) (2025.1)
Requirement already satisfied: tzdata>=2022.7 in
/usr/local/lib/python3.11/dist-packages (from pandas>=1.1.4-
>ultralytics) (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-
>ultralytics) (3.18.0)
Requirement already satisfied: typing-extensions>=4.10.0 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralytics) (4.12.2)
Requirement already satisfied: networkx in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralytics) (3.4.2)
Requirement already satisfied: jinja2 in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralytics) (3.1.6)
Requirement already satisfied: fsspec in
/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
>ultralytics) (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-
>ultralytics) (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-
>ultralytics) (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-
>ultralytics) (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-
>ultralytics) (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-
>ultralytics) (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-
>ultralytics) (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-
```

```
>ultralytics) (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-
>ultralytics) (11.6.1.9)
Requirement already satisfied: nvidia-cusparse-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-cusparselt-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("yolo11n.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=yolo11n.pt,
data=/content/Traffic-violation-8/data.yaml, epochs=5, time=None,
patience=100, batch=8, imgsz=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, df1=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=randaugment, erasing=0.4, crop_fraction=1.0, cfg=None,
tracker=botsort.yaml, save_dir=runs/detect/train4
```

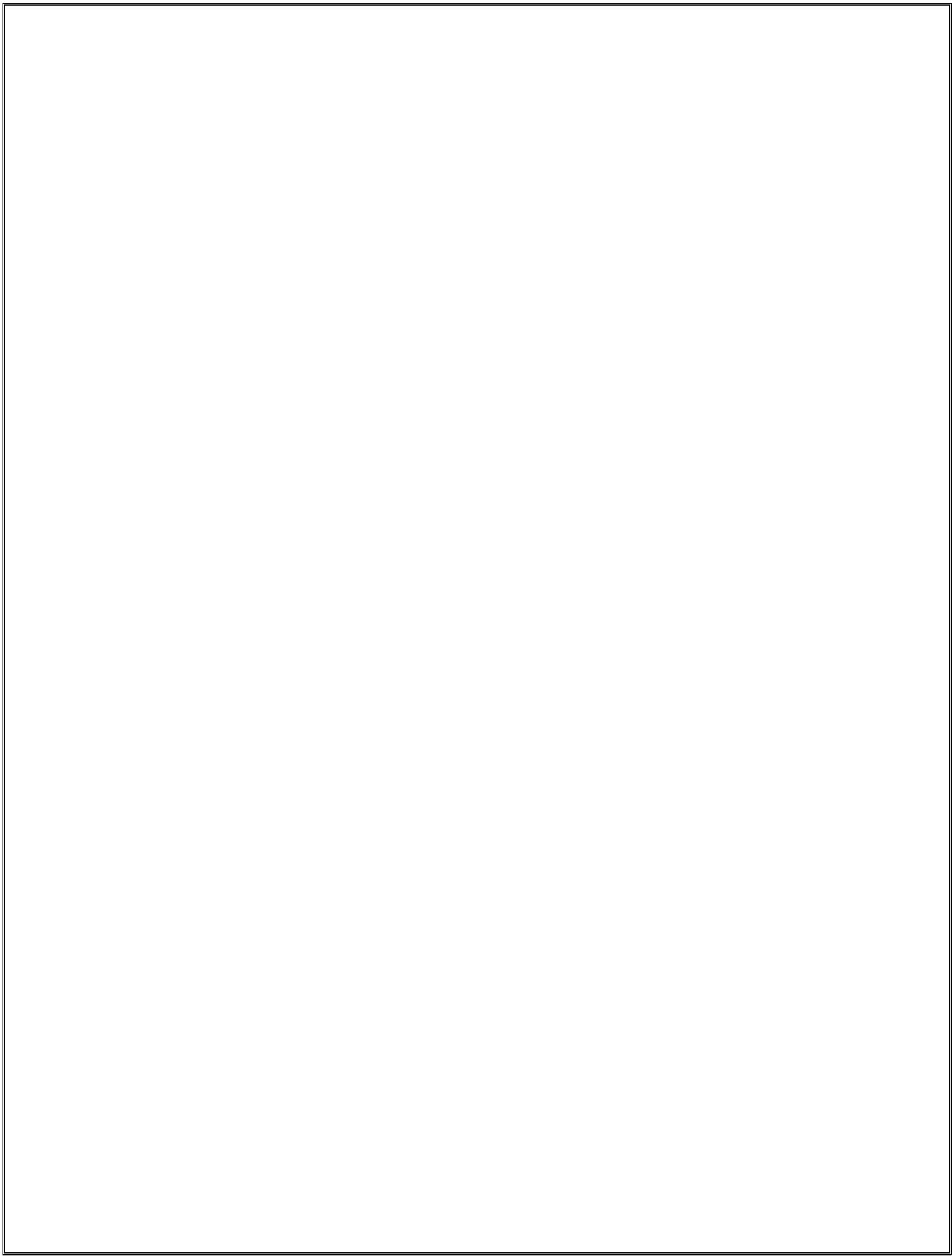
```
Downloading https://ultralytics.com/assets/Arial.ttf to
```

```
'/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	

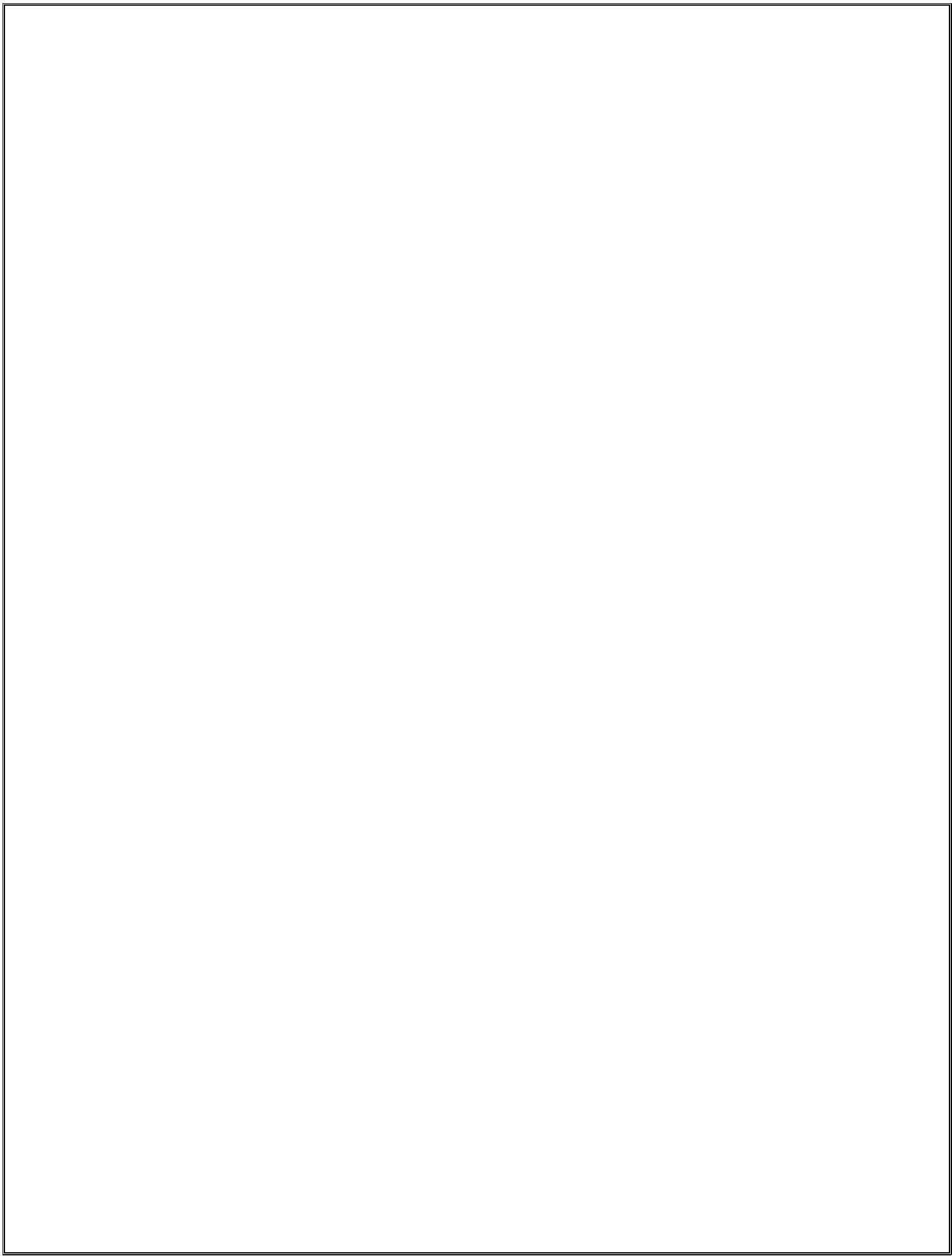


```
ultralytics.nn.modules.block.C2PSA [256, 256, 1]

11 -1 1
torch.nn.modules.upsampling.Upsample [None, 2, 'nearest']
12 [-1, 6] 1
ultralytics.nn.modules.conv.Concat [1]
13 -1 1 11129
ultralytics.nn.modules.block.C3k2 [384, 128, 1, False]
14 -1 1
torch.nn.modules.upsampling.Upsample [None, 2, 'nearest']
15 [-1, 4] 1
ultralytics.nn.modules.conv.Concat [1]
16 -1 1 3209
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
ultralytics.nn.modules.conv.Concat [1]
19 -1 1 8672
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
ultralytics.nn.modules.conv.Concat [1]
22 -1 1 37888
ultralytics.nn.modules.block.C3k2 [384, 256, 1, True]
23 [16, 19, 22] 1 43301
ultralytics.nn.modules.head.Detect [12, [64, 128, 256]]
YOLO1In 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  
albumentations: 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 |
|-------|------------------------------------------------|----------|----------|----------|-----------|
| 1/5   | 0G                                             | 1.074    | 3.532    | 1.169    | 243       |
| 640:  | 100% ██████████  81/81 [09:03<00:00, 6.71s/it] |          |          |          |           |


| mAP50      | Class | Images     | Instances                   | Box(P | R      |
|------------|-------|------------|-----------------------------|-------|--------|
| mAP50-95): | 100%  | ██████████ | 5/5 [00:23<00:00, 4.64s/it] |       |        |
| 0.261      | all   | 80         | 751                         | 0.991 | 0.0717 |

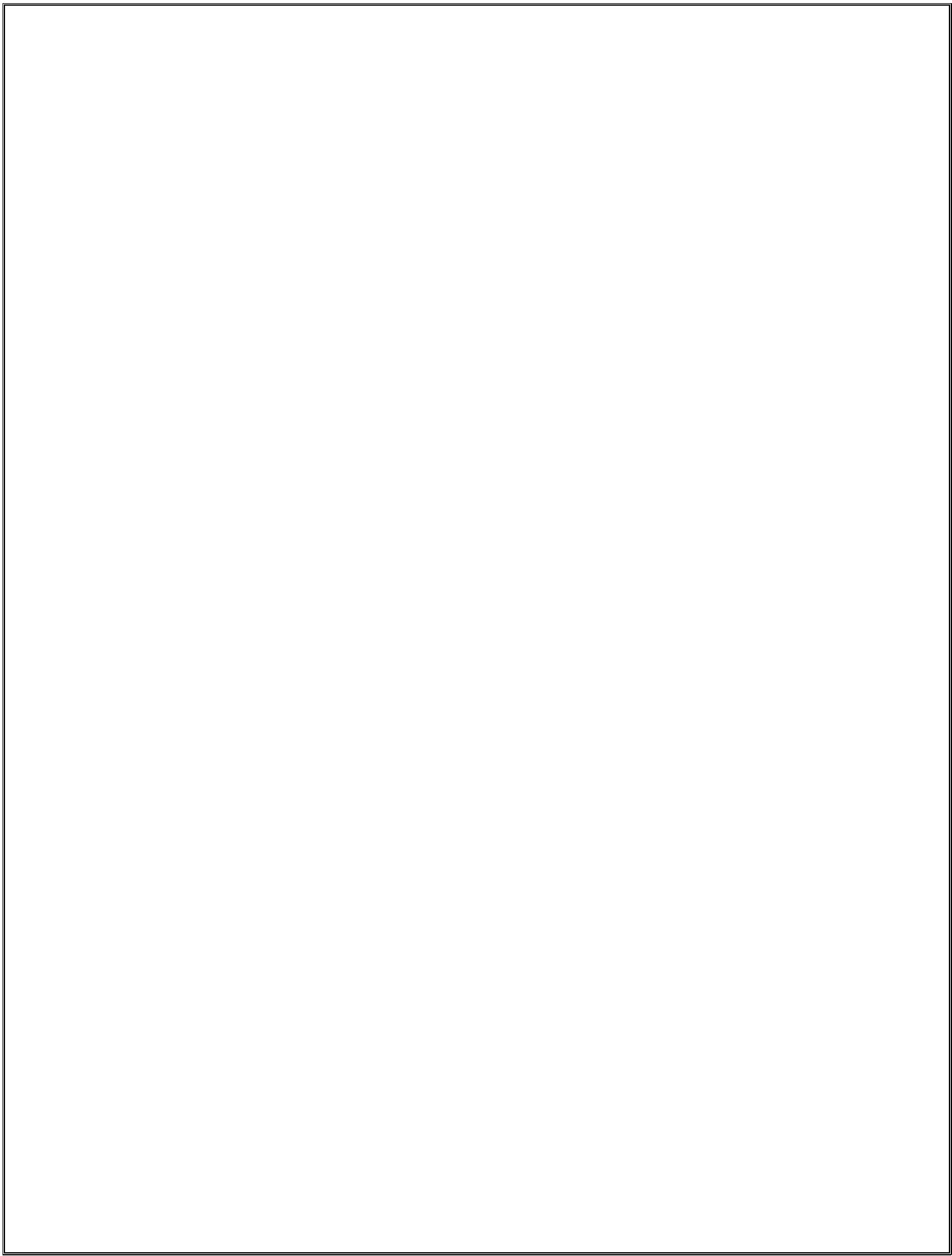
  


| Epoch | GPU_mem                                        | box_loss | cls_loss | dfl_loss | Instances |
|-------|------------------------------------------------|----------|----------|----------|-----------|
| 2/5   | 0G                                             | 1.063    | 2.376    | 1.154    | 146       |
| 640:  | 100% ██████████  81/81 [08:56<00:00, 6.62s/it] |          |          |          |           |


| mAP50      | Class | Images     | Instances                   | Box(P | R     |
|------------|-------|------------|-----------------------------|-------|-------|
| mAP50-95): | 100%  | ██████████ | 5/5 [00:21<00:00, 4.22s/it] |       |       |
| 0.453      | all   | 80         | 751                         | 0.846 | 0.372 |


```



Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
3/5	0G	1.032	1.787	1.125	191
640: 100% ██████████ 81/81 [08:54<00:00, 6.59s/it]					
mAP50 mAP50-95): 100% ██████████ 5/5 [00:20<00:00, 4.01s/it]					
0.489	0.387				
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
4/5	0G	0.9667	1.495	1.118	124
640: 100% ██████████ 81/81 [08:54<00:00, 6.60s/it]					
mAP50 mAP50-95): 100% ██████████ 5/5 [00:21<00:00, 4.27s/it]					
0.538	0.433				
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
5/5	0G	0.8977	1.362	1.076	144
640: 100% ██████████ 81/81 [08:56<00:00, 6.62s/it]					
mAP50 mAP50-95): 100% ██████████ 5/5 [00:21<00:00, 4.23s/it]					
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
```

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

```
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.372bb01
c8e869c99cab7efaf30d3b0b7.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("YOLOv1 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()

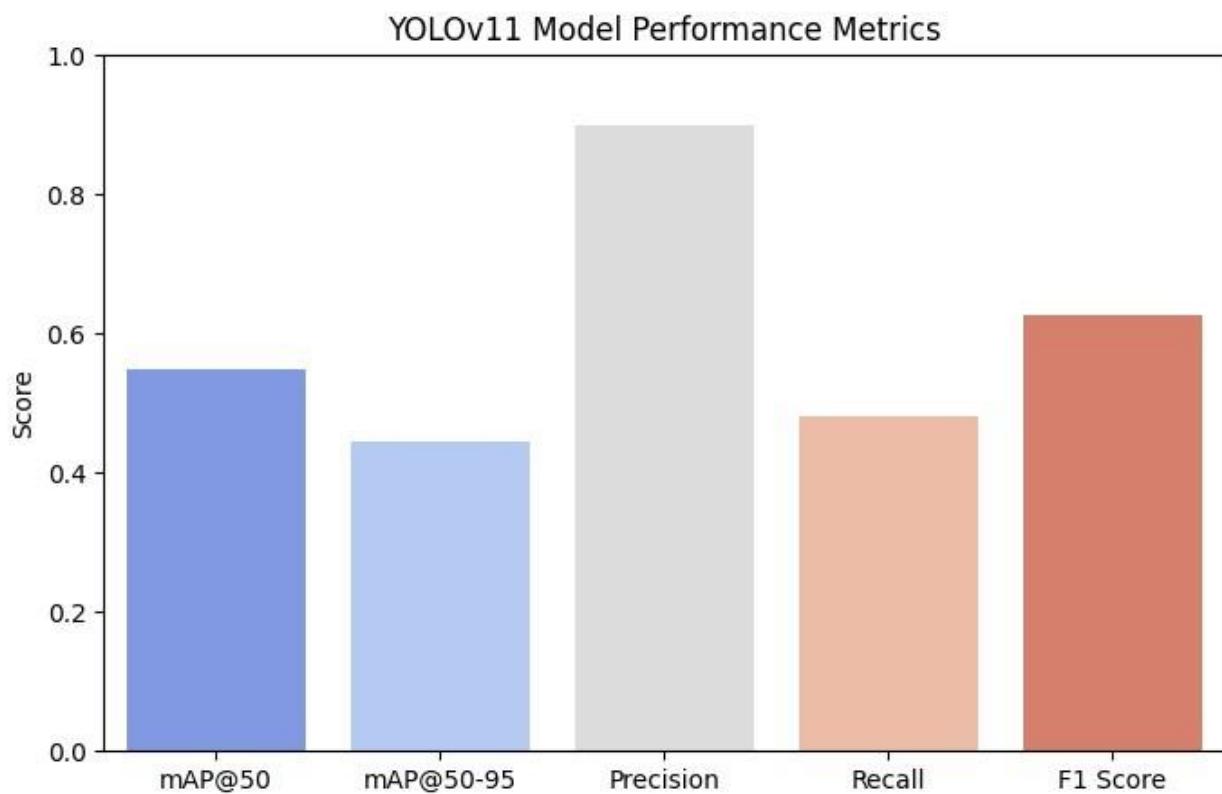
Ultralytics 8.3.96 ✅ Python-3.11.11 torch-2.6.0+cu124 CPU (Intel Xeon
2.20GHz) Loading runs/detect/train4/weights/best.onnx for
ONNX Runtime inference...
Using ONNX Runtime CPUExecutionProvider
Setting batch=1 input of shape (1, 3, 640, 640)

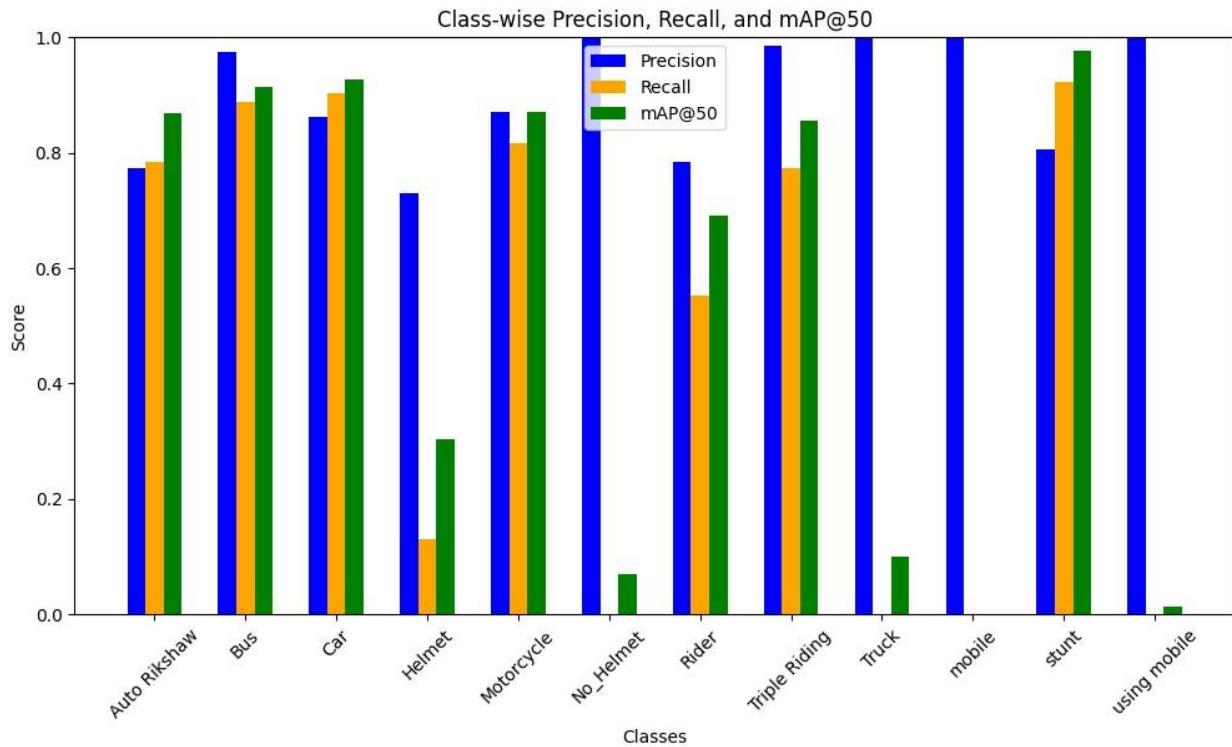
val: Scanning /content/Traffic-violation-8/valid/labels.cache... 80
images, 0 backgrounds, 0 corrupt: 100%|██████████| 80/80 [00:00<?, ?
it/s]
      Class     Images Instances   Box(P      R
mAP50  mAP50-95): 100%|██████████| 80/80 [00:16<00:00,  4.85it/s]

          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

- **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**.

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**.

Class	Precision	Recall	mAP@50	mAP@50-95	3 Class-Wise Performance Insights
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	<input checked="" type="checkbox"/> Best-Performing Classes:
Using Mobile	1.000	0.000	0.0138	0.0124	

- **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.
-

Improvements & Next Steps 4 44

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 5 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.**