AWS MACHINE LEARNING ENGINEER NANODEGREE CAPSTONE PROPOSAL

PNEUMONIA DETECTION USING DEEP LEARNING

- POOJA SINGARI

1.DOMAIN BACKGROUND

A large number of medical malpractice lawsuits as well as degradation of a patient's conditions attribute to misdiagnosis which can not only prove fatal to a patient's life but also to a medical practitioner's career. It is very essential to make sure that any medical condition is judged correctly by analyzing the prevalent symptoms for effective treatment of the patient. The prevailing medical diseases call for the need of automated diagnosis which can be achieved with the help of Deep learning models based on computer vision achieved through supervised learning approach.
Accurate and early detection of diseases such as Pneumonia can help prevent further fatal complications and may moreover lead to recovery at an early stage at the cost of fewer consultations and medications.
The machine learning model not only poses as a solution for achieving accurate diagnosis for the patients but can also help the doctors receive an unbiased second opinion.

2.PROBLEM STATEMENT

"The need for an accurate model for prediction of pneumonia amongst the rising Covid-19 Pneumonia cases"
Through it's natural approach Pneumonia is in its self a dangerous disease which when contracted affects one or more sections of the patient's lungs and may lead to several complications like lung abscesses and sepsis depending on the stage at which the medical treatment has been administered.
Several tests may be used to confirm the diagnosis among which the few common ones are

- Chest X-ray : Pictures comprising of internal tissues, bones and lungs
- Blood tests : To confirm and affirm the spread and presence of infection in the patient's bloodstream
- Bronchoscopy : Direct examination of the bronchi to assess blockages and takes out samples of lung fluid for testing

For this project the main focus will be on the usage of chest-xrays to diagnose the patient as it helps in checking both bacterial and viral pneumonic conditions.
With the recent spread of Covid-19 the world has also witnessed the rise of Covid-19 pneumonia cases. This is a far threatening condition wherein the infection hijack's the lung's immune cells and damages certain vital organs including the kidney,brain,heart.
To help diagnose the condition an accurate machine learning model will be required to analyze as to whether or not a patient has contracted pneumonia in addition to being infected by Covid-19 virus. I propose to use a pre-trained convolutional neural network to achieve accurate results which is vital in the case proposed.

3.DATASET

This project will focus on diagnosing Pneumonia from a Chest X-ray dataset. As the main causes of pneumonia are either bacterial, viral or mycoplasmic, for this reason Kaggle's 'Chest X-ray Images' dataset will be used for this project as it's three subsections(train, test, validation) collectively house 5,863 x-rays further labelled as normal/pneumonia.

Category	Number of Images
Train	5216
Test	624
Validation	16

Fig 1:Dataset

For the purpose of this project only train and test sections will be sufficient in modelling a classifier as the number of images in the validation section is comparatively trivial and will not have much effect on the model.

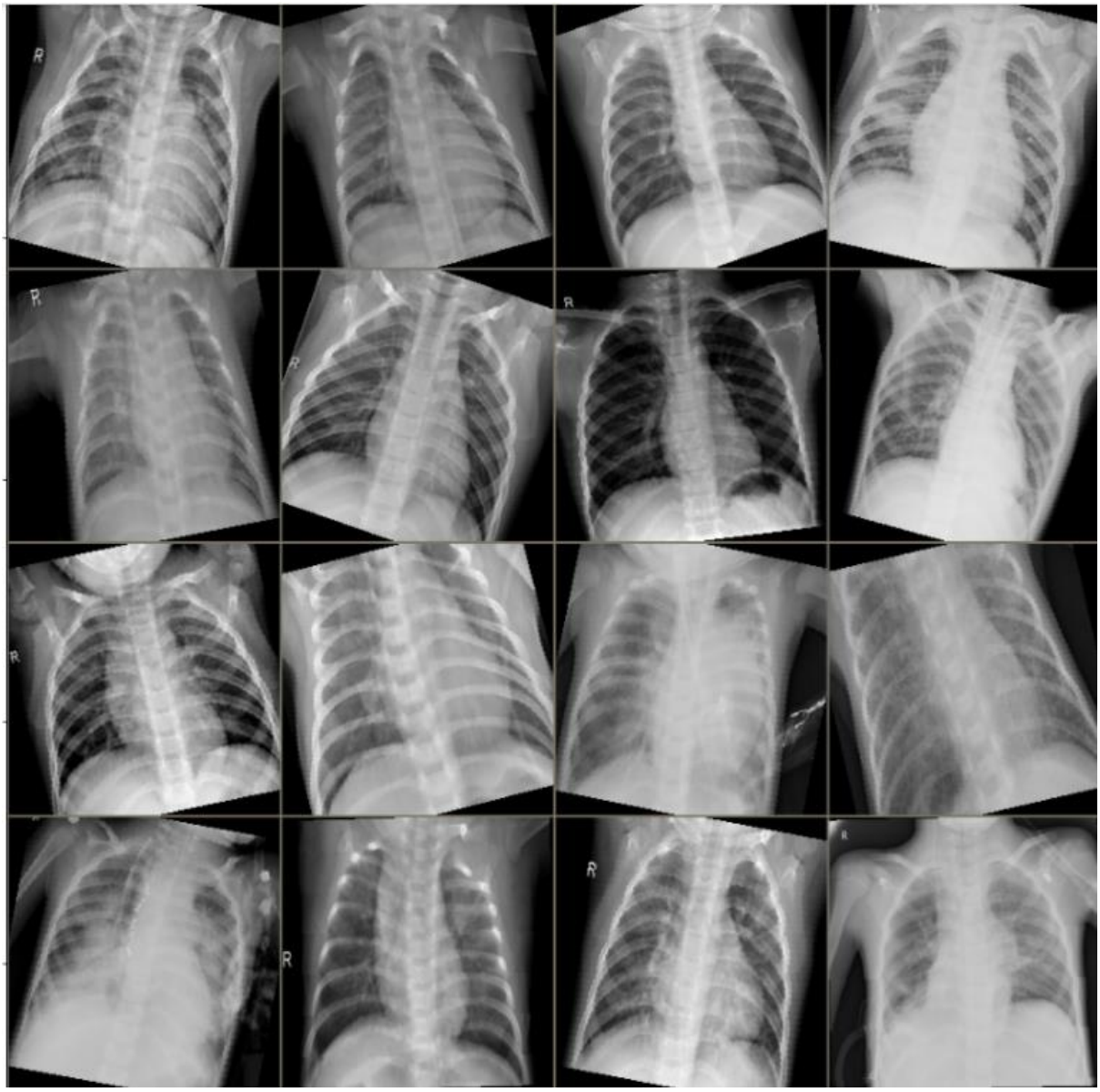

Fig 2: Overview of a subset of the dataset post-processing

4.SOLUTION STATEMENT

For the achievement of accurate results with reduced computational efforts I propose the use of a pre-trained Convolutional network, the most suitable one for this task being the 'efficientnet_b4'. The model has proven to achieve state-of-the-art-accuracy on Imagenet while being smaller and faster than the existing Convnet.
The concept of transfer learning will be implemented in this project as the pre-trained model will be used to extract the essential features from the images and further classify the images into two categories upon manual addition of fully connected layers.

5. BENCHMARK MODEL

Experiments have already been conducted to discover the best pre-trained model which gives the highest accuracy on medical datasets, specifically X-rays for automatic detection of Covid -19. Among the models, EfficientNetB4 achieved better performance with an accuracy of nearly 97%[1].
According to the paper[2], EfficientNet's scaling starts from a good baseline which rationale's it's success in predictive analysis and also contributes to its faster inference on the best existing ConvNet.Consequently, EfficientNetB4 will be used for this project as it is a good fit for the task.

6. EVALUTAION METRICS

Outcomes of the model can be cross-checked with the ground truth of the image and the predicted label along with the accuracy metric to validate the efficiency of the model. As we need to categorize the data into two classes, CrossEntropyLoss will be used as the loss function besides the Adam optimizer. Furthermore, using real-world images outside the test dataset will be an appropriate method to judge the competence of the model.

7. PROJECT DESIGN

This section focuses on the approach to design and fine-tune the model to fit the task at hand.

7.1 Preprocessing

EfficientNet has been trained on coloured('rgb') dataset specifiacally the Imagenet dataset and expects their inputs to be tensors of pixels with values in the range of [0-255] range. For this reason all the data will be resized into (224,224) so that essential features can be extracted for further processing.
The pre-processing includes visualizing the images in each subsection of the dataset to ensure no data leakage occurs. Techniques to be used include permuting the images and finding their mean and standard deviation after which the images will be clipped ,rotated ,resized, and squeezed into a proper normalized tensor to ensure that the model is given the right input.
The major challenge involved in using a x-rays as input to a pre-trained model is to tackle the inherent grayscale issue. X-rays are innately grayscale and have a one-channel input as opposed to coloured images which have a shape of [3,224,224] which in fact is the broadcasting shape of the model. All the images have to be transformed into 'rgb' either by using the transforms library repeating the input channel three times or by

adding an initial layer to the pre-trained model to accept inputs having one channel. This project uses the former approach due to its simplistic operation and bound to succeed method.

7.1 Transfer Learning and Finetuning

A fully connected layer along with dropout and ReLU activation functions will be added to the pre-trained model.A simplified overview of the architecture is shown below in perspective of the design flow.

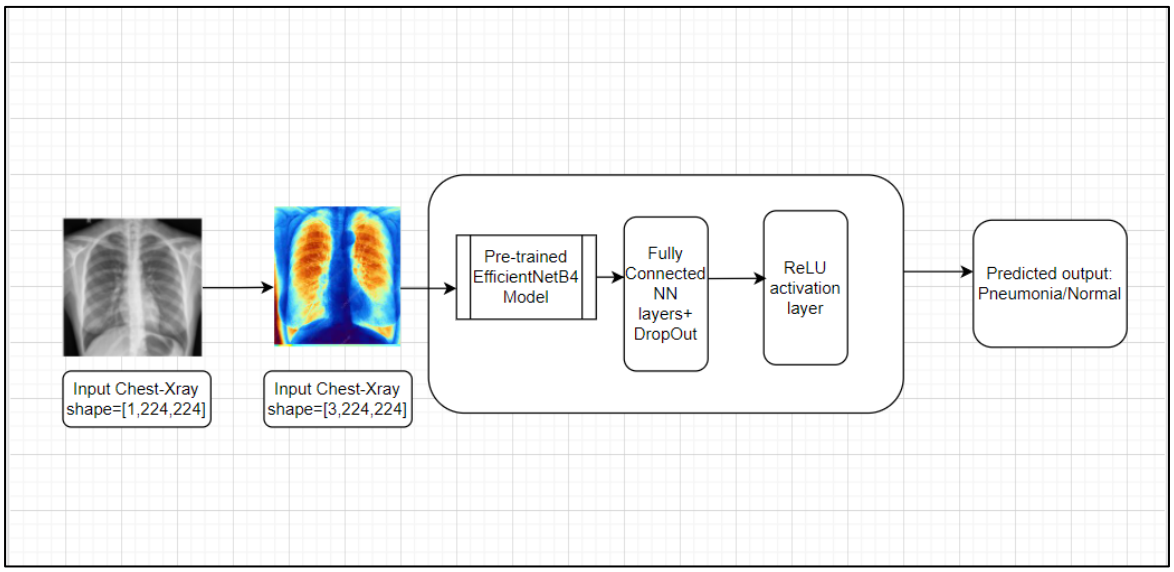

Fig 3: Simplified design of fine-tuning EfficientNetB4 model

Finetuning can be achieved by trial and error of the various number or neurons to be included in each layer apart from the experimentation with the dropout and activation function. Tuner can be used to find the right learning rate and batch-size to achieve optimum results through several iterations of different combinational ranges.

8. REFERENCES

[1] Pre-trained deep learning models in automatic COVID-19 diagnosis(Ahmed Wasif Reza)

[2] EfficientNet: Rethinking Model Scaling for Convolutional Neural Networks