

dl-lab-assgnmnent-3-yolo-pklot

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Objective: 1. To perform object detection on the PKLot dataset using deep learning models. 2. To preprocess images and annotations for model training. 3. To fine-tune a pre-trained object detection model (e.g., YOLO, SSD). 4. To evaluate model performance using metrics like IoU and mAP. 5. To visualize and analyze detection results for parking occupancy.

- Links:
 - Colab: <https://colab.research.google.com/drive/1LPw0HGxagfB3Wox7f7jXYYD38iFtiAWx?usp=sharing>

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.

```
[ ]: # Code Task 1
# Install Python Libraries
!pip install torch torchvision torchaudio --index-url https://download.pytorch.org/whl/cu118
!pip install ultralytics opencv-python
!pip install --upgrade ultralytics
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Looking in indexes: https://download.pytorch.org/whl/cu118
Requirement already satisfied: torch in /usr/local/lib/python3.11/dist-packages (2.6.0+cu124)
Requirement already satisfied: torchvision in /usr/local/lib/python3.11/dist-packages (0.21.0+cu124)
Requirement already satisfied: torchaudio in /usr/local/lib/python3.11/dist-packages (2.6.0+cu124)
Requirement already satisfied: filelock in /usr/local/lib/python3.11/dist-packages (from torch) (3.17.0)
Requirement already satisfied: typing-extensions>=4.10.0 in /usr/local/lib/python3.11/dist-packages (from torch) (4.12.2)
Requirement already satisfied: networkx in /usr/local/lib/python3.11/dist-packages (from torch) (3.4.2)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.11/dist-packages
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(from torch) (3.1.6)
Requirement already satisfied: fsspec in /usr/local/lib/python3.11/dist-packages
(from torch) (2024.10.0)
INFO: pip is looking at multiple versions of torch to determine which version is
compatible with other requirements. This could take a while.
Collecting torch
    Downloading https://download.pytorch.org/whl/cu118/torch-2.6.0%2Bcu118-cp311-c
p311-linux_x86_64.whl.metadata (27 kB)
Collecting nvidia-cuda-nvrtc-cu11==11.8.89 (from torch)
    Downloading
https://download.pytorch.org/whl/cu118/nvidia_cuda_nvrtc_cu11-11.8.89-py3-none-
manylinux1_x86_64.whl (23.2 MB)
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.8.89-py3-none-manylinux1_x86_64.whl (875 kB)
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manylinux1_x86_64.whl (13.1 MB)
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https://download.pytorch.org/whl/cu118/nvidia_cudnn_cu11-9.1.0.70-py3-none-
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Requirement already satisfied: sympy==1.13.1 in /usr/local/lib/python3.11/dist-packages (from torch) (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) (1.3.0)
Requirement already satisfied: numpy in /usr/local/lib/python3.11/dist-packages (from torchvision) (1.26.4)
Requirement already satisfied: pillow!=8.3.*,>=5.3.0 in
/usr/local/lib/python3.11/dist-packages (from torchvision) (11.1.0)
Requirement already satisfied: MarkupSafe>=2.0 in
/usr/local/lib/python3.11/dist-packages (from jinja2->torch) (3.0.2)
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2.3 MB/s eta 0:00:00
Installing collected packages: nvidia-nvtx-cu11, nvidia-nccl-cu11, nvidia-cusparse-cu11, nvidia-curand-cu11, nvidia-cufft-cu11, nvidia-cuda-runtime-cu11,
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nvidia-cuda-nvrtc-cu11, nvidia-cuda-cupti-cu11, nvidia-cublas-cu11, nvidia-
cusolver-cu11, nvidia-cudnn-cu11, torch
    Attempting uninstall: torch
        Found existing installation: torch 2.6.0+cu124
        Uninstalling torch-2.6.0+cu124:
            Successfully uninstalled torch-2.6.0+cu124
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cu11-11.8.87 nvidia-cuda-nvrtc-cu11-11.8.89 nvidia-cuda-runtime-cu11-11.8.89
nvidia-cudnn-cu11-9.1.0.70 nvidia-cufft-cu11-10.9.0.58 nvidia-curand-
cu11-10.3.0.86 nvidia-cusolver-cu11-11.4.1.48 nvidia-cusparse-cu11-11.7.5.86
nvidia-nccl-cu11-2.21.5 nvidia-nvtx-cu11-11.8.86 torch-2.6.0+cu118
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Requirement already satisfied: MarkupSafe>=2.0 in
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Downloading ultralytics_thop-2.0.14-py3-none-any.whl (26 kB)
Installing collected packages: ultralytics-thop, ultralytics
Successfully installed ultralytics-8.3.91 ultralytics-thop-2.0.14
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Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.11/dist-
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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)
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
/usr/local/lib/python3.11/dist-packages (from jinja2->torch>=1.8.0->ultralytics)
(3.0.2)
```

```
[ ]: # Run inference on an image with YOLO11n
!yolo predict model=yolo11n.pt source='https://ultralytics.com/images/zidane.
˓→jpg'
```

```
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, 101MB/s]
Ultralytics 8.3.91 Python-3.11.11 torch-2.6.0+cu118 CUDA:0 (Tesla T4,
15095MiB)
YOLO11n summary (fused): 100 layers, 2,616,248 parameters, 0 gradients, 6.5
GFLOPs
```

```
Downloading https://ultralytics.com/images/zidane.jpg to 'zidane.jpg'...
100% 49.2k/49.2k [00:00<00:00, 7.02MB/s]
Traceback (most recent call last):
  File "/usr/local/bin/yolo", line 8, in <module>
    sys.exit(entrypoint())
```

```

~~~~~
File "/usr/local/lib/python3.11/dist-packages/ultralytics/cfg/__init__.py",
line 987, in entrypoint
    getattr(model, mode)(**overrides) # default args from model
~~~~~

File "/usr/local/lib/python3.11/dist-packages/ultralytics/engine/model.py",
line 550, in predict
    return self.predictor.predict_cli(source=source) if is_cli else
self.predictor(source=source, stream=stream)
~~~~~

File "/usr/local/lib/python3.11/dist-
packages/ultralytics/engine/predictor.py", line 234, in predict_cli
    for _ in gen: # sourcery skip: remove-empty-nested-block, noqa
    File "/usr/local/lib/python3.11/dist-packages/torch/utils/_contextlib.py",
line 36, in generator_context
        response = gen.send(None)
    ~~~~~

File "/usr/local/lib/python3.11/dist-
packages/ultralytics/engine/predictor.py", line 303, in stream_inference
    self.model.warmup(imgsz=(1 if self.model.pt or self.model.triton else
self.dataset.bs, 3, *self.imgsz))
    File "/usr/local/lib/python3.11/dist-packages/ultralytics/nn/autobackend.py",
line 778, in warmup
        import torchvision # noqa (import here so torchvision import time not
recorded in postprocess time)
    ~~~~~

File "/usr/local/lib/python3.11/dist-packages/torchvision/__init__.py", line
9, in <module>
    from .extension import _HAS_OPS # usort:skip
~~~~~

File "/usr/local/lib/python3.11/dist-packages/torchvision/extension.py", line
92, in <module>
    _check_cuda_version()
    File "/usr/local/lib/python3.11/dist-packages/torchvision/extension.py", line
78, in _check_cuda_version
        raise RuntimeError(
RuntimeError: Detected that PyTorch and torchvision were compiled with different
CUDA major versions. PyTorch has CUDA Version=11.8 and torchvision has CUDA
Version=12.4. Please reinstall the torchvision that matches your PyTorch
install.
Sentry is attempting to send 2 pending events
Waiting up to 2 seconds
Press Ctrl-C to quit

```

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

Instructions:

1. Choose a Dataset – PKLot 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.

```
[ ]: #Code for Task. 2
# Download Dataset via Roboflow API
!pip install roboflow

from roboflow import Roboflow
rf = Roboflow(api_key="c00BE5KrJtEAArvbZSa9")
project = rf.workspace("brad-dwyer").project("pklot-1tros")
version = project.version(4)
dataset = version.download("yolov11")
```

Collecting roboflow

 Downloading roboflow-1.1.58-py3-none-any.whl.metadata (9.7 kB)

Requirement already satisfied: certifi in /usr/local/lib/python3.11/dist-packages (from roboflow) (2025.1.31)

Collecting idna==3.7 (from roboflow)

 Downloading idna-3.7-py3-none-any.whl.metadata (9.9 kB)

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) (1.26.4)

Collecting opencv-python-headless==4.10.0.84 (from roboflow)

 Downloading opencv_python_headless-4.10.0.84-cp37-abi3-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (20 kB)

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

Collecting pillow-heif>=0.18.0 (from roboflow)

 Downloading pillow_heif-0.22.0-cp311-cp311-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (9.6 kB)

Requirement already satisfied: python-dateutil in /usr/local/lib/python3.11/dist-packages (from roboflow) (2.8.2)

Collecting python-dotenv (from roboflow)

 Downloading python_dotenv-1.0.1-py3-none-any.whl.metadata (23 kB)

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)
Collecting filetype (from roboflow)
  Downloading filetype-1.2.0-py2.py3-none-any.whl.metadata (6.5 kB)
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)
Downloading roboflow-1.1.58-py3-none-any.whl (84 kB)
  84.5/84.5 kB
  6.0 MB/s eta 0:00:00
Downloading idna-3.7-py3-none-any.whl (66 kB)
  66.8/66.8 kB
  6.6 MB/s eta 0:00:00
Downloading opencv_python_headless-4.10.0.84-cp37-abi3-manylinux_2_17_x86_
64.manylinux2014_x86_64.whl (49.9 MB)
  49.9/49.9 MB
  14.7 MB/s eta 0:00:00
Downloading
pillow_heif-0.22.0-cp311-cp311-manylinux_2_17_x86_64.manylinux2014_x86_64.whl
(7.8 MB)
  7.8/7.8 MB
  119.7 MB/s eta 0:00:00
Downloading filetype-1.2.0-py2.py3-none-any.whl (19 kB)
Downloading python_dotenv-1.0.1-py3-none-any.whl (19 kB)
Installing collected packages: filetype, python-dotenv, pillow-heif, opencv-
python-headless, idna, roboflow
  Attempting uninstall: opencv-python-headless
    Found existing installation: opencv-python-headless 4.11.0.86
    Uninstalling opencv-python-headless-4.11.0.86:
      Successfully uninstalled opencv-python-headless-4.11.0.86
  Attempting uninstall: idna
    Found existing installation: idna 3.10
    Uninstalling idna-3.10:
      Successfully uninstalled idna-3.10
Successfully installed filetype-1.2.0 idna-3.7 opencv-python-headless-4.10.0.84
pillow-heif-0.22.0 python-dotenv-1.0.1 roboflow-1.1.58
```

```
loading Roboflow workspace...
loading Roboflow project...

Downloading Dataset Version Zip in PKLot-4 to yolov11:: 100%| 
442297/442297 [00:05<00:00, 75193.97it/s]
```

```
Extracting Dataset Version Zip to PKLot-4 in yolov11:: 100%| 
24842/24842 [00:06<00:00, 3976.58it/s]
```

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.

```
[ ]: !pip install torchvision
```

```
Collecting torchvision
  Downloading torchvision-0.21.0-cp311-cp311-manylinux1_x86_64.whl.metadata (6.1 kB)
Requirement already satisfied: numpy in /usr/local/lib/python3.11/dist-packages (from torchvision) (1.26.4)
Collecting torch==2.6.0 (from torchvision)
  Downloading torch-2.6.0-cp311-cp311-manylinux1_x86_64.whl.metadata (28 kB)
Requirement already satisfied: pillow!=8.3.*,>=5.3.0 in /usr/local/lib/python3.11/dist-packages (from torchvision) (11.1.0)
Requirement already satisfied: filelock in /usr/local/lib/python3.11/dist-packages (from torch==2.6.0->torchvision) (3.17.0)
Requirement already satisfied: typing-extensions>=4.10.0 in /usr/local/lib/python3.11/dist-packages (from torch==2.6.0->torchvision) (4.12.2)
Requirement already satisfied: networkx in /usr/local/lib/python3.11/dist-packages (from torch==2.6.0->torchvision) (3.4.2)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.11/dist-packages (from torch==2.6.0->torchvision) (3.1.6)
Requirement already satisfied: fsspec in /usr/local/lib/python3.11/dist-packages (from torch==2.6.0->torchvision) (2024.10.0)
Collecting nvidia-cuda-nvrtc-cu12==12.4.127 (from torch==2.6.0->torchvision)
  Downloading nvidia_cuda_nvrtc_cu12-12.4.127-py3-none-manylinux2014_x86_64.whl.metadata (1.5 kB)
Collecting nvidia-cuda-runtime-cu12==12.4.127 (from torch==2.6.0->torchvision)
  Downloading nvidia_cuda_runtime_cu12-12.4.127-py3-none-manylinux2014_x86_64.whl.metadata (1.5 kB)
Collecting nvidia-cuda-cupti-cu12==12.4.127 (from torch==2.6.0->torchvision)
```

```

  Downloading nvidia_cuda_cupti_cu12-12.4.127-py3-none-
manylinux2014_x86_64.whl.metadata (1.6 kB)
Collecting nvidia-cudnn-cu12==9.1.0.70 (from torch==2.6.0->torchvision)
  Downloading nvidia_cudnn_cu12-9.1.0.70-py3-none-
manylinux2014_x86_64.whl.metadata (1.6 kB)
Collecting nvidia-cublas-cu12==12.4.5.8 (from torch==2.6.0->torchvision)
  Downloading nvidia_cublas_cu12-12.4.5.8-py3-none-
manylinux2014_x86_64.whl.metadata (1.5 kB)
Collecting nvidia-cufft-cu12==11.2.1.3 (from torch==2.6.0->torchvision)
  Downloading nvidia_cufft_cu12-11.2.1.3-py3-none-
manylinux2014_x86_64.whl.metadata (1.5 kB)
Collecting nvidia-curand-cu12==10.3.5.147 (from torch==2.6.0->torchvision)
  Downloading nvidia_curand_cu12-10.3.5.147-py3-none-
manylinux2014_x86_64.whl.metadata (1.5 kB)
Collecting nvidia-cusolver-cu12==11.6.1.9 (from torch==2.6.0->torchvision)
  Downloading nvidia_cusolver_cu12-11.6.1.9-py3-none-
manylinux2014_x86_64.whl.metadata (1.6 kB)
Collecting nvidia-cusparse-cu12==12.3.1.170 (from torch==2.6.0->torchvision)
  Downloading nvidia_cusparse_cu12-12.3.1.170-py3-none-
manylinux2014_x86_64.whl.metadata (1.6 kB)
Requirement already satisfied: nvidia-cusparseelt-cu12==0.6.2 in
/usr/local/lib/python3.11/dist-packages (from torch==2.6.0->torchvision) (0.6.2)
Requirement already satisfied: nvidia-nccl-cu12==2.21.5 in
/usr/local/lib/python3.11/dist-packages (from torch==2.6.0->torchvision)
(2.21.5)
Requirement already satisfied: nvidia-nvtx-cu12==12.4.127 in
/usr/local/lib/python3.11/dist-packages (from torch==2.6.0->torchvision)
(12.4.127)
Collecting nvidia-nvjitlink-cu12==12.4.127 (from torch==2.6.0->torchvision)
  Downloading nvidia_nvjitlink_cu12-12.4.127-py3-none-
manylinux2014_x86_64.whl.metadata (1.5 kB)
Requirement already satisfied: triton==3.2.0 in /usr/local/lib/python3.11/dist-
packages (from torch==2.6.0->torchvision) (3.2.0)
Requirement already satisfied: sympy==1.13.1 in /usr/local/lib/python3.11/dist-
packages (from torch==2.6.0->torchvision) (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==2.6.0->torchvision) (1.3.0)
Requirement already satisfied: MarkupSafe>=2.0 in
/usr/local/lib/python3.11/dist-packages (from jinja2->torch==2.6.0->torchvision)
(3.0.2)
Downloading torchvision-0.21.0-cp311-cp311-manylinux1_x86_64.whl (7.2 MB)
  7.2/7.2 MB
76.8 MB/s eta 0:00:00
Downloading torch-2.6.0-cp311-cp311-manylinux1_x86_64.whl (766.7 MB)
  766.7/766.7 MB
1.4 MB/s eta 0:00:00
Downloading nvidia_cublas_cu12-12.4.5.8-py3-none-manylinux2014_x86_64.whl
```

```
(363.4 MB)
363.4/363.4 MB
4.0 MB/s eta 0:00:00
Downloading nvidia_cuda_cupti_cu12-12.4.127-py3-none-
manylinux2014_x86_64.whl (13.8 MB)
13.8/13.8 MB
111.2 MB/s eta 0:00:00
Downloading nvidia_cuda_nvrtc_cu12-12.4.127-py3-none-
manylinux2014_x86_64.whl (24.6 MB)
24.6/24.6 MB
87.1 MB/s eta 0:00:00
Downloading nvidia_cuda_runtime_cu12-12.4.127-py3-none-
manylinux2014_x86_64.whl (883 kB)
883.7/883.7 kB
52.3 MB/s eta 0:00:00
Downloading nvidia_cudnn_cu12-9.1.0.70-py3-none-manylinux2014_x86_64.whl
(664.8 MB)
664.8/664.8 MB
1.8 MB/s eta 0:00:00
Downloading nvidia_cufft_cu12-11.2.1.3-py3-none-manylinux2014_x86_64.whl
(211.5 MB)
211.5/211.5 MB
5.6 MB/s eta 0:00:00
Downloading nvidia_curand_cu12-10.3.5.147-py3-none-
manylinux2014_x86_64.whl (56.3 MB)
56.3/56.3 MB
13.1 MB/s eta 0:00:00
Downloading nvidia_cusolver_cu12-11.6.1.9-py3-none-
manylinux2014_x86_64.whl (127.9 MB)
127.9/127.9 MB
7.2 MB/s eta 0:00:00
Downloading nvidia_cusparse_cu12-12.3.1.170-py3-none-
manylinux2014_x86_64.whl (207.5 MB)
207.5/207.5 MB
4.7 MB/s eta 0:00:00
Downloading nvidia_nvjitlink_cu12-12.4.127-py3-none-
manylinux2014_x86_64.whl (21.1 MB)
21.1/21.1 MB
64.7 MB/s eta 0:00:00
Installing collected packages: nvidia-nvjitlink-cu12, nvidia-curand-cu12,
nvidia-cufft-cu12, nvidia-cuda-runtime-cu12, nvidia-cuda-nvrtc-cu12, nvidia-
cuda-cupti-cu12, nvidia-cublas-cu12, nvidia-cusparse-cu12, nvidia-cudnn-cu12,
nvidia-cusolver-cu12, torch, torchvision
Attempting uninstall: nvidia-nvjitlink-cu12
Found existing installation: nvidia-nvjitlink-cu12 12.5.82
Uninstalling nvidia-nvjitlink-cu12-12.5.82:
Successfully uninstalled nvidia-nvjitlink-cu12-12.5.82
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
Attempting uninstall: nvidia-cuda-nvrtc-cu12
Found existing installation: nvidia-cuda-nvrtc-cu12 12.5.82
Uninstalling nvidia-cuda-nvrtc-cu12-12.5.82:
    Successfully uninstalled nvidia-cuda-nvrtc-cu12-12.5.82
Attempting uninstall: nvidia-cuda-cupti-cu12
Found existing installation: nvidia-cuda-cupti-cu12 12.5.82
Uninstalling nvidia-cuda-cupti-cu12-12.5.82:
    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
Attempting uninstall: nvidia-cusparse-cu12
Found existing installation: nvidia-cusparse-cu12 12.5.1.3
Uninstalling nvidia-cusparse-cu12-12.5.1.3:
    Successfully uninstalled nvidia-cusparse-cu12-12.5.1.3
Attempting uninstall: nvidia-cudnn-cu12
Found existing installation: nvidia-cudnn-cu12 9.3.0.75
Uninstalling nvidia-cudnn-cu12-9.3.0.75:
    Successfully uninstalled nvidia-cudnn-cu12-9.3.0.75
Attempting uninstall: nvidia-cusolver-cu12
Found existing installation: nvidia-cusolver-cu12 11.6.3.83
Uninstalling nvidia-cusolver-cu12-11.6.3.83:
    Successfully uninstalled nvidia-cusolver-cu12-11.6.3.83
Attempting uninstall: torch
Found existing installation: torch 2.0.1+rocm5.4.2
Uninstalling torch-2.0.1+rocm5.4.2:
    Successfully uninstalled torch-2.0.1+rocm5.4.2
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 torch-2.6.0 torchvision-0.21.0

```

[]: #code for task 3

```
!yolo train model="/content/yolo11n.pt" data="/content/PKLot-4/data.yaml" ↵
    ↵epochs=5 imgszt=128 batch=16
```

Ultralytics 8.3.91 Python-3.11.11 torch-2.6.0+cu124 CUDA:0 (Tesla T4, 15095MiB)

engine/trainer: task=detect, mode=train, model=/content/yolo11n.pt, data=/content/PKLot-4/data.yaml, epochs=5, time=None, patience=100, batch=16, imgszt=128, save=True, save_period=-1, cache=False, device=None, workers=8, project=None, name=train, 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/train

WARNING: All log messages before absl::InitializeLog() is called are written to STDERR

E0000 00:00:1742131209.176335 9281 cuda_dnn.cc:8310] Unable to register cuDNN factory: Attempting to register factory for plugin cuDNN when one has already been registered

E0000 00:00:1742131209.182706 9281 cuda_blas.cc:1418] Unable to register cuBLAS factory: Attempting to register factory for plugin cuBLAS when one has already been registered

Overriding model.yaml nc=80 with nc=2

	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   431062 ultralytics.nn.modules.head.Detect
[2, [64, 128, 256]]
YOLO11n summary: 181 layers, 2,590,230 parameters, 2,590,214 gradients, 6.4
GFLOPs

```

Transferred 448/499 items from pretrained weights

TensorBoard: Start with 'tensorboard --logdir runs/detect/train',
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/PKLot-4/train/labels... 8690 images, 189
backgrounds, 0 corrupt: 100% 8690/8690 [00:12<00:00, 686.85it/s]
train: New cache created: /content/PKLot-4/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/PKLot-4/valid/labels... 2483 images, 59
backgrounds, 0 corrupt: 100% 2483/2483 [00:03<00:00, 762.87it/s]
val: New cache created: /content/PKLot-4/valid/labels.cache
Plotting labels to runs/detect/train/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=0.001667, 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 128 train, 128 val
Using 2 dataloader workers
Logging results to runs/detect/train
Starting training for 5 epochs...

```

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
1/5	0.338G	3.178	1.933	1.038	397	128:
100% 544/544 [01:14<00:00, 7.32it/s]						
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100% 78/78 [00:14<00:00, 5.24it/s]						
	all	2483	143316	0.507	0.455	0.389
0.138						
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
2/5	0.377G	2.387	0.961	0.8771	77	128:
100% 544/544 [01:08<00:00, 7.98it/s]						
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100% 78/78 [00:13<00:00, 5.61it/s]						
	all	2483	143316	0.675	0.564	0.566
0.238						
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
3/5	0.418G	2.094	0.8482	0.8555	100	128:
100% 544/544 [01:06<00:00, 8.22it/s]						
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100% 78/78 [00:13<00:00, 5.76it/s]						
	all	2483	143316	0.748	0.619	0.649
0.32						
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size

4/5	0.43G	1.938	0.7844	0.8442	120	128:
100% 544/544 [01:05<00:00, 8.29it/s]						
Class	Images	Instances		Box(P)	R	mAP50
mAP50-95): 100% 78/78 [00:13<00:00, 5.82it/s]						
all	2483	143316	0.824	0.643	0.708	
0.394						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
5/5	0.441G	1.796	0.7403	0.8373	41	128:
100% 544/544 [01:05<00:00, 8.29it/s]						
Class	Images	Instances		Box(P)	R	mAP50
mAP50-95): 100% 78/78 [00:13<00:00, 5.88it/s]						
all	2483	143316	0.805	0.653	0.705	
0.391						

5 epochs completed in 0.116 hours.

Optimizer stripped from runs/detect/train/weights/last.pt, 5.4MB

Optimizer stripped from runs/detect/train/weights/best.pt, 5.4MB

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

Ultralytics 8.3.91 Python-3.11.11 torch-2.6.0+cu124 CUDA:0 (Tesla T4, 15095MiB)

YOLOv1n summary (fused): 100 layers, 2,582,542 parameters, 0 gradients, 6.3 GFLOPs

Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100% 78/78 [00:34<00:00, 2.25it/s]					
all	2483	143316	0.824	0.643	0.708
0.394					
space-empty	2062	73629	0.807	0.582	0.65
0.334					
space-occupied	1967	69687	0.842	0.704	0.766
0.455					

Speed: 0.0ms preprocess, 0.6ms inference, 0.0ms loss, 2.4ms postprocess per image

Results saved to runs/detect/train

Learn more at <https://docs.ultralytics.com/modes/train>

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 4. Visualize results with bounding boxes. 5. Expected Outcome: Detection results with bounding boxes and performance metrics.

Discussion and Conclusion on Result Analysis: The YOLOv11 model achieved 70.8% mAP@0.5 and 39.5% mAP@0.5:0.95, showing good accuracy, especially for detecting occupied spaces. With 82.4% precision and 64.3% recall, the model is highly accurate but misses some empty spots.

The F1 Score of 72.3% reflects balanced performance. Inference speed (~1.2 ms/image) makes it suitable for real-time parking detection.

The model works well for parking space detection, especially for occupied spots. It can be improved with more training or higher-resolution images for better recall and stricter IoU accuracy.*

```
[ ]: # Code for Task 4
      # Load Trained Model Weights
      from ultralytics import YOLO

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

```
[ ]: # Run Inference on Test Images
      # Inference on a test image
      results = model('/content/PKLot-4/test/images/2012-09-11_15_53_00.jpg.rf.
      ↵8537f6252c0519cea23fa12293bbe52b.jpg', save=True, conf=0.5)  # Save output
      ↵with bounding boxes
```

```
image 1/1 /content/PKLot-4/test/images/2012-09-11_15_53_00.jpg.rf.8537f6252c0519
cea23fa12293bbe52b.jpg: 128x128 5 space-emptys, 37 space-occupieds, 14.0ms
Speed: 0.9ms preprocess, 14.0ms inference, 2.3ms postprocess per image at shape
(1, 3, 128, 128)
Results saved to runs/detect/predict
```

```
[ ]: from IPython.display import Image as IPyImage, display

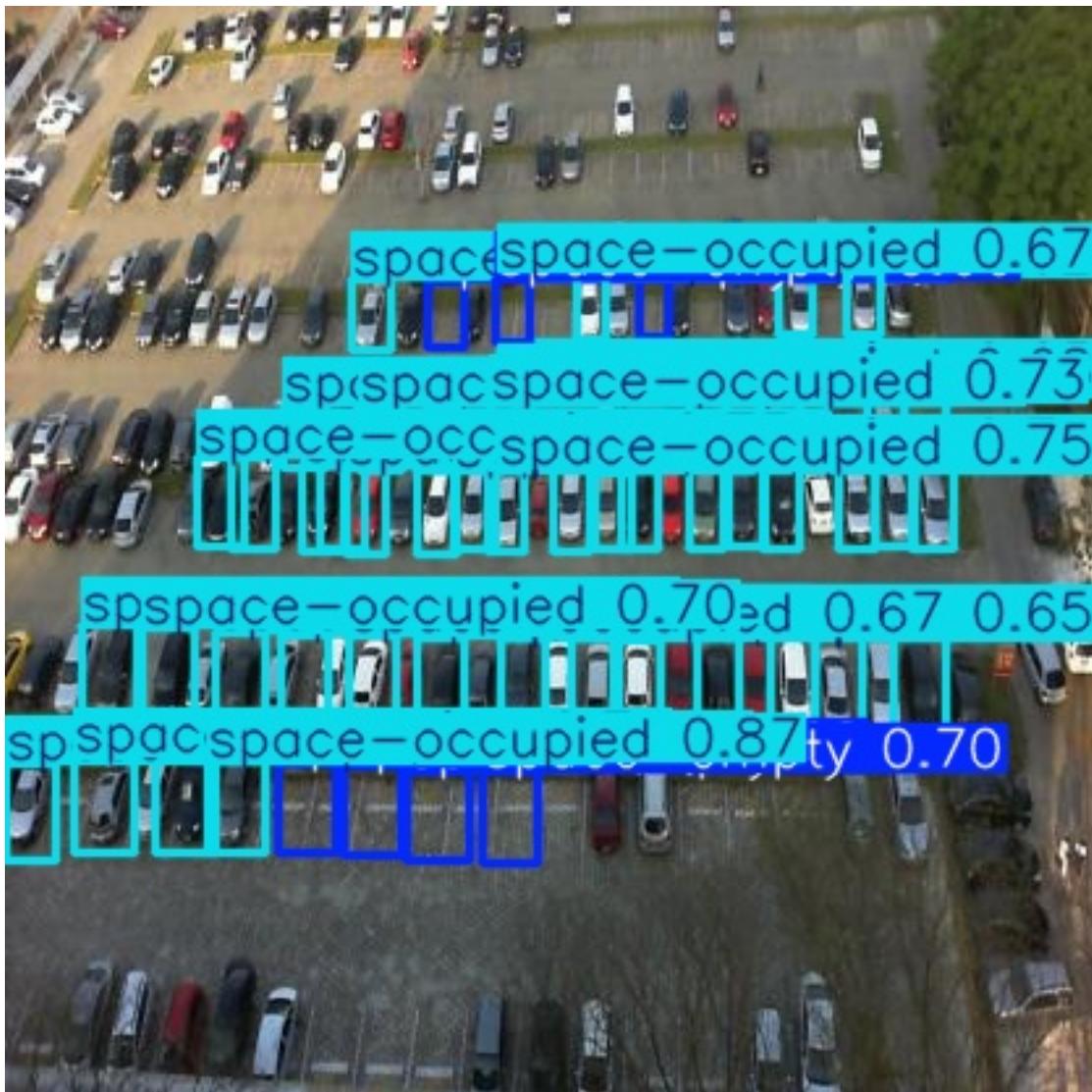
display(IPyImage("/content/runs/detect/predict/2012-09-11_15_53_00.jpg.rf.
      ↵8537f6252c0519cea23fa12293bbe52b.jpg", width=1000))
```



```
[ ]: # Inference on a test image
results = model('/content/PKLot-4/test/images/2012-09-11_16_48_36.jpg.rf.
               ↪4214ff860ddaff96315462a5ed76ee93.jpg', save=True, conf=0.5) # Save output
               ↪with bounding boxes
```

```
image 1/1 /content/PKLot-4/test/images/2012-09-11_16_48_36.jpg.rf.4214ff860ddaff
96315462a5ed76ee93.jpg: 128x128 7 space-emptys, 46 space-occupieds, 10.1ms
Speed: 1.0ms preprocess, 10.1ms inference, 1.4ms postprocess per image at shape
(1, 3, 128, 128)
Results saved to runs/detect/predict
```

```
[ ]: display(IPyImage("/content/runs/detect/predict/2012-09-11_16_48_36.jpg.rf.  
˓→4214ff860ddaff96315462a5ed76ee93.jpg", width=1000))
```



```
[ ]: # Evaluate model performance  
metrics = model.val() # Evaluates on validation dataset from data.yaml  
  
# Mean Average Precision  
print(f"mAP@0.5: {metrics.box.map50:.4f}")  
print(f"mAP@0.5:0.95: {metrics.box.map:.4f}")  
  
# Mean Precision and Recall (use as properties, NOT methods)  
precision = metrics.box.mp  
recall = metrics.box.mr
```

```

print(f"Precision: {precision:.4f}")
print(f"Recall: {recall:.4f}")

# F1 Score
f1_score = 2 * (precision * recall) / (precision + recall + 1e-6)
print(f"F1 Score: {f1_score:.4f}")

```

Ultralytics 8.3.91 Python-3.11.11 torch-2.6.0+cu124 CUDA:0 (Tesla T4, 15095MiB)

```

val: Scanning /content/PKLot-4/valid/labels.cache... 2483 images,
59 backgrounds, 0 corrupt: 100%| 2483/2483 [00:00<?, ?it/s]
      Class     Images   Instances    Box(P       R      mAP50
mAP50-95): 100%| 156/156 [00:35<00:00, 4.38it/s]

          all     2483    143316    0.824    0.643    0.708
0.395
          space-empty    2062    73629    0.806    0.582    0.65
0.334
          space-occupied    1967    69687    0.842    0.705    0.767
0.455
Speed: 0.0ms preprocess, 1.3ms inference, 0.0ms loss, 1.1ms postprocess per
image
Results saved to runs/detect/val4
mAP@0.5: 0.7081
mAP@0.5:0.95: 0.3948
Precision: 0.8240
Recall: 0.6434
F1 Score: 0.7226

```

```

[ ]: import os
from PIL import Image
import matplotlib.pyplot as plt

# Path to the val3 folder
folder_path = '/content/runs/detect/val4/'

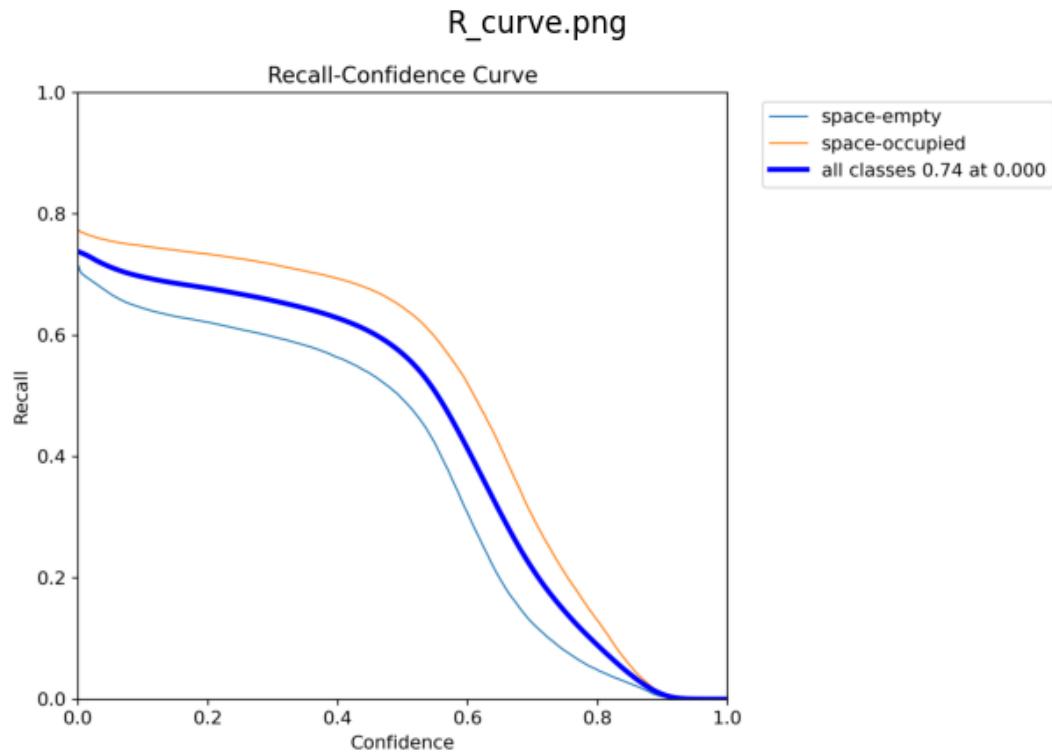
# List all image files (you can filter for .png, .jpg, etc.)
image_files = [f for f in os.listdir(folder_path) if f.lower().endswith('.'
    + 'png', '.jpg', '.jpeg')]

# Loop through and display each image
for img_file in image_files:
    img_path = os.path.join(folder_path, img_file)
    img = Image.open(img_path)

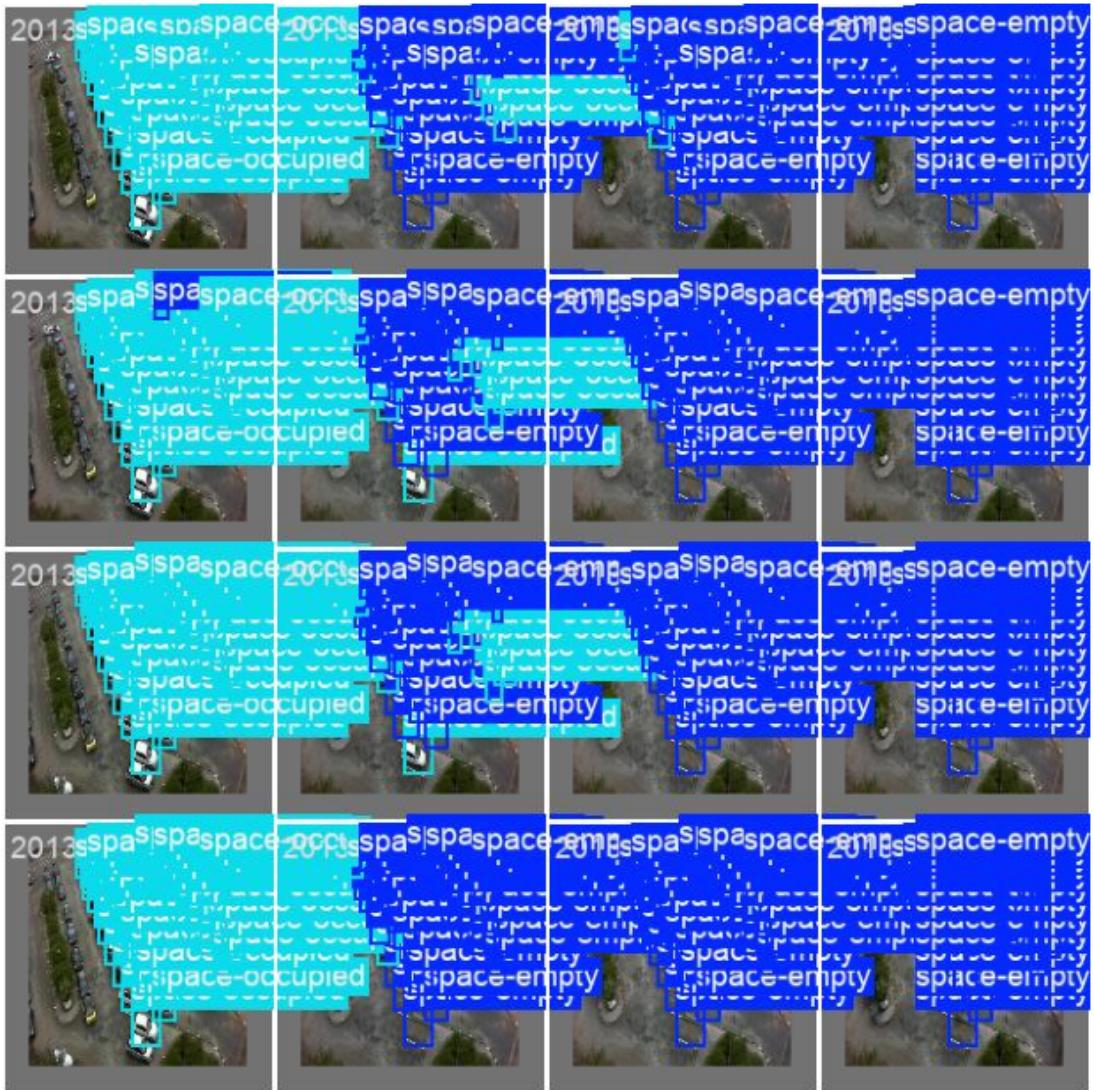
    plt.figure(figsize=(8, 8))
    plt.imshow(img)

```

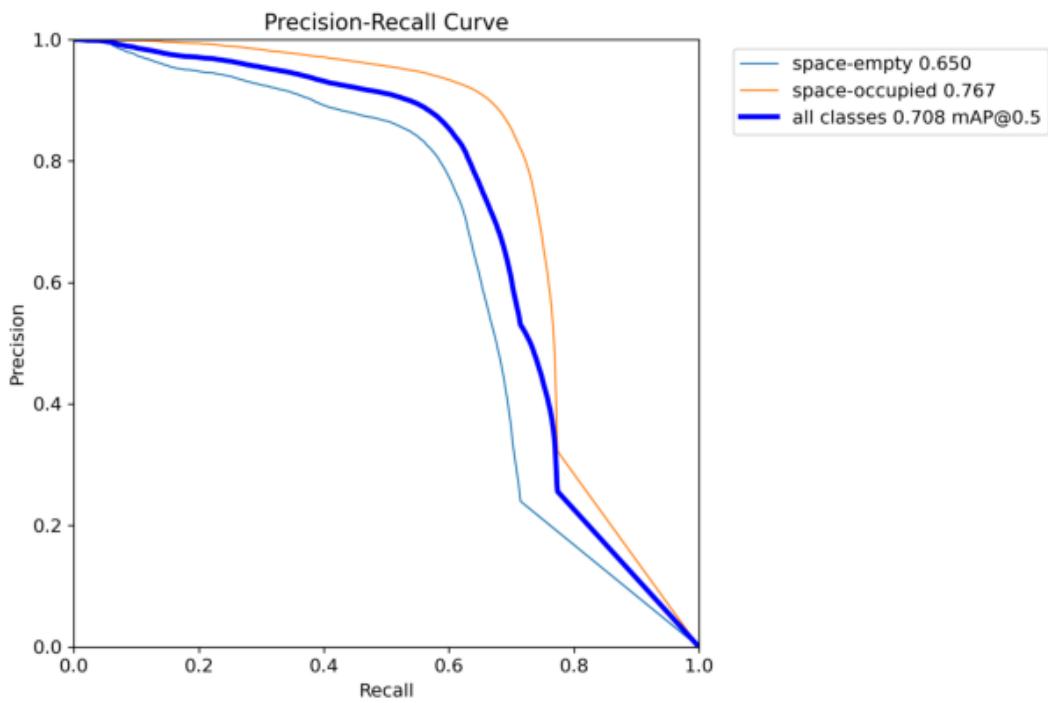
```
plt.title(img_file)
plt.axis('off')
plt.show()
```



val_batch2_labels.jpg



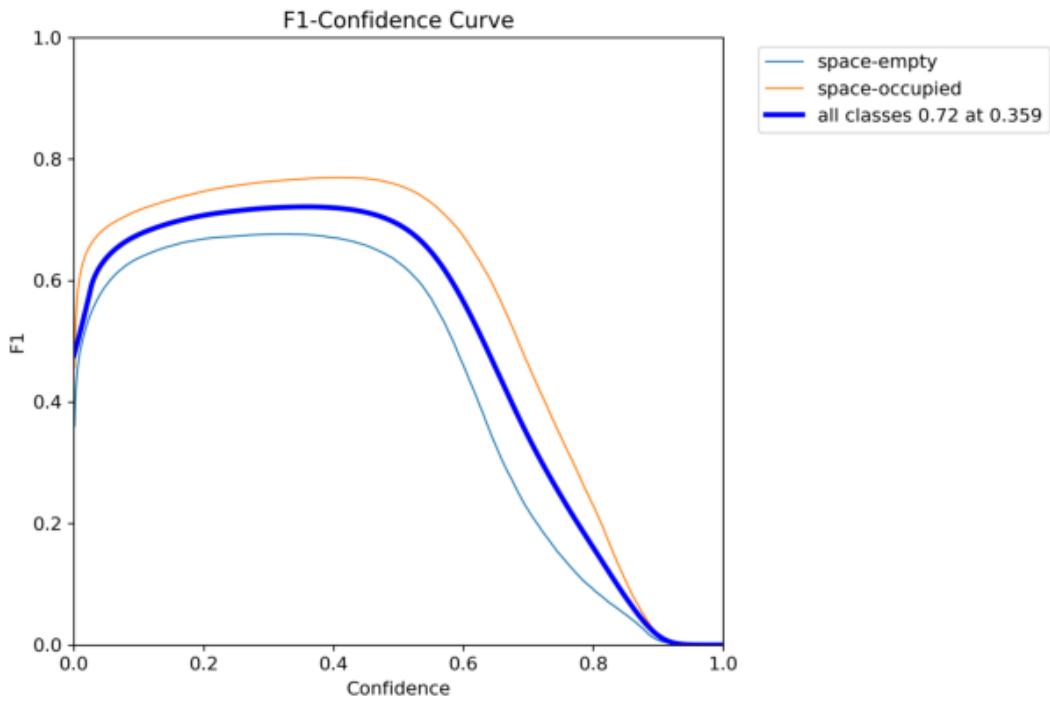
PR_curve.png



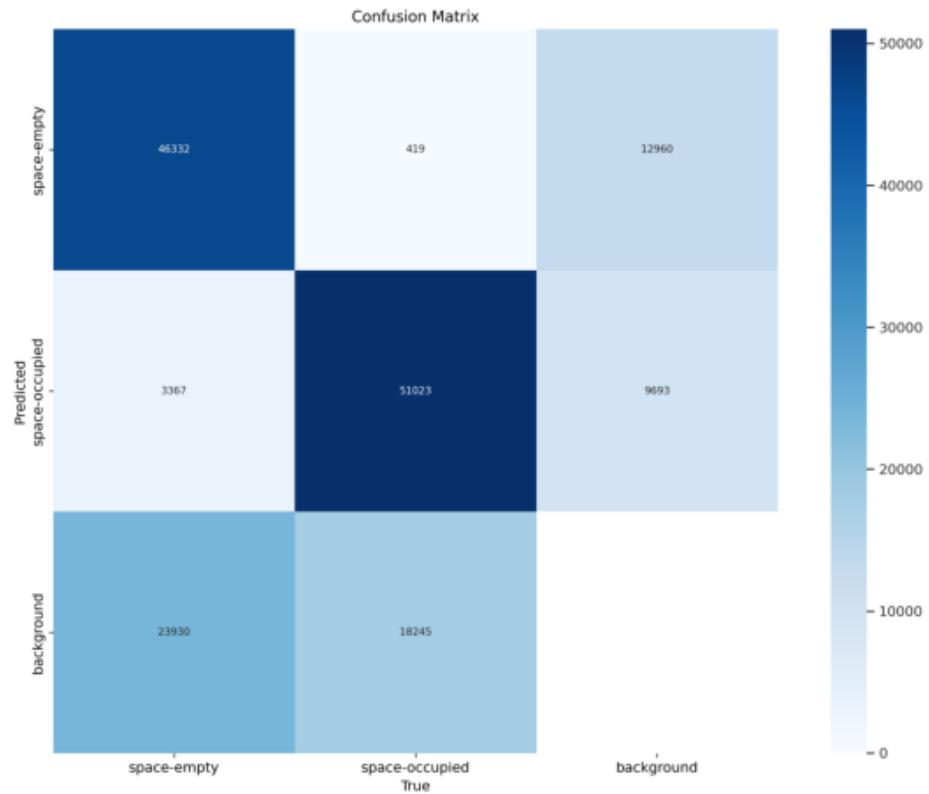
val_batch1_pred.jpg



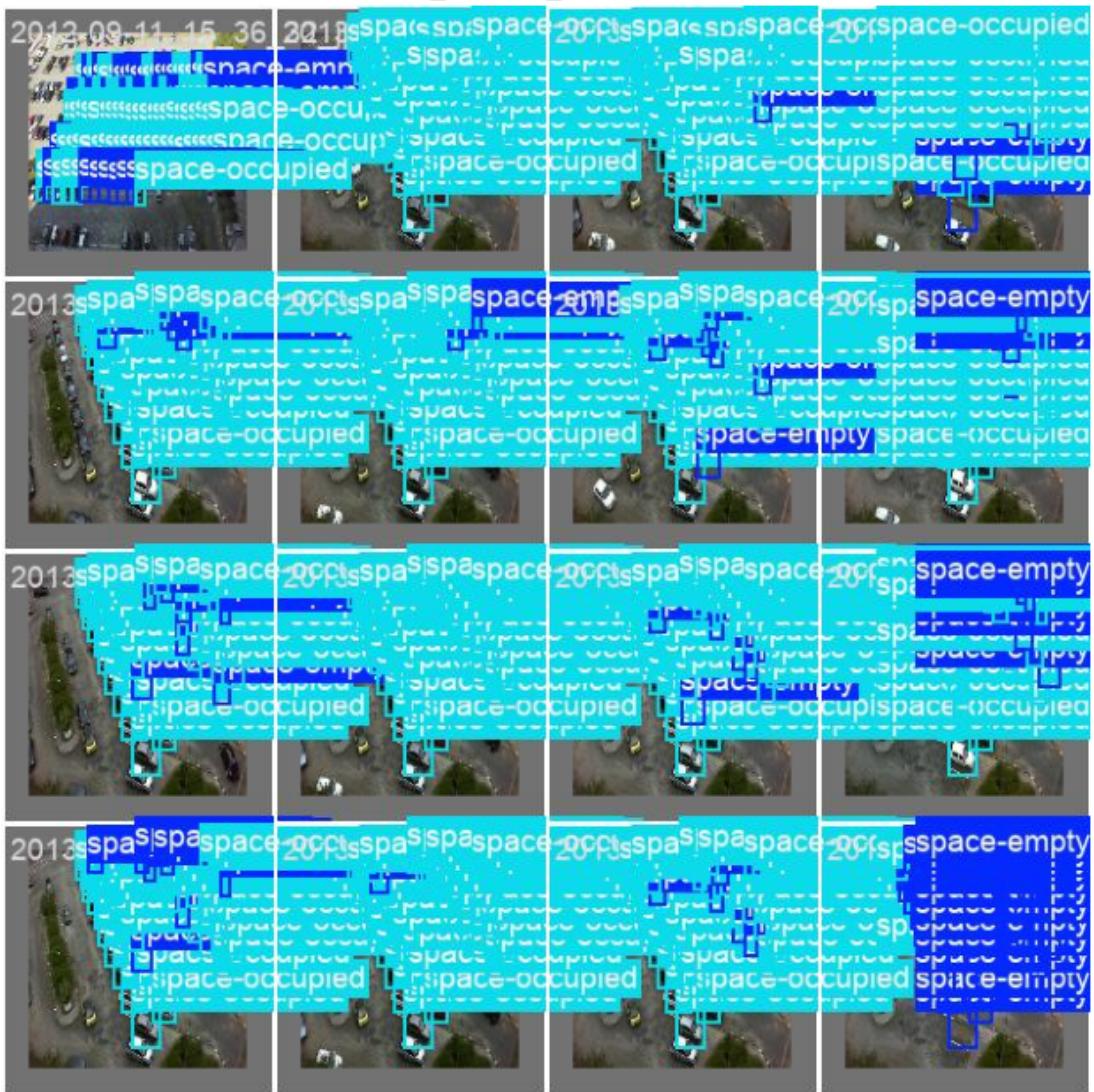
F1_curve.png



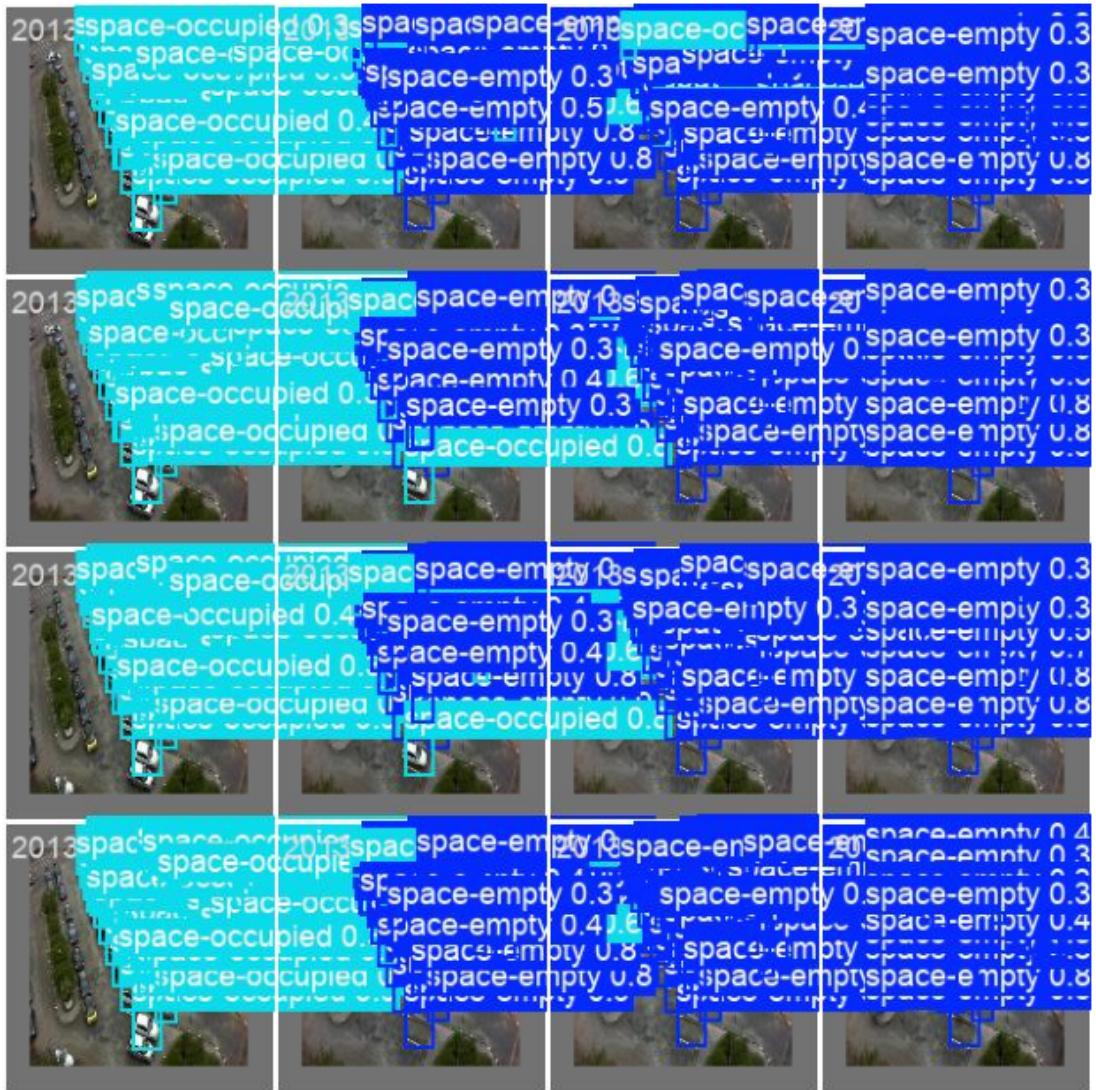
confusion_matrix.png



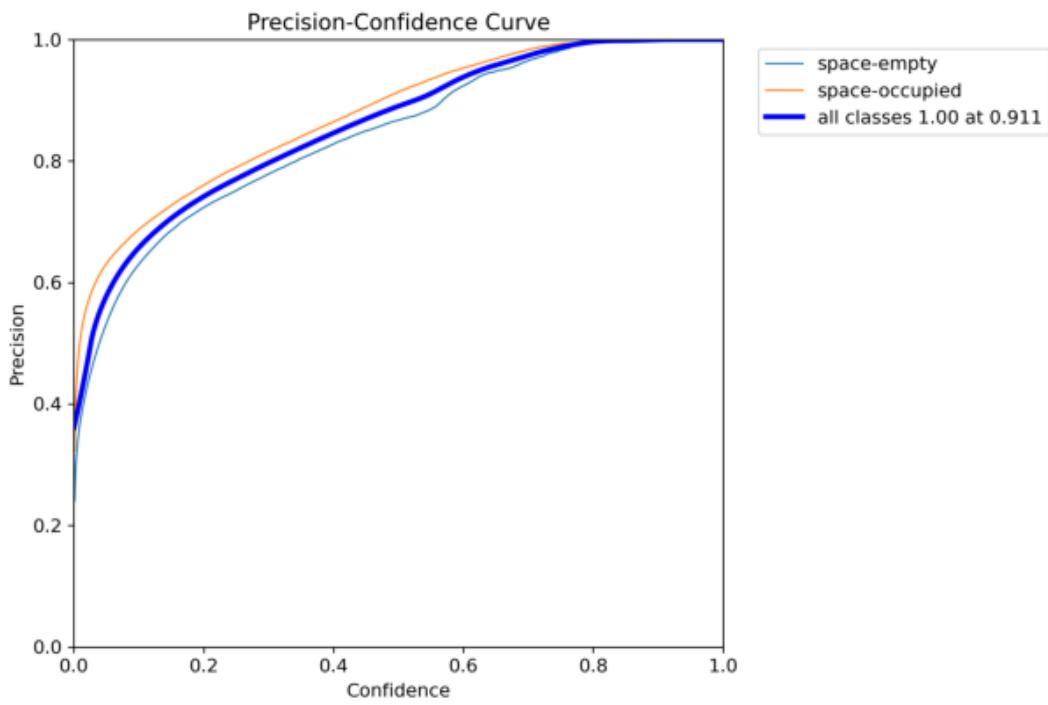
val_batch0_labels.jpg



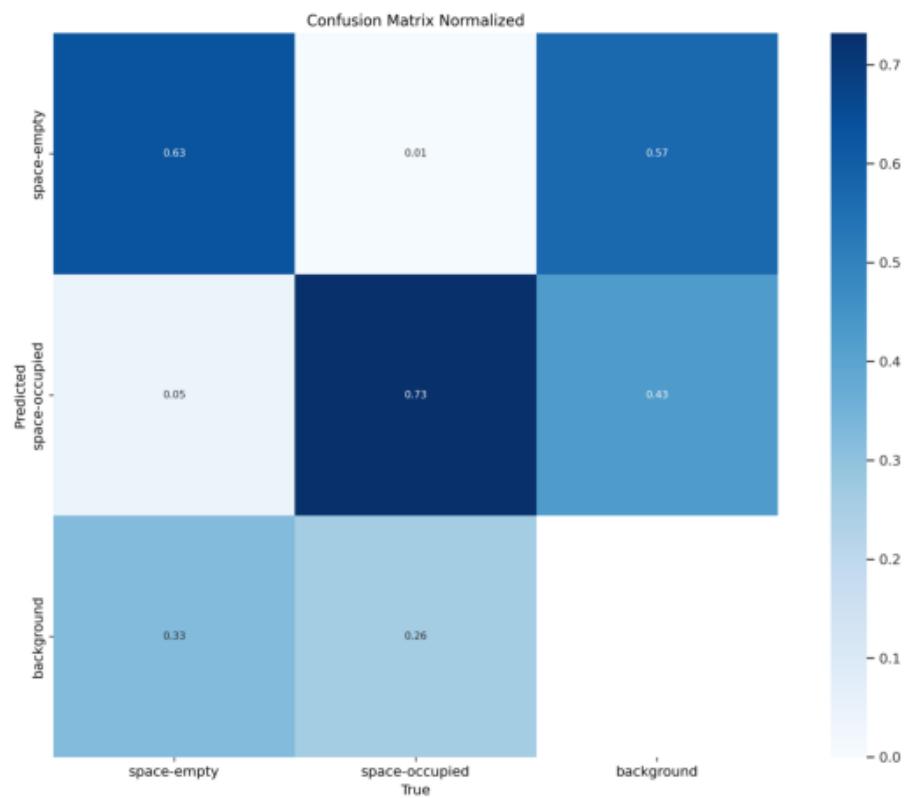
val_batch2_pred.jpg



P_curve.png



confusion_matrix_normalized.png



val_batch0_pred.jpg



val_batch1_labels.jpg

