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Classification of medical images of patients with Covid-19 using transfer learning technology of convolutional neural network

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Abstract. The paper shows an approach to solving the problem of classifying X-ray images of the chest part of a healthy person and with the presence of COVID-19. The method is a trainable convolutional neural network. The results obtained allow improving existing approaches and methods in the field of classification of medical images with COVID-19, as well as obtaining an auxiliary mechanism for detecting COVID-19 in patients.

1. Introduction

Diagnosis of COVID-19 patients is usually associated with pneumonia and chest x-ray [1]. Chest X-ray is one of the main methods for diagnosing COVID-19 disease. Figure 1 below is an example of an x-ray image of a patient with COVID-19.

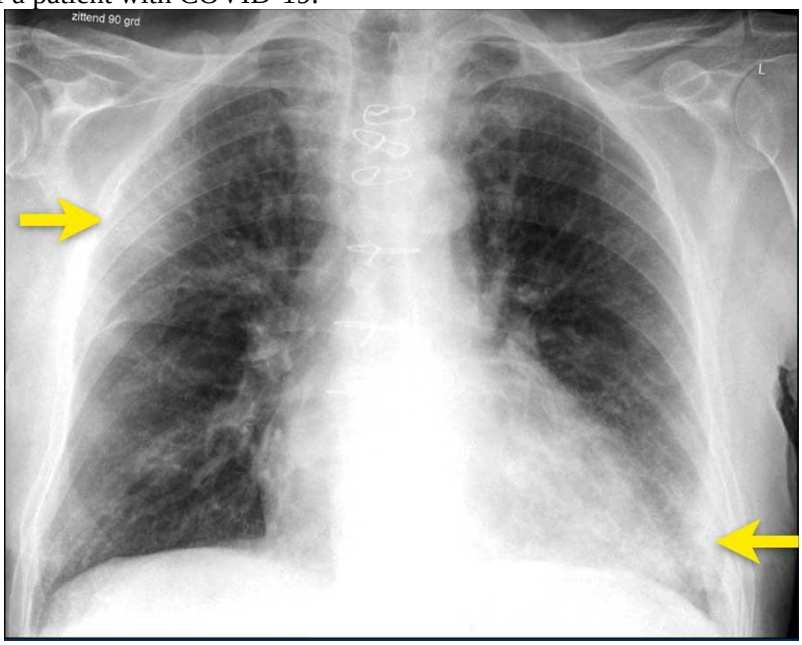

Figure 1. Chest X-ray of a COVID-19 Patient [2].

There are a number of classical machine learning methods that were previously used to automatically classify medical images [3-7]. For example, in [4], three static features were calculated from texture to distinguish between benign and malignant nodules in the lungs using SVM support vector machines. The methods [6-7] are based on the use of CNN convolutional neural networks with pre-trained models built on the Xception architecture. The main idea behind using pretrained convolutional neural networks is to transfer previously learned "knowledge" from pretraining. This method is faster and more practical to use without the need to use a huge set of annotated data for training, so many research scientists tend to use this approach to solve classification problems.

2. Materials and methods

In this paper, we use the transfer learning approach of a convolutional neural network. Transfer learning can be implemented according to three scenarios [9]:

1. "Shallow adjustment", adapting only the last classification layer to cope with the new task and freezes the parameters of other layers without further training
2. "Deep tuning", aimed at a complete retraining of all parameters of the previously trained network from start to finish.
3. "Fine tuning", focused on the iterative process of training more layers, adjusting the training parameters to the maximum quality of training the model.

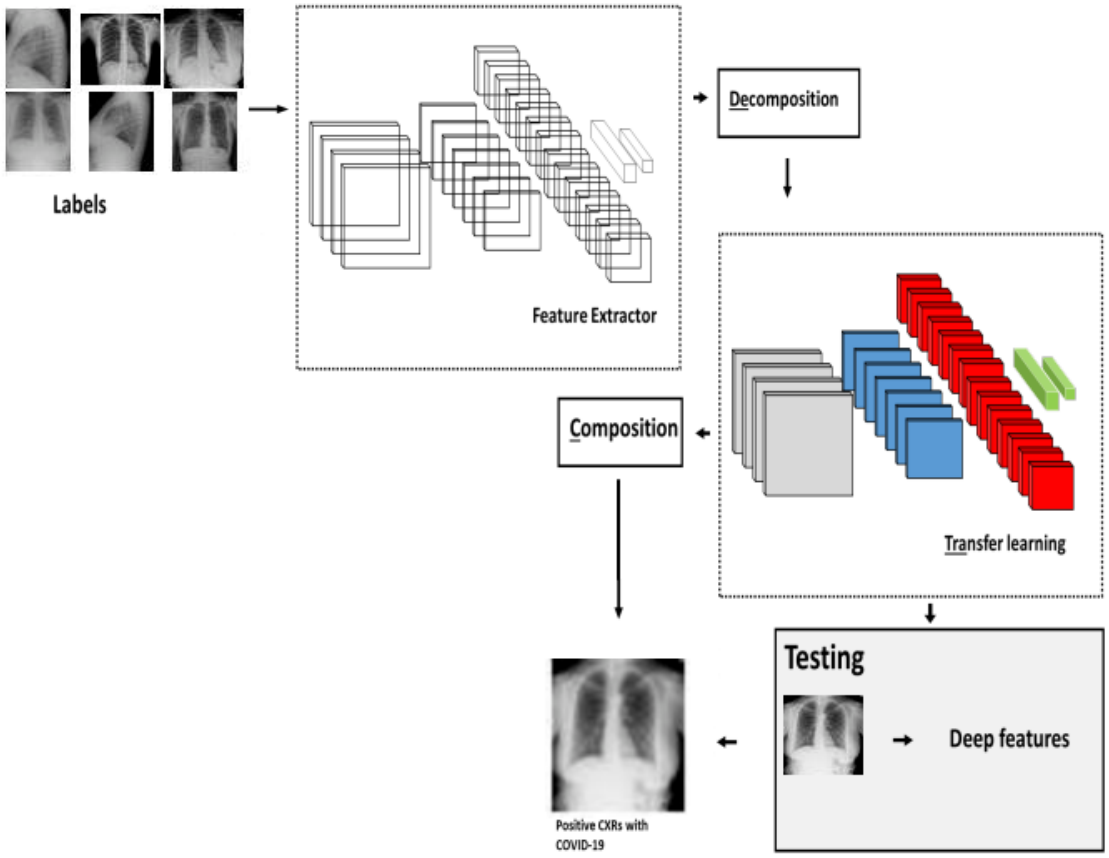

Figure 2. Schematic diagram of a neural network model with transfer learning.

To train the neural network, a set of X-ray images of the human thoracic part of the Indiana university bloomington dataset was used [10].

The transfer learning model has three stages. In the first step, we train a basic pre-used trained neural model [8] to extract deep local features from each image. Next, we apply a class decomposition layer to simplify the local data distribution structure. The second stage of training is to apply gradient

descent and the third stage, we use the class composition level of the transfer model to refine the final classification of the images. Figure 2 below shows that class decomposition and composition components are added, respectively, before and after the transformation of features from a pretrained model [8]. A decomposition step aimed at dividing each class in the image dataset into k subclasses, where each subclass is handled independently. These subclasses are then reassembled using the class composition component to produce the final classification of the original image dataset [10].

3. Conclusion

Convolutional neural networks provide an effective solution for detecting COVID-19 cases in medical images, this approach can help to combat the spread of COVID-19, which in turn is one of the most pressing problems of 2020. When testing this method, classifications of medical images with COVID-19 achieved an accuracy of 94.17% using a pre-trained model [8] on a dataset [10]. This method has demonstrated reliability under conditions of insufficient training sample size, uneven distribution of data between classes.

Further work is aimed at improving the quality of model learning and improving the learning approach. Also considered is the option of improving the method for detecting the classification of positive COVID-19 results in images.

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