

```
%tensorflow_version 1.x

↳ TensorFlow 1.x selected.

import os
from google.colab import drive

drive.mount('/content/drive/')

↳ Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client\_id=947318989803-6bn6qk8qdgf4n4g3pfee6491t

Enter your authorization code:
.....
Mounted at /content/drive/

DATA_DIR = "/content/drive/My Drive/test/data_complete/"

# Directory to save logs and trained model
ROOT_DIR = '/content/drive/My Drive/test/working/'

os.chdir(ROOT_DIR)

#!git clone https://www.github.com/matterport/Mask\_RCNN.git
```

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

```
!python3 setup.py install
!pip3 install pydicom

install_reqs()
#
```



```
Requirement already satisfied: webencodings in /usr/local/lib/python3.6/dist-packages (from bleach->nbconvert; extra ==)
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.6/dist-packages (from importlib-metadata; python_ver
Building wheels for collected packages: gast
  Building wheel for gast (setup.py) ... done
  Created wheel for gast: filename=gast-0.2.2-cp36-none-any.whl size=7540 sha256=90545414d84354cdd60c68923c4302a82880d8
  Stored in directory: /root/.cache/pip/wheels/5c/2e/7e/a1d4d4fcebe6c381f378ce7743a3ced3699feb89bcfbadadd
Successfully built gast
Installing collected packages: gast, nose, ipyparallel
  Found existing installation: gast 0.3.3
    Uninstalling gast-0.3.3:
      Successfully uninstalled gast-0.3.3
Successfully installed gast-0.2.2 ipyparallel-6.3.0 nose-1.3.7
WARNING:root:Fail load requirements file, so using default ones.
running install
running bdist_egg
running egg_info
writing mask_rcnn.egg-info/PKG-INFO
writing dependency_links to mask_rcnn.egg-info/dependency_links.txt
writing top-level names to mask_rcnn.egg-info/top_level.txt
reading manifest template 'MANIFEST.in'
writing manifest file 'mask_rcnn.egg-info/SOURCES.txt'
installing library code to build/bdist.linux-x86_64/egg
running install_lib
running build_py
creating build/bdist.linux-x86_64/egg
creating build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/utils.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/__init__.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/config.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/visualize.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/parallel_model.py -> build/bdist.linux-x86_64/egg/mrcnn
copying build/lib/mrcnn/model.py -> build/bdist.linux-x86_64/egg/mrcnn
```

Automatic saving failed. This file was updated remotely or in another tab.

[Show](#)

[diff](#)

thon-36.pyc
_.cpython-36.pyc
python-36.pyc

```
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/visualize.py to visualize.cpython-36.pyc
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/parallel_model.py to parallel_model.cpython-36.pyc
byte-compiling build/bdist.linux-x86_64/egg/mrcnn/model.py to model.cpython-36.pyc
creating build/bdist.linux-x86_64/egg/EGG-INFO
copying mask_rcnn.egg-info/PKG-INFO -> build/bdist.linux-x86_64/egg/EGG-INFO
copying mask_rcnn.egg-info/SOURCES.txt -> build/bdist.linux-x86_64/egg/EGG-INFO
copying mask_rcnn.egg-info/dependency_links.txt -> build/bdist.linux-x86_64/egg/EGG-INFO
copying mask_rcnn.egg-info/top_level.txt -> build/bdist.linux-x86_64/egg/EGG-INFO
```

```
zip_safe flag not set; analyzing archive contents...
creating 'dist/mask_rcnn-2.1-py3.6.egg' and adding 'build/bdist.linux-x86_64/egg' to it
removing 'build/bdist.linux-x86_64/egg' (and everything under it)
Processing mask_rcnn-2.1-py3.6.egg
Copying mask_rcnn-2.1-py3.6.egg to /usr/local/lib/python3.6/dist-packages
Adding mask-rcnn 2.1 to easy-install.pth file

Installed /usr/local/lib/python3.6/dist-packages/mask_rcnn-2.1-py3.6.egg
Processing dependencies for mask-rcnn==2.1
Finished processing dependencies for mask-rcnn==2.1
Collecting pydicom
    Downloading https://files.pythonhosted.org/packages/d3/56/342e1f8ce5afe63bf65c23d0b2c1cd5a05600caad1c211c39725d3a4cc5
[██████████] 35.5MB 88kB/s
Installing collected packages: pydicom
Successfully installed pydicom-2.0.0
```

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

```
import sys
import random
import math
import numpy as np
import cv2
import matplotlib.pyplot as plt
import json

Automatic saving failed. This file was updated remotely or in another tab. Show diff
from tqdm import tqdm
import pandas as pd
import glob
from sklearn.model_selection import KFold

# Import Mask RCNN
sys.path.append(os.path.join(ROOT_DIR, 'Mask_RCNN')) # To find local version of the library
https://colab.research.google.com/drive/1EYRIWdSs3ighQK--CZ1gyva-knZqhUp#scrollTo=zV5\_VYrGAlfG&printMode=true
```

```
from mrcnn.config import Config
from mrcnn import utils
import mrcnn.model as modellib
from mrcnn import visualize
from mrcnn.model import log
```

→ Using TensorFlow backend.

```
train_dicom_dir = os.path.join(DATA_DIR, 'stage_2_train_images')
test_dicom_dir = os.path.join(DATA_DIR, 'stage_2_test_images')
```

```
#!wget --quiet https://github.com/matterport/Mask_RCNN/releases/download/v2.0/mask_rcnn_coco.h5
#!ls -lh mask_rcnn_coco.h5
```

```
COCO_WEIGHTS_PATH = "mask_rcnn_coco.h5"
```

```
def get_dicom_fps(dicom_dir):
    dicom_fps = glob.glob(dicom_dir+'/*.*.dcm')
    temp = list(set(dicom_fps))
    print(len(temp))
    return list(set(dicom_fps))
```

```
#def get_file_path(pid) :
#    return dicom_dir+'/'+pid+'.dcm'
```

```
def get_dicom_fps_downsample(dicom_dir, anns):
    #dicom_fps = glob.glob(dicom_dir+'/*.*.dcm')
```

Automatic saving failed. This file was updated remotely or in another tab. [Show](#)

```
diff dicom_fps.append(dicom_dir + '/' + pid + '.dcm')
```

```
#temp = list(set(dicom_fps))
print(len(dicom_fps))
return dicom_fps
```

```
def parse_dataset(dicom_dir, anns):
    #image_fps = get_dicom_fps(dicom_dir)
```

```
image_fps = get_dicom_fps_downsample(dicom_dir, anns)

image_annotations = {fp: [] for fp in image_fps}
print("number of annotations ", anns.shape[0])
print("fp", image_fps[0:5])
for index, row in anns.iterrows():
    #print("index ", index)
    fp = os.path.join(dicom_dir, row['patientId']+'.dcm')
    image_annotations[fp].append(row)
return image_fps, image_annotations

# The following parameters have been selected to reduce running time for demonstration purposes
# These are not optimal

class OpacityModelConfig(Config):
    """Configuration for training pneumonia detection on the RSNA pneumonia dataset.
    Overrides values in the base Config class.
    """

    # Give the configuration a recognizable name
    NAME = 'pneumonia'

    # Train on 1 GPU and 8 images per GPU. We can put multiple images on each
    # GPU because the images are small. Batch size is 8 (GPUs * images/GPU).
    GPU_COUNT = 1
    IMAGES_PER_GPU = 8

    BACKBONE = 'resnet50'
```

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

```
IMAGE_MIN_DIM = 256
IMAGE_MAX_DIM = 256
RPN_ANCHOR_SCALES = (16, 32, 64, 128, 256)
TRAIN_ROIS_PER_IMAGE = 32
MAX_GT_INSTANCES = 4
DETECTION_MAX_INSTANCES = 3
DETECTION_MIN_CONFIDENCE = 0.78 ## match target distribution
```

```
DETECTION_NMS_THRESHOLD = 0.01
```

```
STEPS_PER_EPOCH = 200
```

```
config = OpacityModelConfig()  
config.display()
```



Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

```
Configurations:
BACKBONE           resnet50
BACKBONE_STRIDES   [4, 8, 16, 32, 64]
BATCH_SIZE          8
BBOX_STD_DEV        [0.1 0.1 0.2 0.2]
COMPUTE_BACKBONE_SHAPE None
DETECTION_MAX_INSTANCES 3
DETECTION_MIN_CONFIDENCE 0.78
DETECTION_NMS_THRESHOLD 0.01
FPN_CLASSIF_FC_LAYERS_SIZE 1024
GPU_COUNT           1
GRADIENT_CLIP_NORM 5.0
IMAGES_PER_GPU      8
IMAGE_CHANNEL_COUNT 3
IMAGE_MAX_DIM       256
IMAGE_META_SIZE     14
IMAGE_MIN_DIM       256

class OpacityModelDataset(utils.Dataset):
    """Dataset class for training pneumonia detection on the RSNA pneumonia dataset.
    """

    def __init__(self, image_fps, image_annotations, orig_height, orig_width):
        super().__init__()

        # Add classes
        self.add_class('pneumonia', 1, 'Lung Opacity')

        # add images
        for i, fp in enumerate(image_fps):

            Automatic saving failed. This file was updated remotely or in another tab. Show diff
            annotations=annotations, orig_height=orig_height, orig_width=orig_width)

    def image_reference(self, image_id):
        info = self.image_info[image_id]
        return info['path']

    def load_image(self, image_id):
        info = self.image_info[image_id]
```

```
fp = info['path']
ds = pydicom.read_file(fp)
image = ds.pixel_array
# If grayscale. Convert to RGB for consistency.
if len(image.shape) != 3 or image.shape[2] != 3:
    image = np.stack((image,) * 3, -1)
return image

def load_mask(self, image_id):
    info = self.image_info[image_id]
    annotations = info['annotations']
    count = len(annotations)
    if count == 0:
        mask = np.zeros((info['orig_height'], info['orig_width'], 1), dtype=np.uint8)
        class_ids = np.zeros((1,), dtype=np.int32)
    else:
        mask = np.zeros((info['orig_height'], info['orig_width'], count), dtype=np.uint8)
        class_ids = np.zeros((count,), dtype=np.int32)
        for i, a in enumerate(annotations):
            if a['Target'] == 1:
                x = int(a['x'])
                y = int(a['y'])
                w = int(a['width'])
                h = int(a['height'])
                mask_instance = mask[:, :, i].copy()
                cv2.rectangle(mask_instance, (x, y), (x+w, y+h), 255, -1)
                mask[:, :, i] = mask_instance
                class_ids[i] = 1
    return mask.astype(np.bool), class_ids.astype(np.int32)
```

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

```
anns = pd.read_csv(os.path.join(DATA_DIR, 'stage_2_train_labels.csv'))
print(anns.head(), '\n\n')
print(anns.Target.value_counts())
```



	patientId	x	y	width	height	Target
0	0004cfab-14fd-4e49-80ba-63a80b6bdd6	NaN	NaN	NaN	NaN	0
1	00313ee0-9eaa-42f4-b0ab-c148ed3241cd	NaN	NaN	NaN	NaN	0
2	00322d4d-1c29-4943-afc9-b6754be640eb	NaN	NaN	NaN	NaN	0
3	003d8fa0-6bf1-40ed-b54c-ac657f8495c5	NaN	NaN	NaN	NaN	0
4	00436515-870c-4b36-a041-de91049b9ab4	264.0	152.0	213.0	379.0	1

```
from sklearn.utils import resample

# Separate majority and minority classes
anns_majority = anns[anns.Target==0]
anns_minority = anns[anns.Target==1]
```

▼ Upsample minority class

```
# Upsample minority class
anns_minority_upsampled = resample(anns_minority,
                                    replace=True,      # sample with replacement
                                    n_samples=anns_majority['Target'].size,    # to match majority class
                                    random_state=123) # reproducible results

# Combine majority class with upsampled minority class
anns_upsampled = pd.concat([anns_majority, anns_minority_upsampled])
```

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

```
1 20672
0 20672
Name: Target, dtype: int64
```

▼ Downsample majority class

```
# Downsample majority class
anns_majority_downsampled = resample(anns_majority,
                                      replace=False,      # sample without replacement
                                      n_samples=anns_minority['Target'].size,    # to match minority class
                                      random_state=123) # reproducible results

# Combine minority class with downsampled majority class
anns_downsampled = pd.concat([anns_majority_downsampled, anns_minority])

# Display new class counts
anns_downsampled.Target.value_counts()
```

```
↳ 1    9555
  0    9555
Name: Target, dtype: int64
```

```
anns_downsampled.head()
```

	patientId	x	y	width	height	Target
18317	ad182aff-7085-408e-bac3-51a7c705a711	NaN	NaN	NaN	NaN	0
25806	e6b00554-e9ed-4f60-bd14-71dbb7892b40	NaN	NaN	NaN	NaN	0
11943	7aef347d-05aa-4c06-8e24-956aa91ace5e	NaN	NaN	NaN	NaN	0
22429	d0800d0d-4b20-45f5-9026-016c2d162ab4	NaN	NaN	NaN	NaN	0

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

```
#image_fps, image_annotations = parse_dataset(train_dicom_dir, anns=anns)
image_fps, image_annotations = parse_dataset(train_dicom_dir, anns=anns_downsampled)
len(image_annotations.items())
```

```

↳ 19110
  number of annotations 19110
  fp ['/content/drive/My Drive/test/data_complete/stage_2_train_images/ad182aff-7085-408e-bac3-51a7c705a711.dcm', '/conte
  15567

ds = pydicom.read_file(image_fps[5]) # read dicom image from filepath
image = ds.pixel_array # get image array

# show dicom fields
ds

```

```

↳ -----
  OSError                                     Traceback (most recent call last)
  <ipython-input-19-293b31972db3> in <module>()
    ----> 1 ds = pydicom.read_file(image_fps[5]) # read dicom image from filepath
          2 image = ds.pixel_array # get image array
          3
          4 # show dicom fields
          5 ds

/usr/local/lib/python3.6/dist-packages/pydicom/filereader.py in dcmread(fp, defer_size, stop_before_pixels, force, spec
  845         except Exception:
  846             logger.debug("Reading file '{0}'".format(fp))
--> 847             fp = open(fp, 'rb')
  848
  849     if config.debugging:

OSError: [Errno 5] Input/output error: '/content/drive/My Drive/test/data_complete/stage_2_train_images/7e722f23-4ffe-4

```

[SEARCH STACK OVERFLOW](#)

Automatic saving failed. This file was updated remotely or in another tab. [Show](#)

[diff](#)
 # ORIGINL DICOM IMAGE SIZE. 1024 x 1024
 ORIG_SIZE = 1024

```

image_fps_list = list(image_fps)
random.seed(42)
random.shuffle(image_fps_list)
val_size = 1500

```

```
image_tps_val = image_tps_list[:val_size]
image_fps_train = image_fps_list[val_size:]

print(len(image_fps_train), len(image_fps_val))
# print(image_fps_val[:6])

print(len(image_annotations))

# prepare the training dataset
dataset_train = OpacityModelDataset(image_fps_train, image_annotations, ORIG_SIZE, ORIG_SIZE)
dataset_train.prepare()

# Show annotation(s) for a DICOM image
test_fp = random.choice(image_fps_train)
image_annotations[test_fp]

# prepare the validation dataset
dataset_val = OpacityModelDataset(image_fps_val, image_annotations, ORIG_SIZE, ORIG_SIZE)
dataset_val.prepare()

# Load and display random sample and their bounding boxes

class_ids = [0]
while class_ids[0] == 0: ## look for a mask
    image_id = random.choice(dataset_train.image_ids)
    image_fp = dataset_train.image_reference(image_id)

Automatic saving failed. This file was updated remotely or in another tab. Show diff

print(image.shape)

plt.figure(figsize=(10, 10))
plt.subplot(1, 2, 1)
plt.imshow(image)
plt.axis('off')
```

```
plt.subplot(1, 2, 2)
masked = np.zeros(image.shape[:2])
for i in range(mask.shape[2]):
    masked += image[:, :, 0] * mask[:, :, i]
plt.imshow(masked, cmap='gray')
plt.axis('off')

print(image_fp)
print(class_ids)

os.path.exists('/content/drive/My Drive/test/data_complete/stage_2_train_images/fd8770d4-c595-4cfe-965b-9e51bf004dbd.dcm')

# Image augmentation (light but constant)
augmentation = iaa.Sequential([
    iaa.OneOf([
        ### geometric transform
        iaa.Affine(
            scale={"x": (0.98, 1.02), "y": (0.98, 1.04)},
            translate_percent={"x": (-0.02, 0.02), "y": (-0.04, 0.04)},
            rotate=(-2, 2),
            shear=(-1, 1),
        ),
        iaa.PiecewiseAffine(scale=(0.001, 0.025)),
    ]),
    iaa.OneOf([
        ### brightness or contrast
        iaa.Multiply((0.9, 1.1)),
        iaa.ContrastNormalization((0.9, 1.1)),
    ]),
    iaa.CropAndPad(
        height_px=10,
        width_px=10,
        height_percent=None,
        width_percent=None,
        crop_px=False,
        pad_px=True,
        pad_mode="constant",
        pad_cval=0
    )
]),

Automatic saving failed. This file was updated remotely or in another tab. Show diff
```

```
]),
])

# test on the same image as above
imggrid = augmentation.draw_grid(image[:, :, 0], cols=5, rows=2)
plt.figure(figsize=(30, 12))
_ = plt.imshow(imggrid[:, :, 0], cmap='gray')
```

```
import tensorflow.compat.v1 as tf
tf.disable_v2_behavior()

model = modellib.MaskRCNN(mode='training', config=config, model_dir=ROOT_DIR)

# Exclude the last layers because they require a matching
# number of classes
model.load_weights(COCO_WEIGHTS_PATH, by_name=True, exclude=[
    "mrcnn_class_logits", "mrcnn_bbox_fc",
    "mrcnn_bbox", "mrcnn_mask"])

LEARNING_RATE = 0.006

# Train Mask-RCNN Model
import warnings
warnings.filterwarnings("ignore")

#This needs to be uncommented
model.keras_model.metrics_tensors = []

%%time

## train heads with higher lr to speedup the learning
model.train(dataset_train, dataset_val,
            learning_rate=LEARNING_RATE*2,
```

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

```
history = model.keras_model.history.history
```



Starting at epoch 0. LR=0.012

Checkpoint Path: /content/drive/My Drive/test/working/pneumonia20200704T1803/mask_rcnn_pneumonia_{epoch:04d}.h5
Selecting layers to train

fpn_c5p5	(Conv2D)
fpn_c4p4	(Conv2D)
fpn_c3p3	(Conv2D)
fpn_c2p2	(Conv2D)
fpn_p5	(Conv2D)
fpn_p2	(Conv2D)
fpn_p3	(Conv2D)
fpn_p4	(Conv2D)
In model: rpn_model	
rpn_conv_shared	(Conv2D)
rpn_class_raw	(Conv2D)
rpn_bbox_pred	(Conv2D)
mrcnn_mask_conv1	(TimeDistributed)
mrcnn_mask_bn1	(TimeDistributed)
mrcnn_mask_conv2	(TimeDistributed)
mrcnn_mask_bn2	(TimeDistributed)
mrcnn_class_conv1	(TimeDistributed)
mrcnn_class_bn1	(TimeDistributed)
mrcnn_mask_conv3	(TimeDistributed)
mrcnn_mask_bn3	(TimeDistributed)
mrcnn_class_conv2	(TimeDistributed)
mrcnn_class_bn2	(TimeDistributed)
mrcnn_mask_conv4	(TimeDistributed)
mrcnn_mask_bn4	(TimeDistributed)
mrcnn_bbox_fc	(TimeDistributed)
mrcnn_mask_deconv	(TimeDistributed)
mrcnn_class_logits	(TimeDistributed)

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

ckend/tensorflow_backend.py:422: The name tf.glc

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:431: The name tf.is_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:438: The name tf.var

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks/tensorboard_v1.py:200: The name tf.summa

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks/tensorboard_v1.py:203: The name tf.summa

```
Epoch 1/2
200/200 [=====] - 1136s 6s/step - loss: 1.8562 - val_loss: 1.3087
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks/tensorboard_v1.py:343: The name tf.Summa

Epoch 00001: saving model to /content/drive/My Drive/test/working/pneumonia20200704T1803/mask_rcnn_pneumonia_0001.h5
Epoch 2/2

%%time
model.train(dataset_train, dataset_val,
            learning_rate=LEARNING_RATE,
            epochs=6,
            layers='all',
            augmentation=augmentation)

new_history = model.keras_model.history.history
for k in new_history: history[k] = history[k] + new_history[k]
```



Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

```
bn4b_branch2b      (BatchNorm)
res4b_branch2c     (Conv2D)
bn4b_branch2c      (BatchNorm)
res4c_branch2a     (Conv2D)
bn4c_branch2a     (BatchNorm)
res4c_branch2b     (Conv2D)
bn4c_branch2b      (BatchNorm)
res4c_branch2c     (Conv2D)
bn4c_branch2c      (BatchNorm)
res4d_branch2a     (Conv2D)
bn4d_branch2a     (BatchNorm)
res4d_branch2b     (Conv2D)
bn4d_branch2b      (BatchNorm)
res4d_branch2c     (Conv2D)
bn4d_branch2c      (BatchNorm)
res4e_branch2a     (Conv2D)
bn4e_branch2a     (BatchNorm)
res4e_branch2b     (Conv2D)
bn4e_branch2b      (BatchNorm)
res4e_branch2c     (Conv2D)
bn4e_branch2c      (BatchNorm)
res4f_branch2a     (Conv2D)
bn4f_branch2a     (BatchNorm)
res4f_branch2b     (Conv2D)
bn4f_branch2b      (BatchNorm)
res4f_branch2c     (Conv2D)
bn4f_branch2c      (BatchNorm)
res5a_branch2a     (Conv2D)
bn5a_branch2a     (BatchNorm)
res5a_branch2b     (Conv2D)
bn5a_branch2b      (BatchNorm)
res5a_branch2c     (Conv2D)
bn5a_branch2c      (BatchNorm)
res5b_branch2a     (Conv2D)
bn5b_branch2a     (BatchNorm)
res5b_branch2b     (Conv2D)
bn5b_branch2b      (BatchNorm)
res5b_branch2c     (Conv2D)
bn5b_branch2c      (BatchNorm)
res5c_branch2a     (Conv2D)
bn5c_branch2a     (BatchNorm)
res5c_branch2b     (Conv2D)
```

Automatic saving failed. This file was updated remotely or in another tab. [Show](#)

diff

```
res5b_branch2a     (Conv2D)
bn5b_branch2a     (BatchNorm)
res5b_branch2b     (Conv2D)
bn5b_branch2b      (BatchNorm)
res5b_branch2c     (Conv2D)
bn5b_branch2c      (BatchNorm)
res5c_branch2a     (Conv2D)
bn5c_branch2a     (BatchNorm)
res5c_branch2b     (Conv2D)
```

```
bn5c_branch2b          (BatchNorm)
res5c_branch2c          (Conv2D)
bn5c_branch2c          (BatchNorm)
fpn_c5p5                (Conv2D)
fpn_c4p4                (Conv2D)
fpn_c3p3                (Conv2D)
fpn_c2p2                (Conv2D)
fpn_p5                  (Conv2D)
fpn_p2                  (Conv2D)
fpn_p3                  (Conv2D)
fpn_p4                  (Conv2D)

In model: rpn_model
    rpn_conv_shared        (Conv2D)
    rpn_class_raw          (Conv2D)
    rpn_bbox_pred          (Conv2D)
mrcnn_mask_conv1         (TimeDistributed)
mrcnn_mask_bn1           (TimeDistributed)
mrcnn_mask_conv2         (TimeDistributed)
mrcnn_mask_bn2           (TimeDistributed)
mrcnn_class_conv1        (TimeDistributed)
mrcnn_class_bn1          (TimeDistributed)
mrcnn_mask_conv3         (TimeDistributed)
mrcnn_mask_bn3           (TimeDistributed)
mrcnn_class_conv2        (TimeDistributed)
mrcnn_class_bn2          (TimeDistributed)
mrcnn_mask_conv4         (TimeDistributed)
mrcnn_mask_bn4           (TimeDistributed)
mrcnn_bbox_fc            (TimeDistributed)
mrcnn_mask_deconv         (TimeDistributed)
mrcnn_class_logits        (TimeDistributed)
mrcnn_mask               (TimeDistributed)
```

Epoch 3/6

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

- val_loss: 1.8079

- val_loss: 2.0015

Epoch 5/6

200/200 [=====] - 951s 5s/step - loss: 1.6056 - val_loss: 1.5849

Epoch 6/6

200/200 [=====] - 1241s 6s/step - loss: 1.5129 - val_loss: 1.3872

CPU times: user 7min 34s, sys: 59.8 s, total: 8min 34s

Wall time: 1h 3min 31s

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

```
%%time
model.train(dataset_train, dataset_val,
https://colab.research.google.com/drive/1EYRIWdSs3ighQK--CZ1gyva-knZqhUp#scrollTo=zV5_VYrGAlfG&printMode=true
```

```
learning_rate=LEARNING_RATE/5,  
epochs=25,  
layers='all',  
augmentation=augmentation)  
  
new_history = model.keras_model.history.history  
for k in new_history: history[k] = history[k] + new_history[k]
```



Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

Starting at epoch 23. LR=0.0012000000000000001

Checkpoint Path: /content/drive/My Drive/test/working/pneumonia20200628T0708/mask_rcnn_pneumonia_{epoch:04d}.h5

Selecting layers to train

conv1	(Conv2D)
bn_conv1	(BatchNorm)
res2a_branch2a	(Conv2D)
bn2a_branch2a	(BatchNorm)
res2a_branch2b	(Conv2D)
bn2a_branch2b	(BatchNorm)
res2a_branch2c	(Conv2D)
res2a_branch1	(Conv2D)
bn2a_branch2c	(BatchNorm)
bn2a_branch1	(BatchNorm)
res2b_branch2a	(Conv2D)
bn2b_branch2a	(BatchNorm)
res2b_branch2b	(Conv2D)
bn2b_branch2b	(BatchNorm)
res2b_branch2c	(Conv2D)
bn2b_branch2c	(BatchNorm)
res2c_branch2a	(Conv2D)
bn2c_branch2a	(BatchNorm)
res2c_branch2b	(Conv2D)
bn2c_branch2b	(BatchNorm)
res2c_branch2c	(Conv2D)
bn2c_branch2c	(BatchNorm)
res3a_branch2a	(Conv2D)
bn3a_branch2a	(BatchNorm)
res3a_branch2b	(Conv2D)
bn3a_branch2b	(BatchNorm)
res3a_branch2c	(Conv2D)

Automatic saving failed. This file was updated remotely or in another tab. [Show](#)

diff

res3b_branch2a	(Conv2D)
bn3b_branch2a	(BatchNorm)
res3b_branch2b	(Conv2D)
bn3b_branch2b	(BatchNorm)
res3b_branch2c	(Conv2D)
bn3b_branch2c	(BatchNorm)
res3c_branch2a	(Conv2D)
bn3c_branch2a	(BatchNorm)

```
res3c_branch2b      (Conv2D)
bn3c_branch2b      (BatchNorm)
res3c_branch2c      (Conv2D)
bn3c_branch2c      (BatchNorm)
res3d_branch2a      (Conv2D)
bn3d_branch2a      (BatchNorm)
res3d_branch2b      (Conv2D)
bn3d_branch2b      (BatchNorm)
res3d_branch2c      (Conv2D)
bn3d_branch2c      (BatchNorm)
res4a_branch2a      (Conv2D)
bn4a_branch2a      (BatchNorm)
res4a_branch2b      (Conv2D)
bn4a_branch2b      (BatchNorm)
res4a_branch2c      (Conv2D)
res4a_branch1       (Conv2D)
bn4a_branch2c      (BatchNorm)
bn4a_branch1       (BatchNorm)
res4b_branch2a      (Conv2D)
bn4b_branch2a      (BatchNorm)
res4b_branch2b      (Conv2D)
bn4b_branch2b      (BatchNorm)
res4b_branch2c      (Conv2D)
bn4b_branch2c      (BatchNorm)
res4c_branch2a      (Conv2D)
bn4c_branch2a      (BatchNorm)
res4c_branch2b      (Conv2D)
bn4c_branch2b      (BatchNorm)
res4c_branch2c      (Conv2D)
bn4c_branch2c      (BatchNorm)
res4d_branch2a      (Conv2D)
bn4d_branch2a      (BatchNorm)
bn4d_branch2b      (Conv2D)
```

Automatic saving failed. This file was updated remotely or in another tab. [Show](#)

diff

```
bn4d_branch2c      (BatchNorm)
res4e_branch2a      (Conv2D)
bn4e_branch2a      (BatchNorm)
res4e_branch2b      (Conv2D)
bn4e_branch2b      (BatchNorm)
res4e_branch2c      (Conv2D)
bn4e_branch2c      (BatchNorm)
res4f_branch2a      (Conv2D)
bn4f_branch2a      (BatchNorm)
```

```
        (BatchNorm)
res4f_branch2b      (Conv2D)
bn4f_branch2b       (BatchNorm)
res4f_branch2c      (Conv2D)
bn4f_branch2c       (BatchNorm)
res5a_branch2a      (Conv2D)
bn5a_branch2a       (BatchNorm)
res5a_branch2b      (Conv2D)
bn5a_branch2b       (BatchNorm)
res5a_branch2c      (Conv2D)
bn5a_branch2c       (BatchNorm)
res5a_branch1        (Conv2D)
bn5a_branch1         (BatchNorm)
res5b_branch2a      (Conv2D)
bn5b_branch2a       (BatchNorm)
res5b_branch2b      (Conv2D)
bn5b_branch2b       (BatchNorm)
res5b_branch2c      (Conv2D)
bn5b_branch2c       (BatchNorm)
res5c_branch2a      (Conv2D)
bn5c_branch2a       (BatchNorm)
res5c_branch2b      (Conv2D)
bn5c_branch2b       (BatchNorm)
res5c_branch2c      (Conv2D)
bn5c_branch2c       (BatchNorm)
fpn_c5p5             (Conv2D)
fpn_c4p4             (Conv2D)
fpn_c3p3             (Conv2D)
fpn_c2p2             (Conv2D)
fpn_p5               (Conv2D)
fpn_p2               (Conv2D)
fpn_p3               (Conv2D)
fpn_p4               (Conv2D)
```

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

```
rpn_bbox_pred        (Conv2D)
mrcnn_mask_conv1     (TimeDistributed)
mrcnn_mask_bn1       (TimeDistributed)
mrcnn_mask_conv2     (TimeDistributed)
```

```
model_path = ROOT_DIR + "pneumonia20200628T0708/mask_rcnn_pneumonia_0023.h5"
model.load_weights(model_path, by_name=True)
```

↳ Re-starting from epoch 23

```
%%time
#model.train(dataset_train, dataset_val,
#             learning_rate=LEARNING_RATE/5,
#             epochs=26,
#             layers='all',
#             augmentation=augmentation)

#new_history = model.keras_model.history.history
#for k in new_history: history[k] = history[k] + new_history[k]
```

↳ CPU times: user 3 µs, sys: 1 µs, total: 4 µs
Wall time: 7.15 µs

```
model.keras_model.summary()
```

↳

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

Model: "mask_rcnn"

Layer (type)	Output Shape	Param #	Connected to
input_image (InputLayer)	(None, None, None, 3 0		
zero_padding2d_1 (ZeroPadding2D)	(None, None, None, 3 0		input_image[0][0]
conv1 (Conv2D)	(None, None, None, 6 9472		zero_padding2d_1[0][0]
bn_conv1 (BatchNorm)	(None, None, None, 6 256		conv1[0][0]
activation_1 (Activation)	(None, None, None, 6 0		bn_conv1[0][0]
max_pooling2d_1 (MaxPooling2D)	(None, None, None, 6 0		activation_1[0][0]
res2a_branch2a (Conv2D)	(None, None, None, 6 4160		max_pooling2d_1[0][0]
bn2a_branch2a (BatchNorm)	(None, None, None, 6 256		res2a_branch2a[0][0]
activation_2 (Activation)	(None, None, None, 6 0		bn2a_branch2a[0][0]
res2a_branch2b (Conv2D)	(None, None, None, 6 36928		activation_2[0][0]
bn2a_branch2b (BatchNorm)	(None, None, None, 6 256		res2a_branch2b[0][0]
activation_3 (Activation)	(None, None, None, 6 0		bn2a_branch2b[0][0]
res2a_branch2c (Conv2D)	(None, None, None, 2 16640		activation_3[0][0]
res2a_branch1 (Conv2D)	(None, None, None, 2 16640		max_pooling2d_1[0][0]
<hr/>			
Automatic saving failed. This file was updated remotely or in another tab. Show diff			
<hr/>			
add_1 (Add)	(None, None, None, 2 0		bn2a_branch2c[0][0] bn2a_branch1[0][0]
res2a_out (Activation)	(None, None, None, 2 0		add_1[0][0]
res2b_branch2a (Conv2D)	(None, None, None, 6 16448		res2a_out[0][0]

bn2b_branch2a (BatchNorm)	(None, None, None, 6 256	res2b_branch2a[0][0]
activation_4 (Activation)	(None, None, None, 6 0	bn2b_branch2a[0][0]
res2b_branch2b (Conv2D)	(None, None, None, 6 36928	activation_4[0][0]
bn2b_branch2b (BatchNorm)	(None, None, None, 6 256	res2b_branch2b[0][0]
activation_5 (Activation)	(None, None, None, 6 0	bn2b_branch2b[0][0]
res2b_branch2c (Conv2D)	(None, None, None, 2 16640	activation_5[0][0]
bn2b_branch2c (BatchNorm)	(None, None, None, 2 1024	res2b_branch2c[0][0]
add_2 (Add)	(None, None, None, 2 0	bn2b_branch2c[0][0] res2a_out[0][0]
res2b_out (Activation)	(None, None, None, 2 0	add_2[0][0]
res2c_branch2a (Conv2D)	(None, None, None, 6 16448	res2b_out[0][0]
bn2c_branch2a (BatchNorm)	(None, None, None, 6 256	res2c_branch2a[0][0]
activation_6 (Activation)	(None, None, None, 6 0	bn2c_branch2a[0][0]
res2c_branch2b (Conv2D)	(None, None, None, 6 36928	activation_6[0][0]
bn2c_branch2b (BatchNorm)	(None, None, None, 6 256	res2c_branch2b[0][0]
activation_7 (Activation)	(None, None, None, 6 0	bn2c_branch2b[0][0]
res2c_branch2c (Conv2D)	(None, None, None, 2 16640	activation_7[0][0]

Automatic saving failed. This file was updated remotely or in another tab.

[Show](#)

branch2c[0][0]

diff add_3 (Add)	(None, None, None, 2 0	bn2c_branch2c[0][0] res2b_out[0][0]
res2c_out (Activation)	(None, None, None, 2 0	add_3[0][0]
res3a_branch2a (Conv2D)	(None, None, None, 1 32896	res2c_out[0][0]
bn3a_branch2a (BatchNorm)	(None, None, None, 1 512	res3a_branch2a[0][0]

activation_8 (Activation)	(None, None, None, 1 0	bn3a_branch2a[0][0]
res3a_branch2b (Conv2D)	(None, None, None, 1 147584	activation_8[0][0]
bn3a_branch2b (BatchNorm)	(None, None, None, 1 512	res3a_branch2b[0][0]
activation_9 (Activation)	(None, None, None, 1 0	bn3a_branch2b[0][0]
res3a_branch2c (Conv2D)	(None, None, None, 5 66048	activation_9[0][0]
res3a_branch1 (Conv2D)	(None, None, None, 5 131584	res2c_out[0][0]
bn3a_branch2c (BatchNorm)	(None, None, None, 5 2048	res3a_branch2c[0][0]
bn3a_branch1 (BatchNorm)	(None, None, None, 5 2048	res3a_branch1[0][0]
add_4 (Add)	(None, None, None, 5 0	bn3a_branch2c[0][0] bn3a_branch1[0][0]
res3a_out (Activation)	(None, None, None, 5 0	add_4[0][0]
res3b_branch2a (Conv2D)	(None, None, None, 1 65664	res3a_out[0][0]
bn3b_branch2a (BatchNorm)	(None, None, None, 1 512	res3b_branch2a[0][0]
activation_10 (Activation)	(None, None, None, 1 0	bn3b_branch2a[0][0]
res3b_branch2b (Conv2D)	(None, None, None, 1 147584	activation_10[0][0]
bn3b_branch2b (BatchNorm)	(None, None, None, 1 512	res3b_branch2b[0][0]
activation_11 (Activation)	(None, None, None, 1 0	bn3b_branch2b[0][0]
Automatic saving failed. This file was updated remotely or in another tab. Show diff		
bn3b_branch2c (BatchNorm)	(None, None, None, 5 2048	res3b_branch2c[0][0]
add_5 (Add)	(None, None, None, 5 0	bn3b_branch2c[0][0] res3a_out[0][0]
res3b_out (Activation)	(None, None, None, 5 0	add_5[0][0]
res3c_branch2a (Conv2D)	(None, None, None, 1 65664	res3b_out[0][0]

bn3c_branch2a (BatchNorm)	(None, None, None, 1 512	res3c_branch2a[0][0]
activation_12 (Activation)	(None, None, None, 1 0	bn3c_branch2a[0][0]
res3c_branch2b (Conv2D)	(None, None, None, 1 147584	activation_12[0][0]
bn3c_branch2b (BatchNorm)	(None, None, None, 1 512	res3c_branch2b[0][0]
activation_13 (Activation)	(None, None, None, 1 0	bn3c_branch2b[0][0]
res3c_branch2c (Conv2D)	(None, None, None, 5 66048	activation_13[0][0]
bn3c_branch2c (BatchNorm)	(None, None, None, 5 2048	res3c_branch2c[0][0]
add_6 (Add)	(None, None, None, 5 0	bn3c_branch2c[0][0] res3b_out[0][0]
res3c_out (Activation)	(None, None, None, 5 0	add_6[0][0]
res3d_branch2a (Conv2D)	(None, None, None, 1 65664	res3c_out[0][0]
bn3d_branch2a (BatchNorm)	(None, None, None, 1 512	res3d_branch2a[0][0]
activation_14 (Activation)	(None, None, None, 1 0	bn3d_branch2a[0][0]
res3d_branch2b (Conv2D)	(None, None, None, 1 147584	activation_14[0][0]
bn3d_branch2b (BatchNorm)	(None, None, None, 1 512	res3d_branch2b[0][0]
activation_15 (Activation)	(None, None, None, 1 0	bn3d_branch2b[0][0]
res3d_branch2c (Conv2D)	(None, None, None, 5 66048	activation_15[0][0]

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)

add_7 (Add)	(None, None, None, 5 0	bn3d_branch2c[0][0] res3c_out[0][0]
res3d_out (Activation)	(None, None, None, 5 0	add_7[0][0]
res4a_branch2a (Conv2D)	(None, None, None, 2 131328	res3d_out[0][0]
bn4a_branch2a (BatchNorm)	(None, None, None, 2 1024	res4a_branch2a[0][0]

activation_16 (Activation)	(None, None, None, 2 0	bn4a_branch2a[0][0]
res4a_branch2b (Conv2D)	(None, None, None, 2 590080	activation_16[0][0]
bn4a_branch2b (BatchNorm)	(None, None, None, 2 1024	res4a_branch2b[0][0]
activation_17 (Activation)	(None, None, None, 2 0	bn4a_branch2b[0][0]
res4a_branch2c (Conv2D)	(None, None, None, 1 263168	activation_17[0][0]
res4a_branch1 (Conv2D)	(None, None, None, 1 525312	res3d_out[0][0]
bn4a_branch2c (BatchNorm)	(None, None, None, 1 4096	res4a_branch2c[0][0]
bn4a_branch1 (BatchNorm)	(None, None, None, 1 4096	res4a_branch1[0][0]
add_8 (Add)	(None, None, None, 1 0	bn4a_branch2c[0][0] bn4a_branch1[0][0]
res4a_out (Activation)	(None, None, None, 1 0	add_8[0][0]
res4b_branch2a (Conv2D)	(None, None, None, 2 262400	res4a_out[0][0]
bn4b_branch2a (BatchNorm)	(None, None, None, 2 1024	res4b_branch2a[0][0]
activation_18 (Activation)	(None, None, None, 2 0	bn4b_branch2a[0][0]
res4b_branch2b (Conv2D)	(None, None, None, 2 590080	activation_18[0][0]
bn4b_branch2b (BatchNorm)	(None, None, None, 2 1024	res4b_branch2b[0][0]
bn4b_branch2c (BatchNorm)	(None, None, None, 1 4096	res4b_branch2c[0][0]
add_9 (Add)	(None, None, None, 1 0	bn4b_branch2c[0][0] res4a_out[0][0]
res4b_out (Activation)	(None, None, None, 1 0	add_9[0][0]

Automatic saving failed. This file was updated remotely or in another tab. [Show diff](#)