Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 02, February -2018

Image Classification with Deep Learning and Comparison between Different Convolutional Neural Network Structures using Tensorflow and Keras

Karan Chauhan[1], Shrwan Ram[2]

Computer Science Department, M.B.M. Engineering College Jodhpur
Computer Science Department, M.B.M. Engineering College Jodhpur

Abstract - *Deep learning technologies are becoming the major approaches for natural signal and information processing, like image classification, speech recognition. Deep learning is a technology inspired by the functioning of human brain. In deep learning, networks of artificial neurons analyze large dataset to automatically discover underlying patterns, without human intervention, deep learning identify patterns in unstructured data such as, Images, sound, video and text. Convolutional neural networks (CNN) become very popular for image classification in deep learning; CNN's perform better than human subjects on many of the image classification datasets.*
In this paper, a deep learning convolutional network based on keras and tensorflow is deployed using python for binary image classification. In this study, a large number of different images, which contains two types of animals, namely cat and dog are used for image classification. Four different structures of CNN are compared on CPU system, with four different combinations of classifiers and activation functions.
It is shown that, for Binary image classification combination of sigmoid classifier and Relu activation function gives higher classification accuracy than any other combination of classifier and activation function.

Keywords *- Deep Learning, Convolutional Neural Network, Keras, Tensorflow, Relu, Sigmoid, Tanh, Softmax, Image Classification.*

I. INTRODUCTION

Deep learning is a technology inspired by the functioning of human brain. In deep learning, networks of artificial neurons analyze large dataset to automatically discover underlying patterns, without human intervention. [9]
In deep learning, a computer learns to classify images, text and sound. The computer is trained with large image datasets and then it changes the pixel value of the picture to an internal representation, where the classifier can detect patterns on the input image. [4]
Deep learning for image classification is becomes essential use of machine learning method. To increase performance the application of neural networks to learning tasks that contains more than one hidden layers. Deep learning is part of a broader family of machine learning methods based on learning data representation, as opposed to hard code machine algorithms. [7]
One of the most frequently used deep learning method for image classification is the convolutional neural network (CNN). CNN learns directly from the image data, thus eliminating manual feature extraction. [4]
Common problem in image classification using deep learning is low performance because of over fitting. To increase performance and preventing over fitting large dataset and model used. CNN have fewer connection and hyper parameter that make CNN model easy to train and perform slightly worse than other models. [7]
In this paper, a deep learning convolutional neural network based on keras and tensorflow is deployed using python for binary image classification. In this study, 10000 different images, which contains two types of animals, namely cat and dog are used for classification. Fig. 1.1 shows the example of dataset.

Fig. 1.1 Dataset Sample

In this paper, four different structures of CNN are compared on CPU system, with combination of different classifiers and activation functions, namely softmax, sigmoid classifiers and Relu, Tanh activation functions. For computation and processing we are using Tensorflow and Keras framework.
Tensorflow is one of the libraries used for image classification in deep learning. Tensorflow is an open source software library developed by the google in 2015 for numerical computation. Keras is an open source neural network library written in python, it is capable of running on top of MxNet, Deep learning, Tensorflow, and Theano. It designed to enable fast experimentation with deep neural networks.
The first section of this paper contains general introduction about deep learning, tensorflow, keras and dataset. Second section contains basic theory about CNN, classifiers and activation functions. Third section of this paper contains literature review, research methodology, and final section contains experimental setup and results.

II. BASIC THEORY

A. Neural Network: Neural Network receives an input and passes it through a number of hidden layers. Each hidden layer has set of neurons, where each neuron is fully connected to all neurons in the previous layer. Each layer in a single layer functions independently. The last layer in neural network is called 'output layer', which represents the class to which input belongs.

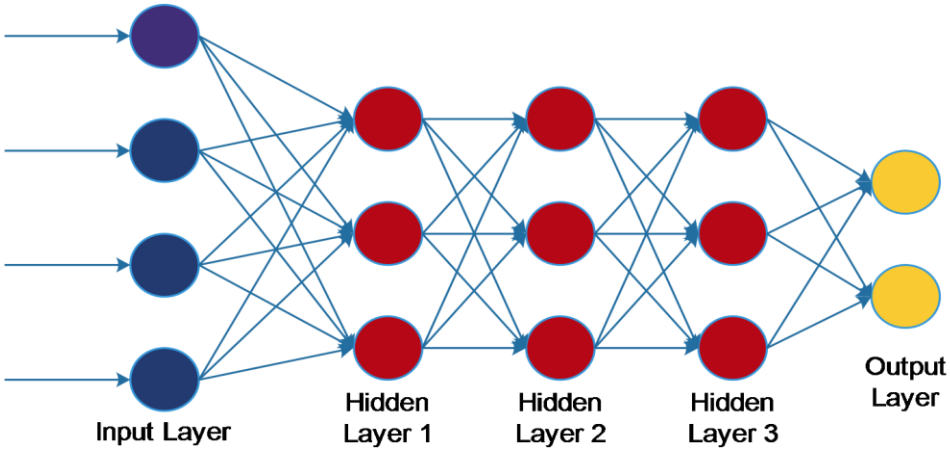


Fig. 2.1 Neural Network Architecture

B. Convolutional Neural Network (CNN): Convolutional Neural Network is a special type of feed forward artificial neural network, which inspired by visual cortex. In CNN, the neuron in a layer is only connected to a small region of the layer before it, instead of all the neurons in a fully connected manner, so CNN handle fewer amounts of weights and also less number of neurons.

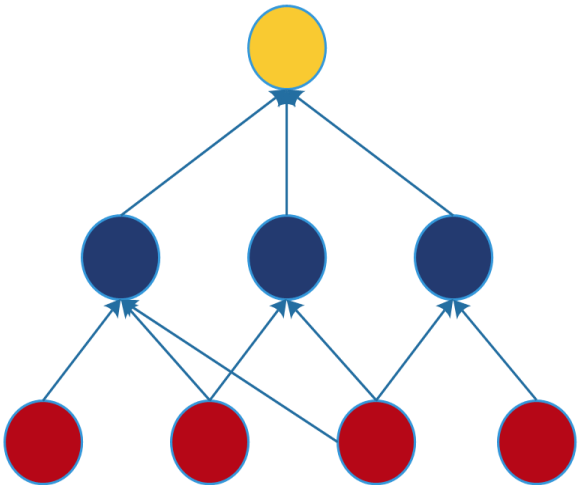


Fig. 2.2 Convolutional Neural Network

Relu Activation Function: Relu F(x) = max (x, 0), is mostly used deep learning activation function, for hidden layers. A rectified linear unit has output '0' if the input is less than '0', and raw output 'otherwise'. Relu is the simplest non-linear

activation function. Research has shown that relu result is much faster for large networks training. Most frameworks like tensorflow, make it simple to use relu on hidden layers.

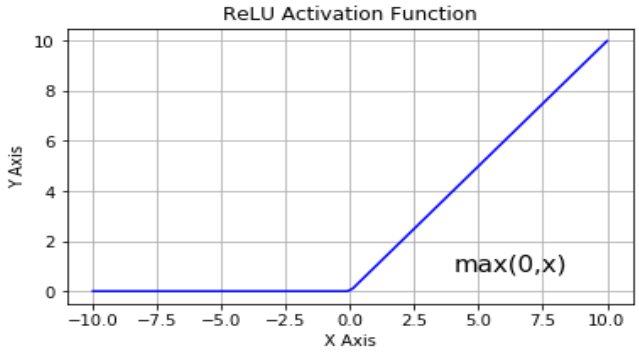


Fig. 2.3 Relu activation function

C. Tanh activation function: Tanh function [tanh(x) = (e^x - e^{-x}) / (e^x + e^{-x})] produces output in range of -1 to +1. It is continuous function, which produces output for every 'x' value.

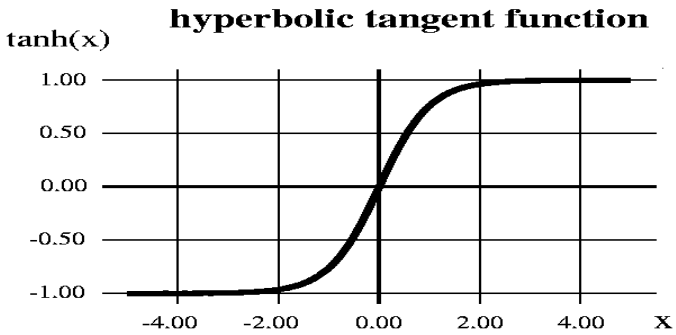


Fig. 2.4 Tanh activation function

D. Sigmoid classifier: Sigmoid classifier [F(x) = 1/ (1 + e^{-x})] takes any range of real number and returns the output value which falls in the range of '0'to '1'. It produces the curve in 'S' shape. Sigmoid classifier is mainly use for binary data classification.

E. Softmax classifier: The softmax classifier [F(x) = e^{xi} / ($\sum_{j=0}^{k}$ e^{xj})] squashes the outputs of each unit to be between 0 and 1, just like a sigmoid classifier. But it also divides each output such that the total sum of the outputs is equal to 1. The output of the softmax classifier is equivalent to a categorical probability distribution, it tells you the probability that any of the classes are true. Softmax classifier is use for multiple data classification.

III. LITERATURE REVIEW

Hasbi Ash Shiddieqy, Farkhad Ihsan Hariadi, Trio Adiono "Implementation of Deep-Learning based Image Classification on Single Board Computer", In this paper, a deep-learning algorithm based on convolutional neural-network is implemented using python and tflearn for image classification, in which two different structures of CNN are used, namely with two and five layers and It conclude that the CNN with higher layer performs classification process with much higher accuracy.

Rui Wang, Wei Li, Runnan Qin and JinZhong Wu "Blur Image Classification based on Deep Learning", In this paper, a convolution neural network (CNN) of Simplified-Fast-Alexnet (SFA) based on the learning features is proposed for handling the classification issue of defocus blur, Gaussian blur, haze blur and motion blur four blur type images. The experiment results demonstrate that the performance of classification accuracy of SFA, which is 96.99% for simulated blur dataset and 92.75% for natural blur dataset, is equivalent to Alexnet and superior to other classification methods.

Sameer Khan and Suet-Peng Yong "A Deep Learning Architecture for Classifying Medical Image of Anatomy Object", In this paper, a modified CNN architecture that combines multiple convolution and pooling layers for higher level feature learning is proposed. In this, medical image anatomy classification has been carried out and it shows that the proposed CNN feature representation outperforms the three baseline architectures for classifying medical image anatomies.

Ye Tao, Ming Zhang, Mark Parsons "Deep Learning in Photovoltaic Penetration Classification", this paper proposed a deep learning based algorithm to differentiate photovoltaic events from other grid events, and it conclude that a deep convolutional neural network can achieve higher classification accuracy than a fully connected model.

IV. RESEARCH METHODOLOGY

The flow diagram of proposed methodology is shown in fig. 4.1. Each block of proposed flow diagram is clearly labeled and represents processing steps. Using this methodology, we compare four different structure of CNN, with four different combinations of classifiers and activation functions.

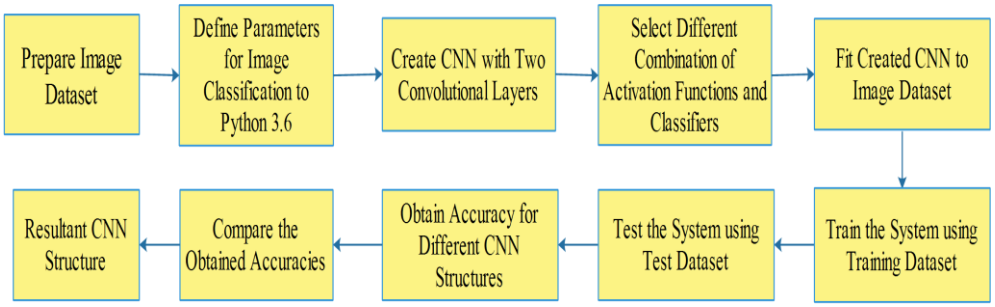


Fig. 4.1 Proposed Methodology

In first step image dataset is prepared, there are 4 files in dataset, which contains 10000 images of dogs and cats, where 8000 images used for training and 2000 images used for testing purpose. In second step, define parameters for image classification to python. In third step create CNN with two convolutional layers, than we select different combination of activation functions and classifiers for comparison purpose. In next steps, we fit the created CNN to image dataset and Train, Test the system with training and test datasets respectively.
Finally, we obtain the accuracy for different CNN structures and compare these accuracies for performance measurement, and then get the resultant CNN structure.

V. EXPERIMENTAL SETUP

In this paper, we perform experiments on windows 10 in python 3.6 on CPU system and create the CNN model based on keras and tensorflow libraries. The CNN model used for experiments is shown in fig 5.1. This model mainly consists of four layers including, convolutional, pooling, flattening and fully connected layers.

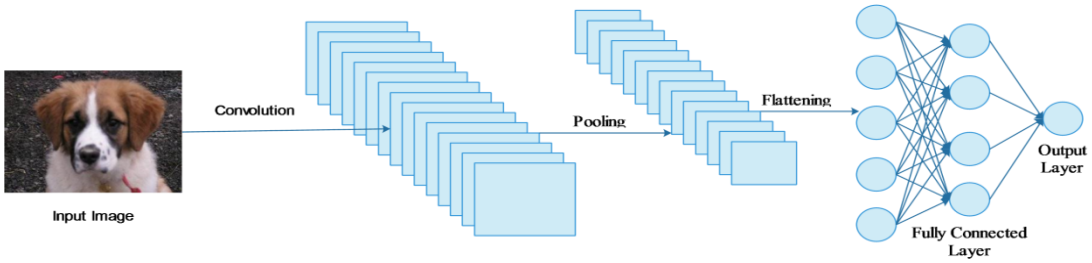


Fig. 5.1 Convolutional neural network model

For convolutional layer, the size of input image is set to 64*64 pixels with 3 channels (RGB). To extract the features from the image we use 32 filters of size 3*3 pixels. For pooling layer, we use a window of size 2*2 pixels, which used to compress the original image size for further processing.
For performance measurement we use two activation functions namely, Relu (Rectified linear unit), Tanh (Hyperbolic tangent), and two classifiers namely Softmax, Sigmoid. In experiment, we use combination of these activation functions and classifiers, and analyze that which combination gives better classification accuracy for binary image classification.

Table 5.1 Combinations of activation function and classifier

Serial number	Activation Function	Classifier
1.	Softmax	Relu
2.	Sigmoid	Relu
3.	Softmax	Tanh
4.	Sigmoid	Tanh

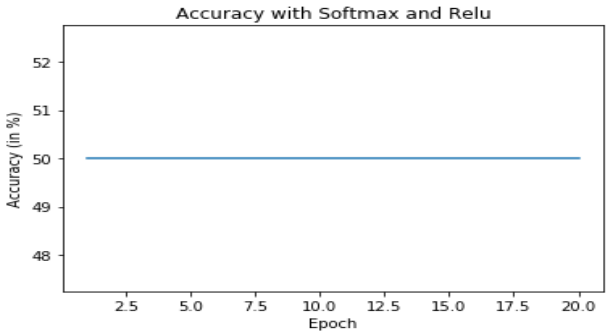
After implementing all above parameters in python, we train and test CNN model using training and test datasets, and then obtain accuracy for different CNN structures. After then we compare the obtained accuracies and find a CNN structure with higher accuracy.

VI. RESULT

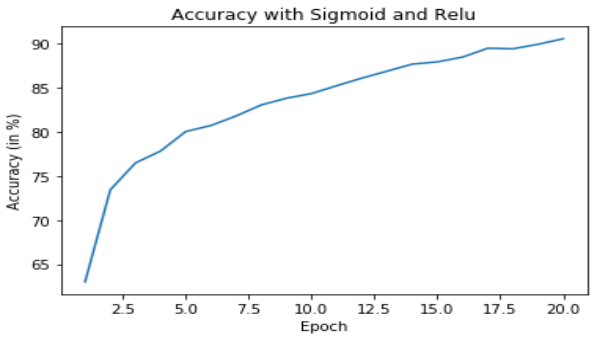
There are four classification accuracies obtained (as shown in table 6.1) from above defined CNN structures, and these accuracies are graphically represent in below graphs (a, b, c, d), where each CNN structure shown with epochsand accuracies.

Table 6.1 Obtained accuracies with different combinations of activation function and classifier

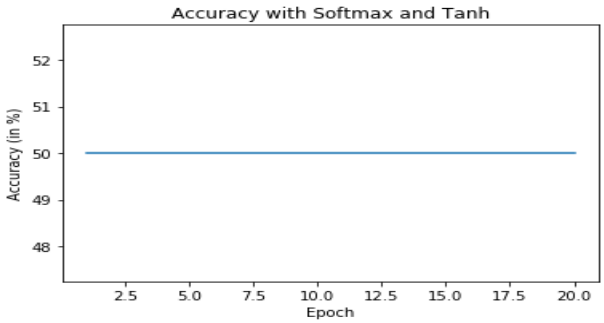
Number of convolutional layers	Activation Function	Classifier	Classification Accuracy
2	Relu	Softmax	50%
2	Relu	Sigmoid	90.54%
2	Tanh	Softmax	50%
2	Tanh	Sigmoid	87.22%



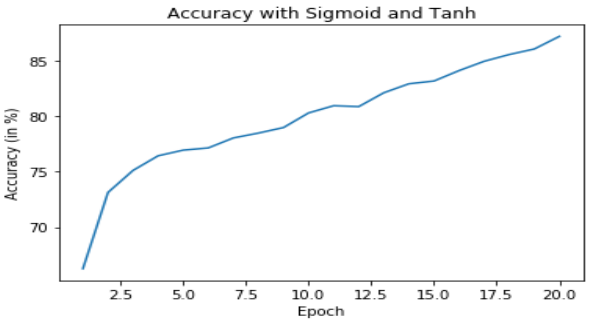
(a)



(b)



(c)



(d)

We compare accuracies of graph a, b, c and d and we find out that CNN with combination of Relu activation function and Sigmoid classifier (graph b) gives better accuracy 90.54%, which is far better than accuracies of graph a and graph c (50%), and slightly better than graph d (87.22%).

VII. CONCLUSION

Deep learning is a learning method for data analysis and predictions, now days it also become very popular for image classification problems.

In this paper, a deep learning convolutional neural network based on keras and tensorflow is deployed using python for binary image classification. In this study, we compare four different structures of CNN on CPU system, with different combinations of classifier and activation function.

With experiments, we obtained results for each combination and observed that for binary image classification, Relu activation function and Sigmoid classifier combination gives better classification accuracy (90.54%) than any other combination of activation function and classifier.

So, we conclude that on CPU system, Relu activation function and Sigmoid classifier gives better classification accuracy for binary image classification.

ACKNOWLEDGEMENT

We would like to thank Dr. Anil Gupta, Professor and Head of the Department, Computer Science and Engineering, MBM College, for his motivation without which we would not be able to write this paper. We are grateful to our family and friends for their support.

REFERENCES

[1] Sameer Khan and Suet-Peng Yong "A Deep Learning Architecture for Classifying Medical Image of Anatomy Object", Annual Summit and Conference, ISBN 978-1-5386-1543-0, pp. 1661-1668, 2017
[2] Rui Wang, Wei Li, Runnan Qin and JinZhong Wu "Blur Image Classification based on Deep Learning", IEEE, ISBN 978-1-5386-1621-5 pp. 1-6, 2017
[3] Teny Handhayani, Janson Hendryli, Lely Hiryantyo "Comparison of Shallow and Deep Learning Models for Classification of Lasem Batik Patterns", ICICoS, ISBN 978-1-5386-0904-0, pp. 11-16, 2017
[4] Laila Ma'rifatul Azizah, Sitti Fadillah Umayah, Slamet Riyadi, Cahya Damarjati, Nafi Ananda Utama "Deep Learning Implementation using Convolutional Neural Network in Mangosteen Surface Defect Detection", ICCSCE, ISBN 978-1-5386-3898-9, pp. 242-246, 2017
[5] Ye Tao, Ming Zhang, Mark Parsons "Deep Learning in Photovoltaic Penetration Classification", IEEE Power & Energy Society General Meeting, ISBN 978-1-5386-2213-1, pp. 1-5, 2017
[6] Sebastian Stabinger, Antonio Rodr´ıguez-S´anchez "Evaluation of Deep Learning on an Abstract Image Classification Dataset", IEEE International Conference on Computer Vision Workshops (ICCVW), ISBN 978-1-5386-1035-0, pp. 2767-2772, 2017
[7] Hasbi Ash Shiddieqy, Farkhad Ihsan Hariadi, Trio Adiono "Implementation of Deep-Learning based Image Classification on Single Board Computer", International Symposium on Electronics and Smart Devices (ISESD), ISBN 978-1-5386-2779-2, pp. 133-137, 2017
[8] Hangning Zhou, Fengying Xie, Zhiguo Jiang, Jie Liu, Shiqi Wang, Chenyu Zhu "Multi-classification of skin diseases for dermoscopy images using deep learning", International Conference on Imaging Systems and Techniques (IST), ISBN 978-1-5386-1621-5, pp. 1-5, 2017
[9] Sachchidanand Singh, Nirmala Singh "Object Classification to Analyze Medical Imaging Data using Deep Learning", International Conference on Innovations in information Embedded and Communication Systems (ICIIECS), ISBN 978-1-5090-3295-2, pp. 1-4, 2017
[10] Rika Sustika, Asri R. Yuliani, Efendi Zaenudin, Hilman F. Pardede "On Comparison of Deep Learning Architectures for Distant Speech Recognition", 2nd International Conferences on Information Technology, Information Systems and Electrical Engineering (ICITISEE), ISBN 978-1-5386-0659-9, pp. 17-21, 2017

