```
import os
import pathlib

# Clone the tensorflow models repository if it doesn't already exist
if "models" in pathlib.Path.cwd().parts:
  while "models" in pathlib.Path.cwd().parts:
    os.chdir('..')
elif not pathlib.Path('models').exists():
  !git clone --depth 1 https://github.com/tensorflow/models
```

```
Cloning into 'models'...
remote: Enumerating objects: 2532, done.
remote: Counting objects: 100% (2532/2532), done.
remote: Compressing objects: 100% (2110/2110), done.
remote: Total 2532 (delta 625), reused 1202 (delta 391), pack-reused 0
Receiving objects: 100% (2532/2532), 31.66 MiB | 20.66 MiB/s, done.
Resolving deltas: 100% (625/625), done.
```

```
# Install the Object Detection API
%%bash
cd /content/models/research/
protoc object_detection/protos/*.proto --python_out=.
cp object_detection/packages/tf2/setup.py .
python -m pip install .
```

```
Requirement already satisfied: rsa>=3.1.4 in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: pyasn1-modules>=0.0.5 in /usr/local/lib/python3.7/d
Requirement already satisfied: pyasn1>=0.1.7 in /usr/local/lib/python3.7/dist-pack
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/dist
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.7/d
Requirement already satisfied: chardet<5,>=3.0.2 in /usr/local/lib/python3.7/dist-
Requirement already satisfied: typeguard>=2.7 in /usr/local/lib/python3.7/dist-pac
Requirement already satisfied: scikit-learn>=0.21.3 in /usr/local/lib/python3.7/di
Requirement already satisfied: tqdm in /usr/local/lib/python3.7/dist-packages (fro
Requirement already satisfied: python-slugify in /usr/local/lib/python3.7/dist-pac
Requirement already satisfied: h5py~=2.10.0 in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: gast==0.3.3 in /usr/local/lib/python3.7/dist-packag
Requirement already satisfied: opt-einsum~=3.3.0 in /usr/local/lib/python3.7/dist-
Requirement already satisfied: keras-preprocessing~=1.1.2 in /usr/local/lib/python
Requirement already satisfied: flatbuffers~=1.12.0 in /usr/local/lib/python3.7/dis
Requirement already satisfied: termcolor~=1.1.0 in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: tensorflow-estimator<2.5.0,>=2.4.0 in /usr/local/li
Requirement already satisfied: astunparse~=1.6.3 in /usr/local/lib/python3.7/dist-
Requirement already satisfied: wheel~=0.35 in /usr/local/lib/python3.7/dist-packag
Requirement already satisfied: google-pasta~=0.2 in /usr/local/lib/python3.7/dist-
Requirement already satisfied: tensorboard~=2.4 in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: wrapt~=1.12.1 in /usr/local/lib/python3.7/dist-pack
Requirement already satisfied: uritemplate<4dev,>=3.0.0 in /usr/local/lib/python3.
Requirement already satisfied: google-auth>=1.16.0 in /usr/local/lib/python3.7/dis
Requirement already satisfied: google-api-core<2dev,>=1.21.0 in /usr/local/lib/pyt
Requirement already satisfied: google-auth-httplib2>=0.0.3 in /usr/local/lib/pytho
Requirement already satisfied: google-cloud-core<2.0dev,>=1.0.3 in /usr/local/lib/
Requirement already satisfied: google-resumable-media!=0.4.0,<0.5.0dev,>=0.3.1 in
Requirement already satisfied: tensorflow-metadata in /usr/local/lib/python3.7/dis
Requirement already satisfied: attrs>=18.1.0 in /usr/local/lib/python3.7/dist-pack
Requirement already satisfied: promise in /usr/local/lib/python3.7/dist-packages (
Requirement already satisfied: importlib-resources; python_version < "3.9" in /usr
```

```
Requirement already satisfied: dm-tree in /usr/local/lib/python3.7/dist-packages (
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: text-unidecode>=1.3 in /usr/local/lib/python3.7/dis

Requirement already satisfied: werkzeug>=0.11.15 in /usr/local/lib/python3.7/dist-
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /usr/local/lib/
Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.7/dist-pa
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in /usr/local/lib/pyt
Requirement already satisfied: cachetools<5.0,>=2.0.0 in /usr/local/lib/python3.7/
Requirement already satisfied: packaging>=14.3 in /usr/local/lib/python3.7/dist-pa
Requirement already satisfied: googleapis-common-protos<2.0dev,>=1.6.0 in /usr/loc
Requirement already satisfied: zipp>=0.4; python_version < "3.8" in /usr/local/lib
Requirement already satisfied: requests-oauthlib>=0.7.0 in /usr/local/lib/python3.
Requirement already satisfied: importlib-metadata; python_version < "3.8" in /usr/
Requirement already satisfied: oauthlib>=3.0.0 in /usr/local/lib/python3.7/dist-pa
Building wheels for collected packages: object-detection
  Building wheel for object-detection (setup.py): started
  Building wheel for object-detection (setup.py): finished with status 'done'
  Created wheel for object-detection: filename=object_detection-0.1-cp37-none-any.
  Stored in directory: /tmp/pip-ephem-wheel-cache-h563_k5y/wheels/94/49/4b/39b0516
Successfully built object-detection
Installing collected packages: object-detection
  Found existing installation: object-detection 0.1
    Uninstalling object-detection-0.1:
      Successfully uninstalled object-detection-0.1
Successfully installed object-detection-0.1
```

```
import matplotlib
import matplotlib.pyplot as plt

import os
import random
import io
import imageio
import glob
import scipy.misc
import numpy as np
from six import BytesIO
from PIL import Image, ImageDraw, ImageFont
from IPython.display import display, Javascript
from IPython.display import Image as IPyImage

import tensorflow as tf

from object_detection.utils import label_map_util
from object_detection.utils import config_util
from object_detection.utils import visualization_utils as viz_utils
from object_detection.utils import colab_utils
from object_detection.builders import model_builder

%matplotlib inline
```

```
!python /content/models/research/object_detection/builders/model_builder_tf2_test.py
```

```
I0330 06:08:06.750690 139718911186816 efficientnet_model.py:458] Building model ef
I0330 06:08:06.885504 139718911186816 ssd_efficientnet_bifpn_feature_extractor.py:
I0330 06:08:06.885726 139718911186816 ssd_efficientnet_bifpn_feature_extractor.py:
```

```
I0330 06:08:06.885833 139718911186816 ssd_efficientnet_bifpn_feature_extractor.py:
I0330 06:08:06.890661 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:06.909429 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:06.909557 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:07.210711 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:07.210906 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:07.904829 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:07.905023 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:08.595530 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:08.595797 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:09.528208 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:09.528413 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:10.483924 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:10.484125 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:11.706422 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:11.706690 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:12.092901 139718911186816 efficientnet_model.py:147] round_filter inpu
I0330 06:08:12.126414 139718911186816 efficientnet_model.py:458] Building model ef
INFO:tensorflow:time(__main__.ModelBuilderTF2Test.test_create_ssd_models_from_conf
I0330 06:08:12.549163 139718911186816 test_util.py:2076] time(__main__.ModelBuilde
[       OK ] ModelBuilderTF2Test.test_create_ssd_models_from_config
[ RUN      ] ModelBuilderTF2Test.test_invalid_faster_rcnn_batchnorm_update
INFO:tensorflow:time(__main__.ModelBuilderTF2Test.test_invalid_faster_rcnn_batchno
I0330 06:08:12.556810 139718911186816 test_util.py:2076] time(__main__.ModelBuilde
[       OK ] ModelBuilderTF2Test.test_invalid_faster_rcnn_batchnorm_update
[ RUN      ] ModelBuilderTF2Test.test_invalid_first_stage_nms_iou_threshold
INFO:tensorflow:time(__main__.ModelBuilderTF2Test.test_invalid_first_stage_nms_iou
I0330 06:08:12.558827 139718911186816 test_util.py:2076] time(__main__.ModelBuilde
[       OK ] ModelBuilderTF2Test.test_invalid_first_stage_nms_iou_threshold
[ RUN      ] ModelBuilderTF2Test.test_invalid_model_config_proto
INFO:tensorflow:time(__main__.ModelBuilderTF2Test.test_invalid_model_config_proto)
I0330 06:08:12.559420 139718911186816 test_util.py:2076] time(__main__.ModelBuilde
[       OK ] ModelBuilderTF2Test.test_invalid_model_config_proto
[ RUN      ] ModelBuilderTF2Test.test_invalid_second_stage_batch_size
INFO:tensorflow:time(__main__.ModelBuilderTF2Test.test_invalid_second_stage_batch_
I0330 06:08:12.561364 139718911186816 test_util.py:2076] time(__main__.ModelBuilde
[       OK ] ModelBuilderTF2Test.test_invalid_second_stage_batch_size
[ RUN      ] ModelBuilderTF2Test.test_session
[  SKIPPED ] ModelBuilderTF2Test.test_session
[ RUN      ] ModelBuilderTF2Test.test_unknown_faster_rcnn_feature_extractor
INFO:tensorflow:time(__main__.ModelBuilderTF2Test.test_unknown_faster_rcnn_feature
I0330 06:08:12.563117 139718911186816 test_util.py:2076] time(__main__.ModelBuilde
[       OK ] ModelBuilderTF2Test.test_unknown_faster_rcnn_feature_extractor
[ RUN      ] ModelBuilderTF2Test.test_unknown_meta_architecture
INFO:tensorflow:time(__main__.ModelBuilderTF2Test.test_unknown_meta_architecture):
I0330 06:08:12.563741 139718911186816 test_util.py:2076] time(__main__.ModelBuilde
[       OK ] ModelBuilderTF2Test.test_unknown_meta_architecture
[ RUN      ] ModelBuilderTF2Test.test_unknown_ssd_feature_extractor
INFO:tensorflow:time(__main__.ModelBuilderTF2Test.test_unknown_ssd_feature_extract
I0330 06:08:12.564959 139718911186816 test_util.py:2076] time(__main__.ModelBuilde
[       OK ] ModelBuilderTF2Test.test_unknown_ssd_feature_extractor
----------------------------------------------------------------------
Ran 21 tests in 34.493s

OK (skipped=1)
```

```
%cd /content
```

```
import os
```

```
import os
import pathlib

# Clone the training set repository if it doesn't already exist
if "ECE209AS-AI-ML_CPS-IoT" in pathlib.Path.cwd().parts:
  while "ECE209AS-AI-ML_CPS-IoT" in pathlib.Path.cwd().parts:
    os.chdir('..')
elif not pathlib.Path('ECE209AS-AI-ML_CPS-IoT').exists():
  !git clone --depth 1 https://github.com/Riyya-HI/ECE209AS-AI-ML_CPS-IoT
  %cd /content/ECE209AS-AI-ML_CPS-IoT/Training_Set
  !unzip Video_1.v1-train_vid_1.tfrecord.zip -d /content/
  %cd /content/ECE209AS-AI-ML_CPS-IoT/Test_Set
  !unzip Test_Vid_1.v1yyyy-test_vid_1.tfrecord.zip -d /content/

test_record_fname = '/content/test/Objects.tfrecord'
train_record_fname = '/content/train/Objects.tfrecord'
label_map_pbtxt_fname = '/content/train/Objects_label_map.pbtxt'
```

```
/content
Cloning into 'ECE209AS-AI-ML_CPS-IoT'...
remote: Enumerating objects: 282, done.
remote: Counting objects: 100% (282/282), done.
remote: Compressing objects: 100% (224/224), done.
remote: Total 282 (delta 48), reused 245 (delta 41), pack-reused 0
Receiving objects: 100% (282/282), 23.61 MiB | 14.39 MiB/s, done.
Resolving deltas: 100% (48/48), done.
/content/ECE209AS-AI-ML_CPS-IoT/Training_Set
Archive:  Video_1.v1-train_vid_1.tfrecord.zip
 extracting: /content/README.roboflow.txt
   creating: /content/train/
 extracting: /content/train/Objects.tfrecord
 extracting: /content/train/Objects_label_map.pbtxt
/content/ECE209AS-AI-ML_CPS-IoT/Test_Set
unzip:  cannot find or open Test_Vid_1.v1yyyy-test_vid_1.tfrecord.zip, Test_Vid_1.v1y
```

```
MODELS_CONFIG = {
    'ssd_mobilenet_v2_320x320_coco17': {
        'model_name': 'ssd_mobilenet_v2_320x320_coco17_tpu-8',
        'base_pipeline_file': 'ssd_mobilenet_v2_320x320_coco17_tpu-8.config',
        'pretrained_checkpoint': 'ssd_mobilenet_v2_320x320_coco17_tpu-8.tar.gz',
        'batch_size': 16
    }
}
chosen_model = 'ssd_mobilenet_v2_320x320_coco17'
num_steps = 1800
num_eval_steps = 500 #Perform evaluation after so many steps
model_name = MODELS_CONFIG[chosen_model]['model_name']
pretrained_checkpoint = MODELS_CONFIG[chosen_model]['pretrained_checkpoint']
batch_size = MODELS_CONFIG[chosen_model]['batch_size']
```

```
#Download pretrained weights
%mkdir /content/deploy/
%cd /content/deploy/
import tarfile
```

```
download_tar = 'http://download.tensorflow.org/models/object_detection/tf2/20200711/' + pr

!wget {download_tar}
tar = tarfile.open(pretrained_checkpoint)
tar.extractall()
tar.close()
#Shorten the folder name,because long file paths are not yet supported :(
os.rename('ssd_mobilenet_v2_320x320_coco17_tpu-8','mobilnetv2')
```

```
/content/deploy
--2021-03-30 06:08:28--  http://download.tensorflow.org/models/object_detection/tf2/2
Resolving download.tensorflow.org (download.tensorflow.org)... 108.177.125.128, 2404
Connecting to download.tensorflow.org (download.tensorflow.org)|108.177.125.128|:80.
HTTP request sent, awaiting response... 200 OK
Length: 46042990 (44M) [application/x-tar]
Saving to: ‘ssd_mobilenet_v2_320x320_coco17_tpu-8.tar.gz’

ssd_mobilenet_v2_32 100%[===================>]  43.91M  45.2MB/s    in 1.0s

2021-03-30 06:08:30 (45.2 MB/s) - ‘ssd_mobilenet_v2_320x320_coco17_tpu-8.tar.gz’ save
```

```
#Download training configuration file for mobilenetV2.
#note: configuration file contain references to your trainig set of images,
#you can change it for your dataset.
%cd /content/deploy
download_config = 'https://raw.githubusercontent.com/Riyya-HI/ECE209AS-AI-ML_CPS-IoT/main/
!wget {download_config}

#Prepare frozen model for retraining
fine_tune_checkpoint = '/content/deploy/mobilnetv2/checkpoint/ckpt-0'
pipeline_file = '/content/deploy/ssd_mobilenet_v2_320x320_coco17_tpu-8.config'
model_dir = '/content/training/'

def get_num_classes(pbtxt_fname):
    from object_detection.utils import label_map_util
    label_map = label_map_util.load_labelmap(pbtxt_fname)
    categories = label_map_util.convert_label_map_to_categories(
        label_map, max_num_classes=90, use_display_name=True)
    category_index = label_map_util.create_category_index(categories)
    return len(category_index.keys())
num_classes = get_num_classes(label_map_pbtxt_fname)
```

```
/content/deploy
--2021-03-30 06:08:33--  https://raw.githubusercontent.com/Riyya-HI/ECE209AS-AI-ML_CP
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 185.199.111.133, 1
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|185.199.111.133|
HTTP request sent, awaiting response... 200 OK
Length: 4566 (4.5K) [text/plain]
Saving to: ‘ssd_mobilenet_v2_320x320_coco17_tpu-8.config’

ssd_mobilenet_v2_32 100%[===================>]   4.46K  --.-KB/s    in 0s

2021-03-30 06:08:33 (10.9 MB/s) - ‘ssd_mobilenet_v2_320x320_coco17_tpu-8.config’ save
```

```
#Download training configuration file for mobilenetV2.

%cd /content/deploy
download_config = 'https://raw.githubusercontent.com/Riyya-HI/ECE209AS-AI-ML_CPS-IoT/main/
!wget {download_config}
```

```
/content/deploy
--2021-03-30 06:08:40--  https://raw.githubusercontent.com/Riyya-HI/ECE209AS-AI-ML_CP
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 185.199.108.133, 1
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|185.199.108.133|
HTTP request sent, awaiting response... 200 OK
Length: 4566 (4.5K) [text/plain]
Saving to: ‘ssd_mobilenet_v2_320x320_coco17_tpu-8.config.1’

ssd_mobilenet_v2_32 100%[===================>]   4.46K  --.-KB/s    in 0s

2021-03-30 06:08:40 (62.8 MB/s) - ‘ssd_mobilenet_v2_320x320_coco17_tpu-8.config.1’ sa
```

```
#Prepare loaded model for retraining
fine_tune_checkpoint = '/content/deploy/mobilnetv2/checkpoint/ckpt-0'
pipeline_file = '/content/deploy/ssd_mobilenet_v2_320x320_coco17_tpu-8.config'
model_dir = '/content/training/'

def get_num_classes(pbtxt_fname):
    from object_detection.utils import label_map_util
    label_map = label_map_util.load_labelmap(pbtxt_fname)
    categories = label_map_util.convert_label_map_to_categories(
        label_map, max_num_classes=90, use_display_name=True)
    category_index = label_map_util.create_category_index(categories)
    return len(category_index.keys())
num_classes = get_num_classes(label_map_pbtxt_fname)


#Check if all configuration is OK:
print(fine_tune_checkpoint)
print(train_record_fname)
print(label_map_pbtxt_fname)
print(batch_size)
print(num_steps)
print(num_classes)
print(pipeline_file)
print(model_dir)
```

```
/content/deploy/mobilnetv2/checkpoint/ckpt-0
/content/train/Objects.tfrecord
/content/train/Objects_label_map.pbtxt
16
1800
3
/content/deploy/ssd_mobilenet_v2_320x320_coco17_tpu-8.config
/content/training/
```

```
!python /content/models/research/object_detection/model_main_tf2.py \
    --pipeline_config_path={pipeline_file} \
    --model_dir={model_dir} \
    --alsologtostderr \
    --num_train_steps={num_steps} \
    --sample_1_of_n_eval_examples=1 \
    --num_eval_steps={num_eval_steps}
```

```
Instructions for updating:
Use fn_output_signature instead
INFO:tensorflow:Step 100 per-step time 0.430s loss=0.398
I0330 06:11:18.645122 140447261349760 model_lib_v2.py:682] Step 100 per-step time
INFO:tensorflow:Step 200 per-step time 0.439s loss=0.230
I0330 06:12:03.103222 140447261349760 model_lib_v2.py:682] Step 200 per-step time
INFO:tensorflow:Step 300 per-step time 0.425s loss=0.259
I0330 06:12:48.187092 140447261349760 model_lib_v2.py:682] Step 300 per-step time
INFO:tensorflow:Step 400 per-step time 0.432s loss=0.248
I0330 06:13:32.772857 140447261349760 model_lib_v2.py:682] Step 400 per-step time

INFO:tensorflow:Step 500 per-step time 0.468s loss=0.285
I0330 06:14:17.206605 140447261349760 model_lib_v2.py:682] Step 500 per-step time
INFO:tensorflow:Step 600 per-step time 0.419s loss=0.406
I0330 06:15:01.284596 140447261349760 model_lib_v2.py:682] Step 600 per-step time
INFO:tensorflow:Step 700 per-step time 0.436s loss=0.285
I0330 06:15:45.616692 140447261349760 model_lib_v2.py:682] Step 700 per-step time
INFO:tensorflow:Step 800 per-step time 0.429s loss=0.249
I0330 06:16:29.765930 140447261349760 model_lib_v2.py:682] Step 800 per-step time
INFO:tensorflow:Step 900 per-step time 0.464s loss=0.238
I0330 06:17:13.871546 140447261349760 model_lib_v2.py:682] Step 900 per-step time
INFO:tensorflow:Step 1000 per-step time 0.444s loss=0.224
I0330 06:17:58.137957 140447261349760 model_lib_v2.py:682] Step 1000 per-step time
INFO:tensorflow:Step 1100 per-step time 0.432s loss=0.325
I0330 06:18:43.299706 140447261349760 model_lib_v2.py:682] Step 1100 per-step time
INFO:tensorflow:Step 1200 per-step time 0.430s loss=0.274
I0330 06:19:27.648650 140447261349760 model_lib_v2.py:682] Step 1200 per-step time
INFO:tensorflow:Step 1300 per-step time 0.434s loss=0.256
I0330 06:20:12.144777 140447261349760 model_lib_v2.py:682] Step 1300 per-step time
INFO:tensorflow:Step 1400 per-step time 0.427s loss=0.217
I0330 06:20:56.534318 140447261349760 model_lib_v2.py:682] Step 1400 per-step time
INFO:tensorflow:Step 1500 per-step time 0.474s loss=0.279
I0330 06:21:41.327451 140447261349760 model_lib_v2.py:682] Step 1500 per-step time
Traceback (most recent call last):
  File "/content/models/research/object_detection/model_main_tf2.py", line 113, in
    tf.compat.v1.app.run()
  File "/usr/local/lib/python3.7/dist-packages/tensorflow/python/platform/app.py",
    _run(main=main, argv=argv, flags_parser=_parse_flags_tolerate_undef)
  File "/usr/local/lib/python3.7/dist-packages/absl/app.py", line 300, in run
    _run_main(main, args)
  File "/usr/local/lib/python3.7/dist-packages/absl/app.py", line 251, in _run_mai
    sys.exit(main(argv))
  File "/content/models/research/object_detection/model_main_tf2.py", line 110, in
    record_summaries=FLAGS.record_summaries)
  File "/usr/local/lib/python3.7/dist-packages/object_detection/model_lib_v2.py",
    loss = _dist_train_step(train_input_iter)
  File "/usr/local/lib/python3.7/dist-packages/tensorflow/python/eager/def_functio
    result = self._call(*args, **kwds)
  File "/usr/local/lib/python3.7/dist-packages/tensorflow/python/eager/def_functio
    return self._stateless_fn(*args, **kwds)  # pylint: disable=not-callable
  File "/usr/local/lib/python3.7/dist-packages/tensorflow/python/eager/function.py
    filtered_flat_args, captured_inputs=graph_function.captured_inputs)  # pylint:
  File "/usr/local/lib/python3.7/dist-packages/tensorflow/python/eager/function.py
    ctx, args, cancellation_manager=cancellation_manager))
```

```
  File "/usr/local/lib/python3.7/dist-packages/tensorflow/python/eager/function.py
    ctx=ctx)
  File "/usr/local/lib/python3.7/dist-packages/tensorflow/python/eager/execute.py"
    inputs, attrs, num_outputs)
KeyboardInterrupt
```

```
#Your trained weights will be in this directory:
%ls -l '/content/training/'
```

```
total 54936
-rw-r--r-- 1 root root      254 Mar 30 06:17 checkpoint
-rw-r--r-- 1 root root 18780069 Mar 30 06:10 ckpt-1.data-00000-of-00001
-rw-r--r-- 1 root root    22266 Mar 30 06:10 ckpt-1.index
-rw-r--r-- 1 root root 37392549 Mar 30 06:17 ckpt-2.data-00000-of-00001
-rw-r--r-- 1 root root    41646 Mar 30 06:17 ckpt-2.index
drwxr-xr-x 2 root root     4096 Mar 30 06:09 train/
```

```
#Run conversion script to save the retrained model:
#Saved model will be in saved_model.pb file:

import re
import numpy as np

output_directory = '/content/fine_tuned_model'

#place the model weights you would like to export here
last_model_path = '/content/training/'
print(last_model_path)
!python /content/models/research/object_detection/exporter_main_v2.py \
    --trained_checkpoint_dir {last_model_path} \
    --output_directory {output_directory} \
    --pipeline_config_path {pipeline_file}
```

```
pciBusID: 0000:00:04.0 name: Tesla K80 computeCapability: 3.7

coreClock: 0.8235GHz coreCount: 13 deviceMemorySize: 11.17GiB deviceMemoryBandwidt
2021-03-30 06:21:56.871613: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 06:21:56.871684: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 06:21:56.871731: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 06:21:56.871774: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 06:21:56.871838: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 06:21:56.871885: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 06:21:56.871931: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 06:21:56.871971: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 06:21:56.872102: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc
2021-03-30 06:21:56.872937: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc
2021-03-30 06:21:56.873694: I tensorflow/core/common_runtime/gpu/gpu_device.cc:186
2021-03-30 06:21:56.873748: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 06:21:57.326333: I tensorflow/core/common_runtime/gpu/gpu_device.cc:126
2021-03-30 06:21:57.326419: I tensorflow/core/common_runtime/gpu/gpu_device.cc:126
2021-03-30 06:21:57.326450: I tensorflow/core/common_runtime/gpu/gpu_device.cc:128
2021-03-30 06:21:57.326808: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc
2021-03-30 06:21:57.327714: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc
2021-03-30 06:21:57.328513: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc
2021-03-30 06:21:57.329312: W tensorflow/core/common_runtime/gpu/gpu_bfc_allocator
2021-03-30 06:21:57.329379: I tensorflow/core/common_runtime/gpu/gpu_device.cc:140
WARNING:tensorflow:From /usr/local/lib/python3.7/dist-packages/object_detection/ex
```

```
Instructions for updating:
back_prop=False is deprecated. Consider using tf.stop_gradient instead.
Instead of:
results = tf.map_fn(fn, elems, back_prop=False)
Use:
results = tf.nest.map_structure(tf.stop_gradient, tf.map_fn(fn, elems))
W0330 06:21:57.549896 140593704208256 deprecation.py:604] From /usr/local/lib/pyth
Instructions for updating:
back_prop=False is deprecated. Consider using tf.stop_gradient instead.
Instead of:
results = tf.map_fn(fn, elems, back_prop=False)
Use:
results = tf.nest.map_structure(tf.stop_gradient, tf.map_fn(fn, elems))
INFO:tensorflow:depth of additional conv before box predictor: 0
I0330 06:22:04.625980 140593704208256 convolutional_keras_box_predictor.py:154] de
INFO:tensorflow:depth of additional conv before box predictor: 0
I0330 06:22:04.626435 140593704208256 convolutional_keras_box_predictor.py:154] de
INFO:tensorflow:depth of additional conv before box predictor: 0
I0330 06:22:04.626771 140593704208256 convolutional_keras_box_predictor.py:154] de
INFO:tensorflow:depth of additional conv before box predictor: 0
I0330 06:22:04.627090 140593704208256 convolutional_keras_box_predictor.py:154] de
INFO:tensorflow:depth of additional conv before box predictor: 0
I0330 06:22:04.627359 140593704208256 convolutional_keras_box_predictor.py:154] de
INFO:tensorflow:depth of additional conv before box predictor: 0
I0330 06:22:04.627695 140593704208256 convolutional_keras_box_predictor.py:154] de
WARNING:tensorflow:Skipping full serialization of Keras layer <object_detection.me
W0330 06:22:14.895884 140593704208256 save_impl.py:78] Skipping full serialization
2021-03-30 06:22:28.820163: W tensorflow/python/util/util.cc:348] Sets are not cur
W0330 06:22:50.284532 140593704208256 save.py:241] Found untraced functions such a
W0330 06:22:51.810807 140593704208256 save.py:241] Found untraced functions such a
INFO:tensorflow:Assets written to: /content/fine_tuned_model/saved_model/assets
I0330 06:22:57.659996 140593704208256 builder_impl.py:775] Assets written to: /con
INFO:tensorflow:Writing pipeline config file to /content/fine_tuned_model/pipeline
I0330 06:22:58.434734 140593704208256 config_util.py:254] Writing pipeline config
```

```
%ls '/content/fine_tuned_model/saved_model/'
```

```
assets/  saved_model.pb  variables/
```

```
%mkdir /content/test
%cd /content/test
d_image = 'https://raw.githubusercontent.com/Riyya-HI/ECE209AS-AI-ML_CPS-IoT/main/test.jpg
!wget {d_image}
```

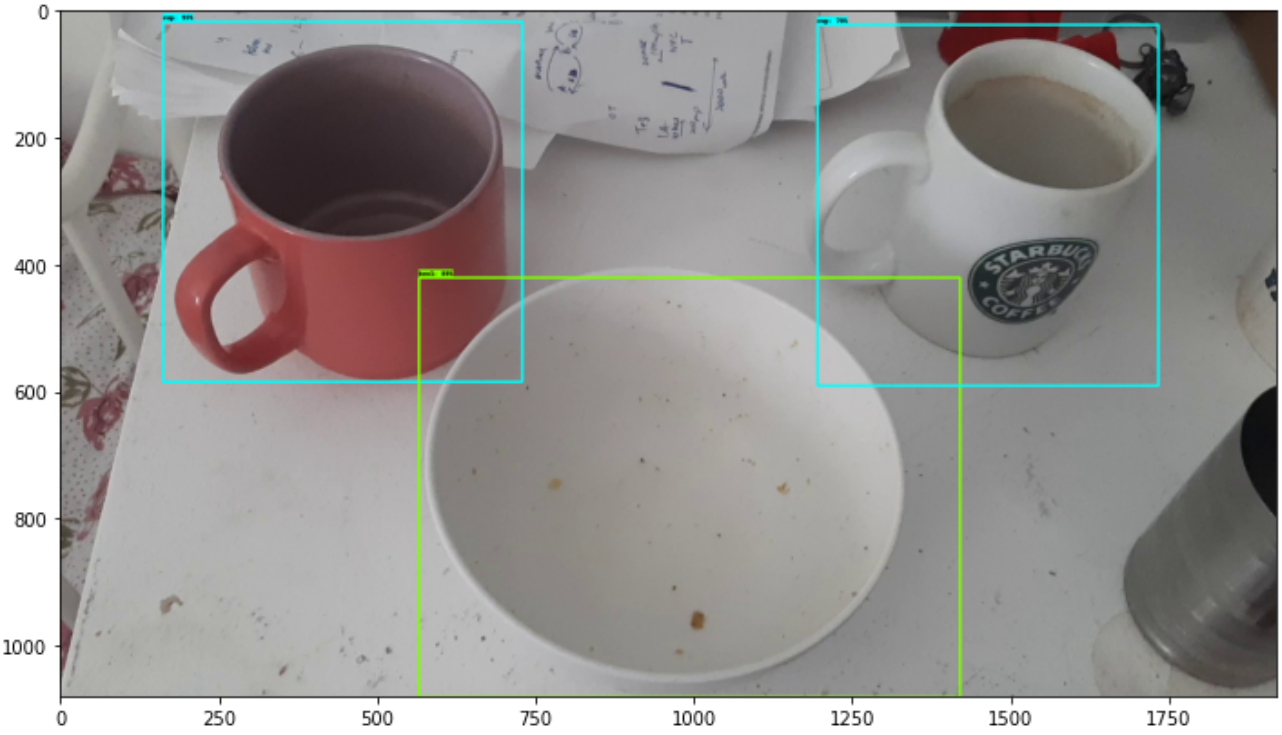
```
/content/test
--2021-03-30 06:23:31--  https://raw.githubusercontent.com/Riyya-HI/ECE209AS-AI-ML_CP
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 185.199.109.133, 1
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|185.199.109.133|
HTTP request sent, awaiting response... 200 OK
Length: 338089 (330K) [image/jpeg]
Saving to: ‘test.jpg’

test.jpg            100%[===================>] 330.17K  --.-KB/s    in 0.04s

2021-03-30 06:23:32 (7.93 MB/s) - ‘test.jpg’ saved [338089/338089]
```

```
import os
import glob
import matplotlib
import matplotlib.pyplot as plt

import io
import scipy.misc
import numpy as np
from six import BytesIO
from PIL import Image, ImageDraw, ImageFont

import tensorflow as tf

from object_detection.utils import label_map_util
from object_detection.utils import config_util
from object_detection.utils import visualization_utils as viz_utils
from object_detection.builders import model_builder

%matplotlib inline


#Recover our saved model with the latest checkpoint:
pipeline_config = pipeline_file
#Put the last ckpt from training in here, don't use long pathnames:
model_dir = '/content/training/ckpt-2'
configs = config_util.get_configs_from_pipeline_file(pipeline_config)
model_config = configs['model']
detection_model = model_builder.build(
      model_config=model_config, is_training=False)

# Restore last checkpoint
ckpt = tf.compat.v2.train.Checkpoint(
      model=detection_model)
#ckpt.restore(os.path.join(model_dir))
ckpt.restore(model_dir)

#Function perform detection of the object on image in tensor format:
def get_model_detection_function(model):
  """Get a tf.function for detection."""

  @tf.function
  def detect_fn(image):
    """Detect objects in image."""
    image, shapes = model.preprocess(image)
    prediction_dict = model.predict(image, shapes)
    detections = model.postprocess(prediction_dict, shapes)

    return detections, prediction_dict, tf.reshape(shapes, [-1])

  return detect_fn

#Define function which performs detection:
detect_fn = get_model_detection_function(detection_model)
```

```
#map labels for inference decoding
label_map_path = configs['eval_input_config'].label_map_path
label_map = label_map_util.load_labelmap(label_map_path)
categories = label_map_util.convert_label_map_to_categories(
    label_map,
    max_num_classes=label_map_util.get_max_label_map_index(label_map),
    use_display_name=True)
category_index = label_map_util.create_category_index(categories)
label_map_dict = label_map_util.get_label_map_dict(label_map, use_display_name=True)


#run detector on test image
#it takes a little longer on the first run and then runs at normal speed.
import random

#Define utility functions for presenting the results:
def load_image_into_numpy_array(path):
  """Load an image from file into a numpy array.
  Puts image into numpy array to feed into tensorflow graph.
  Note that by convention we put it into a numpy array with shape
  (height, width, channels), where channels=3 for RGB.
  Args:
    path: the file path to the image
  Returns:
    uint8 numpy array with shape (img_height, img_width, 3)
  """
  img_data = tf.io.gfile.GFile(path, 'rb').read()
  image = Image.open(BytesIO(img_data))
  (im_width, im_height) = image.size
  return np.array(image.getdata()).reshape(
      (im_height, im_width, 3)).astype(np.uint8)


#Place your test images here:
image_path = '/content/test/test.jpg'

#Store test images in nmpy array:
image_np = load_image_into_numpy_array(image_path)

#Convert images to tensor form:
input_tensor = tf.convert_to_tensor(
    np.expand_dims(image_np, 0), dtype=tf.float32)

#Perform detection on the image in tensor format:
detections, predictions_dict, shapes = detect_fn(input_tensor)

#Visualize the detection boxes on the image:
label_id_offset = 1
image_np_with_detections = image_np.copy()

viz_utils.visualize_boxes_and_labels_on_image_array(
      image_np_with_detections,
      detections['detection_boxes'][0].numpy(),
      (detections['detection_classes'][0].numpy() + label_id_offset).astype(int),
      detections['detection_scores'][0].numpy(),
```

```
      category_index,
      use_normalized_coordinates=True,
      max_boxes_to_draw=200,
      min_score_thresh=0.70,#0.5,#0.5
      agnostic_mode=False,
)

plt.figure(figsize=(12,16))
plt.imshow(image_np_with_detections)
plt.show()
```

```
INFO:tensorflow:depth of additional conv before box predictor: 0
INFO:tensorflow:depth of additional conv before box predictor: 0
INFO:tensorflow:depth of additional conv before box predictor: 0
INFO:tensorflow:depth of additional conv before box predictor: 0
INFO:tensorflow:depth of additional conv before box predictor: 0
INFO:tensorflow:depth of additional conv before box predictor: 0
```




```
plt.figure(figsize=(40,48))
plt.imshow(image_np_with_detections)
plt.show()
```


cup: 93%
cup: 70%
bowl: 89%
STARBUCKS
COFFEE
0
200
400
600
800
1000
0
250
500
750
1000
1250
1500
1750