Visualization of Leaf Botanical Features Extracted from AlexNet Convolutional Layers

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Abstract:
To recognize tree species from pictures of their leaves, one way is to automatically extract the features botanists look at for identification and use them in a classification system. This is the approach developed in the Folia application [1]. Another way that has emerged in the past years is to train Convolutional Neural Networks (CNN) to recognize plants directly from pictures, as done by many researchers in the PlantCLEF challenge [2]. CNN-based methods have spread into many fields as they generally give the best results, but can arguably be considered a black box. The aim of our work is to try to understand their core and establish a link between the features extracted through such networks and botanical characteristics of the species, in order to improve expressiveness and propose alternative recognition algorithms.

For our study, we worked with the widely used AlexNet network [3]. Its performances are inferior to those of the most recent CNN (GoogLeNet, ResNet, VGGNet) [2] but its linear architecture allows to visualize more easily the different convolutional layers. Thus, we chose to train AlexNet on an image database of 72 simple-leaved species developed by the PlantCLEF challenge, where leaves are shot on a plain color sheet (no complex background). We trained AlexNet from scratch to construct its convolutional filters directly on plant organ elements. As the entry of AlexNet is a 256x256 image, the images have been resized and filled with random values on the borders to preserve the aspect ratio of the leaves. Then, we have visualized the obtained filters and analyzed them.

Figure1 gives an idea of such visualization result for two different leaves with different shapes. The first two layers extract low level information (contour with various orientations). The next layers exploit contour, base, shape or apex. Two leaves having similar base, for example, produce high response in some specific filters. Generalizing the detection of such filters for different shapes could be a way to enrich species recognition and a step towards, for example, a higher level botany-based classification.
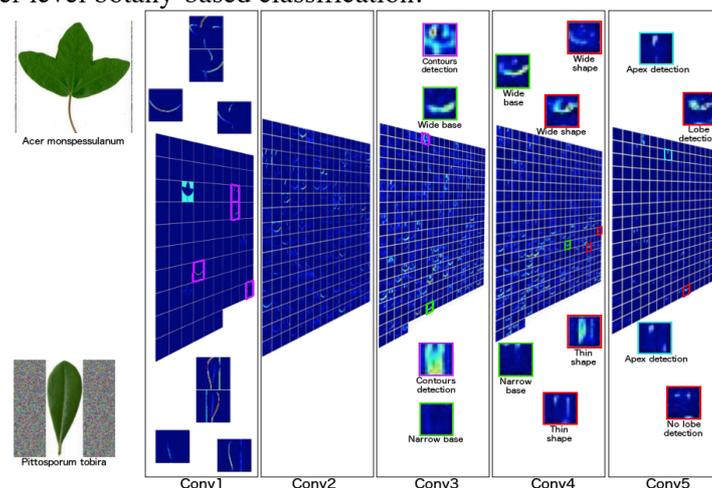
Figure1. Convolutional layers visualization from AlexNet network applied on leaf database.

References:
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