In [1]:

```
!git clone https://github.com/ksideks/UCSD.git
```

```
fatal: docelowa ścieżka „UCSD” już istnieje i nie jest pustym katalogiem.
```

In [2]:

```
!pip install keras-layer-normalization
```

```
Requirement already satisfied: keras-layer-normalization in ./jupyterenv/li
b/python3.8/site-packages (0.15.0)
Requirement already satisfied: Keras in ./jupyterenv/lib/python3.8/site-pac
kages (from keras-layer-normalization) (2.7.0)
Requirement already satisfied: numpy in ./jupyterenv/lib/python3.8/site-pac
kages (from keras-layer-normalization) (1.21.3)
```

In [3]:

```
TestVideoFile = {}
TestVideoFile[1] = range(59,152)
TestVideoFile[2] = range(49,175)
TestVideoFile[3] = range(90,200)
TestVideoFile[4] = range(30,168)
TestVideoFile[5] = list(range(4,90)) + list(range(139,200))
TestVideoFile[6] = list(range(0,100)) + list(range(109,200))
TestVideoFile[7] = range(0,175)
TestVideoFile[8] = range(0,94)
TestVideoFile[9] = range(0,48)
TestVideoFile[10] = range(0,140)
TestVideoFile[11] = range(69,165)
TestVideoFile[12] = range(130,200)
TestVideoFile[13] = range(0,156)
TestVideoFile[14] = range(3,198)  # 0 200
TestVideoFile[15] = range(137,200)
TestVideoFile[16] = range(122,200)
TestVideoFile[17] = range(0,47)
TestVideoFile[18] = range(53,120)
TestVideoFile[19] = range(63,138)
TestVideoFile[20] = range(44,175)
TestVideoFile[21] = range(30,200)
TestVideoFile[22] = range(16,107)
TestVideoFile[23] = range(8,165)
TestVideoFile[24] = range(49,171)
TestVideoFile[25] = range(39,135)
TestVideoFile[26] = range(77,144)
TestVideoFile[27] = range(9,122)
TestVideoFile[28] = range(104,200)
TestVideoFile[29] = list(range(0,15)) + list(range(44,113))
TestVideoFile[30] = range(174,200)
TestVideoFile[31] = range(0,180)
TestVideoFile[32] = list(range(0,52)) + list(range(64,115))
TestVideoFile[33] = range(4,165)
TestVideoFile[34] = range(0,121)
TestVideoFile[35] = range(85,200)
TestVideoFile[36] = range(14,108)
```

In [4]:

```
#imports
from os import listdir
from os.path import isfile, join, isdir
from PIL import Image
import numpy as np
import shelve

import keras
import tensorflow as tf
from keras.layers import Conv2DTranspose, ConvLSTM2D, BatchNormalization, T
from keras.models import Sequential, load_model

from os import listdir
from os.path import isfile, join, isdir
import matplotlib.pyplot as plt
import pandas as pd
from sklearn import metrics
```

```
2021-11-10 19:47:51.170952: W tensorflow/stream_executor/platform/default/d
so_loader.cc:64] Could not load dynamic library 'libcudart.so.11.0'; dlerro
r: libcudart.so.11.0: cannot open shared object file: No such file or direc
tory
2021-11-10 19:47:51.170997: I tensorflow/stream_executor/cuda/cudart_stub.c
c:29] Ignore above cudart dlerror if you do not have a GPU set up on your m
achine.
```

In [5]:

```
class Config:
  DATASET_PATH ="UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Train"
  TEST_PATH ="UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test"
  SINGLE_TEST_PATH = "UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test001"
  SINGLE_TEST_VIDEO_FILE = 1
  BATCH_SIZE =  32
  EPOCHS = 50
  MODEL_PATH = "UCSD/model.hdf5"
  THRESHOLD = 0.95
```

In [6]:

```
def get_clips_by_step(step, frames_list, sequence_size):

    #data pre-processing, one volume has 10 clips, with different steps (1
    volumes = []
    size = len(frames_list)
    clip = np.zeros(shape=(sequence_size, 227, 227, 1))
    cnt = 0
    for start in range(0, step):
        for i in range(start, size, step):
            clip[cnt, :, :, 0] = frames_list[i]
            cnt = cnt + 1
            if cnt == sequence_size:
                volumes.append(np.copy(clip))
                cnt = 0
    return volumes


def get_training_set():
    clips = []
    for f in sorted(listdir(Config.DATASET_PATH)):
        if isdir(join(Config.DATASET_PATH, f)):
            all_frames = []
            for c in sorted(listdir(join(Config.DATASET_PATH, f))):
                if str(join(join(Config.DATASET_PATH, f), c))[-3:] == "tif
                    img = Image.open(join(join(Config.DATASET_PATH, f), c)
                    img = np.array(img, dtype=np.float32) / 256.0
                    all_frames.append(img)
            for stride in range(1, 3):
                clips.extend(get_clips_by_step(step=stride, frames_list=al
    return clips
```

In [7]:

```
def get_model(reload_model=True):

    #model is already saved, there's posibility to retrain it, but not unt
    if not reload_model:
        return load_model(Config.MODEL_PATH,custom_objects={'LayerNormaliza

    #adding print checkpoints to see if model works
    print("starting training")
    training_set = get_training_set()
    training_set = np.array(training_set)
    print("got training set")

    training_set = training_set.reshape(-1,10,227,227,1)

    seq = Sequential()

    #AUTOENCODER --> spatial part

    seq.add(TimeDistributed(Conv2D(128, (11, 11), strides=4, padding="valid
    seq.add(LayerNormalization())
    seq.add(TimeDistributed(Conv2D(64, (5, 5), strides=2, padding="valid",
    seq.add(LayerNormalization())


    # Convolutional Long-short term memory --> temporal part
    seq.add(ConvLSTM2D(64, (3, 3), strides=1, padding="same", return_sequen
    seq.add(LayerNormalization())
    seq.add(ConvLSTM2D(32, (3, 3), strides=1, padding="same", return_sequen
    seq.add(LayerNormalization())
    seq.add(ConvLSTM2D(64, (3, 3), strides=1, padding="same", return_sequen
    seq.add(LayerNormalization())

    # AUTODECODER --> spatial part

    seq.add(TimeDistributed(Conv2DTranspose(128, (5, 5), strides=2, padding
    seq.add(LayerNormalization())
    seq.add(TimeDistributed(Conv2DTranspose(1, (11, 11), strides=4, padding
    seq.add(LayerNormalization())
    #seq.add(TimeDistributed(Conv2D(1, (11, 11), activation="sigmoid", padd

    print(seq.summary())  # SUMMARY Should be visible /seq.summary()


    seq.compile(loss='mse', optimizer=tf.keras.optimizers.Adam(lr=1e-3)) #
    seq.fit(training_set, training_set,
            batch_size=Config.BATCH_SIZE, epochs=Config.EPOCHS, shuffle=Fa
    seq.save(Config.MODEL_PATH)
    return seq
```

In [8]:
```
def get_single_test():
    size = 200
    test = np.zeros(shape=(size, 227, 227, 1))
    cnt = 0
    for f in sorted(listdir(Config.SINGLE_TEST_PATH)):
        if str(join(Config.SINGLE_TEST_PATH, f))[-3:] == "tif":
            img = Image.open(join(Config.SINGLE_TEST_PATH, f)).resize((227
            img = np.array(img, dtype=np.float32) / 256.0
            test[cnt, :, :, 0] = img
            cnt = cnt + 1
    return test
```

In [9]:
```
def evaluate(reload_model=False):
    model = get_model(reload_model) #get_model(True) ->to retrain the mode
    print("got model")
    test = get_single_test()
    print(test.shape)
    size = test.shape[0] - 10 + 1
    sequences = np.zeros((size, 10, 227, 227, 1))
    # apply the sliding window technique to get the sequences
    for i in range(0, size):
        clip = np.zeros((10, 227, 227, 1))
        for j in range(0, 10):
            clip[j] = test[i + j, :, :, :]
        sequences[i] = clip

    print("got data")

    # get the reconstruction cost of all the sequences
    reconstructed_sequences = model.predict(sequences,batch_size=4)

    #caluclating the Eculidean distance/norm2
    sequences_reconstruction_cost = np.array([np.linalg.norm(np.subtract(se

    #anomaly score as = sa
    anomaly_score = (sequences_reconstruction_cost - np.min(sequences_recon

    #Regularity score -> sr
    regularity_score = 1.0 - anomaly_score

    # plot the regularity scores vs frames
    plt.plot(regularity_score)
    plt.ylabel('regularity score(t)')
    plt.xlabel('frame t')
    plt.show()

    return regularity_score
```

In [10]:
```
pr = evaluate(reload_model=True)  #checking for one video
```

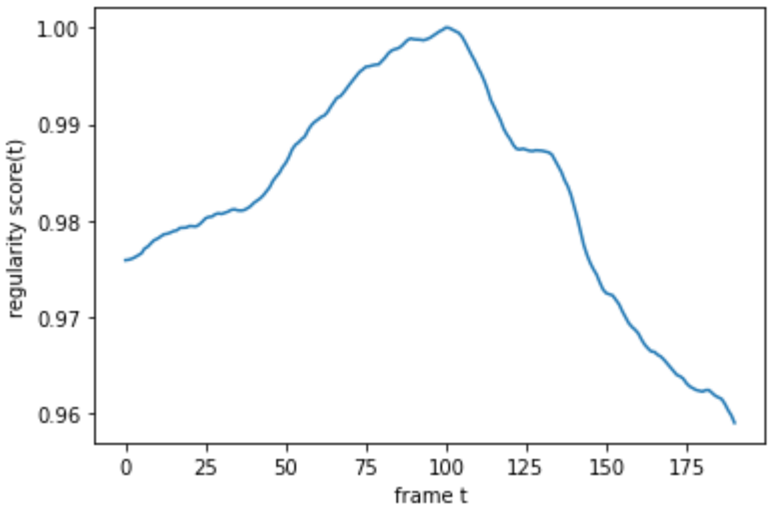
```
starting training
got training set
```

```
2021-11-10 19:48:11.026840: W tensorflow/stream_executor/platform/default/d
so_loader.cc:64] Could not load dynamic library 'libcuda.so.1'; dlerror: li
bcuda.so.1: cannot open shared object file: No such file or directory
2021-11-10 19:48:11.026896: W tensorflow/stream_executor/cuda/cuda_driver.c
c:269] failed call to cuInit: UNKNOWN ERROR (303)
2021-11-10 19:48:11.026928: I tensorflow/stream_executor/cuda/cuda_diagnost
```

```
ics.cc:156] kernel driver does not appear to be running on this host (ml):
/proc/driver/nvidia/version does not exist
2021-11-10 19:48:11.027374: I tensorflow/core/platform/cpu_feature_guard.c
c:151] This TensorFlow binary is optimized with oneAPI Deep Neural Network
Library (oneDNN) to use the following CPU instructions in performance-criti
cal operations:  AVX2 AVX512F FMA
To enable them in other operations, rebuild TensorFlow with the appropriate
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 time_distributed (TimeDistr  (None, 10, 55, 55, 128)  15616     
 ibuted)                                                         
                                                                 
 layer_normalization (LayerN  (None, 10, 55, 55, 128)  256       
 ormalization)                                                   
                                                                 
 time_distributed_1 (TimeDis  (None, 10, 26, 26, 64)   204864    
 tributed)                                                       
                                                                 
 layer_normalization_1 (Laye  (None, 10, 26, 26, 64)   128       
 rNormalization)                                                 
                                                                 
 conv_lstm2d (ConvLSTM2D)    (None, 10, 26, 26, 64)    295168    
                                                                 
 layer_normalization_2 (Laye  (None, 10, 26, 26, 64)   128       
 rNormalization)                                                 
                                                                 
 conv_lstm2d_1 (ConvLSTM2D)  (None, 10, 26, 26, 32)    110720    
                                                                 
 layer_normalization_3 (Laye  (None, 10, 26, 26, 32)   64        
 rNormalization)                                                 
                                                                 
 conv_lstm2d_2 (ConvLSTM2D)  (None, 10, 26, 26, 64)    221440    
                                                                 
 layer_normalization_4 (Laye  (None, 10, 26, 26, 64)   128       
 rNormalization)                                                 
                                                                 
 time_distributed_2 (TimeDis  (None, 10, 55, 55, 128)  204928    
 tributed)                                                       
                                                                 
 layer_normalization_5 (Laye  (None, 10, 55, 55, 128)  256       
 rNormalization)                                                 
                                                                 
 time_distributed_3 (TimeDis  (None, 10, 227, 227, 1)  15489     
 tributed)                                                       
                                                                 
 layer_normalization_6 (Laye  (None, 10, 227, 227, 1)  2         
 rNormalization)                                                 
                                                                 
=================================================================
Total params: 1,069,187
Trainable params: 1,069,187
Non-trainable params: 0
_________________________________________________________________
None
/home/user/notebook/jupyterenv/lib/python3.8/site-packages/keras/optimizer_
v2/adam.py:105: UserWarning: The `lr` argument is deprecated, use `learning
_rate` instead.
  super(Adam, self).__init__(name, **kwargs)
Epoch 1/50
43/43 [==============================] - 492s 11s/step - loss: 0.1657
```

```
Epoch 2/50
43/43 [==============================] - 478s 11s/step - loss: 0.1382
Epoch 3/50
43/43 [==============================] - 484s 11s/step - loss: 0.1155
Epoch 4/50
43/43 [==============================] - 480s 11s/step - loss: 0.0971
Epoch 5/50
43/43 [==============================] - 490s 11s/step - loss: 0.0825
Epoch 6/50
43/43 [==============================] - 474s 11s/step - loss: 0.0711
Epoch 7/50
43/43 [==============================] - 483s 11s/step - loss: 0.0624
Epoch 8/50
43/43 [==============================] - 470s 11s/step - loss: 0.0559
Epoch 9/50
43/43 [==============================] - 482s 11s/step - loss: 0.0511
Epoch 10/50
43/43 [==============================] - 474s 11s/step - loss: 0.0477
Epoch 11/50
43/43 [==============================] - 477s 11s/step - loss: 0.0453
Epoch 12/50
43/43 [==============================] - 477s 11s/step - loss: 0.0437
Epoch 13/50
43/43 [==============================] - 472s 11s/step - loss: 0.0427
Epoch 14/50
43/43 [==============================] - 483s 11s/step - loss: 0.0420
Epoch 15/50
43/43 [==============================] - 467s 11s/step - loss: 0.0416
Epoch 16/50
43/43 [==============================] - 482s 11s/step - loss: 0.0413
Epoch 17/50
43/43 [==============================] - 469s 11s/step - loss: 0.0411
Epoch 18/50
43/43 [==============================] - 480s 11s/step - loss: 0.0411
Epoch 19/50
43/43 [==============================] - 470s 11s/step - loss: 0.0410
Epoch 20/50
43/43 [==============================] - 469s 11s/step - loss: 0.0410
Epoch 21/50
43/43 [==============================] - 470s 11s/step - loss: 0.0410
Epoch 22/50
43/43 [==============================] - 467s 11s/step - loss: 0.0410
Epoch 23/50
43/43 [==============================] - 476s 11s/step - loss: 0.0410
Epoch 24/50
43/43 [==============================] - 465s 11s/step - loss: 0.0410
Epoch 25/50
43/43 [==============================] - 478s 11s/step - loss: 0.0410
Epoch 26/50
43/43 [==============================] - 463s 11s/step - loss: 0.0410
Epoch 27/50
43/43 [==============================] - 474s 11s/step - loss: 0.0410
Epoch 28/50
43/43 [==============================] - 467s 11s/step - loss: 0.0410
Epoch 29/50
43/43 [==============================] - 468s 11s/step - loss: 0.0410
Epoch 30/50
43/43 [==============================] - 472s 11s/step - loss: 0.0410
Epoch 31/50
43/43 [==============================] - 464s 11s/step - loss: 0.0410
Epoch 32/50
43/43 [==============================] - 476s 11s/step - loss: 0.0410
Epoch 33/50
```

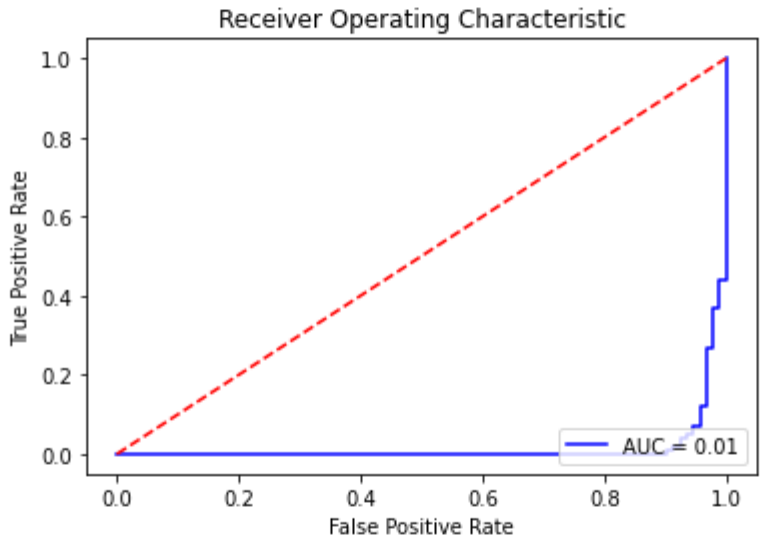
```
43/43 [==============================] - 463s 11s/step - loss: 0.0410
Epoch 34/50
43/43 [==============================] - 478s 11s/step - loss: 0.0410
Epoch 35/50
43/43 [==============================] - 467s 11s/step - loss: 0.0410
Epoch 36/50
43/43 [==============================] - 473s 11s/step - loss: 0.0410
Epoch 37/50
43/43 [==============================] - 471s 11s/step - loss: 0.0410
Epoch 38/50
43/43 [==============================] - 468s 11s/step - loss: 0.0410
Epoch 39/50
43/43 [==============================] - 476s 11s/step - loss: 0.0410
Epoch 40/50
43/43 [==============================] - 468s 11s/step - loss: 0.0410
Epoch 41/50
43/43 [==============================] - 475s 11s/step - loss: 0.0410
Epoch 42/50
43/43 [==============================] - 469s 11s/step - loss: 0.0410
Epoch 43/50
43/43 [==============================] - 475s 11s/step - loss: 0.0410
Epoch 44/50
43/43 [==============================] - 480s 11s/step - loss: 0.0410
Epoch 45/50
43/43 [==============================] - 471s 11s/step - loss: 0.0410
Epoch 46/50
43/43 [==============================] - 485s 11s/step - loss: 0.0410
Epoch 47/50
43/43 [==============================] - 471s 11s/step - loss: 0.0410
Epoch 48/50
43/43 [==============================] - 484s 11s/step - loss: 0.0410
Epoch 49/50
43/43 [==============================] - 479s 11s/step - loss: 0.0410
Epoch 50/50
43/43 [==============================] - 478s 11s/step - loss: 0.0410
got model
(200, 227, 227, 1)
```



In [11]:

```
def plotROC(pr):
  y_pred = pr
  y_test = [1 for element in range(0, 200)]

  for i in TestVideoFile[Config.SINGLE_TEST_VIDEO_FILE]:
    y_test[i] = 0

  y_test = y_test[8:199] #testing with different removals to match number 

  fpr, tpr, thresholds = metrics.roc_curve(y_test, y_pred)
  fnr = 1 - tpr
  auc = metrics.roc_auc_score(y_test, y_pred)

  eer_threshold = thresholds[np.nanargmin(np.absolute((fnr - fpr)))]
  eer = fpr[np.nanargmin(np.absolute((fnr - fpr)))]

  optimal = np.argmax(tpr - fpr)
  optimal_threshold = thresholds[optimal]


  #print("FPR: ", fpr)
  #print("TPR: ", tpr)
  #print("THRESHOLDS", thresholds)
  print("AUC: ", auc)
  print("EER: ", eer)
  print("EER THRESHOLD: ", eer_threshold)
  print("Optimal threshold value is:", optimal_threshold)

  plt.title('Receiver Operating Characteristic')
  plt.plot(fpr, tpr, 'b', label = 'AUC = %0.2f' % auc)
  plt.legend(loc = 'lower right')
  plt.plot([0, 1], [0, 1],'r--')
  plt.ylabel('True Positive Rate')
  plt.xlabel('False Positive Rate')
  plt.show()

  plt.plot(y_test)
  plt.title('Labels')  #labels(flags, 0-1)
  plt.ylabel('GT')
  plt.xlabel('Frame')
  plt.show()

  return auc, eer

plotROC(pr)
```

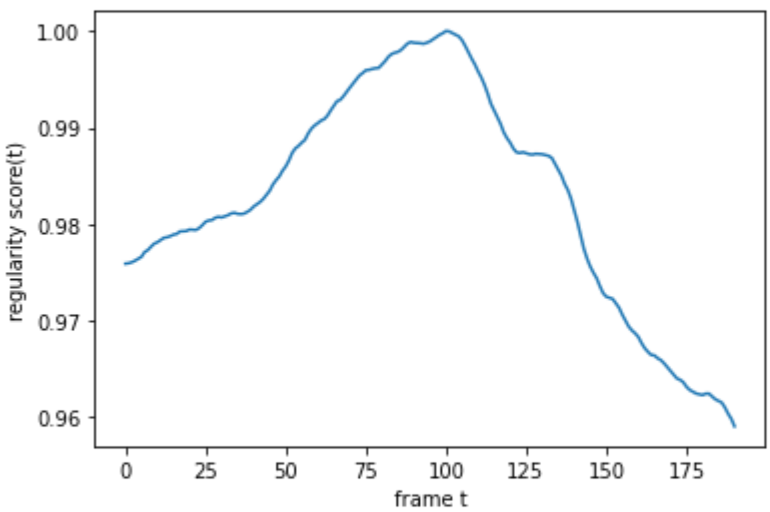
```
AUC:  0.01492209787140662
EER:  0.946236559139785
EER THRESHOLD:  0.9835342593082625
Optimal threshold value is: 2.0
```



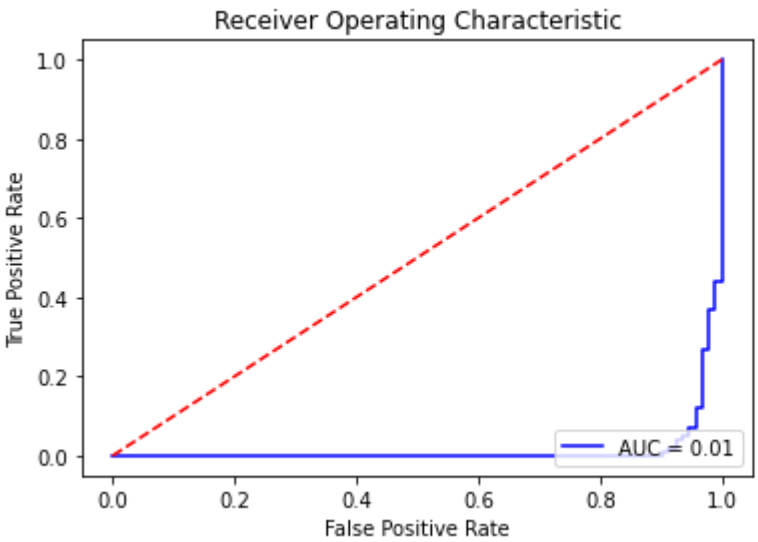
In [12]:

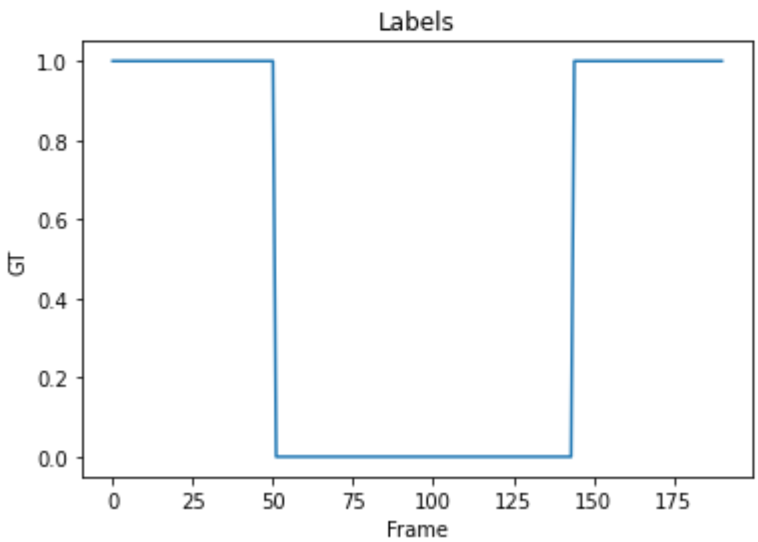
```
clips = []
# loop over the testing videos to get everysingle one
for f in sorted(listdir(Config.TEST_PATH)):
    if isdir(join(Config.TEST_PATH, f)):
      if not 'gt' in f:
        clips.append(join(Config.TEST_PATH, f))


scores = []

for i in range(len(clips)):
  if(i == 16): #skip clip 17 -> does not work
    continue

  Config.SINGLE_TEST_PATH = clips[i]
  Config.SINGLE_TEST_VIDEO_FILE = i+1

  print("PATH: ", Config.SINGLE_TEST_PATH)
  print("GT: ", Config.SINGLE_TEST_VIDEO_FILE)

  pr = evaluate()
  scores.append(plotROC(pr))


mean = np.mean(scores, axis=0)   #calculating the mean value of all AUCs a
#print(scores)
print("AUC: ", mean[0])
print("EER: ", mean[1])
```

```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test001
GT:  1
got model
(200, 227, 227, 1)
got data
```

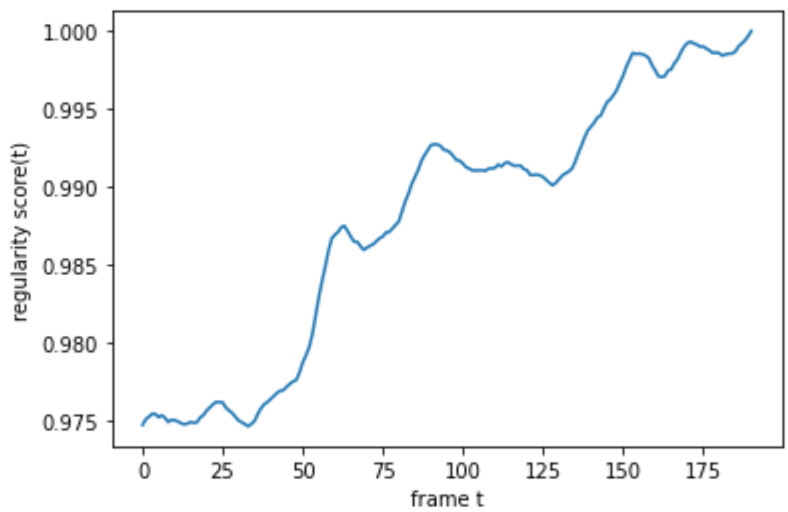



```
AUC:  0.01492209787140662
EER:  0.946236559139785
EER THRESHOLD:  0.9835342593082625
Optimal threshold value is: 2.0
```

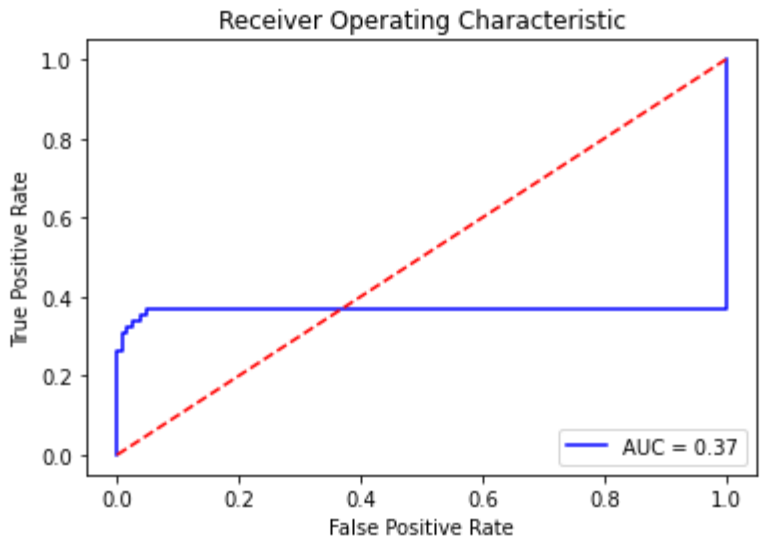


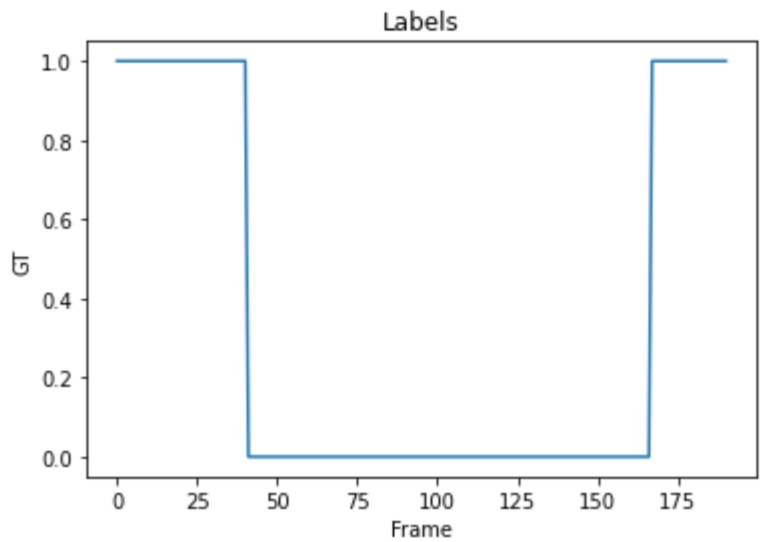



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test002
GT:  2
got model
(200, 227, 227, 1)
got data
```

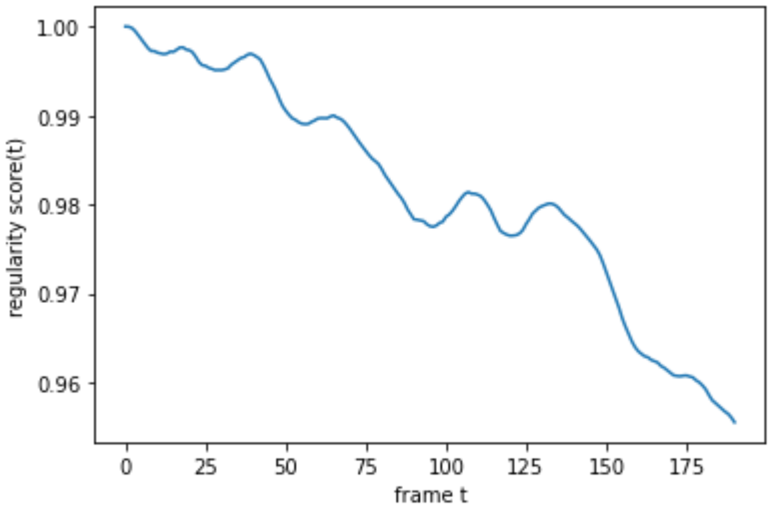



```
AUC:  0.36691086691086694
EER:  1.0
EER THRESHOLD:  0.9765661355120089
Optimal threshold value is: 0.9981894548688542
```

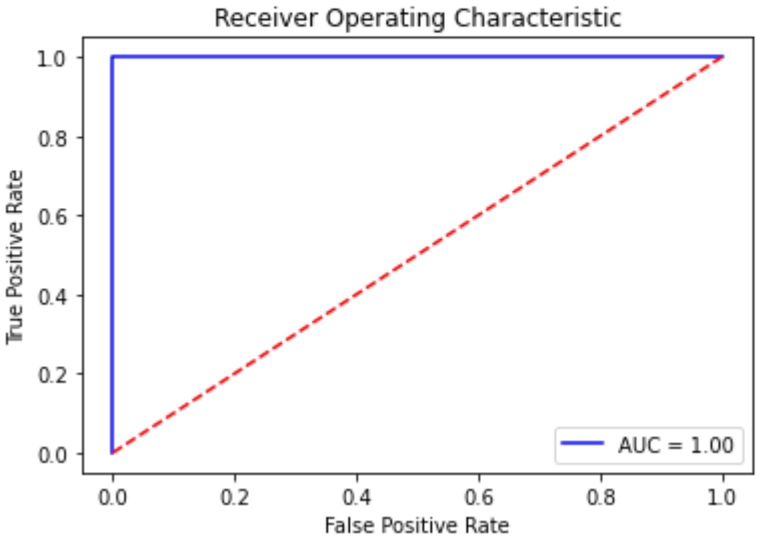


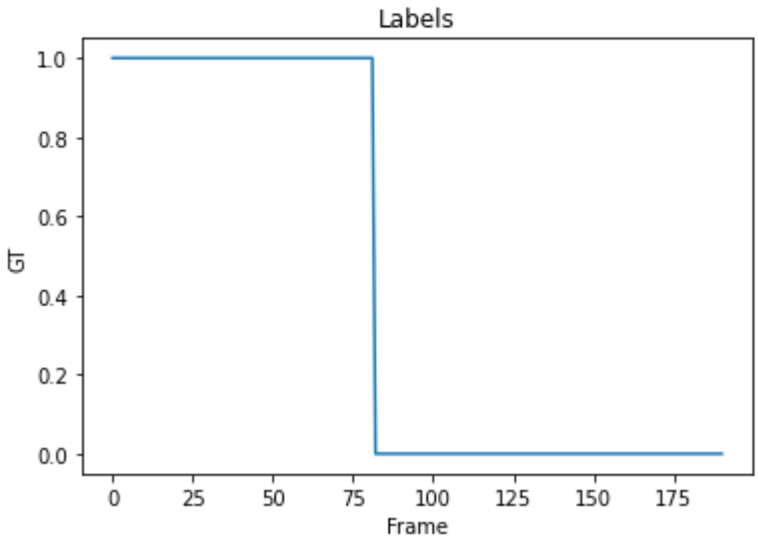



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test003
GT:  3
got model
(200, 227, 227, 1)
got data
```

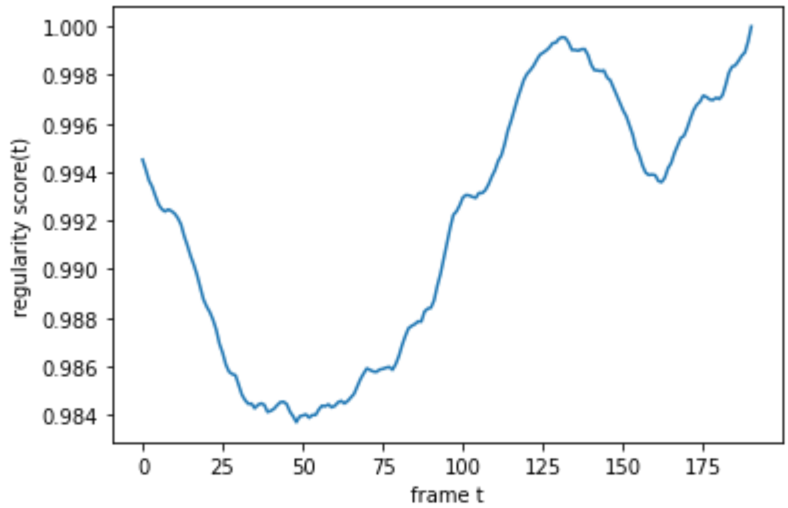



```
AUC:  1.0
EER:  0.0
EER THRESHOLD:  0.9832831117613453
Optimal threshold value is: 0.9832831117613453
```

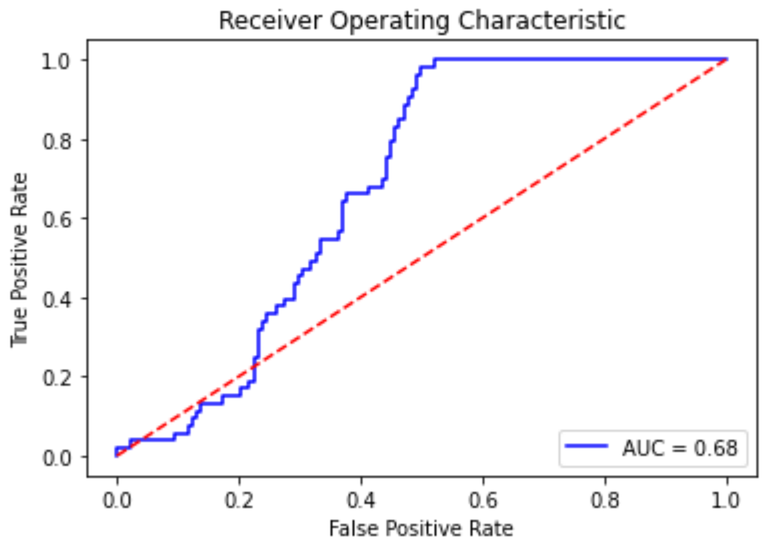


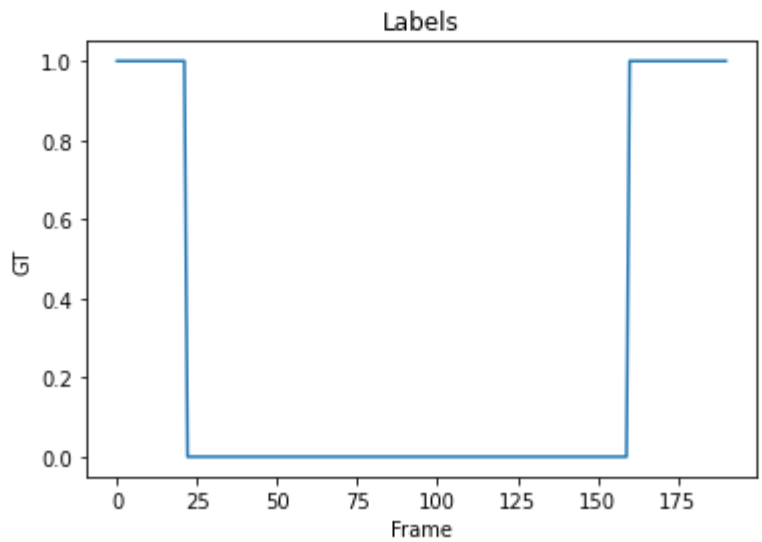



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test004
GT:  4
got model
(200, 227, 227, 1)
got data
```

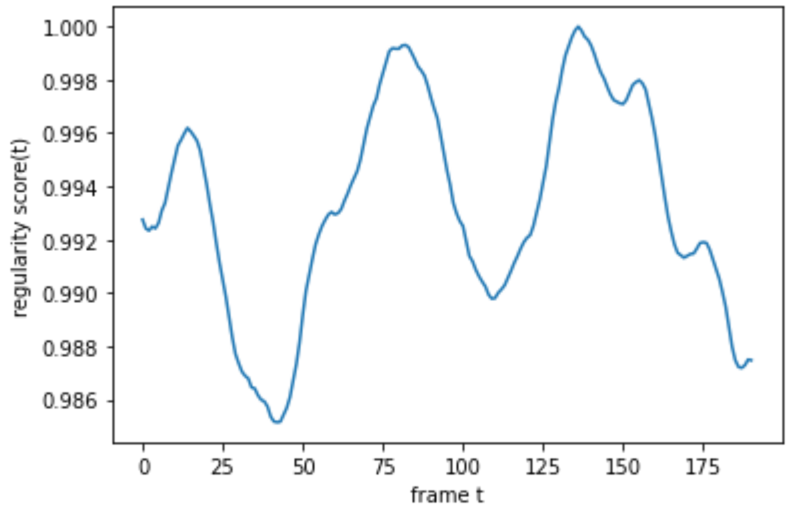



```
AUC:  0.6808859721082855
EER:  0.3695652173913043
EER THRESHOLD:  0.9935879839434365
Optimal threshold value is: 0.9884600386638904
```

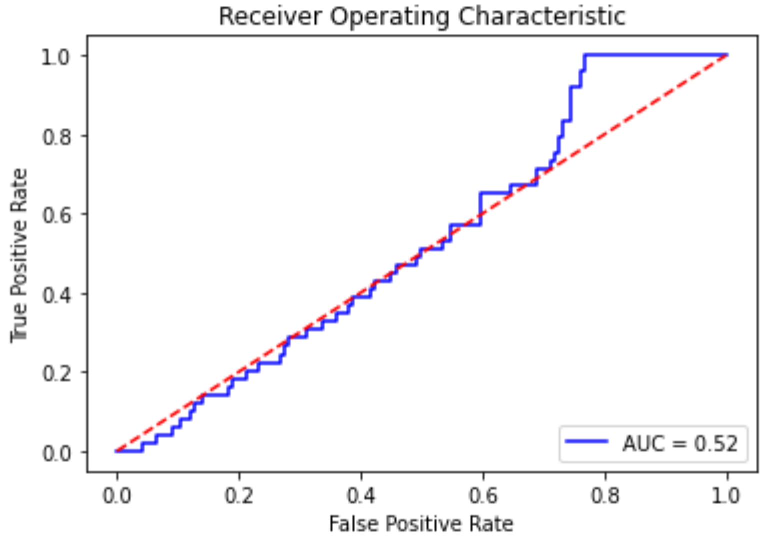


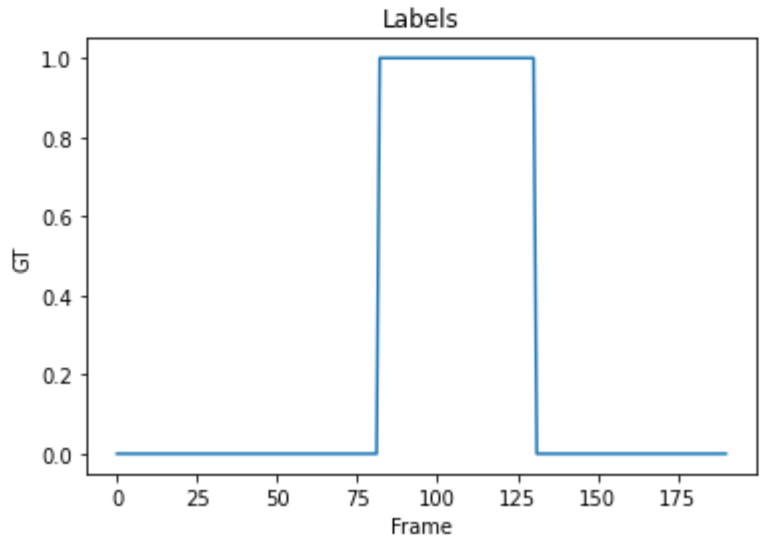



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test005
GT:  5
got model
(200, 227, 227, 1)
got data
```

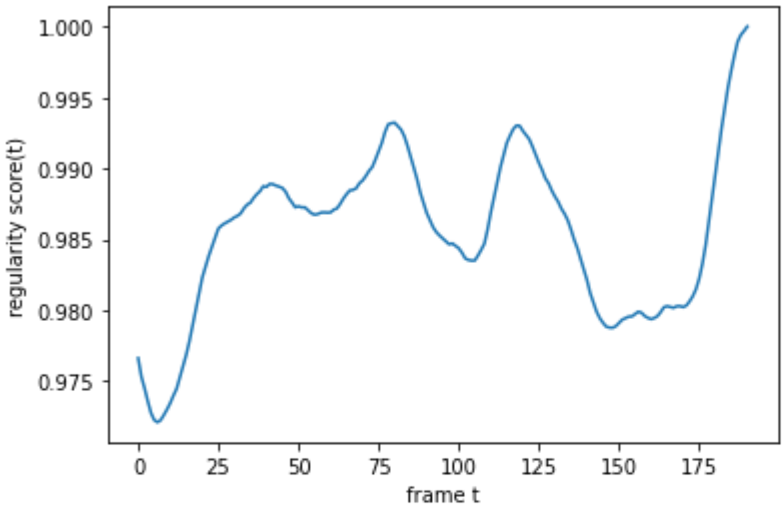



```
AUC:  0.524719747053751
EER:  0.5
EER THRESHOLD:  0.992992553386964
Optimal threshold value is: 0.9897817352494181
```

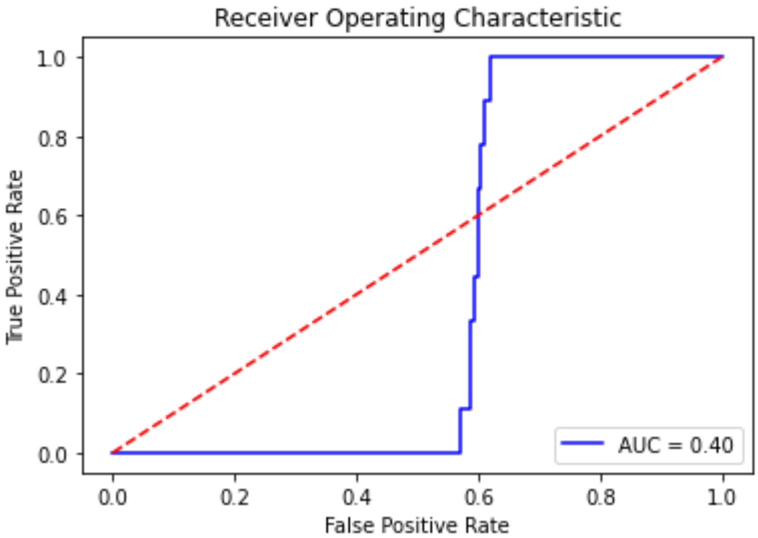


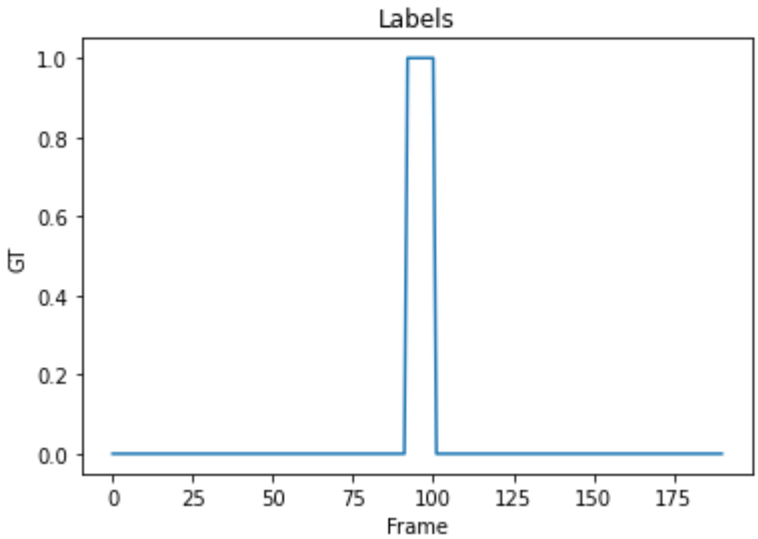



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test006
GT:  6
got model
(200, 227, 227, 1)
got data
```

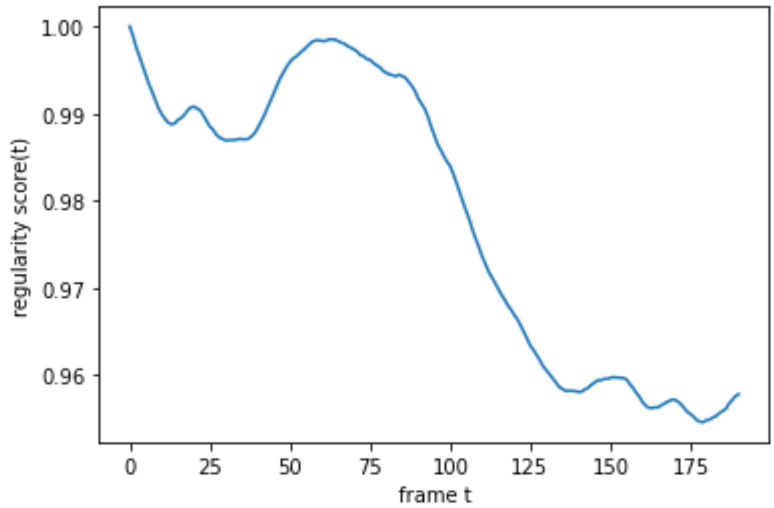



```
AUC:  0.40293040293040294
EER:  0.5934065934065934
EER THRESHOLD:  0.9850714971400839
Optimal threshold value is: 0.984377318730777
```

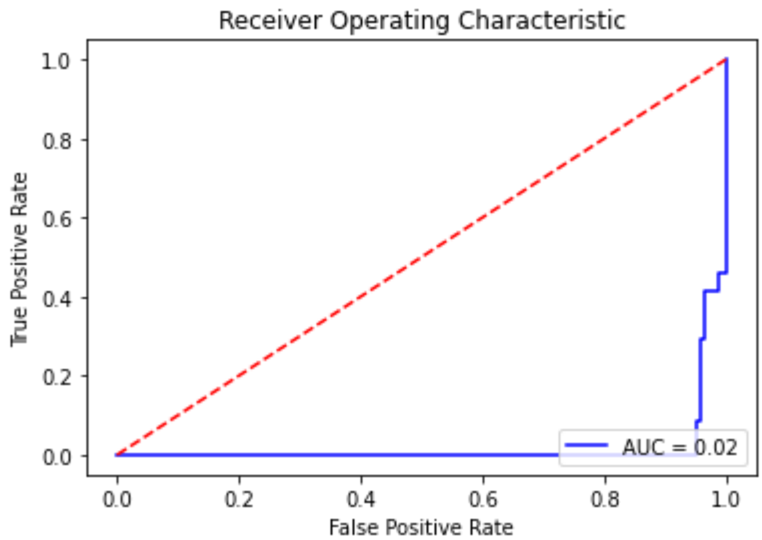


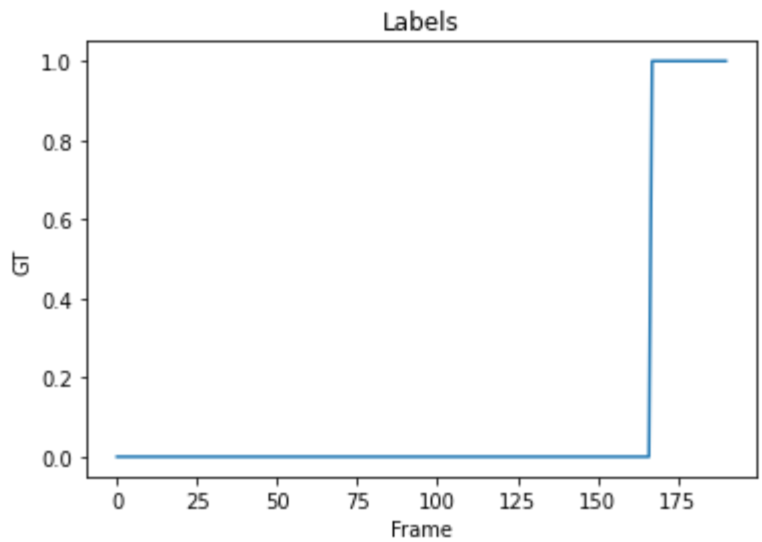



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test007
GT:  7
got model
(200, 227, 227, 1)
got data
```

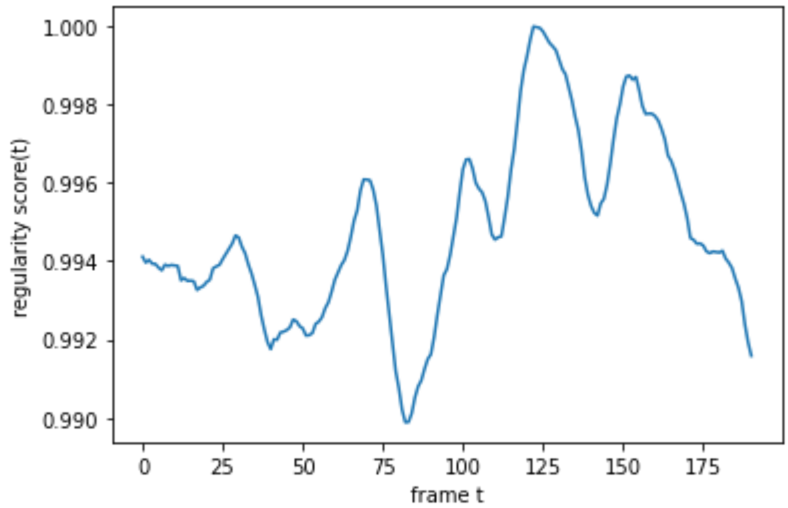



```
AUC:  0.017714570858283433
EER:  0.9520958083832335
EER THRESHOLD:  0.9575469374729314
Optimal threshold value is: 2.0
```

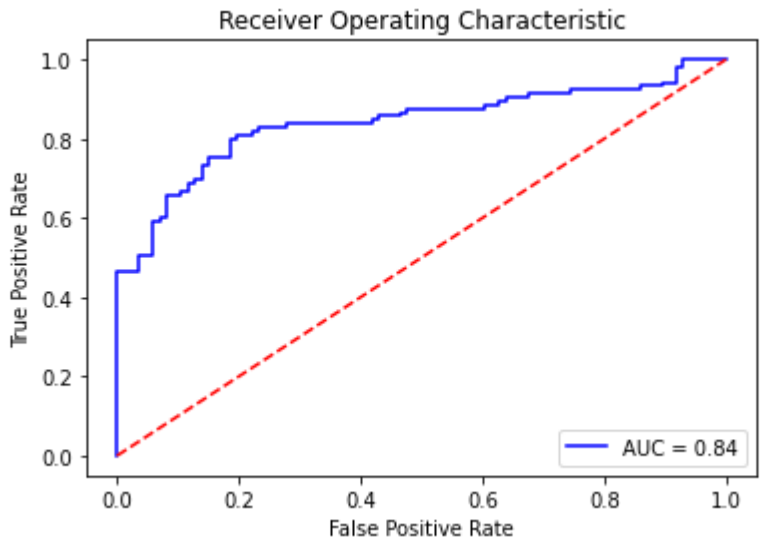


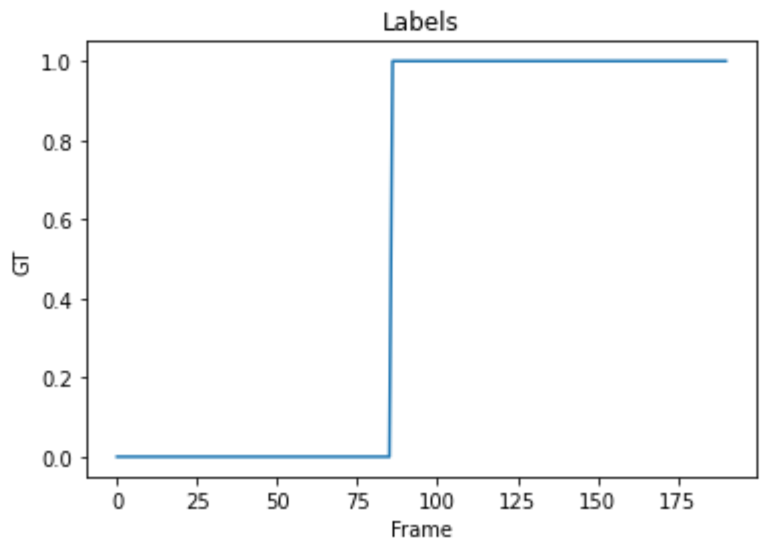



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test008
GT:  8
got model
(200, 227, 227, 1)
got data
```

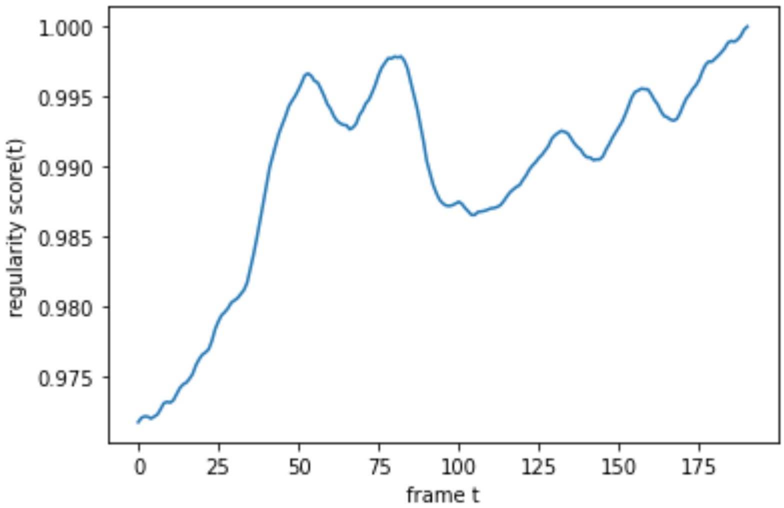



```
AUC:  0.8401993355481728
EER:  0.19767441860465115
EER THRESHOLD:  0.9942065413785959
Optimal threshold value is: 0.9942228813400523
```

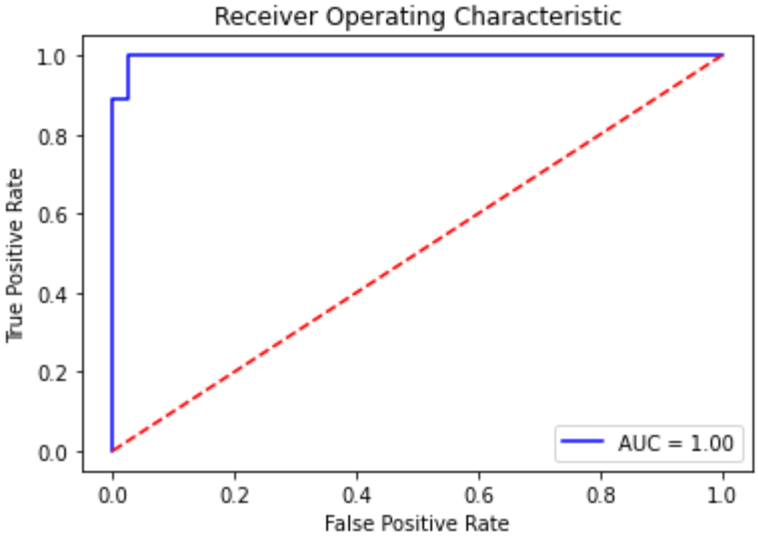


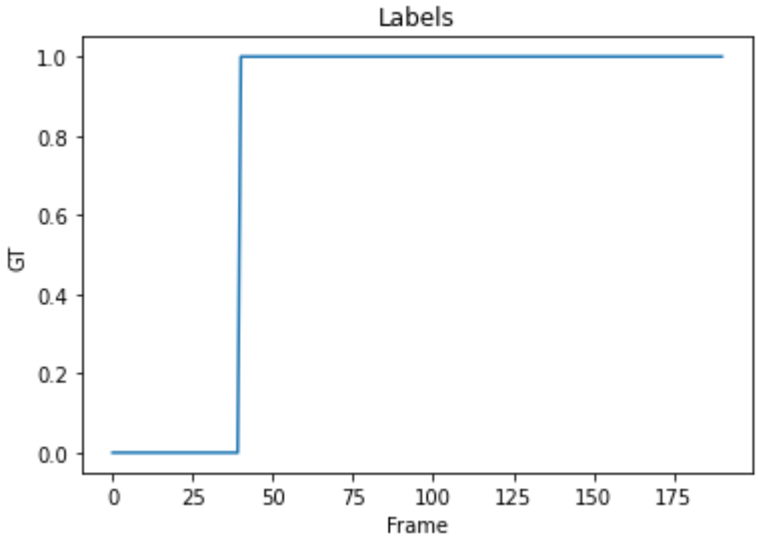



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test009
GT:  9
got model
(200, 227, 227, 1)
got data
```

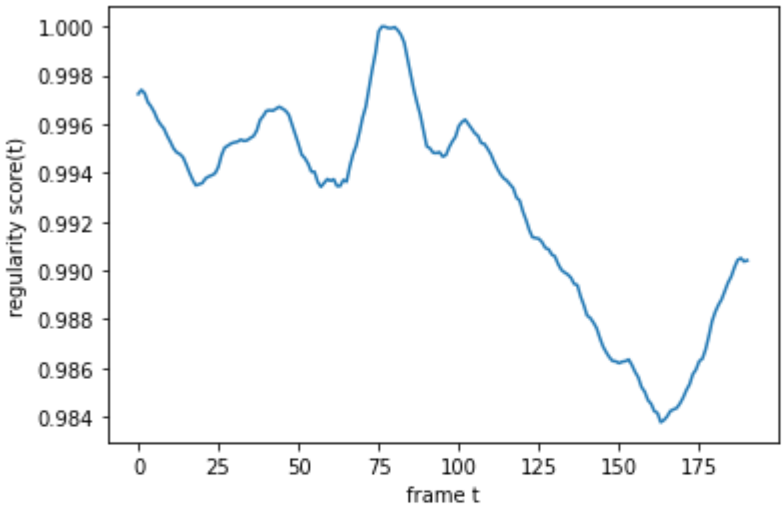



```
AUC:  0.9971854304635761
EER:  0.025
EER THRESHOLD:  0.9865614367290209
Optimal threshold value is: 0.9865614367290209
```

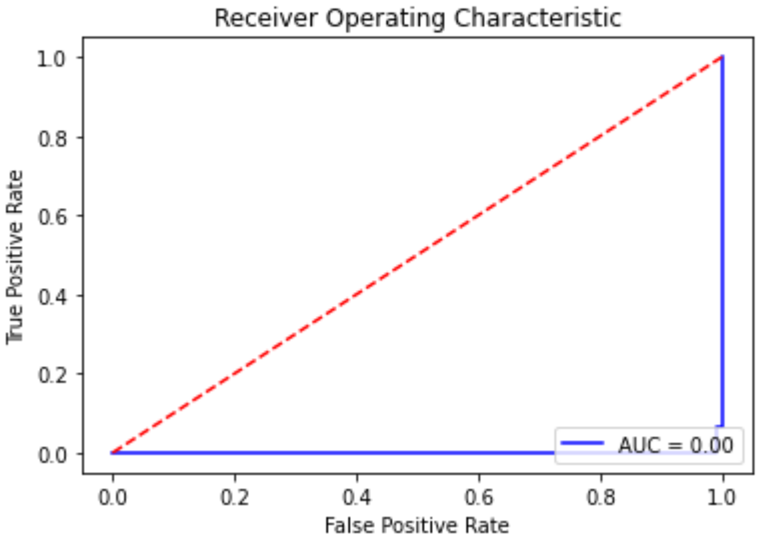


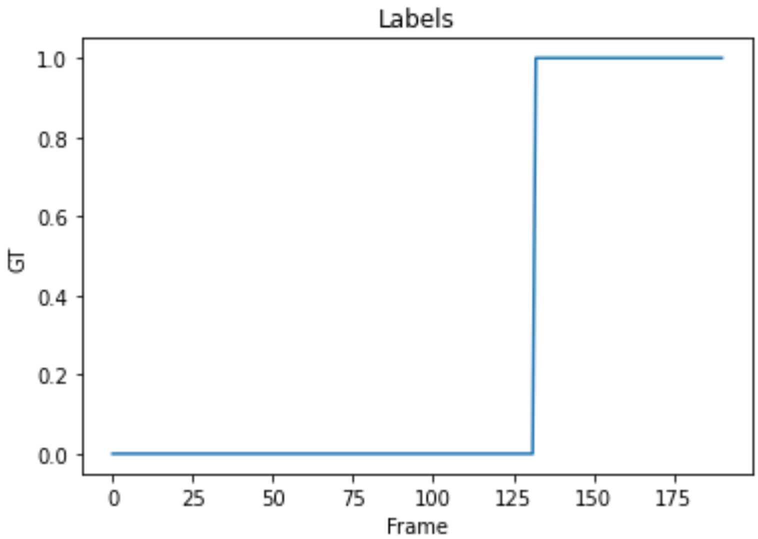



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test010
GT:  10
got model
(200, 227, 227, 1)
got data
```

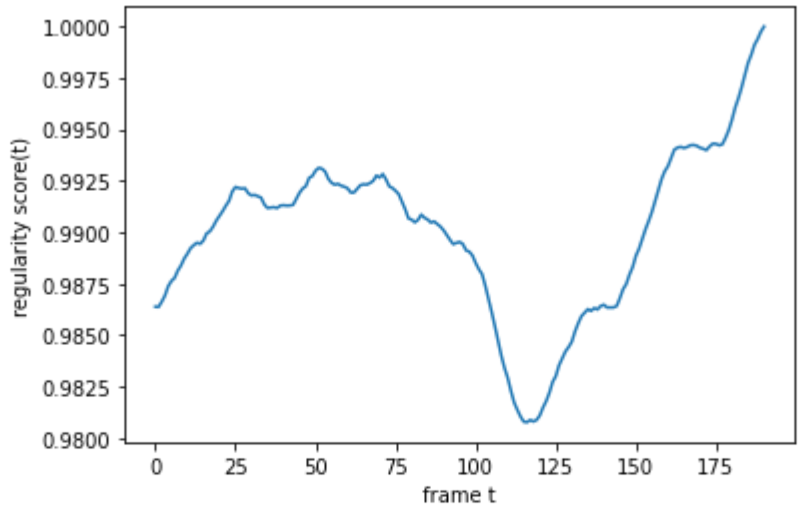



```
AUC:  0.0005136106831022081
EER:  0.9924242424242424
EER THRESHOLD:  0.9905735379262769
Optimal threshold value is: 2.0
```

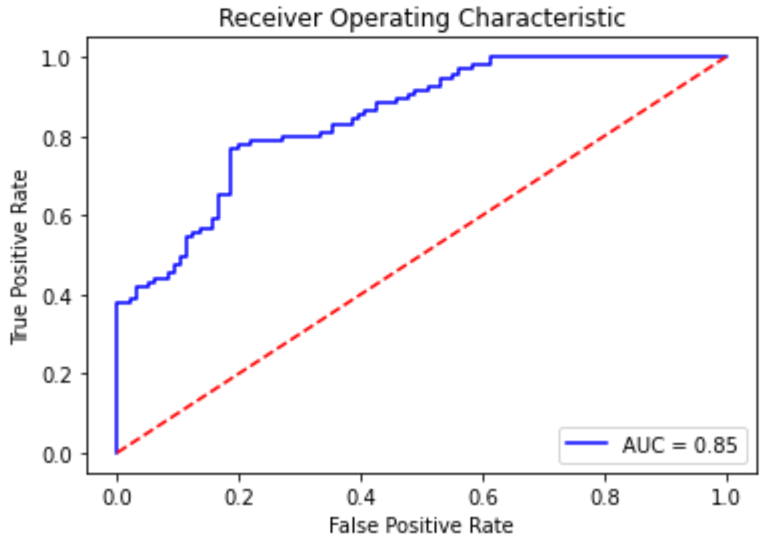


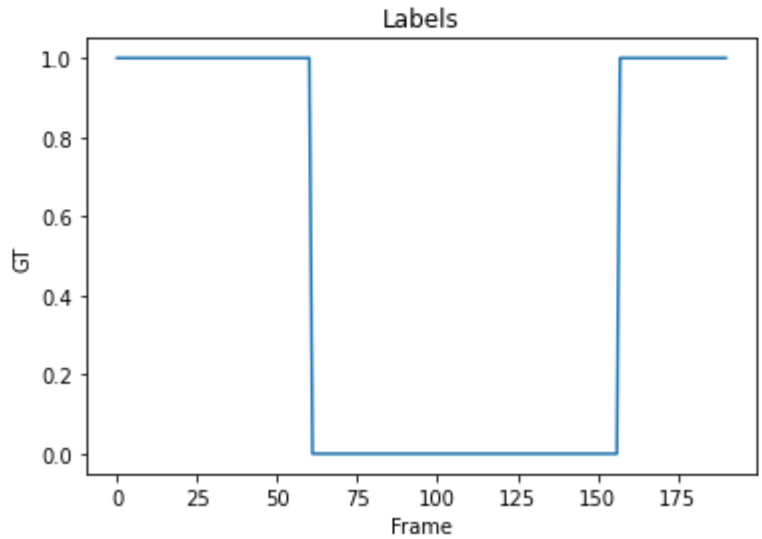



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test011
GT:  11
got model
(200, 227, 227, 1)
got data
```

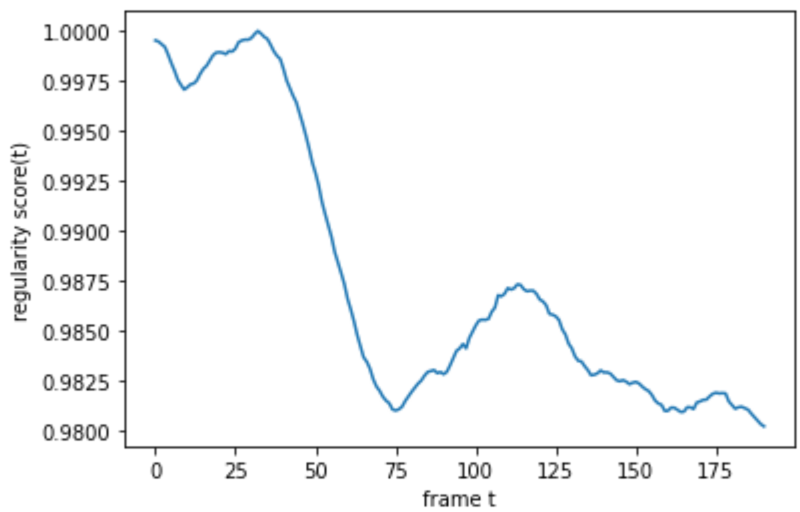



```
AUC:  0.8461622807017544
EER:  0.21875
EER THRESHOLD:  0.9908593848831139
Optimal threshold value is: 0.9910252394932282
```

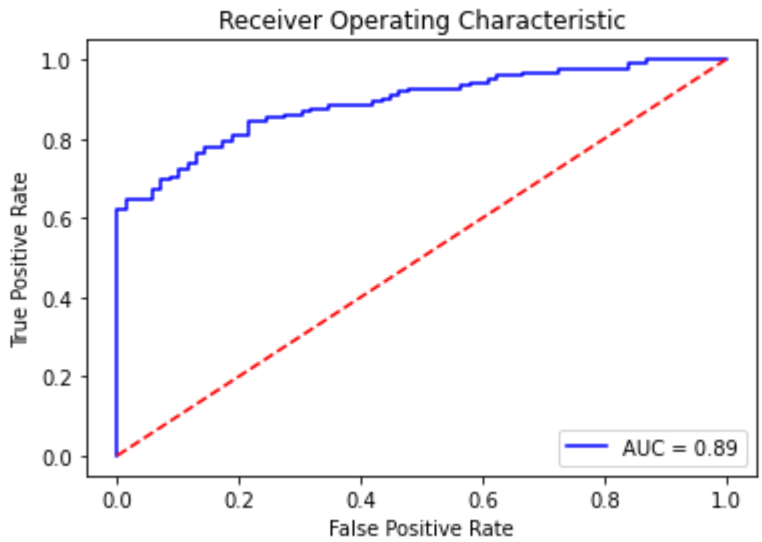


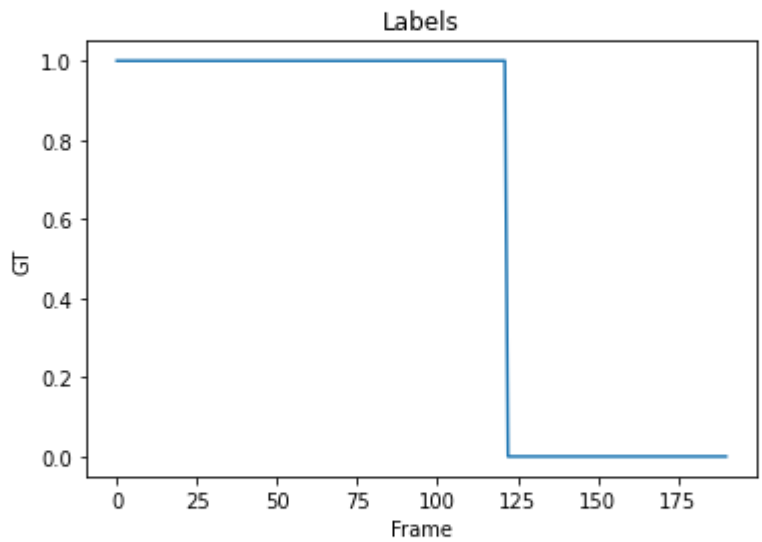



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test012
GT:  12
got model
(200, 227, 227, 1)
got data
```

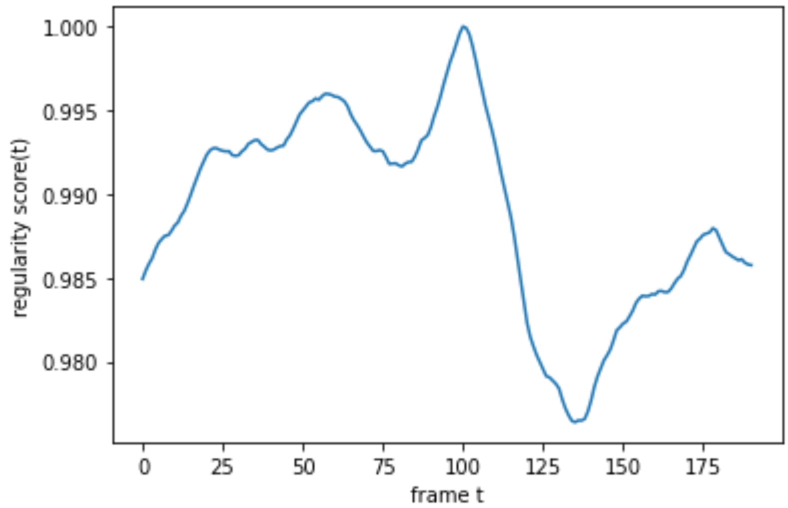



```
AUC:  0.8910667617011166
EER:  0.18840579710144928
EER THRESHOLD:  0.9830369514753164
Optimal threshold value is: 0.9836363992900877
```

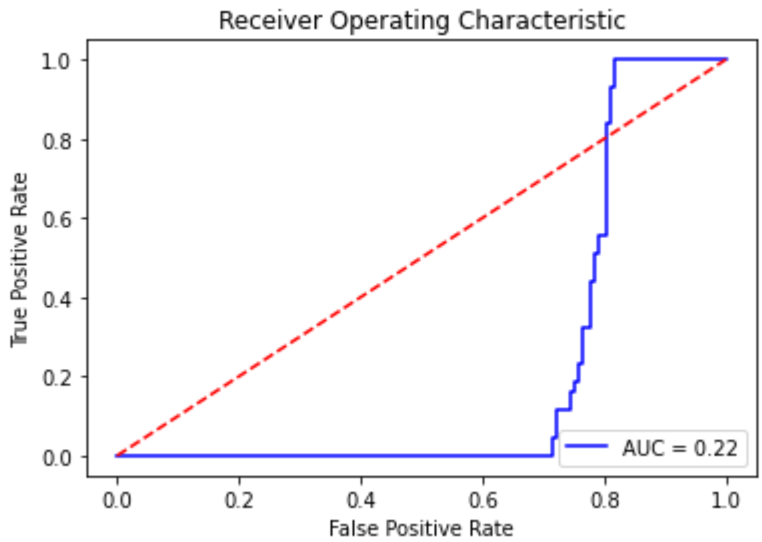


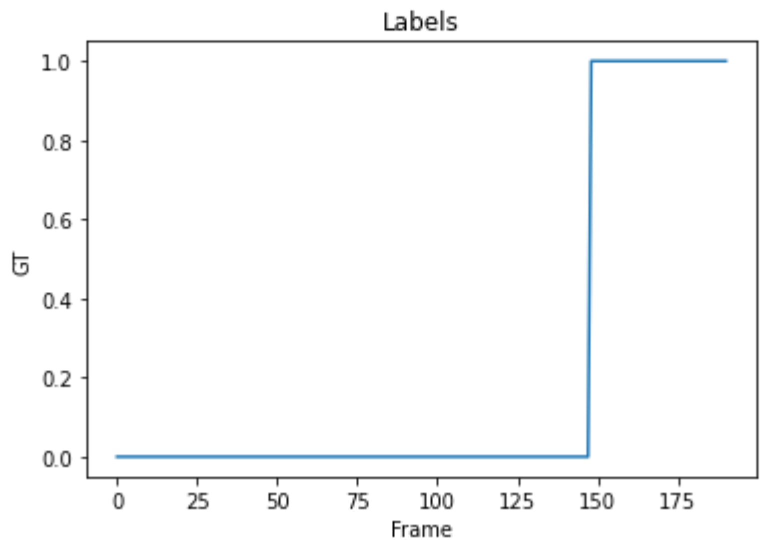



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test013
GT:  13
got model
(200, 227, 227, 1)
got data
```

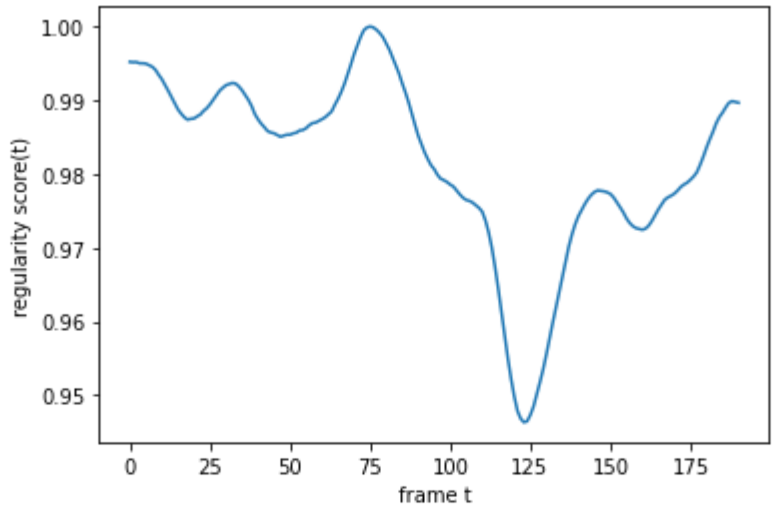



```
AUC:  0.21935889377749843
EER:  0.7635135135135135
EER THRESHOLD:  0.9866933152347778
Optimal threshold value is: 0.9818682193562874
```

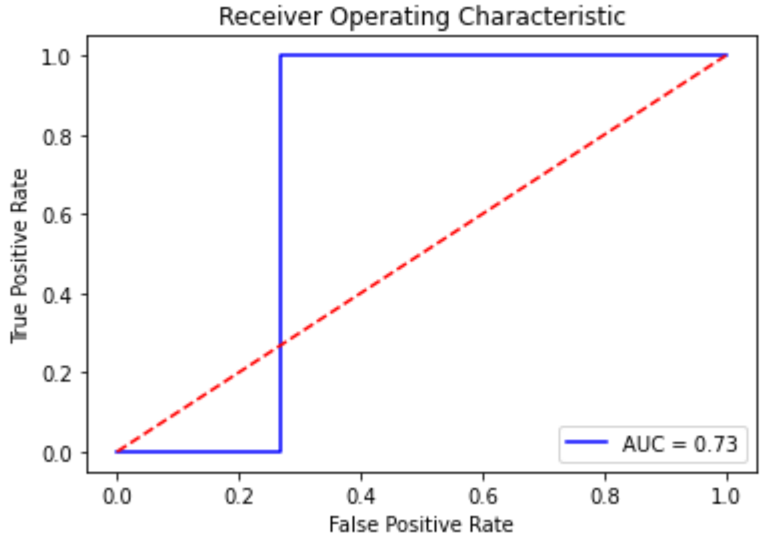


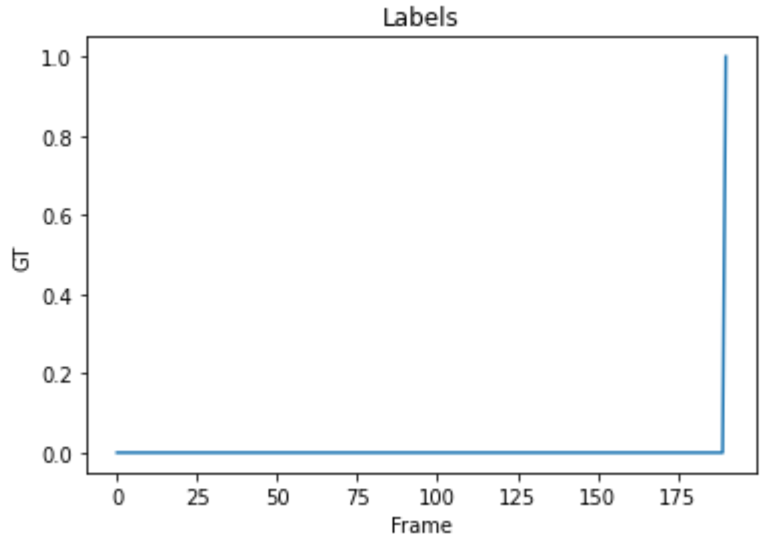



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test014
GT:  14
got model
(200, 227, 227, 1)
got data
```

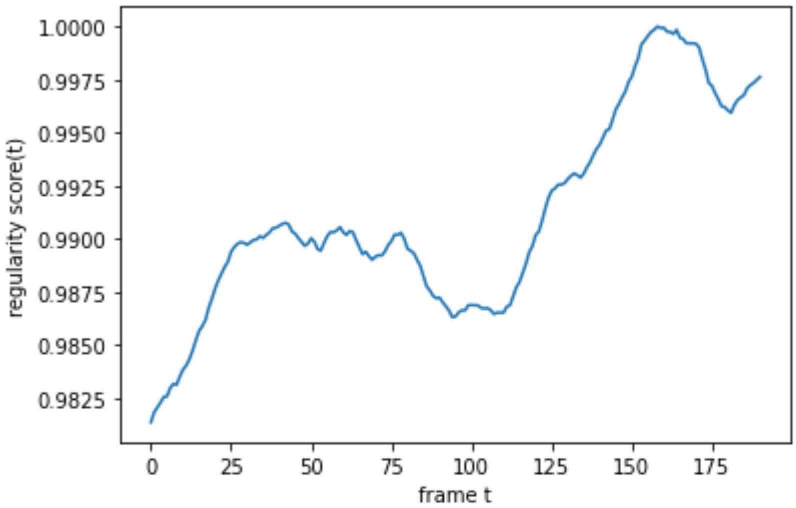



```
AUC:  0.7315789473684211
EER:  0.26842105263157895
EER THRESHOLD:  0.9896666297555512
Optimal threshold value is: 0.9896666297555512
```

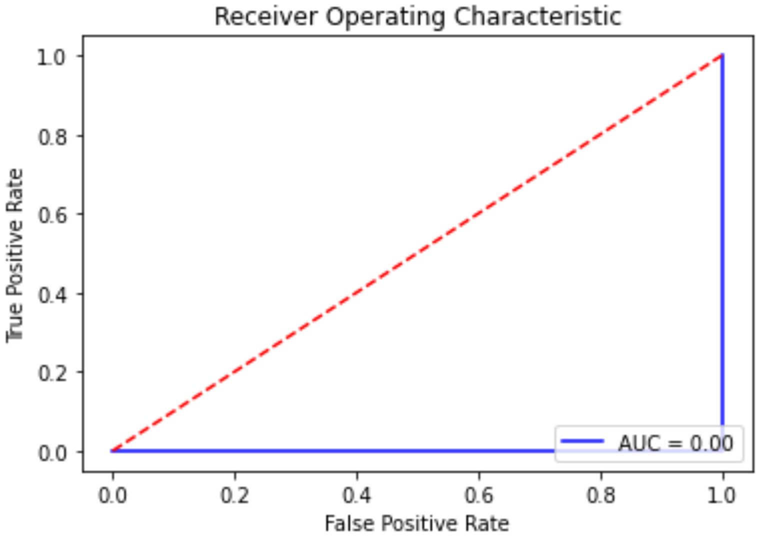


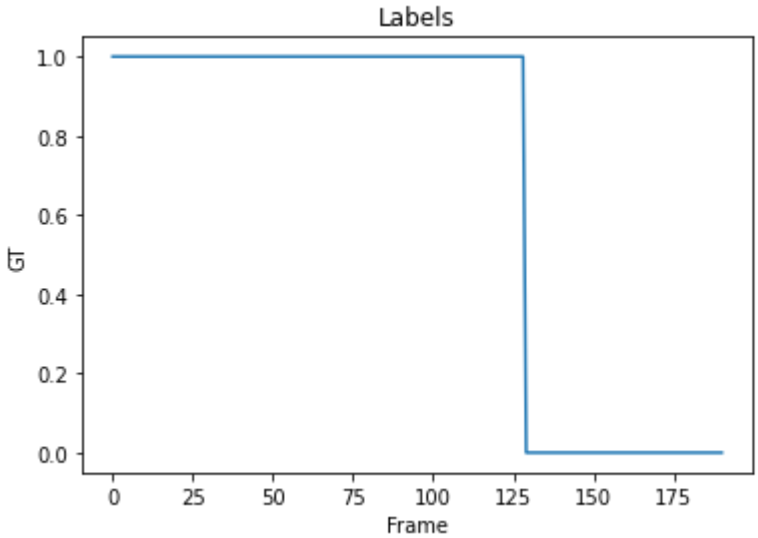



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test015
GT:  15
got model
(200, 227, 227, 1)
got data
```

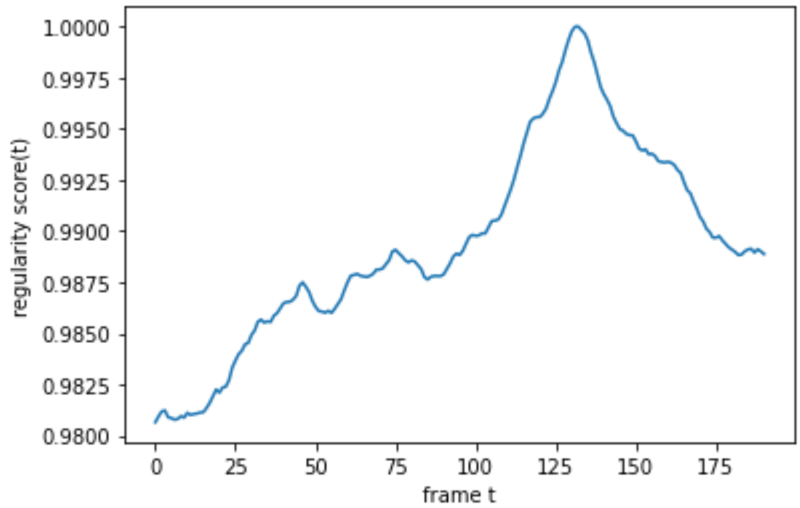



```
AUC:  0.0
EER:  1.0
EER THRESHOLD:  0.9926132559432149
Optimal threshold value is: 2.0
```

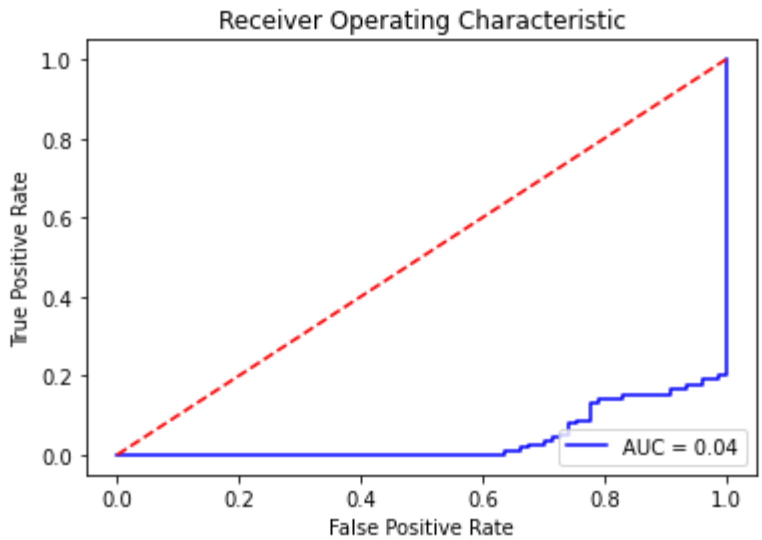


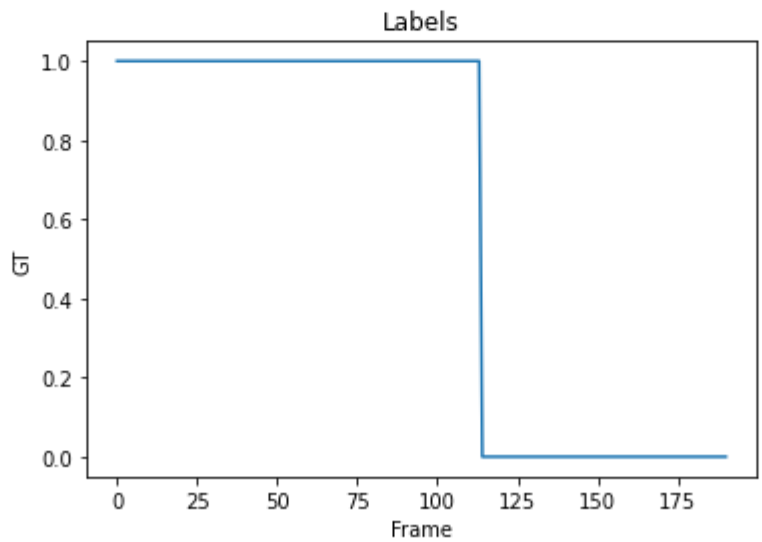



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test016
GT:  16
got model
(200, 227, 227, 1)
got data
```

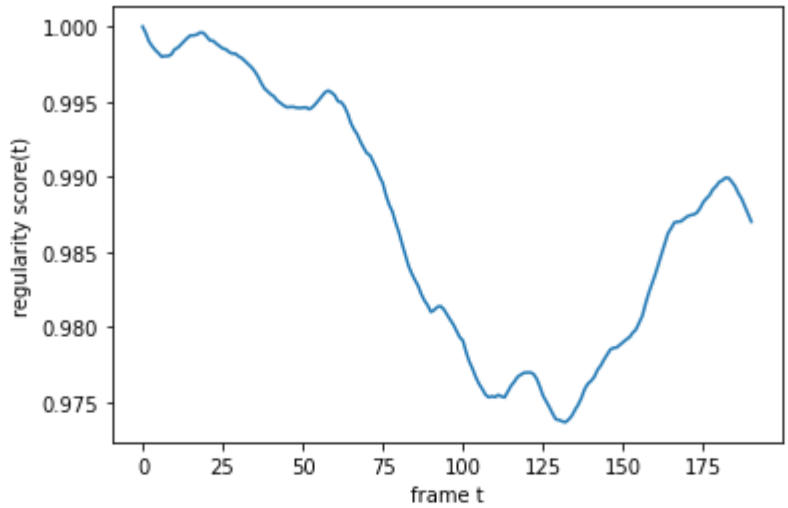



```
AUC:  0.04146730462519936
EER:  0.8311688311688312
EER THRESHOLD:  0.9893914217536139
Optimal threshold value is: 2.0
```

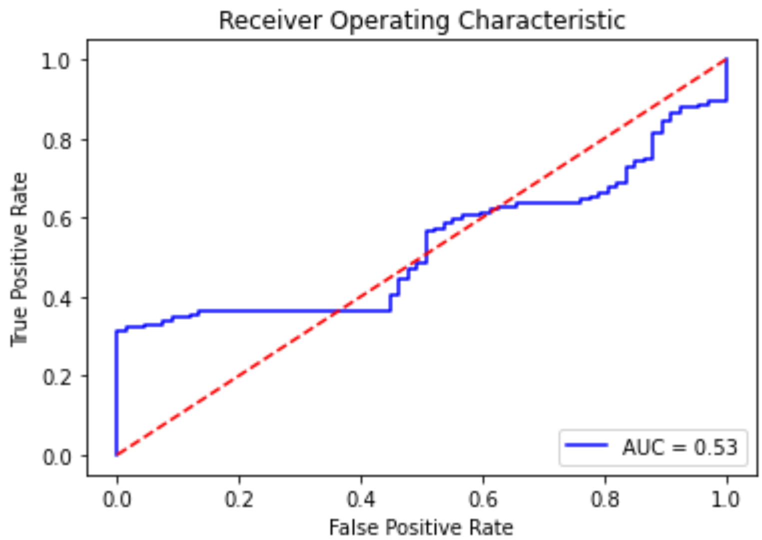


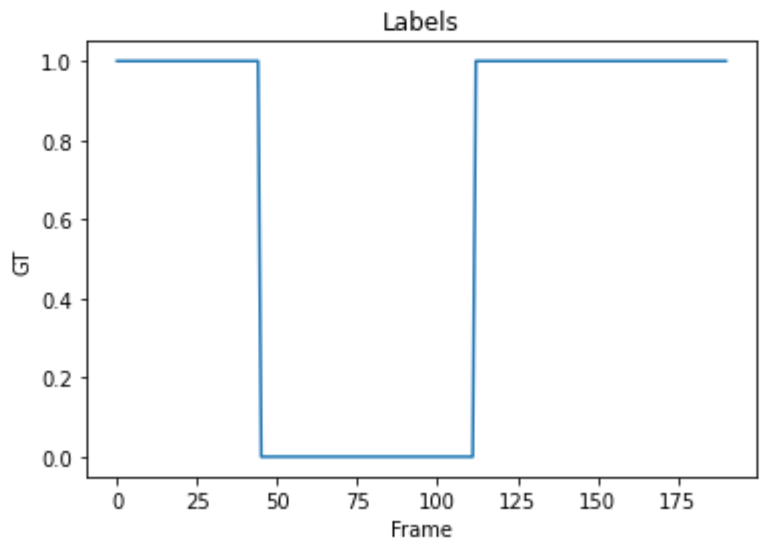



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test018
GT:  18
got model
(200, 227, 227, 1)
got data
```

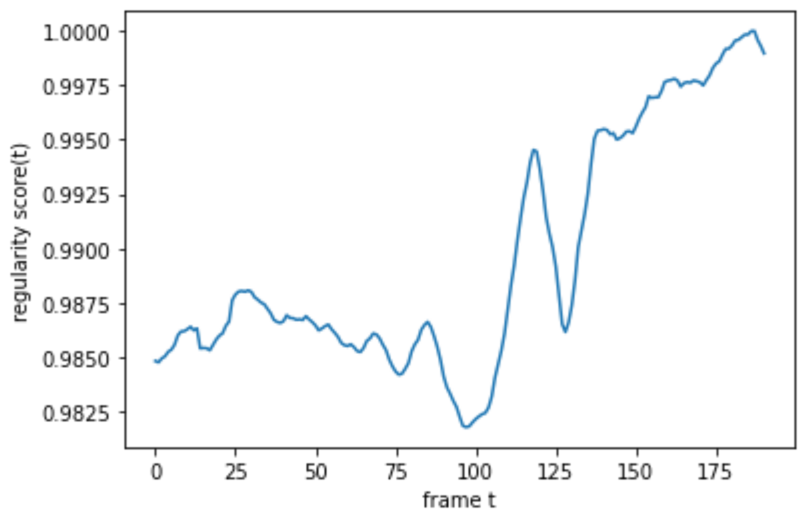



```
AUC:  0.5285267212325471
EER:  0.5074626865671642
EER THRESHOLD:  0.9876727939531719
Optimal threshold value is: 0.9958917549340376
```

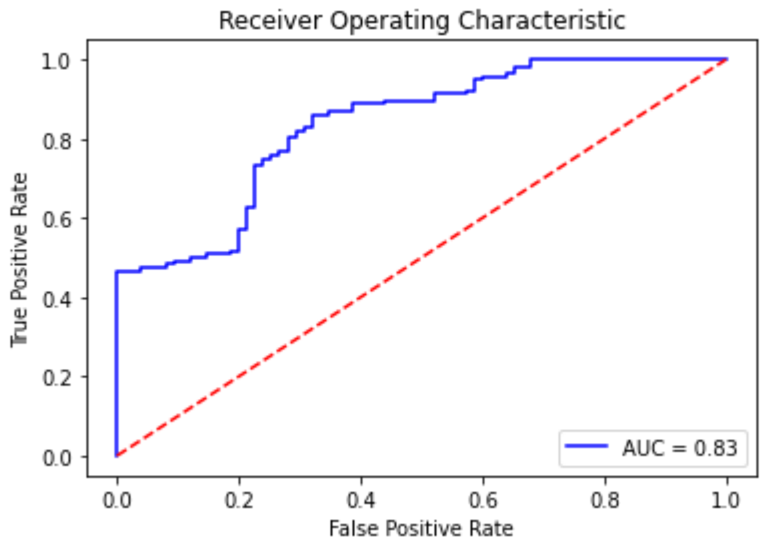


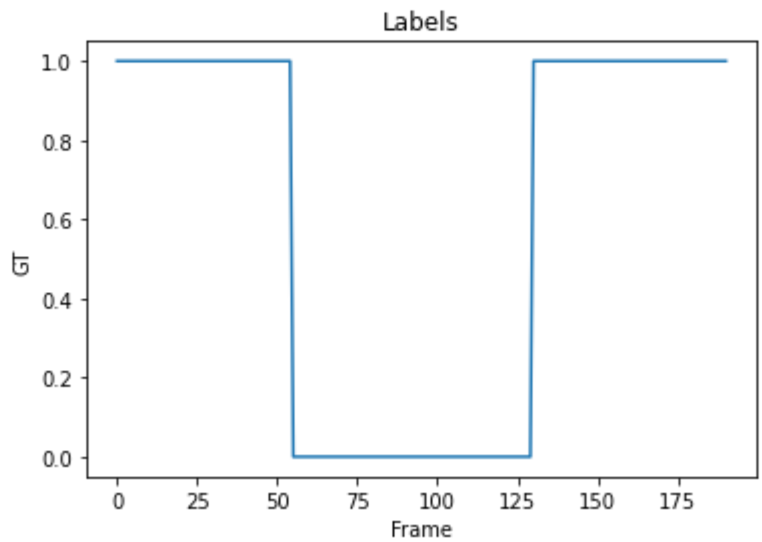



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test019
GT:  19
got model
(200, 227, 227, 1)
got data
```

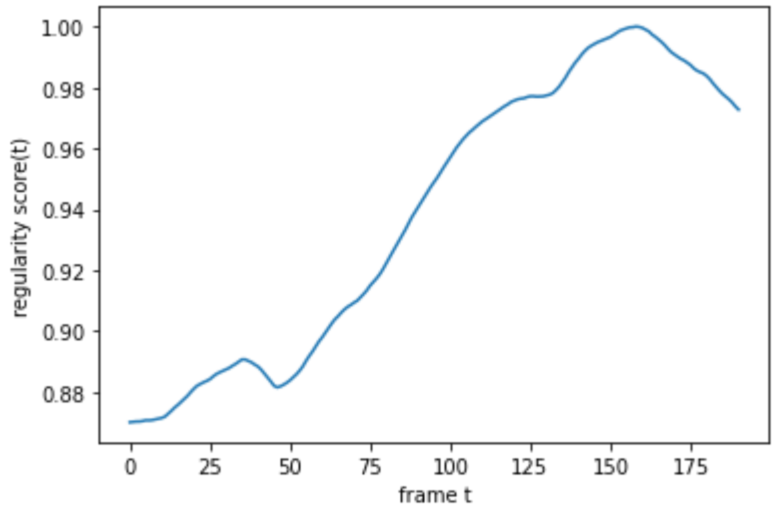



```
AUC:  0.834367816091954
EER:  0.25333333333333335
EER THRESHOLD:  0.9865940753007022
Optimal threshold value is: 0.9861698738756182
```

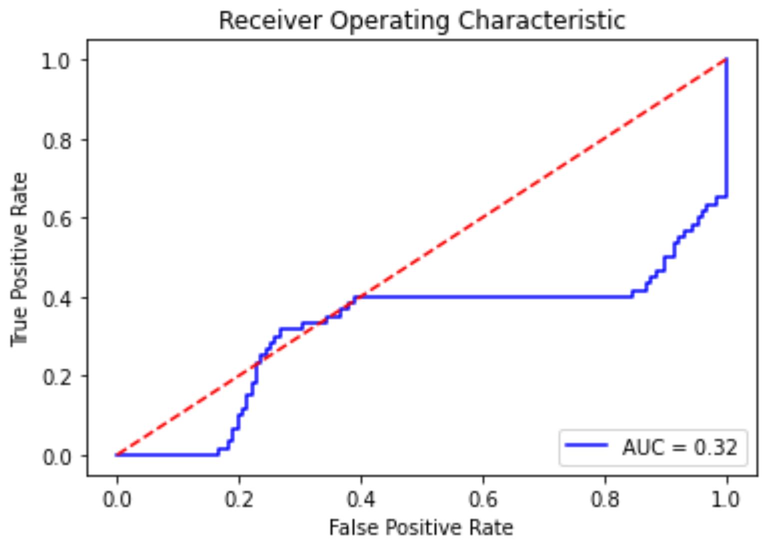


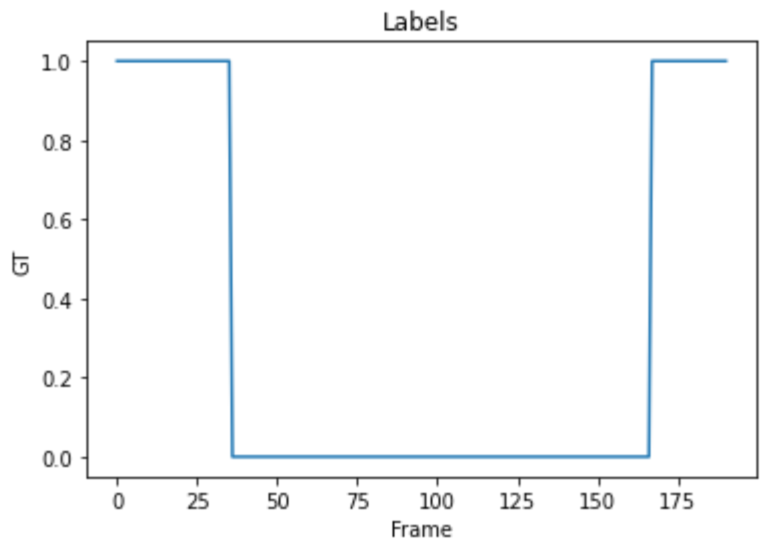



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test020
GT:  20
got model
(200, 227, 227, 1)
got data
```

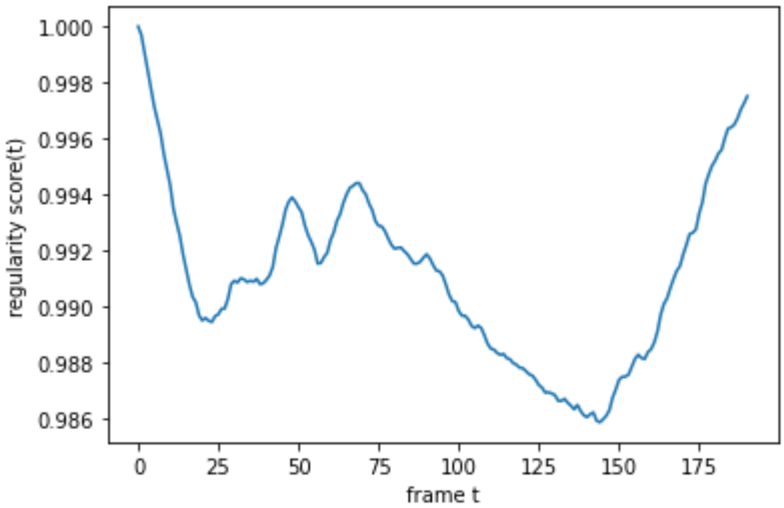



```
AUC:  0.3212468193384224
EER:  0.3893129770992366
EER THRESHOLD:  0.9727222086574338
Optimal threshold value is: 0.9778758299170154
```

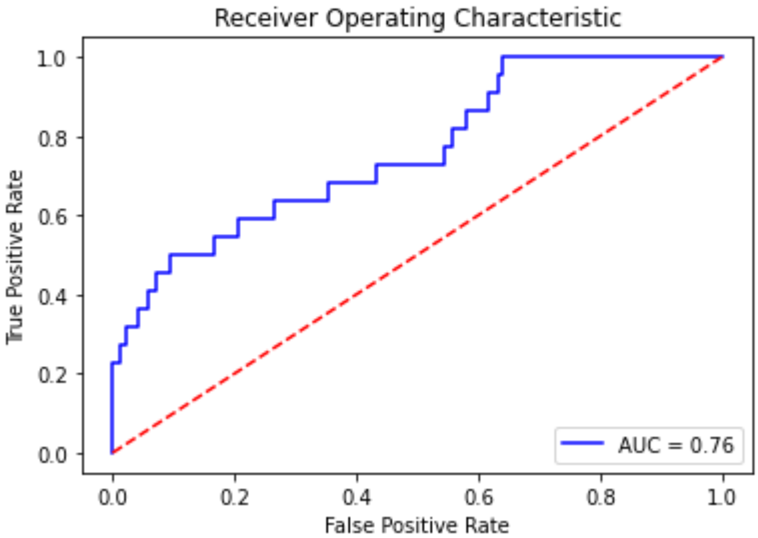


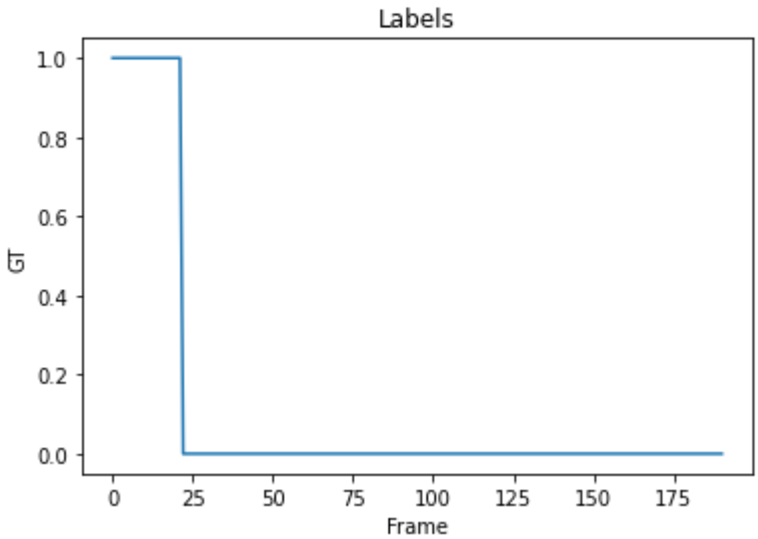



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test021
GT:  21
got model
(200, 227, 227, 1)
got data
```

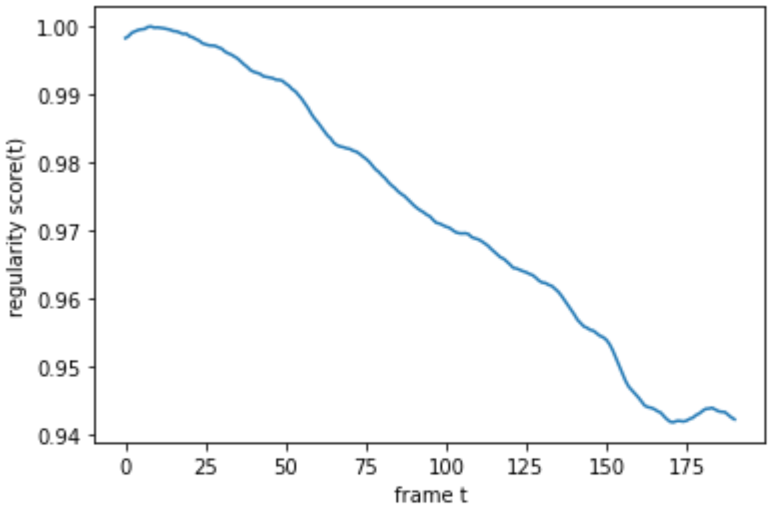



```
AUC:  0.7592791823561054
EER:  0.35502958579881655
EER THRESHOLD:  0.9918657316418088
Optimal threshold value is: 0.9943260540056195
```

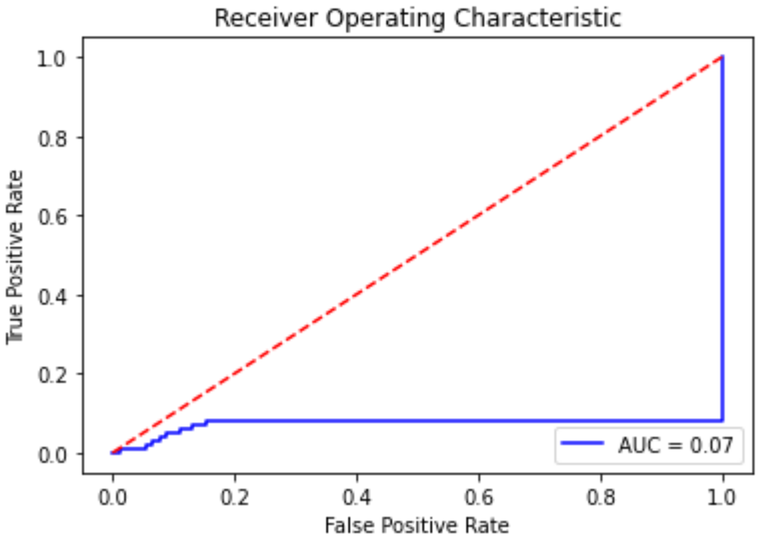


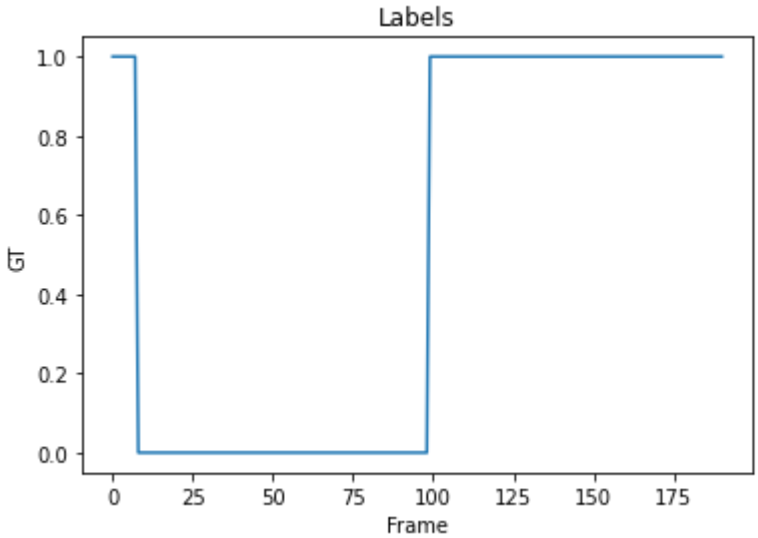



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test022
GT:  22
got model
(200, 227, 227, 1)
got data
```

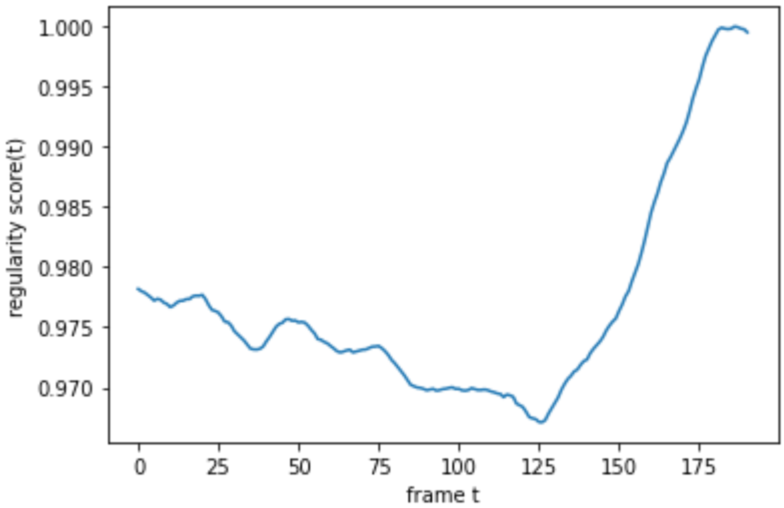



```
AUC:  0.07307692307692308
EER:  1.0
EER THRESHOLD:  0.9709700642441029
Optimal threshold value is: 2.0
```

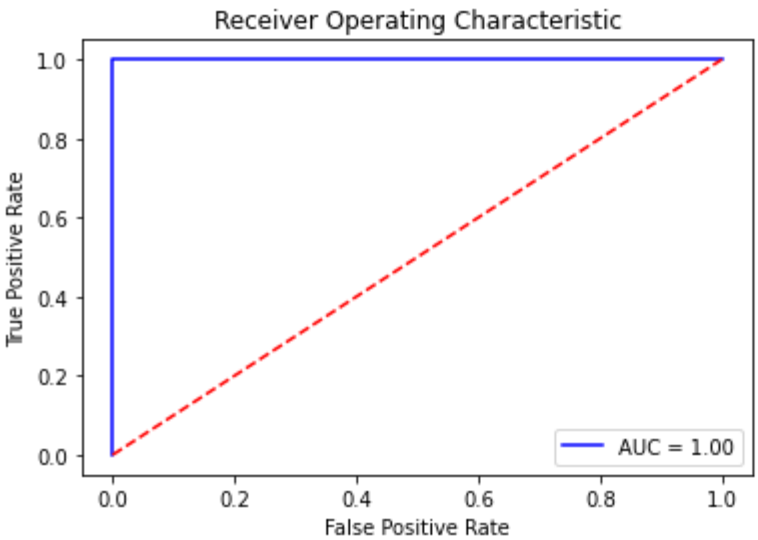


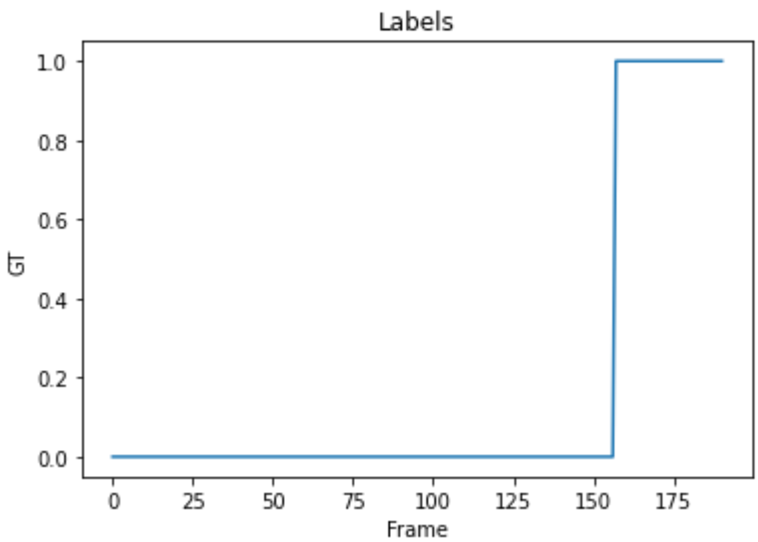



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test023
GT:  23
got model
(200, 227, 227, 1)
got data
```

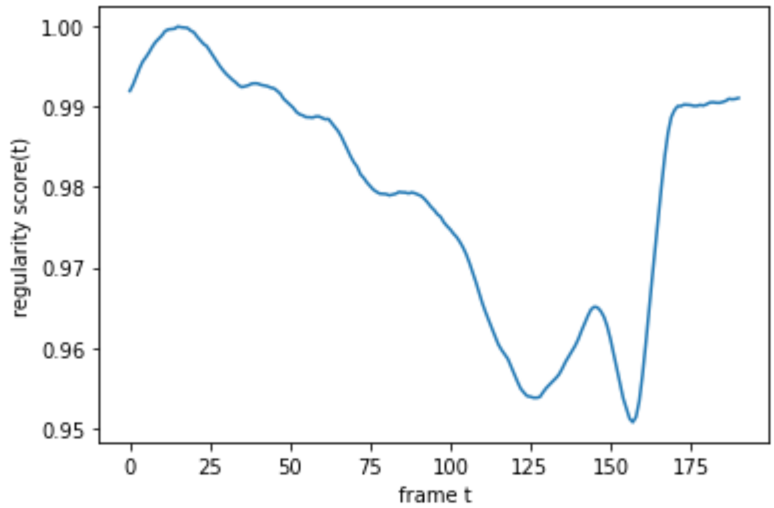



```
AUC:  1.0
EER:  0.0
EER THRESHOLD:  0.9811948858539867
Optimal threshold value is: 0.9811948858539867
```

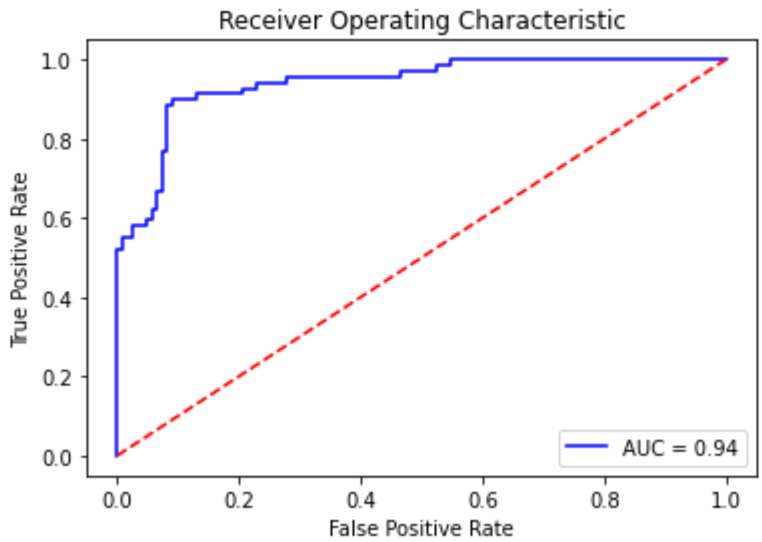


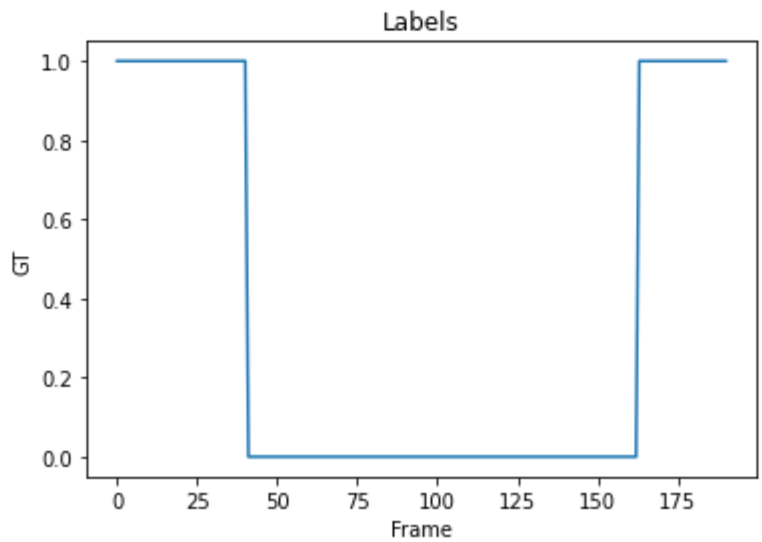



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test024
GT:  24
got model
(200, 227, 227, 1)
got data
```

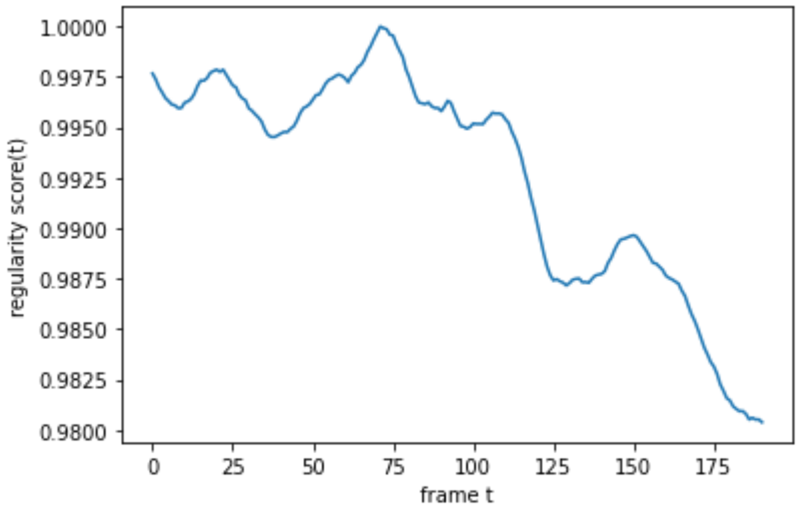



```
AUC:  0.9409598479448801
EER:  0.09016393442622951
EER THRESHOLD:  0.9895739094008191
Optimal threshold value is: 0.9895739094008191
```

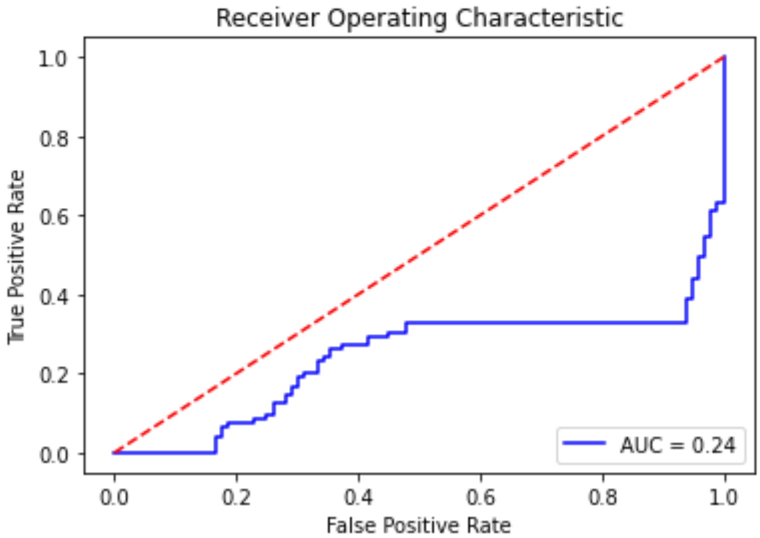


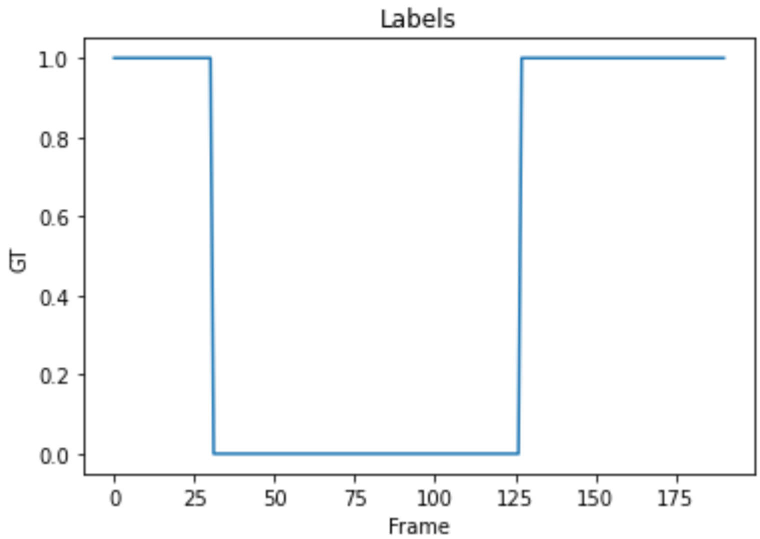



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test025
GT:  25
got model
(200, 227, 227, 1)
got data
```

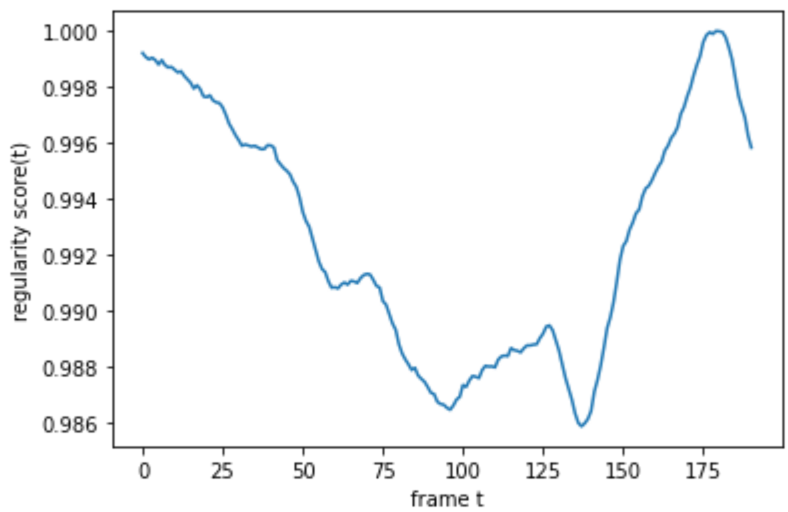



```
AUC:  0.24155701754385966
EER:  0.4791666666666667
EER THRESHOLD:  0.9959463228848823
Optimal threshold value is: 2.0
```

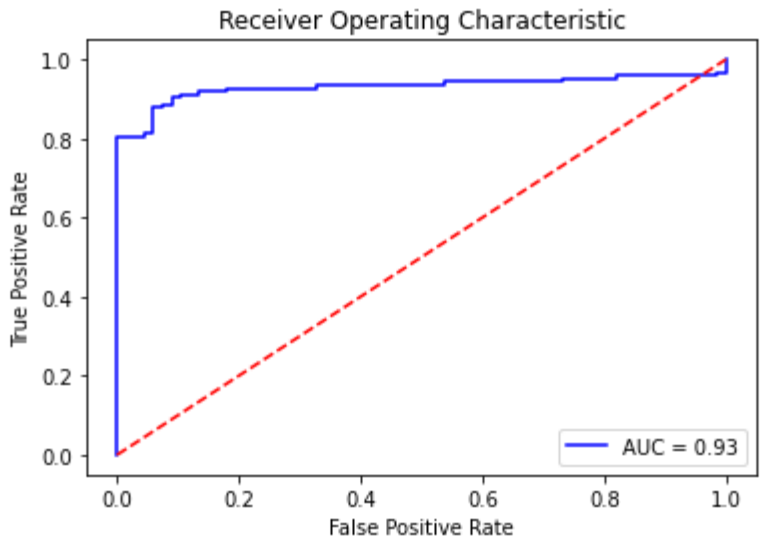


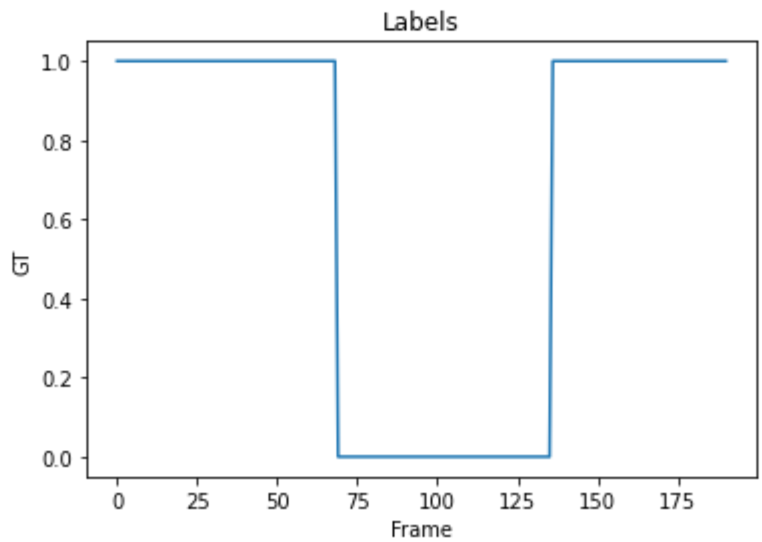



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test026
GT:  26
got model
(200, 227, 227, 1)
got data
```

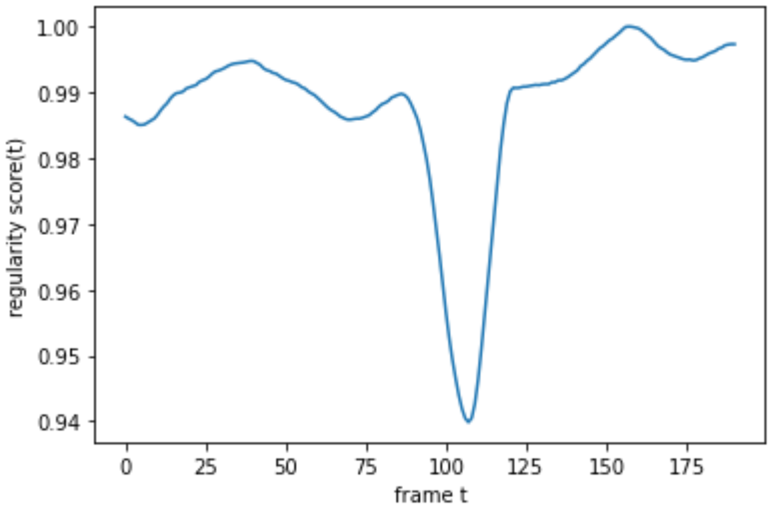



```
AUC:  0.9306692344727974
EER:  0.08955223880597014
EER THRESHOLD:  0.9907851614574545
Optimal threshold value is: 0.9909204029240108
```

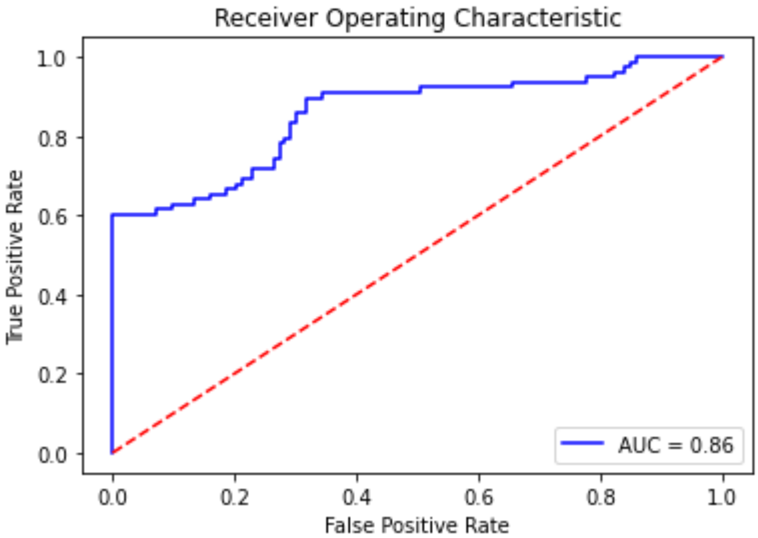


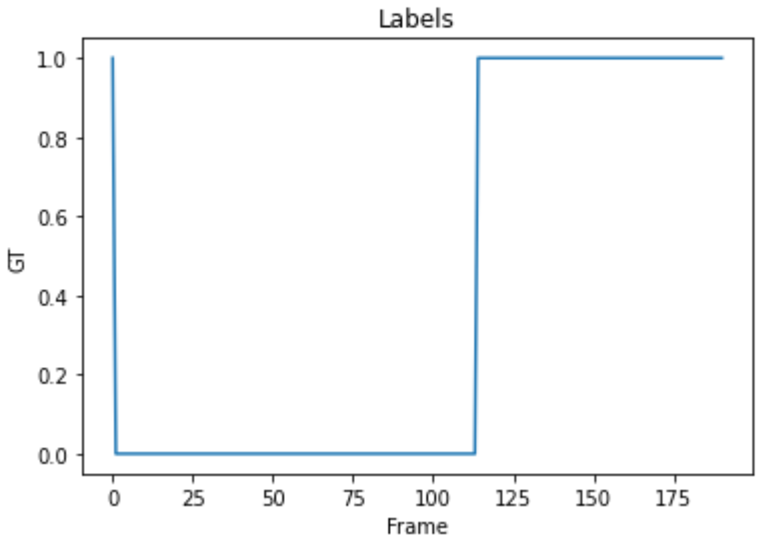



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test027
GT:  27
got model
(200, 227, 227, 1)
got data
```

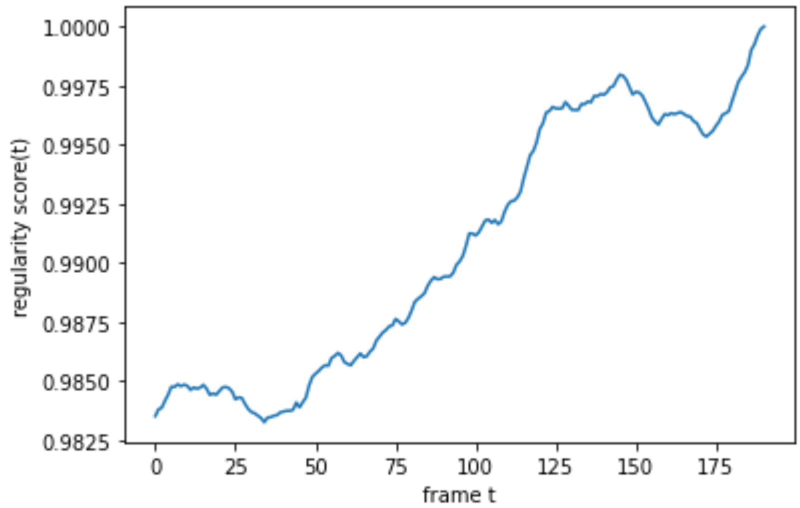



```
AUC:  0.8557975947356478
EER:  0.26548672566371684
EER THRESHOLD:  0.9915194228022246
Optimal threshold value is: 0.9947984979406236
```

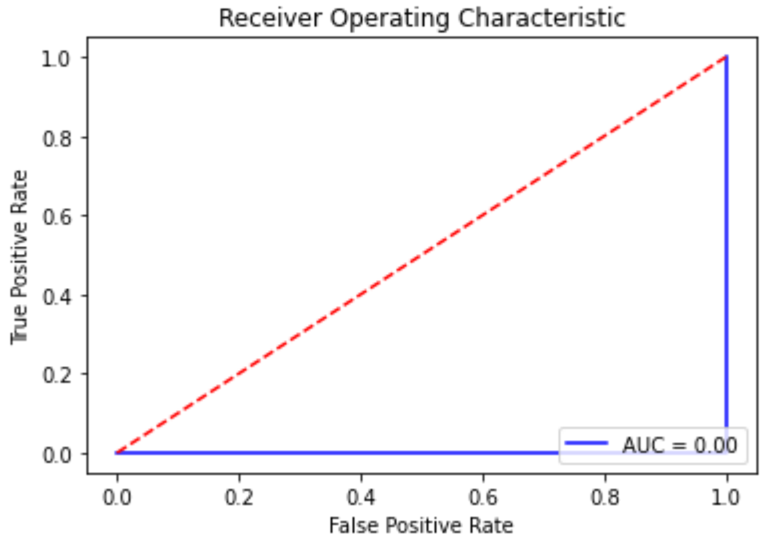


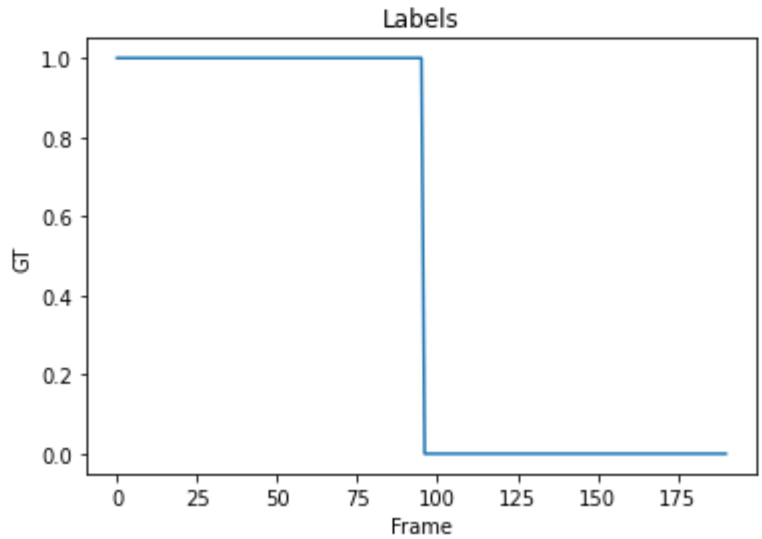



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test028
GT:  28
got model
(200, 227, 227, 1)
got data
```

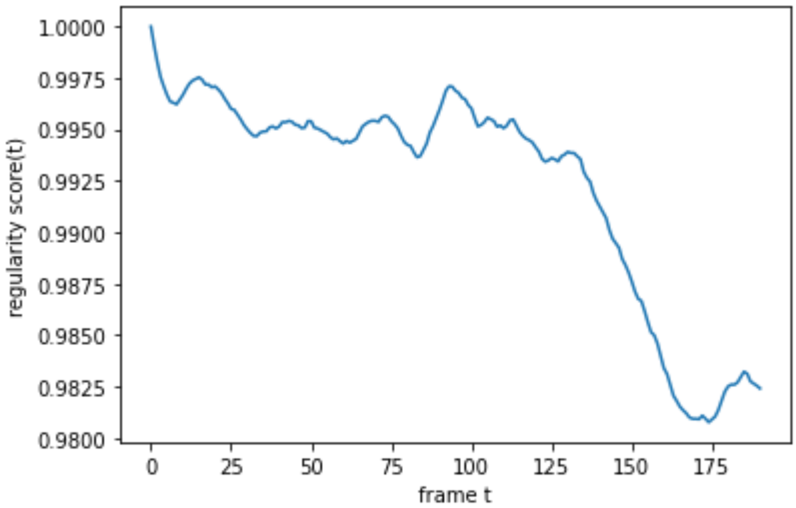



```
AUC:  0.0
EER:  1.0
EER THRESHOLD:  0.9902996203898919
Optimal threshold value is: 2.0
```

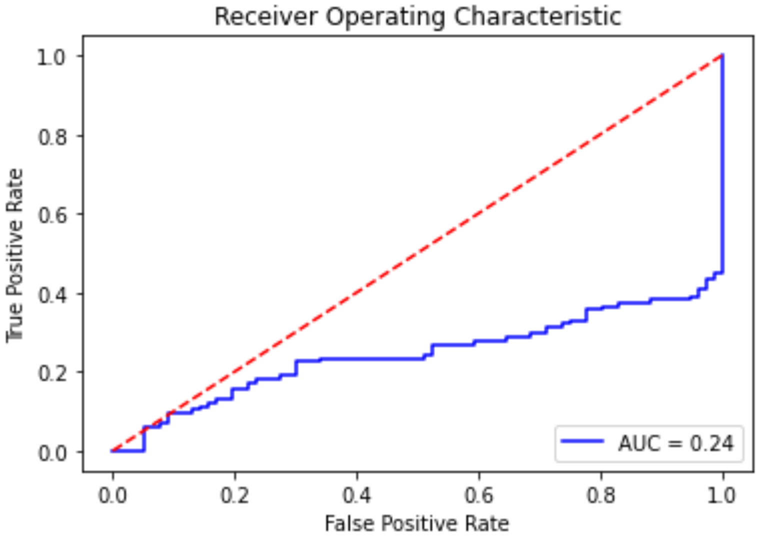


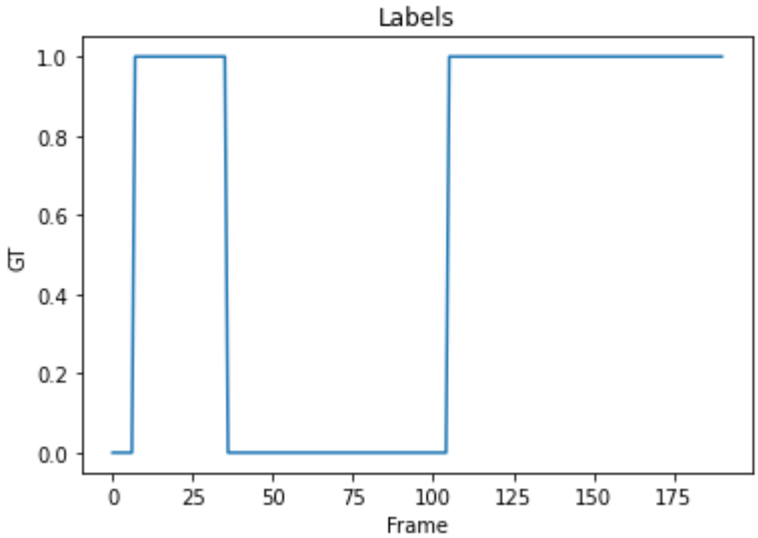



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test029
GT:  29
got model
(200, 227, 227, 1)
got data
```

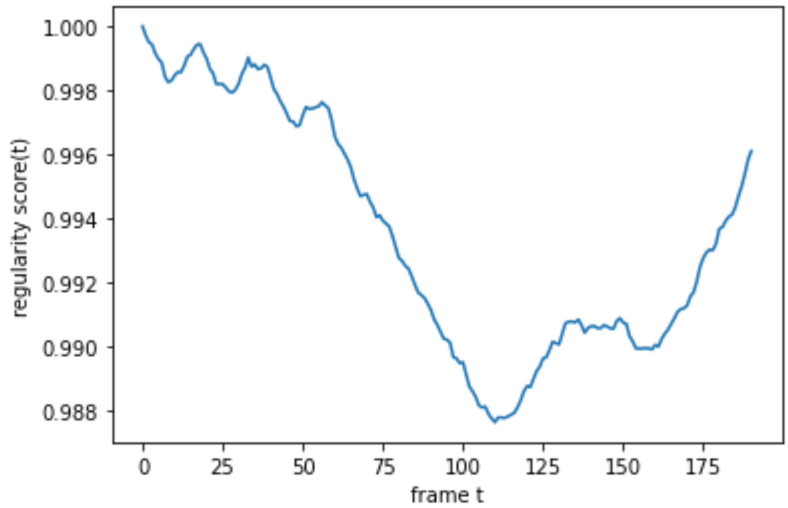



```
AUC:  0.24382151029748286
EER:  0.7105263157894737
EER THRESHOLD:  0.994904464217343
Optimal threshold value is: 0.9971800478413467
```

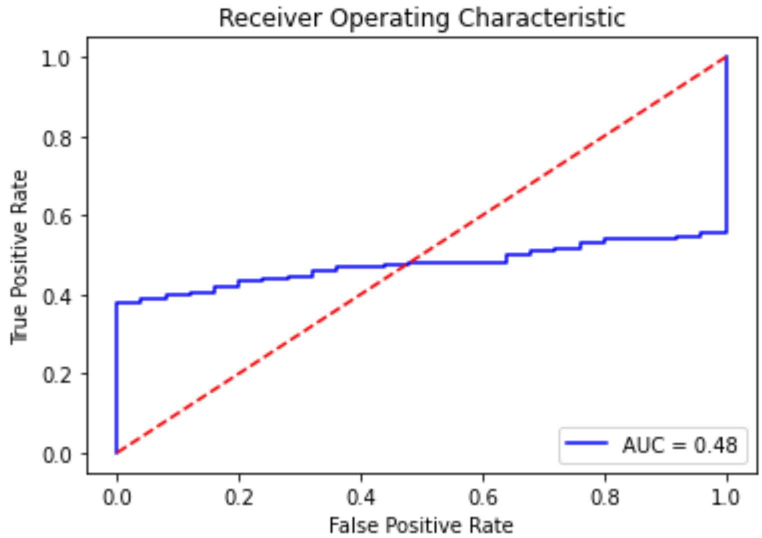


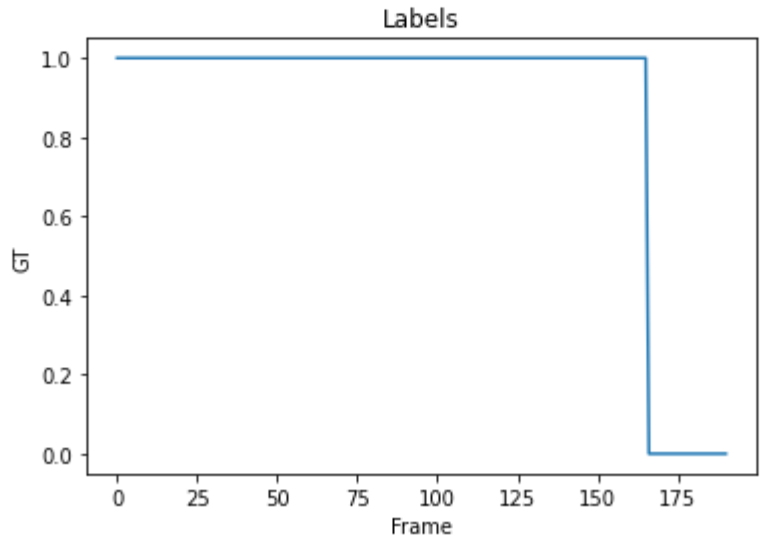



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test030
GT:  30
got model
(200, 227, 227, 1)
got data
```

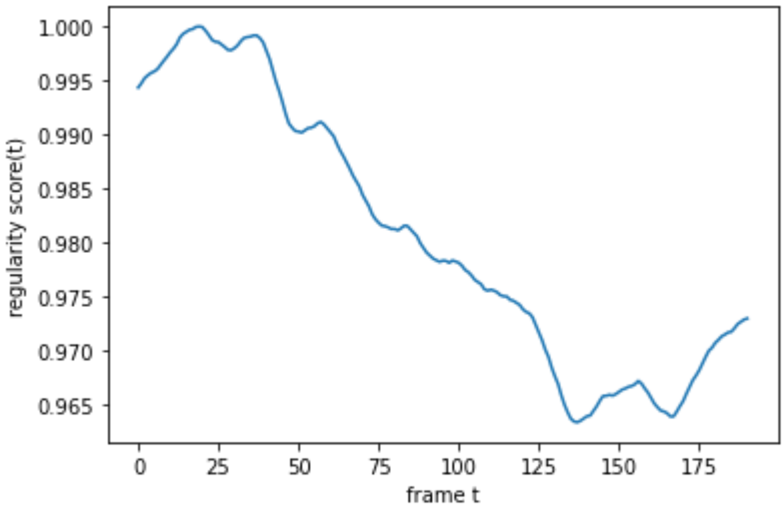



```
AUC:  0.4761445783132531
EER:  0.48
EER THRESHOLD:  0.9931200708512489
Optimal threshold value is: 0.9962185845343665
```

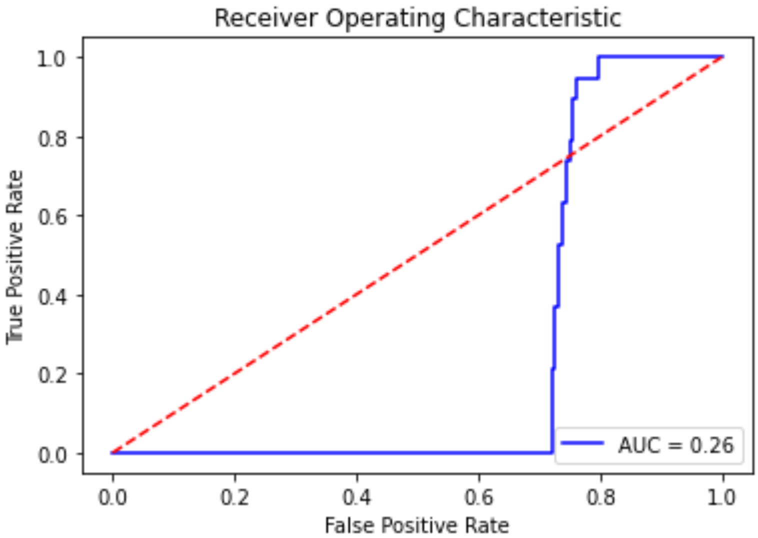


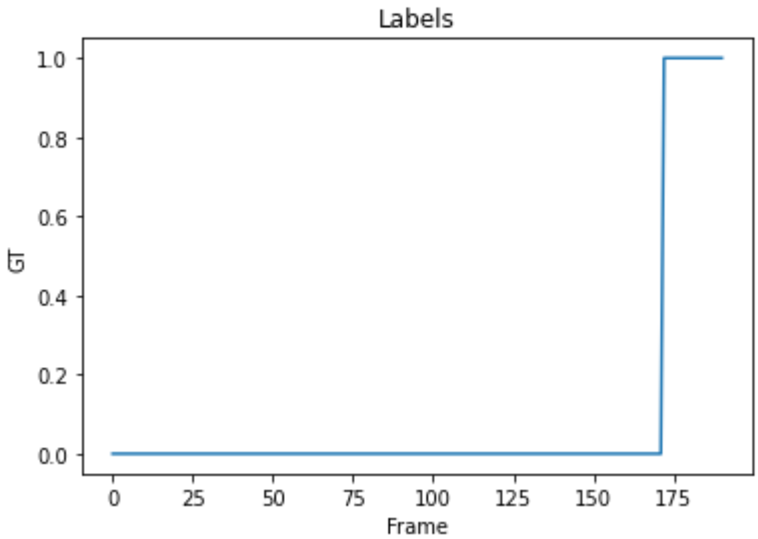



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test031
GT:  31
got model
(200, 227, 227, 1)
got data
```

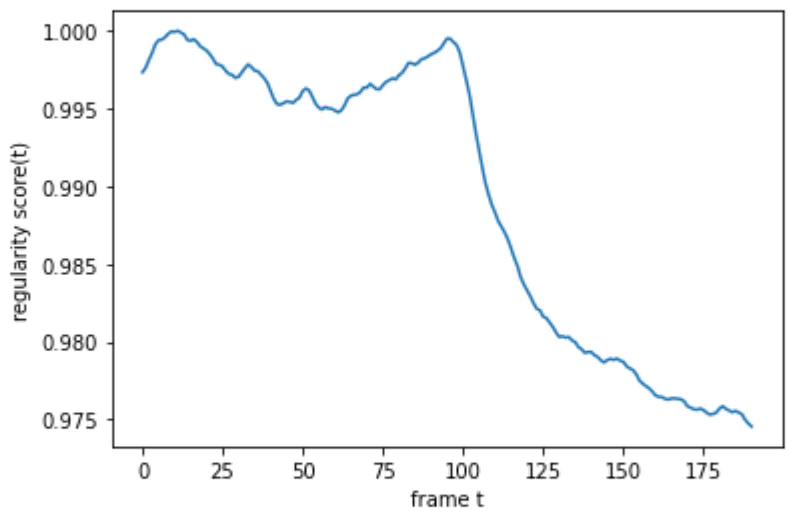



```
AUC:  0.26070991432068547
EER:  0.7267441860465116
EER THRESHOLD:  0.9724247640801621
Optimal threshold value is: 0.9666916064894348
```

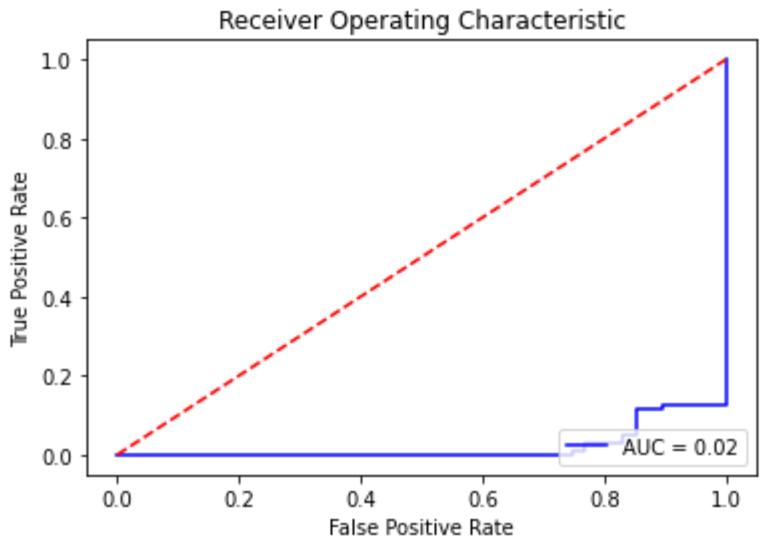


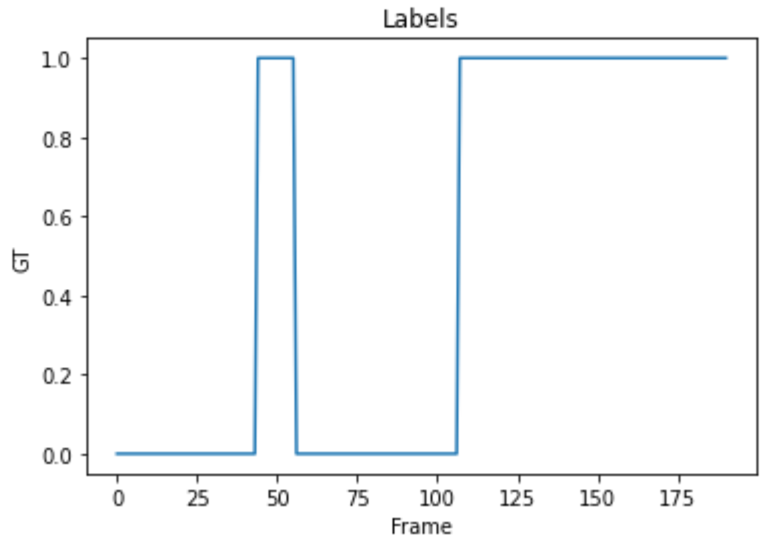



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test032
GT:  32
got model
(200, 227, 227, 1)
got data
```

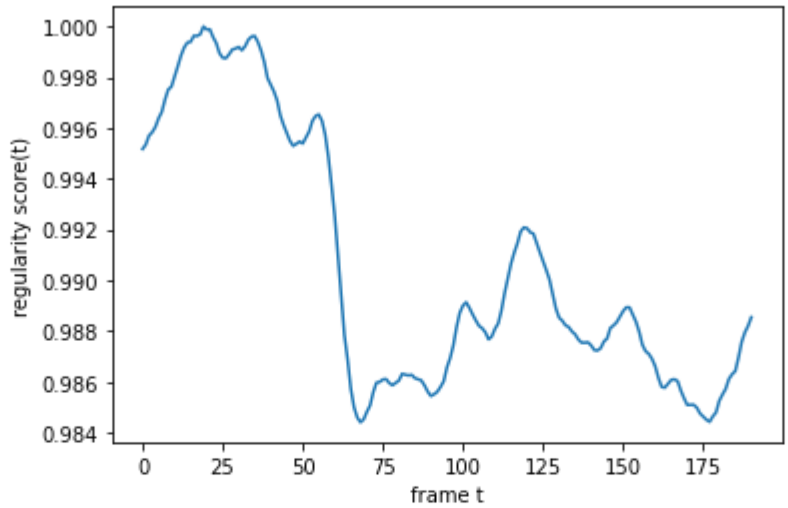



```
AUC:  0.021271929824561404
EER:  0.8947368421052632
EER THRESHOLD:  0.9950976292890535
Optimal threshold value is: 2.0
```

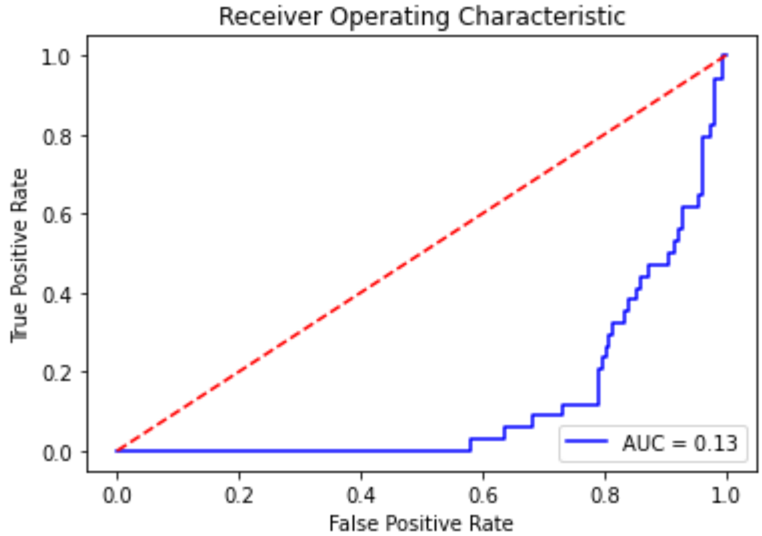


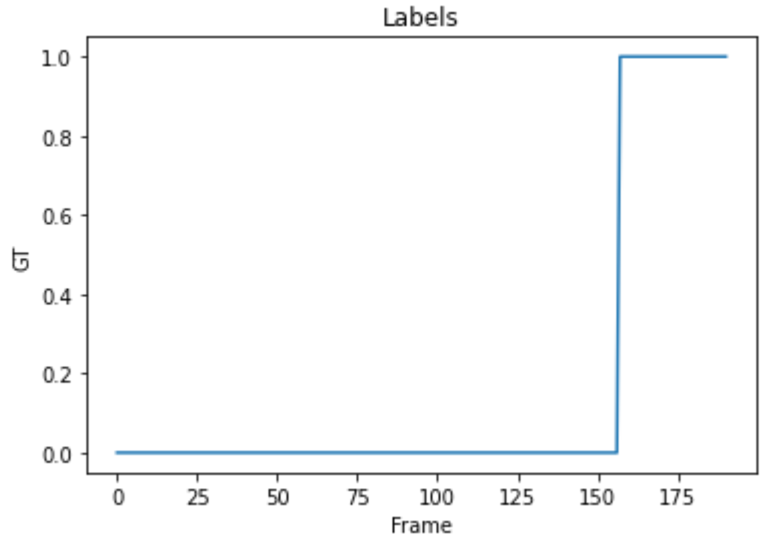



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test033
GT:  33
got model
(200, 227, 227, 1)
got data
```

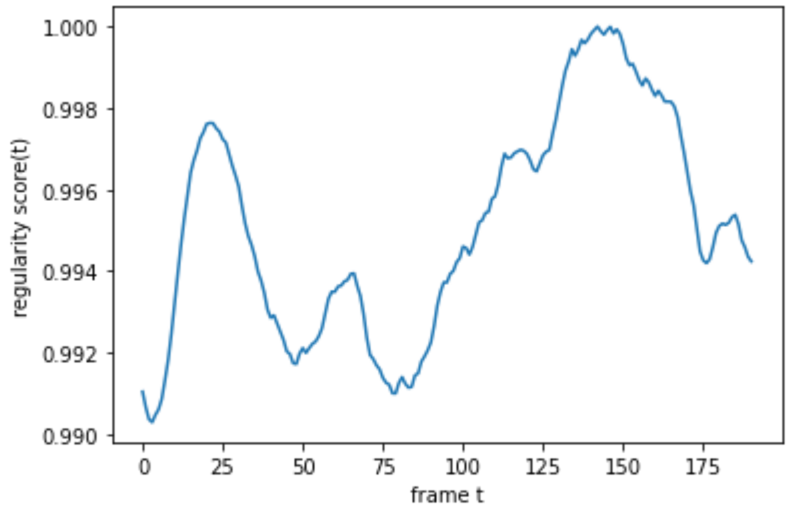



```
AUC:  0.12532783814162607
EER:  0.7961783439490446
EER THRESHOLD:  0.9869319638317873
Optimal threshold value is: 0.9844201956651223
```

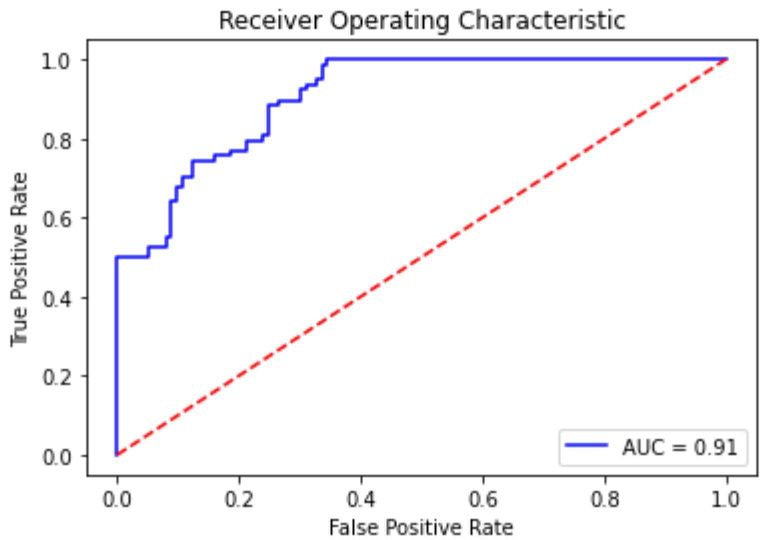


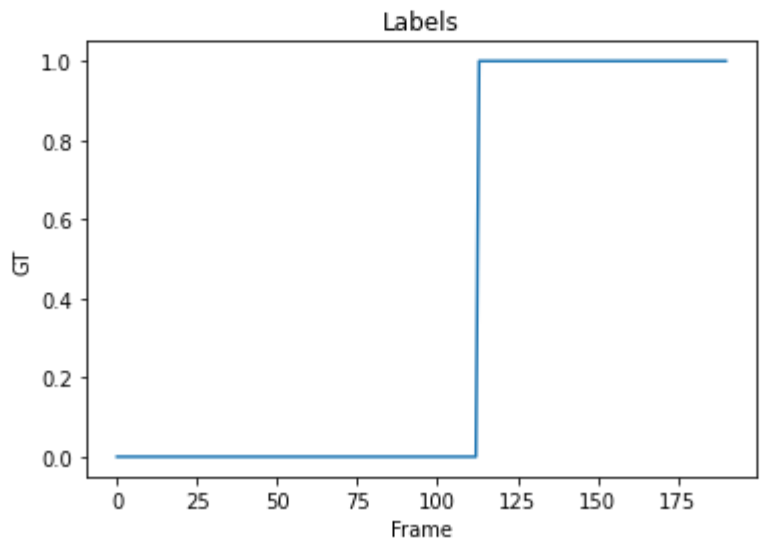



```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test034
GT:  34
got model
(200, 227, 227, 1)
got data
```

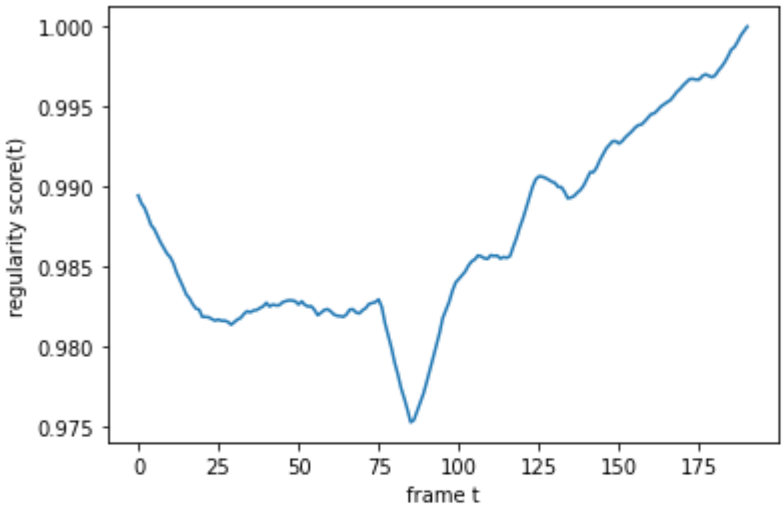



```
AUC:  0.9087814840027229
EER:  0.21238938053097345
EER THRESHOLD:  0.9953304895562725
Optimal threshold value is: 0.9941964849224201
```






```
PATH:  UCSD/UCSD_Anomaly_Dataset.v1p2/UCSDped1/Test/Test035
GT:  35
got model
(200, 227, 227, 1)
got data
```




```
AUC:  0.20141262246525404
EER:  0.8070175438596491
EER THRESHOLD:  0.9837361944188204
Optimal threshold value is: 0.9813665937689471
```

Receiver Operating Characteristic

In [13]:

```
"""
#manually counting tp, fp, tn, fn

#OUTCOME: very similar ROC and AUC, but this manual version would require c

def multiTresh(pr):
    treshMin, treshMax, step=min(pr),max(pr),0.01
    treshold = treshMin
    dif=0
    rangeFrom, rangeTo = 59, 152+1  #range from the TestVideoFile[1]
    rate,pair=[],[]


    while(treshold<treshMax):
        treshold = treshold + step
        truePositive, falsePositive, falseNegative, trueNegative = 0,0,0,0

        for ii in range(len(pr)):
            if pr[ii]<treshold and ii in range(rangeFrom, rangeTo):
                truePositive +=1
            if pr[ii]<treshold and ii not in range(rangeFrom, rangeTo):
                falsePositive += 1
            if pr[ii]>treshold and ii in range(rangeFrom, rangeTo):
                falseNegative +=1
            if pr[ii]>treshold and ii not in range(rangeFrom, rangeTo):
                trueNegative += 1
        pair=[]
        tpr=truePositive/(truePositive  + falseNegative)
        pair.append(tpr)
        fpr=falsePositive/(trueNegative+ falsePositive )
        pair.append(fpr)
        rate.append(pair)
    return rate


pairs=multiTresh(pr)
for ii in range(len(pairs)):
    print(pairs[ii])

roc_point = pairs
pivot = pd.DataFrame(roc_point, columns = ["x", "y"])
pivot

#ROC
plt.scatter(pivot.y, pivot.x)
plt.plot([0,1])
plt.xlabel('false positive rate')
plt.ylabel('true positive rate')

#AUC
from numpy import trapz
auc = np.trapz(pivot.x, pivot.y)
auc
"""
```

Out[13]:

```
'\n#manually counting tp, fp, tn, fn  \n\n#OUTCOME: very similar ROC and AU
C, but this manual version would require changing the videos each time by h
and\n\ndef multiTresh(pr):\n    treshMin, treshMax, step=min(pr),max(pr),0.
01\n    treshold = treshMin\n    dif=0\n    rangeFrom, rangeTo = 59, 152+1 
#range from the TestVideoFile[1]\n    rate,pair=[],[]\n      \n\n    while
(treshold<treshMax):\n        treshold = treshold + step\n        truePosit
```

```
ive, falsePositive, falseNegative, trueNegative = 0,0,0,0 \n      \n
for ii in range(len(pr)):\n            if pr[ii]<treshold and ii in range(r
angeFrom, rangeTo):\n                truePositive +=1\n            if pr[i
i]<treshold and ii not in range(rangeFrom, rangeTo):\n                false
Positive += 1  \n            if pr[ii]>treshold and ii in range(rangeFrom,
rangeTo):\n                falseNegative +=1\n            if pr[ii]>treshol
d and ii not in range(rangeFrom, rangeTo):\n                trueNegative +=
1 \n        pair=[]\n        tpr=truePositive/(truePositive  + falseNegativ
e)\n        pair.append(tpr)\n        fpr=falsePositive/(trueNegative+ fals
ePositive )\n        pair.append(fpr)\n        rate.append(pair)\n    retur
n rate\n\n\npairs=multiTresh(pr)\nfor ii in range(len(pairs)):\n    print(p
airs[ii]) \n\nroc_point = pairs    \npivot = pd.DataFrame(roc_point, column
s = ["x", "y"])\npivot\n\n#ROC\nplt.scatter(pivot.y, pivot.x)\nplt.plot([0,
1])\nplt.xlabel(\'false positive rate\')\nplt.ylabel(\'true positive rat
e\')\n\n#AUC\nfrom numpy import trapz\nauc = np.trapz(pivot.x, pivot.y)\nau
```