data_aug_adam_val__recall_97_62

November 7, 2021

1 Covid Classifier Model

1.0.1 Goals

Classify: - Normal CXR - Viral Pneumonia CXR - COVID CXR

1.1 Create Directories for Dataset

Separate the data to use later as generators.

```python
# Aumentar threshold de Early Stop.
# Aumentar las rotaciones y escalas.
# Jugar con las metricas AUC y recall.
import os

BASE_PATH = '/home/hivini/learn/research/new-covid'
ORIGINAL_DATASET_DIR = os.path.join(BASE_PATH, 'COVID-19_Radiography_Dataset')
ORIGINAL_VIRAL_DIR = os.path.join(ORIGINAL_DATASET_DIR, 'Viral Pneumonia')
ORIGINAL_COVID_DIR = os.path.join(ORIGINAL_DATASET_DIR, 'COVID')
ORIGINAL_NORMAL_DIR = os.path.join(ORIGINAL_DATASET_DIR, 'Normal')
DATASET_DIR = os.path.join(BASE_PATH, 'small_dataset')
TRAIN_DIR = os.path.join(DATASET_DIR, 'train')
VALIDATION_DIR = os.path.join(DATASET_DIR, 'validation')
TEST_DIR = os.path.join(DATASET_DIR, 'test')
TRAIN_VIRAL_DIR = os.path.join(TRAIN_DIR, 'viral_pneumonia')
TRAIN_COVID_DIR = os.path.join(TRAIN_DIR, 'covid')
TRAIN_NORMAL_DIR = os.path.join(TRAIN_DIR, 'normal')
VALIDATION_VIRAL_DIR = os.path.join(VALIDATION_DIR, 'viral_pneumonia')
VALIDATION_COVID_DIR = os.path.join(VALIDATION_DIR, 'covid')
VALIDATION_NORMAL_DIR = os.path.join(VALIDATION_DIR, 'normal')
TEST_VIRAL_DIR = os.path.join(TEST_DIR, 'viral_pneumonia')
TEST_COVID_DIR = os.path.join(TEST_DIR, 'covid')
TEST_NORMAL_DIR = os.path.join(TEST_DIR, 'normal')


def createDir(path: str) -> None:
    if not os.path.exists(path):
        os.mkdir(path)
```

```
createDir(DATASET_DIR)
createDir(TRAIN_DIR)
createDir(VALIDATION_DIR)
createDir(TEST_DIR)
createDir(TRAIN_VIRAL_DIR)
createDir(TRAIN_COVID_DIR)
createDir(TRAIN_NORMAL_DIR)
createDir(VALIDATION_VIRAL_DIR)
createDir(VALIDATION_COVID_DIR)
createDir(VALIDATION_NORMAL_DIR)
createDir(TEST_VIRAL_DIR)
createDir(TEST_COVID_DIR)
createDir(TEST_NORMAL_DIR)
```

```python
import numpy as np
import shutil


def generate_sets(source: str):
    allFiles = os.listdir(source)
    np.random.shuffle(allFiles)
    return np.split(np.array(allFiles), [int(len(allFiles)*0.7),
 int(len(allFiles)*0.85)])


def saveAndSeparateFiles(src_dir: str, train_dir: str, val_dir: str, test_dir):
    train_fnames, val_fnames, test_fnames = generate_sets(src_dir)
    for fname in train_fnames:
        src = os.path.join(src_dir, fname)
        dst = os.path.join(train_dir, fname)
        shutil.copyfile(src, dst)

    for fname in val_fnames:
        src = os.path.join(src_dir, fname)
        dst = os.path.join(val_dir, fname)
        shutil.copyfile(src, dst)

    for fname in test_fnames:
        src = os.path.join(src_dir, fname)
        dst = os.path.join(test_dir, fname)
        shutil.copyfile(src, dst)

create = False
if create:
    saveAndSeparateFiles(ORIGINAL_NORMAL_DIR, TRAIN_NORMAL_DIR,
                         VALIDATION_NORMAL_DIR, TEST_NORMAL_DIR)
```

```
        saveAndSeparateFiles(ORIGINAL_COVID_DIR, TRAIN_COVID_DIR,
                             VALIDATION_COVID_DIR, TEST_COVID_DIR)
        saveAndSeparateFiles(ORIGINAL_VIRAL_DIR, TRAIN_VIRAL_DIR,
                             VALIDATION_VIRAL_DIR, TEST_VIRAL_DIR)
```

1.2   Counting our images

```python
import tensorflow as tf
import matplotlib.pyplot as plt
normal_train = tf.io.gfile.glob(TRAIN_NORMAL_DIR + '/*')
viral_train = tf.io.gfile.glob(TRAIN_VIRAL_DIR + '/*')
covid_train = tf.io.gfile.glob(TRAIN_COVID_DIR + '/*')

# Plotting Distribution of Each Classes
image_count = {'covid': len(covid_train), 'normal': len(
    normal_train), 'viral': len(viral_train)}
print(image_count)
fig1, ax1 = plt.subplots()
ax1.pie(image_count.values(),
        labels=image_count.keys(),
        shadow=True,
        autopct='%1.1f%%',
        startangle=90)
plt.show()
```

2021-11-07 15:33:08.779744: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcudart.so.10.1

{'covid': 2531, 'normal': 7134, 'viral': 941}
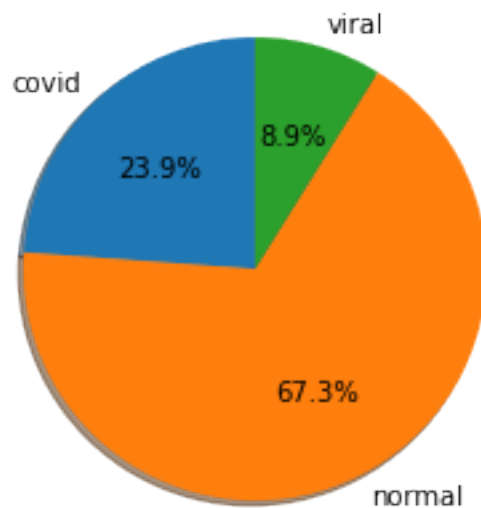
1.3 Create our Covnet Model

In this case we are doing a multi class classification, our total clases are 3: - Viral CXR - Covid CXR - Normal CXR

Our neural network will output neurons as 3 classes that will calculate the probability of being one using the softmax function.

```python
from keras.preprocessing.image import ImageDataGenerator

train_datagen = ImageDataGenerator(
    rescale=1./255,
    samplewise_center=False,  # set each sample mean to 0
    featurewise_std_normalization=False,  # divide inputs by std of the dataset
    samplewise_std_normalization=False,  # divide each input by its std
    zca_whitening=False,  # apply ZCA whitening
    # randomly rotate images in the range (degrees, 0 to 180)
    rotation_range=15,
    zoom_range=0.1,  # Randomly zoom image
    # randomly shift images horizontally (fraction of total width)
    width_shift_range=0.1,
    # randomly shift images vertically (fraction of total height)
    height_shift_range=0.1,
    horizontal_flip=False,  # randomly flip images
    vertical_flip=False  # randomly flip images
)

# train_datagen = ImageDataGenerator(rescale=1./255)
test_datagen = ImageDataGenerator(rescale=1./255)
evaluate_datagen = ImageDataGenerator(rescale=1./255)

train_generator = train_datagen.flow_from_directory(
    TRAIN_DIR,
    target_size=(150, 150),
    batch_size=32,
    class_mode='categorical',
    color_mode='grayscale'
)

print(train_generator.class_indices)

validation_generator = test_datagen.flow_from_directory(
    VALIDATION_DIR,
    target_size=(150, 150),
    batch_size=32,
```

```python
        class_mode='categorical',
        color_mode='grayscale'
)

print(validation_generator.class_indices)

test_generator = evaluate_datagen.flow_from_directory(
        TEST_DIR,
        target_size=(150, 150),
        batch_size=32,
        class_mode='categorical',
        color_mode='grayscale'
)

print(test_generator.class_indices)
```

```
Found 10606 images belonging to 3 classes.
{'covid': 0, 'normal': 1, 'viral_pneumonia': 2}
Found 2273 images belonging to 3 classes.
{'covid': 0, 'normal': 1, 'viral_pneumonia': 2}
Found 2274 images belonging to 3 classes.
{'covid': 0, 'normal': 1, 'viral_pneumonia': 2}
```

```python
[ ]: # for X_batch, y_batch in train_generator:
     #         # create a grid of 3x3 images
     #         for i in range(0, 9):
     #                 plt.subplot(330 + 1 + i)
     #                 plt.imshow(X_batch[i].reshape(150, 150), cmap=plt.
     →get_cmap('gray'))
     #         # show the plot
     #         plt.show()
     #         break
```

```python
[ ]: from keras.layers import Conv2D, BatchNormalization, MaxPooling2D, Dropout,
     →Flatten, Dense
     from keras.models import Sequential
     from keras import backend

     # We want to make sure we start from the start when training our model
     →everytime we run it.
     backend.clear_session()

     model = Sequential()
     model.add(Conv2D(64, (3, 3), activation='relu', input_shape=(150, 150, 1)))
     model.add(BatchNormalization())
     model.add(MaxPooling2D((2, 2)))
     model.add(Conv2D(64, (3, 3), activation='relu'))
```

```
model.add(BatchNormalization())
model.add(MaxPooling2D((2, 2)))
model.add(Conv2D(128, (3, 3), activation='relu'))
model.add(BatchNormalization())
model.add(MaxPooling2D((2, 2)))
model.add(Conv2D(128, (3, 3), activation='relu'))
model.add(BatchNormalization())
model.add(MaxPooling2D((2, 2)))
model.add(Flatten())
model.add(Dropout(0.5))
model.add(Dense(512, activation='relu'))
model.add(Dense(64, activation='relu'))
model.add(Dense(3, activation='softmax'))
model.summary()
```

2021-11-07 15:33:10.585015: I tensorflow/compiler/jit/xla_cpu_device.cc:41] Not creating XLA devices, tf_xla_enable_xla_devices not set
2021-11-07 15:33:10.594478: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcuda.so.1
2021-11-07 15:33:10.875349: E tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:927] could not open file to read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
2021-11-07 15:33:10.875391: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1720] Found device 0 with properties:
pciBusID: 0000:01:00.0 name: NVIDIA GeForce RTX 2080 with Max-Q Design computeCapability: 7.5
coreClock: 1.215GHz coreCount: 46 deviceMemorySize: 8.00GiB deviceMemoryBandwidth: 357.69GiB/s
2021-11-07 15:33:10.875417: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcudart.so.10.1
2021-11-07 15:33:10.877197: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcublas.so.10
2021-11-07 15:33:10.877261: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcublasLt.so.10
2021-11-07 15:33:10.878849: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcufft.so.10
2021-11-07 15:33:10.879270: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcurand.so.10
2021-11-07 15:33:10.882357: I

tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcusolver.so.10
2021-11-07 15:33:10.884067: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcusparse.so.10
2021-11-07 15:33:10.890343: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcudnn.so.7
2021-11-07 15:33:10.891243: E
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:927] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
2021-11-07 15:33:10.892030: E
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:927] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
2021-11-07 15:33:10.892047: I
tensorflow/core/common_runtime/gpu/gpu_device.cc:1862] Adding visible gpu
devices: 0
2021-11-07 15:33:10.893880: I tensorflow/core/platform/cpu_feature_guard.cc:142]
This TensorFlow binary is optimized with oneAPI Deep Neural Network Library
(oneDNN) to use the following CPU instructions in performance-critical
operations: SSE4.1 SSE4.2 AVX AVX2 FMA
To enable them in other operations, rebuild TensorFlow with the appropriate
compiler flags.
2021-11-07 15:33:10.895249: E
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:927] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
2021-11-07 15:33:10.895275: I
tensorflow/core/common_runtime/gpu/gpu_device.cc:1720] Found device 0 with
properties:
pciBusID: 0000:01:00.0 name: NVIDIA GeForce RTX 2080 with Max-Q Design
computeCapability: 7.5
coreClock: 1.215GHz coreCount: 46 deviceMemorySize: 8.00GiB
deviceMemoryBandwidth: 357.69GiB/s
2021-11-07 15:33:10.895301: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcudart.so.10.1
2021-11-07 15:33:10.895325: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcublas.so.10
2021-11-07 15:33:10.895337: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcublasLt.so.10
2021-11-07 15:33:10.895347: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcufft.so.10

2021-11-07 15:33:10.895358: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcurand.so.10
2021-11-07 15:33:10.895369: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcusolver.so.10
2021-11-07 15:33:10.895380: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcusparse.so.10
2021-11-07 15:33:10.895391: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcudnn.so.7
2021-11-07 15:33:10.896068: E
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:927] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
2021-11-07 15:33:10.896725: E
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:927] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
2021-11-07 15:33:10.896741: I
tensorflow/core/common_runtime/gpu/gpu_device.cc:1862] Adding visible gpu
devices: 0
2021-11-07 15:33:10.896791: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcudart.so.10.1
2021-11-07 15:33:11.718818: I
tensorflow/core/common_runtime/gpu/gpu_device.cc:1261] Device interconnect
StreamExecutor with strength 1 edge matrix:
2021-11-07 15:33:11.718841: I
tensorflow/core/common_runtime/gpu/gpu_device.cc:1267]   0
2021-11-07 15:33:11.718847: I
tensorflow/core/common_runtime/gpu/gpu_device.cc:1280] 0:   N
2021-11-07 15:33:11.766676: E
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:927] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
2021-11-07 15:33:11.766717: I
tensorflow/core/common_runtime/gpu/gpu_device.cc:1489] Could not identify NUMA
node of platform GPU id 0, defaulting to 0. Your kernel may not have been built
with NUMA support.
2021-11-07 15:33:11.767629: E
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:927] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node
Your kernel may have been built without NUMA support.
2021-11-07 15:33:11.768379: E
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:927] could not open file to
read NUMA node: /sys/bus/pci/devices/0000:01:00.0/numa_node

```
Your kernel may have been built without NUMA support.
2021-11-07 15:33:11.768414: I
tensorflow/core/common_runtime/gpu/gpu_device.cc:1406] Created TensorFlow device
(/job:localhost/replica:0/task:0/device:GPU:0 with 6575 MB memory) -> physical
GPU (device: 0, name: NVIDIA GeForce RTX 2080 with Max-Q Design, pci bus id:
0000:01:00.0, compute capability: 7.5)
2021-11-07 15:33:11.768818: I tensorflow/compiler/jit/xla_gpu_device.cc:99] Not
creating XLA devices, tf_xla_enable_xla_devices not set

Model: "sequential"
_____
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 148, 148, 64)      640
_____
batch_normalization (BatchNo (None, 148, 148, 64)      256
_____
max_pooling2d (MaxPooling2D) (None, 74, 74, 64)        0
_____
conv2d_1 (Conv2D)            (None, 72, 72, 64)        36928
_____
batch_normalization_1 (Batch (None, 72, 72, 64)        256
_____
max_pooling2d_1 (MaxPooling2 (None, 36, 36, 64)        0
_____
conv2d_2 (Conv2D)            (None, 34, 34, 128)       73856
_____
batch_normalization_2 (Batch (None, 34, 34, 128)       512
_____
max_pooling2d_2 (MaxPooling2 (None, 17, 17, 128)       0
_____
conv2d_3 (Conv2D)            (None, 15, 15, 128)       147584
_____
batch_normalization_3 (Batch (None, 15, 15, 128)       512
_____
max_pooling2d_3 (MaxPooling2 (None, 7, 7, 128)         0
_____
flatten (Flatten)            (None, 6272)              0
_____
dropout (Dropout)            (None, 6272)              0
_____
dense (Dense)                (None, 512)               3211776
_____
dense_1 (Dense)              (None, 64)                32832
_____
dense_2 (Dense)              (None, 3)                 195
=================================================================
Total params: 3,505,347
```

```
    Trainable params: 3,504,579
    Non-trainable params: 768

    _____
```

```python
from keras import optimizers

# opt = RMSprop(lr=0.0001, decay=1e-6)
lr_schedule = optimizers.schedules.ExponentialDecay(
    initial_learning_rate=1e-5,
    decay_steps=100000,
    decay_rate=0.96,
    staircase=True)
opt = optimizers.Adam(learning_rate=lr_schedule)

# try with metric categorical_crossentropy
model.compile(loss='categorical_crossentropy', optimizer=opt,
 ↪metrics=['accuracy', tf.keras.metrics.Recall()])
```

```python
import numpy as np
from sklearn.utils import class_weight
from keras.callbacks import EarlyStopping
from keras.callbacks import ModelCheckpoint

classes = train_generator.classes
class_weights = class_weight.compute_class_weight(None,
                                                  np.unique(classes),
                                                  classes)
best_model_path = os.path.join(BASE_PATH, 'best_model.h5')
es = EarlyStopping(monitor='val_loss', mode='min', verbose=1, patience=80)
mc = ModelCheckpoint(best_model_path, monitor='val_accuracy', mode='max',
 ↪verbose=1, save_best_only=True)
history = model.fit(
    train_generator,
    steps_per_epoch=train_generator.n // 32,
    epochs=400,
    validation_data=validation_generator,
    class_weight=dict(zip(np.unique(classes), class_weights)),
    callbacks=[es, mc]
)
```

```
/home/hivini/anaconda3/envs/tf-gpu/lib/python3.9/site-
packages/sklearn/utils/validation.py:67: FutureWarning: Pass classes=[0 1 2],
y=[0 0 0 … 2 2 2] as keyword args. From version 0.25 passing these as
positional arguments will result in an error
  warnings.warn("Pass {} as keyword args. From version 0.25 "
2021-11-07 15:33:12.934038: I
tensorflow/compiler/mlir/mlir_graph_optimization_pass.cc:116] None of the MLIR
optimization passes are enabled (registered 2)
```

```
2021-11-07 15:33:12.934555: I
tensorflow/core/platform/profile_utils/cpu_utils.cc:112] CPU Frequency:
2208005000 Hz

Epoch 1/400

2021-11-07 15:33:13.836465: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcublas.so.10
2021-11-07 15:33:14.104395: I
tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully
opened dynamic library libcudnn.so.7
2021-11-07 15:33:15.312335: W tensorflow/stream_executor/gpu/asm_compiler.cc:63]
Running ptxas --version returned 256
2021-11-07 15:33:15.411658: W
tensorflow/stream_executor/gpu/redzone_allocator.cc:314] Internal: ptxas exited
with non-zero error code 256, output:
Relying on driver to perform ptx compilation.
Modify $PATH to customize ptxas location.
This message will be only logged once.

331/331 [==============================] - 83s 196ms/step - loss: 0.8962 -
accuracy: 0.6413 - recall: 0.6046 - val_loss: 1.8882 - val_accuracy: 0.2609 -
val_recall: 0.2033

Epoch 00001: val_accuracy improved from -inf to 0.26089, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 2/400
331/331 [==============================] - 42s 126ms/step - loss: 0.6009 -
accuracy: 0.7399 - recall: 0.7166 - val_loss: 0.4696 - val_accuracy: 0.8108 -
val_recall: 0.7831

Epoch 00002: val_accuracy improved from 0.26089 to 0.81082, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 3/400
331/331 [==============================] - 42s 126ms/step - loss: 0.5360 -
accuracy: 0.7632 - recall: 0.7448 - val_loss: 0.3800 - val_accuracy: 0.8324 -
val_recall: 0.8240

Epoch 00003: val_accuracy improved from 0.81082 to 0.83238, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 4/400
331/331 [==============================] - 42s 128ms/step - loss: 0.4688 -
accuracy: 0.7991 - recall: 0.7842 - val_loss: 0.3682 - val_accuracy: 0.8403 -
val_recall: 0.8293

Epoch 00004: val_accuracy improved from 0.83238 to 0.84030, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 5/400
```

```
331/331 [==============================] - 42s 125ms/step - loss: 0.4610 -
accuracy: 0.7965 - recall: 0.7853 - val_loss: 0.3402 - val_accuracy: 0.8592 -
val_recall: 0.8526

Epoch 00005: val_accuracy improved from 0.84030 to 0.85922, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 6/400
331/331 [==============================] - 41s 124ms/step - loss: 0.4312 -
accuracy: 0.8136 - recall: 0.8055 - val_loss: 0.3250 - val_accuracy: 0.8649 -
val_recall: 0.8619

Epoch 00006: val_accuracy improved from 0.85922 to 0.86494, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 7/400
331/331 [==============================] - 41s 124ms/step - loss: 0.4025 -
accuracy: 0.8349 - recall: 0.8268 - val_loss: 0.3259 - val_accuracy: 0.8658 -
val_recall: 0.8645

Epoch 00007: val_accuracy improved from 0.86494 to 0.86582, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 8/400
331/331 [==============================] - 42s 127ms/step - loss: 0.3712 -
accuracy: 0.8471 - recall: 0.8409 - val_loss: 0.2821 - val_accuracy: 0.8874 -
val_recall: 0.8843

Epoch 00008: val_accuracy improved from 0.86582 to 0.88737, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 9/400
331/331 [==============================] - 43s 128ms/step - loss: 0.3774 -
accuracy: 0.8403 - recall: 0.8347 - val_loss: 0.2812 - val_accuracy: 0.8847 -
val_recall: 0.8825

Epoch 00009: val_accuracy did not improve from 0.88737
Epoch 10/400
331/331 [==============================] - 42s 127ms/step - loss: 0.3684 -
accuracy: 0.8520 - recall: 0.8454 - val_loss: 0.2641 - val_accuracy: 0.8900 -
val_recall: 0.8891

Epoch 00010: val_accuracy improved from 0.88737 to 0.89001, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 11/400
331/331 [==============================] - 43s 129ms/step - loss: 0.3422 -
accuracy: 0.8557 - recall: 0.8522 - val_loss: 0.2787 - val_accuracy: 0.8905 -
val_recall: 0.8896

Epoch 00011: val_accuracy improved from 0.89001 to 0.89045, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 12/400
```

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331/331 [==============================] - 42s 128ms/step - loss: 0.3414 -
accuracy: 0.8614 - recall: 0.8582 - val_loss: 0.2441 - val_accuracy: 0.8988 -
val_recall: 0.8979

Epoch 00012: val_accuracy improved from 0.89045 to 0.89881, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 13/400
331/331 [==============================] - 41s 124ms/step - loss: 0.3199 -
accuracy: 0.8641 - recall: 0.8600 - val_loss: 0.2350 - val_accuracy: 0.9045 -
val_recall: 0.9032

Epoch 00013: val_accuracy improved from 0.89881 to 0.90453, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 14/400
331/331 [==============================] - 41s 124ms/step - loss: 0.3310 -
accuracy: 0.8634 - recall: 0.8590 - val_loss: 0.2393 - val_accuracy: 0.9023 -
val_recall: 0.9001

Epoch 00014: val_accuracy did not improve from 0.90453
Epoch 15/400
331/331 [==============================] - 42s 125ms/step - loss: 0.3007 -
accuracy: 0.8754 - recall: 0.8723 - val_loss: 0.2193 - val_accuracy: 0.9085 -
val_recall: 0.9076

Epoch 00015: val_accuracy improved from 0.90453 to 0.90849, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 16/400
331/331 [==============================] - 43s 130ms/step - loss: 0.2902 -
accuracy: 0.8820 - recall: 0.8785 - val_loss: 0.2044 - val_accuracy: 0.9155 -
val_recall: 0.9147

Epoch 00016: val_accuracy improved from 0.90849 to 0.91553, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 17/400
331/331 [==============================] - 46s 139ms/step - loss: 0.2835 -
accuracy: 0.8855 - recall: 0.8833 - val_loss: 0.2019 - val_accuracy: 0.9151 -
val_recall: 0.9138

Epoch 00017: val_accuracy did not improve from 0.91553
Epoch 18/400
331/331 [==============================] - 50s 152ms/step - loss: 0.2720 -
accuracy: 0.8903 - recall: 0.8891 - val_loss: 0.1953 - val_accuracy: 0.9177 -
val_recall: 0.9160

Epoch 00018: val_accuracy improved from 0.91553 to 0.91773, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 19/400
331/331 [==============================] - 40s 121ms/step - loss: 0.2618 -
```

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accuracy: 0.8974 - recall: 0.8940 - val_loss: 0.2046 - val_accuracy: 0.9151 -
val_recall: 0.9138


Epoch 00019: val_accuracy did not improve from 0.91773
Epoch 20/400
331/331 [==============================] - 40s 120ms/step - loss: 0.2710 -
accuracy: 0.8937 - recall: 0.8923 - val_loss: 0.1821 - val_accuracy: 0.9234 -
val_recall: 0.9217


Epoch 00020: val_accuracy improved from 0.91773 to 0.92345, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 21/400
331/331 [==============================] - 40s 120ms/step - loss: 0.2470 -
accuracy: 0.9025 - recall: 0.9012 - val_loss: 0.1795 - val_accuracy: 0.9287 -
val_recall: 0.9274


Epoch 00021: val_accuracy improved from 0.92345 to 0.92873, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 22/400
331/331 [==============================] - 40s 119ms/step - loss: 0.2484 -
accuracy: 0.9003 - recall: 0.8989 - val_loss: 0.1703 - val_accuracy: 0.9248 -
val_recall: 0.9234


Epoch 00022: val_accuracy did not improve from 0.92873
Epoch 23/400
331/331 [==============================] - 40s 119ms/step - loss: 0.2337 -
accuracy: 0.9076 - recall: 0.9053 - val_loss: 0.1708 - val_accuracy: 0.9340 -
val_recall: 0.9318


Epoch 00023: val_accuracy improved from 0.92873 to 0.93401, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 24/400
331/331 [==============================] - 39s 119ms/step - loss: 0.2269 -
accuracy: 0.9095 - recall: 0.9081 - val_loss: 0.1719 - val_accuracy: 0.9252 -
val_recall: 0.9243


Epoch 00024: val_accuracy did not improve from 0.93401
Epoch 25/400
331/331 [==============================] - 40s 119ms/step - loss: 0.2359 -
accuracy: 0.9079 - recall: 0.9070 - val_loss: 0.1655 - val_accuracy: 0.9349 -
val_recall: 0.9340


Epoch 00025: val_accuracy improved from 0.93401 to 0.93489, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 26/400
331/331 [==============================] - 40s 119ms/step - loss: 0.2194 -
accuracy: 0.9153 - recall: 0.9136 - val_loss: 0.1597 - val_accuracy: 0.9340 -
val_recall: 0.9336
```

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Epoch 00026: val_accuracy did not improve from 0.93489
Epoch 27/400
331/331 [==============================] - 39s 119ms/step - loss: 0.2082 -
accuracy: 0.9193 - recall: 0.9182 - val_loss: 0.1428 - val_accuracy: 0.9424 -
val_recall: 0.9410

Epoch 00027: val_accuracy improved from 0.93489 to 0.94237, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 28/400
331/331 [==============================] - 39s 119ms/step - loss: 0.2080 -
accuracy: 0.9195 - recall: 0.9173 - val_loss: 0.1381 - val_accuracy: 0.9459 -
val_recall: 0.9454

Epoch 00028: val_accuracy improved from 0.94237 to 0.94589, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 29/400
331/331 [==============================] - 39s 119ms/step - loss: 0.2058 -
accuracy: 0.9196 - recall: 0.9189 - val_loss: 0.1445 - val_accuracy: 0.9415 -
val_recall: 0.9402

Epoch 00029: val_accuracy did not improve from 0.94589
Epoch 30/400
331/331 [==============================] - 39s 119ms/step - loss: 0.2087 -
accuracy: 0.9171 - recall: 0.9157 - val_loss: 0.1445 - val_accuracy: 0.9397 -
val_recall: 0.9388

Epoch 00030: val_accuracy did not improve from 0.94589
Epoch 31/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1947 -
accuracy: 0.9256 - recall: 0.9248 - val_loss: 0.1446 - val_accuracy: 0.9432 -
val_recall: 0.9424

Epoch 00031: val_accuracy did not improve from 0.94589
Epoch 32/400
331/331 [==============================] - 40s 119ms/step - loss: 0.2009 -
accuracy: 0.9264 - recall: 0.9247 - val_loss: 0.1659 - val_accuracy: 0.9322 -
val_recall: 0.9318

Epoch 00032: val_accuracy did not improve from 0.94589
Epoch 33/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1920 -
accuracy: 0.9231 - recall: 0.9223 - val_loss: 0.1479 - val_accuracy: 0.9406 -
val_recall: 0.9402

Epoch 00033: val_accuracy did not improve from 0.94589
Epoch 34/400
331/331 [==============================] - 40s 120ms/step - loss: 0.1922 -
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accuracy: 0.9242 - recall: 0.9225 - val_loss: 0.1319 - val_accuracy: 0.9485 -
val_recall: 0.9481


Epoch 00034: val_accuracy improved from 0.94589 to 0.94853, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 35/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1879 -
accuracy: 0.9290 - recall: 0.9282 - val_loss: 0.1516 - val_accuracy: 0.9380 -
val_recall: 0.9371


Epoch 00035: val_accuracy did not improve from 0.94853
Epoch 36/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1892 -
accuracy: 0.9274 - recall: 0.9261 - val_loss: 0.1435 - val_accuracy: 0.9410 -
val_recall: 0.9402


Epoch 00036: val_accuracy did not improve from 0.94853
Epoch 37/400
331/331 [==============================] - 40s 120ms/step - loss: 0.1778 -
accuracy: 0.9344 - recall: 0.9329 - val_loss: 0.1387 - val_accuracy: 0.9472 -
val_recall: 0.9472


Epoch 00037: val_accuracy did not improve from 0.94853
Epoch 38/400
331/331 [==============================] - 40s 121ms/step - loss: 0.1792 -
accuracy: 0.9337 - recall: 0.9331 - val_loss: 0.1289 - val_accuracy: 0.9507 -
val_recall: 0.9503


Epoch 00038: val_accuracy improved from 0.94853 to 0.95073, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 39/400
331/331 [==============================] - 40s 120ms/step - loss: 0.1960 -
accuracy: 0.9256 - recall: 0.9245 - val_loss: 0.1141 - val_accuracy: 0.9564 -
val_recall: 0.9547


Epoch 00039: val_accuracy improved from 0.95073 to 0.95645, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 40/400
331/331 [==============================] - 40s 120ms/step - loss: 0.1781 -
accuracy: 0.9313 - recall: 0.9306 - val_loss: 0.1195 - val_accuracy: 0.9520 -
val_recall: 0.9520


Epoch 00040: val_accuracy did not improve from 0.95645
Epoch 41/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1797 -
accuracy: 0.9332 - recall: 0.9321 - val_loss: 0.1303 - val_accuracy: 0.9432 -
val_recall: 0.9415
```

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Epoch 00041: val_accuracy did not improve from 0.95645
Epoch 42/400
331/331 [==============================] - 40s 120ms/step - loss: 0.1643 -
accuracy: 0.9383 - recall: 0.9374 - val_loss: 0.1320 - val_accuracy: 0.9437 -
val_recall: 0.9428

Epoch 00042: val_accuracy did not improve from 0.95645
Epoch 43/400
331/331 [==============================] - 40s 120ms/step - loss: 0.1667 -
accuracy: 0.9366 - recall: 0.9358 - val_loss: 0.1155 - val_accuracy: 0.9542 -
val_recall: 0.9529

Epoch 00043: val_accuracy did not improve from 0.95645
Epoch 44/400
331/331 [==============================] - 40s 120ms/step - loss: 0.1556 -
accuracy: 0.9401 - recall: 0.9391 - val_loss: 0.1146 - val_accuracy: 0.9564 -
val_recall: 0.9547

Epoch 00044: val_accuracy did not improve from 0.95645
Epoch 45/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1514 -
accuracy: 0.9403 - recall: 0.9387 - val_loss: 0.1300 - val_accuracy: 0.9490 -
val_recall: 0.9485

Epoch 00045: val_accuracy did not improve from 0.95645
Epoch 46/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1645 -
accuracy: 0.9373 - recall: 0.9367 - val_loss: 0.1318 - val_accuracy: 0.9498 -
val_recall: 0.9490

Epoch 00046: val_accuracy did not improve from 0.95645
Epoch 47/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1592 -
accuracy: 0.9406 - recall: 0.9394 - val_loss: 0.1887 - val_accuracy: 0.9274 -
val_recall: 0.9265

Epoch 00047: val_accuracy did not improve from 0.95645
Epoch 48/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1608 -
accuracy: 0.9396 - recall: 0.9385 - val_loss: 0.1155 - val_accuracy: 0.9538 -
val_recall: 0.9534

Epoch 00048: val_accuracy did not improve from 0.95645
Epoch 49/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1523 -
accuracy: 0.9423 - recall: 0.9419 - val_loss: 0.1222 - val_accuracy: 0.9516 -
val_recall: 0.9512
```

```
Epoch 00049: val_accuracy did not improve from 0.95645
Epoch 50/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1551 -
accuracy: 0.9406 - recall: 0.9389 - val_loss: 0.1232 - val_accuracy: 0.9512 -
val_recall: 0.9503

Epoch 00050: val_accuracy did not improve from 0.95645
Epoch 51/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1573 -
accuracy: 0.9404 - recall: 0.9397 - val_loss: 0.1216 - val_accuracy: 0.9534 -
val_recall: 0.9525

Epoch 00051: val_accuracy did not improve from 0.95645
Epoch 52/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1518 -
accuracy: 0.9449 - recall: 0.9439 - val_loss: 0.1081 - val_accuracy: 0.9569 -
val_recall: 0.9560

Epoch 00052: val_accuracy improved from 0.95645 to 0.95689, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 53/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1416 -
accuracy: 0.9512 - recall: 0.9507 - val_loss: 0.1008 - val_accuracy: 0.9591 -
val_recall: 0.9582

Epoch 00053: val_accuracy improved from 0.95689 to 0.95908, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 54/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1469 -
accuracy: 0.9502 - recall: 0.9488 - val_loss: 0.1097 - val_accuracy: 0.9551 -
val_recall: 0.9547

Epoch 00054: val_accuracy did not improve from 0.95908
Epoch 55/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1483 -
accuracy: 0.9450 - recall: 0.9437 - val_loss: 0.1063 - val_accuracy: 0.9560 -
val_recall: 0.9547

Epoch 00055: val_accuracy did not improve from 0.95908
Epoch 56/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1491 -
accuracy: 0.9433 - recall: 0.9428 - val_loss: 0.1268 - val_accuracy: 0.9516 -
val_recall: 0.9516

Epoch 00056: val_accuracy did not improve from 0.95908
Epoch 57/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1451 -
accuracy: 0.9448 - recall: 0.9442 - val_loss: 0.0998 - val_accuracy: 0.9617 -
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val_recall: 0.9613

Epoch 00057: val_accuracy improved from 0.95908 to 0.96172, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 58/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1392 -
accuracy: 0.9498 - recall: 0.9487 - val_loss: 0.1128 - val_accuracy: 0.9595 -
val_recall: 0.9591

Epoch 00058: val_accuracy did not improve from 0.96172
Epoch 59/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1439 -
accuracy: 0.9491 - recall: 0.9483 - val_loss: 0.1503 - val_accuracy: 0.9388 -
val_recall: 0.9388

Epoch 00059: val_accuracy did not improve from 0.96172
Epoch 60/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1221 -
accuracy: 0.9528 - recall: 0.9523 - val_loss: 0.1046 - val_accuracy: 0.9595 -
val_recall: 0.9582

Epoch 00060: val_accuracy did not improve from 0.96172
Epoch 61/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1279 -
accuracy: 0.9499 - recall: 0.9489 - val_loss: 0.1441 - val_accuracy: 0.9410 -
val_recall: 0.9393

Epoch 00061: val_accuracy did not improve from 0.96172
Epoch 62/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1244 -
accuracy: 0.9530 - recall: 0.9520 - val_loss: 0.1190 - val_accuracy: 0.9494 -
val_recall: 0.9494

Epoch 00062: val_accuracy did not improve from 0.96172
Epoch 63/400
331/331 [==============================] - 40s 121ms/step - loss: 0.1247 -
accuracy: 0.9552 - recall: 0.9548 - val_loss: 0.1588 - val_accuracy: 0.9415 -
val_recall: 0.9415

Epoch 00063: val_accuracy did not improve from 0.96172
Epoch 64/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1364 -
accuracy: 0.9480 - recall: 0.9473 - val_loss: 0.0903 - val_accuracy: 0.9644 -
val_recall: 0.9644

Epoch 00064: val_accuracy improved from 0.96172 to 0.96436, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 65/400

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331/331 [==============================] - 39s 117ms/step - loss: 0.1270 -
accuracy: 0.9504 - recall: 0.9496 - val_loss: 0.1023 - val_accuracy: 0.9626 -
val_recall: 0.9626


Epoch 00065: val_accuracy did not improve from 0.96436
Epoch 66/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1205 -
accuracy: 0.9564 - recall: 0.9557 - val_loss: 0.0921 - val_accuracy: 0.9613 -
val_recall: 0.9608


Epoch 00066: val_accuracy did not improve from 0.96436
Epoch 67/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1178 -
accuracy: 0.9584 - recall: 0.9567 - val_loss: 0.0965 - val_accuracy: 0.9613 -
val_recall: 0.9608


Epoch 00067: val_accuracy did not improve from 0.96436
Epoch 68/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1255 -
accuracy: 0.9525 - recall: 0.9524 - val_loss: 0.0944 - val_accuracy: 0.9617 -
val_recall: 0.9613


Epoch 00068: val_accuracy did not improve from 0.96436
Epoch 69/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1318 -
accuracy: 0.9492 - recall: 0.9485 - val_loss: 0.0939 - val_accuracy: 0.9666 -
val_recall: 0.9666


Epoch 00069: val_accuracy improved from 0.96436 to 0.96656, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 70/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1184 -
accuracy: 0.9551 - recall: 0.9547 - val_loss: 0.0894 - val_accuracy: 0.9635 -
val_recall: 0.9626


Epoch 00070: val_accuracy did not improve from 0.96656
Epoch 71/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1185 -
accuracy: 0.9581 - recall: 0.9575 - val_loss: 0.0987 - val_accuracy: 0.9578 -
val_recall: 0.9578


Epoch 00071: val_accuracy did not improve from 0.96656
Epoch 72/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1157 -
accuracy: 0.9578 - recall: 0.9573 - val_loss: 0.0955 - val_accuracy: 0.9622 -
val_recall: 0.9617


Epoch 00072: val_accuracy did not improve from 0.96656
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Epoch 73/400
331/331 [==============================] - 40s 120ms/step - loss: 0.1178 -
accuracy: 0.9585 - recall: 0.9582 - val_loss: 0.1083 - val_accuracy: 0.9573 -
val_recall: 0.9573

Epoch 00073: val_accuracy did not improve from 0.96656
Epoch 74/400
331/331 [==============================] - 40s 120ms/step - loss: 0.1140 -
accuracy: 0.9588 - recall: 0.9583 - val_loss: 0.1159 - val_accuracy: 0.9520 -
val_recall: 0.9503

Epoch 00074: val_accuracy did not improve from 0.96656
Epoch 75/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1102 -
accuracy: 0.9613 - recall: 0.9607 - val_loss: 0.0876 - val_accuracy: 0.9639 -
val_recall: 0.9630

Epoch 00075: val_accuracy did not improve from 0.96656
Epoch 76/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1178 -
accuracy: 0.9583 - recall: 0.9574 - val_loss: 0.1333 - val_accuracy: 0.9463 -
val_recall: 0.9450

Epoch 00076: val_accuracy did not improve from 0.96656
Epoch 77/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1157 -
accuracy: 0.9581 - recall: 0.9578 - val_loss: 0.0917 - val_accuracy: 0.9639 -
val_recall: 0.9635

Epoch 00077: val_accuracy did not improve from 0.96656
Epoch 78/400
331/331 [==============================] - 42s 125ms/step - loss: 0.1158 -
accuracy: 0.9578 - recall: 0.9573 - val_loss: 0.0956 - val_accuracy: 0.9604 -
val_recall: 0.9604

Epoch 00078: val_accuracy did not improve from 0.96656
Epoch 79/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1103 -
accuracy: 0.9620 - recall: 0.9619 - val_loss: 0.1052 - val_accuracy: 0.9573 -
val_recall: 0.9573

Epoch 00079: val_accuracy did not improve from 0.96656
Epoch 80/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1133 -
accuracy: 0.9578 - recall: 0.9575 - val_loss: 0.0812 - val_accuracy: 0.9688 -
val_recall: 0.9683

Epoch 00080: val_accuracy improved from 0.96656 to 0.96876, saving model to
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/home/hivini/learn/research/new-covid/best_model.h5
Epoch 81/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1182 -
accuracy: 0.9572 - recall: 0.9568 - val_loss: 0.1352 - val_accuracy: 0.9516 -
val_recall: 0.9512

Epoch 00081: val_accuracy did not improve from 0.96876
Epoch 82/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1100 -
accuracy: 0.9592 - recall: 0.9584 - val_loss: 0.0802 - val_accuracy: 0.9688 -
val_recall: 0.9688

Epoch 00082: val_accuracy did not improve from 0.96876
Epoch 83/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1081 -
accuracy: 0.9592 - recall: 0.9584 - val_loss: 0.0950 - val_accuracy: 0.9635 -
val_recall: 0.9622

Epoch 00083: val_accuracy did not improve from 0.96876
Epoch 84/400
331/331 [==============================] - 39s 119ms/step - loss: 0.1096 -
accuracy: 0.9584 - recall: 0.9583 - val_loss: 0.1051 - val_accuracy: 0.9586 -
val_recall: 0.9582

Epoch 00084: val_accuracy did not improve from 0.96876
Epoch 85/400
331/331 [==============================] - 40s 120ms/step - loss: 0.1084 -
accuracy: 0.9617 - recall: 0.9615 - val_loss: 0.1005 - val_accuracy: 0.9600 -
val_recall: 0.9595

Epoch 00085: val_accuracy did not improve from 0.96876
Epoch 86/400
331/331 [==============================] - 41s 122ms/step - loss: 0.1024 -
accuracy: 0.9639 - recall: 0.9627 - val_loss: 0.0867 - val_accuracy: 0.9648 -
val_recall: 0.9644

Epoch 00086: val_accuracy did not improve from 0.96876
Epoch 87/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1101 -
accuracy: 0.9601 - recall: 0.9595 - val_loss: 0.1008 - val_accuracy: 0.9564 -
val_recall: 0.9556

Epoch 00087: val_accuracy did not improve from 0.96876
Epoch 88/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1039 -
accuracy: 0.9605 - recall: 0.9601 - val_loss: 0.0935 - val_accuracy: 0.9652 -
val_recall: 0.9644
```

```
Epoch 00088: val_accuracy did not improve from 0.96876
Epoch 89/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1063 -
accuracy: 0.9620 - recall: 0.9618 - val_loss: 0.0837 - val_accuracy: 0.9657 -
val_recall: 0.9648

Epoch 00089: val_accuracy did not improve from 0.96876
Epoch 90/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1054 -
accuracy: 0.9616 - recall: 0.9608 - val_loss: 0.0809 - val_accuracy: 0.9683 -
val_recall: 0.9670

Epoch 00090: val_accuracy did not improve from 0.96876
Epoch 91/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1075 -
accuracy: 0.9609 - recall: 0.9601 - val_loss: 0.0948 - val_accuracy: 0.9630 -
val_recall: 0.9622

Epoch 00091: val_accuracy did not improve from 0.96876
Epoch 92/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0961 -
accuracy: 0.9622 - recall: 0.9616 - val_loss: 0.0863 - val_accuracy: 0.9679 -
val_recall: 0.9670

Epoch 00092: val_accuracy did not improve from 0.96876
Epoch 93/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1032 -
accuracy: 0.9655 - recall: 0.9650 - val_loss: 0.1202 - val_accuracy: 0.9516 -
val_recall: 0.9512

Epoch 00093: val_accuracy did not improve from 0.96876
Epoch 94/400
331/331 [==============================] - 40s 119ms/step - loss: 0.1017 -
accuracy: 0.9623 - recall: 0.9622 - val_loss: 0.1214 - val_accuracy: 0.9556 -
val_recall: 0.9551

Epoch 00094: val_accuracy did not improve from 0.96876
Epoch 95/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0938 -
accuracy: 0.9651 - recall: 0.9648 - val_loss: 0.0803 - val_accuracy: 0.9688 -
val_recall: 0.9679

Epoch 00095: val_accuracy did not improve from 0.96876
Epoch 96/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0888 -
accuracy: 0.9660 - recall: 0.9644 - val_loss: 0.0887 - val_accuracy: 0.9661 -
val_recall: 0.9661
```

```
Epoch 00096: val_accuracy did not improve from 0.96876
Epoch 97/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0940 -
accuracy: 0.9678 - recall: 0.9676 - val_loss: 0.0860 - val_accuracy: 0.9661 -
val_recall: 0.9657

Epoch 00097: val_accuracy did not improve from 0.96876
Epoch 98/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0918 -
accuracy: 0.9683 - recall: 0.9679 - val_loss: 0.0831 - val_accuracy: 0.9644 -
val_recall: 0.9644

Epoch 00098: val_accuracy did not improve from 0.96876
Epoch 99/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0990 -
accuracy: 0.9628 - recall: 0.9625 - val_loss: 0.1034 - val_accuracy: 0.9591 -
val_recall: 0.9586

Epoch 00099: val_accuracy did not improve from 0.96876
Epoch 100/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0891 -
accuracy: 0.9652 - recall: 0.9648 - val_loss: 0.1207 - val_accuracy: 0.9498 -
val_recall: 0.9498

Epoch 00100: val_accuracy did not improve from 0.96876
Epoch 101/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0940 -
accuracy: 0.9646 - recall: 0.9643 - val_loss: 0.1298 - val_accuracy: 0.9551 -
val_recall: 0.9547

Epoch 00101: val_accuracy did not improve from 0.96876
Epoch 102/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0880 -
accuracy: 0.9690 - recall: 0.9687 - val_loss: 0.0936 - val_accuracy: 0.9613 -
val_recall: 0.9608

Epoch 00102: val_accuracy did not improve from 0.96876
Epoch 103/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0957 -
accuracy: 0.9641 - recall: 0.9635 - val_loss: 0.0797 - val_accuracy: 0.9679 -
val_recall: 0.9679

Epoch 00103: val_accuracy did not improve from 0.96876
Epoch 104/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0946 -
accuracy: 0.9653 - recall: 0.9648 - val_loss: 0.0838 - val_accuracy: 0.9679 -
val_recall: 0.9674
```

```
Epoch 00104: val_accuracy did not improve from 0.96876
Epoch 105/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0928 -
accuracy: 0.9649 - recall: 0.9646 - val_loss: 0.1014 - val_accuracy: 0.9573 -
val_recall: 0.9569

Epoch 00105: val_accuracy did not improve from 0.96876
Epoch 106/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0890 -
accuracy: 0.9690 - recall: 0.9680 - val_loss: 0.0785 - val_accuracy: 0.9714 -
val_recall: 0.9714

Epoch 00106: val_accuracy improved from 0.96876 to 0.97140, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 107/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0826 -
accuracy: 0.9694 - recall: 0.9688 - val_loss: 0.0820 - val_accuracy: 0.9683 -
val_recall: 0.9683

Epoch 00107: val_accuracy did not improve from 0.97140
Epoch 108/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0859 -
accuracy: 0.9699 - recall: 0.9696 - val_loss: 0.0790 - val_accuracy: 0.9683 -
val_recall: 0.9679

Epoch 00108: val_accuracy did not improve from 0.97140
Epoch 109/400
331/331 [==============================] - 40s 122ms/step - loss: 0.0951 -
accuracy: 0.9659 - recall: 0.9655 - val_loss: 0.0765 - val_accuracy: 0.9688 -
val_recall: 0.9688

Epoch 00109: val_accuracy did not improve from 0.97140
Epoch 110/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0906 -
accuracy: 0.9689 - recall: 0.9686 - val_loss: 0.0843 - val_accuracy: 0.9652 -
val_recall: 0.9652

Epoch 00110: val_accuracy did not improve from 0.97140
Epoch 111/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0871 -
accuracy: 0.9662 - recall: 0.9659 - val_loss: 0.0933 - val_accuracy: 0.9648 -
val_recall: 0.9648

Epoch 00111: val_accuracy did not improve from 0.97140
Epoch 112/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0842 -
accuracy: 0.9668 - recall: 0.9665 - val_loss: 0.0811 - val_accuracy: 0.9688 -
val_recall: 0.9688
```

```
Epoch 00112: val_accuracy did not improve from 0.97140
Epoch 113/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0850 -
accuracy: 0.9698 - recall: 0.9695 - val_loss: 0.0838 - val_accuracy: 0.9705 -
val_recall: 0.9705

Epoch 00113: val_accuracy did not improve from 0.97140
Epoch 114/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0907 -
accuracy: 0.9664 - recall: 0.9661 - val_loss: 0.0831 - val_accuracy: 0.9661 -
val_recall: 0.9657

Epoch 00114: val_accuracy did not improve from 0.97140
Epoch 115/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0873 -
accuracy: 0.9685 - recall: 0.9682 - val_loss: 0.0780 - val_accuracy: 0.9692 -
val_recall: 0.9683

Epoch 00115: val_accuracy did not improve from 0.97140
Epoch 116/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0846 -
accuracy: 0.9690 - recall: 0.9687 - val_loss: 0.0834 - val_accuracy: 0.9661 -
val_recall: 0.9661

Epoch 00116: val_accuracy did not improve from 0.97140
Epoch 117/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0724 -
accuracy: 0.9716 - recall: 0.9713 - val_loss: 0.0788 - val_accuracy: 0.9674 -
val_recall: 0.9674

Epoch 00117: val_accuracy did not improve from 0.97140
Epoch 118/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0756 -
accuracy: 0.9743 - recall: 0.9738 - val_loss: 0.0989 - val_accuracy: 0.9617 -
val_recall: 0.9617

Epoch 00118: val_accuracy did not improve from 0.97140
Epoch 119/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0877 -
accuracy: 0.9676 - recall: 0.9672 - val_loss: 0.0798 - val_accuracy: 0.9705 -
val_recall: 0.9701

Epoch 00119: val_accuracy did not improve from 0.97140
Epoch 120/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0767 -
accuracy: 0.9718 - recall: 0.9718 - val_loss: 0.0973 - val_accuracy: 0.9604 -
val_recall: 0.9604
```

```
Epoch 00120: val_accuracy did not improve from 0.97140
Epoch 121/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0884 -
accuracy: 0.9690 - recall: 0.9688 - val_loss: 0.1204 - val_accuracy: 0.9512 -
val_recall: 0.9507

Epoch 00121: val_accuracy did not improve from 0.97140
Epoch 122/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0783 -
accuracy: 0.9717 - recall: 0.9715 - val_loss: 0.1033 - val_accuracy: 0.9613 -
val_recall: 0.9608

Epoch 00122: val_accuracy did not improve from 0.97140
Epoch 123/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0852 -
accuracy: 0.9696 - recall: 0.9694 - val_loss: 0.0962 - val_accuracy: 0.9639 -
val_recall: 0.9635

Epoch 00123: val_accuracy did not improve from 0.97140
Epoch 124/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0880 -
accuracy: 0.9687 - recall: 0.9686 - val_loss: 0.0716 - val_accuracy: 0.9740 -
val_recall: 0.9736

Epoch 00124: val_accuracy improved from 0.97140 to 0.97404, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 125/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0814 -
accuracy: 0.9726 - recall: 0.9723 - val_loss: 0.0916 - val_accuracy: 0.9639 -
val_recall: 0.9630

Epoch 00125: val_accuracy did not improve from 0.97404
Epoch 126/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0797 -
accuracy: 0.9714 - recall: 0.9710 - val_loss: 0.0787 - val_accuracy: 0.9674 -
val_recall: 0.9674

Epoch 00126: val_accuracy did not improve from 0.97404
Epoch 127/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0902 -
accuracy: 0.9686 - recall: 0.9677 - val_loss: 0.1088 - val_accuracy: 0.9608 -
val_recall: 0.9608

Epoch 00127: val_accuracy did not improve from 0.97404
Epoch 128/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0750 -
accuracy: 0.9732 - recall: 0.9731 - val_loss: 0.0898 - val_accuracy: 0.9652 -
```

val_recall: 0.9652

Epoch 00128: val_accuracy did not improve from 0.97404
Epoch 129/400
331/331 [==============================] - 40s 121ms/step - loss: 0.0783 -
accuracy: 0.9744 - recall: 0.9744 - val_loss: 0.0940 - val_accuracy: 0.9630 -
val_recall: 0.9630

Epoch 00129: val_accuracy did not improve from 0.97404
Epoch 130/400
331/331 [==============================] - 41s 124ms/step - loss: 0.0724 -
accuracy: 0.9767 - recall: 0.9763 - val_loss: 0.1421 - val_accuracy: 0.9498 -
val_recall: 0.9498

Epoch 00130: val_accuracy did not improve from 0.97404
Epoch 131/400
331/331 [==============================] - 41s 124ms/step - loss: 0.0688 -
accuracy: 0.9760 - recall: 0.9751 - val_loss: 0.0788 - val_accuracy: 0.9701 -
val_recall: 0.9701

Epoch 00131: val_accuracy did not improve from 0.97404
Epoch 132/400
331/331 [==============================] - 42s 125ms/step - loss: 0.0786 -
accuracy: 0.9735 - recall: 0.9734 - val_loss: 0.0774 - val_accuracy: 0.9688 -
val_recall: 0.9688

Epoch 00132: val_accuracy did not improve from 0.97404
Epoch 133/400
331/331 [==============================] - 41s 122ms/step - loss: 0.0825 -
accuracy: 0.9668 - recall: 0.9663 - val_loss: 0.1156 - val_accuracy: 0.9569 -
val_recall: 0.9569

Epoch 00133: val_accuracy did not improve from 0.97404
Epoch 134/400
331/331 [==============================] - 41s 123ms/step - loss: 0.0726 -
accuracy: 0.9712 - recall: 0.9711 - val_loss: 0.0853 - val_accuracy: 0.9696 -
val_recall: 0.9692

Epoch 00134: val_accuracy did not improve from 0.97404
Epoch 135/400
331/331 [==============================] - 41s 123ms/step - loss: 0.0793 -
accuracy: 0.9715 - recall: 0.9715 - val_loss: 0.0878 - val_accuracy: 0.9666 -
val_recall: 0.9657

Epoch 00135: val_accuracy did not improve from 0.97404
Epoch 136/400
331/331 [==============================] - 41s 122ms/step - loss: 0.0771 -
accuracy: 0.9723 - recall: 0.9721 - val_loss: 0.0796 - val_accuracy: 0.9688 -

val_recall: 0.9688

Epoch 00136: val_accuracy did not improve from 0.97404
Epoch 137/400
331/331 [==============================] - 41s 122ms/step - loss: 0.0807 - accuracy: 0.9722 - recall: 0.9718 - val_loss: 0.0945 - val_accuracy: 0.9630 - val_recall: 0.9630

Epoch 00137: val_accuracy did not improve from 0.97404
Epoch 138/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0720 - accuracy: 0.9720 - recall: 0.9717 - val_loss: 0.0746 - val_accuracy: 0.9718 - val_recall: 0.9714

Epoch 00138: val_accuracy did not improve from 0.97404
Epoch 139/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0753 - accuracy: 0.9736 - recall: 0.9732 - val_loss: 0.0746 - val_accuracy: 0.9740 - val_recall: 0.9740

Epoch 00139: val_accuracy did not improve from 0.97404
Epoch 140/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0723 - accuracy: 0.9746 - recall: 0.9744 - val_loss: 0.0851 - val_accuracy: 0.9679 - val_recall: 0.9679

Epoch 00140: val_accuracy did not improve from 0.97404
Epoch 141/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0598 - accuracy: 0.9780 - recall: 0.9780 - val_loss: 0.0815 - val_accuracy: 0.9696 - val_recall: 0.9696

Epoch 00141: val_accuracy did not improve from 0.97404
Epoch 142/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0684 - accuracy: 0.9748 - recall: 0.9747 - val_loss: 0.1141 - val_accuracy: 0.9560 - val_recall: 0.9560

Epoch 00142: val_accuracy did not improve from 0.97404
Epoch 143/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0727 - accuracy: 0.9725 - recall: 0.9721 - val_loss: 0.0782 - val_accuracy: 0.9714 - val_recall: 0.9710

Epoch 00143: val_accuracy did not improve from 0.97404
Epoch 144/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0621 - accuracy: 0.9770 - recall: 0.9770 - val_loss: 0.0942 - val_accuracy: 0.9674 -

val_recall: 0.9670

Epoch 00144: val_accuracy did not improve from 0.97404
Epoch 145/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0649 - accuracy: 0.9752 - recall: 0.9750 - val_loss: 0.0782 - val_accuracy: 0.9692 - val_recall: 0.9692

Epoch 00145: val_accuracy did not improve from 0.97404
Epoch 146/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0663 - accuracy: 0.9766 - recall: 0.9765 - val_loss: 0.0780 - val_accuracy: 0.9736 - val_recall: 0.9736

Epoch 00146: val_accuracy did not improve from 0.97404
Epoch 147/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0681 - accuracy: 0.9732 - recall: 0.9730 - val_loss: 0.0860 - val_accuracy: 0.9692 - val_recall: 0.9688

Epoch 00147: val_accuracy did not improve from 0.97404
Epoch 148/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0701 - accuracy: 0.9755 - recall: 0.9753 - val_loss: 0.0745 - val_accuracy: 0.9718 - val_recall: 0.9718

Epoch 00148: val_accuracy did not improve from 0.97404
Epoch 149/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0686 - accuracy: 0.9736 - recall: 0.9735 - val_loss: 0.0708 - val_accuracy: 0.9749 - val_recall: 0.9749

Epoch 00149: val_accuracy improved from 0.97404 to 0.97492, saving model to /home/hivini/learn/research/new-covid/best_model.h5
Epoch 150/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0632 - accuracy: 0.9747 - recall: 0.9743 - val_loss: 0.0879 - val_accuracy: 0.9666 - val_recall: 0.9666

Epoch 00150: val_accuracy did not improve from 0.97492
Epoch 151/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0732 - accuracy: 0.9732 - recall: 0.9732 - val_loss: 0.0866 - val_accuracy: 0.9701 - val_recall: 0.9701

Epoch 00151: val_accuracy did not improve from 0.97492
Epoch 152/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0644 -

```
accuracy: 0.9764 - recall: 0.9763 - val_loss: 0.0797 - val_accuracy: 0.9696 -
val_recall: 0.9688


Epoch 00152: val_accuracy did not improve from 0.97492
Epoch 153/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0649 -
accuracy: 0.9760 - recall: 0.9758 - val_loss: 0.0711 - val_accuracy: 0.9736 -
val_recall: 0.9736


Epoch 00153: val_accuracy did not improve from 0.97492
Epoch 154/400
331/331 [==============================] - 40s 122ms/step - loss: 0.0663 -
accuracy: 0.9767 - recall: 0.9767 - val_loss: 0.0935 - val_accuracy: 0.9666 -
val_recall: 0.9666


Epoch 00154: val_accuracy did not improve from 0.97492
Epoch 155/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0597 -
accuracy: 0.9764 - recall: 0.9762 - val_loss: 0.1472 - val_accuracy: 0.9498 -
val_recall: 0.9490


Epoch 00155: val_accuracy did not improve from 0.97492
Epoch 156/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0622 -
accuracy: 0.9763 - recall: 0.9763 - val_loss: 0.0841 - val_accuracy: 0.9692 -
val_recall: 0.9688


Epoch 00156: val_accuracy did not improve from 0.97492
Epoch 157/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0680 -
accuracy: 0.9749 - recall: 0.9747 - val_loss: 0.0840 - val_accuracy: 0.9710 -
val_recall: 0.9701


Epoch 00157: val_accuracy did not improve from 0.97492
Epoch 158/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0660 -
accuracy: 0.9769 - recall: 0.9769 - val_loss: 0.1114 - val_accuracy: 0.9578 -
val_recall: 0.9573


Epoch 00158: val_accuracy did not improve from 0.97492
Epoch 159/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0650 -
accuracy: 0.9765 - recall: 0.9762 - val_loss: 0.0870 - val_accuracy: 0.9666 -
val_recall: 0.9661


Epoch 00159: val_accuracy did not improve from 0.97492
Epoch 160/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0700 -
```

accuracy: 0.9757 - recall: 0.9750 - val_loss: 0.2985 - val_accuracy: 0.9010 - val_recall: 0.9010

Epoch 00160: val_accuracy did not improve from 0.97492
Epoch 161/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0673 - accuracy: 0.9753 - recall: 0.9750 - val_loss: 0.0950 - val_accuracy: 0.9692 - val_recall: 0.9692

Epoch 00161: val_accuracy did not improve from 0.97492
Epoch 162/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0564 - accuracy: 0.9786 - recall: 0.9786 - val_loss: 0.0766 - val_accuracy: 0.9718 - val_recall: 0.9718

Epoch 00162: val_accuracy did not improve from 0.97492
Epoch 163/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0615 - accuracy: 0.9771 - recall: 0.9765 - val_loss: 0.0736 - val_accuracy: 0.9762 - val_recall: 0.9762

Epoch 00163: val_accuracy improved from 0.97492 to 0.97624, saving model to /home/hivini/learn/research/new-covid/best_model.h5
Epoch 164/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0587 - accuracy: 0.9810 - recall: 0.9805 - val_loss: 0.1032 - val_accuracy: 0.9648 - val_recall: 0.9644

Epoch 00164: val_accuracy did not improve from 0.97624
Epoch 165/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0623 - accuracy: 0.9744 - recall: 0.9744 - val_loss: 0.0808 - val_accuracy: 0.9723 - val_recall: 0.9714

Epoch 00165: val_accuracy did not improve from 0.97624
Epoch 166/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0573 - accuracy: 0.9789 - recall: 0.9789 - val_loss: 0.0977 - val_accuracy: 0.9644 - val_recall: 0.9635

Epoch 00166: val_accuracy did not improve from 0.97624
Epoch 167/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0618 - accuracy: 0.9763 - recall: 0.9759 - val_loss: 0.0893 - val_accuracy: 0.9688 - val_recall: 0.9688

Epoch 00167: val_accuracy did not improve from 0.97624
Epoch 168/400

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331/331 [==============================] - 40s 120ms/step - loss: 0.0598 -
accuracy: 0.9775 - recall: 0.9773 - val_loss: 0.0799 - val_accuracy: 0.9723 -
val_recall: 0.9723

Epoch 00168: val_accuracy did not improve from 0.97624
Epoch 169/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0705 -
accuracy: 0.9735 - recall: 0.9735 - val_loss: 0.1049 - val_accuracy: 0.9644 -
val_recall: 0.9644

Epoch 00169: val_accuracy did not improve from 0.97624
Epoch 170/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0635 -
accuracy: 0.9751 - recall: 0.9748 - val_loss: 0.0871 - val_accuracy: 0.9683 -
val_recall: 0.9683

Epoch 00170: val_accuracy did not improve from 0.97624
Epoch 171/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0567 -
accuracy: 0.9794 - recall: 0.9793 - val_loss: 0.0759 - val_accuracy: 0.9732 -
val_recall: 0.9727

Epoch 00171: val_accuracy did not improve from 0.97624
Epoch 172/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0540 -
accuracy: 0.9810 - recall: 0.9809 - val_loss: 0.0681 - val_accuracy: 0.9745 -
val_recall: 0.9745

Epoch 00172: val_accuracy did not improve from 0.97624
Epoch 173/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0583 -
accuracy: 0.9795 - recall: 0.9795 - val_loss: 0.0847 - val_accuracy: 0.9696 -
val_recall: 0.9696

Epoch 00173: val_accuracy did not improve from 0.97624
Epoch 174/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0590 -
accuracy: 0.9778 - recall: 0.9776 - val_loss: 0.0908 - val_accuracy: 0.9692 -
val_recall: 0.9692

Epoch 00174: val_accuracy did not improve from 0.97624
Epoch 175/400
331/331 [==============================] - 39s 118ms/step - loss: 0.0586 -
accuracy: 0.9783 - recall: 0.9783 - val_loss: 0.0769 - val_accuracy: 0.9732 -
val_recall: 0.9723

Epoch 00175: val_accuracy did not improve from 0.97624
Epoch 176/400
```

```
331/331 [==============================] - 39s 118ms/step - loss: 0.0529 -
accuracy: 0.9814 - recall: 0.9814 - val_loss: 0.1224 - val_accuracy: 0.9573 -
val_recall: 0.9569

Epoch 00176: val_accuracy did not improve from 0.97624
Epoch 177/400
331/331 [==============================] - 39s 118ms/step - loss: 0.0571 -
accuracy: 0.9796 - recall: 0.9795 - val_loss: 0.0908 - val_accuracy: 0.9661 -
val_recall: 0.9661

Epoch 00177: val_accuracy did not improve from 0.97624
Epoch 178/400
331/331 [==============================] - 39s 118ms/step - loss: 0.0532 -
accuracy: 0.9790 - recall: 0.9789 - val_loss: 0.0938 - val_accuracy: 0.9692 -
val_recall: 0.9692

Epoch 00178: val_accuracy did not improve from 0.97624
Epoch 179/400
331/331 [==============================] - 40s 121ms/step - loss: 0.0547 -
accuracy: 0.9793 - recall: 0.9791 - val_loss: 0.0831 - val_accuracy: 0.9666 -
val_recall: 0.9666

Epoch 00179: val_accuracy did not improve from 0.97624
Epoch 180/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0526 -
accuracy: 0.9808 - recall: 0.9808 - val_loss: 0.0832 - val_accuracy: 0.9696 -
val_recall: 0.9688

Epoch 00180: val_accuracy did not improve from 0.97624
Epoch 181/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0587 -
accuracy: 0.9800 - recall: 0.9800 - val_loss: 0.0930 - val_accuracy: 0.9670 -
val_recall: 0.9661

Epoch 00181: val_accuracy did not improve from 0.97624
Epoch 182/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0523 -
accuracy: 0.9833 - recall: 0.9828 - val_loss: 0.0877 - val_accuracy: 0.9736 -
val_recall: 0.9736

Epoch 00182: val_accuracy did not improve from 0.97624
Epoch 183/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0548 -
accuracy: 0.9785 - recall: 0.9782 - val_loss: 0.0947 - val_accuracy: 0.9661 -
val_recall: 0.9661

Epoch 00183: val_accuracy did not improve from 0.97624
Epoch 184/400
```

```
331/331 [==============================] - 40s 120ms/step - loss: 0.0571 -
accuracy: 0.9804 - recall: 0.9804 - val_loss: 0.0875 - val_accuracy: 0.9688 -
val_recall: 0.9688


Epoch 00184: val_accuracy did not improve from 0.97624
Epoch 185/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0538 -
accuracy: 0.9776 - recall: 0.9775 - val_loss: 0.0748 - val_accuracy: 0.9736 -
val_recall: 0.9736


Epoch 00185: val_accuracy did not improve from 0.97624
Epoch 186/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0564 -
accuracy: 0.9807 - recall: 0.9807 - val_loss: 0.0900 - val_accuracy: 0.9674 -
val_recall: 0.9674


Epoch 00186: val_accuracy did not improve from 0.97624
Epoch 187/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0623 -
accuracy: 0.9745 - recall: 0.9743 - val_loss: 0.0969 - val_accuracy: 0.9626 -
val_recall: 0.9622


Epoch 00187: val_accuracy did not improve from 0.97624
Epoch 188/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0593 -
accuracy: 0.9796 - recall: 0.9796 - val_loss: 0.0817 - val_accuracy: 0.9740 -
val_recall: 0.9740


Epoch 00188: val_accuracy did not improve from 0.97624
Epoch 189/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0538 -
accuracy: 0.9800 - recall: 0.9799 - val_loss: 0.0736 - val_accuracy: 0.9780 -
val_recall: 0.9780


Epoch 00189: val_accuracy improved from 0.97624 to 0.97800, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 190/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0503 -
accuracy: 0.9811 - recall: 0.9809 - val_loss: 0.0993 - val_accuracy: 0.9657 -
val_recall: 0.9657


Epoch 00190: val_accuracy did not improve from 0.97800
Epoch 191/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0485 -
accuracy: 0.9837 - recall: 0.9833 - val_loss: 0.0771 - val_accuracy: 0.9723 -
val_recall: 0.9723


Epoch 00191: val_accuracy did not improve from 0.97800
```

```
Epoch 192/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0566 -
accuracy: 0.9799 - recall: 0.9798 - val_loss: 0.1048 - val_accuracy: 0.9626 -
val_recall: 0.9626

Epoch 00192: val_accuracy did not improve from 0.97800
Epoch 193/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0522 -
accuracy: 0.9828 - recall: 0.9822 - val_loss: 0.1115 - val_accuracy: 0.9595 -
val_recall: 0.9586

Epoch 00193: val_accuracy did not improve from 0.97800
Epoch 194/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0499 -
accuracy: 0.9833 - recall: 0.9833 - val_loss: 0.0767 - val_accuracy: 0.9740 -
val_recall: 0.9736

Epoch 00194: val_accuracy did not improve from 0.97800
Epoch 195/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0560 -
accuracy: 0.9800 - recall: 0.9799 - val_loss: 0.0793 - val_accuracy: 0.9727 -
val_recall: 0.9727

Epoch 00195: val_accuracy did not improve from 0.97800
Epoch 196/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0556 -
accuracy: 0.9789 - recall: 0.9787 - val_loss: 0.1056 - val_accuracy: 0.9661 -
val_recall: 0.9661

Epoch 00196: val_accuracy did not improve from 0.97800
Epoch 197/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0520 -
accuracy: 0.9814 - recall: 0.9812 - val_loss: 0.1052 - val_accuracy: 0.9648 -
val_recall: 0.9644

Epoch 00197: val_accuracy did not improve from 0.97800
Epoch 198/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0518 -
accuracy: 0.9809 - recall: 0.9804 - val_loss: 0.1438 - val_accuracy: 0.9538 -
val_recall: 0.9538

Epoch 00198: val_accuracy did not improve from 0.97800
Epoch 199/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0489 -
accuracy: 0.9812 - recall: 0.9812 - val_loss: 0.0911 - val_accuracy: 0.9701 -
val_recall: 0.9692

Epoch 00199: val_accuracy did not improve from 0.97800
```

```
Epoch 200/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0530 -
accuracy: 0.9803 - recall: 0.9794 - val_loss: 0.0876 - val_accuracy: 0.9705 -
val_recall: 0.9696

Epoch 00200: val_accuracy did not improve from 0.97800
Epoch 201/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0540 -
accuracy: 0.9799 - recall: 0.9798 - val_loss: 0.1868 - val_accuracy: 0.9362 -
val_recall: 0.9362

Epoch 00201: val_accuracy did not improve from 0.97800
Epoch 202/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0538 -
accuracy: 0.9789 - recall: 0.9787 - val_loss: 0.0818 - val_accuracy: 0.9732 -
val_recall: 0.9727

Epoch 00202: val_accuracy did not improve from 0.97800
Epoch 203/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0508 -
accuracy: 0.9823 - recall: 0.9819 - val_loss: 0.0866 - val_accuracy: 0.9688 -
val_recall: 0.9688

Epoch 00203: val_accuracy did not improve from 0.97800
Epoch 204/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0506 -
accuracy: 0.9816 - recall: 0.9816 - val_loss: 0.0896 - val_accuracy: 0.9696 -
val_recall: 0.9692

Epoch 00204: val_accuracy did not improve from 0.97800
Epoch 205/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0493 -
accuracy: 0.9814 - recall: 0.9814 - val_loss: 0.1013 - val_accuracy: 0.9666 -
val_recall: 0.9657

Epoch 00205: val_accuracy did not improve from 0.97800
Epoch 206/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0458 -
accuracy: 0.9840 - recall: 0.9833 - val_loss: 0.0929 - val_accuracy: 0.9657 -
val_recall: 0.9652

Epoch 00206: val_accuracy did not improve from 0.97800
Epoch 207/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0504 -
accuracy: 0.9815 - recall: 0.9814 - val_loss: 0.0864 - val_accuracy: 0.9648 -
val_recall: 0.9644

Epoch 00207: val_accuracy did not improve from 0.97800
```

```
Epoch 208/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0440 -
accuracy: 0.9841 - recall: 0.9840 - val_loss: 0.0762 - val_accuracy: 0.9727 -
val_recall: 0.9723

Epoch 00208: val_accuracy did not improve from 0.97800
Epoch 209/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0470 -
accuracy: 0.9815 - recall: 0.9815 - val_loss: 0.0745 - val_accuracy: 0.9727 -
val_recall: 0.9723

Epoch 00209: val_accuracy did not improve from 0.97800
Epoch 210/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0523 -
accuracy: 0.9823 - recall: 0.9820 - val_loss: 0.0686 - val_accuracy: 0.9732 -
val_recall: 0.9732

Epoch 00210: val_accuracy did not improve from 0.97800
Epoch 211/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0469 -
accuracy: 0.9844 - recall: 0.9844 - val_loss: 0.0967 - val_accuracy: 0.9657 -
val_recall: 0.9648

Epoch 00211: val_accuracy did not improve from 0.97800
Epoch 212/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0512 -
accuracy: 0.9813 - recall: 0.9812 - val_loss: 0.0748 - val_accuracy: 0.9758 -
val_recall: 0.9758

Epoch 00212: val_accuracy did not improve from 0.97800
Epoch 213/400
331/331 [==============================] - 39s 118ms/step - loss: 0.0500 -
accuracy: 0.9809 - recall: 0.9808 - val_loss: 0.0974 - val_accuracy: 0.9648 -
val_recall: 0.9648

Epoch 00213: val_accuracy did not improve from 0.97800
Epoch 214/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0492 -
accuracy: 0.9812 - recall: 0.9811 - val_loss: 0.0712 - val_accuracy: 0.9749 -
val_recall: 0.9745

Epoch 00214: val_accuracy did not improve from 0.97800
Epoch 215/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0435 -
accuracy: 0.9858 - recall: 0.9858 - val_loss: 0.0754 - val_accuracy: 0.9714 -
val_recall: 0.9714

Epoch 00215: val_accuracy did not improve from 0.97800
```

```
Epoch 216/400
331/331 [==============================] - 39s 118ms/step - loss: 0.0440 -
accuracy: 0.9835 - recall: 0.9835 - val_loss: 0.0914 - val_accuracy: 0.9705 -
val_recall: 0.9696

Epoch 00216: val_accuracy did not improve from 0.97800
Epoch 217/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0470 -
accuracy: 0.9852 - recall: 0.9846 - val_loss: 0.0705 - val_accuracy: 0.9749 -
val_recall: 0.9749

Epoch 00217: val_accuracy did not improve from 0.97800
Epoch 218/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0448 -
accuracy: 0.9818 - recall: 0.9818 - val_loss: 0.0996 - val_accuracy: 0.9692 -
val_recall: 0.9683

Epoch 00218: val_accuracy did not improve from 0.97800
Epoch 219/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0481 -
accuracy: 0.9812 - recall: 0.9809 - val_loss: 0.0825 - val_accuracy: 0.9718 -
val_recall: 0.9718

Epoch 00219: val_accuracy did not improve from 0.97800
Epoch 220/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0405 -
accuracy: 0.9868 - recall: 0.9867 - val_loss: 0.1196 - val_accuracy: 0.9617 -
val_recall: 0.9617

Epoch 00220: val_accuracy did not improve from 0.97800
Epoch 221/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0456 -
accuracy: 0.9830 - recall: 0.9830 - val_loss: 0.0770 - val_accuracy: 0.9749 -
val_recall: 0.9749

Epoch 00221: val_accuracy did not improve from 0.97800
Epoch 222/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0440 -
accuracy: 0.9836 - recall: 0.9836 - val_loss: 0.1010 - val_accuracy: 0.9639 -
val_recall: 0.9639

Epoch 00222: val_accuracy did not improve from 0.97800
Epoch 223/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0405 -
accuracy: 0.9843 - recall: 0.9840 - val_loss: 0.0807 - val_accuracy: 0.9718 -
val_recall: 0.9718

Epoch 00223: val_accuracy did not improve from 0.97800
```

```
Epoch 224/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0477 -
accuracy: 0.9837 - recall: 0.9837 - val_loss: 0.1259 - val_accuracy: 0.9582 -
val_recall: 0.9578

Epoch 00224: val_accuracy did not improve from 0.97800
Epoch 225/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0480 -
accuracy: 0.9830 - recall: 0.9830 - val_loss: 0.1279 - val_accuracy: 0.9542 -
val_recall: 0.9542

Epoch 00225: val_accuracy did not improve from 0.97800
Epoch 226/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0461 -
accuracy: 0.9833 - recall: 0.9832 - val_loss: 0.1250 - val_accuracy: 0.9573 -
val_recall: 0.9573

Epoch 00226: val_accuracy did not improve from 0.97800
Epoch 227/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0447 -
accuracy: 0.9843 - recall: 0.9839 - val_loss: 0.0897 - val_accuracy: 0.9679 -
val_recall: 0.9679

Epoch 00227: val_accuracy did not improve from 0.97800
Epoch 228/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0480 -
accuracy: 0.9808 - recall: 0.9806 - val_loss: 0.0767 - val_accuracy: 0.9727 -
val_recall: 0.9727

Epoch 00228: val_accuracy did not improve from 0.97800
Epoch 229/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0429 -
accuracy: 0.9844 - recall: 0.9841 - val_loss: 0.0755 - val_accuracy: 0.9736 -
val_recall: 0.9727

Epoch 00229: val_accuracy did not improve from 0.97800
Epoch 230/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0437 -
accuracy: 0.9831 - recall: 0.9831 - val_loss: 0.0849 - val_accuracy: 0.9710 -
val_recall: 0.9710

Epoch 00230: val_accuracy did not improve from 0.97800
Epoch 231/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0411 -
accuracy: 0.9854 - recall: 0.9851 - val_loss: 0.0866 - val_accuracy: 0.9696 -
val_recall: 0.9696

Epoch 00231: val_accuracy did not improve from 0.97800
```

```
Epoch 232/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0503 -
accuracy: 0.9809 - recall: 0.9809 - val_loss: 0.0849 - val_accuracy: 0.9696 -
val_recall: 0.9688

Epoch 00232: val_accuracy did not improve from 0.97800
Epoch 233/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0407 -
accuracy: 0.9841 - recall: 0.9840 - val_loss: 0.0765 - val_accuracy: 0.9740 -
val_recall: 0.9736

Epoch 00233: val_accuracy did not improve from 0.97800
Epoch 234/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0436 -
accuracy: 0.9832 - recall: 0.9831 - val_loss: 0.0788 - val_accuracy: 0.9701 -
val_recall: 0.9696

Epoch 00234: val_accuracy did not improve from 0.97800
Epoch 235/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0469 -
accuracy: 0.9834 - recall: 0.9834 - val_loss: 0.0908 - val_accuracy: 0.9688 -
val_recall: 0.9683

Epoch 00235: val_accuracy did not improve from 0.97800
Epoch 236/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0429 -
accuracy: 0.9839 - recall: 0.9839 - val_loss: 0.0929 - val_accuracy: 0.9679 -
val_recall: 0.9674

Epoch 00236: val_accuracy did not improve from 0.97800
Epoch 237/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0362 -
accuracy: 0.9870 - recall: 0.9868 - val_loss: 0.0881 - val_accuracy: 0.9683 -
val_recall: 0.9683

Epoch 00237: val_accuracy did not improve from 0.97800
Epoch 238/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0388 -
accuracy: 0.9845 - recall: 0.9842 - val_loss: 0.1009 - val_accuracy: 0.9692 -
val_recall: 0.9688

Epoch 00238: val_accuracy did not improve from 0.97800
Epoch 239/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0416 -
accuracy: 0.9857 - recall: 0.9855 - val_loss: 0.1007 - val_accuracy: 0.9696 -
val_recall: 0.9692

Epoch 00239: val_accuracy did not improve from 0.97800
```

```
Epoch 240/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0438 -
accuracy: 0.9821 - recall: 0.9821 - val_loss: 0.0923 - val_accuracy: 0.9683 -
val_recall: 0.9683

Epoch 00240: val_accuracy did not improve from 0.97800
Epoch 241/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0407 -
accuracy: 0.9866 - recall: 0.9865 - val_loss: 0.0623 - val_accuracy: 0.9820 -
val_recall: 0.9820

Epoch 00241: val_accuracy improved from 0.97800 to 0.98196, saving model to
/home/hivini/learn/research/new-covid/best_model.h5
Epoch 242/400
331/331 [==============================] - 39s 118ms/step - loss: 0.0452 -
accuracy: 0.9825 - recall: 0.9821 - val_loss: 0.0999 - val_accuracy: 0.9666 -
val_recall: 0.9661

Epoch 00242: val_accuracy did not improve from 0.98196
Epoch 243/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0443 -
accuracy: 0.9841 - recall: 0.9838 - val_loss: 0.1067 - val_accuracy: 0.9648 -
val_recall: 0.9648

Epoch 00243: val_accuracy did not improve from 0.98196
Epoch 244/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0427 -
accuracy: 0.9844 - recall: 0.9844 - val_loss: 0.1324 - val_accuracy: 0.9560 -
val_recall: 0.9560

Epoch 00244: val_accuracy did not improve from 0.98196
Epoch 245/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0449 -
accuracy: 0.9827 - recall: 0.9824 - val_loss: 0.0974 - val_accuracy: 0.9683 -
val_recall: 0.9683

Epoch 00245: val_accuracy did not improve from 0.98196
Epoch 246/400
331/331 [==============================] - 39s 118ms/step - loss: 0.0358 -
accuracy: 0.9871 - recall: 0.9870 - val_loss: 0.1039 - val_accuracy: 0.9657 -
val_recall: 0.9644

Epoch 00246: val_accuracy did not improve from 0.98196
Epoch 247/400
331/331 [==============================] - 39s 118ms/step - loss: 0.0397 -
accuracy: 0.9846 - recall: 0.9846 - val_loss: 0.0779 - val_accuracy: 0.9762 -
val_recall: 0.9762
```

```
Epoch 00247: val_accuracy did not improve from 0.98196
Epoch 248/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0418 -
accuracy: 0.9861 - recall: 0.9858 - val_loss: 0.0912 - val_accuracy: 0.9674 -
val_recall: 0.9674

Epoch 00248: val_accuracy did not improve from 0.98196
Epoch 249/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0357 -
accuracy: 0.9874 - recall: 0.9871 - val_loss: 0.0772 - val_accuracy: 0.9749 -
val_recall: 0.9749

Epoch 00249: val_accuracy did not improve from 0.98196
Epoch 250/400
331/331 [==============================] - 39s 118ms/step - loss: 0.0398 -
accuracy: 0.9838 - recall: 0.9832 - val_loss: 0.1265 - val_accuracy: 0.9600 -
val_recall: 0.9600

Epoch 00250: val_accuracy did not improve from 0.98196
Epoch 251/400
331/331 [==============================] - 39s 117ms/step - loss: 0.0360 -
accuracy: 0.9873 - recall: 0.9868 - val_loss: 0.1071 - val_accuracy: 0.9661 -
val_recall: 0.9661

Epoch 00251: val_accuracy did not improve from 0.98196
Epoch 252/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0339 -
accuracy: 0.9892 - recall: 0.9891 - val_loss: 0.0811 - val_accuracy: 0.9767 -
val_recall: 0.9767

Epoch 00252: val_accuracy did not improve from 0.98196
Epoch 253/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0394 -
accuracy: 0.9856 - recall: 0.9855 - val_loss: 0.0972 - val_accuracy: 0.9692 -
val_recall: 0.9692

Epoch 00253: val_accuracy did not improve from 0.98196
Epoch 254/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0434 -
accuracy: 0.9860 - recall: 0.9858 - val_loss: 0.1092 - val_accuracy: 0.9661 -
val_recall: 0.9661

Epoch 00254: val_accuracy did not improve from 0.98196
Epoch 255/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0411 -
accuracy: 0.9839 - recall: 0.9838 - val_loss: 0.0799 - val_accuracy: 0.9732 -
val_recall: 0.9732
```

```
Epoch 00255: val_accuracy did not improve from 0.98196
Epoch 256/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0375 -
accuracy: 0.9859 - recall: 0.9858 - val_loss: 0.0916 - val_accuracy: 0.9666 -
val_recall: 0.9661

Epoch 00256: val_accuracy did not improve from 0.98196
Epoch 257/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0421 -
accuracy: 0.9841 - recall: 0.9841 - val_loss: 0.0725 - val_accuracy: 0.9758 -
val_recall: 0.9758

Epoch 00257: val_accuracy did not improve from 0.98196
Epoch 258/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0334 -
accuracy: 0.9875 - recall: 0.9874 - val_loss: 0.1048 - val_accuracy: 0.9683 -
val_recall: 0.9679

Epoch 00258: val_accuracy did not improve from 0.98196
Epoch 259/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0351 -
accuracy: 0.9862 - recall: 0.9862 - val_loss: 0.0863 - val_accuracy: 0.9696 -
val_recall: 0.9696

Epoch 00259: val_accuracy did not improve from 0.98196
Epoch 260/400
331/331 [==============================] - 40s 122ms/step - loss: 0.0385 -
accuracy: 0.9866 - recall: 0.9865 - val_loss: 0.0741 - val_accuracy: 0.9740 -
val_recall: 0.9740

Epoch 00260: val_accuracy did not improve from 0.98196
Epoch 261/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0425 -
accuracy: 0.9852 - recall: 0.9851 - val_loss: 0.1113 - val_accuracy: 0.9617 -
val_recall: 0.9617

Epoch 00261: val_accuracy did not improve from 0.98196
Epoch 262/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0386 -
accuracy: 0.9850 - recall: 0.9847 - val_loss: 0.0768 - val_accuracy: 0.9749 -
val_recall: 0.9749

Epoch 00262: val_accuracy did not improve from 0.98196
Epoch 263/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0342 -
accuracy: 0.9870 - recall: 0.9870 - val_loss: 0.0846 - val_accuracy: 0.9688 -
val_recall: 0.9688
```

```
Epoch 00263: val_accuracy did not improve from 0.98196
Epoch 264/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0353 -
accuracy: 0.9874 - recall: 0.9874 - val_loss: 0.0799 - val_accuracy: 0.9732 -
val_recall: 0.9727


Epoch 00264: val_accuracy did not improve from 0.98196
Epoch 265/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0412 -
accuracy: 0.9852 - recall: 0.9850 - val_loss: 0.1809 - val_accuracy: 0.9406 -
val_recall: 0.9402


Epoch 00265: val_accuracy did not improve from 0.98196
Epoch 266/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0384 -
accuracy: 0.9848 - recall: 0.9847 - val_loss: 0.2902 - val_accuracy: 0.9239 -
val_recall: 0.9234


Epoch 00266: val_accuracy did not improve from 0.98196
Epoch 267/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0377 -
accuracy: 0.9863 - recall: 0.9860 - val_loss: 0.0772 - val_accuracy: 0.9727 -
val_recall: 0.9727


Epoch 00267: val_accuracy did not improve from 0.98196
Epoch 268/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0447 -
accuracy: 0.9838 - recall: 0.9836 - val_loss: 0.0779 - val_accuracy: 0.9736 -
val_recall: 0.9736


Epoch 00268: val_accuracy did not improve from 0.98196
Epoch 269/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0402 -
accuracy: 0.9855 - recall: 0.9855 - val_loss: 0.0825 - val_accuracy: 0.9732 -
val_recall: 0.9727


Epoch 00269: val_accuracy did not improve from 0.98196
Epoch 270/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0387 -
accuracy: 0.9856 - recall: 0.9855 - val_loss: 0.1163 - val_accuracy: 0.9666 -
val_recall: 0.9666


Epoch 00270: val_accuracy did not improve from 0.98196
Epoch 271/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0375 -
accuracy: 0.9864 - recall: 0.9862 - val_loss: 0.0755 - val_accuracy: 0.9749 -
val_recall: 0.9745
```

```
Epoch 00271: val_accuracy did not improve from 0.98196
Epoch 272/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0353 -
accuracy: 0.9882 - recall: 0.9881 - val_loss: 0.0811 - val_accuracy: 0.9736 -
val_recall: 0.9732

Epoch 00272: val_accuracy did not improve from 0.98196
Epoch 273/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0374 -
accuracy: 0.9863 - recall: 0.9862 - val_loss: 0.0846 - val_accuracy: 0.9710 -
val_recall: 0.9705

Epoch 00273: val_accuracy did not improve from 0.98196
Epoch 274/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0320 -
accuracy: 0.9887 - recall: 0.9887 - val_loss: 0.1058 - val_accuracy: 0.9648 -
val_recall: 0.9648

Epoch 00274: val_accuracy did not improve from 0.98196
Epoch 275/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0321 -
accuracy: 0.9873 - recall: 0.9873 - val_loss: 0.0824 - val_accuracy: 0.9723 -
val_recall: 0.9723

Epoch 00275: val_accuracy did not improve from 0.98196
Epoch 276/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0395 -
accuracy: 0.9856 - recall: 0.9853 - val_loss: 0.1945 - val_accuracy: 0.9384 -
val_recall: 0.9384

Epoch 00276: val_accuracy did not improve from 0.98196
Epoch 277/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0378 -
accuracy: 0.9875 - recall: 0.9874 - val_loss: 0.1216 - val_accuracy: 0.9626 -
val_recall: 0.9622

Epoch 00277: val_accuracy did not improve from 0.98196
Epoch 278/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0351 -
accuracy: 0.9884 - recall: 0.9883 - val_loss: 0.0738 - val_accuracy: 0.9754 -
val_recall: 0.9754

Epoch 00278: val_accuracy did not improve from 0.98196
Epoch 279/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0312 -
accuracy: 0.9891 - recall: 0.9891 - val_loss: 0.1409 - val_accuracy: 0.9547 -
val_recall: 0.9547
```

```
Epoch 00279: val_accuracy did not improve from 0.98196
Epoch 280/400
331/331 [==============================] - 40s 119ms/step - loss: 0.0376 -
accuracy: 0.9864 - recall: 0.9864 - val_loss: 0.0713 - val_accuracy: 0.9776 -
val_recall: 0.9771

Epoch 00280: val_accuracy did not improve from 0.98196
Epoch 281/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0321 -
accuracy: 0.9879 - recall: 0.9879 - val_loss: 0.1250 - val_accuracy: 0.9608 -
val_recall: 0.9608

Epoch 00281: val_accuracy did not improve from 0.98196
Epoch 282/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0305 -
accuracy: 0.9892 - recall: 0.9892 - val_loss: 0.0765 - val_accuracy: 0.9740 -
val_recall: 0.9736

Epoch 00282: val_accuracy did not improve from 0.98196
Epoch 283/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0334 -
accuracy: 0.9866 - recall: 0.9865 - val_loss: 0.0768 - val_accuracy: 0.9745 -
val_recall: 0.9745

Epoch 00283: val_accuracy did not improve from 0.98196
Epoch 284/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0437 -
accuracy: 0.9839 - recall: 0.9838 - val_loss: 0.1936 - val_accuracy: 0.9384 -
val_recall: 0.9380

Epoch 00284: val_accuracy did not improve from 0.98196
Epoch 285/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0356 -
accuracy: 0.9879 - recall: 0.9877 - val_loss: 0.1153 - val_accuracy: 0.9639 -
val_recall: 0.9639

Epoch 00285: val_accuracy did not improve from 0.98196
Epoch 286/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0347 -
accuracy: 0.9858 - recall: 0.9858 - val_loss: 0.1282 - val_accuracy: 0.9538 -
val_recall: 0.9538

Epoch 00286: val_accuracy did not improve from 0.98196
Epoch 287/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0337 -
accuracy: 0.9885 - recall: 0.9885 - val_loss: 0.1199 - val_accuracy: 0.9652 -
val_recall: 0.9652
```

```
Epoch 00287: val_accuracy did not improve from 0.98196
Epoch 288/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0358 -
accuracy: 0.9877 - recall: 0.9877 - val_loss: 0.1218 - val_accuracy: 0.9613 -
val_recall: 0.9604

Epoch 00288: val_accuracy did not improve from 0.98196
Epoch 289/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0327 -
accuracy: 0.9887 - recall: 0.9887 - val_loss: 0.1149 - val_accuracy: 0.9622 -
val_recall: 0.9622

Epoch 00289: val_accuracy did not improve from 0.98196
Epoch 290/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0306 -
accuracy: 0.9895 - recall: 0.9895 - val_loss: 0.0879 - val_accuracy: 0.9710 -
val_recall: 0.9710

Epoch 00290: val_accuracy did not improve from 0.98196
Epoch 291/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0330 -
accuracy: 0.9891 - recall: 0.9891 - val_loss: 0.0677 - val_accuracy: 0.9758 -
val_recall: 0.9758

Epoch 00291: val_accuracy did not improve from 0.98196
Epoch 292/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0285 -
accuracy: 0.9889 - recall: 0.9889 - val_loss: 0.1106 - val_accuracy: 0.9630 -
val_recall: 0.9630

Epoch 00292: val_accuracy did not improve from 0.98196
Epoch 293/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0348 -
accuracy: 0.9868 - recall: 0.9865 - val_loss: 0.0905 - val_accuracy: 0.9705 -
val_recall: 0.9705

Epoch 00293: val_accuracy did not improve from 0.98196
Epoch 294/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0327 -
accuracy: 0.9860 - recall: 0.9860 - val_loss: 0.0863 - val_accuracy: 0.9696 -
val_recall: 0.9696

Epoch 00294: val_accuracy did not improve from 0.98196
Epoch 295/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0351 -
accuracy: 0.9840 - recall: 0.9840 - val_loss: 0.0693 - val_accuracy: 0.9754 -
val_recall: 0.9754
```

```
Epoch 00295: val_accuracy did not improve from 0.98196
Epoch 296/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0363 -
accuracy: 0.9874 - recall: 0.9873 - val_loss: 0.0844 - val_accuracy: 0.9688 -
val_recall: 0.9688

Epoch 00296: val_accuracy did not improve from 0.98196
Epoch 297/400
331/331 [==============================] - 39s 119ms/step - loss: 0.0289 -
accuracy: 0.9899 - recall: 0.9895 - val_loss: 0.1034 - val_accuracy: 0.9644 -
val_recall: 0.9644

Epoch 00297: val_accuracy did not improve from 0.98196
Epoch 298/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0300 -
accuracy: 0.9889 - recall: 0.9889 - val_loss: 0.0702 - val_accuracy: 0.9776 -
val_recall: 0.9771

Epoch 00298: val_accuracy did not improve from 0.98196
Epoch 299/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0329 -
accuracy: 0.9895 - recall: 0.9894 - val_loss: 0.0803 - val_accuracy: 0.9718 -
val_recall: 0.9718

Epoch 00299: val_accuracy did not improve from 0.98196
Epoch 300/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0324 -
accuracy: 0.9892 - recall: 0.9891 - val_loss: 0.0844 - val_accuracy: 0.9692 -
val_recall: 0.9692

Epoch 00300: val_accuracy did not improve from 0.98196
Epoch 301/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0344 -
accuracy: 0.9871 - recall: 0.9870 - val_loss: 0.0942 - val_accuracy: 0.9688 -
val_recall: 0.9683

Epoch 00301: val_accuracy did not improve from 0.98196
Epoch 302/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0351 -
accuracy: 0.9871 - recall: 0.9871 - val_loss: 0.1076 - val_accuracy: 0.9701 -
val_recall: 0.9696

Epoch 00302: val_accuracy did not improve from 0.98196
Epoch 303/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0312 -
accuracy: 0.9873 - recall: 0.9871 - val_loss: 0.0979 - val_accuracy: 0.9674 -
val_recall: 0.9674
```

Epoch 00303: val_accuracy did not improve from 0.98196
Epoch 304/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0348 -
accuracy: 0.9887 - recall: 0.9885 - val_loss: 0.1080 - val_accuracy: 0.9670 -
val_recall: 0.9670

Epoch 00304: val_accuracy did not improve from 0.98196
Epoch 305/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0360 -
accuracy: 0.9876 - recall: 0.9874 - val_loss: 0.0957 - val_accuracy: 0.9710 -
val_recall: 0.9710

Epoch 00305: val_accuracy did not improve from 0.98196
Epoch 306/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0349 -
accuracy: 0.9859 - recall: 0.9859 - val_loss: 0.0945 - val_accuracy: 0.9683 -
val_recall: 0.9683

Epoch 00306: val_accuracy did not improve from 0.98196
Epoch 307/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0333 -
accuracy: 0.9879 - recall: 0.9879 - val_loss: 0.1132 - val_accuracy: 0.9692 -
val_recall: 0.9692

Epoch 00307: val_accuracy did not improve from 0.98196
Epoch 308/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0292 -
accuracy: 0.9892 - recall: 0.9890 - val_loss: 0.0971 - val_accuracy: 0.9674 -
val_recall: 0.9674

Epoch 00308: val_accuracy did not improve from 0.98196
Epoch 309/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0288 -
accuracy: 0.9889 - recall: 0.9886 - val_loss: 0.2822 - val_accuracy: 0.9173 -
val_recall: 0.9173

Epoch 00309: val_accuracy did not improve from 0.98196
Epoch 310/400
331/331 [==============================] - 40s 122ms/step - loss: 0.0284 -
accuracy: 0.9866 - recall: 0.9864 - val_loss: 0.1078 - val_accuracy: 0.9670 -
val_recall: 0.9670

Epoch 00310: val_accuracy did not improve from 0.98196
Epoch 311/400
331/331 [==============================] - 45s 137ms/step - loss: 0.0352 -
accuracy: 0.9885 - recall: 0.9884 - val_loss: 0.0956 - val_accuracy: 0.9692 -
val_recall: 0.9688

```
Epoch 00311: val_accuracy did not improve from 0.98196
Epoch 312/400
331/331 [==============================] - 42s 126ms/step - loss: 0.0301 -
accuracy: 0.9895 - recall: 0.9894 - val_loss: 0.1073 - val_accuracy: 0.9666 -
val_recall: 0.9666

Epoch 00312: val_accuracy did not improve from 0.98196
Epoch 313/400
331/331 [==============================] - 42s 128ms/step - loss: 0.0337 -
accuracy: 0.9880 - recall: 0.9880 - val_loss: 0.1180 - val_accuracy: 0.9626 -
val_recall: 0.9626

Epoch 00313: val_accuracy did not improve from 0.98196
Epoch 314/400
331/331 [==============================] - 44s 133ms/step - loss: 0.0342 -
accuracy: 0.9873 - recall: 0.9873 - val_loss: 0.0758 - val_accuracy: 0.9771 -
val_recall: 0.9771

Epoch 00314: val_accuracy did not improve from 0.98196
Epoch 315/400
331/331 [==============================] - 40s 121ms/step - loss: 0.0272 -
accuracy: 0.9909 - recall: 0.9909 - val_loss: 0.0834 - val_accuracy: 0.9723 -
val_recall: 0.9723

Epoch 00315: val_accuracy did not improve from 0.98196
Epoch 316/400
331/331 [==============================] - 41s 125ms/step - loss: 0.0340 -
accuracy: 0.9885 - recall: 0.9885 - val_loss: 0.0818 - val_accuracy: 0.9727 -
val_recall: 0.9727

Epoch 00316: val_accuracy did not improve from 0.98196
Epoch 317/400
331/331 [==============================] - 41s 123ms/step - loss: 0.0295 -
accuracy: 0.9900 - recall: 0.9894 - val_loss: 0.1100 - val_accuracy: 0.9674 -
val_recall: 0.9674

Epoch 00317: val_accuracy did not improve from 0.98196
Epoch 318/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0323 -
accuracy: 0.9884 - recall: 0.9884 - val_loss: 0.1662 - val_accuracy: 0.9481 -
val_recall: 0.9476

Epoch 00318: val_accuracy did not improve from 0.98196
Epoch 319/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0223 -
accuracy: 0.9925 - recall: 0.9922 - val_loss: 0.1095 - val_accuracy: 0.9666 -
val_recall: 0.9661
```

```
Epoch 00319: val_accuracy did not improve from 0.98196
Epoch 320/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0325 -
accuracy: 0.9885 - recall: 0.9884 - val_loss: 0.0812 - val_accuracy: 0.9758 -
val_recall: 0.9758

Epoch 00320: val_accuracy did not improve from 0.98196
Epoch 321/400
331/331 [==============================] - 40s 120ms/step - loss: 0.0343 -
accuracy: 0.9882 - recall: 0.9881 - val_loss: 0.0694 - val_accuracy: 0.9780 -
val_recall: 0.9780

Epoch 00321: val_accuracy did not improve from 0.98196
Epoch 00321: early stopping
```

```python
model.save(os.path.join(BASE_PATH, 'covid_classifier_result.h5'))
```

```python
test_loss, test_acc, test_recall = model.evaluate(test_generator)
print("Loss on test set: ", test_loss)
print("Accuracy on test set: ", test_acc)
```

```
72/72 [==============================] - 12s 166ms/step - loss: 0.0862 -
accuracy: 0.9763 - recall: 0.9758
Loss on test set:  0.08618113398551941
Accuracy on test set:  0.9762532711029053
```

```python
import matplotlib.pyplot as plt

acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
loss = history.history['loss']
val_loss = history.history['val_loss']

epochs = range(1, len(acc) + 1)
# bo is for blue dot.
plt.plot(epochs, loss, 'g', label='Training loss')
# b is for solid blue line
plt.plot(epochs, val_loss, 'b', label='Validation loss')
plt.title('Training and validation loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()

plt.show()
```

Training and validation loss
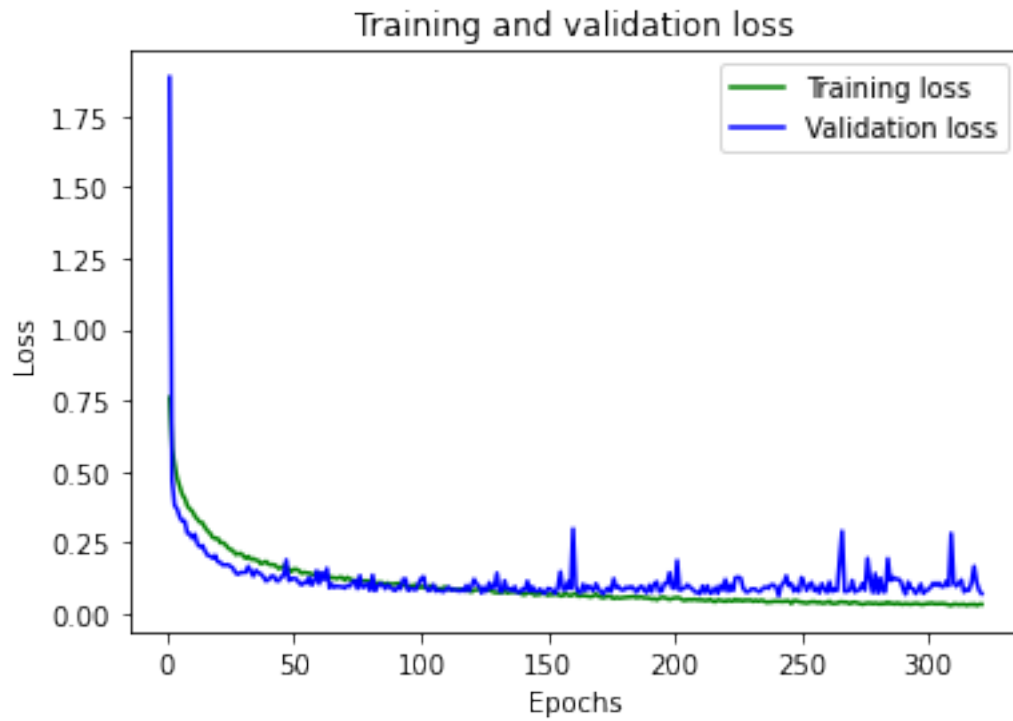
```
plt.clf()

plt.plot(epochs, acc, 'g', label='Training acc')
plt.plot(epochs, val_acc, 'b', label='Validation acc')
plt.title('Training and validation accuracy')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()

plt.show()
```

Training and validation accuracy