```
import kagglehub
gunavenkatdoddi_eye_diseases_classification_path = kagglehub.dataset_download('gunavenkat

print(PATH)
```

```
Using Colab cache for faster access to the 'eye-diseases-classification' dataset.
/kaggle/input/eye-diseases-classification/dataset
```

```
# Install libraries for PyTorch
!pip install torch-summary
!pip install torchmetrics
```

```
Collecting torch-summary
  Downloading torch_summary-1.4.5-py3-none-any.whl.metadata (18 kB)
Downloading torch_summary-1.4.5-py3-none-any.whl (16 kB)
Installing collected packages: torch-summary
Successfully installed torch-summary-1.4.5
Collecting torchmetrics
  Downloading torchmetrics-1.8.2-py3-none-any.whl.metadata (22 kB)
Requirement already satisfied: numpy>1.20.0 in /usr/local/lib/python3.12/dist-package
Requirement already satisfied: packaging>17.1 in /usr/local/lib/python3.12/dist-packa
Requirement already satisfied: torch>=2.0.0 in /usr/local/lib/python3.12/dist-package
Collecting lightning-utilities>=0.8.0 (from torchmetrics)
  Downloading lightning_utilities-0.15.2-py3-none-any.whl.metadata (5.7 kB)
Requirement already satisfied: setuptools in /usr/local/lib/python3.12/dist-packages
Requirement already satisfied: typing_extensions in /usr/local/lib/python3.12/dist-pa
Requirement already satisfied: filelock in /usr/local/lib/python3.12/dist-packages (f
Requirement already satisfied: sympy>=1.13.3 in /usr/local/lib/python3.12/dist-packag
Requirement already satisfied: networkx in /usr/local/lib/python3.12/dist-packages (f
Requirement already satisfied: jinja2 in /usr/local/lib/python3.12/dist-packages (fro
Requirement already satisfied: fsspec in /usr/local/lib/python3.12/dist-packages (fro
Requirement already satisfied: nvidia-cuda-nvrtc-cu12==12.6.77 in /usr/local/lib/pyth
Requirement already satisfied: nvidia-cuda-runtime-cu12==12.6.77 in /usr/local/lib/py
Requirement already satisfied: nvidia-cuda-cupti-cu12==12.6.80 in /usr/local/lib/pyth
Requirement already satisfied: nvidia-cudnn-cu12==9.10.2.21 in /usr/local/lib/python3
Requirement already satisfied: nvidia-cublas-cu12==12.6.4.1 in /usr/local/lib/python3
Requirement already satisfied: nvidia-cufft-cu12==11.3.0.4 in /usr/local/lib/python3.
Requirement already satisfied: nvidia-curand-cu12==10.3.7.77 in /usr/local/lib/python
Requirement already satisfied: nvidia-cusolver-cu12==11.7.1.2 in /usr/local/lib/pytho
Requirement already satisfied: nvidia-cusparse-cu12==12.5.4.2 in /usr/local/lib/pytho
Requirement already satisfied: nvidia-cusparselt-cu12==0.7.1 in /usr/local/lib/python
Requirement already satisfied: nvidia-nccl-cu12==2.27.3 in /usr/local/lib/python3.12/
Requirement already satisfied: nvidia-nvtx-cu12==12.6.77 in /usr/local/lib/python3.12
Requirement already satisfied: nvidia-nvjitlink-cu12==12.6.85 in /usr/local/lib/pytho
Requirement already satisfied: nvidia-cufile-cu12==1.11.1.6 in /usr/local/lib/python3
Requirement already satisfied: triton==3.4.0 in /usr/local/lib/python3.12/dist-packag
Requirement already satisfied: mpmath<1.4,>=1.1.0 in /usr/local/lib/python3.12/dist-p
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.12/dist-pack
Downloading torchmetrics-1.8.2-py3-none-any.whl (983 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 983.2/983.2 kB 9.6 MB/s eta 0:00:00
Downloading lightning_utilities-0.15.2-py3-none-any.whl (29 kB)
```

```
Installing collected packages: lightning-utilities, torchmetrics
Successfully installed lightning-utilities-0.15.2 torchmetrics-1.8.2
```

```
# Import libraries for data workings and setting compute source
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sea
import os
from tqdm.notebook import tqdm
import cv2 as op
import torch
from torchsummary import summary
import torchmetrics

plt.style.use('seaborn-v0_8')
np.__version__

device = 'cuda' if torch.cuda.is_available() else 'cpu'
device
```

```
'cpu'
```

Loading the data

```
PATH = '/kaggle/input/eye-diseases-classification/dataset'
label2id = {}
for i, label in enumerate(os.listdir(PATH)):
    label2id[label] = i

id2label = {key : value for (value, key) in label2id.items()}

filenames, outcome = [], []

for label in tqdm(os.listdir(PATH)):
    for img in os.listdir(os.path.join(PATH, label)):
        filenames.append(os.path.join(PATH, label, img))
        outcome.append(label2id[label])


df = pd.DataFrame({
    "filename" : filenames,
    "outcome" : outcome
})

df = df.sample(frac = 1)
df.head()
```

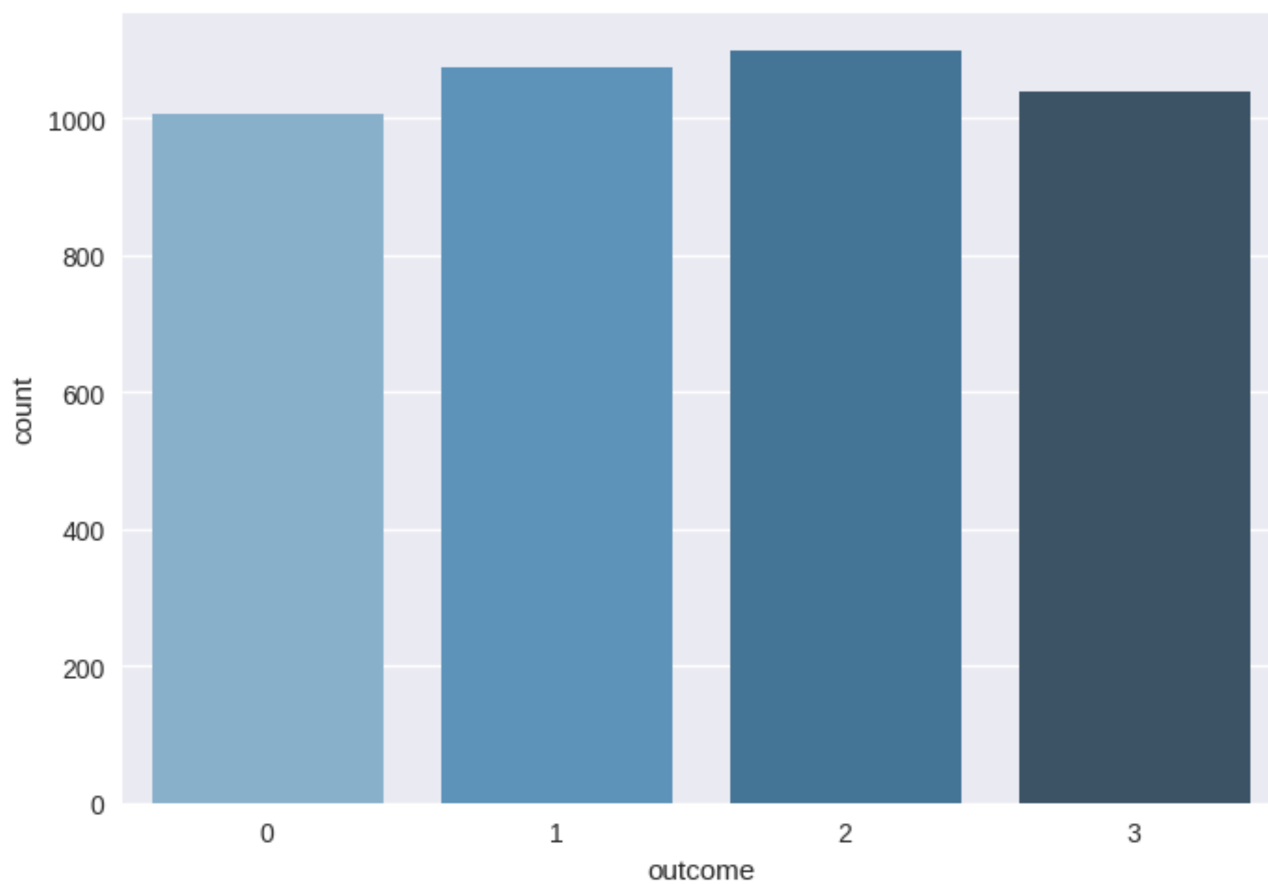
100% 4/4 [00:00<00:00, 89.48it/s]

	filename	outcome
3776	/kaggle/input/eye-diseases-classification/data...	3
3646	/kaggle/input/eye-diseases-classification/data...	3
3823	/kaggle/input/eye-diseases-classification/data...	3
1841	/kaggle/input/eye-diseases-classification/data...	1
199	/kaggle/input/eye-diseases-classification/data...	0

Next steps: Generate code with df | View recommended plots | New interactive sheet

```
# Dataset distribution
sea.countplot(x = 'outcome', data = df, palette = 'Blues_d')
```

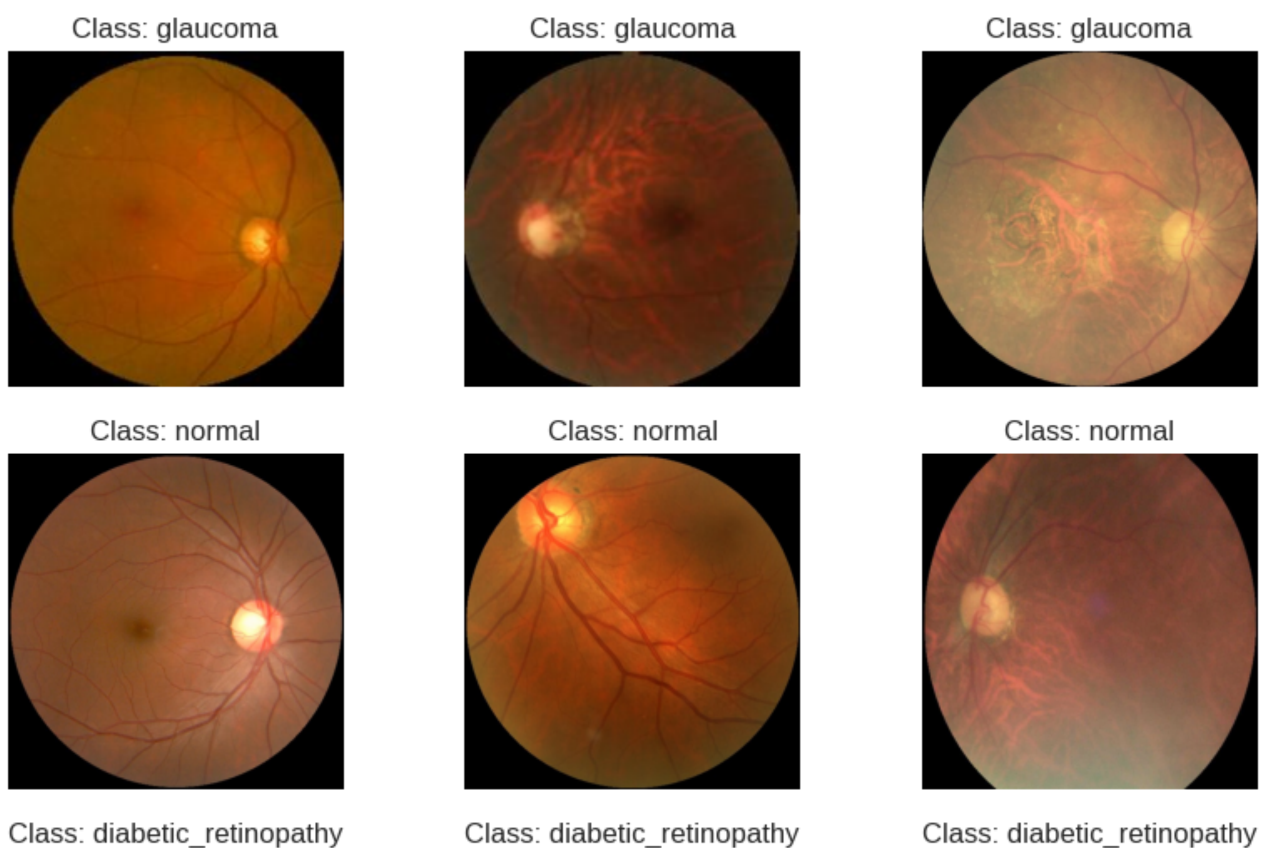
```
/tmp/ipython-input-1478327885.py:2: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.

  sea.countplot(x = 'outcome', data = df, palette = 'Blues_d')
<Axes: xlabel='outcome', ylabel='count'>
```

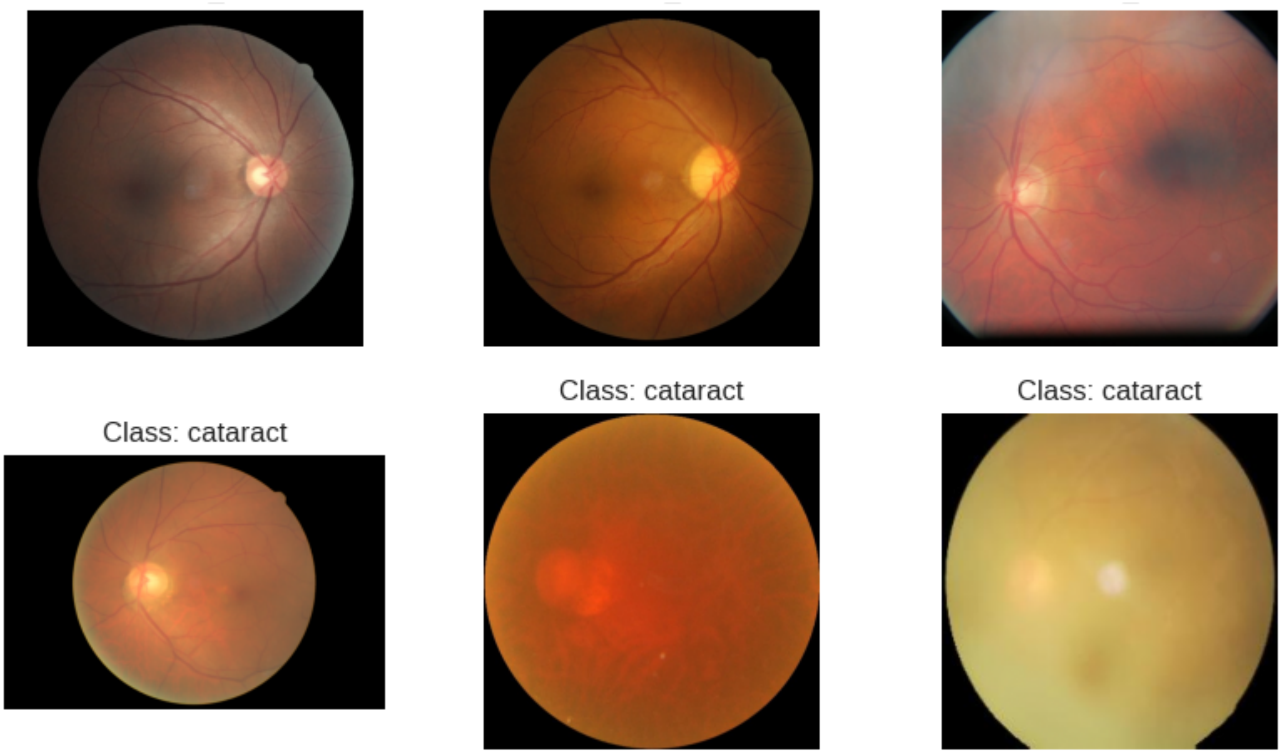


```
display(id2label)
```

```
{0: 'glaucoma', 1: 'normal', 2: 'diabetic_retinopathy', 3: 'cataract'}
```

```
# Normalize image using min-max scale method range (0,1) due to image pixel differences
def load_image(path):
    img = plt.imread(path)
    img = (img - img.min())/img.max()
    return img

counter = 0

plt.figure(figsize = (10, 12))

for i in range(4):
    for path in df[df['outcome'] == i].sample(n = 3)['filename']:
        plt.subplot(4, 3, counter + 1)
        img = load_image(path)
        plt.imshow(img)
        plt.axis('off')
        plt.title('Class:' + " " + id2label[i])
        counter += 1

plt.show()
```






```
# Import torch utilities for dataset loading followed by transformations (Random Horizont
import torch
import torch.nn as nn
from torch.utils.data import Dataset, DataLoader
import torchvision
from torchvision import transforms, models
import torch.nn.functional as f

train_transform = transforms.Compose([
    transforms.ToTensor(),
    transforms.Resize(size = (224, 224)),
    transforms.RandomHorizontalFlip(p = 0.5),
    transforms.RandomVerticalFlip(p = 0.5)
])

val_transform = transforms.Compose([
    transforms.ToTensor(),
    transforms.Resize(size = (224, 224))
])

class EyeDataset(Dataset):
```

```
class EyeDataset(Dataset):
    def __init__(self, df, n_classes, transform = None):
        self.df = df
        self.n_samples = len(self.df)
        self.n_classes = n_classes
        self.transform = transform

    def __len__(self):
        return self.n_samples

    def __getitem__(self, index):
        img = plt.imread(self.df.iloc[index, 0])
        label = self.df.iloc[index, 1]

        img = (img - img.min())/img.max()

        if self.transform:
            img = self.transform(img)

        return img.to(torch.float32), label


# 85/15 (training/valid) split
from sklearn.model_selection import train_test_split

df_train, df_val = train_test_split(df, test_size = 0.15, random_state = 28)

df_train.shape, df_val.shape
```

```
     ((3584, 2), (633, 2))
```

```
NUM_CLASSES = 4
BATCH_SIZE = 128

train_dataset = EyeDataset(df_train, NUM_CLASSES, train_transform)
val_dataset = EyeDataset(df_val, NUM_CLASSES, val_transform)

train_loader = DataLoader(train_dataset, batch_size = BATCH_SIZE, shuffle = True)
val_loader = DataLoader(val_dataset, batch_size = BATCH_SIZE, shuffle = False)


a, b = next(iter(train_loader))

print(a.shape, b.shape)
del(a)
del(b)
```

```
     torch.Size([128, 3, 224, 224]) torch.Size([128])
```

```
#ResNet 18 neural network pre-trained model used (transfer learning)
```

```
#ResNet-18 neural network pre-trained model used (transfer learning)
from math import ceil

class Net(nn.Module):
    def __init__(self):
        super().__init__()
        self.base = torchvision.models.resnet18(pretrained = True)

# Last 15 layers are left trainable while earlier layers are frozen
        for param in list(self.base.parameters())[:-15]:
            param.requires_grad = False

        self.block = nn.Sequential(
            nn.Linear(512, 128),
            nn.ReLU(),
            nn.Dropout(0.2),
            nn.Linear(128, 4),
        )
        self.base.classifier = nn.Sequential()
        self.base.fc = nn.Sequential()

#Adam optimizer and setting learning rates
    def get_optimizer(self):
        return torch.optim.AdamW([
            {'params' : self.base.parameters(), 'lr': 3e-5},
            {'params' : self.block.parameters(), 'lr': 8e-4}
        ])


    def forward(self, x):
        x = self.base(x)
        x = self.block(x)
        return x

#Now Eye Disease Classification

class Trainer(nn.Module):
    def __init__(self, train_loader, val_loader, device):
        super().__init__()
        self.train_loader = train_loader
        self.val_loader= val_loader
        self.device = device

        self.model = Net().to(self.device)
        self.optimizer = self.model.get_optimizer()
        self.loss_fxn = nn.CrossEntropyLoss()
        self.accuracy = torchmetrics.Accuracy(task = "multiclass", num_classes = NUM_CLAS

        self.history = {'train_loss' : [], 'val_loss': [], 'train_acc': [], 'val_acc': []

    def training_step(self, x, y):
```

```
        pred = self.model(x)
        loss = self.loss_fxn(pred, y)
        acc = self.accuracy(pred, y)

        self.optimizer.zero_grad()
        loss.backward()
        self.optimizer.step()

        return loss, acc

    def val_step(self, x, y):
        with torch.no_grad():
            pred = self.model(x)
            loss = self.loss_fxn(pred, y)
            acc = self.accuracy(pred, y)

        return loss, acc

    def step_fxn(self, loader, step):
        loss, acc = 0, 0

        for X, y in tqdm(loader):
            X, y = X.to(self.device), y.to(self.device)
            l, a = step(X, y)
            loss, acc = loss + l.item(), acc + a.item()

        return loss/len(loader), acc/len(loader)

    def train(self, epochs):

        for epoch in tqdm(range(epochs)):

            train_loss, train_acc = self.step_fxn(self.train_loader, self.training_step)
            val_loss, val_acc = self.step_fxn(self.val_loader, self.val_step)

            for item, value in zip(self.history.keys(), list([train_loss, val_loss, train
                self.history[item].append(value)


            print("[Epoch: {}] Train: [loss: {:.3f} acc: {:.3f}] Val: [loss: {:.3f} acc:{



trainer = Trainer(train_loader, val_loader, device)
```

```
/usr/local/lib/python3.12/dist-packages/torchvision/models/_utils.py:208: UserWarning
  warnings.warn(
/usr/local/lib/python3.12/dist-packages/torchvision/models/_utils.py:223: UserWarning
  warnings.warn(msg)
Downloading: "https://download.pytorch.org/models/resnet18-f37072fd.pth" to /root/.ca
100%|██████████| 44.7M/44.7M [00:00<00:00, 103MB/s]
```

```
#Model summary
summary(trainer.model.base, (3, 224, 224))
```

```
=========================================================================================
Layer (type:depth-idx)                   Output Shape              Param #
=========================================================================================
├─Conv2d: 1-1                            [-1, 64, 112, 112]        (9,408)
├─BatchNorm2d: 1-2                       [-1, 64, 112, 112]        (128)
├─ReLU: 1-3                              [-1, 64, 112, 112]        --
├─MaxPool2d: 1-4                         [-1, 64, 56, 56]          --
├─Sequential: 1-5                        [-1, 64, 56, 56]          --
|    └─BasicBlock: 2-1                   [-1, 64, 56, 56]          --
|    |    └─Conv2d: 3-1                  [-1, 64, 56, 56]          (36,864)
|    |    └─BatchNorm2d: 3-2             [-1, 64, 56, 56]          (128)
|    |    └─ReLU: 3-3                    [-1, 64, 56, 56]          --
|    |    └─Conv2d: 3-4                  [-1, 64, 56, 56]          (36,864)
|    |    └─BatchNorm2d: 3-5             [-1, 64, 56, 56]          (128)
|    |    └─ReLU: 3-6                    [-1, 64, 56, 56]          --
|    └─BasicBlock: 2-2                   [-1, 64, 56, 56]          --
|    |    └─Conv2d: 3-7                  [-1, 64, 56, 56]          (36,864)
|    |    └─BatchNorm2d: 3-8             [-1, 64, 56, 56]          (128)
|    |    └─ReLU: 3-9                    [-1, 64, 56, 56]          --
|    |    └─Conv2d: 3-10                 [-1, 64, 56, 56]          (36,864)
|    |    └─BatchNorm2d: 3-11            [-1, 64, 56, 56]          (128)
|    |    └─ReLU: 3-12                   [-1, 64, 56, 56]          --
├─Sequential: 1-6                        [-1, 128, 28, 28]         --
|    └─BasicBlock: 2-3                   [-1, 128, 28, 28]         --
|    |    └─Conv2d: 3-13                 [-1, 128, 28, 28]         (73,728)
|    |    └─BatchNorm2d: 3-14            [-1, 128, 28, 28]         (256)
|    |    └─ReLU: 3-15                   [-1, 128, 28, 28]         --
|    |    └─Conv2d: 3-16                 [-1, 128, 28, 28]         (147,456)
|    |    └─BatchNorm2d: 3-17            [-1, 128, 28, 28]         (256)
|    |    └─Sequential: 3-18             [-1, 128, 28, 28]         (8,448)
|    |    └─ReLU: 3-19                   [-1, 128, 28, 28]         --
|    └─BasicBlock: 2-4                   [-1, 128, 28, 28]         --
|    |    └─Conv2d: 3-20                 [-1, 128, 28, 28]         (147,456)
|    |    └─BatchNorm2d: 3-21            [-1, 128, 28, 28]         (256)
|    |    └─ReLU: 3-22                   [-1, 128, 28, 28]         --
|    |    └─Conv2d: 3-23                 [-1, 128, 28, 28]         (147,456)
|    |    └─BatchNorm2d: 3-24            [-1, 128, 28, 28]         (256)
|    |    └─ReLU: 3-25                   [-1, 128, 28, 28]         --
├─Sequential: 1-7                        [-1, 256, 14, 14]         --
|    └─BasicBlock: 2-5                   [-1, 256, 14, 14]         --
|    |    └─Conv2d: 3-26                 [-1, 256, 14, 14]         (294,912)
|    |    └─BatchNorm2d: 3-27            [-1, 256, 14, 14]         (512)
|    |    └─ReLU: 3-28                   [-1, 256, 14, 14]         --
|    |    └─Conv2d: 3-29                 [-1, 256, 14, 14]         (589,824)
|    |    └─BatchNorm2d: 3-30            [-1, 256, 14, 14]         (512)
|    |    └─Sequential: 3-31             [-1, 256, 14, 14]         (33,280)
|    |    └─ReLU: 3-32                   [-1, 256, 14, 14]         --
|    └─BasicBlock: 2-6                   [-1, 256, 14, 14]         --
|    |    └─Conv2d: 3-33                 [-1, 256, 14, 14]         (589,824)
|    |    └─BatchNorm2d: 3-34            [-1, 256, 14, 14]         (512)
|    |    └─ReLU: 3-35                   [-1, 256, 14, 14]         --
```

```
│    │    └─Conv2d: 3-36                [-1, 256, 14, 14]        (589,824)
│    │    └─BatchNorm2d: 3-37           [-1, 256, 14, 14]        (512)
│    │    └─ReLU: 3-38                  [-1, 256, 14, 14]        --
├─Sequential: 1-8                       [-1, 512, 7, 7]          --
│    └─BasicBlock: 2-7                  [-1, 512, 7, 7]          --
│    │    └─Conv2d: 3-39                [-1, 512, 7, 7]          (1,179,648)
│    │    └─BatchNorm2d: 3-40           [-1, 512, 7, 7]          (1,024)
```

Model Training

```
trainer.train(epochs = 2)
```

```
#Accuracy and loss line chart (accuracy goes up after second epoch and loss goes down aft
plt.figure(figsize = (15, 4))

plt.subplot(1,2,1)
plt.title('Loss')
plt.plot(trainer.history['train_loss'], label = 'Training')
plt.plot(trainer.history['val_loss'], label = 'Validation')
plt.legend()

plt.subplot(1,2,2)
plt.title('Accuracy')
plt.plot(trainer.history['train_acc'], label = 'Training')
plt.plot(trainer.history['val_acc'], label = 'Validation')
plt.legend()
```

```
# Model Predictions
preds, true = [], []

with torch.no_grad():
    for x, y in tqdm(val_loader):
        pred = torch.argmax(trainer.model(x.to(device)), axis = 1).detach().cpu().numpy()
        preds.extend(pred)
        true.extend(y)

len(preds), len(true)
```

```
from sklearn.metrics import confusion_matrix

cm = confusion_matrix(true, preds)
sea.heatmap(cm, annot=True, fmt='d', cmap='Blues', cbar=True)

plt.xlabel('Predicted labels')
plt.ylabel('True labels')
plt.title('Confusion Matrix')
```

```
from sklearn.metrics import classification_report

print(classification_report(true, preds, target_names = label2id.keys()))

                      precision    recall  f1-score   support

            glaucoma       0.89      0.80      0.84       168
              normal       0.84      0.89      0.86       154
diabetic_retinopathy       0.96      0.97      0.96       161
            cataract       0.90      0.93      0.91       150

            accuracy                           0.89       633
           macro avg       0.89      0.90      0.89       633
        weighted avg       0.89      0.89      0.89       633
```