```
import cv2
import os
import random
import numpy as np
from matplotlib import pyplot as plt


from tensorflow.keras.models import Model
from tensorflow.keras.layers import Layer, Conv2D, Dense, MaxPooling2D, Input, Flatten


POS_PATH = "/content/sample_data/positive"
NEG_PATH = "/content/sample_data/negative"
ANC_PATH = "/content/sample_data/anchor"


# os.getcwd()
# /content/sample_data/anchor


import tensorflow as tf


anchor = tf.data.Dataset.list_files(ANC_PATH+'/*.jpg').take(300)
positive = tf.data.Dataset.list_files(POS_PATH+'/*.jpg').take(300)
negative = tf.data.Dataset.list_files(NEG_PATH+'/*.jpg').take(300)


def preprocess(file_path):

    byte_img = tf.io.read_file(file_path)
    img = tf.io.decode_jpeg(byte_img)
    img = tf.image.resize(img, (100,100))
    img = img / 255.0

    return img


positives = tf.data.Dataset.zip((anchor, positive, tf.data.Dataset.from_tensor_slices(tf.ones(len(anchor)))))
negatives = tf.data.Dataset.zip((anchor, negative, tf.data.Dataset.from_tensor_slices(tf.zeros(len(anchor)))))
data = positives.concatenate(negatives)


sample = data.as_numpy_iterator()


eg = sample.next()
eg

     (b'/content/sample_data/anchor/461bcb07-2bb9-11ee-ac0d-204ef6489e9c.jpg',
      b'/content/sample_data/positive/810acd42-2bba-11ee-b148-204ef6489e9c.jpg',
      1.0)


def preprocess_twin(input_img, validation_img, label):
    return (preprocess(input_img) , preprocess(validation_img) , label)


# preprocess_twin(*eg)
res = preprocess_twin(*eg)
plt.imshow(res[0])
```

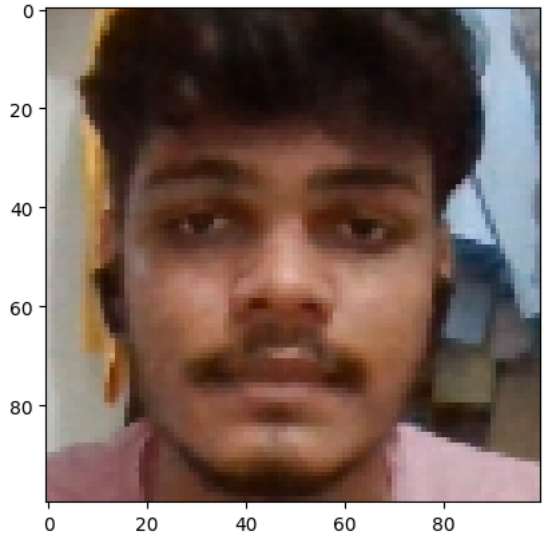
```
<matplotlib.image.AxesImage at 0x7a4724bd7190>
```

```
data = data.map(preprocess_twin)
data = data.cache()
data = data.shuffle(buffer_size = 1024)
```

```
# training partitian
train_data = data.take(round(len(data)*0.7))
train_data = train_data.batch(16)
train_data = train_data.prefetch(8)
```

```
train_samples = train_data.as_numpy_iterator()
train_sample = train_samples.next()
plt.imshow(train_sample[0][6])
```

```
<matplotlib.image.AxesImage at 0x7a47200ee710>
```




```
#  we have batch of 16
len(train_sample[0])
```

```
16
```

```
# testing partitian
test_data = data.skip(round(len(data)*0.7))
test_data = test_data.batch(16)
test_data = test_data.prefetch(8)
# test_data = data.take(round(len(data)*0.3)) # no sense writing it
```

```
def make_embedding():

    # first block
    inp = Input(shape = (100, 100, 3), name = 'input_image')
    c1 = Conv2D(64, (10, 10), activation = 'relu')(inp)
    m1 = MaxPooling2D(64, (2, 2), padding = 'same')(c1)

    # second block
    c2 = Conv2D(128, (7,7), activation = 'relu')(m1)
    m2 = MaxPooling2D(64, (2, 2), padding = 'same')(c2)

    # third block
    c3 = Conv2D(128, (4,4), activation = 'relu')(m2)
    m3 = MaxPooling2D(64, (2, 2), padding = 'same')(c3)

    # fouth layer
    c4 = Conv2D(256, (4,4), activation = 'relu')(m3)
    f1 = Flatten()(c4)
    d1 = Dense(4096, activation = 'sigmoid')(f1)

    return Model(inputs = [inp], outputs = [d1], name = 'embedding')



embedding = make_embedding()
embedding.summary()
```

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

```
 input_image (InputLayer)    [(None, 100, 100, 3)]     0

 conv2d (Conv2D)             (None, 91, 91, 64)        19264

 max_pooling2d (MaxPooling2D  (None, 46, 46, 64)       0
 )

 conv2d_1 (Conv2D)           (None, 40, 40, 128)       401536

 max_pooling2d_1 (MaxPooling  (None, 20, 20, 128)      0
 2D)

 conv2d_2 (Conv2D)           (None, 17, 17, 128)       262272

 max_pooling2d_2 (MaxPooling  (None, 9, 9, 128)        0
 2D)

 conv2d_3 (Conv2D)           (None, 6, 6, 256)         524544

 flatten (Flatten)           (None, 9216)              0

 dense (Dense)               (None, 4096)              37752832

=================================================================
Total params: 38,960,448
Trainable params: 38,960,448
Non-trainable params: 0
_________________________________________________________________
```

```
# will create a custom nn layer
class L1Dist(Layer):

    def __init__(self, **kwargs):
        super().__init__()

    # the crux of the paper lies here(charaterstics of the siamese nn)!
    def call(self, input_embedding, validation_embedding):
        return tf.math.abs(input_embedding - validation_embedding)
```

```
l1 = L1Dist()
l1
```

```
<__main__.L1Dist at 0x7a46eb9a0e20>
```

```
def make_siamese_model():

    input_image = Input(name = 'input_img', shape = (100, 100, 3))
    validation_image = Input(name = 'validation_img', shape = (100, 100, 3))

    siamese_layer = L1Dist(name = 'distance')
#     siamese_layer.name = 'distance'
    distances = siamese_layer(embedding(input_image), embedding(validation_image))

    # final classification layer
    classifier = Dense(1, activation = 'sigmoid')(distances)

    return Model(inputs = [input_image, validation_image], outputs = classifier, name = 'SiameseNetwork')


siamese_model = make_siamese_model()
siamese_model.summary()
```

```
Model: "SiameseNetwork"
__________________________________________________________________________________________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================================
 input_img (InputLayer)         [(None, 100, 100, 3  0           []
                                )]

 validation_img (InputLayer)    [(None, 100, 100, 3  0           []
                                )]

 embedding (Functional)         (None, 4096)         38960448    ['input_img[0][0]',
                                                                  'validation_img[0][0]']

 l1_dist_1 (L1Dist)             (None, 4096)         0           ['embedding[0][0]',
                                                                  'embedding[1][0]']

 dense_1 (Dense)                (None, 1)            4097        ['l1_dist_1[0][0]']

==================================================================================================
Total params: 38,964,545
```

```
Trainable params: 38,964,545
Non-trainable params: 0
_________________________________________________________________
```

```
binary_cross_loss = tf.losses.BinaryCrossentropy() # recommended set logits = true when the data is not standerizer
opt = tf.keras.optimizers.Adam(1e-4)


checkpoint_dir = "./training_checkpoints"
checkpoint_prefix = os.path.join(checkpoint_dir, 'ckpt')
checkpoints = tf.train.Checkpoint(opt = opt, siamese_model = siamese_model)


test_batch = test_data.as_numpy_iterator().next()
len(test_batch)

# understanding the data

# np.array(test_batch).shape
# x = test_batch[:2]
# np.array(x).shape
# len(test_batch[1])

# np.array(sample[0]).shape
# len(sample[0][0][0][0])
```

```
3
```

```
@tf.function # this line will make the follwing function will integrate the following function to be a computational grpah!
def train_step(batch):

    # recording all of our operations
    with tf.GradientTape() as tape:

        # getting anchor and positive images
        X = batch[:2]
        y = batch[2]

        # forward pass
        yhat = siamese_model(X, training = True) # setting training = true madetory for training
        # calculate loss
        loss = binary_cross_loss(y, yhat)

    print(loss)

    # calculating gradients
    grad = tape.gradient(loss, siamese_model.trainable_variables)

    # calcualtes updated weights and apply to the siamese network
    opt.apply_gradients(zip(grad, siamese_model.trainable_variables))

    return loss


def train(data, EPOCHS):

    for epoch in range(1, EPOCHS + 1):

        print('\n Epoch {}/{}'.format(epoch, EPOCHS))
        progbar = tf.keras.utils.Progbar(len(data)) # to inculcate the progression!

        for idx, batch in enumerate(data):
            train_step(batch)
            progbar.update(idx + 1)

        if epoch % 10 == 0:
            checkpoints.save(file_prefix = checkpoint_prefix)


EPOCHS = 50
train(train_data, EPOCHS)
```

```
Epoch 35/50
27/27 [==============================] - 5s 190ms/step

Epoch 36/50
27/27 [==============================] - 5s 190ms/step

Epoch 37/50
27/27 [==============================] - 5s 190ms/step

Epoch 38/50
27/27 [==============================] - 5s 190ms/step

Epoch 39/50
27/27 [==============================] - 5s 191ms/step

Epoch 40/50
27/27 [==============================] - 5s 191ms/step

Epoch 41/50
27/27 [==============================] - 5s 190ms/step

Epoch 42/50
27/27 [==============================] - 5s 190ms/step

Epoch 43/50
27/27 [==============================] - 5s 190ms/step

Epoch 44/50
27/27 [==============================] - 5s 190ms/step

Epoch 45/50
27/27 [==============================] - 5s 191ms/step

Epoch 46/50
27/27 [==============================] - 5s 190ms/step

Epoch 47/50
27/27 [==============================] - 5s 190ms/step

Epoch 48/50
27/27 [==============================] - 5s 190ms/step

Epoch 49/50
27/27 [==============================] - 5s 190ms/step

Epoch 50/50
27/27 [==============================] - 5s 190ms/step
```

```
from tensorflow.keras.metrics import Precision, Recall
```

```
test_input, test_val, y_true = test_data.as_numpy_iterator().next()
```

```
test_var = test_data.as_numpy_iterator().next()
test_var
```

```
len(test_input[0])
```

```
100
```

```
siamese_model.save('siamese_model.h5')
```

```
the loaded model, but the compiled metrics have yet to be built. `model.compile_metrics` will be empty until you train or evaluate
```

```
# siamese_model.predict(test_input, test_val)
```

```
siamese_model.predict([test_input, test_val])
```

```
y_hat = siamese_model.predict([test_input, test_val])
y_hat
```

```
# post processing the results
```

```
[1 if prediction > 0.5 else 0 for prediction in y_hat]
```

```
[0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0]
```

```
y_true
```

```
array([0., 0., 0., 1., 0., 1., 0., 0., 1., 0., 1., 1., 0., 0., 0., 0.],
      dtype=float32)
```

```
m = Recall()
m.update_state(y_true, y_hat)
m.result().numpy()
```

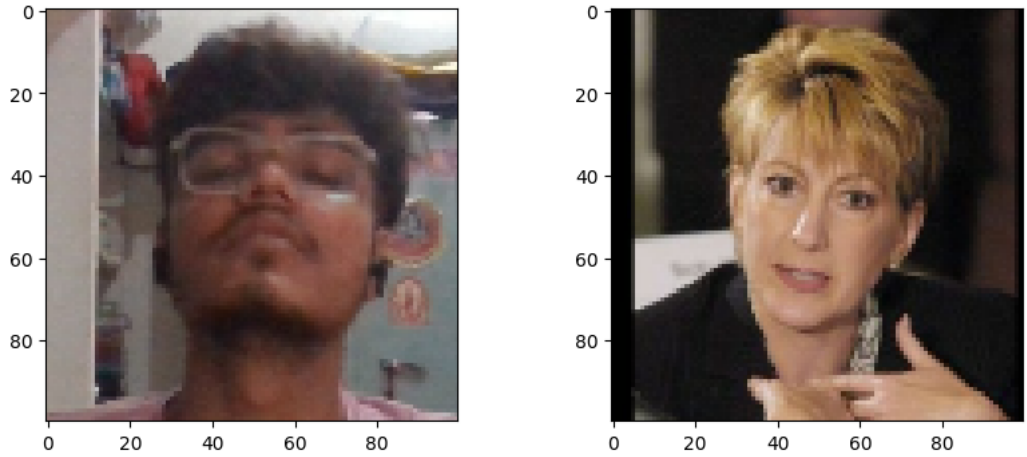
```
1.0
```

```
m = Precision()
m.update_state(y_true, y_hat)
m.result().numpy()
```

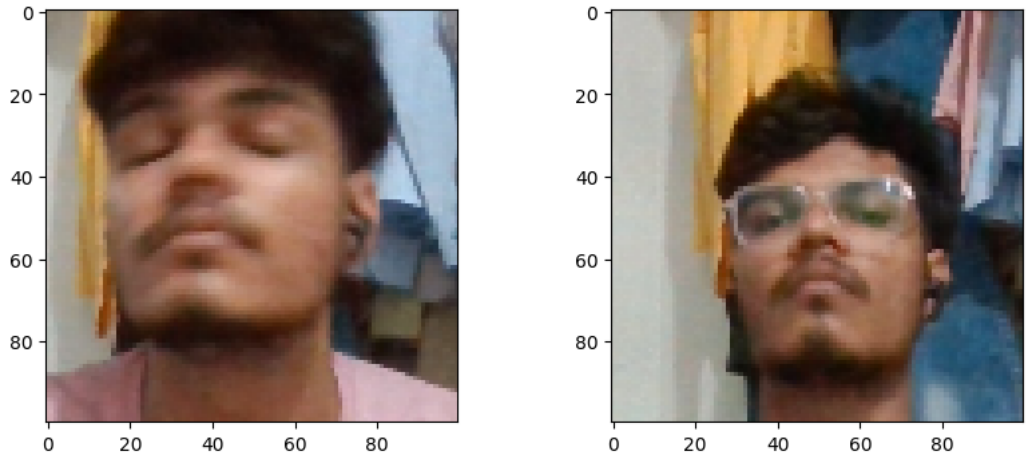
```
1.0
```

visulatizing the results

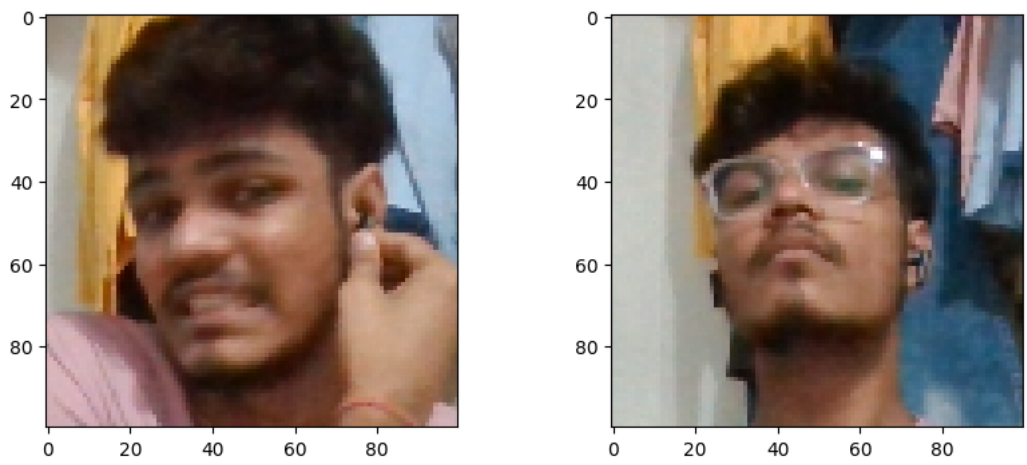
```
plt.figure(figsize=(10,4))
plt.subplot(1, 2, 1)
plt.imshow(test_input[0])
plt.subplot(1, 2, 2)
plt.imshow(test_val[0])
plt.show()
```



```
plt.figure(figsize=(10,4))
plt.subplot(1, 2, 1)
plt.imshow(test_input[3])
plt.subplot(1, 2, 2)
plt.imshow(test_val[3])
plt.show()
```



```
plt.figure(figsize=(10,4))
plt.subplot(1, 2, 1)
plt.imshow(test_input[5])
plt.subplot(1, 2, 2)
plt.imshow(test_val[5])
plt.show()
```



Double-click (or enter) to edit