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PREDICTION OF PNEUMONIA DISEASE BY USING DEEP CONVOLUTIONAL NEURAL NETWORKS

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ABSTRACT

Pneumonia is a disease which occurs in the lungs caused by a bacterial infection. Early diagnosis is an important factor in terms of the successful treatment process. Generally, the disease can be diagnosed from chest x-ray images by an expert radiologist. The diagnosis can be subjective for some reasons such as the appearance of disease which can be unclear in chest x-ray images or can be confused with other diseases. Therefore, computer-aided diagnosis systems are needed to guide the clinicians for predicting whether the person has "Pneumonia from his x-ray report of lungs." Here, we used a neural network classification model to classify Normal and Pneumonia persons.

Keywords: classification, disease, diagnosis

1. INTRODUCTION

Machine learning (ML) is the construction of algorithms and statistical models which can extract information hidden within a dataset [1]. By learning a model from a dataset, one then has the ability to make prediction son unseen data from the same underlying probability distribution [2][3].Forseveraldecades,researchinmachinelearningwasfocusedonmodelsthatcanprovidetheoretical guarantees for their performance. However, in recent years, methods based on heuristics have become dominant, partly due to an abundance of data and computational resources[4].

Deep learning is one such heuristic method which has seen great success. Deep learning methods are based on learning a representation of the dataset in the form of networks of parameterized layers[5].These parameters are then tuned by minimizing a function of the model outputs, called the loss function[6]. This function quantifies the fit of the model to the dataset [41] [42].

In parallel to the recent advances in deep learning there has been a significant growth of interest in quantum computing in both academia and industry[7][8]. Quantum computing is the use of engineered quantum systems to perform computations. Quantum systems are described by a generalization of probability theory allowing novel behavior such as super position[9] and entanglement[10] [43], which are generally difficult to simulate with a classical computer. The main motivation to build a quantum computer is to access efficient simulation of these uniquely quantum mechanical behaviors [11]. Quantum computers could one day accelerate computations for chemical and materials development, decryption, optimization, and many other tasks[12]. Google's recent achievement of quantum supremacy marked the first glimpse of this promised power[13].

Pneumonia can be diagnosed in a number of different ways. Healthcare providers candiagnose pneumonia by the symptoms, a physical examination, or by ordering diagnostic[14][15]. Laboratory tests can include chest X-rays and cell cultures (followed by PCR antigen testing of blood orantigen testing of urine.) to look for pathogenic bacteria in the infected part of the body[16]Usually there should be a combination of clinical ,radiological, and laboratory findings to increase the likelihood of correct diagnosis. Chest X-rays and laboratory tests can help confirm the diagnosis of pneumonia by presence of specific findings, such as consolidation or infiltration in the lung, which still would need qualified assessment in conjunction with clinical picture [44]. Localization of infiltrates is important for differential diagnosis (e.g. Primary tuberculosis with other pathogens, and in the case of upper lob infiltrate, diffusive infiltration can be seen in pneumocystis pneumonia

and sometimes in disease caused by virus orChlamydia), but should not be used as a unique criterion[17][18].

In the developing world,children with suspected pneumonia are diagnosed based on their clinical symptoms, given that access to laboratory technologies is often unavailable in resource-poor settings[19].Healthcare providers can diagnose many cases by using a stethoscope and/or observe achild's respiratory rate and any breathing problems. Children and infants are presumed to have pneumonia if they exhibit a cough and fast or difficult breathing. The WHO[20] and UNICEF[21] Integrated Management of Childhood Illness (IMCI) guidelines help inform healthcare providers and personnel on standard clinical symptoms and effective treatment for pneumonia [45] [46]. Pneumonia is a disease in one or both lungs. It can be caused by bacteria, viruses, or fungi[22]. Bacterial pneumonia is the most common type in adults. Pneumonia causes inflammation in the air sacs in your lungs, which are called alveoli. The alveoli fill with fluid or pus, making it difficult to breathe[23] [47]. According to National Institutes of Health (NIH), chest x-ray is the best test for pneumonia diagnosis. However, reading x-ray images can be tricky and requires domain expertise and experience[24][25]. It would be nice if we can just ask a computer to read the images and tell us the results[26].

The main aim of this work is to predict whether the person has Pneumonia from his X-ray report of lungs [48]. For this we select a dataset so that we can build a model to predict the rate of Pneumonia in a city by collecting the people's x-ray reports[24][25]. We use a neural network classification model to classify Normal and Pneumonia persons[26][27]. Here the input parameters are the training data and the output will either 0 or 1 i.e. having Pneumonia or not[28]. By using Convolution Neural Network, Dense Layer to avoid overfitting, Pooling, Fully Connected layers (FC) and apply Soft Max function.3[29]

2. SYSTEM ANALYSIS

In the existing system, here used machine learning techniques for diagnosis of pneumonia [30].Random forest is a supervised learning algorithm which is used for both classification as well as regression [31]. It is mainly used for classification problems. We know that a forest is made up of trees and more trees means more robust forest[32]. Similarly, random forest algorithm creates decision trees on data samples and then gets the prediction from each of them and finally selects the best solution by means of voting[33][34]. It is an ensemble method which is better than a single decision tree because it reduces the over-fitting by averaging the result.

Random Forest creates a lot of trees (unlike only one tree in case of decision tree) and combines their outputs[35]. By default, it creates 100 trees in Python sklearn library. To do so, this algorithm requires much more computational power and resources. Random Forest require much more time to train as compared to decision trees as it generates a lot of trees (instead of one tree in case of decision tree) and makes decision on the majority of votes[36].Another major challenge is the ability to accurately interpret results generated by the algorithms. So proposed using Machine Learning techniques predicting patients pneumonia disease is a time consuming task which degrades patients survival rate, by applying different machine learning techniques an early diagnosis of lungs problems will increase patients' survival rate based on accuracy, to find the best suitable algorithm for pneumonia prediction which gives best performance[37].

It added a greater advantage to medical field[38].The technique that is used is CNN sequential model for classification. Technically, deep learning CNN models to train and test, each input image will pass it through a series of convolution layers with filters (Kernals), Pooling, Fully Connected layers (FC) and apply Soft Max function to classify an object with probabilistic values between 0 and 1[39]. This system features are automatically deduced and optimally tuned for desired outcome. Robustness to natural variations in the data is automatically learned. The same neural network based approach can be applied to many different applications and data types. Ability to deliver high-quality results. Maximum utilization of unstructured data [40].

3. EXPERIMENTAL RESULTS

Supervised classification is a canonical task in classical machine learning. Similarly, it is also one of the most well-studied applications for QNNs. As such it is a natural starting point for our exploration

of applications for quantum machine learning. Discriminative machine learning with hierarchical models can be understood as a form of compression to isolate the information containing the label. In the case of quantum data, the hidden classical parameter (real scalar in the case of regression, discrete label in the case of classification) can be embedded in a non-local subsystem or subspace of the quantum system. One then has to perform some disentangling quantum transformation to extract information from this non-local subspace.

In deep learning, a convolutional neural network (CNN, or ConvNet) is a class of deep neural networks, most commonly applied to analysing visual imagery. They have applications in image and video recognition, recommended systems, image classification, medical image analysis, natural language processing.

The name "convolutional neural network" indicates that the network employs a mathematical operation called convolution. Convolution is a specialized kind of linear operation. Convolutional networks are simply neural networks that use convolution in place of general matrix multiplication in at least one of their layers.

a) DATA SET DESCRIPTION FOR BINARY DATA

Classifying the X-ray images as Pneumonia and Normal Dataset contains totally 5856 images. This data set contains 5856 X-rays in which 1583 are normal images and 4273 are Pneumonia images. There are 5856 total images ,624 test set images, 5216 train set images,16 validation set images. The total dataset is divided into validation set, testing set, training set ((8,8), (234,390), (1341,3875)) respectively.

```
Epoch 1/5
200/200 [==============================] - 168s 841ms/step - loss: 0.3218 - acc: 0.8597 - val_loss: 0.7119 - val_acc: 0.7434
Epoch 2/5
200/200 [==============================] - 156s 780ms/step - loss: 0.2099 - acc: 0.9142 - val_loss: 0.3683 - val_acc: 0.8531
Epoch 3/5
200/200 [==============================] - 161s 806ms/step - loss: 0.1925 - acc: 0.9214 - val_loss: 0.2235 - val_acc: 0.9145
Epoch 4/5
200/200 [==============================] - 167s 834ms/step - loss: 0.1885 - acc: 0.9248 - val_loss: 0.3746 - val_acc: 0.8156
Epoch 5/5
200/200 [==============================] - 153s 766ms/step - loss: 0.1646 - acc: 0.9356 - val_loss: 0.3531 - val_acc: 0.8783
```

Fig.1: Accuracy for Binary data

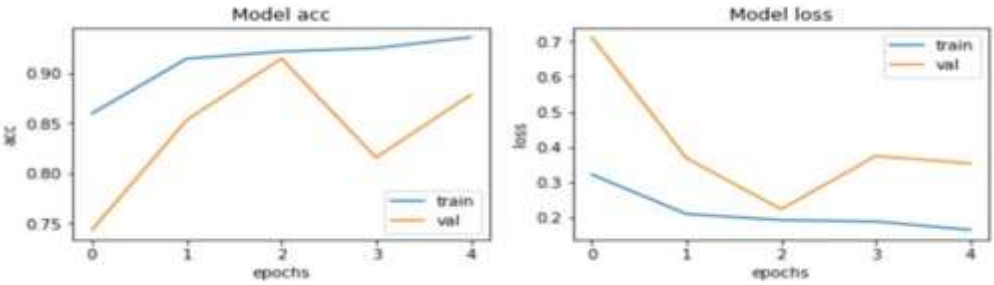

Fig.2: Graph Differentiation for Binary data

b) DATA SET DESCRIPTION FOR CATEGORICAL DATA

Classifying the X-ray images as Pneumonia and Normal Dataset contains totally 5858 images. This data set contains 5858 X-rays in which 1583 are normal images, 2774 Bacterial Images and 1501 Viral Images. Total 1583 Normal images, 2774 Bacterial Images and 1501 Viral Images are present. There are 5858 total images ,624 test set images, 5210 train set images, 24 validation set images. The total dataset is divided into validation set, testing set, training set ((8,8,8), (242,234,148), (2521,1341,1345)) respectively.

```
Epoch 1/5
200/200 [==============================] - 226s 1s/step - loss: 0.5199 - acc: 0.7793 - val_loss: 0.4593 - val_acc: 0.8355
Epoch 2/5
200/200 [==============================] - 227s 1s/step - loss: 0.5237 - acc: 0.7743 - val_loss: 0.4927 - val_acc: 0.8438
Epoch 3/5
200/200 [==============================] - 227s 1s/step - loss: 0.5186 - acc: 0.7754 - val_loss: 0.4436 - val_acc: 0.8651
Epoch 4/5
200/200 [==============================] - 223s 1s/step - loss: 0.5069 - acc: 0.7801 - val_loss: 0.5741 - val_acc: 0.8281
Epoch 5/5
200/200 [==============================] - 226s 1s/step - loss: 0.4985 - acc: 0.7850 - val_loss: 0.4615 - val_acc: 0.8717
```

Fig. 3. Accuracy for Categorical Data

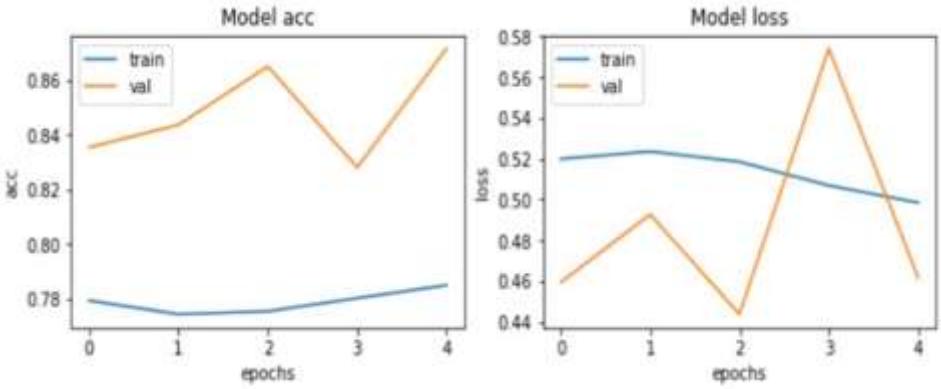

Fig. 4. Graph differentiation for Categorical Data

4. CONCLUSIONS & FUTURE ENHANCEMENT

In this paper, we have proposed methods for predicting pneumonia in patients using Convolutional Neural Networks. The system was implemented using all the models and their performance was evaluated. Performance evaluation was based on certain performance metric. The trained model was compiled with "adam" as optimizer, loss function is "binary crossentrophy", metrics as "auc". The final accuracy is around 85-95% after all 5 final epochs.The trained model was compiled with "adam" as optimizer, loss function is "categorical crossentrophy", metrics as "auc". The final accuracy is around 70-80% after all 5 final epochs. In future, build an MRI Scanner that immediately predicts whether the person has Pneumonia disease or not. It also predicts the chances of having the disease for a particular person in future.

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