Diagnosis of Pneumonia using Transfer Learning Approach

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Abstract

In the health care industries, lung infection is caused by bacteria, viruses or germs where pneumonia is one of the dangerous diseases which may infect one or both lungs. Pneumonia is caused when inflammation is caused the infection in the air sacs and the lungs which are called alveoli. Fluid, cough or pus are filled up in the lungs by which the air sacs become inflamed due to pneumonia. Pneumonia creates difficulties in exhalation and inhalation. If not controlled by pills or drugs at the correct time initially, pneumonia may result in the death of individuals. Therefore, the infection should be determined at the initial stage by using a chest x-ray diagnosis technique. This paper discusses the pneumonia detection technique which uses different and challenging medical-imaging techniques (chest x-ray image). To get the efficient, quick and accurate result in the detection of pneumonia infection, the transfer learning technique is used which is helpful to improve the performance of learning of pneumonia detection model where already learned prediction task learns new prediction task through the transfer knowledge. This model can detect pneumonia automatically by providing the training with the proper data set. Through the preprocessing multistep, deep learning architecture is used in task classification with the training of modify images. Using some different neural network model images are selected and pre-trained on imageNet which are delivered in prediction classifier for pneumonia prediction. This model solves the accuracy problem in pneumonia detection at the initial stage.

Keywords- Pneumonia, medical chest x-ray, image processing transfer learning, deep learning, radiology, diagnosis.

1. INTRODUCTION

In 1995 AI is founded as AI winter and AI has achieved by examining how the human brain thinks, decides, learns and works while trying to solve a problem. Transfer learning, deep learning, and machine learning are the subsets of AI which are used to develop different types of models according to the requirement.

Transfer learning for medical imaging is one of the biggest impacts in the healthcare sectors with the prediction of disease accurately. Transfer learning is the process the creating new AI models by fine-tuning previously trained neural networks. Instead of training their neural network for search developers can download a pre-trained, open-source deep learning model and fine-tune it for their purpose.

AI-powered healthcare systems and applications will succeed to save time in the medical sectors. AI healthcare with image processing using the transfer learning approach has used a complex algorithm design to perform certain tasks. There is a strong possibility that in coming future AI may easily aid physicians and doctors to make analytical and critical decisions. AI is especially useful in the healthcare fields because it can bring to shine crucial and essential pieces of information that would be else ways be buried in data bundles that are heaps of data. There are several ways to prepare disease detection models.

For accurate and quick response in the result of medical project models, there are many startups already data machine learning which decides on the correct mode of action by providing medical experts with more descriptive and informational data. The deep mind of the Google Health Project designs the amazing treatment plan for cancer patients by medical test result’s rapid analyzation and immediately referring that patients to the right Specialist, Hence building a Test to Treatment flow which has been justified to be beneficial for the patients. Similarly in the journal Annals of Oncology mentioned that skin cancer could be detected by an AI system more accurately (86.6 accuracy %). Electronic health catalogs are crucial to spread information and digitalization of the healthcare industry. These are the application of AI developed models with machine learning & transfer learning approaches.
There are many diseases which can be effectively and accurately diagnosed by different way of technique i.e. AI using Transfer Learning. In few notorious diseases (Diabetes, Cardiovascular disease (CVD), Pneumonia), Pneumonia is popular disease which cause the death worldwide which has been basic backside a lot of testing and research to achieve an accurate diagnosis.

Previously doctors recommend some specific tests to the patients and that tests are blood test, chest x-ray, pulse oximetry, sputum test and in serious condition additional tests are CT scan and pleural fluid culture. However this thesis is targeted on one of these applications that is the diagnosis of pneumonia using X-ray of chest.

Pneumonia is an infection in one or both lungs which are caused by Bacteria, Virus, and Fungi. Inflammation causes the infection in the air sacs of lungs which are called alveoli. Along with chest X-ray analysis physical examination is involved in the diagnosis of pneumonia.

By using a machine learning technique the analysis if chest X-ray can be involved to provide results quickly and accurately. Five thousand above images of categorized patient’s chest x-rays are used in learning of machine learning algorithm and this learning algorithm applies to diagnose new images.

The main purpose of this developing model to allow specialists to get a near accurate and rapid prediction of diagnosis using chest x-ray and to possibly further needed patient’s examination, in fact allowing more time on needed patients. With the technical background including transfer learning, machine learning and deep convolutional neural networks that states a critical state of the art to solve the problems by providing training to the pneumonia detecting model. The trained model fetches the images of a chest x-ray and recognize that the person is normal or infected by the pneumonia disease.

2. METHODOLOGY

2.1. Machine Learning

Machine learning is a basic and main part of Artificial Intelligence (AI). Basically, machine learning is used in scientific study algorithms and it is also used in the study of statistical models. There are different type of machine learning which are used for further aided tasks. Deep learning, transfer learning, convolutional neural network are used to build a sample data-based model i.e. mathematical model based on “training data” without being explicit use in decision-making tasks.

For the better decision system and improvisation in the performance of learning elements, it decides what actions to take and modify the performance of the element.

Supervised and unsupervised two learning methods are used in the learning model according to the system requirement. Reinforcement learning is the other type of learning method of machine learning system which studies on animals and artificial system’s learning strategy to optimize their behavior.

Count and marks per class should be calculated initially which is done by softmax regression. Softmax is a function used in the framing of the project work model. The softmax regression function is enforced to scores and it calculates an approximate probability for every class. Figure 2 shows the softmax equation.
The learning rate is the main term of gradient descent and the local gradient of the cost function is determined at cost function’s random parameters which are the random utilization of parameters. The learning rate shows the size in gradient descent.

With the satisfaction of machine learning model helps to identify the pneumonia infection in a person using the chest x-ray with image processing by providing the training to the model and is very interesting to predict pneumonia.

2.2. Deep Learning

Artificial intelligence (AI) has the number of subsets in which machine learning is one of them and it also has subset i.e. deep learning. Deep learning is a function of AI and this function of AI act like the working of the human brain which uses in processing and making the pattern to create similarity in decision making.

The difficult and complicated structure of the human brain is solved only by the subset of machine learning which is used to develop Artificial Neural Network (ANN). ANN work as similar as biological neurons and with the different positive and negative weights where several inputs are received and after receiving inputs (with individual weights) these are added in the summation processor due to the activation of a function, hence output gets at the destination.

Deep learning has brought about an explosion of data because deep learning has spread and evolved conjointly in the digital era. The neurons fire off its own impulse through a long structure due to exceeding of impulses called axon to the next neuron.

2.3. Transfer Learning

Transfer learning is a highly popular technique which is emerged to develop the deep learning models same as deep neural networks applies on a diverse set of domains and these domains are in increasing order. Here transfer learning is specially used in medical images. There are two steps by which the neural network is trained in transfer learning and these two steps are:

- Pre-Training
- Fine-Tuning

Due to the pre-training, a neural network is trained on a large scale dataset and this dataset expresses a wide diversity of labels. An example of this category is image-net with large scale benchmark datasets. And due to fine-tuning, the pre-trained model network is again trained and this further training is applied on a particular targeted task.
These pre-trained network helps the model’s network to learn general and common features which can be reuse on that particular task. This pre-trained network has corresponding pre-trained weights with image-net and these weights are fine-tuned on healthcare tasks which can be interpreting chest x-ray, identifying eye disease, electronic health records, etc. Transfer learning is a research problem in machine learning (ML) where transfer learning focuses on storing and collecting knowledge gained while solving a problem by applying this stored knowledge to a different but in the related problem.

2.4. Convolutional Neural Network

The convolutional neural network is used as a powerful and essential tool that helps to identify normal and local patterns in the given samples of data. Convolutional neural networks (CNNs) have specific architecture specially used in task classification. In the data samples weight data is interconnected which is suitable for the classification task of CNNs.

Functions of convolutional neural network (CNN) architecture are used to do experiments to recognize the local patterns and these local patterns are detected in input data with the creation of feature maps. With the slide or shifted value of input and kernel the multiplication of conducting elements accordance wise creates feature maps. After that, all values are added with each other which generate a result for feature map. To eliminate the unnecessary data portion within an image and to extract the necessary data having a significant portion of information in the used image, these are the managing part of the feature map. Feature maps are the essential and crucial step for arrangement. Two-dimensional process of CNNs is a 2-dimensional version which is summarized in figure 2. There are few layers such as R, G, Band for each single such layers of an image two-dimensional process is conducted and after finishing it the layers of the image linked together for the further step. Hence the classification is done through the artificial neural network with CNN.
Nonlinear functions are used in CNN in the next step. The nonlinear functions are used after the feature map capturing process. The nonlinear functions are applied in the next step and it helps to maintain or arrange the positive values as they are and to convert the negative values in value 0. Figure 7 shows the formula which helps to understand the nonlinear function with the help of the Rectified Linear Unit (ReLU) function.

Polling is also the main application which is very helpful to do the next task. Polling application is applied and it shows the alternation of average, maximum and sum polling. Minimization of dimensions should change and it is only possible with max polling which helps to reduce the dimension of the feature map. This reduction is done while arranging the very important identity values by sliding kernels on the rectified feature map and mainly over the clicking highest values. This architecture enhances the utilization of max polling and get the more effective feature of it. As the dimension is reduced it makes data more familiar and manageable using minimum parameters then the next step is done after that.
Flattering is the next step after the polling application and is also an application that does the same work but it is a more effective application. In this step flattering is used on current output and output is flattened after the flattening it is converted to a long vector. A flattening application is applied to find the more manageable version and this better version. This application is used within the algorithm classification and artificial neural network.

![Perceptron Equation](image)

Figure 9: Perceptron equation

Artificial neural networks (ANNs) are used in the constitution of layers and perceptron. Multiple perceptron are composed and it happens when the ANNs are comprised of layers. Here input layer is also known as a hidden neuron. Figure 9 shows the formula of the perceptron.

2.5. Mobile Net Architecture

Point-wise convolution is the other name of depth wise convolution where 1×1 convolution and depth-wise convolution is the base of the architecture of mobile net model. Embedded based applications take the help of the mobile net architecture which is used maximum in this process and it lacks computer power. This is not used on the combined channels in short we can say its performance is not good for collected channels with single convolution. Generally it will perform a unit convolution on every channel. The base of mobile net i.e. depth wise convolution has two faces: one is the single filter and the other is multi-filter where single filter is used for each and every channel one by one. A new feature is created by depth wise convolution which give the priority to each and every single input channel. In the first step depth wise convolutional network creates a comparison scenario from extremely efficient convolution to standard convolution. 1×1 convolution is taken to create new feature. The other term of depth in convolution is known as depth-wise separable convolution that is the combined form of 1×1 convolution and depth-wise convolution which helps to recognize and explain the structure of mobile net. It also helps in fine-grain recognition, face attribution, object detection, image recognition and face embedding with minimum training data set and fast processing.

2.6. Inception V3 Architecture

There are 1000 classes of the trained model which can easily be classified and per trained model are the part of inception V3. These classes may have living beings including flowers and non-living things.

![Inception V3](image)

Figure 10: Inception V3
This model has initially extracted the common and general features in inception v3 process for the input images and secondly do the classification. And the classification part depends on softmax layers.

3. CONCLUSION

Early diagnosis of pneumonia and the treatment is critical to solving complicated problems and preventing from the death to the patients. By presenting this research paper pneumonia detecting model identifies the infection and investigates a deep convolutional neural network that combines with training idea of transfer learning and this method is used in solving the complicated task of radiography image classification. By training of the model along with above 5000 datasets of chest x-ray images (infected and normal) can identify the infection accurately and rapidly within a few minutes or sometimes in seconds. The result of this thesis does not purpose to perfectly diagnose the patients for identify pneumonia. While this research paper points towards the simply ease of the radiologist’s decision powered by taking simply light specific features that may human eye missed in the initial stages of pneumonia.

Machine learning, transfer learning, and deep learning with a convolutional neural network (subsets of AI) help to make the pneumonia detection model with an image processing technique. With a fine, accurate and quick response as a result, it also satisfies all criteria of diagnosis of pneumonia (lung infection disease) with a chest x-ray. Hence this model aids doctors with disease’s diagnosis by fulfilling all medical healthcare aspects.

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