1. Installing dependencies and setup

In [34]:
```
!pip install --upgrade tensorflow[and-cuda] opencv-python matplotlib
```

```
Requirement already satisfied: opencv-python in ./EmotionDetector/lib/python3.10/sit
e-packages (4.11.0.86)
Requirement already satisfied: matplotlib in ./EmotionDetector/lib/python3.10/site-p
ackages (3.10.0)
Requirement already satisfied: tensorflow[and-cuda] in ./EmotionDetector/lib/python
3.10/site-packages (2.18.0)
Requirement already satisfied: absl-py>=1.0.0 in ./EmotionDetector/lib/python3.10/si
te-packages (from tensorflow[and-cuda]) (2.1.0)
Requirement already satisfied: astunparse>=1.6.0 in ./EmotionDetector/lib/python3.1
0/site-packages (from tensorflow[and-cuda]) (1.6.3)
Requirement already satisfied: flatbuffers>=24.3.25 in ./EmotionDetector/lib/python
3.10/site-packages (from tensorflow[and-cuda]) (24.12.23)
Requirement already satisfied: gast!=0.5.0,!=0.5.1,!=0.5.2,>=0.2.1 in ./EmotionDetec
tor/lib/python3.10/site-packages (from tensorflow[and-cuda]) (0.6.0)
Requirement already satisfied: google-pasta>=0.1.1 in ./EmotionDetector/lib/python3.
10/site-packages (from tensorflow[and-cuda]) (0.2.0)
Requirement already satisfied: libclang>=13.0.0 in ./EmotionDetector/lib/python3.10/
site-packages (from tensorflow[and-cuda]) (18.1.1)
Requirement already satisfied: opt-einsum>=2.3.2 in ./EmotionDetector/lib/python3.1
0/site-packages (from tensorflow[and-cuda]) (3.4.0)
Requirement already satisfied: packaging in ./EmotionDetector/lib/python3.10/site-pa
ckages (from tensorflow[and-cuda]) (24.2)
Requirement already satisfied: protobuf!=4.21.0,!=4.21.1,!=4.21.2,!=4.21.3,!=4.21.
4,!=4.21.5,<6.0.0dev,>=3.20.3 in ./EmotionDetector/lib/python3.10/site-packages (fro
m tensorflow[and-cuda]) (5.29.3)
Requirement already satisfied: requests<3,>=2.21.0 in ./EmotionDetector/lib/python3.
10/site-packages (from tensorflow[and-cuda]) (2.32.3)
Requirement already satisfied: setuptools in ./EmotionDetector/lib/python3.10/site-p
ackages (from tensorflow[and-cuda]) (59.6.0)
Requirement already satisfied: six>=1.12.0 in ./EmotionDetector/lib/python3.10/site-
packages (from tensorflow[and-cuda]) (1.17.0)
Requirement already satisfied: termcolor>=1.1.0 in ./EmotionDetector/lib/python3.10/
site-packages (from tensorflow[and-cuda]) (2.5.0)
Requirement already satisfied: typing-extensions>=3.6.6 in ./EmotionDetector/lib/pyt
hon3.10/site-packages (from tensorflow[and-cuda]) (4.12.2)
Requirement already satisfied: wrapt>=1.11.0 in ./EmotionDetector/lib/python3.10/sit
e-packages (from tensorflow[and-cuda]) (1.17.2)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in ./EmotionDetector/lib/python3.
10/site-packages (from tensorflow[and-cuda]) (1.69.0)
Requirement already satisfied: tensorboard<2.19,>=2.18 in ./EmotionDetector/lib/pyth
on3.10/site-packages (from tensorflow[and-cuda]) (2.18.0)
Requirement already satisfied: keras>=3.5.0 in ./EmotionDetector/lib/python3.10/site
-packages (from tensorflow[and-cuda]) (3.8.0)
Requirement already satisfied: numpy<2.1.0,>=1.26.0 in ./EmotionDetector/lib/python
3.10/site-packages (from tensorflow[and-cuda]) (2.0.2)
Requirement already satisfied: h5py>=3.11.0 in ./EmotionDetector/lib/python3.10/site
-packages (from tensorflow[and-cuda]) (3.12.1)
Requirement already satisfied: ml-dtypes<0.5.0,>=0.4.0 in ./EmotionDetector/lib/pyth
on3.10/site-packages (from tensorflow[and-cuda]) (0.4.1)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in ./EmotionDete
ctor/lib/python3.10/site-packages (from tensorflow[and-cuda]) (0.37.1)
Requirement already satisfied: nvidia-cublas-cu12==12.5.3.2 in ./EmotionDetector/li
b/python3.10/site-packages (from tensorflow[and-cuda]) (12.5.3.2)
Requirement already satisfied: nvidia-cuda-cupti-cu12==12.5.82 in ./EmotionDetector/
lib/python3.10/site-packages (from tensorflow[and-cuda]) (12.5.82)
Requirement already satisfied: nvidia-cuda-nvcc-cu12==12.5.82 in ./EmotionDetector/l
```

```
ib/python3.10/site-packages (from tensorflow[and-cuda]) (12.5.82)
Requirement already satisfied: nvidia-cuda-nvrtc-cu12==12.5.82 in ./EmotionDetector/
lib/python3.10/site-packages (from tensorflow[and-cuda]) (12.5.82)
Requirement already satisfied: nvidia-cuda-runtime-cu12==12.5.82 in ./EmotionDetecto
r/lib/python3.10/site-packages (from tensorflow[and-cuda]) (12.5.82)
Requirement already satisfied: nvidia-cudnn-cu12==9.3.0.75 in ./EmotionDetector/lib/
python3.10/site-packages (from tensorflow[and-cuda]) (9.3.0.75)
Requirement already satisfied: nvidia-cufft-cu12==11.2.3.61 in ./EmotionDetector/li
b/python3.10/site-packages (from tensorflow[and-cuda]) (11.2.3.61)
Requirement already satisfied: nvidia-curand-cu12==10.3.6.82 in ./EmotionDetector/li
b/python3.10/site-packages (from tensorflow[and-cuda]) (10.3.6.82)
Requirement already satisfied: nvidia-cusolver-cu12==11.6.3.83 in ./EmotionDetector/
lib/python3.10/site-packages (from tensorflow[and-cuda]) (11.6.3.83)
Requirement already satisfied: nvidia-cusparse-cu12==12.5.1.3 in ./EmotionDetector/l
ib/python3.10/site-packages (from tensorflow[and-cuda]) (12.5.1.3)
Requirement already satisfied: nvidia-nccl-cu12==2.21.5 in ./EmotionDetector/lib/pyt
hon3.10/site-packages (from tensorflow[and-cuda]) (2.21.5)
Requirement already satisfied: nvidia-nvjitlink-cu12==12.5.82 in ./EmotionDetector/l
ib/python3.10/site-packages (from tensorflow[and-cuda]) (12.5.82)
Requirement already satisfied: contourpy>=1.0.1 in ./EmotionDetector/lib/python3.10/
site-packages (from matplotlib) (1.3.1)
Requirement already satisfied: cycler>=0.10 in ./EmotionDetector/lib/python3.10/site
-packages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in ./EmotionDetector/lib/python3.1
0/site-packages (from matplotlib) (4.55.3)
Requirement already satisfied: kiwisolver>=1.3.1 in ./EmotionDetector/lib/python3.1
0/site-packages (from matplotlib) (1.4.8)
Requirement already satisfied: pillow>=8 in ./EmotionDetector/lib/python3.10/site-pa
ckages (from matplotlib) (11.1.0)
Requirement already satisfied: pyparsing>=2.3.1 in ./EmotionDetector/lib/python3.10/
site-packages (from matplotlib) (3.2.1)
Requirement already satisfied: python-dateutil>=2.7 in ./EmotionDetector/lib/python
3.10/site-packages (from matplotlib) (2.9.0.post0)
Requirement already satisfied: wheel<1.0,>=0.23.0 in ./EmotionDetector/lib/python3.1
0/site-packages (from astunparse>=1.6.0->tensorflow[and-cuda]) (0.45.1)
Requirement already satisfied: rich in ./EmotionDetector/lib/python3.10/site-package
s (from keras>=3.5.0->tensorflow[and-cuda]) (13.9.4)
Requirement already satisfied: namex in ./EmotionDetector/lib/python3.10/site-packag
es (from keras>=3.5.0->tensorflow[and-cuda]) (0.0.8)
Requirement already satisfied: optree in ./EmotionDetector/lib/python3.10/site-packa
ges (from keras>=3.5.0->tensorflow[and-cuda]) (0.14.0)
Requirement already satisfied: charset-normalizer<4,>=2 in ./EmotionDetector/lib/pyt
hon3.10/site-packages (from requests<3,>=2.21.0->tensorflow[and-cuda]) (3.4.1)
Requirement already satisfied: idna<4,>=2.5 in ./EmotionDetector/lib/python3.10/site
-packages (from requests<3,>=2.21.0->tensorflow[and-cuda]) (3.10)
Requirement already satisfied: urllib3<3,>=1.21.1 in ./EmotionDetector/lib/python3.1
0/site-packages (from requests<3,>=2.21.0->tensorflow[and-cuda]) (2.3.0)
Requirement already satisfied: certifi>=2017.4.17 in ./EmotionDetector/lib/python3.1
0/site-packages (from requests<3,>=2.21.0->tensorflow[and-cuda]) (2024.12.14)
Requirement already satisfied: markdown>=2.6.8 in ./EmotionDetector/lib/python3.10/s
ite-packages (from tensorboard<2.19,>=2.18->tensorflow[and-cuda]) (3.7)
Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in ./EmotionDet
ector/lib/python3.10/site-packages (from tensorboard<2.19,>=2.18->tensorflow[and-cud
a]) (0.7.2)
Requirement already satisfied: werkzeug>=1.0.1 in ./EmotionDetector/lib/python3.10/s
ite-packages (from tensorboard<2.19,>=2.18->tensorflow[and-cuda]) (3.1.3)
```

```
Requirement already satisfied: MarkupSafe>=2.1.1 in ./EmotionDetector/lib/python3.1
0/site-packages (from werkzeug>=1.0.1->tensorboard<2.19,>=2.18->tensorflow[and-cud
a]) (3.0.2)
Requirement already satisfied: markdown-it-py>=2.2.0 in ./EmotionDetector/lib/python
3.10/site-packages (from rich->keras>=3.5.0->tensorflow[and-cuda]) (3.0.0)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in ./EmotionDetector/lib/pyth
on3.10/site-packages (from rich->keras>=3.5.0->tensorflow[and-cuda]) (2.19.1)
Requirement already satisfied: mdurl~=0.1 in ./EmotionDetector/lib/python3.10/site-p
ackages (from markdown-it-py>=2.2.0->rich->keras>=3.5.0->tensorflow[and-cuda]) (0.1.
2)
```

2. Checking installations

In [35]:
```
!pip list
```

```
Package                       Version
----------------------------- -------------
absl-py                       2.1.0
anyio                         4.8.0
argon2-cffi                   23.1.0
argon2-cffi-bindings          21.2.0
arrow                         1.3.0
asttokens                     3.0.0
astunparse                    1.6.3
async-lru                     2.0.4
attrs                         24.3.0
babel                         2.16.0
beautifulsoup4                4.12.3
bleach                        6.2.0
certifi                       2024.12.14
cffi                          1.17.1
charset-normalizer            3.4.1
comm                          0.2.2
contourpy                     1.3.1
cycler                        0.12.1
debugpy                       1.8.12
decorator                     5.1.1
defusedxml                    0.7.1
exceptiongroup                1.2.2
executing                     2.1.0
fastjsonschema                2.21.1
flatbuffers                   24.12.23
fonttools                     4.55.3
fqdn                          1.5.1
gast                          0.6.0
google-pasta                  0.2.0
grpcio                        1.69.0
h11                           0.14.0
h5py                          3.12.1
httpcore                      1.0.7
httpx                         0.28.1
idna                          3.10
ipykernel                     6.29.5
ipython                       8.31.0
isoduration                   20.11.0
jedi                          0.19.2
Jinja2                        3.1.5
json5                         0.10.0
jsonpointer                   3.0.0
jsonschema                    4.23.0
jsonschema-specifications     2024.10.1
jupyter_client                8.6.3
jupyter_core                  5.7.2
jupyter-events                0.11.0
jupyter-lsp                   2.2.5
jupyter_server                2.15.0
jupyter_server_terminals      0.5.3
jupyterlab                    4.3.4
jupyterlab_pygments           0.3.0
jupyterlab_server             2.27.3
keras                         3.8.0
```

```
kiwisolver                1.4.8
libclang                  18.1.1
Markdown                  3.7
markdown-it-py            3.0.0
MarkupSafe                3.0.2
matplotlib                3.10.0
matplotlib-inline         0.1.7
mdurl                     0.1.2
mistune                   3.1.0
ml-dtypes                 0.4.1
namex                     0.0.8
nbclient                  0.10.2
nbconvert                 7.16.5
nbformat                  5.10.4
nest-asyncio              1.6.0
notebook                  7.3.2
notebook_shim             0.2.4
numpy                     2.0.2
nvidia-cublas-cu12        12.5.3.2
nvidia-cuda-cupti-cu12    12.5.82
nvidia-cuda-nvcc-cu12     12.5.82
nvidia-cuda-nvrtc-cu12    12.5.82
nvidia-cuda-runtime-cu12  12.5.82
nvidia-cudnn-cu12         9.3.0.75
nvidia-cufft-cu12         11.2.3.61
nvidia-curand-cu12        10.3.6.82
nvidia-cusolver-cu12      11.6.3.83
nvidia-cusparse-cu12      12.5.1.3
nvidia-nccl-cu12          2.21.5
nvidia-nvjitlink-cu12     12.5.82
opencv-python             4.11.0.86
opt_einsum                3.4.0
optree                    0.14.0
overrides                 7.7.0
packaging                 24.2
pandocfilters             1.5.1
parso                     0.8.4
pexpect                   4.9.0
pillow                    11.1.0
pip                       24.3.1
platformdirs              4.3.6
prometheus_client         0.21.1
prompt_toolkit            3.0.48
protobuf                  5.29.3
psutil                    6.1.1
ptyprocess                0.7.0
pure_eval                 0.2.3
pycparser                 2.22
Pygments                  2.19.1
pyparsing                 3.2.1
python-dateutil           2.9.0.post0
python-json-logger        3.2.1
PyYAML                    6.0.2
pyzmq                     26.2.0
referencing               0.36.1
requests                  2.32.3
```

```
rfc3339-validator           0.1.4
rfc3986-validator           0.1.1
rich                        13.9.4
rpds-py                     0.22.3
Send2Trash                  1.8.3
setuptools                  59.6.0
six                         1.17.0
sniffio                     1.3.1
soupsieve                   2.6
stack-data                  0.6.3
tensorboard                 2.18.0
tensorboard-data-server     0.7.2
tensorflow                  2.18.0
tensorflow-io-gcs-filesystem 0.37.1
termcolor                   2.5.0
terminado                   0.18.1
tinycss2                    1.4.0
tomli                       2.2.1
tornado                     6.4.2
traitlets                   5.14.3
types-python-dateutil       2.9.0.20241206
typing_extensions           4.12.2
uri-template                1.3.0
urllib3                     2.3.0
wcwidth                     0.2.13
webcolors                   24.11.1
webencodings                0.5.1
websocket-client            1.8.0
Werkzeug                    3.1.3
wheel                       0.45.1
wrapt                       1.17.2
```

3. Importing libraries

In [139…

```
import os
os.environ["CUDA_VISIBLE_DEVICES"] = "-1"  # Disables GPU
import tensorflow as tf
import cv2
import imghdr
import numpy as np
import matplotlib.pyplot as plt
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Dense, Flatten, Dropout
from tensorflow.keras.metrics import Precision, Recall, BinaryAccuracy
import cv2
from tensorflow.keras.models import load_model
```

4. Removing dodgy images from data sets

In [37]:

```
data_dir = 'data'
```

In [38]:
```
image_exts = ['jpeg','jpg', 'bmp', 'png']
```

5. Loading data

In [40]:
```
data = tf.keras.utils.image_dataset_from_directory('data')
```

```
Found 376 files belonging to 2 classes.
```

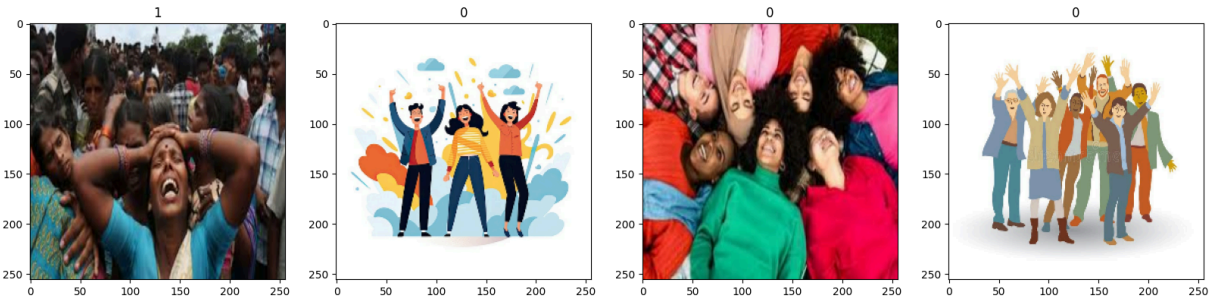
In [41]:
```
data_iterator = data.as_numpy_iterator()
```

In [42]:
```
batch = data_iterator.next()
```

In [43]:
```
#checking what is assigned to 0 and 1

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])

#happy = 0
#sad = 1
```



6. Scaling Data from 0-255 to 0-1

In [44]:
```
data = data.map(lambda x,y: (x/255, y))
```

In [45]:
```
data.as_numpy_iterator().next()
```

```
2025-01-20 21:05:58.529035: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
```

```
Out[45]: (array([[[[9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   [9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   [9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   ...,
                   [9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   [9.30147052e-01, 9.30147052e-01, 9.30147052e-01],
                   [9.98284340e-01, 9.98284340e-01, 9.98284340e-01]],

                  [[9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   [9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   [9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   ...,
                   [9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   [9.30147052e-01, 9.30147052e-01, 9.30147052e-01],
                   [9.98284340e-01, 9.98284340e-01, 9.98284340e-01]],

                  [[9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   [9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   [9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   ...,
                   [9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   [9.30147052e-01, 9.30147052e-01, 9.30147052e-01],
                   [9.98284340e-01, 9.98284340e-01, 9.98284340e-01]],

                  ...,

                  [[9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   [9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   [9.33333337e-01, 9.33333337e-01, 9.33333337e-01],
                   ...,
                   [9.29626226e-01, 9.29626226e-01, 9.29626226e-01],
                   [9.26271439e-01, 9.26271439e-01, 9.26271439e-01],
                   [9.95756745e-01, 9.95756745e-01, 9.95756745e-01]],

                  [[9.30147052e-01, 9.30147052e-01, 9.30147052e-01],
                   [9.30147052e-01, 9.30147052e-01, 9.30147052e-01],
                   [9.30147052e-01, 9.30147052e-01, 9.30147052e-01],
                   ...,
                   [9.30147052e-01, 9.30147052e-01, 9.30147052e-01],
                   [9.25765932e-01, 9.25765932e-01, 9.25765932e-01],
                   [9.95343149e-01, 9.95343149e-01, 9.95343149e-01]],

                  [[9.98284340e-01, 9.98284340e-01, 9.98284340e-01],
                   [9.98284340e-01, 9.98284340e-01, 9.98284340e-01],
                   [9.98284340e-01, 9.98284340e-01, 9.98284340e-01],
                   ...,
                   [9.98284340e-01, 9.98284340e-01, 9.98284340e-01],
                   [9.98284340e-01, 9.98284340e-01, 9.98284340e-01],
                   [9.40609694e-01, 9.40609694e-01, 9.40609694e-01]]],


                 [[[4.62699145e-01, 6.93979800e-01, 7.64522076e-01],
                   [4.58685666e-01, 6.81663632e-01, 7.47916639e-01],
                   [4.55591291e-01, 6.62285566e-01, 7.16727912e-01],
                   ...,
                   [3.80392164e-01, 5.68627477e-01, 6.47058845e-01],
```

```
  [3.80392164e-01, 5.68627477e-01, 6.47058845e-01],
  [3.84267777e-01, 5.72503090e-01, 6.50934458e-01]],

 [[4.57867205e-01, 6.81697011e-01, 7.44817376e-01],
  [4.64155436e-01, 6.77324474e-01, 7.36155689e-01],
  [4.76107746e-01, 6.75235152e-01, 7.22255707e-01],
  ...,
  [3.85340065e-01, 5.73575377e-01, 6.52006745e-01],
  [3.85340065e-01, 5.73575377e-01, 6.52006745e-01],
  [3.89215678e-01, 5.77450991e-01, 6.55882359e-01]],

 [[4.62654978e-01, 6.68562710e-01, 7.16760397e-01],
  [4.81360346e-01, 6.76665783e-01, 7.19242156e-01],
  [5.14205873e-01, 6.95590854e-01, 7.30635703e-01],
  ...,
  [3.89744192e-01, 5.77979445e-01, 6.56410873e-01],
  [3.91200006e-01, 5.79435349e-01, 6.57866716e-01],
  [3.93637478e-01, 5.81872821e-01, 6.60304189e-01]],

 ...,

 [[0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  ...,
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00]],

 [[0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  ...,
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00]],

 [[0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
  ...,
  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
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  [0.00000000e+00, 0.00000000e+00, 0.00000000e+00]]],


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```

7. Splitting data

In [46]:
```
len(data)
```

Out[46]: 12

In [47]:
```
train_size = int(len(data)*.8)
val_size = int(len(data)*.1)
test_size = int(len(data)*.1)
```

In [48]:
```
print(train_size)
print(val_size)
print(test_size)
```

```
9
1
1
```

In [49]:
```
train = data.take(train_size) #take 8 batches
val = data.skip(train_size).take(val_size) #skip batches already taken and take 1 b
test = data.skip(train_size+val_size).take(test_size) #skip batches already taken a
```

8. Building Model

In [50]:
```
model = Sequential()
```

In [51]:
```
tf.random.set_seed(1234)

model = Sequential(
    [
        ### START CODE HERE ###
        Conv2D(16, (3,3), strides=1, activation='relu', input_shape=(256,256,3), na
        MaxPooling2D(name="maxpool1"),

        Conv2D(32, (3,3), strides=1, activation='relu', name="conv2"),
        MaxPooling2D(name="maxpool2"),

        Conv2D(16, (3,3), strides=1, activation='relu', name="conv3"),
        MaxPooling2D(name="maxpool3"),

        Flatten(name="flatten"),
        Dense(256, activation='relu', name="dense1"),
        Dense(1, activation='sigmoid', name="output")

    ], name="my_model"
)
```

In [52]:
```
model.compile('adam', loss=tf.losses.BinaryCrossentropy(), metrics=['accuracy'])
```

In [53]:
```
model.summary()
```

Model: "my_model"

Layer (type)	Output Shape	Param #
conv1 (Conv2D)	(None, 254, 254, 16)	448
maxpool1 (MaxPooling2D)	(None, 127, 127, 16)	0
conv2 (Conv2D)	(None, 125, 125, 32)	4,640
maxpool2 (MaxPooling2D)	(None, 62, 62, 32)	0
conv3 (Conv2D)	(None, 60, 60, 16)	4,624
maxpool3 (MaxPooling2D)	(None, 30, 30, 16)	0
flatten (Flatten)	(None, 14400)	0
dense1 (Dense)	(None, 256)	3,686,656
output (Dense)	(None, 1)	257

Total params: 3,696,625 (14.10 MB)

```
Trainable params: 3,696,625 (14.10 MB)
Non-trainable params: 0 (0.00 B)
```

9. Training

In [54]:
```
logdir='logs'
```

In [55]:
```
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=logdir)
```

In [56]:
```
hist = model.fit(train, epochs=20, validation_data=val, callbacks=[tensorboard_call
```

```
Epoch 1/20
2025-01-20 21:06:03.133075: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 223ms/step - accuracy: 0.7515 - loss: 0.7956
2025-01-20 21:06:05.545320: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 4s 301ms/step - accuracy: 0.7503 - loss: 0.7907 - val_accur
acy: 0.8438 - val_loss: 0.4591
Epoch 2/20
1/9 ━━━━━━━━━━━━━━━━━━━━ 3s 427ms/step - accuracy: 0.8438 - loss: 0.4259
2025-01-20 21:06:06.355613: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 238ms/step - accuracy: 0.7618 - loss: 0.5226
2025-01-20 21:06:08.312843: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 3s 308ms/step - accuracy: 0.7595 - loss: 0.5245 - val_accur
acy: 0.7812 - val_loss: 0.4997
Epoch 3/20
2025-01-20 21:06:08.884249: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 219ms/step - accuracy: 0.7475 - loss: 0.5118
2025-01-20 21:06:11.076086: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 3s 318ms/step - accuracy: 0.7467 - loss: 0.5126 - val_accur
acy: 0.7812 - val_loss: 0.4027
Epoch 4/20
2025-01-20 21:06:12.066747: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 654ms/step - accuracy: 0.7354 - loss: 0.4851
2025-01-20 21:06:18.989873: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 8s 937ms/step - accuracy: 0.7362 - loss: 0.4839 - val_accur
acy: 0.7500 - val_loss: 0.4424
Epoch 5/20
1/9 ━━━━━━━━━━━━━━━━━━━━ 6s 833ms/step - accuracy: 0.8125 - loss: 0.3923
2025-01-20 21:06:21.510474: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 460ms/step - accuracy: 0.7725 - loss: 0.4245
```

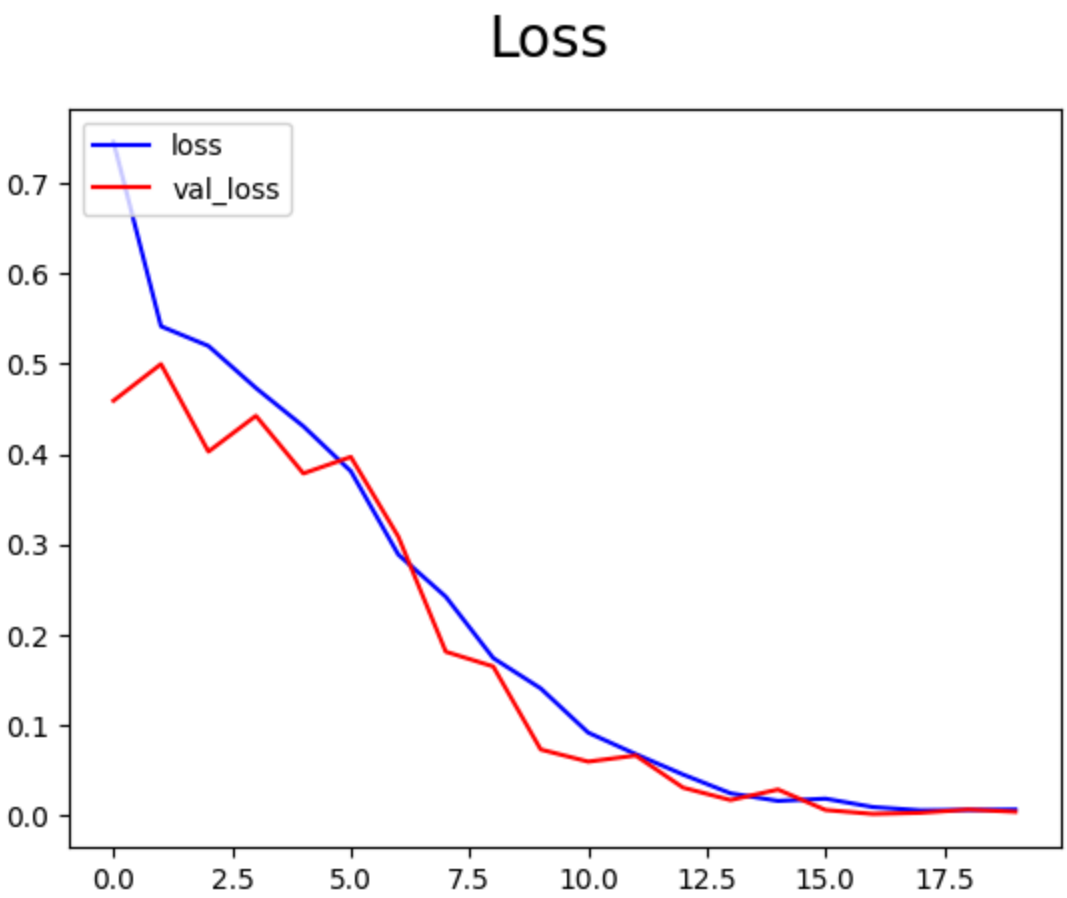
```
2025-01-20 21:06:25.238880: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 6s 613ms/step - accuracy: 0.7730 - loss: 0.4252 - val_accur
acy: 0.7500 - val_loss: 0.3785
Epoch 6/20
1/9 ━━━━━━━━━━━━━━━━━━━━ 6s 805ms/step - accuracy: 0.9375 - loss: 0.2139
2025-01-20 21:06:26.999117: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 431ms/step - accuracy: 0.8380 - loss: 0.3496
2025-01-20 21:06:30.738799: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 5s 586ms/step - accuracy: 0.8362 - loss: 0.3527 - val_accur
acy: 0.8125 - val_loss: 0.3968
Epoch 7/20
2025-01-20 21:06:31.550618: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 392ms/step - accuracy: 0.8982 - loss: 0.2991
2025-01-20 21:06:35.642936: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 5s 549ms/step - accuracy: 0.8980 - loss: 0.2980 - val_accur
acy: 0.9375 - val_loss: 0.3085
Epoch 8/20
2025-01-20 21:06:37.018087: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 400ms/step - accuracy: 0.9122 - loss: 0.2673
2025-01-20 21:06:40.864910: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 5s 555ms/step - accuracy: 0.9123 - loss: 0.2648 - val_accur
acy: 0.9062 - val_loss: 0.1809
Epoch 9/20
2025-01-20 21:06:42.079362: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 456ms/step - accuracy: 0.9283 - loss: 0.1783
2025-01-20 21:06:46.896167: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 6s 615ms/step - accuracy: 0.9296 - loss: 0.1779 - val_accur
acy: 0.8750 - val_loss: 0.1645
Epoch 10/20
2025-01-20 21:06:47.762891: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 399ms/step - accuracy: 0.9343 - loss: 0.1425
2025-01-20 21:06:52.421516: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 6s 593ms/step - accuracy: 0.9360 - loss: 0.1423 - val_accur
acy: 1.0000 - val_loss: 0.0725
Epoch 11/20
1/9 ━━━━━━━━━━━━━━━━━━━━ 5s 677ms/step - accuracy: 1.0000 - loss: 0.0702
2025-01-20 21:06:54.031945: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 410ms/step - accuracy: 0.9850 - loss: 0.0999
2025-01-20 21:06:57.474300: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
```

```
9/9 ━━━━━━━━━━━━━━━━━━━━ 5s 560ms/step - accuracy: 0.9847 - loss: 0.0991 - val_accur
acy: 0.9688 - val_loss: 0.0591
Epoch 12/20
2025-01-20 21:06:58.856567: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 391ms/step - accuracy: 0.9833 - loss: 0.0671
2025-01-20 21:07:02.890293: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 5s 536ms/step - accuracy: 0.9829 - loss: 0.0672 - val_accur
acy: 0.9688 - val_loss: 0.0658
Epoch 13/20
1/9 ━━━━━━━━━━━━━━━━━━━━ 4s 625ms/step - accuracy: 0.9688 - loss: 0.0596
2025-01-20 21:07:04.121315: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 406ms/step - accuracy: 0.9879 - loss: 0.0431
2025-01-20 21:07:07.610815: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 5s 564ms/step - accuracy: 0.9881 - loss: 0.0433 - val_accur
acy: 1.0000 - val_loss: 0.0302
Epoch 14/20
1/9 ━━━━━━━━━━━━━━━━━━━━ 6s 853ms/step - accuracy: 1.0000 - loss: 0.0046
2025-01-20 21:07:09.775382: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 442ms/step - accuracy: 0.9941 - loss: 0.0171
2025-01-20 21:07:13.635765: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 6s 617ms/step - accuracy: 0.9940 - loss: 0.0178 - val_accur
acy: 1.0000 - val_loss: 0.0165
Epoch 15/20
2025-01-20 21:07:14.737538: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 407ms/step - accuracy: 1.0000 - loss: 0.0125
2025-01-20 21:07:19.259725: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 5s 545ms/step - accuracy: 1.0000 - loss: 0.0128 - val_accur
acy: 1.0000 - val_loss: 0.0281
Epoch 16/20
1/9 ━━━━━━━━━━━━━━━━━━━━ 5s 732ms/step - accuracy: 1.0000 - loss: 0.0340
2025-01-20 21:07:20.562510: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 406ms/step - accuracy: 1.0000 - loss: 0.0203
2025-01-20 21:07:23.711656: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 5s 559ms/step - accuracy: 1.0000 - loss: 0.0201 - val_accur
acy: 1.0000 - val_loss: 0.0055
Epoch 17/20
2025-01-20 21:07:24.976787: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 387ms/step - accuracy: 1.0000 - loss: 0.0077
2025-01-20 21:07:28.920561: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
```

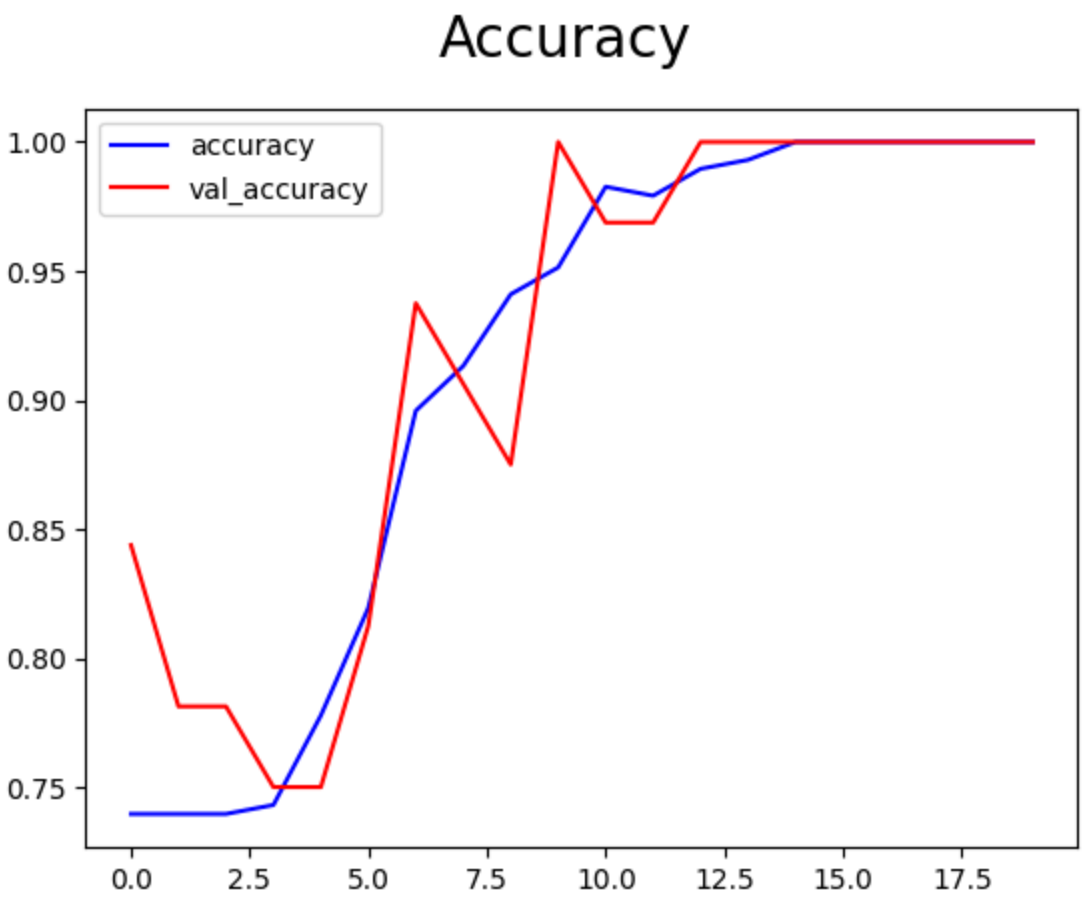
```
9/9 ━━━━━━━━━━━━━━━━━━━━ 5s 552ms/step - accuracy: 1.0000 - loss: 0.0078 - val_accur
acy: 1.0000 - val_loss: 0.0011
Epoch 18/20
2025-01-20 21:07:30.385570: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 444ms/step - accuracy: 1.0000 - loss: 0.0049
2025-01-20 21:07:34.813397: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 6s 606ms/step - accuracy: 1.0000 - loss: 0.0049 - val_accur
acy: 1.0000 - val_loss: 0.0024
Epoch 19/20
2025-01-20 21:07:35.719502: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 485ms/step - accuracy: 1.0000 - loss: 0.0036
2025-01-20 21:07:40.794310: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 6s 680ms/step - accuracy: 1.0000 - loss: 0.0038 - val_accur
acy: 1.0000 - val_loss: 0.0060
Epoch 20/20
1/9 ━━━━━━━━━━━━━━━━━━━━ 6s 752ms/step - accuracy: 1.0000 - loss: 0.0023
2025-01-20 21:07:42.258960: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 0s 415ms/step - accuracy: 1.0000 - loss: 0.0028
2025-01-20 21:07:46.605691: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
9/9 ━━━━━━━━━━━━━━━━━━━━ 5s 578ms/step - accuracy: 1.0000 - loss: 0.0031 - val_accur
acy: 1.0000 - val_loss: 0.0035
```

10. Plotting

In [57]:
```python
fig = plt.figure()
plt.plot(hist.history['loss'], color='blue', label='loss')
plt.plot(hist.history['val_loss'], color='red', label='val_loss')
fig.suptitle('Loss', fontsize=20)
plt.legend(loc="upper left")
plt.show()
```



In [58]:
```
fig = plt.figure()
plt.plot(hist.history['accuracy'], color='blue', label='accuracy')
plt.plot(hist.history['val_accuracy'], color='red', label='val_accuracy')
fig.suptitle('Accuracy', fontsize=20)
plt.legend(loc="upper left")
plt.show()
```



11. Evaluating Performance

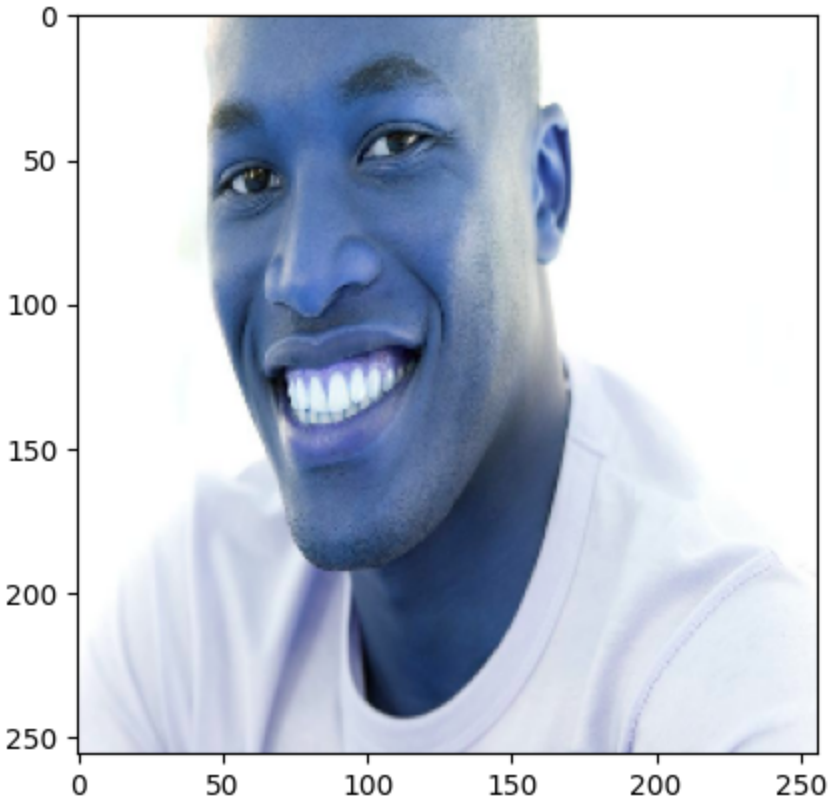
In [289…

```
precision = Precision()
recall = Recall()
accuracy = BinaryAccuracy()

# Ensure dataset iteration does not go out of range
for batch in test.take(len(test)):  # Use `.take()` to iterate safely
    X, y = batch
    yhat = model.predict(X)

    precision.update_state(y, yhat)
    recall.update_state(y, yhat)
    accuracy.update_state(y, yhat)

print(f'Precision: {precision.result().numpy()}, Recall: {recall.result().numpy()},

print("yhat shape:", yhat.shape)
```

```
2025-01-20 22:27:50.496365: W tensorflow/core/lib/png/png_io.cc:89] PNG warning: iCC
P: known incorrect sRGB profile
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 189ms/step
Precision: 1.0, Recall: 1.0, Accuracy: 1.0
yhat shape: (32, 1)
```

In [290…
```
img = cv2.imread('happyExample2.jpg')
plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
plt.show()
```

In [291…
```
resizedImg = tf.image.resize(img, (256,256))
plt.imshow(resizedImg.numpy().astype(int))
plt.show()
```



In [292…

```
np.expand_dims(resizedImg, 0)
```

Out[292…

```
array([[[[255.     , 255.     , 255.     ],
         [255.     , 255.     , 255.     ],
         [255.     , 255.     , 255.     ],
         ...,
         [255.     , 255.     , 255.     ],
         [255.     , 255.     , 255.     ],
         [255.     , 255.     , 255.     ]],

        [[255.     , 255.     , 255.     ],
         [255.     , 255.     , 255.     ],
         [255.     , 255.     , 255.     ],
         ...,
         [255.     , 255.     , 255.     ],
         [255.     , 255.     , 255.     ],
         [255.     , 255.     , 255.     ]],

        [[255.     , 255.     , 255.     ],
         [255.     , 255.     , 255.     ],
         [255.     , 255.     , 255.     ],
         ...,
         [255.     , 255.     , 255.     ],
         [255.     , 255.     , 255.     ],
         [255.     , 255.     , 255.     ]],

        ...,

        [[236.16406, 237.16406, 247.16406],
         [235.13187, 236.13187, 246.13187],
         [235.     , 236.     , 246.     ],
         ...,
         [242.59012, 246.59012, 251.59012],
         [240.1914 , 244.1914 , 249.1914 ],
         [243.84995, 246.43198, 252.68588]],

        [[236.75528, 237.75528, 247.75528],
         [235.96072, 236.96072, 246.96072],
         [235.     , 236.     , 246.     ],
         ...,
         [241.72562, 245.72562, 250.72562],
         [240.73416, 244.73416, 249.73416],
         [243.74219, 246.74219, 251.74219]],

        [[235.76517, 236.76517, 246.76517],
         [236.     , 237.     , 247.     ],
         [236.3164 , 237.3164 , 247.3164 ],
         ...,
         [240.77505, 244.77505, 249.77505],
         [241.07169, 245.07169, 250.07169],
         [243.74219, 246.74219, 250.74219]]]], dtype=float32)
```

In [293…

```
yhat = model.predict(np.expand_dims(resizedImg/255, 0))
print(yhat)

if yhat > 0.5:
    print("Prediction: Sad")
```

```
else:
    print("Prediction: Happy")
```

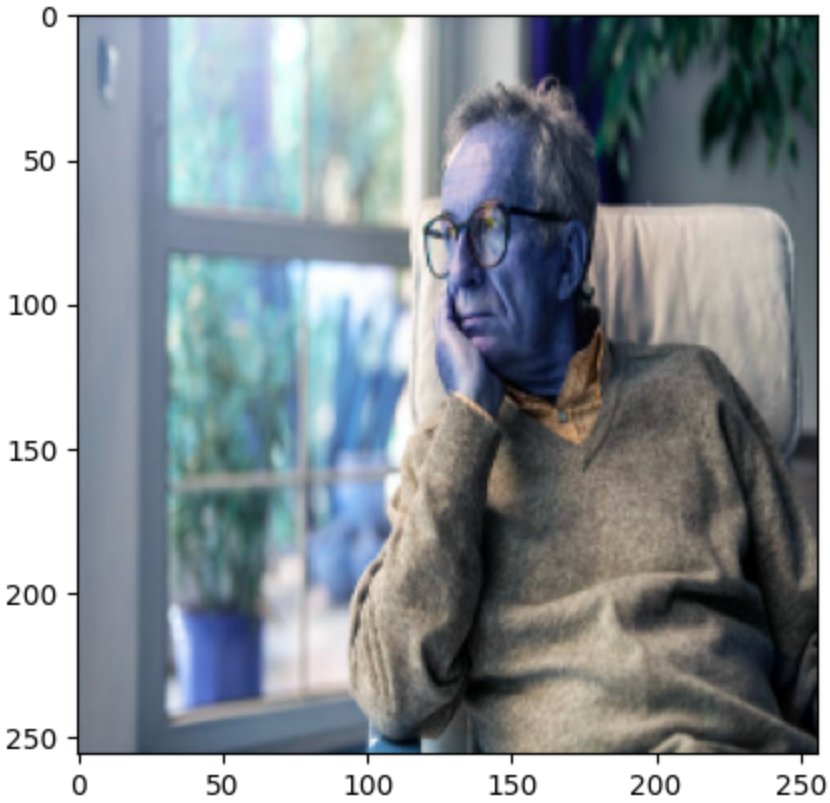
```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 56ms/step
[[0.01000653]]
Prediction: Happy
```

In [294…

```
img = cv2.imread('sadExample1.jpg')
plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
plt.show()
```

In [295…

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



In [296…

```
np.expand_dims(resizedImg, 0)
```

Out[296…

```
array([[[[140.78577  , 155.78577  , 174.78577  ],
         [141.3573   , 156.3573   , 175.3573   ],
         [142.63196  , 157.63196  , 176.63196  ],
         ...,
         [  7.491333 ,  31.788208 ,  21.788208 ],
         [  9.511963 ,  34.33069  ,  29.815063 ],
         [ 24.2948   ,  52.828125 ,  48.317017 ]],

        [[141.61926  , 156.61926  , 175.61926  ],
         [142.07654  , 157.07654  , 176.07654  ],
         [143.42444  , 158.42444  , 177.42444  ],
         ...,
         [  8.325562 ,  35.10681  ,  25.997437 ],
         [  4.309204 ,  31.090454 ,  26.651367 ],
         [ 19.884888 ,  50.427612 ,  45.427612 ]],

        [[142.8429   , 157.8429   , 176.8429   ],
         [143.57031  , 158.57031  , 177.57031  ],
         [144.7301   , 159.7301   , 178.7301   ],
         ...,
         [ 12.428955 ,  42.397705 ,  34.366455 ],
         [  1.3226318,  33.090942 ,  27.387695 ],
         [ 13.5321045,  45.532104 ,  40.532104 ]],

        ...,

        [[115.484375 , 121.484375 , 132.48438  ],
         [115.484375 , 121.484375 , 132.48438  ],
         [115.484375 , 121.484375 , 132.48438  ],
         ...,
         [ 41.992188 ,  47.992188 ,  52.992188 ],
         [ 46.10913  ,  49.838257 ,  54.395508 ],
         [ 57.83423  ,  61.349854 ,  65.86548  ]],

        [[114.890625 , 120.890625 , 131.89062  ],
         [114.890625 , 120.890625 , 131.89062  ],
         [114.890625 , 120.890625 , 131.89062  ],
         ...,
         [ 33.604126 ,  39.604126 ,  44.604126 ],
         [ 39.642334 ,  45.642334 ,  52.47046  ],
         [ 46.320312 ,  52.320312 ,  59.320312 ]],

        [[114.       , 120.       , 131.       ],
         [114.       , 120.       , 131.       ],
         [114.       , 120.       , 131.       ],
         ...,
         [ 27.17273  ,  33.17273  ,  38.17273  ],
         [ 31.904663 ,  37.904663 ,  44.732788 ],
         [ 41.70642  ,  47.70642  ,  54.70642  ]]]], dtype=float32)
```

In [297…

```
yhat = model.predict(np.expand_dims(resizedImg/255, 0))
print(yhat)

if yhat > 0.5:
    print("Prediction: Sad")
```

```
else:
    print("Prediction: Happy")
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 50ms/step
[[0.9501678]]
Prediction: Sad
```

12. Saving the Model

In [301…

```
model.save(os.path.join('models','EmotionDetector.h5'))
```

```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`. This file format is considered legacy. We recommend using instead the native Keras format, e.g. `model.save('my_model.keras')` or `keras.saving.save_model(model, 'my_model.keras')`.
```

In [302…

```
new_model = load_model(os.path.join('models', 'EmotionDetector.h5'))
yhatnew = new_model.predict(np.expand_dims(resize/255, 0))
if yhat > 0.5:
    print("Prediction: Sad")
else:
    print("Prediction: Happy")
```

```
WARNING:absl:Compiled the loaded model, but the compiled metrics have yet to be built. `model.compile_metrics` will be empty until you train or evaluate the model.
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 126ms/step
Prediction: Sad
```