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A Neural Network Architecture Using Separable Neural Networks for the Identification of "Pneumonia" in Digital Chest Radiographs

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ABSTRACT

In recent years, convolutional neural networks had a wide impact in the fields of medical image processing. Image semantic segmentation and image classification have been the main challenges in this field. These two techniques have been seeing a lot of improvement in medical surgeries which are being carried out by robots and autonomous machines. This work will be working on a convolutional model to detect pneumonia in a given chest x-ray scan. In addition to the convolution model, the proposed model consists of deep separable convolution kernels which replace few convolutional layers; one main advantage is these take in a smaller number of parameters and filters. The described model will be more efficient, robust, and fine-tuned than previous models developed using convolutional neural networks. The authors also benchmarked the present model with the CheXnet model, which almost predicts over 16 abnormalities in the given chest-x-rays.

KEYWORDS

Artificial Neural Network, Deep Convolutional Networks, Hyper Parameters, Optimization, Separable CNNs

1. INTRODUCTION

Pneumonia is one of the dreadful and viral diseases which is mainly caused because of micro bacteria, virus, and Mycoplasma. It grows dangerous fluidic material inside the air sacs making breathing more difficult. Pneumonia can easily survive in a healthy throat and can multiply and work their way into the lungs. Pneumonia also has few symptoms including a mild headache, shaking chills, shortness of breathing, loss of appetite, and in older people, confusion is also observed as one of the symptoms for pneumonia. There is a high chance of an increase in the pneumonia severity if the patient smokes tobacco or if he's a frequent swimmer. People living in the hospital environment and nursing homes are vulnerable to pneumonia. Due to these reasons, millions of people are being hospitalized across the world. To overcome such dreadful scenarios, a fast and accurate diagnosis is the need of the hour.

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The traditional methods currently being used mainly revolve around radiographic imaging as the primary tool. Chest X-rays seem to be the only reliable source in detecting pneumonia. Some thresholds are set to identify the affected regions. However, to get accurate results from that, expert radiologists are required. This might not always be the case in remote, rural areas. Also, a doctor manually examining chest x-ray might not always be correct if at all the patterns are blurred. This could lead to an incorrect diagnosis. Hence, these aren't the best and reliable techniques that can yield dependable results.

In this work, we will be using these symptoms as the parameters for the network and build a highly efficient classifier. We shall be using neural networks, which are a class of machine learning algorithms to build a classifier that classifies pneumonia in chest x-ray images. In recent years, the artificial neural network made a wide impact in the fields of medical image processing from detecting tumors in brains to finding the cure to several diseases using different types of neural network architectures. A few main medical fields where neural networks are widely used are diagnostic systems, biomedical analysis, image analysis, and drug development. The concept of developing neural networks for medical purposes started with processing techniques used for reducing noises and blurs that are indispensable. Secondly, these are also used for Magnetic Resonance Images (MRIs), where these could produce high-quality images of x-ray scans, however, with little pixel variation. Neural Networks are used on these MRIs for semantic segmentation of tumors and blood clots.

In our architecture, we shall be training our CNN extensively to extract precise output images wherein Pneumonia detection statistics are plotted. We feed a set of chest x-rays, and the model trains on the images given and outputs the labels associated with each image.

2. BACKGROUND

Most of the classification in which pneumonia is categorized is based on the country average low income and high income (Agweyu & Lilford 2018) which was presented by the World Health Organization. There are a few guidelines that classify the clinical signs of pneumonia which describe the threshold of risk for children. In this work, we aim to work on the chest radiology images which give a complete report of the threshold data as well as pneumonia classified images. We've identified that almost 832 out of 16,031 children die by pneumonia which is 5% of the whole. When it comes to teenagers, out of 11,788, 321 die due to pneumonia, which when summed up, boils down to 3% (Causes of Pneumoniua n.d.). Most of the diagnosis that is carried out in the intensive care configuration is highly unreliable; this includes the diagnosis of the chest radiology manually. There are a few advanced techniques in neural networks dedicated to finding several abnormalities in chest X-Rays. Few include ChexNet (Rajpurkar et al., 2017), a 121-layer neural network architecture that is used to find about 14 abnormalities that also include screening, diagnosis, critical segmentation, and pneumonia classification, and achieved classification accuracy of 0.7680 on the pathology pneumonia. The one main disadvantage is that they take a lot of time to be implemented in rural areas and less populated countries due to minimal availability of the required data. The current practices in detecting pneumonia include manual identification by the radiologist using the weights of the deep neural networks (less precise) for classification, and by using the parameters with respective to the fields of microbiology, etiology, radiology, etc, calculating the entropy to measure the difference between normal respiratory system that's all fine with the one affected by pathology, and comprehending the snoring patterns to detect for irregularities that might be the causes for pneumonia.

Along with the mentioned ones, a lot more techniques have forayed trying to improvise the mundane ways of detecting Pneumonia. It started with the work (Khobragade et al., 2016) proposed. It involved pulmonary segmentation and extraction of characteristics using an ANN. The other work (Paing & Choomchuay 2017) includes detecting the pulmonary nodules from a set of CT images.

Pattern recognition in machine learning includes four main steps: data acquisition, preprocessing, feature extraction by Convolutional neural networks and classification. Convolutional Neural Networks