

# Building a portable offline bark identification system through training Neural Network by Knowledge Distillation and Network Pruning

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## Introduction

Automatic identification of tree species using images of tree bark can be useful for several forestry-related tasks [1]. Current well-performing bark identification systems rely heavily on real-time internet connection to access massive computing power. There are instances where such connections may be scarce in the forest. An off-line framework with acceptable performance on smart device may be a solution to this problem. Knowledge distilling [2] and Network pruning [3] are modern neural network techniques which focus on reducing the size of the neural network but maintaining a relatively good performance. In this research, we focus on training a light-

weight neural network MobileNet-V2 with knowledge distillation and network pruning approach to obtain better model weights.

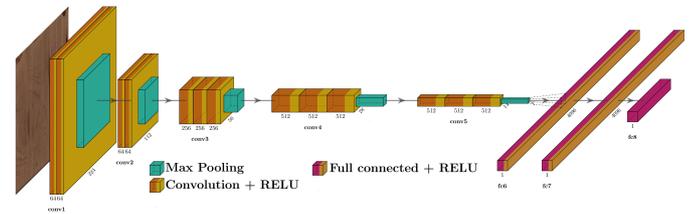


Figure 1. VGG-16 Architecture

## Material & Method

### 1. Data pre-processing

We collected in total 309 images by iPhone Xs from Martell Forest located in West Lafayette, Indianan, USA. Table 1 shows the general description for our data. The original image resolution is set to  $3024 \times 4032$  and we crop 3  $1000 \times 1000$  patches without overlapping from the data-set. Apart from our own data, we also trained a separate Neural Network from BarkNet [1].



Figure 2. Sample Images. Left:beech from our dataset, Right:Maple from BarkNet.

Table.1 Species List: Image # represents the number of images we screened, and patch # is the final patch ( $1000 \times 1000$ ) count for each species.

Species	Image #	Patch #	Species	Image #	Patch #
Beech	24	388	Northern Red Oak	35	420
Black Cherry	30	360	Sugar Maple	31	372
Black Locust	32	384	Sycamore	30	360
Black Walnut	30	360	White Oak	32	384
Muclewood	30	360	Yellow Poplar	35	420
<b>Total</b>	<b>309</b>	<b>3808</b>			

### 2. Knowledge distillation

In general, the idea of distillation is to train network in two steps. First train a large Network, so called teacher network, and then use the predicted label of the large network as soft label to train a small network called the student network. The new soft label could be seen as teacher to help student network to learn, since the hard label (classification label) are hard to learn [4].

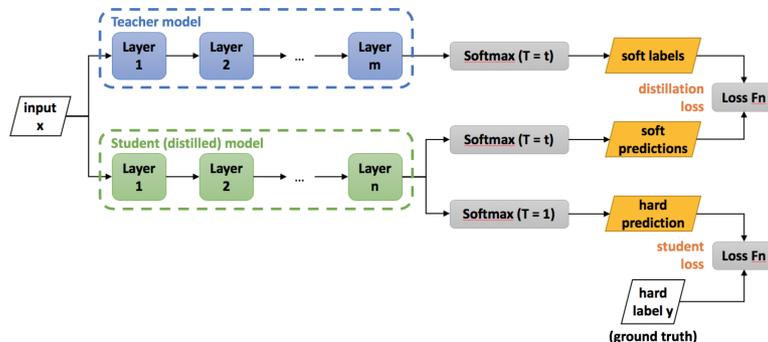


Figure 3. A schematic diagram of knowledge distillation [5].

### 3. Network Pruning

Network pruning based methods aim to discover the redundancy of parameters in neural networks and try to remove the redundant and uncritical ones. Some works showed that network pruning is effective in reducing the network complexity and addressing the over-fitting problem [6]. After it was found that pruning can bring regularization to neural networks and hence improve generalization, it has been widely studied to compress neural networks.

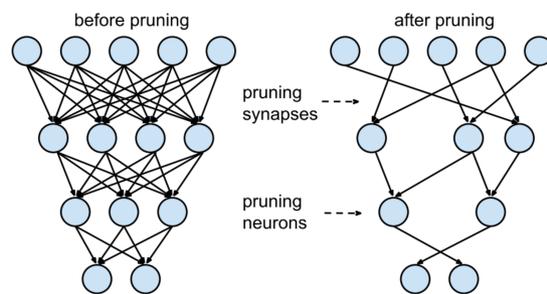


Figure 4. A schematic diagram of Network Pruning [7].

## Result & Discussion

Table.2 Model Accuracy. Early stop is applied to prevent long time training which might lead to the fluctuation of reported performance.

Method	Dataset	Acc@1	Method	Dataset	Acc@1
ResNet-50	Ours	92.72%	L1-Pruned-ResNet-50	Ours	94.74%
	BarkNet	90.73%		BarkNet	90.75%
MobileNet-V2	Ours	76.01%	Distilled-MobileNet-V2	Ours	94.47 %
	BarkNet	86.45%		BarkNet	90.30%

• Network Pruning is an effective method that can not only help to reduce FLOPs of network, but also to maintain relatively good performance.

• To fully investigate the power of knowledge distillation and network pruning, a careful designed experiment setting is needed.

## Reference

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