

# Vehicle type classification

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# Imports

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```
import os
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from collections import OrderedDict
import cv2
from PIL import Image
import keras
# For one-hot-encoding
from keras.utils import np_utils
# For creating sequential model
from keras.models import Sequential
from keras.layers import Conv2D,MaxPooling2D,Dense,Flatten,Dropout
# For saving and loading models
from keras.models import load_model
```

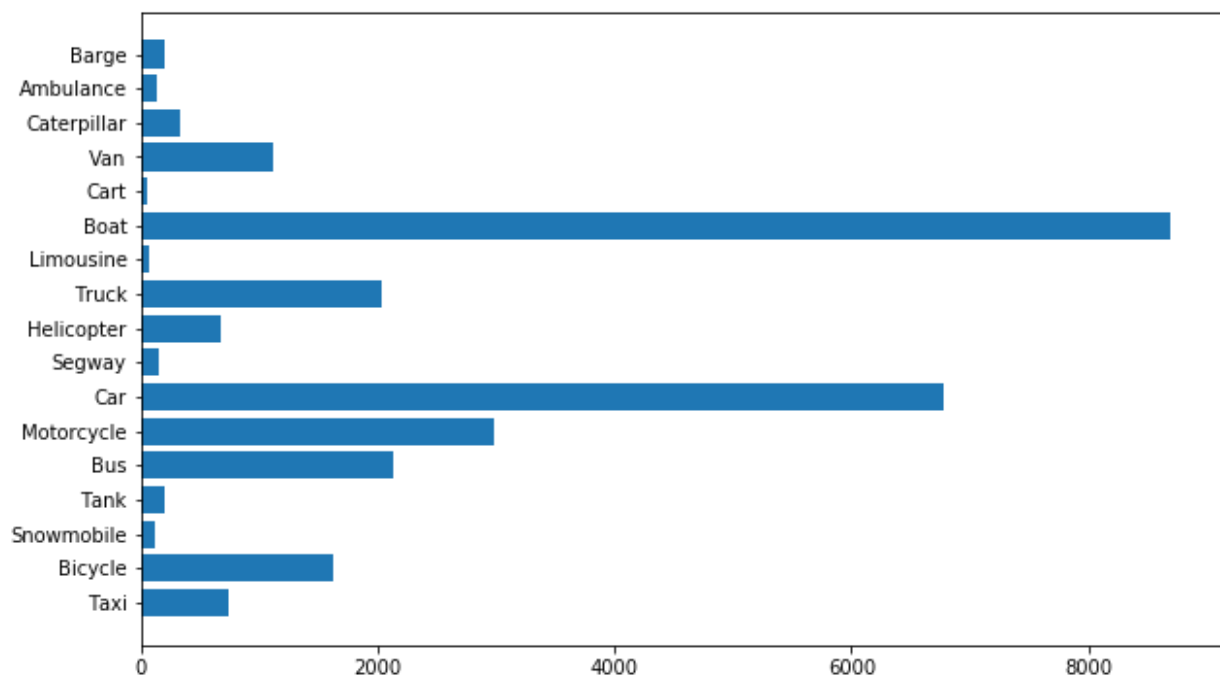
- NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays.
- Pandas is a software library written for the Python programming language for data manipulation and analysis. In particular, it offers data structures and operations for manipulating numerical tables and time series.
- Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy. It provides an object-oriented API for embedding plots into applications using general-purpose GUI toolkits like Tkinter, wxPython, Qt, or GTK+.
- OpenCV is a library of programming functions mainly aimed at real-time computer vision.
- Python Imaging Library is a free and open-source additional library for the Python programming language that adds support for opening, manipulating, and saving many different image file formats.
- Keras is an open-source neural-network library written in Python. Designed to enable fast experimentation with deep neural networks, it focuses on being user-friendly, modular, and extensible.

# Dataset

<https://www.kaggle.com/c/vehicle/data>

## Categories

The data contains vehicles from altogether 17 classes: Ambulance, Boat, Cart, Limousine, Snowmobile, Truck, Barge, Bus, Caterpillar, Motorcycle, Tank, Van, Bicycle, Car, Helicopter, Segway, Taxi.



# Train

We use a ready resnet model to train our data set:

Layer (type)	Output Shape	Param #	Connected to
=====			
input_2 (InputLayer)	(None, None, None, 3 0		
<hr/>			
conv1_pad (ZeroPadding2D)	(None, None, None, 3 0		input_2[0][0]
<hr/>			
conv1 (Conv2D)	(None, None, None, 6 9472		conv1_pad[0][0]
<hr/>			
bn_conv1 (BatchNormalization)	(None, None, None, 6 256		conv1[0][0]
<hr/>			
activation_50 (Activation)	(None, None, None, 6 0		bn_conv1[0][0]
<hr/>			
pool1_pad (ZeroPadding2D)	(None, None, None, 6 0		activation_50[0][0]
<hr/>			
max_pooling2d_2 (MaxPooling2D)	(None, None, None, 6 0		pool1_pad[0][0]
<hr/>			
res2a_branch2a (Conv2D)	(None, None, None, 6 4160		max_pooling2d_2[0][0]
<hr/>			
bn2a_branch2a (BatchNormalizati	(None, None, None, 6 256		res2a_branch2a[0][0]
<hr/>			
activation_51 (Activation)	(None, None, None, 6 0		bn2a_branch2a[0][0]
<hr/>			
res2a_branch2b (Conv2D)	(None, None, None, 6 36928		activation_51[0][0]
<hr/>			
bn2a_branch2b (BatchNormalizati	(None, None, None, 6 256		res2a_branch2b[0][0]

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activation_52 (Activation)	(None, None, None, 6 0	bn2a_branch2b[0][0]
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res2a_branch2c (Conv2D)	(None, None, None, 2 16640	activation_52[0][0]
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res2a_branch1 (Conv2D)	(None, None, None, 2 16640	max_pooling2d_2[0][0]
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bn2a_branch2c (BatchNormalizati	(None, None, None, 2 1024	res2a_branch2c[0][0]
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bn2a_branch1 (BatchNormalizatio	(None, None, None, 2 1024	res2a_branch1[0][0]
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add_17 (Add)	(None, None, None, 2 0	bn2a_branch2c[0][0]
		bn2a_branch1[0][0]

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activation_53 (Activation)	(None, None, None, 2 0	add_17[0][0]
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res2b_branch2a (Conv2D)	(None, None, None, 6 16448	activation_53[0][0]
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bn2b_branch2a (BatchNormalizati	(None, None, None, 6 256	res2b_branch2a[0][0]
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activation_54 (Activation)	(None, None, None, 6 0	bn2b_branch2a[0][0]
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res2b_branch2b (Conv2D)	(None, None, None, 6 36928	activation_54[0][0]
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bn2b_branch2b (BatchNormalizati	(None, None, None, 6 256	res2b_branch2b[0][0]
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activation_55 (Activation)	(None, None, None, 6 0	bn2b_branch2b[0][0]
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res2b_branch2c (Conv2D)	(None, None, None, 2 16640	activation_55[0][0]
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bn2b_branch2c (BatchNormalizati	(None, None, None, 2 1024	res2b_branch2c[0][0]
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add_18 (Add)	(None, None, None, 2 0	bn2b_branch2c[0][0]
	activation_53[0][0]	

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activation_56 (Activation)	(None, None, None, 2 0	add_18[0][0]
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res2c_branch2a (Conv2D)	(None, None, None, 6 16448	activation_56[0][0]
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bn2c_branch2a (BatchNormalizati	(None, None, None, 6 256	res2c_branch2a[0][0]
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---

activation_57 (Activation)	(None, None, None, 6 0	bn2c_branch2a[0][0]
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res2c_branch2b (Conv2D)	(None, None, None, 6 36928	activation_57[0][0]
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bn2c_branch2b (BatchNormalizati	(None, None, None, 6 256	res2c_branch2b[0][0]
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activation_58 (Activation)	(None, None, None, 6 0	bn2c_branch2b[0][0]
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res2c_branch2c (Conv2D)	(None, None, None, 2 16640	activation_58[0][0]
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bn2c_branch2c (BatchNormalizati	(None, None, None, 2 1024	res2c_branch2c[0][0]
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add_19 (Add)	(None, None, None, 2 0	bn2c_branch2c[0][0]
	activation_56[0][0]	

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activation_59 (Activation)	(None, None, None, 2 0	add_19[0][0]
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res3a\_branch2a (Conv2D) (None, None, None, 1 32896 activation\_59[0][0]

---

bn3a\_branch2a (BatchNormalizati (None, None, None, 1 512 res3a\_branch2a[0][0]

---

activation\_60 (Activation) (None, None, None, 1 0 bn3a\_branch2a[0][0]

---

res3a\_branch2b (Conv2D) (None, None, None, 1 147584 activation\_60[0][0]

---

bn3a\_branch2b (BatchNormalizati (None, None, None, 1 512 res3a\_branch2b[0][0]

---

activation\_61 (Activation) (None, None, None, 1 0 bn3a\_branch2b[0][0]

---

res3a\_branch2c (Conv2D) (None, None, None, 5 66048 activation\_61[0][0]

---

res3a\_branch1 (Conv2D) (None, None, None, 5 131584 activation\_59[0][0]

---

bn3a\_branch2c (BatchNormalizati (None, None, None, 5 2048 res3a\_branch2c[0][0]

---

bn3a\_branch1 (BatchNormalizatio (None, None, None, 5 2048 res3a\_branch1[0][0]

---

add\_20 (Add) (None, None, None, 5 0 bn3a\_branch2c[0][0]

bn3a\_branch1[0][0]

---

activation\_62 (Activation) (None, None, None, 5 0 add\_20[0][0]

---

res3b\_branch2a (Conv2D) (None, None, None, 1 65664 activation\_62[0][0]

---

bn3b\_branch2a (BatchNormalizati (None, None, None, 1 512 res3b\_branch2a[0][0]

---

activation\_63 (Activation) (None, None, None, 1 0 bn3b\_branch2a[0][0]

---

res3b\_branch2b (Conv2D) (None, None, None, 1 147584 activation\_63[0][0]

---

bn3b\_branch2b (BatchNormalizati (None, None, None, 1 512 res3b\_branch2b[0][0]

---

activation\_64 (Activation) (None, None, None, 1 0 bn3b\_branch2b[0][0]

---

res3b\_branch2c (Conv2D) (None, None, None, 5 66048 activation\_64[0][0]

---

bn3b\_branch2c (BatchNormalizati (None, None, None, 5 2048 res3b\_branch2c[0][0]

---

add\_21 (Add) (None, None, None, 5 0 bn3b\_branch2c[0][0]  
activation\_62[0][0]

---

activation\_65 (Activation) (None, None, None, 5 0 add\_21[0][0]

---

res3c\_branch2a (Conv2D) (None, None, None, 1 65664 activation\_65[0][0]

---

bn3c\_branch2a (BatchNormalizati (None, None, None, 1 512 res3c\_branch2a[0][0]

---

activation\_66 (Activation) (None, None, None, 1 0 bn3c\_branch2a[0][0]

---

res3c\_branch2b (Conv2D) (None, None, None, 1 147584 activation\_66[0][0]

---

bn3c\_branch2b (BatchNormalizati (None, None, None, 1 512 res3c\_branch2b[0][0]

---

activation\_67 (Activation) (None, None, None, 1 0 bn3c\_branch2b[0][0]

---



res3c\_branch2c (Conv2D) (None, None, None, 5 66048 activation\_67[0][0]

---

bn3c\_branch2c (BatchNormalizati (None, None, None, 5 2048 res3c\_branch2c[0][0]

---

add\_22 (Add) (None, None, None, 5 0 bn3c\_branch2c[0][0]  
activation\_65[0][0]

---

activation\_68 (Activation) (None, None, None, 5 0 add\_22[0][0]

---

res3d\_branch2a (Conv2D) (None, None, None, 1 65664 activation\_68[0][0]

---

bn3d\_branch2a (BatchNormalizati (None, None, None, 1 512 res3d\_branch2a[0][0]

---

activation\_69 (Activation) (None, None, None, 1 0 bn3d\_branch2a[0][0]

---

res3d\_branch2b (Conv2D) (None, None, None, 1 147584 activation\_69[0][0]

---

bn3d\_branch2b (BatchNormalizati (None, None, None, 1 512 res3d\_branch2b[0][0]

---

activation\_70 (Activation) (None, None, None, 1 0 bn3d\_branch2b[0][0]

---

res3d\_branch2c (Conv2D) (None, None, None, 5 66048 activation\_70[0][0]

---

bn3d\_branch2c (BatchNormalizati (None, None, None, 5 2048 res3d\_branch2c[0][0]

---

add\_23 (Add) (None, None, None, 5 0 bn3d\_branch2c[0][0]  
activation\_68[0][0]

---

activation\_71 (Activation) (None, None, None, 5 0 add\_23[0][0]

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res4a_branch2a (Conv2D)	(None, None, None, 2 131328	activation_71[0][0]
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bn4a_branch2a (BatchNormalizati	(None, None, None, 2 1024	res4a_branch2a[0][0]
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activation_72 (Activation)	(None, None, None, 2 0	bn4a_branch2a[0][0]
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res4a_branch2b (Conv2D)	(None, None, None, 2 590080	activation_72[0][0]
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bn4a_branch2b (BatchNormalizati	(None, None, None, 2 1024	res4a_branch2b[0][0]
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activation_73 (Activation)	(None, None, None, 2 0	bn4a_branch2b[0][0]
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res4a_branch2c (Conv2D)	(None, None, None, 1 263168	activation_73[0][0]
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res4a_branch1 (Conv2D)	(None, None, None, 1 525312	activation_71[0][0]
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bn4a_branch2c (BatchNormalizati	(None, None, None, 1 4096	res4a_branch2c[0][0]
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---

bn4a_branch1 (BatchNormalizatio	(None, None, None, 1 4096	res4a_branch1[0][0]
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add_24 (Add)	(None, None, None, 1 0	bn4a_branch2c[0][0] bn4a_branch1[0][0]
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activation_74 (Activation)	(None, None, None, 1 0	add_24[0][0]
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res4b_branch2a (Conv2D)	(None, None, None, 2 262400	activation_74[0][0]
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bn4b_branch2a (BatchNormalizati	(None, None, None, 2 1024	res4b_branch2a[0][0]
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activation_75 (Activation)	(None, None, None, 2 0	bn4b_branch2a[0][0]
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res4b_branch2b (Conv2D)	(None, None, None, 2 590080	activation_75[0][0]
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---

bn4b_branch2b (BatchNormalizati	(None, None, None, 2 1024	res4b_branch2b[0][0]
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activation_76 (Activation)	(None, None, None, 2 0	bn4b_branch2b[0][0]
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---

res4b_branch2c (Conv2D)	(None, None, None, 1 263168	activation_76[0][0]
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---

bn4b_branch2c (BatchNormalizati	(None, None, None, 1 4096	res4b_branch2c[0][0]
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add_25 (Add)	(None, None, None, 1 0	bn4b_branch2c[0][0]
		activation_74[0][0]

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activation_77 (Activation)	(None, None, None, 1 0	add_25[0][0]
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res4c_branch2a (Conv2D)	(None, None, None, 2 262400	activation_77[0][0]
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bn4c_branch2a (BatchNormalizati	(None, None, None, 2 1024	res4c_branch2a[0][0]
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activation_78 (Activation)	(None, None, None, 2 0	bn4c_branch2a[0][0]
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res4c_branch2b (Conv2D)	(None, None, None, 2 590080	activation_78[0][0]
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bn4c_branch2b (BatchNormalizati	(None, None, None, 2 1024	res4c_branch2b[0][0]
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activation_79 (Activation)	(None, None, None, 2 0	bn4c_branch2b[0][0]
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res4c_branch2c (Conv2D)	(None, None, None, 1 263168	activation_79[0][0]
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bn4c_branch2c (BatchNormalizati	(None, None, None, 1 4096	res4c_branch2c[0][0]
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add_26 (Add)	(None, None, None, 1 0	bn4c_branch2c[0][0]
		activation_77[0][0]

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activation_80 (Activation)	(None, None, None, 1 0	add_26[0][0]
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res4d_branch2a (Conv2D)	(None, None, None, 2 262400	activation_80[0][0]
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bn4d_branch2a (BatchNormalizati	(None, None, None, 2 1024	res4d_branch2a[0][0]
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activation_81 (Activation)	(None, None, None, 2 0	bn4d_branch2a[0][0]
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res4d_branch2b (Conv2D)	(None, None, None, 2 590080	activation_81 [0][0]
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bn4d_branch2b (BatchNormalizati	(None, None, None, 2 1024	res4d_branch2b[0][0]
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activation_82 (Activation)	(None, None, None, 2 0	bn4d_branch2b[0][0]
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res4d_branch2c (Conv2D)	(None, None, None, 1 263168	activation_82[0][0]
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bn4d_branch2c (BatchNormalizati	(None, None, None, 1 4096	res4d_branch2c[0][0]
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add_27 (Add)	(None, None, None, 1 0	bn4d_branch2c[0][0]
		activation_80[0][0]

---

activation\_83 (Activation) (None, None, None, 1 0 add\_27[0][0]

---

res4e\_branch2a (Conv2D) (None, None, None, 2 262400 activation\_83[0][0]

---

bn4e\_branch2a (BatchNormalizati (None, None, None, 2 1024 res4e\_branch2a[0][0]

---

activation\_84 (Activation) (None, None, None, 2 0 bn4e\_branch2a[0][0]

---

res4e\_branch2b (Conv2D) (None, None, None, 2 590080 activation\_84[0][0]

---

bn4e\_branch2b (BatchNormalizati (None, None, None, 2 1024 res4e\_branch2b[0][0]

---

activation\_85 (Activation) (None, None, None, 2 0 bn4e\_branch2b[0][0]

---

res4e\_branch2c (Conv2D) (None, None, None, 1 263168 activation\_85[0][0]

---

bn4e\_branch2c (BatchNormalizati (None, None, None, 1 4096 res4e\_branch2c[0][0]

---

add\_28 (Add) (None, None, None, 1 0 bn4e\_branch2c[0][0]  
activation\_83[0][0]

---

activation\_86 (Activation) (None, None, None, 1 0 add\_28[0][0]

---

res4f\_branch2a (Conv2D) (None, None, None, 2 262400 activation\_86[0][0]

---

bn4f\_branch2a (BatchNormalizati (None, None, None, 2 1024 res4f\_branch2a[0][0]

---

activation\_87 (Activation) (None, None, None, 2 0 bn4f\_branch2a[0][0]

---

res4f\_branch2b (Conv2D) (None, None, None, 2 590080 activation\_87[0][0]

---

bn4f\_branch2b (BatchNormalizati (None, None, None, 2 1024 res4f\_branch2b[0][0]

---

activation\_88 (Activation) (None, None, None, 2 0 bn4f\_branch2b[0][0]

---

res4f\_branch2c (Conv2D) (None, None, None, 1 263168 activation\_88[0][0]

---

bn4f\_branch2c (BatchNormalizati (None, None, None, 1 4096 res4f\_branch2c[0][0]

---

add\_29 (Add) (None, None, None, 1 0 bn4f\_branch2c[0][0]  
activation\_86[0][0]

---

activation\_89 (Activation) (None, None, None, 1 0 add\_29[0][0]

---

res5a\_branch2a (Conv2D) (None, None, None, 5 524800 activation\_89[0][0]

---

bn5a\_branch2a (BatchNormalizati (None, None, None, 5 2048 res5a\_branch2a[0][0]

---

activation\_90 (Activation) (None, None, None, 5 0 bn5a\_branch2a[0][0]

---

res5a\_branch2b (Conv2D) (None, None, None, 5 2359808 activation\_90[0][0]

---

bn5a\_branch2b (BatchNormalizati (None, None, None, 5 2048 res5a\_branch2b[0][0]

---

activation\_91 (Activation) (None, None, None, 5 0 bn5a\_branch2b[0][0]

---

res5a\_branch2c (Conv2D) (None, None, None, 2 1050624 activation\_91[0][0]

---

res5a\_branch1 (Conv2D) (None, None, None, 2 2099200 activation\_89[0][0]

---

bn5a\_branch2c (BatchNormalizati (None, None, None, 2 8192 res5a\_branch2c[0][0]

---

bn5a\_branch1 (BatchNormalizatio (None, None, None, 2 8192 res5a\_branch1[0][0]

---

add\_30 (Add) (None, None, None, 2 0 bn5a\_branch2c[0][0]  
bn5a\_branch1[0][0]

---

activation\_92 (Activation) (None, None, None, 2 0 add\_30[0][0]

---

res5b\_branch2a (Conv2D) (None, None, None, 5 1049088 activation\_92[0][0]

---

bn5b\_branch2a (BatchNormalizati (None, None, None, 5 2048 res5b\_branch2a[0][0]

---

activation\_93 (Activation) (None, None, None, 5 0 bn5b\_branch2a[0][0]

---

res5b\_branch2b (Conv2D) (None, None, None, 5 2359808 activation\_93[0][0]

---

bn5b\_branch2b (BatchNormalizati (None, None, None, 5 2048 res5b\_branch2b[0][0]

---

activation\_94 (Activation) (None, None, None, 5 0 bn5b\_branch2b[0][0]

---

res5b\_branch2c (Conv2D) (None, None, None, 2 1050624 activation\_94[0][0]

---

bn5b\_branch2c (BatchNormalizati (None, None, None, 2 8192 res5b\_branch2c[0][0]

---

add\_31 (Add) (None, None, None, 2 0 bn5b\_branch2c[0][0]  
activation\_92[0][0]

activation_95 (Activation)	(None, None, None, 2 0	add_31[0][0]
res5c_branch2a (Conv2D)	(None, None, None, 5 1049088	activation_95[0][0]
bn5c_branch2a (BatchNormalizati	(None, None, None, 5 2048	res5c_branch2a[0][0]
activation_96 (Activation)	(None, None, None, 5 0	bn5c_branch2a[0][0]
res5c_branch2b (Conv2D)	(None, None, None, 5 2359808	activation_96[0][0]
bn5c_branch2b (BatchNormalizati	(None, None, None, 5 2048	res5c_branch2b[0][0]
activation_97 (Activation)	(None, None, None, 5 0	bn5c_branch2b[0][0]
res5c_branch2c (Conv2D)	(None, None, None, 2 1050624	activation_97[0][0]
bn5c_branch2c (BatchNormalizati	(None, None, None, 2 8192	res5c_branch2c[0][0]
add_32 (Add)	(None, None, None, 2 0	bn5c_branch2c[0][0] activation_95[0][0]
activation_98 (Activation)	(None, None, None, 2 0	add_32[0][0]
global_average_pooling2d_3 (Glo	(None, 2048)	0 activation_98[0][0]
dense_6 (Dense)	(None, 1024)	2098176 global_average_pooling2d_3[0][0]
dense_7 (Dense)	(None, 512)	524800 dense_6[0][0]



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dense_8 (Dense)	(None, 7)	3591	dense_7[0][0]
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Total params: 26,214,279

Trainable params: 2,626,567

For gain better results on accuracy of our model we use transfer learning method with pretrained imagenet weights.

We use adam optimizer and '**categorical\_crossentropy**' loss function. Finally our model trained in 30 epochs.

```
Epoch 1/30
10/10 [=====] - 22s 2s/step - loss: 1.6414 - accuracy: 0.4094 - val_loss: 0.3412 -
val_accuracy: 0.8938
Epoch 2/30
10/10 [=====] - 12s 1s/step - loss: 0.9057 - accuracy: 0.6656 - val_loss: 0.4451 -
val_accuracy: 0.7719
Epoch 3/30
10/10 [=====] - 17s 2s/step - loss: 0.7734 - accuracy: 0.7224 - val_loss: 2.4557 -
val_accuracy: 0.8219
Epoch 4/30
10/10 [=====] - 19s 2s/step - loss: 0.6671 - accuracy: 0.7344 - val_loss: 1.9470 -
val_accuracy: 0.3562
Epoch 5/30
10/10 [=====] - 17s 2s/step - loss: 0.6054 - accuracy: 0.7656 - val_loss: 0.1346 -
val_accuracy: 0.8219
Epoch 6/30
10/10 [=====] - 18s 2s/step - loss: 0.8157 - accuracy: 0.7094 - val_loss: 2.0725 -
val_accuracy: 0.7500
Epoch 7/30
10/10 [=====] - 18s 2s/step - loss: 0.8227 - accuracy: 0.6781 - val_loss: 1.4786 -
val_accuracy: 0.7987
Epoch 8/30
10/10 [=====] - 12s 1s/step - loss: 0.5413 - accuracy: 0.7750 - val_loss: 0.6214 -
val_accuracy: 0.7406
Epoch 9/30
10/10 [=====] - 16s 2s/step - loss: 0.6543 - accuracy: 0.7563 - val_loss: 0.1905 -
val_accuracy: 0.8375
Epoch 10/30
10/10 [=====] - 18s 2s/step - loss: 0.5918 - accuracy: 0.8031 - val_loss: 1.4169 -
val_accuracy: 0.6344
Epoch 11/30
10/10 [=====] - 18s 2s/step - loss: 0.5938 - accuracy: 0.7812 - val_loss: 1.8953 -
val_accuracy: 0.4500
Epoch 12/30
10/10 [=====] - 18s 2s/step - loss: 0.5958 - accuracy: 0.7844 - val_loss: 0.2606 -
val_accuracy: 0.8687
Epoch 13/30
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10/10 [=====] - 16s 2s/step - loss: 0.6653 - accuracy: 0.7688 - val\_loss: 0.4528 - val\_accuracy: 0.8062  
Epoch 14/30  
10/10 [=====] - 19s 2s/step - loss: 0.6667 - accuracy: 0.7375 - val\_loss: 0.5886 - val\_accuracy: 0.8474  
Epoch 15/30  
10/10 [=====] - 11s 1s/step - loss: 0.6265 - accuracy: 0.7500 - val\_loss: 0.9290 - val\_accuracy: 0.7594  
Epoch 16/30  
10/10 [=====] - 19s 2s/step - loss: 0.5987 - accuracy: 0.8031 - val\_loss: 0.4412 - val\_accuracy: 0.8781  
Epoch 17/30  
10/10 [=====] - 17s 2s/step - loss: 0.4819 - accuracy: 0.8156 - val\_loss: 1.7211 - val\_accuracy: 0.4531  
Epoch 18/30  
10/10 [=====] - 17s 2s/step - loss: 0.5931 - accuracy: 0.8000 - val\_loss: 0.5677 - val\_accuracy: 0.6687  
Epoch 19/30  
10/10 [=====] - 20s 2s/step - loss: 0.5144 - accuracy: 0.8156 - val\_loss: 0.7916 - val\_accuracy: 0.8687  
Epoch 20/30  
10/10 [=====] - 16s 2s/step - loss: 0.6577 - accuracy: 0.7531 - val\_loss: 0.6584 - val\_accuracy: 0.4870  
Epoch 21/30  
10/10 [=====] - 13s 1s/step - loss: 0.5845 - accuracy: 0.7781 - val\_loss: 0.9416 - val\_accuracy: 0.8000  
Epoch 22/30  
10/10 [=====] - 17s 2s/step - loss: 0.5538 - accuracy: 0.8188 - val\_loss: 0.4568 - val\_accuracy: 0.6875  
Epoch 23/30  
10/10 [=====] - 19s 2s/step - loss: 0.4953 - accuracy: 0.8406 - val\_loss: 2.0161 - val\_accuracy: 0.7344  
Epoch 24/30  
10/10 [=====] - 16s 2s/step - loss: 0.5623 - accuracy: 0.7750 - val\_loss: 0.9804 - val\_accuracy: 0.5188  
Epoch 25/30  
10/10 [=====] - 18s 2s/step - loss: 0.4880 - accuracy: 0.8156 - val\_loss: 0.2788 - val\_accuracy: 0.8031  
Epoch 26/30  
10/10 [=====] - 17s 2s/step - loss: 0.4447 - accuracy: 0.8562 - val\_loss: 0.5736 - val\_accuracy: 0.8062  
Epoch 27/30  
10/10 [=====] - 19s 2s/step - loss: 0.3927 - accuracy: 0.8625 - val\_loss: 0.6152 - val\_accuracy: 0.7695  
Epoch 28/30  
10/10 [=====] - 11s 1s/step - loss: 0.5453 - accuracy: 0.7969 - val\_loss: 0.7905 - val\_accuracy: 0.7563  
Epoch 29/30  
10/10 [=====] - 17s 2s/step - loss: 0.4454 - accuracy: 0.8438 - val\_loss: 0.7099 - val\_accuracy: 0.8156  
Epoch 30/30  
10/10 [=====] - 17s 2s/step - loss: 0.4842 - accuracy: 0.8125 - val\_loss: 1.8044 - val\_accuracy: 0.5688