Wilderness Image Classification using Neural Networks

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Abstract:

Satellite image classification is a challenging problem that lies at the crossroads of remote sensing, computer vision, and machine learning. Due to the high similarity in the satellite data, deep learning models have found it difficult to classify images with similar characteristics. In this project we have reviewed the currently available image classification architectures (LeNet, ResNet, VGG, Google-Inception, DenseNet and MobileNet) based on their accuracies while training them on dataset of monoculture and forest. The data used for training and validation has been collected by us for this specific purpose, since this attempt has been done for the first time, there is no available dataset.

Experimental Setup:

The Experiment has been done in two parts:

1. Classification between forest and others (includes every terrain other than forest)
2. Classification between forest and monoculture

Data:

The data has been downloaded from Google Earth Pro (GE). We collected 24 (4800 x 2822) images belonging to category of forest and 24 images that belong to non-forest category. These raw images were sliced into 256 x 256-pixel size images. As a result, we have 2978 images and 4798 images of forest and non-forest(green and others) category. We have separated 2000 images taken randomly out of 7776 images in the validation set for the first experiment. For the second experiment classification has been done using 2978 images of forest and 1980 green images. Green images are images that include monoculture, agriculture and terrains which look similar to forest but are not considered forest.

Training:

We have trained the following models:

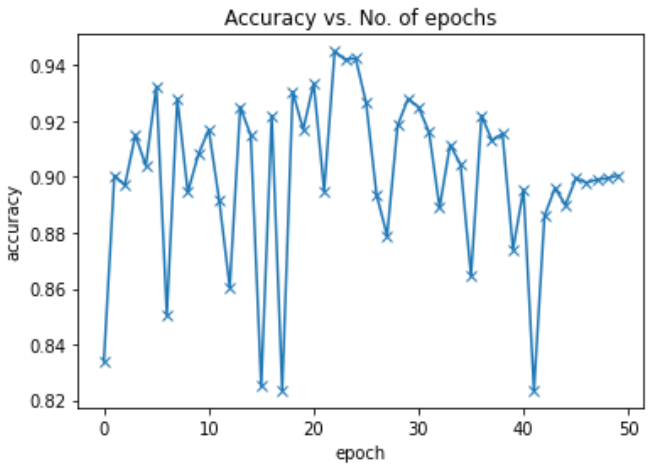
- LeNet
- VGGNet11, VGGNet13, VGGNet16, VGGNet19
- ResNet9
- Google-Inceptionv1
- DenseNet
- MobileNetv2

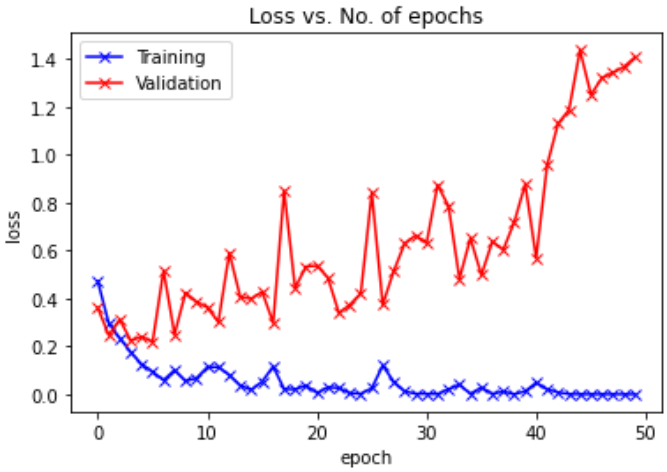
The models have been trained for 50 epochs with learning rate of 1e-5 while using Adam optimizer. Models were trained on a Nvidia Tesla K80 Graphic Processing Unit.

Results:

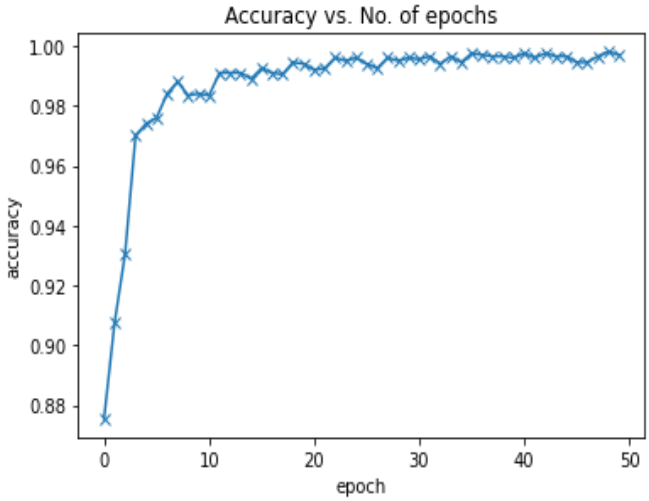
Test accuracies and losses during Classification between forest and non-forest.

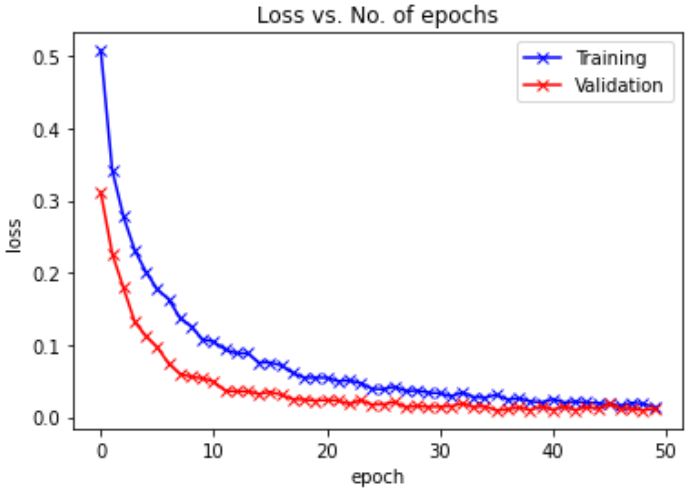
LeNet:



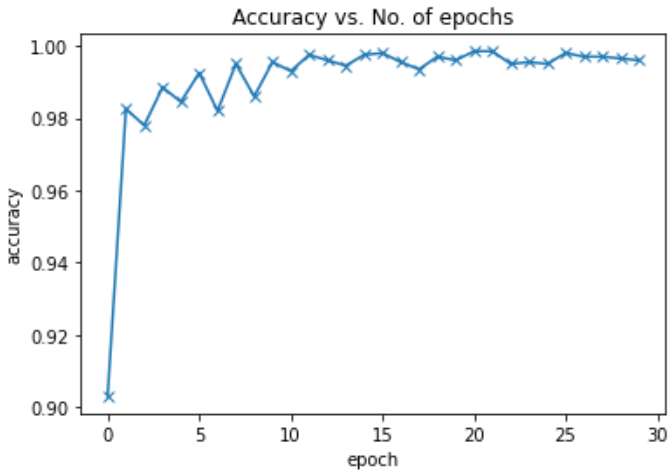


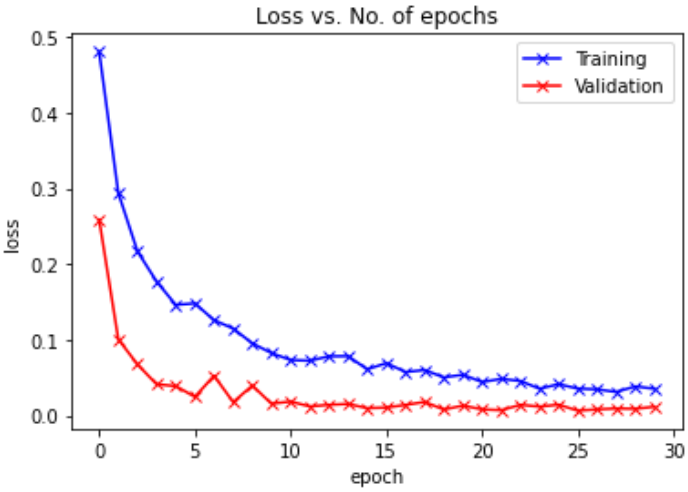
Resnet9:



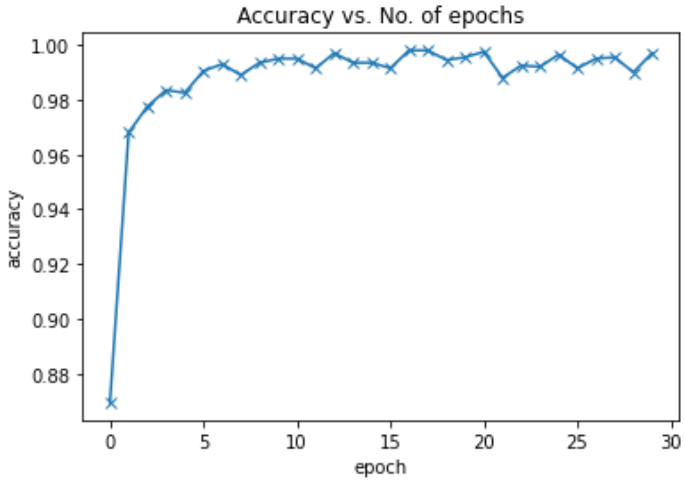


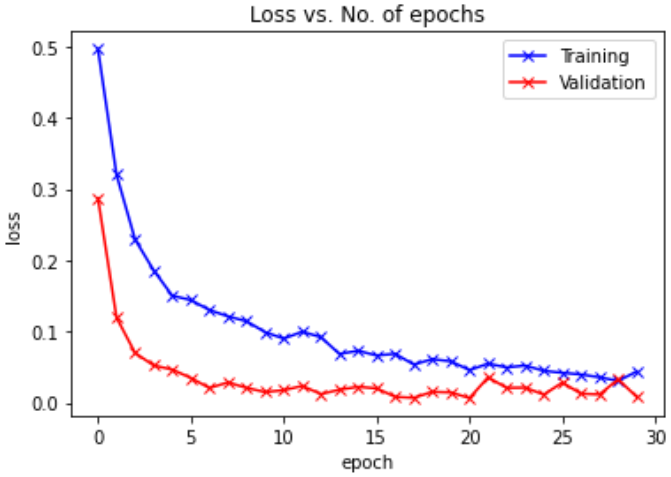
VGG11:



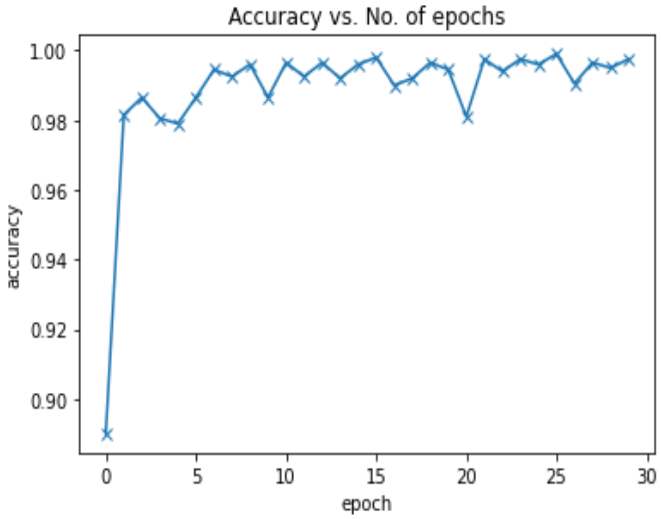


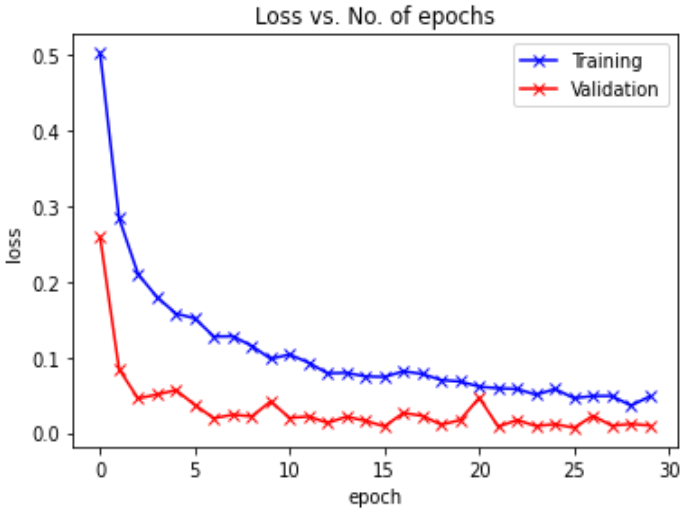
VGG13



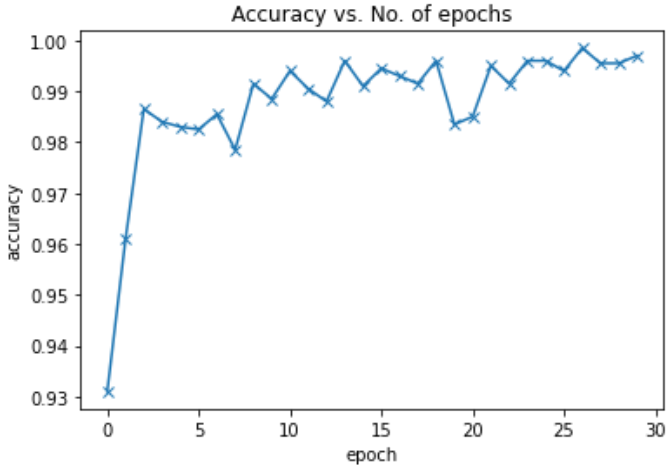


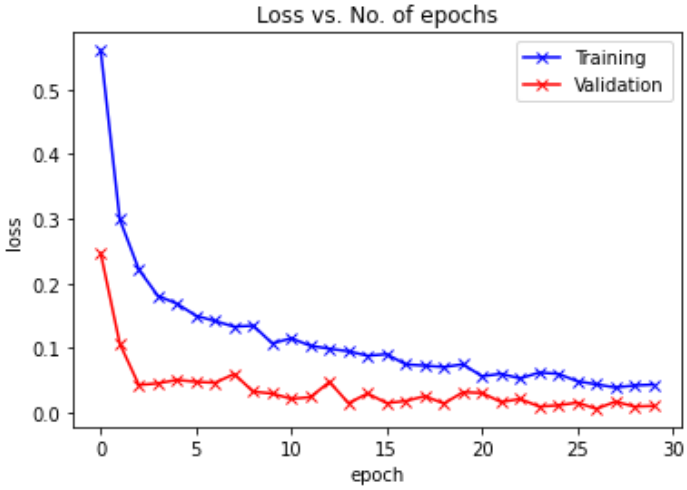
VGG16



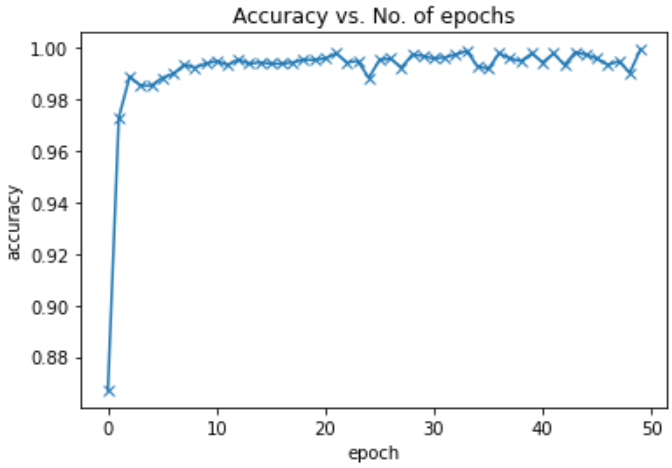


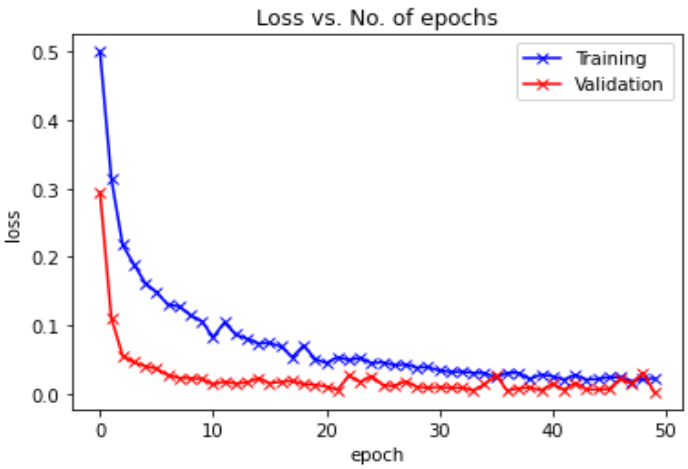
VGG19



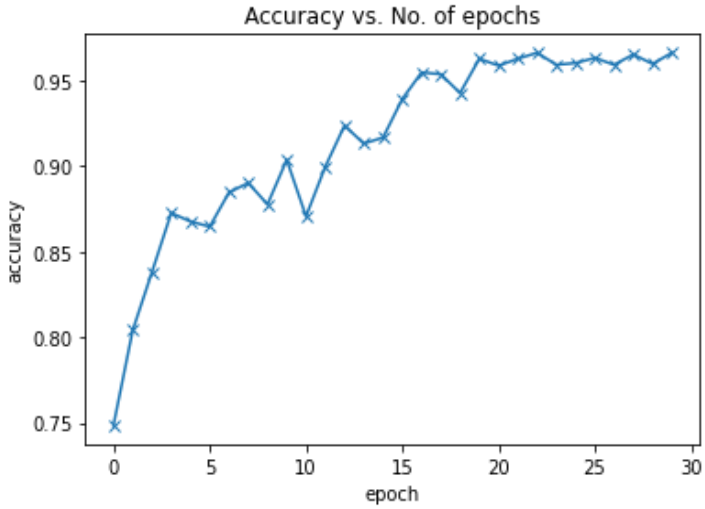


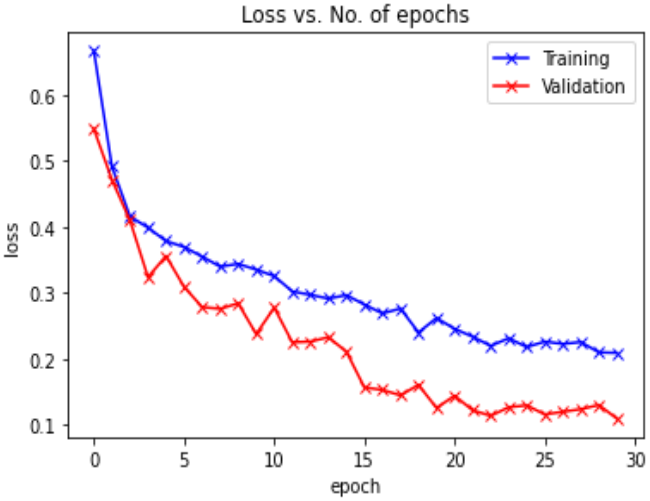
Google-Inceptionv1



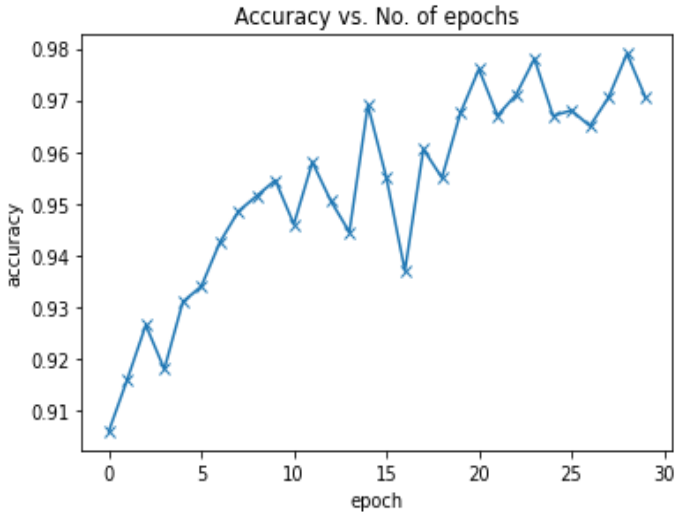


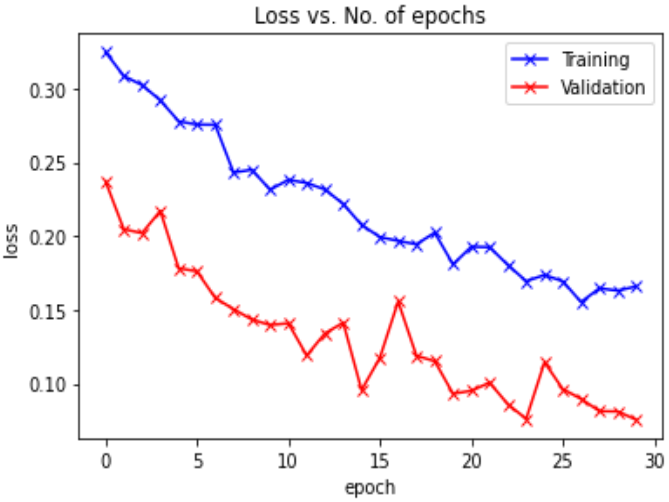
DenseNet121





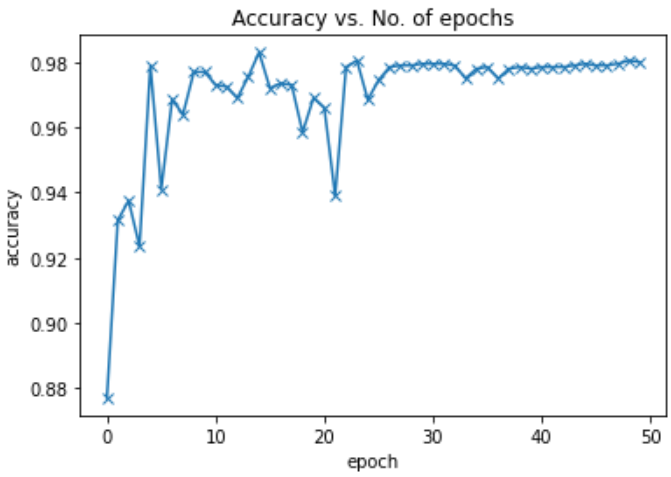
MobileNetv2

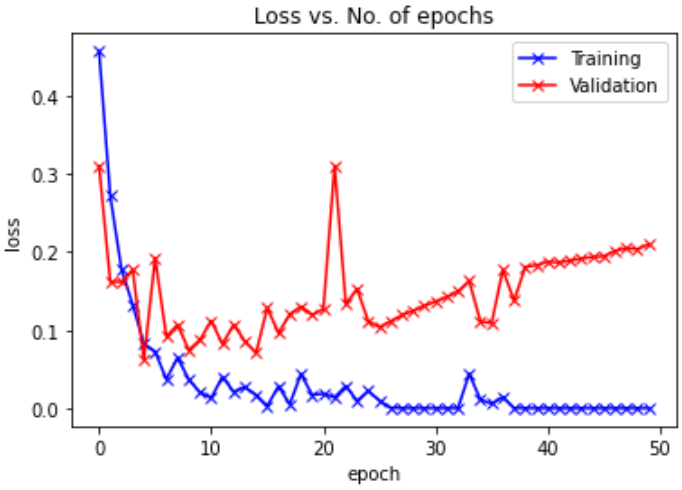




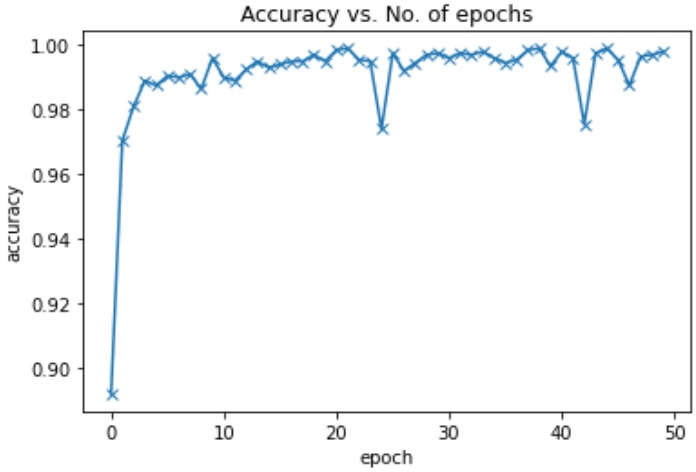
Test accuracies and losses during Classification between forest and green.

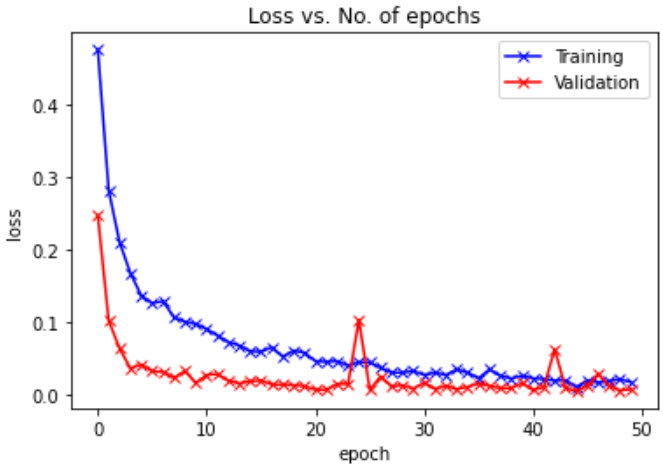
LeNet:



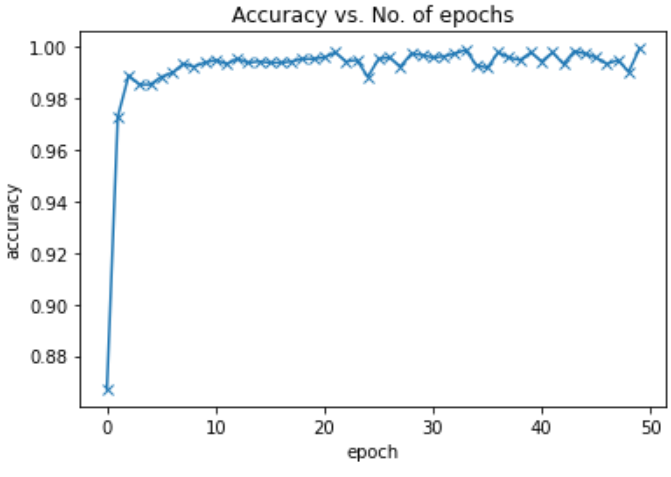


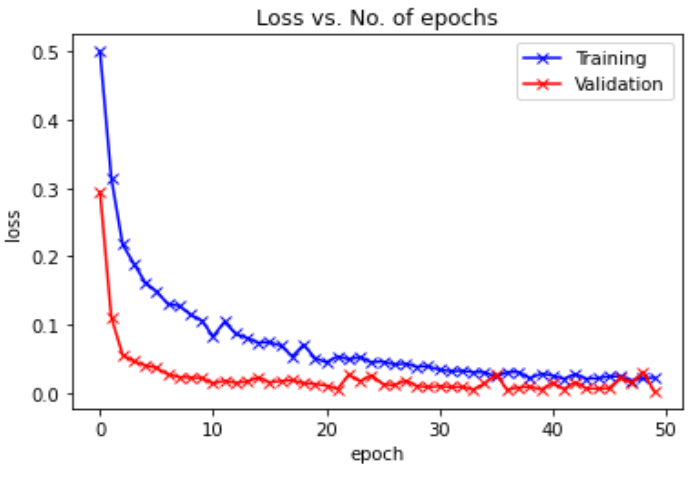
VGGNet11:



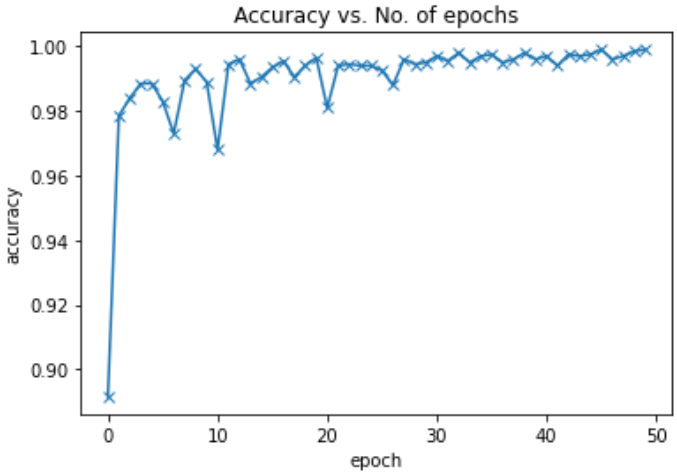


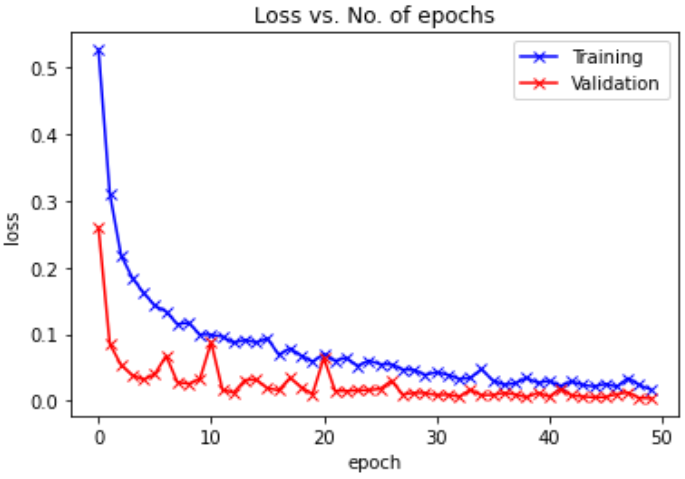
VGGNet13:



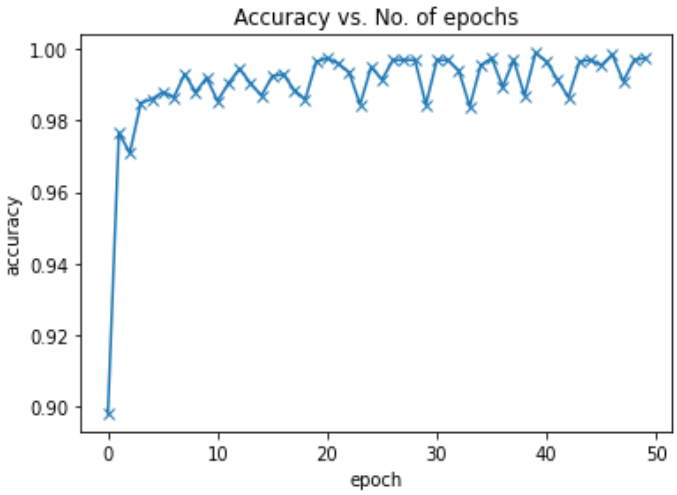


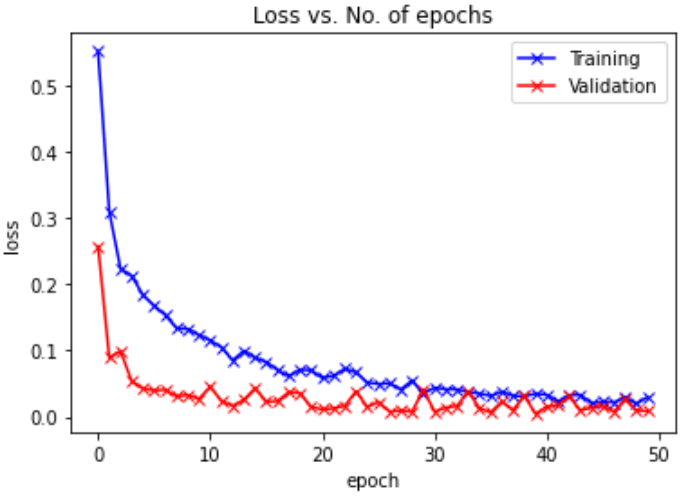
VGGNet16:



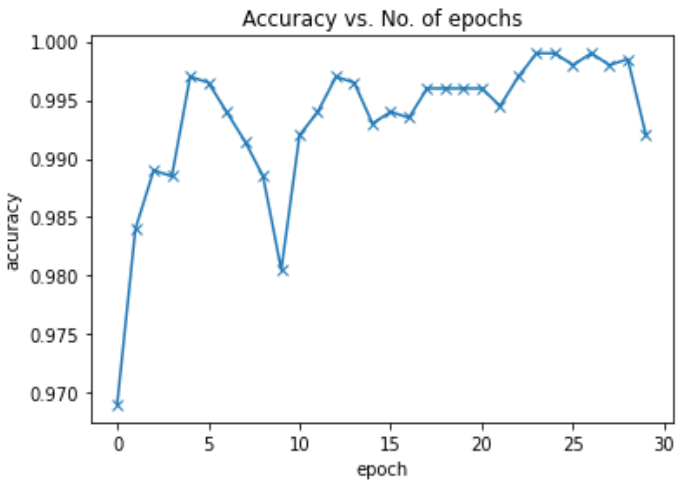


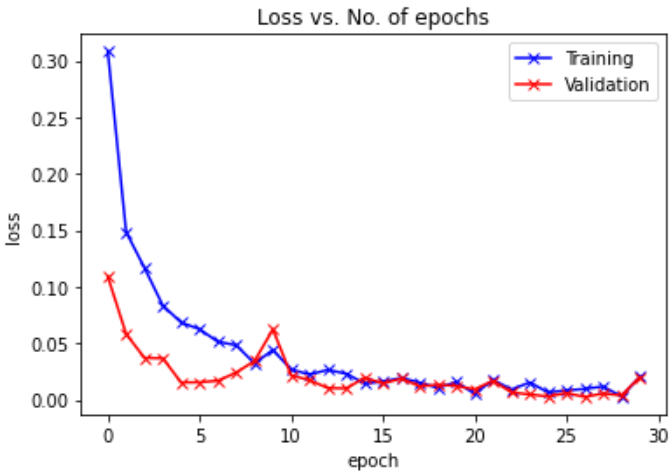
VGGNet19:



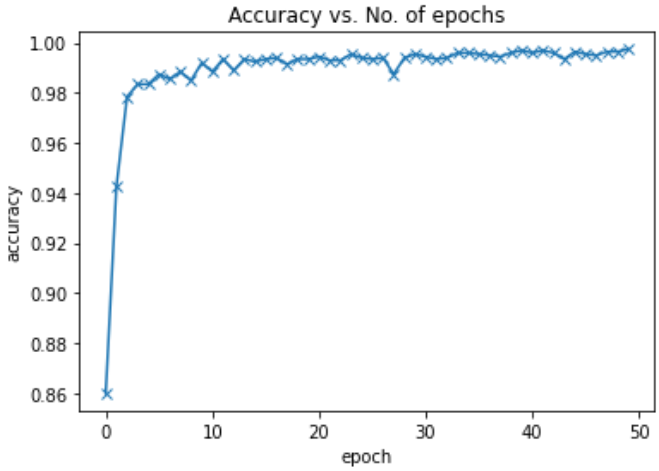


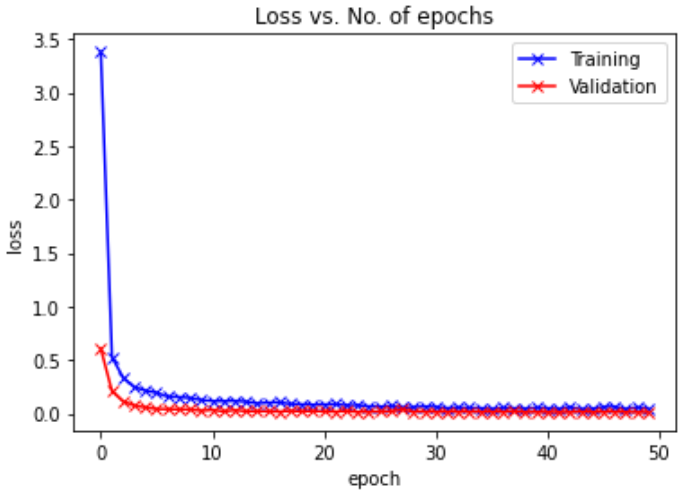
ResNet9:



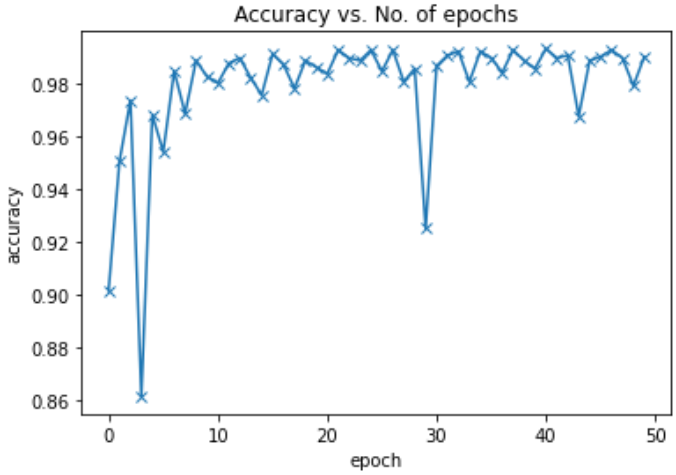


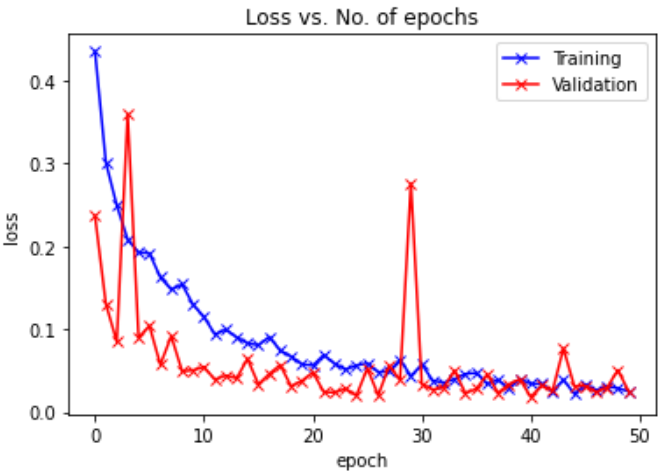
Google-Inceptionv1:



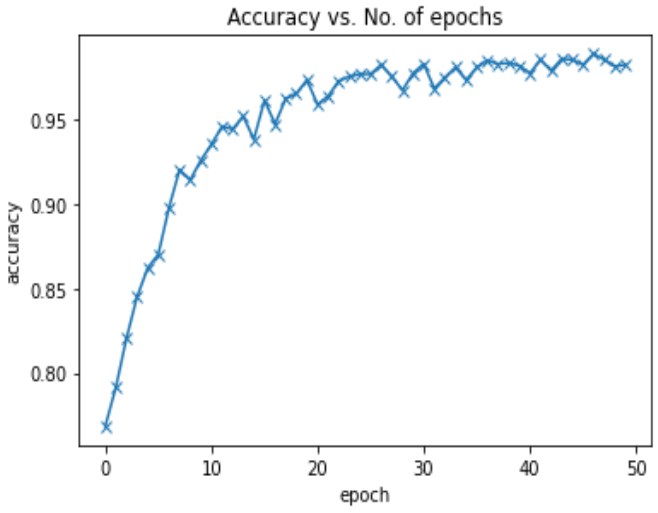


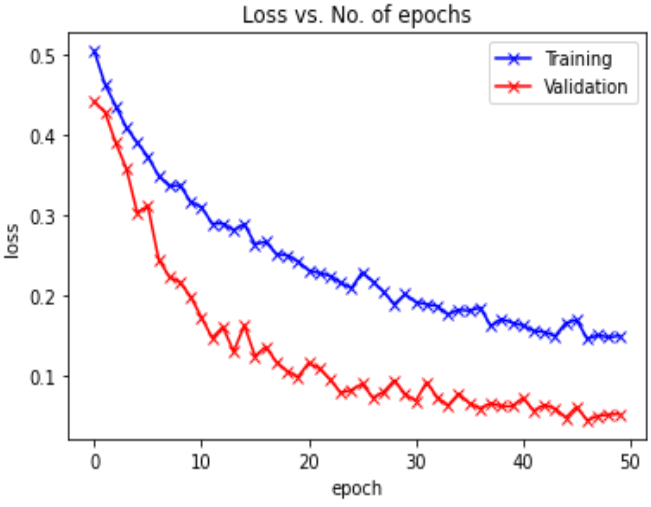
DenseNet121:





MobileNetv2:





The following tables summarise the results. The binary cross entropy loss values provided are the average of the three lowest values observed and accuracy mentioned is the average of the three highest accuracies obtained.

Table 1. Classification between forest and non-forest images

Models	Test Accuracy	Test Loss	Training Loss
LeNet	0.9235	0.2397	0.0000
VGGNet11	0.9984	0.0070	0.0328
VGGNet13	0.9978	0.0378	0.0352
VGGNet16	0.9982	0.0083	0.0434
VGGNet19	0.9971	0.0099	0.0412
ResNet9	0.9975	0.0114	0.0160
Google-Inceptionv1	0.9968	0.0118	0.0225
DenseNet121	0.9650	0.1170	0.2160
MobileNetv2	0.9760	0.0775	0.1645

Table 1. Classification between forest and green images

Models	Test Accuracy	Test Loss	Training Loss
LeNet	0.9795	0.0710	0.0000
VGGNet11	0.9943	0.0057	0.0148
VGGNet13	0.9990	0.0044	0.0201
VGGNet16	0.9985	0.0047	0.0199
VGGNet19	0.9983	0.0070	0.0206
ResNet9	0.9990	0.0031	0.0048
Google-Inceptionv1	0.9970	0.0125	0.0423
DenseNet121	0.9961	0.0099	0.0328
MobileNetv2	0.9861	0.0469	0.1474

Conclusion:

The results shown by the models were satisfactorily good. The best accuracy was shown by -----.