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T81-558: Applications of Deep Neural Networks

Module 6: Convolutional Neural Networks (CNN) for Computer Vision

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- For more information visit the class website.

Module 6 Material

- Part 6.1: Image Processing in Python [Video] [Notebook]
- Part 6.2: Using Convolutional Neural Networks [Video] [Notebook]
- Part 6.3: Using Pretrained Neural Networks with Keras [Video] [Notebook]
- Part 6.4: Looking at Keras Generators and Image Augmentation [Video] [Notebook]
- **Part 6.5: Recognizing Multiple Images with YOLOv5** [Video] [Notebook]

Google CoLab Instructions

The following code ensures that Google CoLab is running the correct version of TensorFlow. Running the following code will map your GDrive to `/content/drive`.

In [1]:

```
try:
    from google.colab import drive
    COLAB = True
    print("Note: using Google CoLab")
    %tensorflow_version 2.x
except:
    print("Note: not using Google CoLab")
    COLAB = False
```

```
Note: using Google CoLab
Colab only includes TensorFlow 2.x; %tensorflow_version has no effect.
```

Part 6.5: Recognizing Multiple Images with YOLO5

Programmers typically design convolutional neural networks to classify a single item centered in an image. However, as humans, we can recognize many items in our field of view in real-time. It is advantageous to recognize multiple items in a single image. One of the most advanced means of doing this is YOLOv5. You Only Look Once (YOLO) was introduced by Joseph Redmon, who supported YOLO up through V3. [Cite:redmon2016you] The fact that YOLO must only look once speaks to the efficiency of the algorithm. In this context, to "look" means to perform one scan over the image. It is also possible to run YOLO on live video streams.

Joseph Redmon left computer vision to pursue other interests. The current version, YOLOv5 is supported by the startup company Ultralytics, who released the open-source library that we use in this class.[Cite:zhu2021tph]

Researchers have trained YOLO on a variety of different computer image datasets. The version of YOLO weights used in this course is from the dataset Common Objects in Context (COCO). [Cite: lin2014microsoft] This dataset contains images labeled into 80 different classes. COCO is the source of the file coco.txt used in this module.

Using YOLO in Python

To use YOLO in Python, we will use the open-source library provided by Ultralytics.

- YOLOv5 GitHub

The code provided in this notebook works equally well when run either locally or from Google CoLab. It is easier to run YOLOv5 from CoLab, which is recommended for this course.

We begin by obtaining an image to classify.

In [2]:

```
import urllib.request
import shutil
from IPython.display import Image
!mkdir /content/images/

URL = "https://github.com/jeffheaton/t81_558_deep_learning"
URL += "/raw/master/photos/jeff_cook.jpg"
LOCAL_IMG_FILE = "/content/images/jeff_cook.jpg"

with urllib.request.urlopen(URL) as response, \
  open(LOCAL_IMG_FILE, 'wb') as out_file:
    shutil.copyfileobj(response, out_file)

Image(filename=LOCAL_IMG_FILE)
```

Out[2]:

Installing YOLOv5

YOLO is not available directly through either PIP or CONDA. Additionally, YOLO is not installed in Google CoLab by default. Therefore, whether you wish to use YOLO through CoLab or run it locally, you need to go through several steps to install it. This section describes the process of installing YOLO. The same steps apply to either CoLab or a local install. For CoLab, you must repeat these steps each time the system restarts your virtual environment. You must perform these steps only once for your virtual Python environment for a local install. If you are installing locally, install to the same virtual environment you created for this course. The following commands install YOLO directly from its GitHub repository.

In [3]:

```
import sys

!git clone https://github.com/ultralytics/yolov5 --tag 6.2  # clone
!mv /content/6.2 /content/yolov5
%pip install -qr /content/yolov5/requirements.txt  # install
sys.path.insert(0,'/content/yolov5')

import torch
import utils
display = utils.notebook_init()  # checks
```

```
YOLOv5 🚀 v6.2-195-gdf80e7c Python-3.7.14 torch-1.12.1+cu113 CUDA:0 (Tesla
T4, 15110MiB)
Setup complete ✅ (2 CPUs, 12.7 GB RAM, 38.8/166.8 GB disk)
```

Next, we will run YOLO from the command line and classify the previously downloaded kitchen picture. You can run this classification on any image you choose.

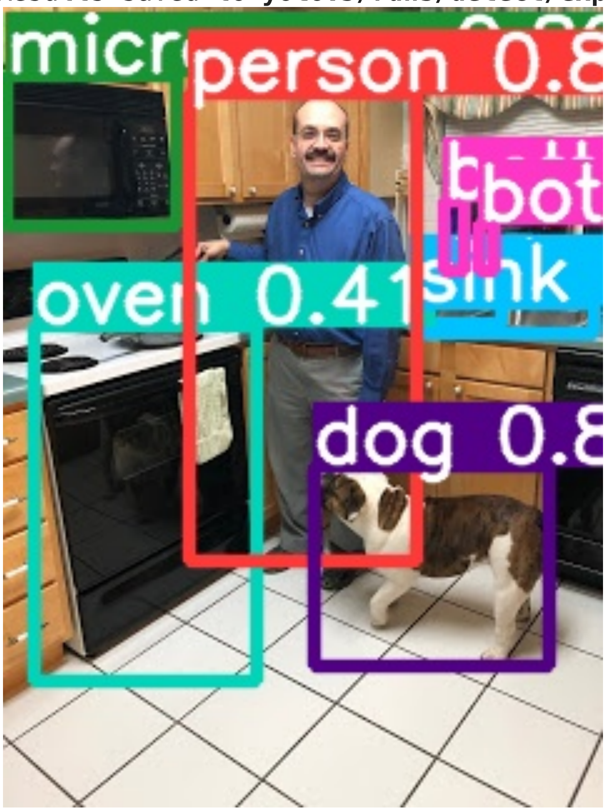
In [4]:

```
# Prepare directories for YOLO command line
!rm -R /content/yolov5/runs/detect/*
!mkdir /content/images
```

```
!cp /content/street/jeff_cook.jpg /content/images

# Run YOLO to classify
!python /content/yolov5/detect.py --weights yolov5s.pt --img 1024 \
  --conf 0.25 --source /content/images/

# Display the images
from IPython.display import Image

URL = '/content/yolov5/runs/detect/exp/jeff_cook.jpg'
Image(filename=URL, width=300)
```

```
rm: cannot remove '/content/yolov5/runs/detect/*': No such file or directo
ry
mkdir: cannot create directory ‘/content/images’: File exists
cp: cannot stat '/content/street/jeff_cook.jpg': No such file or directory
detect: weights=['yolov5s.pt'], source=/content/images/, data=yolov5/data/
coco128.yaml, imgsz=[1024, 1024], conf_thres=0.25, iou_thres=0.45, max_det
=1000, device=, view_img=False, save_txt=False, save_conf=False, save_crop
=False, nosave=False, classes=None, agnostic_nms=False, augment=False, vis
ualize=False, update=False, project=yolov5/runs/detect, name=exp, exist_ok
=False, line_thickness=3, hide_labels=False, hide_conf=False, half=False,
dnn=False, vid_stride=1
YOLOv5 🚀 v6.2-195-gdf80e7c Python-3.7.14 torch-1.12.1+cu113 CUDA:0 (Tesla
T4, 15110MiB)

Downloading https://github.com/ultralytics/yolov5/releases/download/v6.2/y
olov5s.pt to yolov5s.pt...
100% 14.1M/14.1M [00:00<00:00, 236MB/s]

Fusing layers...
YOLOv5s summary: 213 layers, 7225885 parameters, 0 gradients
image 1/1 /content/images/jeff_cook.jpg: 1024x768 1 person, 1 dog, 2 bottl
es, 1 microwave, 1 oven, 2 sinks, 21.3ms
Speed: 0.8ms pre-process, 21.3ms inference, 41.7ms NMS per image at shape
(1, 3, 1024, 1024)
Results saved to yolov5/runs/detect/exp
```

Out[4]:



In [5]:

```
!ls /content/yolov5/
```

```
benchmarks.py      detect.py    models             runs         tutorial.ipynb
classify           export.py    __pycache__        segment      utils
CONTRIBUTING.md    hubconf.py   README.md          setup.cfg    val.py
data               LICENSE      requirements.txt   train.py
```

Running YOLOv5

In addition to the command line execution, we just saw. The following code adds the downloaded YOLOv5 to Python's environment, allowing **yolov5** to be imported like a regular Python library.

In [6]:

```
import torch

# Model
yolo_model = torch.hub.load('ultralytics/yolov5', 'yolov5s')  # or yolov:

# Inference
results = yolo_model(LOCAL_IMG_FILE)

# Results
df = results.pandas().xyxy[0]
df
```

```
/usr/local/lib/python3.7/dist-packages/torch/hub.py:267: UserWarning: You
are about to download and run code from an untrusted repository. In a futu
re release, this won't be allowed. To add the repository to your trusted l
ist, change the command to {calling_fn}(..., trust_repo=False) and a comma
nd prompt will appear asking for an explicit confirmation of trust, or loa
d(..., trust_repo=True), which will assume that the prompt is to be answer
ed with 'yes'. You can also use load(..., trust_repo='check') which will o
nly prompt for confirmation if the repo is not already trusted. This will
eventually be the default behaviour
  "You are about to download and run code from an untrusted repository. In
a future release, this won't "
Downloading: "https://github.com/ultralytics/yolov5/zipball/master" to /ro
ot/.cache/torch/hub/master.zip
YOLOv5 🚀 v6.2-195-gdf80e7c Python-3.7.14 torch-1.12.1+cu113 CUDA:0 (Tesla
T4, 15110MiB)

Fusing layers...
YOLOv5s summary: 213 layers, 7225885 parameters, 0 gradients
Adding AutoShape...
```

Out[6]:

	xmin	ymin	xmax	ymax	confidence	class	name
0	125.092232	182.010025	219.074036	264.044983	0.928736	16	dog
1	72.338425	36.174423	162.752075	229.957077	0.928245	0	person
2	0.428009	25.537472	68.613434	89.955139	0.891785	68	microwave
3	0.000000	98.033714	103.113159	266.426483	0.739207	69	oven
4	176.110916	76.847527	183.783249	105.030785	0.725925	39	bottle
5	189.972397	85.284508	196.409378	105.729591	0.593492	39	bottle
6	161.864563	115.693741	237.386475	131.211624	0.571422	71	sink
7	216.053223	137.275635	239.968109	230.737457	0.364453	69	oven
8	181.397934	82.266541	195.568832	105.023056	0.252385	39	bottle

It is important to note that the **yolo** class instantiated here is a callable object, which can fill the role of both an object and a function. Acting as a function, *yolo* returns a Pandas dataframe that contains the bounding boxes (xmin/xmax and ymin/ymax), confidence, and name/class of each item detected.

Your program should use these values to perform whatever actions you wish due to the input image. The following code displays the images detected above the threshold.

You can obtain the counts of images through the use of a Pandas groupby and pivot.

In [7]:

```
df2 = df[['name','class']].groupby(by=["name"]).count().reset_index()
df2.columns = ['name','count']
df2['image'] = 1
df2.pivot(index=['image'],columns='name',values='count').reset_index().f
```

Out[7]:

name	image	bottle	dog	microwave	oven	person	sink
0	1	3	1	1	2	1	1

Module 6 Assignment

You can find the first assignment here: assignment 6