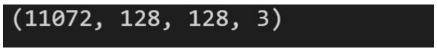
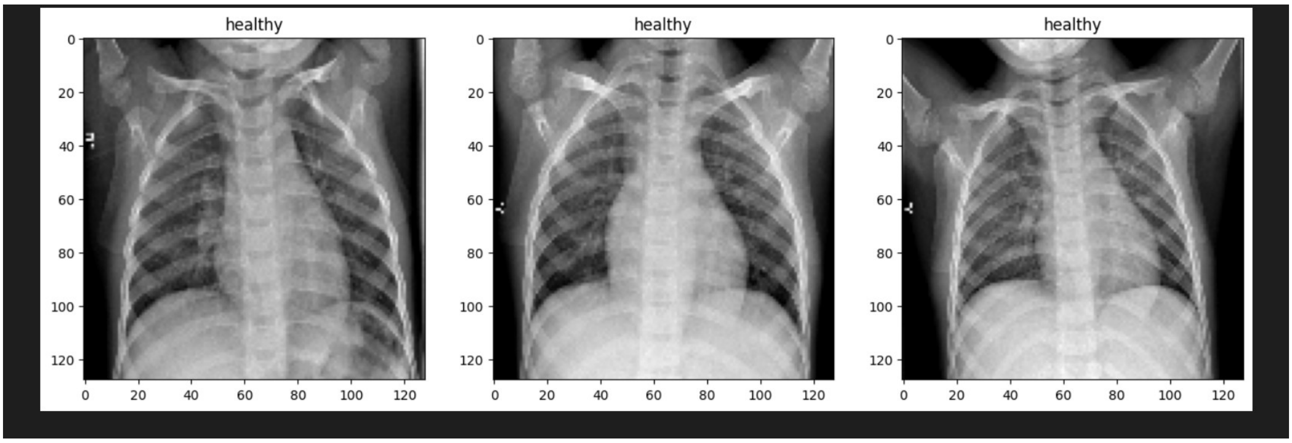
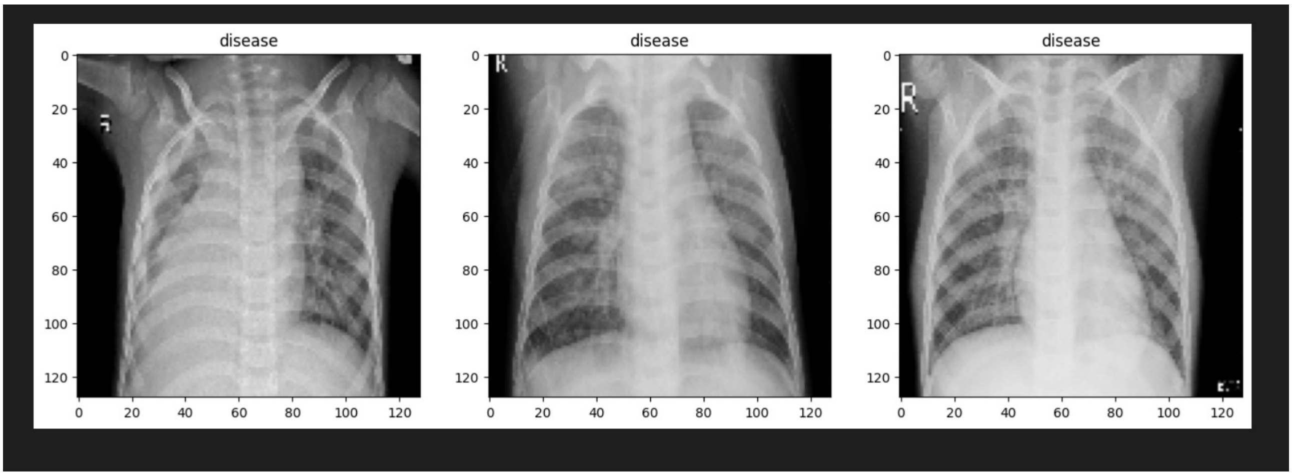
```
import numpy as np
import torch
from torch.utils.data import Dataset, DataLoader
import glob
import matplotlib.pyplot as plt
from sklearn.metrics import confusion_matrix, accuracy_score
import cv2
import random
import sys

# Reading images
disease = []
path = './test/PNEUMONIA/*.jpeg'
for f in glob.iglob(path):
    img = cv2.imread(f)
    img = cv2.resize(img,(128,128))
    b, g, r = cv2.split(img);
    img = cv2.merge([r, g, b])
    disease.append(img)
path = './train/PNEUMONIA/*.jpeg'
for f in glob.iglob(path):
    img = cv2.imread(f)
    img = cv2.resize(img,(128,128))
    b, g, r = cv2.split(img);
    img = cv2.merge([r, g, b])
    disease.append(img)
path = './val/PNEUMONIA/*.jpeg'
for f in glob.iglob(path):
    img = cv2.imread(f)
    img = cv2.resize(img,(128,128))
    b, g, r = cv2.split(img);
    img = cv2.merge([r, g, b])
    disease.append(img)




healthy = []
path = './test/NORMAL/*.jpeg'
for f in glob.iglob(path):
    img = cv2.imread(f)
    img = cv2.resize(img,(128,128))
    b, g, r = cv2.split(img);
    img = cv2.merge([r, g, b])
    healthy.append(img)
path = './train/NORMAL/*.jpeg'
for f in glob.iglob(path):
    img = cv2.imread(f)
    img = cv2.resize(img,(128,128))
    b, g, r = cv2.split(img);
    img = cv2.merge([r, g, b])
    healthy.append(img)
path = './val/NORMAL/*.jpeg'
for f in glob.iglob(path):
    img = cv2.imread(f)
    img = cv2.resize(img,(128,128))
    b, g, r = cv2.split(img);
    img = cv2.merge([r, g, b])
    healthy.append(img)


healthy = np.array(healthy)
disease = np.array(disease)
All = np.concatenate((healthy, disease))




All.shape
```



```
(11072, 128, 128, 3)
```

```
# Visualising lung disease images
def plot_random(healthy, disease, num=5):
    healthy_imgs = healthy[np.random.choice(healthy.shape[0], num, replace=False)]
    disease_imgs = disease[np.random.choice(disease.shape[0], num, replace=False)]

    plt.figure(figsize=(16,9))
    for i in range(num):
        plt.subplot(1, num, i+1)
        plt.title("healthy")
        plt.imshow(healthy_imgs[i])

    plt.figure(figsize=(16,9))
    for i in range(num):
        plt.subplot(1, num, i+1)
        plt.title("disease")
        plt.imshow(disease_imgs[i])


plot_random(healthy,disease,3)
```

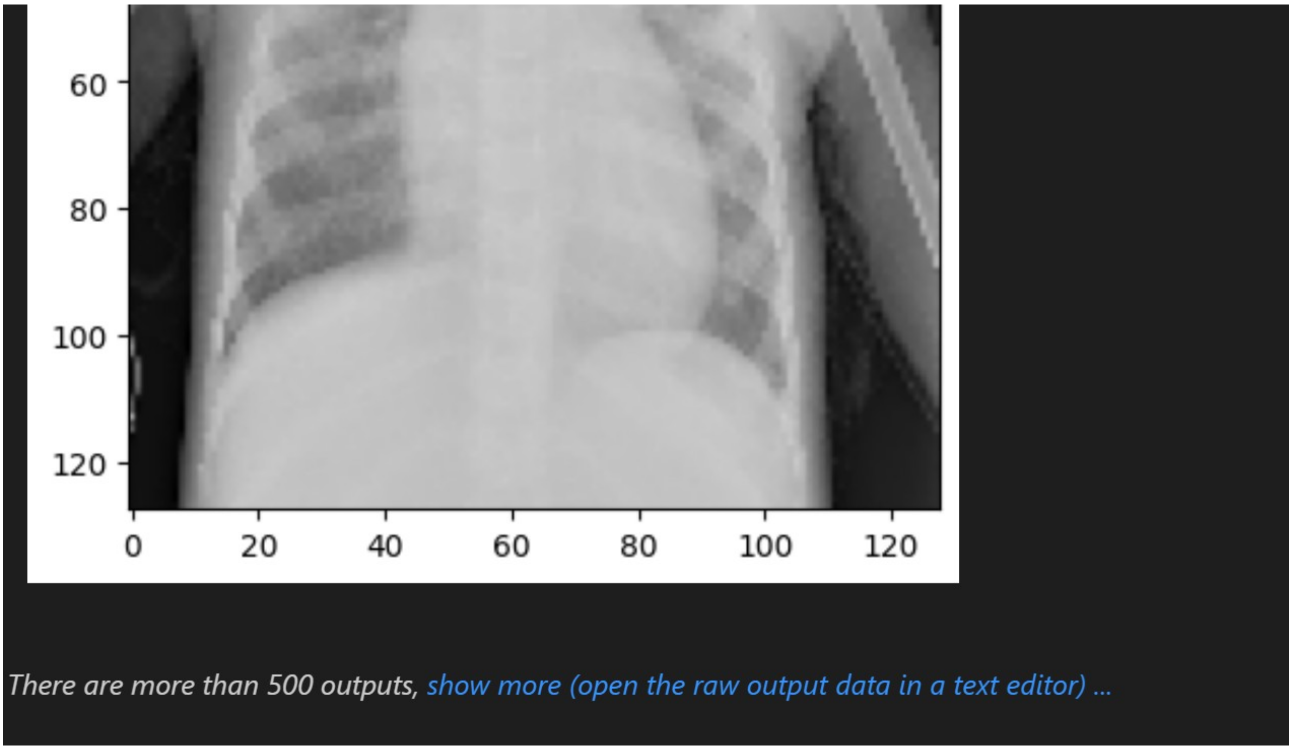




```
from torch.utils.data import ConcatDataset


class Dataset(object):
    def __getitem__(self, index):
        raise NotImplementedError

    def __len__(self):
        raise NotImplementedError

    def __add__(self,other):
        return ConcatDataset([self, other])


# CT class

class CT(Dataset):
    def __init__(self):
        disease = []
        path = './test/PNEUMONIA/*.jpeg'
        for f in glob.iglob(path):
            img = cv2.imread(f)
            img = cv2.resize(img,(128,128))
            b, g, r = cv2.split(img);
            img = cv2.merge([r, g, b])
            disease.append(img)
        path = './train/PNEUMONIA/*.jpeg'
        for f in glob.iglob(path):
            img = cv2.imread(f)
            img = cv2.resize(img,(128,128))
            b, g, r = cv2.split(img);
            img = cv2.merge([r, g, b])
            disease.append(img)
        path = './val/PNEUMONIA/*.jpeg'
        for f in glob.iglob(path):
            img = cv2.imread(f)
            img = cv2.resize(img,(128,128))
            b, g, r = cv2.split(img);
            img = cv2.merge([r, g, b])
            disease.append(img)

        healthy = []
        path = './test/NORMAL/*.jpeg'
        for f in glob.iglob(path):
            img = cv2.imread(f)
            img = cv2.resize(img,(128,128))
            b, g, r = cv2.split(img);
            img = cv2.merge([r, g, b])
            healthy.append(img)
        path = './train/NORMAL/*.jpeg'
        for f in glob.iglob(path):
            img = cv2.imread(f)
            img = cv2.resize(img,(128,128))
            b, g, r = cv2.split(img);
            img = cv2.merge([r, g, b])
            healthy.append(img)
        path = './val/NORMAL/*.jpeg'
        for f in glob.iglob(path):
            img = cv2.imread(f)
            img = cv2.resize(img,(128,128))
            b, g, r = cv2.split(img);
            img = cv2.merge([r, g, b])
            healthy.append(img)

        # Images
        healthy = np.array(healthy,dtype=np.float32)
        disease = np.array(disease,dtype=np.float32)
        All = np.concatenate((healthy, disease))

        # Assign labels: 0 for healthy, 1 for disease
        healthy_labels = np.zeros(healthy.shape[0], dtype=np.float32)
        disease_labels = np.ones(disease.shape[0], dtype=np.float32)

        #Concatenate
        self.images = np.concatenate((healthy, disease), axis = 0)
        self.labels = np.concatenate((healthy_labels, disease_labels))

    def __len__(self):
        return self.images.shape[0]

    def __getitem__(self,index):
        sample = {'image':self.images[index], 'label': self.labels[index]}
        return sample

    def normalize(self):
        self.images = self.images/255.0



# Create an object of the CT class
ct_dataset = CT()
ct_dataset.normalize()


healthy.shape
```

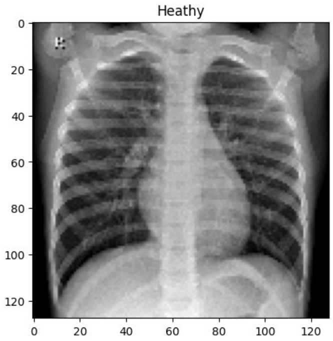
```
(2924, 128, 128, 3) (output)
```

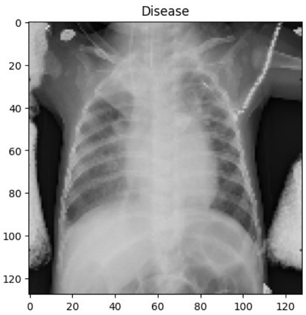
```
# Iterating through the dataset

index = list(range(len(ct_dataset)))

random.shuffle(index)

for idx in index:

    sample = ct_dataset[idx]

    img = sample['image']

    label = sample['label']

    plt.title(label)

    plt.imshow(img)

    plt.show()
```

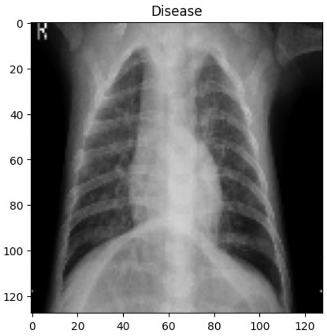


There are more than 500 outputs, show more (open the raw output data in a text editor) ...

```
# Creating a dataloader
dataloader = DataLoader(ct_dataset)

# One way of iterating
names={0:'Heathy', 1:'Disease'}
dataloader = DataLoader(ct_dataset, shuffle=True)
for i, sample in enumerate(dataloader):
    img = sample['image'].squeeze()
    img = img.reshape((img.shape[1], img.shape[2], img.shape[0]))
    img = img.reshape((img.shape[0], img.shape[2], img.shape[1]))
    plt.title(names[sample['label'].item()])
    plt.imshow(img)
    plt.show()
    if i == 5:
        break
```

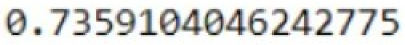






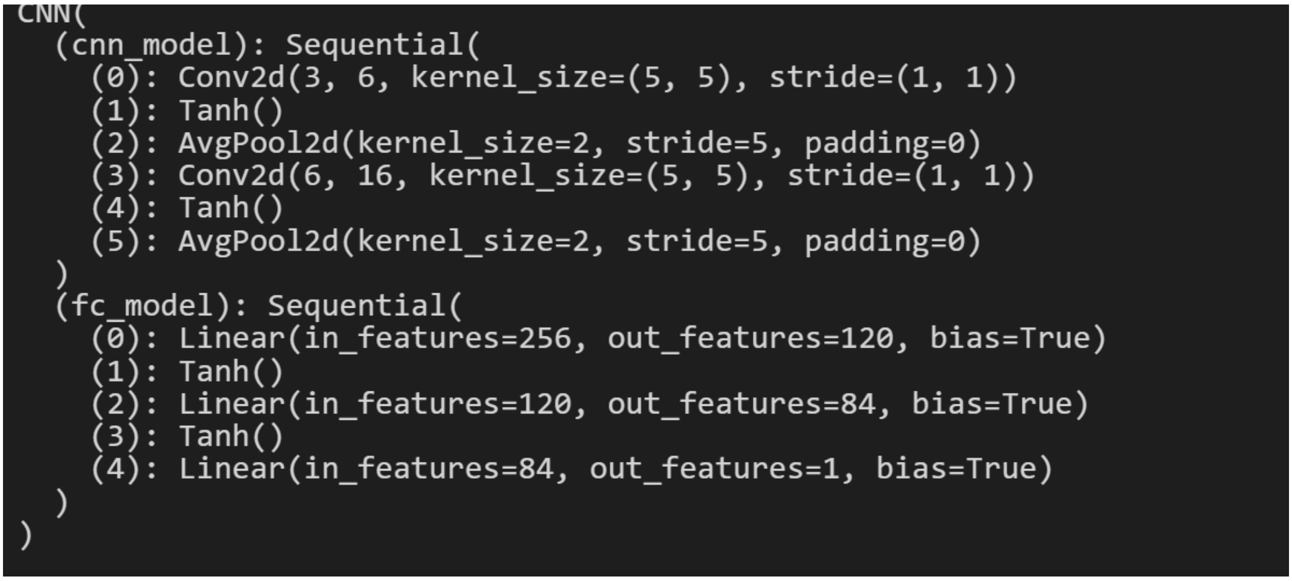
# Model

```
import torch.nn as nn
import torch.nn.functional as F

class CNN(nn.Module):
    def __init__(self):
        super(CNN,self).__init__()
        self.cnn_model = nn.Sequential(
        nn.Conv2d(in_channels=3, out_channels=6, kernel_size=5),
        nn.Tanh(),
        nn.AvgPool2d(kernel_size=2, stride=5),
        nn.Conv2d(in_channels=6, out_channels=16, kernel_size=5),
        nn.Tanh(),
        nn.AvgPool2d(kernel_size=2, stride=5))

        self.fc_model = nn.Sequential(
        nn.Linear(in_features=256, out_features=120),
        nn.Tanh(),
        nn.Linear(in_features=120, out_features=84),
        nn.Tanh(),
        nn.Linear(in_features=84, out_features=1))

    def forward(self, x):
        x = self.cnn_model(x)
        x = x.reshape(x.size(0), -1)
        x = self.fc_model(x)
        x = F.sigmoid(x)

        return x




ct_dataset = CT()
ct_dataset.normalize()
device = torch.device('cuda:0')
model = CNN()


dataloader = DataLoader(ct_dataset, batch_size=32, shuffle=False)

model.eval()
outputs = []
y_true = []
with torch.no_grad():
    for D in dataloader:
        image = D['image'].to('cpu').float()  # Convert input data to float32
        # Assuming the input data shape is (batch_size, 128, 128, 3)
        image = image.permute(0, 3, 1, 2)  # Rearrange channels to (batch_size, 3, 128, 128)
        label = D['label'].to('cpu')
        y_hat = model(image)

        outputs.append(y_hat.cpu().detach().numpy())
        y_true.append(label.cpu().detach().numpy())



outputs = np.concatenate( outputs, axis=0 ).squeeze()
y_true = np.concatenate( y_true, axis=0 ).squeeze()



def threshold(scores,threshold=0.50, minimum=0, maximum = 1.0):
    x = np.array(list(scores))
    x[x >= threshold] = maximum
    x[x < threshold] = minimum
    return x
#  accuracy of un-trained model

accuracy_score(y_true, threshold(outputs))
```



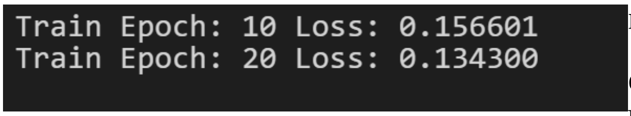
```
0.7359104046242775
```

```
eta = 0.0001
EPOCH = 21
optimizer = torch.optim.Adam(model.parameters(), lr=eta)
dataloader = DataLoader(ct_dataset, batch_size=32, shuffle=True)
model.train()
```



```
CNN(
  (cnn_model): Sequential(
    (0): Conv2d(3, 6, kernel_size=(5, 5), stride=(1, 1))
    (1): Tanh()
    (2): AvgPool2d(kernel_size=2, stride=5, padding=0)
    (3): Conv2d(6, 16, kernel_size=(5, 5), stride=(1, 1))
    (4): Tanh()
    (5): AvgPool2d(kernel_size=2, stride=5, padding=0)
  )
  (fc_model): Sequential(
    (0): Linear(in_features=256, out_features=120, bias=True)
    (1): Tanh()
    (2): Linear(in_features=120, out_features=84, bias=True)
    (3): Tanh()
    (4): Linear(in_features=84, out_features=1, bias=True)
  )
)
```

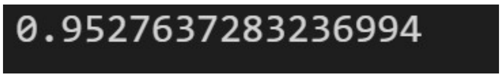
```
for epoch in range(1, EPOCH):
    losses = []
    for D in dataloader:
        optimizer.zero_grad()
        data = D['image'].to('cpu').float()
        data = data.permute(0, 3, 1, 2)
        label = D['label'].to('cpu').float()
        y_hat = model(data)
        # define loss function
        error = nn.BCELoss()
        loss = torch.sum(error(y_hat.squeeze(), label))
        loss.backward()
        optimizer.step()
        losses.append(loss.item())
    if (epoch+1) % 10 == 0:
        print('Train Epoch: {}\tLoss: {:.6f}'.format(epoch+1, np.mean(losses)))
```



```
Train Epoch: 10 Loss: 0.156601
Train Epoch: 20 Loss: 0.134300
```

```
model.eval()
dataloader = DataLoader(ct_dataset, batch_size=32, shuffle=False)
outputs=[]
```

```
y_true = []
with torch.no_grad():
    for D in dataloader:
        image =  D['image'].to('cpu').float()
        image = image.permute(0, 3, 1, 2)
        label = D['label'].to('cpu').float()

        y_hat = model(image)

        outputs.append(y_hat.cpu().detach().numpy())
        y_true.append(label.cpu().detach().numpy())

outputs = np.concatenate( outputs, axis=0 )
y_true = np.concatenate( y_true, axis=0 )



# accuracy of trained mode
accuracy_score(y_true, threshold(outputs))
```



```
0.9527637283236994
```