

First, let us set up a few dependencies

Don't forget to switch to a GPU-enabled colab runtime!

Runtime -> Change Runtime Type -> GPU

```
In [ ]: import os
import contextlib
@contextlib.contextmanager
def directory(name):
    ret = os.getcwd()
    os.chdir(name)
    yield None
    os.chdir(ret)

import subprocess
def run(input, exception_on_failure=False):
    try:
        program_output = subprocess.check_output(f"{input}", shell=True, univers
    except Exception as e:
        if exception_on_failure:
            raise e
        program_output = e.output

    return program_output
def prun(input, exception_on_failure=False):
    x = run(input, exception_on_failure)
    print(x)
    return x
```

This mounts your google drive to this notebook. You might have to change the path to fit with your dataset folder inside your drive.

Read the instruction output by the cell bellow carefully!

```
In [ ]: # Create a temporary workspace
import tempfile

SESSION_WORKSPACE = tempfile.mkdtemp()
print(f"Session workspace created at: {SESSION_WORKSPACE}")
```

Session workspace created at: /tmp/tmpm1vock2i

```
In [ ]: # Mount the drive
        from google.colab import drive
        drive.mount('/content/drive')
        DRIVE_PATH = "/content/drive/My Drive"
```

Mounted at /content/drive

```
In [ ]: # Unzip the dataset
        import shutil
        import os

        DATASET_DIR_NAME = "duckietown_object_detection_dataset"
        DATASET_ZIP_NAME = f"{DATASET_DIR_NAME}.zip"
        DATASET_DIR_PATH = os.path.join(SESSION_WORKSPACE, DATASET_DIR_NAME)
        TRAIN_DIR = "train"
        VALIDATION_DIR = "val"
        IMAGES_DIR = "images"
        LABELS_DIR = "labels"

        def show_info(base_path: str):
            for l1 in [TRAIN_DIR, VALIDATION_DIR]:
                for l2 in [IMAGES_DIR, LABELS_DIR]:
                    p = os.path.join(base_path, l1, l2)
                    print(f"#Files in {l1}/{l2}: {len(os.listdir(p))}")

        def unzip_dataset():
            # check zipped file
            zip_path = os.path.join(DRIVE_PATH, DATASET_ZIP_NAME)
            assert os.path.exists(zip_path), f"No zipped dataset found at {zip_path}!

            # unzip the data
            print("Unpacking zipped data...")
            shutil.unpack_archive(zip_path, DATASET_DIR_PATH)
            print(f"Zipped dataset unpacked to {DATASET_DIR_PATH}")

            # show some info
            show_info(DATASET_DIR_PATH)

        unzip_dataset()
```

Unpacking zipped data...

Zipped dataset unpacked to /tmp/tmpm1vock2i/duckietown_object_detection_data
set

#Files in train/images: 964

#Files in train/labels: 964

#Files in val/images: 242

#Files in val/labels: 242

```
In [ ]: # change working directory to the session workspace
        os.chdir(SESSION_WORKSPACE)
        print(f"PWD: {os.getcwd()}")
```

```
# install pytorch and torchvision  
!pip3 install torch==1.13.0 torchvision==0.14.0
```

```

PWD: /tmp/tmpm1vock2i
Collecting torch==1.13.0
  Downloading torch-1.13.0-cp310-cp310-manylinux1_x86_64.whl (890.1 MB)
    _____ 890.1/890.1 MB 705.3 kB/s eta
0:00:00
Collecting torchvision==0.14.0
  Downloading torchvision-0.14.0-cp310-cp310-manylinux1_x86_64.whl (24.3 MB)
    _____ 24.3/24.3 MB 21.8 MB/s eta 0:00
0:00
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.10/dist-packages (from torch==1.13.0) (4.5.0)
Collecting nvidia-cuda-runtime-cu11==11.7.99 (from torch==1.13.0)
  Downloading nvidia_cuda_runtime_cu11-11.7.99-py3-none-manylinux1_x86_64.whl (849 kB)
    _____ 849.3/849.3 kB 28.1 MB/s eta
0:00:00
Collecting nvidia-cudnn-cu11==8.5.0.96 (from torch==1.13.0)
  Downloading nvidia_cudnn_cu11-8.5.0.96-2-py3-none-manylinux1_x86_64.whl (557.1 MB)
    _____ 557.1/557.1 MB 2.6 MB/s eta 0:00:00
Collecting nvidia-cublas-cu11==11.10.3.66 (from torch==1.13.0)
  Downloading nvidia_cublas_cu11-11.10.3.66-py3-none-manylinux1_x86_64.whl (317.1 MB)
    _____ 317.1/317.1 MB 2.7 MB/s eta 0:00:00
Collecting nvidia-cuda-nvrtc-cu11==11.7.99 (from torch==1.13.0)
  Downloading nvidia_cuda_nvrtc_cu11-11.7.99-2-py3-none-manylinux1_x86_64.whl (21.0 MB)
    _____ 21.0/21.0 MB 38.1 MB/s eta 0:00
0:00
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from torchvision==0.14.0) (1.23.5)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-packages (from torchvision==0.14.0) (2.31.0)
Requirement already satisfied: pillow!=8.3.*,>=5.3.0 in /usr/local/lib/python3.10/dist-packages (from torchvision==0.14.0) (9.4.0)
Requirement already satisfied: setuptools in /usr/local/lib/python3.10/dist-packages (from nvidia-cublas-cu11==11.10.3.66->torch==1.13.0) (67.7.2)
Requirement already satisfied: wheel in /usr/local/lib/python3.10/dist-packages (from nvidia-cublas-cu11==11.10.3.66->torch==1.13.0) (0.42.0)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests->torchvision==0.14.0) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests->torchvision==0.14.0) (3.6)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests->torchvision==0.14.0) (2.0.7)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests->torchvision==0.14.0) (2023.11.17)
Installing collected packages: nvidia-cuda-runtime-cu11, nvidia-cuda-nvrtc-cu11, nvidia-cublas-cu11, nvidia-cudnn-cu11, torch, torchvision
  Attempting uninstall: torch
    Found existing installation: torch 2.1.0+cu121
    Uninstalling torch-2.1.0+cu121:
      Successfully uninstalled torch-2.1.0+cu121
  Attempting uninstall: torchvision

```

```
Found existing installation: torchvision 0.16.0+cu121
Uninstalling torchvision-0.16.0+cu121:
  Successfully uninstalled torchvision-0.16.0+cu121
ERROR: pip's dependency resolver does not currently take into account all the
packages that are installed. This behaviour is the source of the following
dependency conflicts.
torchaudio 2.1.0+cu121 requires torch==2.1.0, but you have torch 1.13.0 which
is incompatible.
torchdata 0.7.0 requires torch==2.1.0, but you have torch 1.13.0 which is in
compatible.
torchtext 0.16.0 requires torch==2.1.0, but you have torch 1.13.0 which is i
ncompatible.
Successfully installed nvidia-cublas-cu11-11.10.3.66 nvidia-cuda-nvrtc-cu11-
11.7.99 nvidia-cuda-runtime-cu11-11.7.99 nvidia-cudnn-cu11-8.5.0.96 torch-1.
13.0 torchvision-0.14.0
```

Next, we will clone YOLOv5

```
In [ ]: !rm -rf ./yolov5
        !git clone https://github.com/ultralytics/yolov5.git -b v7.0
        !cd yolov5 && pip3 install -r requirements.txt
```

```
Cloning into 'yolov5'...
remote: Enumerating objects: 16117, done.
remote: Counting objects: 100% (28/28), done.
remote: Compressing objects: 100% (27/27), done.
remote: Total 16117 (delta 9), reused 11 (delta 1), pack-reused 16089
Receiving objects: 100% (16117/16117), 14.86 MiB | 21.02 MiB/s, done.
Resolving deltas: 100% (11032/11032), done.
Note: switching to '915bbf294bb74c859f0b41f1c23bc395014ea679'.
```

You are in 'detached HEAD' state. You can look around, make experimental changes and commit them, and you can discard any commits you make in this state without impacting any branches by switching back to a branch.

If you want to create a new branch to retain commits you create, you may do so (now or later) by using `-c` with the switch command. Example:

```
git switch -c <new-branch-name>
```

Or undo this operation with:

```
git switch -
```

Turn off this advice by setting config variable `advice.detachedHead` to false

```
Collecting gitpython (from -r requirements.txt (line 5))
```

```
  Downloading GitPython-3.1.40-py3-none-any.whl (190 kB)
```

```
100% |#####| 190.6/190.6 kB 1.7 MB/s eta 0:00:00
```

```
Requirement already satisfied: ipython in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 6)) (7.34.0)
```

```
Requirement already satisfied: matplotlib>=3.2.2 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 7)) (3.7.1)
```

```
Requirement already satisfied: numpy>=1.18.5 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 8)) (1.23.5)
```

```
Requirement already satisfied: opencv-python>=4.1.1 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 9)) (4.8.0.76)
```

```
Requirement already satisfied: Pillow>=7.1.2 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 10)) (9.4.0)
```

```
Requirement already satisfied: psutil in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 11)) (5.9.5)
```

```
Requirement already satisfied: PyYAML>=5.3.1 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 12)) (6.0.1)
```

```
Requirement already satisfied: requests>=2.23.0 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 13)) (2.31.0)
```

```
Requirement already satisfied: scipy>=1.4.1 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 14)) (1.11.4)
```

```
Collecting thop>=0.1.1 (from -r requirements.txt (line 15))
```

```
  Downloading thop-0.1.1.post2209072238-py3-none-any.whl (15 kB)
```

```
Requirement already satisfied: torch>=1.7.0 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 16)) (1.13.0)
```

```
Requirement already satisfied: torchvision>=0.8.1 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 17)) (0.14.0)
```

```
Requirement already satisfied: tqdm>=4.64.0 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 18)) (4.66.1)
```

```
Requirement already satisfied: tensorboard>=2.4.1 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 22)) (2.15.1)
```

Requirement already satisfied: pandas>=1.1.4 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 27)) (1.5.3)
Requirement already satisfied: seaborn>=0.11.0 in /usr/local/lib/python3.10/dist-packages (from -r requirements.txt (line 28)) (0.12.2)
Collecting gitdb<5,>=4.0.1 (from gitpython->-r requirements.txt (line 5))
 Downloading gitdb-4.0.11-py3-none-any.whl (62 kB)

 62.7/62.7 kB 8.4 MB/s eta 0:00
0:00
Requirement already satisfied: setuptools>=18.5 in /usr/local/lib/python3.10/dist-packages (from ipython->-r requirements.txt (line 6)) (67.7.2)
Collecting jedi>=0.16 (from ipython->-r requirements.txt (line 6))
 Downloading jedi-0.19.1-py2.py3-none-any.whl (1.6 MB)

 1.6/1.6 MB 13.1 MB/s eta 0:00:
00
Requirement already satisfied: decorator in /usr/local/lib/python3.10/dist-packages (from ipython->-r requirements.txt (line 6)) (4.4.2)
Requirement already satisfied: pickleshare in /usr/local/lib/python3.10/dist-packages (from ipython->-r requirements.txt (line 6)) (0.7.5)
Requirement already satisfied: traitlets>=4.2 in /usr/local/lib/python3.10/dist-packages (from ipython->-r requirements.txt (line 6)) (5.7.1)
Requirement already satisfied: prompt-toolkit!=3.0.0,!<3.0.1,<3.1.0,>=2.0.0 in /usr/local/lib/python3.10/dist-packages (from ipython->-r requirements.txt (line 6)) (3.0.43)
Requirement already satisfied: pygments in /usr/local/lib/python3.10/dist-packages (from ipython->-r requirements.txt (line 6)) (2.16.1)
Requirement already satisfied: backcall in /usr/local/lib/python3.10/dist-packages (from ipython->-r requirements.txt (line 6)) (0.2.0)
Requirement already satisfied: matplotlib-inline in /usr/local/lib/python3.10/dist-packages (from ipython->-r requirements.txt (line 6)) (0.1.6)
Requirement already satisfied: pexpect>4.3 in /usr/local/lib/python3.10/dist-packages (from ipython->-r requirements.txt (line 6)) (4.9.0)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.2.2->-r requirements.txt (line 7)) (1.2.0)
Requirement already satisfied: cycycler>=0.10 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.2.2->-r requirements.txt (line 7)) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.2.2->-r requirements.txt (line 7)) (4.46.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.2.2->-r requirements.txt (line 7)) (1.4.5)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.2.2->-r requirements.txt (line 7)) (23.2)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.2.2->-r requirements.txt (line 7)) (3.1.1)
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.2.2->-r requirements.txt (line 7)) (2.8.2)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests>=2.23.0->-r requirements.txt (line 13)) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests>=2.23.0->-r requirements.txt (line 13)) (3.6)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.

10/dist-packages (from requests>=2.23.0->-r requirements.txt (line 13)) (2.0.7)

Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests>=2.23.0->-r requirements.txt (line 13)) (2023.11.17)

Requirement already satisfied: typing-extensions in /usr/local/lib/python3.10/dist-packages (from torch>=1.7.0->-r requirements.txt (line 16)) (4.5.0)

Requirement already satisfied: nvidia-cuda-runtime-cu11==11.7.99 in /usr/local/lib/python3.10/dist-packages (from torch>=1.7.0->-r requirements.txt (line 16)) (11.7.99)

Requirement already satisfied: nvidia-cudnn-cu11==8.5.0.96 in /usr/local/lib/python3.10/dist-packages (from torch>=1.7.0->-r requirements.txt (line 16)) (8.5.0.96)

Requirement already satisfied: nvidia-cublas-cu11==11.10.3.66 in /usr/local/lib/python3.10/dist-packages (from torch>=1.7.0->-r requirements.txt (line 16)) (11.10.3.66)

Requirement already satisfied: nvidia-cuda-nvrtc-cu11==11.7.99 in /usr/local/lib/python3.10/dist-packages (from torch>=1.7.0->-r requirements.txt (line 16)) (11.7.99)

Requirement already satisfied: wheel in /usr/local/lib/python3.10/dist-packages (from nvidia-cublas-cu11==11.10.3.66->torch>=1.7.0->-r requirements.txt (line 16)) (0.42.0)

Requirement already satisfied: absl-py>=0.4 in /usr/local/lib/python3.10/dist-packages (from tensorboard>=2.4.1->-r requirements.txt (line 22)) (1.4.0)

Requirement already satisfied: grpcio>=1.48.2 in /usr/local/lib/python3.10/dist-packages (from tensorboard>=2.4.1->-r requirements.txt (line 22)) (1.60.0)

Requirement already satisfied: google-auth<3,>=1.6.3 in /usr/local/lib/python3.10/dist-packages (from tensorboard>=2.4.1->-r requirements.txt (line 22)) (2.17.3)

Requirement already satisfied: google-auth-oauthlib<2,>=0.5 in /usr/local/lib/python3.10/dist-packages (from tensorboard>=2.4.1->-r requirements.txt (line 22)) (1.2.0)

Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.10/dist-packages (from tensorboard>=2.4.1->-r requirements.txt (line 22)) (3.5.1)

Requirement already satisfied: protobuf<4.24,>=3.19.6 in /usr/local/lib/python3.10/dist-packages (from tensorboard>=2.4.1->-r requirements.txt (line 22)) (3.20.3)

Requirement already satisfied: six>1.9 in /usr/local/lib/python3.10/dist-packages (from tensorboard>=2.4.1->-r requirements.txt (line 22)) (1.16.0)

Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in /usr/local/lib/python3.10/dist-packages (from tensorboard>=2.4.1->-r requirements.txt (line 22)) (0.7.2)

Requirement already satisfied: werkzeug>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from tensorboard>=2.4.1->-r requirements.txt (line 22)) (3.0.1)

Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-packages (from pandas>=1.1.4->-r requirements.txt (line 27)) (2023.3.post1)

Collecting smmap<6,>=3.0.1 (from gitdb<5,>=4.0.1->gitpython->-r requirements.txt (line 5))

Downloading smmap-5.0.1-py3-none-any.whl (24 kB)

Requirement already satisfied: cachetools<6.0,>=2.0.0 in /usr/local/lib/python3.10/dist-packages (from google-auth<3,>=1.6.3->tensorboard>=2.4.1->-r requirements.txt (line 22)) (5.3.2)

Requirement already satisfied: pyasn1-modules<=0.2.1 in /usr/local/lib/python3.10/dist-packages (from google-auth<3,>=1.6.3->tensorboard<=2.4.1-->-r requirements.txt (line 22)) (0.3.0)

Requirement already satisfied: rsa<5,>=3.1.4 in /usr/local/lib/python3.10/dist-packages (from google-auth<3,>=1.6.3->tensorboard<=2.4.1-->-r requirements.txt (line 22)) (4.9)

Requirement already satisfied: requests-oauthlib<=0.7.0 in /usr/local/lib/python3.10/dist-packages (from google-auth-oauthlib<2,>=0.5->tensorboard<=2.4.1-->-r requirements.txt (line 22)) (1.3.1)

Requirement already satisfied: parso<0.9.0,>=0.8.3 in /usr/local/lib/python3.10/dist-packages (from jedi<=0.16->ipython->-r requirements.txt (line 6)) (0.8.3)

Requirement already satisfied: ptyprocess<=0.5 in /usr/local/lib/python3.10/dist-packages (from pexpect<4.3->ipython->-r requirements.txt (line 6)) (0.7.0)

Requirement already satisfied: wcwidth in /usr/local/lib/python3.10/dist-packages (from prompt-toolkit!=3.0.0,!<3.0.1,<3.1.0,>=2.0.0->ipython->-r requirements.txt (line 6)) (0.2.12)

Requirement already satisfied: MarkupSafe<=2.1.1 in /usr/local/lib/python3.10/dist-packages (from werkzeug<=1.0.1->tensorboard<=2.4.1-->-r requirements.txt (line 22)) (2.1.3)

Requirement already satisfied: pyasn1<0.6.0,>=0.4.6 in /usr/local/lib/python3.10/dist-packages (from pyasn1-modules<=0.2.1->google-auth<3,>=1.6.3->tensorboard<=2.4.1-->-r requirements.txt (line 22)) (0.5.1)

Requirement already satisfied: oauthlib<=3.0.0 in /usr/local/lib/python3.10/dist-packages (from requests-oauthlib<=0.7.0->google-auth-oauthlib<2,>=0.5->tensorboard<=2.4.1-->-r requirements.txt (line 22)) (3.2.2)

Installing collected packages: smmap, jedi, gitdb, gitpython, thop

Successfully installed gitdb-4.0.11 gitpython-3.1.40 jedi-0.19.1 smmap-5.0.1 thop-0.1.1.post2209072238

We now inform the training process of the format and location of our dataset

```
In [ ]: %%writefile ./yolov5/data/duckietown.yaml

# train and val data as 1) directory: path/images/, 2) file: path/images.txt
train: ../duckietown_object_detection_dataset/train
val: ../duckietown_object_detection_dataset/val

# number of classes
nc: 4

# class names
names: [ 'duckie', 'cone', 'truck', 'bus' ]
```


Writing ./yolov5/data/duckietown.yaml


And we're ready to train! This step will take about 5 minutes.

Notice that we're only training for 10 epochs. That's probably not enough!


```
In [ ]: !cd yolov5 && python3 train.py --cfg ./models/yolov5n.yaml --img 416 --batch
```


train: weights=yolov5n.pt, cfg=./models/yolov5n.yaml, data=duckietown.yaml, hyp=data/hyps/hyp.scratch-low.yaml, epochs=10, batch_size=32, imgsz=416, rect=False, resume=False, nosave=False, noval=False, noautoanchor=False, noplots=False, evolve=None, bucket=, cache=None, image_weights=False, device=, multi_scale=False, single_cls=False, optimizer=SGD, sync_bn=False, workers=8, project=runs/train, name=exp, exist_ok=False, quad=False, cos_lr=False, label_smoothing=0.0, patience=100, freeze=[0], save_period=-1, seed=0, local_rank=-1, entity=None, upload_dataset=False, bbox_interval=-1, artifact_alias=latest

github:  YOLOv5 is out of date by 254 commits. Use `git pull` or `git clone https://github.com/ultralytics/yolov5` to update.

YOLOv5  v7.0-0-g915bbf2 Python-3.10.12 torch-1.13.0+cu117 CUDA:0 (Tesla T4, 15102MiB)

hyperparameters: 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=0.05, cls=0.5, cls_pw=1.0, obj=1.0, obj_pw=1.0, iou_t=0.2, anchor_t=4.0, fl_gamma=0.0, 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, mosaic=1.0, mixup=0.0, copy_paste=0.0

ClearML: run 'pip install clearml' to automatically track, visualize and remotely train YOLOv5  in ClearML

Comet: run 'pip install comet_ml' to automatically track and visualize YOLOv5  runs in Comet

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

2023-12-31 17:40:32.017915: E external/local_xla/xla/stream_executor/cuda/cuda_dnn.cc:9261] Unable to register cuDNN factory: Attempting to register factory for plugin cuDNN when one has already been registered

2023-12-31 17:40:32.018029: E external/local_xla/xla/stream_executor/cuda/cuda_fft.cc:607] Unable to register cuFFT factory: Attempting to register factory for plugin cuFFT when one has already been registered

2023-12-31 17:40:32.135164: E external/local_xla/xla/stream_executor/cuda/cuda_blas.cc:1515] Unable to register cuBLAS factory: Attempting to register factory for plugin cuBLAS when one has already been registered

2023-12-31 17:40:32.386202: I tensorflow/core/platform/cpu_feature_guard.cc:182] This TensorFlow binary is optimized to use available CPU instructions in performance-critical operations.

To enable the following instructions: AVX2 FMA, in other operations, rebuild TensorFlow with the appropriate compiler flags.

2023-12-31 17:40:34.680389: W tensorflow/compiler/tf2tensorrt/utils/py_utils.cc:38] TF-TRT Warning: Could not find TensorRT

Downloading https://ultralytics.com/assets/Arial.ttf to /root/.config/Ultralytics/Arial.ttf...

100% 755k/755k [00:00<00:00, 17.9MB/s]

Downloading https://github.com/ultralytics/yolov5/releases/download/v7.0/yolov5n.pt to yolov5n.pt...

100% 3.87M/3.87M [00:00<00:00, 59.4MB/s]

Overriding model.yaml nc=80 with nc=4

	from	n	params	module
arguments				
0	-1	1	1760	models.common.Conv
[3, 16, 6, 2, 2]				
1	-1	1	4672	models.common.Conv

[16, 32, 3, 2]				
2	-1	1	4800	models.common.C3
[32, 32, 1]				
3	-1	1	18560	models.common.Conv
[32, 64, 3, 2]				
4	-1	2	29184	models.common.C3
[64, 64, 2]				
5	-1	1	73984	models.common.Conv
[64, 128, 3, 2]				
6	-1	3	156928	models.common.C3
[128, 128, 3]				
7	-1	1	295424	models.common.Conv
[128, 256, 3, 2]				
8	-1	1	296448	models.common.C3
[256, 256, 1]				
9	-1	1	164608	models.common.SPPF
[256, 256, 5]				
10	-1	1	33024	models.common.Conv
[256, 128, 1, 1]				
11	-1	1	0	torch.nn.modules.upsampling.Upsample
[None, 2, 'nearest']				
12	[-1, 6]	1	0	models.common.Concat
[1]				
13	-1	1	90880	models.common.C3
[256, 128, 1, False]				
14	-1	1	8320	models.common.Conv
[128, 64, 1, 1]				
15	-1	1	0	torch.nn.modules.upsampling.Upsample
[None, 2, 'nearest']				
16	[-1, 4]	1	0	models.common.Concat
[1]				
17	-1	1	22912	models.common.C3
[128, 64, 1, False]				
18	-1	1	36992	models.common.Conv
[64, 64, 3, 2]				
19	[-1, 14]	1	0	models.common.Concat
[1]				
20	-1	1	74496	models.common.C3
[128, 128, 1, False]				
21	-1	1	147712	models.common.Conv
[128, 128, 3, 2]				
22	[-1, 10]	1	0	models.common.Concat
[1]				
23	-1	1	296448	models.common.C3
[256, 256, 1, False]				
24	[17, 20, 23]	1	12177	models.yolo.Detect
[4, [[10, 13, 16, 30, 33, 23], [30, 61, 62, 45, 59, 119], [116, 90, 156, 19, 8, 373, 326]], [64, 128, 256]]				
YOLOv5n summary: 214 layers, 1769329 parameters, 1769329 gradients, 4.2 GFLOPs				

Transferred 342/349 items from yolov5n.pt

AMP: checks passed 

optimizer: SGD(lr=0.01) with parameter groups 57 weight(decay=0.0), 60 weight(decay=0.0005), 60 bias

augmentations: Blur(p=0.01, blur_limit=(3, 7)), MedianBlur(p=0.01, blur_lim


```
it=(3, 7)), ToGray(p=0.01), CLAHE(p=0.01, clip_limit=(1, 4.0), tile_grid_size=(8, 8))
```

```
train: Scanning /tmp/tmpm1vock2i/duckietown_object_detection_dataset/train/labels... 964 images, 43 backgrounds, 0 corrupt: 100% 964/964 [00:02<00:00, 396.97it/s]
```

```
train: New cache created: /tmp/tmpm1vock2i/duckietown_object_detection_dataset/train/labels.cache
```

```
val: Scanning /tmp/tmpm1vock2i/duckietown_object_detection_dataset/val/labels... 242 images, 5 backgrounds, 0 corrupt: 100% 242/242 [00:00<00:00, 357.13it/s]
```

```
val: New cache created: /tmp/tmpm1vock2i/duckietown_object_detection_dataset/val/labels.cache
```

```
AutoAnchor: 4.89 anchors/target, 0.994 Best Possible Recall (BPR). Current anchors are a good fit to dataset 
```

```
Plotting labels to runs/train/exp/labels.jpg...
```

```
Image sizes 416 train, 416 val
```

```
Using 2 dataloader workers
```

```
Logging results to runs/train/exp
```

```
Starting training for 10 epochs...
```

	Epoch	GPU_mem	box_loss	obj_loss	cls_loss	Instances	Size
e	0/9	1.57G	0.1245	0.01648	0.0321	25	41
6:	100% 31/31	[00:20<00:00,	1.51it/s]				
		Class	Images	Instances	P	R	mAP5
0	mAP50-95:	100% 4/4	[00:05<00:00,	1.33s/it]			
		all	242	627	0.0013	0.301	0.001
9	0.000445						

	Epoch	GPU_mem	box_loss	obj_loss	cls_loss	Instances	Size
e	1/9	1.94G	0.09396	0.01847	0.01341	18	41
6:	100% 31/31	[00:17<00:00,	1.81it/s]				
		Class	Images	Instances	P	R	mAP5
0	mAP50-95:	100% 4/4	[00:05<00:00,	1.31s/it]			
		all	242	627	0.856	0.118	0.10
8	0.0343						

	Epoch	GPU_mem	box_loss	obj_loss	cls_loss	Instances	Size
e	2/9	1.94G	0.08235	0.01709	0.0111	7	41
6:	100% 31/31	[00:15<00:00,	1.95it/s]				
		Class	Images	Instances	P	R	mAP5
0	mAP50-95:	100% 4/4	[00:02<00:00,	1.45it/s]			
		all	242	627	0.844	0.108	0.15
3	0.0363						

	Epoch	GPU_mem	box_loss	obj_loss	cls_loss	Instances	Size
e	3/9	1.94G	0.07206	0.01681	0.008152	12	41
6:	100% 31/31	[00:15<00:00,	2.01it/s]				
		Class	Images	Instances	P	R	mAP5
0	mAP50-95:	100% 4/4	[00:04<00:00,	1.15s/it]			
		all	242	627	0.358	0.621	0.43
1	0.166						

```

Epoch      GPU_mem    box_loss    obj_loss    cls_loss    Instances    Siz
e
      4/9      1.94G      0.06605     0.01632     0.00699         13         41
6: 100% 31/31 [00:15<00:00,  2.00it/s]
      Class      Images  Instances          P          R      mAP5
0  mAP50-95: 100% 4/4 [00:03<00:00,  1.06it/s]
      all         242         627         0.686         0.621         0.61
8      0.308

```

```

Epoch      GPU_mem    box_loss    obj_loss    cls_loss    Instances    Siz
e
      5/9      1.94G      0.05746     0.01581     0.006323         4         41
6: 100% 31/31 [00:16<00:00,  1.93it/s]
      Class      Images  Instances          P          R      mAP5
0  mAP50-95: 100% 4/4 [00:02<00:00,  1.42it/s]
      all         242         627         0.559         0.553         0.62
7      0.234

```

```

Epoch      GPU_mem    box_loss    obj_loss    cls_loss    Instances    Siz
e
      6/9      1.94G      0.05156     0.01478     0.004606         16         41
6: 100% 31/31 [00:16<00:00,  1.92it/s]
      Class      Images  Instances          P          R      mAP5
0  mAP50-95: 100% 4/4 [00:02<00:00,  1.51it/s]
      all         242         627         0.518         0.627         0.60
9      0.288

```

```

Epoch      GPU_mem    box_loss    obj_loss    cls_loss    Instances    Siz
e
      7/9      1.94G      0.0467      0.01409     0.004122         18         41
6: 100% 31/31 [00:16<00:00,  1.93it/s]
      Class      Images  Instances          P          R      mAP5
0  mAP50-95: 100% 4/4 [00:02<00:00,  1.51it/s]
      all         242         627         0.77         0.665         0.74
8      0.387

```

```

Epoch      GPU_mem    box_loss    obj_loss    cls_loss    Instances    Siz
e
      8/9      1.94G      0.04248     0.01339     0.003558         7         41
6: 100% 31/31 [00:15<00:00,  1.94it/s]
      Class      Images  Instances          P          R      mAP5
0  mAP50-95: 100% 4/4 [00:03<00:00,  1.13it/s]
      all         242         627         0.872         0.671         0.80
2      0.46

```

```

Epoch      GPU_mem    box_loss    obj_loss    cls_loss    Instances    Siz
e
      9/9      1.94G      0.03865     0.01267     0.002999         9         41
6: 100% 31/31 [00:15<00:00,  1.97it/s]
      Class      Images  Instances          P          R      mAP5
0  mAP50-95: 100% 4/4 [00:04<00:00,  1.10s/it]
      all         242         627         0.761         0.852         0.83
3      0.492

```

10 epochs completed in 0.057 hours.

Optimizer stripped from runs/train/exp/weights/last.pt, 3.8MB

Optimizer stripped from runs/train/exp/weights/best.pt, 3.8MB

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

Fusing layers...

YOLOv5n summary: 157 layers, 1764577 parameters, 0 gradients, 4.1 GFLOPs

	Class	Images	Instances	P	R	mAP5
0	mAP50-95: 100% 4/4 [00:05<00:00, 1.43s/it]					
	all	242	627	0.748	0.836	0.83
2	0.491					
	duckie	242	494	0.783	0.849	0.85
7	0.495					
	cone	242	103	0.817	0.66	0.72
2	0.36					
	truck	242	12	0.634	0.833	0.83
6	0.613					
	bus	242	18	0.759	1	0.91
4	0.494					

Results saved to runs/train/exp

```
In [ ]: import numpy as np

all_exps = os.listdir("yolov5/runs/train")
all_exps_filtered = map(lambda x: int(x.replace("exp", "1")), filter(lambda
all_exps_filtered = np.array(list(all_exps))
latest_exp_index = np.argmax(all_exps)
latest_exp = all_exps[latest_exp_index]
print(f"Latest exp is {latest_exp}")

prun(f"cp yolov5/runs/train/{latest_exp}/weights/best.pt yolov5/best.pt")
print(f"Marked the model from the latest run ({latest_exp}) as yolov5/best.p
```

Latest exp is exp

None

Marked the model from the latest run (exp) as yolov5/best.pt.

Next, we can upload your model to Duckietown's cloud!

We will need our token to access our personal cloud space.

```
In [ ]: # TODO: Fill in the duckietown token here
YOUR_DT_TOKEN = "dt1-3nT7FDbT7NLPrXykNJW6pwvofokYQzZeC8eNrAXJqeVCqtQ-43dzqWF
```

Then, we chose the location of the trained model on disk and its name once uploaded to our cloud space. You should not change these values, or the robots will not be able to find the model to download.

```
In [ ]: import sys
sys.path.insert(0, './yolov5')

# DO NOT CHANGE THESE
```

```

model_name = "yolov5n"
model_local_path = "./yolov5/best.pt"
model_remote_path = f"courses/mooc/objdet/data/nn_models/{model_name}.pt"

# install DCSS client
!pip3 install dt-data-api-daffy

```

```

Collecting dt-data-api-daffy
  Downloading dt-data-api-daffy-1.2.0.tar.gz (12 kB)
  Preparing metadata (setup.py) ... done
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-packages (from dt-data-api-daffy) (2.31.0)
Requirement already satisfied: beautifulsoup4 in /usr/local/lib/python3.10/dist-packages (from dt-data-api-daffy) (4.11.2)
Requirement already satisfied: lxml in /usr/local/lib/python3.10/dist-packages (from dt-data-api-daffy) (4.9.3)
Collecting dt-authentication-daffy (from dt-data-api-daffy)
  Downloading dt-authentication-daffy-0.1.16.tar.gz (3.3 kB)
  Preparing metadata (setup.py) ... done
Requirement already satisfied: soupsieve>1.2 in /usr/local/lib/python3.10/dist-packages (from beautifulsoup4->dt-data-api-daffy) (2.5)
Collecting base58 (from dt-authentication-daffy->dt-data-api-daffy)
  Downloading base58-2.1.1-py3-none-any.whl (5.6 kB)
Collecting ecdsa (from dt-authentication-daffy->dt-data-api-daffy)
  Downloading ecdsa-0.18.0-py2.py3-none-any.whl (142 kB)
    _____ 142.9/142.9 kB 1.6 MB/s eta 0:00:00
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests->dt-data-api-daffy) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests->dt-data-api-daffy) (3.6)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests->dt-data-api-daffy) (2.0.7)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests->dt-data-api-daffy) (2023.11.17)
Requirement already satisfied: six>=1.9.0 in /usr/local/lib/python3.10/dist-packages (from ecdsa->dt-authentication-daffy->dt-data-api-daffy) (1.16.0)
Building wheels for collected packages: dt-data-api-daffy, dt-authentication-daffy
  Building wheel for dt-data-api-daffy (setup.py) ... done
  Created wheel for dt-data-api-daffy: filename=dt_data_api_daffy-1.2.0-py3-none-any.whl size=14284 sha256=b890db9a7085181501a989f027d141852c2d262226137500402f5190a814acd8
  Stored in directory: /root/.cache/pip/wheels/74/53/2a/80f68075691d924b254fc10c2fd5de630705daadab01c961b4
  Building wheel for dt-authentication-daffy (setup.py) ... done
  Created wheel for dt-authentication-daffy: filename=dt_authentication_daff-0.1.16-py3-none-any.whl size=3140 sha256=78f6b016867689eb36e98da412858bd438584c0404cc3e55602f9cb86dd319e2
  Stored in directory: /root/.cache/pip/wheels/a1/02/64/f1edbb576157ed7ec13aa57e824ce80df9ab24080f3a0d8e37
Successfully built dt-data-api-daffy dt-authentication-daffy
Installing collected packages: ecdsa, base58, dt-authentication-daffy, dt-data-api-daffy
Successfully installed base58-2.1.1 dt-authentication-daffy-0.1.16 dt-data-api-daffy-1.2.0 ecdsa-0.18.0

```


We now open a pointer to our cloud space and upload the model.

```
In [ ]: import torch
        from dt_data_api import DataClient, Storage

        # open a pointer to our personal duckietown cloud space
        client = DataClient(YOUR_DT_TOKEN)
        storage = client.storage("user")

        # upload model
        upload = storage.upload(model_local_path, model_remote_path)
        upload.join()
```

Done!

We're done training! You can now close this tab and go back to the **Training** notebook