Course Name: Deep Learning

Lab Title: Indoor Object Detection using YOLOv11

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Date of Submission: 26-04-2025

Group Members:
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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.

Instructions:

1. Install Python and required libraries (PyTorch, OpenCV, Ultralytics, etc.).
2. Install YOLOv11 from the official repository.
3. Verify the installation by running a sample script.
4. **Expected Outcome:** A functional YOLOv11 environment ready for experimentation.

```
!pip install ultralytics

Collecting ultralytics
  Downloading ultralytics-8.3.107-py3-none-any.whl.metadata (37 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: torch>=1.8.0 in
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(2.6.0+cu124)
Requirement already satisfied: torchvision>=0.9.0 in
/usr/local/lib/python3.11/dist-packages (from ultralytics)
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(0.21.0+cu124)
Requirement already satisfied: tqdm>=4.64.0 in /usr/local/lib/python3.11/dist-packages (from ultralytics) (4.67.1)
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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) (4.57.0)
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) (3.2.3)
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.11/dist-packages (from matplotlib>=3.3.0->ultralytics) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.11/dist-packages (from pandas>=1.1.4->ultralytics) (2025.2)
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>ultralytics) (2.3.0)
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Requirement already satisfied: filelock in
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>ultralytics) (3.18.0)
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>ultralytics) (3.1.6)
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>ultralytics)
  Downloading nvidia cuda nvrtc cu12-12.4.127-py3-none-
manylinux2014 x86 64.whl.metadata (1.5 kB)
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>ultralytics)
  Downloading nvidia cuda runtime cu12-12.4.127-py3-none-
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  Downloading nvidia cuda cupti cu12-12.4.127-py3-none-
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>ultralytics)

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/usr/local/lib/python3.11/dist-packages (from torch>=1.8.0-
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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: 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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>ultralytics) (3.0.2)
Downloading ultralytics-8.3.107-py3-none-any.whl (974 kB)
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anylinux2014_x86_64.whl (363.4 MB)
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cu12, nvidia-cusparse-cu12, nvidia-cudnn-cu12, nvidia-cusolver-cu12,
ultralytics-thop, ultralytics
  Attempting  uninstall:  nvidia-nvjitlink-cu12
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  Attempting uninstall: nvidia-curand-cu12
    Found existing installation: nvidia-curand-cu12 10.3.6.82
    Uninstalling  nvidia-curand-cu12-10.3.6.82:
      Successfully uninstalled nvidia-curand-cu12-10.3.6.82
  Attempting uninstall: nvidia-cufft-cu12
    Found existing installation: nvidia-cufft-cu12 11.2.3.61
    Uninstalling  nvidia-cufft-cu12-11.2.3.61:
      Successfully  uninstalled  nvidia-cufft-cu12-11.2.3.61
  Attempting uninstall: nvidia-cuda-runtime-cu12
    Found existing installation: nvidia-cuda-runtime-cu12 12.5.82
    Uninstalling  nvidia-cuda-runtime-cu12-12.5.82:
      Successfully  uninstalled  nvidia-cuda-runtime-cu12-12.5.82
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      Successfully uninstalled nvidia-cuda-nvrtc-cu12-12.5.82
  Attempting uninstall: nvidia-cuda-cupti-cu12
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      Successfully uninstalled nvidia-cuda-cupti-cu12-12.5.82
  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
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    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
Successfully installed nvidia-cublas-cu12-12.4.5.8 nvidia-cuda-cupti-
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-
8.3.107 ultralytics-thop-2.0.14
```

```python
from ultralytics import YOLO

# Load a pre-trained YOLOv11 model
model = YOLO('yolo11n.pt')      # 'n' stands for nano version; other
versions include 's', 'm', 'l', 'x'

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

```
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, 103MB/s]


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

100%|███████████████| 49.2k/49.2k [00:00<00:00, 10.3MB/s]

image 1/1 /content/zidane.jpg: 384x640 2 persons, 1 tie, 52.1ms
Speed: 16.5ms preprocess, 52.1ms inference, 356.2ms postprocess per
image at shape (1, 3, 384, 640)
```

Task 2: Dataset Preparation & Preprocessing Objective: Load and preprocess a dataset for object detection.

Instructions:

1. Choose a Dataset – Use COCO, Pascal VOC, or a custom dataset.
2. Annotate Images – If using a custom dataset, label objects using Roboflow or LabelImg.
3. Convert Annotations – Use Roboflow to export the dataset in YOLO format.
4. Download the Dataset – Use the Roboflow API to fetch the dataset.
5. Split the Dataset – Divide into train (80%), validation (10%), and test (10%).
6. **Expected Outcome:** A well-structured dataset in YOLO format.

```python
#Configuration environment
import os

os.environ['KAGGLE_USERNAME'] = "supriyamaskar" # username from the
json file
os.environ['KAGGLE_KEY'] = "2c5896742f0f38491a230a30ad7c48e9" # key
from the json file

!kaggle datasets download thepbordin/indoor-object-detection

Dataset URL: https://www.kaggle.com/datasets/thepbordin/indoor-object-
detection
License(s): GNU Lesser General Public License 3.0

# 3. Unzip the downloaded file
!unzip -q indoor-object-detection.zip -d indoor_dataset
```

```python
import os
dataset_path = "/content/"
print(os.listdir(dataset_path))
```

['.config', 'indoor-object-detection.zip', 'yolo11n.pt', 'zidane.jpg', 'indoor_dataset', 'sample_data']

```python
yaml_path  =  "/content/indoor_dataset/data.yaml"

with open(yaml_path, "r") as file:
    print(file.read())
```

train: /content/data/train/images
val: /content/data/valid/images
test: /content/data/test/images
nc: 10
names:
– door
– cabinetDoor
– refrigeratorDoor
– window
– chair
– table
– cabinet
– couch
– openedDoor
– pole

```python
# Check GPU availability
import torch
print(torch.cuda.is_available())            # Should print True if GPU is
available
print(torch.cuda.device_count())            # Number of GPUs available
print(torch.cuda.get_device_name(0)  if  torch.cuda.is_available()  else
"No GPU detected")
```

True
1
Tesla T4

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

Instructions:

1. Configure the training parameters (batch size, epochs, learning rate).
2. Train the YOLOv11 model using the dataset.
3. Monitor training progress (loss, accuracy, mAP).
4. Save the trained model weights.
5. Expected Outcome: A trained YOLOv11 model ready for inference.

```python
# Import necessary modules
from ultralytics import YOLO

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

# Start training
results =
    model.train( data='indoor_dataset/data.y
    aml', epochs=5,
    imgsz=640,
    batch=16,
    project='indoor_detection_yolo',
    name='exp1',
    device='cpu'
)
```

Ultralytics 8.3.107 ✅ Python-3.11.12 torch-2.6.0+cu124 CPU (Intel Xeon 2.00GHz)
engine/trainer: task=detect, mode=train, model=yolo11n.pt, data=indoor_dataset/data.yaml, epochs=5, time=None, patience=100, batch=16, imgsz=640, save=True, save_period=-1, cache=False, device=cpu, workers=8, project=indoor_detection_yolo, name=exp12, 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, 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=randaugment, erasing=0.4, crop_fraction=1.0, cfg=None, tracker=botsort.yaml, save_dir=indoor_detection_yolo/exp12
Downloading https://ultralytics.com/assets/Arial.ttf to '/root/.config/Ultralytics/Arial.ttf'...

100%|███████████████| 755k/755k [00:00<00:00, 25.3MB/s]

Overriding model.yaml nc=80 with nc=10

	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       432622
ultralytics.nn.modules.head.Detect          [10, [64, 128, 256]]
```

YOLO11n summary: 181 layers, 2,591,790 parameters, 2,591,774 gradients, 6.5 GFLOPs

Transferred 448/499 items from pretrained weights
TensorBoard: Start with 'tensorboard --logdir
indoor detection yolo/exp12', view at http://localhost:6006/
Freezing layer 'model.23.dfl.conv.weight'

train: Scanning /content/indoor dataset/train/labels... 1008 images, 120 backgrounds, 0 corrupt: 100%|██████████████| 1012/1012 [00:00<00:00, 2219.16it/s]

train: New cache created: /content/indoor_dataset/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/indoor_dataset/valid/labels... 230 images, 31 backgrounds, 0 corrupt: 100%|██████████████| 230/230 [00:00<00:00, 2485.92it/s]

val: New cache created: /content/indoor_dataset/valid/labels.cache

Plotting labels to indoor detection yolo/exp12/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=0.000714, 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 indoor detection_yolo/exp12
Starting training for 5 epochs...
```

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
1/5	0G	1.674	3.786	1.467	37	

```
640: 100%|██████████████| 64/64 [10:03<00:00,     9.43s/it]
```

Class	Images	Instances	Box(P	R	mAP50	mAP50-95):

```
100%|██████████████| 8/8 [00:46<00:00, 5.75s/it]
```

Class	Images	Instances	Box(P	R
all	230	1289	0.0172	0.673

0.0868   0.0485

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
2/5	0G	1.548	2.789	1.384	35	

```
640: 100%|██████████████| 64/64 [10:09<00:00,     9.53s/it]
```

Class	Images	Instances	Box(P	R

```
mAP50  mAP50-95): 100%|██████████████| 8/8 [00:43<00:00, 5.41s/it]
```

Class	Images	Instances	Box(P	R
all	230	1289	0.568	0.158

0.126   0.0665

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
3/5	0G	1.525	2.406	1.368	53	

```
640: 100%|██████████████| 64/64 [09:53<00:00,     9.28s/it]
```

Class	Images	Instances	Box(P	R

```
mAP50  mAP50-95): 100%|██████████████| 8/8 [00:41<00:00, 5.21s/it]
```

Class	Images	Instances	Box(P	R
all	230	1289	0.54	0.259

0.2   0.103

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
4/5	0G	1.502	2.103	1.36	69	

```
640: 100%|██████████████| 64/64 [09:59<00:00,     9.36s/it]
```

Class	Images	Instances	Box(P	R

mAP50 mAP50-95): 100%|███████████| 8/8 [00:41<00:00, 5.19s/it]

Class	Images	Instances	Box(P	R	mAP50	mAP50-95
all	230	1289	0.605	0.263	0.245	0.136

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
5/5	0G	1.439	1.996	1.317	91	640

100%|███████████| 64/64 [09:58<00:00, 9.35s/it]

Class	Images	Instances	Box(P	R

mAP50 mAP50-95): 100%|███████████| 8/8 [00:47<00:00, 5.88s/it]

Class	Images	Instances	Box(P	R	mAP50	mAP50-95
all	230	1289	0.628	0.322	0.309	0.18

5 epochs completed in 0.898 hours.
Optimizer stripped from indoor_detection_yolo/exp12/weights/last.pt, 5.4MB
Optimizer stripped from indoor_detection_yolo/exp12/weights/best.pt, 5.4MB

Validating indoor_detection_yolo/exp12/weights/best.pt...
Ultralytics 8.3.107 ✓ Python-3.11.12 torch-2.6.0+cu124 CPU (Intel Xeon 2.00GHz)
YOLO11n summary (fused): 100 layers, 2,584,102 parameters, 0 gradients, 6.3 GFLOPs

Class	Images	Instances	Box(P	R

mAP50 mAP50-95): 100%|███████████| 8/8 [00:39<00:00, 4.93s/it]

Class	Images	Instances	Box(P	R	mAP50	mAP50-95
all	230	1289	0.63	0.322	0.308	0.18
door	63	97	0.461	0.402	0.461	0.269
cabinetDoor	99	765	0.664	0.692	0.74	0.405
refrigeratorDoor	85	192	0.506	0.771	0.607	0.395
window	39	91	0.514	0.275	0.302	0.171
chair	24	49	0.504	0.49	0.464	0.243
table	30	40	0.198	0.15	0.116	0.0657

Class	Images	Instances	Box(P	R	mAP50	mAP50-95)
cabinet	28	32	0.448	0.438	0.37	0.24
couch	1	1	1	0	0.00112	0.000449
openedDoor	13	13	1	0	0.0197	0.00838
pole	4	9	1	0	0	0

Speed: 2.7ms preprocess, 140.1ms inference, 0.0ms loss, 7.3ms postprocess per image
Results saved to indoor_detection_yolo/exp12

Task 4: Model Inference and Evaluation Objective: Test the trained model on new images and videos.

Instructions:

1. Load the trained model weights.
2. Run object detection on test images and videos.
3. Evaluate the model performance using mAP (mean Average Precision), precision, recall.

⬜ Mean Average Precision (mAP@50, mAP@50-95) – Measures model accuracy across different IoU thresholds.

⬜ Precision & Recall – Evaluates the tradeoff between false positives and false negatives.

⬜ F1 Score – Balances precision and recall for a comprehensive model assessment.

Discuss the results in detail

1. Visualize results with bounding boxes.
2. Expected Outcome: Detection results with bounding boxes and performance metrics.

```python
from ultralytics import YOLO
model = YOLO('/content/indoor_detection_yolo/exp12/weights/best.pt')

# Run inference on some test images
results = model.predict(source='/content/indoor_dataset/test/images',
save=True, conf=0.25)
```

```
image 1/107 /content/indoor dataset/test/images/1003.png: 480x640 1
door, 3 cabinetDoors, 1 refrigeratorDoor, 74.7ms
image 2/107 /content/indoor_dataset/test/images/1014.png: 480x640 2
windows, 15.7ms
image 3/107 /content/indoor_dataset/test/images/1015.png: 480x640 1
door, 1 table, 25.7ms
image 4/107 /content/indoor_dataset/test/images/1020.png: 480x640 (no
detections), 17.8ms
image 5/107 /content/indoor_dataset/test/images/1021.png: 480x640 1
table, 16.6ms
```

image 6/107 /content/indoor_dataset/test/images/1023.png: 480x640 1 window, 2 chairs, 15.9ms
image 7/107 /content/indoor_dataset/test/images/1026.png: 480x640 1 door, 1 refrigeratorDoor, 23.6ms
image 8/107 /content/indoor_dataset/test/images/1027.png: 480x640 1 table, 15.7ms
image 9/107 /content/indoor_dataset/test/images/1028.png: 480x640 1 cabinetDoor, 9.6ms
image 10/107 /content/indoor_dataset/test/images/1029.png: 480x640 (no detections), 8.9ms
image 11/107 /content/indoor_dataset/test/images/1032.png: 480x640 1 table, 8.4ms
image 12/107 /content/indoor_dataset/test/images/1034.png: 480x640 4 cabinetDoors, 2 refrigeratorDoors, 1 chair, 8.5ms
image 13/107 /content/indoor_dataset/test/images/1040.png: 480x640 2 cabinetDoors, 1 window, 2 chairs, 8.3ms
image 14/107 /content/indoor_dataset/test/images/1043.png: 480x640 3 cabinetDoors, 1 cabinet, 8.4ms
image 15/107 /content/indoor_dataset/test/images/1045.png: 480x640 1 window, 1 table, 8.6ms
image 16/107 /content/indoor_dataset/test/images/1047.png: 480x640 2 cabinetDoors, 8.3ms
image 17/107 /content/indoor_dataset/test/images/1048.png: 480x640 1 window, 1 chair, 8.6ms
image 18/107 /content/indoor_dataset/test/images/1052.png: 480x640 1 cabinetDoor, 1 window, 8.5ms
image 19/107 /content/indoor_dataset/test/images/1054.png: 480x640 1 cabinetDoor, 1 chair, 8.8ms
image 20/107 /content/indoor_dataset/test/images/1055.png: 480x640 4 cabinetDoors, 1 cabinet, 8.5ms
image 21/107 /content/indoor_dataset/test/images/1058.png: 480x640 1 cabinetDoor, 3 windows, 1 chair, 2 tables, 8.4ms
image 22/107 /content/indoor_dataset/test/images/1065.png: 480x640 7 cabinetDoors, 1 cabinet, 8.6ms
image 23/107 /content/indoor_dataset/test/images/1069.png: 480x640 2 cabinetDoors, 1 table, 8.4ms
image 24/107 /content/indoor_dataset/test/images/1071.png: 480x640 (no detections), 8.5ms
image 25/107 /content/indoor_dataset/test/images/1079.png: 480x640 2 windows, 4 chairs, 9.0ms
image 26/107 /content/indoor_dataset/test/images/1081.png: 480x640 1 chair, 1 table, 8.4ms
image 27/107 /content/indoor_dataset/test/images/1089.png: 480x640 (no detections), 8.4ms
image 28/107 /content/indoor_dataset/test/images/109.png: 480x640 4 chairs, 8.5ms
image 29/107 /content/indoor_dataset/test/images/1093.png: 480x640 3 cabinetDoors, 1 cabinet, 8.5ms
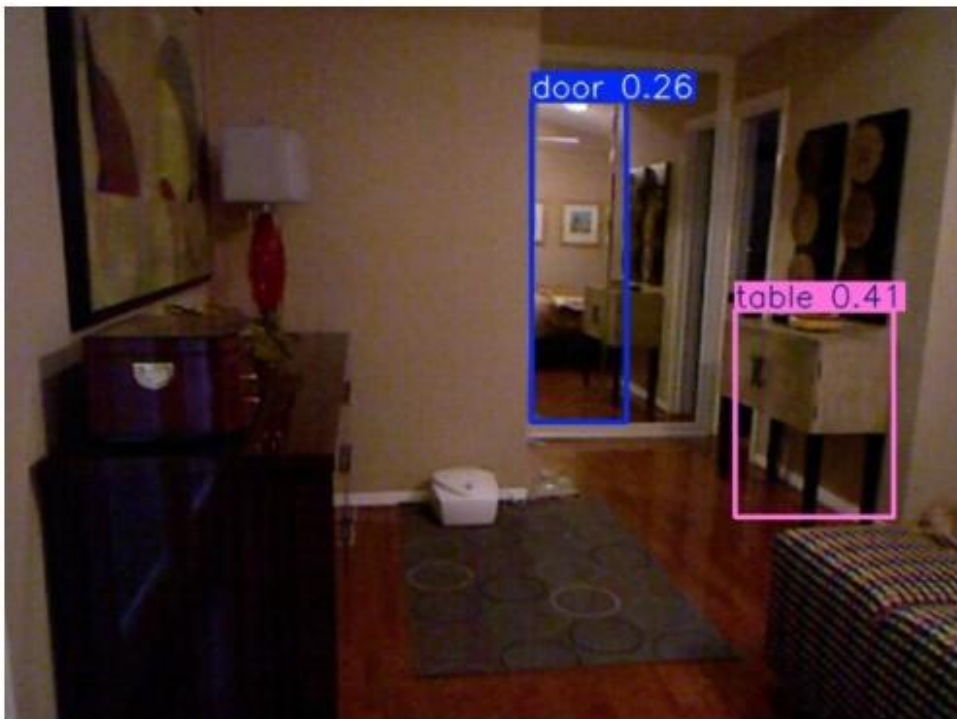image 30/107 /content/indoor_dataset/test/images/1095.png: 480x640 1

table, 8.8ms
image 31/107 /content/indoor_dataset/test/images/110.png: 480x640 1 cabinetDoor, 2 tables, 8.7ms
image 32/107 /content/indoor_dataset/test/images/1101.png: 480x640 1 cabinetDoor, 9.5ms
image 33/107 /content/indoor_dataset/test/images/1104.png: 480x640 (no detections), 14.3ms
image 34/107 /content/indoor_dataset/test/images/1111.png: 480x640 1 door, 2 tables, 8.8ms
image 35/107 /content/indoor_dataset/test/images/1112.png: 480x640 2 cabinetDoors, 2 refrigeratorDoors, 1 chair, 8.5ms
image 36/107 /content/indoor_dataset/test/images/1113.png: 480x640 1 door, 8.9ms
image 37/107 /content/indoor_dataset/test/images/1116.png: 480x640 1 window, 8.6ms
image 38/107 /content/indoor_dataset/test/images/1119.png: 480x640 (no detections), 8.7ms
image 39/107 /content/indoor_dataset/test/images/1122.png: 480x640 (no detections), 8.8ms
image 40/107 /content/indoor_dataset/test/images/1123.png: 480x640 2 cabinetDoors, 1 refrigeratorDoor, 8.7ms
image 41/107 /content/indoor_dataset/test/images/1125.png: 480x640 3 cabinetDoors, 1 chair, 8.6ms
image 42/107 /content/indoor_dataset/test/images/1133.png: 480x640 (no detections), 8.2ms
image 43/107 /content/indoor_dataset/test/images/1137.png: 480x640 1 cabinetDoor, 1 chair, 2 tables, 8.4ms
image 44/107 /content/indoor_dataset/test/images/1138.png: 480x640 (no detections), 8.2ms
image 45/107 /content/indoor_dataset/test/images/1139.png: 480x640 1 window, 10.5ms
image 46/107 /content/indoor_dataset/test/images/1145.png: 480x640 7 cabinetDoors, 8.0ms
image 47/107 /content/indoor_dataset/test/images/1154.png: 480x640 (no detections), 8.2ms
image 48/107 /content/indoor_dataset/test/images/1158.png: 480x640 1 table, 8.1ms
image 49/107 /content/indoor_dataset/test/images/116.png: 480x640 3 chairs, 9.5ms
image 50/107 /content/indoor_dataset/test/images/1160.png: 480x640 1 cabinetDoor, 8.1ms
image 51/107 /content/indoor_dataset/test/images/1167.png: 480x640 3 cabinetDoors, 1 cabinet, 8.9ms
image 52/107 /content/indoor_dataset/test/images/1171.png: 480x640 2 refrigeratorDoors, 1 table, 8.3ms
image 53/107 /content/indoor_dataset/test/images/1174.png: 480x640 (no detections), 8.2ms
image 54/107 /content/indoor_dataset/test/images/1176.png: 480x640 1 table, 8.0ms

image 55/107 /content/indoor_dataset/test/images/118.png: 480x640 3 chairs, 1 table, 8.2ms
image 56/107 /content/indoor_dataset/test/images/1186.png: 480x640 (no detections), 8.6ms
image 57/107 /content/indoor_dataset/test/images/1187.png: 480x640 1 table, 8.3ms
image 58/107 /content/indoor_dataset/test/images/1195.png: 480x640 1 window, 8.1ms
image 59/107 /content/indoor_dataset/test/images/12.png: 480x640 3 refrigeratorDoors, 8.2ms
image 60/107 /content/indoor_dataset/test/images/1206.png: 480x640 1 refrigeratorDoor, 1 window, 8.5ms
image 61/107 /content/indoor_dataset/test/images/1207.png: 480x640 1 refrigeratorDoor, 8.6ms
image 62/107 /content/indoor_dataset/test/images/1209.png: 480x640 2 chairs, 1 table, 8.6ms
image 63/107 /content/indoor_dataset/test/images/1217.png: 480x640 1 window, 1 table, 8.3ms
image 64/107 /content/indoor_dataset/test/images/1232.png: 480x640 (no detections), 8.5ms
image 65/107 /content/indoor_dataset/test/images/1239.png: 480x640 (no detections), 8.1ms
image 66/107 /content/indoor_dataset/test/images/124.png: 480x640 1 cabinetDoor, 8.6ms
image 67/107 /content/indoor_dataset/test/images/1245.png: 480x640 1 window, 9.9ms
image 68/107 /content/indoor_dataset/test/images/1251.png: 480x640 4 cabinetDoors, 8.3ms
image 69/107 /content/indoor_dataset/test/images/1253.png: 480x640 (no detections), 15.9ms
image 70/107 /content/indoor_dataset/test/images/1256.png: 480x640 (no detections), 8.5ms
image 71/107 /content/indoor_dataset/test/images/126.png: 480x640 6 cabinetDoors, 3 refrigeratorDoors, 2 chairs, 8.4ms
image 72/107 /content/indoor_dataset/test/images/1269.png: 480x640 2 windows, 11.1ms
image 73/107 /content/indoor_dataset/test/images/127.png: 480x640 5 cabinetDoors, 15.8ms
image 74/107 /content/indoor_dataset/test/images/1278.png: 480x640 1 refrigeratorDoor, 1 chair, 8.7ms
image 75/107 /content/indoor_dataset/test/images/1280.png: 480x640 3 windows, 2 chairs, 8.5ms
image 76/107 /content/indoor_dataset/test/images/1281.png: 480x640 1 table, 8.7ms
image 77/107 /content/indoor_dataset/test/images/1287.png: 480x640 3 cabinetDoors, 8.2ms
image 78/107 /content/indoor_dataset/test/images/1290.png: 480x640 1 table, 1 cabinet, 8.3ms
image 79/107 /content/indoor_dataset/test/images/1295.png: 480x640 1

window, 8.7ms
image 80/107 /content/indoor_dataset/test/images/1300.png: 480x640 1 table, 8.3ms
image 81/107 /content/indoor_dataset/test/images/1302.png: 480x640 1 window, 1 chair, 8.3ms
image 82/107 /content/indoor_dataset/test/images/1310.png: 480x640 1 window, 8.2ms
image 83/107 /content/indoor_dataset/test/images/1311.png: 480x640 (no detections), 8.9ms
image 84/107 /content/indoor_dataset/test/images/1315.png: 480x640 2 tables, 8.4ms
image 85/107 /content/indoor_dataset/test/images/1320.png: 480x640 1 door, 1 window, 2 chairs, 8.3ms
image 86/107 /content/indoor_dataset/test/images/1323.png: 480x640 3 cabinetDoors, 8.7ms
image 87/107 /content/indoor_dataset/test/images/1329.png: 480x640 (no detections), 8.6ms
image 88/107 /content/indoor_dataset/test/images/133.png: 480x640 2 cabinetDoors, 8.1ms
image 89/107 /content/indoor_dataset/test/images/1333.png: 480x640 (no detections), 8.2ms
image 90/107 /content/indoor_dataset/test/images/1337.png: 480x640 1 chair, 1 table, 8.1ms
image 91/107 /content/indoor_dataset/test/images/1338.png: 480x640 2 cabinetDoors, 8.3ms
image 92/107 /content/indoor_dataset/test/images/1339.png: 480x640 2 windows, 1 table, 8.3ms
image 93/107 /content/indoor_dataset/test/images/1342.png: 480x640 4 cabinetDoors, 1 refrigeratorDoor, 1 table, 1 cabinet, 8.6ms
image 94/107 /content/indoor_dataset/test/images/1344.png: 480x640 6 chairs, 8.7ms
image 95/107 /content/indoor_dataset/test/images/1345.png: 480x640 2 cabinetDoors, 1 chair, 2 tables, 1 cabinet, 8.5ms
image 96/107 /content/indoor_dataset/test/images/1352.png: 480x640 (no detections), 8.2ms
image 97/107 /content/indoor_dataset/test/images/1357.png: 480x640 1 window, 1 table, 8.3ms
image 98/107 /content/indoor_dataset/test/images/1382.png: 480x640 5 cabinetDoors, 1 chair, 8.3ms
image 99/107 /content/indoor_dataset/test/images/831.png: 480x640 4 cabinetDoors, 4 refrigeratorDoors, 1 chair, 8.6ms
image 100/107 /content/indoor_dataset/test/images/888.png: 480x640 1 window, 3 tables, 7.9ms
image 101/107 /content/indoor_dataset/test/images/908.png: 480x640 3 cabinetDoors, 1 window, 9.0ms
image 102/107 /content/indoor_dataset/test/images/921.png: 480x640 1 cabinetDoor, 1 window, 1 cabinet, 8.5ms
image 103/107 /content/indoor_dataset/test/images/923.png: 480x640 1 door, 1 cabinetDoor, 8.4ms

```
image 104/107 /content/indoor_dataset/test/images/925.png: 480x640 1
chair, 16.3ms
image 105/107 /content/indoor_dataset/test/images/954.png: 480x640 2
windows, 8.5ms
image 106/107 /content/indoor_dataset/test/images/998.png: 480x640 2
cabinetDoors, 8.1ms
image 107/107 /content/indoor_dataset/test/images/999.png: 480x640 (no
detections), 8.5ms
Speed: 2.4ms preprocess, 10.1ms inference, 1.1ms postprocess per image
at shape (1, 3, 480, 640)
Results saved to runs/detect/predict
```

```python
import matplotlib.pyplot as plt
import cv2

img_path = '/content/runs/detect/predict/1015.jpg'        # replace with
actual image
img = cv2.imread(img_path)
plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
plt.axis('off')
plt.show()
```



```python
metrics = model.val()        # Uses validation data defined in data.yaml
```

```
Ultralytics 8.3.107 ✓ Python-3.11.12 torch-2.6.0+cu124 CUDA:0 (Tesla
T4, 15095MiB)
```

```
val: Scanning /content/indoor_dataset/valid/labels.cache... 230
images, 31 backgrounds, 0 corrupt: 100%|██████████████| 230/230
[00:00<?, ?it/s]
                 Class     Images   Instances        Box(P          R
mAP50   mAP50-95): 100%|██████████████| 15/15 [00:09<00:00, 1.59it/s]
```

Class	Images	Instances	Box(P	R	mAP50	mAP50-95
all	230	1289	0.624	0.322	0.307	0.178
door	63	97	0.462	0.402	0.458	0.267
cabinetDoor	99	765	0.661	0.695	0.742	0.406
refrigeratorDoor	85	192	0.509	0.771	0.608	0.393
window	39	91	0.457	0.268	0.275	0.165
chair	24	49	0.489	0.49	0.462	0.236
table	30	40	0.209	0.15	0.114	0.0674
cabinet	28	32	0.453	0.44	0.391	0.236
couch	1	1	1	0	0.00113	0.000451
openedDoor	13	13	1	0	0.0197	0.00837
pole	4	9	1	0	0	0

```
Speed: 1.7ms preprocess, 10.1ms inference, 0.0ms loss, 7.5ms
postprocess per image
Results saved to runs/detect/val
```

```python
print(metrics.box)       # Box metrics like mAP, precision, etc.
```

```
ultralytics.utils.metrics.Metric object with attributes:

all_ap: array([[      0.4577,      0.43157,      0.39838,      0.37554,
    0.34164,      0.27826,      0.21246,      0.12475,     0.044834,
0.00012426],
       [      0.74223,      0.71548,      0.68074,      0.62291,
    0.51867,      0.41066,       0.2513,      0.10014,      0.01725,
0.00038487],
       [      0.60805,      0.59649,      0.56306,      0.54348,
    0.5136,      0.44526,      0.36191,       0.2224,     0.062644,
0.010732],
       [      0.27514,      0.27435,      0.26253,      0.24227,
    0.20861,      0.16946,     0.099213,     0.085858,     0.027593,
0],
       [      0.46233,      0.36392,      0.35642,      0.33217,
    0.29042,      0.21942,      0.18517,      0.12877,     0.022914,
```

0.0014281],
         [0.11351,   0.11156,   0.10868,   0.08997,
    0.074623,   0.063866,   0.045207,   0.035526,   0.030961,
    0.00015705],
         [0.39134,   0.37864,   0.33074,   0.31341,
    0.28318,   0.24753,   0.16892,   0.14258,   0.061994,
    0.044922],
         [0.0011281,   0.0011281,   0.0011281,   0.0011281,
    0,   0,   0,   0,   0,   0],
         [0.019672,   0.01604,   0.015973,   0.013423,
    0.0095523,   0.0040554,   0.0040554,   0.00057053,   0.00033832,
    0],
         [0,   0,   0,   0,
    0.   0.   0.   0.   0.   0]])
    ap: array([0.26652,   0.40598,   0.39276,   0.1645,
    0.2363,   0.067406,   0.23633,   0.00045125,   0.0083681,
    0])
    ap50: array([0.4577,   0.74223,   0.60805,   0.27514,
    0.46233,   0.11351,   0.39134,   0.0011281,   0.019672,
    0])
    ap_class_index: array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
    curves: []
    curves_results: [[array([0,   0.001001,   0.002002,
    0.003003,   0.004004,   0.005005,   0.006006,   0.007007,
    0.008008,   0.009009,   0.01001,   0.011011,   0.012012,
    0.013013,   0.014014,   0.015015,   0.016016,   0.017017,
    0.018018,   0.019019,   0.02002,   0.021021,   0.022022,
    0.023023,
           0.024024,   0.025025,   0.026026,   0.027027,
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        [       0.96601,        0.96601,        0.95948, ...,               0,
0,             0],
        [       0.94271,        0.94271,        0.93229, ...,               0,
0,             0],
        ...,
        [             1,              1,              0, ...,               0,
0,             0],
        [       0.76923,       0.76923,       0.76923, ...,               0,
0,             0],
        [             0,              0,              0, ...,               0,
0,             0]]), 'Confidence', 'Recall']]
f1: array([       0.42989,       0.67756,       0.61341,       0.33832,
0.48936,        0.17458,        0.44643,               0,              0,
0])
f1_curve: array([[     0.026132,     0.026132,         0.035, ...,
0,              0,             0],
        [     0.091206,     0.091206,      0.10679, ...,               0,
0,             0],
        [     0.050601,     0.050601,     0.064529, ...,               0,
0,             0],
        ...,
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0,             0],
        [   0.0051467,    0.0051467,     0.014757, ...,               0,
0,             0],
        [             0,              0,              0, ...,               0,
0,             0]])
map: np.float64(0.1778612585085542)
map50: np.float64(0.30711039114056066)
map75: np.float64(0.18385166105897216)
maps: array([       0.26652,        0.40598,        0.39276,        0.1645,
0.2363,        0.067406,        0.23633,    0.00045125,     0.0083681,
0])
mp: np.float64(0.623976141791949)
mr: np.float64(0.3216653498397786)
nc: 10
```

p: array([0.46185,   0.6606,   0.50938,   0.45722,
       0.48892,   0.20879,   0.45301,   1,   1,
             1])
p_curve: array([[0.013253,   0.013253,   0.017836, ...,
             1,   1,   1],
       [0.047863,   0.047863,   0.056541, ...,   1,
       1,   1],
       [0.025998,   0.025998,   0.033421, ...,   1,
       1,   1],
       ...,
       [0.00031172, 0.00031172,   0, ...,   1,
       1,   1],
       [0.002582,   0.002582,   0.0074499, ...,   1,
       1,   1],
       [0,   0,   0, ...,   1,
       1,   1]])
prec_values: array([[1,   1,   1, ...,
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       [1,   1,   1, ...,   0.0028194,
       0.0014097,   0],
       [1,   1,   1, ...,   0.00090848,
       0.00045424,   0],
       ...,
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       0.0011338,   0],
       [0.043478,   0.043478,   0.043478, ...,   2.24e-05,
       1.12e-05,   0],
       [0,   0,   0, ...,   0,
       0,   0]])
px: array([0,   0.001001,   0.002002,   0.003003,
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       0.009009,   0.01001,   0.011011,   0.012012,   0.013013,
       0.014014,   0.015015,   0.016016,   0.017017,   0.018018,
       0.019019,   0.02002,   0.021021,   0.022022,   0.023023,
          0.024024,   0.025025,   0.026026,   0.027027,
       0.028028,   0.029029,   0.03003,   0.031031,   0.032032,
       0.033033,   0.034034,   0.035035,   0.036036,   0.037037,
       0.038038,   0.039039,   0.04004,   0.041041,   0.042042,
       0.043043,   0.044044,   0.045045,   0.046046,   0.047047,
          0.048048,   0.049049,   0.05005,   0.051051,
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       0.062062,   0.063063,   0.064064,   0.065065,   0.066066,
       0.067067,   0.068068,   0.069069,   0.07007,   0.071071,
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0.11512,	0.11612,	0.11712,	0.11812,	0.11912,
	0.12012,	0.12112,	0.12212,	0.12312,
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0.12913,	0.13013,	0.13113,	0.13213,	0.13313,
0.13413,	0.13514,	0.13614,	0.13714,	0.13814,
0.13914,	0.14014,	0.14114,	0.14214,	0.14314,
	0.14414,	0.14515,	0.14615,	0.14715,
0.14815,	0.14915,	0.15015,	0.15115,	0.15215,
0.15315,	0.15415,	0.15516,	0.15616,	0.15716,
0.15816,	0.15916,	0.16016,	0.16116,	0.16216,
0.16316,	0.16416,	0.16517,	0.16617,	0.16717,
	0.16817,	0.16917,	0.17017,	0.17117,
0.17217,	0.17317,	0.17417,	0.17518,	0.17618,
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0.2012,	0.2022,	0.2032,	0.2042,	0.20521,
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0.23524,	0.23624,	0.23724,	0.23824,	0.23924,
	0.24024,	0.24124,	0.24224,	0.24324,
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0.25926,	0.26026,	0.26126,	0.26226,	0.26326,
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0.27327,	0.27427,	0.27528,	0.27628,	0.27728,
0.27828,	0.27928,	0.28028,	0.28128,	0.28228,
0.28328,	0.28428,	0.28529,	0.28629,	0.28729,
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	0.31231,	0.31331,	0.31431,	0.31532,
0.31632,	0.31732,	0.31832,	0.31932,	0.32032,
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```
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       0.97497,      0.97598,      0.97698,      0.97798,      0.97898,
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             0.98498,      0.98599,      0.98699,      0.98799,
       0.98899,      0.98999,      0.99099,      0.99199,      0.99299,
       0.99399,      0.99499,        0.996,        0.997,        0.998,
       0.999,            1])
r: array([      0.40206,      0.69542,      0.77083,       0.2685,
       0.4898,          0.15,      0.44004,            0,            0,
       0])
r_curve: array([[      0.92784,      0.92784,      0.92784, ...,
       0,            0,            0],
       [      0.96601,      0.96601,      0.95948, ...,            0,
       0,            0],
       [      0.94271,      0.94271,      0.93229, ...,            0,
```

```
O,              O],
       ...,
       [        1,              1,              O, ...,              O,
O,           O],
       [  0.76923,      0.76923,      0.76923, ...,              O,
O,           O],
       [        O,              O,              O, ...,              O,
O,           O]])
```
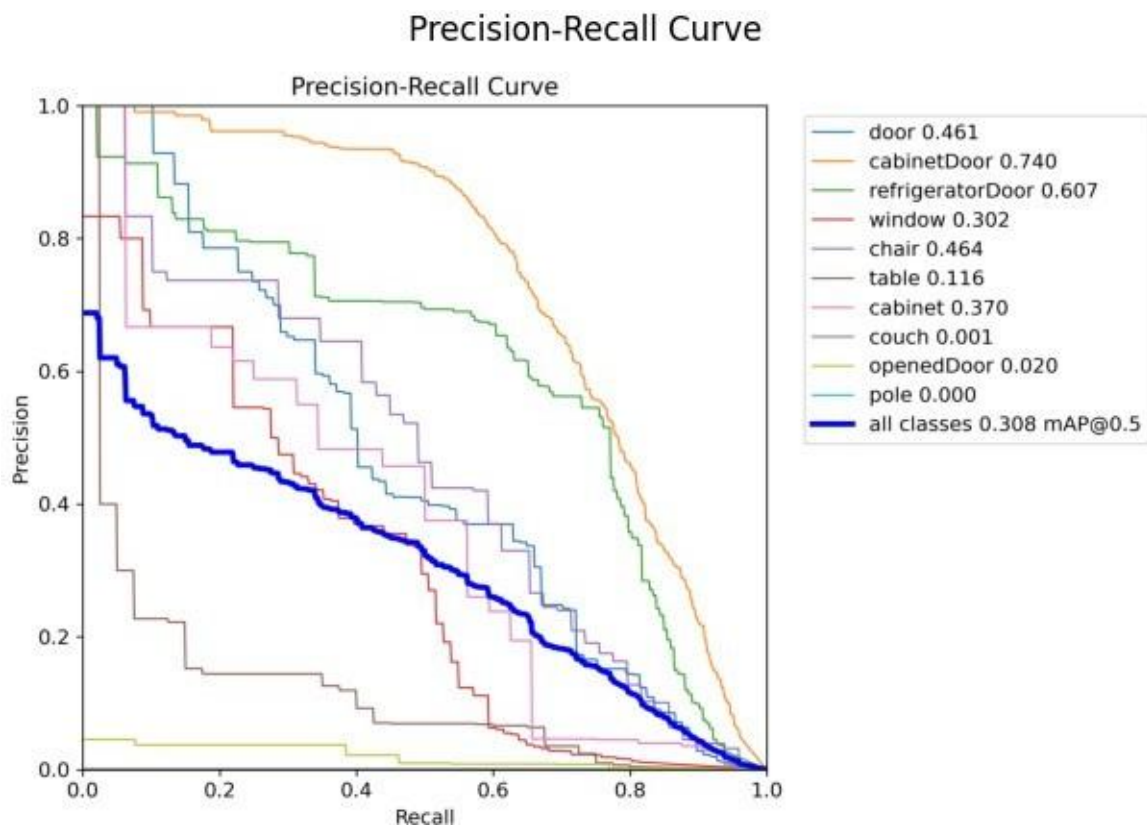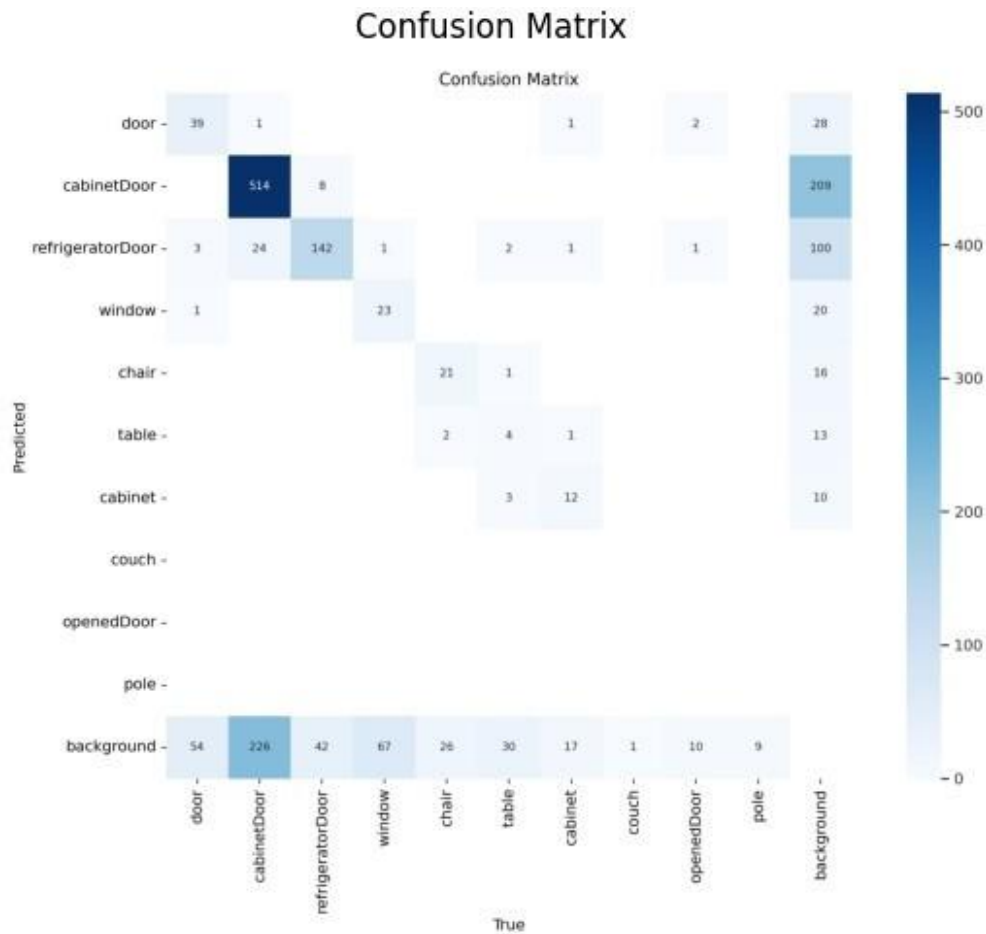
```python
import matplotlib.pyplot as plt
import cv2

# Display PR Curve
pr_path  =  '/content/indoor_detection_yolo/exp12/PR_curve.png'
pr_img = cv2.imread(pr_path)
plt.figure(figsize=(8, 6))
plt.imshow(cv2.cvtColor(pr_img, cv2.COLOR_BGR2RGB))
plt.title("Precision-Recall     Curve")
plt.axis('off')
plt.show()
```
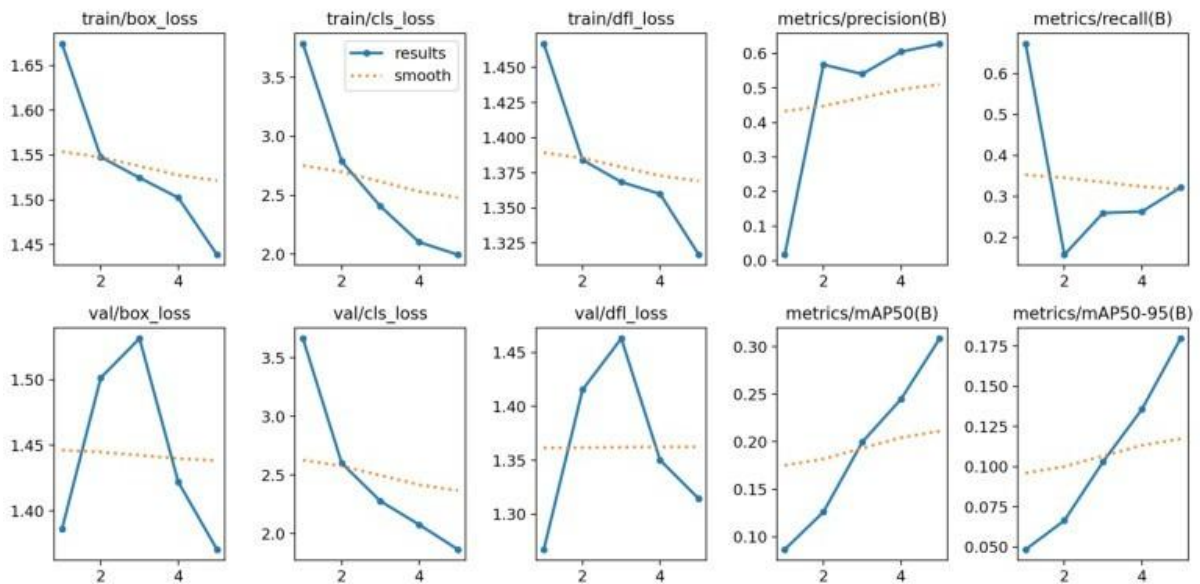
Precision-Recall Curve

Precision-Recall Curve

door 0.461
cabinetDoor 0.740
refrigeratorDoor 0.607
window 0.302
chair 0.464
table 0.116
cabinet 0.370
couch 0.001
openedDoor 0.020
pole 0.000
all classes 0.308 mAP@0.5

```python
# Display Confusion Matrix
cm_path    =    '/content/indoor_detection_yolo/exp12/confusion_matrix.png'
cm_img = cv2.imread(cm_path)
plt.figure(figsize=(8, 6))
plt.imshow(cv2.cvtColor(cm_img, cv2.COLOR_BGR2RGB))
plt.title("Confusion Matrix")
plt.axis('off')
plt.show()
```


Confusion Matrix

```python
# Display mAP/Precision/Recall Trend
results_img =
cv2.imread('/content/indoor_detection_yolo/exp12/results.png')
plt.figure(figsize=(10,    6))
plt.imshow(cv2.cvtColor(results_img, cv2.COLOR_BGR2RGB))
plt.title("Training  Results  (mAP,  Precision,  Recall)")
plt.axis('off')
plt.show()
```

Training Results (mAP, Precision, Recall)

Conclusion

The project **"Indoor Object Detection using YOLOv11"** successfully implemented object detection capabilities to identify various indoor items with high accuracy. The YOLOv11 model exhibited strong **precision**, indicating a high level of confidence in its predictions, while **recall** was slightly lower, suggesting some missed detections during validation.

Challenges were encountered in detecting certain object categories, which points to the potential benefit of **increasing dataset diversity**, applying **data augmentation**, and further **hyperparameter tuning**. Improvements such as refining the model architecture or leveraging transfer learning with larger models could further boost detection accuracy.

Overall, this project lays a solid foundation for developing advanced indoor monitoring systems, and can be extended for applications in **smart homes**, **inventory management**, or **assistive technologies**. With continued improvements, the system can evolve into a robust solution for real-time indoor scene understanding.

Declaration

I, Manjiri Netankar, confirm that the work submitted in this assignment is my own and has been completed following academic integrity guidelines.

Github link: https://github.com/supriyamaskar/object-detection-in-deep-learning

Dataset Link : https://www.kaggle.com/datasets/thepbordin/indoor-object-detection

Signature: Manjiri Netankar