The Study of Image Classification using Machine Learning

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ABSTRACT: *Machine learning is the new technology of Artificial Intelligence (AI) that provide machine with the ability to automatically learn and optimize from its experience without explicitly programming. Deep Learning has emerged as a new area in machine learning and is applied to a number of signal and image applications. The main purpose of the work presented in this paper, is to apply the concept of a Deep Learning algorithms namely,Dense Neural Network &Convolutional Neural Networks (CNN) in image classification. The algorithm is tested on various standard datasets. As we are introducing latest technologies like Deep learning and Neural Networks, this is way of teaching computer to recognize the input from the user and give the appropriate outcome and remember it for the future reference. This project will Classify the image that are first given as an input to the application. The output of Neural Network would be classified on the basis of the combination or pattern. This project will demonstrate the Machine learning and uses Deep learning and Neural Network.*
KEY WARDS: *Machine Learning, Deep Learning, Dense Neural Network (DNN), Convolutional Neural Networks(CNN)*

I. INTRODUCTION

Today's generation is witnessing wide spread of technologies, unlike early days everything was done manually and now almost everything is done with the help of machines. That's the reason the machines has become the integral part of human's life. Artificial Intelligence or Machine Learning provides enhancement to this technology. Arthur Samuel, a pioneer in the field of artificial intelligence and computer gaming, coined the term "Machine Learning". He defined machine learning as – "Field of study that gives computers the capability to learn without being explicitly programmed"[1].Machine Learning (ML) is gaining more popularity and it can play animportant role in various applications such as image processing, image classification, data mining, etc.Machine Learning can be important pillar for future civilization.

Deep Learning is a part of Machine Learning methods, these methods can be supervised, semi-supervised and unsupervised. Its various architectures like deep neural networks, deep belief networks, recurrent neural network are used in various applications such as image recognition, speech recognition, social networks, etc. Deep Neural Network is an Artificial neural network with multiple layer between input and output layers [2]. This network finds the correct mathematical solution to the input to generate the desired output, whether it is linear relationship or non-linear relationship. Neural network is set of various algorithms which are modeled resembling the human brain neuron system. As brain's neuron system teaches itself to perform task in specific manner to get desired output and remember it for future, the artificial neural network has various nodes within its layers which act as a human brain neuron system, it trains itself with the help of some collection of inputs also known as datasets to produce the desired output.

1.1 Convolutional Neural Network.

Convolutional Neural Networks are not different from the ordinary Neural Network, they are made up of neurons that have learnable weights and biases. Each neuron receives some inputs and perform some mathematical operation to train the network and give output follows it with non-linearity. The whole network still expresses a single differentiable score function: from the raw image pixels on one end to class scores at the other. And they still have a loss function (e.g. SVM/Softmax) on the last (fully-connected) layer and all the tips/tricks we developed for learning regular Neural Networks still apply[3].

1.2 Architecture of Convolutional Neural Network (CNN)

Convolutional Neural Networks consist of input and output layers with hidden layers between them, this hidden layers comprises of various convolutional layers they are activation function, pooling layers, fully connected layers and normalization layers.[4]
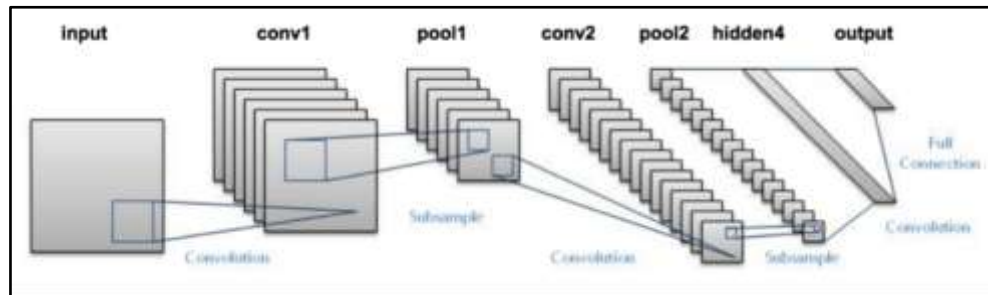

Fig 1.1 Convolutional Neural Network[4]

The input image is passed to first convolutional layer. The convoluted output is obtained. The extraction of features is done by the filters in the convolutional layer.Each filter shall give a different feature to aid the correct class prediction. In case we need to retain the size of the image, we use same padding (zero padding), otherwise valid padding is used since it helps to reduce the number of features.

Pooling layers are then added to further reduce the number of parameters. Several convolution and pooling layers are added before the prediction is made. Convolutional layer help in extracting features. As we go deeper in the network more specific features are extracted as compared to a shallow network where the features extracted are more generic.

The output layer in a CNN as mentioned previously is a fully connected layer, where the input from the other layers is flattened and sent so as the transform the output into the number of classes as desired by the network.

The output is then generated through the output layer and is compared to the output layer for error generation. A loss function is defined in the fully connected output layer to compute the mean square loss.

The gradient of error is then calculated.The error is then backpropagated to update the filter(weights) and bias values.One training cycle is completed in a single forward and backward pass.

II. LITERATURE REVIEW

There are various method to create the Image Classifier using the machine learning. The most common and widely used algorithms are the Dense Neural Network (DNN) and Convolution Neural Network (CNN). But there are different approaches for the implementation of these algorithm. These approaches are shown in the Table 2.1

Table 1: Different Machine Learning Algorithm

Contributed By	Research Paper By	Algorithm Used	Mathematical Representation of Deep Learning Algorithm	Characteristics
Prudhvi Raj Dachapally[5]	Facial Emotion Detection Using Convolutional Neural Networks and Representational Autoencoder Units	Convolutional Neural Network & Representational Autoencoder Units	-	1. Takes an Input Image of Human face(64 x 64). 2. Feed to the 8 layers of CNN. 3. Network's output later will give the appropriate output
AlexKrizhevsky et .al [6]	ImageNet Classification withDeepConvolutional NeuralNetworks	Convolutional Neural Networks	$f(x) = \tanh(x)$ or $f(x) = (1 + e^{-x})^{-1}$	1. Takes an Input Image of Handwritten Digits (28 x 28). 2. Feed to the hidden layers of CNN.

				3. Network's output later will give the appropriate output
Deepika Jaswalet .al [7]	Image Classification Using Convolutional Neural Networks	Convolutional Neural Networks	$E(w) = \frac{1}{k*n}\sum_{k=1}^{k} * \sum_{N}^{N_1} * (y_n^k - d_n^k)^2$	1. Takes an Input Image of various types 2. Feed to the hidden layers of CNN. 3. Network's output later will give the appropriate output
J. Jayapradha et .al [8]	Image Classification Using Convolutional Neural Networks	Convolutional Neural Networks	-	1. Takes an Input Image of various types. 2. Extracts the features using the applied feature extraction algorithm. 3. Classify Images using neural network.
Manisha et .al [9]	Facial Expression Recognition Using Neural Network	Deep Neural Network	-	1. Takes an Input Image of various types. 2. Use Principle Component Analysis PCA. 3. Extract features using neural network. 4. Network layer will give the desired output.
W.N. Widanagamaachch, A.T. Dharmaratne[10]	Emotion Recognition with Image Processing and Neural Networks	Deep Neural Network	-	1. Takes an input of image 2. Passes to the dense hidden layer 3. Predict the output

In the paper of Prudhvi Raj Dachapally[5], ImageNet Classification withDeepConvolutional NeuralNetworks, they have used the autoencoder to construct the representation of different emotions and also created the 8 hidden layers convolutional network, three pooling layers and two fully connected layers. This Convolutional Network will look like the Fig[2.1].

AlexKrizhevsky et .al[6], suggested that the Deep convolutional works with the ReLUs trains faster than the ordinary units. The CNN model they used has four convolutional layers in which the output of the first convolutional layer is normalized and pooled and is given as input to second convolutional layer. Thethird,fourth,andfifthconvolutionallayersareconnectedtoone another withoutanyintervening pooling or normalization layers.

Deepika Jaswal et .al[7] suggested that with the CNN model that takes 2D image as a input and output layer where the network gets train within the hidden layer. The CNN models have series of hidden layers such as convolutional layer and sub sampling layer as shown in the fig 2.2.
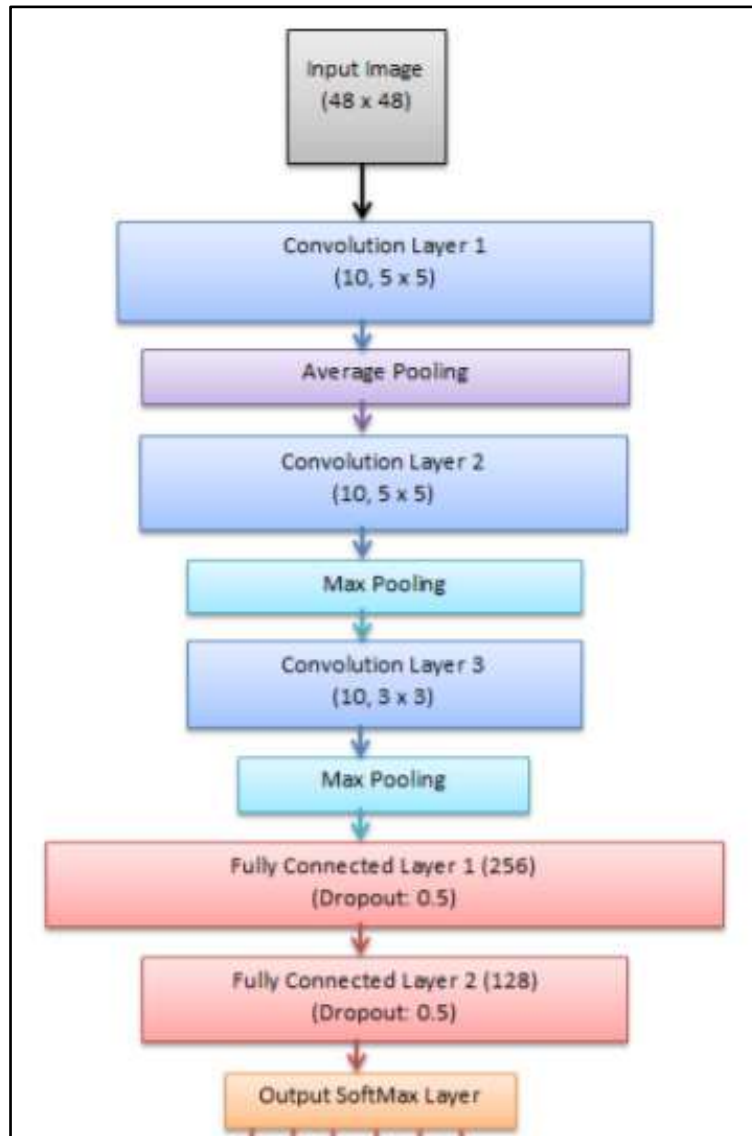
Fig 2.1: Convolutional Neural Network[5]

J. Jayapradha et .al[8], they have suggested pre- processing of dataset to make it compatible with the neural network. The pre-processing includes feature extraction of human face. In this they have used dense neural network model which has several dropout and max pooling layers.

Manisha et .al[9] they have suggested the model which studies the geometrical feature of human face, for this purpose Principal Component Analysis (PCA) and the dense neural network which has ability to be trained by the given input images and get the classified output.
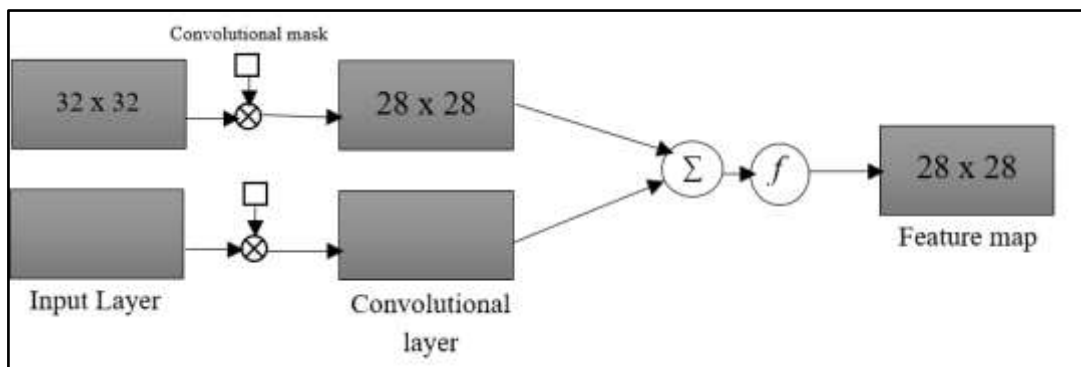

Fig 2.2: Convolutional layer working[6]

W.N. Widanagamaachchi& A.T. Dharmaratne[10], they suggested PCA approach to for the features extraction as the human faces are very complex and of different types and shapes. They have divided the system into 3 parts; face detection, feature extraction and emotion recognition. The input image are then classified into the 6 emotions as an output.

III. ANALYSIS OF ALGORITHM

Neural Networks are the preferable approach for the image classification for deep learning. There are mainly Dense Neural Network and Convolutional Neural Network which are used for deep learning. Dense Neural Network are made up of multiple nodes in multiple dense layers whereas Convolutional Neural Network has the convolutional layer, max pooling and dense/fully-connected layers. Several researches as mentioned in the Table 2.1 have studied and implemented both the approaches.

Researches have implemented the algorithm for not only various type of image classification. Some of them have used the Dense Neural Network, which has complex structure because of use of large number of nodes in each layer, that consumes the time for the training and increasing the weight and the biases of network by considerable amount. Whereas, otherresearchershave used the Latest or say the upgrade version of DNN which the Convolutional Neural Network (CNN), which has the at least one convolutional layer in the network. Each convolutional layer has filters. This model also shares the weights to the dense layer or fully connection to be flatten to output layers. The use of CNN has increased the speed of training and accuracy in the prediction.

IV, CONCLUSIONS AND RECOMMENDATIONS

This paperis concerned with how the various researches uses deep learning algorithms in the different ways. This paperstudies the papers of this researchers that has implemented this algorithm for their research or for their project. This paper highlights the drawbacks and the advantages of the Dense Neural Network (DNN) and Convolutional Neural Network (CNN). DNN has various layers, each layer may many nodes, this creates the complexity in the network, resulting in the drop of accuracy rate. The CNN which is built upon DNN has filters and max pooling. The use of CNN is beneficial because it reduces and the complexity for the implementation and helps in getting the accuracy for the network. The CNN shares the weights, which is max pooled and normalized for output layers, to get the appropriate output. This paper mainly focuses on the image classification of input image by predicting its output using the Neural Network, by optimizing its accuracy.

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