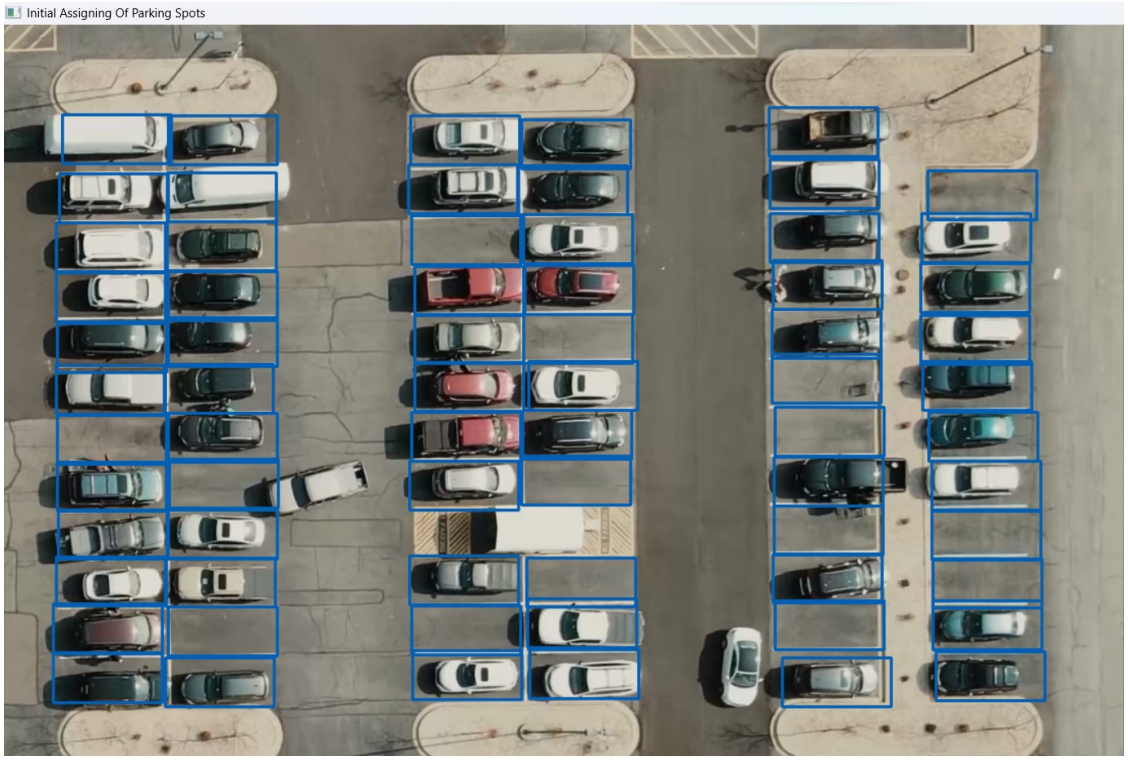
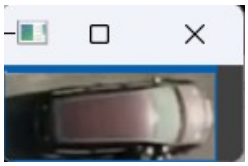
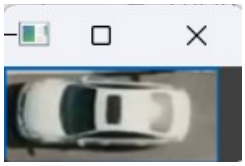
```python
import cv2
import pickle

width, height = 107, 48

try:
    with open('CarParkPos', 'rb') as f:
        posList = pickle.load(f)
except:
    posList = []


def mouseClick(events, x, y, flags, params):
    if events == cv2.EVENT_LBUTTONDOWN:
        posList.append((x, y))
    if events == cv2.EVENT_RBUTTONDOWN:
        for i, pos in enumerate(posList):
            x1, y1 = pos
            if x1 < x < x1 + width and y1 < y < y1 + height:
                posList.pop(i)

    with open('CarParkPos', 'wb') as f:
        pickle.dump(posList, f)


while True:
    img = cv2.imread('carParkImg.png')
    for pos in posList:
        cv2.rectangle(img, pos, (pos[0] + width, pos[1] + height),
(179,95,5), 2)

    cv2.imshow("Image", img)
    cv2.setMouseCallback("Image", mouseClick)
    cv2.waitKey(1)
```

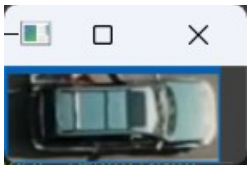


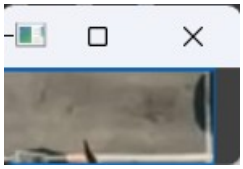

```
import cv2
import pickle
import cvzone
import numpy as np

# Video feed
cap = cv2.VideoCapture('carPark.mp4')

with open('CarParkPos', 'rb') as f:
        posList = pickle.load(f)


width, height = 107, 48


def checkParkingSpace():
    spaceCounter = 0

    for pos in posList:
        x, y = pos
        cv2.rectangle(img, pos, (pos[0] + width, pos[1] + height),
(179,95,5), 2)

        imgCrop = img[y:y + height, x:x + width]
        cv2.imshow(str(x * y), imgCrop)
```

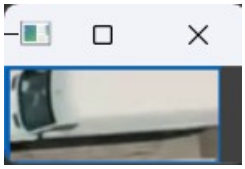
```
while True:

    if cap.get(cv2.CAP_PROP_POS_FRAMES) ==
cap.get(cv2.CAP_PROP_FRAME_COUNT):
        cap.set(cv2.CAP_PROP_POS_FRAMES, 0)

    success,img=cap.read()

    checkParkingSpace()
    cv2.imshow("Image", img)
    # cv2.imshow("ImageBlur", imgBlur)
    # cv2.imshow("ImageThres", imgMedian)
    cv2.waitKey(10)
```











```
import cv2
import pickle
import cvzone
import numpy as np

# Video feed
cap = cv2.VideoCapture('carPark.mp4')

with open('CarParkPos', 'rb') as f:
```

```
    posList = pickle.load(f)

width, height = 107, 48


def checkParkingSpace(imgPro):
    spaceCounter = 0

    for pos in posList:
        x, y = pos

        imgCrop = imgPro[y:y + height, x:x + width]
        cv2.imshow(str(x * y), imgCrop)
        count = cv2.countNonZero(imgCrop)


        if count < 900:
            color = (0, 255, 0)
            thickness = 5
            spaceCounter += 1
        else:
            color = (0, 0, 255)
            thickness = 2

        cv2.rectangle(img, pos, (pos[0] + width, pos[1] + height),
color, thickness)
        cvzone.putTextRect(img, str(count), (x, y + height - 3),
scale=1,
                           thickness=2, offset=0, colorR=color)

    cvzone.putTextRect(img, f'Free: {spaceCounter}/{len(posList)}',
(100, 50), scale=3,
                           thickness=5, offset=20, colorR=(0,200,0))
while True:

    if cap.get(cv2.CAP_PROP_POS_FRAMES) ==
cap.get(cv2.CAP_PROP_FRAME_COUNT):
        cap.set(cv2.CAP_PROP_POS_FRAMES, 0)
    success, img = cap.read()
    imgGray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    imgBlur = cv2.GaussianBlur(imgGray, (3, 3), 1)
    imgThreshold = cv2.adaptiveThreshold(imgBlur, 255,
cv2.ADAPTIVE_THRESH_GAUSSIAN_C,
                                         cv2.THRESH_BINARY_INV, 25,
16)
    imgMedian = cv2.medianBlur(imgThreshold, 5)
    kernel = np.ones((3, 3), np.uint8)
    imgDilate = cv2.dilate(imgMedian, kernel, iterations=1)
```

```
checkParkingSpace(imgDilate)
cv2.imshow("Image", img)
cv2.imshow("ImageBlur", imgBlur)
cv2.imshow("ImageThres", imgMedian)
cv2.waitKey(10)
```

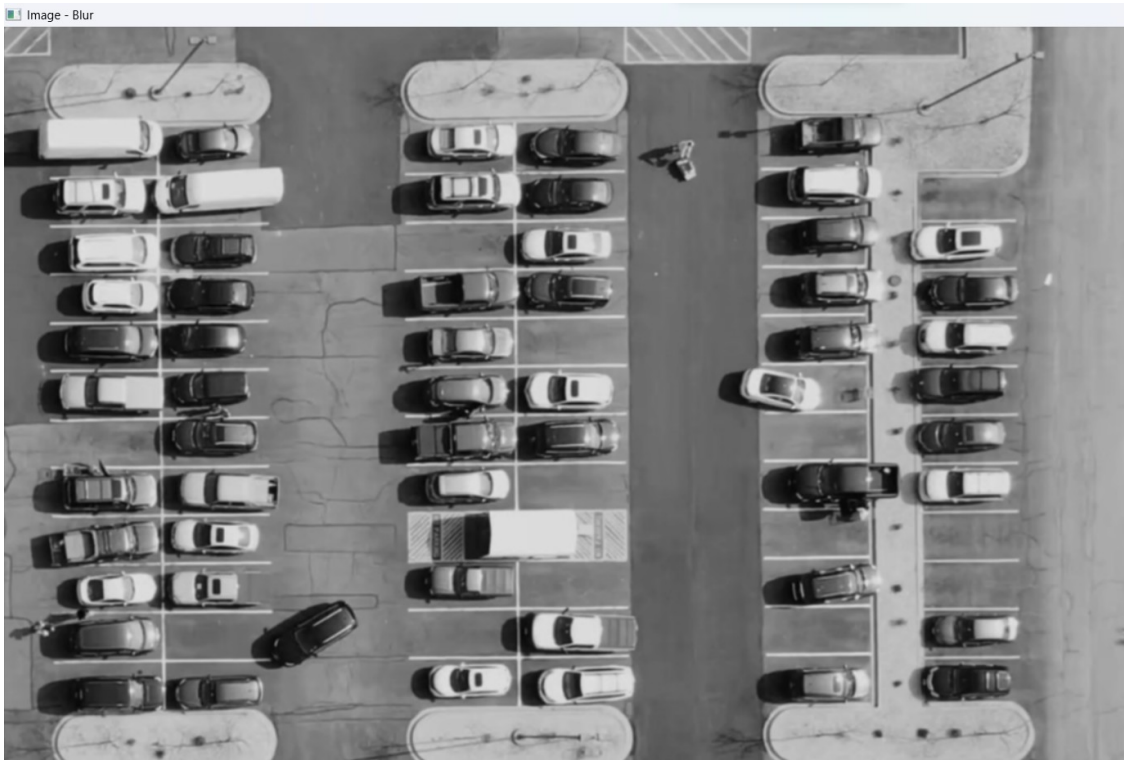
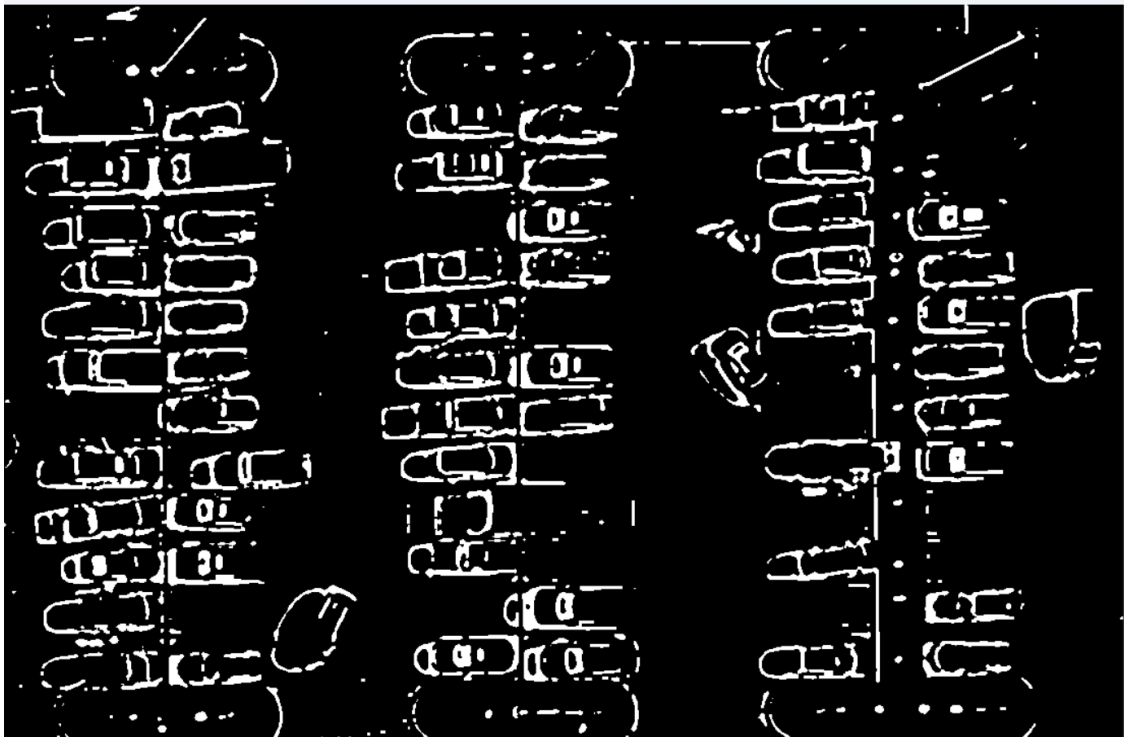


Image - Threshold



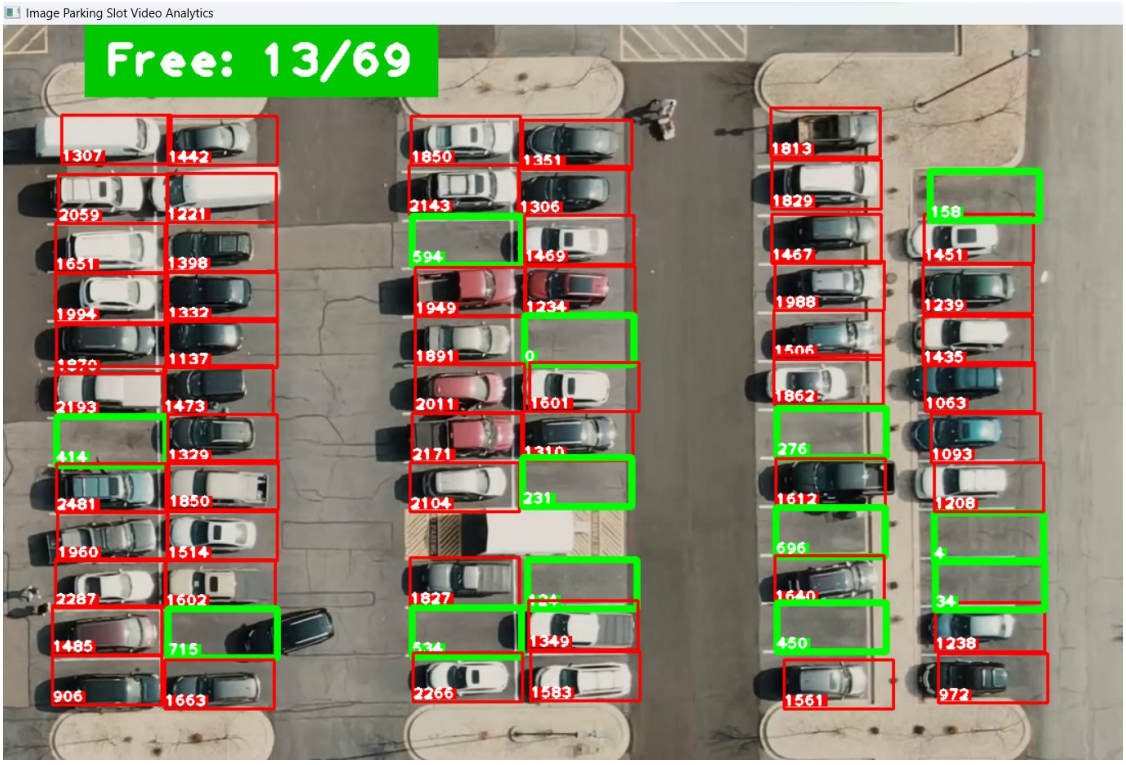
12393

30880

69012

19916

133393




```
import os
import zipfile

local_zip = '/content/dataset_car_or_not.zip'
zip_ref = zipfile.ZipFile(local_zip, 'r')
zip_ref.extractall('/content')
zip_ref.close()

base_dir = '/content/dataset_car_or_not'
train_dir = os.path.join(base_dir, 'train')
validation_dir = os.path.join(base_dir, 'validation')
train_cars_dir = os.path.join(train_dir, 'busy')
train_not_dir = os.path.join(train_dir, 'free')
validation_cars_dir = os.path.join(validation_dir, 'busy')
validation_not_dir = os.path.join(validation_dir, 'free')

train_car_fnames = os.listdir(train_cars_dir)
print(train_car_fnames[:10])

train_not_fnames = os.listdir(train_not_dir)
train_not_fnames.sort()
print(train_not_fnames[:10])
```

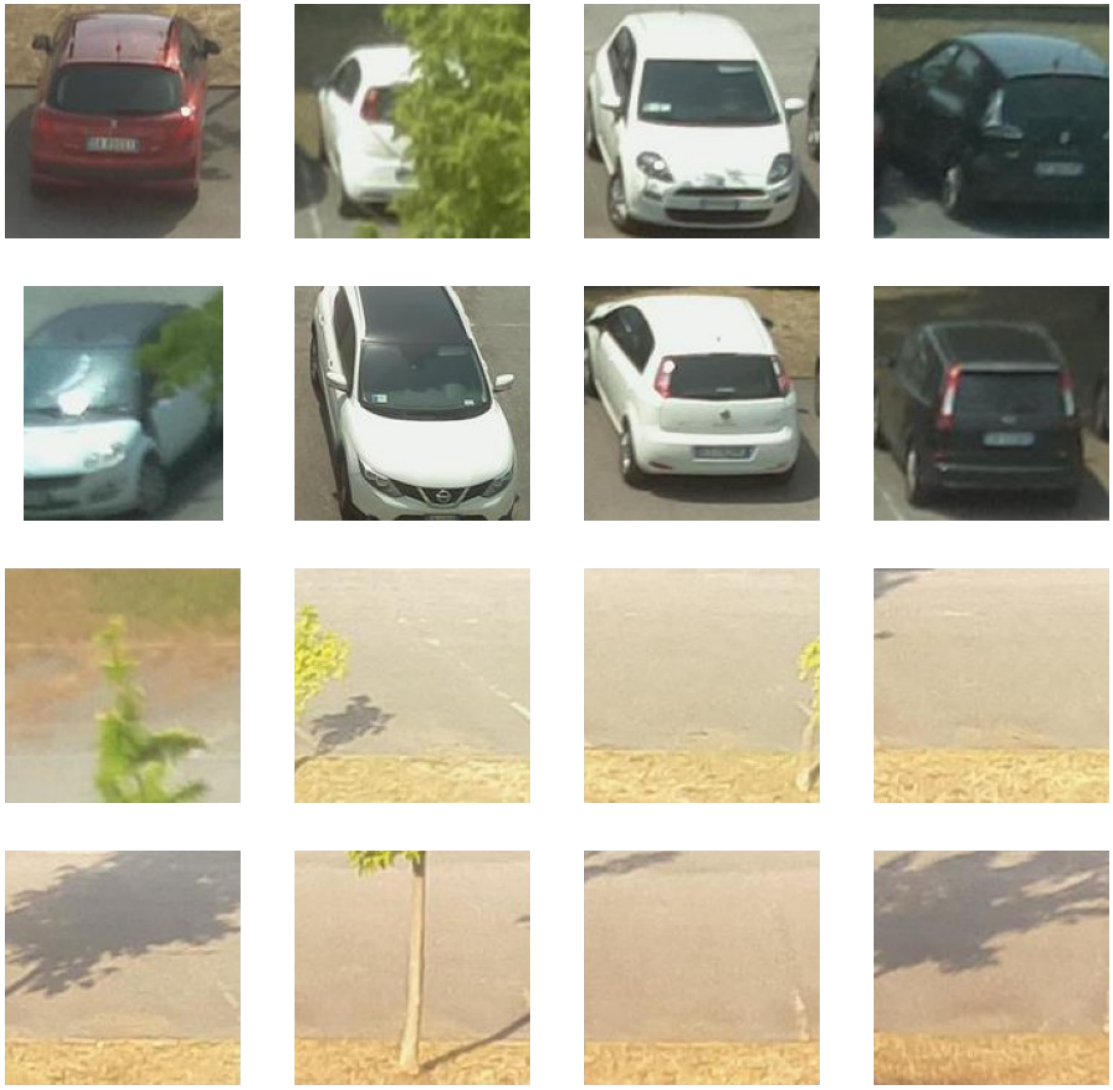
```
['20150703_1155_11.jpg', '20150703_1805_15.jpg',
'20150703_1000_29.jpg', '20150703_1115_6.jpg', '20150703_0925_51.jpg',
'20150703_1235_2.jpg', '20150703_0840_15.jpg', '20150703_1705_3.jpg',
'20150703_1700_38.jpg', '20150703_1055_11.jpg']
['20150703_0805_1.jpg', '20150703_0805_10.jpg',
```

```
'20150703_0805_11.jpg', '20150703_0805_12.jpg',
'20150703_0805_13.jpg', '20150703_0805_16.jpg',
'20150703_0805_18.jpg', '20150703_0805_19.jpg', '20150703_0805_2.jpg',
'20150703_0805_20.jpg']
```

```
print('total training car images:', len(os.listdir(train_cars_dir)))
print('total training not car images:',
len(os.listdir(train_not_dir)))
print('total validation car images:',
len(os.listdir(validation_cars_dir)))
print('total validation not car images:',
len(os.listdir(validation_not_dir)))
```

```
total training car images: 3621
total training not car images: 2550
total validation car images: 4781
total validation not car images: 1632
```

```
%matplotlib inline
import matplotlib.pyplot as plt
import matplotlib.image as mpimg

nrows = 4
ncols = 4

pic_index = 0

# Set up matplotlib fig, and size it to fit 4x4 pics
fig = plt.gcf()
fig.set_size_inches(ncols * 4, nrows * 4)

pic_index += 8
next_car_pix = [os.path.join(train_cars_dir, fname)
                for fname in train_car_fnames[pic_index-8:pic_index]]
next_not_pix = [os.path.join(train_not_dir, fname)
                for fname in train_not_fnames[pic_index-8:pic_index]]

for i, img_path in enumerate(next_car_pix+next_not_pix):
  sp = plt.subplot(nrows, ncols, i + 1)
  sp.axis('Off')

  img = mpimg.imread(img_path)
  plt.imshow(img)

plt.show()
```



```
from tensorflow.keras import layers
from tensorflow.keras import Model
```

We build a model with augmentation and without dropout:

```
train_datagen = ImageDataGenerator(
    rescale=1./255,
    rotation_range=40,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,)

val_datagen = ImageDataGenerator(rescale=1./255)

train_generator = train_datagen.flow_from_directory(
```

```
        train_dir,
        target_size=(150, 150),
        batch_size=20,
        class_mode='binary')

validation_generator = val_datagen.flow_from_directory(
        validation_dir,
        target_size=(150, 150),
        batch_size=20,
        class_mode='binary')
```

```
Found 6171 images belonging to 2 classes.
Found 6413 images belonging to 2 classes.
```

```
from tensorflow import keras
img_input = layers.Input(shape=(150, 150, 3))

model_2 = keras.Sequential(
    [
        layers.Input(shape=(150, 150, 3)),
        layers.Conv2D(16, 3, activation='relu'),
        layers.MaxPooling2D(2),
        layers.Conv2D(32, 3, activation='relu'),
        layers.MaxPooling2D(2),
        layers.Conv2D(64, 3, activation='relu'),
        layers.MaxPooling2D(2),
        layers.Flatten(),
        layers.Dense(512, activation='relu'),
        layers.Dense(1, activation='sigmoid'),
    ]
)

model_2.summary()
```

```
WARNING:tensorflow:Please add `keras.layers.InputLayer` instead of
`keras.Input` to Sequential model. `keras.Input` is intended to be
used by Functional model.
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_3 (Conv2D)            (None, 148, 148, 16)      448
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 74, 74, 16)        0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 72, 72, 32)        4640
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 36, 36, 32)        0
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 34, 34, 64)        18496
```

```
_________________________________________________________________
max_pooling2d_5 (MaxPooling2 (None, 17, 17, 64)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 18496)             0
_________________________________________________________________
dense_2 (Dense)              (None, 512)               9470464
_________________________________________________________________
dense_3 (Dense)              (None, 1)                 513
=================================================================
Total params: 9,494,561
Trainable params: 9,494,561
Non-trainable params: 0
_________________________________________________________________
```

```
from tensorflow.keras.optimizers import RMSprop

model_2.compile(loss='binary_crossentropy',
              optimizer=RMSprop(lr=0.001),
              metrics=['acc'])
```

```
/usr/local/lib/python3.7/dist-packages/tensorflow/python/keras/
optimizer_v2/optimizer_v2.py:375: UserWarning: The `lr` argument is
deprecated, use `learning_rate` instead.
  "The `lr` argument is deprecated, use `learning_rate` instead.")
```

```
history_2 = model_2.fit_generator(
      train_generator,
      steps_per_epoch=100,
      epochs=15,
      validation_data=validation_generator,
      validation_steps=50,
      verbose=2)
```

```
/usr/local/lib/python3.7/dist-packages/tensorflow/python/keras/
engine/training.py:1940: UserWarning: `Model.fit_generator` is
deprecated and will be removed in a future version. Please use
`Model.fit`, which supports generators.
  warnings.warn('`Model.fit_generator` is deprecated and '
```

```
Epoch 1/15
100/100 - 11s - loss: 0.5547 - acc: 0.7565 - val_loss: 0.4453 -
val_acc: 0.8300
Epoch 2/15
100/100 - 11s - loss: 0.2706 - acc: 0.8980 - val_loss: 0.4499 -
val_acc: 0.7690
Epoch 3/15
100/100 - 11s - loss: 0.1704 - acc: 0.9613 - val_loss: 0.4463 -
val_acc: 0.8150
Epoch 4/15
100/100 - 10s - loss: 0.1743 - acc: 0.9417 - val_loss: 0.4852 -
val_acc: 0.8290
```

```
Epoch 5/15
100/100 - 11s - loss: 0.1414 - acc: 0.9550 - val_loss: 0.4944 -
val_acc: 0.8370
Epoch 6/15
100/100 - 11s - loss: 0.1037 - acc: 0.9689 - val_loss: 0.4828 -
val_acc: 0.8810
Epoch 7/15
100/100 - 11s - loss: 0.1035 - acc: 0.9633 - val_loss: 0.4324 -
val_acc: 0.8630
Epoch 8/15
100/100 - 11s - loss: 0.0975 - acc: 0.9709 - val_loss: 0.5988 -
val_acc: 0.8830
Epoch 9/15
100/100 - 11s - loss: 0.1023 - acc: 0.9710 - val_loss: 0.6951 -
val_acc: 0.8700
Epoch 10/15
100/100 - 11s - loss: 0.0953 - acc: 0.9690 - val_loss: 0.6546 -
val_acc: 0.8640
Epoch 11/15
100/100 - 11s - loss: 0.0713 - acc: 0.9755 - val_loss: 0.5905 -
val_acc: 0.8690
Epoch 12/15
100/100 - 11s - loss: 0.0908 - acc: 0.9660 - val_loss: 0.6466 -
val_acc: 0.8440
Epoch 13/15
100/100 - 11s - loss: 0.0669 - acc: 0.9789 - val_loss: 0.5285 -
val_acc: 0.8780
Epoch 14/15
100/100 - 10s - loss: 0.0571 - acc: 0.9825 - val_loss: 0.8034 -
val_acc: 0.8720
Epoch 15/15
100/100 - 11s - loss: 0.0628 - acc: 0.9775 - val_loss: 0.5078 -
val_acc: 0.8620
```

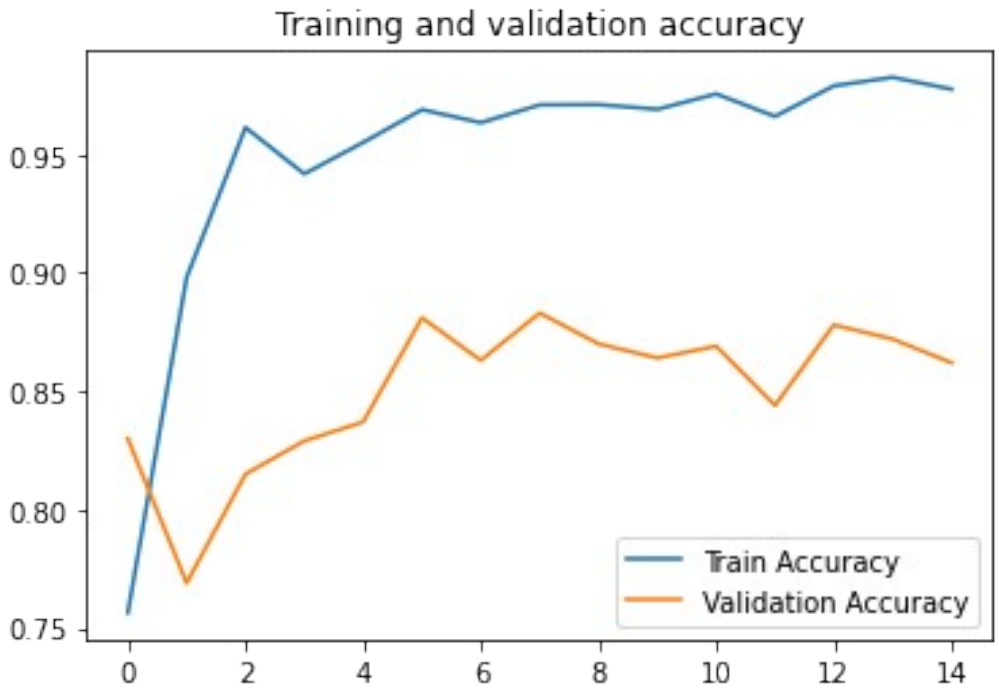
```
score_2 = model_2.evaluate(validation_generator, verbose=0)
print("Test loss:", score_2[0])
print("Test accuracy:", score_2[1])
```

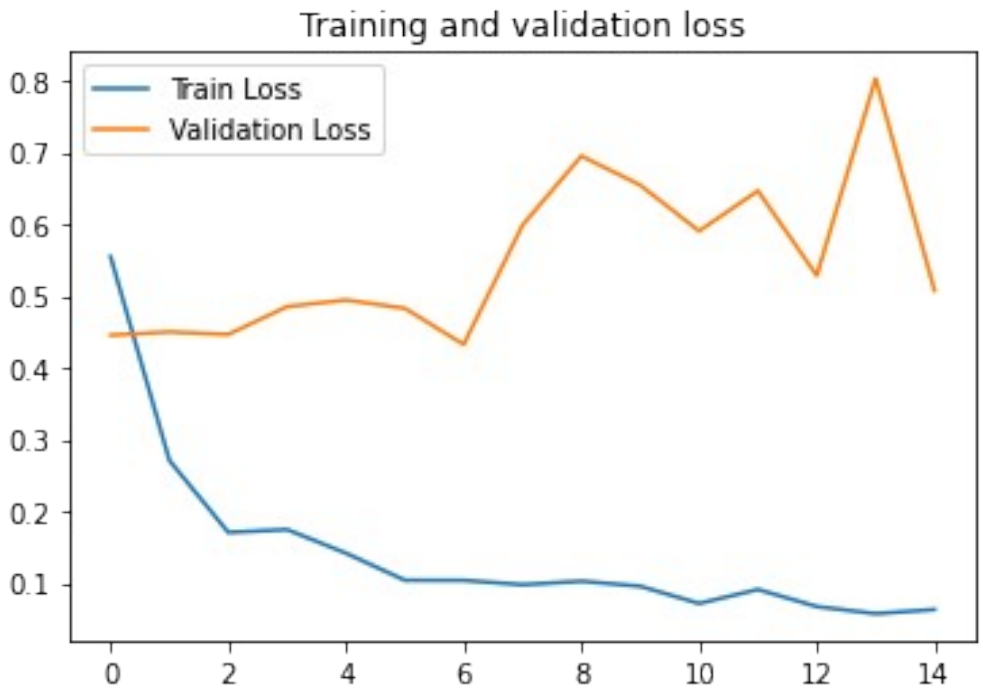
```
Test loss: 0.5515168309211731
Test accuracy: 0.8566973209381104
```

```
acc = history_2.history['acc']
val_acc = history_2.history['val_acc']

loss = history_2.history['loss']
val_loss = history_2.history['val_loss']

epochs = range(len(acc))
```

```
plt.plot(epochs, acc, label="Train Accuracy")
plt.plot(epochs, val_acc, label="Validation Accuracy")
plt.title('Training and validation accuracy')

plt.legend()
plt.figure()

plt.plot(epochs, loss, label="Train Loss")
plt.plot(epochs, val_loss, label="Validation Loss")
plt.title('Training and validation loss')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7f06f6113b50>
```





We build a model with both dropout and augmentation:

```
train_datagen = ImageDataGenerator(
    rescale=1./255,
    rotation_range=40,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,)

val_datagen = ImageDataGenerator(rescale=1./255)

train_generator = train_datagen.flow_from_directory(
        train_dir,
        target_size=(150, 150),
        batch_size=20,
        class_mode='binary')

validation_generator = val_datagen.flow_from_directory(
        validation_dir,
        target_size=(150, 150),
        batch_size=20,
        class_mode='binary')
```

```
Found 6171 images belonging to 2 classes.
Found 6413 images belonging to 2 classes.
```

```
from tensorflow.keras import layers
from tensorflow.keras import Model
from tensorflow.keras.optimizers import RMSprop

from tensorflow import keras

model_4 = keras.Sequential(
    [
        layers.Input(shape=(150, 150, 3)),
        layers.Conv2D(16, 3, activation='relu'),
        layers.MaxPooling2D(2),
        layers.Conv2D(32, 3, activation='relu'),
        layers.MaxPooling2D(2),
        layers.Conv2D(64, 3, activation='relu'),
        layers.MaxPooling2D(2),
        layers.Flatten(),
        layers.Dropout(0.5),
        layers.Dense(512, activation='relu'),
        layers.Dense(1, activation='sigmoid'),
    ]
)
model_4.summary()
```

```
WARNING:tensorflow:Please add `keras.layers.InputLayer` instead of
`keras.Input` to Sequential model. `keras.Input` is intended to be
used by Functional model.
Model: "sequential_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_9 (Conv2D)            (None, 148, 148, 16)      448
_________________________________________________________________
max_pooling2d_9 (MaxPooling2 (None, 74, 74, 16)        0
_________________________________________________________________
conv2d_10 (Conv2D)           (None, 72, 72, 32)        4640
_________________________________________________________________
max_pooling2d_10 (MaxPooling (None, 36, 36, 32)        0
_________________________________________________________________
conv2d_11 (Conv2D)           (None, 34, 34, 64)        18496
_________________________________________________________________
max_pooling2d_11 (MaxPooling (None, 17, 17, 64)        0
_________________________________________________________________
flatten_3 (Flatten)          (None, 18496)             0
_________________________________________________________________
dropout_1 (Dropout)          (None, 18496)             0
_________________________________________________________________
dense_6 (Dense)              (None, 512)               9470464
_________________________________________________________________
dense_7 (Dense)              (None, 1)                 513
=================================================================
```

```
Total params: 9,494,561
Trainable params: 9,494,561
Non-trainable params: 0
_________________________________________________________________
```

```
from tensorflow.keras.optimizers import RMSprop

model_4.compile(loss='binary_crossentropy',
              optimizer=RMSprop(lr=0.001),
              metrics=['acc'])
```

```
/usr/local/lib/python3.7/dist-packages/tensorflow/python/keras/
optimizer_v2/optimizer_v2.py:375: UserWarning: The `lr` argument is
deprecated, use `learning_rate` instead.
  "The `lr` argument is deprecated, use `learning_rate` instead.")
```

```
history_4 = model_4.fit_generator(
      train_generator,
      steps_per_epoch=100,
      epochs=15,
      validation_data=validation_generator,
      validation_steps=50,
      verbose=2)
```

```
/usr/local/lib/python3.7/dist-packages/tensorflow/python/keras/
engine/training.py:1940: UserWarning: `Model.fit_generator` is
deprecated and will be removed in a future version. Please use
`Model.fit`, which supports generators.
  warnings.warn('`Model.fit_generator` is deprecated and '
```

```
Epoch 1/15
100/100 - 12s - loss: 0.6214 - acc: 0.7945 - val_loss: 0.5966 -
val_acc: 0.6850
Epoch 2/15
100/100 - 11s - loss: 0.2279 - acc: 0.9145 - val_loss: 0.5055 -
val_acc: 0.8140
Epoch 3/15
100/100 - 11s - loss: 0.2002 - acc: 0.9410 - val_loss: 0.5401 -
val_acc: 0.8070
Epoch 4/15
100/100 - 10s - loss: 0.1261 - acc: 0.9585 - val_loss: 0.7044 -
val_acc: 0.7700
Epoch 5/15
100/100 - 11s - loss: 0.1111 - acc: 0.9704 - val_loss: 0.5885 -
val_acc: 0.8650
Epoch 6/15
100/100 - 11s - loss: 0.1366 - acc: 0.9635 - val_loss: 0.8468 -
val_acc: 0.8150
Epoch 7/15
100/100 - 11s - loss: 0.1156 - acc: 0.9665 - val_loss: 0.7946 -
val_acc: 0.8750
```

```
Epoch 8/15
100/100 - 11s - loss: 0.1575 - acc: 0.9760 - val_loss: 0.4872 -
val_acc: 0.8360
Epoch 9/15
100/100 - 10s - loss: 0.1067 - acc: 0.9685 - val_loss: 0.5445 -
val_acc: 0.8800
Epoch 10/15
100/100 - 10s - loss: 0.0636 - acc: 0.9760 - val_loss: 0.7443 -
val_acc: 0.7750
Epoch 11/15
100/100 - 10s - loss: 0.1178 - acc: 0.9730 - val_loss: 0.4620 -
val_acc: 0.8920
Epoch 12/15
100/100 - 10s - loss: 0.0670 - acc: 0.9775 - val_loss: 0.6090 -
val_acc: 0.8550
Epoch 13/15
100/100 - 10s - loss: 0.0754 - acc: 0.9735 - val_loss: 0.5425 -
val_acc: 0.8660
Epoch 14/15
100/100 - 10s - loss: 0.0727 - acc: 0.9725 - val_loss: 1.0996 -
val_acc: 0.7750
Epoch 15/15
100/100 - 10s - loss: 0.0656 - acc: 0.9779 - val_loss: 1.2640 -
val_acc: 0.8580
```

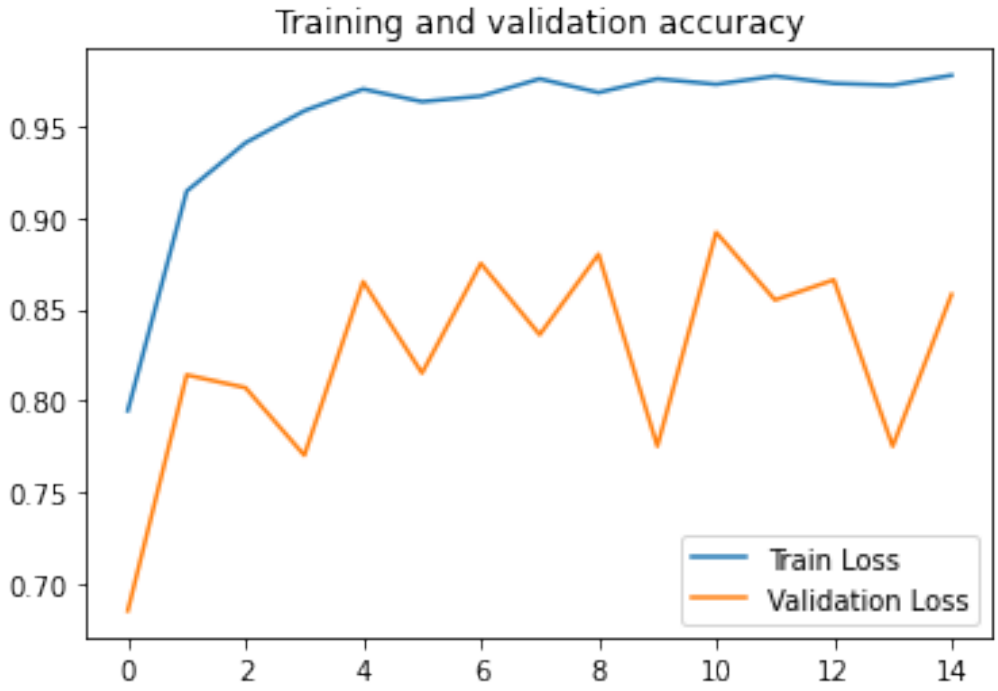
```
score_4 = model_4.evaluate(validation_generator, verbose=0)
print("Test loss:", score_4[0])
print("Test accuracy:", score_4[1])
```

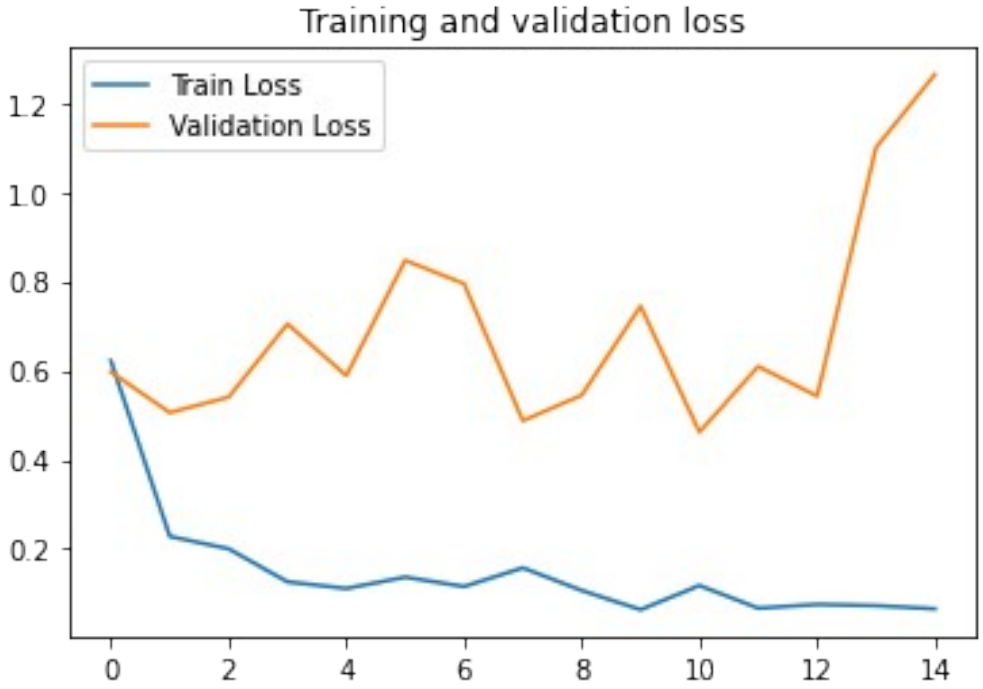
```
Test loss: 1.2329983711242676
Test accuracy: 0.8607515692710876
```

```
acc = history_4.history['acc']
val_acc = history_4.history['val_acc']

loss = history_4.history['loss']
val_loss = history_4.history['val_loss']

epochs = range(len(acc))

plt.plot(epochs, acc, label="Train Loss")
plt.plot(epochs, val_acc, label="Validation Loss")
plt.title('Training and validation accuracy')

plt.legend()
plt.figure()

plt.plot(epochs, loss, label="Train Loss")
plt.plot(epochs, val_loss, label="Validation Loss")
```

```
plt.title('Training and validation loss')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7f06d2487cd0>
```






```
import keras,os
from keras.models import Sequential
```

```
from keras.layers import Dense, Conv2D, MaxPool2D , Flatten
from keras.preprocessing.image import ImageDataGenerator
import numpy as np

trdata = ImageDataGenerator()
traindata =
trdata.flow_from_directory(directory="dataset_car_or_not/train",target
_size=(224,224))
tsdata = ImageDataGenerator()
testdata =
tsdata.flow_from_directory(directory="dataset_car_or_not/validation",
target_size=(224,224))
```

```
Found 6171 images belonging to 2 classes.
Found 6413 images belonging to 2 classes.
```

```
model = Sequential()
model.add(Conv2D(input_shape=(224,224,3),filters=64,kernel_size=(3,3),
padding="same", activation="relu"))
model.add(Conv2D(filters=64,kernel_size=(3,3),padding="same",
activation="relu"))
model.add(MaxPool2D(pool_size=(2,2),strides=(2,2)))
model.add(Conv2D(filters=128, kernel_size=(3,3), padding="same",
activation="relu"))
model.add(Conv2D(filters=128, kernel_size=(3,3), padding="same",
activation="relu"))
model.add(MaxPool2D(pool_size=(2,2),strides=(2,2)))
model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same",
activation="relu"))
model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same",
activation="relu"))
model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same",
activation="relu"))
model.add(MaxPool2D(pool_size=(2,2),strides=(2,2)))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same",
activation="relu"))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same",
activation="relu"))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same",
activation="relu"))
model.add(MaxPool2D(pool_size=(2,2),strides=(2,2)))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same",
activation="relu"))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same",
activation="relu"))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same",
activation="relu"))
model.add(MaxPool2D(pool_size=(2,2),strides=(2,2)))

model.summary()
```

```
Model: "sequential_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_39 (Conv2D)           (None, 224, 224, 64)      1792
_________________________________________________________________
conv2d_40 (Conv2D)           (None, 224, 224, 64)      36928
_________________________________________________________________
max_pooling2d_15 (MaxPooling (None, 112, 112, 64)      0
_________________________________________________________________
conv2d_41 (Conv2D)           (None, 112, 112, 128)     73856
_________________________________________________________________
conv2d_42 (Conv2D)           (None, 112, 112, 128)     147584
_________________________________________________________________
max_pooling2d_16 (MaxPooling (None, 56, 56, 128)       0
_________________________________________________________________
conv2d_43 (Conv2D)           (None, 56, 56, 256)       295168
_________________________________________________________________
conv2d_44 (Conv2D)           (None, 56, 56, 256)       590080
_________________________________________________________________
conv2d_45 (Conv2D)           (None, 56, 56, 256)       590080
_________________________________________________________________
max_pooling2d_17 (MaxPooling (None, 28, 28, 256)       0
_________________________________________________________________
conv2d_46 (Conv2D)           (None, 28, 28, 512)       1180160
_________________________________________________________________
conv2d_47 (Conv2D)           (None, 28, 28, 512)       2359808
_________________________________________________________________
conv2d_48 (Conv2D)           (None, 28, 28, 512)       2359808
_________________________________________________________________
max_pooling2d_18 (MaxPooling (None, 14, 14, 512)       0
_________________________________________________________________
conv2d_49 (Conv2D)           (None, 14, 14, 512)       2359808
_________________________________________________________________
conv2d_50 (Conv2D)           (None, 14, 14, 512)       2359808
_________________________________________________________________
conv2d_51 (Conv2D)           (None, 14, 14, 512)       2359808
_________________________________________________________________
max_pooling2d_19 (MaxPooling (None, 7, 7, 512)         0
=================================================================
Total params: 14,714,688
Trainable params: 14,714,688
Non-trainable params: 0
_________________________________________________________________
```

```
model.add(Flatten())
model.add(Dense(units=4096,activation="relu"))
model.add(Dense(units=4096,activation="relu"))
model.add(Dense(units=2, activation="softmax"))
```

```
from keras.optimizers import Adam
opt = Adam(lr=0.001)
model.compile(optimizer=opt,
loss=keras.losses.categorical_crossentropy, metrics=['accuracy'])
```

```
/usr/local/lib/python3.7/dist-packages/tensorflow/python/keras/
optimizer_v2/optimizer_v2.py:375: UserWarning: The `lr` argument is
deprecated, use `learning_rate` instead.
  "The `lr` argument is deprecated, use `learning_rate` instead.")
```

```
model.summary()
```

```
Model: "sequential_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_39 (Conv2D)           (None, 224, 224, 64)      1792
_________________________________________________________________
conv2d_40 (Conv2D)           (None, 224, 224, 64)      36928
_________________________________________________________________
max_pooling2d_15 (MaxPooling (None, 112, 112, 64)      0
_________________________________________________________________
conv2d_41 (Conv2D)           (None, 112, 112, 128)     73856
_________________________________________________________________
conv2d_42 (Conv2D)           (None, 112, 112, 128)     147584
_________________________________________________________________
max_pooling2d_16 (MaxPooling (None, 56, 56, 128)       0
_________________________________________________________________
conv2d_43 (Conv2D)           (None, 56, 56, 256)       295168
_________________________________________________________________
conv2d_44 (Conv2D)           (None, 56, 56, 256)       590080
_________________________________________________________________
conv2d_45 (Conv2D)           (None, 56, 56, 256)       590080
_________________________________________________________________
max_pooling2d_17 (MaxPooling (None, 28, 28, 256)       0
_________________________________________________________________
conv2d_46 (Conv2D)           (None, 28, 28, 512)       1180160
_________________________________________________________________
conv2d_47 (Conv2D)           (None, 28, 28, 512)       2359808
_________________________________________________________________
conv2d_48 (Conv2D)           (None, 28, 28, 512)       2359808
_________________________________________________________________
max_pooling2d_18 (MaxPooling (None, 14, 14, 512)       0
_________________________________________________________________
conv2d_49 (Conv2D)           (None, 14, 14, 512)       2359808
_________________________________________________________________
conv2d_50 (Conv2D)           (None, 14, 14, 512)       2359808
_________________________________________________________________
conv2d_51 (Conv2D)           (None, 14, 14, 512)       2359808
_________________________________________________________________
max_pooling2d_19 (MaxPooling (None, 7, 7, 512)         0
```

```
_________________________________________________________________
flatten_2 (Flatten)          (None, 25088)             0
_________________________________________________________________
dense_6 (Dense)              (None, 4096)              102764544
_________________________________________________________________
dense_7 (Dense)              (None, 4096)              16781312
_________________________________________________________________
dense_8 (Dense)              (None, 2)                 8194
=================================================================
Total params: 134,268,738
Trainable params: 134,268,738
Non-trainable params: 0
_________________________________________________________________
```

```
from keras.callbacks import ModelCheckpoint, EarlyStopping
checkpoint = ModelCheckpoint("vgg16_1.h5",
                             monitor='val_acc',
                             verbose=1,
                             save_best_only=True,
                             save_weights_only=False,
                             mode='auto',
                             period=1)
early = EarlyStopping(monitor='val_acc',
                      min_delta=0,
                      patience=20,
                      verbose=1,
                      mode='auto')
hist = model.fit_generator(steps_per_epoch=100,
                           generator=traindata,
                           validation_data= testdata,
                           validation_steps=10,
                           epochs=100,
                           callbacks=[checkpoint,early])
```

```
WARNING:tensorflow:`period` argument is deprecated. Please use
`save_freq` to specify the frequency in number of batches seen.
Epoch 1/100

/usr/local/lib/python3.7/dist-packages/keras/engine/training.py:1915:
UserWarning: `Model.fit_generator` is deprecated and will be removed
in a future version. Please use `Model.fit`, which supports
generators.
  warnings.warn('`Model.fit_generator` is deprecated and '

100/100 [==============================] - 62s 398ms/step - loss:
201.6031 - accuracy: 0.5603 - val_loss: 0.6354 - val_accuracy: 0.7406
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
```

```
Epoch 2/100
100/100 [==============================] - 47s 473ms/step - loss:
0.6662 - accuracy: 0.6529 - val_loss: 0.6167 - val_accuracy: 0.7344
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 3/100
100/100 [==============================] - 40s 394ms/step - loss:
0.7544 - accuracy: 0.5868 - val_loss: 0.6859 - val_accuracy: 0.5375
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 4/100
100/100 [==============================] - 40s 398ms/step - loss:
0.6776 - accuracy: 0.5961 - val_loss: 0.6734 - val_accuracy: 0.7219
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 5/100
100/100 [==============================] - 40s 402ms/step - loss:
0.5592 - accuracy: 0.6976 - val_loss: 0.5786 - val_accuracy: 0.7906
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 6/100
100/100 [==============================] - 40s 404ms/step - loss:
0.1109 - accuracy: 0.9645 - val_loss: 0.6414 - val_accuracy: 0.8594
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 7/100
100/100 [==============================] - 40s 405ms/step - loss:
0.0343 - accuracy: 0.9917 - val_loss: 0.5906 - val_accuracy: 0.8313
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 8/100
100/100 [==============================] - 41s 406ms/step - loss:
```

```
0.0078 - accuracy: 0.9978 - val_loss: 1.4915 - val_accuracy: 0.8375
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 9/100
100/100 [==============================] - 41s 408ms/step - loss:
0.0284 - accuracy: 0.9948 - val_loss: 2.4136 - val_accuracy: 0.8500
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 10/100
100/100 [==============================] - 41s 409ms/step - loss:
0.0427 - accuracy: 0.9885 - val_loss: 1.3017 - val_accuracy: 0.8469
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 11/100
100/100 [==============================] - 41s 408ms/step - loss:
0.0172 - accuracy: 0.9959 - val_loss: 1.2702 - val_accuracy: 0.8469
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 12/100
100/100 [==============================] - 41s 409ms/step - loss:
0.0186 - accuracy: 0.9950 - val_loss: 1.0134 - val_accuracy: 0.8375
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 13/100
100/100 [==============================] - 41s 407ms/step - loss:
4.2568 - accuracy: 0.8787 - val_loss: 0.6165 - val_accuracy: 0.7219
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 14/100
100/100 [==============================] - 40s 404ms/step - loss:
0.6812 - accuracy: 0.5856 - val_loss: 0.6353 - val_accuracy: 0.7594
WARNING:tensorflow:Can save best model only with val_acc available,
```

```
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 15/100
100/100 [==============================] - 40s 403ms/step - loss:
0.6813 - accuracy: 0.5850 - val_loss: 0.6112 - val_accuracy: 0.7594
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 16/100
100/100 [==============================] - 40s 401ms/step - loss:
0.6859 - accuracy: 0.5683 - val_loss: 0.6464 - val_accuracy: 0.6750
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 17/100
100/100 [==============================] - 40s 401ms/step - loss:
0.6764 - accuracy: 0.5932 - val_loss: 0.6406 - val_accuracy: 0.6875
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 18/100
100/100 [==============================] - 40s 403ms/step - loss:
0.6990 - accuracy: 0.5956 - val_loss: 0.6333 - val_accuracy: 0.7375
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 19/100
100/100 [==============================] - 40s 401ms/step - loss:
0.7261 - accuracy: 0.5782 - val_loss: 0.6587 - val_accuracy: 0.7281
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 20/100
100/100 [==============================] - 40s 401ms/step - loss:
0.6745 - accuracy: 0.6042 - val_loss: 0.6336 - val_accuracy: 0.7250
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
```

```
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 21/100
100/100 [==============================] - 40s 400ms/step - loss:
0.6784 - accuracy: 0.5887 - val_loss: 0.6275 - val_accuracy: 0.7531
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 22/100
100/100 [==============================] - 40s 400ms/step - loss:
0.6822 - accuracy: 0.5738 - val_loss: 0.6276 - val_accuracy: 0.7625
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 23/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6695 - accuracy: 0.6121 - val_loss: 0.6423 - val_accuracy: 0.7250
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 24/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6785 - accuracy: 0.5874 - val_loss: 0.6098 - val_accuracy: 0.7437
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 25/100
100/100 [==============================] - 40s 400ms/step - loss:
0.6822 - accuracy: 0.5783 - val_loss: 0.6096 - val_accuracy: 0.7531
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 26/100
100/100 [==============================] - 40s 400ms/step - loss:
0.6772 - accuracy: 0.5904 - val_loss: 0.6386 - val_accuracy: 0.7250
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
```

```
Epoch 27/100
100/100 [==============================] - 40s 401ms/step - loss:
0.6774 - accuracy: 0.5910 - val_loss: 0.6197 - val_accuracy: 0.7500
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 28/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6772 - accuracy: 0.5917 - val_loss: 0.6287 - val_accuracy: 0.7531
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 29/100
100/100 [==============================] - 40s 400ms/step - loss:
0.6787 - accuracy: 0.5858 - val_loss: 0.6081 - val_accuracy: 0.7406
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 30/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6804 - accuracy: 0.5841 - val_loss: 0.6388 - val_accuracy: 0.7469
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 31/100
100/100 [==============================] - 40s 401ms/step - loss:
0.6793 - accuracy: 0.5866 - val_loss: 0.6228 - val_accuracy: 0.7625
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 32/100
100/100 [==============================] - 40s 401ms/step - loss:
0.6730 - accuracy: 0.6021 - val_loss: 0.6294 - val_accuracy: 0.7469
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 33/100
100/100 [==============================] - 40s 401ms/step - loss:
```

```
0.6725 - accuracy: 0.6043 - val_loss: 0.6135 - val_accuracy: 0.7312
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 34/100
100/100 [==============================] - 40s 401ms/step - loss:
0.6813 - accuracy: 0.5809 - val_loss: 0.6209 - val_accuracy: 0.7594
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 35/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6772 - accuracy: 0.5914 - val_loss: 0.6150 - val_accuracy: 0.7625
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 36/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6846 - accuracy: 0.5684 - val_loss: 0.6325 - val_accuracy: 0.7250
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 37/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6799 - accuracy: 0.5821 - val_loss: 0.6070 - val_accuracy: 0.7812
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 38/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6815 - accuracy: 0.5778 - val_loss: 0.6262 - val_accuracy: 0.7281
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 39/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6802 - accuracy: 0.5815 - val_loss: 0.6263 - val_accuracy: 0.7219
WARNING:tensorflow:Can save best model only with val_acc available,
```

```
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 40/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6802 - accuracy: 0.5779 - val_loss: 0.6280 - val_accuracy: 0.7188
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 41/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6742 - accuracy: 0.5976 - val_loss: 0.6187 - val_accuracy: 0.7688
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 42/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6795 - accuracy: 0.5828 - val_loss: 0.5886 - val_accuracy: 0.7906
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 43/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6719 - accuracy: 0.6028 - val_loss: 0.6235 - val_accuracy: 0.7344
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 44/100
100/100 [==============================] - 40s 401ms/step - loss:
0.6747 - accuracy: 0.5960 - val_loss: 0.6169 - val_accuracy: 0.7875
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 45/100
100/100 [==============================] - 40s 401ms/step - loss:
0.6753 - accuracy: 0.5958 - val_loss: 0.6150 - val_accuracy: 0.7594
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
```

```
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 46/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6785 - accuracy: 0.5863 - val_loss: 0.6302 - val_accuracy: 0.7469
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 47/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6775 - accuracy: 0.5893 - val_loss: 0.6391 - val_accuracy: 0.6906
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 48/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6768 - accuracy: 0.5905 - val_loss: 0.6238 - val_accuracy: 0.7656
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 49/100
100/100 [==============================] - 40s 403ms/step - loss:
0.6799 - accuracy: 0.5814 - val_loss: 0.6449 - val_accuracy: 0.6844
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 50/100
100/100 [==============================] - 40s 401ms/step - loss:
0.6786 - accuracy: 0.5856 - val_loss: 0.6331 - val_accuracy: 0.7188
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 51/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6804 - accuracy: 0.5808 - val_loss: 0.6239 - val_accuracy: 0.7281
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
```

```
Epoch 52/100
100/100 [==============================] - 40s 402ms/step - loss:
0.6764 - accuracy: 0.5921 - val_loss: 0.6199 - val_accuracy: 0.7437
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 53/100
100/100 [==============================] - 40s 401ms/step - loss:
0.6792 - accuracy: 0.5838 - val_loss: 0.6241 - val_accuracy: 0.7406
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 54/100
100/100 [==============================] - 40s 400ms/step - loss:
0.6745 - accuracy: 0.5970 - val_loss: 0.6187 - val_accuracy: 0.7656
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 55/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6746 - accuracy: 0.5978 - val_loss: 0.6222 - val_accuracy: 0.7531
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 56/100
100/100 [==============================] - 40s 401ms/step - loss:
0.6723 - accuracy: 0.6042 - val_loss: 0.6276 - val_accuracy: 0.7250
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 57/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6823 - accuracy: 0.5753 - val_loss: 0.6341 - val_accuracy: 0.7531
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 58/100
100/100 [==============================] - 40s 399ms/step - loss:
```

```
0.6792 - accuracy: 0.5844 - val_loss: 0.6506 - val_accuracy: 0.6625
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 59/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6855 - accuracy: 0.5663 - val_loss: 0.6183 - val_accuracy: 0.7594
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 60/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6768 - accuracy: 0.5916 - val_loss: 0.6305 - val_accuracy: 0.7250
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 61/100
100/100 [==============================] - 40s 400ms/step - loss:
0.6715 - accuracy: 0.6059 - val_loss: 0.6326 - val_accuracy: 0.7250
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 62/100
100/100 [==============================] - 40s 400ms/step - loss:
0.6800 - accuracy: 0.5813 - val_loss: 0.6185 - val_accuracy: 0.7688
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 63/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6767 - accuracy: 0.5909 - val_loss: 0.6224 - val_accuracy: 0.7500
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 64/100
100/100 [==============================] - 40s 398ms/step - loss:
0.6734 - accuracy: 0.6010 - val_loss: 0.6292 - val_accuracy: 0.7219
WARNING:tensorflow:Can save best model only with val_acc available,
```

```
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 65/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6744 - accuracy: 0.5977 - val_loss: 0.6118 - val_accuracy: 0.7563
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 66/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6794 - accuracy: 0.5848 - val_loss: 0.6262 - val_accuracy: 0.7500
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 67/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6820 - accuracy: 0.5752 - val_loss: 0.6391 - val_accuracy: 0.7000
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 68/100
100/100 [==============================] - 40s 400ms/step - loss:
0.6786 - accuracy: 0.5868 - val_loss: 0.6389 - val_accuracy: 0.7031
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 69/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6757 - accuracy: 0.5940 - val_loss: 0.6028 - val_accuracy: 0.8125
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 70/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6791 - accuracy: 0.5835 - val_loss: 0.6222 - val_accuracy: 0.7344
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
```

```
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 71/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6794 - accuracy: 0.5843 - val_loss: 0.6227 - val_accuracy: 0.7437
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 72/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6812 - accuracy: 0.5776 - val_loss: 0.6304 - val_accuracy: 0.7469
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 73/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6814 - accuracy: 0.5761 - val_loss: 0.6250 - val_accuracy: 0.7344
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 74/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6760 - accuracy: 0.5929 - val_loss: 0.6229 - val_accuracy: 0.7500
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 75/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6768 - accuracy: 0.5910 - val_loss: 0.6272 - val_accuracy: 0.7219
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 76/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6741 - accuracy: 0.5978 - val_loss: 0.6157 - val_accuracy: 0.7594
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
```

```
Epoch 77/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6828 - accuracy: 0.5732 - val_loss: 0.6258 - val_accuracy: 0.7437
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 78/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6737 - accuracy: 0.5990 - val_loss: 0.6244 - val_accuracy: 0.7063
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 79/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6770 - accuracy: 0.5904 - val_loss: 0.6142 - val_accuracy: 0.7563
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 80/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6846 - accuracy: 0.5703 - val_loss: 0.6113 - val_accuracy: 0.7656
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 81/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6736 - accuracy: 0.5990 - val_loss: 0.6267 - val_accuracy: 0.7500
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 82/100
100/100 [==============================] - 40s 398ms/step - loss:
0.6739 - accuracy: 0.6001 - val_loss: 0.6334 - val_accuracy: 0.7094
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 83/100
100/100 [==============================] - 40s 399ms/step - loss:
```

```
0.6785 - accuracy: 0.5853 - val_loss: 0.6411 - val_accuracy: 0.7156
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 84/100
100/100 [==============================] - 40s 400ms/step - loss:
0.6744 - accuracy: 0.5992 - val_loss: 0.6070 - val_accuracy: 0.7688
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 85/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6786 - accuracy: 0.5860 - val_loss: 0.5991 - val_accuracy: 0.8031
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 86/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6790 - accuracy: 0.5844 - val_loss: 0.6071 - val_accuracy: 0.7750
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 87/100
100/100 [==============================] - 40s 398ms/step - loss:
0.6758 - accuracy: 0.5935 - val_loss: 0.6231 - val_accuracy: 0.7500
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 88/100
100/100 [==============================] - 40s 398ms/step - loss:
0.6781 - accuracy: 0.5869 - val_loss: 0.6276 - val_accuracy: 0.7375
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 89/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6789 - accuracy: 0.5845 - val_loss: 0.6415 - val_accuracy: 0.7156
WARNING:tensorflow:Can save best model only with val_acc available,
```

```
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 90/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6789 - accuracy: 0.5859 - val_loss: 0.6290 - val_accuracy: 0.7688
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 91/100
100/100 [==============================] - 40s 398ms/step - loss:
0.6768 - accuracy: 0.5920 - val_loss: 0.6135 - val_accuracy: 0.7844
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 92/100
100/100 [==============================] - 40s 398ms/step - loss:
0.6798 - accuracy: 0.5822 - val_loss: 0.6367 - val_accuracy: 0.7063
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 93/100
100/100 [==============================] - 40s 399ms/step - loss:
0.6695 - accuracy: 0.6102 - val_loss: 0.6316 - val_accuracy: 0.7625
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 94/100
100/100 [==============================] - 40s 397ms/step - loss:
0.6825 - accuracy: 0.5744 - val_loss: 0.6351 - val_accuracy: 0.7281
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 95/100
100/100 [==============================] - 40s 396ms/step - loss:
0.6795 - accuracy: 0.5839 - val_loss: 0.6262 - val_accuracy: 0.7312
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
```

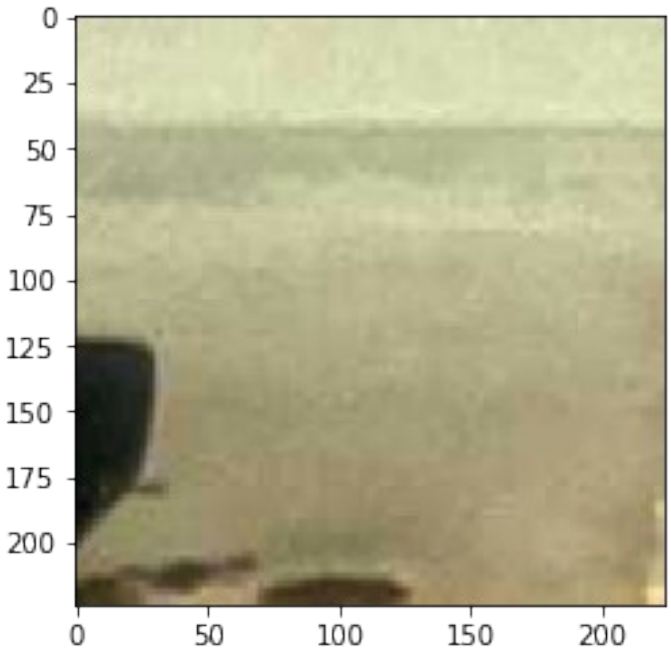
```
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 96/100
100/100 [==============================] - 40s 397ms/step - loss:
0.6833 - accuracy: 0.5723 - val_loss: 0.6323 - val_accuracy: 0.7312
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 97/100
100/100 [==============================] - 40s 398ms/step - loss:
0.6771 - accuracy: 0.5904 - val_loss: 0.6429 - val_accuracy: 0.6812
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 98/100
100/100 [==============================] - 40s 397ms/step - loss:
0.6780 - accuracy: 0.5873 - val_loss: 0.6239 - val_accuracy: 0.7469
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 99/100
100/100 [==============================] - 40s 397ms/step - loss:
0.6805 - accuracy: 0.5796 - val_loss: 0.6117 - val_accuracy: 0.7656
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
Epoch 100/100
100/100 [==============================] - 40s 397ms/step - loss:
0.6813 - accuracy: 0.5782 - val_loss: 0.6107 - val_accuracy: 0.7875
WARNING:tensorflow:Can save best model only with val_acc available,
skipping.
WARNING:tensorflow:Early stopping conditioned on metric `val_acc`
which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
```

We will try to get a model with VGG16 & using the imagenet with the data augmentation and the dropout layer

```
from keras.preprocessing import image
from matplotlib.pyplot import imshow

fnames = [os.path.join(train_not_dir, fname) for fname in
```

```
os.listdir(train_not_dir)]
img_path = fnames[1] # Choose one image to view
img = image.load_img(img_path, target_size=(224, 224)) # load image
and resize it
x = image.img_to_array(img) # Convert to a Numpy array with shape
(224, 224, 3)

x = x.reshape((1,) + x.shape)

plt.imshow(image.array_to_img(x[0]))
```

```
<matplotlib.image.AxesImage at 0x7f06d23f05d0>
```




```
from keras.applications.imagenet_utils import decode_predictions
from keras.applications import VGG16

model = VGG16(weights='imagenet', include_top=True)

features = model.predict(x)
decode_predictions(features, top=5)

from keras import layers, models, optimizers

conv_base = VGG16(weights='imagenet',
                  include_top=False,
                  input_shape=(224, 224, 3))

model = models.Sequential()
model.add(conv_base)
model.add(layers.Flatten())
```

```
model.add(layers.Dropout(0.5))
model.add(layers.Dense(256, activation='relu'))
model.add(layers.Dense(1, activation='sigmoid'))

conv_base.trainable = False

model.compile(loss='binary_crossentropy',
              optimizer=optimizers.RMSprop(lr=2e-5),
              metrics=['acc'])

from keras.applications.vgg16 import preprocess_input
from keras.preprocessing.image import ImageDataGenerator

train_datagen =
ImageDataGenerator(preprocessing_function=preprocess_input)
test_datagen =
ImageDataGenerator(preprocessing_function=preprocess_input)
train_generator = train_datagen.flow_from_directory(
    train_dir,
    target_size=(224, 224),
    batch_size=50,
    class_mode='binary')

validation_generator = test_datagen.flow_from_directory(
    validation_dir,
    target_size=(224, 224),
    batch_size=50,
    class_mode='binary')

Found 2000 images belonging to 2 classes.
Found 1000 images belonging to 2 classes.

history = model.fit_generator(
    train_generator,
    steps_per_epoch=40,
    epochs=30,
    validation_data=validation_generator,
    validation_steps=20)

/usr/local/lib/python3.7/dist-packages/tensorflow/python/keras/
engine/training.py:1844: UserWarning: `Model.fit_generator` is
deprecated and will be removed in a future version. Please use
`Model.fit`, which supports generators.
  warnings.warn('`Model.fit_generator` is deprecated and '

Epoch 1/30
40/40 [==============================] - 25s 624ms/step - loss: 0.3426
- acc: 0.9560 - val_loss: 0.2458 - val_acc: 0.9700
Epoch 2/30
40/40 [==============================] - 25s 624ms/step - loss: 0.2709
- acc: 0.9695 - val_loss: 0.2575 - val_acc: 0.9720
```

```
Epoch 3/30
40/40 [==============================] - 25s 630ms/step - loss: 0.1899
- acc: 0.9740 - val_loss: 0.2186 - val_acc: 0.9730
Epoch 4/30
40/40 [==============================] - 25s 630ms/step - loss: 0.1404
- acc: 0.9805 - val_loss: 0.1842 - val_acc: 0.9750
Epoch 5/30
40/40 [==============================] - 25s 629ms/step - loss: 0.1153
- acc: 0.9795 - val_loss: 0.1886 - val_acc: 0.9730
Epoch 6/30
40/40 [==============================] - 25s 628ms/step - loss: 0.0930
- acc: 0.9860 - val_loss: 0.2157 - val_acc: 0.9720
Epoch 7/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0785
- acc: 0.9845 - val_loss: 0.2165 - val_acc: 0.9740
Epoch 8/30
40/40 [==============================] - 25s 628ms/step - loss: 0.0894
- acc: 0.9875 - val_loss: 0.2294 - val_acc: 0.9730
Epoch 9/30
40/40 [==============================] - 25s 629ms/step - loss: 0.0475
- acc: 0.9920 - val_loss: 0.2029 - val_acc: 0.9770
Epoch 10/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0187
- acc: 0.9950 - val_loss: 0.2103 - val_acc: 0.9760
Epoch 11/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0275
- acc: 0.9965 - val_loss: 0.2185 - val_acc: 0.9770
Epoch 12/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0282
- acc: 0.9945 - val_loss: 0.2084 - val_acc: 0.9790
Epoch 13/30
40/40 [==============================] - 25s 628ms/step - loss: 0.0139
- acc: 0.9975 - val_loss: 0.2301 - val_acc: 0.9780
Epoch 14/30
40/40 [==============================] - 25s 628ms/step - loss: 0.0505
- acc: 0.9915 - val_loss: 0.1911 - val_acc: 0.9830
Epoch 15/30
40/40 [==============================] - 25s 628ms/step - loss: 0.0249
- acc: 0.9945 - val_loss: 0.1982 - val_acc: 0.9810
Epoch 16/30
40/40 [==============================] - 25s 628ms/step - loss: 0.0188
- acc: 0.9970 - val_loss: 0.2122 - val_acc: 0.9770
Epoch 17/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0133
- acc: 0.9970 - val_loss: 0.2165 - val_acc: 0.9770
Epoch 18/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0163
- acc: 0.9975 - val_loss: 0.2100 - val_acc: 0.9770
Epoch 19/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0158
```

```
- acc: 0.9975 - val_loss: 0.2388 - val_acc: 0.9780
Epoch 20/30
40/40 [==============================] - 25s 629ms/step - loss: 0.0194
- acc: 0.9970 - val_loss: 0.2007 - val_acc: 0.9770
Epoch 21/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0108
- acc: 0.9980 - val_loss: 0.2118 - val_acc: 0.9780
Epoch 22/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0164
- acc: 0.9970 - val_loss: 0.2428 - val_acc: 0.9750
Epoch 23/30
40/40 [==============================] - 25s 628ms/step - loss: 0.0124
- acc: 0.9980 - val_loss: 0.1924 - val_acc: 0.9780
Epoch 24/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0047
- acc: 0.9985 - val_loss: 0.2205 - val_acc: 0.9810
Epoch 25/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0102
- acc: 0.9980 - val_loss: 0.2594 - val_acc: 0.9790
Epoch 26/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0133
- acc: 0.9965 - val_loss: 0.2301 - val_acc: 0.9810
Epoch 27/30
40/40 [==============================] - 25s 629ms/step - loss: 0.0095
- acc: 0.9980 - val_loss: 0.2051 - val_acc: 0.9810
Epoch 28/30
40/40 [==============================] - 25s 627ms/step - loss: 0.0086
- acc: 0.9985 - val_loss: 0.2351 - val_acc: 0.9790
Epoch 29/30
40/40 [==============================] - 25s 629ms/step - loss: 0.0080
- acc: 0.9980 - val_loss: 0.2235 - val_acc: 0.9790
Epoch 30/30
40/40 [==============================] - 25s 628ms/step - loss: 0.0082
- acc: 0.9990 - val_loss: 0.2116 - val_acc: 0.9800
```

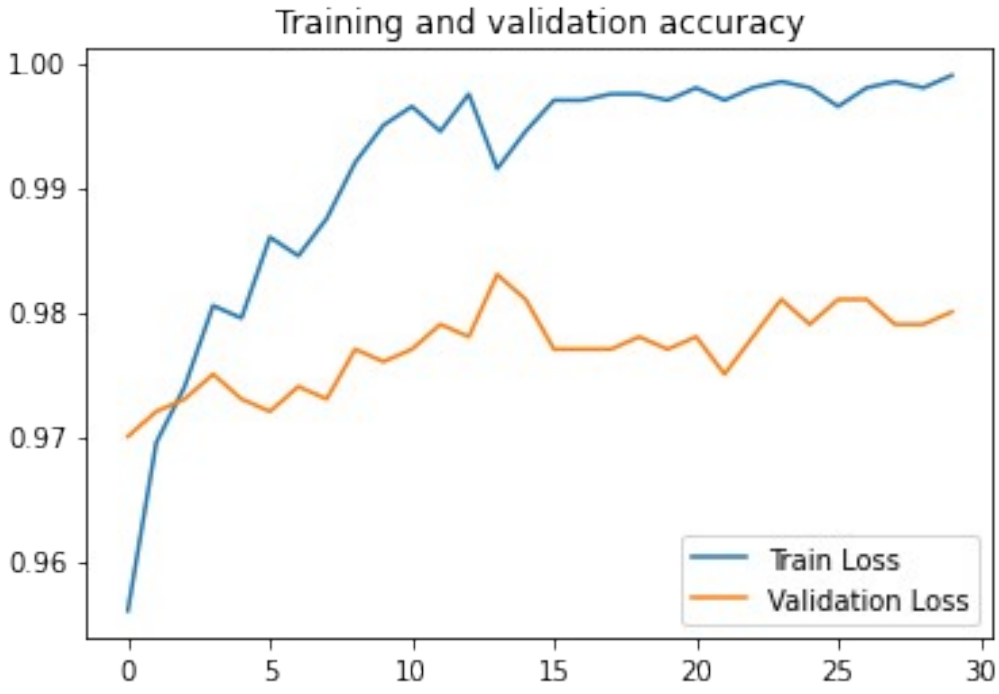
```
score = model.evaluate(validation_generator, verbose=0)
print("Test loss:", score[0])
print("Test accuracy:", score[1])
```

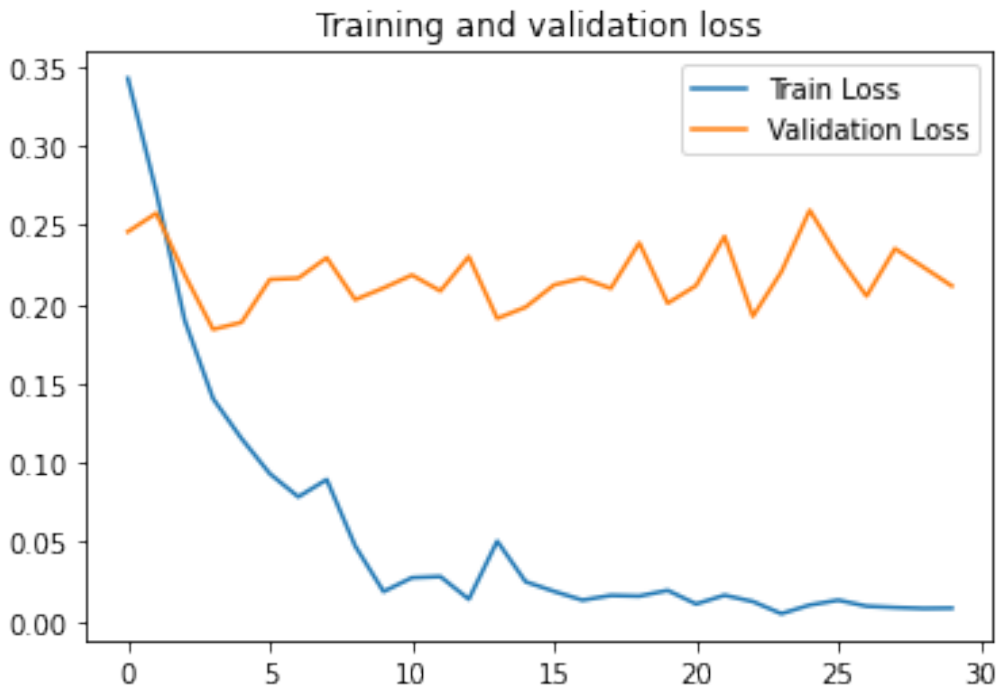
```
Test loss: 0.21156862378120422
Test accuracy: 0.9800000190734863
```

```
# Retrieve a list of accuracy results on training and validation data
# sets for each training epoch
acc = history.history['acc']
val_acc = history.history['val_acc']

# Retrieve a list of list results on training and validation data
# sets for each training epoch
loss = history.history['loss']
val_loss = history.history['val_loss']
```

```
# Get number of epochs
epochs = range(len(acc))

# Plot training and validation accuracy per epoch
plt.plot(epochs, acc, label="Train Loss")
plt.plot(epochs, val_acc, label="Validation Loss")
plt.title('Training and validation accuracy')

plt.legend()
plt.figure()

# Plot training and validation loss per epoch
plt.plot(epochs, loss, label="Train Loss")
plt.plot(epochs, val_loss, label="Validation Loss")
plt.title('Training and validation loss')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7fd627bdbfd0>
```





This is the best model we were able to get to!

The Test accuracy is 0.9800000190734863 and the Test loss: 0.21156862378120422 !