

Import libraies

```
In [1]: import tensorflow as tf
        from tensorflow import keras
        from tensorflow.keras import layers
        import cv2
        import os
        import matplotlib.pyplot as plt
        import numpy as np
        from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img, img_to_arr
```

```
In [2]: print(tf.config.list_physical_devices('GPU')) # checking tensorflow gpu is enabled or n
        print(tf.__version__)
```

```
[PhysicalDevice(name='/physical_device:GPU:0', device_type='GPU')]
2.4.0
```

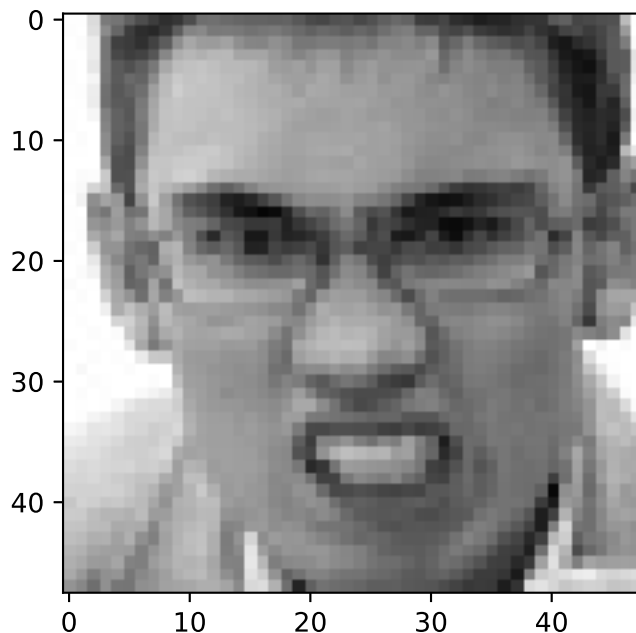
```
In [3]: img_array = cv2.imread("dataset/train/0/Training_345125.jpg")
```

```
In [4]: img_array.shape
```

```
Out[4]: (48, 48, 3)
```

```
In [5]: plt.imshow(img_array)
```

```
Out[5]: <matplotlib.image.AxesImage at 0x1be0d8aee20>
```



```
In [6]: data_directory = "dataset/train" # training datasets
```

```
In [7]: classes = ["0","1","2","3","4","5","6"] # list of classes
```

data generator

```
In [8]: # in our training data folder "1" has only 436 images, but others have more. It will ef
datagen = ImageDataGenerator(
    rotation_range=40,
    width_shift_range=0.2,
    height_shift_range=0.2,
    rescale=1./255,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    fill_mode='nearest')
```

```
In [9]: # Add 11 images names to a list from 1 folder
imagesgen = ["Training_5420780.jpg", "Training_5387344.jpg", "Training_11050021.jpg", "Tra
```

```
In [10]: # create a folder named genPics1
try:
    directory = "genPic1"
    path_dir = os.path.join(data_directory, directory)
    os.mkdir(path_dir)
except Exception as e:
    print(e)
```

```
In [11]: def imagesgenerator(img_list):
    for i in range(len(img_list)):
        pic = load_img(data_directory+"/"+1+"/"+img_list[i])
        pic_array = img_to_array(pic)
        pic_array = pic_array.reshape((1,) + pic_array.shape) # Converting into 4 dimen
        # Generate 11 images
        # batch_size: At a time, how many image should be created.
        count = 0
        for batch in datagen.flow(pic_array, batch_size=5, save_to_dir=data_directory+"/
            count += 1
            if count > 95:
                break
```

```
In [12]: imagesgenerator(imagesgen)
```

```
In [13]: # Moved images from genPic1 to 1 folder
target_fol = r"dataset\train\1" + "\\"
source_fol = r"dataset\train\genPic1" + "\\"
def move_files(source_fol, target_fol):
    try:
        for path, dir, files in os.walk(source_fol):
            for file in files:
                if not os.path.isfile(target_fol + file):
                    os.rename(path + '\\' + file, target_fol + file)
    print("All files are moved")
```

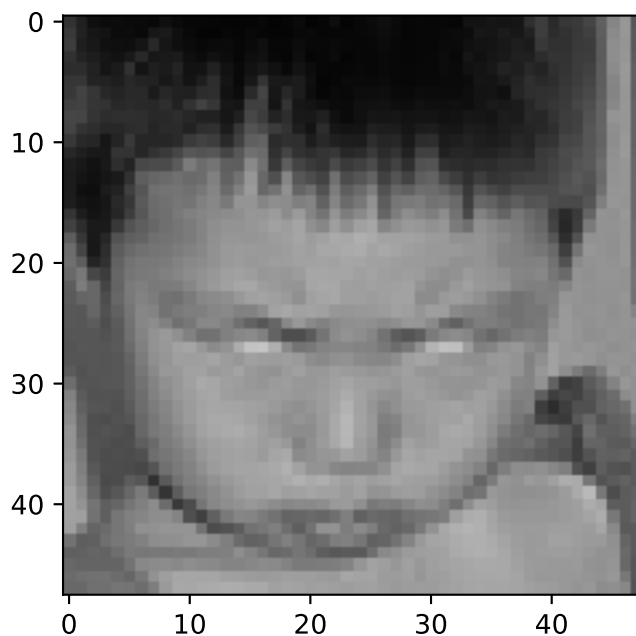
```
except Exception as e:  
    print(e)
```

```
In [14]: move_files(source_fol,target_fol)
```

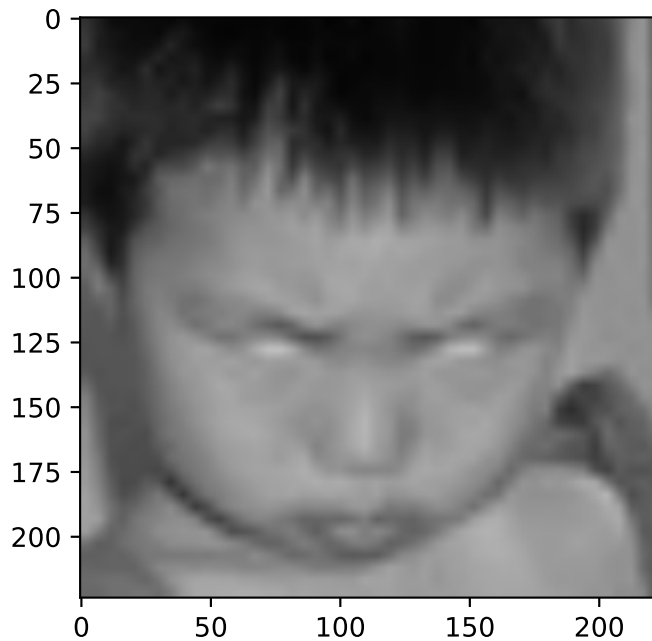
All files are moved

```
In [15]: # Removed empty directory  
try:  
    os.rmdir(source_fol)  
except Exception as e:  
    print(e)
```

```
In [16]: for catagory in classes:  
    path = os.path.join(data_directory,catagory)  
    for img in os.listdir(path):  
        img_array = cv2.imread(os.path.join(path,img))  
        plt.imshow(cv2.cvtColor(img_array,cv2.COLOR_BGR2RGB))  
        plt.show()  
        break  
    break
```



```
In [17]: img_size = (224,224) # ImageNet 224 x 224  
new_img_array = cv2.resize(img_array,img_size)  
plt.imshow(cv2.cvtColor(new_img_array,cv2.COLOR_BGR2RGB))  
plt.show()
```



```
In [18]: new_img_array.shape
```

```
Out[18]: (224, 224, 3)
```

```
In [19]: # read all the images and convert them into array
training_data = [] # data array
def create_training_data():
    for catagory in classes:
        path = os.path.join(data_directory,catagory)
        class_num = classes.index(catagory)
        for img in os.listdir(path):
            try:
                img_array = cv2.imread(os.path.join(path,img))
                new_img_array = cv2.resize(img_array,img_size)
                training_data.append([new_img_array,class_num])
            except Exception as e:
                print(f"...{e}")
```

```
In [20]: create_training_data()
```

```
In [21]: print(len(training_data))
```

```
10884
```

```
In [22]: import random
random.shuffle(training_data)
```

```
In [23]: X = [] # features
y = [] # label
```

```

for features,label in training_data:
    X.append(features)
    y.append(label)

X = np.array(X).reshape(-1,img_size[0],img_size[1],3)  ## convert it to 4 dimenion for

```

In [24]: `X.shape`

Out[24]: (10884, 224, 224, 3)

In [25]: `# Normalizing the data`
`X = X / 255.0`

In [26]: `y = np.array(y)`

In [27]: `y.shape`

Out[27]: (10884,)

Deep learning model for training - Transfer learning

In [28]: `model = tf.keras.applications.MobileNetV2() # pre-trained model`

In [29]: `model.summary()`

Model: "mobilenetv2_1.00_224"

Layer (type)	Output Shape	Param #	Connected to
=====			
input_1 (InputLayer)	[(None, 224, 224, 3) 0		

Conv1 (Conv2D)	(None, 112, 112, 32) 864		input_1[0][0]

bn_Conv1 (BatchNormalization)	(None, 112, 112, 32) 128		Conv1[0][0]

Conv1_relu (ReLU)	(None, 112, 112, 32) 0		bn_Conv1[0][0]

expanded_conv_depthwise (Depthw	(None, 112, 112, 32) 288		Conv1_relu[0][0]

expanded_conv_depthwise_BN (Bat	(None, 112, 112, 32) 128		expanded_conv_depthwise
[0][0]			

expanded_conv_depthwise_relu (R (None, 112, 112, 32) 0 _BN[0][0]		expanded_conv_depthwise
expanded_conv_project (Conv2D) (None, 112, 112, 16) 512 _relu[0][0]		expanded_conv_depthwise
expanded_conv_project_BN (Batch (None, 112, 112, 16) 64 [0][0]		expanded_conv_project
block_1_expand (Conv2D) (None, 112, 112, 96) 1536 N[0][0]		expanded_conv_project_B
block_1_expand_BN (BatchNormali (None, 112, 112, 96) 384		block_1_expand[0][0]
block_1_expand_relu (ReLU) (None, 112, 112, 96) 0		block_1_expand_BN[0][0]
block_1_pad (ZeroPadding2D) (None, 113, 113, 96) 0 [0]		block_1_expand_relu[0]
block_1_depthwise (DepthwiseCon (None, 56, 56, 96) 864		block_1_pad[0][0]
block_1_depthwise_BN (BatchNorm (None, 56, 56, 96) 384		block_1_depthwise[0][0]
block_1_depthwise_relu (ReLU) (None, 56, 56, 96) 0 [0]		block_1_depthwise_BN[0]
block_1_project (Conv2D) (None, 56, 56, 24) 2304 [0][0]		block_1_depthwise_relu
block_1_project_BN (BatchNormal (None, 56, 56, 24) 96		block_1_project[0][0]
block_2_expand (Conv2D) (None, 56, 56, 144) 3456 [0]		block_1_project_BN[0]
block_2_expand_BN (BatchNormali (None, 56, 56, 144) 576		block_2_expand[0][0]
block_2_expand_relu (ReLU) (None, 56, 56, 144) 0		block_2_expand_BN[0][0]
block_2_depthwise (DepthwiseCon (None, 56, 56, 144) 1296 [0]		block_2_expand_relu[0]
block_2_depthwise_BN (BatchNorm (None, 56, 56, 144) 576		block_2_depthwise[0][0]
block_2_depthwise_relu (ReLU) (None, 56, 56, 144) 0 [0]		block_2_depthwise_BN[0]
block_2_project (Conv2D) (None, 56, 56, 24) 3456		block_2_depthwise_relu

[0][0]

block_2_project_BN (BatchNormal	(None, 56, 56, 24)	96	block_2_project[0][0]
block_2_add (Add)	(None, 56, 56, 24)	0	block_1_project_BN[0]
[0]			block_2_project_BN[0]
[0]			
block_3_expand (Conv2D)	(None, 56, 56, 144)	3456	block_2_add[0][0]
block_3_expand_BN (BatchNormali	(None, 56, 56, 144)	576	block_3_expand[0][0]
block_3_expand_relu (ReLU)	(None, 56, 56, 144)	0	block_3_expand_BN[0][0]
block_3_pad (ZeroPadding2D)	(None, 57, 57, 144)	0	block_3_expand_relu[0]
[0]			
block_3_depthwise (DepthwiseCon	(None, 28, 28, 144)	1296	block_3_pad[0][0]
block_3_depthwise_BN (BatchNorm	(None, 28, 28, 144)	576	block_3_depthwise[0][0]
block_3_depthwise_relu (ReLU)	(None, 28, 28, 144)	0	block_3_depthwise_BN[0]
[0]			
block_3_project (Conv2D)	(None, 28, 28, 32)	4608	block_3_depthwise_relu
[0][0]			
block_3_project_BN (BatchNormal	(None, 28, 28, 32)	128	block_3_project[0][0]
block_4_expand (Conv2D)	(None, 28, 28, 192)	6144	block_3_project_BN[0]
[0]			
block_4_expand_BN (BatchNormali	(None, 28, 28, 192)	768	block_4_expand[0][0]
block_4_expand_relu (ReLU)	(None, 28, 28, 192)	0	block_4_expand_BN[0][0]
block_4_depthwise (DepthwiseCon	(None, 28, 28, 192)	1728	block_4_expand_relu[0]
[0]			
block_4_depthwise_BN (BatchNorm	(None, 28, 28, 192)	768	block_4_depthwise[0][0]
block_4_depthwise_relu (ReLU)	(None, 28, 28, 192)	0	block_4_depthwise_BN[0]
[0]			
block_4_project (Conv2D)	(None, 28, 28, 32)	6144	block_4_depthwise_relu
[0][0]			

block_4_project_BN (BatchNormal	(None, 28, 28, 32)	128	block_4_project[0][0]
block_4_add (Add)	(None, 28, 28, 32)	0	block_3_project_BN[0]
[0]			block_4_project_BN[0]
[0]			
block_5_expand (Conv2D)	(None, 28, 28, 192)	6144	block_4_add[0][0]
block_5_expand_BN (BatchNormali	(None, 28, 28, 192)	768	block_5_expand[0][0]
block_5_expand_relu (ReLU)	(None, 28, 28, 192)	0	block_5_expand_BN[0][0]
block_5_depthwise (DepthwiseCon	(None, 28, 28, 192)	1728	block_5_expand_relu[0]
[0]			
block_5_depthwise_BN (BatchNorm	(None, 28, 28, 192)	768	block_5_depthwise[0][0]
block_5_depthwise_relu (ReLU)	(None, 28, 28, 192)	0	block_5_depthwise_BN[0]
[0]			
block_5_project (Conv2D)	(None, 28, 28, 32)	6144	block_5_depthwise_relu
[0][0]			
block_5_project_BN (BatchNormal	(None, 28, 28, 32)	128	block_5_project[0][0]
block_5_add (Add)	(None, 28, 28, 32)	0	block_4_add[0][0]
[0]			block_5_project_BN[0]
[0]			
block_6_expand (Conv2D)	(None, 28, 28, 192)	6144	block_5_add[0][0]
block_6_expand_BN (BatchNormali	(None, 28, 28, 192)	768	block_6_expand[0][0]
block_6_expand_relu (ReLU)	(None, 28, 28, 192)	0	block_6_expand_BN[0][0]
block_6_pad (ZeroPadding2D)	(None, 29, 29, 192)	0	block_6_expand_relu[0]
[0]			
block_6_depthwise (DepthwiseCon	(None, 14, 14, 192)	1728	block_6_pad[0][0]
block_6_depthwise_BN (BatchNorm	(None, 14, 14, 192)	768	block_6_depthwise[0][0]
block_6_depthwise_relu (ReLU)	(None, 14, 14, 192)	0	block_6_depthwise_BN[0]
[0]			

block_6_project (Conv2D) [0][0]	(None, 14, 14, 64)	12288	block_6_depthwise_relu
block_6_project_BN (BatchNormal	(None, 14, 14, 64)	256	block_6_project[0][0]
block_7_expand (Conv2D) [0]	(None, 14, 14, 384)	24576	block_6_project_BN[0]
block_7_expand_BN (BatchNormali	(None, 14, 14, 384)	1536	block_7_expand[0][0]
block_7_expand_relu (ReLU)	(None, 14, 14, 384)	0	block_7_expand_BN[0][0]
block_7_depthwise (DepthwiseCon [0]	(None, 14, 14, 384)	3456	block_7_expand_relu[0]
block_7_depthwise_BN (BatchNorm	(None, 14, 14, 384)	1536	block_7_depthwise[0][0]
block_7_depthwise_relu (ReLU) [0]	(None, 14, 14, 384)	0	block_7_depthwise_BN[0]
block_7_project (Conv2D) [0][0]	(None, 14, 14, 64)	24576	block_7_depthwise_relu
block_7_project_BN (BatchNormal	(None, 14, 14, 64)	256	block_7_project[0][0]
block_7_add (Add) [0]	(None, 14, 14, 64)	0	block_6_project_BN[0]
[0]			block_7_project_BN[0]
block_8_expand (Conv2D)	(None, 14, 14, 384)	24576	block_7_add[0][0]
block_8_expand_BN (BatchNormali	(None, 14, 14, 384)	1536	block_8_expand[0][0]
block_8_expand_relu (ReLU)	(None, 14, 14, 384)	0	block_8_expand_BN[0][0]
block_8_depthwise (DepthwiseCon [0]	(None, 14, 14, 384)	3456	block_8_expand_relu[0]
block_8_depthwise_BN (BatchNorm	(None, 14, 14, 384)	1536	block_8_depthwise[0][0]
block_8_depthwise_relu (ReLU) [0]	(None, 14, 14, 384)	0	block_8_depthwise_BN[0]
block_8_project (Conv2D) [0][0]	(None, 14, 14, 64)	24576	block_8_depthwise_relu

block_8_project_BN (BatchNormal	(None, 14, 14, 64)	256	block_8_project[0][0]
block_8_add (Add)	(None, 14, 14, 64)	0	block_7_add[0][0] block_8_project_BN[0] [0]
block_9_expand (Conv2D)	(None, 14, 14, 384)	24576	block_8_add[0][0]
block_9_expand_BN (BatchNormali	(None, 14, 14, 384)	1536	block_9_expand[0][0]
block_9_expand_relu (ReLU)	(None, 14, 14, 384)	0	block_9_expand_BN[0][0]
block_9_depthwise (DepthwiseCon	(None, 14, 14, 384)	3456	block_9_expand_relu[0] [0]
block_9_depthwise_BN (BatchNorm	(None, 14, 14, 384)	1536	block_9_depthwise[0][0]
block_9_depthwise_relu (ReLU)	(None, 14, 14, 384)	0	block_9_depthwise_BN[0] [0]
block_9_project (Conv2D)	(None, 14, 14, 64)	24576	block_9_depthwise_relu [0][0]
block_9_project_BN (BatchNormal	(None, 14, 14, 64)	256	block_9_project[0][0]
block_9_add (Add)	(None, 14, 14, 64)	0	block_8_add[0][0] block_9_project_BN[0] [0]
block_10_expand (Conv2D)	(None, 14, 14, 384)	24576	block_9_add[0][0]
block_10_expand_BN (BatchNormal	(None, 14, 14, 384)	1536	block_10_expand[0][0]
block_10_expand_relu (ReLU)	(None, 14, 14, 384)	0	block_10_expand_BN[0] [0]
block_10_depthwise (DepthwiseCo	(None, 14, 14, 384)	3456	block_10_expand_relu[0] [0]
block_10_depthwise_BN (BatchNor	(None, 14, 14, 384)	1536	block_10_depthwise[0] [0]
block_10_depthwise_relu (ReLU)	(None, 14, 14, 384)	0	block_10_depthwise_BN [0][0]
block_10_project (Conv2D)	(None, 14, 14, 96)	36864	block_10_depthwise_relu [0][0]

block_10_project_BN (BatchNormal	(None, 14, 14, 96)	384	block_10_project[0][0]
block_11_expand (Conv2D)	(None, 14, 14, 576)	55296	block_10_project_BN[0][0]
block_11_expand_BN (BatchNormal	(None, 14, 14, 576)	2304	block_11_expand[0][0]
block_11_expand_relu (ReLU)	(None, 14, 14, 576)	0	block_11_expand_BN[0][0]
block_11_depthwise (DepthwiseCo	(None, 14, 14, 576)	5184	block_11_expand_relu[0][0]
block_11_depthwise_BN (BatchNor	(None, 14, 14, 576)	2304	block_11_depthwise[0][0]
block_11_depthwise_relu (ReLU)	(None, 14, 14, 576)	0	block_11_depthwise_BN[0][0]
block_11_project (Conv2D)	(None, 14, 14, 96)	55296	block_11_depthwise_relu[0][0]
block_11_project_BN (BatchNorma	(None, 14, 14, 96)	384	block_11_project[0][0]
block_11_add (Add)	(None, 14, 14, 96)	0	block_10_project_BN[0][0]
			block_11_project_BN[0][0]
block_12_expand (Conv2D)	(None, 14, 14, 576)	55296	block_11_add[0][0]
block_12_expand_BN (BatchNormal	(None, 14, 14, 576)	2304	block_12_expand[0][0]
block_12_expand_relu (ReLU)	(None, 14, 14, 576)	0	block_12_expand_BN[0][0]
block_12_depthwise (DepthwiseCo	(None, 14, 14, 576)	5184	block_12_expand_relu[0][0]
block_12_depthwise_BN (BatchNor	(None, 14, 14, 576)	2304	block_12_depthwise[0][0]
block_12_depthwise_relu (ReLU)	(None, 14, 14, 576)	0	block_12_depthwise_BN[0][0]
block_12_project (Conv2D)	(None, 14, 14, 96)	55296	block_12_depthwise_relu[0][0]

block_12_project_BN (BatchNorma	(None, 14, 14, 96)	384	block_12_project[0][0]
block_12_add (Add)	(None, 14, 14, 96)	0	block_11_add[0][0] block_12_project_BN[0] [0]
block_13_expand (Conv2D)	(None, 14, 14, 576)	55296	block_12_add[0][0]
block_13_expand_BN (BatchNormal	(None, 14, 14, 576)	2304	block_13_expand[0][0]
block_13_expand_relu (ReLU)	(None, 14, 14, 576)	0	block_13_expand_BN[0] [0]
block_13_pad (ZeroPadding2D)	(None, 15, 15, 576)	0	block_13_expand_relu[0] [0]
block_13_depthwise (DepthwiseCo	(None, 7, 7, 576)	5184	block_13_pad[0][0]
block_13_depthwise_BN (BatchNor	(None, 7, 7, 576)	2304	block_13_depthwise[0] [0]
block_13_depthwise_relu (ReLU)	(None, 7, 7, 576)	0	block_13_depthwise_BN [0][0]
block_13_project (Conv2D)	(None, 7, 7, 160)	92160	block_13_depthwise_relu [0][0]
block_13_project_BN (BatchNorma	(None, 7, 7, 160)	640	block_13_project[0][0]
block_14_expand (Conv2D)	(None, 7, 7, 960)	153600	block_13_project_BN[0] [0]
block_14_expand_BN (BatchNormal	(None, 7, 7, 960)	3840	block_14_expand[0][0]
block_14_expand_relu (ReLU)	(None, 7, 7, 960)	0	block_14_expand_BN[0] [0]
block_14_depthwise (DepthwiseCo	(None, 7, 7, 960)	8640	block_14_expand_relu[0] [0]
block_14_depthwise_BN (BatchNor	(None, 7, 7, 960)	3840	block_14_depthwise[0] [0]
block_14_depthwise_relu (ReLU)	(None, 7, 7, 960)	0	block_14_depthwise_BN [0][0]

block_14_project (Conv2D) [0][0]	(None, 7, 7, 160)	153600	block_14_depthwise_relu
block_14_project_BN (BatchNorma	(None, 7, 7, 160)	640	block_14_project[0][0]
block_14_add (Add) [0]	(None, 7, 7, 160)	0	block_13_project_BN[0] block_14_project_BN[0]
block_15_expand (Conv2D)	(None, 7, 7, 960)	153600	block_14_add[0][0]
block_15_expand_BN (BatchNormal	(None, 7, 7, 960)	3840	block_15_expand[0][0]
block_15_expand_relu (ReLU) [0]	(None, 7, 7, 960)	0	block_15_expand_BN[0]
block_15_depthwise (DepthwiseCo [0]	(None, 7, 7, 960)	8640	block_15_expand_relu[0]
block_15_depthwise_BN (BatchNor [0]	(None, 7, 7, 960)	3840	block_15_depthwise[0]
block_15_depthwise_relu (ReLU) [0][0]	(None, 7, 7, 960)	0	block_15_depthwise_BN
block_15_project (Conv2D) [0][0]	(None, 7, 7, 160)	153600	block_15_depthwise_relu
block_15_project_BN (BatchNorma	(None, 7, 7, 160)	640	block_15_project[0][0]
block_15_add (Add) [0]	(None, 7, 7, 160)	0	block_14_add[0][0] block_15_project_BN[0]
block_16_expand (Conv2D)	(None, 7, 7, 960)	153600	block_15_add[0][0]
block_16_expand_BN (BatchNormal	(None, 7, 7, 960)	3840	block_16_expand[0][0]
block_16_expand_relu (ReLU) [0]	(None, 7, 7, 960)	0	block_16_expand_BN[0]
block_16_depthwise (DepthwiseCo [0]	(None, 7, 7, 960)	8640	block_16_expand_relu[0]
block_16_depthwise_BN (BatchNor [0]	(None, 7, 7, 960)	3840	block_16_depthwise[0]

block_16_depthwise_relu (ReLU)	(None, 7, 7, 960)	0	block_16_depthwise_BN[0][0]
block_16_project (Conv2D)	(None, 7, 7, 320)	307200	block_16_depthwise_relu[0][0]
block_16_project_BN (BatchNorma	(None, 7, 7, 320)	1280	block_16_project[0][0]
Conv_1 (Conv2D)	(None, 7, 7, 1280)	409600	block_16_project_BN[0][0]
Conv_1_bn (BatchNormalization)	(None, 7, 7, 1280)	5120	Conv_1[0][0]
out_relu (ReLU)	(None, 7, 7, 1280)	0	Conv_1_bn[0][0]
global_average_pooling2d (Globa	(None, 1280)	0	out_relu[0][0]
predictions (Dense)	(None, 1000)	1281000	global_average_pooling2d[0][0]
=====			
=====			
Total params: 3,538,984			
Trainable params: 3,504,872			
Non-trainable params: 34,112			

Transfer Learning

Tuning , weights will start from last check point

```
In [30]: base_input = model.layers[0].input
```

```
In [31]: base_output = model.layers[-2].output
```

```
In [32]: base_output
```

```
Out[32]: <KerasTensor: shape=(None, 1280) dtype=float32 (created by layer 'global_average_pooling2d')>
```

```
In [33]: # Adding Layers
final_output = layers.Dense(128)(base_output) # Adding layer after the output of the global average pooling
final_output = layers.Activation('relu')(final_output) # Activation function
final_output = layers.Dense(64)(final_output)
final_output = layers.Activation('relu')(final_output)
final_output = layers.Dense(7, activation='softmax')(final_output) # Output classes are
```

```
In [34]: final_output # output
```

```
Out[34]: <KerasTensor: shape=(None, 7) dtype=float32 (created by layer 'dense_2')>
```

```
In [35]: new_model = keras.Model(inputs=base_input,outputs= final_output)
```

```
In [36]: new_model.summary()
```

Model: "model"

Layer (type)	Output Shape	Param #	Connected to
=====			
input_1 (InputLayer)	[(None, 224, 224, 3) 0		
Conv1 (Conv2D)	(None, 112, 112, 32) 864		input_1[0][0]
bn_Conv1 (BatchNormalization)	(None, 112, 112, 32) 128		Conv1[0][0]
Conv1_relu (ReLU)	(None, 112, 112, 32) 0		bn_Conv1[0][0]
expanded_conv_depthwise (Depthw	(None, 112, 112, 32) 288		Conv1_relu[0][0]
expanded_conv_depthwise_BN (Bat	(None, 112, 112, 32) 128		expanded_conv_depthwise
[0][0]			
expanded_conv_depthwise_relu (R	(None, 112, 112, 32) 0		expanded_conv_depthwise
_BN[0][0]			
expanded_conv_project (Conv2D)	(None, 112, 112, 16) 512		expanded_conv_depthwise
_relu[0][0]			
expanded_conv_project_BN (Batch	(None, 112, 112, 16) 64		expanded_conv_project
[0][0]			
block_1_expand (Conv2D)	(None, 112, 112, 96) 1536		expanded_conv_project_B
N[0][0]			
block_1_expand_BN (BatchNormali	(None, 112, 112, 96) 384		block_1_expand[0][0]
block_1_expand_relu (ReLU)	(None, 112, 112, 96) 0		block_1_expand_BN[0][0]
block_1_pad (ZeroPadding2D)	(None, 113, 113, 96) 0		block_1_expand_relu[0]
[0]			
block_1_depthwise (DepthwiseCon	(None, 56, 56, 96) 864		block_1_pad[0][0]

block_1_depthwise_BN (BatchNorm (None, 56, 56, 96)	384	block_1_depthwise[0][0]
block_1_depthwise_relu (ReLU) [0]	(None, 56, 56, 96) 0	block_1_depthwise_BN[0]
block_1_project (Conv2D) [0][0]	(None, 56, 56, 24) 2304	block_1_depthwise_relu[0][0]
block_1_project_BN (BatchNormal (None, 56, 56, 24)	96	block_1_project[0][0]
block_2_expand (Conv2D) [0]	(None, 56, 56, 144) 3456	block_1_project_BN[0]
block_2_expand_BN (BatchNormali (None, 56, 56, 144)	576	block_2_expand[0][0]
block_2_expand_relu (ReLU)	(None, 56, 56, 144) 0	block_2_expand_BN[0][0]
block_2_depthwise (DepthwiseCon (None, 56, 56, 144)	1296	block_2_expand_relu[0]
block_2_depthwise_BN (BatchNorm (None, 56, 56, 144)	576	block_2_depthwise[0][0]
block_2_depthwise_relu (ReLU) [0]	(None, 56, 56, 144) 0	block_2_depthwise_BN[0]
block_2_project (Conv2D) [0][0]	(None, 56, 56, 24) 3456	block_2_depthwise_relu[0][0]
block_2_project_BN (BatchNormal (None, 56, 56, 24)	96	block_2_project[0][0]
block_2_add (Add) [0]	(None, 56, 56, 24) 0	block_1_project_BN[0]
		block_2_project_BN[0]
block_3_expand (Conv2D)	(None, 56, 56, 144) 3456	block_2_add[0][0]
block_3_expand_BN (BatchNormali (None, 56, 56, 144)	576	block_3_expand[0][0]
block_3_expand_relu (ReLU)	(None, 56, 56, 144) 0	block_3_expand_BN[0][0]
block_3_pad (ZeroPadding2D) [0]	(None, 57, 57, 144) 0	block_3_expand_relu[0]
block_3_depthwise (DepthwiseCon (None, 28, 28, 144)	1296	block_3_pad[0][0]

block_3_depthwise_BN (BatchNorm	(None, 28, 28, 144)	576	block_3_depthwise[0][0]
block_3_depthwise_relu (ReLU)	(None, 28, 28, 144)	0	block_3_depthwise_BN[0][0]
block_3_project (Conv2D)	(None, 28, 28, 32)	4608	block_3_depthwise_relu[0][0]
block_3_project_BN (BatchNormal	(None, 28, 28, 32)	128	block_3_project[0][0]
block_4_expand (Conv2D)	(None, 28, 28, 192)	6144	block_3_project_BN[0][0]
block_4_expand_BN (BatchNormali	(None, 28, 28, 192)	768	block_4_expand[0][0]
block_4_expand_relu (ReLU)	(None, 28, 28, 192)	0	block_4_expand_BN[0][0]
block_4_depthwise (DepthwiseCon	(None, 28, 28, 192)	1728	block_4_expand_relu[0][0]
block_4_depthwise_BN (BatchNorm	(None, 28, 28, 192)	768	block_4_depthwise[0][0]
block_4_depthwise_relu (ReLU)	(None, 28, 28, 192)	0	block_4_depthwise_BN[0][0]
block_4_project (Conv2D)	(None, 28, 28, 32)	6144	block_4_depthwise_relu[0][0]
block_4_project_BN (BatchNormal	(None, 28, 28, 32)	128	block_4_project[0][0]
block_4_add (Add)	(None, 28, 28, 32)	0	block_3_project_BN[0][0]
			block_4_project_BN[0][0]
block_5_expand (Conv2D)	(None, 28, 28, 192)	6144	block_4_add[0][0]
block_5_expand_BN (BatchNormali	(None, 28, 28, 192)	768	block_5_expand[0][0]
block_5_expand_relu (ReLU)	(None, 28, 28, 192)	0	block_5_expand_BN[0][0]
block_5_depthwise (DepthwiseCon	(None, 28, 28, 192)	1728	block_5_expand_relu[0][0]
block_5_depthwise_BN (BatchNorm	(None, 28, 28, 192)	768	block_5_depthwise[0][0]
block_5_depthwise_relu (ReLU)	(None, 28, 28, 192)	0	block_5_depthwise_BN[0][0]

[0]

block_5_project (Conv2D) [0][0]	(None, 28, 28, 32)	6144	block_5_depthwise_relu
block_5_project_BN (BatchNormal	(None, 28, 28, 32)	128	block_5_project[0][0]
block_5_add (Add) [0]	(None, 28, 28, 32)	0	block_4_add[0][0] block_5_project_BN[0]
block_6_expand (Conv2D)	(None, 28, 28, 192)	6144	block_5_add[0][0]
block_6_expand_BN (BatchNormali	(None, 28, 28, 192)	768	block_6_expand[0][0]
block_6_expand_relu (ReLU)	(None, 28, 28, 192)	0	block_6_expand_BN[0][0]
block_6_pad (ZeroPadding2D) [0]	(None, 29, 29, 192)	0	block_6_expand_relu[0]
block_6_depthwise (DepthwiseCon	(None, 14, 14, 192)	1728	block_6_pad[0][0]
block_6_depthwise_BN (BatchNorm	(None, 14, 14, 192)	768	block_6_depthwise[0][0]
block_6_depthwise_relu (ReLU) [0]	(None, 14, 14, 192)	0	block_6_depthwise_BN[0]
block_6_project (Conv2D) [0][0]	(None, 14, 14, 64)	12288	block_6_depthwise_relu
block_6_project_BN (BatchNormal	(None, 14, 14, 64)	256	block_6_project[0][0]
block_7_expand (Conv2D) [0]	(None, 14, 14, 384)	24576	block_6_project_BN[0]
block_7_expand_BN (BatchNormali	(None, 14, 14, 384)	1536	block_7_expand[0][0]
block_7_expand_relu (ReLU)	(None, 14, 14, 384)	0	block_7_expand_BN[0][0]
block_7_depthwise (DepthwiseCon [0]	(None, 14, 14, 384)	3456	block_7_expand_relu[0]
block_7_depthwise_BN (BatchNorm	(None, 14, 14, 384)	1536	block_7_depthwise[0][0]
block_7_depthwise_relu (ReLU) [0]	(None, 14, 14, 384)	0	block_7_depthwise_BN[0]

block_7_project (Conv2D) [0][0]	(None, 14, 14, 64)	24576	block_7_depthwise_relu
block_7_project_BN (BatchNormal	(None, 14, 14, 64)	256	block_7_project[0][0]
block_7_add (Add) [0]	(None, 14, 14, 64)	0	block_6_project_BN[0] block_7_project_BN[0]
block_8_expand (Conv2D)	(None, 14, 14, 384)	24576	block_7_add[0][0]
block_8_expand_BN (BatchNormali	(None, 14, 14, 384)	1536	block_8_expand[0][0]
block_8_expand_relu (ReLU)	(None, 14, 14, 384)	0	block_8_expand_BN[0][0]
block_8_depthwise (DepthwiseCon	(None, 14, 14, 384)	3456	block_8_expand_relu[0]
block_8_depthwise_BN (BatchNorm	(None, 14, 14, 384)	1536	block_8_depthwise[0][0]
block_8_depthwise_relu (ReLU) [0]	(None, 14, 14, 384)	0	block_8_depthwise_BN[0]
block_8_project (Conv2D) [0][0]	(None, 14, 14, 64)	24576	block_8_depthwise_relu
block_8_project_BN (BatchNormal	(None, 14, 14, 64)	256	block_8_project[0][0]
block_8_add (Add) [0]	(None, 14, 14, 64)	0	block_7_add[0][0] block_8_project_BN[0]
block_9_expand (Conv2D)	(None, 14, 14, 384)	24576	block_8_add[0][0]
block_9_expand_BN (BatchNormali	(None, 14, 14, 384)	1536	block_9_expand[0][0]
block_9_expand_relu (ReLU)	(None, 14, 14, 384)	0	block_9_expand_BN[0][0]
block_9_depthwise (DepthwiseCon	(None, 14, 14, 384)	3456	block_9_expand_relu[0]
block_9_depthwise_BN (BatchNorm	(None, 14, 14, 384)	1536	block_9_depthwise[0][0]
block_9_depthwise_relu (ReLU) [0]	(None, 14, 14, 384)	0	block_9_depthwise_BN[0]

block_9_project (Conv2D)	(None, 14, 14, 64)	24576	block_9_depthwise_relu[0][0]
block_9_project_BN (BatchNormal	(None, 14, 14, 64)	256	block_9_project[0][0]
block_9_add (Add)	(None, 14, 14, 64)	0	block_8_add[0][0] block_9_project_BN[0]
block_10_expand (Conv2D)	(None, 14, 14, 384)	24576	block_9_add[0][0]
block_10_expand_BN (BatchNormal	(None, 14, 14, 384)	1536	block_10_expand[0][0]
block_10_expand_relu (ReLU)	(None, 14, 14, 384)	0	block_10_expand_BN[0]
block_10_depthwise (DepthwiseCo	(None, 14, 14, 384)	3456	block_10_expand_relu[0]
block_10_depthwise_BN (BatchNor	(None, 14, 14, 384)	1536	block_10_depthwise[0]
block_10_depthwise_relu (ReLU)	(None, 14, 14, 384)	0	block_10_depthwise_BN[0][0]
block_10_project (Conv2D)	(None, 14, 14, 96)	36864	block_10_depthwise_relu[0][0]
block_10_project_BN (BatchNorma	(None, 14, 14, 96)	384	block_10_project[0][0]
block_11_expand (Conv2D)	(None, 14, 14, 576)	55296	block_10_project_BN[0]
block_11_expand_BN (BatchNormal	(None, 14, 14, 576)	2304	block_11_expand[0][0]
block_11_expand_relu (ReLU)	(None, 14, 14, 576)	0	block_11_expand_BN[0]
block_11_depthwise (DepthwiseCo	(None, 14, 14, 576)	5184	block_11_expand_relu[0]
block_11_depthwise_BN (BatchNor	(None, 14, 14, 576)	2304	block_11_depthwise[0]
block_11_depthwise_relu (ReLU)	(None, 14, 14, 576)	0	block_11_depthwise_BN[0][0]

block_11_project (Conv2D) [0][0]	(None, 14, 14, 96)	55296	block_11_depthwise_relu [0][0]
block_11_project_BN (BatchNorma	(None, 14, 14, 96)	384	block_11_project[0][0]
block_11_add (Add) [0]	(None, 14, 14, 96)	0	block_10_project_BN[0] block_11_project_BN[0]
block_12_expand (Conv2D)	(None, 14, 14, 576)	55296	block_11_add[0][0]
block_12_expand_BN (BatchNormal	(None, 14, 14, 576)	2304	block_12_expand[0][0]
block_12_expand_relu (ReLU) [0]	(None, 14, 14, 576)	0	block_12_expand_BN[0]
block_12_depthwise (DepthwiseCo [0]	(None, 14, 14, 576)	5184	block_12_expand_relu[0]
block_12_depthwise_BN (BatchNor [0]	(None, 14, 14, 576)	2304	block_12_depthwise[0]
block_12_depthwise_relu (ReLU) [0][0]	(None, 14, 14, 576)	0	block_12_depthwise_BN [0][0]
block_12_project (Conv2D) [0][0]	(None, 14, 14, 96)	55296	block_12_depthwise_relu [0][0]
block_12_project_BN (BatchNorma	(None, 14, 14, 96)	384	block_12_project[0][0]
block_12_add (Add) [0]	(None, 14, 14, 96)	0	block_11_add[0][0] block_12_project_BN[0]
block_13_expand (Conv2D)	(None, 14, 14, 576)	55296	block_12_add[0][0]
block_13_expand_BN (BatchNormal	(None, 14, 14, 576)	2304	block_13_expand[0][0]
block_13_expand_relu (ReLU) [0]	(None, 14, 14, 576)	0	block_13_expand_BN[0]
block_13_pad (ZeroPadding2D) [0]	(None, 15, 15, 576)	0	block_13_expand_relu[0]
block_13_depthwise (DepthwiseCo	(None, 7, 7, 576)	5184	block_13_pad[0][0]
block_13_depthwise_BN (BatchNor	(None, 7, 7, 576)	2304	block_13_depthwise[0]

[0]

block_13_depthwise_relu (ReLU)	(None, 7, 7, 576)	0	block_13_depthwise_BN[0][0]
block_13_project (Conv2D)	(None, 7, 7, 160)	92160	block_13_depthwise_relu[0][0]
block_13_project_BN (BatchNormal	(None, 7, 7, 160)	640	block_13_project[0][0]
block_14_expand (Conv2D)	(None, 7, 7, 960)	153600	block_13_project_BN[0][0]
block_14_expand_BN (BatchNormal	(None, 7, 7, 960)	3840	block_14_expand[0][0]
block_14_expand_relu (ReLU)	(None, 7, 7, 960)	0	block_14_expand_BN[0][0]
block_14_depthwise (DepthwiseCo	(None, 7, 7, 960)	8640	block_14_expand_relu[0][0]
block_14_depthwise_BN (BatchNor	(None, 7, 7, 960)	3840	block_14_depthwise[0][0]
block_14_depthwise_relu (ReLU)	(None, 7, 7, 960)	0	block_14_depthwise_BN[0][0]
block_14_project (Conv2D)	(None, 7, 7, 160)	153600	block_14_depthwise_relu[0][0]
block_14_project_BN (BatchNorma	(None, 7, 7, 160)	640	block_14_project[0][0]
block_14_add (Add)	(None, 7, 7, 160)	0	block_13_project_BN[0][0] block_14_project_BN[0][0]
block_15_expand (Conv2D)	(None, 7, 7, 960)	153600	block_14_add[0][0]
block_15_expand_BN (BatchNormal	(None, 7, 7, 960)	3840	block_15_expand[0][0]
block_15_expand_relu (ReLU)	(None, 7, 7, 960)	0	block_15_expand_BN[0][0]
block_15_depthwise (DepthwiseCo	(None, 7, 7, 960)	8640	block_15_expand_relu[0][0]
block_15_depthwise_BN (BatchNor	(None, 7, 7, 960)	3840	block_15_depthwise[0][0]

[0]

block_15_depthwise_relu (ReLU)	(None, 7, 7, 960)	0	block_15_depthwise_BN
block_15_project (Conv2D)	(None, 7, 7, 160)	153600	block_15_depthwise_relu
block_15_project_BN (BatchNorma	(None, 7, 7, 160)	640	block_15_project[0][0]
block_15_add (Add)	(None, 7, 7, 160)	0	block_14_add[0][0] block_15_project_BN[0]
block_16_expand (Conv2D)	(None, 7, 7, 960)	153600	block_15_add[0][0]
block_16_expand_BN (BatchNormal	(None, 7, 7, 960)	3840	block_16_expand[0][0]
block_16_expand_relu (ReLU)	(None, 7, 7, 960)	0	block_16_expand_BN[0]
block_16_depthwise (DepthwiseCo	(None, 7, 7, 960)	8640	block_16_expand_relu[0]
block_16_depthwise_BN (BatchNor	(None, 7, 7, 960)	3840	block_16_depthwise[0]
block_16_depthwise_relu (ReLU)	(None, 7, 7, 960)	0	block_16_depthwise_BN
block_16_project (Conv2D)	(None, 7, 7, 320)	307200	block_16_depthwise_relu
block_16_project_BN (BatchNorma	(None, 7, 7, 320)	1280	block_16_project[0][0]
Conv_1 (Conv2D)	(None, 7, 7, 1280)	409600	block_16_project_BN[0]
Conv_1_bn (BatchNormalization)	(None, 7, 7, 1280)	5120	Conv_1[0][0]
out_relu (ReLU)	(None, 7, 7, 1280)	0	Conv_1_bn[0][0]
global_average_pooling2d (Globa	(None, 1280)	0	out_relu[0][0]
dense (Dense)	(None, 128)	163968	global_average_pooling2

activation (Activation)	(None, 128)	0	dense[0][0]
dense_1 (Dense)	(None, 64)	8256	activation[0][0]
activation_1 (Activation)	(None, 64)	0	dense_1[0][0]
dense_2 (Dense)	(None, 7)	455	activation_1[0][0]
=====			
=====			
Total params: 2,430,663			
Trainable params: 2,396,551			
Non-trainable params: 34,112			
=====			
<div><div></div></div>			

```
In [37]: new_model.compile(loss="sparse_categorical_crossentropy",optimizer="adam",metrics=["acc
```

```
In [38]: os.environ['TF_FORCE_GPU_ALLOW_GROWTH'] = 'true'
```

```
In [39]: new_model.fit(X,y,epochs=15)
```

Epoch 1/15
341/341 [=====] - 140s 316ms/step - loss: 1.5225 - accuracy: 0.4249
Epoch 2/15
341/341 [=====] - 195s 571ms/step - loss: 1.1612 - accuracy: 0.5643
Epoch 3/15
341/341 [=====] - 267s 784ms/step - loss: 1.0166 - accuracy: 0.6216
Epoch 4/15
341/341 [=====] - 314s 922ms/step - loss: 0.9492 - accuracy: 0.6399
Epoch 5/15
341/341 [=====] - 340s 998ms/step - loss: 0.8931 - accuracy: 0.6758
Epoch 6/15
341/341 [=====] - 376s 1s/step - loss: 0.8185 - accuracy: 0.6967
Epoch 7/15
341/341 [=====] - 381s 1s/step - loss: 0.7236 - accuracy: 0.7353
Epoch 8/15
341/341 [=====] - 372s 1s/step - loss: 0.7158 - accuracy: 0.7424
Epoch 9/15
341/341 [=====] - 398s 1s/step - loss: 0.6513 - accuracy: 0.7581
Epoch 10/15
341/341 [=====] - 400s 1s/step - loss: 0.5846 - accuracy: 0.7934
Epoch 11/15
341/341 [=====] - 394s 1s/step - loss: 0.5702 - accuracy: 0.7933
Epoch 12/15
341/341 [=====] - 383s 1s/step - loss: 0.4770 - accuracy: 0.829


```

0
Epoch 13/15
341/341 [=====] - 377s 1s/step - loss: 0.4161 - accuracy: 0.851
4
Epoch 14/15
341/341 [=====] - 404s 1s/step - loss: 0.3777 - accuracy: 0.868
0
Epoch 15/15
341/341 [=====] - 404s 1s/step - loss: 0.3283 - accuracy: 0.889
4

```

Out[39]: <tensorflow.python.keras.callbacks.History at 0x1bed8439220>

In [40]: `new_model.save('face_emotion_rec_v2.h5')`

In [41]: `# new_model = tf.keras.models.load_model("face_emotion_rec_v2.h5")`

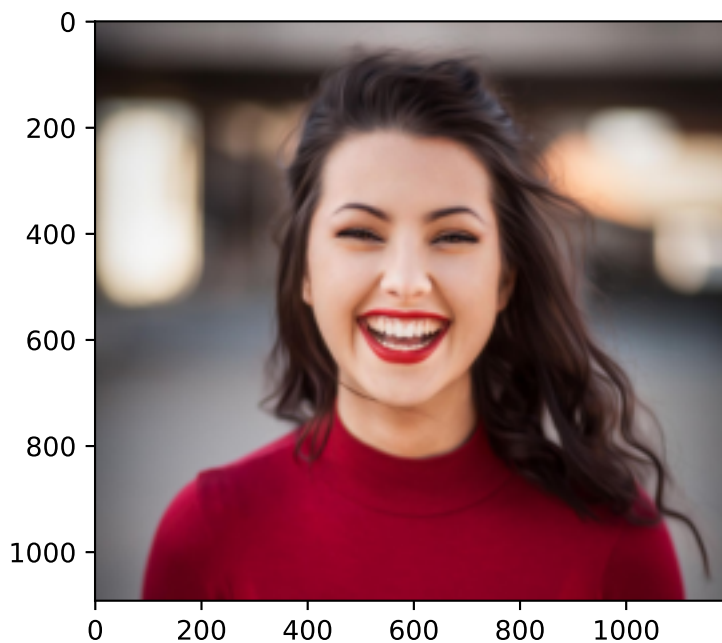
In [42]: `frame = cv2.imread("smiley_girl1.jpg")`

In [43]: `frame.shape`

Out[43]: (1092, 1200, 3)

In [44]: `plt.imshow(cv2.cvtColor(frame,cv2.COLOR_BGR2RGB))`

Out[44]: <matplotlib.image.AxesImage at 0x1c4b73b4ee0>



In [45]: `# Convert it into gray image and use face detection algorithm to detect face`

```

face_detect = cv2.CascadeClassifier(cv2.data.harcascades + 'haarcascade_frontalface_de

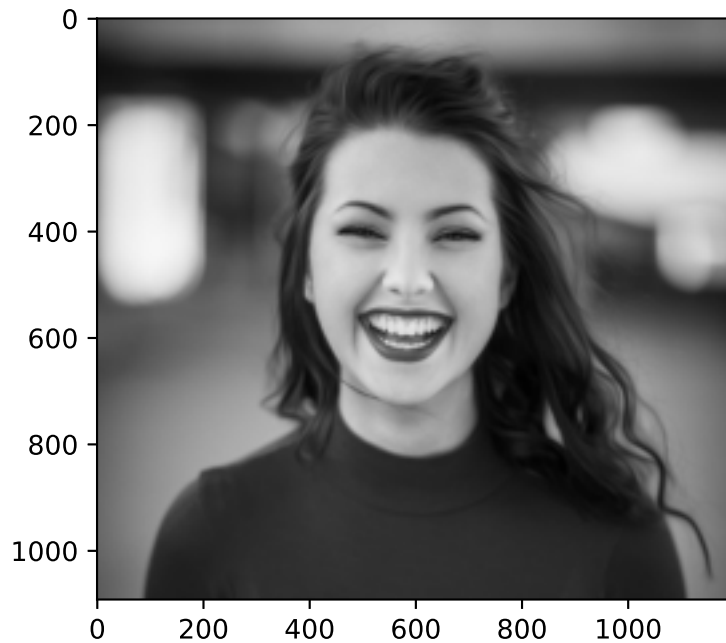
gray_img = cv2.cvtColor(frame,cv2.COLOR_BGR2GRAY)
gray_img.shape

```

Out[45]: (1092, 1200)

```
In [46]: plt.imshow(cv2.cvtColor(gray_img,cv2.COLOR_BGR2RGB))
```

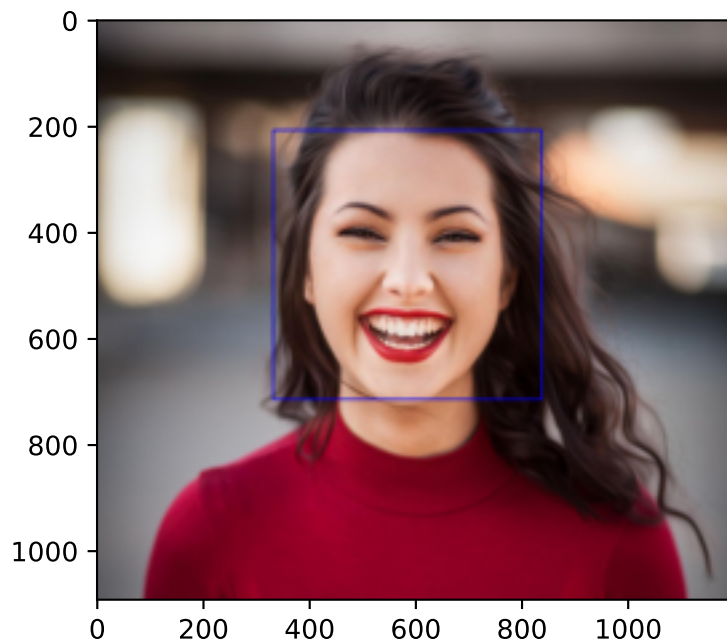
Out[46]: <matplotlib.image.AxesImage at 0x1c4bef9b730>



```
In [47]: faces = face_detect.detectMultiScale(gray_img,1.1,4)
for x,y,w,h in faces:
    roi_gray_img = gray_img[y:y+h,x:x+w]
    roi_color = frame[y:y+h,x:x+w]
    cv2.rectangle(frame,(x,y),(x+w,y+h),(255,0,0),2)
    facess = face_detect.detectMultiScale(roi_gray_img)
    if len(facess) == 0:
        print("Face not detected")
    else:
        for (ex,ey,ew,eh) in facess:
            face_roi = roi_color[ey: ey+eh,ex:ex +ew]
```

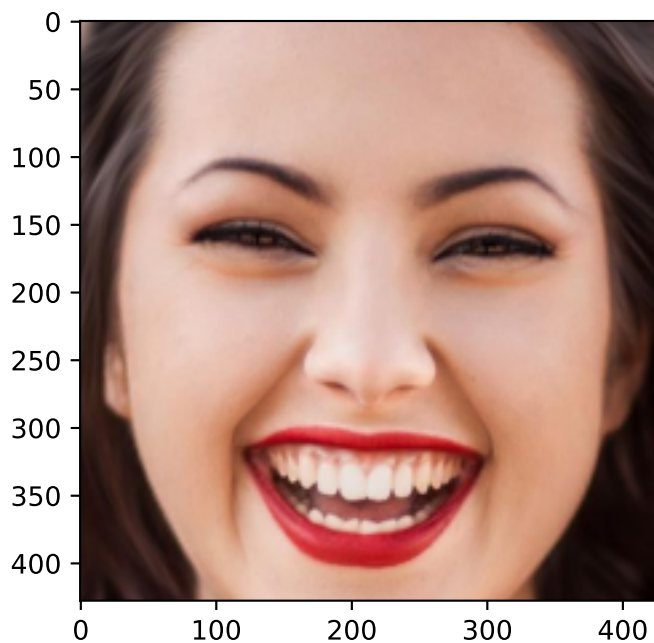
```
In [48]: plt.imshow(cv2.cvtColor(frame,cv2.COLOR_BGR2RGB))
```

Out[48]: <matplotlib.image.AxesImage at 0x1c4c255ce20>



```
In [49]: # cropped image
plt.imshow(cv2.cvtColor(face_roi, cv2.COLOR_BGR2RGB))
```

```
Out[49]: <matplotlib.image.AxesImage at 0x1c4c2ac2be0>
```



```
In [50]: final_img = cv2.resize(face_roi, (224, 224))
final_img = np.expand_dims(final_img, axis=0) # need 4th dimension
final_img = final_img / 255 # normalizing
```

```
In [51]: prediction = new_model.predict(final_img)
pred = np.argmax(prediction[0])
pred
```

Out[51]: 3

```
In [53]:
classNames= []
classFile = 'label.names'
with open(classFile,'rt') as f:
    classNames = f.read().rstrip('\n').split('\n')
```

```
In [54]:
classNames[pred]
```

Out[54]: 'Happy'

Make a predict function

```
In [55]:
def prediction_img(img,detect_model,classNames,draw=False):
    frame = cv2.imread(img)
    if draw:
        plt.imshow(cv2.cvtColor(frame,cv2.COLOR_BGR2RGB))
    face_detect = cv2.CascadeClassifier(cv2.data.harcascades + 'haarcascade_frontalfac

    gray_img = cv2.cvtColor(frame,cv2.COLOR_BGR2GRAY)
    faces = face_detect.detectMultiScale(gray_img,1.1,4)
    for x,y,w,h in faces:
        roi_gray_img = gray_img[y:y+h,x:x+w]
        roi_color = frame[y:y+h,x:x+w]
        cv2.rectangle(frame,(x,y),(x+w,y+h),(255,0,0),2)
        facess = face_detect.detectMultiScale(roi_gray_img)
        if len(facess) == 0:
            print("Face not detected")
        else:
            for (ex,ey,ew,eh) in facess:
                face_roi = roi_color[ey: ey+eh,ex:ex +ew]

    final_img = cv2.resize(face_roi,(224,224))
    final_img = np.expand_dims(final_img,axis=0) # need 4th dimension
    final_img = final_img/255 # normalizing

    prediction = detect_model.predict(final_img)
    pred = np.argmax(prediction[0])

    return classNames[pred]

if __name__ == "__main__":
    classNames= []
    classFile = 'label.names'
    with open(classFile,'rt') as f:
        classNames = f.read().rstrip('\n').split('\n')

    detect_model = tf.keras.models.load_model("face_emotion_rec_v2.h5")
    img = "surprise_girl.jpg"
    print(prediction_img(img,detect_model,classNames,draw=True))
```

Surprise

