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# Classification of Leaves Using Convolutional Neural Networks

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***Abstract:*** *In our approach, we introduce a deep learning convolutional neural networks which takes into account both hybrid and generic information. Plants plays an important role in human life ,so it is necessary to build an automatic system for recognizing plant. Leaf classification has become a research focus for twenty years. In this paper ,we propose fully connected layers structure adding into the convolutional neural network. We use this CNN model for plant leaf identification for some improvement on it to let it perform better. This approach supports classification based on varying number of plant views. We also present the qualitative results of our proposed models, based on feature visualization techniques and show that outcome depict our hypothesis and expectation.*

## I. Introduction

### 1.1 Neural networks:

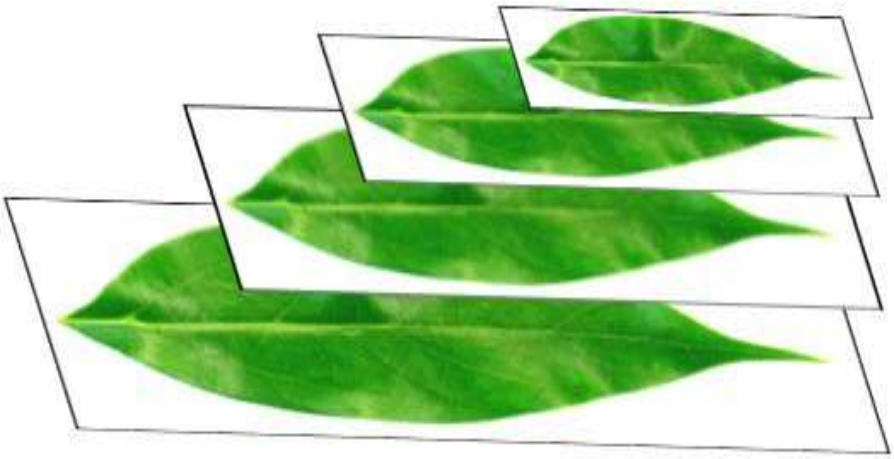
There are different kinds of trees in the natural ecosystem and it is very difficult to distinguish them. There are approximately 100,000 species of trees on earth, which account for about 25% of all plants. For an human eye it can be somewhat easy to find difference but in many cases it will be difficult to find the minute differences and it is hard to find the species .so for complex inputs neural networks are used in an computer system.

Neural networks is series of algorithms that endeavor of to recognize underlying relationships in a set of data through a process that mimics the way that human brain operates.

Neural network is a machine learning that is used to automatically classify leaf types.Neural networks is not itself an algorithm but a framework for different machine learning algorithm work together for complex inputs. best possible results without needing to redesign the output criteria a computer system modeled on human brain and nervous system. Neural is a network or circuit of neurona , It is interconnection of nodes. Each nodes is perceptron.

### 1.2 Artificial Neural Network

Artficial neural network is interconnected group of nodes similar to vast networks of neuron in brain. Based on collection of connected units or nodes called artificial neurons .it can transmit the signals from one node to other node. The output of ANN is non-linear function of sum of input. Connection between neuron is edges. The main aim of ANN is to solve problems in same way that human brain would do.



To identify trees like these, considerable information is required, including leafshape, shape of the leaves that are directly attached to branches, branch shape, shape of the whole tree, tree size, flower shape, flowering time, and fruit. When using branches of biology such as cell biology, molecular biology, Phytochemistry, or morphologic anatomy, it may be possible to distinguish plants without time constraints. However, it is unrealistic for the general public to identify the names of trees or plants using these methods when, for example, they are walking in a woodland. Since the public will usually distinguish trees by their appearance, studies have been carried out to recognize trees using this method alone.
The eight leaf types are lanceolate, light oval, acupuncture, linear, long oval, elongated, heart, and long

**Type and Number Of Leaves**
Leaf type Number of images
Lanceolate - 568
Oval- 554
Acicular -612
Linear -439
Oblong- 374
Reniform, kidney-shaped -580
Cordate, heart-shaped -379
Palmate leaf -361

**Deep Learning**
Deep learning is an emerging technology that has proved extremely high recognition capabilities with very large datasets, replacing the need of designing

Hand-crafted features as to previous approaches .the convolutional neural networks ,as one of the most used DL methods has been employed to learn generic representation for images of plants.a new CNN architecture that can go beyond the regular generic description of a plant, integrating the oragan-specific features together with the generic features to explicity force the designed network to focus on the organ regions during species classification.

## II. Proposed System

**Convolutional Neural Network:**
CNN consider only inputs**.** In deep learning, a **convolutional neural network** (**CNN**, or **ConvNet**) is a class of deep neural networks, most commonlyapplied to analyzing visual imagery. CNNs use a variation of multilayerperceptrons designed to require minimal pre processing. They are also known as shift invariant or space invariant artificial neural networks(SIANN), based on their share-weights architecture and translation invariance characteristics.
CNN use relatively little pre-processing compared to other image classification algorithms. This means that the network learns the filters that in traditional algorithms were hand-engineered.

**Design**

A convolutional neural network consists of an input and an output layer, as well as multiple hidden layers. The hidden layers of a CNN typically consist of convolutional layers, RELU layer i.e Design activation

function, pooling layers,fully connected layers and normalization layers. Description of the process as a convolution in neural networks is by convention. Mathematically it is crosscorrelation rather than a convolution (although cross-correlation is a related operation). This only has significance for the indices in the matrix, and thus which weights are placed at which index.

**Layers Of Convolutional Neural Networks**

**Convolution Layer**

Convolutional layers apply a convolution operation to the input, passing the result to the next layer. The convolution emulates the response of an individual neuron to visual stimuli. Each convolutional neuron processes data only for its receptive field. Although fully connected feed forward neural networks can be used to learn features as well as classify data, it is not practical to apply this architecture to images. A very high number of neurons would be necessary, even in a shallow (opposite of deep) architecture, due to the very large input sizes associated with images, where each pixel is a relevant variable. For instance, a fully connected layer for a (small) image of size 100 x 100 has 10000 weights for eachneuron in the second layer.

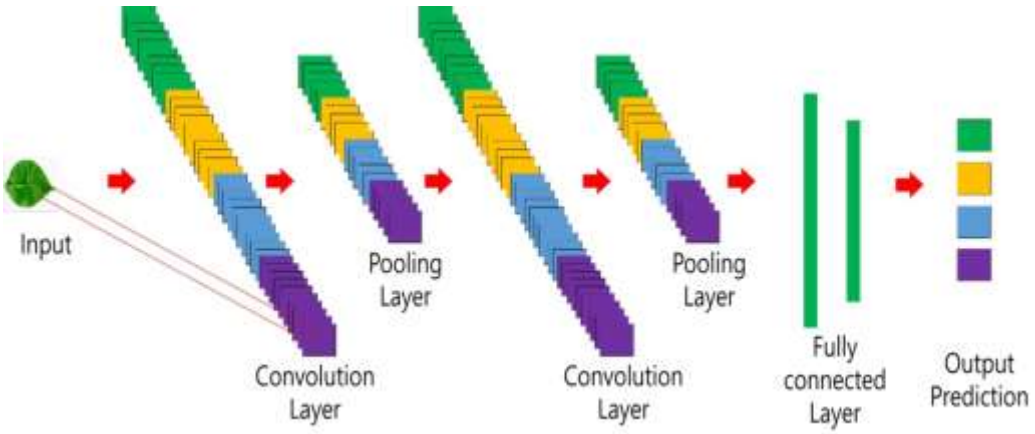
The convolution operation brings a solution to this problem as itreduces the number of free parameters, allowing the network to be deeper with fewer parameters. For instance, regardless of image size, tiling regions of size 5 x 5, each with the same shared weights, requires only 25 learnable parameters. In this way, it resolves the vanishing or exploding gradients problem in training traditional multi-layer neural networks with many layers by using back propagation.

**3.3.2 Pooling**

Convolutional networks may include local or global pooling layers, which combine the outputs of neuron clusters at one layer into a single neuron in the next layer. For example, max poolinguses the maximum value from each of a cluster of neurons at the prior layer. Another example is average pooling, which uses the average value from each of a cluster of neurons at the prior layer.

**3.3.3 Fully Connected**

Fully connected layers connect every neuron in one layer to every neuron in another layer. It is in principle the same as the traditional multi-layer perceptron neural network (MLP). The flattened matrix goes through a fully connected layer to classify the images.




**(a) Layers of convolutional neural networks.**

**3.3.4 ReLU layer**

ReLU is the abbreviation of rectified linear unit, which applies the nonsaturating activation function $f(x)=\max(0,x)$.It effectively removes negative values from an activation map by setting them to zero.It increases the nonlinear properties of the decision function and of the overall network without affecting the receptive fields of the convolution layer.Other functions are also used to increasenonlinearity, for example the saturating hyperbolic tangent $f(x)=\tanh(x)$,$f(x)=|\tanh(x)|$, and the sigmoid function . ReLU is often preferred to other functions because it trains the neural network several times faster without a significant penalty to generalization accuracy.

**3.4 Parameters Of CNN**
**W=Weight**
**B=bias**

Weights and bias are initiated randomly at the start,but through a sophisticated learning process , the values are set correctly in such a way as to maximize the ability of network to perform accurate classification on a given task .
At start both are highly incorrect but are adjusted for accuracy.

Three hyperparameters control the size of the output volume of the convolutional neural network : the depth, stride and zero-padding .The depth of the output volume controls the number of neurons in a layer that connect to the same region of the input volume. Stride controls how depth columns around the spatial dimensions (width and height) are allocated.

The spatial size of the output volume can be computed as a function of the input volume size W,the kernel field size of the convolutional neuron K,the stride with which they are applied S,and the amount of zero padding P used on the border.The formula for calculating how many neurons "fit" in a given volume is given by

$$\frac{W-K+2P}{S}+1.$$

Where **P = (K-1) / 2.**

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## III. Conclusion

In previous studies, the leaf color, contour, texture, and shape were used to classify plants. The color image was transformed into a grayscale image the grayscale image was then converted to a binary one through binarization, and the contour then extracted. The features are extracted using the characteristics of the contour line . Using these features, the recognition rate was 90% when classified through machine learning. Because the shape of the leaf outlines are similar to each other, the features alone make it difficult to classify the plant.Grau = 0:299 Ir + 0:587 I0 + 0:114 I