Google Colab Lab Assignment -YOLO 11 Model

Course Name: MDM Deep Learning

Lab Title: YOLOv11 for object detection on the COCO dataset

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Date of Submission: 17/03/2025

Group Members:

1. Yashas Nepalia

2. Rohan Magdum

3. **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

Objective:
Set up the required libraries and dependencies to run YOLOv11.

Steps:

1. **Install Python Libraries:**
   Install required libraries using pip: roboflow and ultralytics (which includes PyTorch, OpenCV, etc.).

In [ ]:

 # Install roboffow and ultralytics

!pip install roboflow

!pip install ultralytics

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 /usr/local/lib/python3.11/dist-packages (from roboflow) (3.7)

Requirement already satisfied: cycler in /usr/local/lib/python3.11/dist-packages (from roboflow) (0.12.1)

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 /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)

Requirement already satisfied: python-dateutil in /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) (1.0.1)

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)

Requirement already satisfied: urllib3>=1.26.6 in /usr/local/lib/python3.11/dist-packages (from roboflow) (2.3.0)

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)

Requirement already satisfied: ultralytics in /usr/local/lib/python3.11/dist-packages (8.3.94)

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 /usr/local/lib/python3.11/dist-packages (from ultralytics) (4.11.0.86)

Requirement already satisfied: pillow>=7.1.2 in /usr/local/lib/python3.11/dist-packages (from ultralytics) (11.1.0)

Requirement already satisfied: pyyaml>=5.3.1 in /usr/local/lib/python3.11/dist-packages (from ultralytics) (6.0.2)

Requirement already satisfied: requests>=2.23.0 in /usr/local/lib/python3.11/dist-packages (from ultralytics) (2.32.3)

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)

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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>=3.3.0->ultralytics) (1.3.1)

Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.11/dist-packages (from matplotlib>=3.3.0->ultralytics) (0.12.1)

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)

Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.11/dist-packages (from matplotlib>=3.3.0->ultralytics) (3.2.1)

Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.11/dist-packages (from matplotlib>=3.3.0->ultralytics) (2.8.2)

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

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Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.11/dist-packages (from requests>=2.23.0->ultralytics) (3.7)

Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.11/dist-packages (from requests>=2.23.0->ultralytics) (2.3.0)

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Requirement already satisfied: filelock in /usr/local/lib/python3.11/dist-packages (from torch>=1.8.0->ultralytics) (3.17.0)

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) (2024.10.0)

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)

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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)

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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 /usr/local/lib/python3.11/dist-packages (from jinja2->torch>=1.8.0->ultralytics) (3.0.2)

Task 2: Dataset Preparation s Preprocessing

Objective:
Load and preprocess a dataset for object detection.

Steps:

1. **Dataset Acquisition:**

   - Use Roboflow to download the COCO dataset (version 34) in YOLOv11 format.

   - Utilize your API key and select the Microsoft workspace.

In [ ]:

```python
from roboflow import Roboflow

# Initialize Roboffow with your API key
rf = Roboflow(api_key="sLpQp9tNRxVlPd1zmIqo")

# Load COCO dataset (version 34) from Microsoft workspace
project = rf.workspace("microsoft").project("coco")
version = project.version(34)
dataset = version.download("yolov11")
```

loading Roboflow workspace...

loading Roboflow project...

2. **Dataset Structure and Preprocessing:**

- Verify that the dataset has been downloaded with the expected directory structure (train/, valid/, and test/ folders containing images and labels).

- Confirm that annotations are in the correct YOLO format.

In [ ]:

```python
import os

# List files to confirm dataset download
!ls -R /content/COCO-Dataset-34
```

/content/COCO-Dataset-34:

data.yaml README.dataset.txt README.roboflow.txt test train valid

/content/COCO-Dataset-34/test:

images   labels

/content/COCO-Dataset-34/test/images:

000000005345_jpg.rf.48e7947456159d44cbe1a733ad832bf1.jpg

000000005425_jpg.rf.96fb87ccc22e6e81c6a800fc4a1210dd.jpg

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/content/COCO-Dataset-34/test/labels:

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/content/COCO-Dataset-34/train:

images   labels labels.cache

/content/COCO-Dataset-34/train/images:

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000000009845_jpg.rf.e229e70f09239f18efbf68ae064b7247.txt

000000011122_jpg.rf.bfc38911a4f880cee0cffa41f275837a.txt

000000012933_jpg.rf.e98d33ed492106c2d80d711bef83d5ce.txt

000000013524_jpg.rf.62e7b283211f3fd55bcf1e1364cc3812.txt

000000014044_jpg.rf.705d3b529479a1a99ddc4bbc78f156ae.txt

000000015002_jpg.rf.81315262e3826c263eeb98454c9915ea.txt

000000015690_jpg.rf.3adbdfb64b57e251c0339af16d13a075.txt

000000017778_jpg.rf.dea0f3c966f432e6e0b2198ddb78640f.txt

000000018290_jpg.rf.0beefa821825a6188aaa43dc0bccb94c.txt

000000018614_jpg.rf.3bb733baf94efba3e208c14748f687ef.txt

000000018728_jpg.rf.5be59d76b01d5c9ed7919c7919ada9c8.txt

000000020291_jpg.rf.86880a9523e87511712bc976ff7eade7.txt

000000021248_jpg.rf.768f85b6c4bf2f060d08d1d5bf676a48.txt

000000021353_jpg.rf.ac4c8d046e14d5baca46987ce66f3756.txt

000000022199_jpg.rf.336aff9c0ebafa13dfbae4efbebe9763.txt

000000022229_jpg.rf.63c40b56ea6ca8600bd0d301d7143a25.txt

000000022526_jpg.rf.8f54e5a73f964df75a7b06d772fa2a50.txt

000000024023_jpg.rf.3a5cda5ea8eedddcbd1d90999ccf2321.txt

000000024980_jpg.rf.5beded38714f45bc2f04d51417b552d0.txt

000000026310_jpg.rf.e333707ea808eae6bc759e7a45e32bd9.txt

000000027246_jpg.rf.2470a0fe8d3deaa9647327a4601ba80b.txt

000000029482_jpg.rf.f37a043f6006625b4a189a2d2196da8d.txt

000000029715_jpg.rf.1539158c462c1ec6a3494478c803cd64.txt

000000030519_jpg.rf.469e348276c997d2c67f1d0e16286e09.txt

000000031373_jpg.rf.7092d7fbf231700030682dd72b7b1ab0.txt

000000032720_jpg.rf.13aa2ce4375761c6a534e259ef419695.txt

000000032990_jpg.rf.bdc9882221cf6630d933b3b48cd7d511.txt

000000034489_jpg.rf.656d672eff71374a5577fd086f4ba724.txt

000000034702_jpg.rf.d91a68a75b16b3ae997e72b5f1411d68.txt

000000035318_jpg.rf.583328d907b37e5b4c297b0b9d911baa.txt

000000035351_jpg.rf.dada74c3812da496ac2cd96746f7bec1.txt

000000037437_jpg.rf.c5d2023789cc50088a4402e52c1e0422.txt

000000039468_jpg.rf.ae709a23f600bbd9e6b23defce534bdb.txt

000000039993_jpg.rf.832d479e79fd38925415503344b6b9e1.txt

000000040658_jpg.rf.ce3b384940c0dd675926320a52d2c336.txt

000000043270_jpg.rf.9e594cfd7829a43be8d233bf6279c3ce.txt

000000043813_jpg.rf.cc5e5901986576a4746d9b3edb2079bb.txt

000000044946_jpg.rf.af6c86f6999b30246bdced6d684a50ce.txt

000000045148_jpg.rf.e551e6c88648e955043cba5143a3d31a.txt

000000047619_jpg.rf.4ba17653fd252aea9d043ebdbea40f29.txt

000000049135_jpg.rf.cd7b7ef54ac9a9cf445bb06753e53966.txt

000000050727_jpg.rf.924ab9fa11edc6d0a091e9747b51cf7d.txt

000000126137_jpg.rf.8a875933888aa097e28a4beed3773aa6.txt

Outcome:

- A well-organized dataset (COCO in YOLOv11 format) ready for training.

Task 3: Training YOLOv11 Model

Objective:
Train YOLOv11 on the prepared dataset.

Steps:

1. **Model Initialization:**

   - Load the YOLOv11 model using the pre-trained weights file
     (e.g., yolo11n.pt).

In [ ]:

```python
from ultralytics import YOLO

# Load YOLOv11 model with pretrained weights
model = YOLO('yolo11n.pt')  # Load YOLOv11 pretrained model

# training parameters
batch_size = 16
epochs = 50
learning_rate = 0.001
```

2. **Set Training Parameters:**
   - Configure key parameters such as epochs, batch size, and lr0 (initial learning rate).
3. **Monitoring Training:**
   - Watch for improvements in loss, mAP, and other metrics as the training progresses.
   - Save the best model weights for further inference.

In [ ]:

```python
results = model.train(
    data='/content/COCO-Dataset-34/data.yaml',  # Path to data.yaml
    epochs=50,          # Number of epochs
    batch=16,           # Batch size
    lr0=0.001,          # Learning rate
    imgsz=640           # Input size
)
```

Ultralytics 8.3.94 🚀 Python-3.11.11 torch-2.6.0+cu124 CUDA:0 (Tesla T4, 15095MiB)

engine/trainer: task=detect, mode=train, model=yolo11n.pt, data=/content/COCO-Dataset-34/data.yaml, epochs=50, time=None, patience=100, batch=16, imgsz=640, save=True, save_period=-1, cache=False, device=None, workers=8, project=None, name=train3, 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=0.001, 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=randaugment, erasing=0.4, crop_fraction=1.0, cfg=None, tracker=botsort.yaml, save_dir=runs/detect/train3

Overriding model.yaml nc=80 with nc=78

	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	462024	ultralytics.nn.modules.head.Detect	[78, [64, 128, 256]]

YOLO11n summary: 181 layers, 2,621,192 parameters, 2,621,176 gradients, 6.6 GFLOPs

Transferred 448/499 items from pretrained weights

TensorBoard: Start with 'tensorboard --logdir runs/detect/train3', view at http://localhost:6006/

Freezing layer 'model.23.dfl.conv.weight'

AMP: running Automatic Mixed Precision (AMP) checks...

AMP: checks passed ▮

train: Scanning /content/COCO-Dataset-34/train/labels.cache... 135 images, 3 backgrounds, 0 corrupt: 100%|███████████| 135/135 [00:00<?, ?it/s]

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/COCO-Dataset-34/valid/labels.cache... 55 images, 0 backgrounds, 0 corrupt: 100%|████████████| 55/55 [00:00<?, ?it/s]

Plotting labels to runs/detect/train3/labels.jpg...

optimizer: 'optimizer=auto' found, ignoring 'lr0=0.001' and 'momentum=0.937' and determining best 'optimizer', 'lr0' and 'momentum' automatically...

optimizer: AdamW(lr=0.000122, 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 2 dataloader workers

Logging results to **runs/detect/train3**

Starting training for 50 epochs...

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
1/50	2.63G	1.112	4.977	1.175	100	640: 100%|████████████| 9/9 [00:04<00:00, 2.13it/s]

Class	Images	Instances	Box(P	R	mAP50	mAP50-95):
100%	████████████	2/2 [00:00<00:00, 3.81it/s]
all	55	397	0	0	0	0

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
2/50	3.46G	1.096	4.94	1.153	74	640: 100%|████████████| 9/9 [00:03<00:00, 2.44it/s]

Class	Images	Instances	Box(P	R	mAP50	mAP50-95):
100%	████████████	2/2 [00:00<00:00, 4.19it/s]
all	55	397	0	0	0	0

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
3/50	3.48G	1.047	4.898	1.159	56	640: 100%|████████████| 9/9 [00:02<00:00, 3.59it/s]

```
              Class     Images Instances     Box(P      R    mAP50 mAP50-95):
100%|███████████████| 2/2 [00:00<00:00, 3.71it/s]
               all     55     397      0      0      0      0

   Epoch   GPU_mem   box_loss   cls_loss   dfl_loss   Instances      Size
     4/50    3.48G    1.072    4.929    1.145      33     640: 100%|██████████████| 9/9
[00:02<00:00, 3.65it/s]
              Class     Images Instances     Box(P      R    mAP50 mAP50-95):
100%|███████████████| 2/2 [00:00<00:00, 3.57it/s]
               all     55     397      0      0      0      0

   Epoch   GPU_mem   box_loss   cls_loss   dfl_loss   Instances      Size
     5/50    3.49G    1.104    4.903    1.134      79     640: 100%|██████████████| 9/9
[00:04<00:00, 2.13it/s]
              Class     Images Instances     Box(P      R    mAP50 mAP50-95):
100%|███████████████| 2/2 [00:00<00:00, 3.45it/s]
               all     55     397      0      0      0      0

   Epoch   GPU_mem   box_loss   cls_loss   dfl_loss   Instances      Size
     6/50    3.5G    1.11    4.877    1.15      56     640: 100%|██████████████| 9/9
[00:02<00:00, 3.68it/s]
              Class     Images Instances     Box(P      R    mAP50 mAP50-95):
100%|███████████████| 2/2 [00:00<00:00, 3.94it/s]
               all     55     397      0      0      0      0

   Epoch   GPU_mem   box_loss   cls_loss   dfl_loss   Instances      Size
     7/50    3.5G    1.064    4.817    1.134      74     640: 100%|██████████████| 9/9
[00:02<00:00, 3.59it/s]
              Class     Images Instances     Box(P      R    mAP50 mAP50-95):
100%|███████████████| 2/2 [00:00<00:00, 3.57it/s]
               all     55     397      0      0      0      0

   Epoch   GPU_mem   box_loss   cls_loss   dfl_loss   Instances      Size
     8/50    3.5G    1.054    4.754    1.118      56     640: 100%|██████████████| 9/9
[00:02<00:00, 3.11it/s]
```

```
          Class     Images Instances     Box(P        R    mAP50 mAP50-95):
100%|█████████████████| 2/2 [00:00<00:00, 2.17it/s]
           all     55     397     0      0      0      0

  Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances     Size
   9/50    3.5G    1.121    4.736    1.126      95     640: 100%|██████████████| 9/9
[00:02<00:00, 3.69it/s]
          Class     Images Instances     Box(P        R    mAP50 mAP50-95):
100%|█████████████████| 2/2 [00:00<00:00, 3.86it/s]
           all     55     397   0.0175  0.000335  0.00894  0.00864

  Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances     Size
  10/50    3.5G    1.023    4.651    1.121      43     640: 100%|██████████████| 9/9
[00:02<00:00, 3.82it/s]
          Class     Images Instances     Box(P        R    mAP50 mAP50-95):
100%|█████████████████| 2/2 [00:00<00:00, 3.07it/s]
           all     55     397   0.0156  0.000894   0.0083  0.00747

  Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances     Size
  11/50    3.5G    1.074    4.664    1.14       87     640: 100%|██████████████| 9/9
[00:02<00:00, 3.91it/s]
          Class     Images Instances     Box(P        R    mAP50 mAP50-95):
100%|█████████████████| 2/2 [00:00<00:00, 2.66it/s]
           all     55     397   0.0373   0.0353   0.0366   0.0354

  Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances     Size
  12/50    3.5G    1.041    4.579    1.126      43     640: 100%|██████████████| 9/9
[00:03<00:00, 2.84it/s]
          Class     Images Instances     Box(P        R    mAP50 mAP50-95):
100%|█████████████████| 2/2 [00:00<00:00, 3.27it/s]
           all     55     397   0.0333    0.073   0.0486   0.0466

  Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances     Size
  13/50    3.5G    1.038    4.534    1.098      69     640: 100%|██████████████| 9/9
[00:02<00:00, 3.69it/s]
```

```
        Class     Images Instances     Box(P      R    mAP50 mAP50-95):
100%|███████████████| 2/2 [00:00<00:00, 3.24it/s]
          all     55     397    0.0256    0.086    0.052    0.0496

   Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances    Size
   14/50   3.5G    1.157     4.508     1.149      107      640: 100%|███████████| 9/9
[00:02<00:00, 3.74it/s]
        Class     Images Instances     Box(P      R    mAP50 mAP50-95):
100%|███████████████| 2/2 [00:00<00:00, 3.12it/s]
          all     55     397    0.0277    0.109    0.0551    0.0519

   Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances    Size
   15/50   3.5G    1.087     4.44      1.127      94       640: 100%|███████████| 9/9
[00:03<00:00, 2.94it/s]
        Class     Images Instances     Box(P      R    mAP50 mAP50-95):
100%|███████████████| 2/2 [00:01<00:00, 1.67it/s]
          all     55     397    0.0194    0.11     0.0529    0.0499

   Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances    Size
   16/50   3.5G    1.104     4.412     1.123      82       640: 100%|███████████| 9/9
[00:02<00:00, 3.76it/s]
        Class     Images Instances     Box(P      R    mAP50 mAP50-95):
100%|███████████████| 2/2 [00:00<00:00, 2.77it/s]
          all     55     397    0.0224    0.128    0.0587    0.0529

   Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances    Size
   17/50   3.5G    1.119     4.377     1.158      64       640: 100%|███████████| 9/9
[00:02<00:00, 3.87it/s]
        Class     Images Instances     Box(P      R    mAP50 mAP50-95):
100%|███████████████| 2/2 [00:00<00:00, 2.79it/s]
          all     55     397    0.0219    0.136    0.055    0.0484

   Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances    Size
   18/50   3.52G   1.106     4.336     1.109      88       640: 100%|███████████| 9/9
[00:02<00:00, 3.66it/s]
```

```
              Class     Images Instances      Box(P        R    mAP50 mAP50-95):
100%|█████████████| 2/2 [00:00<00:00, 2.31it/s]
                all      55      397    0.022    0.153   0.0596   0.0507

     Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size
     19/50    3.53G     1.083     4.27     1.131       43      640: 100%|█████████████| 9/9
[00:02<00:00, 3.03it/s]
              Class     Images Instances      Box(P        R    mAP50 mAP50-95):
100%|█████████████| 2/2 [00:00<00:00, 2.80it/s]
                all      55      397   0.0212    0.165   0.0636   0.0535

     Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size
     20/50    3.55G     1.072    4.222     1.105       93      640: 100%|█████████████| 9/9
[00:02<00:00, 3.73it/s]
              Class     Images Instances      Box(P        R    mAP50 mAP50-95):
100%|█████████████| 2/2 [00:00<00:00, 2.61it/s]
                all      55      397   0.0195    0.187   0.0652   0.0552

     Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size
     21/50    3.55G     1.069    4.188     1.138       63      640: 100%|█████████████| 9/9
[00:02<00:00, 3.61it/s]
              Class     Images Instances      Box(P        R    mAP50 mAP50-95):
100%|█████████████| 2/2 [00:00<00:00, 3.47it/s]
                all      55      397   0.0199    0.203   0.0593    0.048

     Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size
     22/50    3.55G     1.041    4.161     1.114       76      640: 100%|█████████████| 9/9
[00:03<00:00, 2.77it/s]
              Class     Images Instances      Box(P        R    mAP50 mAP50-95):
100%|█████████████| 2/2 [00:00<00:00, 2.54it/s]
                all      55      397   0.0202     0.22   0.0693   0.0573

     Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size
     23/50    3.55G     1.082     4.15     1.15       103      640: 100%|█████████████| 9/9
[00:02<00:00, 3.62it/s]
```

```
            Class     Images Instances     Box(P        R    mAP50 mAP50-95):
100%|█████████████|  2/2 [00:00<00:00, 3.04it/s]
             all      55      397    0.0201    0.233    0.0723    0.0602

   Epoch   GPU_mem   box_loss  cls_loss  dfl_loss  Instances      Size
   24/50    3.55G     1.067     4.144     1.117      80       640: 100%|█████████████| 9/9
[00:02<00:00, 3.79it/s]
            Class     Images Instances     Box(P        R    mAP50 mAP50-95):
100%|█████████████|  2/2 [00:00<00:00, 2.93it/s]
             all      55      397    0.02     0.249     0.07     0.0584

   Epoch   GPU_mem   box_loss  cls_loss  dfl_loss  Instances      Size
   25/50    3.55G     1.077     3.985     1.119      69       640: 100%|█████████████| 9/9
[00:02<00:00, 3.43it/s]
            Class     Images Instances     Box(P        R    mAP50 mAP50-95):
100%|█████████████|  2/2 [00:01<00:00, 1.81it/s]
             all      55      397    0.0197    0.264    0.0707    0.0589

   Epoch   GPU_mem   box_loss  cls_loss  dfl_loss  Instances      Size
   26/50    3.58G     1.074     3.983     1.125      40       640: 100%|█████████████| 9/9
[00:02<00:00, 3.42it/s]
            Class     Images Instances     Box(P        R    mAP50 mAP50-95):
100%|█████████████|  2/2 [00:00<00:00, 3.54it/s]
             all      55      397    0.0205    0.276    0.0723    0.0605

   Epoch   GPU_mem   box_loss  cls_loss  dfl_loss  Instances      Size
   27/50    3.58G     1.049     3.954     1.104      48       640: 100%|█████████████| 9/9
[00:02<00:00, 3.74it/s]
            Class     Images Instances     Box(P        R    mAP50 mAP50-95):
100%|█████████████|  2/2 [00:00<00:00, 2.92it/s]
             all      55      397    0.02     0.261    0.0724    0.0608

   Epoch   GPU_mem   box_loss  cls_loss  dfl_loss  Instances      Size
   28/50    3.58G     1.087     3.86      1.145      52       640: 100%|█████████████| 9/9
[00:02<00:00, 3.69it/s]
```

```
           Class     Images Instances     Box(P       R    mAP50 mAP50-95):
100%|████████████| 2/2 [00:00<00:00, 2.46it/s]
             all      55      397    0.525   0.0934   0.0733   0.0605

   Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances     Size
   29/50    3.58G    1.082    3.802    1.131       39      640: 100%|████████████| 9/9
[00:03<00:00, 2.98it/s]
           Class     Images Instances     Box(P       R    mAP50 mAP50-95):
100%|████████████| 2/2 [00:00<00:00, 2.31it/s]
             all      55      397    0.55    0.093   0.0746   0.0601

   Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances     Size
   30/50    3.58G    1.035    3.831    1.133       44      640: 100%|████████████| 9/9
[00:02<00:00, 3.76it/s]
           Class     Images Instances     Box(P       R    mAP50 mAP50-95):
100%|████████████| 2/2 [00:00<00:00, 3.61it/s]
             all      55      397    0.529   0.0938   0.0761   0.0609

   Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances     Size
   31/50    3.58G    1.067    3.893    1.122       69      640: 100%|████████████| 9/9
[00:02<00:00, 3.92it/s]
           Class     Images Instances     Box(P       R    mAP50 mAP50-95):
100%|████████████| 2/2 [00:00<00:00, 2.77it/s]
             all      55      397    0.691   0.074   0.0803   0.0646

   Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances     Size
   32/50    3.58G    1.081    3.801    1.13        80      640: 100%|████████████| 9/9
[00:03<00:00, 2.86it/s]
           Class     Images Instances     Box(P       R    mAP50 mAP50-95):
100%|████████████| 2/2 [00:01<00:00, 1.79it/s]
             all      55      397    0.693   0.0911   0.0844   0.0657

   Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances     Size
   33/50    3.58G    1.008    3.759    1.09        70      640: 100%|████████████| 9/9
[00:02<00:00, 3.72it/s]
```

```
                 Class      Images Instances      Box(P      R    mAP50 mAP50-95):
100%|█████████████████| 2/2 [00:00<00:00, 3.12it/s]
                   all      55      397    0.712    0.0841    0.0845    0.0665

   Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size
   34/50    3.58G    1.106    3.739    1.12      66      640: 100%|█████████████████| 9/9
[00:02<00:00, 3.96it/s]
                 Class      Images Instances      Box(P      R    mAP50 mAP50-95):
100%|█████████████████| 2/2 [00:00<00:00, 2.51it/s]
                   all      55      397    0.712    0.0802    0.085    0.0674

   Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size
   35/50    3.58G    1.09     3.738    1.119     97      640: 100%|█████████████████| 9/9
[00:02<00:00, 3.83it/s]
                 Class      Images Instances      Box(P      R    mAP50 mAP50-95):
100%|█████████████████| 2/2 [00:01<00:00, 1.81it/s]
                   all      55      397    0.71     0.0802    0.0863    0.0686

   Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size
   36/50    3.58G    1.055    3.714    1.115     52      640: 100%|█████████████████| 9/9
[00:02<00:00, 3.32it/s]
                 Class      Images Instances      Box(P      R    mAP50 mAP50-95):
100%|█████████████████| 2/2 [00:00<00:00, 3.06it/s]
                   all      55      397    0.697    0.0849    0.0886    0.0719

   Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size
   37/50    3.58G    1.036    3.573    1.095     58      640: 100%|█████████████████| 9/9
[00:02<00:00, 3.67it/s]
                 Class      Images Instances      Box(P      R    mAP50 mAP50-95):
100%|█████████████████| 2/2 [00:00<00:00, 3.38it/s]
                   all      55      397    0.715    0.0852    0.0894    0.0724

   Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size
   38/50    3.58G    1.067    3.665    1.149     82      640: 100%|█████████████████| 9/9
[00:02<00:00, 3.97it/s]
```

```
              Class     Images Instances      Box(P          R      mAP50  mAP50-95):
100%|          | 2/2 [00:00<00:00, 2.44it/s]
                all         55        397      0.715      0.087     0.0916     0.0717

      Epoch   GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      39/50     3.58G      1.002       3.61      1.102         38        640: 100%|          | 9/9 [00:03<00:00, 2.74it/s]
              Class     Images Instances      Box(P          R      mAP50  mAP50-95):
100%|          | 2/2 [00:00<00:00, 2.26it/s]
                all         55        397       0.72     0.0883        0.1     0.0804

      Epoch   GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      40/50     3.58G      1.031      3.618      1.127         53        640: 100%|          | 9/9 [00:02<00:00, 3.77it/s]
              Class     Images Instances      Box(P          R      mAP50  mAP50-95):
100%|          | 2/2 [00:00<00:00, 2.48it/s]
                all         55        397      0.715     0.0807     0.0999     0.0794
```

Closing dataloader mosaic

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))

```
      Epoch   GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      41/50     3.58G      1.055      3.485      1.125         47        640: 100%|          | 9/9 [00:03<00:00, 2.38it/s]
              Class     Images Instances      Box(P          R      mAP50  mAP50-95):
100%|          | 2/2 [00:00<00:00, 3.27it/s]
                all         55        397      0.667     0.0908        0.1     0.0793

      Epoch   GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      42/50     3.58G      1.051      3.433      1.112         52        640: 100%|          | 9/9 [00:02<00:00, 3.06it/s]
              Class     Images Instances      Box(P          R      mAP50  mAP50-95):
100%|          | 2/2 [00:00<00:00, 3.14it/s]
```

```
                 all      55      397    0.647   0.0912    0.102    0.081

     Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size

     43/50    3.58G    1.032    3.408    1.106      49      640: 100%|████████████| 9/9
[00:02<00:00, 4.26it/s]

          Class     Images  Instances      Box(P       R    mAP50 mAP50-95):
100%|████████| 2/2 [00:00<00:00, 3.30it/s]

                 all      55      397    0.646    0.105    0.104   0.0823

     Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size

     44/50    3.58G    1.044    3.475    1.133      23      640: 100%|████████████| 9/9
[00:02<00:00, 4.09it/s]

          Class     Images  Instances      Box(P       R    mAP50 mAP50-95):
100%|████████| 2/2 [00:00<00:00, 3.91it/s]

                 all      55      397    0.649    0.112    0.106    0.084

     Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size

     45/50    3.58G     1.06    3.357    1.119      47      640: 100%|████████████| 9/9
[00:02<00:00, 3.88it/s]

          Class     Images  Instances      Box(P       R    mAP50 mAP50-95):
100%|████████| 2/2 [00:01<00:00, 1.86it/s]

                 all      55      397    0.648    0.113    0.105   0.0833

     Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size

     46/50    3.58G    1.072    3.447    1.126      49      640: 100%|████████████| 9/9
[00:02<00:00, 4.15it/s]

          Class     Images  Instances      Box(P       R    mAP50 mAP50-95):
100%|████████| 2/2 [00:00<00:00, 3.37it/s]

                 all      55      397    0.631    0.116    0.105   0.0837

     Epoch   GPU_mem  box_loss  cls_loss  dfl_loss  Instances      Size

     47/50    3.58G     1.06    3.341    1.102      42      640: 100%|████████████| 9/9
[00:02<00:00, 4.11it/s]

          Class     Images  Instances      Box(P       R    mAP50 mAP50-95):
100%|████████| 2/2 [00:00<00:00, 3.24it/s]

                 all      55      397    0.629    0.115    0.105   0.0838
```

```
   Epoch   GPU_mem   box_loss   cls_loss   dfl_loss   Instances      Size
   48/50    3.58G     1.052      3.392      1.097       67        640: 100%|████████████| 9/9
[00:02<00:00, 4.00it/s]

        Class    Images  Instances      Box(P       R    mAP50  mAP50-95):
100%|████████| 2/2 [00:00<00:00, 3.91it/s]
         all       55      397      0.629    0.116    0.105    0.0836

   Epoch   GPU_mem   box_loss   cls_loss   dfl_loss   Instances      Size
   49/50    3.58G     1.011      3.34       1.116       31        640: 100%|████████████| 9/9
[00:02<00:00, 3.19it/s]

        Class    Images  Instances      Box(P       R    mAP50  mAP50-95):
100%|████████| 2/2 [00:00<00:00, 2.25it/s]
         all       55      397      0.611    0.116    0.105    0.084

   Epoch   GPU_mem   box_loss   cls_loss   dfl_loss   Instances      Size
   50/50    3.58G     1.051      3.366      1.114       58        640: 100%|████████████| 9/9
[00:02<00:00, 4.17it/s]

        Class    Images  Instances      Box(P       R    mAP50  mAP50-95):
100%|████████| 2/2 [00:00<00:00, 3.65it/s]
         all       55      397      0.593    0.119    0.106    0.0838
```

50 epochs completed in 0.055 hours.

Optimizer stripped from runs/detect/train3/weights/last.pt, 5.5MB

Optimizer stripped from runs/detect/train3/weights/best.pt, 5.5MB

Validating runs/detect/train3/weights/best.pt...

Ultralytics 8.3.94 🚀 Python-3.11.11 torch-2.6.0+cu124 CUDA:0 (Tesla T4, 15095MiB)

YOLO11n summary (fused): 100 layers, 2,613,378 parameters, 0 gradients, 6.5 GFLOPs

```
        Class    Images  Instances      Box(P       R    mAP50  mAP50-95):
100%|████████| 2/2 [00:00<00:00, 3.03it/s]
         all       55      397      0.649    0.111    0.105    0.084
      backpack      1        1        0        0        0        0
       banana       1        2        1        0        0        0
```

baseball bat	1	1	1	0	0	0
baseball glove	1	4	1	0	0	0
bench	3	4	0	0	0	0
bicycle	3	3	0	0	0	0
bird	2	4	1	0	0	0
boat	1	1	1	0	0.0585	0.0468
bottle	4	7	0.113	0.429	0.0654	0.0393
bus	3	3	0.196	0.262	0.178	0.178
cake	1	8	1	0	0	0
car	5	13	0.15	0.231	0.186	0.123
cat	2	2	0.442	1	0.663	0.341
cell phone	4	4	1	0	0	0
chair	6	16	0.253	0.0625	0.0619	0.0366
clock	2	2	0.18	0.5	0.126	0.1
couch	1	1	1	0	0	0
cup	4	10	0.708	0.3	0.372	0.243
dining table	6	8	1	0	0.114	0.0852
dog	2	4	0	0	0.0248	0.0154
donut	2	12	1	0	0	0
elephant	2	13	0.309	0.154	0.226	0.188
fire hydrant	3	3	0.888	0.333	0.361	0.323
fork	1	1	1	0	0	0
frisbee	1	1	1	0	0	0
handbag	5	11	1	0	0	0
horse	1	1	0.329	1	0.995	0.995
keyboard	2	7	1	0	0.00807	0.00726
kite	1	3	1	0	0	0
knife	2	3	1	0	0	0

Class	Images	Instances	P	R	mAP50	mAP50-95
laptop	4	10	1	0	0.224	0.212
microwave	1	4	1	0	0	0
motorcycle	3	4	0	0	0.113	0.104
mouse	3	4	1	0	0	0
oven	1	1	1	0	0	0
person	35	157	0.5	0.516	0.524	0.334
pizza	1	1	0	0	0.199	0.139
potted plant	1	1	1	0	0	0
refrigerator	2	3	0	0	0	0
remote	2	2	1	0	0.0229	0.016
sink	1	1	0.0951	0.476	0.199	0.159
skateboard	2	8	0	0	0.01	0.00903
snowboard	2	2	1	0	0.0286	0.00572
sports ball	2	2	1	0	0	0
stop sign	2	2	1	0	0.0362	0.0245
suitcase	1	1	0	0	0.014	0.00657
surfboard	2	3	1	0	0	0
tennis racket	3	3	1	0	0	0
tie	2	2	1	0	0	0
toilet	1	1	0	0	0	0
traffic light	1	1	1	0	0	0
train	3	6	10			0.0786
truck	5	8				0.0863
tv	4	8				0.0499

umbrella	5	5	0
vase	1	1	1
wine glass	1	:	0

Speed: 0.2ms preprocess, 2.3ms inference, 0.0ms loss, 3.1ms postprocess per image

Results saved to **runs/detect/train3**

Outcome:

- A successfully trained YOLOv11 model with improved detection accuracy and better performance metrics.

Task 4: Model Inference and Evaluation

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

Steps:

1. **Load Trained Model:**

   - Load the best-performing model weights saved during training.

In [ ]:

```
from ultralytics import YOLO
```

```
# Load the trained model weights
model = YOLO('/content/runs/detect/train/weights/best.pt')
```

2. **Run Inference:**

   - Choose a test image from the dataset and run the model's prediction.

In [ ]:

```
import cv2
from matplotlib import pyplot as plt
import os
```

```
# Path to test images
```

```python
test_image_path = '/content/COCO-Dataset-34/test/images/'

# List test images
test_images = os.listdir(test_image_path)

# Run inference on the first test image
img_path = os.path.join(test_image_path, test_images[3])

# Perform inference
results = model.predict(img_path, save=True)

# Display result
img = cv2.imread(img_path)
plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
plt.axis('off')
plt.show()
```

image 1/1 /content/COCO-Dataset-34/test/images/000000025668_jpg.rf.f67afc05b355ac25bef196980e6d7f99.jpg: 640x640 2 persons, 19.0ms

Speed: 2.6ms preprocess, 19.0ms inference, 5.7ms postprocess per image at shape (1, 3, 640, 640)

Results saved to **runs/detect/predict3**

3. **Evaluate Model Performance:**

- Compute and display key metrics such as mAP@50, mAP@50-95, Precision, Recall, and F1-Score.

In [ ]:

 # Evaluate model performance on the validation set

metrics = model.val()

Ultralytics 8.3.94 Python-3.11.11 torch-2.6.0+cu124 CUDA:0 (Tesla T4, 15095MiB)

val: Scanning /content/COCO-Dataset-34/valid/labels.cache... 55 images, 0 backgrounds, 0 corrupt: 100%|███████████| 55/55 [00:00<?, ?it/s]

```
        Class   Images Instances    Box(P       R    mAP50  mAP50-95):
100%|███████████| 4/4 [00:02<00:00,  1.66it/s]
         all      55     397     0.649    0.111    0.105    0.0839
    backpack       1       1         0        0        0        0
      banana       1       2         1        0        0        0
```

baseball bat	1	1	1	0	0	0
baseball glove	1	4	1	0	0	0
bench	3	4	0	0	0	0
bicycle	3	3	0	0	0	0
bird	2	4	1	0	0	0
boat	1	1	1	0	0.0622	0.0498
bottle	4	7	0.113	0.429	0.0654	0.0393
bus	3	3	0.184	0.245	0.179	0.179
cake	1	8	1	0	0	0
car	5	13	0.15	0.231	0.18	0.122
cat	2	2	0.441	1	0.663	0.341
cell phone	4	4	1	0	0	0
chair	6	16	0.253	0.0625	0.0614	0.0363
clock	2	2	0.18	0.5	0.126	0.1
couch	1	1	1	0	0	0
cup	4	10	0.707	0.3	0.373	0.244
dining table	6	8	1	0	0.105	0.0772
dog	2	4	0	0	0.0248	0.0155
donut	2	12	1	0	0	0
elephant	2	13	0.31	0.154	0.226	0.188
fire hydrant	3	3	0.889	0.333	0.362	0.324
fork	1	1	1	0	0	0
frisbee	1	1	1	0	0	0
handbag	5	11	1	0	0	0
horse	1	1	0.33	1	0.995	0.995
keyboard	2	7	1	0	0.00821	0.00657
kite	1	3	1	0	0	0
knife	2	3	1	0	0	0

laptop	4	10	1	0	0.224	0.212
microwave	1	4	1	0	0	0
motorcycle	3	4	0	0	0.113	0.104
mouse	3	4	1	0	0	0
oven	1	1	1	0	0	0
person	35	157	0.498	0.51	0.516	0.334
pizza	1	1	0	0	0.199	0.139
potted plant	1	1	1	0	0	0
refrigerator	2	3	0	0	0	0
remote	2	2	1	0	0.0229	0.016
sink	1	1	0.0923	0.462	0.199	0.159
skateboard	2	8	0	0	0.01	0.00903
snowboard	2	2	1	0	0.0286	0.00572
sports ball	2	2	1	0	0	0
stop sign	2	2	1	0	0.0355	0.0241
suitcase	1	1	0	0	0.014	0.00657
surfboard	2	3	1	0	0	0
tennis racket	3	3	1	0	0	0
tie	2	2	1	0	0	0
toilet	1	1	0	0	0	0
traffic light	1	1	1	0	0	0
train	3	6	1	0		
truck	5	8	0.094	0.0823		
tv	4	8	1	0	0.0501	
umbrella	5	5	1	(		
vase	1	1	0.75	1		

| wine glass | 1 | 3 | 0 |

Speed: 7.3ms preprocess, 12.0ms inference, 0.0ms loss, 2.9ms postprocess per image

Results saved to **runs/detect/val8**

In [ ]:

 # Display key metrics

print(f"mAP@50: {metrics.box.map50:.4f}")   *# Mean Average Precision at IoU 0.5*

print(f"mAP@50-95: {metrics.box.map:.4f}")   *# Mean Average Precision at IoU 0.5 to 0.S5*

print(f"Precision: {metrics.box.mp:.4f}")   *# Mean Precision*

print(f"Recall: {metrics.box.mr:.4f}")   *# Mean Recall*

mAP@50: 0.1051

mAP@50-95: 0.0839

Precision: 0.6490

Recall: 0.1107

In [ ]:

precision = metrics.box.mp

recall = metrics.box.mr

if precision + recall > 0:
    f1_score = 2 * (precision * recall) / (precision + recall)
    print(f"F1 Score: {f1_score:.4f}")
else:
    print("F1 Score: Undefined (precision + recall = 0)")

F1 Score: 0.1891

4. **Visualize Inference Results:**

- Use glob to locate the saved prediction image, then display it using matplotlib or PIL.

In [ ]:

```python
import cv2

import matplotlib.pyplot as plt

from PIL import Image

import glob


# Run inference
results = model.predict(img_path, save=True, show=False)


# Find the saved prediction file
result_img_path = glob.glob('runs/detect/predict*/*.jpg')[3]


# Load and display the result using PIL and matplotlib
img = Image.open(result_img_path)

plt.figure(figsize=(8, 8))

plt.imshow(img)

plt.axis('off')

plt.show()
```
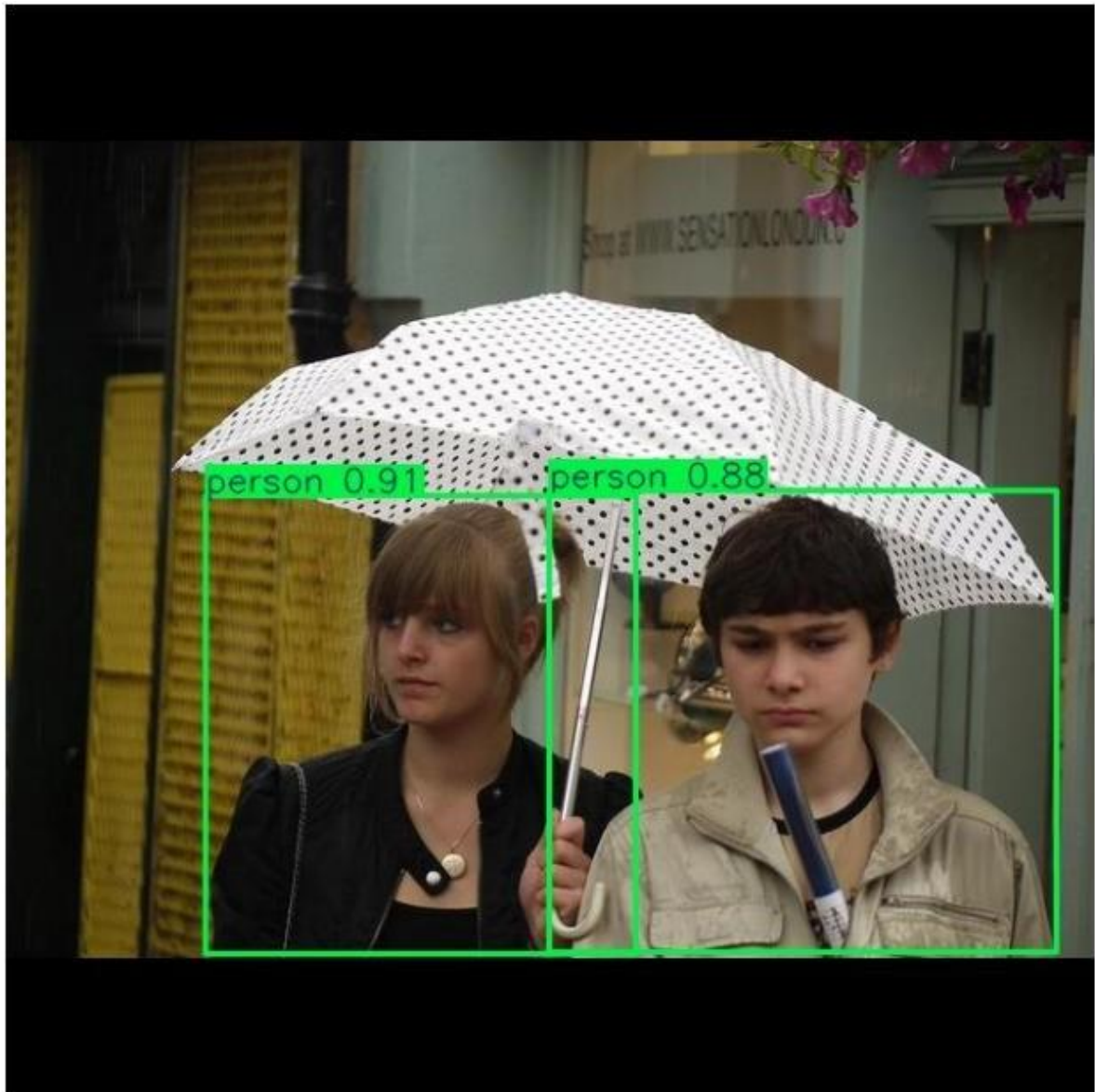
image 1/1 /content/COCO-Dataset-34/test/images/000000025668_jpg.rf.f67afc05b355ac25bef196980e6d7f99.jpg: 640x640 2 persons, 10.4ms

Speed: 2.3ms preprocess, 10.4ms inference, 1.3ms postprocess per image at shape (1, 3, 640, 640)

Results saved to **runs/detect/predict3**

Discussion and Conclusion

After running inference and visualizing the detection results on the COCO test images, the following performance metrics were observed:

- **mAP@50:** 0.1051

- **mAP@50-G5:** 0.0839

- **Precision:** 0.6490

- **Recall:** 0.1107

- **F1 Score:** 0.1891

Discussion:

1. **Precision vs. Recall:**

   - The model achieves a relatively high precision (~0.65), indicating that when it predicts an object, it is often correct.

   - However, the recall is notably low (~0.11), meaning that the model is missing a large number of objects present in the images. This imbalance suggests that while the model is cautious in its predictions, it is not sensitive enough to detect all relevant objects.

2. **Training Considerations:**

   - The current training setup, although a good starting point, appears to be insufficient for achieving robust detection performance on the COCO dataset.

   - Increasing training epochs, applying more extensive data augmentation, and further hyperparameter tuning (such as adjusting the learning rate schedule and modifying anchor boxes) are potential strategies to improve recall without compromising precision.

3. **Visual Inspection:**

   - The visualizations show that detected objects have correctly drawn bounding boxes and appropriate confidence scores. However, many objects are still missed, which is consistent with the low recall metric.

   - The visualization reinforces the notion that while the model is reliable when it makes a detection, its overall sensitivity is low.

Conclusion:

- **Strengths:** The model demonstrates reliable detections when it does identify an object, as evidenced by the high precision. This is promising for applications where false positives are particularly problematic.

- **Weaknesses:** The low recall and overall mAP highlight the need for improvement in detecting all relevant objects in a scene.

Overall, this experiment provides valuable insights into the strengths and limitations of using YOLOv11 for object detection on the COCO dataset. With further refinements, the model can be optimized to achieve a more balanced performance, which is crucial for real-world applications.

Declaration

I, Rohan Magdum, confirm that the work submitted in this assignment is my own and has been completed following academic integrity guidelines. The code is uploaded on my GitHub repository account, and the repository link is provided below:

GitHub Repository Link: https://github.com/rohandsaritamagdum/DeepLearning.git

Signature: Rohan Magdum