CSCE636 Project Part V

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PART I TOPIC

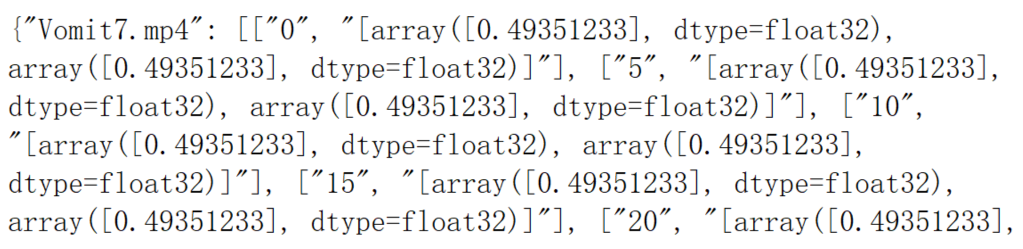
The purpose of the project is to train a neural network so it could be applied to video detection in the future smart home environment. The topic assigned to me is “detecting vomit”.

In the Part IV submission, the network is trained and the trained model is generated. The video used for testing the accuracy of the generated model is interpreted and each frame of the video is tested to get the probability of vomiting.

PART II EXISTING PROBLEMS

In the Part IV, although I could generate the model and predict the input video, the .json file is not correct.

As shown below, the probability of vomiting stays the same.

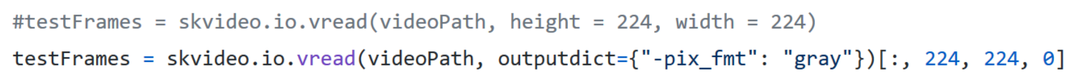


```
{"Vomit7.mp4": [["0", "[array([0.49351233], dtype=float32),
array([0.49351233], dtype=float32)]"], ["5", "[array([0.49351233],
dtype=float32), array([0.49351233], dtype=float32)]"], ["10",
"[array([0.49351233], dtype=float32), array([0.49351233],
dtype=float32)]"], ["15", "[array([0.49351233], dtype=float32),
array([0.49351233], dtype=float32)]"], ["20", "[array([0.49351233],
```

At first, I thought it’s because the video is too short and the differences between the frames is too subtle so the prediction stays the same. Then I change several input videos but the prediction stays the same.

To find out if I saved and loaded the trained model correctly, I change the epochs and learning rate of the training process to get a new model. The probability changes as I change the parameters but the probability of different frames still stays the same. Which indicates that the model is saved and loaded correctly.

After testing I found out there is a dimension mismatching while I was using the module skvideo (the code which caused error is shown below). I searched for the solution but it seems that skvideo is out of date and there is no more updates.



```
#testFrames = skvideo.io.vread(videoPath, height = 224, width = 224)
testFrames = skvideo.io.vread(videoPath, outputdict={"-pix_fmt": "gray"})[:, 224, 224, 0]
```

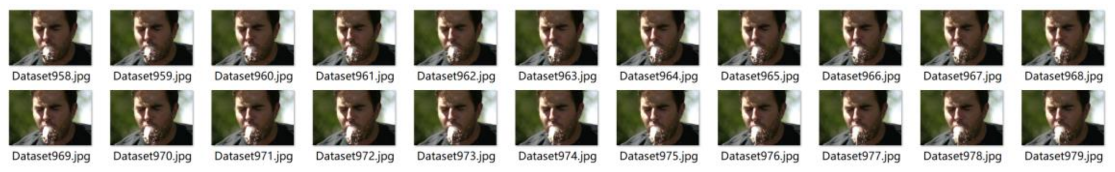
So one of the most important improvements I made is that I find out the problem which causes the wrong output .json file. After changing the video capture module to opencv2 and resizing the images I get, the json file seems correct for now.

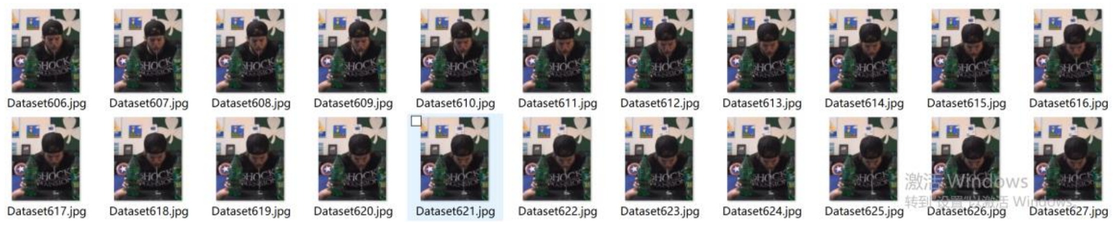
Another problem is that the training set is still too small. Previously, the videos I found contains a vomiting face, however later I realized that in a smart home, the camera usually captures your whole body and gesture, so I add more images which include the whole body of a vomiting person.

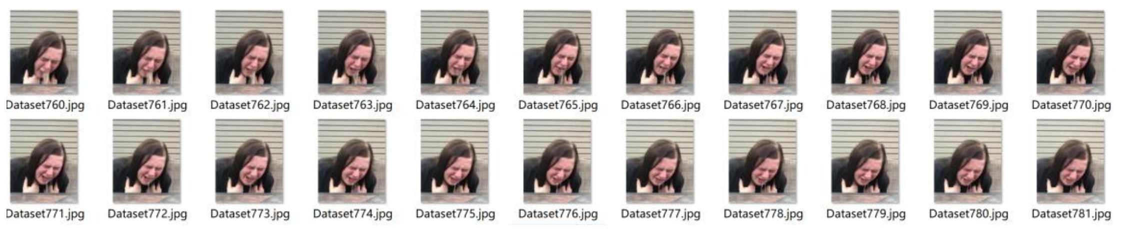
PART III DATASET

Since the topic is a little weird, I looked through the training dataset and I couldn't find related videos/images which I could make use of. I searched Youtube and most of the uploaded videos don't have any actual vomit scene. I managed to find several videos and transfer them into images. By sorting and labeling the images I get a preliminary dataset which could be used for training the network.

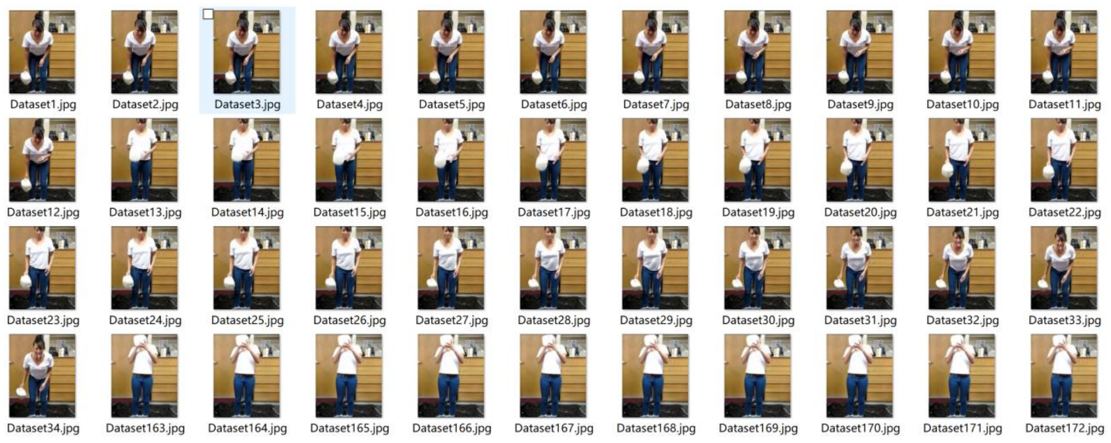
Shown below are parts of the images used for training in the Part IV, most of them are vomiting faces.







Shown below are parts of the images I added to the training dataset.



Since the images contain the whole body of a vomiting person, the trained network would be more accurate while dealing with videos captured by the cameras in a smart home.

By enlarging the training dataset, the prediction would be more accurate theoretically.

	Training Dataset
# of Vomit Images	784
# of Non-vomit Images	319
# of All Images	1103

Although the dataset is not ideal, the number of the videos and images could be enlarged for the future submissions.

PART IV ARCHITECTURE IMPROVEMENTS

Previously there are over fitting problems, but as I added the epochs and the number of layers, the over fitting problem is solved. Also I resize the image to 64 since the resized 32 doesn’t work well for images which include the whole body of a person.

Privious input shape of tensor:

X_train shape is (1004,32,32)

Y_train shape is (216,32,32)

Previous output shape of tensor:

x_train shape is (1004,32,32)

y_train shape is (216,32,32)

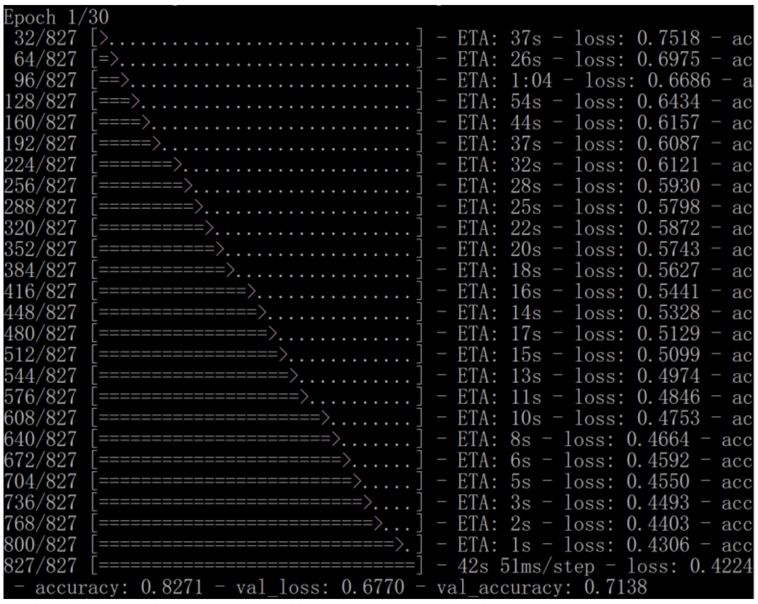
New input shape of tensor:

X_train shape is (827,64,64)

Y_train shape is (276,64,64)

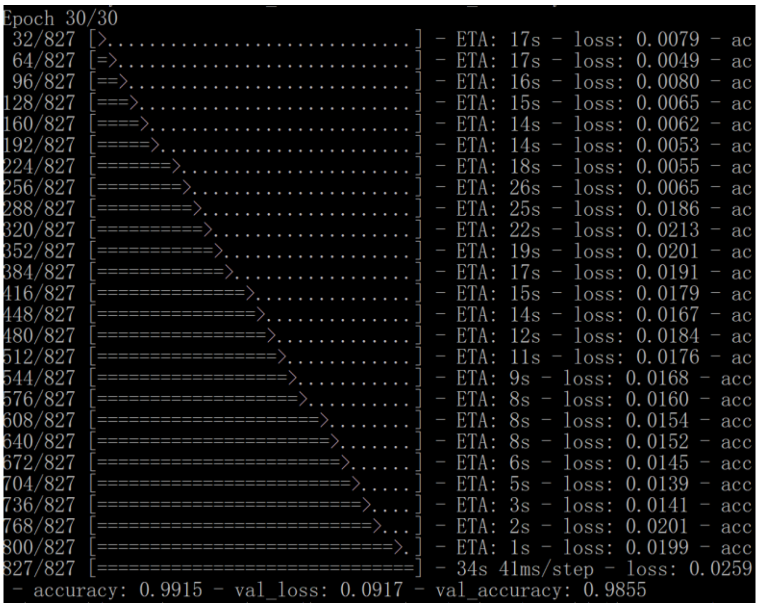
The parameters I attempted to tune include epochs and batch size. The epoch I am using for optimization is 30. The new batch size I am using is 32.

Testing performance of the first epoch is shown below:



```
Epoch 1/30
 32/827 [>.............................] - ETA: 37s - loss: 0.7518 - ac
 64/827 [=>............................] - ETA: 26s - loss: 0.6975 - ac
 96/827 [==>...........................] - ETA: 1:04 - loss: 0.6686 - a
128/827 [===>..........................] - ETA: 54s - loss: 0.6434 - ac
160/827 [====>.........................] - ETA: 44s - loss: 0.6157 - ac
192/827 [=====>........................] - ETA: 37s - loss: 0.6087 - ac
224/827 [=======>......................] - ETA: 32s - loss: 0.6121 - ac
256/827 [========>.....................] - ETA: 28s - loss: 0.5930 - ac
288/827 [=========>....................] - ETA: 25s - loss: 0.5798 - ac
320/827 [==========>...................] - ETA: 22s - loss: 0.5872 - ac
352/827 [===========>..................] - ETA: 20s - loss: 0.5743 - ac
384/827 [============>.................] - ETA: 18s - loss: 0.5627 - ac
416/827 [==============>...............] - ETA: 16s - loss: 0.5441 - ac
448/827 [===============>..............] - ETA: 14s - loss: 0.5328 - ac
480/827 [================>.............] - ETA: 17s - loss: 0.5129 - ac
512/827 [=================>............] - ETA: 15s - loss: 0.5099 - ac
544/827 [==================>...........] - ETA: 13s - loss: 0.4974 - ac
576/827 [===================>..........] - ETA: 11s - loss: 0.4846 - ac
608/827 [=====================>........] - ETA: 10s - loss: 0.4753 - ac
640/827 [======================>.......] - ETA: 8s - loss: 0.4664 - acc
672/827 [=======================>......] - ETA: 6s - loss: 0.4592 - acc
704/827 [========================>.....] - ETA: 5s - loss: 0.4550 - acc
736/827 [=========================>....] - ETA: 3s - loss: 0.4493 - acc
768/827 [==========================>...] - ETA: 2s - loss: 0.4403 - acc
800/827 [============================>.] - ETA: 1s - loss: 0.4306 - acc
827/827 [==============================] - 42s 51ms/step - loss: 0.4224
 - accuracy: 0.8271 - val_loss: 0.6770 - val_accuracy: 0.7138
```

Testing performance of the last (30th) epoch is shown below:



```
Epoch 30/30
 32/827 [>.............................] - ETA: 17s - loss: 0.0079 - ac
 64/827 [=>............................] - ETA: 17s - loss: 0.0049 - ac
 96/827 [==>...........................] - ETA: 16s - loss: 0.0080 - ac
128/827 [===>..........................] - ETA: 15s - loss: 0.0065 - ac
160/827 [====>.........................] - ETA: 14s - loss: 0.0062 - ac
192/827 [=====>........................] - ETA: 14s - loss: 0.0053 - ac
224/827 [=======>......................] - ETA: 18s - loss: 0.0055 - ac
256/827 [========>.....................] - ETA: 26s - loss: 0.0065 - ac
288/827 [=========>....................] - ETA: 25s - loss: 0.0186 - ac
320/827 [==========>...................] - ETA: 22s - loss: 0.0213 - ac
352/827 [===========>..................] - ETA: 19s - loss: 0.0201 - ac
384/827 [============>.................] - ETA: 17s - loss: 0.0191 - ac
416/827 [==============>...............] - ETA: 15s - loss: 0.0179 - ac
448/827 [===============>..............] - ETA: 14s - loss: 0.0167 - ac
480/827 [================>.............] - ETA: 12s - loss: 0.0184 - ac
512/827 [=================>............] - ETA: 11s - loss: 0.0176 - ac
544/827 [==================>...........] - ETA: 9s - loss: 0.0168 - acc
576/827 [===================>..........] - ETA: 8s - loss: 0.0160 - acc
608/827 [=====================>........] - ETA: 8s - loss: 0.0154 - acc
640/827 [======================>.......] - ETA: 8s - loss: 0.0152 - acc
672/827 [=======================>......] - ETA: 6s - loss: 0.0145 - acc
704/827 [========================>.....] - ETA: 5s - loss: 0.0139 - acc
736/827 [=========================>....] - ETA: 3s - loss: 0.0141 - acc
768/827 [==========================>...] - ETA: 2s - loss: 0.0201 - acc
800/827 [============================>.] - ETA: 1s - loss: 0.0199 - acc
827/827 [==============================] - 34s 41ms/step - loss: 0.0259
 - accuracy: 0.9915 - val_loss: 0.0917 - val_accuracy: 0.9855
```

In the previous network training process, the loss is 0.6733 and the accuracy is 72.33%. However as for now, the accuracy is 0.9915 and the loss is 0.0917.

PART V CODE

Shown below is the structure of the network:

```
model.add(Conv2D(32, (3, 3), padding="same",
    input_shape=inputShape,kernel_initializer=TruncatedNormal(mean=0.0, stddev=0.01)))
model.add(Activation("relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(MaxPooling2D(pool_size=(2, 2)))
#model.add(Dropout(0.25))

model.add(Conv2D(64, (3, 3), padding="same",kernel_initializer=TruncatedNormal(mean=0.0, stddev=0.01)))
model.add(Activation("relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(64, (3, 3), padding="same",kernel_initializer=TruncatedNormal(mean=0.0, stddev=0.01)))
model.add(Activation("relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(MaxPooling2D(pool_size=(2, 2)))
#model.add(Dropout(0.25))

model.add(Conv2D(128, (3, 3), padding="same",kernel_initializer=TruncatedNormal(mean=0.0, stddev=0.01)))
model.add(Activation("relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(128, (3, 3), padding="same",kernel_initializer=TruncatedNormal(mean=0.0, stddev=0.01)))
model.add(Activation("relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(128, (3, 3), padding="same",kernel_initializer=TruncatedNormal(mean=0.0, stddev=0.01)))
model.add(Activation("relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(MaxPooling2D(pool_size=(2, 2)))
#model.add(Dropout(0.25))

model.add(Flatten())
model.add(Dense(512,kernel_initializer=TruncatedNormal(mean=0.0, stddev=0.01)))
model.add(Activation("relu"))
model.add(BatchNormalization())
model.add(Dropout(0.6))

model.add(Dense(classes,kernel_initializer=TruncatedNormal(mean=0.0, stddev=0.01)))
model.add(Activation("softmax"))
```

Shown below is the code used for training the network:

```
data = []
labels = []

imagePaths = sorted(list(getpath.list_images('C:\Vomit\Dataset')))
random.seed(42)
random.shuffle(imagePaths)


for imagePath in imagePaths:
    image = cv2.imread(imagePath)
    image = cv2.resize(image, (64, 64))
    data.append(image)
    label = imagePath.split(os.path.sep)[-2]
    #print(label)
    labels.append(label)


data = np.array(data, dtype="float") / 255.0
labels = np.array(labels)


(trainX, testX, trainY, testY) = train_test_split(data,labels, test_size=0.25, random_state=42)
```

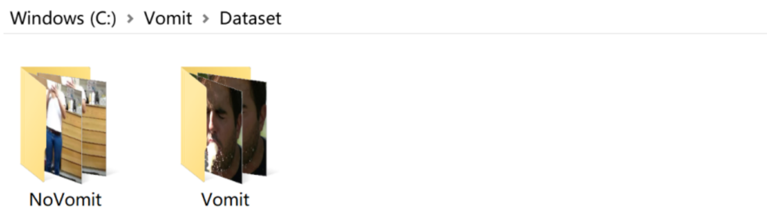
```
lb = LabelBinarizer()
trainY = lb.fit_transform(trainY)
testY = lb.transform(testY)


aug = ImageDataGenerator(rotation_range=30, width_shift_range=0.1,
    height_shift_range=0.1, shear_range=0.2, zoom_range=0.2,
    horizontal_flip=True, fill_mode="nearest")

model = SimpleVGGNet.build(width=64, height=64, depth=3,classes=len(lb.classes_))

INIT_LR = 0.01
EPOCHS = 30
BS = 32

opt = SGD(lr=INIT_LR, decay=INIT_LR / EPOCHS)
model.compile(loss="sparse_categorical_crossentropy", optimizer=opt,metrics=["accuracy"])
'''
H = model.fit_generator(aug.flow(trainX, trainY, batch_size=BS),
    validation_data=(testX, testY), steps_per_epoch=len(trainX)//BS,
    epochs=EPOCHS)
'''

H = model.fit(trainX, trainY, validation_data=(testX, testY),
    epochs=EPOCHS, batch_size=32)

predictions = model.predict(testX, batch_size=32)
print(classification_report(testY.argmax(axis=1),
    predictions.argmax(axis=1), target_names=lb.classes_))

N = np.arange(0, EPOCHS)
plt.style.use("ggplot")
plt.figure()
plt.plot(N, H.history["loss"], label="train_loss")
plt.plot(N, H.history["val_loss"], label="val_loss")
plt.plot(N, H.history["accuracy"], label="train_acc")
plt.plot(N, H.history["val_accuracy"], label="val_acc")

plt.xlabel("Epoch #")
plt.ylabel("Loss/Accuracy")
plt.legend()
plt.savefig('./cnn_plot.png')

model.save('./cnn.model')
f = open('./cnn_lb.pickle', "wb")
f.write(pickle.dumps(lb))
f.close()
```

Shown below is the code used for predicting the input video:

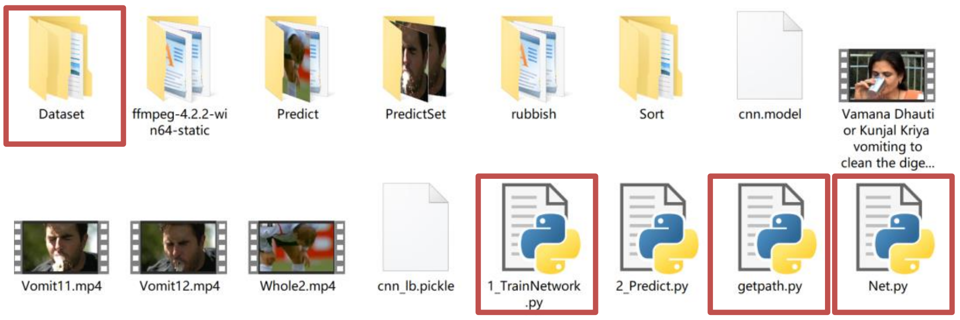
```
model = load_model('./cnn.model')
lb = pickle.loads(open('./cnn_lb.pickle', "rb").read())
fileJson = {}
fileJson["Vomit10.mp4"] = []

import cv2
vc=cv2.VideoCapture("Vomit10.mp4")
c=1
if vc.isOpened():
      rval,frame=vc.read()
else:
      rval=False
while rval:
      cv2.imwrite('C:\\Vomit\\PredictSet\\Predict'+str(c)+'.jpg',frame)
      rval,frame=vc.read()
      image = cv2.imread('C:\\Vomit\\PredictSet\\Predict'+str(c)+'.jpg')
      output = image.copy()
      image = cv2.resize(image, (64, 64))
      image = image.astype("float") / 255.0
      image = image.reshape((1, image.shape[0],
      image.shape[1],image.shape[2]))
      preds = model.predict(image)
      i = preds.argmax(axis=1)[0]
      label = lb.classes_[i]
      text = "{}: {:.2f}%".format(label, preds[0][i] * 100)
      fileJson["Vomit10.mp4"].append([str(c),str([preds[0][0],preds[0][1]])])

      c=c+1
      cv2.waitKey(1)
vc.release()

import json

with open("File.json", "w") as outfile:
    json.dump(fileJson, outfile)

fileJson
```

PART VI IMPLEMENTATION

To train the model, create a folder which contains sorted training data (as shown below). The training set is divided into two folders, one contains images in which the person is vomiting, while the other one contains images in which the person is not vomiting.

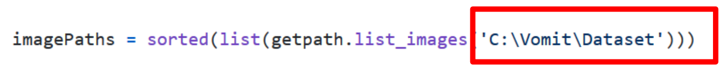


The necessary files include: ./Dataset; 1_TrainNetwork.py; Net.py; getpath.py



To change the network structure, edit Net.py
To train the network, use the demand:
python 1_TrainNetwork.py

Need to notice, the file path of Dataset should be edited in file 1_TrainNetwork.py

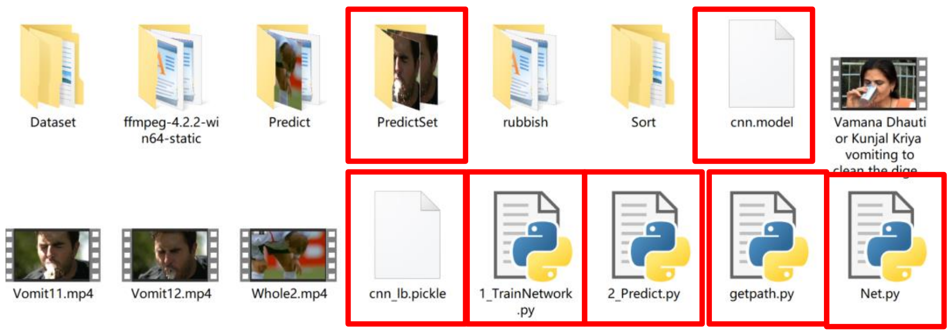


```
imagePaths = sorted(list(getpath.list_images('C:\Vomit\Dataset')))
```

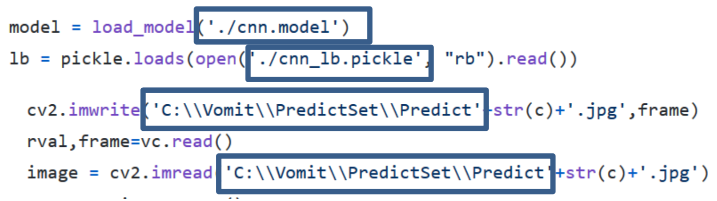
If the file cnn.model and the cnn_lb.pickle are generated then the model is trained and saved successfully.

To use the trained network model and predict an input video, use the demand:
python 2_Predict.py

The necessary files include: ./Predictset; 1_TrainNetwork.py; 2_Predict.py; Net.py; getpath.py; cnn.model; cnn_lb.pickle



Need to notice, the file path of the model and the input video should be edited in file 2_Predict.py

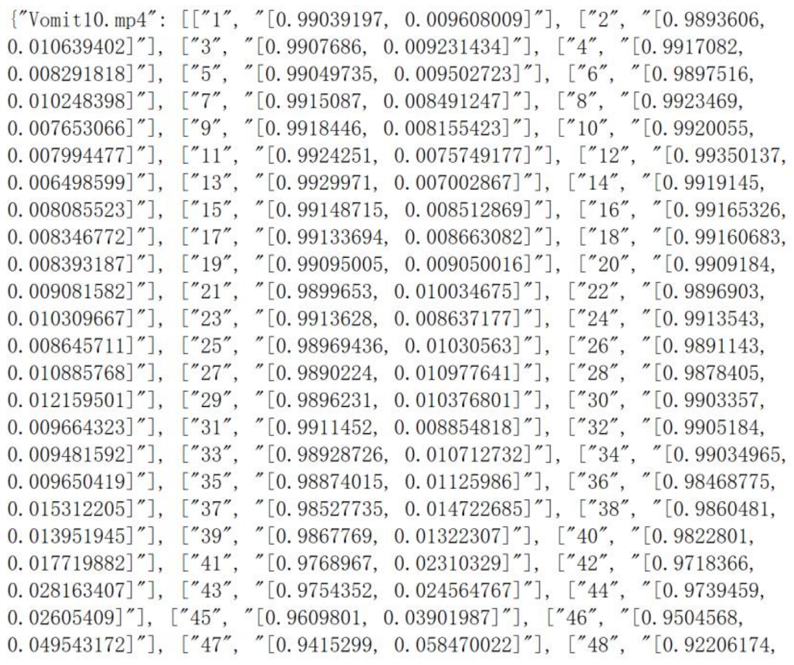


```
model = load_model('./cnn.model')
lb = pickle.loads(open('./cnn_lb.pickle', "rb").read())

  cv2.imwrite('C:\\Vomit\\PredictSet\\Predict'+str(c)+'.jpg',frame)
  rval,frame=vc.read()
  image = cv2.imread('C:\\Vomit\\PredictSet\\Predict'+str(c)+'.jpg')
```

Since the model is too large to be uploaded to Github, the model is uploaded to Google Drive for accessing.

PART VII RESULTS

The generated json file for input video Vomit10.mp4 is like:



```
{"Vomit10.mp4": [["1", "[0.99039197, 0.009608009]"], ["2", "[0.9893606,
0.010639402]"], ["3", "[0.9907686, 0.009231434]"], ["4", "[0.9917082,
0.008291818]"], ["5", "[0.99049735, 0.009502723]"], ["6", "[0.9897516,
0.010248398]"], ["7", "[0.9915087, 0.008491247]"], ["8", "[0.9923469,
0.007653066]"], ["9", "[0.9918446, 0.008155423]"], ["10", "[0.9920055,
0.007994477]"], ["11", "[0.9924251, 0.0075749177]"], ["12", "[0.99350137,
0.006498599]"], ["13", "[0.9929971, 0.007002867]"], ["14", "[0.9919145,
0.008085523]"], ["15", "[0.99148715, 0.008512869]"], ["16", "[0.99165326,
0.008346772]"], ["17", "[0.99133694, 0.008663082]"], ["18", "[0.99160683,
0.008393187]"], ["19", "[0.99095005, 0.009050016]"], ["20", "[0.9909184,
0.009081582]"], ["21", "[0.9899653, 0.010034675]"], ["22", "[0.9896903,
0.010309667]"], ["23", "[0.9913628, 0.008637177]"], ["24", "[0.9913543,
0.008645711]"], ["25", "[0.98969436, 0.01030563]"], ["26", "[0.9891143,
0.010885768]"], ["27", "[0.9890224, 0.010977641]"], ["28", "[0.9878405,
0.012159501]"], ["29", "[0.9896231, 0.010376801]"], ["30", "[0.9903357,
0.009664323]"], ["31", "[0.9911452, 0.008854818]"], ["32", "[0.9905184,
0.009481592]"], ["33", "[0.98928726, 0.010712732]"], ["34", "[0.99034965,
0.009650419]"], ["35", "[0.98874015, 0.01125986]"], ["36", "[0.98468775,
0.015312205]"], ["37", "[0.98527735, 0.014722685]"], ["38", "[0.9860481,
0.013951945]"], ["39", "[0.9867769, 0.01322307]"], ["40", "[0.9822801,
0.017719882]"], ["41", "[0.9768967, 0.02310329]"], ["42", "[0.9718366,
0.028163407]"], ["43", "[0.9754352, 0.024564767]"], ["44", "[0.9739459,
0.02605409]"], ["45", "[0.9609801, 0.03901987]"], ["46", "[0.9504568,
0.049543172]"], ["47", "[0.9415299, 0.058470022]"], ["48", "[0.92206174,
```

[["1", "[0.99039197, 0.009608009]"] indicate that at the first frame, the probability of non-vomiting is 99.039197%, the probability of vomiting is 0.9608009%.

["55", "[0.45397803, 0.54602194]"] indicate that at the 55th frame, the probability of non-vomiting is 45.397803%, the probability of vomiting is 54.602194%.

The generated json file and the corresponding videos are also uploaded to Github.