PROJECT - (5th Mar, 2021 - 21st Mar, 2021)

I]. PART ONE

```
# Mounting google drive

from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
%tensorflow_version 2.x
import tensorflow
tensorflow.__version__
```

```
'2.4.1'
```

```
project_path  = '/content/drive/MyDrive/My Files/AIML Workbooks/Part 1/'
```

```
import os                   # Importing os library
import pandas as pd         # To read the data set
import numpy as np          # Importing numpy library
import seaborn as sns       # For data visualization
import matplotlib.pyplot as plt      # Necessary library for plotting graphs
from glob import glob       # Importing necessary library
%matplotlib inline
sns.set(color_codes = True)

from sklearn import metrics          # Importing metrics
from sklearn.model_selection import train_test_split       # Splitting data into
from sklearn.metrics import classification_report, accuracy_score, recall_score,
from sklearn.preprocessing import StandardScaler           # Importing to standa
from sklearn.impute import SimpleImputer                   # Importing to fill i
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import PolynomialFeatures       # Importing polynomia
from sklearn.decomposition import PCA           # Importing to run pca analysis
from sklearn import svm              # Importing necessary library for model bui
from sklearn.ensemble import RandomForestClassifier        # Importing necessary
from sklearn.neighbors import KNeighborsClassifier         # Importing necessary
from sklearn import preprocessing               # Importing preprocessing librar
```

```
from sklearn.model_selection import KFold, cross_val_score          # Importing
from sklearn.model_selection import GridSearchCV, RandomizedSearchCV          #
from sklearn.cluster import KMeans             # For KMeans cluster model build
from scipy.stats import zscore      # Import zscore library
from scipy.spatial.distance import cdist       # Importing cdist functionality
import tensorflow          # Importing tensorflow library
from tensorflow.keras.models import Sequential, Model              # Importing
from tensorflow.keras.utils import to_categorical         # Importing tensorflo
from tensorflow.keras import optimizers                   # Importing optimizer
from tensorflow.keras.layers import Dense, Dropout, Activation, BatchNormalizati
from tensorflow.keras.applications.mobilenet import preprocess_input          #
from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping, ReduceLRO
from tensorflow.keras.applications.mobilenet import MobileNet       # Importing
from tensorflow.keras.losses import binary_crossentropy             # Importing
from tensorflow.keras.backend import log, epsilon         # Importing necessary
from keras.utils import np_utils     # Importing necessary library
from sklearn import svm              # Importing necessary library for model bui
from sklearn.svm import SVC          # Import svc library for model building

from skimage.color import rgb2gray             # Loading color library
from sklearn.preprocessing import OneHotEncoder           # Library for one hot
from sklearn.metrics import confusion_matrix              # Loading necessary l
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img, i
from keras.preprocessing import image          # Importing necessary image libr
from tensorflow import keras         # Loading keras libaray
from tensorflow.keras.optimizers import Adam, SGD         # Importing optimizer
import cv2                  # Importing necessary library
from PIL import ImageFile           # Importing image library
from tqdm import tqdm               # Importing necessary library
import time                 # Importing time library
from mpl_toolkits.axes_grid1 import ImageGrid             # Importing necessary
from PIL import Image       # Importing image library
import tensorflow as tf     # Importing library
```

1. Import the dataset.

```
# Path of the dataset

data = "Part 1- Train data - images.npy"


# Loading the file

df = np.load(project_path + data, allow_pickle = True)
```

```
df.shape    # Shape of dataset
```

```
(409, 2)
```

```
# Visualizing image from the dataset

plt.axis('off')
plt.imshow(df[100][0])
plt.show()
```


```
plt.axis ('off')
plt.imshow(df[125][0])
plt.show()
```

```
# Setting dimensions of the image

image_height = 224
image_width = 224

num_img = int(df.shape[0])
print('Number of images in dataset:', num_img)
```

```
Number of images in dataset: 409
```

2. Create features (images) and labels (mask) using that data.

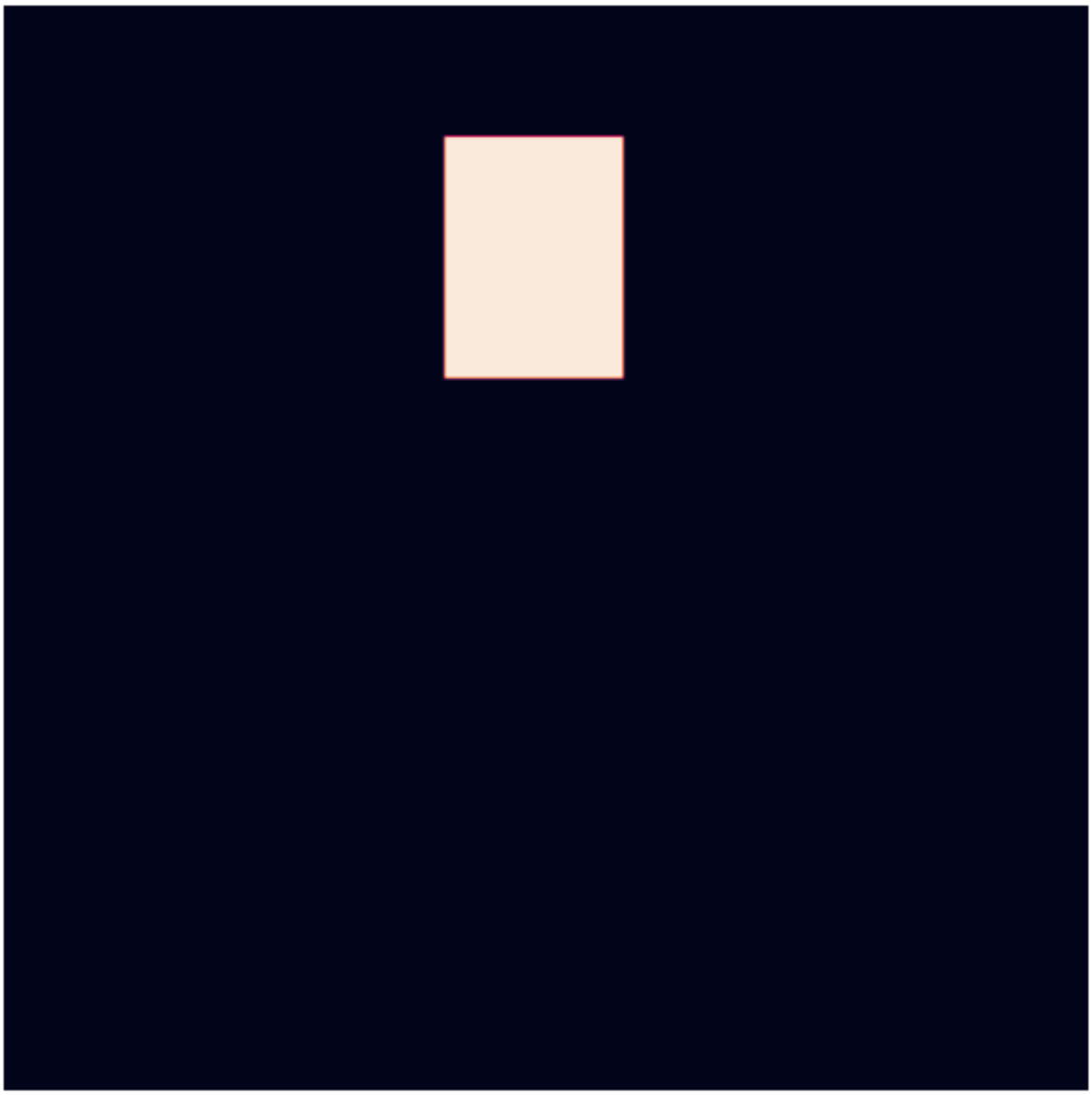
```
masks = np.zeros((num_img, image_height, image_width))
X = np.zeros((num_img, image_height, image_width, 3))
for index in range(num_img):
    image = df[index][0]
    image= cv2.resize(image, dsize = (image_height, image_width))
    try:
      image = image[:, :, :3]
    except:
      continue
    X[index] = preprocess_input(np.array(image, dtype = np.float32))
    for i in df[index][1]:
        x1 = int(i['points'][0]['x'] * image_width)
        x2 = int(i['points'][1]['x'] * image_width)
        y1 = int(i['points'][0]['y'] * image_height)
        y2 = int(i['points'][1]['y'] * image_height)
        masks[index][y1:y2, x1:x2] = 1


print('Shape of image features :', X.shape)      # Image feature shape
print('Shape of image masks :', masks.shape)     # Image masks shape
```

```
Shape of image features : (409, 224, 224, 3)
Shape of image masks : (409, 224, 224)
```

```
# Visualizing image and its mask

Img = plt.figure(figsize = (10,10))
plt.axis('off')
plt.imshow(X[130])
plt.show()
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
```

```
# Visualizing image and its mask

Img = plt.figure(figsize = (10,10))
plt.axis('off')
plt.imshow(masks[130])
plt.show()
```



3. Mask detection model

```
def conv_block_simple(prevlayer, filters, prefix, strides=(1, 1)):
    conv = Conv2D(filters, (3, 3), padding = 'same', kernel_initializer = 'he_no
    conv = BatchNormalization(name = prefix + 'BatchNormalization')(conv)
    conv = Activation('relu', name = prefix + 'ActivationLayer')(conv)
    return conv

def create_model(trainable = True):
    model = MobileNet(input_shape = (image_height, image_width, 3), include_top
    for layer in model.layers:
        layer.trainable = trainable

    block1 = model.get_layer('conv_pw_13_relu').output
    block2 = model.get_layer('conv_pw_11_relu').output
    block3 = model.get_layer('conv_pw_5_relu').output
    block4 = model.get_layer('conv_pw_3_relu').output
    block5 = model.get_layer('conv_pw_1_relu').output

    up1 = Concatenate()([UpSampling2D()(block1), block2])
    conv6 = conv_block_simple(up1, 512, 'Conv_6_1')
    conv6 = conv_block_simple(conv6, 512, 'Conv_6_2')

    up2 = Concatenate()([UpSampling2D()(conv6), block3])
    conv7 = conv_block_simple(up2, 256, 'Conv_7_1')
    conv7 = conv_block_simple(conv7, 256, 'Conv_7_2')

    up3 = Concatenate()([UpSampling2D()(conv7), block4])
    conv8 = conv_block_simple(up3, 128, 'Conv_8_1')
    conv8 = conv_block_simple(conv8, 64, 'Conv_8_2')

    up4 = Concatenate()([UpSampling2D()(conv8), block5])
    conv9 = conv_block_simple(up4, 64, 'Conv_9_1')
    conv9 = conv_block_simple(conv9, 32, 'Conv_9_2')

    up5 = Concatenate()([UpSampling2D()(conv9), model.input])
    conv10 = conv_block_simple(up5, 32, 'Conv_10_1')
    conv10 = conv_block_simple(conv10, 16, 'Conv_10_2')
    conv10 = SpatialDropout2D(0.1)(conv10)

    x = Conv2D(1, (1, 1), activation = 'sigmoid')(conv10)
    x = Reshape((image_height, image_width))(x)
    return Model(inputs = model.input, outputs = x)


model = create_model(True)
model.summary()
```

```
_________________________________________________________________
concatenate_2 (Concatenate)     (None, 56, 56, 384)  0           up_samplin
                                                                 conv_pw_3_
```

Conv_8_1_conv (Conv2D)	(None, 56, 56, 128)	442496	concatenat
Conv_8_1BatchNormalization (Bat	(None, 56, 56, 128)	512	Conv_8_1_c
Conv_8_1ActivationLayer (Activa	(None, 56, 56, 128)	0	Conv_8_1Ba
Conv_8_2_conv (Conv2D)	(None, 56, 56, 64)	73792	Conv_8_1Ac
Conv_8_2BatchNormalization (Bat	(None, 56, 56, 64)	256	Conv_8_2_c
Conv_8_2ActivationLayer (Activa	(None, 56, 56, 64)	0	Conv_8_2Ba
up_sampling2d_3 (UpSampling2D)	(None, 112, 112, 64)	0	Conv_8_2Ac
concatenate_3 (Concatenate)	(None, 112, 112, 128	0	up_samplin conv_pw_1_
Conv_9_1_conv (Conv2D)	(None, 112, 112, 64)	73792	concatenat
Conv_9_1BatchNormalization (Bat	(None, 112, 112, 64)	256	Conv_9_1_c
Conv_9_1ActivationLayer (Activa	(None, 112, 112, 64)	0	Conv_9_1Ba
Conv_9_2_conv (Conv2D)	(None, 112, 112, 32)	18464	Conv_9_1Ac
Conv_9_2BatchNormalization (Bat	(None, 112, 112, 32)	128	Conv_9_2_c
Conv_9_2ActivationLayer (Activa	(None, 112, 112, 32)	0	Conv_9_2Ba
up_sampling2d_4 (UpSampling2D)	(None, 224, 224, 32)	0	Conv_9_2Ac
concatenate_4 (Concatenate)	(None, 224, 224, 35)	0	up_samplin input_1[0]
Conv_10_1_conv (Conv2D)	(None, 224, 224, 32)	10112	concatenat
Conv_10_1BatchNormalization (Ba	(None, 224, 224, 32)	128	Conv_10_1_
Conv_10_1ActivationLayer (Activ	(None, 224, 224, 32)	0	Conv_10_1B
Conv_10_2_conv (Conv2D)	(None, 224, 224, 16)	4624	Conv_10_1A
Conv_10_2BatchNormalization (Ba	(None, 224, 224, 16)	64	Conv_10_2_
Conv_10_2ActivationLayer (Activ	(None, 224, 224, 16)	0	Conv_10_2B
spatial_dropout2d (SpatialDropo	(None, 224, 224, 16)	0	Conv_10_2A
conv2d (Conv2D)	(None, 224, 224, 1)	17	spatial_dr
reshape (Reshape)	(None, 224, 224)	0	conv2d[0][

Total params: 15,657,665
Trainable params: 15,632,033

```
Trainable params: 13,032,033
Non-trainable params: 25,632
_________________________________________________________________
```

```
# Designing Dice Coefficient

def dice_coefficient (y_true, y_pred):
  numerator = 2 * tf.reduce_sum(y_true * y_pred)
  denominator = tf.reduce_sum(y_true + y_pred)

  return numerator / (denominator + tf.keras.backend.epsilon())


def loss(y_true, y_pred):
  return binary_crossentropy(y_true, y_pred) - log(dice_coefficient(y_true, y_pr


# Building model

adam = Adam(lr = 1e-7, beta_1 = 0.9, beta_2 = 0.999, epsilon = None, decay = 0.0
model.compile(loss = loss, optimizer = adam, metrics = [dice_coefficient])


checkpoint = ModelCheckpoint('model_{loss:.2f}.h5', monitor = 'loss', verbose =
earlystop = EarlyStopping(monitor = 'loss', patience = 5, mode = 'min')
learn_red = ReduceLROnPlateau(monitor = 'loss', factor = 0.2, patience = 5, min_
```

```
WARNING:tensorflow:`period` argument is deprecated. Please use `save_freq`
```

```
X_train, X_val, y_train, y_val = train_test_split(X, masks, test_size = 0.20, ra


print(X_train.shape)
print(X_val.shape)
print(y_train.shape)
print(y_val.shape)
```

```
(327, 224, 224, 3)
(82, 224, 224, 3)
(327, 224, 224)
(82, 224, 224)
```

```
# Fitting the model

model.fit(X_train, y_train, epochs = 10, verbose = 1, batch_size = 32, callbacks
```

```
Epoch 1/10
11/11 [==============================] - 458s 41s/step - loss: 2.3134 - dic

Epoch 00001: loss improved from inf to 2.35713, saving model to model_2.36.
Epoch 2/10
11/11 [==============================] - 448s 41s/step - loss: 2.3322 - dic

Epoch 00002: loss did not improve from 2.35713
Epoch 3/10
11/11 [==============================] - 452s 41s/step - loss: 2.3489 - dic

Epoch 00003: loss did not improve from 2.35713
Epoch 4/10
11/11 [==============================] - 456s 41s/step - loss: 2.3103 - dic

Epoch 00004: loss improved from 2.35713 to 2.34221, saving model to model_2
Epoch 5/10
11/11 [==============================] - 459s 42s/step - loss: 2.3337 - dic

Epoch 00005: loss improved from 2.34221 to 2.33673, saving model to model_2
Epoch 6/10
11/11 [==============================] - 448s 41s/step - loss: 2.3557 - dic

Epoch 00006: loss did not improve from 2.33673
Epoch 7/10
11/11 [==============================] - 451s 41s/step - loss: 2.3829 - dic

Epoch 00007: loss did not improve from 2.33673
Epoch 8/10
11/11 [==============================] - 448s 41s/step - loss: 2.3378 - dic

Epoch 00008: loss did not improve from 2.33673
Epoch 9/10
11/11 [==============================] - 448s 41s/step - loss: 2.3068 - dic

Epoch 00009: loss improved from 2.33673 to 2.33591, saving model to model_2
Epoch 10/10
11/11 [==============================] - 450s 41s/step - loss: 2.3959 - dic

Epoch 00010: loss did not improve from 2.33591
<tensorflow.python.keras.callbacks.History at 0x7f855a877a90>
```

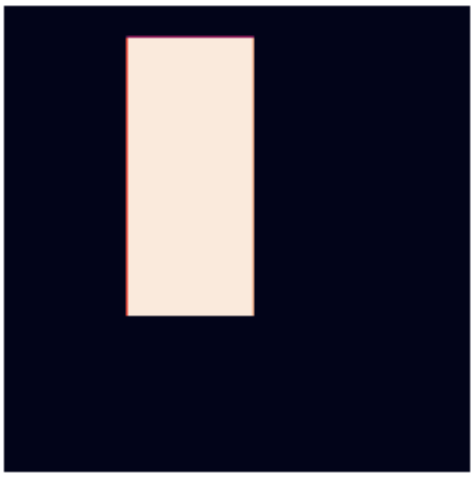
```
model.evaluate(X_val, y_val)
```

```
3/3 [==============================] - 25s 8s/step - loss: 2.2894 - dice_co
[2.2893853187561035, 0.20786602795124054]
```

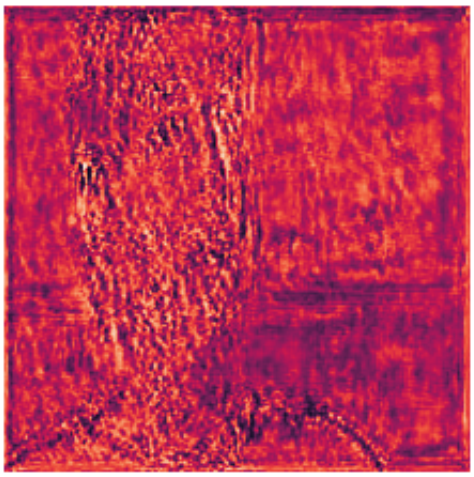
```
# Sample image

n = 75
sample_img = X_train[n]
final_img = sample_img
print('Shape of image: ', sample_img.shape)
plt.axis("off")
plt.imshow(sample_img)
plt.show()
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
Shape of image:  (224, 224, 3)
```

```
sample_mask = masks[n]
final_mask = sample_mask
plt.axis("off")
plt.imshow(sample_mask)
plt.show()
```



```
sample_img = np.resize(sample_img, (1, image_height, image_width, 3))
pd_mask = model.predict(x = sample_img)
pd_mask = np.resize(pd_mask, (image_height, image_width))
plt.axis("off")
plt.imshow(pd_mask)
plt.show()
```



```
final_pd_mask = np.resize(pd_mask, (image_height, image_width))
final_img = np.resize(sample_img, (image_height, image_width, 3))
plt.axis("off")
plt.imshow(final_img)
plt.show()
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
```

```
# Mask on image

fig = plt.figure()
plt.axis("off")
img_1 = plt.imshow(final_img)
img_2 = plt.imshow(final_pd_mask, alpha = 0.6)
plt.show()
```

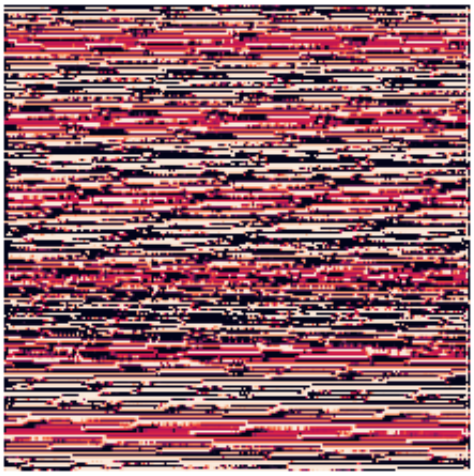
```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
```

4. Use the “Prediction image” as an input to your designed model and display the output of the image.

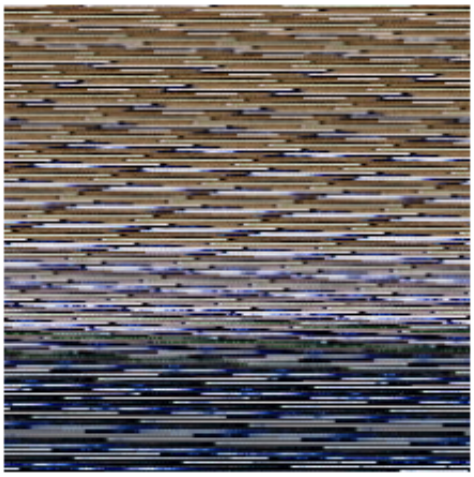
```
# Testing the model on the test image

test_img = cv2.imread(project_path + "Part 1Test Data - Prediction Image.jpeg")
print(test_img.shape)
plt.axis("off")
plt.imshow(test_img)
plt.show()
```

```
(500, 500, 3)
```


```
# Mask for the test image

test_img = np.resize(test_img, (1, image_height, image_width, 3))
pd_mask = model.predict(x = test_img)
pd_mask = np.resize(pd_mask, (image_height, image_width))
plt.axis("off")
plt.imshow(pd_mask)
plt.show()
```



```
final_pd_mask = np.resize(pd_mask, (image_height, image_width))
final_img = np.resize(test_img, (image_height, image_width, 3))
plt.axis("off")
plt.imshow(final_img)
plt.show()
```



```
# Mask imposed on the image

fig = plt.figure()
img_1 = plt.imshow(final_img)
img_2 = plt.imshow(final_pd_mask, alpha = 0.6)
plt.axis("off")
plt.show()
```

II]. PART TWO

```
%tensorflow_version 2.x
import tensorflow as tf
tf.__version__
```

```
'2.4.1'
```

```
from google.colab import drive
drive.mount('/content/drive/')
```

```
Mounted at /content/drive/
```

```
# Set the appropriate path for the Project Path
project_path = "/content/drive/MyDrive/My Files/AIML Workbooks/"
```

```
import os                   # Importing os library
import pandas as pd         # To read the data set
import numpy as np          # Importing numpy library
import seaborn as sns       # For data visualization
import matplotlib.pyplot as plt      # Necessary library for plotting graphs
from glob import glob       # Importing necessary library
%matplotlib inline
sns.set(color_codes = True)

from sklearn import metrics          # Importing metrics
from sklearn.model_selection import train_test_split       # Splitting data into
from sklearn.metrics import classification_report, accuracy_score, recall_score,
from sklearn.preprocessing import StandardScaler           # Importing to standa
from sklearn.impute import SimpleImputer                   # Importing to fill i
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from sklearn.model_selection import KFold, cross_val_score           # Importing
from sklearn.model_selection import GridSearchCV, RandomizedSearchCV           #
from sklearn.cluster import KMeans              # For KMeans cluster model build
from scipy.stats import zscore       # Import zscore library
from scipy.spatial.distance import cdist        # Importing cdist functionality
import tensorflow           # Importing tensorflow library
from tensorflow.keras.models import Sequential, Model              # Importing
from tensorflow.keras.utils import to_categorical          # Importing tensorflo
from tensorflow.keras import optimizers                    # Importing optimizer
```

```
from tensorflow.keras.layers import Dense, Dropout, Activation, BatchNormalizati
from tensorflow.keras.applications.mobilenet import preprocess_input
from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping, ReduceLRO
from tensorflow.keras.applications.mobilenet import MobileNet       # Importing
from tensorflow.keras.losses import binary_crossentropy             # Importing
from tensorflow.keras.backend import log, epsilon          # Importing necessary
from keras.utils import np_utils     # Importing necessary library
from sklearn import svm              # Importing necessary library for model bui
from sklearn.svm import SVC          # Import svc library for model building

from skimage.color import rgb2gray              # Loading color library
from sklearn.preprocessing import OneHotEncoder           # Library for one hot
from sklearn.metrics import confusion_matrix              # Loading necessary l
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img, i
from keras.preprocessing import image           # Importing necessary image libr
from tensorflow import keras         # Loading keras libaray
from tensorflow.keras.optimizers import Adam, SGD          # Importing optimizer
import cv2                  # Importing necessary library
from PIL import ImageFile            # Importing image library
from tqdm import tqdm                # Importing necessary library
import time                 # Importing time library
from mpl_toolkits.axes_grid1 import ImageGrid              # Importing necessary
from PIL import Image       # Importing image library
import tensorflow as tf     # Importing library


face_cascade = cv2.CascadeClassifier(project_path + 'haarcascade_frontalface_def


# Set the appropriate path for the Dataset
dataset2_path = "Part 2 - training images.zip"

# Extracting the "Part 2 - training images.zip" to the present working directory
from zipfile import ZipFile
with ZipFile(project_path + dataset2_path, 'r') as faces_annot:
  faces_annot.extractall()


face_train_images = []

for image_path in glob(os.path.join('./training_images', '*.jpg')):
  image = cv2.imread(image_path, cv2.IMREAD_COLOR)
  if image is None: # ignore if any file contains any missing value
      missing += 1
      continue
  face_train_images.append(image)
```

```
# Number of images in training set
print("Number of images in training set:", len(face_train_images))
```

```
Number of images in training set: 1091
```

```
# Print the sample Image 10
img = cv2.imread('training_images/real_00010.jpg', cv2.IMREAD_COLOR)
plt.imshow(img)
plt.axis("off")
plt.show()
```

```
face_train_images = []

# Write a function to print the Face annotation
def face_annot_det(image_file):
  global face_train_images
  print(image_file)
  # Read the image from the folder
  image = cv2.imread(image_file, cv2.IMREAD_COLOR)
  if image is None: # ignore if any file contains any missing value
      missing += 1
      exit()
  face_train_images.append(image)

  # perform face detection
  faces = face_cascade.detectMultiScale(image, 1.3, 5)
  print("Image_name: ", image_file)
  print("Total_faces: ", faces.shape[0])
  # Get the coordinates of bounding box for each detected face
  for face in faces:
   # Print the coordinates of the face in a dataframe
    print(f'x: {face[0]}  y: {face[1]}   w: {face[2]}    h: {face[3]}')
```

```
for image_path in glob(os.path.join('./training_images', '*.jpg')):
  face_annot_det(image_path)
```

```
Image_name:  ./training_images/real_00322.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_00568.jpg
Image_name:  ./training_images/real_00568.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_00240.jpg
Image_name:  ./training_images/real_00240.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_00880.jpg
Image_name:  ./training_images/real_00880.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_00598.jpg
Image_name:  ./training_images/real_00598.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_00188.jpg
Image_name:  ./training_images/real_00188.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_00291.jpg
Image_name:  ./training_images/real_00291.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_00799.jpg
Image_name:  ./training_images/real_00799.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_00462.jpg
Image_name:  ./training_images/real_00462.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_00977.jpg
Image_name:  ./training_images/real_00977.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_00762.jpg
Image_name:  ./training_images/real_00762.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_01044.jpg
Image_name:  ./training_images/real_01044.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
```

```
./training_images/real_00622.jpg
Image_name:  ./training_images/real_00622.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_00184.jpg
Image_name:  ./training_images/real_00184.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
./training_images/real_01068.jpg
Image_name:  ./training_images/real_01068.jpg
Total_faces:  1
x: 18  y: 93   w: 430    h: 430
```

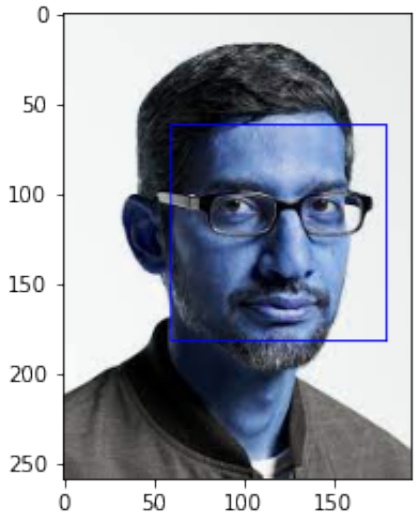
```
# print bounding box for each detected face
for face in faces:
  # extract
  x, y, width, height = face
  x2, y2 = x + width, y + height
  # draw a rectangle over the pixels
  rectangle(img, (x, y), (x2, y2), (255,255,255), 1)
# show the image
plt.axis("off")
plt.imshow(img)
# keep the window open until we press a key
cv2.waitKey(0)
# close the window
cv2.destroyAllWindows()
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-32-77fee9c6573c> in <module>()
      1 # print bounding box for each detected face
----> 2 for face in faces:
      3         # extract
      4         x, y, width, height = face
      5         x2, y2 = x + width, y + height

NameError: name 'faces' is not defined
```

SEARCH STACK OVERFLOW

```
faces = face_cascade.detectMultiScale(img, 1.3, 5)
#print(face.shape[0])
face.shape
#for face in faces:
 # print(face)


#cv2.putText(image, "Number of faces detected: " + str(faces.shape[0]), (0,image



    (4,)


for (x,y,w,h) in faces:
    cv2.rectangle(img,(x,y),(x+w,y+h),(255,0,0),2)
    roi_gray = gray[y:y+h, x:x+w]
    roi_color = img[y:y+h, x:x+w]
    eyes = eye_cascade.detectMultiScale(roi_gray)
    for (ex,ey,ew,eh) in eyes:
        cv2.rectangle(roi_color,(ex,ey),(ex+ew,ey+eh),(0,255,0),2)
cv2.imshow('img',img)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

```
# plot photo with detected faces using opencv cascade classifier
from cv2 import imread
import matplotlib.pyplot as plt
from cv2 import waitKey
from cv2 import destroyAllWindows
from cv2 import CascadeClassifier
from cv2 import rectangle
# load the photograph
pixels = imread('download.jpg')
# load the pre-trained model
classifier = CascadeClassifier('haarcascade_frontalface_default.xml')
# perform face detection
bboxes = classifier.detectMultiScale(pixels)
# print bounding box for each detected face
for box in bboxes:
  # extract
  x, y, width, height = box
  x2, y2 = x + width, y + height
  # draw a rectangle over the pixels
  rectangle(pixels, (x, y), (x2, y2), (0,0,255), 1)
# show the image
plt.imshow(pixels)
# keep the window open until we press a key
waitKey(0)
# close the window
destroyAllWindows()
```



III]. PART THREE

1. Load the dataset and create the metadata.

```
# Mounting google drive

from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, ca
```

```
%tensorflow_version 2.x
import tensorflow
tensorflow.__version__
```

```
'2.4.1'
```

```
import os                   # Importing os library
import pandas as pd         # To read the data set
import numpy as np          # Importing numpy library
import seaborn as sns       # For data visualization
import matplotlib.pyplot as plt      # Necessary library for plotting graphs
from glob import glob       # Importing necessary library
%matplotlib inline
sns.set(color_codes = True)

from sklearn import metrics          # Importing metrics
from sklearn.model_selection import train_test_split       # Splitting data into
from sklearn.metrics import classification_report, accuracy_score, recall_score,
from sklearn.preprocessing import StandardScaler           # Importing to standa
from sklearn.impute import SimpleImputer                   # Importing to fill i
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import PolynomialFeatures       # Importing polynomia
from sklearn.decomposition import PCA          # Importing to run pca analysis
from sklearn import svm              # Importing necessary library for model bui
from sklearn.ensemble import RandomForestClassifier        # Importing necessary
from sklearn.neighbors import KNeighborsClassifier         # Importing necessary
from sklearn import preprocessing              # Importing preprocessing librar

from sklearn.model_selection import KFold, cross_val_score           # Importing
from sklearn.model_selection import GridSearchCV, RandomizedSearchCV          #
from sklearn.cluster import KMeans             # For KMeans cluster model build
from scipy.stats import zscore       # Import zscore library
from scipy.spatial.distance import cdist        # Importing cdist functionality
import tensorflow           # Importing tensorflow library
from tensorflow.keras.models import Sequential, Model              # Importing
```

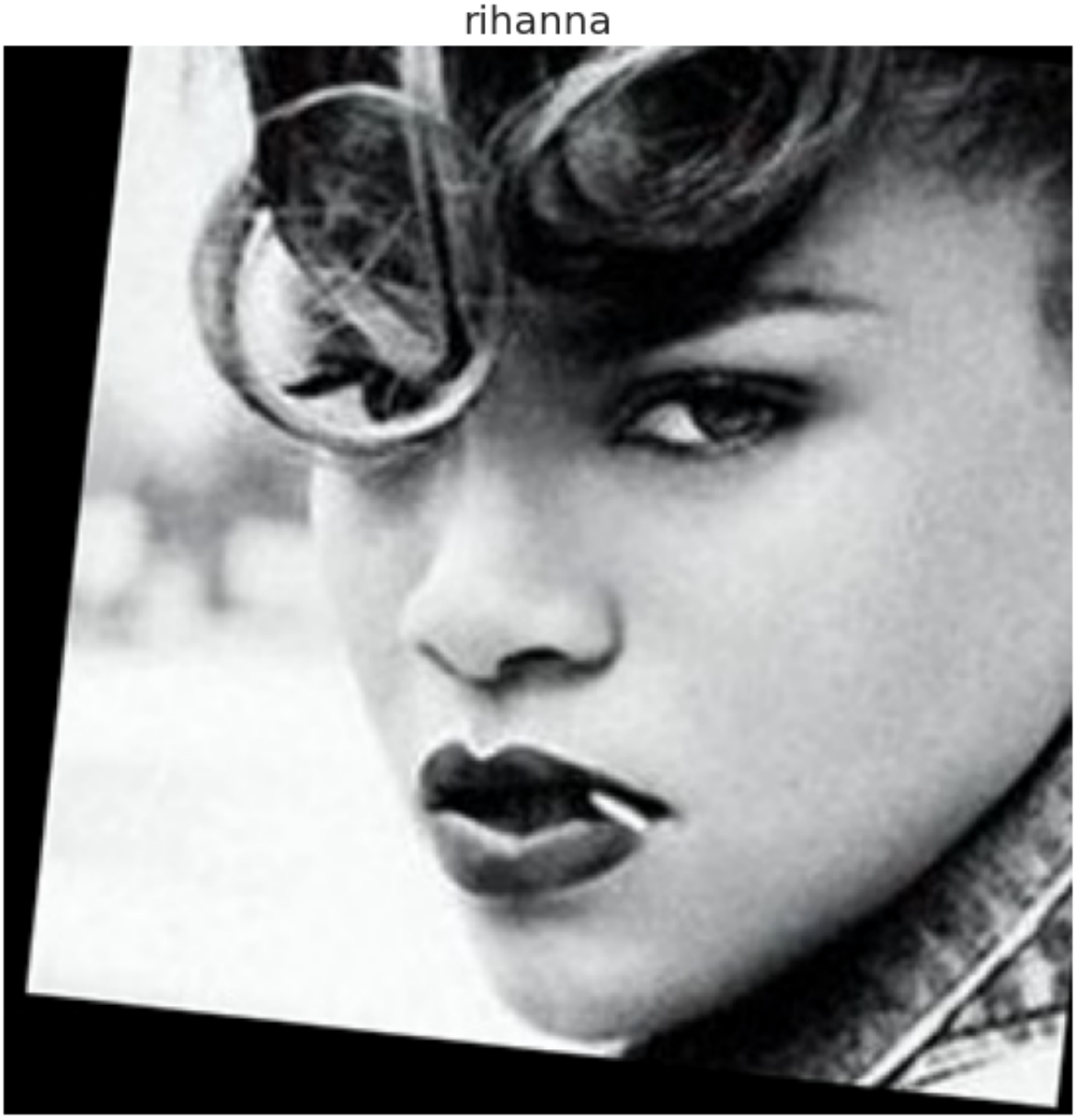
```
from tensorflow.keras.utils import to_categorical          # Importing tensorflo
from tensorflow.keras import optimizers                    # Importing optimizer
from tensorflow.keras.layers import Dense, Dropout, Activation, BatchNormalizati
from tensorflow.keras.applications.mobilenet import preprocess_input          #
from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping, ReduceLRO
from tensorflow.keras.applications.mobilenet import MobileNet       # Importing
from tensorflow.keras.losses import binary_crossentropy             # Importing
from tensorflow.keras.backend import log, epsilon          # Importing necessary
from keras.utils import np_utils     # Importing necessary library
from sklearn import svm              # Importing necessary library for model bui
from sklearn.svm import SVC          # Import svc library for model building

from skimage.color import rgb2gray              # Loading color library
from sklearn.preprocessing import OneHotEncoder           # Library for one hot
from sklearn.metrics import confusion_matrix              # Loading necessary l
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img, i
from keras.preprocessing import image           # Importing necessary image libr
from tensorflow import keras         # Loading keras libaray
from tensorflow.keras.optimizers import Adam, SGD          # Importing optimizer
import cv2                  # Importing necessary library
from PIL import ImageFile            # Importing image library
from tqdm import tqdm                # Importing necessary library
import time                 # Importing time library
from mpl_toolkits.axes_grid1 import ImageGrid              # Importing necessary
from PIL import Image       # Importing image library
import tensorflow as tf     # Importing library


project_path  = '/content/drive/MyDrive/My Files/AIML Workbooks/'


# File path

data_path = "Part 3 - Aligned Face Dataset from Pinterest.zip"


# Extracting from zip file

from zipfile import ZipFile
with ZipFile(project_path + data_path, 'r') as face:
  face.extractall()
```

2. Check some samples of metadata.

```
# Define a function to load the images from the extracted folder and map each im

class IdentityMetadata():
    def __init__(self, base, name, file):
        # print(base, name, file)
        # dataset base directory
        self.base = base
        # identity name
        self.name = name
        # image file name
        self.file = file

    def __repr__(self):
        return self.image_path()

    def image_path(self):
        return os.path.join(self.base, self.name, self.file)

def load_metadata(path):
    metadata = []
    exts = []
    for i in os.listdir(path):
        for f in os.listdir(os.path.join(path, i)):
            # Check file extension. Allow only jpg/jpeg' files.
            ext = os.path.splitext(f)[1]
            if ext == '.jpg' or ext == '.jpeg':
                metadata.append(IdentityMetadata(path, i, f))
                exts.append(ext)
    return np.array(metadata), exts

metadata, exts = load_metadata('PINS')
labels = np.array([meta.name for meta in metadata])


# Loading image from metadata

def load_image(path):
    img = cv2.imread(path, 1)
    # OpenCV loads images with color channels
    # in BGR order. So we need to reverse them
    return img[...,::1]
```

```
# Load sample image using the function "load_image"

n = np.random.randint(1, len(metadata))
image = load_image(metadata[n].image_path())
fig = plt.figure(figsize = (15, 10))
ax = fig.add_subplot(1, 1, 1)
title = labels[n].split('_')[1]
ax.set_title(title, fontsize = 20)

plt.axis("off")
plt.imshow(image)
plt.show()
```

```
# Loading image from metadata

def load_image(path):
    img = cv2.imread(path, 1)
    # OpenCV loads images with color channels
    # in BGR order. So we need to reverse them
    return img[...,::1]


# Load sample image using the function "load_image"

n = np.random.randint(1, len(metadata))
image = load_image(metadata[n].image_path())
fig = plt.figure(figsize = (15, 10))
ax = fig.add_subplot(1, 1, 1)
title = labels[n].split('_')[1]
ax.set_title(title, fontsize = 20)

plt.axis("off")
plt.imshow(image)
plt.show()
```



3. Load the pre-trained model and weights.

```
# Use predefined model for VGG

def vgg_mod():

    model = Sequential()
    model.add(ZeroPadding2D((1, 1), input_shape = (224, 224, 3)))
    model.add(Convolution2D(64, (3, 3), activation = 'relu'))
    model.add(ZeroPadding2D((1, 1)))
    model.add(Convolution2D(64, (3, 3), activation = 'relu'))
    model.add(MaxPooling2D((2, 2), strides = (2, 2)))
```

```
    model.add(ZeroPadding2D((1, 1)))
    model.add(Convolution2D(128, (3, 3), activation = 'relu'))
    model.add(ZeroPadding2D((1, 1)))
    model.add(Convolution2D(128, (3, 3), activation = 'relu'))
    model.add(MaxPooling2D((2, 2), strides = (2, 2)))

    model.add(ZeroPadding2D((1, 1)))
    model.add(Convolution2D(256, (3, 3), activation = 'relu'))
    model.add(ZeroPadding2D((1, 1)))
    model.add(Convolution2D(256, (3, 3), activation = 'relu'))
    model.add(ZeroPadding2D((1, 1)))
    model.add(Convolution2D(256, (3, 3), activation = 'relu'))
    model.add(MaxPooling2D((2, 2), strides = (2, 2)))

    model.add(ZeroPadding2D((1, 1)))
    model.add(Convolution2D(512, (3, 3), activation = 'relu'))
    model.add(ZeroPadding2D((1, 1)))
    model.add(Convolution2D(512, (3, 3), activation = 'relu'))
    model.add(ZeroPadding2D((1, 1)))
    model.add(Convolution2D(512, (3, 3), activation = 'relu'))
    model.add(MaxPooling2D((2, 2), strides =(2, 2)))

    model.add(ZeroPadding2D((1, 1)))
    model.add(Convolution2D(512, (3, 3), activation = 'relu'))
    model.add(ZeroPadding2D((1, 1)))
    model.add(Convolution2D(512, (3, 3), activation = 'relu'))
    model.add(ZeroPadding2D((1, 1)))
    model.add(Convolution2D(512, (3, 3), activation = 'relu'))
    model.add(MaxPooling2D((2, 2), strides=(2, 2)))

    model.add(Convolution2D(4096, (7, 7), activation = 'relu'))
    model.add(Dropout(0.5))
    model.add(Convolution2D(4096, (1, 1), activation = 'relu'))
    model.add(Dropout(0.5))
    model.add(Convolution2D(2622, (1, 1)))
    model.add(Flatten())
    model.add(Activation('softmax'))
    return model


# Loading the above defined model

mod = vgg_mod()
mod.load_weights(project_path + 'Part 3 - vgg_face_weights.h5')
print(mod.summary())
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
```

zero_padding2d (ZeroPadding2	(None, 226, 226, 3)	0
conv2d (Conv2D)	(None, 224, 224, 64)	1792
zero_padding2d_1 (ZeroPaddin	(None, 226, 226, 64)	0
conv2d_1 (Conv2D)	(None, 224, 224, 64)	36928
max_pooling2d (MaxPooling2D)	(None, 112, 112, 64)	0
zero_padding2d_2 (ZeroPaddin	(None, 114, 114, 64)	0
conv2d_2 (Conv2D)	(None, 112, 112, 128)	73856
zero_padding2d_3 (ZeroPaddin	(None, 114, 114, 128)	0
conv2d_3 (Conv2D)	(None, 112, 112, 128)	147584
max_pooling2d_1 (MaxPooling2	(None, 56, 56, 128)	0
zero_padding2d_4 (ZeroPaddin	(None, 58, 58, 128)	0
conv2d_4 (Conv2D)	(None, 56, 56, 256)	295168
zero_padding2d_5 (ZeroPaddin	(None, 58, 58, 256)	0
conv2d_5 (Conv2D)	(None, 56, 56, 256)	590080
zero_padding2d_6 (ZeroPaddin	(None, 58, 58, 256)	0
conv2d_6 (Conv2D)	(None, 56, 56, 256)	590080
max_pooling2d_2 (MaxPooling2	(None, 28, 28, 256)	0
zero_padding2d_7 (ZeroPaddin	(None, 30, 30, 256)	0
conv2d_7 (Conv2D)	(None, 28, 28, 512)	1180160
zero_padding2d_8 (ZeroPaddin	(None, 30, 30, 512)	0
conv2d_8 (Conv2D)	(None, 28, 28, 512)	2359808
zero_padding2d_9 (ZeroPaddin	(None, 30, 30, 512)	0
conv2d_9 (Conv2D)	(None, 28, 28, 512)	2359808
max_pooling2d_3 (MaxPooling2	(None, 14, 14, 512)	0
zero_padding2d_10 (ZeroPaddi	(None, 16, 16, 512)	0
conv2d_10 (Conv2D)	(None, 14, 14, 512)	2359808
zero_padding2d_11 (ZeroPaddi	(None, 16, 16, 512)	0

```
conv2d_11 (Conv2D)           (None, 14, 14, 512)       2359808
```

```
vgg_face = Model(inputs = mod.layers[0].input, outputs = mod.layers[-2].output)
```

4. Generate Embedding vectors for each face in the dataset.

```
# Embedding vector for first image in the metadata using the pre-trained model

img_path = metadata[0].image_path()
img = load_image(img_path)

# Normalising pixel values from [0-255] to [0-1]: scale RGB values to interval [
img = (img / 255.).astype(np.float32)

img = cv2.resize(img, dsize = (224, 224))
print(img.shape)

# Obtain embedding vector for an image
# Get the embedding vector for the above image using vgg_face model and print th
# If there is any error in reading any image in the dataset, fill the emebdding

embedding_vector = vgg_face.predict(np.expand_dims(img, axis = 0))[0]
print(embedding_vector.shape)
```

```
(224, 224, 3)
(2622,)
```

```
# Build distance metrics for identifying the distance between two given images.

from tqdm.notebook import tqdm

embeddings = []
embeddings = np.zeros((metadata.shape[0], 2622))
for i, meta in tqdm(enumerate(metadata)):
  try:
    image = load_image(str(meta))
    image = (image/255.).astype(np.float32)
    image = cv2.resize(image, (224, 224))
    embeddings[i] = vgg_face.predict(np.expand_dims(image, axis = 0))[0]
  except:
    embeddings[i] = np.zeros(2622)
```

```
HBox(children=(FloatProgress(value=1.0, bar_style='info', max=1.0), HTML(va
```

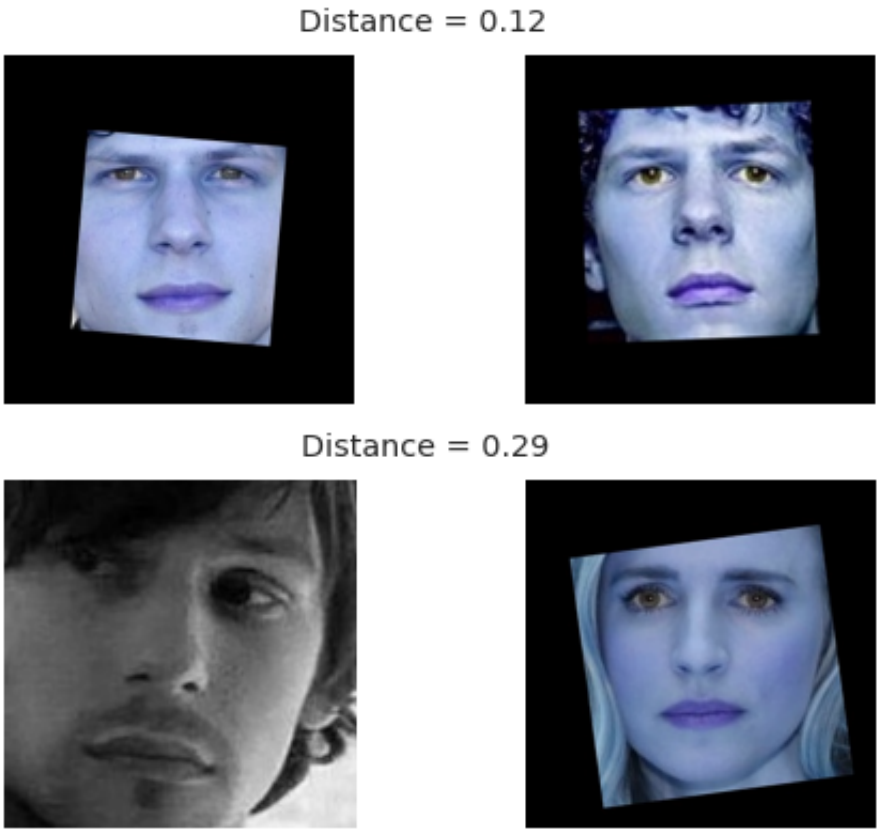
5. Build distance metrics for identifying the distance between two given images.

```
def distance(embed1, embed2):
    return np.sum(np.square(embed1 - embed2))
```

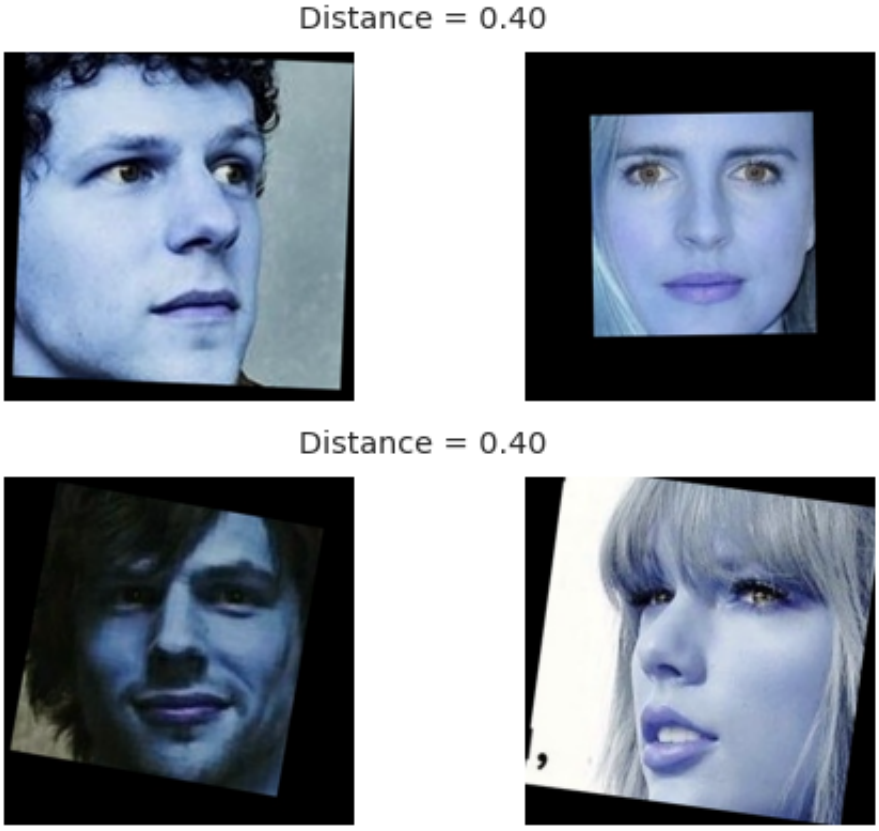
Considering the distance metric as "Squared L2 distance" Squared l2 distance between 2 points (x1, y1) and (x2, y2) = (x1-x2)^2 + (y1-y2)^2

```
# Visualizing the images & their distances

def show_pair(idx1, idx2):
    plt.figure(figsize = (8, 3))
    plt.suptitle(f'Distance = {distance(embeddings[idx1], embeddings[idx2]):.2f}
    plt.subplot(121)
    plt.axis("off")
    plt.imshow(load_image(metadata[idx1].image_path()))
    plt.subplot(122)
    plt.axis("off")
    plt.imshow(load_image(metadata[idx2].image_path()))
```

```
show_pair(50, 51)
show_pair(70, 170)
```



```
show_pair(80, 115)
show_pair(90, 240)
```




```
train_idx = np.arange(metadata.shape[0]) % 9 != 0
test_idx = np.arange(metadata.shape[0]) % 9 == 0

# Features
x_train = np.array(embeddings)[train_idx]
x_test = np.array(embeddings)[test_idx]

# Labels
y_train = np.array([meta.name for meta in metadata[train_idx]])
y_test = np.array([meta.name for meta in metadata[test_idx]])

display(x_train.shape, x_test.shape, y_train.shape, y_test.shape)
```

```
(9573, 2622)
(1197, 2622)
(9573,)
(1197,)
```

```
# Encoding the labels

en = LabelEncoder()
y_train = en.fit_transform(y_train)
y_test = en.transform(y_test)


# Standarizing the features

sc = StandardScaler()
x_train_sc = sc.fit_transform(x_train)
x_test_sc = sc.transform(x_test)
```

6. Use PCA for dimensionality reduction.

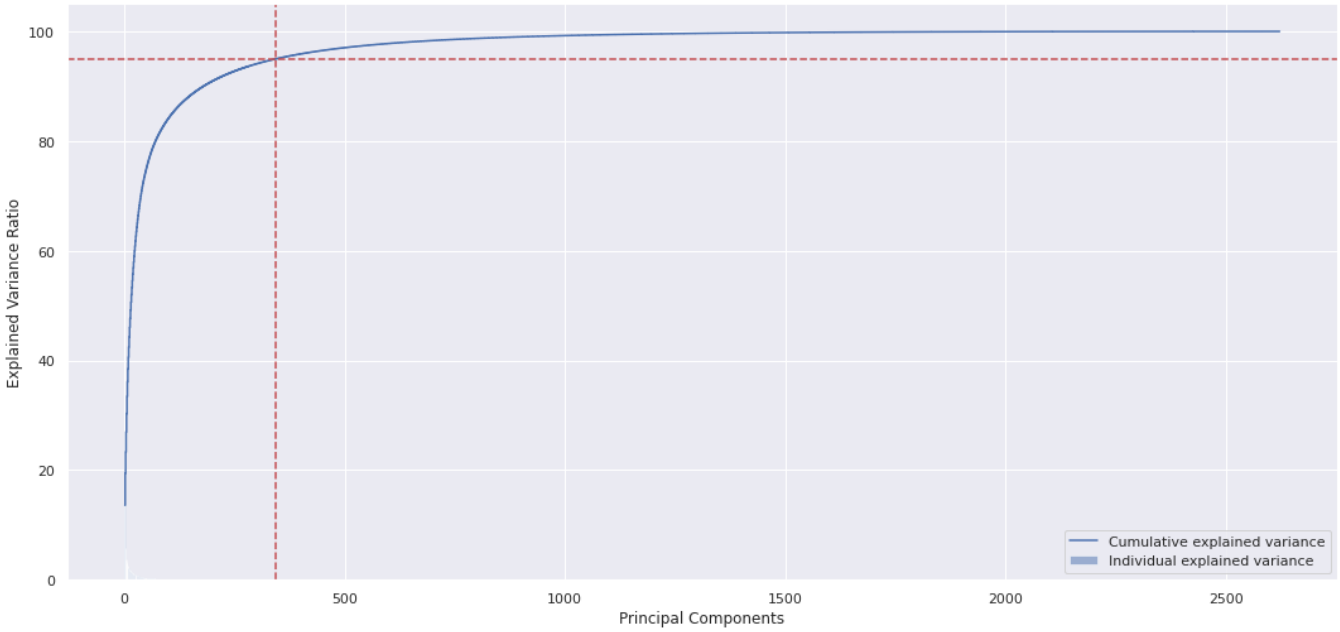
```
# Covariance matrix
cov_mat = np.cov(x_train_sc.T)

# Eigen values and vector
eig_vals, eig_vecs = np.linalg.eig(cov_mat)

# Cumulative variance explained
tot = sum(eig_vals)
var_exp = [(i /tot) * 100 for i in sorted(eig_vals, reverse = True)]
cum_var_exp = np.cumsum(var_exp)

print('Cumulative Variance Explained', cum_var_exp)
```

```
Cumulative Variance Explained [ 13.60497834  19.47013665  23.29490742 ...
 100.        ]
```

```
# Get index where cumulative variance explained is > threshold

threshold = 95
res = list(filter(lambda i: i > threshold, cum_var_exp))[0]
index = (cum_var_exp.tolist().index(res))
print(f'Index of element just greater than {threshold}: {str(index)}')
```

```
Index of element just greater than 95: 344
```

```
# Visualizing individual & cummulative variance

plt.figure(figsize = (15 , 7.2))
plt.bar(range(1, eig_vals.size + 1), var_exp, alpha = 0.5, align = 'center', lab
plt.step(range(1, eig_vals.size + 1), cum_var_exp, where = 'mid', label = 'Cumul
plt.axhline(y = threshold, color = 'r', linestyle = '--')
plt.axvline(x = index, color = 'r', linestyle = '--')
plt.ylabel('Explained Variance Ratio')
plt.xlabel('Principal Components')
plt.legend(loc = 'best')
plt.tight_layout()
plt.show()
```



```
# Dimenson reduction

dim = PCA(n_components = index, random_state = 42, svd_solver = 'full', whiten =
dim.fit(x_train_sc)

x_train_pca = dim.transform(x_train_sc)
x_test_pca = dim.transform(x_test_sc)
display(x_train_pca.shape, x_test_pca.shape)
```

```
(9573, 344)
(1197, 344)
```

7. Build an SVM classifier to map each image to its right person.

```
# Building svm model

svm_pca = SVC(C = 1, gamma = 0.0025, kernel = 'rbf', class_weight = 'balanced',
svm_pca.fit(x_train_pca, y_train)

print('SVC accuracy for train set: {0:.3f}'.format(svm_pca.score(x_train_pca, y_
```

```
SVC accuracy for train set: 0.998
```

```
# Predicting
y_pred = svm_pca.predict(x_test_pca)

print('Accuracy Score: {}'.format(accuracy_score(y_test, y_pred).round(3)))
```

```
Accuracy Score: 0.961
```

```
names = [name.split('_')[1].title().strip() for name in labels]

# Classification Report
print('Classification Report: \n{}'.format(classification_report(y_test, y_pred,
```

```
Classification Report:
                          precision    recall  f1-score   support

              Aaron Paul       1.00      1.00      1.00        10
       Alexandra Daddario       0.91      1.00      0.95        10
            Alvaro Morte       1.00      0.92      0.96        13
Alycia Debnam Carey Face       1.00      1.00      1.00        12
            Amanda Crew       1.00      1.00      1.00         8
          Amaury Nolasco       1.00      1.00      1.00         9
        Amber Heard Face       1.00      0.71      0.83         7
                Anna Gunn       0.92      0.86      0.89        14
```

Anna Gunn	0.92	0.86	0.89	14
Anne Hathaway	1.00	1.00	1.00	13
Barbara Palvin Face	0.90	1.00	0.95	9
Bellamy Blake Face	1.00	0.93	0.96	14
Benedict Cumberbatch	1.00	1.00	1.00	12
Betsy Brandt	1.00	1.00	1.00	10
Bill Gates	0.75	1.00	0.86	9
Brenton Thwaites	1.00	0.87	0.93	15
Brie Larson	1.00	1.00	1.00	14
Brit Marling	1.00	0.92	0.96	13
Bryan Cranston	1.00	0.93	0.96	14
Caity Lotz	1.00	1.00	1.00	12
Cameron Monaghan	0.92	0.92	0.92	13
Chadwick Boseman Face	0.94	1.00	0.97	17
Chance Perdomo	0.89	1.00	0.94	8
Chris Evans	0.93	1.00	0.97	14
Chris Pratt	1.00	1.00	1.00	14
Cobie Smulders	0.93	0.87	0.90	15
Danielle Panabaker	1.00	1.00	1.00	14
Dave Franco	0.93	1.00	0.96	13
David Mazouz	1.00	0.91	0.95	11
Dominic Purcell	1.00	1.00	1.00	12
Drake	1.00	1.00	1.00	7
Dua Lipa Face	1.00	0.91	0.95	11
Dwayne Johnson	0.92	1.00	0.96	12
Eliza Taylor	1.00	1.00	1.00	13
Elizabeth Olsen Face	1.00	1.00	1.00	10
Elon Musk	1.00	1.00	1.00	17
Emilia Clarke	1.00	1.00	1.00	13
Emily Bett Rickards	1.00	0.80	0.89	5
Emma Stone	1.00	0.85	0.92	13
Emma Watson Face	1.00	1.00	1.00	8
Gal Gadot Face	1.00	1.00	1.00	15
Grant Gustin Face	1.00	0.91	0.95	11
Gwyneth Paltrow	0.93	1.00	0.96	13
Henry Cavil	0.89	1.00	0.94	8
Jason Isaacs	1.00	0.93	0.97	15
Jason Momoa	0.73	1.00	0.84	8
Jeff Bezos	0.91	1.00	0.95	10
Jeremy Renner	1.00	1.00	1.00	8
Jesse Eisenberg	1.00	1.00	1.00	8
Jim Parsons	1.00	1.00	1.00	11
Jon Bernthal	1.00	1.00	1.00	11
Josh Radnor	1.00	0.90	0.95	10
Kiernan Shipka	0.93	0.93	0.93	14
Kit Harington	1.00	1.00	1.00	17
Kristen Stewart Face	0.92	1.00	0.96	12
Krysten Ritter	1.00	1.00	1.00	14
Kumail Nanjiani	1.00	0.91	0.95	11
Lindsey Morgan Face	1.00	1.00	1.00	10

```
def sample_img_plot(sample_idx):

  # Load image for sample_idx from test data
  sample_img = load_image(metadata[test_idx][sample_idx].image_path())

  # Get actual name
  actual_name = metadata[test_idx][sample_idx].name.split('_')[-1].title().strip

  # Normalizing pixel values
  sample_img = (sample_img/255.).astype(np.float32)

  # Resize
  sample_img = cv2.resize(sample_img, (224, 224))

  # Obtain embedding vector for sample image
  embedding = vgg_face.predict(np.expand_dims(sample_img, axis = 0))[0]

  # Scaled the vector and reshape
  embedding_scaled = sc.transform(embedding.reshape(1, -1))

  # Predict
  sample_pred = svm_pca.predict(dim.transform(embedding_scaled))

  # Transform back
  pred_name = en.inverse_transform(sample_pred)[0].split('_')[-1].title().strip(
  return sample_img, actual_name, pred_name
```

```
# Plot for 10th image in test data

sample_img, actual_name, pred_name = sample_img_plot(10)
fig = plt.figure(figsize = (15, 8))
plt.axis('off')
plt.imshow(sample_img)
plt.title(f"Actual: {actual_name} \n Predicted: {pred_name}", color = 'green' if
plt.show()
```


```
import matplotlib.gridspec as gridspec
import random

# Random 20 sample images from test data

plt.figure(figsize = (15, 15))
gs1 = gridspec.GridSpec(5, 4)
gs1.update(wspace = 0, hspace = 0.3)

for i in range(20):
    ax1 = plt.subplot(gs1[i])
```

```
    plt.axis('on')
    ax1.set_xticklabels([])
    ax1.set_yticklabels([])
    ax1.set_aspect('equal')

    sample_img, actual_name, pred_name = sample_img_plot(random.randint(1, 1197)

    plt.axis('off')
    plt.imshow(sample_img)

    plt.title(f"Actual: {actual_name} \n Predicted: {pred_name}", color = 'green
plt.show()
```

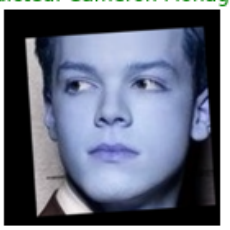
Actual: Danielle Panabaker
Predicted: Danielle Panabaker

Actual: Amber Heard Face
Predicted: Amber Heard Face

Actual: Alexandra Daddario
Predicted: Alexandra Daddario

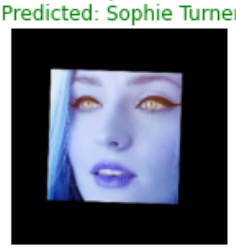
Actual: Mark Zuckerberg
Predicted: Mark Zuckerberg

Actual: Cameron Monaghan
Predicted: Cameron Monaghan



Actual: Brenton Thwaites
Predicted: Brenton Thwaites

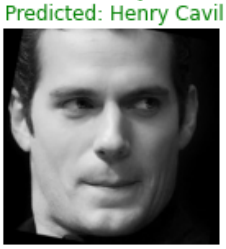
Actual: Sophie Turner
Predicted: Sophie Turner



Actual: Tom Holland Face
Predicted: Tom Holland Face

Actual: Kit Harington
Predicted: Kit Harington

Actual: Henry Cavil
Predicted: Henry Cavil



Actual: Emma Watson Face
Predicted: Emma Watson Face

Actual: Chris Pratt
Predicted: Chris Pratt

Actual: Krysten Ritter
Predicted: Krysten Ritter

Actual: Paul Rudd
Predicted: Paul Rudd

Actual: Sophie Turner
Predicted: Sophie Turner

Actual: Josh Radnor
Predicted: Josh Radnor

Actual: Amanda Crew
Predicted: Amanda Crew

Actual: Kiernan Shipka
Predicted: Kiernan Shipka

Actual: Willa Holland
Predicted: Willa Holland

Actual: Kit Harington
Predicted: Kit Harington

Observation :

Task here was to recognize (aligned) faces from a dataset containing 10k+ images for 100 people using a pre-trained model on Face Recognition.

- VGG model with pre-trained weights was used to generate embeddings for each images in the dataset.
- Since, there were 2,622 features for each image, PCA was used for dimension reduction after standardizing the features.
- Using SVC we predicted the labels for test dataset with an accuracy of more than 96%.
- Compared predicted and Actual labels for a given sample image as well as for 20 random images from test dataset.
- Distance between two pair of images was calculated.
- Cumulative explained variance of 95%, 347 PCA components were used.

IV]. PART FOUR // VIDEO FILE

```
# Mounting google drive

from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, ca
```

```
# Set the appropriate path for the Project

path = "/content/drive/MyDrive/My Files/AIML Workbooks/"
```

```
%tensorflow_version 1.4.x
import tensorflow
tensorflow.__version__
```

```
`%tensorflow_version` only switches the major version: 1.x or 2.x.
You set: `1.4.x`. This will be interpreted as: `1.x`.


TensorFlow 1.x selected.
'1.15.2'
```

```
import os                  # Importing os library
import pandas as pd        # To read the data set
import numpy as np         # Importing numpy library
import seaborn as sns      # For data visualization
import matplotlib.pyplot as plt      # Necessary library for plotting graphs
from glob import glob      # Importing necessary library
%matplotlib inline
sns.set(color_codes = True)

from sklearn import metrics          # Importing metrics
from sklearn.model_selection import train_test_split       # Splitting data into
from sklearn.metrics import classification_report, accuracy_score, recall_score,
from sklearn.preprocessing import StandardScaler           # Importing to standa
from sklearn.impute import SimpleImputer                   # Importing to fill i
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import PolynomialFeatures       # Importing polynomia
from sklearn.decomposition import PCA           # Importing to run pca analysis
from sklearn import svm              # Importing necessary library for model bui
from sklearn.ensemble import RandomForestClassifier        # Importing necessary
from sklearn.neighbors import KNeighborsClassifier         # Importing necessary
from sklearn import preprocessing              # Importing preprocessing librar

from sklearn.model_selection import KFold, cross_val_score           # Importing
from sklearn.model_selection import GridSearchCV, RandomizedSearchCV           #
from sklearn.cluster import KMeans             # For KMeans cluster model build
from scipy.stats import zscore       # Import zscore library
from scipy.spatial.distance import cdist        # Importing cdist functionality
import tensorflow          # Importing tensorflow library
from tensorflow.keras.models import Sequential, Model             # Importing te
from tensorflow.keras.utils import to_categorical          # Importing tensorflo
from tensorflow.keras import optimizers                    # Importing optimizer
from tensorflow.keras.layers import Dense, Dropout, Activation, BatchNormalizati
from keras.utils import np_utils     # Importing necessary library
from sklearn import svm              # Importing necessary library for model bui
from sklearn.svm import SVC          # Import svc library for model building

from skimage.color import rgb2gray             # Loading color library
from sklearn.preprocessing import OneHotEncoder            # Library for one hot
from sklearn.metrics import confusion_matrix               # Loading necessary l
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img, i
from keras.preprocessing import image          # Importing necessary image libr
from tensorflow import keras         # Loading keras libaray
from tensorflow.keras.optimizers import Adam, SGD          # Importing optimizer
import cv2                   # Importing necessary library
from PIL import ImageFile            # Importing image library
from tqdm import tqdm                # Importing necessary library
import time                  # Importing time library
from mpl_toolkits.axes_grid1 import ImageGrid              # Importing necessary
from PIL import Image        # Importing image library
```

```
import os, sys
import random
import math
import skimage.io
import matplotlib
from matplotlib.patches import Polygon


!git clone https://github.com/matterport/Mask_RCNN.git
```

```
Cloning into 'Mask_RCNN'...
remote: Enumerating objects: 956, done.
remote: Total 956 (delta 0), reused 0 (delta 0), pack-reused 956
Receiving objects: 100% (956/956), 125.23 MiB | 30.91 MiB/s, done.
Resolving deltas: 100% (562/562), done.
```

```
os.chdir("/content/Mask_RCNN")
sys.path.append("/content/Mask_RCNN")
VIDEO_STREAM = "/content/drive/MyDrive/My Files/AIML Workbooks/Part 4 - Video/vi
VIDEO_STREAM_OUT = "/content/drive/MyDrive/My Files/AIML Workbooks/Part 4 - Vide


# Root directory of the project

ROOT_DIR = os.path.abspath(".")


# Import Mask RCNN

sys.path.append(ROOT_DIR)     # To find local version of the library

from mrcnn import utils
import mrcnn.model as modellib
from mrcnn import visualize

# Import COCO config

sys.path.append(os.path.join(ROOT_DIR, "samples/coco/"))       # To find local v
import coco
```

```
# Directory to save logs and trained model

MODEL_DIR = os.path.join(ROOT_DIR, "logs")

# Local path to trained weights file

COCO_MODEL_PATH = os.path.join(ROOT_DIR, "mask_rcnn_coco.h5")

# Download COCO trained weights from Releases if needed

if not os.path.exists(COCO_MODEL_PATH):
    utils.download_trained_weights(COCO_MODEL_PATH)

# Directory of images to run detection on

IMAGE_DIR = os.path.join(ROOT_DIR, "images")

class InferenceConfig(coco.CocoConfig):
    # Set batch size to 1 since we'll be running inference on
    # one image at a time. Batch size = GPU_COUNT * IMAGES_PER_GPU

    GPU_COUNT = 1
    IMAGES_PER_GPU = 1
```

```
def display_instances(image, boxes, masks, ids, names, scores):
    """
        take the image and results and apply the mask, box, and Label
    """
    n_instances = boxes.shape[0]
    colors = visualize.random_colors(n_instances)

    if not n_instances:
        print('NO INSTANCES TO DISPLAY')
    else:
        assert boxes.shape[0] == masks.shape[-1] == ids.shape[0]

    for i, color in enumerate(colors):
        if not np.any(boxes[i]):
            continue

        y1, x1, y2, x2 = boxes[i]
        label = names[ids[i]]
        score = scores[i] if scores is not None else None
        caption = '{} {:.2f}'.format(label, score) if score else label
        mask = masks[:, :, i]

        image = visualize.apply_mask(image, mask, color)
        image = cv2.rectangle(image, (x1, y1), (x2, y2), color, 2)
        image = cv2.putText(
            image, caption, (x1, y1), cv2.FONT_HERSHEY_COMPLEX, 0.7, color, 2
        )

    return image


config = InferenceConfig()
config.display()
```

```
Configurations:
BACKBONE                        resnet101
BACKBONE_STRIDES                [4, 8, 16, 32, 64]
BATCH_SIZE                      1
BBOX_STD_DEV                    [0.1 0.1 0.2 0.2]
COMPUTE_BACKBONE_SHAPE          None
DETECTION_MAX_INSTANCES         100
DETECTION_MIN_CONFIDENCE        0.7
DETECTION_NMS_THRESHOLD         0.3
FPN_CLASSIF_FC_LAYERS_SIZE      1024
GPU_COUNT                       1
GRADIENT_CLIP_NORM              5.0
IMAGES_PER_GPU                  1
IMAGE_CHANNEL_COUNT             3
IMAGE_MAX_DIM                   1024
IMAGE_META_SIZE                 93
IMAGE_MIN_DIM                   800
IMAGE_MIN_SCALE                 0
IMAGE_RESIZE_MODE               square
IMAGE_SHAPE                     [1024 1024    3]
LEARNING_MOMENTUM               0.9
LEARNING_RATE                   0.001
LOSS_WEIGHTS                    {'rpn_class_loss': 1.0, 'rpn_bbox_loss': 1.0
MASK_POOL_SIZE                  14
MASK_SHAPE                      [28, 28]
MAX_GT_INSTANCES                100
MEAN_PIXEL                      [123.7 116.8 103.9]
MINI_MASK_SHAPE                 (56, 56)
NAME                            coco
NUM_CLASSES                     81
POOL_SIZE                       7
POST_NMS_ROIS_INFERENCE         1000
POST_NMS_ROIS_TRAINING          2000
PRE_NMS_LIMIT                   6000
ROI_POSITIVE_RATIO              0.33
RPN_ANCHOR_RATIOS               [0.5, 1, 2]
RPN_ANCHOR_SCALES               (32, 64, 128, 256, 512)
RPN_ANCHOR_STRIDE               1
RPN_BBOX_STD_DEV                [0.1 0.1 0.2 0.2]
RPN_NMS_THRESHOLD               0.7
RPN_TRAIN_ANCHORS_PER_IMAGE     256
STEPS_PER_EPOCH                 1000
TOP_DOWN_PYRAMID_SIZE           256
TRAIN_BN                        False
TRAIN_ROIS_PER_IMAGE            200
USE_MINI_MASK                   True
USE_RPN_ROIS                    True
VALIDATION_STEPS                50
WEIGHT_DECAY                    0.0001
```

```
# Create model object in inference mode.

model = modellib.MaskRCNN(mode = 'inference', model_dir = MODEL_DIR, config = co

# Load weights trained on MS-COCO

model.load_weights(COCO_MODEL_PATH, by_name=True)

# COCO Class names
# Index of the class in the list is its ID. For example, to get ID of

class_names = ['person', 'bus', 'car', 'motorcycle']


# Initialize the video stream and pointer to output video file

vs = cv2.VideoCapture(VIDEO_STREAM)
writer = None
vs.set(cv2.CAP_PROP_POS_FRAMES, 5)
```

```
    True
```

```
i = 0
while i < 20:
  # read the next frame from the file
  (grabbed, frame) = vs.read()
  i += 1

  # If the frame was not grabbed, then we have reached the end of the stream

  if not grabbed:
    print ("Not grabbed.")
    break;

  # Run detection
  results = model.detect([frame], verbose=1)

  # Visualize results
  r = results[0]
  masked_frame = display_instances(frame, r['rois'], r['masks'], r['class_ids'],
                             class_names, r['scores'])

  # Check if the video writer is None
  if writer is None:
    # Initialize our video writer
    fourcc = cv2.VideoWriter_fourcc(*"XVID")
    writer = cv2.VideoWriter(VIDEO_STREAM_OUT, fourcc, 30,
```

```
        (masked_frame.shape[1], masked_frame.shape[0]), True)
    # Write the output frame to disk
    writer.write(masked_frame)

  # Release the file pointers
  print("[INFO] cleaning up...")
  writer.release()
```

```
Processing 1 images
image                    shape: (360, 640, 3)         min:    0.00000  max:
molded_images            shape: (1, 1024, 1024, 3)    min: -123.70000  max:
image_metas              shape: (1, 93)               min:    0.00000  max:
anchors                  shape: (1, 261888, 4)        min:   -0.35390  max:
NO INSTANCES TO DISPLAY
Processing 1 images
image                    shape: (360, 640, 3)         min:    0.00000  max:
molded_images            shape: (1, 1024, 1024, 3)    min: -123.70000  max:
image_metas              shape: (1, 93)               min:    0.00000  max:
anchors                  shape: (1, 261888, 4)        min:   -0.35390  max:
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anchors                  shape: (1, 261888, 4)        min:   -0.35390  max:
NO INSTANCES TO DISPLAY
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image                    shape: (360, 640, 3)         min:    0.00000  max:
molded_images            shape: (1, 1024, 1024, 3)    min: -123.70000  max:
image_metas              shape: (1, 93)               min:    0.00000  max:
anchors                  shape: (1, 261888, 4)        min:   -0.35390  max:
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molded_images            shape: (1, 1024, 1024, 3)    min: -123.70000  max:
```

```
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image_metas                shape: (1, 93)               min:    0.00000  max:
anchors                    shape: (1, 261888, 4)        min:   -0.35390  max:
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Processing 1 images
image                      shape: (360, 640, 3)         min:    0.00000  max:
molded_images              shape: (1, 1024, 1024, 3)    min: -123.70000  max:
image_metas                shape: (1, 93)               min:    0.00000  max:
anchors                    shape: (1, 261888, 4)        min:   -0.35390  max:
NO INSTANCES TO DISPLAY
Processing 1 images
image                      shape: (360, 640, 3)         min:    0.00000  max:
molded_images              shape: (1, 1024, 1024, 3)    min: -123.70000  max:
image_metas                shape: (1, 93)               min:    0.00000  max:
anchors                    shape: (1, 261888, 4)        min:   -0.35390  max:
NO INSTANCES TO DISPLAY
```