ASG3 Ian Feekes

This notebook contains all materials for assignment 3 USD MSAAI Image Procesing submission by Ian Feekes (ifeekes@sandiego.edu 916-333-9381).

If the materials here do not meet the criteria, or find their way into the correct place, please contact me an I will gratefully and expediently make the corrections.

Part 1

```
import tensorflow as tf
import tensorflow_datasets as tfds
import matplotlib.pylab as plt
import numpy as np
import cv2
import pandas as pd
```

```
#a) Load the oxford_iiit_pet dataset
dataset, info = tfds.load('oxford_iiit_pet:3.*.*', with_info=True)
```

```
Downloading and preparing dataset 773.52 MiB (download: 773.52 MiB,
Dl Completed...: 100%  2/2 [00:22<00:00, 8.99s/ url]
Dl Size...: 100%  773/773 [00:22<00:00, 77.45 MiB/s]
Extraction completed...: 100%  2/2 [00:22<00:00, 11.59s/ file]
```

```
def read_and_preprocess(data):
  input_image = tf.image.resize(data['image'], (128, 128))  #Resize the data['image'] to 128x1
  input_mask = tf.image.resize(data['segmentation_mask'], (128, 128)) #Resize the data['segmer

  input_image = tf.image.convert_image_dtype(input_image, tf.float32) # [0,1]
  input_mask -= 1 # {1,2,3} to {0,1,2}
  return input_image, input_mask
```

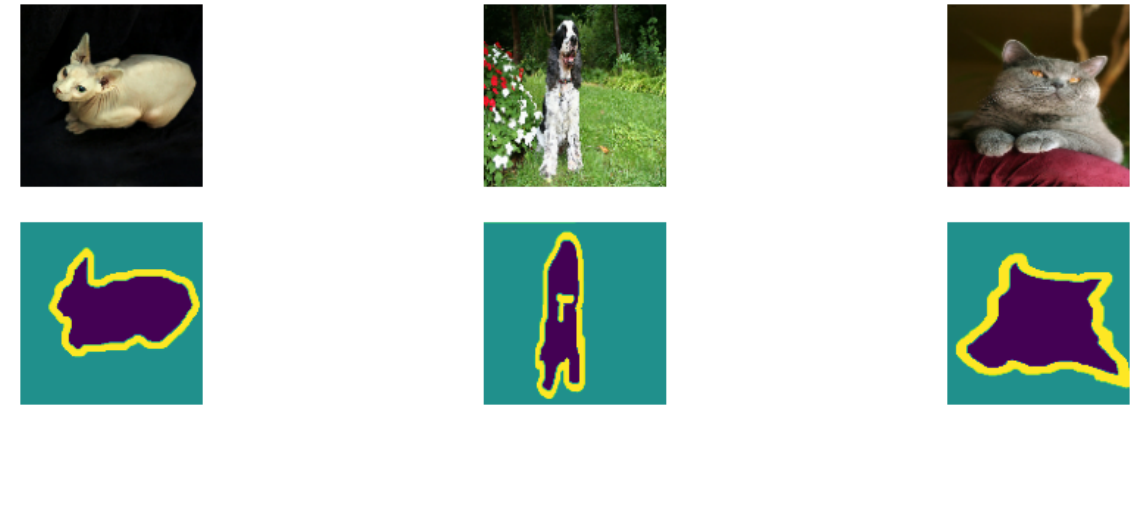
```
train = dataset['train'].map(read_and_preprocess, num_parallel_calls=tf.data.AUTOTUNE)
test = dataset['test'].map(read_and_preprocess)
```

```
# b) Create the segmentation mask
# Show some images from dataset and their segmented version

f, ax = plt.subplots(2, 3, figsize=(16,5))

for idx, (img, mask) in enumerate(train.take(3)):
```

```
  ax[0, idx].imshow(tf.keras.preprocessing.image.array_to_img(img))
  ax[0, idx].axis('off')
  mask = tf.reshape(mask, [128, 128])
  ax[1, idx].imshow(mask.numpy())
  ax[1, idx].axis('off')
```



Part 2- Annotation

```
!git clone https://github.com/matterport/Mask_RCNN.git
!pip install -r 'Mask_RCNN/requirements.txt'
!cd Mask_RCNN ; python setup.py install
```

```
    Requirement already satisfied: jsonschema>=2.6 in /usr/local/lib/python3.7/dist-package
    Requirement already satisfied: pyrsistent!=0.17.0,!=0.17.1,!=0.17.2,>=0.14.0 in /usr/lo
    Requirement already satisfied: attrs>=17.4.0 in /usr/local/lib/python3.7/dist-packages
    Requirement already satisfied: importlib-resources>=1.4.0 in /usr/local/lib/python3.7/d
    Requirement already satisfied: ptyprocess in /usr/local/lib/python3.7/dist-packages (fr
    Requirement already satisfied: webencodings in /usr/local/lib/python3.7/dist-packages (
    Collecting qtpy>=2.0.1
      Downloading QtPy-2.3.0-py3-none-any.whl (83 kB)
         |████████████████████████████████| 83 kB 2.4 MB/s
    Requirement already satisfied: sphinxcontrib-serializinghtml in /usr/local/lib/python3.
    Installing collected packages: jedi, qtpy, qtconsole, nose, ipyparallel
    Successfully installed ipyparallel-8.4.1 jedi-0.18.1 nose-1.3.7 qtconsole-5.4.0 qtpy-2.
    WARNING:root:Fail load requirements file, so using default ones.
    /usr/local/lib/python3.7/dist-packages/setuptools/dist.py:700: UserWarning: Usage of da
      % (opt, underscore_opt))
    /usr/local/lib/python3.7/dist-packages/setuptools/dist.py:700: UserWarning: Usage of da
      % (opt, underscore_opt))
    /usr/local/lib/python3.7/dist-packages/setuptools/dist.py:700: UserWarning: Usage of da
      % (opt, underscore_opt))
    running install
    running bdist_egg
    running egg_info
    creating mask_rcnn.egg-info
    writing mask_rcnn.egg-info/PKG-INFO
    writing dependency_links to mask_rcnn.egg-info/dependency_links.txt

    writing top-level names to mask_rcnn.egg-info/top_level.txt
    writing manifest file 'mask_rcnn.egg-info/SOURCES.txt'
    reading manifest template 'MANIFEST.in'
```

```
adding license file 'LICENSE'
writing manifest file 'mask_rcnn.egg-info/SOURCES.txt'
installing library code to build/bdist.linux-x86_64/egg
running install_lib
running build_py
creating build
creating build/lib
creating build/lib/mrcnn
copying mrcnn/parallel_model.py -> build/lib/mrcnn
copying mrcnn/visualize.py -> build/lib/mrcnn
copying mrcnn/__init__.py -> build/lib/mrcnn
copying mrcnn/config.py -> build/lib/mrcnn
copying mrcnn/utils.py -> build/lib/mrcnn
copying mrcnn/model.py -> build/lib/mrcnn
creating build/bdist.linux-x86_64
creating build/bdist.linux-x86_64/egg
creating build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/parallel_model.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/visualize.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/__init__.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/config.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/utils.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/model.py -> build/bdist.linux-x86_64/egg/mrcnn
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/parallel_model.py to parallel_model.c
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/visualize.py to visualize.cpython-37.
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/__init__.py to __init__.cpython-37.py
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/config.py to config.cpython-37.pyc
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/utils.py to utils.cpython-37.pyc
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/model.py to model.cpython-37.pyc
```

```
!git clone https://github.com/matterport/Mask_RCNN.git
%cd Mask_RCNN/
!python setup.py install
!wget https://github.com/matterport/Mask_RCNN/releases/download/v2.0/mask_rcnn_coco.h5
```

```
running install
running bdist_egg
running egg_info
writing mask_rcnn.egg-info/PKG-INFO
writing dependency_links to mask_rcnn.egg-info/dependency_links.txt
writing top-level names to mask_rcnn.egg-info/top_level.txt
reading manifest template 'MANIFEST.in'
adding license file 'LICENSE'
writing manifest file 'mask_rcnn.egg-info/SOURCES.txt'
installing library code to build/bdist.linux-x86_64/egg
running install_lib
running build_py
creating build/bdist.linux-x86_64/egg
creating build/bdist.linux-x86_64/egg/mrcnn

copying build/lib/mrcnn/parallel_model.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/visualize.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/__init__.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/config.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/utils.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/model.py -> build/bdist.linux-x86_64/egg/mrcnn
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/parallel_model.py to parallel_model.c
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/visualize.py to visualize.cpython-37.
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/__init__.py to __init__.cpython-37.py
```

```
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/config.py to config.cpython-37.pyc
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/utils.py to utils.cpython-37.pyc
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/model.py to model.cpython-37.pyc
creating build/bdist.linux-x86_64/egg/EGG-INFO
copying mask_rcnn.egg-info/PKG-INFO -> build/bdist.linux-x86_64/egg/EGG-INFO
copying mask_rcnn.egg-info/SOURCES.txt -> build/bdist.linux-x86_64/egg/EGG-INFO
copying mask_rcnn.egg-info/dependency_links.txt -> build/bdist.linux-x86_64/egg/EGG-INF
copying mask_rcnn.egg-info/top_level.txt -> build/bdist.linux-x86_64/egg/EGG-INFO
zip_safe flag not set; analyzing archive contents...
creating 'dist/mask_rcnn-2.1-py3.7.egg' and adding 'build/bdist.linux-x86_64/egg' to it
removing 'build/bdist.linux-x86_64/egg' (and everything under it)
Processing mask_rcnn-2.1-py3.7.egg
Removing /usr/local/lib/python3.7/dist-packages/mask_rcnn-2.1-py3.7.egg
Copying mask_rcnn-2.1-py3.7.egg to /usr/local/lib/python3.7/dist-packages
mask-rcnn 2.1 is already the active version in easy-install.pth

Installed /usr/local/lib/python3.7/dist-packages/mask_rcnn-2.1-py3.7.egg
Processing dependencies for mask-rcnn==2.1
Finished processing dependencies for mask-rcnn==2.1
--2022-11-16 14:39:26--  https://github.com/matterport/Mask_RCNN/releases/download/v2.0
Resolving github.com (github.com)... 140.82.121.4
Connecting to github.com (github.com)|140.82.121.4|:443... connected.
HTTP request sent, awaiting response... 302 Found
Location: https://objects.githubusercontent.com/github-production-release-asset-2e65be/
--2022-11-16 14:39:27--  https://objects.githubusercontent.com/github-production-releas
Resolving objects.githubusercontent.com (objects.githubusercontent.com)... 185.199.108.
Connecting to objects.githubusercontent.com (objects.githubusercontent.com)|185.199.108
HTTP request sent, awaiting response... 200 OK
Length: 257557808 (246M) [application/octet-stream]
Saving to: ‘mask_rcnn_coco.h5’

mask_rcnn_coco.h5   100%[===================>] 245.63M  12.2MB/s    in 15s

2022-11-16 14:39:42 (16.3 MB/s) - ‘mask_rcnn_coco.h5’ saved [257557808/257557808]
```

```
%cd /content/
```

```
/content
```

```
# Get data from here https://github.com/experiencor/raccoon_dataset
!git clone https://github.com/experiencor/raccoon_dataset
```

```
Cloning into 'raccoon_dataset'...
remote: Enumerating objects: 646, done.
remote: Total 646 (delta 0), reused 0 (delta 0), pack-reused 646
Receiving objects: 100% (646/646), 48.00 MiB | 21.57 MiB/s, done.
Resolving deltas: 100% (412/412), done.
```

```
%cd /content/raccoon_dataset/data
```

```
/content/raccoon_dataset/data
```

```
full_labels = pd.read_csv('raccoon_labels.csv')
full_labels
```

	filename	width	height	class	xmin	ymin	xmax	ymax
0	raccoon-1.jpg	650	417	raccoon	81	88	522	408
1	raccoon-10.jpg	450	495	raccoon	130	2	446	488
2	raccoon-100.jpg	960	576	raccoon	548	10	954	520
3	raccoon-101.jpg	640	426	raccoon	86	53	400	356
4	raccoon-102.jpg	259	194	raccoon	1	1	118	152
...	...	...	...	...	...	...	...	...
212	raccoon-95.jpg	320	400	raccoon	50	45	272	289
213	raccoon-96.jpg	230	219	raccoon	28	25	203	175
214	raccoon-97.jpg	500	393	raccoon	1	32	343	307
215	raccoon-98.jpg	480	360	raccoon	108	31	351	308
216	raccoon-99.jpg	252	228	raccoon	15	40	132	226

```
%cd /content/Mask_RCNN
```

```
/content/Mask_RCNN
```

```
from mrcnn import utils
```

```
%cd /content
```

```
/content
```

```
def draw_boxes(image_name):
    selected_value = full_labels[full_labels.filename == image_name]
    img = cv2.imread('{}'.format(image_name))
    for index, row in selected_value.iterrows():
        print(index, row)
        print(row['xmin'], row['ymin'])
        img = cv2.rectangle(img, (row['xmin'], row['ymin']), (row['xmax'], row['ymax']), (0, 2
    return img
```

```
from PIL import Image

raccoon_path = 'raccoon_dataset/images/'

# Look into data
# Plot some samples here
imageName = raccoon_path + full_labels.sample()['filename'].values[0]

Image.open(imageName)
```


```
from os import listdir
from xml.etree import ElementTree
from numpy import zeros
from numpy import asarray
from mrcnn.utils import Dataset

# class that defines and loads the raccoon dataset
class RaccoonDataset(Dataset):
    # load the dataset definitions
    def load_dataset(self, dataset_dir, is_train=True):
        # define one class
        self.add_class("raccoon_dataset", 1, "raccoon")
        # define data locations
        images_dir = dataset_dir + '/images/'
        annotations_dir = dataset_dir + '/annotations/raccoon-'
        # find all images
        for filename in listdir(images_dir):
            # extract image id
            image_id = filename[8:-4]
            # skip bad images
            if image_id in ['00090']:
                continue
            # skip all images after 150 if we are building the train set
            if is_train and int(image_id) >= 150:
                continue
            # skip all images before 150 if we are building the test/val set
            if not is_train and int(image_id) < 150:
                continue
            img_path = images_dir + filename
            ann_path = annotations_dir + image_id + '.xml'
            # add to dataset
            self.add_image('dataset', image_id=image_id, path=img_path, annotation=ann_path)

    # extract bounding boxes from an annotation file
    def extract_boxes(self, filename):
        # load and parse the file
```

```
        tree = ElementTree.parse(filename)
        # get the root of the document
        root = tree.getroot()
        # extract each bounding box
        boxes = list()
        for box in root.findall('.//bndbox'):
            xmin = int(box.find('xmin').text)
            ymin = int(box.find('ymin').text)
            xmax = int(box.find('xmax').text)
            ymax = int(box.find('ymax').text)
            coors = [xmin, ymin, xmax, ymax]
            boxes.append(coors)
        # extract image dimensions
        width = int(root.find('.//size/width').text)
        height = int(root.find('.//size/height').text)
        return boxes, width, height

    # load the masks for an image
    def load_mask(self, image_id):
        # get details of image
        info = self.image_info[image_id]
        # define box file location
        path = info['annotation']
        # load XML
        #path = '/content/raccoon_dataset/annotations/raccoon-'+image_id   #Added by me
        boxes, w, h = self.extract_boxes(path)
        # create one array for all masks, each on a different channel
        masks = zeros([h, w, len(boxes)], dtype='uint8')
        # create masks
        class_ids = list()
        for i in range(len(boxes)):
            box = boxes[i]
            row_s, row_e = box[1], box[3]
            col_s, col_e = box[0], box[2]
            masks[row_s:row_e, col_s:col_e, i] = 1
            class_ids.append(self.class_names.index('raccoon'))
        return masks, asarray(class_ids, dtype='int32')

    # load an image reference
    def image_reference(self, image_id):
        info = self.image_info[image_id]
        return info['path']

# train set
train_set = RaccoonDataset()
train_set.load_dataset('raccoon_dataset', is_train=True)
train_set.prepare()
print('Train: %d' % len(train_set.image_ids))

# test/val set
test_set = RaccoonDataset()
test_set.load_dataset('raccoon_dataset', is_train=False)
test_set.prepare()
print('Test: %d' % len(test_set.image_ids))
```

```
Train: 149
Test: 51
```

```
# load an image
train_set.image_reference(0)

# Use the function above to create the image and its mask
train_set.load_mask(0)
train_set.extract_boxes('raccoon_dataset/annotations/raccoon-1.xml')
```

```
([[81, 88, 522, 408]], 650, 417)
```

Part 3- YOLO 5

```
# a- Create annotation
# You can upload the file using ![title](filename.jpeg)
# import image module
from google.colab import drive
drive.mount('/content/drive')

Image.open("/content/drive/MyDrive/Colab Notebooks/Image_Processing/ASG3/raykin_pre_annotation
```

```
Drive already mounted at /content/drive; to attempt to forcibly rem
```


```
!git clone https://github.com/ultralytics/yolov5.git
%cd yolov5
! pip install -r requirements.txt
```

```
Requirement already satisfied: numpy>=1.18.5 in /usr/local/lib/python3.7/dist-packages
```

```
Requirement already satisfied: opencv-python>=4.1.1 in /usr/local/lib/python3.7/dist-pa
Requirement already satisfied: Pillow>=7.1.2 in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: psutil in /usr/local/lib/python3.7/dist-packages (from -
Requirement already satisfied: PyYAML>=5.3.1 in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: requests>=2.23.0 in /usr/local/lib/python3.7/dist-packag
Requirement already satisfied: scipy>=1.4.1 in /usr/local/lib/python3.7/dist-packages (
Collecting thop>=0.1.1
  Downloading thop-0.1.1.post2209072238-py3-none-any.whl (15 kB)
Requirement already satisfied: torch>=1.7.0 in /usr/local/lib/python3.7/dist-packages (
Requirement already satisfied: torchvision>=0.8.1 in /usr/local/lib/python3.7/dist-pack
Requirement already satisfied: tqdm>=4.64.0 in /usr/local/lib/python3.7/dist-packages (
Requirement already satisfied: tensorboard>=2.4.1 in /usr/local/lib/python3.7/dist-pack
Requirement already satisfied: pandas>=1.1.4 in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: seaborn>=0.11.0 in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/l
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.7/dist-pa
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.7/dist-packages (
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/dist-pack
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr/local/li
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-packages (
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: protobuf<3.20,>=3.9.2 in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: setuptools>=41.0.0 in /usr/local/lib/python3.7/dist-pack
Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /usr/local/lib/pytho
Requirement already satisfied: wheel>=0.26 in /usr/local/lib/python3.7/dist-packages (f
Requirement already satisfied: grpcio>=1.24.3 in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: werkzeug>=1.0.1 in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: absl-py>=0.4 in /usr/local/lib/python3.7/dist-packages (
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in /usr/local/lib/python3.
Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0 in /usr/local/lib/
Requirement already satisfied: google-auth<3,>=1.6.3 in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: pytz>=2017.3 in /usr/local/lib/python3.7/dist-packages (
Requirement already satisfied: rsa<5,>=3.1.4 in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: pyasn1-modules>=0.2.1 in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: cachetools<6.0,>=2.0.0 in /usr/local/lib/python3.7/dist-
Requirement already satisfied: six>=1.9.0 in /usr/local/lib/python3.7/dist-packages (fr
Requirement already satisfied: requests-oauthlib>=0.7.0 in /usr/local/lib/python3.7/dis
Requirement already satisfied: importlib-metadata>=4.4 in /usr/local/lib/python3.7/dist
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/dist-packages (fro
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in /usr/local/lib/python3.7/dist-pa
Requirement already satisfied: oauthlib>=3.0.0 in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: decorator in /usr/local/lib/python3.7/dist-packages (fro
Requirement already satisfied: backcall in /usr/local/lib/python3.7/dist-packages (from
Requirement already satisfied: pygments in /usr/local/lib/python3.7/dist-packages (from
Requirement already satisfied: pickleshare in /usr/local/lib/python3.7/dist-packages (f
Requirement already satisfied: pexpect in /usr/local/lib/python3.7/dist-packages (from

Requirement already satisfied: jedi>=0.10 in /usr/local/lib/python3.7/dist-packages (fr
Requirement already satisfied: traitlets>=4.2 in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: prompt-toolkit<2.1.0,>=2.0.0 in /usr/local/lib/python3.7
Requirement already satisfied: parso<0.9.0,>=0.8.0 in /usr/local/lib/python3.7/dist-pac
Requirement already satisfied: wcwidth in /usr/local/lib/python3.7/dist-packages (from
Requirement already satisfied: ptyprocess>=0.5 in /usr/local/lib/python3.7/dist-package
Installing collected packages: thop
```

```
#b- Download required tools
# Clone yolo 5 and check all dependencies
```

```
!python detect.py --weights yolov5s.pt --img 640 --conf 0.25 --source data/images
```

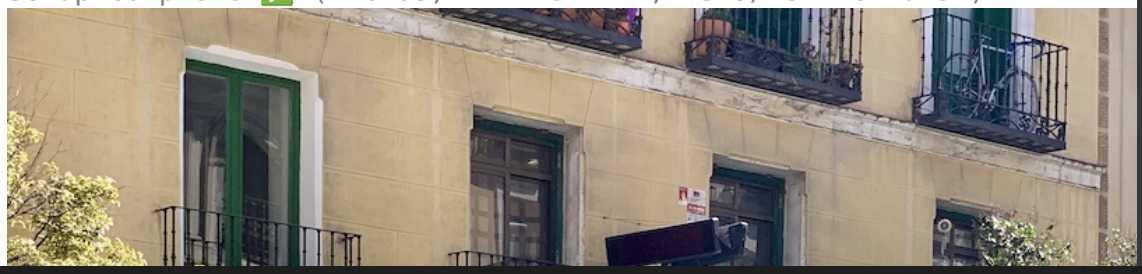
```
detect: weights=['yolov5s.pt'], source=data/images, data=data/coco128.yaml, imgsz=[640, (
YOLOv5 🚀 v6.2-243-g5e03f5f Python-3.7.15 torch-1.12.1+cu113 CUDA:0 (Tesla T4, 15110MiB)

Downloading https://github.com/ultralytics/yolov5/releases/download/v6.2/yolov5s.pt to y(
100% 14.1M/14.1M [00:00<00:00, 17.7MB/s]

Fusing layers...
YOLOv5s summary: 213 layers, 7225885 parameters, 0 gradients
image 1/2 /content/yolov5/data/images/bus.jpg: 640x480 4 persons, 1 bus, 17.1ms
image 2/2 /content/yolov5/data/images/zidane.jpg: 384x640 2 persons, 2 ties, 13.4ms
Speed: 0.5ms pre-process, 15.2ms inference, 18.9ms NMS per image at shape (1, 3, 640, 64(
Results saved to runs/detect/exp
```

```
import utils
display = utils.notebook_init() # checks
display.Image(filename='runs/detect/exp/bus.jpg', width=600)
```

```
YOLOv5 🚀 v6.2-243-g5e03f5f Python-3.7.15 torch-1.12.1+cu113 CUDA:0
Setup complete ✅ (2 CPUs, 12.7 GB RAM, 25.5/78.2 GB disk)
```



```
#c- Train the model here
# Use train.py  to train based on given criteria
!python train.py --img 640 --batch 16 --epochs 3 --data coco128.yaml --weights yolov5s.pt
```

bus	128	7	0.635	0.714	0.756	0.66
train	128	3	0.691	0.333	0.753	0.51
truck	128	12	0.604	0.333	0.472	0.2
boat	128	6	0.941	0.333	0.46	0.18
traffic light	128	14	0.557	0.183	0.302	0.21
stop sign	128	2	0.827	1	0.995	0.84
bench	128	9	0.79	0.556	0.677	0.31
bird	128	16	0.962	1	0.995	0.66
cat	128	4	0.867	1	0.995	0.75
dog	128	9	1	0.649	0.903	0.65
horse	128	2	0.853	1	0.995	0.62
elephant	128	17	0.908	0.882	0.934	0.69
bear	128	1	0.697	1	0.995	0.99
zebra	128	4	0.867	1	0.995	0.90
giraffe	128	9	0.788	0.829	0.912	0.70
backpack	128	6	0.841	0.5	0.738	0.31
umbrella	128	18	0.786	0.815	0.859	0.4
handbag	128	19	0.772	0.263	0.366	0.21
tie	128	7	0.975	0.714	0.77	0.49
suitcase	128	4	0.643	0.75	0.912	0.56
frisbee	128	5	0.72	0.8	0.76	0.71
skis	128	1	0.748	1	0.995	0.
snowboard	128	7	0.827	0.686	0.833	0.5
sports ball	128	6	0.637	0.667	0.602	0.31
kite	128	10	0.645	0.6	0.594	0.22
baseball bat	128	4	0.519	0.278	0.468	0.20
baseball glove	128	7	0.483	0.429	0.465	0.27
skateboard	128	5	0.923	0.6	0.687	0.49
tennis racket	128	7	0.774	0.429	0.544	0.33
bottle	128	18	0.577	0.379	0.551	0.27
wine glass	128	16	0.715	0.875	0.893	0.51
cup	128	36	0.843	0.667	0.833	0.53
fork	128	6	0.998	0.333	0.45	0.31
knife	128	16	0.77	0.688	0.695	0.39
spoon	128	22	0.839	0.473	0.638	0.38
bowl	128	28	0.765	0.583	0.715	0.51
banana	128	1	0.903	1	0.995	0.30
sandwich	128	2	1	0	0.359	0.30
orange	128	4	0.718	0.75	0.912	0.58
broccoli	128	11	0.545	0.364	0.43	0.31
carrot	128	24	0.62	0.625	0.724	0.49
hot dog	128	2	0.385	1	0.828	0.76
pizza	128	5	0.833	1	0.962	0.72
donut	128	14	0.631	1	0.96	0.83
cake	128	4	0.871	1	0.995	0.8
chair	128	35	0.583	0.6	0.608	0.31

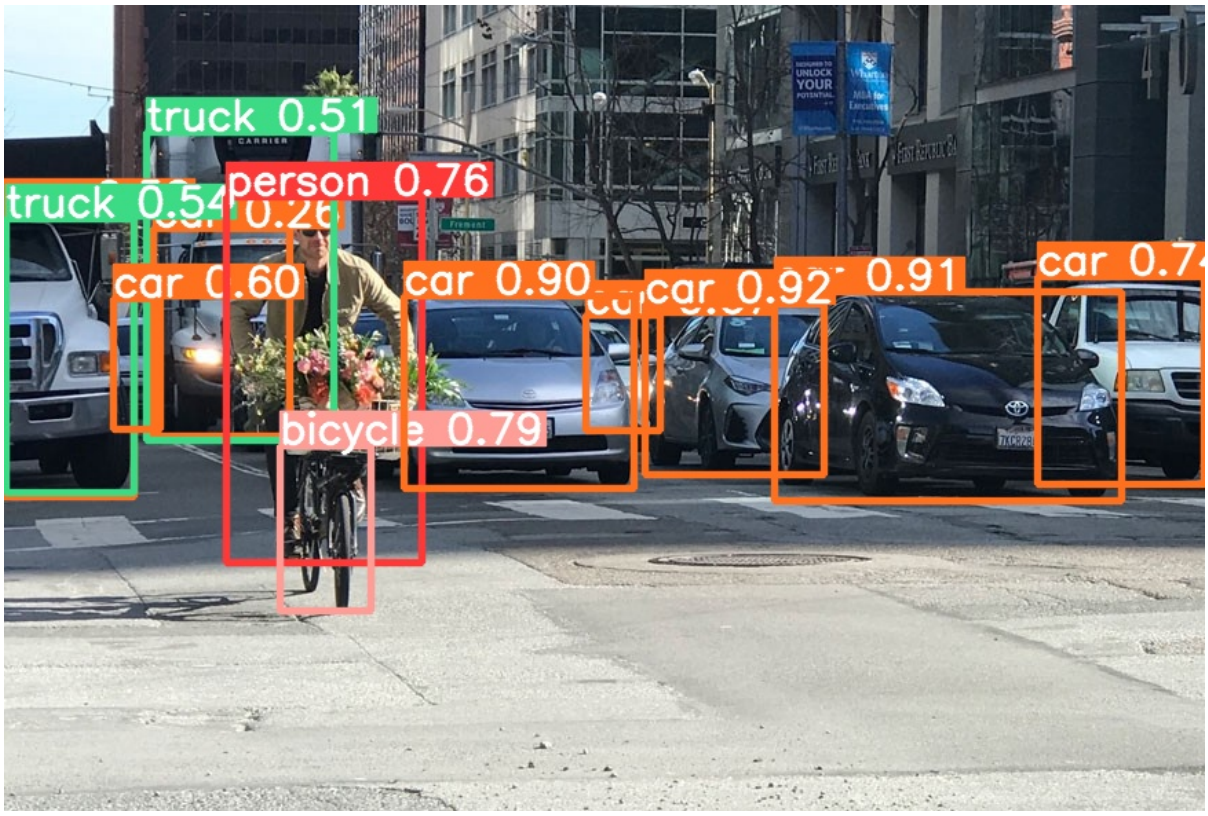
couch	128	6	0.909	0.667	0.813	0.54
potted plant	128	14	0.745	0.786	0.822	0.4
bed	128	3	0.973	0.333	0.753	0.4
dining table	128	13	0.821	0.356	0.577	0.34
toilet	128	2	1	0.949	0.995	0.79
tv	128	2	0.566	1	0.995	0.79
laptop	128	3	1	0	0.59	0.31
mouse	128	2	1	0	0.105	0.052
remote	128	8	1	0.623	0.634	0.53
cell phone	128	8	0.565	0.375	0.399	0.17
microwave	128	3	0.709	1	0.995	0.73

```
#d- Test model
# Detect the images in the given folder exp/
!python detect.py --source "/content/drive/MyDrive/Colab Notebooks/Image_Processing/ASG3/testD
```

```
detect: weights=yolov5s.pt, source=/content/drive/MyDrive/Colab Notebooks/Image_Processi
YOLOv5 🚀 v6.2-243-g5e03f5f Python-3.7.15 torch-1.12.1+cu113 CUDA:0 (Tesla T4, 15110MiB)

Fusing layers...
YOLOv5s summary: 213 layers, 7225885 parameters, 0 gradients
image 1/2 /content/drive/MyDrive/Colab Notebooks/Image_Processing/ASG3/testData/Bike.jpg
image 2/2 /content/drive/MyDrive/Colab Notebooks/Image_Processing/ASG3/testData/raykin_p
Speed: 0.5ms pre-process, 12.8ms inference, 1.2ms NMS per image at shape (1, 3, 640, 640
Results saved to runs/detect/exp3
```

```
# e- See the result.
# Show the result and all the assigned objects here
display.Image(filename='runs/detect/exp3/Bike.jpg', width=600)
```



What is your understanding from this image? What is the meaning of these numbers all over the

This image shows a person with value assigned 0.76 on a bycicle with value assigned 0.90. Behind this person there are border boxes drawn around 8 cars and 2 trucks, with values ranging from 0.51 to 0.92.

We know that YOLOv5 has 3 loss functions it undergoes during training: box_loss — bounding box regression loss (Mean Squared Error).

1. obj_loss — the confidence of object presence is the objectness loss (Binary Cross Entropy).
2. cls_loss — the classification loss (Cross Entropy).
3. box_loss — bounding box regression loss (Mean Squared Error).

These values are the normalized regression values yielded by the model, representing the confidence of the prediction towards the given class within the bounding box. We can see that on the truck on the left with a value of 0.54, there is also an orange bounding box around the same object predicting it is a car, illustrating these values in how YOLO works.