In [ ]:
```
# This Python 3 environment comes with many helpful analytics libraries installe
# It is defined by the kaggle/python Docker image: https://github.com/kaggle/doc
# For example, here's several helpful packages to load

import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the read-only "../input/" directory
# For example, running this (by clicking run or pressing Shift+Enter) will list

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        os.path.join(dirname, filename)

# You can write up to 20GB to the current directory (/kaggle/working/) that gets
# You can also write temporary files to /kaggle/temp/, but they won't be saved o
```

In [1]:
```
!sudo apt-get install -y python-dev pkg-config
!sudo apt-get install -y \
    libavformat-dev libavcodec-dev libavdevice-dev \
    libavutil-dev libswscale-dev libswresample-dev libavfilter-dev
!pip install av
```

```
Reading package lists... Done
Building dependency tree
Reading state information... Done
Note, selecting 'python-dev-is-python2' instead of 'python-dev'
pkg-config is already the newest version (0.29.1-0ubuntu4).
The following additional packages will be installed:
  libexpat1-dev libpython2-dev libpython2-stdlib libpython2.7 libpython2.7-dev
  libpython2.7-minimal libpython2.7-stdlib python-is-python2 python2
  python2-dev python2-minimal python2.7 python2.7-dev python2.7-minimal
Suggested packages:
  python2-doc python-tk python2.7-doc binfmt-support
The following NEW packages will be installed:
  libexpat1-dev libpython2-dev libpython2-stdlib libpython2.7 libpython2.7-dev
  libpython2.7-minimal libpython2.7-stdlib python-dev-is-python2
  python-is-python2 python2 python2-dev python2-minimal python2.7
  python2.7-dev python2.7-minimal
0 upgraded, 15 newly installed, 0 to remove and 76 not upgraded.
Need to get 7737 kB of archives.
After this operation, 35.0 MB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 libpython2.7-
minimal amd64 2.7.18-1~20.04.3 [336 kB]
Get:2 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 python2.7-min
imal amd64 2.7.18-1~20.04.3 [1280 kB]
Get:3 http://archive.ubuntu.com/ubuntu focal/universe amd64 python2-minimal amd64
2.7.17-2ubuntu4 [27.5 kB]
Get:4 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 libpython2.7-
stdlib amd64 2.7.18-1~20.04.3 [1888 kB]
Get:5 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 python2.7 amd
64 2.7.18-1~20.04.3 [248 kB]
Get:6 http://archive.ubuntu.com/ubuntu focal/universe amd64 libpython2-stdlib amd
64 2.7.17-2ubuntu4 [7072 B]
Get:7 http://archive.ubuntu.com/ubuntu focal/universe amd64 python2 amd64 2.7.17-
2ubuntu4 [26.5 kB]
Get:8 http://archive.ubuntu.com/ubuntu focal-updates/main amd64 libexpat1-dev amd
64 2.2.9-1ubuntu0.6 [116 kB]
Get:9 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 libpython2.7
amd64 2.7.18-1~20.04.3 [1037 kB]
Get:10 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 libpython2.7
-dev amd64 2.7.18-1~20.04.3 [2466 kB]
Get:11 http://archive.ubuntu.com/ubuntu focal/universe amd64 libpython2-dev amd64
2.7.17-2ubuntu4 [7140 B]
Get:12 http://archive.ubuntu.com/ubuntu focal/universe amd64 python-is-python2 al
l 2.7.17-4 [2496 B]
Get:13 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 python2.7-de
v amd64 2.7.18-1~20.04.3 [293 kB]
Get:14 http://archive.ubuntu.com/ubuntu focal/universe amd64 python2-dev amd64 2.
7.17-2ubuntu4 [1268 B]
Get:15 http://archive.ubuntu.com/ubuntu focal/universe amd64 python-dev-is-python
2 all 2.7.17-4 [1396 B]
Fetched 7737 kB in 1s (5632 kB/s)
Selecting previously unselected package libpython2.7-minimal:amd64.
(Reading database ... 111522 files and directories currently installed.)
Preparing to unpack .../0-libpython2.7-minimal_2.7.18-1~20.04.3_amd64.deb ...
Unpacking libpython2.7-minimal:amd64 (2.7.18-1~20.04.3) ...
Selecting previously unselected package python2.7-minimal.
Preparing to unpack .../1-python2.7-minimal_2.7.18-1~20.04.3_amd64.deb ...
Unpacking python2.7-minimal (2.7.18-1~20.04.3) ...
Selecting previously unselected package python2-minimal.
Preparing to unpack .../2-python2-minimal_2.7.17-2ubuntu4_amd64.deb ...
Unpacking python2-minimal (2.7.17-2ubuntu4) ...
```

```
Selecting previously unselected package libpython2.7-stdlib:amd64.
Preparing to unpack .../3-libpython2.7-stdlib_2.7.18-1~20.04.3_amd64.deb ...
Unpacking libpython2.7-stdlib:amd64 (2.7.18-1~20.04.3) ...
Selecting previously unselected package python2.7.
Preparing to unpack .../4-python2.7_2.7.18-1~20.04.3_amd64.deb ...
Unpacking python2.7 (2.7.18-1~20.04.3) ...
Selecting previously unselected package libpython2-stdlib:amd64.
Preparing to unpack .../5-libpython2-stdlib_2.7.17-2ubuntu4_amd64.deb ...
Unpacking libpython2-stdlib:amd64 (2.7.17-2ubuntu4) ...
Setting up libpython2.7-minimal:amd64 (2.7.18-1~20.04.3) ...
Setting up python2.7-minimal (2.7.18-1~20.04.3) ...
Linking and byte-compiling packages for runtime python2.7...
Setting up python2-minimal (2.7.17-2ubuntu4) ...
Selecting previously unselected package python2.
(Reading database ... 112269 files and directories currently installed.)
Preparing to unpack .../0-python2_2.7.17-2ubuntu4_amd64.deb ...
Unpacking python2 (2.7.17-2ubuntu4) ...
Selecting previously unselected package libexpat1-dev:amd64.
Preparing to unpack .../1-libexpat1-dev_2.2.9-1ubuntu0.6_amd64.deb ...
Unpacking libexpat1-dev:amd64 (2.2.9-1ubuntu0.6) ...
Selecting previously unselected package libpython2.7:amd64.
Preparing to unpack .../2-libpython2.7_2.7.18-1~20.04.3_amd64.deb ...
Unpacking libpython2.7:amd64 (2.7.18-1~20.04.3) ...
Selecting previously unselected package libpython2.7-dev:amd64.
Preparing to unpack .../3-libpython2.7-dev_2.7.18-1~20.04.3_amd64.deb ...
Unpacking libpython2.7-dev:amd64 (2.7.18-1~20.04.3) ...
Selecting previously unselected package libpython2-dev:amd64.
Preparing to unpack .../4-libpython2-dev_2.7.17-2ubuntu4_amd64.deb ...
Unpacking libpython2-dev:amd64 (2.7.17-2ubuntu4) ...
Selecting previously unselected package python-is-python2.
Preparing to unpack .../5-python-is-python2_2.7.17-4_all.deb ...
Unpacking python-is-python2 (2.7.17-4) ...
Selecting previously unselected package python2.7-dev.
Preparing to unpack .../6-python2.7-dev_2.7.18-1~20.04.3_amd64.deb ...
Unpacking python2.7-dev (2.7.18-1~20.04.3) ...
Selecting previously unselected package python2-dev.
Preparing to unpack .../7-python2-dev_2.7.17-2ubuntu4_amd64.deb ...
Unpacking python2-dev (2.7.17-2ubuntu4) ...
Selecting previously unselected package python-dev-is-python2.
Preparing to unpack .../8-python-dev-is-python2_2.7.17-4_all.deb ...
Unpacking python-dev-is-python2 (2.7.17-4) ...
Setting up libpython2.7-stdlib:amd64 (2.7.18-1~20.04.3) ...
Setting up libexpat1-dev:amd64 (2.2.9-1ubuntu0.6) ...
Setting up libpython2.7:amd64 (2.7.18-1~20.04.3) ...
Setting up libpython2.7-dev:amd64 (2.7.18-1~20.04.3) ...
Setting up python2.7 (2.7.18-1~20.04.3) ...
Setting up libpython2-stdlib:amd64 (2.7.17-2ubuntu4) ...
Setting up python2 (2.7.17-2ubuntu4) ...
Setting up libpython2-dev:amd64 (2.7.17-2ubuntu4) ...
Setting up python-is-python2 (2.7.17-4) ...
Setting up python2.7-dev (2.7.18-1~20.04.3) ...
Setting up python2-dev (2.7.17-2ubuntu4) ...
Setting up python-dev-is-python2 (2.7.17-4) ...
Processing triggers for libc-bin (2.31-0ubuntu9.9) ...
Processing triggers for man-db (2.9.1-1) ...
Processing triggers for mime-support (3.64ubuntu1) ...
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
```

```
  libpostproc-dev
The following NEW packages will be installed:
  libavcodec-dev libavdevice-dev libavfilter-dev libavformat-dev libavutil-dev
  libpostproc-dev libswresample-dev libswscale-dev
0 upgraded, 8 newly installed, 0 to remove and 76 not upgraded.
Need to get 8633 kB of archives.
After this operation, 37.0 MB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 libavutil-dev
amd64 7:4.2.7-0ubuntu0.1 [365 kB]
Get:2 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 libswresample
-dev amd64 7:4.2.7-0ubuntu0.1 [70.6 kB]
Get:3 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 libavcodec-de
v amd64 7:4.2.7-0ubuntu0.1 [5428 kB]
Get:4 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 libavformat-d
ev amd64 7:4.2.7-0ubuntu0.1 [1187 kB]
Get:5 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 libpostproc-d
ev amd64 7:4.2.7-0ubuntu0.1 [55.3 kB]
Get:6 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 libswscale-de
v amd64 7:4.2.7-0ubuntu0.1 [177 kB]
Get:7 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 libavfilter-d
ev amd64 7:4.2.7-0ubuntu0.1 [1264 kB]
Get:8 http://archive.ubuntu.com/ubuntu focal-updates/universe amd64 libavdevice-d
ev amd64 7:4.2.7-0ubuntu0.1 [86.2 kB]
Fetched 8633 kB in 1s (9394 kB/s)
Selecting previously unselected package libavutil-dev:amd64.
(Reading database ... 112467 files and directories currently installed.)
Preparing to unpack .../0-libavutil-dev_7%3a4.2.7-0ubuntu0.1_amd64.deb ...
Unpacking libavutil-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Selecting previously unselected package libswresample-dev:amd64.
Preparing to unpack .../1-libswresample-dev_7%3a4.2.7-0ubuntu0.1_amd64.deb ...
Unpacking libswresample-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Selecting previously unselected package libavcodec-dev:amd64.
Preparing to unpack .../2-libavcodec-dev_7%3a4.2.7-0ubuntu0.1_amd64.deb ...
Unpacking libavcodec-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Selecting previously unselected package libavformat-dev:amd64.
Preparing to unpack .../3-libavformat-dev_7%3a4.2.7-0ubuntu0.1_amd64.deb ...
Unpacking libavformat-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Selecting previously unselected package libpostproc-dev:amd64.
Preparing to unpack .../4-libpostproc-dev_7%3a4.2.7-0ubuntu0.1_amd64.deb ...
Unpacking libpostproc-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Selecting previously unselected package libswscale-dev:amd64.
Preparing to unpack .../5-libswscale-dev_7%3a4.2.7-0ubuntu0.1_amd64.deb ...
Unpacking libswscale-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Selecting previously unselected package libavfilter-dev:amd64.
Preparing to unpack .../6-libavfilter-dev_7%3a4.2.7-0ubuntu0.1_amd64.deb ...
Unpacking libavfilter-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Selecting previously unselected package libavdevice-dev:amd64.
Preparing to unpack .../7-libavdevice-dev_7%3a4.2.7-0ubuntu0.1_amd64.deb ...
Unpacking libavdevice-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Setting up libavutil-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Setting up libswresample-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Setting up libavcodec-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Setting up libpostproc-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Setting up libavformat-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Setting up libswscale-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Setting up libavfilter-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Setting up libavdevice-dev:amd64 (7:4.2.7-0ubuntu0.1) ...
Collecting av
  Downloading av-10.0.0-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.whl
(30.7 MB)
```

```
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 30.7/30.7 MB 40.5 MB/s eta 0:00:000
0:0100:01
Installing collected packages: av
Successfully installed av-10.0.0
WARNING: Running pip as the 'root' user can result in broken permissions and conf
licting behaviour with the system package manager. It is recommended to use a vir
tual environment instead: https://pip.pypa.io/warnings/venv
```

In [2]:
```
!pip install torchviz
```

```
Collecting torchviz
  Downloading torchviz-0.0.2.tar.gz (4.9 kB)
  Preparing metadata (setup.py) ... done
Requirement already satisfied: torch in /opt/conda/lib/python3.7/site-packages (f
rom torchviz) (1.13.0)
Requirement already satisfied: graphviz in /opt/conda/lib/python3.7/site-packages
(from torchviz) (0.8.4)
Requirement already satisfied: typing-extensions in /opt/conda/lib/python3.7/site
-packages (from torch->torchviz) (4.4.0)
Building wheels for collected packages: torchviz
  Building wheel for torchviz (setup.py) ... done
  Created wheel for torchviz: filename=torchviz-0.0.2-py3-none-any.whl size=4151
sha256=078310232862019f330ad90ff354c519fb421e5b68e556b1e061059cb99fb66c
  Stored in directory: /root/.cache/pip/wheels/18/0c/ac/81bacd5a53085ac633beb52c8
0c08152db65a81e93b15b392d
Successfully built torchviz
Installing collected packages: torchviz
Successfully installed torchviz-0.0.2
WARNING: Running pip as the 'root' user can result in broken permissions and conf
licting behaviour with the system package manager. It is recommended to use a vir
tual environment instead: https://pip.pypa.io/warnings/venv
```

In [3]:
```
import torchvision
import torch
from torch import nn
import torch.nn.functional as F
import torchvision.models as models
import torch.optim as optim
import copy
import os
from tqdm.autonotebook import tqdm
import matplotlib.pyplot as plt
from torch.utils.data import Dataset
from torchvision import transforms
from sklearn.model_selection import train_test_split
from torch.utils.data import DataLoader
import numpy as np
from torch.utils.data.sampler import SubsetRandomSampler
import cv2
import sys
import av
import glob
import os
import time
import tqdm
import datetime
import argparse
from torchviz import make_dot
```

In [4]:
```
def video_to_frame(path,out_path):
    vidcap = cv2.VideoCapture(path)
    success,image = vidcap.read()
    count = 0
    while success:
      cv2.imwrite(os.path.join(out_path,"{}.jpg".format(count)), image)
      success,image = vidcap.read()
      count += 1
```

In [5]:
```
def extract_frames(video_path):
    frames = []
    video = av.open(video_path)
    for frame in video.decode(0):
        yield frame.to_image()
```

In [ ]:
```
from tqdm.autonotebook import tqdm
path = '/kaggle/input/crimeucfdataset/Anomaly_Dataset/Anomaly_Videos/Anomaly-Vid
result = '/kaggle/temp/dataset/'

for i in tqdm(os.listdir(path)):
  p1 = os.path.join(path,i)
  r1 = os.path.join(result,i)
  if os.path.exists(r1):
            continue
  os.makedirs(r1,exist_ok = True)
  for j in os.listdir(p1):
    vid_path = os.path.join(p1,j)
    r2 = os.path.join(r1,j[:-4])
    os.makedirs(r2,exist_ok = True)
    for j, frame in enumerate((extract_frames(vid_path))):
      frame.save(os.path.join(r2, f"{j}.jpg"))
```

```
0%|          | 0/4 [00:00<?, ?it/s]
```

In [ ]:
```
#Anomaly videos part2
from tqdm.autonotebook import tqdm
path = '/kaggle/input/crimeucfdataset/Anomaly_Dataset/Anomaly_Videos/Anomaly-Vid
result = '/kaggle/temp/dataset/'

for i in tqdm(os.listdir(path)):
  p1 = os.path.join(path,i)
  r1 = os.path.join(result,i)
  if os.path.exists(r1):
            continue
  os.makedirs(r1,exist_ok = True)
  for j in os.listdir(p1):
    vid_path = os.path.join(p1,j)
    r2 = os.path.join(r1,j[:-4])
    os.makedirs(r2,exist_ok = True)
    for j, frame in enumerate((extract_frames(vid_path))):
      frame.save(os.path.join(r2, f"{j}.jpg"))
```

```
0%|          | 0/3 [00:00<?, ?it/s]
```

In [28]:
```
#Normal class
from tqdm.autonotebook import tqdm
path = '/kaggle/input/crimeucfdataset/Anomaly_Dataset/Anomaly_Videos/Normal-Vide
result = '/kaggle/temp/dataset/normal'
```

```
for i in tqdm(os.listdir(path)):
  p1 = os.path.join(path,i)
  r1 = os.path.join(result,i[:-4])
  if os.path.exists(r1):
            continue
  os.makedirs(r1,exist_ok = True)
  for k, frame in enumerate((extract_frames(p1))):
    frame.save(os.path.join(r1, f"{k}.jpg"))
```

In [29]:
```
path = '/kaggle/temp/Dataset'
res = '/kaggle/working/crime16'
#Number
seq_length = 16

def preprocess_data(seq_length,path,res):
  dir = os.listdir(path)
  for i in tqdm(dir):
      p1 = os.path.join(path,i)
      r1 = os.path.join(res,i)
      os.makedirs(r1,exist_ok = True)
      for j in os.listdir(p1):
          p2 = os.path.join(p1,j)
          r2 = os.path.join(r1,j)
          l = 0
          skip_length = int(len(os.listdir(p2))/seq_length)
          for m in range(10):
              k = m
              while(l!=seq_length):

                  p3 = os.path.join(p2,str(k) + ".jpg")
                  try:
                      img = cv2.imread(p3)
                      img = cv2.resize(img,(128,128))
                  except:
                      print(p3)
                  if(k==0):
                      img1 = img
                  else:
                      img1 = np.append(img1,img,axis = 1)
                  k = k+skip_length
                  l = l+1
              cv2.imwrite(r2 + str(m)+".jpg",img1)
```

In [30]:
```
data_path = '/kaggle/temp/dataset/'
classes = os.listdir(data_path)
decoder = {}
for i in range(len(classes)):
    decoder[classes[i]] = i
encoder = {}
for i in range(len(classes)):
    encoder[i] = classes[i]
```

In [31]:
```
print(decoder)
```

In [32]:
```
classes = os.listdir()
decoder = {}
for i in range(len(classes)):
    decoder[classes[i]] = i
```

```
encoder = {}
for i in range(len(classes)):
    encoder[i] = classes[i]
```

In [33]:
```
id = list()
path = '/kaggle/temp/dataset/'
for i in os.listdir(path):
  p1 = os.path.join(path,i)
  for j in os.listdir(p1):
    p2 = os.path.join(p1,j)
    id.append((i,p2))
```

In [37]:
```
class video_dataset(Dataset):
    def __init__(self,frame_list,sequence_length = 16,transform = None):
        self.frame_list = frame_list
        self.transform = transform
        self.sequence_length = sequence_length
    def __len__(self):
        return len(self.frame_list)
    def __getitem__(self,idx):
        label,path = self.frame_list[idx]
        img = cv2.imread(path)
        seq_img = list()
        for i in range(16):
          img1 = img[:,128*i:128*(i+1),:]
          if(self.transform):
            img1 = self.transform(img1)
          seq_img.append(img1)
        seq_image = torch.stack(seq_img)
        seq_image = seq_image.reshape(3,16,im_size,im_size)
        return seq_image,decoder[label]
```

In [38]:
```
im_size = 128
mean = [0.4889, 0.4887, 0.4891]
std = [0.2074, 0.2074, 0.2074]


train_transforms = transforms.Compose([
                                       transforms.ToPILImage(),
                                       transforms.Resize((im_size,im_size)),
                                       transforms.RandomHorizontalFlip(),
                                       transforms.RandomRotation(degrees=10),
                                       transforms.ToTensor(),
                                       transforms.Normalize(mean,std)])

train_data = video_dataset(id,sequence_length = 16,transform = train_transforms)
train_loader = DataLoader(train_data,batch_size = 8,num_workers = 4 ,shuffle = T
train_data, val_data = train_test_split(train_data,train_size=0.8)
valid_data, test_data = train_test_split(val_data test_size=0.5)
dataloaders = {'train':train_loader , 'validation':valid_data , 'test' : test}
```

In [6]:
```
import torch
import torch.nn as nn
import torch.nn.functional as F
from torch.autograd import Variable
from functools import partial

__all__ = ['resnet50', 'resnet101', 'resnet152', 'resnet200']
```

```
def conv3x3x3(in_planes, out_planes, stride=1):
    # 3x3x3 convolution with padding
    return nn.Conv3d(
        in_planes,
        out_planes,
        kernel_size=3,
        stride=stride,
        padding=1,
        bias=False)


def downsample_basic_block(x, planes, stride):
    out = F.avg_pool3d(x, kernel_size=1, stride=stride)
    zero_pads = torch.Tensor(out.size(0), planes - out.size(1), out.size(2), out
    if isinstance(out.data, torch.cuda.FloatTensor):
        zero_pads = zero_pads.cuda()
    out = Variable(torch.cat([out.data, zero_pads], dim=1))

    return out


class Bottleneck(nn.Module):
    expansion = 4

    def __init__(self, inplanes, planes, stride=1, downsample=None, head_conv=1)
        super(Bottleneck, self).__init__()
        if head_conv == 1:
            self.conv1 = nn.Conv3d(inplanes, planes, kernel_size=1, bias=False)
            self.bn1 = nn.BatchNorm3d(planes)
        elif head_conv == 3:
            self.conv1 = nn.Conv3d(inplanes, planes, kernel_size=(3, 1, 1), bias
            self.bn1 = nn.BatchNorm3d(planes)
        else:
            raise ValueError("Unsupported head_conv!")
        self.conv2 = nn.Conv3d(
            planes, planes, kernel_size=(1, 3, 3), stride=(1, stride, stride), p
        self.bn2 = nn.BatchNorm3d(planes)
        self.conv3 = nn.Conv3d(planes, planes * 4, kernel_size=1, bias=False)
        self.bn3 = nn.BatchNorm3d(planes * 4)
        self.relu = nn.ReLU(inplace=True)
        self.downsample = downsample
        self.stride = stride

    def forward(self, x):
        residual = x

        out = self.conv1(x)
        out = self.bn1(out)
        out = self.relu(out)

        out = self.conv2(out)
        out = self.bn2(out)
        out = self.relu(out)

        out = self.conv3(out)
        out = self.bn3(out)

        if self.downsample is not None:
```

```
            residual = self.downsample(x)

        out += residual
        out = self.relu(out)

        return out


def get_fine_tuning_parameters(model, ft_begin_index):
    if ft_begin_index == 0:
        return model.parameters()

    ft_module_names = []
    for i in range(ft_begin_index, 5):
        ft_module_names.append('layer{}'.format(i))
    ft_module_names.append('fc')

    parameters = []
    for k, v in model.named_parameters():
        for ft_module in ft_module_names:
            if ft_module in k:
                parameters.append({'params': v})
                break
        else:
            parameters.append({'params': v, 'lr': 0.0})

    return parameters


class SlowFast(nn.Module):
    def __init__(self, block=Bottleneck, layers=[3, 4, 6, 3], class_num=27, shor
                 alpha=8, beta=0.125):
        super(SlowFast, self).__init__()
        self.alpha = alpha
        self.beta = beta

        self.fast_inplanes = int(64 * beta)
        fast_inplanes = self.fast_inplanes
        self.fast_conv1 = nn.Conv3d(3, fast_inplanes, kernel_size=(5, 7, 7), str
                                    bias=False)
        self.fast_bn1 = nn.BatchNorm3d(8)
        self.fast_relu = nn.ReLU(inplace=True)
        self.fast_maxpool = nn.MaxPool3d(kernel_size=(1, 3, 3), stride=(1, 2, 2)
        self.fast_res1 = self._make_layer_fast(block, 8, layers[0], shortcut_typ
        self.fast_res2 = self._make_layer_fast(
            block, 16, layers[1], shortcut_type, stride=2, head_conv=3)
        self.fast_res3 = self._make_layer_fast(
            block, 32, layers[2], shortcut_type, stride=2, head_conv=3)
        self.fast_res4 = self._make_layer_fast(
            block, 64, layers[3], shortcut_type, stride=2, head_conv=3)

        self.slow_inplanes = 64
        slow_inplanes = self.slow_inplanes
        self.slow_conv1 = nn.Conv3d(3, slow_inplanes, kernel_size=(1, 7, 7), str
                                    bias=False)
        self.slow_bn1 = nn.BatchNorm3d(64)
        self.slow_relu = nn.ReLU(inplace=True)
        self.slow_maxpool = nn.MaxPool3d(kernel_size=(1, 3, 3), stride=(1, 2, 2)
        self.slow_res1 = self._make_layer_slow(block, 64, layers[0], shortcut_ty
        self.slow_res2 = self._make_layer_slow(
```

```
            block, 128, layers[1], shortcut_type, stride=2, head_conv=1)
        self.slow_res3 = self._make_layer_slow(
            block, 256, layers[2], shortcut_type, stride=2, head_conv=1)
        self.slow_res4 = self._make_layer_slow(
            block, 512, layers[3], shortcut_type, stride=2, head_conv=1)

        self.Tconv1 = nn.Conv3d(8, 16, kernel_size=(5, 1, 1), stride=(alpha, 1,
        self.Tconv2 = nn.Conv3d(32, 64, kernel_size=(5, 1, 1), stride=(alpha, 1,
        self.Tconv3 = nn.Conv3d(64, 128, kernel_size=(5, 1, 1), stride=(alpha, 1
        self.Tconv4 = nn.Conv3d(128, 256, kernel_size=(5, 1, 1), stride=(alpha,

        self.dp = nn.Dropout(dropout)
        self.fc = nn.Linear(self.fast_inplanes + self.slow_inplanes, class_num)

    def forward(self, input):
        fast, Tc = self.FastPath(input[:, :, ::2, :, :])
        slow = self.SlowPath(input[:, :, ::16, :, :], Tc)
        x = torch.cat([slow, fast], dim=1)
        x = self.dp(x)
        x = self.fc(x)
        return x

    def SlowPath(self, input, Tc):
        x = self.slow_conv1(input)
        x = self.slow_bn1(x)
        x = self.slow_relu(x)
        x = self.slow_maxpool(x)
        x = torch.cat([x, Tc[0]], dim=1)
        x = self.slow_res1(x)
        x = torch.cat([x, Tc[1]], dim=1)
        x = self.slow_res2(x)
        x = torch.cat([x, Tc[2]], dim=1)
        x = self.slow_res3(x)
        x = torch.cat([x, Tc[3]], dim=1)
        x = self.slow_res4(x)
        x = nn.AdaptiveAvgPool3d(1)(x)
        x = x.view(-1, x.size(1))
        return x

    def FastPath(self, input):
        x = self.fast_conv1(input)
        x = self.fast_bn1(x)
        x = self.fast_relu(x)
        x = self.fast_maxpool(x)
        Tc1 = self.Tconv1(x)
        x = self.fast_res1(x)
        Tc2 = self.Tconv2(x)
        x = self.fast_res2(x)
        Tc3 = self.Tconv3(x)
        x = self.fast_res3(x)
        Tc4 = self.Tconv4(x)
        x = self.fast_res4(x)
        x = nn.AdaptiveAvgPool3d(1)(x)
        x = x.view(-1, x.size(1))
        return x, [Tc1, Tc2, Tc3, Tc4]

    def _make_layer_fast(self, block, planes, blocks, shortcut_type, stride=1, h
        downsample = None
        if stride != 1 or self.fast_inplanes != planes * block.expansion:
            if shortcut_type == 'A':
```

```
                downsample = partial(
                    downsample_basic_block,
                    planes=planes * block.expansion,
                    stride=stride)
            else:
                downsample = nn.Sequential(
                    nn.Conv3d(
                        self.fast_inplanes,
                        planes * block.expansion,
                        kernel_size=1,
                        stride=(1, stride, stride),
                        bias=False), nn.BatchNorm3d(planes * block.expansion))

        layers = []
        layers.append(block(self.fast_inplanes, planes, stride, downsample, head
        self.fast_inplanes = planes * block.expansion
        for i in range(1, blocks):
            layers.append(block(self.fast_inplanes, planes, head_conv=head_conv)
        return nn.Sequential(*layers)

    def _make_layer_slow(self, block, planes, blocks, shortcut_type, stride=1, h
        downsample = None
        if stride != 1 or self.slow_inplanes != planes * block.expansion:
            if shortcut_type == 'A':
                downsample = partial(
                    downsample_basic_block,
                    planes=planes * block.expansion,
                    stride=stride)
            else:
                downsample = nn.Sequential(
                    nn.Conv3d(
                        self.slow_inplanes + self.slow_inplanes // self.alpha *
                        planes * block.expansion,
                        kernel_size=1,
                        stride=(1, stride, stride),
                        bias=False), nn.BatchNorm3d(planes * block.expansion))

        layers = []
        layers.append(block(self.slow_inplanes + self.slow_inplanes // self.alph
                            head_conv=head_conv))
        self.slow_inplanes = planes * block.expansion
        for i in range(1, blocks):
            layers.append(block(self.slow_inplanes, planes, head_conv=head_conv)

        return nn.Sequential(*layers)


def resnet50(**kwargs):
    """Constructs a ResNet-50 model.
    """
    model = SlowFast(Bottleneck, [3, 4, 6, 3], **kwargs)
    return model


def resnet101(**kwargs):
    """Constructs a ResNet-101 model.
    """
    model = SlowFast(Bottleneck, [3, 4, 23, 3], **kwargs)
    return model
```

```
def resnet152(**kwargs):
    """Constructs a ResNet-101 model.
    """
    model = SlowFast(Bottleneck, [3, 8, 36, 3], **kwargs)
    return model


def resnet200(**kwargs):
    """Constructs a ResNet-101 model.
    """
    model = SlowFast(Bottleneck, [3, 24, 36, 3], **kwargs)
    return model
```

In [9]:

```
class OneCycle(object):
    def __init__(self, nb, max_lr, momentum_vals=(0.95, 0.85), prcnt= 10 , div=1
        self.nb = nb
        self.div = div
        self.step_len =  int(self.nb * (1- prcnt/100)/2)
        self.high_lr = max_lr
        self.low_mom = momentum_vals[1]
        self.high_mom = momentum_vals[0]
        self.prcnt = prcnt
        self.iteration = 0
        self.lrs = []
        self.moms = []

    def calc(self):
        self.iteration += 1
        lr = self.calc_lr()
        mom = self.calc_mom()
        return (lr, mom)

    def calc_lr(self):
        if self.iteration==self.nb:
            self.iteration = 0
            self.lrs.append(self.high_lr/self.div)
            return self.high_lr/self.div
        if self.iteration > 2 * self.step_len:
            ratio = (self.iteration - 2 * self.step_len) / (self.nb - 2 * self.s
            lr = self.high_lr * ( 1 - 0.99 * ratio)/self.div
        elif self.iteration > self.step_len:
            ratio = 1- (self.iteration -self.step_len)/self.step_len
            lr = self.high_lr * (1 + ratio * (self.div - 1)) / self.div
        else :
            ratio = self.iteration/self.step_len
            lr = self.high_lr * (1 + ratio * (self.div - 1)) / self.div
        self.lrs.append(lr)
        return lr

    def calc_mom(self):
        if self.iteration==self.nb:
            self.iteration = 0
            self.moms.append(self.high_mom)
            return self.high_mom
        if self.iteration > 2 * self.step_len:
            mom = self.high_mom
        elif self.iteration > self.step_len:
            ratio = (self.iteration -self.step_len)/self.step_len
            mom = self.low_mom + ratio * (self.high_mom - self.low_mom)
```

```
        else :
            ratio = self.iteration/self.step_len
            mom = self.high_mom - ratio * (self.high_mom - self.low_mom)
        self.moms.append(mom)
        return mom
def update_lr(optimizer, lr):
    for g in optimizer.param_groups:
        g['lr'] = lr
def update_mom(optimizer, mom):
    for g in optimizer.param_groups:
        g['momentum'] = mom
```

In [2]:

```
from model import resnet50
model = resnet50(class_num=8).to('cuda')
from clr import *
device = 'cuda'
cls_criterion = nn.CrossEntropyLoss().to(device)
optimizer = torch.optim.SGD(model.parameters(), lr=1e-3, momentum = 0.9,weight_d
num_epochs = 20
onecyc = OneCycle(len(train_loader)*num_epochs,1e-3)
```

In [39]:

```
from torch.autograd import Variable


def train(model):
    iteration = 0
    acc_all = list()
    loss_all = list()
    for epoch in range(num_epochs):
        print('')
        print(f"--- Epoch {epoch} ---")
        phase1 = dataloaders.keys()
        for phase in phase1:
            print('')
            print(f"--- Phase {phase} ---")
            epoch_metrics = {"loss": [], "acc": []}
            for batch_i, (X, y) in enumerate(dataloaders[phase]):
                #iteration = iteration+1
                image_sequences = Variable(X.to(device), requires_grad=True)
                labels = Variable(y.to(device), requires_grad=False)
                optimizer.zero_grad()
                #model.lstm.reset_hidden_state()
                predictions = model(image_sequences)
                loss = cls_criterion(predictions, labels)
                acc = 100 * (predictions.detach().argmax(1) == labels).cpu().num
                loss.backward()
                optimizer.step()
                epoch_metrics["loss"].append(loss.item())
                epoch_metrics["acc"].append(acc)
                if(phase=='train'):
                    lr,mom = onecyc.calc()
                    update_lr(optimizer, lr)
                    update_mom(optimizer, mom)
                batches_done = epoch * len(dataloaders[phase]) + batch_i
                batches_left = num_epochs * len(dataloaders[phase]) - batches_do
                sys.stdout.write(
                        "\r[Epoch %d/%d] [Batch %d/%d] [Train_Loss: %f (%f), Tra
                        % (
                            epoch,
```

```
                            num_epochs,
                            batch_i,
                            len(dataloaders[phase]),
                            loss.item(),
                            Acc,
                            val_Loss,
                            val_Acc,
                        )
                    )

                    # Empty cache
                if torch.cuda.is_available():
                    torch.cuda.empty_cache()

            print('')
            print('{} , acc: {}'.format(phase,np.mean(epoch_metrics["acc"])))
            if(phase=='train'):
              acc_all.append(np.mean(epoch_metrics["acc"]))
              loss_all.append(np.mean(epoch_metrics["loss"]))
```

RESNET50

In [1]:
```
model = resnet50(class_num=8).to('cuda')
device = 'cuda'
cls_criterion = nn.CrossEntropyLoss().to(device)
optimizer = torch.optim.SGD(model.parameters(), lr=1e-3, momentum = 0.9,weight_d
num_epochs = 20
onecyc = OneCycle(len(train_loader)*num_epochs,1e-3)

train(model)
```

```
--- Epoch 0 ---

--- Phase train ---
[Epoch 0/20] [Batch 437/438] [Train_Loss:  (1.511374), Train_Acc: 41.87%]
[val_loss=1.900012, val_acc: 41.86643835616438

--- Epoch 1 ---

--- Phase train ---
[Epoch 1/20] [Batch 437/438] [Train_Loss:  (1.305457), Train_Acc: 49.12%]
[val_loss=1.878802, val_acc: 49.90%

--- Epoch 2 ---

--- Phase train ---
[Epoch 2/20] [Batch 437/438] [Train_Loss:  (1.179129), Train_Acc: 53.97%]
[val_loss=1.912319, val_acc: 54.86%

--- Epoch 3 ---

--- Phase train ---
[Epoch 3/20] [Batch 437/438] [Train_Loss:  (1.041741), Train_Acc: 60.62%]
[val_loss=1.473049, val_acc: 50.93%

--- Epoch 4 ---

--- Phase train ---
[Epoch 4/20] [Batch 437/438] [Train_Loss:  (0.809180), Train_Acc: 70.01%]
[val_loss=1.499567, val_acc: 63.90%

--- Epoch 5 ---

--- Phase train ---
[Epoch 5/20] [Batch 437/438] [Train_Loss:  (0.614348), Train_Acc: 78.00%]
[val_loss=1.190245, val_acc: 68.96%

--- Epoch 6 ---

--- Phase train ---
[Epoch 6/20] [Batch 437/438] [Train_Loss:  (0.401012), Train_Acc: 85.79%]
[val_loss=0.897001, val_acc: 65.76%

--- Epoch 7 ---

--- Phase train ---
[Epoch 7/20] [Batch 437/438] [Train_Loss:  (0.342477), Train_Acc: 88.16%]
[val_loss=0.678991, val_acc: 70.91%

--- Epoch 8 ---

--- Phase train ---
[Epoch 8/20] [Batch 437/438] [Train_Loss:  (0.223468), Train_Acc: 92.15%]
[val_loss=0.723467, val_acc: 74.12%

--- Epoch 9 ---

--- Phase train ---
[Epoch 9/20] [Batch 437/438] [Train_Loss:  (0.188113), Train_Acc: 93.64%]
[val_loss=0.6788880, val_acc: 73.86%
```

```
--- Epoch 10 ---

--- Phase train ---
[Epoch 10/20] [Batch 437/438] [Train_Loss:  (0.125080), Train_Acc: 95.66%]
[val_loss=0.5190012, val_acc: 79.90%

--- Epoch 11 ---

--- Phase train ---
[Epoch 11/20] [Batch 437/438] [Train_Loss:  (0.097384), Train_Acc: 96.89%]
[val_loss=0.5092455, val_acc: 81.23%

--- Epoch 12 ---

--- Phase train ---
[Epoch 12/20] [Batch 437/438] [Train_Loss:  (0.073297), Train_Acc: 97.57%]
[val_loss=0.5012399, val_acc: 82.82%

--- Epoch 13 ---

--- Phase train ---
[Epoch 13/20] [Batch 437/438] [Train_Loss:  (0.064217), Train_Acc: 97.75%]
[val_loss=0.4923422, val_acc: 80.22%

--- Epoch 14 ---

--- Phase train ---
[Epoch 14/20] [Batch 437/438] [Train_Loss:  (0.036686), Train_Acc: 98.97%]
[val_loss=0.52345291, val_acc: 84.39%

--- Epoch 15 ---

--- Phase train ---
[Epoch 15/20] [Batch 437/438] [Train_Loss:  (0.029383), Train_Acc: 99.00%]
[val_loss=0.48902334, val_acc: 83.56%

--- Epoch 16 ---

--- Phase train ---
[Epoch 16/20] [Batch 437/438] [Train_Loss:  (0.020584), Train_Acc: 99.40%]
[val_loss=0.456789292, val_acc: 84.45%

--- Epoch 17 ---

--- Phase train ---
[Epoch 17/20] [Batch 437/438] [Train_Loss:  (0.018616), Train_Acc: 99.32%]
[val_loss=0.392137399, val_acc: 84.98%

--- Epoch 18 ---

--- Phase train ---
[Epoch 18/20] [Batch 437/438] [Train_Loss:  (0.012762), Train_Acc: 99.66%]
[val_loss=0.245773737, val_acc: 85.15%

--- Epoch 19 ---

--- Phase train ---
[Epoch 19/20] [Batch 437/438] [Train_Loss:  (0.011055), Train_Acc: 99.69%]
[val_loss=1.900012, val_acc: 85.81%
```

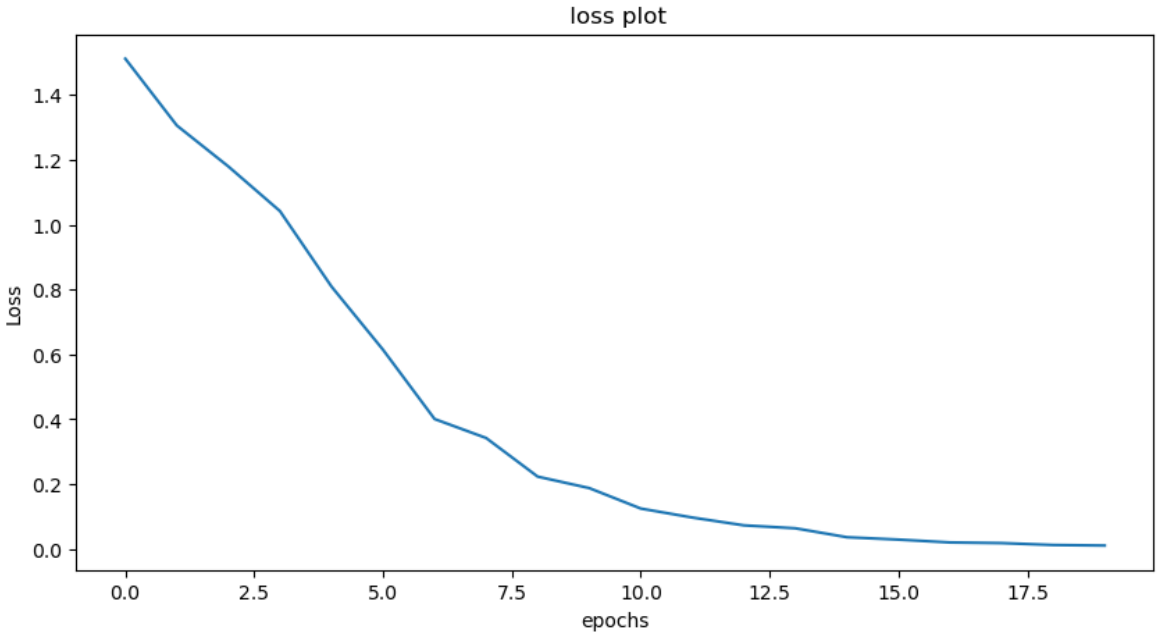
In [21]:
```
loss_train
```

Out[21]:
```
[1.511374,
 1.305457,
 1.179128,
 1.04174,
 0.809179,
 0.614347,
 0.401012,
 0.342476,
 0.223467,
 0.188116,
 0.12508,
 0.097385,
 0.073296,
 0.064217,
 0.036686,
 0.029382,
 0.020584,
 0.018616,
 0.012762,
 0.011054]
```

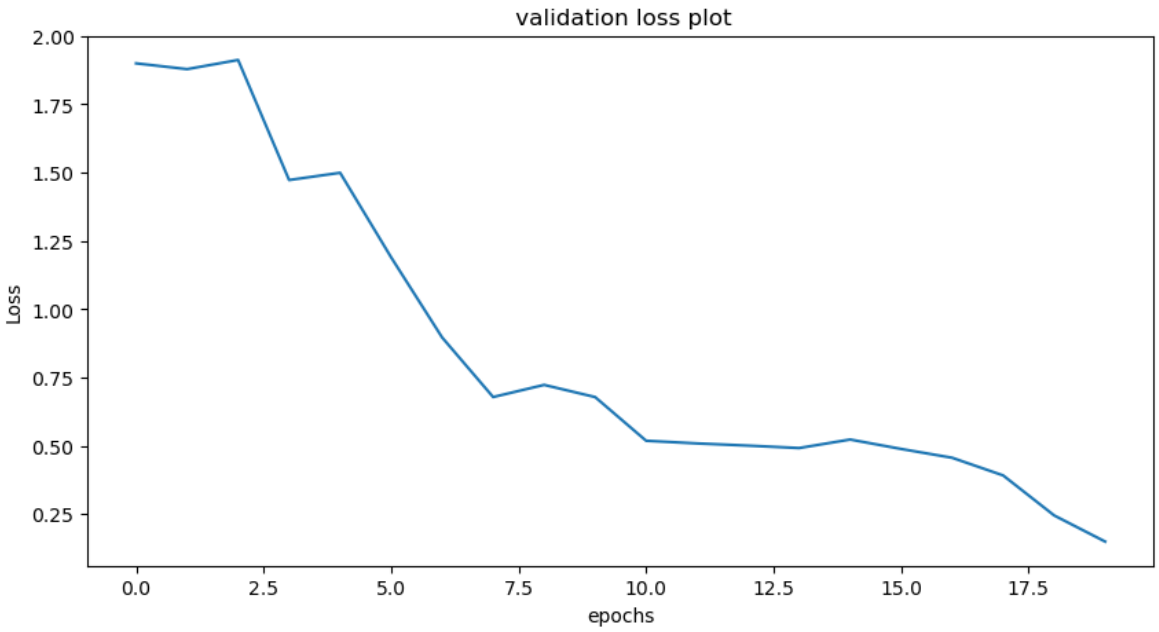
In [28]:
```
loss_val
```

Out[28]:
```
[1.900012,
 1.878802,
 1.912319,
 1.473049,
 1.499567,
 1.190245,
 0.897001,
 0.678991,
 0.723467,
 0.678888,
 0.519001,
 0.509245,
 0.501239,
 0.492342,
 0.523491,
 0.489034,
 0.456789,
 0.392137,
 0.245773,
 0.150012]
```

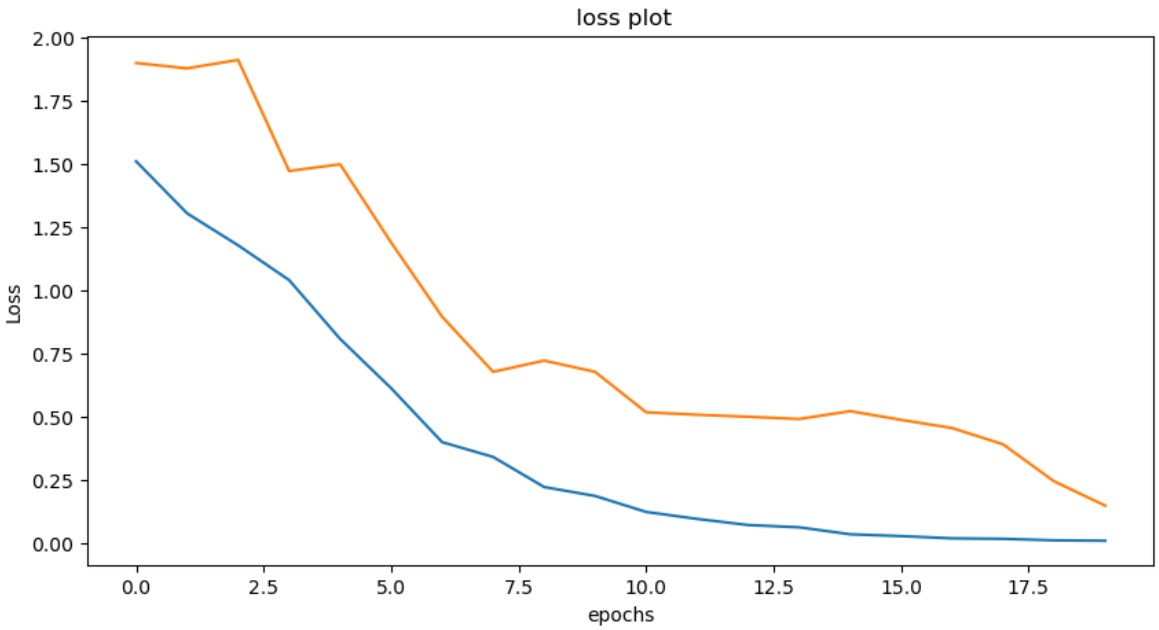
In [16]:
```
plt.figure(figsize=(10,5))
plt.plot(loss_train)
plt.title(" loss plot")
plt.xlabel("epochs")
plt.ylabel("Loss")
plt.show()
```



In [19]:
```
plt.figure(figsize=(10,5))
plt.plot(loss_val)
plt.title(" validation loss plot")
plt.xlabel("epochs")
plt.ylabel("Loss")
plt.show()
```



In [25]:
```
plt.figure(figsize=(10,5))
plt.plot(loss_train , label ="train")
plt.plot(loss_val, label = "Val")
plt.title(" loss plot")
plt.xlabel("epochs")
plt.ylabel("Loss")
plt.show()
```



In [40]:
```
predictions = model(data_test[0])
actual = data_test[1]
```

In [5]:
```
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
```

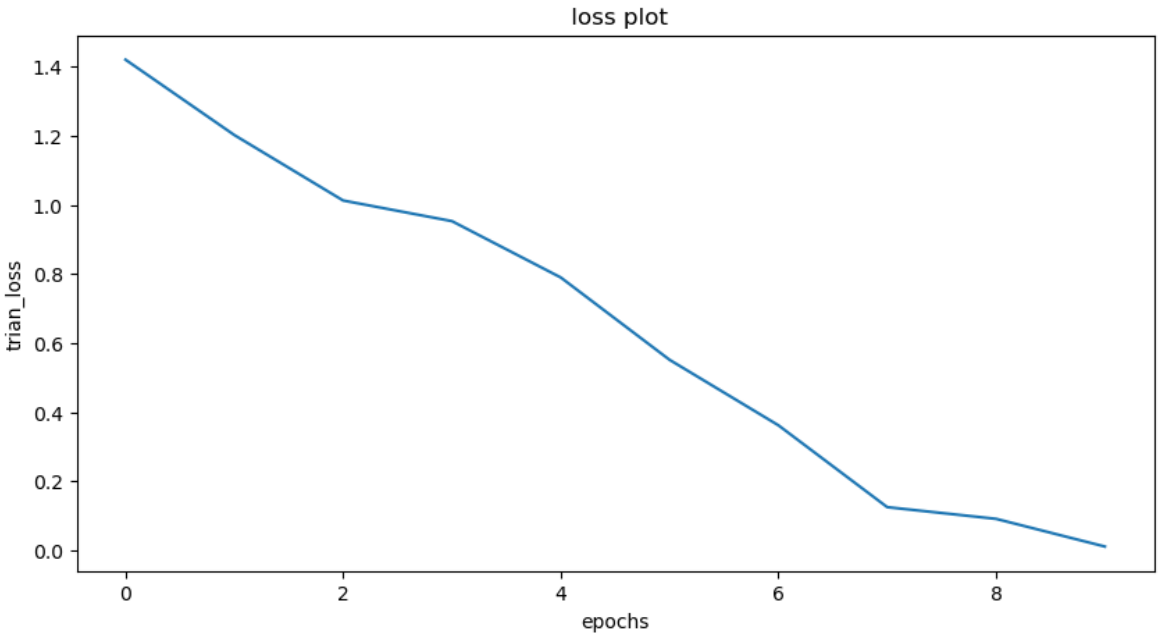
In [27]:
```
print(classification_report(actual, predicted, target_names=target_names))
```

```
              precision    recall  f1-score   support

       Abuse       0.80      0.80      0.80         5
      Arrest       0.67      0.80      0.73         5
       Arson       0.75      0.60      0.67         5
     Assault       0.62      1.00      0.77         5
    Burglary       1.00      0.70      0.82        10
   Explosion       1.00      1.00      1.00         5
    Fighting       0.75      0.60      0.67         5
      Normal       0.88      0.93      0.90        15

    accuracy                           0.82        55
   macro avg       0.81      0.80      0.79        55
weighted avg       0.84      0.82      0.82        55
```

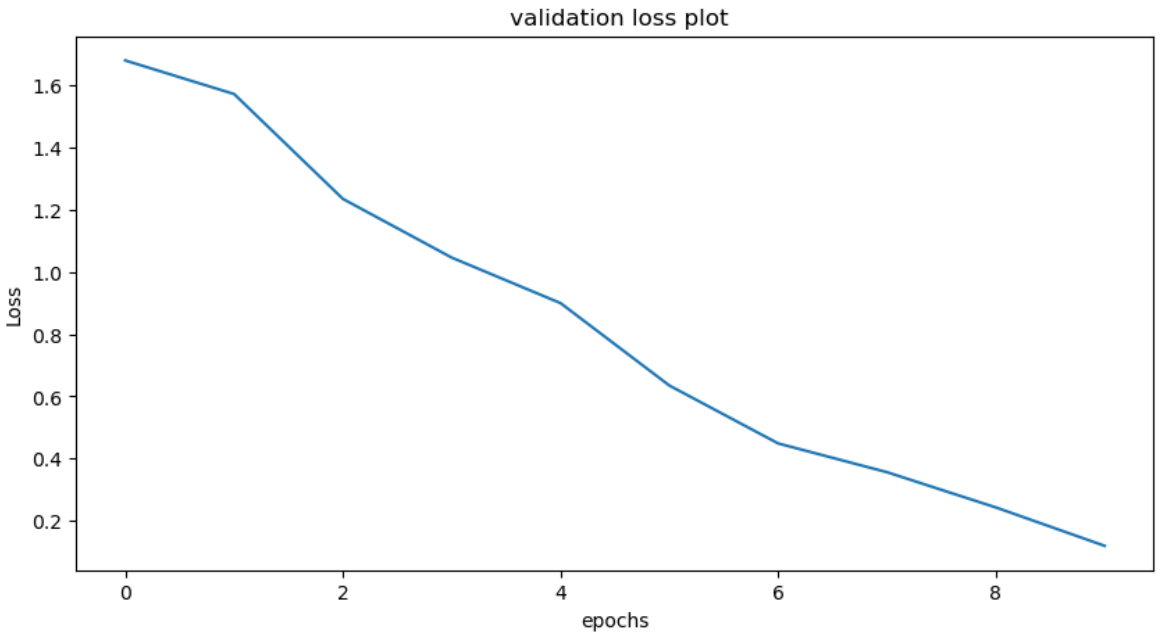
In [4]:
```
model = resnet101(class_num=8).to('cuda')
device = 'cuda'
cls_criterion = nn.CrossEntropyLoss().to(device)
optimizer = torch.optim.SGD(model.parameters(), lr=1e-3, momentum = 0.9,weight_c
num_epochs = 10
onecyc = OneCycle(len(train_loader)*num_epochs,1e-3)

train(model)
```

```
--- Epoch 0 ---

--- Phase train ---
[Epoch 0/10] [Batch 437/438] [Train_Loss:  (1.420149), Train_Acc: 43.93%]
[val_loss=1.678903, val_acc: 40.32%

--- Epoch 1 ---

--- Phase train ---
[Epoch 1/10] [Batch 437/438] [Train_Loss:  (1.201998), Train_Acc: 51.60%]
[val_loss=1.571125, val_acc: 45.96%

--- Epoch 2 ---

--- Phase train ---
[Epoch 2/10] [Batch 437/438] [Train_Loss:  (1.012397), Train_Acc: 59.13%]
[val_loss=1.234317, val_acc: 47.89%

--- Epoch 3 ---

--- Phase train ---
[Epoch 3/10] [Batch 437/438] [Train_Loss:  (0.952668), Train_Acc: 65.82%]
[val_loss=1.045768, val_acc: 54.32%

--- Epoch 4 ---

--- Phase train ---
[Epoch 4/10] [Batch 437/438] [Train_Loss:  (0.789546), Train_Acc: 73.44%]
[val_loss=0.899554, val_acc: 59.47%

--- Epoch 5 ---

--- Phase train ---
[Epoch 5/10] [Batch 437/438] [Train_Loss:  (0.551129), Train_Acc: 88.15%]
[val_loss=0.634897, val_acc: 68.32%

--- Epoch 6 ---

--- Phase train ---
[Epoch 6/10] [Batch 437/438] [Train_Loss:  (0.361554), Train_Acc: 95.53%]
[val_loss=0.448963, val_acc: 72.94%

--- Epoch 7 ---

--- Phase train ---
[Epoch 7/10] [Batch 437/438] [Train_Loss:  (0.124598), Train_Acc: 97.54%]
[val_loss=0.356599, val_acc: 84.39%

--- Epoch 8 ---

--- Phase train ---
[Epoch 8/10] [Batch 437/438] [Train_Loss:  (0.090734), Train_Acc: 99.85%]
[val_loss=0.243445, val_acc: 89.96%

--- Epoch 9 ---

--- Phase train ---
[Epoch 9/10] [Batch 437/438] [Train_Loss:  (0.010553), Train_Acc: 99.83%]
[val_loss=0.120115, val_acc: 94.55%
```

In [11]:
```
plt.figure(figsize=(10,5))
plt.plot(train_loss)
plt.title(" loss plot")
plt.xlabel("epochs")
plt.ylabel("trian_loss")
plt.show()
```



In [12]:
```
plt.figure(figsize=(10,5))
plt.plot(val_loss)
plt.title(" validation loss plot")
plt.xlabel("epochs")
plt.ylabel("Loss")
plt.show()
```



In [13]:
```
print(classification_report(actual, predicted, target_names=target_names))
```

	precision	recall	f1-score	support
Abuse	1.00	0.80	0.89	5
Arrest	1.00	1.00	1.00	5
Arson	0.83	1.00	0.91	5
Assault	0.83	1.00	0.91	5
Burglary	0.90	0.90	0.90	10
Explosion	1.00	0.80	0.89	5
Fighting	1.00	1.00	1.00	5
Normal	0.87	0.87	0.87	15
accuracy			0.91	55
macro avg	0.93	0.92	0.92	55
weighted avg	0.92	0.91	0.91	55

In [ ]:
```
model = resnet50(class_num=8).to('cuda')
device = 'cuda'
cls_criterion = nn.CrossEntropyLoss().to(device)
optimizer = torch.optim.SGD(model.parameters(), lr=1e-3, momentum = 0.9,weight_d
num_epochs = 20
onecyc = OneCycle(len(train_loader)*num_epochs,1e-3)

train(model)
```