Yawn detection

November 20, 2023

[4]:
```
import numpy as np
import pandas as pd
import os
import matplotlib.pylab as plt
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.preprocessing import image
from keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.models import Sequential, load_model
from tensorflow.keras.layers import Dense, Conv2D, MaxPooling2D, Flatten
from keras.callbacks import ModelCheckpoint
```

[5]:
```
import os
from tensorflow.keras.preprocessing.image import ImageDataGenerator

train_path = "data_yawning/train"
test_path = "data_yawning/test"

# Get a list of subdirectories in the training and testing directories
train_subdirectories = [d for d in os.listdir(train_path) if os.path.isdir(os.
 ↪path.join(train_path, d))]
test_subdirectories = [d for d in os.listdir(test_path) if os.path.isdir(os.
 ↪path.join(test_path, d))]

# Filter out the ".ipynb_checkpoints" folder
train_subdirectories = [d for d in train_subdirectories if d != ".
 ↪ipynb_checkpoints"]
test_subdirectories = [d for d in test_subdirectories if d != ".
 ↪ipynb_checkpoints"]

# Create data generators
train_datagen = ImageDataGenerator(rescale=1./255, shear_range=0.2,␣
 ↪zoom_range=0.2, horizontal_flip=True)
test_datagen = ImageDataGenerator(rescale=1./255)
```

```
x_train = train_datagen.flow_from_directory(train_path, target_size=(256, 256),␣
 ↪batch_size=32, color_mode='grayscale', class_mode='categorical',␣
 ↪classes=train_subdirectories)
x_test = test_datagen.flow_from_directory(test_path, target_size=(256, 256),␣
 ↪batch_size=32, color_mode='grayscale', class_mode='categorical',␣
 ↪classes=test_subdirectories)

x_train.class_indices
```

```
Found 1233 images belonging to 2 classes.
Found 215 images belonging to 2 classes.
```

[5]:
```
{'no_yawn': 0, 'yawn': 1}
```

[6]:
```
classes=2
model = Sequential()
model.add(Conv2D(16, (3,3), padding = 'same', input_shape = (256,256,1),␣
 ↪activation = 'relu'))
model.add(MaxPooling2D(pool_size = (2,2)))

model.add(Conv2D(32, (3,3), padding = 'same', activation = 'relu'))
model.add(MaxPooling2D(pool_size = (2,2)))

model.add(Conv2D(64, (3,3), padding = 'same', activation = 'relu'))
model.add(MaxPooling2D(pool_size = (2,2)))

model.add(Conv2D(128,(3,3), padding='same', activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))

model.add(Flatten())

model.add(Dense(128, activation = 'relu'))

model.add(Dense(classes, activation = 'softmax'))
print(model.summary())
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 256, 256, 16)      160

 max_pooling2d (MaxPooling2  (None, 128, 128, 16)      0
 D)

 conv2d_1 (Conv2D)           (None, 128, 128, 32)      4640

 max_pooling2d_1 (MaxPoolin  (None, 64, 64, 32)        0
```

```
g2D)

conv2d_2 (Conv2D)           (None, 64, 64, 64)        18496

max_pooling2d_2 (MaxPoolin  (None, 32, 32, 64)        0
g2D)

conv2d_3 (Conv2D)           (None, 32, 32, 128)       73856

max_pooling2d_3 (MaxPoolin  (None, 16, 16, 128)       0
g2D)

flatten (Flatten)           (None, 32768)             0

dense (Dense)               (None, 128)               4194432

dense_1 (Dense)             (None, 2)                 258

=================================================================
Total params: 4291842 (16.37 MB)
Trainable params: 4291842 (16.37 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
None
```

[7]:
```
model.
  ↪compile(loss='categorical_crossentropy',optimizer='adam',metrics='accuracy')
```

[8]:
```
model_path="yawn_detection1.h5"

checkpoint = ModelCheckpoint(model_path, monitor='val_accuracy', verbose=1,
                             save_best_only=True, mode='max')

callbacks_list = [checkpoint]
```

[9]:
```
num_epochs = 50
training_steps=x_train.n//x_train.batch_size
validation_steps =x_test.n//x_test.batch_size

history = model.fit_generator(x_train, epochs=num_epochs,␣
  ↪steps_per_epoch=training_steps,validation_data=x_test,
                    validation_steps=validation_steps, callbacks =␣
  ↪callbacks_list)
```

```
C:\Users\ajars\AppData\Local\Temp\ipykernel_16548\1703616830.py:5: UserWarning:
`Model.fit_generator` is deprecated and will be removed in a future version.
Please use `Model.fit`, which supports generators.
  history = model.fit_generator(x_train, epochs=num_epochs,
```

```
steps_per_epoch=training_steps,validation_data=x_test,

Epoch 1/50
38/38 [==============================] - ETA: 0s - loss: 0.6768 - accuracy:
0.5853
Epoch 1: val_accuracy improved from -inf to 0.53646, saving model to
yawn_detection1.h5
38/38 [==============================] - 25s 637ms/step - loss: 0.6768 -
accuracy: 0.5853 - val_loss: 0.8870 - val_accuracy: 0.5365
Epoch 2/50

C:\Users\ajars\anaconda3\Lib\site-packages\keras\src\engine\training.py:3079:
UserWarning: You are saving your model as an HDF5 file via `model.save()`. This
file format is considered legacy. We recommend using instead the native Keras
format, e.g. `model.save('my_model.keras')`.
  saving_api.save_model(

38/38 [==============================] - ETA: 0s - loss: 0.6082 - accuracy:
0.6586
Epoch 2: val_accuracy improved from 0.53646 to 0.58854, saving model to
yawn_detection1.h5
38/38 [==============================] - 27s 714ms/step - loss: 0.6082 -
accuracy: 0.6586 - val_loss: 0.6034 - val_accuracy: 0.5885
Epoch 3/50
38/38 [==============================] - ETA: 0s - loss: 0.5759 - accuracy:
0.6703
Epoch 3: val_accuracy improved from 0.58854 to 0.66667, saving model to
yawn_detection1.h5
38/38 [==============================] - 28s 721ms/step - loss: 0.5759 -
accuracy: 0.6703 - val_loss: 0.5866 - val_accuracy: 0.6667
Epoch 4/50
38/38 [==============================] - ETA: 0s - loss: 0.5499 - accuracy:
0.6811
Epoch 4: val_accuracy did not improve from 0.66667
38/38 [==============================] - 28s 729ms/step - loss: 0.5499 -
accuracy: 0.6811 - val_loss: 0.5642 - val_accuracy: 0.6302
Epoch 5/50
38/38 [==============================] - ETA: 0s - loss: 0.5362 - accuracy:
0.6978
Epoch 5: val_accuracy improved from 0.66667 to 0.69271, saving model to
yawn_detection1.h5
38/38 [==============================] - 29s 753ms/step - loss: 0.5362 -
accuracy: 0.6978 - val_loss: 0.5323 - val_accuracy: 0.6927
Epoch 6/50
38/38 [==============================] - ETA: 0s - loss: 0.5055 - accuracy:
0.7244
Epoch 6: val_accuracy improved from 0.69271 to 0.76042, saving model to
yawn_detection1.h5
38/38 [==============================] - 28s 741ms/step - loss: 0.5055 -
```

```
accuracy: 0.7244 - val_loss: 0.5072 - val_accuracy: 0.7604
Epoch 7/50
38/38 [==============================] - ETA: 0s - loss: 0.4914 - accuracy:
0.7477
Epoch 7: val_accuracy did not improve from 0.76042
38/38 [==============================] - 29s 777ms/step - loss: 0.4914 -
accuracy: 0.7477 - val_loss: 0.4846 - val_accuracy: 0.7552
Epoch 8/50
38/38 [==============================] - ETA: 0s - loss: 0.4517 - accuracy:
0.7635
Epoch 8: val_accuracy improved from 0.76042 to 0.78125, saving model to
yawn_detection1.h5
38/38 [==============================] - 29s 754ms/step - loss: 0.4517 -
accuracy: 0.7635 - val_loss: 0.4427 - val_accuracy: 0.7812
Epoch 9/50
38/38 [==============================] - ETA: 0s - loss: 0.4474 - accuracy:
0.7843
Epoch 9: val_accuracy did not improve from 0.78125
38/38 [==============================] - 29s 762ms/step - loss: 0.4474 -
accuracy: 0.7843 - val_loss: 0.4669 - val_accuracy: 0.7604
Epoch 10/50
38/38 [==============================] - ETA: 0s - loss: 0.3848 - accuracy:
0.8068
Epoch 10: val_accuracy improved from 0.78125 to 0.82812, saving model to
yawn_detection1.h5
38/38 [==============================] - 29s 760ms/step - loss: 0.3848 -
accuracy: 0.8068 - val_loss: 0.4030 - val_accuracy: 0.8281
Epoch 11/50
38/38 [==============================] - ETA: 0s - loss: 0.3666 - accuracy:
0.8301
Epoch 11: val_accuracy improved from 0.82812 to 0.86979, saving model to
yawn_detection1.h5
38/38 [==============================] - 29s 758ms/step - loss: 0.3666 -
accuracy: 0.8301 - val_loss: 0.3234 - val_accuracy: 0.8698
Epoch 12/50
38/38 [==============================] - ETA: 0s - loss: 0.3164 - accuracy:
0.8751
Epoch 12: val_accuracy did not improve from 0.86979
38/38 [==============================] - 30s 784ms/step - loss: 0.3164 -
accuracy: 0.8751 - val_loss: 0.3442 - val_accuracy: 0.8333
Epoch 13/50
38/38 [==============================] - ETA: 0s - loss: 0.2897 - accuracy:
0.8734
Epoch 13: val_accuracy improved from 0.86979 to 0.93750, saving model to
yawn_detection1.h5
38/38 [==============================] - 33s 863ms/step - loss: 0.2897 -
accuracy: 0.8734 - val_loss: 0.2225 - val_accuracy: 0.9375
Epoch 14/50
```

```
38/38 [==============================] - ETA: 0s - loss: 0.2679 - accuracy:
0.8859
Epoch 14: val_accuracy did not improve from 0.93750
38/38 [==============================] - 41s 1s/step - loss: 0.2679 - accuracy:
0.8859 - val_loss: 0.3013 - val_accuracy: 0.8802
Epoch 15/50
38/38 [==============================] - ETA: 0s - loss: 0.2463 - accuracy:
0.9051
Epoch 15: val_accuracy did not improve from 0.93750
38/38 [==============================] - 36s 953ms/step - loss: 0.2463 -
accuracy: 0.9051 - val_loss: 0.2650 - val_accuracy: 0.8958
Epoch 16/50
38/38 [==============================] - ETA: 0s - loss: 0.2204 - accuracy:
0.9192
Epoch 16: val_accuracy did not improve from 0.93750
38/38 [==============================] - 35s 902ms/step - loss: 0.2204 -
accuracy: 0.9192 - val_loss: 0.2277 - val_accuracy: 0.9271
Epoch 17/50
38/38 [==============================] - ETA: 0s - loss: 0.1704 - accuracy:
0.9351
Epoch 17: val_accuracy did not improve from 0.93750
38/38 [==============================] - 35s 902ms/step - loss: 0.1704 -
accuracy: 0.9351 - val_loss: 0.1741 - val_accuracy: 0.9323
Epoch 18/50
38/38 [==============================] - ETA: 0s - loss: 0.1630 - accuracy:
0.9367
Epoch 18: val_accuracy did not improve from 0.93750
38/38 [==============================] - 34s 899ms/step - loss: 0.1630 -
accuracy: 0.9367 - val_loss: 0.1633 - val_accuracy: 0.9375
Epoch 19/50
38/38 [==============================] - ETA: 0s - loss: 0.1805 - accuracy:
0.9342
Epoch 19: val_accuracy did not improve from 0.93750
38/38 [==============================] - 34s 901ms/step - loss: 0.1805 -
accuracy: 0.9342 - val_loss: 0.2561 - val_accuracy: 0.8854
Epoch 20/50
38/38 [==============================] - ETA: 0s - loss: 0.1636 - accuracy:
0.9292
Epoch 20: val_accuracy did not improve from 0.93750
38/38 [==============================] - 34s 892ms/step - loss: 0.1636 -
accuracy: 0.9292 - val_loss: 0.1726 - val_accuracy: 0.9323
Epoch 21/50
38/38 [==============================] - ETA: 0s - loss: 0.1223 - accuracy:
0.9559
Epoch 21: val_accuracy improved from 0.93750 to 0.94271, saving model to
yawn_detection1.h5
38/38 [==============================] - 31s 822ms/step - loss: 0.1223 -
accuracy: 0.9559 - val_loss: 0.1589 - val_accuracy: 0.9427
```

```
Epoch 22/50
38/38 [==============================] - ETA: 0s - loss: 0.1010 - accuracy:
0.9617
Epoch 22: val_accuracy did not improve from 0.94271
38/38 [==============================] - 35s 908ms/step - loss: 0.1010 -
accuracy: 0.9617 - val_loss: 0.2173 - val_accuracy: 0.9219
Epoch 23/50
38/38 [==============================] - ETA: 0s - loss: 0.1008 - accuracy:
0.9634
Epoch 23: val_accuracy did not improve from 0.94271
38/38 [==============================] - 35s 911ms/step - loss: 0.1008 -
accuracy: 0.9634 - val_loss: 0.2138 - val_accuracy: 0.9323
Epoch 24/50
38/38 [==============================] - ETA: 0s - loss: 0.0977 - accuracy:
0.9634
Epoch 24: val_accuracy did not improve from 0.94271
38/38 [==============================] - 36s 947ms/step - loss: 0.0977 -
accuracy: 0.9634 - val_loss: 0.1760 - val_accuracy: 0.9375
Epoch 25/50
38/38 [==============================] - ETA: 0s - loss: 0.0977 - accuracy:
0.9592
Epoch 25: val_accuracy improved from 0.94271 to 0.96354, saving model to
yawn_detection1.h5
38/38 [==============================] - 32s 852ms/step - loss: 0.0977 -
accuracy: 0.9592 - val_loss: 0.1543 - val_accuracy: 0.9635
Epoch 26/50
38/38 [==============================] - ETA: 0s - loss: 0.0745 - accuracy:
0.9725
Epoch 26: val_accuracy did not improve from 0.96354
38/38 [==============================] - 33s 859ms/step - loss: 0.0745 -
accuracy: 0.9725 - val_loss: 0.1666 - val_accuracy: 0.9583
Epoch 27/50
38/38 [==============================] - ETA: 0s - loss: 0.0774 - accuracy:
0.9709
Epoch 27: val_accuracy did not improve from 0.96354
38/38 [==============================] - 33s 870ms/step - loss: 0.0774 -
accuracy: 0.9709 - val_loss: 0.1378 - val_accuracy: 0.9635
Epoch 28/50
38/38 [==============================] - ETA: 0s - loss: 0.0742 - accuracy:
0.9734
Epoch 28: val_accuracy did not improve from 0.96354
38/38 [==============================] - 32s 835ms/step - loss: 0.0742 -
accuracy: 0.9734 - val_loss: 0.1776 - val_accuracy: 0.9375
Epoch 29/50
38/38 [==============================] - ETA: 0s - loss: 0.0556 - accuracy:
0.9833
Epoch 29: val_accuracy did not improve from 0.96354
38/38 [==============================] - 31s 817ms/step - loss: 0.0556 -
```

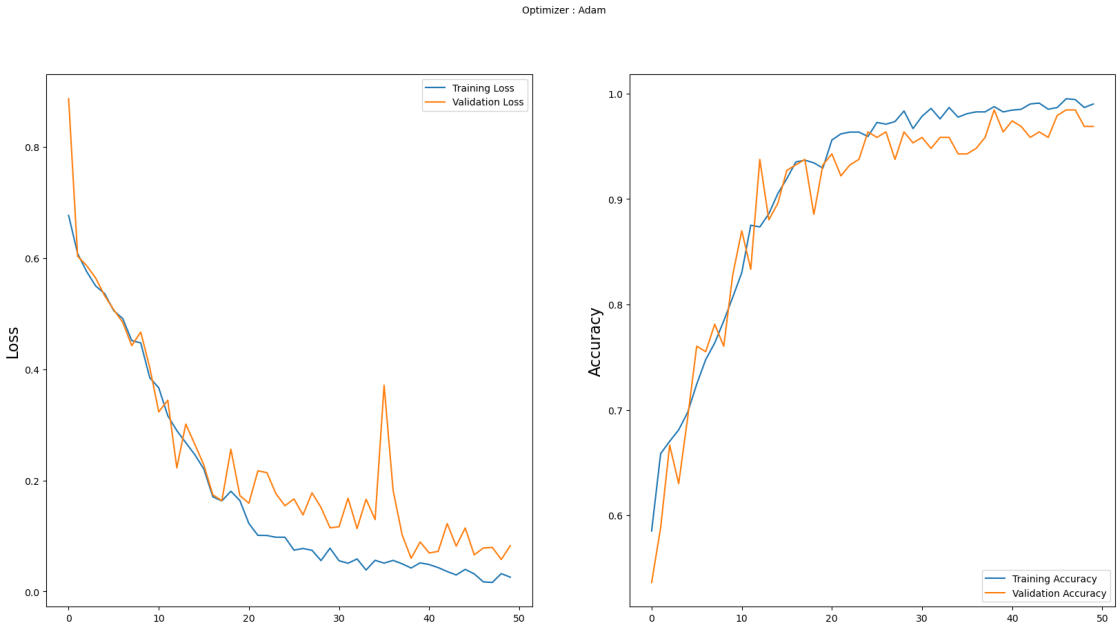
```
accuracy: 0.9833 - val_loss: 0.1513 - val_accuracy: 0.9635
Epoch 30/50
38/38 [==============================] - ETA: 0s - loss: 0.0779 - accuracy:
0.9667
Epoch 30: val_accuracy did not improve from 0.96354
38/38 [==============================] - 32s 837ms/step - loss: 0.0779 -
accuracy: 0.9667 - val_loss: 0.1147 - val_accuracy: 0.9531
Epoch 31/50
38/38 [==============================] - ETA: 0s - loss: 0.0554 - accuracy:
0.9784
Epoch 31: val_accuracy did not improve from 0.96354
38/38 [==============================] - 30s 791ms/step - loss: 0.0554 -
accuracy: 0.9784 - val_loss: 0.1166 - val_accuracy: 0.9583
Epoch 32/50
38/38 [==============================] - ETA: 0s - loss: 0.0508 - accuracy:
0.9858
Epoch 32: val_accuracy did not improve from 0.96354
38/38 [==============================] - 31s 800ms/step - loss: 0.0508 -
accuracy: 0.9858 - val_loss: 0.1680 - val_accuracy: 0.9479
Epoch 33/50
38/38 [==============================] - ETA: 0s - loss: 0.0586 - accuracy:
0.9759
Epoch 33: val_accuracy did not improve from 0.96354
38/38 [==============================] - 33s 874ms/step - loss: 0.0586 -
accuracy: 0.9759 - val_loss: 0.1134 - val_accuracy: 0.9583
Epoch 34/50
38/38 [==============================] - ETA: 0s - loss: 0.0387 - accuracy:
0.9867
Epoch 34: val_accuracy did not improve from 0.96354
38/38 [==============================] - 31s 804ms/step - loss: 0.0387 -
accuracy: 0.9867 - val_loss: 0.1662 - val_accuracy: 0.9583
Epoch 35/50
38/38 [==============================] - ETA: 0s - loss: 0.0561 - accuracy:
0.9775
Epoch 35: val_accuracy did not improve from 0.96354
38/38 [==============================] - 31s 824ms/step - loss: 0.0561 -
accuracy: 0.9775 - val_loss: 0.1294 - val_accuracy: 0.9427
Epoch 36/50
38/38 [==============================] - ETA: 0s - loss: 0.0510 - accuracy:
0.9808
Epoch 36: val_accuracy did not improve from 0.96354
38/38 [==============================] - 33s 868ms/step - loss: 0.0510 -
accuracy: 0.9808 - val_loss: 0.3712 - val_accuracy: 0.9427
Epoch 37/50
38/38 [==============================] - ETA: 0s - loss: 0.0560 - accuracy:
0.9825
Epoch 37: val_accuracy did not improve from 0.96354
38/38 [==============================] - 34s 901ms/step - loss: 0.0560 -
```

```
accuracy: 0.9825 - val_loss: 0.1819 - val_accuracy: 0.9479
Epoch 38/50
38/38 [==============================] - ETA: 0s - loss: 0.0499 - accuracy:
0.9825
Epoch 38: val_accuracy did not improve from 0.96354
38/38 [==============================] - 36s 945ms/step - loss: 0.0499 -
accuracy: 0.9825 - val_loss: 0.1020 - val_accuracy: 0.9583
Epoch 39/50
38/38 [==============================] - ETA: 0s - loss: 0.0422 - accuracy:
0.9875
Epoch 39: val_accuracy improved from 0.96354 to 0.98438, saving model to
yawn_detection1.h5
38/38 [==============================] - 35s 912ms/step - loss: 0.0422 -
accuracy: 0.9875 - val_loss: 0.0598 - val_accuracy: 0.9844
Epoch 40/50
38/38 [==============================] - ETA: 0s - loss: 0.0516 - accuracy:
0.9825
Epoch 40: val_accuracy did not improve from 0.98438
38/38 [==============================] - 39s 1s/step - loss: 0.0516 - accuracy:
0.9825 - val_loss: 0.0892 - val_accuracy: 0.9635
Epoch 41/50
38/38 [==============================] - ETA: 0s - loss: 0.0485 - accuracy:
0.9842
Epoch 41: val_accuracy did not improve from 0.98438
38/38 [==============================] - 34s 887ms/step - loss: 0.0485 -
accuracy: 0.9842 - val_loss: 0.0694 - val_accuracy: 0.9740
Epoch 42/50
38/38 [==============================] - ETA: 0s - loss: 0.0430 - accuracy:
0.9850
Epoch 42: val_accuracy did not improve from 0.98438
38/38 [==============================] - 32s 843ms/step - loss: 0.0430 -
accuracy: 0.9850 - val_loss: 0.0722 - val_accuracy: 0.9688
Epoch 43/50
38/38 [==============================] - ETA: 0s - loss: 0.0360 - accuracy:
0.9900
Epoch 43: val_accuracy did not improve from 0.98438
38/38 [==============================] - 33s 857ms/step - loss: 0.0360 -
accuracy: 0.9900 - val_loss: 0.1222 - val_accuracy: 0.9583
Epoch 44/50
38/38 [==============================] - ETA: 0s - loss: 0.0298 - accuracy:
0.9908
Epoch 44: val_accuracy did not improve from 0.98438
38/38 [==============================] - 32s 848ms/step - loss: 0.0298 -
accuracy: 0.9908 - val_loss: 0.0817 - val_accuracy: 0.9635
Epoch 45/50
38/38 [==============================] - ETA: 0s - loss: 0.0398 - accuracy:
0.9850
Epoch 45: val_accuracy did not improve from 0.98438
```

```
38/38 [==============================] - 34s 887ms/step - loss: 0.0398 -
accuracy: 0.9850 - val_loss: 0.1144 - val_accuracy: 0.9583
Epoch 46/50
38/38 [==============================] - ETA: 0s - loss: 0.0317 - accuracy:
0.9867
Epoch 46: val_accuracy did not improve from 0.98438
38/38 [==============================] - 32s 845ms/step - loss: 0.0317 -
accuracy: 0.9867 - val_loss: 0.0660 - val_accuracy: 0.9792
Epoch 47/50
38/38 [==============================] - ETA: 0s - loss: 0.0174 - accuracy:
0.9950
Epoch 47: val_accuracy did not improve from 0.98438
38/38 [==============================] - 33s 867ms/step - loss: 0.0174 -
accuracy: 0.9950 - val_loss: 0.0783 - val_accuracy: 0.9844
Epoch 48/50
38/38 [==============================] - ETA: 0s - loss: 0.0162 - accuracy:
0.9942
Epoch 48: val_accuracy did not improve from 0.98438
38/38 [==============================] - 33s 864ms/step - loss: 0.0162 -
accuracy: 0.9942 - val_loss: 0.0794 - val_accuracy: 0.9844
Epoch 49/50
38/38 [==============================] - ETA: 0s - loss: 0.0322 - accuracy:
0.9867
Epoch 49: val_accuracy did not improve from 0.98438
38/38 [==============================] - 33s 876ms/step - loss: 0.0322 -
accuracy: 0.9867 - val_loss: 0.0577 - val_accuracy: 0.9688
Epoch 50/50
38/38 [==============================] - ETA: 0s - loss: 0.0258 - accuracy:
0.9900
Epoch 50: val_accuracy did not improve from 0.98438
38/38 [==============================] - 32s 838ms/step - loss: 0.0258 -
accuracy: 0.9900 - val_loss: 0.0824 - val_accuracy: 0.9688
```

[17]:
```
plt.figure(figsize=(20,10))
plt.subplot(1, 2, 1)
plt.suptitle('Optimizer : Adam', fontsize=10)
plt.ylabel('Loss', fontsize=16)
plt.plot(history.history['loss'], label='Training Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.legend(loc='upper right')

plt.subplot(1, 2, 2)
plt.ylabel('Accuracy', fontsize=16)
plt.plot(history.history['accuracy'], label='Training Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.legend(loc='lower right')
plt.show()
```



[11]:
```
img=image.load_img(r"C:\Users\ajars\Downloads\photo_2023-11-19_23-03-42.jpg",␣
↪target_size= (256,256), color_mode="grayscale")
x=image.img_to_array(img)
x=np.expand_dims(x,axis=0)
```

[15]:
```
pred=np.argmax(model.predict(x))
pred
```

```
1/1 [==============================] - 0s 28ms/step
```

[15]:
```
1
```

[16]:
```
if pred < 0.5:
    print("no yawn")
else:
    print("yawn")
```

```
yawn
```

[ ]:
```

```