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Diagnosis and Detection of COVID-19 from Lung Tomography Images Using Deep Learning and Machine Learning Methods

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Abstract: Coronavirus (COVID-19) is an epidemic disease that spreads all over the world in a very short time and has fatal consequences. Such infectious diseases must be correctly detected without harming people or with minimal harm, and the necessary treatment must be initiated early. At this point, traditional treatment methods applied by doctors may be insufficient or diagnosis and treatment may be delayed. Therefore, Artificial Intelligence (AI) and Machine Learning (ML) techniques that are widely used in many areas and effective in solving complex problems come to the fore, to obtain a more effective and successful treatment in these situations. This study aimed to diagnose and detect the COVID-19 image from different lung tomography images (COVID-19, viral pneumonia, bacterial pneumonia, and normal) with AI and ML techniques. In this context, it was used the K-Nearest Neighbor (KNN) method, which is an ML algorithm, and Convolutional Neural Networks (CNN) and Deep Neural Networks (DNN) deep learning approaches are among the current techniques of AI. In addition, the results were tested by creating models with combinations of different optimization and activation functions and neuron numbers in the CNN method. Thus, the application potential of CNN, DNN, and KNN methods in image recognition and classification was seen and the success of the proposed model was demonstrated with the obtained findings.

Keywords: *Deep Learning, Machine Learning, CNN, DNN, KNN, COVID-19, Tomography, Artificial Intelligence*

1. Introduction

COVID-19 is a serious epidemic disease that emerged in Wuhan, China in December 2019, passed from bats to humans, spread all over the world and turned into a pandemic, and collapsed the health systems of many countries. Severe acute respiratory syndrome COVID-19 causes significant respiratory failure in the infected creatures and fatal consequences are encountered if the disease progresses. The most obvious symptoms and signs of infection are known as fever, dry cough, sore throat, headache, weakness, muscle pain, diarrhea, and shortness of breath. In more advanced cases, it causes severe pneumonia and as a result, it causes inflammation in the lungs due to oxygen differences, and multiple organ failure. Especially this disease has more dangerous and corrosive effects on those with chronic diseases, those with weak resistance or immune system, smokers, and the elderly [1-4].

COVID-19 is usually transmitted by physical contact with people who have the virus, such as through breath, hand, or mucosal contact [5]. Antibiotics, malaria medication, antipyretic, cough medicine, and painkillers are generally used in the treatment of the disease. It is decided to hospitalize the infected patient according to the disease level, complaints, and severity [3,4]. Worldwide, the number of patients with the COVID-19 virus is increasing day by day. Even strong countries such as the USA, Italy, and Spain could not protect themselves sufficiently and were greatly affected by this virus. In the light of all this information, early diagnosis of the disease is of great importance to prevent the pandemic completely or at least to minimize the possible damage of the virus, taking into account the health system. At least suspicious cases should be detected accurately and quickly with low error [6].

Nowadays, a real-time reverse transcription-polymerase chain reaction (RT-PCR) technique is widely used for the diagnosis of COVID-19. Chest radiological imaging methods such as Computed Tomography (CT) and X-ray are preferred to diagnose COVID-19 in the early stages. Radiological images obtained from COVID-19 cases contain useful information for diagnosis [1]. The rapid spread of the COVID-19 disease and the increase in mortality rates in many countries reveal that an effective treatment method should be developed. Therefore, control of the disease becomes mandatory, including diagnosis, early quarantine, and follow-up. Studies show that remarkable results have been obtained regarding the early and automatic detection of the disease by using x-ray scans. At this point, AI is among the current methods that will contribute to the above perspectives [7]. With a serious shortage of experts, the AI-powered auto-sensing model could be an important milestone towards significantly reducing test time while it has great COVID-19 similarities with traditional pneumonia [8]. AI-based solutions that are effective in solving complex problems offer both a lower cost and a more accurate diagnosis-treatment opportunity for COVID-19 and similar diseases. It can be detected diseases such as COVID-19 using AI technique, early identified and predicted the infected areas with high accuracy. Today, especially in the medical field, successful results are obtained by using image datasets such as retinal imaging, chest x-ray, brain MRI and deep learning techniques [2,9]. Deep learning and ML techniques are used in many applications to extract patterns from data and analyse and recognize them. Deep learning is a learning method that has the capabilities of automatically extracting and

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classifying features using image data. Each layer involves transforming the data to a higher and more abstract level. This method is used in several tasks such as medical image detection, classification, clustering, and segmentation [7,10]. In this sense, deep learning has been able to show high performance by using large datasets and powerful graphic processing units in many applications such as computer vision, speech recognition, and robotic control. In addition, this method is highly effective in both the estimation and analysis of complex problems [11].

In this context, it was aimed to diagnose and detect COVID-19 patients among lung tomography images with four different conditions (COVID-19, viral pneumonia, bacterial pneumonia, and normal) by using CNN, DNN, and KNN algorithms which are widely utilized today. It includes the literature review in the second part of the study, the details of the material and method in the third part, the experimental results and discussion in the fourth part, and finally the conclusions and recommendations obtained from the study in the last part.

2. Literature Review

Many studies have been conducted in the literature using AI techniques to diagnose and detect with COVID-19 virus. For example, in a study realized by Ozturk et al., COVID-19 detection was made from X-Ray images using DNN. The dual classification model for COVID-19 detection using radiological imaging and AI techniques has been developed to make the correct diagnosis. The created model has achieved 98.08% success for dual classes and 87.02% for multi-class situations [1].

Khan et al. (2020) utilized a total of 3084 chest images, including COVID-19 (290), Normal (1203), Bacteria Pneumonia (660), and Viral Pneumonia (931), for the detection of COVID-19 disease. COVID-19 disease detection and four classifications were made using the CNN model CoreNet as a method. It provided 89.6% general accuracy and 95% accuracy was obtained for 3-class classification (COVID-19, Pneumonia, Normal) using the CoreNet model. It has been stated that the performance of the model will be improved by obtaining more training data [9].

Togacar et al. reconstructed data classes on X-ray images using deep learning models. They achieved an accuracy rate of 99.27% for COVID-19 detection with optimization and chest X-ray images and stacking approaches using blurred colors. They concluded that the proposed model could be used effectively in the detection of the said virus [5].

Ioannis et al. detected COVID-19 disease with CNN among the deep learning method using 3905 X-Ray images of seven classes. The general classification accuracy of the seven classes was 87.66% and 99.18% Accuracy, 97.36% Sensitivity, and, 99.42% Specificity-Specificity in the detection of COVID-19. As a result of the study, they revealed that the deep learning approach was effective in the success of the model [7].

Salman et al. realized a study on the detection of COVID-19 disease using the AI technique. In their study, they created a dataset of 260 X-Ray images obtained from "Kaggle" and "GitHub" sources. A model based on CNN was created by using the images of COVID-19, MERS, SARS, ARDS, and Normal X-Ray. This model determined whether there is a COVID-19 virus (healthy or unhealthy), and an accuracy rate of 100% was obtained [12].

In the study realized by Jaiswal et al., it was used DenseNet201-based deep transfer learning to classify patients infected with COVID-19. DenseNet201-based deep transfer learning (DTL) was proposed to classify patients as infected with COVID. The proposed model revealed that DenseNet201-based CNN performed significantly with an accuracy rate of 97%, outputting either COVID-19 (positive) or COVID-19 (negative) [13].

In a study conducted in Iran on the detection of COVID-19 by Rahimzadeh et al., a new dataset containing 48260 CT (tomography) scan images was used. Image classification with ResNet50V2, a 50-layer network trained on the ImageNet dataset achieved 98.49% accuracy in CT scanning [14].

Nour et al. utilized CNN and Bayes optimization algorithms by using X-ray images in their study for the detection of COVID-19 infection. As a result, the most efficient findings were provided by the Support Vector Machine, and the classifier was 96.72% with 98.97% accuracy, 89.39% sensitivity, 99.75% specificity, and an F score. Thus, an inexpensive, fast, and reliable AI application was provided for COVID-19 [15].

Pathak et al. realized COVID-19 detection from computed tomography images based on deep transfer learning. The proposed model provided training and testing accuracy of up to 96.22% and 93.01%, respectively. Considering these results, it was revealed that the proposed model can be used as an alternative for COVID-19 test kits [16].

Rahimzadeh and Attar used 11302 X-Ray images to detect COVID-19 disease and Xception and ResNet50V2 models were used in their study. The average accuracy of the proposed network for detecting COVID-19 cases was found to be 99.50%, and the overall average accuracy for all classes was 91.4%. They stated that the model they proposed would be a very helpful tool for medical diagnosis. They also think that by using more COVID-19 patient data, the accuracy of the model will increase [17].

Li et al. detected the coronavirus infection by using the detection neural network (CovNet) and chest images. With the model used, an accuracy of 95% was achieved by training 3322 patients with 4357 chest images. As a result, they showed that an ML approach using the deep learning model and the CNN model was the ability to differentiate COVID-19 [18].

Sen et al.(2021) used a two-modular hybrid model of dragonfly and support vector machines in their study on Covid19. In the first module, a Convolutional Neural Network (CNN) architecture was used to extract features from chest CT images. In the second module, they proposed a two-step feature selection (FS) approach to find the most appropriate features for the prediction of COVID and non-COVID cases (SVM) from chest CT images. The proposed model has been tested on two open-access datasets. Significant prediction rates of 98% and 90% were found in the data sets in question, respectively [19].

A statistical approach based on artificial intelligence has been developed to predict the survival chances of people infected with a corona in South Korea. The model calibrated in the study is based on cases of positive corona infection and provides an analysis of different aspects that have proven to be effective for investigating deceased cases, as well as analyzing the temporal trends in the current situation. LR, ANN, and SVM algorithms were used in the study. By achieving success rates of 91% for LR, 97% for SVM, and 99% for ANN, it has been shown that guided models can be effective in providing a quantitative view of the epidemic [20].

For COVID-19 prediction, the hybrid quantum-classical convolutional Neural Networks (HQCNN) model used random quantum circuits (RQCS) as the basis to detect COVID-19 patients with CXR images. In the study, 6952 CXR images including 1161 COVID-19, 1575 normal, and 5216 pneumonia images were used as data sets. The proposed HQCNN model achieved higher performance with 98.4% accuracy and 99.3% sensitivity in the first dataset cases. In addition, the second dataset achieved 99% accuracy and 99.7% sensitivity in its cases [21].

3. Material and Method

In this section, it was presented all details of the proposed model and the steps taken in the study process. First, the deep learning methods and ML algorithm used in the study were briefly mentioned, then the processes of obtaining the dataset, removing noise, and preparing data were explained, and finally, the process of creating the model was included. Python open-source software was utilized to create the model. CNN, DNN, and KNN algorithms were used in the study to classify the lung images in the dataset. At this point, CNN and DNN techniques are deep learning approaches and the KNN algorithm is an ML technique.

3.1. Deep Learning

Deep learning is a method that provides solutions for nonlinear problems using multiple layers and is used by machines to perceive and understand the world. It is generally used in areas such as image classification, video analysis, speech recognition, information retrieval, object recognition, and natural language learning [22-27]. Analysis and generalization can be made without the need for an attribute extractor based on a previously created mathematical model using deep learning methods. A learned neural network approach can be used for other applications and data structures. Deep learning is generally developed on artificial neural networks and makes use of its layers and the next layer takes the output of the previous layer as input [23,28-30].

Deep learning methods are Deep Neural Networks (DNN), Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Deep Boltzmann Machine (DBM), Deep Belief Networks (DBN), and Deep Auto-encoders [31]. In this section, the CNN and DNN methods used in the study were given briefly.

3.1.1. CNN

CNN is a type of multilayer perceptron, consisting of one or more connected layers and processing the image with various layers. In the convolution process, the symmetry of the filter to be applied to two-dimensional data is taken according to the x and y-axis. While the filter is hovered over the image depending on the step length, the overlapping values at each step are multiplied element by element, and the sum of all values is recorded as the relevant element of the output matrix. CNN is a technique used to classify images and group them by naming them while classifying (photo search) and object recognition in scenes. CNN uses a standard neural network to solve the classification problem. However, it uses other layers to determine the information and detect some features (Fig. 1) [32-35]

3.1.2. DNN

DNN is a multi-layered state of artificial neural networks, which are developed inspired by the information processing method of the human brain and formed from neurons. DNN has multiple non-linear hidden layers between an input layer and an output layer, and the weight of each layer is adjusted the by delta learning method. DNN is used in supervised and unsupervised learning problems, it can model non-linear relationships, but learning processes take place very slowly. However, it is generally used for classification and regression, high-performance results can be obtained [25, 36–38].

DNN consists of neurons like the human brain. All neurons are interconnected and affect output. Neurons are divided into three different layers. These are the input layer, hidden layers, and exit layer. The introductory dataset is split into two or three separate parts to make a good generalization in the modeling process of architecture. In DNN algorithms, the entire dataset is generally divided into two datasets called the training dataset and the testing dataset. The role of the training dataset is to calculate the estimates of the weights in the neural network, and the role of the test dataset is to test the accuracy of the obtained weight values with data hidden from the model [39]. In Fig. 2, there are 4 classifications for the outlet by directing the sample X-Ray image taken from outside to the training phase with the DNN model

3.2. Machine Learning

ML is considered a subset of AI. ML uses algorithms to identify patterns in data. The results of ML become more accurate as the amount of data and experience increases, as people gain experience as they practice more. ML appears to be the most effective option with its applicability in scenarios where data, requests, or tasks are constantly changing or when a solution cannot be coded effectively [40]. In short, ML is an algorithm that models a problem according to the data of that problem. These algorithms can predict, cluster and classify, etc. [41].

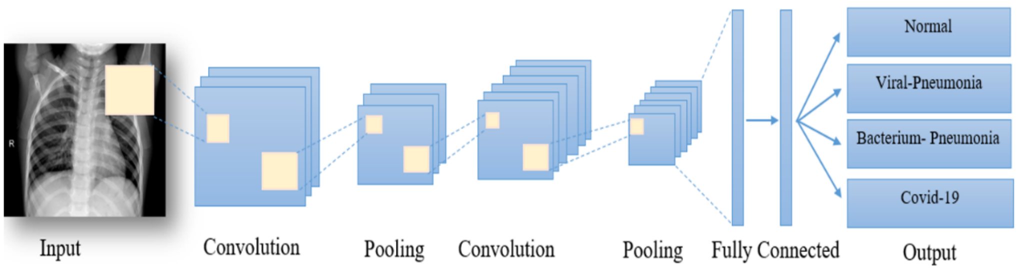

Fig. 1. CNN model [33]

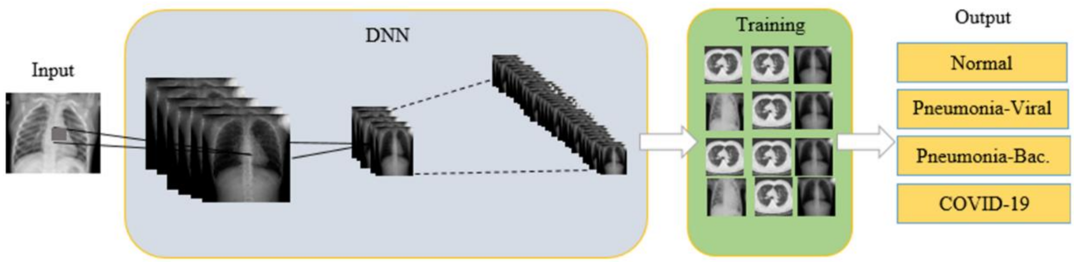

Fig. 2. DNN model [9]

3.2.1. KNN

KNN algorithm is one of the easy-to-implement supervised learning algorithms. Although it is used to solve both classification and regression problems, it is mostly used in the solution of classification problems in the industry. KNN calculates the distances between neighbors and finds the closest neighbors and labels the data by class. KNN is one of the most popular ML algorithms due to its resistance to old, simple, and noisy training data. In general, 3 types of functions are used for distance calculations, Euclidean, Manhattan, and Minkowski. However, it also has a disadvantage. For example, it requires a large amount of memory space when used for large data, as it stores all the states while calculating distance. The main purpose of classification is the process of determining which class the objects belong to by looking at the properties of the objects [42, 43].

The category or class of a particular dataset can be easily determined with the help of KNN as in Fig. 3 when new data arrives. In the working logic of the KNN algorithm in Fig. 3, there are two classes category A and category B.

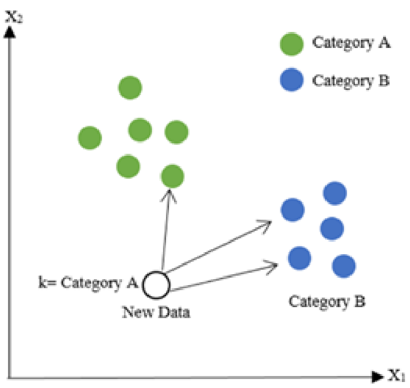

Fig. 3. KNN model [42]

The k parameter is determined when the steps of the KNN algorithm are examined in Fig. 4. This parameter is the number of neighbors closest to a given point. Then, the distance of the new data, which will be included in the sample dataset, to the existing data is calculated one by one. The nearest k neighbors from the respective distances are considered and assigned to the class of k neighbors or neighbors according to their attribute values.

3.3. Data Collection and Preparation

The current and real data (X-Ray images) required for the detection of COVID-19 were obtained from the web address "https://www.kaggle.com/", which was an open platform. This dataset obtained from X-ray (PA-CXR) images of COVID-19 consists of four categories: Bacterial Pneumonia, Viral Pneumonia, COVID-19 (infected, confirmed cases,) and Normal. A total of 14,446 pieces of data were used to create the model. Table 1 includes all the information including category name, training, and data to take the test.

Table 1. Categories and number of data

No	Category Name	Training (%85)	Testing (%15)	Total
1	COVID19	660	116	776
2	Bacterium-Pneumonia	5116	904	6020
3	Normal	5360	945	6305
4	Viral-Pneumonia	1143	202	1345
Total		12279	2167	14446

The X-Ray images in the dataset were rescaled to 220x220 before creating the models. The black background of 200x200 pixels was added to the images to standardize the images in different pixel ratios, prevent distortion and achieve a complete transformation. They have excluded Low contrast images or images containing portions of the entire thoracic X-Ray scan. In Fig. 5, sample lung tomography images were given based on categories.

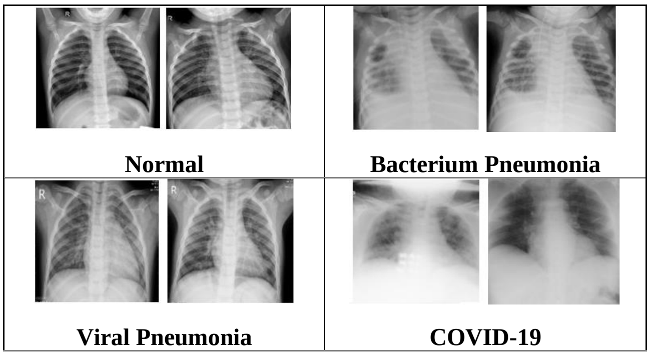

Fig. 5. Lung tomography images according to categories

3.4. Creating Models

3.4.1. CNN model

The data were first included in the training process to create the model after they were de-noise. Lung images were created in 4 classes by writing the names of the categories and the training process was initiated. The number of cycles was determined as Epoch= 10, Batch size=30, and Learning Rate =0.001 in the training process. This process was implemented through Keras, the deep learning library of Python 3.7. Models were created using combinations of optimization functions (Adam, Adadelta, Adamax, and SGD), activation functions (Relu, Softmax,) and neuron numbers on layers. The files of the training and test results were recorded after the training process was completed. These files contain classification reports, confusion matrix, validation plots, and model information. The code block forming the CNN model was given in Fig. 6.

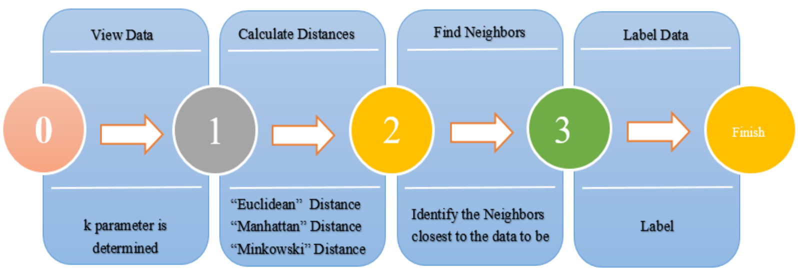

Fig. 4. Steps of the KNN algorithm [44]

```python
if useCkpt:
    model.load_weights(model_out_dir + "/model.h5")

trainGen, testGen = build_data_generators(train_dir, test_dir, labels=labels, image_size=image_size, batch_size=batcn_size)
optimizer = Adadelta(lr=learning_rate)
model.compile(optimizer=optimizer, loss="sparse_categorical_crossentropy", metrics=["acc"])
learning_rate_reduction = ReduceLROnPlateau(monitor='loss', patience=patience, verbose=verbose,
                                            factor=learning_rate_reduction_factor, min_lr=min_learning_rate)
save_model = ModelCheckpoint(filepath=model_out_dir + "/model.h5", monitor='loss', verbose=verbose,
                             save_best_only=True, save_weights_only=False, mode='min', save_freq='epoch')
history = model.fit(trainGen,
                    epochs=epochs,
                    steps_per_epoch=(trainGen.n // batch_size) + 1,
                    verbose=verbose,
                    callbacks=[learning_rate_reduction, save_model])
model.load_weights(model_out_dir + "/model.h5")
```

Fig. 6. The code block for creating the CNN model

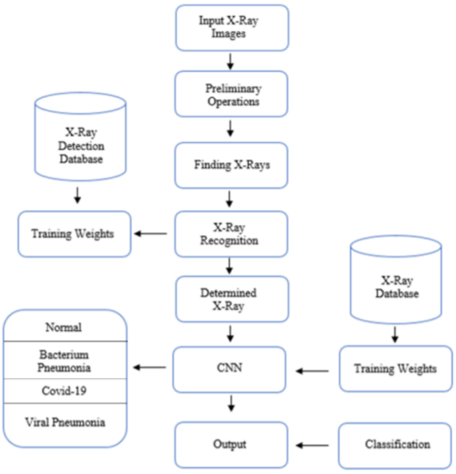

Fig. 7. The general algorithm of the CNN system

It was shown the general algorithm of the study developed with Python programming language and CNN in Fig. 7.

According to the CNN algorithm, X-Ray images were first taken and pre-processed. Then, whether there were X-Ray images from these images was pre-trained and compared with the images in the database. Subsequently, classification was made using the CNN algorithm and the label of the X-Ray image detected as a result was determined. In Fig. 8, the classification stages were shown, labeling according to biomarkers while extracting the features of X-Ray images

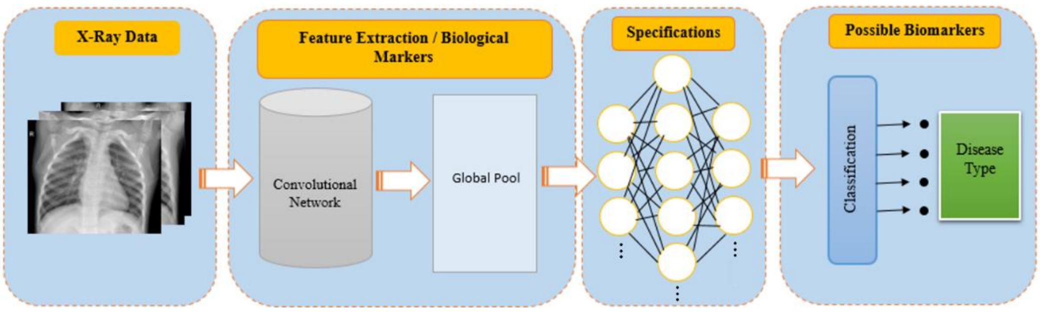

Fig. 6. The code block for creating the CNN model

3.4.2. DNN model

The data coming to the DNN was classified by passing through three layers input, hidden, and output. Later, it was determined that the lung tomography image was COVID-19. In Fig. 9, DNN architecture was given

3.5. KNN model

In the KNN algorithm, firstly, the distances were calculated according to the new lung data. Then, the model was applied by finding the closest neighbors, and the data was classified whether it was COVID-19 or not.

Fig. 10. The KNN model according to X-Ray images

Fig. 10 shows the model of the KNN algorithm and how it is followed when new data is available. It reveals which of the four classifications the X-Ray image belongs to with the new data calculation and find neighbors section.

4. Experimental Results and Discussion

4.1. Results obtained from the CNN model

In this section, the classification of 4 different categories was compared. Results obtained using the Keras library were based on the last cycle number, not the total. Relu function was used in layers (excluding exit). Table 2 shows accuracy and loss values for training and testing according to optimization function tools. The most successful rates (99.4% for training and 98.4% for testing) were obtained with the Adadelta function tool.

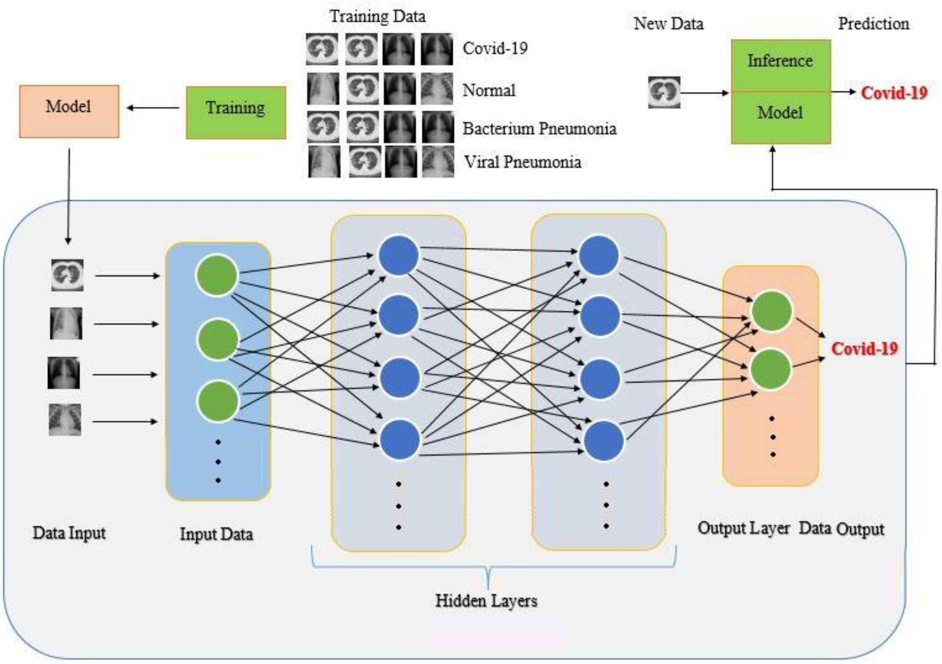

Fig. 9. The DNN model and classification

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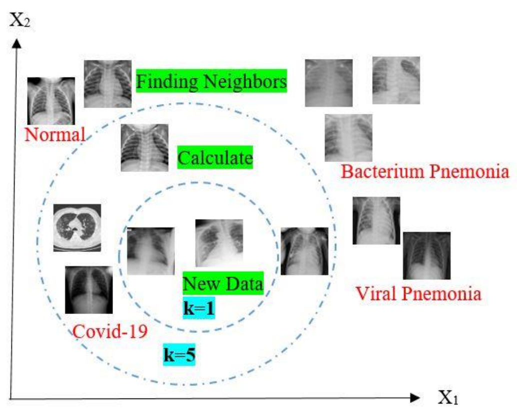

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Table 2. The effect of optimization functions

Epochs: 10, Number of Layers: 5, Stack Volume: 30				
	Training		**Testing**	
Optimization Function	**Loss**	**Accuracy**	**Loss**	**Accuracy**
Adadelta	0.016	0.994	0.049	0.984
Adam	0.017	0.991	0.057	0.978
SGD	0.205	0.931	0.316	0.876
Adamax	0.033	0.986	0.108	0.960

Fig. 11 shows the accuracy and loss status for Adadelta optimization. According to Fig. 11, the turnover value was taken as 10, the batch volume = 30, the training rate was 99% and the testing rate was 98%.

In Fig. 12, the accuracy and loss status for Adam optimization was given. According to the graph, the training and testing rates were obtained as 99% and 97%, respectively.

The accuracy and loss status for SGD optimization was given in Fig. 13. According to Fig. 13, the training and testing rates were obtained as 93% and 86%, respectively.

Fig. 14 shows the accuracy and loss status for Adamax optimization. According to Fig. 14, the training and testing rates were obtained as 98% and 96%, respectively.

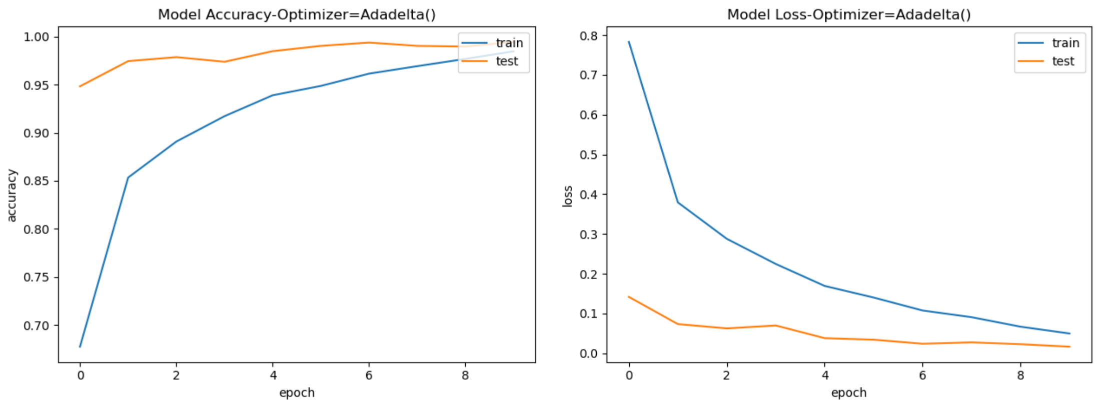

Fig. 11. The accuracy and loss plot for Adadelta

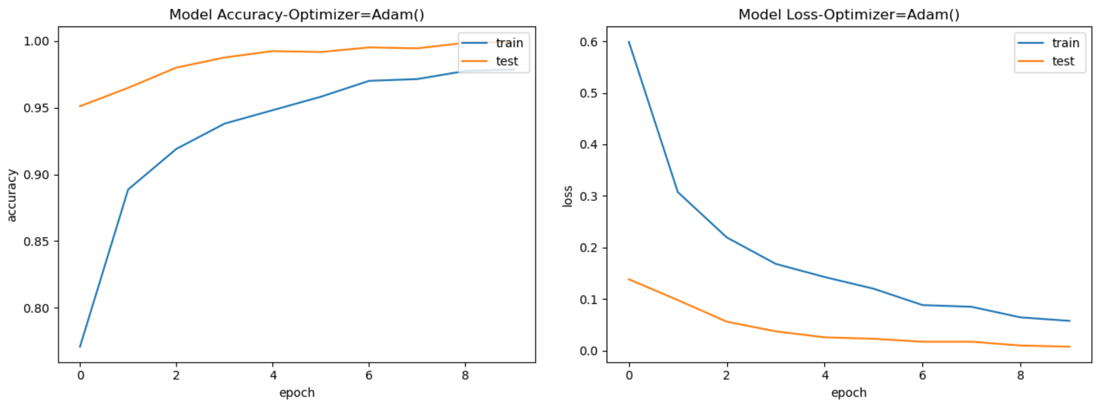

Fig. 12. The accuracy and loss plot for Adam

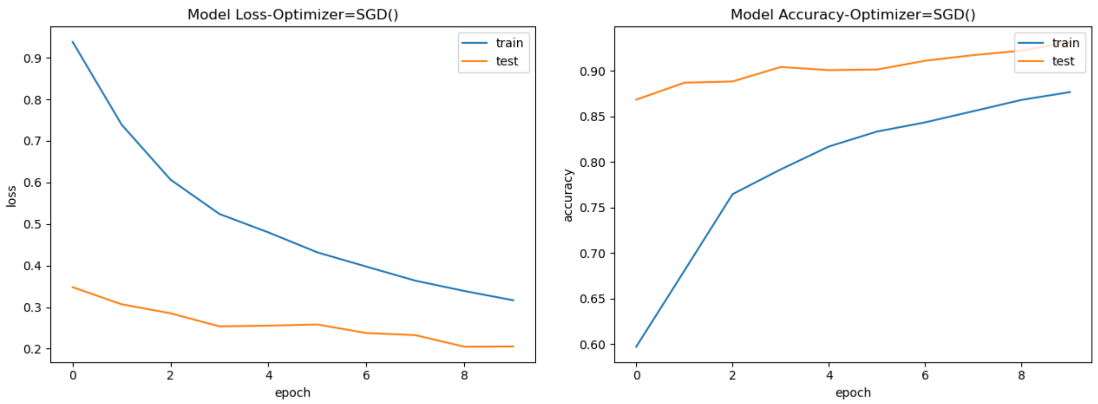

Fig. 13. The accuracy and loss plot for SGD

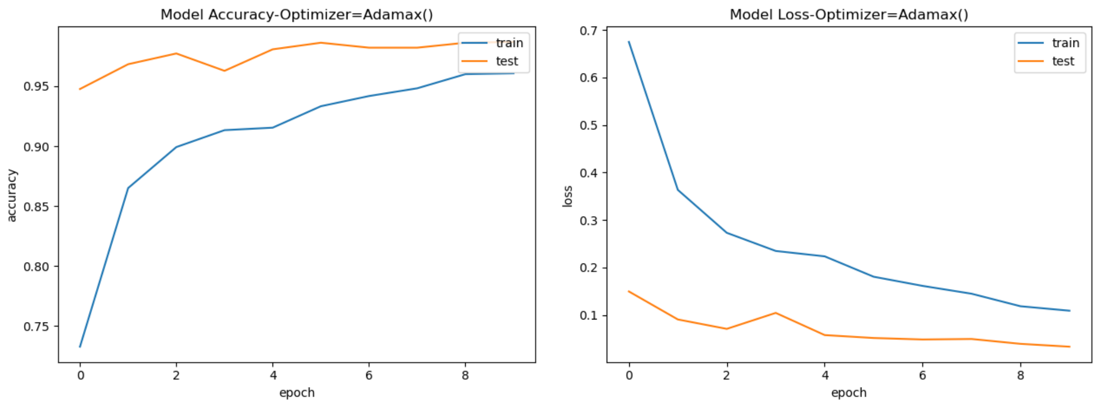

Fig. 14. The accuracy and loss plot for Adamax

The comparison of the results obtained from all functions in the CNN technique was given in Fig. 15. According to Fig. 15, the training, testing, loss (training), and loss (testing) rates were obtained as 99%, 98%, 0.016, and 0.049 by using the “Adadelta Optimization Function”, respectively. The lowest rates were obtained with the "SGD Optimization Function" as 93% training and 87% test rates.

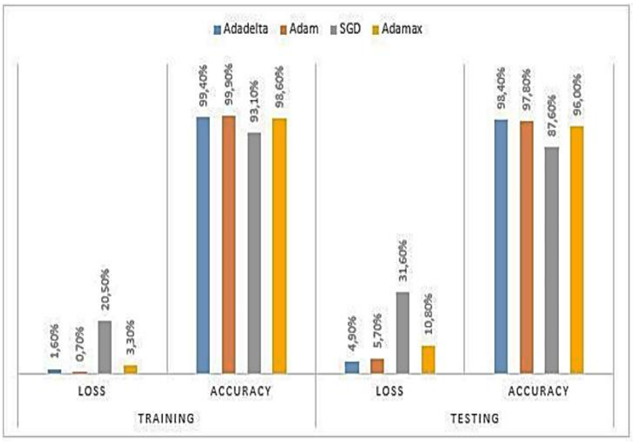

Fig. 15. The performance of optimization functions

After all these testing processes, the X-ray images were classified and labeled (Fig. 16) and the performance results of each model were obtained.

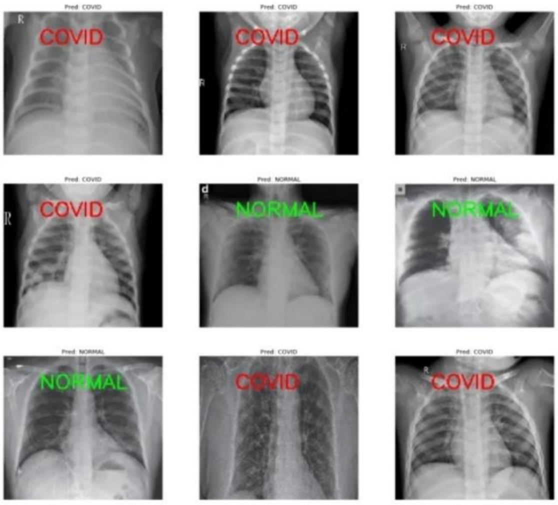

Fig. 16. Classification and labeling procedures

5.2. Results obtained from the DNN model

The training and testing were carried out in 4 categories of X-ray images. In the DNN model, one of the deep learning methods, the dataset was divided into two groups 85% training rate and 15% testing rate. The testing performance and accuracy rate according to the classes were shown in Table 3. The highest testing success rate was obtained in the COVID-19 class and 98.3%.

Table 3. The success rates of the DNN method

Class	Testing	Sensitivity	F1 Score	Average Sensitivity	ROC Accuracy
Viral-Pneumonia	93.6%	73.1%	82.1%	92.4%	99.2%
Bacterium-Pneumonia	91.3%	79.4%	85.0%	93.7%	94.9%
COVID-19	98.3%	50.0%	66.3%	87.6%	98.9%
Normal	94.8%	86.7%	90.5%	97.5%	98.0%

In Fig. 17, a sample given for the test was labeled COVID-19 with a rate of 97.12% according to the DNN method of lung tomography. In addition, the class with the highest score threshold in the classification also receives the same label in the classification of the test data.

5.3. Results obtained from the KNN model

All X-Ray images were divided into 2 groups 85% training data and 15% testing data for the KNN model. The training was carried out in 4 categories of X-Ray images. The number of data used according to the categories and the accuracy percentages was given in Table 4. According to Table 4, success rates were obtained as Normal 98%, Bacteria 97%, Viral 96%, and COVID-19 97%

Table 4. The accuracy rates and number of data by category

Category	Accuracy	Number of data
Normal	98%	946
Bacterium-Pneumonia	97%	903
Viral-Pneumonia	96%	202
COVID-19	97%	117

In Fig. 18, the accuracy and loss graph of all classes in the training and testing stages according to the KNN algorithm was given. According to the graph, success rates of 99% for training and 97% for testing were achieved. The loss per term was 0.8% in the training data and 8.8% in the test data.

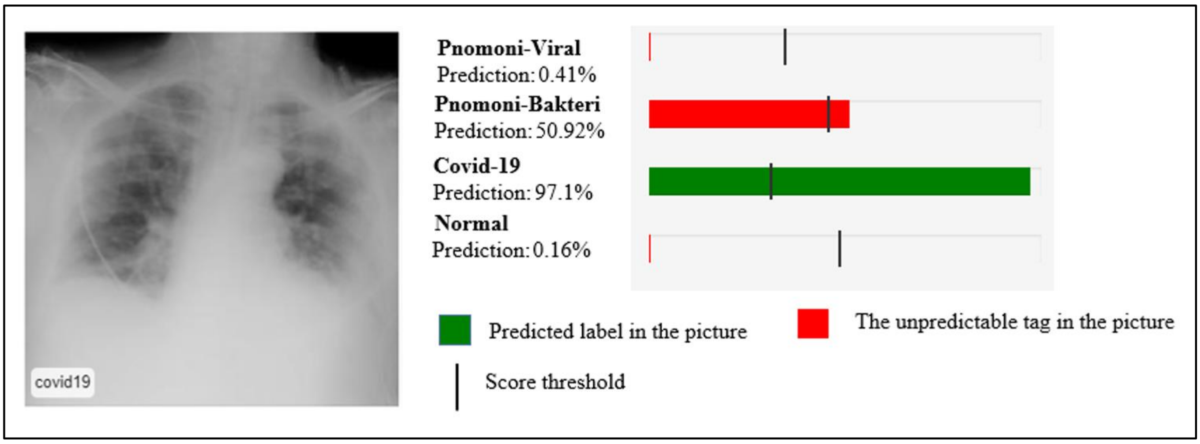

Fig. 17. A simple classification process for the DNN algorithm

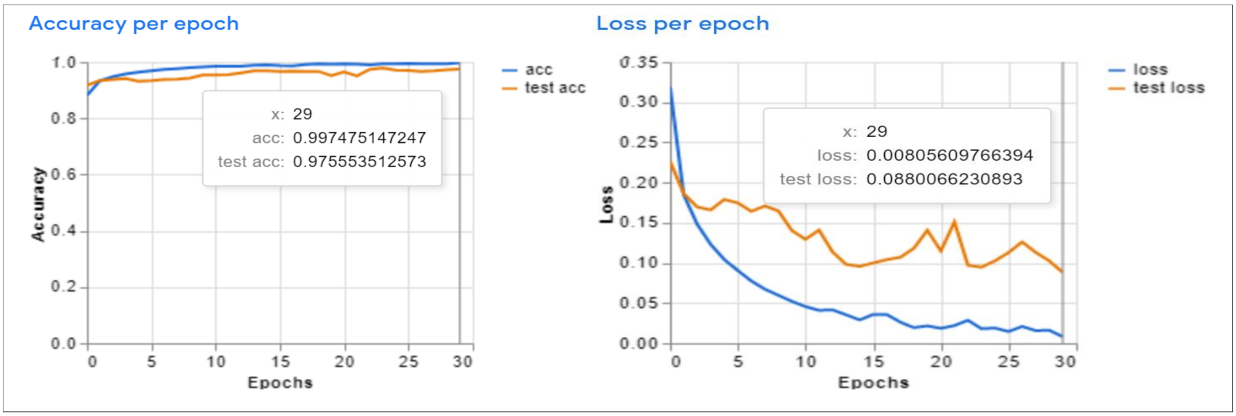

Fig. 18. The accuracy and loss per revolution graph for KNN

Comparison of Findings

It was seen that the highest performance in terms of diagnosis-detection was obtained with CNN, one of the deep learning algorithms when the findings obtained from the study were examined (Table 5). At this point, although the highest education rate is KNN, what is important here is the high testing rate as well as the training rate. According to Table 5, this situation was achieved with the CNN technique.

Table 5. Comparison of algorithm results

No	Training (%)	Loss (Training) (%)	Testing (%)	Loss (Testing) (%)	Model
1	99,56	1,60	98,90	4,90	CNN
2	93,70	6,30	93,40	6,60	DNN
3	99,74	0,80	97,55	8,80	KNN

Finally, 20 different tests were carried out using the proposed CNN, DNN, and KNN models and real data. Experimental results obtained from these tests were given in Table 6. According to the experimental results (Table 6), the best performance and the lowest error rate were obtained with the CNN method.

Table 6. Experimental results obtained from models

No	CNN		DNN		KNN	
	Accuracy	Loss	Accuracy	Loss	Accuracy	Loss
1	99,57	0,43	96,40	3,60	99,09	0,91
2	99,12	0,88	91,41	8,59	99,00	1,00
3	98,67	1,33	90,14	9,86	96,70	3,30
4	99,34	0,66	86,60	13,40	98,50	1,50
5	98,26	1,74	91,15	8,85	99,30	0,70
6	99,10	0,90	91,96	8,04	89,43	10,57
7	99,70	0,30	81,60	18,40	95,46	4,54
8	95,40	4,60	81,60	18,40	46,16	53,84
9	98,67	1,33	90,40	9,60	96,23	3,77
10	99,35	0,65	96,60	3,40	99,08	0,92
11	98,55	1,45	96,47	3,53	98,19	1,81
12	94,29	5,71	85,80	14,20	85,70	14,30
13	96,95	3,05	85,04	14,96	99,39	0,61
14	99,50	0,50	91,96	8,04	99,37	0,63
15	99,18	0,82	95,01	4,99	98,93	1,07
16	99,20	0,80	89,96	10,04	95,72	4,28
17	98,27	1,73	94,67	5,33	96,60	3,40
18	96,78	3,22	92,33	7,67	71,98	28,02
19	99,90	0,10	84,80	15,20	97,78	2,22
20	98,23	1,77	93,57	6,43	71,90	28,10
Average	**98,40**	**1,59**	**90,37**	**9,62**	**91,72**	**8,27**

6. Conclusions and Recommendations

The rapid spread of the COVID-19 pandemic to the whole world and its negative effects on people reveal that the issue should be examined in detail and positive cases should be detected at early stages and rapid and correct intervention should be made. In this context, a model was created and proposed using deep learning (CNN, DNN) and machine learning (KNN) methods in this study. Diagnosis and detection of patients with COVID-19 were performed through different lung tomography images using the proposed model. Results showed that the CNN technique had higher performance values than DNN and KNN methods. COVID-19 diagnostic values with a very high success rate were achieved with the proposed CNN model. Also, the performance of the model is directly proportional to the number of data. Using more data has a positive effect on the performance of the model. The findings indicated that the proposed CNN model can be developed a little more with hybrid approaches and can be easily used in the health system. In the next stage of the study, different algorithms or techniques can also be used to achieve higher success rates. In addition, more accurate comments can be obtained about the results obtained by taking the opinions of experts in this field since the subject of the study is health. As a result, the proposed model's ability to diagnose or detect in a short time, with a low error rate and with minimum cost revealed the potential of using AI techniques in the field of health.

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