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- RESEARCH ARTICLE-

Analysis of Pooling Effect on CNN using Leaf Database

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Abstract

Usage of artificial intelligence and machine learning is widespread in many areas such as information technology, driverless vehicles, health technology and marketing. The remarkable upward trend in studies on data science, machine learning, data visualization, artificial intelligence and deep learning is progressing even faster today. Between the studies of leaf classification in literature, it is seen that it uses feature extraction techniques such as various distance calculations according to the marked points, curvature-based shape feature and the use of different components of the image. The variety of feature extraction techniques is effects performance and models selection. Therefore, nowadays the models are used without features such as deep learning. In this study, leaf images have been classified using CNN model. Feature training, which is one of the many advantages of deep learning, enables to achieve results without using the above mentioned approach.CNN model was created in 2 stages. First step is feature learning contain process such as convolutional layer, nonlinearity layer, pooling, convolution and relu, pooling. Classification process used structures such as flatten, fully connected and softmax steps. Each species is regarded as a label and the classified by CNN model.

Keywords: Deep Learning, Leaf Classification

Introduction

Considering the success of artificial intelligence in many areas, various methods have been developed to use artificial intelligence more effectively with each passing day into different fields. One of these methods is convolutional neural networks (CNN), has wide usage of areas such as medical image computing, health risk assessment, precision medicine etc. The CNN is utilized to handle for visual imagery including the computer vision and object detection solutions (Altan and Kutlu, 2018).CNN models may vary depending on the structure and amount of data

used. Structures such as convolution and pooling used in these models provide feature learning. After the feature learning, the classification layer comes in, using structures such as flatten, fully connected layer and softmax. Also the structure of the classification layers may change. Since the feature detection layer of CNN learns by training data, it avoids explicit feature extraction and implicitly learns from the training data when we use CNN (Liu et al., 2015).

In literature, there are many classification methods depending on different feature extraction techniques, such as identification is done by running a nearest neighbors search using the HoCS feature extracted from the input image as the query(Kumar et al., 2012), simple features such as aspect ratio, compactness, and centroid are used to prune irrelevant leaves (Lee et al., 2006), In implementation, we used Fourier descriptors of PFT, three kinds of geometrics features, color moments, vein features, and texture features based on lacunarity (Kadir et al., 2011). But there are some studies in the literature about the effect of pooling. Different region sizes or max and average pooling are analyzed by Zhang et.al. (2016). Banerjee et. al. (2017) used max pooling average pooling and time-series pooling. Fernando et. al. (2016) reported Hierarchical rank pooling which has its own methods. Lee et. al. (2015) used max and average pooling functions combining. Deng et. al. (2013) used heterogeneous pooling in CNN analyzed different pooling sizes. Wang et. al. (2018) used max, average and stochastic pooling.

Investigation of pooling effect on CNN model using Leaf database

In this paper, pooling effect was analyzed according to pooling layer location. Since CNN model was created with constant convolution layer, different number of pooling were applied for analyzing. For experimental study leaf database was used for classification by model.

Database

The image used for this study were taken from Leafsnap database (Kumar et al., 2012). The search database consists of two set called Field and Lab. But in this study only Field set used for analysis. 5192 field images was taken by mobile devices in this set. Some images are not suitable for use in classification and some species images were not enough to trained CNN for classification. Therefore these were removed from the dataset. After these operations, the remained images are resized, converted to gray image and for each species in this study. It remained 3953 images for 65 species.

Convolutional Neural Networks

Convolutional networks (CN) incorporate constraints and achieve some degree of shift and deformation invariance using three ideas: local receptive fields, shared weights, and spatial subsampling (Lawrence et. al., 1997). The CNN is a main and frequently used type of deep learning for image-based approaches. Advantages of the CNN are standing feature learning with convolutional processes with iterated filters and sizes, and extracting the most significant bits at a specified range on the image using pooling process (Altan and Kutlu, 2018). Convolution takes images as matrix and using filter (kernel) matrix to extract high level features. When we use convolutional, shrinking image means least pixel for more ground. This point padding is come in handy, because of adding additional pixels of image matrix. Relu function must be apply for increase the non linearity in our images. The pooling layer gradually decreases the properties extracted through the convolution layer to make it easier to calculate and reduce the dimensionality of the data. A pooling layer is added on top of the convolution layer to compute a lower resolution representation of the convolution layer activations through sub-sampling. Pooled

multiple features maps are converted to a single column matrix and transmitted to the neural network. Fully connected layers takes features maps from previous layer and use for classification. Distinguish the properties that occur after many iterations and classify them by classification techniques such as softmax.

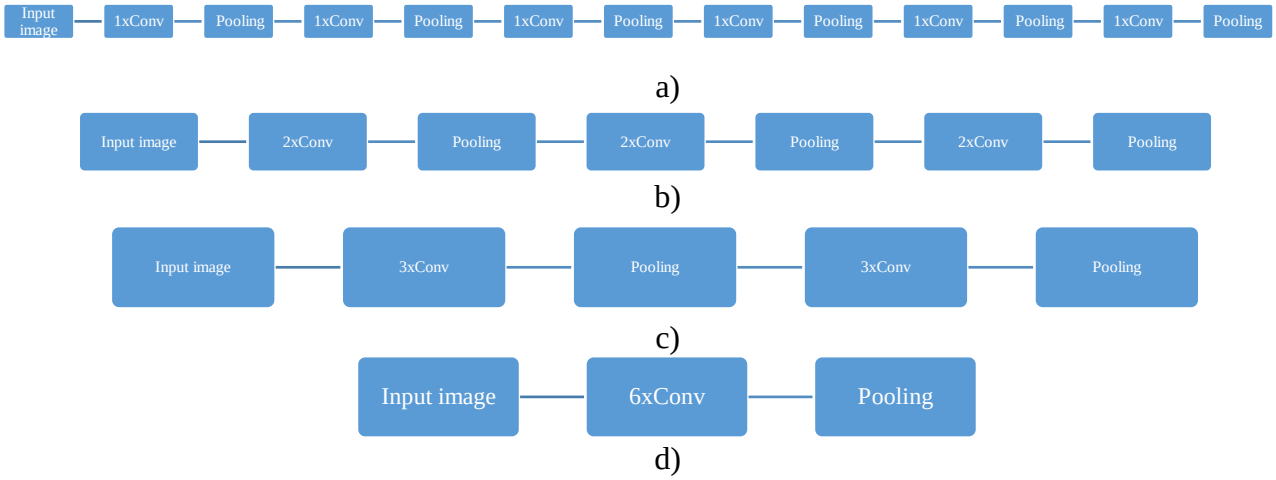

Figure 1. CNN Model Demonstration for Pooling Effect Constant 6xConv layer a)(1xconv+Pooling) repeated b)(2xconv+Pooling) repeated c)(3xconv+Pooling) repeated d)(6xconv+Pooling) used

Results and Discussion

In this study, leafsnap database used for classification by CNN. The CNN model is customized for feature extraction and classification. Due to the large number of images, the images have been carefully selected for better understanding for this analysis. First some image processing operation were evaluated the images for preprocessing stage. For analysis different number of pooling were used toshow pooling effect in leaf classification with CNN. In addition two pooling method, which are max pooling and average pooling, were used in this study.

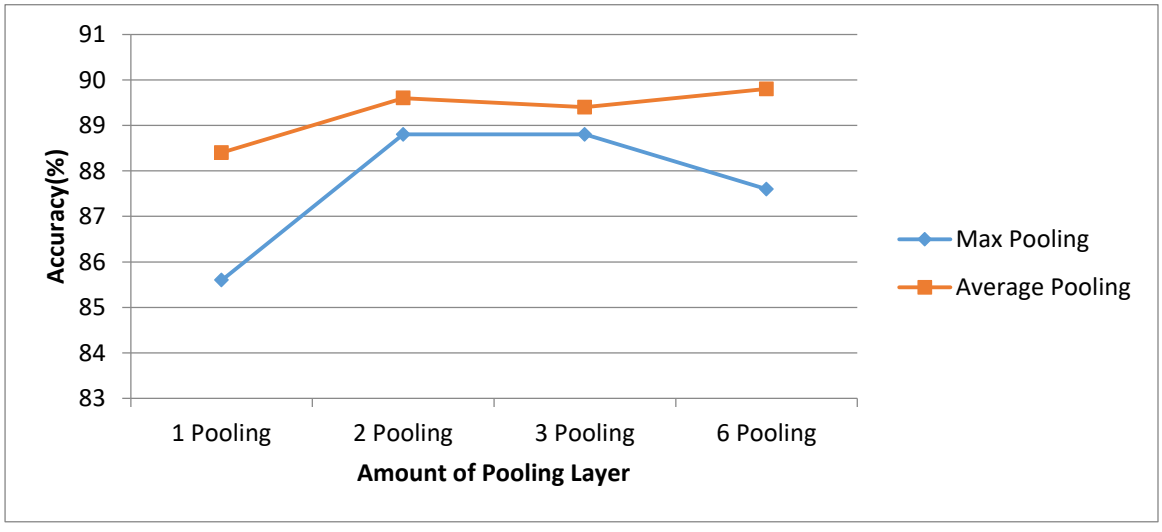

Figure 2. Pooling Effect in Leaf Classification with CNN

The experimental study of training and testing was repeated 5 times. The average of the performance values are shown in Figure 2. When looking at the Figure 2, increasing the number of pooling, the performance of the model has been slightly improved. The fact that this increase does not continue. The performance comparison of average pooling and max pooling is also shown in Figure 2. Average pooling is better choice to get better performance for leaf classification.

Accuracy Graph for different number of pooling layer using Max Pooling and average pooling shown in Figure 3 and Figure 4 respectively. When increasing the number of pooling, it is mentioned that the acceleration of accuracy curve on graph was very low to approach max value of accuracy. When we investigate the other effects of the increase in the number of pooling, it has been observed that a certain amount of increase enables to achieve success with less iteration. As shown in Figures 3 and 4, even in different pooling types, the number of pooling 2 and 3 demonstrated to be better pooling model.

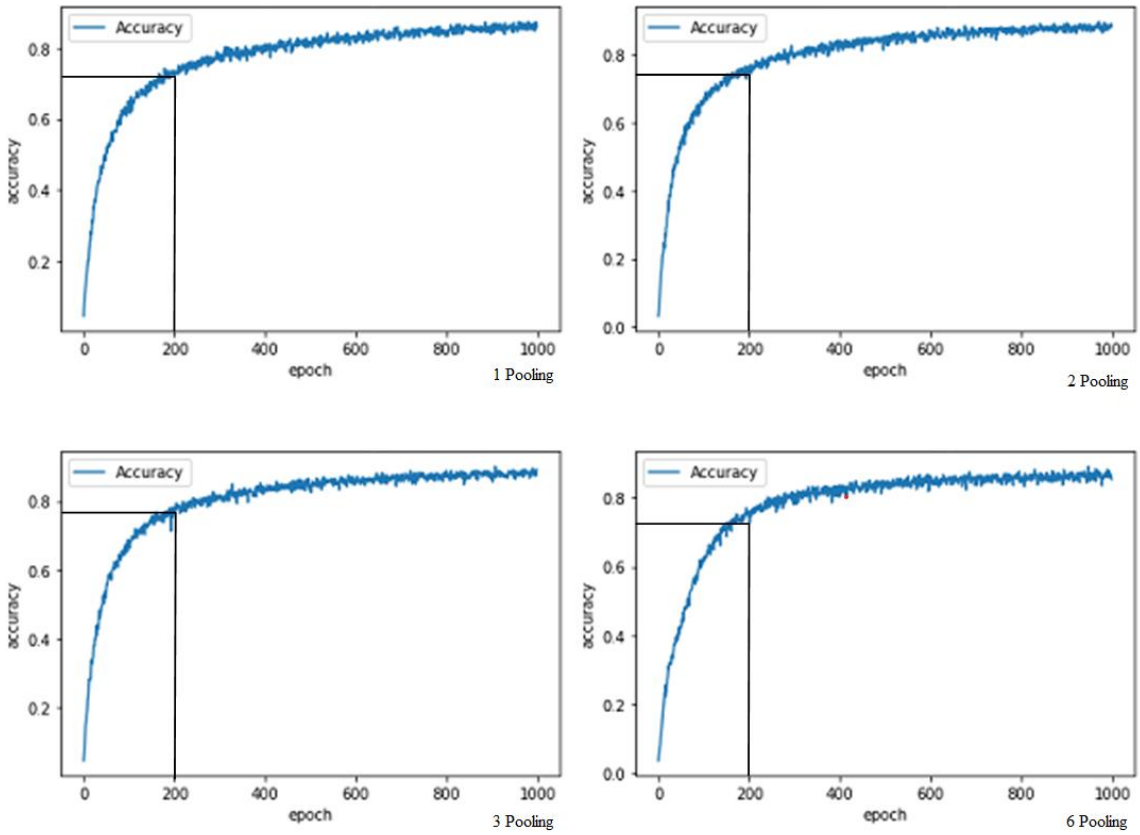

Figure 3. Accuracy Graph for Different Number of Pooling Layer Using Max Pooling

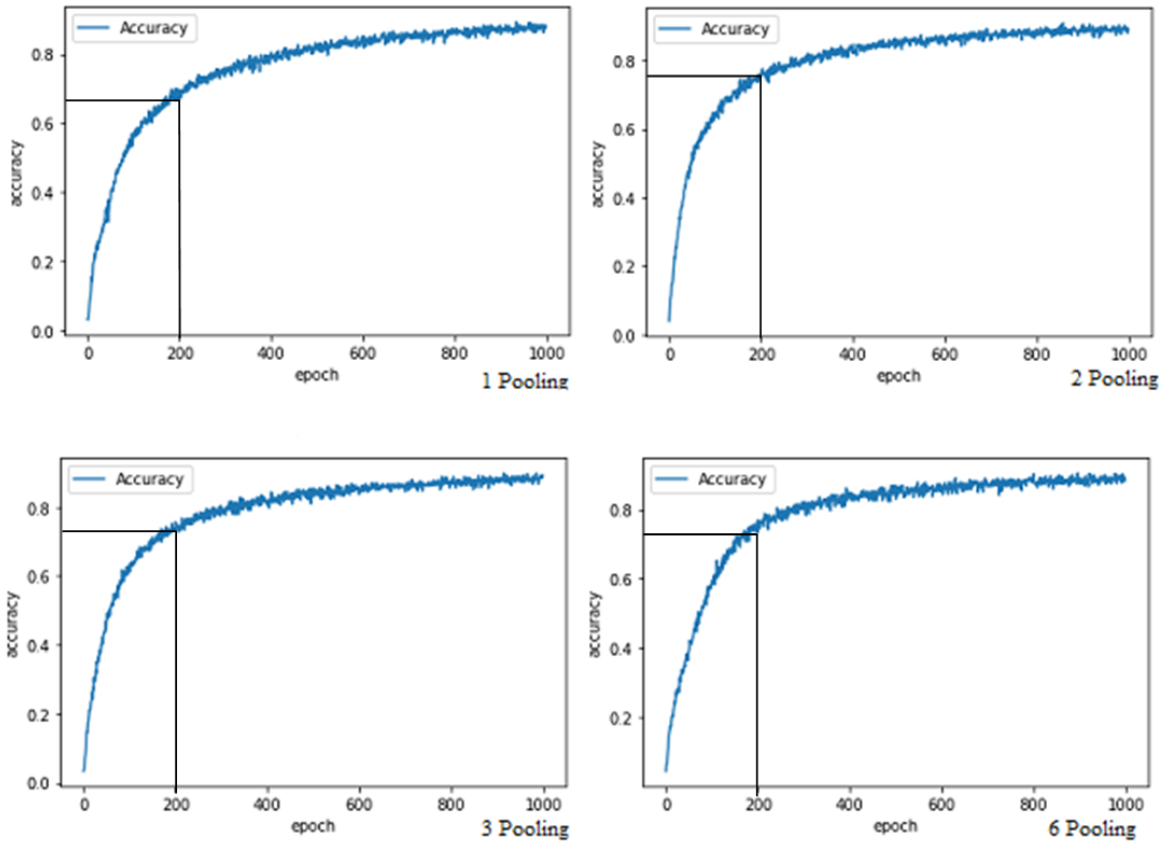

Figure 4. Accuracy Graph for Different Number of Pooling Layer Using Average Pooling

Note: This paper is presented in the International Conference on Artificial Intelligence towards Industry 4.0 held on November 14-16, 2019 at Iskenderun Technical University, Iskenderun, Turkey.

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