Project Development Phase
Sprint - 1

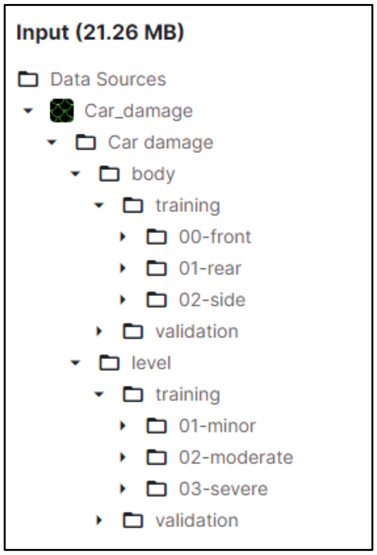
Date	01 November 2022
Team ID	PNT2022TMID35960
Project Name	Project – Intelligent Vehicle Damage Assessment & Cost Estimator for Insurance Companies

Kaggle code Link: https://www.kaggle.com/code/balasubramaniankn/damage-area-v2

Importing Phase:

```
from tensorflow.keras.layers import Input,Dense,Flatten, Dropout
from tensorflow.keras.models import Model,Sequential
from tensorflow.keras.applications.vgg16 import VGG16,preprocess_input
from matplotlib import pyplot as plt
import numpy as np
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import os
from tensorflow.keras.preprocessing.image import img_to_array
from tensorflow.keras.preprocessing.image import load_img
import cv2
import shutil
import random
```

Data Collection:



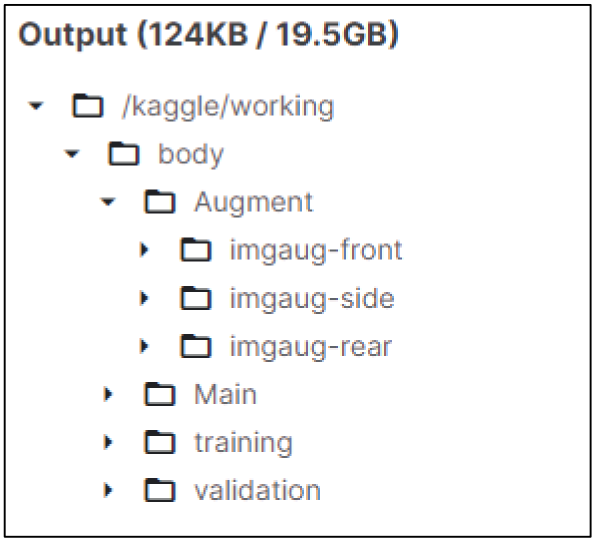
Input (21.26 MB)

- Data Sources
  - Car_damage
    - Car damage
      - body
        - training
          - 00-front
          - 01-rear
          - 02-side
        - validation
      - level
        - training
          - 01-minor
          - 02-moderate
          - 03-severe
        - validation

Creation of Directories:

Different directories are created such as Main, Augment, Training and Validation and performed move and store operations respectively.

```
# creating directory
os.mkdir('./body')
os.mkdir('./body/training')
os.mkdir('./body/training/imgaug-front')
os.mkdir('./body/training/imgaug-rear')
os.mkdir('./body/training/imgaug-side')

os.mkdir('./body/Main')
os.mkdir('./body/Main/real-front')
os.mkdir('./body/Main/real-rear')
os.mkdir('./body/Main/real-side')

os.mkdir('./body/validation')
os.mkdir('./body/validation/imgaug-front')
os.mkdir('./body/validation/imgaug-rear')
os.mkdir('./body/validation/imgaug-side')

os.mkdir('./body/Augment')
os.mkdir('./body/Augment/imgaug-front')
os.mkdir('./body/Augment/imgaug-rear')
os.mkdir('./body/Augment/imgaug-side')
```



Output (124KB / 19.5GB)

```
▾ 🗀 /kaggle/working
  ▾ 🗀 body
    ▾ 🗀 Augment
      ▸ 🗀 imgaug-front
      ▸ 🗀 imgaug-side
      ▸ 🗀 imgaug-rear
    ▸ 🗀 Main
    ▸ 🗀 training
    ▸ 🗀 validation
```

Merging of Dataset:

To merge both training and validation image data into one in to the Main directory sub folders to perform together augmentation.

1) Training data:

```
path_front = "../input/car-damage/Car damage/body/training/00-front"
dir_list_f = os.listdir(path_front)
path_rear = '../input/car-damage/Car damage/body/training/01-rear'
dir_list_r = os.listdir(path_rear)
path_side = '../input/car-damage/Car damage/body/training/02-side'
dir_list_s = os.listdir(path_side)

for j in dir_list_f:
    IMAGE_PATH = path_front+'/'+j

    image = cv2.imread(IMAGE_PATH)
    path = './body/Main/real-front'
    cv2.imwrite(os.path.join(path,j), image)

for j in dir_list_r:
    IMAGE_PATH = path_rear+'/'+j

    image = cv2.imread(IMAGE_PATH)
    path = './body/Main/real-rear'
    cv2.imwrite(os.path.join(path,j), image)

for j in dir_list_s:
    IMAGE_PATH = path_side+'/'+j

    image = cv2.imread(IMAGE_PATH)
    path = './body/Main/real-side'
    cv2.imwrite(os.path.join(path,j), image)
```

2) validation data:

```
path_frontv = "../input/car-damage/Car damage/body/validation/00-front"
dir_list_fv = os.listdir(path_frontv)
path_rearv = '../input/car-damage/Car damage/body/validation/01-rear'
dir_list_rv = os.listdir(path_rearv)
path_sidev = '../input/car-damage/Car damage/body/validation/02-side'
dir_list_sv = os.listdir(path_sidev)

for j in dir_list_fv:
    IMAGE_PATH = path_frontv+'/'+j

    image = cv2.imread(IMAGE_PATH)
    path = './body/Main/real-front'
    cv2.imwrite(os.path.join(path,j), image)

for j in dir_list_rv:
    IMAGE_PATH = path_rearv+'/'+j

    image = cv2.imread(IMAGE_PATH)
    path = './body/Main/real-rear'
    cv2.imwrite(os.path.join(path,j), image)
```

```
for j in dir_list_sv:
    IMAGE_PATH = path_sidev+'/'+j

    image = cv2.imread(IMAGE_PATH)
    path = './body/Main/real-side'
    cv2.imwrite(os.path.join(path,j), image)
```

Image Augmentation:

To perform shifting, Right rotation and horizontal flip on all the images and store the result in the augment directory.

```
#Augmenting and saving train body front view images

OUTPUT_DIRECTORY = './body/Augment/imgaug-front'

# Get the list of all files and directories
path_front = "./body/Main/real-front"
dir_list = os.listdir(path_front)
for j in dir_list:
    IMAGE_PATH = path_front+'/'+j

    image = cv2.imread(IMAGE_PATH)
    path = './body/Augment/imgaug-front'
    cv2.imwrite(os.path.join(path,j), image)

    image = load_img(IMAGE_PATH)
    image = img_to_array(image)
    image = np.expand_dims(image, axis=0)

    datagen_shift = ImageDataGenerator(height_shift_range=0.2, width_shift_range=0.2)
    PREFIX = 'Shifted'
    imGen = datagen_shift.flow(image, batch_size=1, save_to_dir = OUTPUT_DIRECTORY,
                        save_prefix=PREFIX, save_format='jpg')
    for i in range(6):
        batch = imGen.next()

    datagen_rot = ImageDataGenerator(rotation_range=30)
    PREFIX = 'Rotated'
    imGen = datagen_rot.flow(image, batch_size=1, save_to_dir = OUTPUT_DIRECTORY,
                        save_prefix=PREFIX, save_format='jpg')
    for i in range(6):
        batch = imGen.next()

    datagen_hf = ImageDataGenerator(horizontal_flip=True)
    PREFIX = 'Hortizonal_flip'
    imGen = datagen_hf.flow(image, batch_size=1, save_to_dir = OUTPUT_DIRECTORY,
                        save_prefix=PREFIX, save_format='jpg')
    for i in range(1):
        batch = imGen.next()
```

```
#Augmenting and saving train body rear view images

OUTPUT_DIRECTORY = './body/Augment/imgaug-rear'

# Get the list of all files and directories
path_front = "./body/Main/real-rear"
dir_list = os.listdir(path_front)
for j in dir_list:
    IMAGE_PATH = path_front+'/'+j

    image = cv2.imread(IMAGE_PATH)
    path = './body/Augment/imgaug-rear'
    cv2.imwrite(os.path.join(path,j), image)

    image = load_img(IMAGE_PATH)
    image = img_to_array(image)
    image = np.expand_dims(image, axis=0)

    datagen_shift = ImageDataGenerator(height_shift_range=0.2, width_shift_range=0.2)
    PREFIX = 'Shifted'
    imGen = datagen_shift.flow(image, batch_size=1, save_to_dir = OUTPUT_DIRECTORY,
                               save_prefix=PREFIX, save_format='jpg')
    for i in range(6):
        batch = imGen.next()

    datagen_rot = ImageDataGenerator(rotation_range=30)
    PREFIX = 'Rotated'
    imGen = datagen_rot.flow(image, batch_size=1, save_to_dir = OUTPUT_DIRECTORY,
                               save_prefix=PREFIX, save_format='jpg')
    for i in range(6):
        batch = imGen.next()

    datagen_hf = ImageDataGenerator(horizontal_flip=True)
    PREFIX = 'Hortizonal_flip'
    imGen = datagen_hf.flow(image, batch_size=1, save_to_dir = OUTPUT_DIRECTORY,
                               save_prefix=PREFIX, save_format='jpg')
    for i in range(1):
        batch = imGen.next()


#Augmenting and saving train body side view images

OUTPUT_DIRECTORY = './body/Augment/imgaug-side'

# Get the list of all files and directories
path_front = "./body/Main/real-side"
dir_list = os.listdir(path_front)
for j in dir_list:
    IMAGE_PATH = path_front+'/'+j

    image = cv2.imread(IMAGE_PATH)
    path = './body/Augment/imgaug-side'
    cv2.imwrite(os.path.join(path,j), image)
```

```
image = load_img(IMAGE_PATH)
image = img_to_array(image)
image = np.expand_dims(image, axis=0)

datagen_shift = ImageDataGenerator(height_shift_range=0.2, width_shift_range=0.2)
PREFIX = 'Shifted'
imGen = datagen_shift.flow(image, batch_size=1, save_to_dir = OUTPUT_DIRECTORY,
                    save_prefix=PREFIX, save_format='jpg')
for i in range(6):
    batch = imGen.next()

datagen_rot = ImageDataGenerator(rotation_range=30)
PREFIX = 'Rotated'
imGen = datagen_rot.flow(image, batch_size=1, save_to_dir = OUTPUT_DIRECTORY,
                    save_prefix=PREFIX, save_format='jpg')
for i in range(6):
    batch = imGen.next()

datagen_hf = ImageDataGenerator(horizontal_flip=True)
PREFIX = 'Hortizonal_flip'
imGen = datagen_hf.flow(image, batch_size=1, save_to_dir = OUTPUT_DIRECTORY,
                    save_prefix=PREFIX, save_format='jpg')
for i in range(1):
    batch = imGen.next()
```

Splitting of Dataset:

To split the augmented image in the ratio of 80:20 and store it in respective folders and sub folders.

```
# Split the front view data in 80:20 ratio
no_of_frontal = os.listdir('./body/Augment/imgaug-front')
len(no_of_frontal)
augment_data =  './body/Augment/imgaug-front'
for f in no_of_frontal:
    if random.random() > 0.80:
        shutil.move(f'{augment_data}/{f}','./body/validation/imgaug-front' )
    else:
        shutil.move(f'{augment_data}/{f}','./body/training/imgaug-front')
```

```
# Split the side view data in 80:20 ratio
no_of_side = os.listdir('./body/Augment/imgaug-side')

augment_data =  './body/Augment/imgaug-side'
for f in no_of_side:
    if random.random() > 0.80:
        shutil.move(f'{augment_data}/{f}','./body/validation/imgaug-side' )
    else:
        shutil.move(f'{augment_data}/{f}','./body/training/imgaug-side')
```

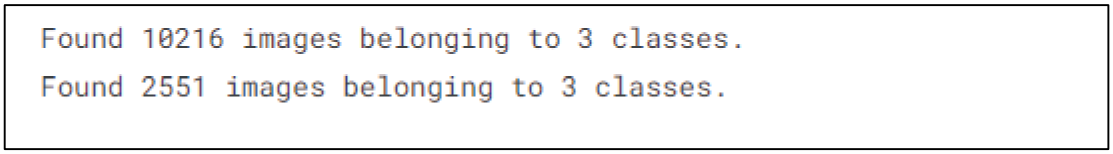
Flow from Directory – Augmentation:

To store the path of the train and validating data.

```
img_size = [224,224] #List which stores the resolution
main_train = './body/training' #Stores the path of the train directory
main_test = './body/validation' #Stores the path of the test directory
```

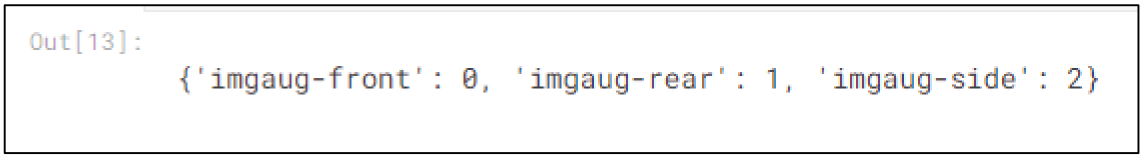
To modify the train and validation data with respect to the properties.

```
train_datagen = ImageDataGenerator(rescale = 1/255.0)

test_datagen = ImageDataGenerator(rescale = 1/255.0)

# flow_from_directory() is used to convert all the images in the specific directo
ry
training_set = train_datagen.flow_from_directory(directory = main_train,
                                                 target_size = (224,224),
                                                 batch_size = 100,
                                                 )

test_set = test_datagen.flow_from_directory(directory = main_test,
                                                 target_size = (224,224),
                                                 batch_size = 100,
                                                 )
```



```
Found 10216 images belonging to 3 classes.
Found 2551 images belonging to 3 classes.
```

```
# Class_indices will display the respective class value
training_set.class_indices
```

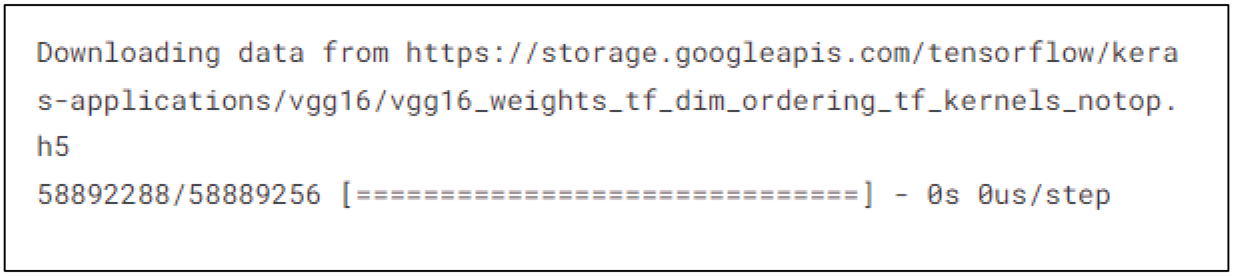


```
Out[13]:
         {'imgaug-front': 0, 'imgaug-rear': 1, 'imgaug-side': 2}
```

Model Building:

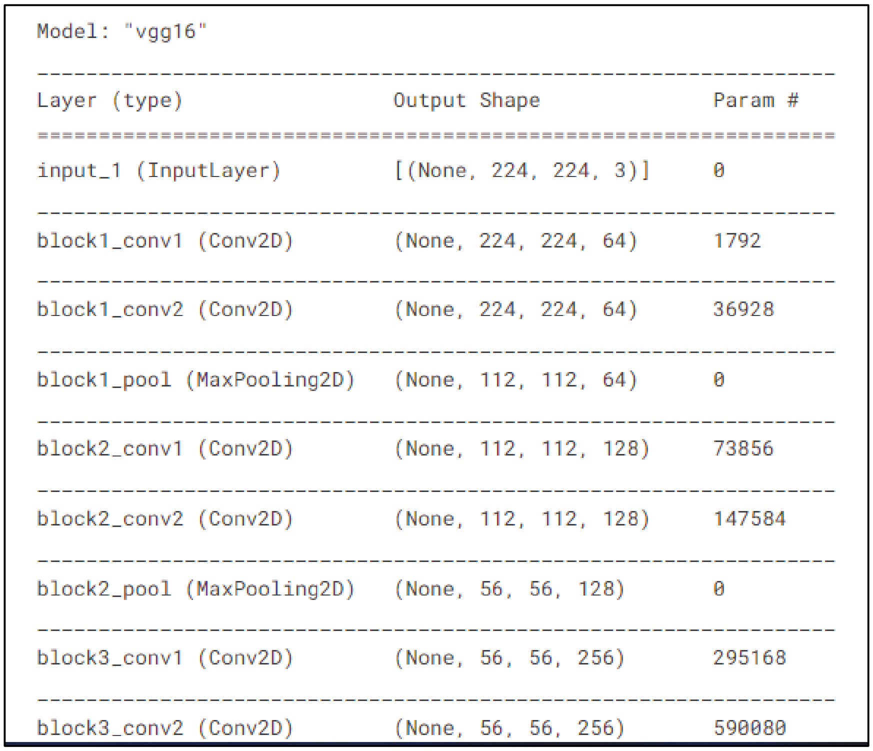
- Loading the VGG16 pre trained model.
- Include_top - this specifies whether the final layer before the output layer has to be include.
- If included then there will be 1000 number of classes at the output. # Weights are trained using imagenet

```
vgg_model = VGG16(include_top=False,
    weights="imagenet",
    input_shape=img_size + [3])
```

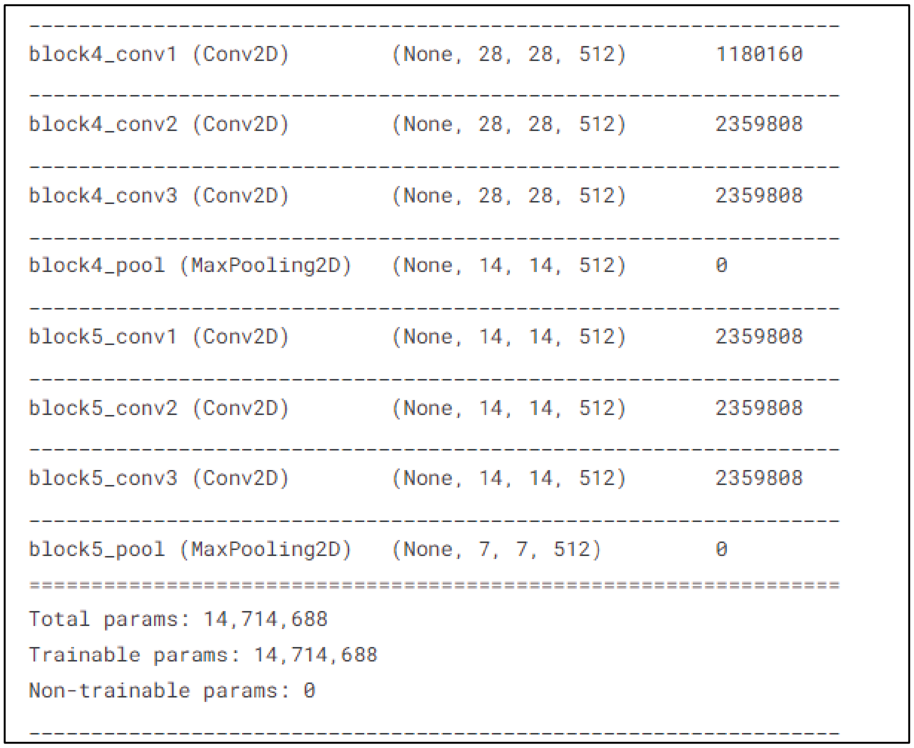


```
Downloading data from https://storage.googleapis.com/tensorflow/kera
s-applications/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels_notop.
h5
58892288/58889256 [==============================] - 0s 0us/step
```

```
# To print the hidden layer summary of vgg model without top layer
vgg_model.summary()
```



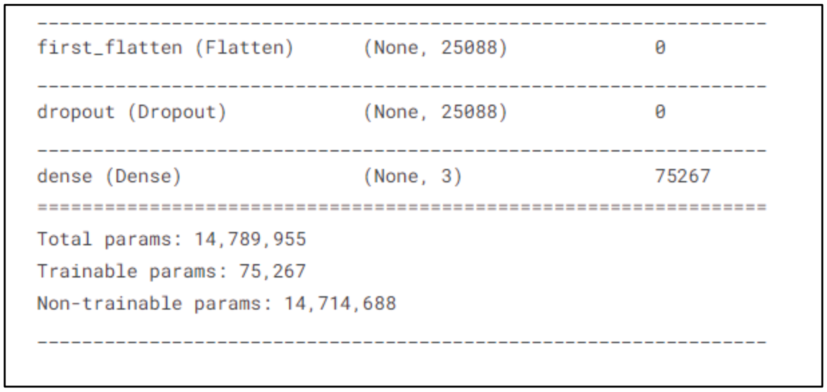
```
Model: "vgg16"
_________________________________________________________________
Layer (type)                Output Shape              Param #
=================================================================
input_1 (InputLayer)        [(None, 224, 224, 3)]     0

_________________________________________________________________
block1_conv1 (Conv2D)       (None, 224, 224, 64)      1792

_________________________________________________________________
block1_conv2 (Conv2D)       (None, 224, 224, 64)      36928

_________________________________________________________________
block1_pool (MaxPooling2D)  (None, 112, 112, 64)      0

_________________________________________________________________
block2_conv1 (Conv2D)       (None, 112, 112, 128)     73856

_________________________________________________________________
block2_conv2 (Conv2D)       (None, 112, 112, 128)     147584

_________________________________________________________________
block2_pool (MaxPooling2D)  (None, 56, 56, 128)       0

_________________________________________________________________
block3_conv1 (Conv2D)       (None, 56, 56, 256)       295168

_________________________________________________________________
block3_conv2 (Conv2D)       (None, 56, 56, 256)       590080
```



```
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 28, 28, 512)       1180160   
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 28, 28, 512)       2359808   
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 28, 28, 512)       2359808   
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 14, 14, 512)       0         
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 14, 14, 512)       2359808   
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 14, 14, 512)       2359808   
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 14, 14, 512)       2359808   
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 7, 7, 512)         0         
=================================================================
Total params: 14,714,688
Trainable params: 14,714,688
Non-trainable params: 0
_________________________________________________________________
```

```python
# To fix the weights of the pre trained model
for lay in vgg_model.layers:
    lay.trainable = False
```

```python
# Flatten() is used to convert the last layer to vector or as fully connected
x = Flatten(name="first_flatten")(vgg_model.output)
# Dense() layer is added such that it outputs only two classess
# Softmax activation layer produces probabilities for different classess.
x = Dropout(0.5)(x)
pred = Dense(3,activation='softmax')(x)
# Model() is used to group layers
model = Model(inputs=vgg_model.input,outputs=pred)
model.summary()
```



```
_________________________________________________________________
first_flatten (Flatten)      (None, 25088)             0         
_________________________________________________________________
dropout (Dropout)            (None, 25088)             0         
_________________________________________________________________
dense (Dense)                (None, 3)                 75267     
=================================================================
Total params: 14,789,955
Trainable params: 75,267
Non-trainable params: 14,714,688
_________________________________________________________________
```

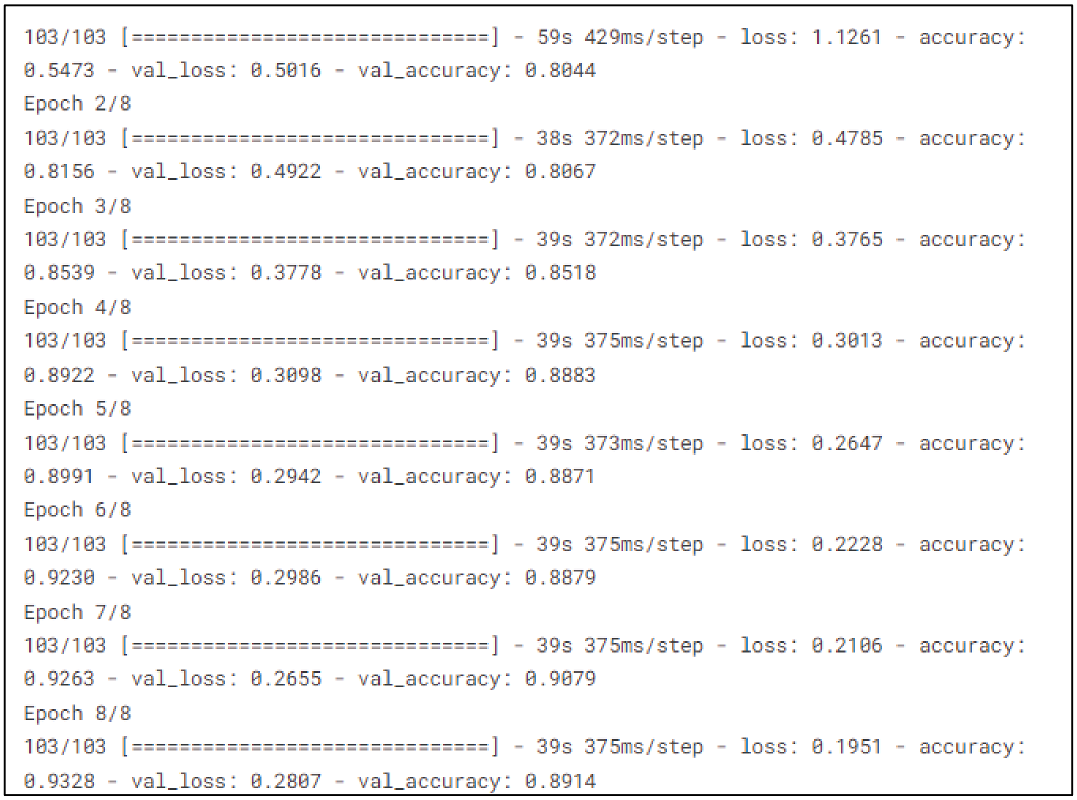
Model Fitting:

- Loss function is used to find the errors or deviations in learning process.
- Optimizer is used to optimize the input weights.
- Metrics is used to measure the performance

```
model.compile(optimizer="adam",
    loss="categorical_crossentropy",
    metrics=['accuracy'])
```

Training the model for 8 epochs:

```
#fit() is used to train the model
mod = model.fit( training_set,
                validation_data=test_set,
                epochs=8,
                steps_per_epoch=len(training_set),
                validation_steps=len(test_set)
               )
```



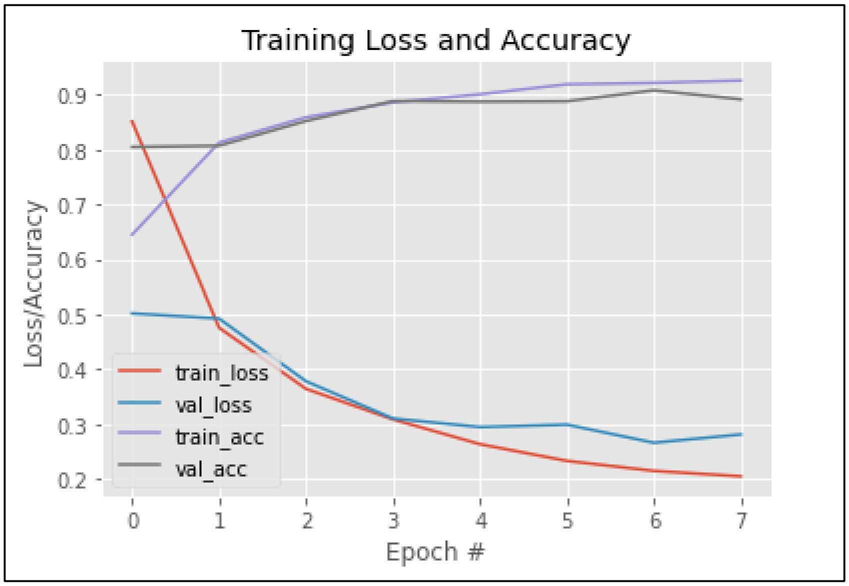
```
103/103 [==============================] - 59s 429ms/step - loss: 1.1261 - accuracy:
0.5473 - val_loss: 0.5016 - val_accuracy: 0.8044
Epoch 2/8
103/103 [==============================] - 38s 372ms/step - loss: 0.4785 - accuracy:
0.8156 - val_loss: 0.4922 - val_accuracy: 0.8067
Epoch 3/8
103/103 [==============================] - 39s 372ms/step - loss: 0.3765 - accuracy:
0.8539 - val_loss: 0.3778 - val_accuracy: 0.8518
Epoch 4/8
103/103 [==============================] - 39s 375ms/step - loss: 0.3013 - accuracy:
0.8922 - val_loss: 0.3098 - val_accuracy: 0.8883
Epoch 5/8
103/103 [==============================] - 39s 373ms/step - loss: 0.2647 - accuracy:
0.8991 - val_loss: 0.2942 - val_accuracy: 0.8871
Epoch 6/8
103/103 [==============================] - 39s 375ms/step - loss: 0.2228 - accuracy:
0.9230 - val_loss: 0.2986 - val_accuracy: 0.8879
Epoch 7/8
103/103 [==============================] - 39s 375ms/step - loss: 0.2106 - accuracy:
0.9263 - val_loss: 0.2655 - val_accuracy: 0.9079
Epoch 8/8
103/103 [==============================] - 39s 375ms/step - loss: 0.1951 - accuracy:
0.9328 - val_loss: 0.2807 - val_accuracy: 0.8914
```

Saving the Model:

```
# To save the particular model in .h5 format
import tensorflow as tf
from tensorflow.keras.models import load_model
model.save('vggmodelfinalbody.h5')
```

Model Visualization:

```
from matplotlib import pyplot as plt
N = 8
plt.style.use("ggplot")
plt.figure()
plt.plot(np.arange(0, N), mod.history["loss"], label="train_loss")
plt.plot(np.arange(0, N), mod.history["val_loss"], label="val_loss")
plt.plot(np.arange(0, N), mod.history["accuracy"], label="train_acc")
plt.plot(np.arange(0, N), mod.history["val_accuracy"], label="val_acc")
plt.title("Training Loss and Accuracy")
plt.xlabel("Epoch #")
plt.ylabel("Loss/Accuracy")
plt.legend(loc="lower left")
plt.savefig('grp.png')
```

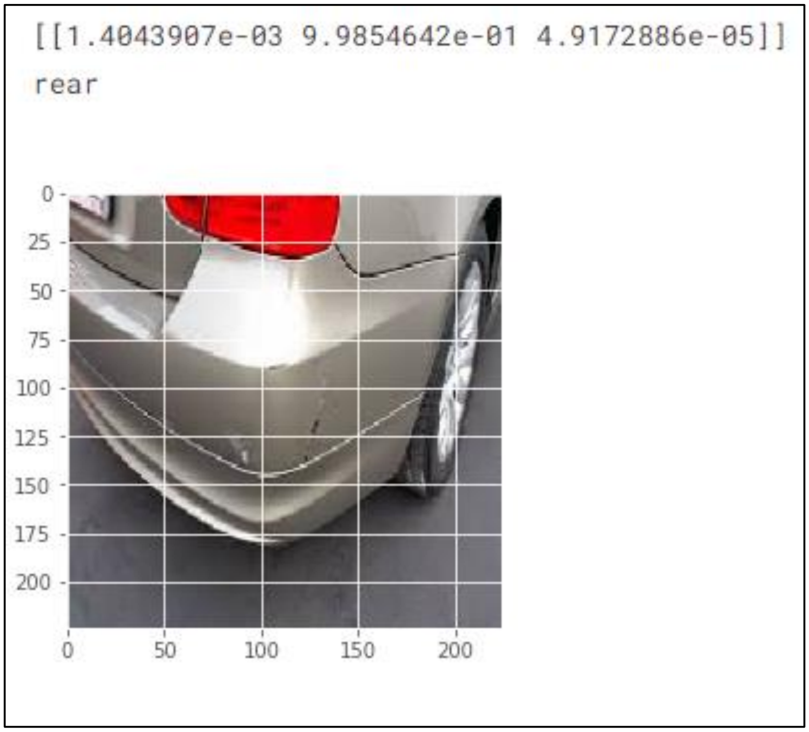


It is evident from the graph that the model is not overfitting and it near to best fit. The validation accuracy obtained is 89%.

Model Testing:

1)

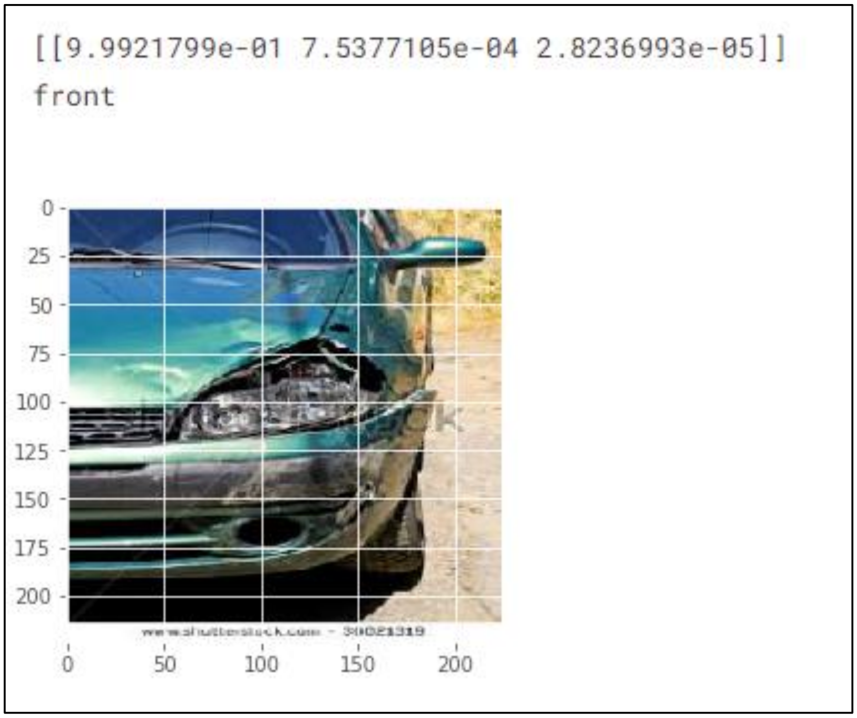
```
from tensorflow.keras.preprocessing import image
img12 =image.load_img('../input/car-damage/Car damage/body/training/01-rear/0003.
JPEG',target_size=(224,224))
plt.imshow(img12)
img12 = image.img_to_array(img12)
img12 = img12/255.0
img12 = np.expand_dims(img12,axis=0)
pred1 = model.predict(img12)
print(pred1)
pred1 = np.argmax(pred1,axis=1)



if pred1[0] == 1:
    print("rear")
elif pred1[0] == 0:
    print("front")
else:
    print("side")
```



```
[[1.4043907e-03 9.9854642e-01 4.9172886e-05]]
rear
```

2)

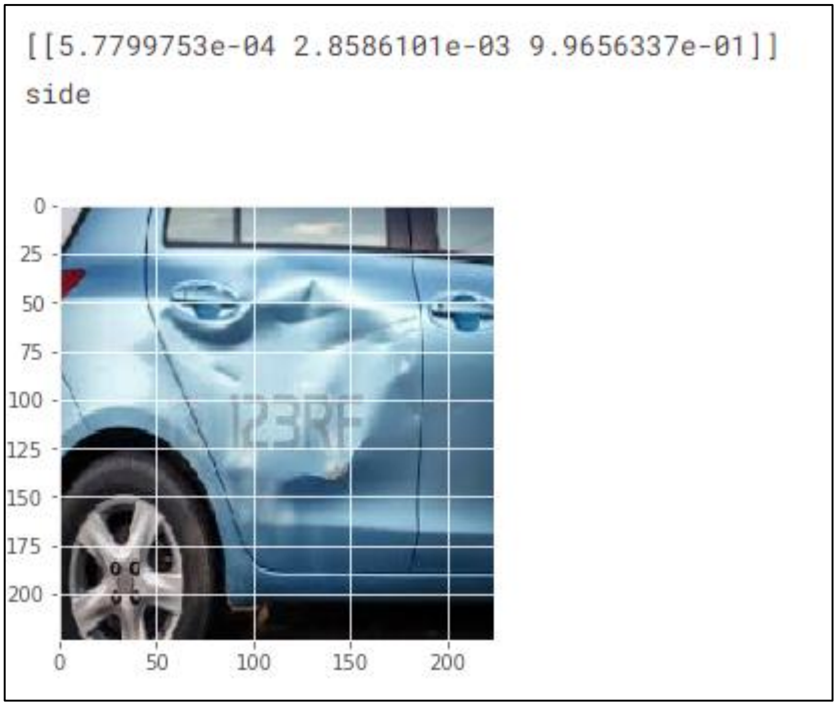
```
img12 =image.load_img('../input/car-damage/Car damage/body/training/00-front/0006
.JPEG',target_size=(224,224))
plt.imshow(img12)
img12 = image.img_to_array(img12)
img12 = img12/255.0
img12 = np.expand_dims(img12,axis=0)
pred1 = model.predict(img12)
print(pred1)
pred1 = np.argmax(pred1,axis=1)



if pred1[0] == 1:
    print("rear")
elif pred1[0] == 0:
    print("front")
else:
    print("side")
```



```
[[9.9921799e-01 7.5377105e-04 2.8236993e-05]]
front
```

3)

```
img12 =image.load_img('../input/car-damage/Car damage/body/training/02-side/0006.
JPEG',target_size=(224,224))
plt.imshow(img12)
img12 = image.img_to_array(img12)
img12 = img12/255.0
img12 = np.expand_dims(img12,axis=0)
pred1 = model.predict(img12)
print(pred1)
pred1 = np.argmax(pred1,axis=1)



if pred1[0] == 1:
    print("rear")
elif pred1[0] == 0:
    print("front")
else:
    print("side")
```



```
[[5.7799753e-04 2.8586101e-03 9.9656337e-01]]
side
```