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Research article

# Classification of healthy and affected lungs by pneumonia disease from x-ray images of lungs and gene sequencing using inception model

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## ABSTRACT

This project is entitled to predict the lung disease using chest x-rays by deep learning technique. Lung disease is a term that refers to improper functioning of lungs. There are many diseases which occur due to the abnormal functioning of lungs. It includes tuberculosis, pneumonia, lung cancer, asthma. The infection can be bacterial, viral or fungal. It causes inflammation of trachea and respiratory failure. If found earlier it can be cured else it can even lead to death. This project classifies the normal and abnormal x-ray with a percentage of accuracy so that we can give the treatment to the patient accordingly by seeing the x-ray. Algorithms used are Convolutional Neural Network (CNN) and Inception Neural Network (INN) and Tensor Flow which is Google open source algorithm. The project is helpful for finding lung disease using chest x-ray.

**Keywords:** Convolutional neural networks, Inspectional v3 model, Inspectional neural network, Trachea, Pneumonia, Bronchitis**.**

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## INTRODUCTION

Lung Disease refers to any disorder or disease in which the lungs do not function properly. Most breathing problems cause major lung disease. There are nearly 32 types of lung diseases such as Asthma, Bronchitis, Chronic disorder, Influenza, Pneumonia, etc. Lung Disease is the 3rd most leading killer in the world. In our India approximately eight people die in a day, out of eight at least one of them die in fond of lung disease, and are the leading cause of death among infants under the age of one. Early identification of this disease allows the patients to prevent the later impacts or consequences of it. For identifying whether the lungs are normal or abnormal, we used inception v3 model, which is mainly used to classify the images by image classification algorithm called Convolutional Neural Network (CNN), Inception Neural Network (INN).

Convolutional neural networks are mainly used for image classification in deep learning techniques. It mainly consists of layers and filters on each layer. The convolutional neural network consists of three layers namely convolutional layer, pooling layer and fully joined layer. The filters on these layers are specific to the classification. In this project we compare the infectious lungs x-ray image with the normal lungs x-ray image. The metaphors container be filtered founded on the tint of walls of lungs. The lungs affected by some disease like pneumonia, bronchitis, coronavirus and by other viruses or bacteria will differ in color from the normal healthy lungs. The filter has to be set in such a way that it recognizes the lungs wall in the image which is given for training. The pooling layer can be classified into two type's namely average pooling layer which selects average number of filtered elements and max pooling layer which selects maximum number of filtered elements.

When the identification is made in the earlier stage of the infection the treatment to this disease can be taken over and the possibility of lung failure can be reduced. Moreover, using the two models namely convolutional neural network and inception neural network will result in the increase of the accuracy percentage of the identification of lungs affected by viral or bacterial disease. To avoid the prediction error, it is always important to train the model with appropriate algorithms which return the highest accuracy rate.

By referring to the existing systems and the number of studies on the lungs disease and the convolutional neural network as well as the inception model the code has been developed for this project. This project has been further extended in the future for the identification of infected organs by using scan images as the dataset. Once those scan images have been given as the input there is a possibility for finding the infected organs out of the healthy one.

## LITERATURE SURVEY

Hu suggested the principle for algebraic entropy in 1962, perhaps stemming from the famous German mathematician David Hilbert [1], and was extensively studied. Moment invariants were first applied to the community for problem solving, which used the

results of algebraic invariants and, subsequently, his seven renowned invariants to 2-D object rotation. Image dispensation systems can be considered as encoding at a low level where we provide data as an image and the output is still an image and involves elimination of noise and sharpening of images. Generation of the intermediate equal duplicate where image is a participation but output would be feature processes such as identification of objects, segmentation.

A general method for territorial identification was established by Uppal Uri et al [8], using small areas which are categorized into six categories on the basis of 15 statistical and fractal texture features. Radiologists need to identify the two lungs when analyzing the X-ray picture and then uncover any possible anomalies. Using certain diagnostic imaging approaches such as radiology, CT or positron emission tomography, CAD systems are generally specialized in anatomical regions including the thorax, breast, or colon (MRI).

In order to solve the DFR problem, including time intervals, Kim Ko and Jung suggested a new approach based on neural networks. Computed tomography (CT) is more effective than X-ray, and is more usable in general. Thus, the initial diagnosis of TB and lung cancer, now carried out by medical doctors, is based largely on X-ray images of the chest [7].

Two approaches were discussed by Cui, F.-y and Zou [3]. The first is a wavelet transformation used to extract noises from the gathered image and the second is analyzed by certain edge detection operators such as Differential edge detection, Log edge detection, canny edge detection, and Binary morphology. And then, the benefits and drawbacks of these edge detection operators are compared according to the simulation outcomes. The Binary morphology operator is shown to be able to obtain better edge characteristics. Finally, the method of bordering closed was provided in order to obtain a simple and integral image profile.

In his paper "Image information retrieval: an overview of current research"[4], Abby A. Goodrum focuses on three aspects of image research (IR): text-based retrieval, content- based retrieval and user experiences with image information retrieval systems. The methodology is broad and interdisciplinary [6].

A. D. and Jain. Zongker dominates the other algorithms evaluated in his paper entitled "Feature Selection: Evaluation, Application, and Small Sample Performance"[14] proposed by Pudil et al. We are studying the problem of using four separate texture models to choose an appropriate feature set for land use classification based on SAR satellite images [5]. Pooling features derived from various texture models, accompanied by a range of features, results in a major increase in the accuracy of classification.

## MATERIALS A ND METHODS

### Convolutional Neural Network (CNN)

A particular type of feed-forward artificial neural network influenced by the visual cortex is the Coevolutionary Neural Network. The visual cortex is little more than a tiny area that is sensitive to particular areas of the visual field in our brain, helping us to identify things viewed by us [8]. In the Coevolutionary Neural Network, the neuron in a layer will be connected only to a small region of the layer before it, instead of all the neurons;[15] in a fully connected way as used in Fully Connected Networks. The following layers are compatible with CNN that is the convolution layer, the pooling layer, the ReLU [16] layer, and lastly the Completely Linked layer.

The convolutional neural network consists of three layers in which each layer has filters which are specific to it. The pooling layer will get its input from the previous convolution layer. There are two types of pooling layers namely max pooling [17] and average pooling. The max pooling layer selects the maximum elements in the areas covered by the filter whereas the average pooling layer selects only the average number of elements in the area covered by the filter. The output from the pooling layer is passed as the input to the next layer called fully connected neural layer [10]. After going through all the filters in each layer the input image from the dataset will get classified based on the specification of the filter. Once the machine gets trained for the input dataset the newly incoming images can be classified easily by the model with high accuracy [11].

### Inception V3 Model

Inception models contains two important parts: the fully extracted part of convolutional networks and the classified part of fully connected networks. In the first part, the typical features of images are extracted from the input, while in the rest, images are classified based on their features. Early v3 models are pre-trained deep learning models that achieve state-of-the-art precision in identifying general objects [12]. It contains many layers and many networks, at each layer, features are extracted and stored for classification.

### Proposed Model

The whole algorithm accepts a Kera's object classifier model, which can be loaded with post ImageNet weights if desired. For concise examples of image classification use cases, see this research. Be sure to read the guide to transfer learning and fine-tuning for transfer learning use cases [13]. Recognize that each Kera's Application needs a different type of input preprocessing. Call tf. Kera's applications for InceptionV3.Until forwarding the inputs to the model, use inception v3. Preprocess input. Input pixels will be scaled between -1 and 1 by inception v3. Preprocess input.

**Figure 1:** Showing CNN Architecture with improvised Max-pool Layers

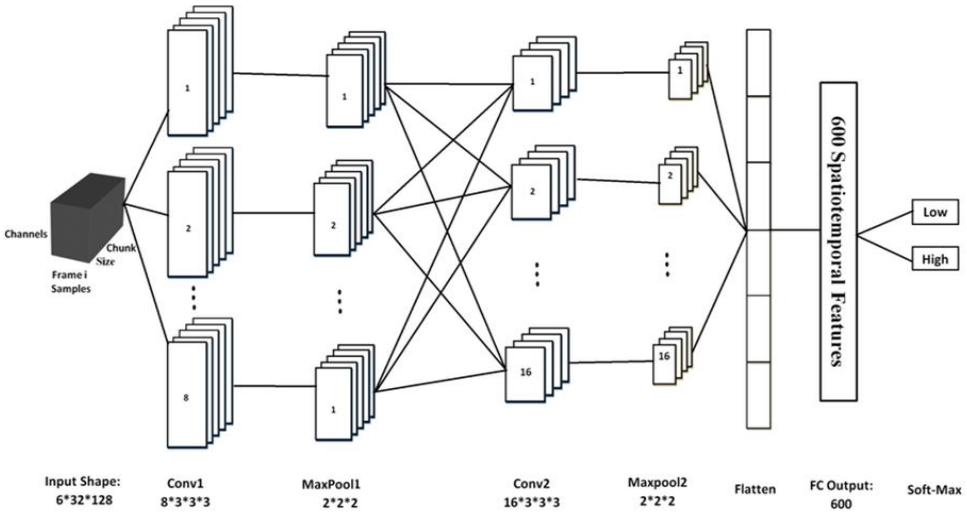
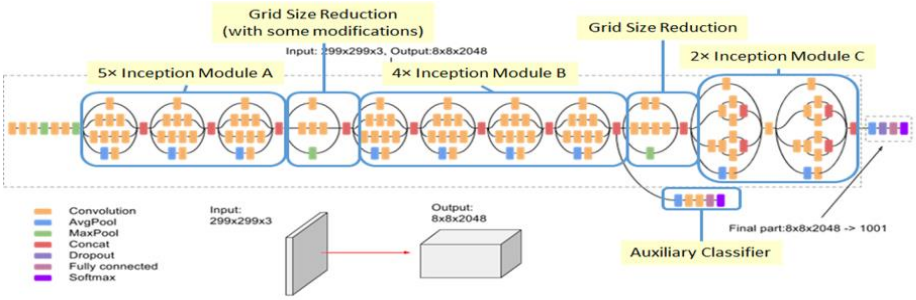



**Figure 2:** Showing the Model of the Proposed Inception V3 Model



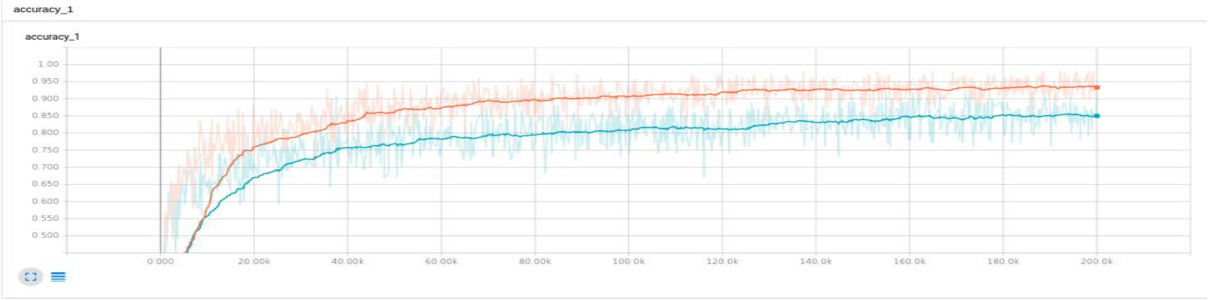

## RESULTS AND DISCUSSIONS

The innovative and split image organization truths. The initial photos of reactive lymphoid hyperplasia, NHL, SCC, and adenocarcinoma had classification accuracies of 88.46 percent, 80.77 percent, 89.29 percent, and 100 percent, respectively. On the test dataset, the overall accuracy was 99.62 percent. The uncertainty medium of the organization results is shown in Table 4, and Cohen' kappa was used to measure the agreement between cytopathologic and DCNN which was 0.8620. 077. Three disjointed imageries of RDH and three split descriptions of SCCs were incorrectly labelled as NHLs. We dug deeper into the untreatable photos to figure out why they failed. The disjointed images of sensitive lymphoid hyperplasia that were misdiagnosed as NHL are shown in Figure 3.

**Table 1:** Accuracy Results of Genes Sequencing with Lung CT scans

| | Classification with topology indices | | | Classification with gene methylation | | |
|---|---|---|---|---|---|---|
| Cancer | Accuracy | Specificity | Sensitivity | Accuracy | Specificity | Sensitivity |
| BLCA | 95.89% | 77.77% | 99.19% | 95.95% | 66.66% | 98.38% |
| BRCA | 96.96% | 91.87% | 98.11% | 97.82% | 87.67% | 98.96% |
| COAD | 99.30% | 94.73% | 100.00% | 99.33% | 94.73% | 100.00% |
| HNSC | 96.70% | 85.57% | 98.69% | 98.60% | 92.27% | 99.36% |
| KIRC | 98.63% | 98.75% | 98.92% | 98.90% | 98.62% | 98.14% |
| KIRP | 99.17% | 97.72% | 100.00% | 96.03% | 95.89% | 95.80% |
| LUAD | 99.43% | 93.75% | 99.01% | 99.39% | 93.72% | 100.00% |
| PRAD | 90.40% | 71.58% | 89.65% | 92.58% | 85.12% | 94.76% |
| THCA | 93.12% | 70.03% | 96.60% | 94.33% | 71.90% | 97.40% |
| UCEC | 98.62% | 91.67% | 99.10% | 99.20% | 91.67% | 100.00% |

**Figure 3:** Showing the Accuracy of the Inception V3 Model With comparison of CNN architecture

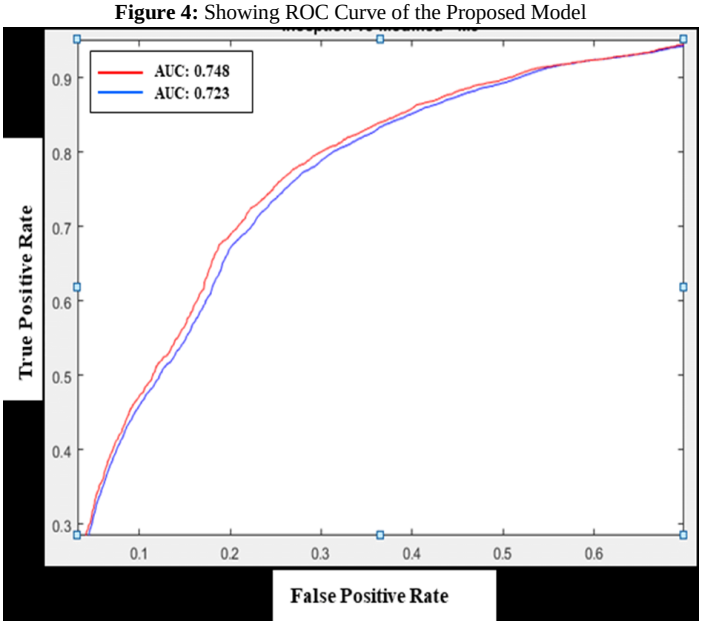


**Proof of concept**

**POC Architecture**

In the proposed model, more than 4,000 images were provided for training purposes. The model uses convolutional neural networks to extract many features for each image. For each feature, a matrix of vector values was assigned. While passing through the model, the matrix values decrease and finally a series of values remain. The model stored array values for all tagged images. Given an unknown image, we apply the same method to extract the features and then compare the extracted features with the stored features of the training image using a fully connected network. Results are displayed based on accuracy. This model has the highest accuracy of 92.57% so far.

**Figure 4:** Showing ROC Curve of the Proposed Model




The user's input image is being entered into the model. After classification, the image is displayed in a separate window with the corresponding results.

**POC Design**

For more user-friendly purposes, a graphical user interface has been developed to include images in the model. The model can run on multiple images as well as a single image, allowing users to clearly identify diseases in a single plant using many images of a particular plant from different angles.

This GUI was developed using Python packages such as Tkinter and Bellow. Images containing classification results are displayed in a separate window, improving efficiency.

## RESULT

With the help of the proposed model with 92.57% prediction accuracy, users can easily detect lung images and classify them as normal or abnormal, helping patients receive treatment in advance.

**Table 2:** Accuracy Results of Genes Sequencing with Lung CT

| type | patch size/ stride | output size | depth | #1×1 | #3×3 reduce | #3×3 | #5×5 reduce | #5×5 | pool proj | params | ops |
|---|---|---|---|---|---|---|---|---|---|---|---|
| convolution | 7×7/2 | 112×112×64 | 1 | | | | | | | 2.7K | 34M |
| max pool | 3×3/2 | 56×56×64 | 0 | | | | | | | | |
| convolution | 3×3/1 | 56×56×192 | 2 | | 64 | 192 | | | | 112K | 360M |
| max pool | 3×3/2 | 28×28×192 | 0 | | | | | | | | |
| inception (3a) | | 28×28×256 | 2 | 64 | 96 | 128 | 16 | 32 | 32 | 159K | 128M |
| inception (3b) | | 28×28×480 | 2 | 128 | 128 | 192 | 32 | 96 | 64 | 380K | 304M |
| max pool | 3×3/2 | 14×14×480 | 0 | | | | | | | | |
| inception (4a) | | 14×14×512 | 2 | 192 | 96 | 208 | 16 | 48 | 64 | 364K | 73M |
| inception (4b) | | 14×14×512 | 2 | 160 | 112 | 224 | 24 | 64 | 64 | 437K | 88M |
| inception (4c) | | 14×14×512 | 2 | 128 | 128 | 256 | 24 | 64 | 64 | 463K | 100M |
| inception (4d) | | 14×14×528 | 2 | 112 | 144 | 288 | 32 | 64 | 64 | 580K | 119M |
| inception (4e) | | 14×14×832 | 2 | 256 | 160 | 320 | 32 | 128 | 128 | 840K | 170M |
| max pool | 3×3/2 | 7×7×832 | 0 | | | | | | | | |
| inception (5a) | | 7×7×832 | 2 | 256 | 160 | 320 | 32 | 128 | 128 | 1072K | 54M |
| inception (5b) | | 7×7×1024 | 2 | 384 | 192 | 384 | 48 | 128 | 128 | 1388K | 71M |
| avg pool | 7×7/1 | 1×1×1024 | 0 | | | | | | | | |
| dropout (40%) | | 1×1×1024 | 0 | | | | | | | | |
| linear | | 1×1×1000 | 1 | | | | | | | 1000K | 1M |
| softmax | | 1×1×1000 | 0 | | | | | | | | |

## CONCLUSION AND FUTURE WORK

With the help of the proposed model with 92.57% prediction accuracy, users can easily detect lung images and classify them as normal or abnormal, helping patients receive treatment in advance. This helps the doctors to give the treatment accordingly to the patient by seeing its severity. The model is not only developed for identifying lung disease but it also can identify the other normal or abnormal images by training their dataset which could possibly affect human organs. The project can be enhanced to classify all possible diseases for all parts of the human body. Implementing this model will provide a better life for people with diseases. Implementing this model makes it easy for users to identify and perform the necessary steps if the disease is mild.

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