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COVID-19 Diagnosis Using Deep Learning Algorithms Based on Chest CT Scan: A Survey

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ABSTRACT

The coronavirus (SARS-CoV-2), which causes severe acute respiratory syndrome (COVID-19), is the most current virus with the potential to kill a substantial number of people around the world. Current procedures are restrictive, time-consuming, inefficient, and obsolete. This is due to their exclusive reliance on the technical expertise of a radiologist or medical consultant. Deep learning and technological advancement have also enabled medical researchers and scientists to investigate various neural networks and algorithms to develop apps, tools, and gadgets that can assist medical radiologists. This paper aims to give an overview of deep learning techniques that have been used in chest radiography of COVID-19 and pneumonia cases, as well as the most important datasets that help researchers test algorithms.

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1. Introduction

COVID-19, also called coronavirus disease, is a lung disease caused by Severe Acute Respiratory Syndrome Coronavirus 2. (SARS-CoV-2). So far, a lot of people have died because of this pandemic. The World Health Organization (WHO) is keeping a close eye on this disease outbreak in different countries and putting out all reports about it [1]. COVID-19 is a lung disease that is mostly spread through the air by very small droplets. Most people get sick from being close to someone else or from the droplets that come out of their nose or mouth when they cough or sneeze. People with this virus cough, find it hard to breathe and get a fever [2].

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If having trouble breathing, might have pneumonia and need to see a doctor right away. There is neither an antibody for COVID-19 contamination nor a specific way to treat it. At emergency clinics, sick people can stay in wards where they can't be around other people. It is most common when people have symptoms, but it might be possible for it to spread before symptoms show up [3]. The disease can live for up to three days on surfaces. Symptoms of COVID-19 can start anywhere from 2 to 14 days after exposure, with 7 days being the average. Can also figure out the same disease from symptoms, risk factors, and a chest CT that shows signs of pneumonia. Because they don't have enough medical kits, many countries can't stop the spread of COVID-19 quickly. Many studies are being done all over the world to figure out how to deal with a pandemic. Many deep-learning models try to predict COVID-19's symptoms as soon as possible to stop it from spreading [4].

Wuhan, China, found that COVID-19 could spread in December 2019. Coronavirus 2 caused SARS (SARS-CoV-2). Then it spread to most countries [5]. Some virus-carriers exhibit no symptoms. RT-PCR is sensitive and specific, however it has difficulties. First, the SARS-CoV-2 test typically misdiagnoses COVID-19. Insufficient virus in the sample can cause this. Second, RT-PCR only verifies the truth. The sickness isn't growing worse. Clinical investigations reveal that most COVID-19 patients' lung scans show the same things, even if they have no symptoms. Researchers suggest lung image patterns can be employed in addition to RT-PCR to discover COVID-19[6]. Ultrasound (US) doesn't show differences between COVID-19 and other viral pneumonia well, and MRI takes a long time and is expensive. CT scans and chest X-rays are used clinically to diagnose COVID-19 [7].

Covid-19 are 26 to 32 RNA viruses. China discovered a novel pneumonia-causing coronavirus in December 2019. Coronavirus causes respiratory sickness in 2019. (COVID-19). Wuhan-to-Malaysia disease spread. WHO declared COVID-19 pandemic on March 11, 2020. The CDC says coronavirus spreads best within 6 feet. SARS-CoV-2 spreads faster than flu but not measles. Disease spreads by air droplets. Coughing and sneezing produce mucous. SARS-CoV-2 causes large and small droplets [10].

It is causes heat and trouble breathing. Deep Learning (DL), is a type of AI, was key in the Corona epidemic. DL enables robots do what humans can. With AI and IoT, medical technology has changed swiftly, providing radiology many alternatives. ML helps AI attain its aim. Part of AI that allows computers learn and accomplish things on their own based on data they acquire. Deep learning models neurons in the human brain. With its technology for classifying, recognizing, and identifying images and videos, ML makes DL an essential topic. The program searches for patterns like the nervous system. DL is a hot topic since it can classify, recognize, and identify images and videos [12].

Complex data with deep layers must be categorized and processed to uncover patterns in Dl Maps. With a powerful GPU, DL can categorize features and produce reliable results [13]. AI algorithms don't need to classify many features. They use statistics to show how well they address problems. DL can interpret data and extract out dimensional features, whether or not the features are visible. This makes it less important to manually segment data. DL architectures are used to discover X-rays in medical and picture processing. DL is used in medicine to generate better outcomes, detect more diseases, and let disease recognition algorithms use valid real-time medical images [14].

The rest of this paper is organized as follows. First, the deep learning approaches is described in Section 2. Section 3 describes the deep learning diagnosis phase. Section 4 reveals the datasets that used to diagnosis Corona disease. Finally, the conclusions in section 5.

2. Deep Learning approaches

There are several distinct models of deep learning, each of which is precise and able to tackle issues that are insurmountable for the average person's brain [15]. Below is a details that reviews the most important Deep Learning Techniques. The structures and methods are in Figure (1).

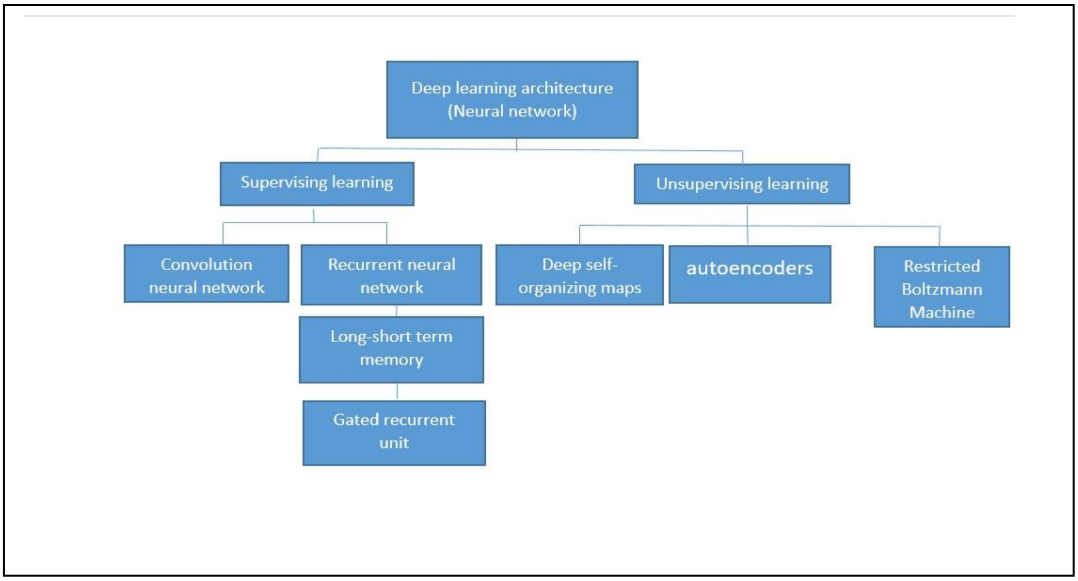


Figure (1): Architectures of Deep Learning[1]

Deep Neural Networks (DNN) it is also called Fully Connected Neural Networks, and its multilayer perceptron's, in which the neurons are connected to the continuous layer, are often used to find it. In 1958, an American psychologist named Fran Rosenblatt came up with the idea. It means that the model needs to be changed so that it can work with simple binary data. This model can be used in three different ways [1]. Convolutional Neural Networks CNN is a more advanced and useful version of the classic artificial neural network model. It is made to handle more difficult tasks, such as preprocessing and data compilation. It depends on the way neurons are set up in an animal's visual cortex. The CNNs are one of the most efficient and flexible ways to specialize in both image data and other types of data [2].

Recurrent Neural Networks (RNNs) The first RNNs were made to help predict sequences. For example, the Long Short-Term Memory (LSTM) algorithm is well-known for all the things it can do. Different lengths of data sequences are needed for these networks to work. The RNN uses what it learned in its last state as an input for the prediction it is making now. , it can help a network have short-term memory, which makes it easier to track changes in stock prices or other time-based data systems [3]. Generative Adversarial Networks (GAN) it is made up of two deep learning techniques for neural networks: a Generator and a Discriminator. The Generator Network gives you fake data, but the Discriminator helps you tell which data is real and which is fake. Both networks are competitive because the Generator keeps making fake data that looks exactly like real data, and the Discriminator keeps telling the difference between real and fake data. When making an image library, the Generator network would make fake data to go along with the real images.

Then, a neural network for deconvolution would be made. The next step would be an Image Detector network that could tell the difference between real and fake images. Starting with a 50 percent chance of accuracy, the detector needs to improve its ability to classify because the generator will get better at making fake images. This type of competition would make the network work better and move faster [4]. Self-Organizing Maps Self-Organizing Maps, or SOMs, use data that has not been checked by a human. This minimizes the number of random variables in a model. In this type of deep learning, each synaptic connection between the input and output nodes always results in a two-dimensional model. As each data point tries to fit into the model, the SOM changes the weight of the nodes or best best-matching units that are closest to it (BMUs). The weights have different values depending on how close they are to a BMU. Since weights are thought of as a node's own property, the value shows where the node is in the network [5]. Boltzmann Machines The nodes in this network model don't have a set direction, so they are all connected in a circle. Because this deep learning method is so unique, it is used to make model parameters. The

Boltzmann Machines model is called stochastic, which is different from all other network models, which were deterministic. [6].

Auto encoders one of the most common deep learning techniques is this model. It works automatically based on the data it gets, and then it uses an activation function and output decoding to finish. When this happens, there are fewer types of data and most of the data structures that come with the program are used [8]. Back propagation Back-prop, which is short for back-propagation, is the main way neural networks figure out where they went wrong when making predictions. On the other hand, data is said to be propagated when it is sent in a certain direction through a certain channel. The whole system can work depending on how the signal is moving forward when the decision is made. It also sends back information about network problems [9]. Gradient Descent A gradient is a slope with a measureable angle that can be shown as a relationship between two variables. "x" and "y" can be used in this deep learning method to show the relationship between the neural network's error and the data parameters. Since a neural network's variables change over time, even small changes can make the error bigger or smaller. Many experts think of the method as a path of a river going down the slopes of a mountain. With this type of method, the goal is to find the best solution. Since a neural network has many local minimum solutions, where data can get stuck and cause slow, wrong compilations [10].Table(1) shows some comparisons between different approaches of deep learning used to diagnosing Covid - 19:

Table (1): The important deep learning models used in Covid -19 diagnosis.

No.	Ref.	Author's Name	Methods	Description
1	[10]	Sertan Serte , Hasan Demirel (2021)	ResNet-50	This AI method merge image-level predictions to diagnose COVID-19 on a 3D CT volume. The proposed deep learning model provides 96% AUC value for detecting COVID-19 on CT scans.
2	[21]	Xingyi Yang et al. (2020)	Residual U-Net	They developed diagnosis methods depending on multi-task learning and self-supervised Learning, achieved an F1 of 0.90, an AUC of 0.98, and an accuracy of 0.89.
3	[22]	Eduardo Soares et al. (2020)	eXplainable Deep Learning (xDNN)	The suggested algorithm works per class; therefore, all the calculations are done for each class separately. This method could achieve an accuracy of 97:31%.
4	[25]	Tomas Sakinis, et al. (2019)	Semi-automatic segmentation + CNN	This paper presents a deep learning (DL) based semi-automated segmentation approach. That aims to be a smart interactive tool for region of interest delineation in medical images.
5	[28]	Mohammad Rahimzadeh et al. (2021)	Feature pyramid network (FPN) RetinaNet	In the single image classification stage, this model achieved 98.49% of accuracy.
6	[29]	Xinggang W. and et al. (2020)	U-Net	The algorithm obtained an accuracy of 0.901, a positive predictive value of 0.840, and a very high negative predictive value of 0.982
7	[30]	Parisa Gifani et al. (2020)	EfficientNets (B0,B1,B2,B3,B4,B5), NasNetLarge, NasNetMobile, InceptionV3, ResNet-50, SeResnet 50, Xception, DenseNet121, ResNext50 and Inception_resnet_v2	The experimental results indicate that the majority voting of 5 deep transfer learning architecture with EfficientNetB0, EfficientNetB3, EfficientNetB5, ception_resnet_v2, and Xception has the higher results than the individual transfer learning structure and among the other models based accuracy (0.85) metrics.
8	[31]	Arnab Kumar Mishra et al. (2020)	Deep CNN(VGG16, InceptionV3, ResNet50, DenseNet121, and DenseNet201)	The individual model, achieving the highest average Acc. of 0.8834.
9	[32]	Zhou Tao et al.	AlexNet, GoogleNet, and	The outcomes demonstrated that the

		(2020)	ResNet	overall classification performance of the ensemble model was better than that of the component classifier.
10	[33]	Mohammed Y. Kamil (2021)	VGG-19	The VGG-19 model achieved the highest acc. of 99%, sens. of 97.4%, and specificity of 99.4%.

As observed above, Convolution Neural Networks (CNNs) are a deep learning architecture that is often used in computer vision for diagnosis Covid-19, extending from U-Net to ResNet , have advanced significantly in recent years and now It outperforms humans in terms of accuracy and speed. In this survey we conclude, CNNs used to have a good feature extraction than preprocessing.

3. DL Diagnosis phase

Chest CT scans and X-rays are needed for COVID-19 diagnosis. AI-powered COVID-19 diagnosis techniques are as accurate as a human, save radiologist time, and are cheaper and faster than lab tests. Compare CT and X-ray data. How is COVID-19 compared to other lung infections? COVID-19 patients often have nonspecific CT abnormalities that can be misinterpreted for streptococcus pneumonia, mycoplasma and chlamydia pneumonia, SARS-CoV, H7N9 pneumonia, H1N1 virus infection, and avian influenza A (H5N1) [17]. Patients with fever and similar imaging abnormalities must have a separate diagnosis to induce early detection of COVID-19 infection. CT scans for colds usually show nothing untoward. H1N1 patients had larger or broader airways, per bronchial ground glass opacity, center lobular nodules, and tree-in-bud opacities. Results affect major and small airways and all lobes. Most H1N1 infections cause border lobe constriction. SARS-CoV CT scans often show GGO or consolidation on one or both sides [18]. As the illness develops, lower lobes consolidate bilaterally. CT scans may show interlobular and interlobular septum thickening in SARS-CoV patients. MERS-CoV patients had bilateral basilar and sub pleural gaps, an abundance of GGO, and septal thickening and pleural effusions. CT scans show these traits. Moderate COVID-19 infections because of patchy, scattered sub pleural GGOs. In severe COVID-19 infections, diffuse GGO accumulation is common. COVID-19 is distinguishable from other viral pneumonia infections by its posterior and peripheral lung detection. H7N9 pneumonia affects the right lower lung, while H1N1 and SARS-CoV attack lung margins [19]. Lower lobes are more affected by COVID-19 than upper lobes in the early stages, and the disease spreads faster than SARS. Like COVID-19, MERS-CoV is typically found in the lungs' rear and margins [19].Figure (2) shows the Generic Work-Flow.

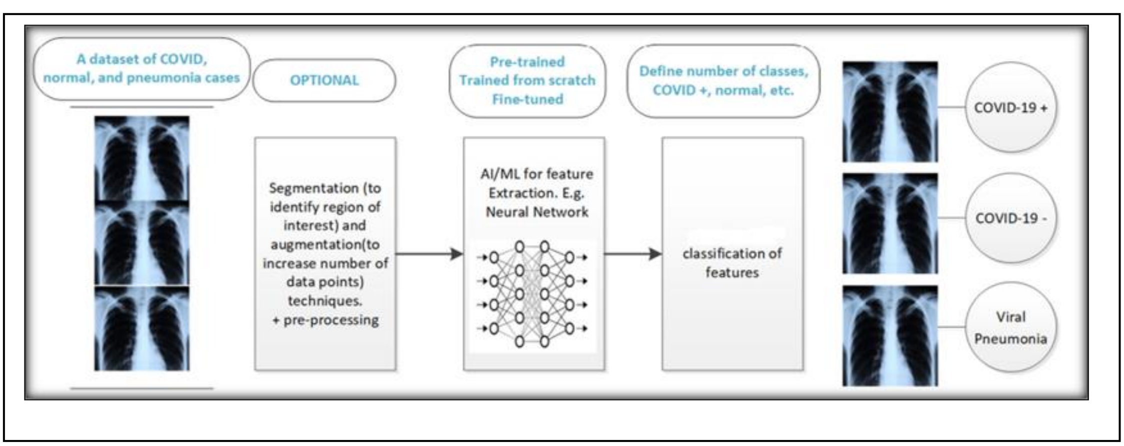
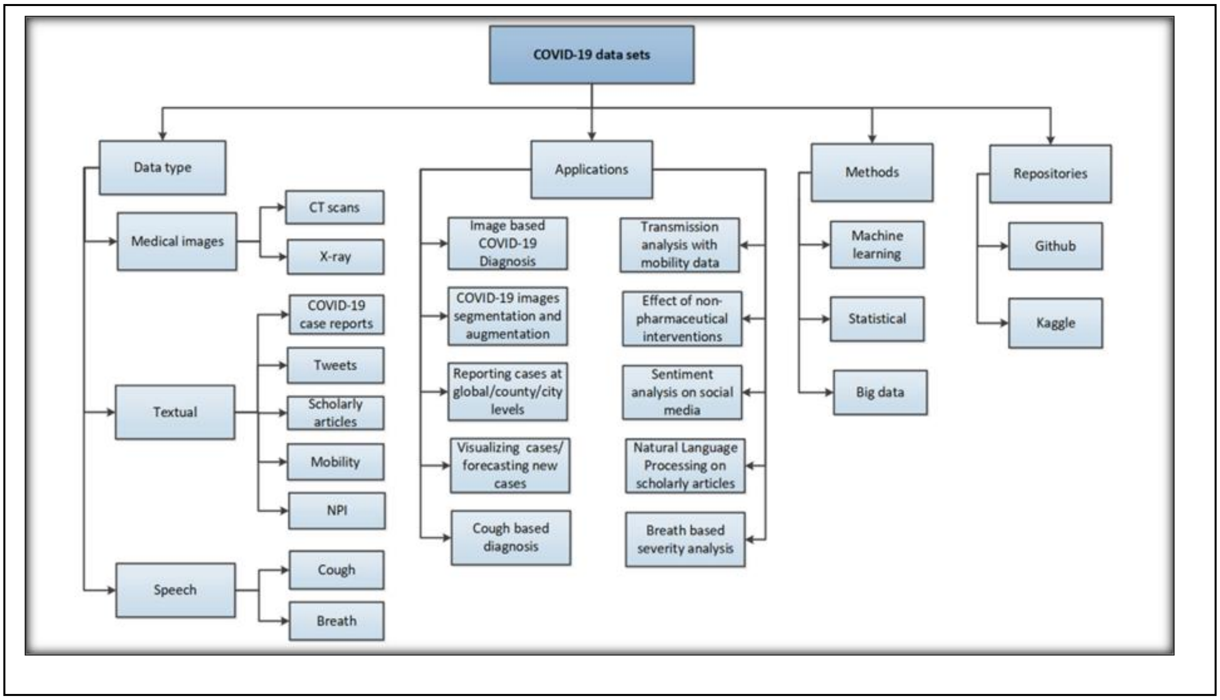


Figure (2): AI/ML COVID-19 Diagnosis Workflow [20].

4. Dataset of Chest to diagnose Corona disease

In order to make an accurate diagnosis of COVID-19, chest X-rays and CT scans are required. The COVID-19 diagnosis procedures, which are powered by AI, have the same level of accuracy as a human, save the radiologist time, are less expensive, and need less time than traditional laboratory methods [21]. The following is a figure that shows how to divide the data allocated to the chest section and its types.



Figure(3): The Classification of COVID-19 Open Source Data Sets[20].

The following table (2) describes the important dataset in Diagnosis of corona disease through chest CT images.

Table (2): important chest CT scan datasets in Diagnosis of covid-19.

Ref.	Year	Description	Advantage	Free
[21]	2020	349 COVID-19 CT images from 216 patients and 463 CT images that weren't from COVID-19.	A senior radiologist who has been diagnosing and treating COVID-19 patients since the outbreak of this epidemic confirms the usefulness of this dataset. It is useful for making AI-based COVID-19 diagnosis models.	☒
[22]	2020	There are a total of 2482 CT scans, 1252 of which are positive for SARS-CoV-2 infection (COVID-19) and 1230 of which are not positive for SARS-CoV-2 infection.	Real patients in hospitals in Sao Paulo, Brazil, have been asked for their information. The goal of this dataset is to promote research and development of AI methods that can tell if a person is infected with SARS-CoV-2 by looking at his or her CT scan.	☒
[23]	2021	Including more than a thousand CT scans of COVID-19. The DICOM standard is used to store all of the data, which are grayscale images with a bit depth of 16 and a pixel count of 512 512.	From March 2020 to January 2021, CT scans were taken at two general university hospitals in Mashhad, Iran, and matched with RT-PCR and clinical complaints. Image headers are scrubbed to safeguard patient privacy. All patient images are encoded and saved in RAR format.	
[7]	2021	CT scans of 169 COVID-19 infected, 60 CAP, and 76 healthy patients. From February to April 2020, COVID-19 instances are gathered. The Babak	COVID-CT-lobe-, MD's slice-, and patient-level labelling could aid COVID-19 research. COVID-CT-MD can develop ML and DNN-based solutions.	

		Imaging Center in Tehran, Iran, collects CAP and normal cases from April 2018 to December 2019 and January 2019 to May 2020. COVID-CT-MD comprises COVID-19 patients, healthy people, and people with CAP (CAP). COVID-CT-MD features lobe, slice, and patient labeling.	
[24] [25]	2019	Dataset of 100 axial CT images from more than 40 patients with COVID-19, converted from JPG images that can be found HERE and are free to use. A radiologist used three labels to divide the mages into three groups: ground-glass (mask value = 1), consolidation (mask value = 2), and pleural effusion (mask value = 3).	Collecting data and getting ready for Artificial Intelligence
[26]	2020	Contains 20 labeled COVID-19 CT scans. Two radiologists put labels on the left lung, the right lung, and any infections. An experienced radiologist then checks the labels.	Set up three benchmark tasks for segmentation based on datasets and deep learning methods that work well with annotations.
[10]	2021	1110 3D CT images from Moscow hospitals. Mosmed-1110 contains five 3D CT volumes. CT0-CT4 are these groups. CT0 has 254 conventional 3D CT volumes. Normal COVID-19 level means CT scan shows no pneumonia or COVID-19. 684 3D CT images for CT2 show that 25% of the lungs are infected with COVID-19. CT3.	Patients' 3D CT scans improve diagnosis.
[27]	2020	Moscow hospitals between March 1 and April 25, 2020. This collection contains anonymized human lung CT scans with and without COVID-19 results (CT1-CT4) (CT0) Dataset contains 1110 studies. Population: 1110; 42% men, 56% women, 2% unknown. 18-97, median 47. First, 1110 studies were categorized into 5 groups (table). CT-0: 254 (22.8%), CT-1: 684 (61.6%), CT-2: 125 (11.3%), CT-3: 45 (4.1%), CT-4: 2 (0 percent). 0.2% Second, every study is saved in NifTI and Gzip. Only every 10th image	Algorithms based on artificial intelligence (computer vision) may be utilized in the fight against COVID-19.

		("Instance") was saved in the final study file..	
[28]	2020	Collected from Negin radiology in Sari, Iran, between March 5 and April 23, 2020. This medical center uses a SOMATOM Scope model and syngo CT VC30-easyIQ software version to capture and view HRCT radiology images of a patient's lungs. The format of the exported radiology images was 16-bit grayscale DICOM format with a resolution of 512*512 pixels. Since the patient's information was available in the DICOM files, changed them to TIFF format, which holds the same 16-bit grayscale data but doesn't reveal the patient's information. The covid-19 Patients Number is 95, Normal Patients Number is 282, Covid-19 Image Number is 15589, and Normal Images Number is 48260.	Data collection and preparation for Artificial Intelligence

5. Conclusion

The lives of people all over the world have been affected by the coronavirus in different ways. The infection caused by the disease could not be prevented, and every day saw the growth of thousands more. Many successes and contributions have been made in making processes and procedures run more smoothly as a direct result of the many artificial intelligence technologies that have been developed to make lives easier. These successes and contributions have been made as a result of the fact that these artificial intelligence techniques have been developed. However, the spread of COVID-19 is faster and more widespread than at any other time in history, making it a very dangerous virus. Because the Coronavirus is always developing new mutations, and because protein mutations have been reported in a large number of countries, the aim of this practical paper is to shed light on the concept of the Corona pandemic, its relationship to deep learning, and methods. Researchers use it to detect the Corona virus with pictures .This paper focused on taking images of the chest taken in a CT in addition to compiling a summary of the data sets that were deemed to be the most relevant and presenting it to other academics in an effort to improve deep learning systems.

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