

# Women\_Dress\_Recommendation

April 26, 2021

```
[1]: %matplotlib inline
from zipfile import ZipFile
import pandas as pd
import os
import random
import shutil
from pathlib import Path
import urllib.request
import shutil
import pickle
import cv2
from google.colab.patches import cv2_imshow
from numpy import expand_dims
from keras.callbacks import ModelCheckpoint
from keras.models import load_model
from keras.preprocessing.image import load_img
from keras.preprocessing.image import img_to_array
from keras.preprocessing.image import ImageDataGenerator
from matplotlib import pyplot
from keras.preprocessing.image import ImageDataGenerator, array_to_img,
→img_to_array, load_img
import keras
import matplotlib.pyplot as plt
from keras.models import Model
import cv2
from keras.datasets import cifar10
from keras.preprocessing.image import ImageDataGenerator
from keras.models import Sequential
from keras.layers import Dense, Dropout, Activation, Flatten
from keras.layers import Conv2D, MaxPooling2D
from keras import models, layers
from keras.models import Model
from keras.layers import BatchNormalization, Activation, Flatten
from keras.optimizers import Adam
from keras.preprocessing.image import ImageDataGenerator

from sklearn.metrics.pairwise import pairwise_distances
```

```
from google.colab.patches import cv2_imshow
import warnings
warnings.filterwarnings("ignore")
! pip install scipy==0.19.1
from vis.visualization import visualize_activation
from vis.utils import utils
from keras import activations
from keras import applications
import matplotlib.pyplot as plt
%matplotlib inline
plt.rcParams['figure.figsize'] = (18,6)
```

Using TensorFlow backend.

```
<IPython.core.display.HTML object>
```

```
Requirement already satisfied: scipy==0.19.1 in /usr/local/lib/python3.6/dist-packages (0.19.1)
```

```
Requirement already satisfied: numpy>=1.8.2 in /usr/local/lib/python3.6/dist-packages (from scipy==0.19.1) (1.17.4)
```

```
[2]: from google.colab import drive
drive.mount('/content/gdrive')
```

Go to this URL in a browser: [https://accounts.google.com/o/oauth2/auth?client\\_id=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redirect\\_uri=urn%3aietf%3awg%3aoauth%3a2.0%3aoob&response\\_type=code&scope=email%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdocs.test%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive.photos.readonly%20https%3a%2f%2fwww.googleapis.com%2fauth%2fpeopleapi.readonly](https://accounts.google.com/o/oauth2/auth?client_id=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redirect_uri=urn%3aietf%3awg%3aoauth%3a2.0%3aoob&response_type=code&scope=email%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdocs.test%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive.photos.readonly%20https%3a%2f%2fwww.googleapis.com%2fauth%2fpeopleapi.readonly)

Enter your authorization code:

.....

Mounted at /content/gdrive

```
[0]: from numpy.random import seed
seed(1)
from tensorflow import set_random_seed
set_random_seed(2)
```

## 1 Download Zip

```
[0]: # extracting each Image into assignment
with ZipFile('/content/gdrive/My Drive/greendeck/assignment.zip', 'r') as zipObj:
    # Extract all the contents of zip file in current directory
    zipObj.extractall()
```

## 2 Download Images from Url's

This is a Working Code But if we are trying to download Images from URL's into PATH- IT TAKES LONG TIME

```
[0]: # creating a path-object for the current_directory  
PATH = Path('/content')  
# creating a assignment_url object folder to store all the downloaded images  
os.mkdir('/content/assignment_url')
```

Function to download Images from URL's(takes long time to download- Try Extracting Images rather)

```
[0]: def download_image(url):  
    # split the single-url and and the last string after splitting which is  
    # the Image-Name of downloaded image  
    filename = url.split('/')[-1]  
    # store the image-name  
    fullname = str(filename)  
    # download the image from Url-given with the following filename to the image  
    urllib.request.urlretrieve(url,fullname)  
    #move the image to the following path-assignment_url  
    shutil.move(PATH/fullname, PATH/'assignment_url'/'fullname')
```

```
[0]: import requests  
import urllib  
from tqdm import tqdm  
  
# map download_image to each element in the df['image_url']  
map(download_image, list(df['image_url']))
```

```
[0]: # can use above one to download images to assignment_url  
for i in tqdm(range(df.shape[0])):  
    link_url = df['image_url'][i]  
    download_image(link_url)
```

## 3 Read The Images-csv file as a Dataframe

```
[0]: # lading the Dataframe which contains Image-Path  
# Image_url which requires url to download image  
# Category of that particular Image  
df = pd.read_csv('/content/gdrive/My Drive/greendeck/dress_patterns.csv')
```

```
[6]: df.head()
```

```
[6]: _unit_id ... image_url  
0 851505458 ... http://s3-eu-west-1.amazonaws.com/we-attribute...  
1 851505459 ... http://s3-eu-west-1.amazonaws.com/we-attribute...
```

```
2 851505460 ... http://s3-eu-west-1.amazonaws.com/we-attribute...
3 851505461 ... http://s3-eu-west-1.amazonaws.com/we-attribute...
4 851505462 ... http://s3-eu-west-1.amazonaws.com/we-attribute...
```

[5 rows x 4 columns]

```
[7]: df['image_url'][0]
```

```
[7]: 'http://s3-eu-west-1.amazonaws.com/we-
attributes/dress/23/5f635c0fa59f4270a6953f67dcddcda3.jpg.png'
```

```
[8]: df.shape
```

```
[8]: (15702, 4)
```

```
[9]: df['image_url'][0].split('/')[-1].split('.')[0] + '.png'
```

```
[9]: '5f635c0fa59f4270a6953f67dcddcda3.png'
```

## 4 creating Train-Dataframe which contains image Path and Image-Category

```
[10]: df.head()
```

```
[10]:   _unit_id ... image_url
0 851505458 ... http://s3-eu-west-1.amazonaws.com/we-attribute...
1 851505459 ... http://s3-eu-west-1.amazonaws.com/we-attribute...
2 851505460 ... http://s3-eu-west-1.amazonaws.com/we-attribute...
3 851505461 ... http://s3-eu-west-1.amazonaws.com/we-attribute...
4 851505462 ... http://s3-eu-west-1.amazonaws.com/we-attribute...
```

[5 rows x 4 columns]

```
[0]: df['path'] = 0
```

extracting Image\_path from the dataframe

```
[12]: from tqdm import tqdm
# Extracting The image Path from Dataframe
for i in tqdm(range(df.shape[0])):
    # extract the path of Image from filename of the image
    df['path'][i] = str(df['image_url'][i].split('/')[-1].split('.')[0]) + '.png'
```

100% | 15702/15702 [00:02<00:00, 5760.52it/s]

```
[13]: df.head()
```

```
[13]:      _unit_id ... path
0  851505458 ... 5f635c0fa59f4270a6953f67dcddcda3.png
1  851505459 ... ca5ca27caca94f9fb0617c226477ae35.png
2  851505460 ... 7be73e354249484db5a8ddf4e05cc63b.png
3  851505461 ... 7e241481162649d39048f522d0653e03.png
4  851505462 ... 808d0bf9fe9745fca13ab461f86e0e4e.png
```

[5 rows x 5 columns]

```
[14]: from keras import backend as K
K.clear_session()
```

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:107: The name tf.reset\_default\_graph is deprecated. Please use tf.compat.v1.reset\_default\_graph instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:111: The name tf.placeholder\_with\_default is deprecated. Please use tf.compat.v1.placeholder\_with\_default instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:66: The name tf.get\_default\_graph is deprecated. Please use tf.compat.v1.get\_default\_graph instead.

```
[0]: %matplotlib inline
```

## 5 Data Augmentation

```
[0]: # train_generator for training
train_gen = ImageDataGenerator(
    vertical_flip=True,
    zoom_range=0.1,
    horizontal_flip=True,
    fill_mode='nearest')
```

```
[0]: # valid_generator for Validation Data
valid_gen = ImageDataGenerator(
    vertical_flip=True,
    zoom_range=0.1,
    horizontal_flip=True,
    fill_mode='nearest')
```

## 6 Model-custom Dense Networks Architecture using Dense Blocks

### Creating Dense-Block's and Output-layer

```
[0]: # Dense Block which concatenates channels of n th layer to (n+5)th layer
# Each dense Block contains l-ub-blocks
# In each sub-block first and lastlayer channel's are concatenated
def denseblock(input, num_filter = 28, dropout_rate = 0.25):
    global compression
    temp = input
    for _ in range(l):
        BatchNorm = layers.BatchNormalization()(temp)
        relu = layers.Activation('relu')(BatchNorm)
        Conv2D_3_3 = layers.Conv2D(int(num_filter*compression), (3,3), use_bias=False ,padding='same')(relu)
        # using Dropout's
        if dropout_rate>0:
            Conv2D_3_3 = layers.Dropout(dropout_rate)(Conv2D_3_3)
        # concatenate the channel's of first-input -(Temp-Layer) and
        ↵Last-(Conv2D_3_3)-layer
        concat = layers.Concatenate(axis=-1)([temp,Conv2D_3_3])
        # This last layer is the next inut ot the sub-block
        temp = concat

    return temp

#
## transition Block for the BottleNeck of Channel's and also Average-Pooling
def transition(input, num_filter = 28, dropout_rate = 0.25):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    # creating Bottle-neck using (1,1)-filter's
    Conv2D_BottleNeck = layers.Conv2D(int(num_filter*compression), (1,1), use_bias=False ,padding='same')(relu)
    if dropout_rate>0:
        Conv2D_BottleNeck = layers.Dropout(dropout_rate)(Conv2D_BottleNeck)
    avg = layers.AveragePooling2D(pool_size=(2,2))(Conv2D_BottleNeck)
    return avg

#output layer-Final output Layer
def output_layer(input):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    AvgPooling = layers.AveragePooling2D(pool_size=(2,2))(relu)
    flat = layers.Flatten()(AvgPooling)
    # final output Layer Softmax
```

```

# at output -the no.of.units = no.of.classes
output = layers.Dense(17, activation='softmax')(flat)
return output

```

## Hyperparameter's for Model

```
[0]: # Hyperparameters
num_filter = 28
dropout_rate = 0.25
num_classes = 17
epochs = 10
l = 7
compression = 1
```

## MODEL-architechture

```
[0]: # input for the model
input = layers.Input(shape=(100,100, 3,))
# First COnv Layer
First_Conv2D = layers.Conv2D(64, (3,3), use_bias=False ,padding='same')(input)
# First Dense Block and Transition-Block
First_Block = denseblock(First_Conv2D, num_filter, dropout_rate)
First_Transition = transition(First_Block, num_filter, dropout_rate)
# Second Dense Block and Transition-Block
Second_Block = denseblock(First_Transition, num_filter, dropout_rate)
Second_Transition = transition(Second_Block, num_filter, dropout_rate)
# Third Dense Block and Transition-Block
Third_Block = denseblock(Second_Transition, num_filter, dropout_rate)
Third_Transition = transition(Third_Block, num_filter, dropout_rate)
# Last Dense Block
Last_Block = denseblock(Third_Transition, num_filter, dropout_rate)
# Second COnv-layer after all Dense and transition Blocks
second_conv2d = layers.Conv2D(128, (3,3), use_bias=False
                           ,padding='same')(Last_Block)
# Output-Layer conatin the last layer with 17 neuron's with -No.of.Classes
output = output_layer(second_conv2d)
```

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:66: The name tf.get\_default\_graph is deprecated. Please use tf.compat.v1.get\_default\_graph instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:541: The name tf.placeholder is deprecated. Please use tf.compat.v1.placeholder instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:4432: The name tf.random\_uniform is deprecated. Please use tf.random.uniform instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:190: The name tf.get\_default\_session is deprecated. Please use tf.compat.v1.get\_default\_session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:197: The name tf.ConfigProto is deprecated. Please use tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:203: The name tf.Session is deprecated. Please use tf.compat.v1.Session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:207: The name tf.global\_variables is deprecated. Please use tf.compat.v1.global\_variables instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:216: The name tf.is\_variable\_initialized is deprecated. Please use tf.compat.v1.is\_variable\_initialized instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:223: The name tf.variables\_initializer is deprecated. Please use tf.compat.v1.variables\_initializer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:2041: The name tf.nn.fused\_batch\_norm is deprecated. Please use tf.compat.v1.nn.fused\_batch\_norm instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:148: The name tf.placeholder\_with\_default is deprecated. Please use tf.compat.v1.placeholder\_with\_default instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:3733: calling dropout (from tensorflow.python.ops.nn\_ops) with keep\_prob is deprecated and will be removed in a future version.

Instructions for updating:

Please use `rate` instead of `keep\_prob`. Rate should be set to `rate = 1 - keep\_prob`.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:4271: The name tf.nn.avg\_pool is deprecated. Please use tf.nn.avg\_pool2d instead.

```
[0]: model = Model(inputs=[input], outputs=[output])

[0]: # compiling model using adam oprimizers and categorical cross-entropy
model.compile(loss='categorical_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/optimizers.py:793: The name tf.train.Optimizer is deprecated.
Please use tf.compat.v1.train.Optimizer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:3576: The name tf.log is
deprecated. Please use tf.math.log instead.

[0]: model.summary()

Model: "model_1"
-----
Layer (type)          Output Shape         Param #
-----  

-----  

input_1 (InputLayer)    (None, 100, 100, 3)  0  

-----  

conv2d_1 (Conv2D)      (None, 100, 100, 64) 1728      input_1[0] [0]  

-----  

batch_normalization_1 (BatchNor (None, 100, 100, 64) 256      conv2d_1[0] [0]  

-----  

activation_1 (Activation) (None, 100, 100, 64) 0  

batch_normalization_1[0] [0]  

-----  

conv2d_2 (Conv2D)      (None, 100, 100, 28) 16128  

activation_1[0] [0]  

-----  

dropout_1 (Dropout)     (None, 100, 100, 28) 0      conv2d_2[0] [0]  

-----  

concatenate_1 (Concatenate) (None, 100, 100, 92) 0      conv2d_1[0] [0]
dropout_1[0] [0]  

-----
```

```
batch_normalization_2 (BatchNor (None, 100, 100, 92) 368
concatenate_1[0] [0]
-----
activation_2 (Activation)      (None, 100, 100, 92) 0
batch_normalization_2[0] [0]
-----
conv2d_3 (Conv2D)            (None, 100, 100, 28) 23184
activation_2[0] [0]
-----
dropout_2 (Dropout)          (None, 100, 100, 28) 0           conv2d_3[0] [0]
-----
concatenate_2 (Concatenate)   (None, 100, 100, 120 0
concatenate_1[0] [0]           dropout_2[0] [0]
-----
batch_normalization_3 (BatchNor (None, 100, 100, 120 480
concatenate_2[0] [0]
-----
activation_3 (Activation)    (None, 100, 100, 120 0
batch_normalization_3[0] [0]
-----
conv2d_4 (Conv2D)            (None, 100, 100, 28) 30240
activation_3[0] [0]
-----
dropout_3 (Dropout)          (None, 100, 100, 28) 0           conv2d_4[0] [0]
-----
concatenate_3 (Concatenate)   (None, 100, 100, 148 0
concatenate_2[0] [0]           dropout_3[0] [0]
-----
batch_normalization_4 (BatchNor (None, 100, 100, 148 592
concatenate_3[0] [0]
-----
activation_4 (Activation)    (None, 100, 100, 148 0
batch_normalization_4[0] [0]
```

```
conv2d_5 (Conv2D)           (None, 100, 100, 28) 37296
activation_4[0] [0]

-----
dropout_4 (Dropout)         (None, 100, 100, 28) 0           conv2d_5[0] [0]

-----
concatenate_4 (Concatenate) (None, 100, 100, 176 0
concatenate_3[0] [0]                                     dropout_4[0] [0]

-----
batch_normalization_5 (BatchNor (None, 100, 100, 176 704
concatenate_4[0] [0]

-----
activation_5 (Activation)   (None, 100, 100, 176 0
batch_normalization_5[0] [0]

-----
conv2d_6 (Conv2D)           (None, 100, 100, 28) 44352
activation_5[0] [0]

-----
dropout_5 (Dropout)         (None, 100, 100, 28) 0           conv2d_6[0] [0]

-----
concatenate_5 (Concatenate) (None, 100, 100, 204 0
concatenate_4[0] [0]                                     dropout_5[0] [0]

-----
batch_normalization_6 (BatchNor (None, 100, 100, 204 816
concatenate_5[0] [0]

-----
activation_6 (Activation)   (None, 100, 100, 204 0
batch_normalization_6[0] [0]

-----
conv2d_7 (Conv2D)           (None, 100, 100, 28) 51408
activation_6[0] [0]

-----
dropout_6 (Dropout)         (None, 100, 100, 28) 0           conv2d_7[0] [0]

-----
concatenate_6 (Concatenate) (None, 100, 100, 232 0
```

```
concatenate_5[0] [0]
dropout_6[0] [0]
-----
batch_normalization_7 (BatchNor (None, 100, 100, 232) 928
concatenate_6[0] [0]
-----
activation_7 (Activation)      (None, 100, 100, 232) 0
batch_normalization_7[0] [0]
-----
conv2d_8 (Conv2D)             (None, 100, 100, 28) 58464
activation_7[0] [0]
-----
dropout_7 (Dropout)          (None, 100, 100, 28) 0           conv2d_8[0] [0]
-----
concatenate_7 (Concatenate)   (None, 100, 100, 260) 0
concatenate_6[0] [0]
dropout_7[0] [0]
-----
batch_normalization_8 (BatchNor (None, 100, 100, 260) 1040
concatenate_7[0] [0]
-----
activation_8 (Activation)     (None, 100, 100, 260) 0
batch_normalization_8[0] [0]
-----
conv2d_9 (Conv2D)             (None, 100, 100, 28) 7280
activation_8[0] [0]
-----
dropout_8 (Dropout)          (None, 100, 100, 28) 0           conv2d_9[0] [0]
-----
average_pooling2d_1 (AveragePoo (None, 50, 50, 28) 0           dropout_8[0] [0]
-----
batch_normalization_9 (BatchNor (None, 50, 50, 28) 112
average_pooling2d_1[0] [0]
-----
activation_9 (Activation)     (None, 50, 50, 28) 0
batch_normalization_9[0] [0]
```

```
-----  
conv2d_10 (Conv2D)           (None, 50, 50, 28)    7056  
activation_9[0] [0]  
  
-----  
dropout_9 (Dropout)          (None, 50, 50, 28)    0           conv2d_10[0] [0]  
  
-----  
concatenate_8 (Concatenate)   (None, 50, 50, 56)    0  
average_pooling2d_1[0] [0]           dropout_9[0] [0]  
  
-----  
batch_normalization_10 (BatchNo (None, 50, 50, 56)    224  
concatenate_8[0] [0]  
  
-----  
activation_10 (Activation)    (None, 50, 50, 56)    0  
batch_normalization_10[0] [0]  
  
-----  
conv2d_11 (Conv2D)           (None, 50, 50, 28)    14112  
activation_10[0] [0]  
  
-----  
dropout_10 (Dropout)          (None, 50, 50, 28)    0           conv2d_11[0] [0]  
  
-----  
concatenate_9 (Concatenate)   (None, 50, 50, 84)    0  
concatenate_8[0] [0]  
dropout_10[0] [0]  
  
-----  
batch_normalization_11 (BatchNo (None, 50, 50, 84)    336  
concatenate_9[0] [0]  
  
-----  
activation_11 (Activation)    (None, 50, 50, 84)    0  
batch_normalization_11[0] [0]  
  
-----  
conv2d_12 (Conv2D)           (None, 50, 50, 28)    21168  
activation_11[0] [0]  
  
-----  
dropout_11 (Dropout)          (None, 50, 50, 28)    0           conv2d_12[0] [0]
```

```
-----  
concatenate_10 (Concatenate)      (None, 50, 50, 112)  0  
concatenate_9[0] [0]  
dropout_11[0] [0]  
-----  
batch_normalization_12 (BatchNo (None, 50, 50, 112)  448  
concatenate_10[0] [0]  
-----  
activation_12 (Activation)      (None, 50, 50, 112)  0  
batch_normalization_12[0] [0]  
-----  
conv2d_13 (Conv2D)              (None, 50, 50, 28)   28224  
activation_12[0] [0]  
-----  
dropout_12 (Dropout)            (None, 50, 50, 28)   0           conv2d_13[0] [0]  
-----  
concatenate_11 (Concatenate)    (None, 50, 50, 140)  0  
concatenate_10[0] [0]  
dropout_12[0] [0]  
-----  
batch_normalization_13 (BatchNo (None, 50, 50, 140)  560  
concatenate_11[0] [0]  
-----  
activation_13 (Activation)      (None, 50, 50, 140)  0  
batch_normalization_13[0] [0]  
-----  
conv2d_14 (Conv2D)              (None, 50, 50, 28)   35280  
activation_13[0] [0]  
-----  
dropout_13 (Dropout)            (None, 50, 50, 28)   0           conv2d_14[0] [0]  
-----  
concatenate_12 (Concatenate)    (None, 50, 50, 168)  0  
concatenate_11[0] [0]  
dropout_13[0] [0]  
-----  
batch_normalization_14 (BatchNo (None, 50, 50, 168)  672  
concatenate_12[0] [0]
```

```
-----  
activation_14 (Activation)      (None, 50, 50, 168)  0  
batch_normalization_14[0] [0]  
  
-----  
conv2d_15 (Conv2D)            (None, 50, 50, 28)   42336  
activation_14[0] [0]  
  
-----  
dropout_14 (Dropout)          (None, 50, 50, 28)   0           conv2d_15[0] [0]  
  
-----  
concatenate_13 (Concatenate)   (None, 50, 50, 196)  0  
concatenate_12[0] [0]  
dropout_14[0] [0]  
  
-----  
batch_normalization_15 (BatchNo (None, 50, 50, 196) 784  
concatenate_13[0] [0]  
  
-----  
activation_15 (Activation)     (None, 50, 50, 196)  0  
batch_normalization_15[0] [0]  
  
-----  
conv2d_16 (Conv2D)            (None, 50, 50, 28)   49392  
activation_15[0] [0]  
  
-----  
dropout_15 (Dropout)          (None, 50, 50, 28)   0           conv2d_16[0] [0]  
  
-----  
concatenate_14 (Concatenate)   (None, 50, 50, 224)  0  
concatenate_13[0] [0]  
dropout_15[0] [0]  
  
-----  
batch_normalization_16 (BatchNo (None, 50, 50, 224) 896  
concatenate_14[0] [0]  
  
-----  
activation_16 (Activation)     (None, 50, 50, 224)  0  
batch_normalization_16[0] [0]  
  
-----  
conv2d_17 (Conv2D)            (None, 50, 50, 28)   6272  
activation_16[0] [0]
```

```
-----  
dropout_16 (Dropout)           (None, 50, 50, 28)  0          conv2d_17[0] [0]  
-----  
average_pooling2d_2 (AveragePoo (None, 25, 25, 28)  0  
dropout_16[0] [0]  
-----  
batch_normalization_17 (BatchNo (None, 25, 25, 28)  112  
average_pooling2d_2[0] [0]  
-----  
activation_17 (Activation)    (None, 25, 25, 28)  0  
batch_normalization_17[0] [0]  
-----  
conv2d_18 (Conv2D)            (None, 25, 25, 28)  7056  
activation_17[0] [0]  
-----  
dropout_17 (Dropout)          (None, 25, 25, 28)  0          conv2d_18[0] [0]  
-----  
concatenate_15 (Concatenate)  (None, 25, 25, 56)  0  
average_pooling2d_2[0] [0]  
dropout_17[0] [0]  
-----  
batch_normalization_18 (BatchNo (None, 25, 25, 56)  224  
concatenate_15[0] [0]  
-----  
activation_18 (Activation)    (None, 25, 25, 56)  0  
batch_normalization_18[0] [0]  
-----  
conv2d_19 (Conv2D)            (None, 25, 25, 28)  14112  
activation_18[0] [0]  
-----  
dropout_18 (Dropout)          (None, 25, 25, 28)  0          conv2d_19[0] [0]  
-----  
concatenate_16 (Concatenate)  (None, 25, 25, 84)  0  
concatenate_15[0] [0]  
dropout_18[0] [0]  
-----
```

```
-----  
batch_normalization_19 (BatchNo (None, 25, 25, 84) 336  
concatenate_16[0] [0]  
-----  
activation_19 (Activation)      (None, 25, 25, 84) 0  
batch_normalization_19[0] [0]  
-----  
conv2d_20 (Conv2D)            (None, 25, 25, 28) 21168  
activation_19[0] [0]  
-----  
dropout_19 (Dropout)          (None, 25, 25, 28) 0           conv2d_20[0] [0]  
-----  
concatenate_17 (Concatenate)   (None, 25, 25, 112) 0  
concatenate_16[0] [0]  
dropout_19[0] [0]  
-----  
batch_normalization_20 (BatchNo (None, 25, 25, 112) 448  
concatenate_17[0] [0]  
-----  
activation_20 (Activation)    (None, 25, 25, 112) 0  
batch_normalization_20[0] [0]  
-----  
conv2d_21 (Conv2D)            (None, 25, 25, 28) 28224  
activation_20[0] [0]  
-----  
dropout_20 (Dropout)          (None, 25, 25, 28) 0           conv2d_21[0] [0]  
-----  
concatenate_18 (Concatenate)   (None, 25, 25, 140) 0  
concatenate_17[0] [0]  
dropout_20[0] [0]  
-----  
batch_normalization_21 (BatchNo (None, 25, 25, 140) 560  
concatenate_18[0] [0]  
-----  
activation_21 (Activation)    (None, 25, 25, 140) 0  
batch_normalization_21[0] [0]
```

```
-----  
conv2d_22 (Conv2D)           (None, 25, 25, 28) 35280  
activation_21[0] [0]  
-----  
dropout_21 (Dropout)         (None, 25, 25, 28) 0          conv2d_22[0] [0]  
-----  
concatenate_19 (Concatenate) (None, 25, 25, 168) 0  
concatenate_18[0] [0]  
dropout_21[0] [0]  
-----  
batch_normalization_22 (BatchNo (None, 25, 25, 168) 672  
concatenate_19[0] [0]  
-----  
activation_22 (Activation)   (None, 25, 25, 168) 0  
batch_normalization_22[0] [0]  
-----  
conv2d_23 (Conv2D)           (None, 25, 25, 28) 42336  
activation_22[0] [0]  
-----  
dropout_22 (Dropout)         (None, 25, 25, 28) 0          conv2d_23[0] [0]  
-----  
concatenate_20 (Concatenate) (None, 25, 25, 196) 0  
concatenate_19[0] [0]  
dropout_22[0] [0]  
-----  
batch_normalization_23 (BatchNo (None, 25, 25, 196) 784  
concatenate_20[0] [0]  
-----  
activation_23 (Activation)   (None, 25, 25, 196) 0  
batch_normalization_23[0] [0]  
-----  
conv2d_24 (Conv2D)           (None, 25, 25, 28) 49392  
activation_23[0] [0]  
-----  
dropout_23 (Dropout)         (None, 25, 25, 28) 0          conv2d_24[0] [0]  
-----
```

```
concatenate_21 (Concatenate)      (None, 25, 25, 224)  0
concatenate_20[0] [0]
dropout_23[0] [0]

-----
batch_normalization_24 (BatchNo (None, 25, 25, 224)  896
concatenate_21[0] [0]

-----
activation_24 (Activation)      (None, 25, 25, 224)  0
batch_normalization_24[0] [0]

-----
conv2d_25 (Conv2D)              (None, 25, 25, 28)   6272
activation_24[0] [0]

-----
dropout_24 (Dropout)            (None, 25, 25, 28)   0           conv2d_25[0] [0]

-----
average_pooling2d_3 (AveragePoo (None, 12, 12, 28)   0
dropout_24[0] [0]

-----
batch_normalization_25 (BatchNo (None, 12, 12, 28)   112
average_pooling2d_3[0] [0]

-----
activation_25 (Activation)      (None, 12, 12, 28)   0
batch_normalization_25[0] [0]

-----
conv2d_26 (Conv2D)              (None, 12, 12, 28)   7056
activation_25[0] [0]

-----
dropout_25 (Dropout)            (None, 12, 12, 28)   0           conv2d_26[0] [0]

-----
concatenate_22 (Concatenate)    (None, 12, 12, 56)   0
average_pooling2d_3[0] [0]
dropout_25[0] [0]

-----
batch_normalization_26 (BatchNo (None, 12, 12, 56)   224
concatenate_22[0] [0]
```

```
activation_26 (Activation)      (None, 12, 12, 56)    0
batch_normalization_26[0] [0]

-----
conv2d_27 (Conv2D)            (None, 12, 12, 28)   14112
activation_26[0] [0]

-----
dropout_26 (Dropout)          (None, 12, 12, 28)    0           conv2d_27[0] [0]

-----
concatenate_23 (Concatenate)  (None, 12, 12, 84)    0
concatenate_22[0] [0]
dropout_26[0] [0]

-----
batch_normalization_27 (BatchNo (None, 12, 12, 84)  336
concatenate_23[0] [0]

-----
activation_27 (Activation)    (None, 12, 12, 84)    0
batch_normalization_27[0] [0]

-----
conv2d_28 (Conv2D)            (None, 12, 12, 28)   21168
activation_27[0] [0]

-----
dropout_27 (Dropout)          (None, 12, 12, 28)    0           conv2d_28[0] [0]

-----
concatenate_24 (Concatenate)  (None, 12, 12, 112)   0
concatenate_23[0] [0]
dropout_27[0] [0]

-----
batch_normalization_28 (BatchNo (None, 12, 12, 112) 448
concatenate_24[0] [0]

-----
activation_28 (Activation)    (None, 12, 12, 112)   0
batch_normalization_28[0] [0]

-----
conv2d_29 (Conv2D)            (None, 12, 12, 28)   28224
activation_28[0] [0]
```

```
dropout_28 (Dropout)           (None, 12, 12, 28)  0           conv2d_29[0] [0]
-----
concatenate_25 (Concatenate)   (None, 12, 12, 140)  0
concatenate_24[0] [0]
dropout_28[0] [0]
-----
batch_normalization_29 (BatchNo (None, 12, 12, 140)  560
concatenate_25[0] [0]
-----
activation_29 (Activation)    (None, 12, 12, 140)  0
batch_normalization_29[0] [0]
-----
conv2d_30 (Conv2D)            (None, 12, 12, 28)  35280
activation_29[0] [0]
-----
dropout_29 (Dropout)          (None, 12, 12, 28)  0           conv2d_30[0] [0]
-----
concatenate_26 (Concatenate)   (None, 12, 12, 168)  0
concatenate_25[0] [0]
dropout_29[0] [0]
-----
batch_normalization_30 (BatchNo (None, 12, 12, 168)  672
concatenate_26[0] [0]
-----
activation_30 (Activation)    (None, 12, 12, 168)  0
batch_normalization_30[0] [0]
-----
conv2d_31 (Conv2D)            (None, 12, 12, 28)  42336
activation_30[0] [0]
-----
dropout_30 (Dropout)          (None, 12, 12, 28)  0           conv2d_31[0] [0]
-----
concatenate_27 (Concatenate)   (None, 12, 12, 196)  0
concatenate_26[0] [0]
dropout_30[0] [0]
-----
```

```
batch_normalization_31 (BatchNo (None, 12, 12, 196) 784
concatenate_27[0] [0]
-----
activation_31 (Activation)      (None, 12, 12, 196) 0
batch_normalization_31[0] [0]
-----
conv2d_32 (Conv2D)            (None, 12, 12, 28) 49392
activation_31[0] [0]
-----
dropout_31 (Dropout)          (None, 12, 12, 28) 0           conv2d_32[0] [0]
-----
concatenate_28 (Concatenate)   (None, 12, 12, 224) 0
concatenate_27[0] [0]
dropout_31[0] [0]
-----
conv2d_33 (Conv2D)            (None, 12, 12, 128) 258048
concatenate_28[0] [0]
-----
batch_normalization_32 (BatchNo (None, 12, 12, 128) 512           conv2d_33[0] [0]
-----
activation_32 (Activation)    (None, 12, 12, 128) 0
batch_normalization_32[0] [0]
-----
average_pooling2d_4 (AveragePoo (None, 6, 6, 128) 0
activation_32[0] [0]
-----
flatten_1 (Flatten)          (None, 4608) 0
average_pooling2d_4[0] [0]
-----
dense_1 (Dense)              (None, 17) 78353           flatten_1[0] [0]
=====
=====
Total params: 1,228,625
Trainable params: 1,220,177
Non-trainable params: 8,448
```

### path and Dataframe for train-Generator

```
[18]: # input for the Data-Generator's
train_generator = train_gen.flow_from_dataframe(
    # passing dataframe as input
    df,
    directory = '/content/assignment',
    x_col = 'path',
    y_col= 'category',
    shuffle = True,
    # this is the target directory
    target_size=(100,100), # all images will be resized to 150x150
    class_mode="categorical",
    # batch_size=32
    batch_size =32,
    seed=5
)
```

Found 15702 validated image filenames belonging to 17 classes.

```
[19]: # input for the valid-generator
valid_generator = valid_gen.flow_from_dataframe(
    # input for the valid_generator
    df,
    directory = '/content/assignment',
    x_col = 'path',
    y_col= 'category',
    shuffle = True,
    # this is the target directory
    target_size=(100,100), # all images will be resized to 150x150
    class_mode="categorical",
    batch_size =32,
    seed=5
)
```

Found 15702 validated image filenames belonging to 17 classes.

### creating a Model-Check-Point for storing the best validation\_loss

```
[0]: # creating a model checkpoint which monitors the training Loss
# Model stores the Parameters of Best Model which has low training-Loss
filepath = "/content/gdrive/My Drive/greendeck/weights_full_train-{epoch:  
→02d}-{val_acc:.2f}.hdf5"
checkpoint = ModelCheckpoint(filepath, monitor='val_loss', verbose=1,  
→save_best_only=True, mode='min')
callbacks_list = [checkpoint]
```

### Loading the best\_model-parameters

```
[20]: model = load_model('/content/gdrive/My Drive/greendeck/weights_full_train-40-0.  
→91.hdf5')
```

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:541: The name tf.placeholder is deprecated. Please use tf.compat.v1.placeholder instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:4432: The name tf.random\_uniform is deprecated. Please use tf.random.uniform instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:190: The name tf.get\_default\_session is deprecated. Please use tf.compat.v1.get\_default\_session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:197: The name tf.ConfigProto is deprecated. Please use tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:203: The name tf.Session is deprecated. Please use tf.compat.v1.Session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:207: The name tf.global\_variables is deprecated. Please use tf.compat.v1.global\_variables instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:216: The name tf.is\_variable\_initialized is deprecated. Please use tf.compat.v1.is\_variable\_initialized instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:223: The name tf.variables\_initializer is deprecated. Please use tf.compat.v1.variables\_initializer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:2041: The name tf.nn.fused\_batch\_norm is deprecated. Please use tf.compat.v1.nn.fused\_batch\_norm instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow\_backend.py:3733: calling dropout (from tensorflow.python.ops.nn\_ops) with keep\_prob is deprecated and will be removed in a future version.

Instructions for updating:

```
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4271: The name tf.nn.avg_pool is deprecated. Please use tf.nn.avg_pool2d instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/optimizers.py:793: The name tf.train.Optimizer is deprecated. Please use tf.compat.v1.train.Optimizer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3576: The name tf.log is deprecated. Please use tf.math.log instead.
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/math_grad.py:1424: where (from tensorflow.python.ops.array_ops) is deprecated and will be removed in a future version.
```

Instructions for updating:

Use tf.where in 2.0, which has the same broadcast rule as np.where

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1033: The name tf.assign_add is deprecated. Please use tf.compat.v1.assign_add instead.
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1020: The name tf.assign is deprecated. Please use tf.compat.v1.assign instead.
```

## Training the Model - Interrupted Manually after we get the Best parameters for the Validation\_data

```
[0]: STEP_SIZE_TRAIN=(train_generator.n//train_generator.batch_size +1)
STEP_SIZE_VALID=(valid_generator.n//valid_generator.batch_size +1)
model.fit_generator(generator=train_generator,
                    steps_per_epoch=STEP_SIZE_TRAIN,
                    validation_data=valid_generator,
                    validation_steps=STEP_SIZE_VALID,
                    epochs=75,
                    callbacks=callbacks_list)
```

```
Epoch 1/75
491/491 [=====] - 332s 677ms/step - loss: 0.3462 - acc: 0.8826 - val_loss: 0.6478 - val_acc: 0.8305
```

```
Epoch 00001: val_loss did not improve from 0.37642
Epoch 2/75
491/491 [=====] - 330s 673ms/step - loss: 0.3456 - acc: 0.8785 - val_loss: 2.1546 - val_acc: 0.6218
```

```
Epoch 00002: val_loss did not improve from 0.37642
Epoch 3/75
491/491 [=====] - 338s 689ms/step - loss: 0.3565 - acc: 0.8771 - val_loss: 0.3410 - val_acc: 0.8924

Epoch 00003: val_loss improved from 0.37642 to 0.34095, saving model to /content/gdrive/My Drive/greendeck/weights_full_train-03-0.89.hdf5
Epoch 4/75
491/491 [=====] - 340s 692ms/step - loss: 0.3533 - acc: 0.8805 - val_loss: 0.5823 - val_acc: 0.8372

Epoch 00004: val_loss did not improve from 0.34095
Epoch 5/75
491/491 [=====] - 340s 692ms/step - loss: 0.3547 - acc: 0.8782 - val_loss: 0.6825 - val_acc: 0.8295

Epoch 00005: val_loss did not improve from 0.34095
Epoch 6/75
491/491 [=====] - 336s 684ms/step - loss: 0.3480 - acc: 0.8807 - val_loss: 0.8067 - val_acc: 0.8186

Epoch 00006: val_loss did not improve from 0.34095
Epoch 7/75
491/491 [=====] - 341s 694ms/step - loss: 0.3468 - acc: 0.8787 - val_loss: 0.6742 - val_acc: 0.8261

Epoch 00007: val_loss did not improve from 0.34095
Epoch 8/75
491/491 [=====] - 343s 698ms/step - loss: 0.3460 - acc: 0.8833 - val_loss: 1.4571 - val_acc: 0.7181

Epoch 00008: val_loss did not improve from 0.34095
Epoch 9/75
491/491 [=====] - 341s 694ms/step - loss: 0.3411 - acc: 0.8837 - val_loss: 0.5171 - val_acc: 0.8528

Epoch 00009: val_loss did not improve from 0.34095
Epoch 10/75
491/491 [=====] - 339s 691ms/step - loss: 0.3414 - acc: 0.8826 - val_loss: 1.0241 - val_acc: 0.7675

Epoch 00010: val_loss did not improve from 0.34095
Epoch 11/75
491/491 [=====] - 338s 689ms/step - loss: 0.3362 - acc: 0.8839 - val_loss: 0.4703 - val_acc: 0.8617

Epoch 00011: val_loss did not improve from 0.34095
```

```
Epoch 12/75
491/491 [=====] - 339s 691ms/step - loss: 0.3325 - acc: 0.8864 - val_loss: 0.7172 - val_acc: 0.8242

Epoch 00012: val_loss did not improve from 0.34095
Epoch 13/75
491/491 [=====] - 336s 685ms/step - loss: 0.3377 - acc: 0.8827 - val_loss: 0.4575 - val_acc: 0.8698

Epoch 00013: val_loss did not improve from 0.34095
Epoch 14/75
491/491 [=====] - 336s 685ms/step - loss: 0.3379 - acc: 0.8857 - val_loss: 0.4396 - val_acc: 0.8682

Epoch 00014: val_loss did not improve from 0.34095
Epoch 15/75
491/491 [=====] - 337s 686ms/step - loss: 0.3338 - acc: 0.8864 - val_loss: 1.3006 - val_acc: 0.7522

Epoch 00015: val_loss did not improve from 0.34095
Epoch 16/75
491/491 [=====] - 339s 690ms/step - loss: 0.3291 - acc: 0.8891 - val_loss: 0.3603 - val_acc: 0.8904

Epoch 00016: val_loss did not improve from 0.34095
Epoch 17/75
491/491 [=====] - 339s 691ms/step - loss: 0.3331 - acc: 0.8850 - val_loss: 0.3532 - val_acc: 0.8900

Epoch 00017: val_loss did not improve from 0.34095
Epoch 18/75
491/491 [=====] - 329s 671ms/step - loss: 0.3232 - acc: 0.8876 - val_loss: 2.5512 - val_acc: 0.6404

Epoch 00018: val_loss did not improve from 0.34095
Epoch 19/75
491/491 [=====] - 326s 663ms/step - loss: 0.3209 - acc: 0.8901 - val_loss: 3.2293 - val_acc: 0.5854

Epoch 00019: val_loss did not improve from 0.34095
Epoch 20/75
491/491 [=====] - 327s 667ms/step - loss: 0.3279 - acc: 0.8852 - val_loss: 0.3543 - val_acc: 0.8933

Epoch 00020: val_loss did not improve from 0.34095
Epoch 21/75
491/491 [=====] - 324s 661ms/step - loss: 0.3235 - acc: 0.8853 - val_loss: 0.4347 - val_acc: 0.8753
```

```
Epoch 00021: val_loss did not improve from 0.34095
Epoch 22/75
491/491 [=====] - 331s 674ms/step - loss: 0.3188 - acc: 0.8882 - val_loss: 0.9028 - val_acc: 0.7711

Epoch 00022: val_loss did not improve from 0.34095
Epoch 23/75
491/491 [=====] - 335s 682ms/step - loss: 0.3033 - acc: 0.8945 - val_loss: 0.5037 - val_acc: 0.8584

Epoch 00023: val_loss did not improve from 0.34095
Epoch 24/75
491/491 [=====] - 334s 679ms/step - loss: 0.3097 - acc: 0.8960 - val_loss: 0.3149 - val_acc: 0.9035

Epoch 00024: val_loss improved from 0.34095 to 0.31490, saving model to /content/gdrive/My Drive/greendeck/weights_full_train-24-0.90.hdf5
Epoch 25/75
491/491 [=====] - 330s 673ms/step - loss: 0.3164 - acc: 0.8920 - val_loss: 0.8255 - val_acc: 0.8059

Epoch 00025: val_loss did not improve from 0.31490
Epoch 26/75
491/491 [=====] - 331s 674ms/step - loss: 0.3124 - acc: 0.8903 - val_loss: 0.3491 - val_acc: 0.8921

Epoch 00026: val_loss did not improve from 0.31490
Epoch 27/75
491/491 [=====] - 330s 673ms/step - loss: 0.3209 - acc: 0.8909 - val_loss: 1.5468 - val_acc: 0.7219

Epoch 00027: val_loss did not improve from 0.31490
Epoch 28/75
491/491 [=====] - 326s 664ms/step - loss: 0.2928 - acc: 0.8992 - val_loss: 0.4461 - val_acc: 0.8700

Epoch 00028: val_loss did not improve from 0.31490
Epoch 29/75
491/491 [=====] - 330s 672ms/step - loss: 0.3122 - acc: 0.8915 - val_loss: 0.3187 - val_acc: 0.8970

Epoch 00029: val_loss did not improve from 0.31490
Epoch 30/75
491/491 [=====] - 333s 677ms/step - loss: 0.3065 - acc: 0.8954 - val_loss: 0.6167 - val_acc: 0.8370

Epoch 00030: val_loss did not improve from 0.31490
```

```
Epoch 31/75
491/491 [=====] - 335s 682ms/step - loss: 0.3032 - acc: 0.8969 - val_loss: 0.3980 - val_acc: 0.8878

Epoch 00031: val_loss did not improve from 0.31490
Epoch 32/75
491/491 [=====] - 331s 674ms/step - loss: 0.3056 - acc: 0.8941 - val_loss: 0.3674 - val_acc: 0.8887

Epoch 00032: val_loss did not improve from 0.31490
Epoch 33/75
491/491 [=====] - 337s 686ms/step - loss: 0.2937 - acc: 0.9009 - val_loss: 0.4094 - val_acc: 0.8808

Epoch 00033: val_loss did not improve from 0.31490
Epoch 34/75
491/491 [=====] - 336s 684ms/step - loss: 0.2969 - acc: 0.8959 - val_loss: 0.3160 - val_acc: 0.9000

Epoch 00034: val_loss did not improve from 0.31490
Epoch 35/75
491/491 [=====] - 336s 684ms/step - loss: 0.3105 - acc: 0.8917 - val_loss: 0.4664 - val_acc: 0.8724

Epoch 00035: val_loss did not improve from 0.31490
Epoch 36/75
491/491 [=====] - 339s 690ms/step - loss: 0.2977 - acc: 0.8982 - val_loss: 0.3426 - val_acc: 0.8971

Epoch 00036: val_loss did not improve from 0.31490
Epoch 37/75
491/491 [=====] - 336s 684ms/step - loss: 0.3000 - acc: 0.8955 - val_loss: 0.4364 - val_acc: 0.8712

Epoch 00037: val_loss did not improve from 0.31490
Epoch 38/75
491/491 [=====] - 336s 685ms/step - loss: 0.2938 - acc: 0.8972 - val_loss: 0.3109 - val_acc: 0.9024

Epoch 00038: val_loss improved from 0.31490 to 0.31090, saving model to /content/gdrive/My Drive/greendeck/weights_full_train-38-0.90.hdf5
Epoch 39/75
491/491 [=====] - 332s 676ms/step - loss: 0.3022 - acc: 0.8963 - val_loss: 0.4078 - val_acc: 0.8738

Epoch 00039: val_loss did not improve from 0.31090
Epoch 40/75
491/491 [=====] - 333s 678ms/step - loss: 0.2964 - acc:
```

```
0.8983 - val_loss: 0.2679 - val_acc: 0.9124
```

```
Epoch 00040: val_loss improved from 0.31090 to 0.26786, saving model to  
/content/gdrive/My Drive/greendeck/weights_full_train-40-0.91.hdf5
```

```
Epoch 41/75
```

```
90/491 [====>...] - ETA: 2:09 - loss: 0.2745 - acc:  
0.9115
```

```
-----  
KeyboardInterrupt Traceback (most recent call last)  
<ipython-input-23-0fbe253eb21d> in <module>()  
      6             validation_steps=STEP_SIZE_VALID,  
      7             epochs=75,  
--> 8             callbacks=callbacks_list)  
  
/usr/local/lib/python3.6/dist-packages/keras/legacy/interfaces.py in __  
 wrapper(*args, **kwargs)  
     89         warnings.warn('Update your `' + object_name + '` call to  
--> the ' +  
     90         'Keras 2 API: ' + signature, stacklevel=2  
---> 91     return func(*args, **kwargs)  
     92     wrapper._original_function = func  
     93     return wrapper  
  
/usr/local/lib/python3.6/dist-packages/keras/engine/training.py in __  
 fit_generator(self, generator, steps_per_epoch, epochs, verbose, callbacks, __  
 validation_data, validation_steps, validation_freq, class_weight, __  
 max_queue_size, workers, use_multiprocessing, shuffle, initial_epoch)  
1656         use_multiprocessing=use_multiprocessing,  
1657         shuffle=shuffle,  
-> 1658         initial_epoch=initial_epoch)  
  
1659  
1660     @interfaces.legacy_generator_methods_support  
  
/usr/local/lib/python3.6/dist-packages/keras/engine/training_generator.py in __  
 fit_generator(model, generator, steps_per_epoch, epochs, verbose, callbacks, __  
 validation_data, validation_steps, validation_freq, class_weight, __  
 max_queue_size, workers, use_multiprocessing, shuffle, initial_epoch)  
213         outs = model.train_on_batch(x, y,  
214                                     sample_weight=sample_weight  
--> 215                                     class_weight=class_weight)  
  
216  
217         outs = to_list(outs)  
  
/usr/local/lib/python3.6/dist-packages/keras/engine/training.py in __  
 train_on_batch(self, x, y, sample_weight, class_weight)  
1447         ins = x + y + sample_weights
```

```

1448         self._make_train_function()
-> 1449         outputs = self.train_function(ins)
1450         return unpack_singleton(outputs)
1451

/usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py in __call__(self, inputs)
2977             return self._legacy_call(inputs)
2978
-> 2979             return self._call(inputs)
2980         else:
2981             if py_any(is_tensor(x) for x in inputs):

/usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py in __call__(self, inputs)
2935             fetched = self._callable_fn(*array_vals, run_metadata=self._run_metadata)
2936         else:
-> 2937             fetched = self._callable_fn(*array_vals)
2938         return fetched[:len(self.outputs)]
2939

/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/client/session.py in __call__(self, *args, **kwargs)
1470         ret = tf_session.TF_SessionRunCallable(self._session._session,
1471                                              self._handle, args,
-> 1472                                              run_metadata_ptr)
1473         if run_metadata:
1474             proto_data = tf_session.TF_GetBuffer(run_metadata_ptr)

KeyboardInterrupt:

```

## 7 Predicting The output

```
[21]: model.evaluate_generator(valid_generator,steps=491,verbose=1)
```

```
491/491 [=====] - 194s 396ms/step
```

```
[21]: [0.2638339966349565, 0.9140236912267464]
```

```
[22]: # Resetting the valid-generator
valid_generator.reset()
# Taking the output's of model
# pred gives us a output 17-dim Vector
pred=model.predict_generator(valid_generator,steps=491,verbose=1)
```

```
491/491 [=====] - 175s 355ms/step
```

```
[23]: pred.shape
```

```
[23]: (15702, 17)
```

Dictionary which contains Class-Label's and Class-Encoding for that class

```
[24]: # labels contain the classes
labels = (valid_generator.class_indices)
labels
```

```
[24]: {'OTHER': 0,
       'animal': 1,
       'cartoon': 2,
       'chevron': 3,
       'floral': 4,
       'geometry': 5,
       'houndstooth': 6,
       'ikat': 7,
       'letter_numb': 8,
       'plain': 9,
       'polka_dot': 10,
       'scales': 11,
       'skull': 12,
       'squares': 13,
       'stars': 14,
       'stripes': 15,
       'tribal': 16}
```

```
[25]: # labels contain classes which contain key is class_id and value is class
labels = dict((v,k) for k,v in labels.items())
labels
```

```
[25]: {0: 'OTHER',
       1: 'animal',
       2: 'cartoon',
       3: 'chevron',
       4: 'floral',
       5: 'geometry',
       6: 'houndstooth',
       7: 'ikat',
       8: 'letter_numb',
       9: 'plain',
       10: 'polka_dot',
       11: 'scales',
       12: 'skull',
       13: 'squares',
       14: 'stars',
```

```
15: 'stripes',
16: 'tribal'}
```

```
[0]: # list_classes contain list of classes
list_classes = list(labels.values())
```

## 8 Output\_Layer-Matrix(last Layer representation of each Image)

```
[0]: # We store the Last layer Representation of Image in the output_layer matrix
import numpy as np
output_layer_matrix = np.zeros((df.shape[0],17))
```

```
[0]: df['prediction_label'] = 0
```

```
[29]: # load the Image
from tqdm import tqdm
output_labels = []
for i in tqdm(range(len(list(df['path'])))):

    image = cv2.imread('/content/assignment/' + df['path'][i])
    image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
#resize image to appropriate dimensions
    image = cv2.resize(image, (100,100))
    image = image.reshape((1, image.shape[0], image.shape[1], image.shape[2]))
    output_layer_matrix[i] = model.predict(image)[0]
    output_labels.append(list(np.argmax(model.predict(image), axis=1))[0])
```

```
100% | 15702/15702 [05:31<00:00, 47.36it/s]
```

```
[0]: df['prediction_label'] = [labels[output_labels[i]] for i in
                             range(len(output_labels))]
```

```
[31]: output_layer_matrix.shape
```

```
[31]: (15702, 17)
```

## 9 saving results to CSV

```
[32]: # create a DF with filenames, Prediction's and also Actual category of that
      ↳image
df.head()
```

```
[32]:   _unit_id   category ...                                path
prediction_label
0  851505458       ikat ...  5f635c0fa59f4270a6953f67dcddcda3.png
ikat
```

```

1 851505459      plain ... ca5ca27caca94f9fb0617c226477ae35.png
plain
2 851505460 polka dot ... 7be73e354249484db5a8ddf4e05cc63b.png
squares
3 851505461      plain ... 7e241481162649d39048f522d0653e03.png
plain
4 851505462 geometry ... 808d0bf9fe9745fca13ab461f86e0e4e.png
geometry

```

[5 rows x 6 columns]

## 10 Confusion Matrix,Precision Matrix, Recall Matrix

Precision matrix says of all those images predicted of class-(X) how many Images Actually belong to that particular class-(X) We could also assume that How many Images of Class-(X) are wrongly predicted

Recall matrix says of all those images actually belong of class-(X)... how many Images are Predicted belong to that particular class-(X) We could also assume that How many Images of Class-(X) are Missing

```

[0]: from sklearn.metrics import accuracy_score
from sklearn.metrics import confusion_matrix
import seaborn as sns
def plot_confusion_matrix(test_y, predict_y):
    C = confusion_matrix(test_y, predict_y)

    # C = 17,17 matrix, each cell (i,j) represents number of points of class i
    # are predicted class j

    A =(((C.T)/(C.sum(axis=1))).T)
    #divid each element of the confusion matrix with the sum of elements in
    #that column

    # C = [[1, 2],
    #      [3, 4]]
    # C.T = [[1, 3],
    #          [2, 4]]
    # C.sum(axis = 1) axis=0 corresonds to columns and axis=1 corresponds to
    #rows in two diamensional array
    # C.sum(axix =1) = [[3, 7]]
    # ((C.T)/(C.sum(axis=1))) = [[1/3, 3/7]
    #                           [2/3, 4/7]]

    # ((C.T)/(C.sum(axis=1))).T = [[1/3, 2/3]
    #                           [3/7, 4/7]]
    # sum of row elements = 1

```

```

B =(C/C.sum(axis=0))
#divid each element of the confusion matrix with the sum of elements in
→that row
# C = [[1, 2],
#       [3, 4]]
# C.sum(axis = 0) axis=0 corresonds to columns and axis=1 corresponds to
→rows in two diamensional array
# C.sum(axix =0) = [[4, 6]]
# (C/C.sum(axis=0)) = [[1/4, 2/6],
#                      [3/4, 4/6]]
# Confusion matrix
labels = list_classes
cmap=sns.light_palette("red")
# representing A in heatmap format
print("-"*50, "Confusion matrix", "*50)
plt.figure(figsize=(17,17))
sns.heatmap(C, annot=True, cmap=cmap, fmt='d',xticklabels=labels,
→yticklabels=labels)
plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()

# PRECISION MATRIX
print("-"*50, "Precision matrix", "*50)
cmap=sns.light_palette("green")
plt.figure(figsize=(17,17))
sns.heatmap(B, annot=True, cmap=cmap, fmt=".2g", xticklabels=labels,
→yticklabels=labels)
plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()
print("Sum of columns in precision matrix",B.sum(axis=0))

# RECALL MATRIX
# representing B in heatmap format
print("-"*50, "Recall matrix" , "*50)
cmap=sns.light_palette("blue")
plt.figure(figsize=(17,17))
sns.heatmap(A, annot=True, cmap=cmap, fmt=".2g", xticklabels=labels,
→yticklabels=labels)
plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()
print("Sum of rows in precision matrix",A.sum(axis=1))
# how many images are wrongly Predicted

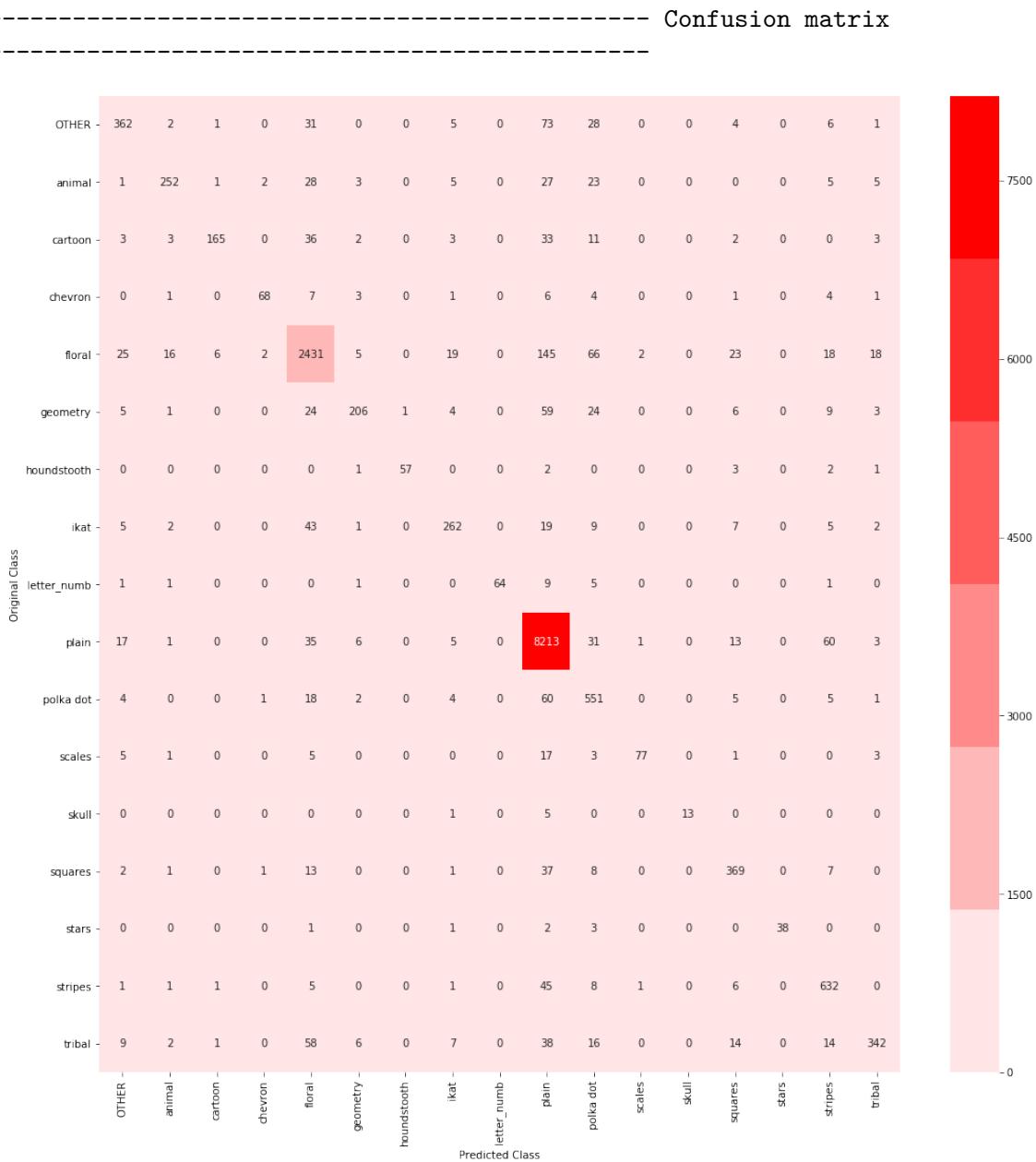
```

```

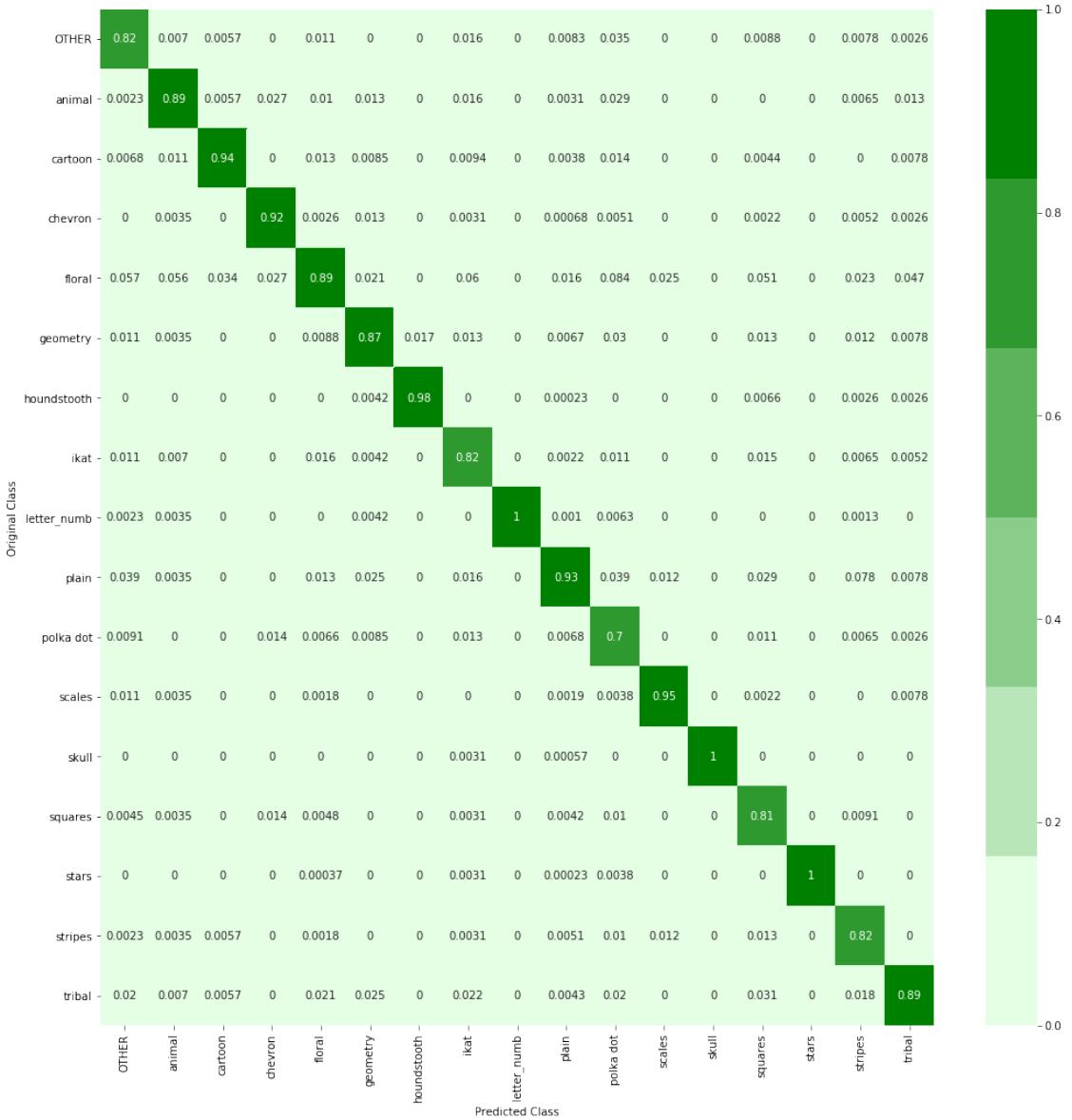
print("Number of misclassified points ",(len(test_y)-np.trace(C))/
→len(test_y)*100)

```

[34]: `plot_confusion_matrix(df['category'],df['prediction_label'])`

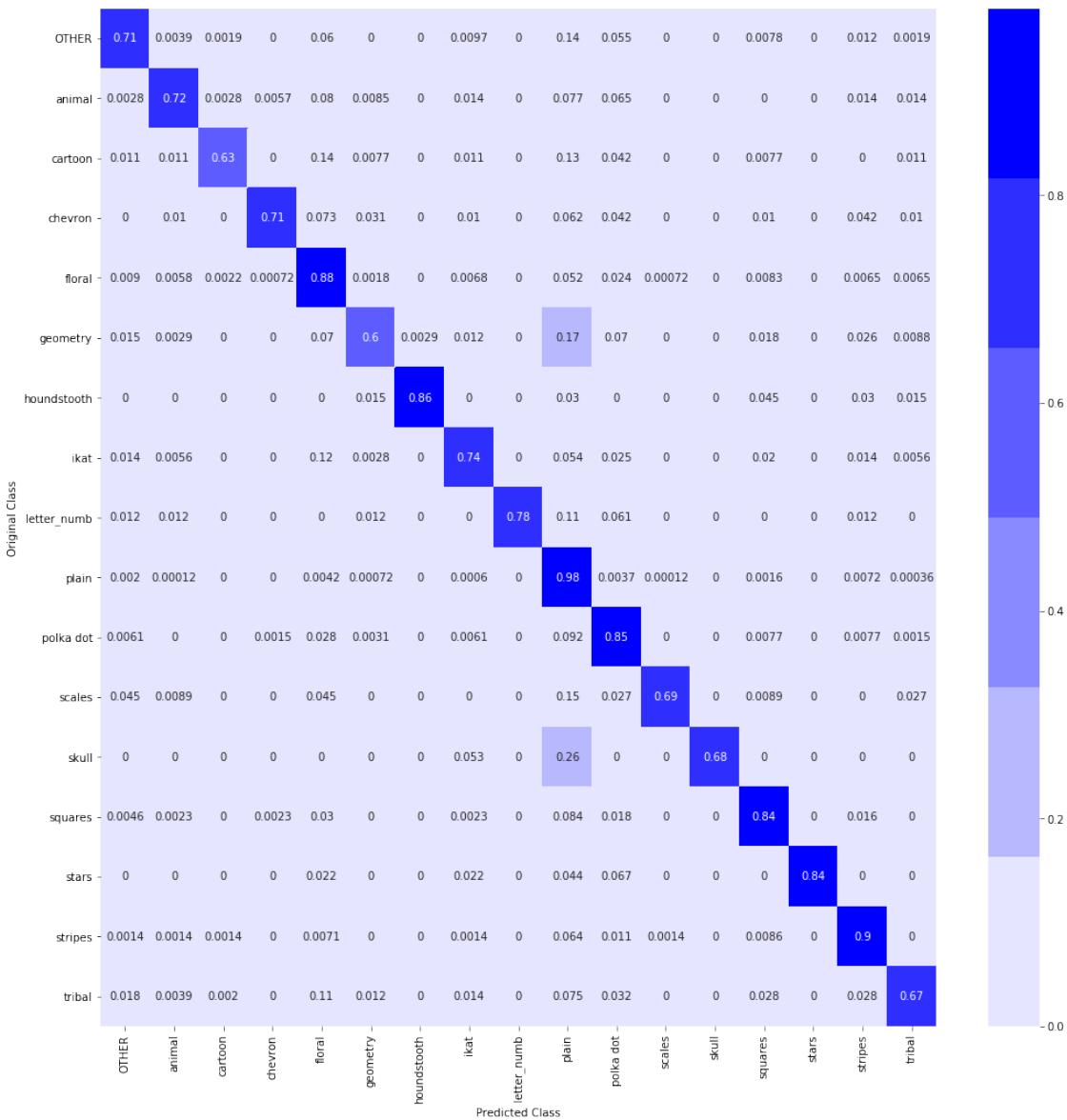


----- Precision matrix -----



Sum of columns in precision matrix [1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]

----- Recall matrix -----



Sum of rows in precision matrix [1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]

Number of misclassified points 10.18978474079735

## 11 print the similar images belonging to that Image

Given a REAL\_TIME-test image - Find the similar images to test Image Images are Downloaded from Google

```
[0]: # we are given a Input Image and Find the Similar images to Given Input Image
def Similar_products_path(path,num_products):
```

```

image = cv2.imread(path)
print('Input Image')

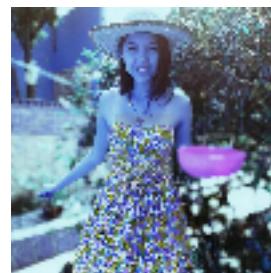
image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
#resize image to appropriate dimensions
image = cv2.resize(image, (100,100))
cv2_imshow(image)
image = image.reshape((1, image.shape[0], image.shape[1], image.shape[2]))

print("Input-Image-Class =", labels[list(np.argmax(model.
→predict(image), axis=1))[0]])
output_layer_path = model.predict(image)[0]
# take the similar of images based on Image_vector present in the Layer layer
# we stored representation of each image in the output_layer-MATRIX
pairwise_dist = pairwise_distances(output_layer_matrix, output_layer_path.
→reshape(1,-1))
# take the first 10 products which are similar to the given image
indices = np.argsort(pairwise_dist.flatten())[0:num_products]
pdists = np.sort(pairwise_dist.flatten())[0:num_products]
print('Similar Images to given Input Image')
for i in range(num_products):
    cv2_imshow(cv2.imread('/content/assignment/' + list(df.
→loc[indices, 'path'])[i]))
    print(df.loc[indices[i], 'prediction_label'])

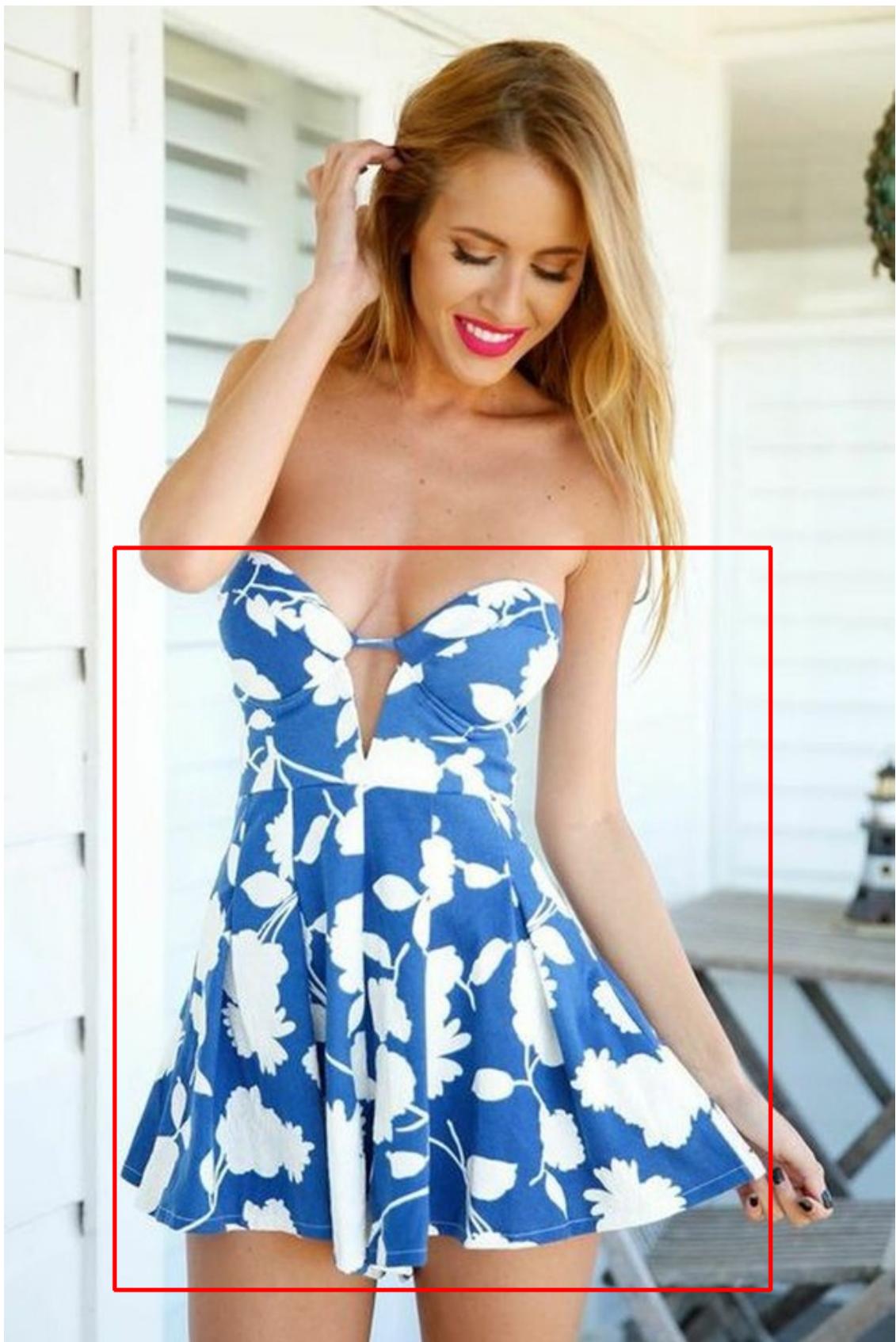
```

[50]: Similar\_products\_path('/content/floral\_image.jpg',10)

Input Image



Input-Image-Class = floral  
Similar Images to given Input Image



floral



floral



floral



floral



floral



floral



floral



floral



floral



floral

```
[52]: Similar_products_path('/content/plain.jpg',10)
```

Input Image



Input-Image-Class = plain

Similar Images to given Input Image



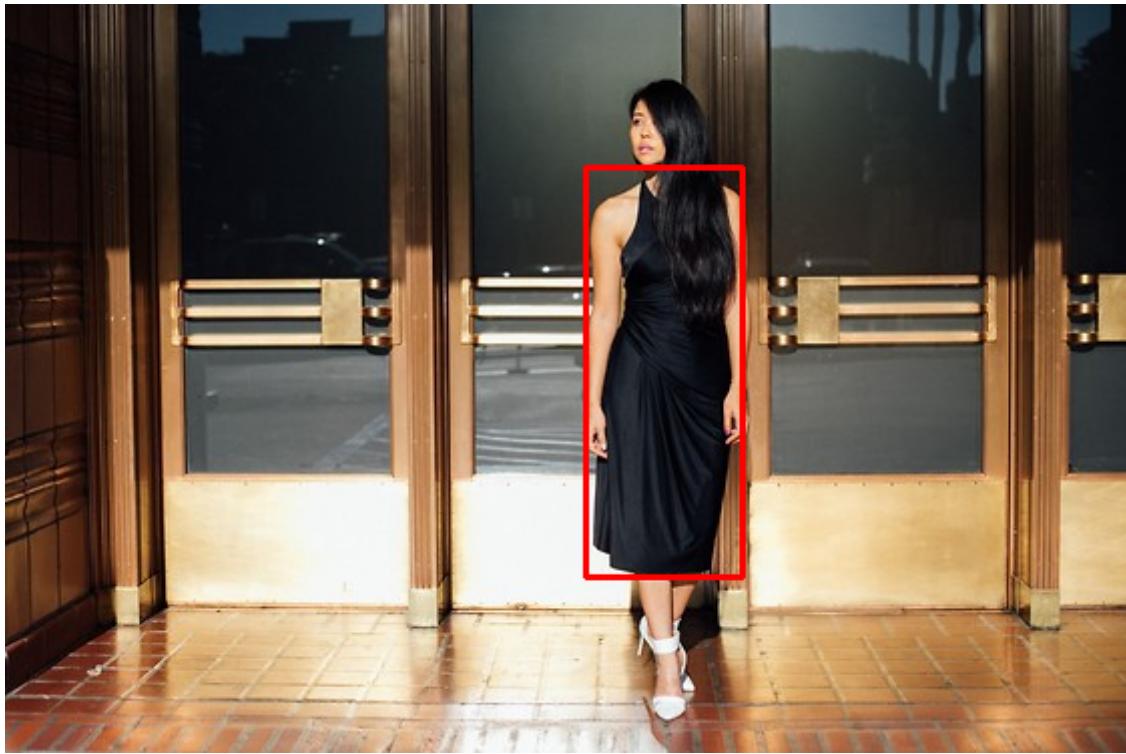
plain



plain



plain



plain



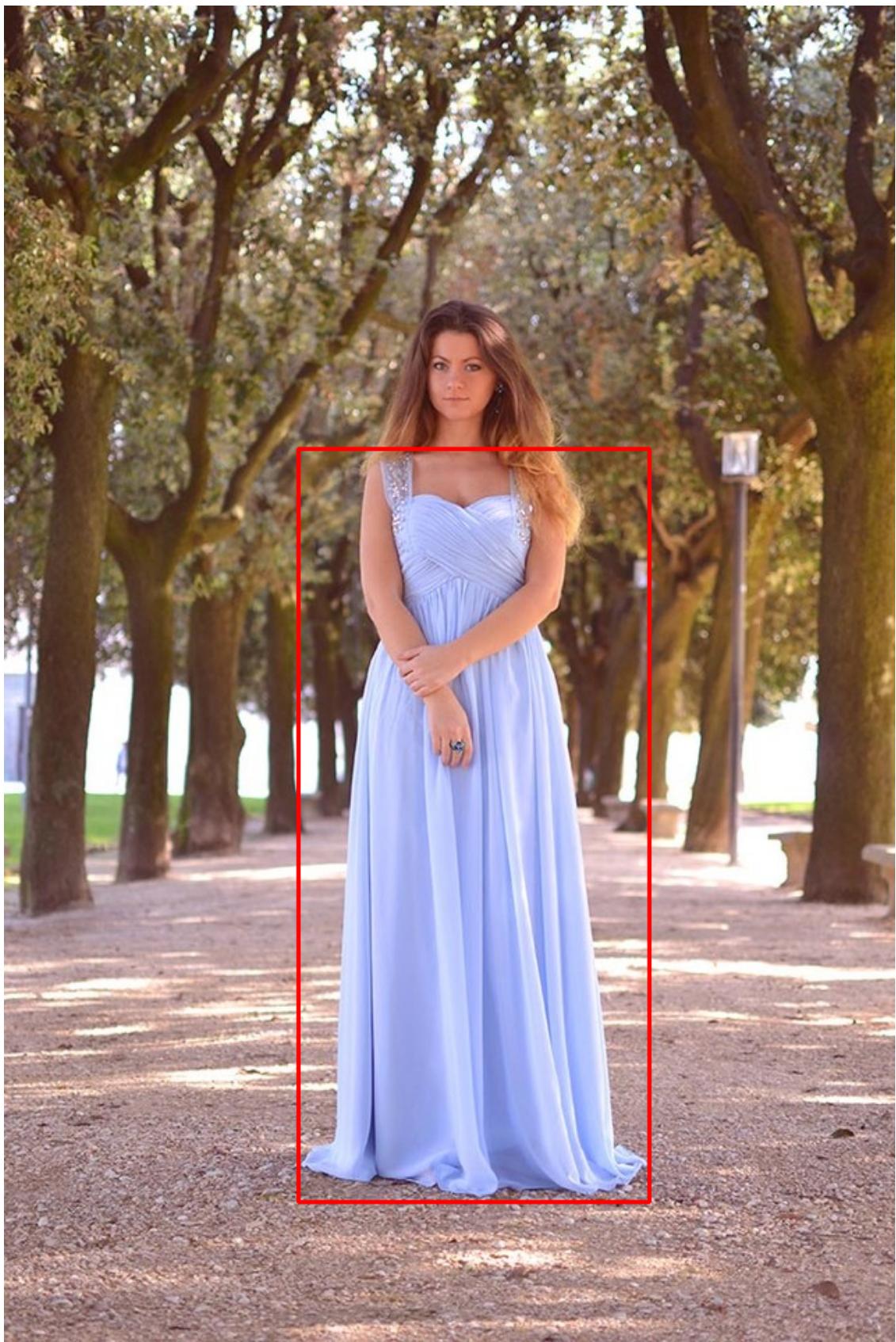
plain



plain



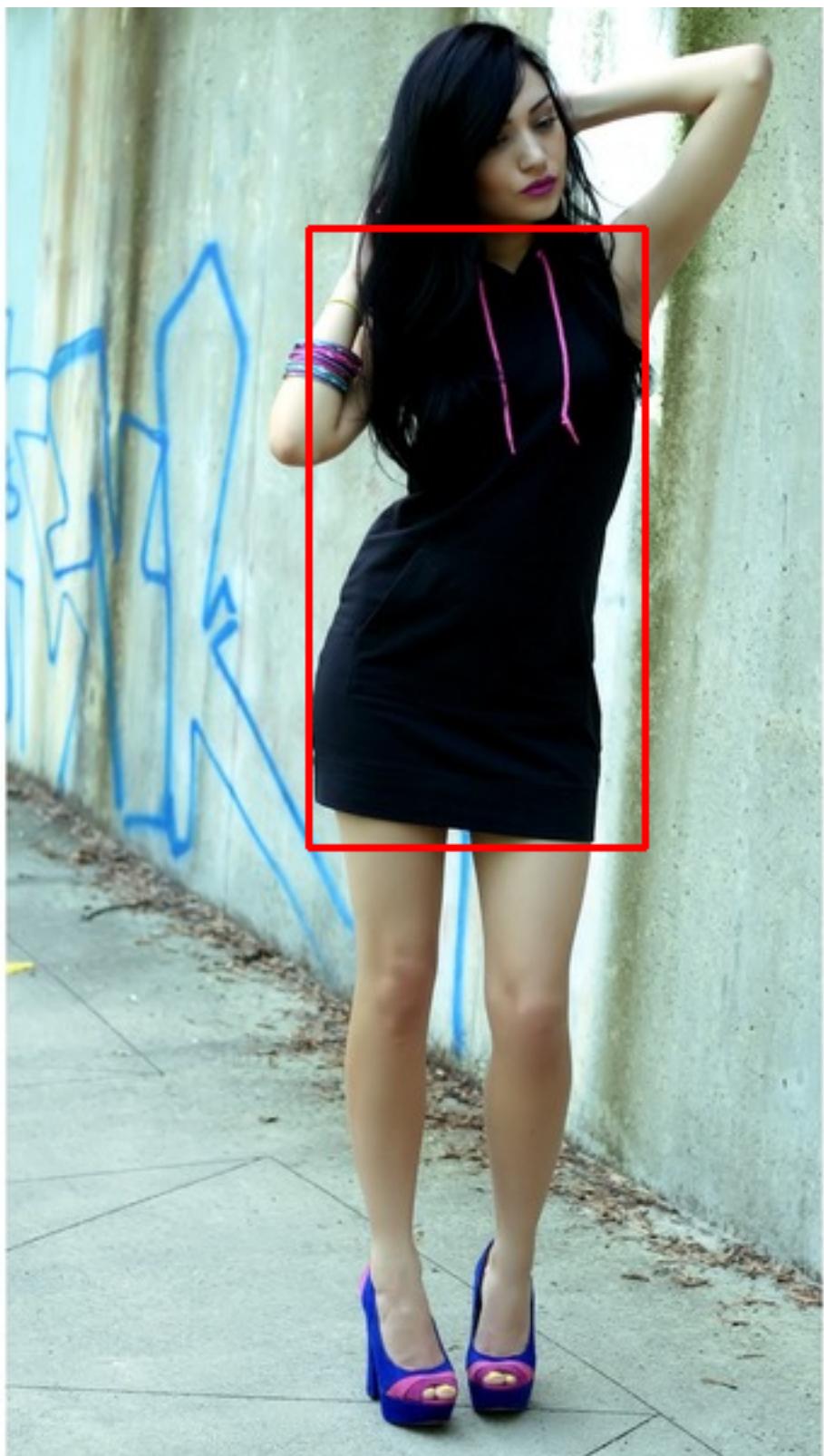
plain



plain



plain



plain

Given a Image from train-set find similar images to the given Image

[0]: `def Similar_products(image_index,num_products):`

```
# take the similar of images based on Image_vector present in the Layer layer
# we stored representation of each image in the output_layer-MATRIX
pairwise_dist = pairwise_distances(output_layer_matrix,
                                   output_layer_matrix[image_index].reshape(1,-1))
# take the first 10 products which are similar to the given image
indices = np.argsort(pairwise_dist.flatten())[0:num_products]
pdists = np.sort(pairwise_dist.flatten())[0:num_products]
print('Similar Images to given Input Image')
for i in range(num_products):
    cv2_imshow(cv2.imread('/content/assignment/' + list(df.
                                                       loc[indices,'path'])[i]))
    print(df.loc[indices[i], 'prediction_label'])
```

[60]: `# the first Image is the given input Image and other Images are Similar Image
 ↪given index
# generates a random Number from the train Images and print similar images to
 ↪the Given input-1st Image
Similar_products(random.randrange(0,df.shape[0]),10)`

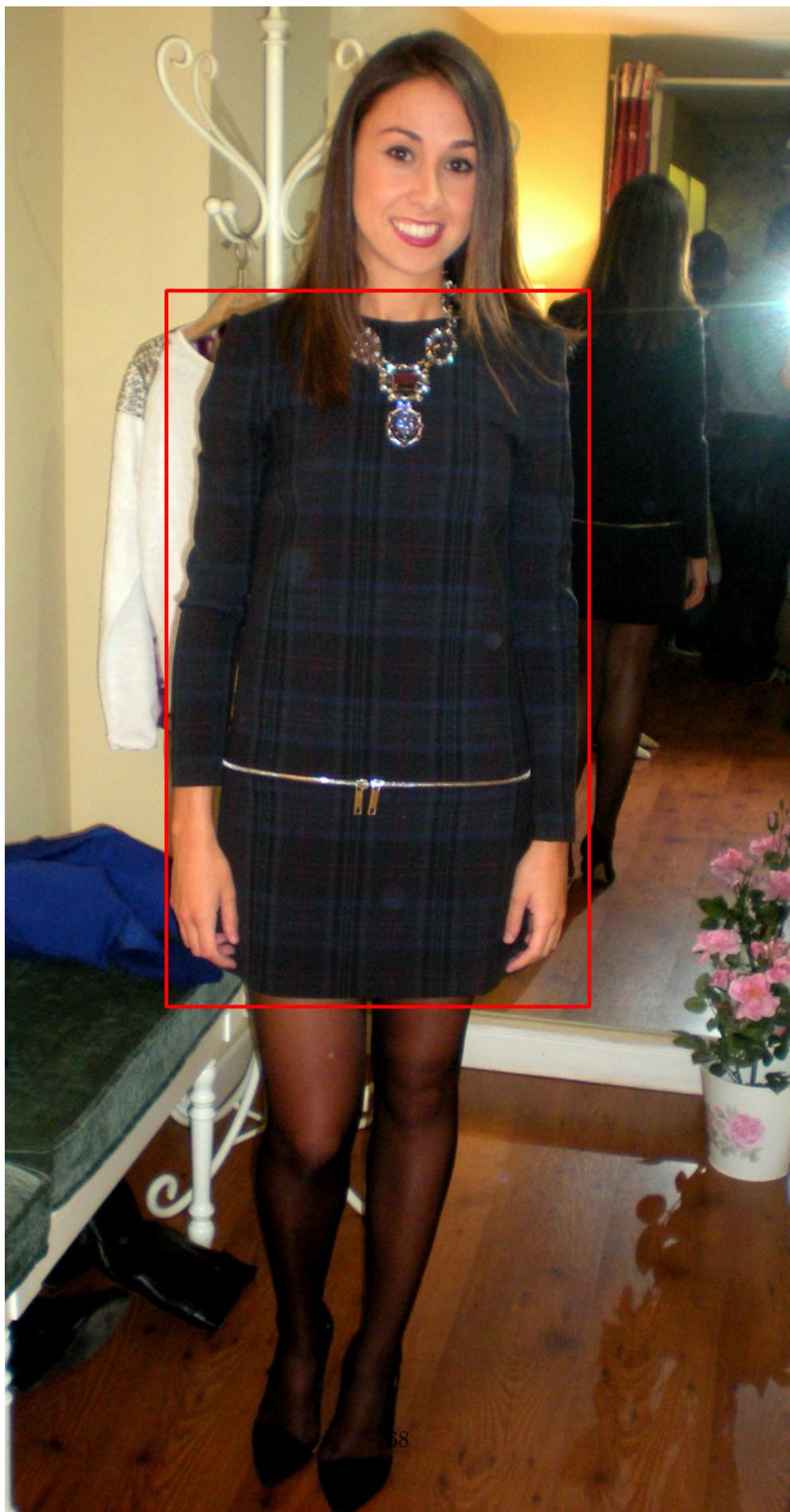
Similar Images to given Input Image



squares



squares



squares



squares



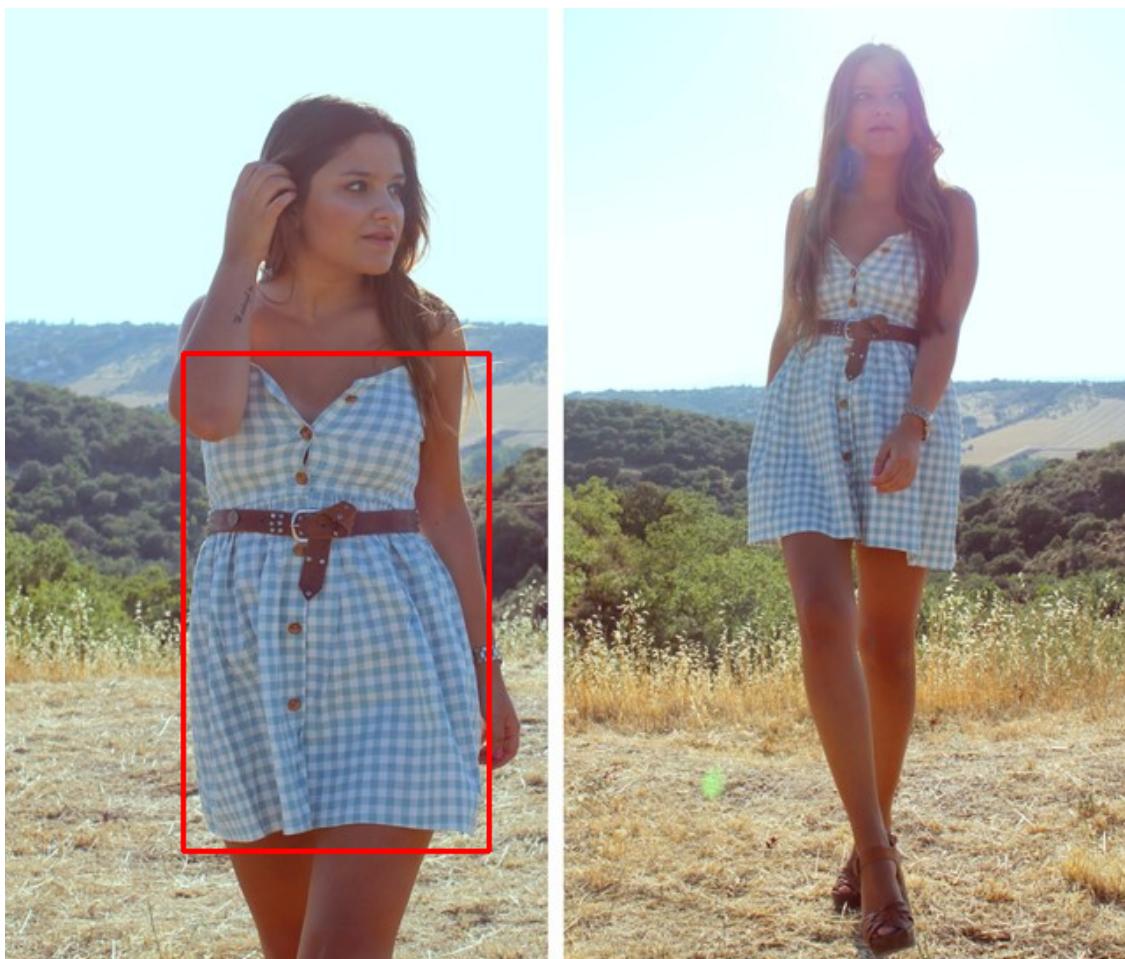
squares



squares



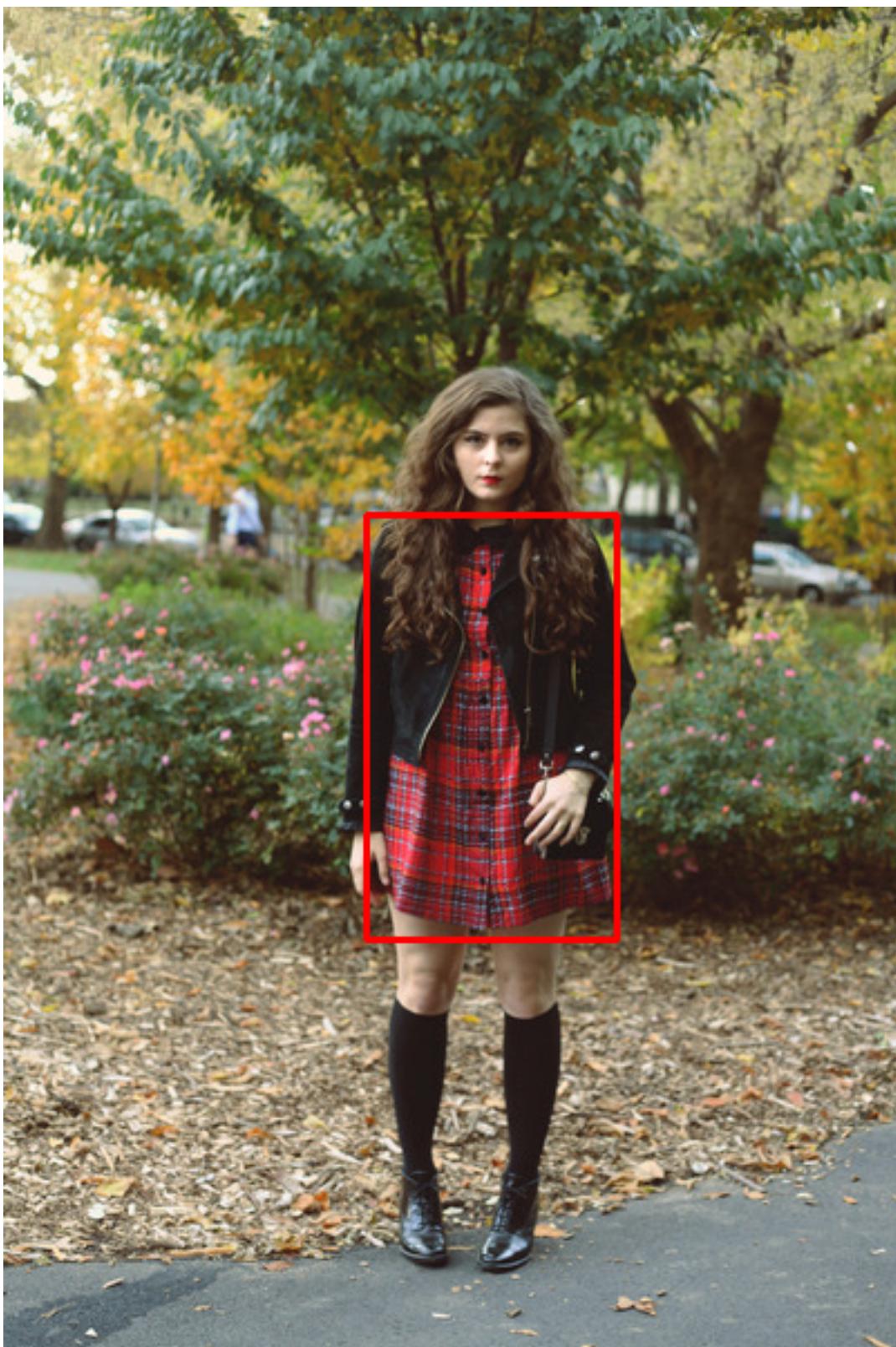
squares



squares



squares



```
squares
```

## 12 what the Model is Seeing - Visualising and Understanding from Images

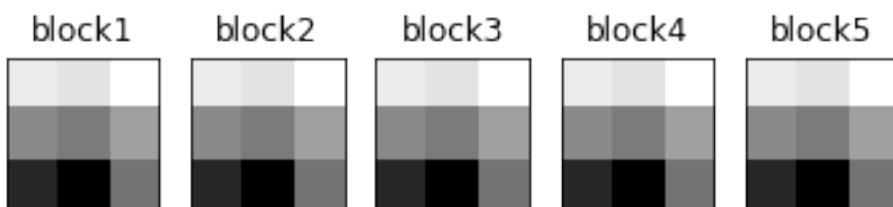
```
[0]: # contain the layer-names  
layers_info = {}  
for i in model.layers:  
    layers_info[i.name] = i.get_config()
```

```
[0]: model.layers[64]
```

```
[0]: <keras.layers.convolutional.Conv2D at 0x7feaa2b732b0>
```

which parts of Convolutions are activated for a particular Filter in a Particular Layer

```
[0]: # model-layer  
layers = model.layers  
# Index of that particular Index  
layer_ids = [64,114,94,14, 4]  
#plot the filters  
fig,ax = plt.subplots(nrows=1,ncols=5)  
for i in range(5):  
    # take a particular filter and get their weights and Visualize the Filter  
    # we are taking only one filter which is a gray-scale image  
    # we could see which parts of filter are activated  
    ax[i].imshow(layers[layer_ids[0]].get_weights()[0][:,:,:,:0][:,:,  
→,0],cmap='gray')  
    ax[i].set_title('block'+str(i+1))  
    ax[i].set_xticks([])  
    ax[i].set_yticks([])
```



Load the Input Image

```
[0]: import cv2
```

```
[0]: # load the Image
image = cv2.imread('/content/00073f06539e4dd7b81f6009eedbcae3.png')
cv2_imshow(image)
image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
#resize image to appropriate dimensions

image = cv2.resize(image, (100,100))
```



### Visualize the output at particular Layer of a respective Image

```
[0]: # layer's names
layer_names = ['conv2d_5','conv2d_32','conv2d_22','conv2d_16','conv2d_10']
outputs = []
image = image.reshape((1, image.shape[0], image.shape[1], image.shape[2]))
#extracting the output and appending to outputs
for layer_name in layer_names:
    # model input = Image , output = values at that particular layer=activation's * previous_pixel's
    intermediate_layer_model = Model(inputs=model.input,outputs=model.get_layer(layer_name).output)
    # predict the output for one-image
    intermediate_output = intermediate_layer_model.predict(image)
    # append the output's for each layer
    # we visualise them later
    outputs.append(intermediate_output)
#plotting the outputs
fig,ax = plt.subplots(nrows=5,ncols=5,figsize=(20,20))

for i in range(5):
    for z in range(5):
        # we are taking the fifth filter and we need to visualize them
        ax[i][z].imshow(outputs[i][0,:,:,:z])
        ax[i][z].set_title(layer_names[i])
        ax[i][z].set_xticks([])
        ax[i][z].set_yticks([])
```

