

Object Detection API Demo

Welcome to the [Object Detection API](#). This notebook will walk you step by step through the process of using a pre-trained model to detect objects in an image.

Important: This tutorial is to help you through the first step towards using [Object Detection API](#) to build models. If you just need an off the shelf model that does the job, see the [TFHub object detection example](#).

Setup

Important: If you're running on a local machine, be sure to follow the [installation instructions](#). This notebook includes only what's necessary to run in Colab.

Get `tensorflow/models` or `cd` to parent directory of the repository.

```
from google.colab import drive
drive.mount('/content/drive')
```

Mounted at /content/drive

```
import os
import pathlib
```

```
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: 4084, done.ote: Counting objects: 100%
(4084/4084), done.ote: Compressing objects: 100% (3074/3074),
done.ote: Total 4084 (delta 1190), reused 2904 (delta 950), pack-
reused 0
```

Compile protobufs and install the object_detection package

```
%%bash
cd models/research/
protoc object_detection/protos/*.proto --python_out=.
```

```
%%bash
cd models/research
```

```
cp object_detection/packages/tf2/setup.py .
#!python -m pip install .
pip install .

Processing /content/models/research
  Preparing metadata (setup.py): started
  Preparing metadata (setup.py): finished with status 'done'
Collecting avro-python3 (from object-detection==0.1)
  Downloading avro-python3-1.10.2.tar.gz (38 kB)
  Preparing metadata (setup.py): started
  Preparing metadata (setup.py): finished with status 'done'
Collecting apache-beam (from object-detection==0.1)
  Downloading apache_beam-2.54.0-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (14.8 MB)
  

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 14.8/14.8 MB 46.7 MB/s
eta 0:00:00
Requirement already satisfied: pillow in
/usr/local/lib/python3.10/dist-packages (from object-detection==0.1)
(9.4.0)
Requirement already satisfied: lxml in /usr/local/lib/python3.10/dist-
packages (from object-detection==0.1) (4.9.4)
Requirement already satisfied: matplotlib in
/usr/local/lib/python3.10/dist-packages (from object-detection==0.1)
(3.7.1)
Requirement already satisfied: Cython in
/usr/local/lib/python3.10/dist-packages (from object-detection==0.1)
(3.0.8)
Requirement already satisfied: contextlib2 in
/usr/local/lib/python3.10/dist-packages (from object-detection==0.1)
(21.6.0)
Requirement already satisfied: tf-slim in
/usr/local/lib/python3.10/dist-packages (from object-detection==0.1)
(1.1.0)
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-
packages (from object-detection==0.1) (1.16.0)
Requirement already satisfied: pycocotools in
/usr/local/lib/python3.10/dist-packages (from object-detection==0.1)
(2.0.7)
Collecting lvis (from object-detection==0.1)
  Downloading lvis-0.5.3-py3-none-any.whl (14 kB)
Requirement already satisfied: scipy in
/usr/local/lib/python3.10/dist-packages (from object-detection==0.1)
(1.11.4)
Requirement already satisfied: pandas in
/usr/local/lib/python3.10/dist-packages (from object-detection==0.1)
(1.5.3)
Collecting tf-models-official>=2.5.1 (from object-detection==0.1)
  Downloading tf_models_official-2.15.0-py2.py3-none-any.whl (2.7 MB)
  

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 2.7/2.7 MB 71.0 MB/s eta
0:00:00
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Collecting tensorflow_io (from object-detection==0.1)
  Downloading tensorflow_io-0.36.0-cp310-cp310-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (49.4 MB)
    _____ 49.4/49.4 MB 9.3 MB/s
eta 0:00:00
Requirement already satisfied: keras in
/usr/local/lib/python3.10/dist-packages (from object-detection==0.1)
(2.15.0)
Collecting pyparsing==2.4.7 (from object-detection==0.1)
  Downloading pyparsing-2.4.7-py2.py3-none-any.whl (67 kB)
    _____ 67.8/67.8 kB 8.7 MB/s
eta 0:00:00
Collecting sacrebleu<=2.2.0 (from object-detection==0.1)
  Downloading sacrebleu-2.2.0-py3-none-any.whl (116 kB)
    _____ 116.6/116.6 kB 15.0 MB/s
eta 0:00:00
Collecting portalocker (from sacrebleu<=2.2.0->object-detection==0.1)
  Downloading portalocker-2.8.2-py3-none-any.whl (17 kB)
Requirement already satisfied: regex in
/usr/local/lib/python3.10/dist-packages (from sacrebleu<=2.2.0-
>object-detection==0.1) (2023.12.25)
Requirement already satisfied: tabulate>=0.8.9 in
/usr/local/lib/python3.10/dist-packages (from sacrebleu<=2.2.0-
>object-detection==0.1) (0.9.0)
Requirement already satisfied: numpy>=1.17 in
/usr/local/lib/python3.10/dist-packages (from sacrebleu<=2.2.0-
>object-detection==0.1) (1.25.2)
Collecting colorama (from sacrebleu<=2.2.0->object-detection==0.1)
  Downloading colorama-0.4.6-py2.py3-none-any.whl (25 kB)
Requirement already satisfied: gin-config in
/usr/local/lib/python3.10/dist-packages (from tf-models-
official>=2.5.1->object-detection==0.1) (0.5.0)
Requirement already satisfied: google-api-python-client>=1.6.7 in
/usr/local/lib/python3.10/dist-packages (from tf-models-
official>=2.5.1->object-detection==0.1) (2.84.0)
Collecting immutabledict (from tf-models-official>=2.5.1->object-
detection==0.1)
  Downloading immutabledict-4.1.0-py3-none-any.whl (4.5 kB)
Requirement already satisfied: kaggle>=1.3.9 in
/usr/local/lib/python3.10/dist-packages (from tf-models-
official>=2.5.1->object-detection==0.1) (1.5.16)
Requirement already satisfied: oauth2client in
/usr/local/lib/python3.10/dist-packages (from tf-models-
official>=2.5.1->object-detection==0.1) (4.1.3)
Requirement already satisfied: opencv-python-headless in
/usr/local/lib/python3.10/dist-packages (from tf-models-
official>=2.5.1->object-detection==0.1) (4.9.0.80)
Requirement already satisfied: psutil>=5.4.3 in
/usr/local/lib/python3.10/dist-packages (from tf-models-
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official>=2.5.1->object-detection==0.1) (5.9.5)
Requirement already satisfied: py-cpuinfo>=3.3.0 in
/usr/local/lib/python3.10/dist-packages (from tf-models-
official>=2.5.1->object-detection==0.1) (9.0.0)
Requirement already satisfied: pyyaml>=6.0.0 in
/usr/local/lib/python3.10/dist-packages (from tf-models-
official>=2.5.1->object-detection==0.1) (6.0.1)
Requirement already satisfied: sentencepiece in
/usr/local/lib/python3.10/dist-packages (from tf-models-
official>=2.5.1->object-detection==0.1) (0.1.99)
Collecting sequeval (from tf-models-official>=2.5.1->object-
detection==0.1)
  Downloading sequeval-1.2.2.tar.gz (43 kB)
    _____ 43.6/43.6 kB 5.6 MB/s
eta 0:00:00
  Preparing metadata (setup.py): started
  Preparing metadata (setup.py): finished with status 'done'
Requirement already satisfied: tensorflow-datasets in
/usr/local/lib/python3.10/dist-packages (from tf-models-
official>=2.5.1->object-detection==0.1) (4.9.4)
Requirement already satisfied: tensorflow-hub>=0.6.0 in
/usr/local/lib/python3.10/dist-packages (from tf-models-
official>=2.5.1->object-detection==0.1) (0.16.1)
Collecting tensorflow-model-optimization>=0.4.1 (from tf-models-
official>=2.5.1->object-detection==0.1)
  Downloading tensorflow_model_optimization-0.8.0-py2.py3-none-any.whl
(242 kB)
    _____ 242.5/242.5 kB 32.2 MB/s
eta 0:00:00
Collecting tensorflow-text~=2.15.0 (from tf-models-official>=2.5.1-
>object-detection==0.1)
  Downloading tensorflow_text-2.15.0-cp310-cp310-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (5.2 MB)
    _____ 5.2/5.2 MB 66.3 MB/s eta
0:00:00
Requirement already satisfied: tensorflow~=2.15.0 in
/usr/local/lib/python3.10/dist-packages (from tf-models-
official>=2.5.1->object-detection==0.1) (2.15.0)
Requirement already satisfied: python-dateutil>=2.8.1 in
/usr/local/lib/python3.10/dist-packages (from pandas->object-
detection==0.1) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in
/usr/local/lib/python3.10/dist-packages (from pandas->object-
detection==0.1) (2023.4)
Requirement already satisfied: absl-py>=0.2.2 in
/usr/local/lib/python3.10/dist-packages (from tf-slim->object-
detection==0.1) (1.4.0)
Collecting crcmod<2.0,>=1.7 (from apache-beam->object-detection==0.1)
  Downloading crcmod-1.7.tar.gz (89 kB)

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      89.7/89.7 kB 13.9 MB/s
eta 0:00:00
  Preparing metadata (setup.py): started
  Preparing metadata (setup.py): finished with status 'done'
Collecting orjson<4,>=3.9.7 (from apache-beam->object-detection==0.1)
  Downloading orjson-3.9.15-cp310-cp310-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (138 kB)
      138.5/138.5 kB 16.3 MB/s
eta 0:00:00
Collecting dill<0.3.2,>=0.3.1.1 (from apache-beam->object-
detection==0.1)
  Downloading dill-0.3.1.1.tar.gz (151 kB)
      152.0/152.0 kB 21.9 MB/s
eta 0:00:00
  Preparing metadata (setup.py): started
  Preparing metadata (setup.py): finished with status 'done'
Requirement already satisfied: cloudpickle~=2.2.1 in
/usr/local/lib/python3.10/dist-packages (from apache-beam->object-
detection==0.1) (2.2.1)
Collecting fastavro<2,>=0.23.6 (from apache-beam->object-
detection==0.1)
  Downloading fastavro-1.9.4-cp310-cp310-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (3.1 MB)
      3.1/3.1 MB 58.6 MB/s eta
0:00:00
Collecting fasteners<1.0,>=0.3 (from apache-beam->object-
detection==0.1)
  Downloading fasteners-0.19-py3-none-any.whl (18 kB)
Requirement already satisfied: grpcio!=1.48.0,<2,>=1.33.1 in
/usr/local/lib/python3.10/dist-packages (from apache-beam->object-
detection==0.1) (1.62.0)
Collecting hdfs<3.0.0,>=2.1.0 (from apache-beam->object-
detection==0.1)
  Downloading hdfs-2.7.3.tar.gz (43 kB)
      43.5/43.5 kB 5.8 MB/s
eta 0:00:00
  Preparing metadata (setup.py): started
  Preparing metadata (setup.py): finished with status 'done'
Requirement already satisfied: httplib2<0.23.0,>=0.8 in
/usr/local/lib/python3.10/dist-packages (from apache-beam->object-
detection==0.1) (0.22.0)
Collecting js2py<1,>=0.74 (from apache-beam->object-detection==0.1)
  Downloading Js2Py-0.74-py3-none-any.whl (1.0 MB)
      1.0/1.0 MB 70.4 MB/s eta
0:00:00
Requirement already satisfied: jsonschema<5.0.0,>=4.0.0 in
/usr/local/lib/python3.10/dist-packages (from apache-beam->object-
detection==0.1) (4.19.2)
Requirement already satisfied: jsonpickle<4.0.0,>=3.0.0 in

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/usr/local/lib/python3.10/dist-packages (from apache-beam->object-
detection==0.1) (3.0.3)
Collecting numpy>=1.17 (from sacrebleu<=2.2.0->object-detection==0.1)
  Downloading numpy-1.24.4-cp310-cp310-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (17.3 MB)
    _____ 17.3/17.3 MB 59.8 MB/s
eta 0:00:00
Collecting objsize<0.8.0,>=0.6.1 (from apache-beam->object-
detection==0.1)
  Downloading objsize-0.7.0-py3-none-any.whl (11 kB)
Requirement already satisfied: packaging>=22.0 in
/usr/local/lib/python3.10/dist-packages (from apache-beam->object-
detection==0.1) (23.2)
Collecting pymongo<5.0.0,>=3.8.0 (from apache-beam->object-
detection==0.1)
  Downloading pymongo-4.6.2-cp310-cp310-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (677 kB)
    _____ 677.2/677.2 kB 57.2 MB/s
eta 0:00:00
Requirement already satisfied: proto-plus<2,>=1.7.1 in
/usr/local/lib/python3.10/dist-packages (from apache-beam->object-
detection==0.1) (1.23.0)
Requirement already satisfied: protobuf!=4.0.*,!=4.21.*,!=4.22.0,!
=4.23.*,!=4.24.*,<4.26.0,>=3.20.3 in /usr/local/lib/python3.10/dist-
packages (from apache-beam->object-detection==0.1) (3.20.3)
Requirement already satisfied: pydot<2,>=1.2.0 in
/usr/local/lib/python3.10/dist-packages (from apache-beam->object-
detection==0.1) (1.4.2)
Requirement already satisfied: requests<3.0.0,>=2.24.0 in
/usr/local/lib/python3.10/dist-packages (from apache-beam->object-
detection==0.1) (2.31.0)
Requirement already satisfied: typing-extensions>=3.7.0 in
/usr/local/lib/python3.10/dist-packages (from apache-beam->object-
detection==0.1) (4.10.0)
Collecting zstandard<1,>=0.18.0 (from apache-beam->object-
detection==0.1)
  Downloading zstandard-0.22.0-cp310-cp310-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (5.4 MB)
    _____ 5.4/5.4 MB 69.0 MB/s eta
0:00:00
Requirement already satisfied: pyarrow<15.0.0,>=3.0.0 in
/usr/local/lib/python3.10/dist-packages (from apache-beam->object-
detection==0.1) (14.0.2)
Requirement already satisfied: pyarrow-hotfix<1 in
/usr/local/lib/python3.10/dist-packages (from apache-beam->object-
detection==0.1) (0.6)
Requirement already satisfied: cycler>=0.10.0 in
/usr/local/lib/python3.10/dist-packages (from lvis->object-
detection==0.1) (0.12.1)
```

Requirement already satisfied: kiwisolver>=1.1.0 in
/usr/local/lib/python3.10/dist-packages (from lvis->object-
detection==0.1) (1.4.5)

Requirement already satisfied: opencv-python>=4.1.0.25 in
/usr/local/lib/python3.10/dist-packages (from lvis->object-
detection==0.1) (4.8.0.76)

Requirement already satisfied: contourpy>=1.0.1 in
/usr/local/lib/python3.10/dist-packages (from matplotlib->object-
detection==0.1) (1.2.0)

Requirement already satisfied: fonttools>=4.22.0 in
/usr/local/lib/python3.10/dist-packages (from matplotlib->object-
detection==0.1) (4.49.0)

Requirement already satisfied: tensorflow-io-gcs-filesystem==0.36.0 in
/usr/local/lib/python3.10/dist-packages (from tensorflow_io->object-
detection==0.1) (0.36.0)

Requirement already satisfied: google-auth<3.0.0dev,>=1.19.0 in
/usr/local/lib/python3.10/dist-packages (from google-api-python-
client>=1.6.7->tf-models-official>=2.5.1->object-detection==0.1)
(2.27.0)

Requirement already satisfied: google-auth-httpplib2>=0.1.0 in
/usr/local/lib/python3.10/dist-packages (from google-api-python-
client>=1.6.7->tf-models-official>=2.5.1->object-detection==0.1)
(0.1.1)

Requirement already satisfied: google-api-core!=2.0.*,!=2.1.*,!
=2.2.*,!=2.3.0,<3.0.0dev,>=1.31.5 in /usr/local/lib/python3.10/dist-
packages (from google-api-python-client>=1.6.7->tf-models-
official>=2.5.1->object-detection==0.1) (2.11.1)

Requirement already satisfied: uritemplate<5,>=3.0.1 in
/usr/local/lib/python3.10/dist-packages (from google-api-python-
client>=1.6.7->tf-models-official>=2.5.1->object-detection==0.1)
(4.1.1)

Collecting docopt (from hdfs<3.0.0,>=2.1.0->apache-beam->object-
detection==0.1)

 Downloading docopt-0.6.2.tar.gz (25 kB)

 Preparing metadata (setup.py): started

 Preparing metadata (setup.py): finished with status 'done'

Requirement already satisfied: tzlocal>=1.2 in
/usr/local/lib/python3.10/dist-packages (from js2py<1,>=0.74->apache-
beam->object-detection==0.1) (5.2)

Collecting pyjparser>=2.5.1 (from js2py<1,>=0.74->apache-beam-
>object-detection==0.1)

 Downloading pyjparser-2.7.1.tar.gz (24 kB)

 Preparing metadata (setup.py): started

 Preparing metadata (setup.py): finished with status 'done'

Requirement already satisfied: attrs>=22.2.0 in
/usr/local/lib/python3.10/dist-packages (from
jsonschema<5.0.0,>=4.0.0->apache-beam->object-detection==0.1) (23.2.0)

Requirement already satisfied: jsonschema-specifications>=2023.03.6 in
/usr/local/lib/python3.10/dist-packages (from

```
jsonschema<5.0.0,>=4.0.0->apache-beam->object-detection==0.1)
(2023.12.1)
Requirement already satisfied: referencing>=0.28.4 in
/usr/local/lib/python3.10/dist-packages (from
jsonschema<5.0.0,>=4.0.0->apache-beam->object-detection==0.1) (0.33.0)
Requirement already satisfied: rpds-py>=0.7.1 in
/usr/local/lib/python3.10/dist-packages (from
jsonschema<5.0.0,>=4.0.0->apache-beam->object-detection==0.1) (0.18.0)
Requirement already satisfied: certifi in
/usr/local/lib/python3.10/dist-packages (from kaggle>=1.3.9->tf-
models-official>=2.5.1->object-detection==0.1) (2024.2.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-
packages (from kaggle>=1.3.9->tf-models-official>=2.5.1->object-
detection==0.1) (4.66.2)
Requirement already satisfied: python-slugify in
/usr/local/lib/python3.10/dist-packages (from kaggle>=1.3.9->tf-
models-official>=2.5.1->object-detection==0.1) (8.0.4)
Requirement already satisfied: urllib3 in
/usr/local/lib/python3.10/dist-packages (from kaggle>=1.3.9->tf-
models-official>=2.5.1->object-detection==0.1) (2.0.7)
Requirement already satisfied: bleach in
/usr/local/lib/python3.10/dist-packages (from kaggle>=1.3.9->tf-
models-official>=2.5.1->object-detection==0.1) (6.1.0)
Collecting dnspython<3.0.0,>=1.16.0 (from pymongo<5.0.0,>=3.8.0-
>apache-beam->object-detection==0.1)
  Downloading dnspython-2.6.1-py3-none-any.whl (307 kB)
      _____ 307.7/307.7 kB 30.9 MB/s
eta 0:00:00
Requirement already satisfied: charset-normalizer<4,>=2 in
/usr/local/lib/python3.10/dist-packages (from requests<3.0.0,>=2.24.0-
>apache-beam->object-detection==0.1) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in
/usr/local/lib/python3.10/dist-packages (from requests<3.0.0,>=2.24.0-
>apache-beam->object-detection==0.1) (3.6)
Requirement already satisfied: astunparse>=1.6.0 in
/usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0->tf-
models-official>=2.5.1->object-detection==0.1) (1.6.3)
Requirement already satisfied: flatbuffers>=23.5.26 in
/usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0->tf-
models-official>=2.5.1->object-detection==0.1) (23.5.26)
Requirement already satisfied: gast!=0.5.0,!0.5.1,!0.5.2,>=0.2.1
in /usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0-
>tf-models-official>=2.5.1->object-detection==0.1) (0.5.4)
Requirement already satisfied: google-pasta>=0.1.1 in
/usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0->tf-
models-official>=2.5.1->object-detection==0.1) (0.2.0)
Requirement already satisfied: h5py>=2.9.0 in
/usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0->tf-
models-official>=2.5.1->object-detection==0.1) (3.9.0)
```


Requirement already satisfied: libclang>=13.0.0 in
/usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0->tf-models-official>=2.5.1->object-detection==0.1) (16.0.6)

Requirement already satisfied: ml-dtypes~=0.2.0 in
/usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0->tf-models-official>=2.5.1->object-detection==0.1) (0.2.0)

Requirement already satisfied: opt-einsum>=2.3.2 in
/usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0->tf-models-official>=2.5.1->object-detection==0.1) (3.3.0)

Requirement already satisfied: setuptools in
/usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0->tf-models-official>=2.5.1->object-detection==0.1) (67.7.2)

Requirement already satisfied: termcolor>=1.1.0 in
/usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0->tf-models-official>=2.5.1->object-detection==0.1) (2.4.0)

Requirement already satisfied: wrapt<1.15,>=1.11.0 in
/usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0->tf-models-official>=2.5.1->object-detection==0.1) (1.14.1)

Requirement already satisfied: tensorboard<2.16,>=2.15 in
/usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0->tf-models-official>=2.5.1->object-detection==0.1) (2.15.2)

Requirement already satisfied: tensorflow-estimator<2.16,>=2.15.0
in /usr/local/lib/python3.10/dist-packages (from tensorflow~=2.15.0->tf-models-official>=2.5.1->object-detection==0.1) (2.15.0)

Requirement already satisfied: tf-keras>=2.14.1 in
/usr/local/lib/python3.10/dist-packages (from tensorflow-hub>=0.6.0->tf-models-official>=2.5.1->object-detection==0.1) (2.15.0)

Requirement already satisfied: dm-tree~=0.1.1 in
/usr/local/lib/python3.10/dist-packages (from tensorflow-model-optimization>=0.4.1->tf-models-official>=2.5.1->object-detection==0.1) (0.1.8)

Requirement already satisfied: pyasn1>=0.1.7 in
/usr/local/lib/python3.10/dist-packages (from oauth2client->tf-models-official>=2.5.1->object-detection==0.1) (0.5.1)

Requirement already satisfied: pyasn1-modules>=0.0.5 in
/usr/local/lib/python3.10/dist-packages (from oauth2client->tf-models-official>=2.5.1->object-detection==0.1) (0.3.0)

Requirement already satisfied: rsa>=3.1.4 in
/usr/local/lib/python3.10/dist-packages (from oauth2client->tf-models-official>=2.5.1->object-detection==0.1) (4.9)

Requirement already satisfied: scikit-learn>=0.21.3 in
/usr/local/lib/python3.10/dist-packages (from sequeval->tf-models-official>=2.5.1->object-detection==0.1) (1.2.2)

Requirement already satisfied: click in
/usr/local/lib/python3.10/dist-packages (from tensorflow-datasets->tf-models-official>=2.5.1->object-detection==0.1) (8.1.7)

Requirement already satisfied: etils[enp,epath,etree]>=0.9.0 in
/usr/local/lib/python3.10/dist-packages (from tensorflow-datasets->tf-models-official>=2.5.1->object-detection==0.1) (1.7.0)

Requirement already satisfied: promise in
/usr/local/lib/python3.10/dist-packages (from tensorflow-datasets->tf-models-official>=2.5.1->object-detection==0.1) (2.3)

Requirement already satisfied: tensorflow-metadata in
/usr/local/lib/python3.10/dist-packages (from tensorflow-datasets->tf-models-official>=2.5.1->object-detection==0.1) (1.14.0)

Requirement already satisfied: toml in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets->tf-models-official>=2.5.1->object-detection==0.1) (0.10.2)

Requirement already satisfied: array-record>=0.5.0 in
/usr/local/lib/python3.10/dist-packages (from tensorflow-datasets->tf-models-official>=2.5.1->object-detection==0.1) (0.5.0)

Requirement already satisfied: wheel<1.0,>=0.23.0 in
/usr/local/lib/python3.10/dist-packages (from astunparse>=1.6.0->tensorflow~=2.15.0->tf-models-official>=2.5.1->object-detection==0.1) (0.42.0)

Requirement already satisfied: fsspec in
/usr/local/lib/python3.10/dist-packages (from etils[enp,epath,etree]>=0.9.0->tensorflow-datasets->tf-models-official>=2.5.1->object-detection==0.1) (2023.6.0)

Requirement already satisfied: importlib_resources in
/usr/local/lib/python3.10/dist-packages (from etils[enp,epath,etree]>=0.9.0->tensorflow-datasets->tf-models-official>=2.5.1->object-detection==0.1) (6.1.2)

Requirement already satisfied: zipp in /usr/local/lib/python3.10/dist-packages (from etils[enp,epath,etree]>=0.9.0->tensorflow-datasets->tf-models-official>=2.5.1->object-detection==0.1) (3.17.0)

Requirement already satisfied: googleapis-common-protos<2.0.dev0,>=1.56.2 in /usr/local/lib/python3.10/dist-packages (from google-api-core!=2.0.*,!=2.1.*,!=2.2.*,!=2.3.0,<3.0.0dev,>=1.31.5->google-api-python-client>=1.6.7->tf-models-official>=2.5.1->object-detection==0.1) (1.62.0)

Requirement already satisfied: cachetools<6.0,>=2.0.0 in
/usr/local/lib/python3.10/dist-packages (from google-auth<3.0.0dev,>=1.19.0->google-api-python-client>=1.6.7->tf-models-official>=2.5.1->object-detection==0.1) (5.3.3)

Requirement already satisfied: joblib>=1.1.1 in
/usr/local/lib/python3.10/dist-packages (from scikit-learn>=0.21.3->seval->tf-models-official>=2.5.1->object-detection==0.1) (1.3.2)

Requirement already satisfied: threadpoolctl>=2.0.0 in
/usr/local/lib/python3.10/dist-packages (from scikit-learn>=0.21.3->seval->tf-models-official>=2.5.1->object-detection==0.1) (3.3.0)

Requirement already satisfied: google-auth-oauthlib<2,>=0.5 in
/usr/local/lib/python3.10/dist-packages (from tensorboard<2.16,>=2.15->tensorflow~=2.15.0->tf-models-official>=2.5.1->object-detection==0.1) (1.2.0)

Requirement already satisfied: markdown>=2.6.8 in
/usr/local/lib/python3.10/dist-packages (from tensorboard<2.16,>=2.15->tensorflow~=2.15.0->tf-models-official>=2.5.1->object-detection==0.1)

```

(3.5.2)
Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0
in /usr/local/lib/python3.10/dist-packages (from
tensorboard<2.16,>=2.15->tensorflow~=2.15.0->tf-models-
official>=2.5.1->object-detection==0.1) (0.7.2)
Requirement already satisfied: werkzeug>=1.0.1 in
/usr/local/lib/python3.10/dist-packages (from tensorboard<2.16,>=2.15-
>tensorflow~=2.15.0->tf-models-official>=2.5.1->object-detection==0.1)
(3.0.1)
Requirement already satisfied: webencodings in
/usr/local/lib/python3.10/dist-packages (from bleach->kaggle>=1.3.9-
>tf-models-official>=2.5.1->object-detection==0.1) (0.5.1)
Requirement already satisfied: text-unidecode>=1.3 in
/usr/local/lib/python3.10/dist-packages (from python-slugify-
>kaggle>=1.3.9->tf-models-official>=2.5.1->object-detection==0.1)
(1.3)
Requirement already satisfied: requests-oauthlib>=0.7.0 in
/usr/local/lib/python3.10/dist-packages (from google-auth-
oauthlib<2,>=0.5->tensorboard<2.16,>=2.15->tensorflow~=2.15.0->tf-
models-official>=2.5.1->object-detection==0.1) (1.3.1)
Requirement already satisfied: MarkupSafe>=2.1.1 in
/usr/local/lib/python3.10/dist-packages (from werkzeug>=1.0.1-
>tensorboard<2.16,>=2.15->tensorflow~=2.15.0->tf-models-
official>=2.5.1->object-detection==0.1) (2.1.5)
Requirement already satisfied: oauthlib>=3.0.0 in
/usr/local/lib/python3.10/dist-packages (from requests-
oauthlib>=0.7.0->google-auth-oauthlib<2,>=0.5-
>tensorboard<2.16,>=2.15->tensorflow~=2.15.0->tf-models-
official>=2.5.1->object-detection==0.1) (3.2.2)
Building wheels for collected packages: object-detection, avro-
python3, crcmod, dill, hdfs, sequeval, pyjsparser, docopt
  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-
py3-none-any.whl size=1697356
sha256=295b6768a551db9df70fc225d6222d298dbf98178e89134a71d48e5602f0ddc
3
  Stored in directory:
/tmp/pip-ephem-wheel-cache-ju_d5x6b/wheels/53/dd/70/2de274d6c443c69d36
7bd6a5606f95e5a6df61aacf1435ec0d
  Building wheel for avro-python3 (setup.py): started
  Building wheel for avro-python3 (setup.py): finished with status
'done'
  Created wheel for avro-python3: filename=avro_python3-1.10.2-py3-
none-any.whl size=43992
sha256=48cfa401ac6ca4244784f1fa1211ed1edb88105886220aab9cc79bc9866595b
8
  Stored in directory:

```

```
/root/.cache/pip/wheels/bc/85/62/6cdd81c56f923946b401cecff38055b94c9b7
66927f7d8ca82
  Building wheel for crcmod (setup.py): started
  Building wheel for crcmod (setup.py): finished with status 'done'
  Created wheel for crcmod: filename=crcmod-1.7-cp310-cp310-
linux_x86_64.whl size=31407
sha256=8ba687a798f40b6161d6a912a1d8a2941a3a4e3c559eb1d43a593e28443f6a8
7
  Stored in directory:
/root/.cache/pip/wheels/85/4c/07/72215c529bd59d67e3dac29711d7aba1b692f
543c808ba9e86
  Building wheel for dill (setup.py): started
  Building wheel for dill (setup.py): finished with status 'done'
  Created wheel for dill: filename=dill-0.3.1.1-py3-none-any.whl
size=78540
sha256=08139cea376f4cb5598224314d27798f563b38dde484691cec36eb811f944ea
9
  Stored in directory:
/root/.cache/pip/wheels/ea/e2/86/64980d90e297e7bf2ce588c2b96e818f5399c
515c4bb8a7e4f
  Building wheel for hdf5 (setup.py): started
  Building wheel for hdf5 (setup.py): finished with status 'done'
  Created wheel for hdf5: filename=hdf5-2.7.3-py3-none-any.whl
size=34325
sha256=c21d59a9822b7fb1da93be4307d15e92b7f972d3c7651352fc4995b0daa662a
0
  Stored in directory:
/root/.cache/pip/wheels/e5/8d/b6/99c1c0a3ac5788c866b0ecd3f48b0134a5910
e6ed26011800b
  Building wheel for sequeval (setup.py): started
  Building wheel for sequeval (setup.py): finished with status 'done'
  Created wheel for sequeval: filename=sequeval-1.2.2-py3-none-any.whl
size=16162
sha256=50484558f962cee2cb4980f12bc64309032d3987723aa2b2f7029f3883d4571
1
  Stored in directory:
/root/.cache/pip/wheels/1a/67/4a/ad4082dd7dfc30f2abfe4d80a2ed5926a506e
b8a972b4767fa
  Building wheel for pyjsparser (setup.py): started
  Building wheel for pyjsparser (setup.py): finished with status
'done'
  Created wheel for pyjsparser: filename=pyjsparser-2.7.1-py3-none-
any.whl size=25984
sha256=5a6d08af17da95fd32b6e05a816014efe69bb5b7ab267fb2f65e226a1b201cb
e
  Stored in directory:
/root/.cache/pip/wheels/5e/81/26/5956478df303e2bf5a85a5df595bb307bd259
48a4bab69f7c7
  Building wheel for docopt (setup.py): started
  Building wheel for docopt (setup.py): finished with status 'done'
```

```
Created wheel for docopt: filename=docopt-0.6.2-py2.py3-none-any.whl
size=13706
sha256=e6d909ce49a4a5b15943a397b0f7d79da3db4f6c19759caf835186477752565
4
```

```
Stored in directory:
/root/.cache/pip/wheels/fc/ab/d4/5da2067ac95b36618c629a5f93f8094257005
06f72c9732fac
```

```
Successfully built object-detection avro-python3 crcmod dill hdfs
segeval pyjsparser docopt
```

```
Installing collected packages: pyjsparser, docopt, crcmod, zstandard,
tensorflow_io, pyparsing, portalocker, orjson, objsize, numpy, js2py,
immutabledict, fasteners, fastavro, dnspython, dill, colorama, avro-
python3, tensorflow-model-optimization, sacrebleu, pymongo, hdfs,
segeval, lvis, apache-beam, tensorflow-text, tf-models-official,
object-detection
```

```
Attempting uninstall: pyparsing
```

```
Found existing installation: pyparsing 3.1.1
```

```
Uninstalling pyparsing-3.1.1:
```

```
Successfully uninstalled pyparsing-3.1.1
```

```
Attempting uninstall: numpy
```

```
Found existing installation: numpy 1.25.2
```

```
Uninstalling numpy-1.25.2:
```

```
Successfully uninstalled numpy-1.25.2
```

```
Successfully installed apache-beam-2.54.0 avro-python3-1.10.2
colorama-0.4.6 crcmod-1.7 dill-0.3.1.1 dnspython-2.6.1 docopt-0.6.2
fastavro-1.9.4 fasteners-0.19 hdfs-2.7.3 immutabledict-4.1.0 js2py-
0.74 lvis-0.5.3 numpy-1.24.4 object-detection-0.1 objsize-0.7.0
orjson-3.9.15 portalocker-2.8.2 pyjsparser-2.7.1 pymongo-4.6.2
pyparsing-2.4.7 sacrebleu-2.2.0 segeval-1.2.2 tensorflow-model-
optimization-0.8.0 tensorflow-text-2.15.0 tensorflow_io-0.36.0 tf-
models-official-2.15.0 zstandard-0.22.0
```

Imports

```
import numpy as np
import os
import six.moves.urllib as urllib
import sys
import tarfile
import tensorflow as tf
import zipfile
import pathlib

from collections import defaultdict
from io import StringIO
from matplotlib import pyplot as plt
from PIL import Image
from IPython.display import display
```

Import the object detection module.

```
from object_detection.utils import ops as utils_ops
from object_detection.utils import label_map_util
from object_detection.utils import visualization_utils as vis_util
```

Patches:

```
# patch tf1 into `utils.ops`
utils_ops.tf = tf.compat.v1

# Patch the location of gfile
tf.gfile = tf.io.gfile
```

Model preparation

Variables

Any model exported using the `export_inference_graph.py` tool can be loaded here simply by changing the path.

By default we use an "SSD with Mobilenet" model here. See the [detection model zoo](#) for a list of other models that can be run out-of-the-box with varying speeds and accuracies.

Loader

Loading label map

Label maps map indices to category names, so that when our convolution network predicts 5, we know that this corresponds to `airplane`. Here we use internal utility functions, but anything that returns a dictionary mapping integers to appropriate string labels would be fine

```
# List of the strings that is used to add correct label for each box.
PATH_TO_LABELS =
    '/content/drive/MyDrive/Object_Detection_API/CVex3/satellite_label_map
    (3).pbtxt'
category_index =
    label_map_util.create_category_index_from_labelmap(PATH_TO_LABELS,
    use_display_name=True)
category_index

{1: {'id': 1, 'name': 'piscina'},
 2: {'id': 2, 'name': 'parking'},
 3: {'id': 3, 'name': 'rotonda'}}

categories= []
for key in category_index:
    categories.append(category_index[key])
```

categories

```
[{'id': 1, 'name': 'piscina'},  
{ 'id': 2, 'name': 'parking'},  
{ 'id': 3, 'name': 'rotonda'}]
```

For the sake of simplicity we will test on 2 images:

```
import zipfile  
with  
zipfile.ZipFile('/content/drive/MyDrive/Object_Detection_API/CVex3/  
sved/cvex3_model.zip', 'r') as zip_ref:  
  
zip_ref.extractall('/content/drive/MyDrive/Object_Detection_API/CVex3/  
sved')
```

Detection

Load an object detection model:

We load the model using tensorflow's `saved_model.load()` function and specify the path of our saved model where there exists pb file of the saved model, variables etc.

```
detection_model=  
tf.saved_model.load("/content/drive/MyDrive/Object_Detection_API/CVex3/  
sved/saved_model")  
  
detection_model  
  
<tensorflow.python.saved_model.load.Loader._recreate_base_user_object.  
<locals>._UserObject at 0x7c34298ad2d0>
```

Check the model's input signature, it expects a batch of 3-color images of type uint8:

```
print(detection_model.signatures['serving_default'].inputs)  
  
[<tf.Tensor 'input_tensor:0' shape=(1, None, None, 3) dtype=uint8>,  
<tf.Tensor 'unknown:0' shape=() dtype=resource>, <tf.Tensor  
'unknown_0:0' shape=() dtype=resource>, <tf.Tensor 'unknown_1:0'  
shape=() dtype=resource>, <tf.Tensor 'unknown_2:0' shape=()  
dtype=resource>, <tf.Tensor 'unknown_3:0' shape=() dtype=resource>,  
<tf.Tensor 'unknown_4:0' shape=() dtype=resource>, <tf.Tensor  
'unknown_5:0' shape=() dtype=resource>, <tf.Tensor 'unknown_6:0'  
shape=() dtype=resource>, <tf.Tensor 'unknown_7:0' shape=()  
dtype=resource>, <tf.Tensor 'unknown_8:0' shape=() dtype=resource>,  
<tf.Tensor 'unknown_9:0' shape=() dtype=resource>, <tf.Tensor  
'unknown_10:0' shape=() dtype=resource>, <tf.Tensor 'unknown_11:0'
```

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

```

shape=() dtype=resource>, <tf.Tensor 'unknown_502:0' shape=()
dtype=resource>, <tf.Tensor 'unknown_503:0' shape=() dtype=resource>,
<tf.Tensor 'unknown_504:0' shape=() dtype=resource>, <tf.Tensor
'unknown_505:0' shape=() dtype=resource>, <tf.Tensor 'unknown_506:0'
shape=() dtype=resource>, <tf.Tensor 'unknown_507:0' shape=()
dtype=resource>, <tf.Tensor 'unknown_508:0' shape=() dtype=resource>,
<tf.Tensor 'unknown_509:0' shape=() dtype=resource>, <tf.Tensor
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dtype=resource>, <tf.Tensor 'unknown_523:0' shape=() dtype=resource>,
<tf.Tensor 'unknown_524:0' shape=() dtype=resource>, <tf.Tensor
'unknown_525:0' shape=() dtype=resource>, <tf.Tensor 'unknown_526:0'
shape=() dtype=resource>, <tf.Tensor 'unknown_527:0' shape=()
dtype=resource>, <tf.Tensor 'unknown_528:0' shape=() dtype=resource>,
<tf.Tensor 'unknown_529:0' shape=() dtype=resource>, <tf.Tensor
'unknown_530:0' shape=() dtype=resource>, <tf.Tensor 'unknown_531:0'
shape=() dtype=resource>]

```

```

detection_model.signatures['serving_default'].output_dtypes

```

```

{'detection_multiclass_scores': tf.float32,
'detection_boxes': tf.float32,
'detection_scores': tf.float32,
'num_detections': tf.float32,
'raw_detection_boxes': tf.float32,
'detection_classes': tf.float32,
'detection_anchor_indices': tf.float32,
'raw_detection_scores': tf.float32}

```

And returns several outputs:

```

detection_model.signatures['serving_default'].output_shapes

```

```

{'detection_multiclass_scores': TensorShape([1, 300, 4]),
'detection_boxes': TensorShape([1, 300, 4]),
'detection_scores': TensorShape([1, 300]),
'num_detections': TensorShape([1]),
'raw_detection_boxes': TensorShape([1, 300, 4]),
'detection_classes': TensorShape([1, 300]),
'detection_anchor_indices': TensorShape([1, 300]),
'raw_detection_scores': TensorShape([1, 300, 4])}

```


Add a wrapper function to call the model, and cleanup the outputs:

```
def run_inference_for_single_image(model, image):
    image = np.asarray(image)
    # The input needs to be a tensor, convert it using
    `tf.convert_to_tensor`.
    input_tensor = tf.convert_to_tensor(image)
    # The model expects a batch of images, so add an axis with
    `tf.newaxis`.
    input_tensor = input_tensor[tf.newaxis,...]

    # Run inference
    model_fn = model.signatures['serving_default']
    output_dict = model_fn(input_tensor)

    # All outputs are batches tensors.
    # Convert to numpy arrays, and take index [0] to remove the batch
    dimension.
    # We're only interested in the first num_detections.
    num_detections = int(output_dict.pop('num_detections'))
    output_dict = {key:value[0,:num_detections].numpy()
                    for key,value in output_dict.items()}
    output_dict['num_detections'] = num_detections

    # detection_classes should be ints.
    output_dict['detection_classes'] =
    output_dict['detection_classes'].astype(np.int64)

    # Handle models with masks:
    if 'detection_masks' in output_dict:
        # Reframe the the bbox mask to the image size.
        detection_masks_reframed =
        utils_ops.reframe_box_masks_to_image_masks(
            output_dict['detection_masks'],
            output_dict['detection_boxes'],
            image.shape[0], image.shape[1])
        detection_masks_reframed = tf.cast(detection_masks_reframed > 0.5,
            tf.uint8)
        output_dict['detection_masks_reframed'] =
        detection_masks_reframed.numpy()

    return output_dict
```

Run it on each test image and show the results:

```
def show_inference(model, image_path):
    # the array based representation of the image will be used later in
    order to prepare the
    # result image with boxes and labels on it.
```

```

image_np = np.array(Image.open(image_path))
# Actual detection.
output_dict = run_inference_for_single_image(model, image_np)
# Visualization of the results of a detection.
vis_util.visualize_boxes_and_labels_on_image_array(
    image_np,
    output_dict['detection_boxes'],
    output_dict['detection_classes'],
    output_dict['detection_scores'],
    category_index,
    instance_masks=output_dict.get('detection_masks_reframed',
None),
    use_normalized_coordinates=True,
    line_thickness=8)
display(Image.fromarray(image_np))

```

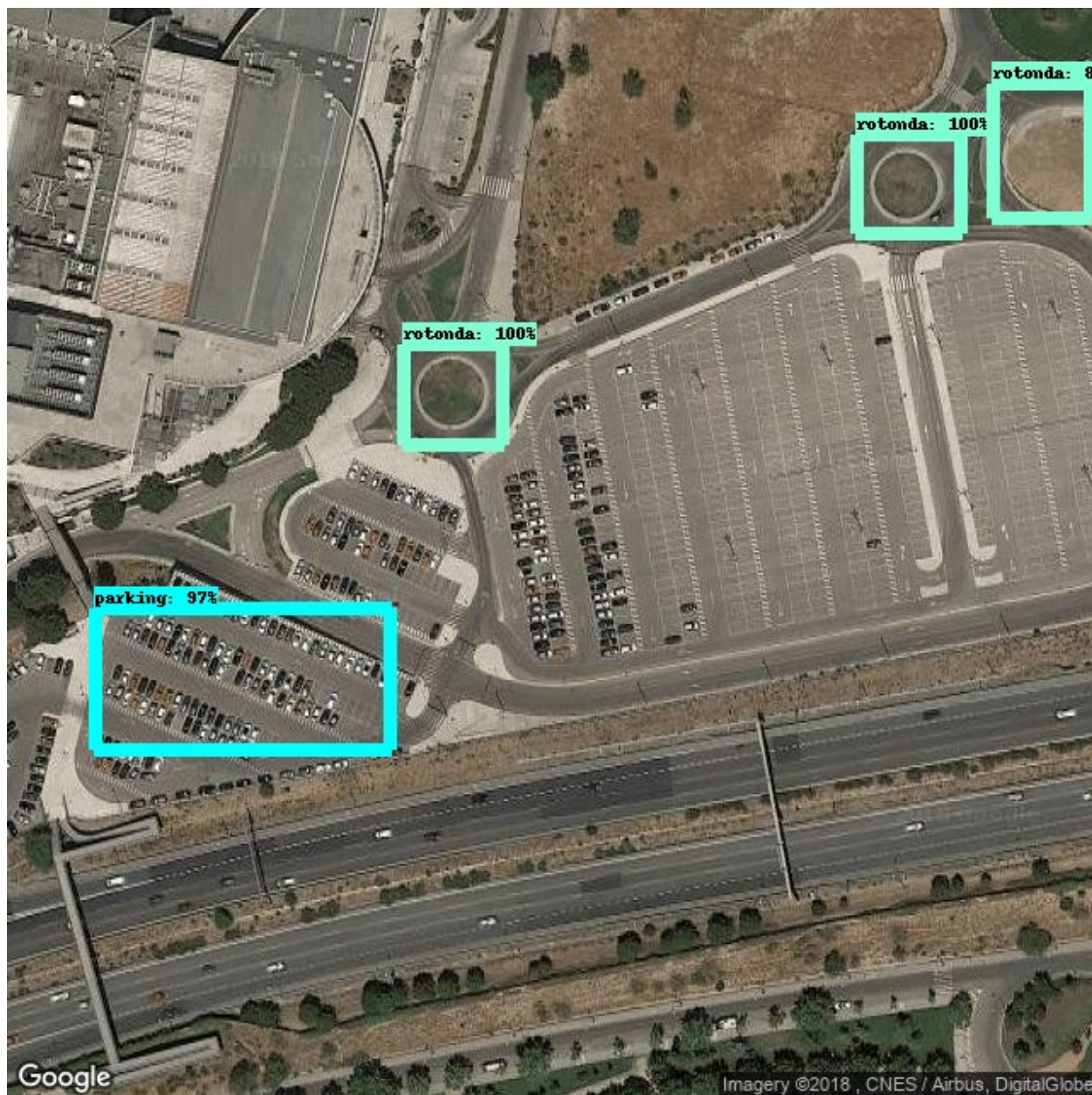
Inference on test images:

Firstly, we attempt to plot a few pictures from the validation set just to see how they perform on it. For certain photographs that are similar to the ones encountered during training, those examples demonstrate how it correctly spotted parking, swimming pools, and roundabouts.

```

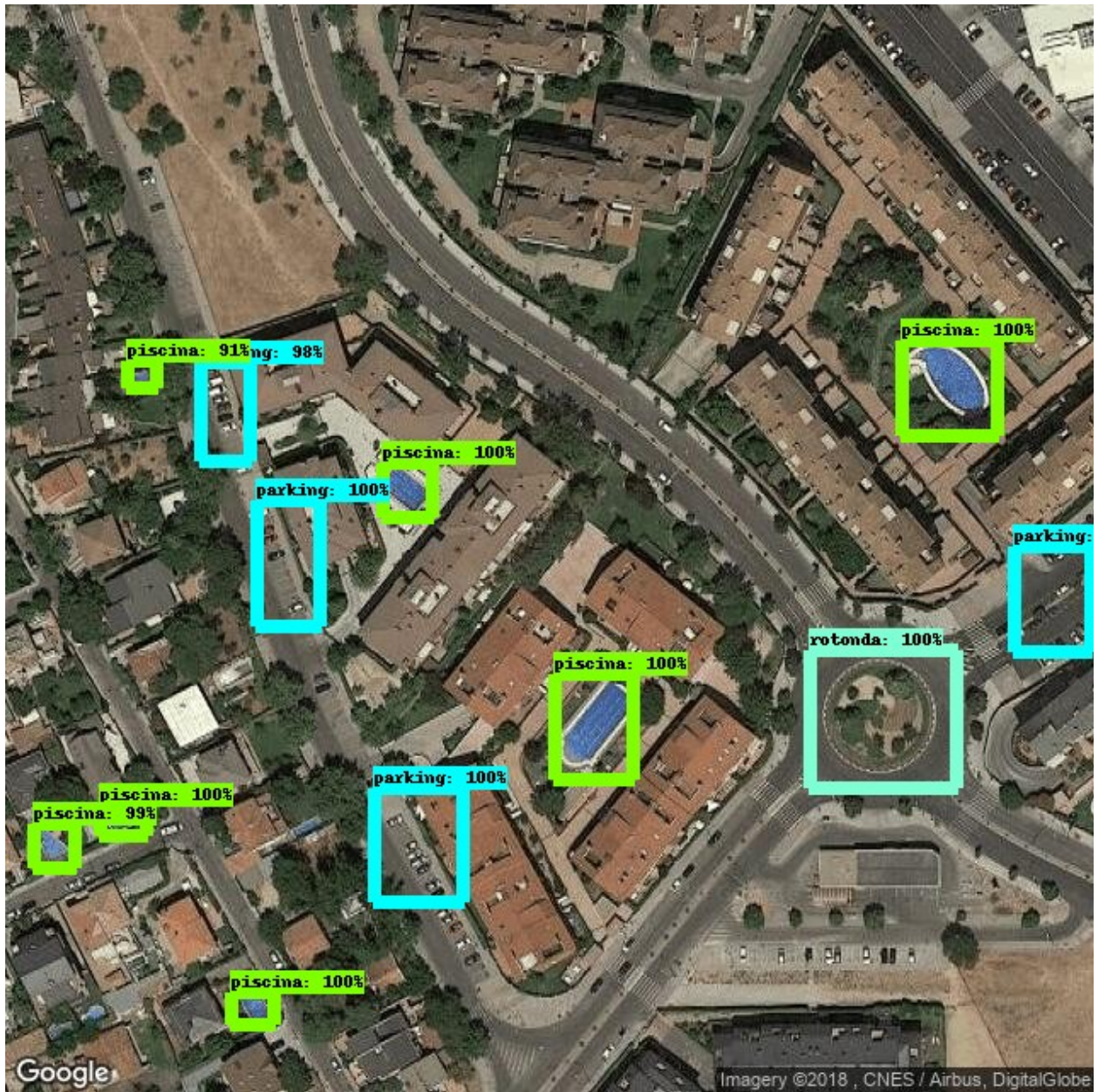
TEST_IMAGE_PATHS="/content/drive/MyDrive/Aerial_Satellite_Images/
validate/imagenes_val/parking_Madrid_40.4620443_-3.8055903.jpg"
db=show_inference(detection_model, TEST_IMAGE_PATHS)

```



This image above was almost detected correctly as it found parking and rotonda instances but left out some instances of parking,

```
show_inference(detection_model,  
"/content/drive/MyDrive/Aerial_Satellite_Images/train/imagenes_train/  
parking_Madrid_40.4593743_-3.8020803.jpg")
```

The image above showed that our model almost got all instances correctly for parking, pool, roundabouts but if we observe closely it missed out some very minute examples of parking which are very fine detailed things maybe which our model didnt pick up. Even with human naked eye its not well observed at first glance.

Testing on images from google:

It was able to identify some photographs from Google that included a pool and a rotunda, but not all of them included parking, etc. As a result, our model performed well on test photos that were comparable to those it encountered during training but not 100% effectively, just partially effective on other kinds.

```
show_inference(detection_model,  
"/content/drive/MyDrive/Object_Detection_API/CVex3/test_imgss/google_t  
est_img2.JPG")
```



For the images above and below, our model did not perform that well and seemed to get only Rotonda for first and missed out all parking instances. For the one below, it missed out an instance of swimming pool, which is probably because it didnt face any swimming pool like this during training. Overall, we would require more data, more variance in data and longer training times with higher batch sizes. If we do so, we have a higher chance of performing well on instanes not seen during training or validation phases.

```
show_inference(detection_model,  
"/content/drive/MyDrive/Object_Detection_API/CVex3/test_imgss/google_t  
est_img3.jpg")
```




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