ml4sci-24-task2-2-efficientnet

March 26, 2024

[1]:
```
import torch
import numpy as np
import pandas as pd
import pyarrow.parquet as pq
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
import timm
import torch
import torch.nn as nn
from torch.utils.data import Dataset,DataLoader, random_split
import torch.nn.functional as F
from torchvision import models

import torch.optim as optim
from tqdm import tqdm

from sklearn.metrics import roc_auc_score, confusion_matrix ,roc_curve
import seaborn as sns
```

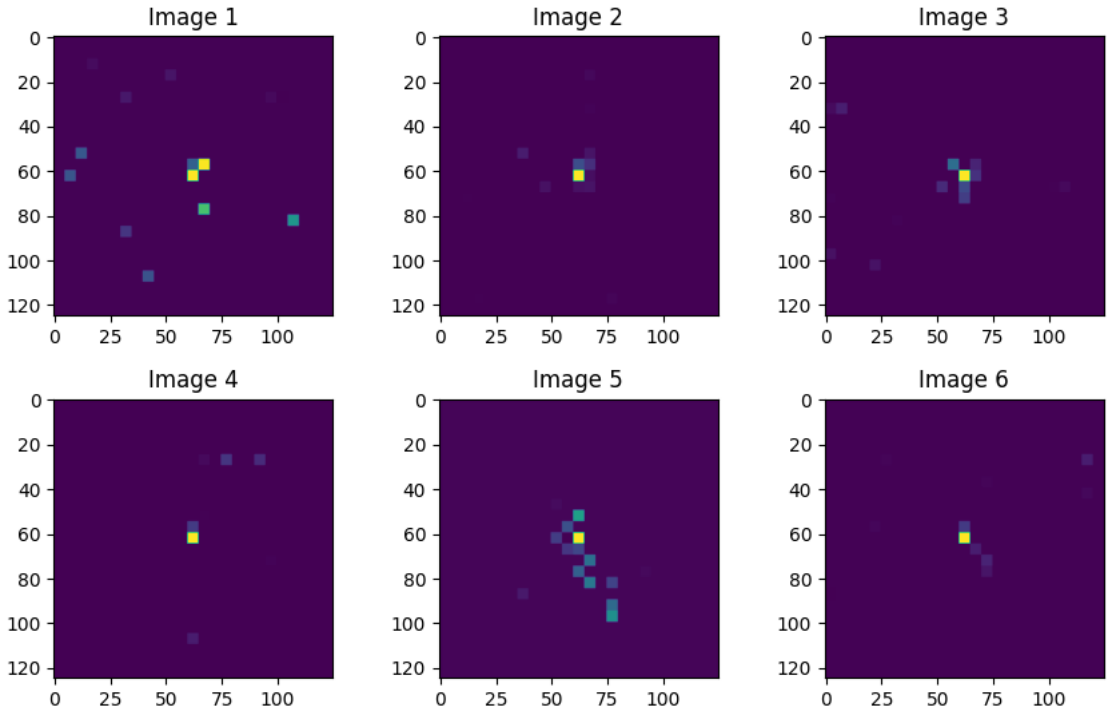
[2]:
```
chunk_size = 15

# List of Parquet file paths
file_paths = [
    '/kaggle/input/task2-24/QCDToGGQQ_IMGjet_RH1all_jet0_run0_n36272.test.
 ↪snappy.parquet',
    '/kaggle/input/task2-24/QCDToGGQQ_IMGjet_RH1all_jet0_run1_n47540.test.
 ↪snappy.parquet',
    '/kaggle/input/task2-24/QCDToGGQQ_IMGjet_RH1all_jet0_run2_n55494.test.
 ↪snappy.parquet'
]

# Initialize an empty list to store dataframes
dfs = []

# Loop through each file path
for file_path in file_paths:
    # Create a Parquet file reader object
```

```
    parquet_file = pq.ParquetFile(file_path)

    # Determine the total number of rows in the file
    total_rows = parquet_file.metadata.num_rows

    # Calculate the number of chunks
    num_chunks = total_rows // chunk_size + (1 if total_rows % chunk_size else␣
 ↪0)

    # Loop over the file in chunks
    for chunk_index in range(num_chunks):
        # Read a chunk of rows from the file
        chunk = parquet_file.read_row_group(chunk_index, columns=None)
        df = chunk.to_pandas()

        # Append the DataFrame to the list
        dfs.append(df)

# Concatenate all the DataFrames into a single DataFrame
data = pd.concat(dfs, ignore_index=True)
```

[3]:
```
def to_3d(arr):
    vishak=[]
    for i in range (0,3):
        vis=np.stack(np.stack(arr)[i],axis=-1)
        vishak.append(vis)
    vishak=np.array(vishak)
    return vishak
```

[4]:
```
data["X_jets"]  = data["X_jets"].apply(to_3d)
```

[5]:
```
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(10, 6))

# Loop over the axes and image ids, and plot each image on a separate subplot
for i, ax in enumerate(axes.flatten()):
    image = data['X_jets'][i][2,:,:]
    ax.imshow(image)
    ax.set_title(f'Image {i+1}')

# Adjust spacing between subplots
plt.subplots_adjust(left=0.1, right=0.9, bottom=0.1, top=0.9, wspace=0.3,␣
 ↪hspace=0.3)

# Show the plot
plt.show()
```



[6]:
```
data.columns
```

[6]:
```
Index(['X_jets', 'pt', 'm0', 'y'], dtype='object')
```

[7]:
```
# data['y']
```

[8]:
```
class task2Dataset(Dataset):
    def __init__(self, dataframe, transform=None):
        self.dataframe = dataframe
        self.transform = transform

    def __len__(self):
        return len(self.dataframe)

    def __getitem__(self, idx):
        # Assuming 'X_jets' column contains paths to images or actual image data
        X = self.dataframe.iloc[idx]['X_jets']
        mean = X.mean(axis=(0, 1, 2), keepdims=True)
        std = X.std(axis=(0, 1, 2), keepdims=True)

        # Normalize each channel separately
        X = (X - mean) / std
        y = self.dataframe.iloc[idx]['y']
```

```
        if self.transform:
            X = self.transform(X)

        # Convert X and y to PyTorch tensors
        X_tensor = torch.tensor(X, dtype=torch.float)
        y_tensor = torch.tensor(y, dtype=torch.long)

        return X_tensor, y_tensor
```

[9]:
```
jet_dataset = task2Dataset(dataframe=data)


train_dataset, val_dataset = train_test_split(jet_dataset, test_size=0.2,␣
 ↪random_state=42)


train_loader = DataLoader(dataset=train_dataset, batch_size=256, shuffle=True)
val_loader = DataLoader(dataset=val_dataset, batch_size=32, shuffle=False)
```

[10]:
```
next(iter(train_loader))[0].shape
```

[10]:
```
torch.Size([256, 3, 125, 125])
```

[11]:
```
class CustomEfficientNet(nn.Module):
    def __init__(self, num_classes=2, pretrained=True):
        super(CustomEfficientNet, self).__init__()
        self.model = timm.create_model('efficientnet_b0',␣
 ↪pretrained=pretrained, num_classes=num_classes)

    def forward(self, x):
        return self.model(x)

# Initialize your model
model = CustomEfficientNet(num_classes=2, pretrained=True)
print(model)
```

```
model.safetensors:   0%|          | 0.00/21.4M [00:00<?, ?B/s]
```

```
CustomEfficientNet(
  (model): EfficientNet(
    (conv_stem): Conv2d(3, 32, kernel_size=(3, 3), stride=(2, 2), padding=(1,
1), bias=False)
    (bn1): BatchNormAct2d(
      32, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
      (drop): Identity()
      (act): SiLU(inplace=True)
    )
    (blocks): Sequential(
```

```
      (0): Sequential(
        (0): DepthwiseSeparableConv(
          (conv_dw): Conv2d(32, 32, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), groups=32, bias=False)
          (bn1): BatchNormAct2d(
            32, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(32, 8, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(8, 32, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pw): Conv2d(32, 16, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn2): BatchNormAct2d(
            16, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
      )
      (1): Sequential(
        (0): InvertedResidual(
          (conv_pw): Conv2d(16, 96, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            96, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(96, 96, kernel_size=(3, 3), stride=(2, 2),
padding=(1, 1), groups=96, bias=False)
          (bn2): BatchNormAct2d(
            96, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(96, 4, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(4, 96, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(96, 24, kernel_size=(1, 1), stride=(1, 1),
```

```
bias=False)
          (bn3): BatchNormAct2d(
            24, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
        (1): InvertedResidual(
          (conv_pw): Conv2d(24, 144, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            144, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(144, 144, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), groups=144, bias=False)
          (bn2): BatchNormAct2d(
            144, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(144, 6, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(6, 144, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(144, 24, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            24, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
      )
      (2): Sequential(
        (0): InvertedResidual(
          (conv_pw): Conv2d(24, 144, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            144, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
```

```
          (conv_dw): Conv2d(144, 144, kernel_size=(5, 5), stride=(2, 2),
padding=(2, 2), groups=144, bias=False)
          (bn2): BatchNormAct2d(
            144, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(144, 6, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(6, 144, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(144, 40, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            40, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
        (1): InvertedResidual(
          (conv_pw): Conv2d(40, 240, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            240, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(240, 240, kernel_size=(5, 5), stride=(1, 1),
padding=(2, 2), groups=240, bias=False)
          (bn2): BatchNormAct2d(
            240, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(240, 10, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(10, 240, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(240, 40, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            40, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
```

```
            (act): Identity()
          )
          (drop_path): Identity()
        )
      )
      (3): Sequential(
        (0): InvertedResidual(
          (conv_pw): Conv2d(40, 240, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            240, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(240, 240, kernel_size=(3, 3), stride=(2, 2),
padding=(1, 1), groups=240, bias=False)
          (bn2): BatchNormAct2d(
            240, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(240, 10, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(10, 240, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(240, 80, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            80, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
        (1): InvertedResidual(
          (conv_pw): Conv2d(80, 480, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            480, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(480, 480, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), groups=480, bias=False)
          (bn2): BatchNormAct2d(
            480, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
```

```
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(480, 20, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(20, 480, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(480, 80, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            80, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
        (2): InvertedResidual(
          (conv_pw): Conv2d(80, 480, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            480, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(480, 480, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), groups=480, bias=False)
          (bn2): BatchNormAct2d(
            480, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(480, 20, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(20, 480, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(480, 80, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            80, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
```

```
      )
      (4): Sequential(
        (0): InvertedResidual(
          (conv_pw): Conv2d(80, 480, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            480, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(480, 480, kernel_size=(5, 5), stride=(1, 1),
padding=(2, 2), groups=480, bias=False)
          (bn2): BatchNormAct2d(
            480, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(480, 20, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(20, 480, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(480, 112, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            112, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
        (1): InvertedResidual(
          (conv_pw): Conv2d(112, 672, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            672, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(672, 672, kernel_size=(5, 5), stride=(1, 1),
padding=(2, 2), groups=672, bias=False)
          (bn2): BatchNormAct2d(
            672, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
```

```
            (conv_reduce): Conv2d(672, 28, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(28, 672, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(672, 112, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            112, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
        (2): InvertedResidual(
          (conv_pw): Conv2d(112, 672, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            672, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(672, 672, kernel_size=(5, 5), stride=(1, 1),
padding=(2, 2), groups=672, bias=False)
          (bn2): BatchNormAct2d(
            672, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(672, 28, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(28, 672, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(672, 112, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            112, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
      )
      (5): Sequential(
        (0): InvertedResidual(
          (conv_pw): Conv2d(112, 672, kernel_size=(1, 1), stride=(1, 1),
```

```
bias=False)
          (bn1): BatchNormAct2d(
            672, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(672, 672, kernel_size=(5, 5), stride=(2, 2),
padding=(2, 2), groups=672, bias=False)
          (bn2): BatchNormAct2d(
            672, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(672, 28, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(28, 672, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(672, 192, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            192, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
        (1): InvertedResidual(
          (conv_pw): Conv2d(192, 1152, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            1152, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(1152, 1152, kernel_size=(5, 5), stride=(1, 1),
padding=(2, 2), groups=1152, bias=False)
          (bn2): BatchNormAct2d(
            1152, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(1152, 48, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(48, 1152, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
```

```
          )
          (conv_pwl): Conv2d(1152, 192, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            192, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
        (2): InvertedResidual(
          (conv_pw): Conv2d(192, 1152, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            1152, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(1152, 1152, kernel_size=(5, 5), stride=(1, 1),
padding=(2, 2), groups=1152, bias=False)
          (bn2): BatchNormAct2d(
            1152, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(1152, 48, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(48, 1152, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(1152, 192, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            192, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
        (3): InvertedResidual(
          (conv_pw): Conv2d(192, 1152, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            1152, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
```

```
          (conv_dw): Conv2d(1152, 1152, kernel_size=(5, 5), stride=(1, 1),
padding=(2, 2), groups=1152, bias=False)
          (bn2): BatchNormAct2d(
            1152, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(1152, 48, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(48, 1152, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(1152, 192, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
            192, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
      )
      (6): Sequential(
        (0): InvertedResidual(
          (conv_pw): Conv2d(192, 1152, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn1): BatchNormAct2d(
            1152, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (conv_dw): Conv2d(1152, 1152, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1), groups=1152, bias=False)
          (bn2): BatchNormAct2d(
            1152, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): SiLU(inplace=True)
          )
          (se): SqueezeExcite(
            (conv_reduce): Conv2d(1152, 48, kernel_size=(1, 1), stride=(1, 1))
            (act1): SiLU(inplace=True)
            (conv_expand): Conv2d(48, 1152, kernel_size=(1, 1), stride=(1, 1))
            (gate): Sigmoid()
          )
          (conv_pwl): Conv2d(1152, 320, kernel_size=(1, 1), stride=(1, 1),
bias=False)
          (bn3): BatchNormAct2d(
```

```
            320, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
            (drop): Identity()
            (act): Identity()
          )
          (drop_path): Identity()
        )
      )
    )
    (conv_head): Conv2d(320, 1280, kernel_size=(1, 1), stride=(1, 1),
bias=False)
    (bn2): BatchNormAct2d(
      1280, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True
      (drop): Identity()
      (act): SiLU(inplace=True)
    )
    (global_pool): SelectAdaptivePool2d(pool_type=avg,
flatten=Flatten(start_dim=1, end_dim=-1))
    (classifier): Linear(in_features=1280, out_features=2, bias=True)
  )
)
```

[12]:
```
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")


model.to(device)

criterion = nn.CrossEntropyLoss()
optimizer = optim.Adam(model.parameters(), lr=0.0001)
scheduler = optim.lr_scheduler.StepLR(optimizer, step_size=30, gamma=0.1)
```

[13]:
```
num_epochs = 20
train_losses, val_losses, val_accuracies = [], [], []
best_loss = 100000
for epoch in range(num_epochs):
    model.train()
    running_loss = 0.0
    train_bar = tqdm(train_loader, desc=f"Epoch {epoch+1}/{num_epochs} [Train]␣
 ↪Loss: 0.0000", leave=False)
    for inputs, labels in train_bar:
        inputs, labels = inputs.to(device), labels.to(device)

        optimizer.zero_grad()

        outputs = model(inputs)
        loss = criterion(outputs, labels)
        loss.backward()
        optimizer.step()
```

```
        running_loss += loss.item() * inputs.size(0)
        train_bar.set_description(f"Epoch {epoch+1}/{num_epochs} [Train] Loss:␣
↪{loss.item():.4f}")

    #scheduler.step()

    epoch_loss = running_loss / len(train_loader.dataset)
    train_losses.append(epoch_loss)

    # Validation phase
    model.eval()
    val_running_loss = 0.0
    correct_predictions = 0
    total_predictions = 0
    val_bar = tqdm(val_loader, desc=f"Epoch {epoch+1}/{num_epochs} [Val] Loss:␣
↪0.0000, Acc: 0.0000", leave=True)

    with torch.no_grad():
        for inputs, labels in val_bar:
            inputs, labels = inputs.to(device), labels.to(device)

            outputs = model(inputs)
            loss = criterion(outputs, labels)
            val_running_loss += loss.item() * inputs.size(0)

            _, predicted = torch.max(outputs, 1)
            correct_predictions += (predicted == labels).sum().item()
            total_predictions += labels.size(0)


            val_bar.set_description(f"Epoch {epoch+1}/{num_epochs} [Val] Loss:␣
↪{loss.item():.4f}, Acc: {correct_predictions/total_predictions:.4f}")

    epoch_val_loss = val_running_loss / len(val_loader.dataset)
    val_losses.append(epoch_val_loss)

    epoch_val_accuracy = correct_predictions / total_predictions
    best_loss = min(epoch_val_loss , best_loss)
    val_accuracies.append(epoch_val_accuracy)

    if(epoch_val_loss== best_loss):

            model_path = f"model_weights_{epoch}.pth"
            torch.save(model.state_dict(), model_path)
```

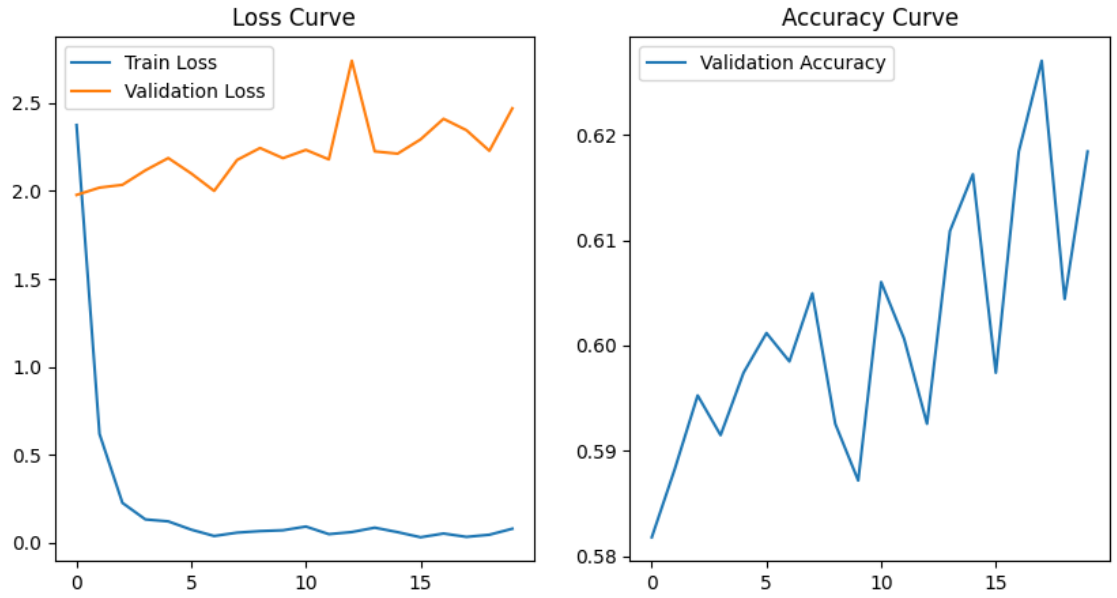
```
    print(f"Epoch {epoch+1}/{num_epochs}, Train Loss: {epoch_loss:.4f}, Val␣
↪Loss: {epoch_val_loss:.4f}, Val Accuracy: {epoch_val_accuracy:.4f}")
```

```
Epoch 1/20 [Val] Loss: 3.3815, Acc: 0.5818: 100%|      | 59/59 [00:01<00:00,
58.59it/s]

Epoch 1/20, Train Loss: 2.3755, Val Loss: 1.9780, Val Accuracy: 0.5818

Epoch 2/20 [Val] Loss: 2.3931, Acc: 0.5883: 100%|      | 59/59 [00:00<00:00,
68.17it/s]

Epoch 2/20, Train Loss: 0.6187, Val Loss: 2.0196, Val Accuracy: 0.5883

Epoch 3/20 [Val] Loss: 3.2673, Acc: 0.5953: 100%|      | 59/59 [00:00<00:00,
67.72it/s]

Epoch 3/20, Train Loss: 0.2260, Val Loss: 2.0355, Val Accuracy: 0.5953

Epoch 4/20 [Val] Loss: 1.1770, Acc: 0.5915: 100%|      | 59/59 [00:00<00:00,
67.56it/s]

Epoch 4/20, Train Loss: 0.1320, Val Loss: 2.1180, Val Accuracy: 0.5915

Epoch 5/20 [Val] Loss: 0.1135, Acc: 0.5974: 100%|      | 59/59 [00:00<00:00,
68.19it/s]

Epoch 5/20, Train Loss: 0.1207, Val Loss: 2.1878, Val Accuracy: 0.5974

Epoch 6/20 [Val] Loss: 0.4347, Acc: 0.6012: 100%|      | 59/59 [00:00<00:00,
67.72it/s]

Epoch 6/20, Train Loss: 0.0737, Val Loss: 2.1002, Val Accuracy: 0.6012

Epoch 7/20 [Val] Loss: 1.1005, Acc: 0.5985: 100%|      | 59/59 [00:00<00:00,
68.14it/s]

Epoch 7/20, Train Loss: 0.0376, Val Loss: 2.0010, Val Accuracy: 0.5985

Epoch 8/20 [Val] Loss: 1.6040, Acc: 0.6050: 100%|      | 59/59 [00:00<00:00,
69.01it/s]

Epoch 8/20, Train Loss: 0.0567, Val Loss: 2.1770, Val Accuracy: 0.6050

Epoch 9/20 [Val] Loss: 0.4433, Acc: 0.5926: 100%|      | 59/59 [00:00<00:00,
67.52it/s]

Epoch 9/20, Train Loss: 0.0654, Val Loss: 2.2450, Val Accuracy: 0.5926

Epoch 10/20 [Val] Loss: 0.6558, Acc: 0.5872: 100%|      | 59/59
[00:00<00:00, 66.93it/s]

Epoch 10/20, Train Loss: 0.0702, Val Loss: 2.1872, Val Accuracy: 0.5872

Epoch 11/20 [Val] Loss: 0.3706, Acc: 0.6060: 100%|      | 59/59
[00:00<00:00, 66.38it/s]

Epoch 11/20, Train Loss: 0.0913, Val Loss: 2.2343, Val Accuracy: 0.6060
```

```
Epoch 12/20 [Val] Loss: 0.1197, Acc: 0.6006: 100%|      | 59/59
[00:00<00:00, 67.78it/s]

Epoch 12/20, Train Loss: 0.0481, Val Loss: 2.1802, Val Accuracy: 0.6006

Epoch 13/20 [Val] Loss: 0.7628, Acc: 0.5926: 100%|      | 59/59
[00:00<00:00, 68.17it/s]

Epoch 13/20, Train Loss: 0.0600, Val Loss: 2.7413, Val Accuracy: 0.5926

Epoch 14/20 [Val] Loss: 0.1900, Acc: 0.6109: 100%|      | 59/59
[00:00<00:00, 68.71it/s]

Epoch 14/20, Train Loss: 0.0849, Val Loss: 2.2256, Val Accuracy: 0.6109

Epoch 15/20 [Val] Loss: 0.0440, Acc: 0.6163: 100%|      | 59/59
[00:00<00:00, 68.66it/s]

Epoch 15/20, Train Loss: 0.0594, Val Loss: 2.2129, Val Accuracy: 0.6163

Epoch 16/20 [Val] Loss: 0.0592, Acc: 0.5974: 100%|      | 59/59
[00:00<00:00, 68.31it/s]

Epoch 16/20, Train Loss: 0.0304, Val Loss: 2.2940, Val Accuracy: 0.5974

Epoch 17/20 [Val] Loss: 0.2811, Acc: 0.6184: 100%|      | 59/59
[00:00<00:00, 69.15it/s]

Epoch 17/20, Train Loss: 0.0516, Val Loss: 2.4111, Val Accuracy: 0.6184

Epoch 18/20 [Val] Loss: 0.0082, Acc: 0.6270: 100%|      | 59/59
[00:00<00:00, 68.51it/s]

Epoch 18/20, Train Loss: 0.0325, Val Loss: 2.3462, Val Accuracy: 0.6270

Epoch 19/20 [Val] Loss: 0.0239, Acc: 0.6044: 100%|      | 59/59
[00:00<00:00, 68.65it/s]

Epoch 19/20, Train Loss: 0.0447, Val Loss: 2.2291, Val Accuracy: 0.6044

Epoch 20/20 [Val] Loss: 1.3777, Acc: 0.6184: 100%|      | 59/59
[00:00<00:00, 68.18it/s]

Epoch 20/20, Train Loss: 0.0789, Val Loss: 2.4707, Val Accuracy: 0.6184
```

[14]:
```
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.plot(train_losses, label='Train Loss')
plt.plot(val_losses, label='Validation Loss')
plt.legend()
plt.title('Loss Curve')

plt.subplot(1, 2, 2)
plt.plot(val_accuracies, label='Validation Accuracy')
```

```
plt.legend()
plt.title('Accuracy Curve')
plt.show()
```



[ ]:

[ ]: