In [1]:
```python
package_paths = [
    '../input/pytorch-image-models/pytorch-image-models-master', #'../input/efficientnet-pytorch-07/eff
icientnet_pytorch-0.7.0'
    '../input/image-fmix/FMix-master'
]
import sys;

for pth in package_paths:
    sys.path.append(pth)

from fmix import sample_mask, make_low_freq_image, binarise_mask
```

In [2]:
```python
from glob import glob
from sklearn.model_selection import GroupKFold, StratifiedKFold
import cv2
from skimage import io
import torch
from torch import nn
import os
from datetime import datetime
import time
import random
import cv2
import torchvision
from torchvision import transforms
import pandas as pd
import numpy as np
from tqdm import tqdm

import matplotlib.pyplot as plt
from torch.utils.data import Dataset,DataLoader
from torch.utils.data.sampler import SequentialSampler, RandomSampler
from torch.cuda.amp import autocast, GradScaler
from torch.nn.modules.loss import _WeightedLoss
import torch.nn.functional as F

import timm

import sklearn
import warnings
import joblib
from sklearn.metrics import roc_auc_score, log_loss
from sklearn import metrics
import warnings
import cv2
import pydicom
#from efficientnet_pytorch import EfficientNet
from scipy.ndimage.interpolation import zoom
```

In [3]:
```python
CFG = {
    'fold_num': 5,
    'seed': 719,
    'model_arch': 'tf_efficientnet_b4_ns',
    'img_size': 512,
    'epochs': 10,
    'train_bs': 16,
    'valid_bs': 32,
    'T_0': 10,
    'lr': 1e-4,
    'min_lr': 1e-6,
    'weight_decay':1e-6,
    'num_workers': 4,
    'accum_iter': 2, # suppoprt to do batch accumulation for backprop with effectively larger batch siz
e
    'verbose_step': 1,
    'device': 'cuda:0'
}
```

In [4]:
```python
train = pd.read_csv('../input/cassava-leaf-disease-classification/train.csv')
train.head()
```

Out[4]:

	image_id	label
0	1000015157.jpg	0
1	1000201771.jpg	3
2	100042118.jpg	1
3	1000723321.jpg	1
4	1000812911.jpg	3

In [5]:
```python
train.label.value_counts()
```

Out[5]:
```
3    13158
4     2577
2     2386
1     2189
0     1087
Name: label, dtype: int64
```

> We could do stratified validation split in each fold to make each fold's train and validation set looks like the whole train set in target distributions.

In [6]:
```python
submission = pd.read_csv('../input/cassava-leaf-disease-classification/sample_submission.csv')
submission.head()
```

Out[6]:

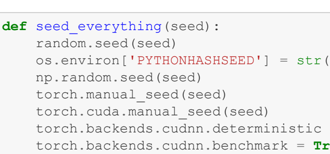
	image_id	label
0	2216849948.jpg	4

Helper Functions

In [7]:
```python
def seed_everything(seed):
    random.seed(seed)
    os.environ['PYTHONHASHSEED'] = str(seed)
    np.random.seed(seed)
    torch.manual_seed(seed)
    torch.cuda.manual_seed(seed)
    torch.backends.cudnn.deterministic = True
    torch.backends.cudnn.benchmark = True

def get_img(path):
    im_bgr = cv2.imread(path)
    im_rgb = im_bgr[:, :, ::-1]
    #print(im_rgb)
    return im_rgb

img = get_img('../input/cassava-leaf-disease-classification/train_images/1000015157.jpg')
plt.imshow(img)
plt.show()
```



Dataset

In [8]:
```python
def rand_bbox(size, lam):
    W = size[0]
    H = size[1]
    cut_rat = np.sqrt(1. - lam)
    cut_w = np.int(W * cut_rat)
    cut_h = np.int(H * cut_rat)

    # uniform
    cx = np.random.randint(W)
    cy = np.random.randint(H)

    bbx1 = np.clip(cx - cut_w // 2, 0, W)
    bby1 = np.clip(cy - cut_h // 2, 0, H)
    bbx2 = np.clip(cx + cut_w // 2, 0, W)
    bby2 = np.clip(cy + cut_h // 2, 0, H)
    return bbx1, bby1, bbx2, bby2


class CassavaDataset(Dataset):
    def __init__(self, df, data_root,
                 transforms=None,
                 output_label=True,
                 one_hot_label=False,
                 do_fmix=False,
                 fmix_params={
                     'alpha': 1.,
                     'decay_power': 3.,
                     'shape': (CFG['img_size'], CFG['img_size']),
                     'max_soft': True,
                     'reformulate': False
                 },
                 do_cutmix=False,
                 cutmix_params={
                     'alpha': 1,
                 }
                ):

        super().__init__()
        self.df = df.reset_index(drop=True).copy()
        self.transforms = transforms
        self.data_root = data_root
        self.do_fmix = do_fmix
        self.fmix_params = fmix_params
        self.do_cutmix = do_cutmix
        self.cutmix_params = cutmix_params

        self.output_label = output_label
        self.one_hot_label = one_hot_label

        if output_label == True:
            self.labels = self.df['label'].values
            #print(self.labels)

            if one_hot_label is True:
                self.labels = np.eye(self.df['label'].max()+1)[self.labels]
                #print(self.labels)

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

    def __getitem__(self, index: int):

        # get labels
        if self.output_label:
            target = self.labels[index]

        img  = get_img("{}/{}".format(self.data_root, self.df.loc[index]['image_id']))

        if self.transforms:
            img = self.transforms(image=img)['image']

        if self.do_fmix and np.random.uniform(0., 1., size=1)[0] > 0.5:
            with torch.no_grad():
                #lam, mask = sample_mask(**self.fmix_params)

                lam = np.clip(np.random.beta(self.fmix_params['alpha'], self.fmix_params['alpha']),0.6,
0.7)

                # Make mask, get mean / std
                mask = make_low_freq_image(self.fmix_params['decay_power'], self.fmix_params['shape'])
                mask = binarise_mask(mask, lam, self.fmix_params['shape'], self.fmix_params['max_soft'
])

                fmix_ix = np.random.choice(self.df.index, size=1)[0]
                fmix_img  = get_img("{}/{}".format(self.data_root, self.df.iloc[fmix_ix]['image_id']))

                if self.transforms:
                    fmix_img = self.transforms(image=fmix_img)['image']

                mask_torch = torch.from_numpy(mask)

                # mix image
                img = mask_torch*img+(1.-mask_torch)*fmix_img

                #print(mask.shape)

                #assert self.output_label==True and self.one_hot_label==True

                # mix target
                rate = mask.sum()/CFG['img_size']/CFG['img_size']
                target = rate*target + (1.-rate)*self.labels[fmix_ix]
                #print(target, mask, img)
                #assert False

        if self.do_cutmix and np.random.uniform(0., 1., size=1)[0] > 0.5:
            #print(img.sum(), img.shape)
            with torch.no_grad():
                cmix_ix = np.random.choice(self.df.index, size=1)[0]
                cmix_img  = get_img("{}/{}".format(self.data_root, self.df.iloc[cmix_ix]['image_id']))
                if self.transforms:
                    cmix_img = self.transforms(image=cmix_img)['image']

                lam = np.clip(np.random.beta(self.cutmix_params['alpha'], self.cutmix_params['alpha']),
0.3,0.4)
                bbx1, bby1, bbx2, bby2 = rand_bbox((CFG['img_size'], CFG['img_size']), lam)

                img[:, bbx1:bbx2, bby1:bby2] = cmix_img[:, bbx1:bbx2, bby1:bby2]

                rate = 1 - ((bbx2 - bbx1) * (bby2 - bby1) / (CFG['img_size'] * CFG['img_size']))
                target = rate*target + (1.-rate)*self.labels[cmix_ix]

            #print('-', img.sum())
            #print(target)
            #assert False

        # do label smoothing
        #print(type(img), type(target))
        if self.output_label == True:
            return img, target
        else:
            return img
```

Define Train\Validation Image Augmentations

In [9]:
```python
from albumentations import (
    HorizontalFlip, VerticalFlip, IAAPerspective, ShiftScaleRotate, CLAHE, RandomRotate90,
    Transpose, ShiftScaleRotate, Blur, OpticalDistortion, GridDistortion, HueSaturationValue,
    IAAAdditiveGaussianNoise, GaussNoise, MotionBlur, MedianBlur, IAAPiecewiseAffine, RandomResizedCrop
,
    IAASharpen, IAAEmboss, RandomBrightnessContrast, Flip, OneOf, Compose, Normalize, Cutout, CoarseDro
pout, ShiftScaleRotate, CenterCrop, Resize
)

from albumentations.pytorch import ToTensorV2

def get_train_transforms():
    return Compose([
            RandomResizedCrop(CFG['img_size'], CFG['img_size']),
            Transpose(p=0.5),
            HorizontalFlip(p=0.5),
            VerticalFlip(p=0.5),
            ShiftScaleRotate(p=0.5),
            HueSaturationValue(hue_shift_limit=0.2, sat_shift_limit=0.2, val_shift_limit=0.2, p=0.5),
            RandomBrightnessContrast(brightness_limit=(-0.1,0.1), contrast_limit=(-0.1, 0.1), p=0.5),
            Normalize(mean=[0.485, 0.456, 0.406], std=[0.229, 0.224, 0.225], max_pixel_value=255.0, p=
1.0),
            CoarseDropout(p=0.5),
            Cutout(p=0.5),
            ToTensorV2(p=1.0),
        ], p=1.)


def get_valid_transforms():
    return Compose([
            CenterCrop(CFG['img_size'], CFG['img_size'], p=1.),
            Resize(CFG['img_size'], CFG['img_size']),
            Normalize(mean=[0.485, 0.456, 0.406], std=[0.229, 0.224, 0.225], max_pixel_value=255.0, p=
1.0),
            ToTensorV2(p=1.0),
        ], p=1.)
```

Model

In [10]:
```python
class CassvaImgClassifier(nn.Module):
    def __init__(self, model_arch, n_class, pretrained=False):
        super().__init__()
        self.model = timm.create_model(model_arch, pretrained=pretrained)
        n_features = self.model.classifier.in_features
        self.model.classifier = nn.Linear(n_features, n_class)
        '''
        self.model.classifier = nn.Sequential(
            nn.Dropout(0.3),
            #nn.Linear(n_features, hidden_size,bias=True), nn.ELU(),
            nn.Linear(n_features, n_class, bias=True)
        )
        '''
    def forward(self, x):
        x = self.model(x)
        return x
```

Training APIs

In [11]:
```python
def prepare_dataloader(df, trn_idx, val_idx, data_root='../input/cassava-leaf-disease-classification/tr
ain_images/'):

    from catalyst.data.sampler import BalanceClassSampler

    train_ = df.loc[trn_idx,:].reset_index(drop=True)
    valid_ = df.loc[val_idx,:].reset_index(drop=True)

    train_ds = CassavaDataset(train_, data_root, transforms=get_train_transforms(), output_label=True,
one_hot_label=False, do_fmix=False, do_cutmix=False)
    valid_ds = CassavaDataset(valid_, data_root, transforms=get_valid_transforms(), output_label=True)

    train_loader = torch.utils.data.DataLoader(
        train_ds,
        batch_size=CFG['train_bs'],
        pin_memory=False,
        drop_last=False,
        shuffle=True,
        num_workers=CFG['num_workers'],
        #sampler=BalanceClassSampler(labels=train_['label'].values, mode="downsampling")
    )
    val_loader = torch.utils.data.DataLoader(
        valid_ds,
        batch_size=CFG['valid_bs'],
        num_workers=CFG['num_workers'],
        shuffle=False,
        pin_memory=False,
    )
    return train_loader, val_loader

def train_one_epoch(epoch, model, loss_fn, optimizer, train_loader, device, scheduler=None, schd_batch_
update=False):
    model.train()

    t = time.time()
    running_loss = None

    pbar = tqdm(enumerate(train_loader), total=len(train_loader))
    for step, (imgs, image_labels) in pbar:
        imgs = imgs.to(device).float()
        image_labels = image_labels.to(device).long()

        #print(image_labels.shape, exam_label.shape)
        with autocast():
            image_preds = model(imgs)   #output = model(input)
            #print(image_preds.shape, exam_pred.shape)

            loss = loss_fn(image_preds, image_labels)

            scaler.scale(loss).backward()

            if running_loss is None:
                running_loss = loss.item()
            else:
                running_loss = running_loss * .99 + loss.item() * .01

            if ((step + 1) %  CFG['accum_iter'] == 0) or ((step + 1) == len(train_loader)):
                # may unscale_ here if desired (e.g., to allow clipping unscaled gradients)

                scaler.step(optimizer)
                scaler.update()
                optimizer.zero_grad()

                if scheduler is not None and schd_batch_update:
                    scheduler.step()

            if ((step + 1) % CFG['verbose_step'] == 0) or ((step + 1) == len(train_loader)):
                description = f'epoch {epoch} loss: {running_loss:.4f}'

                pbar.set_description(description)

    if scheduler is not None and not schd_batch_update:
        scheduler.step()

def valid_one_epoch(epoch, model, loss_fn, val_loader, device, scheduler=None, schd_loss_update=False):
    model.eval()

    t = time.time()
    loss_sum = 0
    sample_num = 0
    image_preds_all = []
    image_targets_all = []

    pbar = tqdm(enumerate(val_loader), total=len(val_loader))
    for step, (imgs, image_labels) in pbar:
        imgs = imgs.to(device).float()
        image_labels = image_labels.to(device).long()

        image_preds = model(imgs)   #output = model(input)
        #print(image_preds.shape, exam_pred.shape)
        image_preds_all += [torch.argmax(image_preds, 1).detach().cpu().numpy()]
        image_targets_all += [image_labels.detach().cpu().numpy()]

        loss = loss_fn(image_preds, image_labels)

        loss_sum += loss.item()*image_labels.shape[0]
        sample_num += image_labels.shape[0]

        if ((step + 1) % CFG['verbose_step'] == 0) or ((step + 1) == len(val_loader)):
            description = f'epoch {epoch} loss: {loss_sum/sample_num:.4f}'
            pbar.set_description(description)

    image_preds_all = np.concatenate(image_preds_all)
    image_targets_all = np.concatenate(image_targets_all)
    print('validation multi-class accuracy = {:.4f}'.format((image_preds_all==image_targets_all).mean
()))

    if scheduler is not None:
        if schd_loss_update:
            scheduler.step(loss_sum/sample_num)
        else:
            scheduler.step()
```

In [12]:
```python
# reference: https://www.kaggle.com/c/siim-isic-melanoma-classification/discussion/173733
class MyCrossEntropyLoss(_WeightedLoss):
    def __init__(self, weight=None, reduction='mean'):
        super().__init__(weight=weight, reduction=reduction)
        self.weight = weight
        self.reduction = reduction

    def forward(self, inputs, targets):
        lsm = F.log_softmax(inputs, -1)

        if self.weight is not None:
            lsm = lsm * self.weight.unsqueeze(0)

        loss = -(targets * lsm).sum(-1)

        if  self.reduction == 'sum':
            loss = loss.sum()
        elif  self.reduction == 'mean':
            loss = loss.mean()

        return loss
```

Main Loop

In [13]:
```python
if __name__ == '__main__':
     # for training only, need nightly build pytorch

    seed_everything(CFG['seed'])

    folds = StratifiedKFold(n_splits=CFG['fold_num'], shuffle=True, random_state=CFG['seed']).split(np.
arange(train.shape[0]), train.label.values)

    for fold, (trn_idx, val_idx) in enumerate(folds):
        # we'll train fold 0 first
        if fold > 0:
            break

        print('Training with {} started'.format(fold))

        print(len(trn_idx), len(val_idx))
        train_loader, val_loader = prepare_dataloader(train, trn_idx, val_idx, data_root='../input/cass
ava-leaf-disease-classification/train_images/')

        device = torch.device(CFG['device'])

        model = CassvaImgClassifier(CFG['model_arch'], train.label.nunique(), pretrained=True).to(devic
e)
        scaler = GradScaler()
        optimizer = torch.optim.Adam(model.parameters(), lr=CFG['lr'], weight_decay=CFG['weight_decay'
])
        #scheduler = torch.optim.lr_scheduler.StepLR(optimizer, gamma=0.1, step_size=CFG['epochs']-1)
        scheduler = torch.optim.lr_scheduler.CosineAnnealingWarmRestarts(optimizer, T_0=CFG['T_0'], T_m
ult=1, eta_min=CFG['min_lr'], last_epoch=-1)
        #scheduler = torch.optim.lr_scheduler.OneCycleLR(optimizer=optimizer, pct_start=0.1, div_factor
=25,
        #                                                max_lr=CFG['lr'], epochs=CFG['epochs'], steps_
per_epoch=len(train_loader))

        loss_tr = nn.CrossEntropyLoss().to(device) #MyCrossEntropyLoss().to(device)
        loss_fn = nn.CrossEntropyLoss().to(device)

        for epoch in range(CFG['epochs']):
            train_one_epoch(epoch, model, loss_tr, optimizer, train_loader, device, scheduler=scheduler
, schd_batch_update=False)

            with torch.no_grad():
                valid_one_epoch(epoch, model, loss_fn, val_loader, device, scheduler=None, schd_loss_up
date=False)

            torch.save(model.state_dict(),'{}_fold_{}_{}'.format(CFG['model_arch'], fold, epoch))

        #torch.save(model.cnn_model.state_dict(),'{}/cnn_model_fold_{}_{}'.format(CFG['model_path'], fo
ld, CFG['tag']))
        del model, optimizer, train_loader, val_loader, scaler, scheduler
        torch.cuda.empty_cache()
```

```
Training with 0 started
17117 4280
```

```
wandb: WARNING W&B installed but not logged in.  Run `wandb login` or set the WANDB_API_KEY env varia
ble.
Downloading: "https://github.com/rwightman/pytorch-image-models/releases/download/v0.1-weights/tf_eff
icientnet_b4_ns-d6313a46.pth" to /root/.cache/torch/hub/checkpoints/tf_efficientnet_b4_ns-d6313a46.pt
h
epoch 0 loss: 0.4855: 100%|██████████| 1070/1070 [13:04<00:00,  1.36it/s]
epoch 0 loss: 0.3678: 100%|██████████| 134/134 [01:18<00:00,  1.71it/s]
```

```
validation multi-class accuracy = 0.8757
```

```
epoch 1 loss: 0.4044: 100%|██████████| 1070/1070 [13:02<00:00,  1.37it/s]
epoch 1 loss: 0.3480: 100%|██████████| 134/134 [01:13<00:00,  1.82it/s]
```

```
validation multi-class accuracy = 0.8790
```

```
epoch 2 loss: 0.3743: 100%|██████████| 1070/1070 [13:02<00:00,  1.37it/s]
epoch 2 loss: 0.3365: 100%|██████████| 134/134 [01:14<00:00,  1.79it/s]
```

```
validation multi-class accuracy = 0.8855
```

```
epoch 3 loss: 0.3589: 100%|██████████| 1070/1070 [13:03<00:00,  1.37it/s]
epoch 3 loss: 0.3508: 100%|██████████| 134/134 [01:15<00:00,  1.78it/s]
```

```
validation multi-class accuracy = 0.8818
```

```
epoch 4 loss: 0.3406: 100%|██████████| 1070/1070 [12:57<00:00,  1.38it/s]
epoch 4 loss: 0.3210: 100%|██████████| 134/134 [01:11<00:00,  1.88it/s]
```

```
validation multi-class accuracy = 0.8921
```

```
epoch 5 loss: 0.3095: 100%|██████████| 1070/1070 [13:00<00:00,  1.37it/s]
epoch 5 loss: 0.3237: 100%|██████████| 134/134 [01:23<00:00,  1.61it/s]
```

```
validation multi-class accuracy = 0.8932
```

```
epoch 6 loss: 0.2846: 100%|██████████| 1070/1070 [12:58<00:00,  1.38it/s]
epoch 6 loss: 0.3230: 100%|██████████| 134/134 [01:13<00:00,  1.83it/s]
```

```
validation multi-class accuracy = 0.8909
```

```
epoch 7 loss: 0.2627: 100%|██████████| 1070/1070 [13:01<00:00,  1.37it/s]
epoch 7 loss: 0.3261: 100%|██████████| 134/134 [01:15<00:00,  1.78it/s]
```

```
validation multi-class accuracy = 0.8897
```

```
epoch 8 loss: 0.2616: 100%|██████████| 1070/1070 [13:07<00:00,  1.36it/s]
epoch 8 loss: 0.3193: 100%|██████████| 134/134 [01:13<00:00,  1.83it/s]
```

```
validation multi-class accuracy = 0.8914
```

```
epoch 9 loss: 0.2400: 100%|██████████| 1070/1070 [13:04<00:00,  1.36it/s]
epoch 9 loss: 0.3250: 100%|██████████| 134/134 [01:15<00:00,  1.77it/s]
```

```
validation multi-class accuracy = 0.8902
```

Inferece part is here: https://www.kaggle.com/khyeh0719/pytorch-efficientnet-baseline-inference-tta