NETAJI SUHBAS UNIVERSITY OF TECHNOLOGY

AI Hardware and tools

Lab File – VI Semester

TASK-1

Submitted by –

Paras Gunjyal (2021UCA1849)

Abhi Kansal (2021UCA1863)

Shivam Gupta (2021UCA1816)

CSAI – 1

Emotion detector model and Tflite version for edge devices

The dataset is scrapped from google images and is then used for training the model

Importing Libraries

In [69]:
```
import os
import numpy as np
import h5py
import matplotlib.pyplot as plt
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.models import load_model,Sequential
from tensorflow.keras.layers import Flatten
from tensorflow.keras.layers import Dense
from tensorflow.keras.losses import SparseCategoricalCrossentropy
from tensorflow.keras.layers import Conv2D, MaxPooling2D,Dropout
from sklearn.metrics import accuracy_score
from tensorflow.keras.metrics import Precision, Recall, BinaryAccuracy
from sys import getsizeof
import cv2
import imghdr
import pathlib
```

Defining Functions

In [2]:
```
def get_file_size(file_path):
    size = os.path.getsize(file_path)
    return size

```

In [3]:
```
def convert_bytes(size, unit=None):
    if unit == "KB":
        return print('File size: ' + str(round(size / 1024, 3)) + ' Kilobytes')
    elif unit == "MB":
        return print('File size: ' + str(round(size / (1024 * 1024), 3)) + ' Mega
    else:
        return print('File size: ' + str(size) + ' bytes')

```

ML Model Creation

In [4]:
```
data_dir = 'data'
```

In [5]:
```
image_exts = ['jpeg','jpg', 'bmp', 'png']
```

In [6]:
```
for image_class in os.listdir(data_dir):
    for image in os.listdir(os.path.join(data_dir, image_class)):
        image_path = os.path.join(data_dir, image_class, image)
        try:
            img = cv2.imread(image_path)
            tip = imghdr.what(image_path)
            if tip not in image_exts:
                print('Image not in ext list {}'.format(image_path))
                os.remove(image_path)
        except Exception as e:
            print('Issue with image {}'.format(image_path))
            # os.remove(image_path)
```

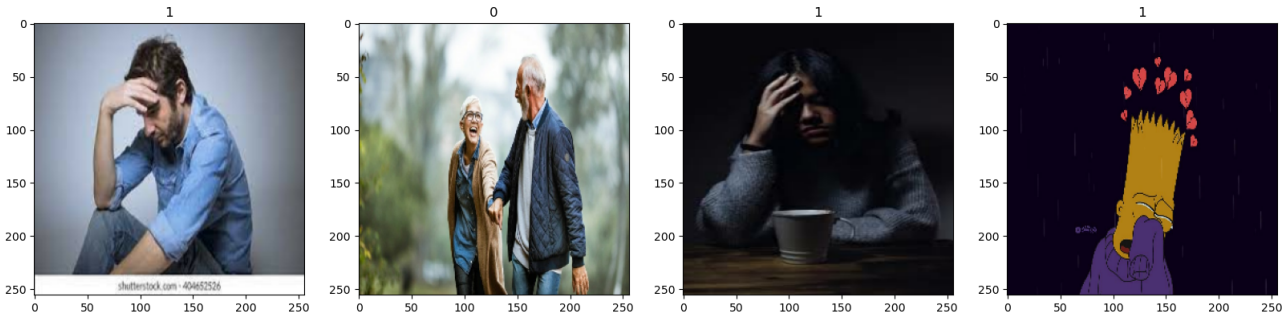
In [7]:
```
data = tf.keras.utils.image_dataset_from_directory('data')
```

```
Found 305 files belonging to 2 classes.
```

In [8]:
```
data_iterator = data.as_numpy_iterator()
```

In [9]:
```
batch = data_iterator.next()
```

In [10]:
```
fig, ax = plt.subplots(ncols=4, figsize=(20,20))
for idx, img in enumerate(batch[0][:4]):
    ax[idx].imshow(img.astype(int))
    ax[idx].title.set_text(batch[1][idx])
```



In [11]:
```
data = data.map(lambda x,y: (x/255, y))
```

In [12]:
```
data.as_numpy_iterator().next()
```

Out[12]:
```
(array([[[[9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
          [9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
          [9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
          ...,
          [9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
          [9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
          [9.60784316e-01, 9.76470590e-01, 9.72549021e-01]],

         [[9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
          [9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
          [9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
          ...,
          [9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
          [9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
          [9.60784316e-01, 9.76470590e-01, 9.72549021e-01]],

         [[9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
          [9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
          [9.60784316e-01, 9.76470590e-01, 9.72549021e-01],
```

In [13]:
```
train_size = int(len(data)*.7)
val_size = int(len(data)*.2)
test_size = int(len(data)*.1)
```

In [14]:
```
train = data.take(train_size)
val = data.skip(train_size).take(val_size)
test = data.skip(train_size+val_size).take(test_size)
```

In [15]:
```
train
```

Out[15]:
```
<TakeDataset element_spec=(TensorSpec(shape=(None, 256, 256, 3), dtype=tf.float32, name=None), TensorSpec(shape=(None,), dtype=tf.int32, name=None))>
```

In [16]:
```
model = Sequential()
```

In [17]:
```
model.add(Conv2D(16, (3,3), 1, activation='relu', input_shape=(256,256,3)))
model.add(MaxPooling2D())
model.add(Conv2D(32, (3,3), 1, activation='relu'))
model.add(MaxPooling2D())
model.add(Conv2D(16, (3,3), 1, activation='relu'))
model.add(MaxPooling2D())
model.add(Flatten())
model.add(Dense(256, activation='relu'))
model.add(Dense(1, activation='sigmoid'))
```

In [18]:
```
model.compile('adam', loss=tf.losses.BinaryCrossentropy(), metrics=['accuracy'])
```

In [19]:
```
1 model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 254, 254, 16)      448

 max_pooling2d (MaxPooling2D  (None, 127, 127, 16)     0
 )

 conv2d_1 (Conv2D)           (None, 125, 125, 32)      4640

 max_pooling2d_1 (MaxPooling  (None, 62, 62, 32)       0
 2D)

 conv2d_2 (Conv2D)           (None, 60, 60, 16)        4624

 max_pooling2d_2 (MaxPooling  (None, 30, 30, 16)       0
 2D)

 flatten (Flatten)           (None, 14400)             0

 dense (Dense)               (None, 256)               3686656

 dense_1 (Dense)             (None, 1)                 257

=================================================================
Total params: 3,696,625
Trainable params: 3,696,625
Non-trainable params: 0
_________________________________________________________________
```

In [20]:
```
1 logdir='logs'
```

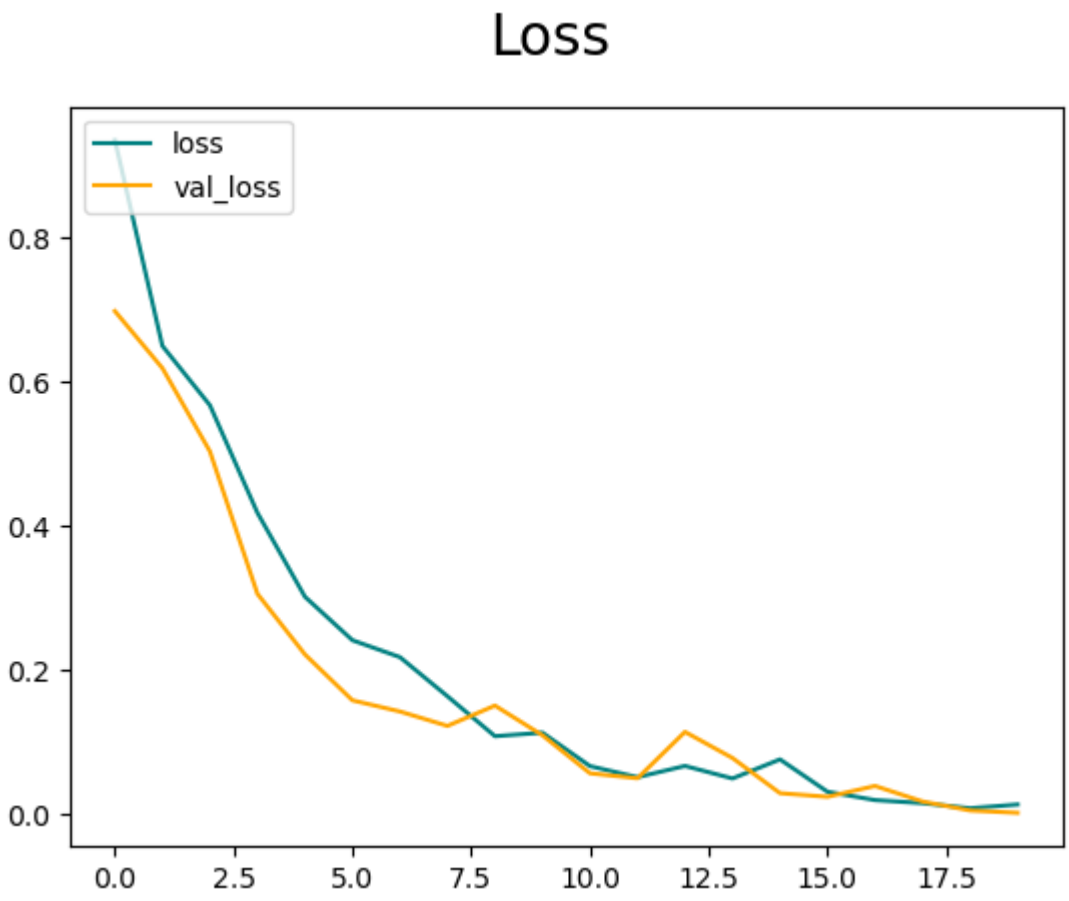
In [21]:
```
1 tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=logdir)
```

In [22]:
```
hist = model.fit(train, epochs=20, validation_data=val, callbacks=[tensorboard_ca
```

```
Epoch 1/20
7/7 [==============================] - 6s 298ms/step - loss: 0.9341 - accuracy: 0.46
88 - val_loss: 0.6971 - val_accuracy: 0.5156
Epoch 2/20
7/7 [==============================] - 4s 330ms/step - loss: 0.6489 - accuracy: 0.52
23 - val_loss: 0.6180 - val_accuracy: 0.5781
Epoch 3/20
7/7 [==============================] - 3s 295ms/step - loss: 0.5666 - accuracy: 0.71
43 - val_loss: 0.5027 - val_accuracy: 0.7969
Epoch 4/20
7/7 [==============================] - 3s 302ms/step - loss: 0.4175 - accuracy: 0.82
59 - val_loss: 0.3053 - val_accuracy: 0.8750
Epoch 5/20
7/7 [==============================] - 3s 308ms/step - loss: 0.3012 - accuracy: 0.88
84 - val_loss: 0.2213 - val_accuracy: 0.9531
Epoch 6/20
7/7 [==============================] - 3s 298ms/step - loss: 0.2410 - accuracy: 0.93
75 - val_loss: 0.1577 - val_accuracy: 0.9531
Epoch 7/20
7/7 [==============================] - 3s 297ms/step - loss: 0.2175 - accuracy: 0.92
41 - val_loss: 0.1422 - val_accuracy: 0.9844
Epoch 8/20
7/7 [==============================] - 3s 305ms/step - loss: 0.1633 - accuracy: 0.95
98 - val_loss: 0.1222 - val_accuracy: 0.9688
Epoch 9/20
7/7 [==============================] - 3s 318ms/step - loss: 0.1080 - accuracy: 0.96
88 - val_loss: 0.1504 - val_accuracy: 0.9531
Epoch 10/20
7/7 [==============================] - 3s 313ms/step - loss: 0.1128 - accuracy: 0.95
09 - val_loss: 0.1092 - val_accuracy: 0.9688
Epoch 11/20
7/7 [==============================] - 3s 306ms/step - loss: 0.0665 - accuracy: 0.97
77 - val_loss: 0.0566 - val_accuracy: 0.9844
Epoch 12/20
7/7 [==============================] - 3s 297ms/step - loss: 0.0511 - accuracy: 0.99
11 - val_loss: 0.0497 - val_accuracy: 0.9844
Epoch 13/20
7/7 [==============================] - 3s 292ms/step - loss: 0.0667 - accuracy: 0.98
21 - val_loss: 0.1139 - val_accuracy: 0.9375
Epoch 14/20
7/7 [==============================] - 3s 308ms/step - loss: 0.0494 - accuracy: 0.98
66 - val_loss: 0.0777 - val_accuracy: 0.9688
Epoch 15/20
7/7 [==============================] - 3s 297ms/step - loss: 0.0758 - accuracy: 0.98
66 - val_loss: 0.0290 - val_accuracy: 1.0000
Epoch 16/20
7/7 [==============================] - 3s 297ms/step - loss: 0.0309 - accuracy: 0.99
55 - val_loss: 0.0240 - val_accuracy: 1.0000
Epoch 17/20
7/7 [==============================] - 3s 300ms/step - loss: 0.0194 - accuracy: 0.99
55 - val_loss: 0.0390 - val_accuracy: 0.9844
Epoch 18/20
7/7 [==============================] - 3s 309ms/step - loss: 0.0152 - accuracy: 0.99
55 - val_loss: 0.0175 - val_accuracy: 1.0000
Epoch 19/20
7/7 [==============================] - 3s 321ms/step - loss: 0.0081 - accuracy: 1.00
00 - val_loss: 0.0050 - val_accuracy: 1.0000
Epoch 20/20
7/7 [==============================] - 3s 300ms/step - loss: 0.0133 - accuracy: 0.99
55 - val_loss: 0.0018 - val_accuracy: 1.0000
```

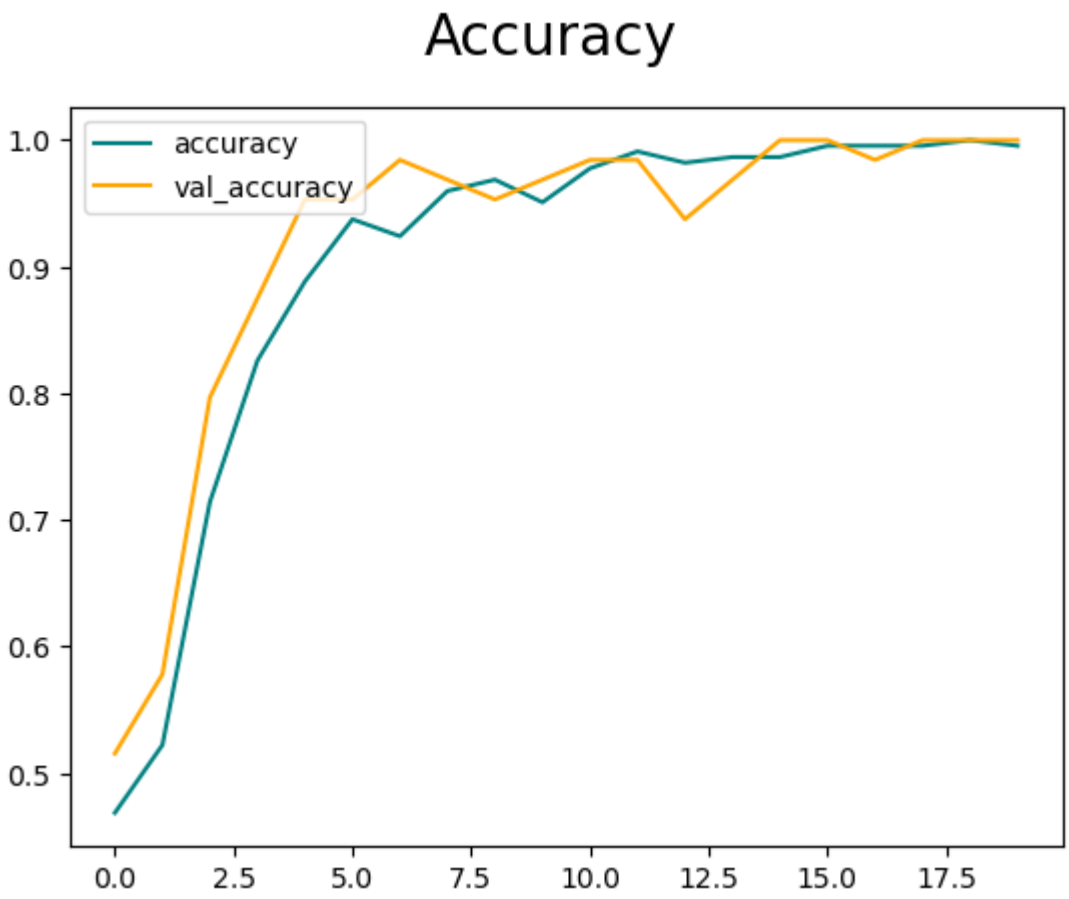
In [23]:

```
fig = plt.figure()
plt.plot(hist.history['loss'], color='teal', label='loss')
plt.plot(hist.history['val_loss'], color='orange', label='val_loss')
fig.suptitle('Loss', fontsize=20)
plt.legend(loc="upper left")
plt.show()
```



In [24]:

```
fig = plt.figure()
plt.plot(hist.history['accuracy'], color='teal', label='accuracy')
plt.plot(hist.history['val_accuracy'], color='orange', label='val_accuracy')
fig.suptitle('Accuracy', fontsize=20)
plt.legend(loc="upper left")
plt.show()
```



Testing the model

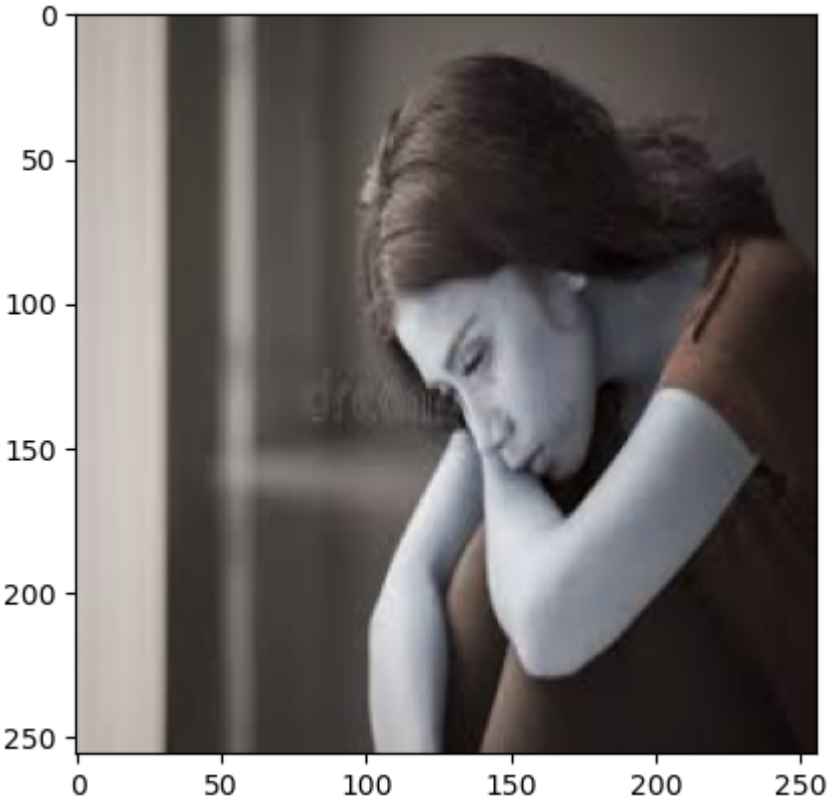
In [25]:

```python
pre = Precision()
re = Recall()
acc = BinaryAccuracy()

for batch in test.as_numpy_iterator():
    X, y = batch
    yhat = model.predict(X)
    pre.update_state(y, yhat)
    re.update_state(y, yhat)
    acc.update_state(y, yhat)

# Get the final results
precision_result = pre.result().numpy()
recall_result = re.result().numpy()
accuracy_result = acc.result().numpy()

# Print the results
print("Accuracy:", accuracy_result)
print("Precision:", precision_result)
print("Recall:", recall_result)
```

```
1/1 [==============================] - 1s 521ms/step
Accuracy: 1.0
Precision: 1.0
Recall: 1.0
```

In [26]:

```
# Load the image using OpenCV
img = cv2.imread('sad_test.jpg')

plt.imshow(img)
plt.show()

resize = tf.image.resize(img, (256,256))
plt.imshow(resize.numpy().astype(int))
plt.show()

```



In [27]:
```
result = model.predict(np.expand_dims(resize/255, 0))
```

```
1/1 [==============================] - 0s 102ms/step
```

In [28]:
```
result

```

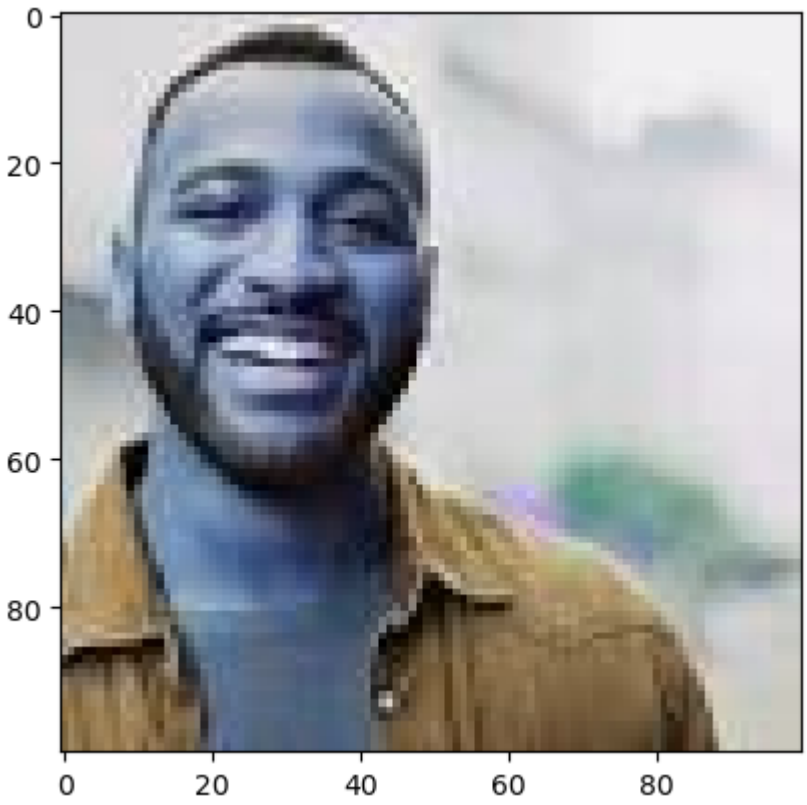
Out[28]:
```
array([[0.9990477]], dtype=float32)
```

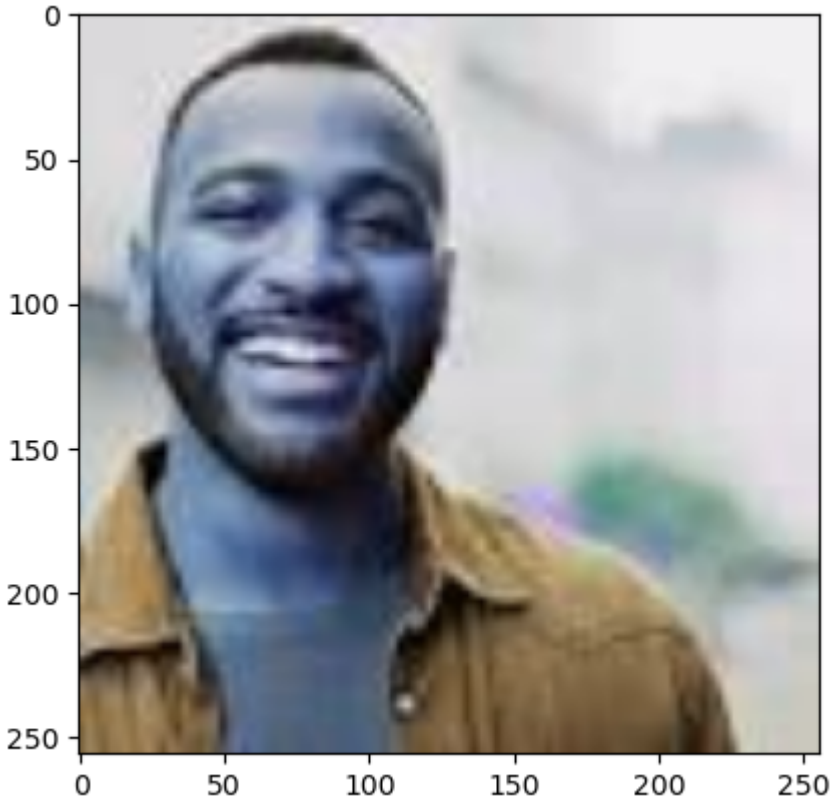
In [29]:
```
if result > 0.5:
    print(f'Predicted class is Sad')
else:
    print(f'Predicted class is Happy')
```

```
Predicted class is Sad
```

In [30]:

```
# Load the image using OpenCV
img = cv2.imread('happy_test.jpg')

plt.imshow(img)
plt.show()

resize = tf.image.resize(img, (256,256))
plt.imshow(resize.numpy().astype(int))
plt.show()

```





In [31]:
```
result = model.predict(np.expand_dims(resize/255, 0))
```

```
1/1 [==============================] - 0s 17ms/step
```

In [32]:
```
result
```

Out[32]:
```
array([[0.08620903]], dtype=float32)
```

In [33]:
```
if result > 0.5:
    print(f'Predicted class is Sad')
else:
    print(f'Predicted class is Happy')
```

```
Predicted class is Happy
```

In [34]:
```
model.save(os.path.join('models','SadUnsad.h5'))
```

In [35]:
```
new_model = load_model('models/SadUnsad.h5')
```

In [36]:
```
convert_bytes(get_file_size('models/SadUnsad.h5'), "MB")
```

```
File size: 42.355 Megabytes
```

Model size before any optimization

Tflite conversion

In [37]:
```
TF_LITE_MODEL_FILE_NAME = "tf_lite_model.tflite"
```

In [38]:
```
tf_lite_converter = tf.lite.TFLiteConverter.from_keras_model(new_model)
tflite_model = tf_lite_converter.convert()

```

```
WARNING:absl:Found untraced functions such as _jit_compiled_convolution_op, _jit_com
piled_convolution_op, _jit_compiled_convolution_op while saving (showing 3 of 3). Th
ese functions will not be directly callable after loading.

INFO:tensorflow:Assets written to: C:\Users\Paras\AppData\Local\Temp\tmptyubqarq\ass
ets

INFO:tensorflow:Assets written to: C:\Users\Paras\AppData\Local\Temp\tmptyubqarq\ass
ets
```

In [39]:
```
tflite_model_name = TF_LITE_MODEL_FILE_NAME
open(tflite_model_name, "wb").write(tflite_model)

```

Out[39]:
```
14790588
```

In [40]:
```
convert_bytes(get_file_size(TF_LITE_MODEL_FILE_NAME), "MB")
```

```
File size: 14.105 Megabytes
```

SIZE AFTER OPTIMIZATION

In [50]:

```

interpreter = tf.lite.Interpreter(model_path = TF_LITE_MODEL_FILE_NAME)
input_details = interpreter.get_input_details()
output_details = interpreter.get_output_details()
print("Input Shape:", input_details[0]['shape'])
print("Input Type:", input_details[0]['dtype'])
print("Output Shape:", output_details[0]['shape'])
print("Output Type:", output_details[0]['dtype'])
```

```
Input Shape: [  1 256 256   3]
Input Type: <class 'numpy.float32'>
Output Shape: [1 1]
Output Type: <class 'numpy.float32'>
```

In [55]:

```
interpreter.resize_tensor_input(input_details[0]['index'], (1000, 256, 256,3))
interpreter.resize_tensor_input(output_details[0]['index'], (1000, 10))
interpreter.allocate_tensors()
input_details = interpreter.get_input_details()
output_details = interpreter.get_output_details()
print("Input Shape:", input_details[0]['shape'])
print("Input Type:", input_details[0]['dtype'])
print("Output Shape:", output_details[0]['shape'])
print("Output Type:", output_details[0]['dtype'])

```

```
Input Shape: [1000  256  256    3]
Input Type: <class 'numpy.float32'>
Output Shape: [1000    1]
Output Type: <class 'numpy.float32'>
```

In [56]:

```
pre = Precision()
re = Recall()
acc = BinaryAccuracy()

for batch in test.as_numpy_iterator():
    X, y = batch
    yhat = model.predict(X)
    pre.update_state(y, yhat)
    re.update_state(y, yhat)
    acc.update_state(y, yhat)

# Get the final results
precision_result = pre.result().numpy()
recall_result = re.result().numpy()
accuracy_result = acc.result().numpy()

# Print the results
print("Accuracy:", accuracy_result)
print("Precision:", precision_result)
print("Recall:", recall_result)
```

```
1/1 [==============================] - 0s 24ms/step
Accuracy: 0.9411765
Precision: 0.875
Recall: 1.0
```

In [73]:

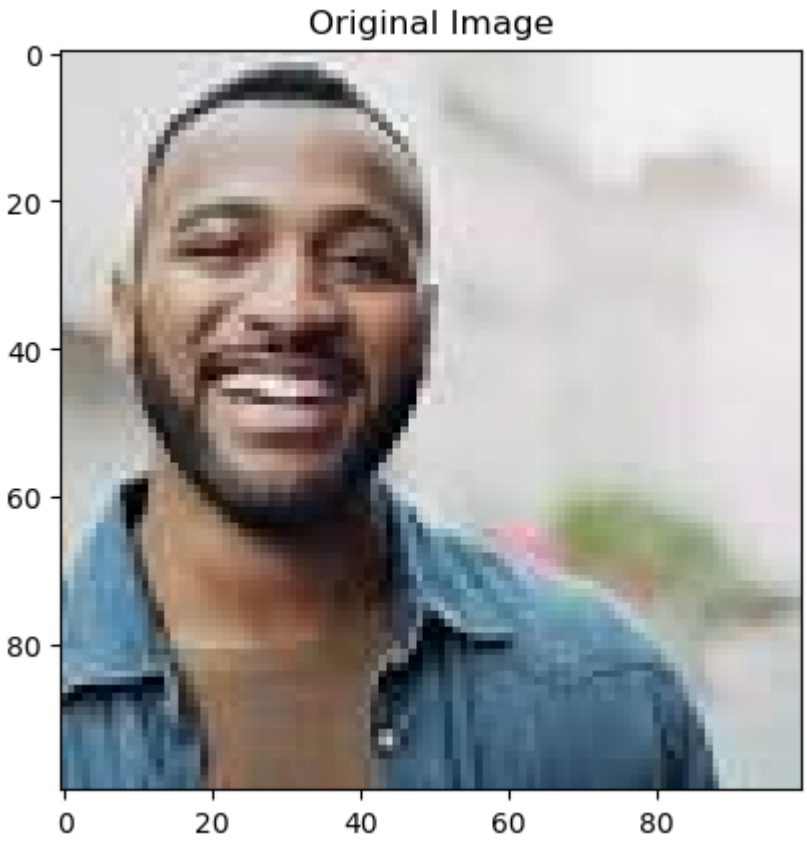
```
for file in pathlib.Path('data').iterdir():
    print("File Path:", file.resolve())
    # Read and resize the image...
```

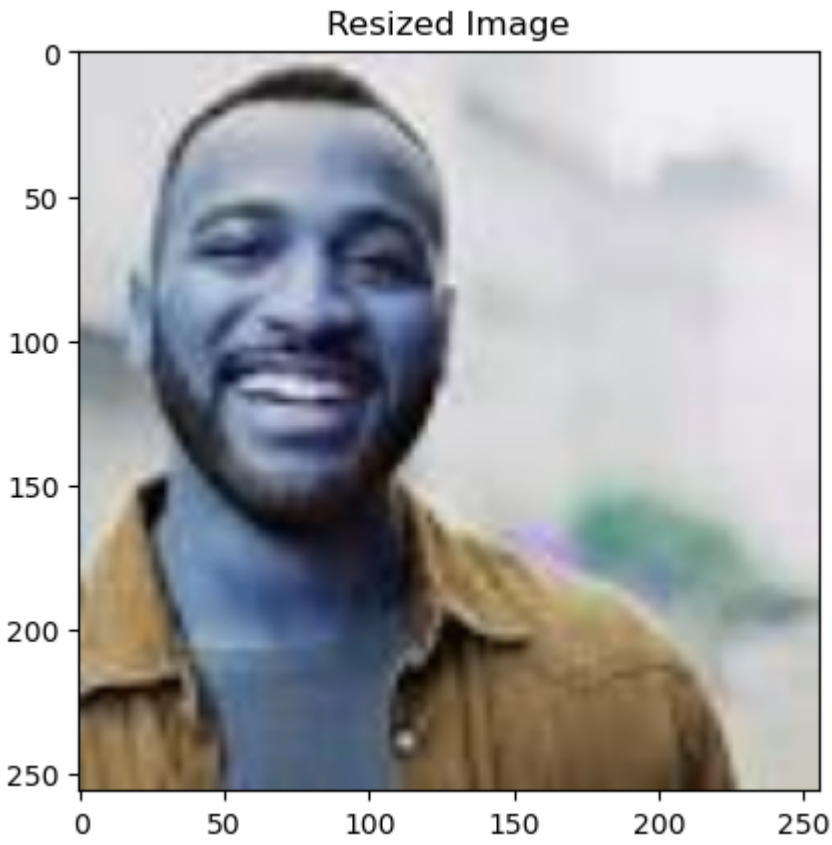
```
File Path: C:\Users\Paras\6 sem\Ai HT\TinyMl\data\happy
File Path: C:\Users\Paras\6 sem\Ai HT\TinyMl\data\sad
```

Testing the Tflite Model

In [87]:

```
# Load TFLite model
model_path = 'tf_lite_model.tflite'
interpreter = tf.lite.Interpreter(model_path=model_path)
interpreter.allocate_tensors()

# Get input and output details
input_details = interpreter.get_input_details()
output_details = interpreter.get_output_details()

# Function to preprocess image
def preprocess_image(image_path):
    image = Image.open(image_path)
    image = image.resize((256, 256))  # Replace with the input size of your model
    image = tf.keras.preprocessing.image.img_to_array(image)
    image = tf.keras.applications.mobilenet_v2.preprocess_input(image)
    return image

# Function to make predictions
def predict_image(image_path):
    input_data = preprocess_image(image_path)
    input_data = tf.expand_dims(input_data, axis=0)

    interpreter.set_tensor(input_details[0]['index'], input_data)
    interpreter.invoke()

    output_data = interpreter.get_tensor(output_details[0]['index'])
    return output_data

# Load image using OpenCV
img_path = 'happy_test.jpg'
img = cv2.imread(img_path)

# Display the original image
plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
plt.title("Original Image")
plt.show()

# Resize using TensorFlow
resize = tf.image.resize(tf.convert_to_tensor(img), (256, 256)).numpy().astype(in

# Display the resized image
plt.imshow(resize)
plt.title("Resized Image")
plt.show()

# Predict using the TFLite model
prediction = predict_image(img_path)
predicted_class = int(prediction[0][0])  # Assuming a single output class, adjust

print(f"Prediction for {img_path}: Class {predicted_class}")
```






```
Prediction for happy_test.jpg: Class 1
```

In [88]:
```
1 result = model.predict(np.expand_dims(resize/255, 0))
```

```
1/1 [==============================] - 0s 19ms/step
```

In [89]:
```
result
```

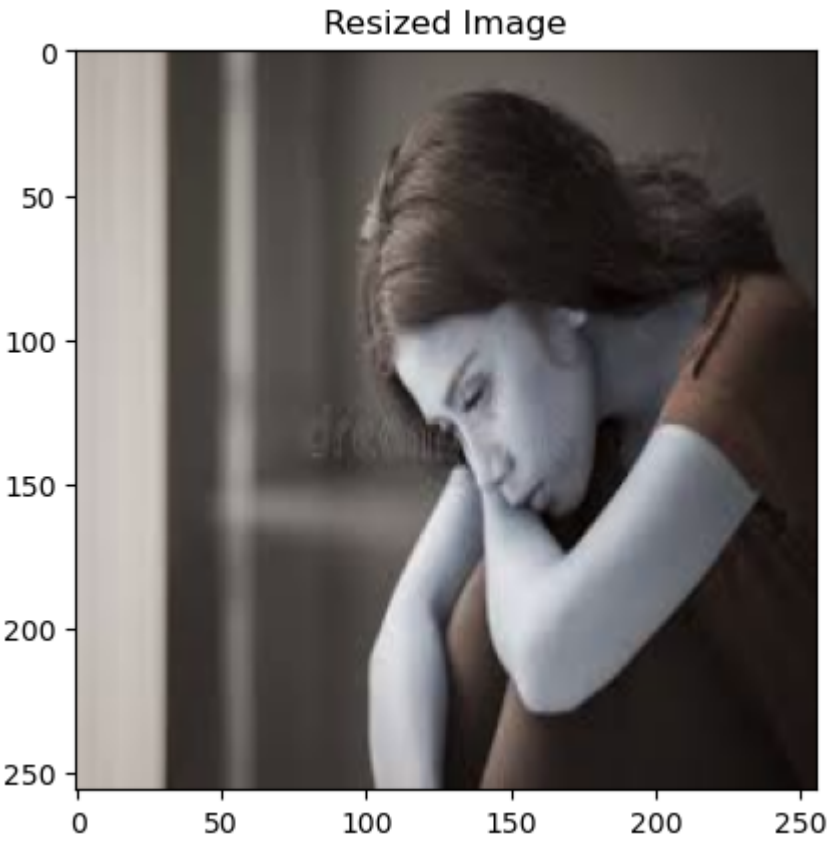
Out[89]:
```
array([[0.08366012]], dtype=float32)
```

In [90]:
```
if result > 0.5:
    print(f'Predicted class is Sad')
else:
    print(f'Predicted class is Happy')
```

```
Predicted class is Happy
```

In [91]:

```
img_path = 'sad_test.jpg'
img = cv2.imread(img_path)

# Display the original image
plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
plt.title("Original Image")
plt.show()

# Resize using TensorFlow
resize = tf.image.resize(tf.convert_to_tensor(img), (256, 256)).numpy().astype(i

# Display the resized image
plt.imshow(resize)
plt.title("Resized Image")
plt.show()

# Predict using the TFLite model
prediction = predict_image(img_path)
predicted_class = int(prediction[0][0])  # Assuming a single output class, adjus

print(f"Prediction for {img_path}: Class {predicted_class}")

```




```
Prediction for sad_test.jpg: Class 1
```

In [92]:
```
result = model.predict(np.expand_dims(resize/255, 0))
```

```
1/1 [==============================] - 0s 17ms/step
```

In [93]:
```
result
```

Out[93]:
```
array([[0.99911946]], dtype=float32)
```

In [94]:
```
if result > 0.5:
    print(f'Predicted class is Sad')
else:
    print(f'Predicted class is Happy')
```

```
Predicted class is Sad
```

Conclusion

Hence, the Model is now finalized and deployable for edge devices for remote usage