PNEUMONIA PREDICTION USING MEDICAL IMAGE MODALITY

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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 for the successful treatment process. Generally, the disease can be diagnosed from chest X-ray images by an expert radiologist. The diagnoses 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. It is also much more difficult to make clinical diagnoses with chest X-rays than with other imaging modalities. Therefore a computer aided diagnosis systems are needed as tools to assist in the clinical interpretation of chest x-rays would therefore fulfill an unmet need.To solve this problem we have developed an application that detects Pneumonia and predicts the accurate probability values.

***Index Terms* - CNN,Deep neural networks,Onnx,Keras,VGG16.**

I. INTRODUCTION

Pneumonia is a disease which occurs in the lungs caused by a bacterial infection. Chest X-rays are currently the be method for diagnosing pneumonia. But there is a lack of access with almost two-thirds of the world's population lacking access to radiology diagnostics. Many doctors do not have the proper diagnosing tools to diagnose patients.The diagnosis by the doctors may not be accurate .It is also much more difficult to make clinical diagnoses with chest X-rays than with other imaging modalities. This diagnoses may be inaccurate. There is a lack of access with almost two-thirds of the world's population lacking access to radiology diagnostics. It is also much more difficult to make clinical diagnoses with chest X-rays than with other imaging modalities and Many doctors do not have the proper diagnosing tools to diagnose patients.

Medical image analysis is an active field of research for machine learning, partly because the data is relatively structured and labeled, and it is likely that this will be the area where patients first interact with functioning, practical artificial intelligence systems [1]. Deep neural network models have conventionally been designed, and experiments were performed upon them by human experts in a continuing trial-and-error method. This process demands enormous time, know-how, and resources. To overcome this problem, a novel but simple model is introduced to automatically perform optimal classification tasks with deep neural network architecture. The neural network architecture was specifically designed for pneumonia image classification tasks. The proposed technique is based on the convolutional neural network algorithm, utilizing a set of neurons to convolve on a given image and extract relevant features from them.

The application developed will be able to act as a diagnostic tool based on a CNN for the screening chest X-ray images of patients having Pneumonia. The Application utilizes transfer learning, which trains a neural network with a fraction of the data of conventional approaches.

II. LITERATURE SURVEY

Manali Shaha et al.[2] proposed Research in image classification seen the evolution in computer vision algorithm from first order moments to handcrafted features to end to end machine learning approaches to improve the classification accuracy.This paper talks about the success of CNN in the order of machine learning and computer vision field. Alex proposed an evolutionary CNN architecture named AlexNet for object recognition task. The major hurdle in training of CNN is availability of large database. To improve the accuracy researches proposed deeper CNN architecture. Simmon el al proposed VGG16 architecture for object recognition task. Improved VGG16 architecture known is VGG19 overcome the drawbacks of AlexNet and increase the system accuracy. Two databases calTech256 and GHIM10K where used to analyze and compare AlexNet and VGG16.SVM classifier was analyzed. Accuracy of CNN highly depends upon the three factors: 1) Large scale database, 2) High end computational model and 3) Network depth.

Shoji Kido[3] proposed Computer-aided diagnosis (CAD) systems include two types of CAD algorithms such as (CADe) and (CADx). CADe which is computer aided detection which detects abnormal lesion CADx which is computer aided diagnosis that differentiates abnormal lesion into benign or malignant. Image features that could detect and classify abnormalities of the lung diseases such as lung nodules or lung disease patterns. These image features are useful for the computer-aided classification on the lung diseases. Defining such image features is a difficult task due to the complicated image patterns. Deep learning techniques improved state-of-the-art in fields of the speech and vision. Therefore with the features of (CADe) and (R-

CNN) and CNN have developed an image based (CADe) for detection of lung abnormalities by use of (R-CNN).In image cases there are four cases: 1.Lung nodules. 2. Diffuse lung diseases. 3. Image based CADx by use of CNN. 4. Image based CADe by use of R-CNN.

Zulfikar Aslan [4] proposed that CNNs are designed to process data types that consist of the multiple dimensions as 2-d images. There is a hierarchy of simple and complex cells from the elements inspired from visual cortex of a human. RNNs are mainly developed for the task of analyzing discrete arrays of data. RNNs have structure of circular connected nodes. There are various imagining modalities in medical field & use of these technologies has increasing. There will be different images from the medical Imagining modalities .CNNs are generally used for tasks of classification, localization, detection, segmentation & registration over the medical image.

Enes Ayan [5] Proposed Pneumonia is inflammation of the tissues in one or both lungs that usually caused by a bacterial infection. Chest x-ray images are the best known and the common clinical method for diagnosing of pneumonia. Dataset represents the distribution of the data when training, validating and testing phases of the model. Data samples from the dataset show pneumonia cases and normal cases. Data argumentation avoids the over fitting and improves the accuracy. Transfer Learning is the idea of overcoming the isolated learning paradigm and utilizing knowledge acquired for task to solve. Data argumentation was used for avoiding over-fitting, xception and vgg16 networks accuracy and loss graphics. While training the model we used transfer learning and fine tuning. Every network has own detection capability on dataset. Xception network is more successful for detecting pneumonia cases.

Phat Nguyen Kieu [6] proposes Chest x-ray images or radiographs provide a single view of the chest cavity. Chest x-ray provides a complete view of the chest internals and thus can be used to detect easily. To extract the information for the task at hand without feature selection CNN is better to work with images. To support physicians in diagnosing disease in medicine and treatment of doctors. The results of their initial findings and compare performances of deep neural nets using a combination of different network topologies and optimization parameters. To predict the accuracy of the classification results of data multi-CNN model used Holdout method for evaluating. To compute the results we use multi-CNN model.V-64L and V-64R is used to know the probability value for the input images. To train the model CNN component are trained.

Emir Skejić et al. [7] Introduced Google TensorFlow is a platform for building models in machine learning. The basic unit in tensorflow is a computational graph, which consist of nodes, which are operations and edges which represent tensors. The core of tensorflow is implemented in C++ programming language; however the main language is python. Methods like (a) Convolution one of the use of convolution in image processing is edge detection. (b)Edge detection Edge detection is often the first step in image preprocessing, which uses two methods Image gradient and Canny filter. (c)Gaussian filtering This is often-used method for reducing Gaussian noise in image.other methods are Image resize, Image segmentation, Image deblurring and Image rotation. All experiments are performed on a single machine running 64bit linux or intel processors. (a) Smaller data size CPU (central processing unit) outperforms GPU (graphics processing unit) in most cases. (b) For bigger data GPU gave better performance. GPU efficiently handled all the bigger inputs with increase in speed size of 3.6 times to 15 times, but for smaller data computation is lower.

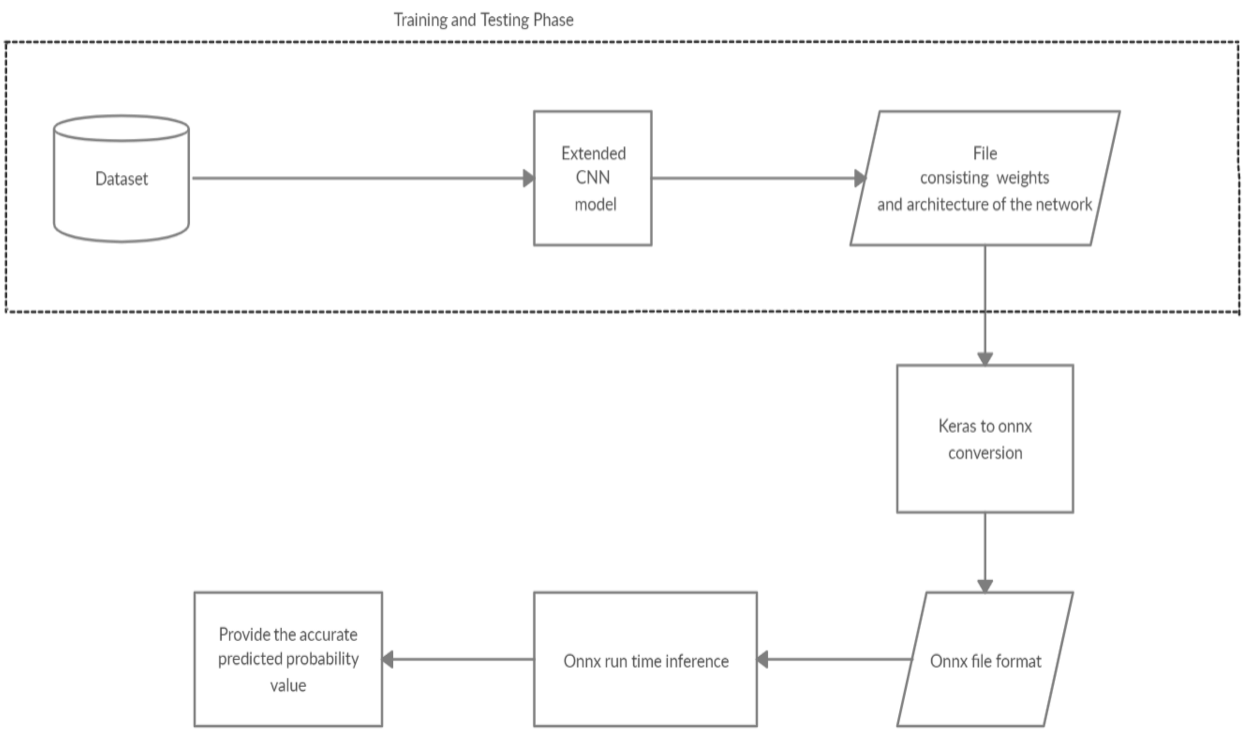
III. DESIGN AND IMPLEMENTATION

3.1 System Architecture:

The process begins with acquiring of the raw dataset from Kaggle proprietary websites. The dataset consisted of chest X-ray images having Pneumonia and not having Pneumonia.The dataset is devided into testing data ,training data and validation data.

In the next stage an image classification model is used. The image classification model used is VGG16.. To make the model to classify X-ray images an additional layer was constructed.This was done so that the model could classify chest X-ray images of a person.To achieve the Data agumentation which was needed to expand the dataset. of .The necessary methods were used to achieve this.Then the model was trained using the dataset.After the training the model the model weights and structure are saved in an file.The keras runtime is then converted to an onnx runtime that is the file is coverted into Onnx file format.An inference program is developed which performs the inference of an X-ray image.Finally as the end result the software that makes use of the above process must be able to predict the probability value of a person having Pneumonia.

Figure 1: Architecture of the Proposed System



3.2 Modules included in the system are:

1. Dataset.
2. Extended CNN model.
3. Model file containing weights and architecture.
4. Keras to Onnx conversion.
5. Onnx file format.
6. Onnx runtime Inference.

3.2.1 Dataset

Machine learning needs two things to work, data (lots of it) and models. Initially data is collected from Kaggle proprietary website.The dataset contains more than five thousand chest X-ray images.The dataset is devided into training data,testing data and validation data.The dataset contains both chest X-ray images having Pneumonia and Not having Pneumonia.

3.2.2 Extended CNN model

The Convolutional Neural Network VGG16 model is used.An CNN is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNets have the ability to learn these filters/characteristics.VGG16 was the model used. VGG16 is a convolutional neural network model proposed by K. Simonyan and A. Zisserman from the University of Oxford in the paper "Very Deep Convolutional Networks for Large-Scale Image Recognition".An additional layer was constructed and the model was extended by adding this layer. So,that it can classify chest X-ray images.20 epochs was done to train the model.

3.2.3 Model file containing weights and architecture

The model weights and architecture is saved in HDF5 format which stores the data in bianary format It stores huge amounts of numerical data, and easily manipulate that data from NumPy.

.**Keras to Onnx conversion:** keras-onnx converts models in ONNX format which can be then used to compute predictions with the backend of your choice. To automatically check every converter with onnxruntime, onnxruntime-gpu. Every converter is tested with this backend**.** keras-onnx converts models from scikit-learn. It was initially part of onnxmltools which can still be used to convert models.Using this the coversion was made to onnx runtime.

Onnx file format: ONNX defines a common set of operators - the building blocks of machine learning and deep learning models - and a common file format to enable AI developers to use models with a variety of frameworks, tools, runtimes, and compilers It defines a set of commonly used operators to compose models.The converted model is in this Onnx format.

Inference: Inference refers to the process of using a trained machine learning algorithm to make a prediction.A program is written which predicts the probability of a person having Pneumonia.This program makes use of the file in Onnx format.

3.2.4 Model Comparison and Result analysis

The dataset is divided into 77:21:2 for training,testing and validation.

Prediction: the output of an algorithm after it has been trained on a historical dataset and applied to new data when forecasting the likelihood of a particular outcome.

Accuracy: Accuracy is the fraction of predictions our model got right.
Accuracy=Number of correct predictions / Total number of prediction.

3.2.5 Predicting if a chest X-ray image has Pneumonia

The final step of the process is to detecting and predicting the probability value of a chest X-ray image containing Pneumonia.

When an image is given as the input to the inference part the prediction is made.

IV. TESTING AND RESULTS

Epoch 1/20

326/326 [==============================] - 139s 427ms/step - loss: 0.5189 - acc: 0.7122 - val_loss: 0.4455 - val_acc: 0.8045

Epoch 2/20

326/326 [==============================] - 128s 394ms/step - loss: 0.2658 - acc: 0.8903 - val_loss: 0.3159 - val_acc: 0.8734

Epoch 3/20

326/326 [==============================] - 127s 391ms/step - loss: 0.2257 - acc: 0.9133 - val_loss: 0.2717 - val_acc: 0.9006

Epoch 4/20

326/326 [==============================] - 127s 389ms/step - loss: 0.1917 - acc: 0.9260 - val_loss: 0.2520 - val_acc: 0.9151

Epoch 5/20

326/326 [==============================] - 126s 387ms/step - loss: 0.1559 - acc: 0.9427 - val_loss: 0.3211 - val_acc: 0.8958

Epoch 6/20

326/326 [==============================] - 129s 396ms/step - loss: 0.1527 - acc: 0.9427 - val_loss: 0.2767 - val_acc: 0.9054

Epoch 7/20

326/326 [==============================] - 128s 392ms/step - loss: 0.1400 - acc: 0.9490 - val_loss: 0.4195 - val_acc: 0.8606

Epoch 8/20

326/326 [==============================] - 128s 391ms/step - loss: 0.1213 - acc: 0.9561 - val_loss: 0.3335 - val_acc: 0.8878

Epoch 9/20

326/326 [==============================] - 129s 397ms/step - loss: 0.1252 - acc: 0.9557 - val_loss: 0.3191 - val_acc: 0.9006

Epoch 10/20

326/326 [==============================] - 130s 398ms/step - loss: 0.1145 - acc: 0.9588 - val_loss: 0.1846 - val_acc: 0.9343

Epoch 11/20

326/326 [==============================] - 126s 387ms/step - loss: 0.1081 - acc: 0.9626 - val_loss: 0.2682 - val_acc: 0.9199

Epoch 12/20

326/326 [==============================] - 125s 382ms/step - loss: 0.1114 - acc: 0.9620 - val_loss: 0.1834 - val_acc: 0.9359

Epoch 13/20

326/326 [==============================] - 125s 382ms/step - loss: 0.0994 - acc: 0.9661 - val_loss: 0.2374 - val_acc: 0.9135

Epoch 14/20

326/326 [==============================] - 126s 386ms/step - loss: 0.0955 - acc: 0.9651 - val_loss: 0.1909 - val_acc: 0.9343

Epoch 15/20

326/326 [==============================] - 124s 381ms/step - loss: 0.0897 - acc: 0.9695 - val_loss: 0.2092 - val_acc: 0.9327

Epoch 16/20

326/326 [==============================] - 125s 382ms/step - loss: 0.0905 - acc: 0.9701 - val_loss: 0.5864 - val_acc: 0.8221

Epoch 17/20

326/326 [==============================] - 124s 381ms/step - loss: 0.0827 - acc: 0.9716 - val_loss: 0.1865 - val_acc: 0.9375

Epoch 18/20

326/326 [==============================] - 125s 385ms/step - loss: 0.0812 - acc: 0.9722 - val_loss: 0.2007 - val_acc: 0.9311

Epoch 19/20

326/326 [==============================] - 124s 381ms/step - loss: 0.0764 - acc: 0.9728 - val_loss: 0.1947 - val_acc: 0.9263

Epoch 20/20

326/326 [==============================] - 123s 376ms/step - loss: 0.0787 - acc: 0.9728 - val_loss: 0.3909 - val_acc: 0.8878

Here acc represents the accuracy of the model from the training and testing the model has reached an accuracy of 88%

V. CONCLUSION

The accuracy obtained by training extended model was 88%. Therefore the best accuracy obtained. which is used in the final prediction of Pneumonia based on chest X-rays.

VI.FUTURE ENHANCEMENTS

In future this can be upgraded to predict other lung diseases based on chest X-ray images by improving and training the model with different lung diseases chest X-ray image dataset.

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