```
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% (2089/2089), done.
remote: Total 2532 (delta 631), reused 1399 (delta 412), pack-reused 0
Receiving objects: 100% (2532/2532), 31.65 MiB | 32.77 MiB/s, done.
Resolving deltas: 100% (631/631), 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: chardet<3,>=3.0.2 in /usr/local/lib/python3.7/dist-
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: pbr>=0.11 in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: rsa>=3.1.4 in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: pyasn1>=0.1.7 in /usr/local/lib/python3.7/dist-pack
Requirement already satisfied: pyasn1-modules>=0.0.5 in /usr/local/lib/python3.7/d
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: scikit-learn>=0.21.3 in /usr/local/lib/python3.7/di
Requirement already satisfied: google-pasta~=0.2 in /usr/local/lib/python3.7/dist-
Requirement already satisfied: h5py~=2.10.0 in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: wheel~=0.35 in /usr/local/lib/python3.7/dist-packag
Requirement already satisfied: wrapt~=1.12.1 in /usr/local/lib/python3.7/dist-pack
Requirement already satisfied: tensorboard~=2.4 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: gast==0.3.3 in /usr/local/lib/python3.7/dist-packag
Requirement already satisfied: termcolor~=1.1.0 in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: keras-preprocessing~=1.1.2 in /usr/local/lib/python
Requirement already satisfied: opt-einsum~=3.3.0 in /usr/local/lib/python3.7/dist-
Requirement already satisfied: astunparse~=1.6.3 in /usr/local/lib/python3.7/dist-
Requirement already satisfied: flatbuffers~=1.12.0 in /usr/local/lib/python3.7/dis
Requirement already satisfied: python-slugify in /usr/local/lib/python3.7/dist-pac
Requirement already satisfied: tqdm in /usr/local/lib/python3.7/dist-packages (fro
Requirement already satisfied: tensorflow-metadata in /usr/local/lib/python3.7/dis
Requirement already satisfied: dm-tree in /usr/local/lib/python3.7/dist-packages (
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: 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-auth-httplib2>=0.0.3 in /usr/local/lib/pytho
Requirement already satisfied: google-api-core<2dev,>=1.21.0 in /usr/local/lib/pyt
```

```
Requirement already satisfied: typeguard>=2.7 in /usr/local/lib/python3.7/dist-pac
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in /usr/local/lib/pyt

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: text-unidecode>=1.3 in /usr/local/lib/python3.7/dis
Requirement already satisfied: googleapis-common-protos<2,>=1.52.0 in /usr/local/l
Requirement already satisfied: zipp>=0.4; python_version < "3.8" in /usr/local/lib
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: 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-9ngymcf2/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 05:33:37.470775 140580451927936 ssd_efficientnet_bifpn_feature_extractor.py:
I0330 05:33:37.470936 140580451927936 ssd_efficientnet_bifpn_feature_extractor.py:
```

```
I0330 05:33:37.471021 140580451927936 ssd_efficientnet_bifpn_feature_extractor.py:
I0330 05:33:37.475758 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:37.491157 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:37.491272 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:37.736769 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:37.736939 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:38.308776 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:38.308966 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:38.863330 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:38.863529 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:39.637200 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:39.637376 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:40.416736 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:40.416938 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:41.438528 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:41.438714 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:41.771392 140580451927936 efficientnet_model.py:147] round_filter inpu
I0330 05:33:41.803578 140580451927936 efficientnet_model.py:458] Building model ef
INFO:tensorflow:time(__main__.ModelBuilderTF2Test.test_create_ssd_models_from_conf
I0330 05:33:42.195984 140580451927936 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 05:33:42.203162 140580451927936 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 05:33:42.204955 140580451927936 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 05:33:42.205523 140580451927936 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 05:33:42.207130 140580451927936 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 05:33:42.208645 140580451927936 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 05:33:42.209110 140580451927936 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 05:33:42.210197 140580451927936 test_util.py:2076] time(__main__.ModelBuilde
[       OK ] ModelBuilderTF2Test.test_unknown_ssd_feature_extractor
----------------------------------------------------------------------
Ran 21 tests in 30.189s

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 | 19.41 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 05:34:17--  http://download.tensorflow.org/models/object_detection/tf2/2
Resolving download.tensorflow.org (download.tensorflow.org)... 209.85.234.128, 2607:f
Connecting to download.tensorflow.org (download.tensorflow.org)|209.85.234.128|: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  41.3MB/s    in 1.1s

2021-03-30 05:34:18 (41.3 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 05:34:22--  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: 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 05:34:22 (70.5 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 05:34:27--  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 05:34:27 (47.2 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}
```

```
INFO:tensorflow:Reduce to /job:localhost/replica:0/task:0/device:CPU:0 then broadc
I0330 05:35:48.642535 140098900535168 cross_device_ops.py:565] Reduce to /job:loca
WARNING:tensorflow:From /usr/local/lib/python3.7/dist-packages/tensorflow/python/u
Instructions for updating:
Use fn_output_signature instead
W0330 05:35:55.363505 140098148964096 deprecation.py:537] From /usr/local/lib/pyth
Instructions for updating:
Use fn_output_signature instead
INFO:tensorflow:Step 100 per-step time 0.421s loss=0.313
I0330 05:36:47.110969 140098900535168 model_lib_v2.py:682] Step 100 per-step time
INFO:tensorflow:Step 200 per-step time 0.374s loss=0.327
I0330 05:37:25.070180 140098900535168 model_lib_v2.py:682] Step 200 per-step time
INFO:tensorflow:Step 300 per-step time 0.391s loss=0.263
I0330 05:38:02.665912 140098900535168 model_lib_v2.py:682] Step 300 per-step time
INFO:tensorflow:Step 400 per-step time 0.353s loss=0.316
I0330 05:38:39.789432 140098900535168 model_lib_v2.py:682] Step 400 per-step time

INFO:tensorflow:Step 500 per-step time 0.392s loss=0.309
I0330 05:39:17.941991 140098900535168 model_lib_v2.py:682] Step 500 per-step time
INFO:tensorflow:Step 600 per-step time 0.439s loss=0.254
I0330 05:39:56.088531 140098900535168 model_lib_v2.py:682] Step 600 per-step time
INFO:tensorflow:Step 700 per-step time 0.421s loss=0.249
I0330 05:40:34.238693 140098900535168 model_lib_v2.py:682] Step 700 per-step time
INFO:tensorflow:Step 800 per-step time 0.355s loss=0.290
I0330 05:41:11.506796 140098900535168 model_lib_v2.py:682] Step 800 per-step time
INFO:tensorflow:Step 900 per-step time 0.428s loss=0.293
I0330 05:41:49.312507 140098900535168 model_lib_v2.py:682] Step 900 per-step time
INFO:tensorflow:Step 1000 per-step time 0.393s loss=0.243
I0330 05:42:26.700266 140098900535168 model_lib_v2.py:682] Step 1000 per-step time
INFO:tensorflow:Step 1100 per-step time 0.389s loss=0.278
I0330 05:43:04.883443 140098900535168 model_lib_v2.py:682] Step 1100 per-step time
INFO:tensorflow:Step 1200 per-step time 0.374s loss=0.274
I0330 05:43:42.477336 140098900535168 model_lib_v2.py:682] Step 1200 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      255 Mar 30 05:42 checkpoint
-rw-r--r-- 1 root root 18780069 Mar 30 05:35 ckpt-1.data-00000-of-00001
-rw-r--r-- 1 root root    22266 Mar 30 05:35 ckpt-1.index
-rw-r--r-- 1 root root 37392549 Mar 30 05:42 ckpt-2.data-00000-of-00001
-rw-r--r-- 1 root root    41646 Mar 30 05:42 ckpt-2.index
drwxr-xr-x 2 root root     4096 Mar 30 05:34 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 P4 computeCapability: 6.1

coreClock: 1.1135GHz coreCount: 20 deviceMemorySize: 7.43GiB deviceMemoryBandwidth
2021-03-30 05:44:00.918078: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 05:44:00.918139: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 05:44:00.918165: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 05:44:00.918191: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 05:44:00.918215: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 05:44:00.918239: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 05:44:00.918262: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 05:44:00.918285: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 05:44:00.918359: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc
2021-03-30 05:44:00.919025: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc
2021-03-30 05:44:00.919747: I tensorflow/core/common_runtime/gpu/gpu_device.cc:186
2021-03-30 05:44:00.919802: I tensorflow/stream_executor/platform/default/dso_load
2021-03-30 05:44:01.460910: I tensorflow/core/common_runtime/gpu/gpu_device.cc:126
2021-03-30 05:44:01.460977: I tensorflow/core/common_runtime/gpu/gpu_device.cc:126
2021-03-30 05:44:01.461003: I tensorflow/core/common_runtime/gpu/gpu_device.cc:128
2021-03-30 05:44:01.461231: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc
2021-03-30 05:44:01.461755: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc
2021-03-30 05:44:01.462233: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc
2021-03-30 05:44:01.462618: W tensorflow/core/common_runtime/gpu/gpu_bfc_allocator
2021-03-30 05:44:01.462690: 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 05:44:01.641786 139881328240512 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 05:44:07.619042 139881328240512 convolutional_keras_box_predictor.py:154] de
INFO:tensorflow:depth of additional conv before box predictor: 0
I0330 05:44:07.619437 139881328240512 convolutional_keras_box_predictor.py:154] de
INFO:tensorflow:depth of additional conv before box predictor: 0
I0330 05:44:07.619685 139881328240512 convolutional_keras_box_predictor.py:154] de
INFO:tensorflow:depth of additional conv before box predictor: 0
I0330 05:44:07.619919 139881328240512 convolutional_keras_box_predictor.py:154] de
INFO:tensorflow:depth of additional conv before box predictor: 0
I0330 05:44:07.620160 139881328240512 convolutional_keras_box_predictor.py:154] de
INFO:tensorflow:depth of additional conv before box predictor: 0
I0330 05:44:07.620390 139881328240512 convolutional_keras_box_predictor.py:154] de
WARNING:tensorflow:Skipping full serialization of Keras layer <object_detection.me
W0330 05:44:16.030057 139881328240512 save_impl.py:78] Skipping full serialization
2021-03-30 05:44:27.144714: W tensorflow/python/util/util.cc:348] Sets are not cur
W0330 05:44:43.911321 139881328240512 save.py:241] Found untraced functions such a
W0330 05:44:45.008176 139881328240512 save.py:241] Found untraced functions such a
INFO:tensorflow:Assets written to: /content/fine_tuned_model/saved_model/assets
I0330 05:44:49.585448 139881328240512 builder_impl.py:775] Assets written to: /con
INFO:tensorflow:Writing pipeline config file to /content/fine_tuned_model/pipeline
I0330 05:44:50.275032 139881328240512 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}
```

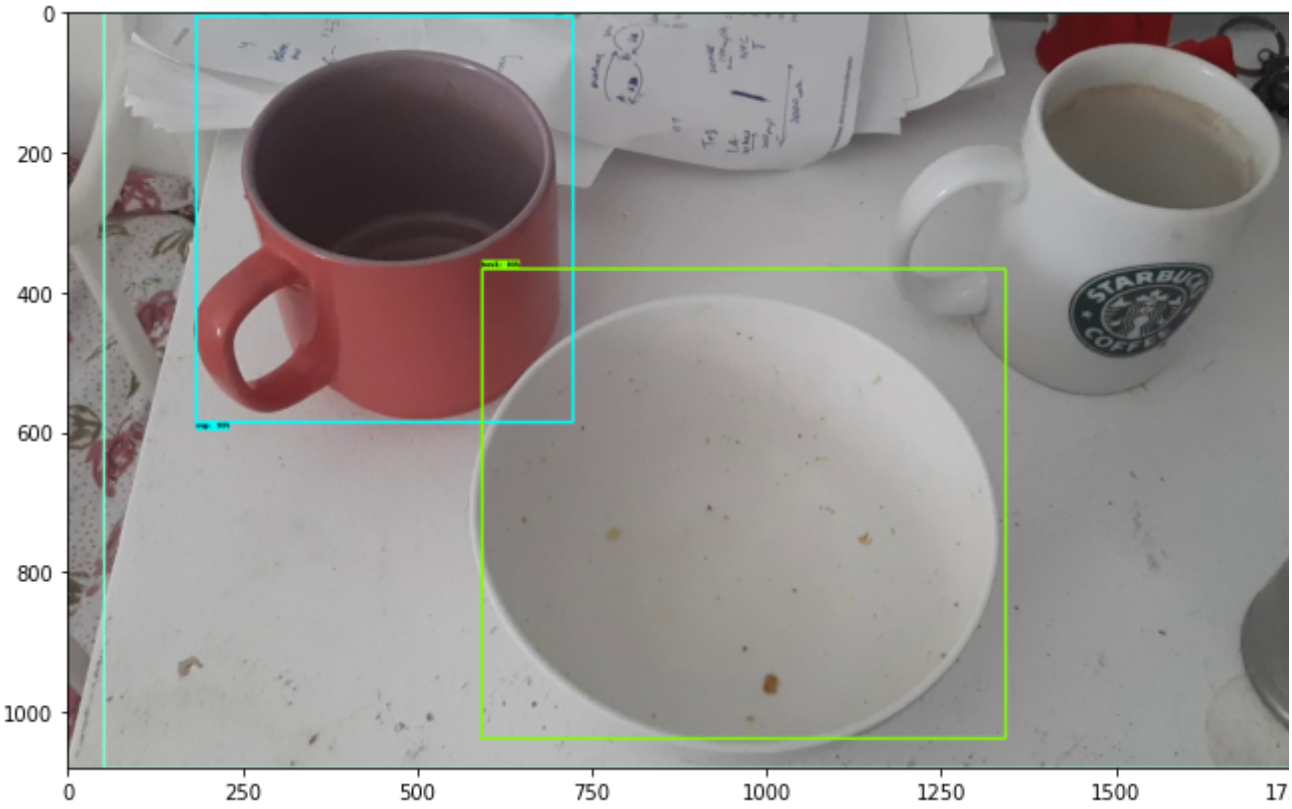
```
/content/test
--2021-03-30 05:45:55--  https://raw.githubusercontent.com/Riyya-HI/ECE209AS-AI-ML_CP
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 185.199.111.133, 1
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|185.199.111.133|
HTTP request sent, awaiting response... 200 OK
Length: 338089 (330K) [image/jpeg]
Saving to: ‘test.jpg’

test.jpg            100%[===================>] 330.17K  --.-KB/s    in 0.03s

2021-03-30 05:45:55 (9.70 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()
```

✓ 3s completed at 10:47 PM