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Binary Image Classification using Parallel Neural Networks

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ABSTRACT

Image Recognition and Classification techniques drives the applied sciences of Image Processing and Computer Vision. Major challenges of image recognition and classification includes time-consumption, inefficient results, learning delay and poor accuracy in classification of images. Recent advancements in cutting-edge technologies address these issues to a greater extent in view of the software, hardware and technology used. Internet of Things (IoT) increases the demand of image classification using enhanced capabilities of Convolution Neural Networks (CNN). Deep Neural Learning capabilities enhances the accuracy rates due to optimized and shared parameters, reduces time consumed in processing due to the application of multiple filters by using pooling layers. Pooling layers outperform the defects of normalization layers. Stochastic Gradient Descent (SGD) optimizer optimizes the objective function by identifying proper smoothing parameters at low convergence rate. The current work performed using Transfer Learning (TL) using Mobilenet, sequential model using SGD optimizer over ReLU and softmax activation functions. Experimental results prove that the proposed method achieves promising classification accuracy for large data of images.

Key words: image classification, CNN, IoT, transfer learning, SGD;

1. INTRODUCTION

Computing in the real world based on emerging technology shows its importance in diverse fields of applications [16]-[19]. Technology holds language barriers using image processing. The use of various search engines like Google image search engine are proliferating the use of image data processing in various aspects of life. Current technology advancements are going to replace traditional text with images, 3D-images and real time video in next few years [1]. Edge Computing demands the image processing and classification techniques to lower the cost of IoT System communication procedures [2]. Non-Parametric image classification techniques are important in view of multisource data classification [3]. Parametric models result in improved accuracy. Parallel processing techniques contribute for analyzing multiple parameters in less time. Deep Neural Networks are used for parallel processing of images using Convolution Neural Networks (CNN) [4]. Transfer learning helps to achieve improved accuracy in less time. Learning of one task can be used, to carry knowledge pertaining to learn similar tasks. This procedure of learning is called transfer learning. Stochastic Gradient Descend (SGD) optimizer replaces the actual gradient by estimates.

2. CONVOLUTION NEURAL NETWORKS AND TRANSFER LEARNING

Image classification using Convolution Neural Networks and Transfer Learning are discussed here.

2.1 Convolution Neural Networks

CNN computationally suitable for large data like images [5]-[7]. Objects in an image are identified and each of the object in the image are learnt to get differentiated and assigned some weights based on the hyper parameters. During the process of object detection, each of the object need to be pre-processed in order to attain its features to get mapped with the stored knowledge. In this process, various filters help to make classification easier. CNNs help in simplifying the learning process of characteristics of objects.

Applications of CNNs vary in terms of the kernel/filter applied in the convolution layer, operations are performed based on the choice of stride at various levels of depth either by using valid padding or same padding, the channels are

produced to have convoluted outputs. To obtain the clarity in the edge of images, high-level features are extracted from convolution operations [8]-[10]. Sometimes, convolution operation performed may not reduce the computation effort in a layer, in such cases pooling layers are applied for efficient computational results. Pooling helps in extracting the most dominant features. Out of the two methods of pooling, max pooling is widely seen in many applications compared to average pooling. In order to facilitate the neural computations, the image in matrix format is flattened into a vector for processing by multi-layer perceptron etc., for making the network learn. In our method after the whole procedure, we apply Softmax classification technique in order to classify the algorithm.

2.2 Transfer Learning

Transfer Learning is the process of sharing information of learning from past experiences of already learnt information from previous learning procedures. TL benefits to reduce extra computations and saves time. Neural networks exhibit learning capability of features from the input. Computed Neurons (Tensors) flow from multiple layers filtering the features and enhancing the learning capability [11]-[14]. When tensors flow, depending on requirement additional neurons are added to the layers. Additionally, added tensors need to start from scratch to get trained. In such situations, transfer learning helps to exchange already learnt information instead of repeating the procedures [15].

3. IMAGE CLASSIFICATION ALGORITHM USING TRANSFER LEARNING AND CNNS

In the current article, an architecture of 2 layered convolution neural network is considered in order to classify image using binary classification. Images of CIFAR10 dataset is considered. As shown in Figure 1. Data is split into training set and testing set as shown in Table 1.

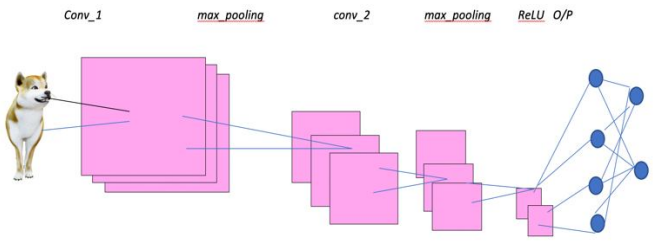

Figure 1: *CNN Architecture to Classify Images*

Each convolution is of 3x3 filter and a ReLU activation function is used to deal with the non-linearity in the activations. In order to achieve better feature identification, max pooling technique is applied using a 2x2 filter.

Table 1: Training and Testing Split

Sample	Color	Batch Size	Class
Training	rgb	32	Categorical
Testing	rgb	1	None

After the convolutions operated, the resultant data is converted into flattened layer form in order to apply the classifier.

```
model.add(Flatten())
```

Softmax classification technique is used with relu at the output layer to get the solution in binary form.

```
model.add(Activation('softmax'))
```

4. EXPERIMENTAL RESULTS

The base model is mobilenet. After that sequential method is used as the model. Activation functions used at each convolution and also at the output layer is ReLU to deal with non-linearity. Different functions used in the work are shown in Table 2. For binary classification Softmax is used.

Table 2: Model Evaluation

Description	Functions used
Base_Model	Mobilenet()
Model	Sequential()
Activation	ReLU
Classifier	Softmax
Optimizer	Sgd
Loss	crossentropy

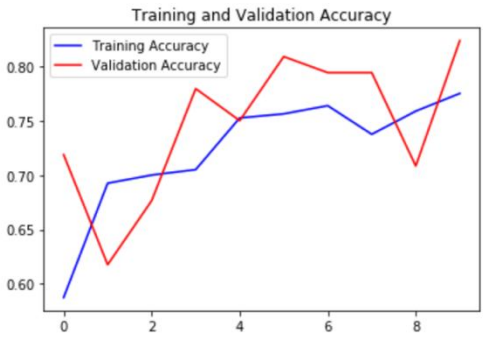

Figure 2: *Accuracy of Classified Samples*

As the parameters are estimated by transfer learning, the SGD optimizer is used to reach convergence at most matched parameters of the model. Loss function used, calculates the entropy and makes the network learn from previously traced parameters in parallel at various levels in much faster way. By executing the model, an accuracy of 74% is attained for the image data of 300 images and is visualized in Figure 2.

5. CONCLUSION

Image recognition and classification are ever demanding areas of work by the advent of Internet of Things. As sensors are used at various fields of work, image capturing and processing has become an essential for the current research works in diverse fields of work. In this work, image classification using binary classifier is used to classify images of dogs and cats. It specifies whether the image is dog or not. A two layered convolution neural network with 3x3 filter is used. Max pool filter of 2x2 is applied and ReLU activation was used. SGD optimizer is used for estimated parameter convergence based on transfer learning. Softmax classifier is used to classify the images. An accuracy of 0.74 is achieved.

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