Data Collection

In [1]:

```
from pydrive.auth import GoogleAuth
from pydrive.drive import GoogleDrive
from google.colab import auth
from oauth2client.client import GoogleCredentials

auth.authenticate_user()
gauth = GoogleAuth()
gauth.credentials = GoogleCredentials.get_application_default()
drive = GoogleDrive(gauth)

file_id = '1WkCyl3kFta2GwV2ZJes0ZNNFNbfBl1LE'

# YD_dataset 1WkCyl3kFta2GwV2ZJes0ZNNFNbfBl1LE
# Yawn_dataset 1LE3BHEpRuIDe-yedGriGg1Ix6_ZliEsp
downloaded = drive.CreateFile({'id': file_id})
downloaded.GetContentFile('yawn_dataset.zip')
```

In [2]:

```
!unzip yawn_dataset.zip
```

```
Archive:  yawn_dataset.zip
   creating: YD_dataset/test/
   creating: YD_dataset/test/no_yawn/
  inflating: YD_dataset/test/no_yawn/1004.jpg
  inflating: YD_dataset/test/no_yawn/1007.jpg
  inflating: YD_dataset/test/no_yawn/1010.jpg
  inflating: YD_dataset/test/no_yawn/1033.jpg
  inflating: YD_dataset/test/no_yawn/1044.jpg
  inflating: YD_dataset/test/no_yawn/1050.jpg
  inflating: YD_dataset/test/no_yawn/1063.jpg
  inflating: YD_dataset/test/no_yawn/1067.jpg
  inflating: YD_dataset/test/no_yawn/1096.jpg
  inflating: YD_dataset/test/no_yawn/1114.jpg
  inflating: YD_dataset/test/no_yawn/1118.jpg
  inflating: YD_dataset/test/no_yawn/1129.jpg
  inflating: YD_dataset/test/no_yawn/113.jpg
  inflating: YD_dataset/test/no_yawn/1134.jpg
  inflating: YD_dataset/test/no_yawn/115.jpg
  inflating: YD_dataset/test/no_yawn/1213.jpg
```

Data Augmentation

In [4]:

```
import numpy as  np
import pandas as pd

train = pd.read_csv('csv_dataset.csv')
train
```

Out[4]:

	image_names	yawn_or_not
0	YD_dataset/train/yawn/1.jpg	1
1	YD_dataset/train/yawn/10.jpg	1
2	YD_dataset/train/yawn/101.jpg	1
3	YD_dataset/train/yawn/103.jpg	1
4	YD_dataset/train/yawn/104.jpg	1
...	...	...
1443	YD_dataset/train/no_yawn/992.jpg	0
1444	YD_dataset/train/no_yawn/993.jpg	0
1445	YD_dataset/train/no_yawn/994.jpg	0
1446	YD_dataset/train/no_yawn/997.jpg	0
1447	YD_dataset/train/no_yawn/998.jpg	0

1448 rows × 2 columns

In [5]:

```
from skimage.io import imread
from skimage.transform import resize
import matplotlib.pyplot as plt
%matplotlib inline



train_img = []
for img_name in train['image_names']:
    # defining the image path
    image_path = '/content/' + img_name
    # reading the image
    img = imread(image_path)
    # normalizing the pixel values
    img = img/255
    # resizing the image to (224,224,3)
    img = resize(img, output_shape=(224,224,3), mode='constant', anti_aliasing=True)
    # converting the type of pixel to float 32
    img = img.astype('float32')
    # appending the image into the list
    train_img.append(img)

images = np.array(train_img)
images.shape
```

Out[5]:

```
(1448, 224, 224, 3)
```

In [6]:

```
labels = train['yawn_or_not'].values
labels.shape
```

Out[6]:

```
(1448,)
```

In [7]:

```
labels
```

Out[7]:

```
array([1, 1, 1, ..., 0, 0, 0])
```

In [8]:

```
from sklearn.model_selection import train_test_split
Xtrain,Xtest,Ytrain,Ytest = train_test_split(images,labels, test_size = 0.148, random_state
(Xtrain.shape, Ytrain.shape), (Xtest.shape, Ytest.shape)
```

Out[8]:

```
(((1233, 224, 224, 3), (1233,)), ((215, 224, 224, 3), (215,)))
```

In [9]:

```
Ytest_bin = Ytest
Ytest_bin
```

Out[9]:

```
array([0, 1, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 0, 1, 0, 1, 1, 0,
       1, 1, 1, 0, 0, 1, 0, 1, 0, 0, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 0, 1,
       1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 1, 1, 0, 0, 1, 0, 1, 0, 0, 0,
       0, 1, 1, 1, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0, 1, 0, 1,
       1, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 1, 1, 0, 0, 0, 1, 1, 1, 1, 0,
       1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 1, 1, 0,
       1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 0, 1, 0, 0,
       1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1,
       0, 0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1,
       1, 1, 0, 0, 0, 0, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1])
```

Building model architecture

In [10]:

```
import tensorflow as tf
from keras.models import Sequential
from keras import layers
from keras.layers import Conv2D, MaxPooling2D, Dropout, Flatten, Dense, Activation,GlobalMa
from keras import applications
from keras.applications import VGG16
from keras.models import Model
from keras import optimizers


pretrained_model = VGG16(include_top=False, weights='imagenet')
pretrained_model.summary()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applic
ations/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels_notop.h5 (https://stor
age.googleapis.com/tensorflow/keras-applications/vgg16/vgg16_weights_tf_dim_
ordering_tf_kernels_notop.h5)
58892288/58889256 [==============================] - 0s 0us/step
Model: "vgg16"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_1 (InputLayer)         [(None, None, None, 3)]   0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, None, None, 64)    1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, None, None, 64)    36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, None, None, 64)    0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, None, None, 128)   73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, None, None, 128)   147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, None, None, 128)   0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, None, None, 256)   295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, None, None, 256)   590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, None, None, 256)   590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, None, None, 256)   0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, None, None, 512)   1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, None, None, 512)   2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, None, None, 512)   2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, None, None, 512)   0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, None, None, 512)   2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, None, None, 512)   2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, None, None, 512)   2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, None, None, 512)   0
```

```
=================================================================
Total params: 14,714,688
Trainable params: 14,714,688
Non-trainable params: 0
_________________________________________________________________
```

In [11]:

```
from keras.utils import to_categorical


vgg_features_train = pretrained_model.predict(Xtrain)
vgg_features_val  = pretrained_model.predict(Xtest)

train_target = to_categorical(Ytrain)
val_target = to_categorical(Ytest)
```

Model Training

In [12]:

```
model = Sequential()
model.add(Flatten(input_shape=(7,7,512)))
model.add(Dense(100, activation='relu'))
model.add(Dropout(0.5))
model.add(BatchNormalization())
model.add(Dense(2, activation='softmax'))

# compile the model
model.compile(optimizer='adam', metrics=['accuracy'], loss='categorical_crossentropy')

model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
flatten (Flatten)            (None, 25088)             0
_________________________________________________________________
dense (Dense)                (None, 100)               2508900
_________________________________________________________________
dropout (Dropout)            (None, 100)               0
_________________________________________________________________
batch_normalization (BatchNo (None, 100)               400
_________________________________________________________________
dense_1 (Dense)              (None, 2)                 202
=================================================================
Total params: 2,509,502
Trainable params: 2,509,302
Non-trainable params: 200
_________________________________________________________________
```

In [13]:

```
from keras.callbacks import ModelCheckpoint

checkpoint = ModelCheckpoint("model_weights.h5", monitor='val_accuracy', verbose=1, save_be
callbacks_list = [checkpoint]
```

In [14]:

```
training = model2.fit(vgg_features_train, train_target,callbacks=callbacks_list, epochs=50,
```

```
Epoch 00045: val_accuracy did not improve from 0.98605
Epoch 46/50
39/39 [==============================] - 0s 5ms/step - loss: 0.0550 - accu
racy: 0.9842 - val_loss: 0.0623 - val_accuracy: 0.9860

Epoch 00046: val_accuracy did not improve from 0.98605
Epoch 47/50
39/39 [==============================] - 0s 5ms/step - loss: 0.0635 - accu
racy: 0.9851 - val_loss: 0.0991 - val_accuracy: 0.9628


Epoch 00047: val_accuracy did not improve from 0.98605
Epoch 48/50
39/39 [==============================] - 0s 5ms/step - loss: 0.0639 - accu
racy: 0.9796 - val_loss: 0.0782 - val_accuracy: 0.9814

Epoch 00048: val_accuracy did not improve from 0.98605
Epoch 49/50
39/39 [==============================] - 0s 5ms/step - loss: 0.0583 - accu
racy: 0.9831 - val_loss: 0.0653 - val_accuracy: 0.9814
```

Model Evaluation

In [15]:

```
training.history.keys()
```

Out[15]:

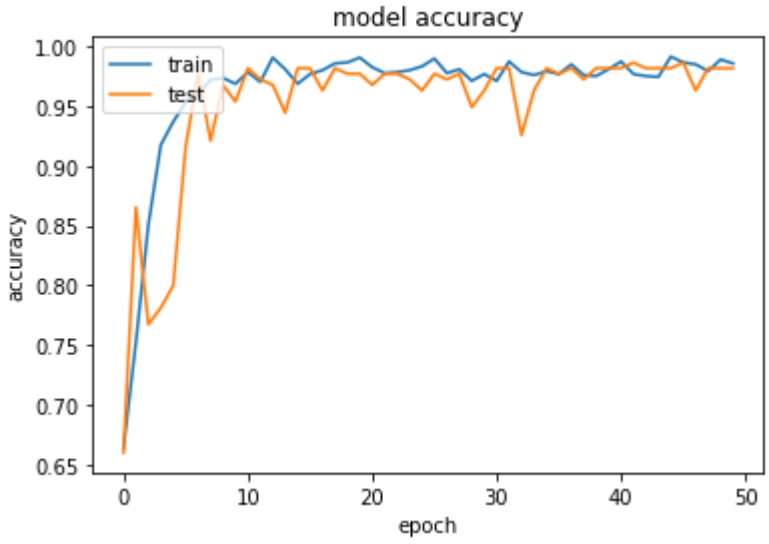
```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```

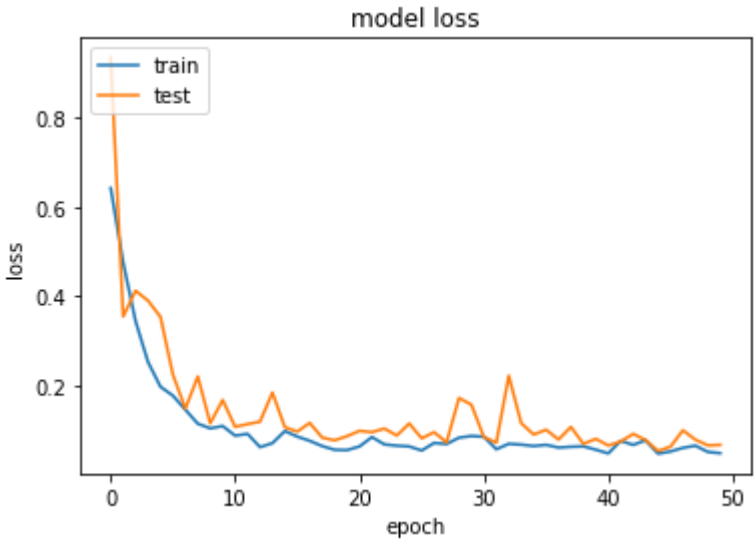
In [16]:

```
import matplotlib.pyplot as plt

# summarize training for accuracy
plt.plot(training.history['accuracy'])
plt.plot(training.history['val_accuracy'])
plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train','test'], loc='upper left')
plt.show()

# summarize traning for loss
plt.plot(training.history['loss'])
plt.plot(training.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train','test'], loc='upper left')
plt.show()
```





In [17]:

```
result = model2.evaluate(vgg_features_val,val_target,verbose=1)

print("test loss : ",result[0])
print("test acc. :",result[1])
```

```
7/7 [==============================] - 0s 3ms/step - loss: 0.0664 - accurac
y: 0.9814
test loss :  0.066448874771595
test acc. : 0.9813953638076782
```

In [18]:

```
predictions= model2.predict(vgg_features_val,verbose=1)
predicted_classes = np.argmax(predictions,axis=1)
```

```
7/7 [==============================] - 0s 3ms/step
```

In [19]:

```
predicted_classes.shape
```

Out[19]:

```
(215,)
```

In [20]:

```
val_target.shape
```

Out[20]:

```
(215, 2)
```

In [21]:

```
from sklearn.metrics import confusion_matrix,classification_report,accuracy_score

print(accuracy_score(Ytest_bin,predicted_classes))
```

```
0.9813953488372092
```

In [22]:

```
print(confusion_matrix(Ytest_bin,predicted_classes))
```

```
[[101   1]
 [  3 110]]
```

In [23]:

```
print(classification_report(Ytest_bin,predicted_classes,target_names=["yawn","no_yawn"]))
```

```
              precision    recall  f1-score   support

        yawn       0.97      0.99      0.98       102
     no_yawn       0.99      0.97      0.98       113

    accuracy                           0.98       215
   macro avg       0.98      0.98      0.98       215
weighted avg       0.98      0.98      0.98       215
```

In [24]:

```
from sklearn.metrics import roc_curve,roc_auc_score

roc_auc_score(Ytest_bin,predicted_classes)
```

Out[24]:

```
0.9818237029325004
```

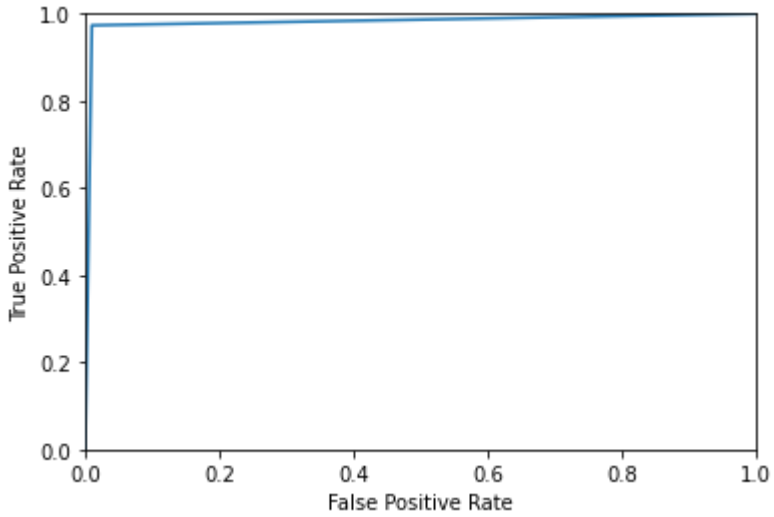
In [25]:

```
fpr , tpr , thresholds = roc_curve(Ytest_bin,predicted_classes)


import matplotlib.pyplot as plt

def plot_roc_curve(fpr,tpr):
  plt.plot(fpr,tpr)
  plt.axis([0,1,0,1])
  plt.xlabel('False Positive Rate')
  plt.ylabel('True Positive Rate')
  plt.show()

plot_roc_curve(fpr,tpr)
```



Saving model

In [26]:

```
model_json = model.to_json()
with open("model.json", "w") as json_file:
    json_file.write(model_json)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-26-0854fc6c373d> in <module>()
----> 1 model_json = model.to_json()
      2 with open("model.json", "w") as json_file:
      3     json_file.write(model_json)

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

In [ ]:

```
model.save("Yawn_classifier.model")
```

In [ ]:

```
!zip -r /content/model.zip /content/Yawn_classifier.model
```

In [ ]:

```
"""
!wget http://skulddata.cs.umass.edu/traces/mmsys/2014/user06.tar
!tar -xvf /content/user06.tar
!pip install patool
!pip install unrar
import patoolib
patoolib.extract_archive("/content/user06/YawDD dataset.rar", outdir="/content/")
"""
```