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PREDICTION AND DETECTION OF COVID 19 USING DATASETS AND XRAY IMAGES BY DEEP LEARNING ALGORITHM

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NEAR EAST UNIVERSITY

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Declaration

I certify that this research work entitled "PREDICTION AND DETECTION OF COVID 19 USING DATASETS AND XRAY IMAGES BY DEEP LEARNING ALGORITHM'' is my own work. No portion of the work presented in this research report has been submitted in support of another award or qualification either at this institution or elsewhere. Where material has been used from other sources it has been properly acknowledged / referred. If any part of this project is proved to be copied or found to be a report of some other, I will stand by the consequences.

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Signature :

Date : 03/02/2022

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Vidura Lakshitha Liyanagamage

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Abstract

This Thesis focused on the COVID -19 prediction by using machine learning (logistic regression) algorithm in the first part and second section is about COVID -19 detection from X-ray DATASET by using Neural Network Method. As the COVID 19 put the great impact on the world health situation as well as economics situation, this effect directly leads toward the crises situation in order to cater with this situation Artificial Intelligence plays a vital role to predict and the number of cases. Prediction help us to take precaution accordingly. Currently more than 293 million of positive cases has been detected and more than 5.4 million deaths has been recorded. To prevail the spread of virus so many countries open sourced the datasets of COVID positive cases for scientist to predict the curve so countries can take measure accordingly. It helps to have a rough idea of epidemic end date as it is very difficult to predict because of its uncertainty. This thesis took the dataset of more than 100 countries and predict the curve of positive cases of top 10 countries. Prediction is 90 percent efficient and accurate. We used this data to integrate it with logistic regression model to have a future view of pandemic. As the process of AI is to train the algorithm according to the dataset available after that we provide a test data for prediction. The results and curves are shown at the result section for clear view. Python code and implementation has also been defined in the later section for understanding and for future use. The main goal of this thesis would be to develop a machine learning model that could predict when this virus would be finished and how much time it will take more to be completely eradicate all the symptoms and analyze the cases. To develop such a model, a literature study alongside an experiment is set to identify a suitable algorithm. To assess the features that impact the prediction model.

As the thesis consist of two part, second part include the detection of COVID 19 using CNN method by training the model with the dataset of XRAY Images. As there are several other methods has been introduced for example image classification model it has several problems of not capturing the accurate

model feature and having problem in low recognition accuracy. As CNN is able to detect the virus at early stages because of its powerful deep learning multiple layers' algorithm. First the COVID 19 Dataset has been taken from the open source data set available on the internet. There are several stages of detection that includes the processing of datasets images, and applying image processing techniques in order to have a clear understanding of features in XRAY images. The model is trained by using convolute method to evaluate the models accuracy, Detecting virus and efficiency score.

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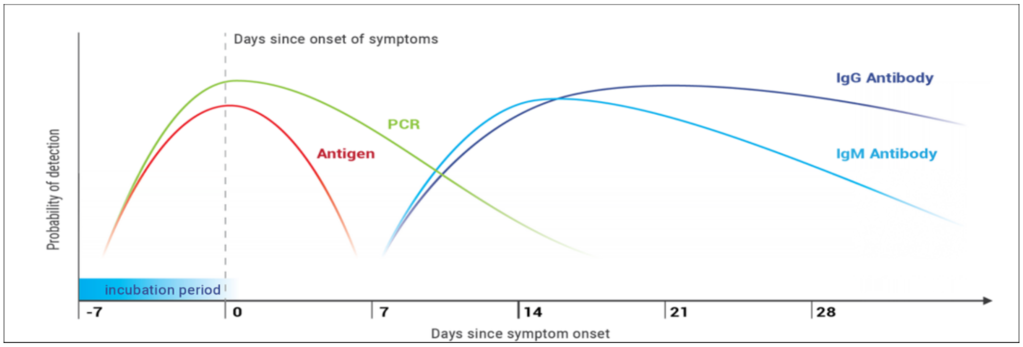
CHAPTER I

Introduction

Since January 2019, SARS COVID -19 spreads like a wild fire in all over the world. Researchers are still trying to find out the better cure for this disease as Number of cases increasing exponentially and death rate also increasing, it is impossible to test Each and every person due to the time and cost factors. Over recent years, machine learning has turned very reliable especially in the medical field. Using machine learning to predict COVID-19 in patients will reduce the time delay for the results of the medical tests and modulate health workers to give proper medical treatment to them and the preparation for future crises can be done easily. Up till now millions of people got effected by the virus and even after the vaccination still people are getting effected because vaccination haven't cured the virus completely. Vaccine helped to build immune system to fight back if the body got effected. As the virus is transmittable and spread quickly the most effective way to stop spreading it is the early detection and taking precaution accordingly by providing special care and treatment.

Figure 1.

Number of days may take to detect COVID-19



Currently ANTIJEN and PCR (Polymerase chain reaction) is commonly used to detect the COVID – 19, despite the facts, PCR and ANTIJEN has very less sensitivity of detection as COVID-19 shows its internal effects after 2 to 3 days. As the both test are expensive and time taking as well. So now here comes the machine learning that plays an important role in order to detect COVID-19 from chest X-RAY Images. In addition, non-COVID-19 viral pneumonia is one of the top causes of death in both young and old adults. According to the Centers for Condition Control and Prevention (CDC), over 10 million adult pneumonia patients are hospitalized each year in the world, with about 250,000 individuals dying from the disease [1]. Chest X-rays, according to the WHO, are the best accessible method of diagnosing pneumonia. Pneumonia is a lung infection caused by bacteria, viruses, or fungi. It can be caused by bacteria, viruses, or fungi. Even professional radiologists find it difficult to diagnose pneumonia since its symptoms appear to be identical to those of other pulmonary diseases. As a result, various algorithms for this aim have been developed. [2] Neural Network, competitive Neural Network, and a deep learning structure were employed in paper [3] to identify chest ailments using the CXR dataset, with deep learning outperforming the others. The use of CXR and CT for the diagnosis of lung-related repository illnesses, particularly pneumonia and COVID-19, is common. Medical images have been demonstrated to be useful and beneficial in identifying respiratory illnesses and COVID-19 in studies. One of the most significant parts of the identification of pulmonary disorders is feature extraction. [7] used K-nearest neighbors (KNN) and support vector machines to solve the COVID-19 classification problem (SVM).

Deep learning models have recently considered to be a successful method in the field of medicine for the diagnosis of pathologies, including lung pathology, which is the subject of this study, as well as for the identification of other medical disorders. [4-5-6] K. Fukushima [8] constructed a convolutional neural network from the visual context research neo cognition in 1980. Yann Lecun, Leon Bottou, and Yoshua Bengio established a major milestone in convolutional neural networks in 1998 when they introduced the LeeNet-5 design [9], which is currently frequently used for handwritten recognition tasks. As a result, we used a convolutional neural network to diagnose the existence of COVID-19 and pneumonia in this study. Because diagnosing those diseases can be difficult, even for experienced radiologists, this study intends to make it easier and faster for radiologists to diagnose COVID-19 and pneumonia from chest X-ray pictures.

Different approaches with Deep Learning Algorithm have been anticipated in many research paper to detect the existence of Virus in X-ray images and computer tomography scan images.

To detect COVID-19 pneumonia on a single chest computer tomography (CT) scan image, Ko et al. [10] proposed a basic 2D deep learning system termed the first-track COVID-19 classification network (FCONet). For training the FCONet model, they used a transfer learning strategy using state-of-the-art deep learning models as the backbone. On the test dataset, ResNet50 FCONet had the greatest performance scores of 99.8%, 100%, and 99.87 percent for sensitivity, precision, and accuracy of all the fully convolutional FCONet models. To detect COVID-19 in chest X-ray pictures, Rajaraman et al. [11] developed an iteratively pruned deep learning model ensemble. In their research, they used two models. The first model was trained to categorize normal and abnormal chest X-rays, whereas the second model was trained to classify COVID-19 and pneumonia cases by transferring the first model's training weights to the second model. They employed the ensemble method to increase their model's prediction performance, achieving a 99.01 percent accuracy. Hammoudi et al. [12] proposed customized models for detecting COVID-19 pulmonary symptoms at an early stage. The researchers used a dataset that includes bacterial pneumonia, viral pneumonia, and normal chest X-ray pictures to train their models. proposed the COVID-Net network as a means of diagnosing COVID-19 and non-COVID-19 pneumonia [13]. They used a new dataset of 13,975 chest X-ray pictures from 13,870 patients, and their algorithm performed with a 93.3 percent accuracy rate. However, for the 3-class classification, the research solely used accuracy as a performance metric. For the screening of COVID-19 pneumonia from other kinds of viral pneumonia, Han et al. [14] utilized an attention-based deep 3D multiple instance learning (AD3D-MIL) technique. The researchers examined a dataset of CT scans that contained 230 COVID-19 CT scans from 79 participants, 100 CT scans from pneumonia patients, and 130 CT scans from those who did not have pneumonia. Their program had a 97.9% total accuracy, according to the researchers.

COVID-19 was detected on CXR using deep learning [15]. There were three phases to the system. The presence of pneumonia was found in the first phase, followed by the identification of COVID-19 and pneumonia, and finally, illness localization. The article used 6,523 CXR pictures and achieved a 97 percent accuracy rate. [16] demonstrated an AI system that uses CXR pictures to predict COVID-19 pneumonia. [17] classified COVID-19 from CT images using transfer learning and semi supervised adversarial detection. [18] presented CCSHNET, which uses transfer learning and discriminatory correlation analysis to identify COVID-19. They reported that CCSHNET outperformed 12 state-of-the-art COVID-19 detection models, with a sensitivity of 98.3 percent. [19] used a patch-based CNN to diagnose COVID-19 in CXR pictures, and their model outperformed the competition. Image feature descriptions, feed-forward NN, and CNN were given in [20] for the identification of illnesses using COVID-19 CXR images. [21] proposed CorNet, a deep convolutional neural network based on the Xception architecture for COVID-19 infection detection utilizing CXR pictures. [22] established a clinical predictive model for COVID-19 disease estimation based on deep learning and laboratory data. The model was put to the test using data from 600 patients and 18 laboratory findings. [23] described the use of CXR and CT images to detect COVID-19 disorders using deep transfer learning. In [24], an optimization approach was used to create a hybrid CNN for diagnosing COVID-19. [25] described a deep learning-assisted technique for COVID-19 diagnosis. The results of a comparison of eight CNN models were provided.

Chest-x ray radiography can be used as a first-line triage process for non-covid-19 patients who have similar symptoms. However, the similarity between features of cxr images of covid-19 and pneumonia caused by other infections make the differential Diagnosis by radiologists challenging. We hypothesized that machine learning-based classifiers can reliably distinguish the cxr images of covid-19 patients from other forms of pneumonia. We used feature extraction and dimensionality reduction methods to generate an efficient Machine learning classifier that can distinguish covid-19 cases from non-covid-19 cases with high accuracy and sensitivity. We propose that Our COVID-classifier classifier can be used in conjunction with other tests for optimal allocation of hospital resources by rapid triage of non-covid-19 cases.

CHAPTER II

Artificial Intelliegence

As the technology become more advanced and continously growing since a decade computer information system takes a new step to train the machine like a human brain. As human brain is able to identify the differences between colours, different between images by learning by seeing or by observing. Similarly scientist had developed the way to train machines by using Artificial Intelligence algorithms. ,

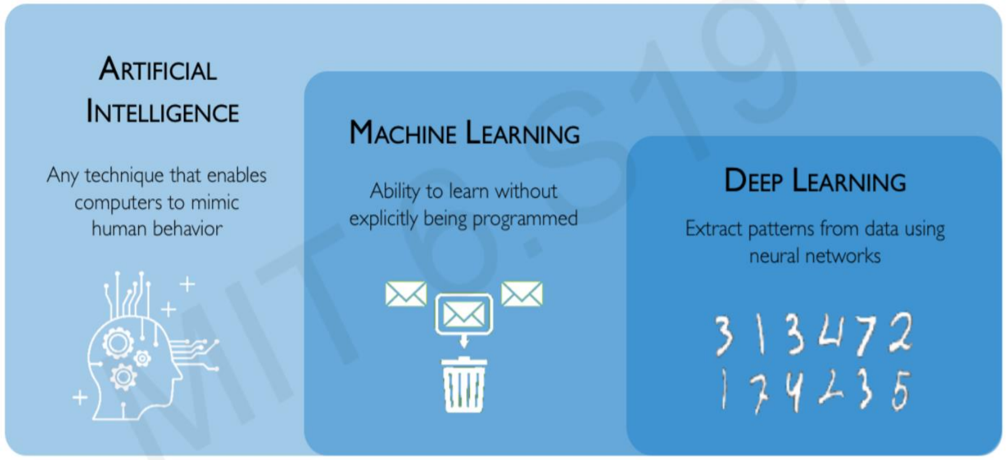
Artificial Intelligence consist of Machine learning, Deep Learning, and nueral Networks. These learning process differ in the term of Training data. Detailed evaluation of above learning methos is define below.

Machine learning is the technique for recognizing pattern that can be applied to medical images. Although it is powerfull sets of code that is able to diagnose dieases. Machine learning generally starts from the identification of images features, classification by using ML algorithm. ML algorithm compute the features of images that are believed to be the important for training and learning purpose. After deep training the machine system is able to predict and diagnose the dieseas. ML algorithm creates its own matrices for recognition of all the important pattern of images in order to provide input for algorithm.

There are multiple methods that can be used having with different strenght and weaknesses. There are open-source versions of most of these machine learning methods that make them easy to try and apply to images. Several metrics for measuring the performance of an algorithm exist; however, one must be aware of the possible associated pitfalls that can result in misleading metrics. More recently, deep learning has started to be used; this method has the benefit that it does not require image feature identification and calculation as a first step; rather, features are identified as part of the learning process. Machine learning has been used in medical imaging and will have a greater influence in the future. Those working in medical imaging must be aware of how machine learning works.

Figure 2.

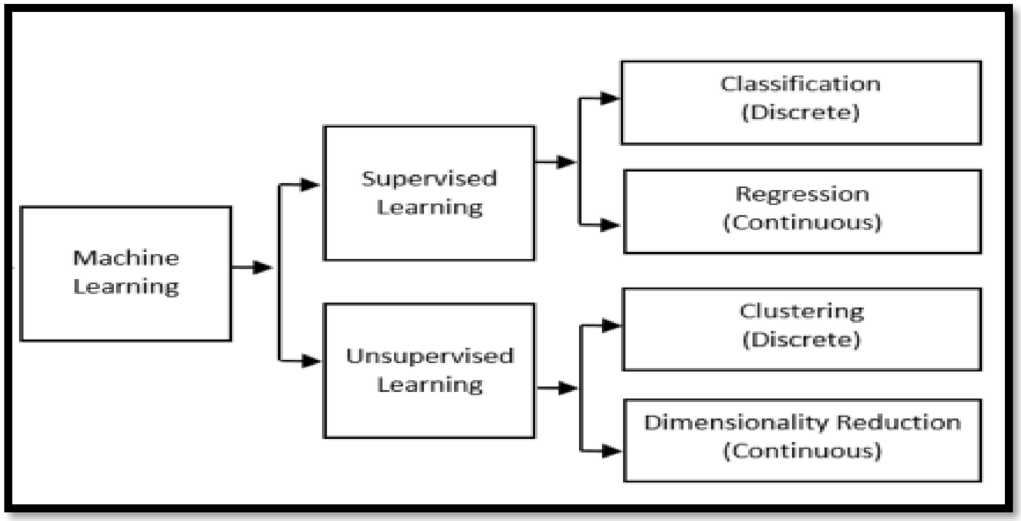
AI, ML and DEEP Learning



There are several terms commonly used in the machine learning community that may not be familiar to radiologists. The following list of key terms may help in understanding how machine learning works. Classification: The assigning of a class or label to a group of pixels, such as those labelled as tumor with use of a segmentation algorithm. For instance, if segmentation has been used to mark some part of an image as "abnormal brain," the classifier might then try to determine whether the marked part represents benign or malignant tissue. Model: The set of weights or decision points learned by a machine learning system. Once learned, the model can be assigned to an unknown example to predict which class that example belongs to. Algorithm: The series of steps taken to create the model that will be used to most accurately predict classes from the features of the training examples. Labelled data: The set of examples (e.g., images), each with the correct "answer." For some tasks, this answer might be the correct boundary of a tumor, and in other cases, it might be whether cancer is present or the type of cancer the lesion represents. Training: The phase during which the machine learning algorithm system is given labelled example data with the answers (i.e., labels)—for example, the tumor type or correct boundary of a lesion. The set of weights or decision points for the model is updated until no substantial improvement in performance is achieved. Validation set: The set of examples used during training. This is also referred to as the training set. Testing: In some cases, a third set of examples is used for “real-world” testing. Because the algorithm system iterates to improve performance with the validation set, it may learn unique features of the training set. Good performance with an “unseen” test set can increase confidence that the algorithm will yield correct answers in the real world. Note that different groups sometimes use validation for testing and vice versa. This tends to reflect the engineering versus statistical background. Therefore, it is important to clarify how these terms are used. Node: A part of a neural network that involves two or more inputs and an activation function. The activation function typically sums the inputs and then uses some type of function and threshold to produce an output. Layer: A collection of nodes that computes outputs (the next layer unless this is the output layer) from one or more inputs (the previous layer unless this is the input layer). Weights: Each input feature is multiplied by some value, or weight; this is referred to as weighting the input feature. During training, the weights are updated until the best model is found. Machine learning algorithms can be classified on the basis of training styles: supervised, unsupervised, and reinforcement learning (15). To explain these training styles, consider the task of separating the regions on a brain image into tumor (malignant or benign) versus normal (non diseased) tissue.

Figure 3.

Machine learning classification

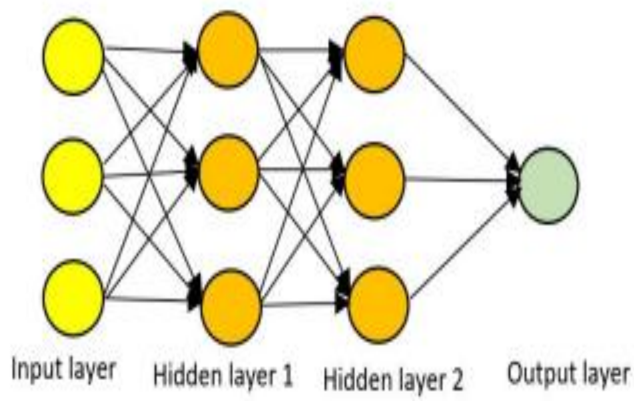


Neural Network

Neural network can be define by taking an example of human brain. Human brain consisit of Nueron that transfer signals to the brain similarly at basic leven ANN or NN comprised of inputs, weights, a bias threshold, and an output. Machine Learning is the Sub Part of Artificial Neural Network. An ANN typically consists of an input layer, multiple hidden layers and an output layer. Finding pattern by training and improving structure and flow of data is called as machine learning in easy words. The patterns are discovered by having some peripheral data. The "machine" then trains itself that how the patterns between the input and output relate. The levels between input and output, where Input data sets has been analysed in deep details by hidden layers and convolution take place or the Machine Learning takes place. This can be seen as a Hidden box where it is not necessarily known how the computer calculates the output but mathematical convolution and correlation method take place. There are two main categories of Machine Learning; these are Unsupervised Learning and Supervised Learning. been analysed in deep details by hidden layers and convolution take place or the Machine Learning takes place. This can be seen as a Hidden box where it is not necessarily known how the computer calculates the output but mathematical convolution and correlation method take place. There are two main categories of Machine Learning; these are Unsupervised Learning and Supervised Learning.

Figure 4.

ANN Model



Neural Network Structure

To understand the structure of NN we need to understand the structure of mathematical equation and description of a Neural Network. Then we will move towards how to train the dataset by supervised learning or labelled data. recurrent neural networks (RNN), Convolutional neural networks (CNN), transformers, and numerous more neural network variations exist. There has been a surge in study on these variants in recent years. However, the simplest, basic vanilla version with no extra embellishments is the first step in comprehending any of them.

Neural Network Layers

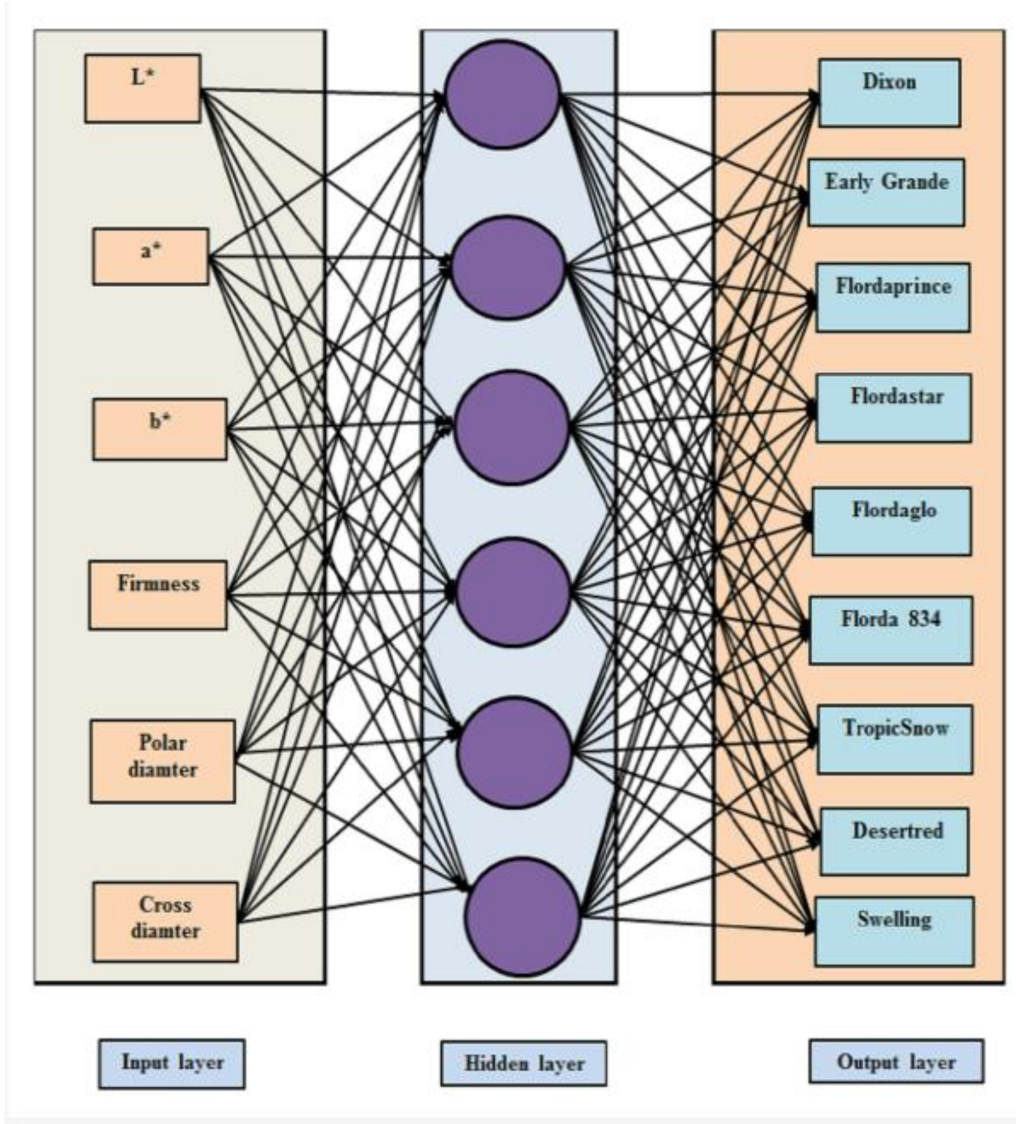
Each neuron from one layer is connected to each neuron from the next layer by a little line in these as shown in the figure above. This is supposed to show how the function of each neuron in one layer, represented by the little number inside it, influences the excitation of each neuron in the following layer.

These links, however, are not all created equal. Some connections will be stronger than others, and as you'll see momentarily, assessing the strength of these connections is at the heart of how a neural network works as an information processing device. Before jumping to the conclusion of mathematical equation that how one-layer impact the next or how algorithm system training works. Let us discuss about that why its even practical to expect a layered structure like this to behave intelligently. What is the reason behind of interlinking the layers why we can’t just directly connect the layers to have an output? The reason behind is when the as a human we recognize a digit or a image our brain neuron learned it according to the patterns.

We may expect that each neuron in the second-to-last layer corresponds to one of these subcomponents in an ideal world. That if you feed in a picture with a loop on top, for example, there will be a certain neuron whose activity is near to 1.0.

Figure 5.

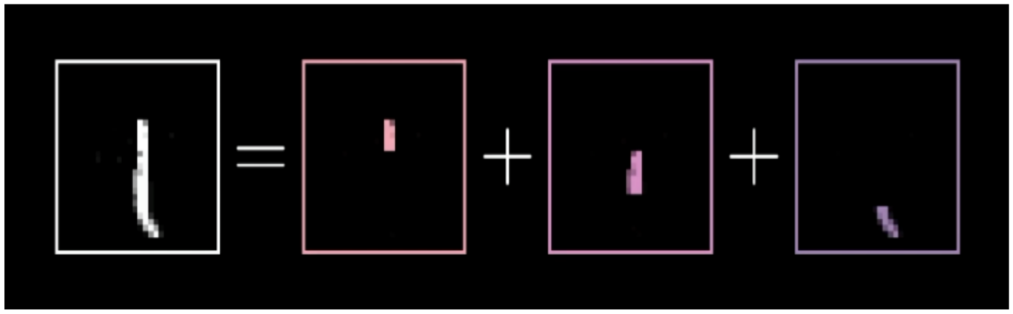
Structural view of nueral network



We are not referring about this specific pixel loop. The hope is that any looping pattern at the top of the picture will activate this cell. Going from the third to the last layer would then simply involve understanding which subcomponent combinations match to which digits. As a fact, this merely pushes the issue farther down the road, because how would you recognize these subcomponents, let alone understand what they should be? And I haven't even touched on how one layer impacts the next! But bear with me for a bit on this.

Figure 6.

Every picture bunch of edges



A loop can be broken down into sub problems by recognizing it. One fair approach would be to identify the numerous edges that make it up first. Similarly, this image recognition approach works on every image.

So we're hoping that each neuron in the network's second layer corresponds to a little edge. When an image is received, it may activate neurons associated with all of the picture's unique tiny edges. This would then light up the neurons in the third layer that are associated with bigger scale patterns like loops and long lines, causing a neuron in the final layer to activate, corresponding to the proper digit.

Transfer of Information Between Layers

How do you put this as a general concept into practice? The objective is to develop a method that can turn pixels into edges, edges into patterns, and patterns into numerals. It would be very nice if all of those stages followed the same mathematical technique.

Let's assume the goal is for this one specific neuron in the second layer to detect whether or not the picture has an edge in this precise spot. We should have to think about which parameters of the image have important information like knobs dial that we need to tweak. So that its expressive enough to potentially capture this pattern or other pixel pattern. Now in order to initiate we have to assign a ignited weights to initialize the process that weight belongs to each connection between neuron and the neuron from the first layers. These weights are just a digital number.

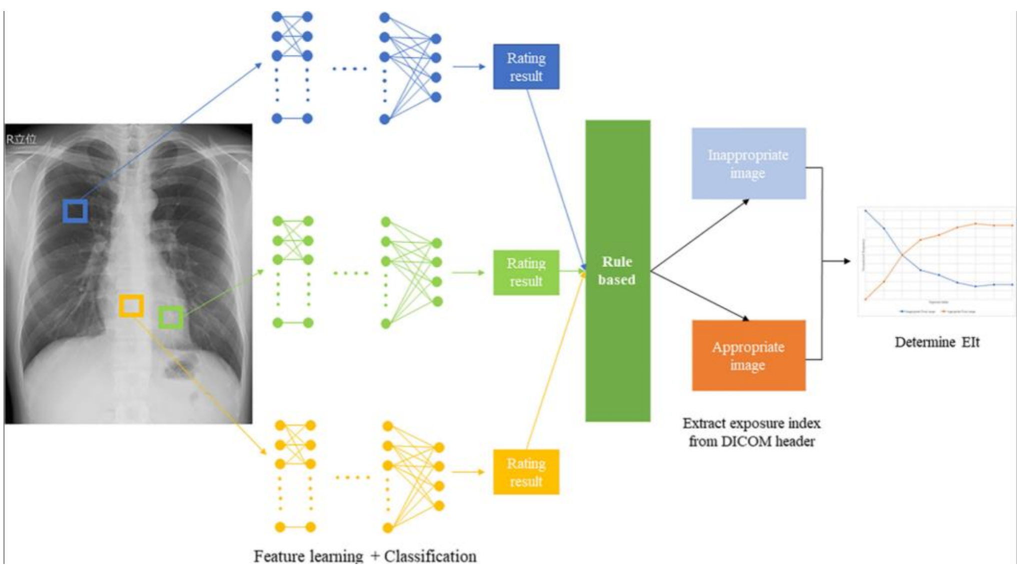
Each weight represents the relationship between the neuron in the first layer and the new neuron in the second layer.

If the first layer neuron is turned on, a positive weight indicates that the second layer neuron should be turned on as well, whereas a negative weight indicates that the second layer neuron should be turned off.

Of course, these weights will interact and conflict in fascinating ways, but the aim is that if we sum up all of the wants from all of the weights, we'll end up with a neuron that can detect the edge we're searching for relatively effectively (as long as the weights are well-chosen).

Figure 7.

Transfer of information between layers

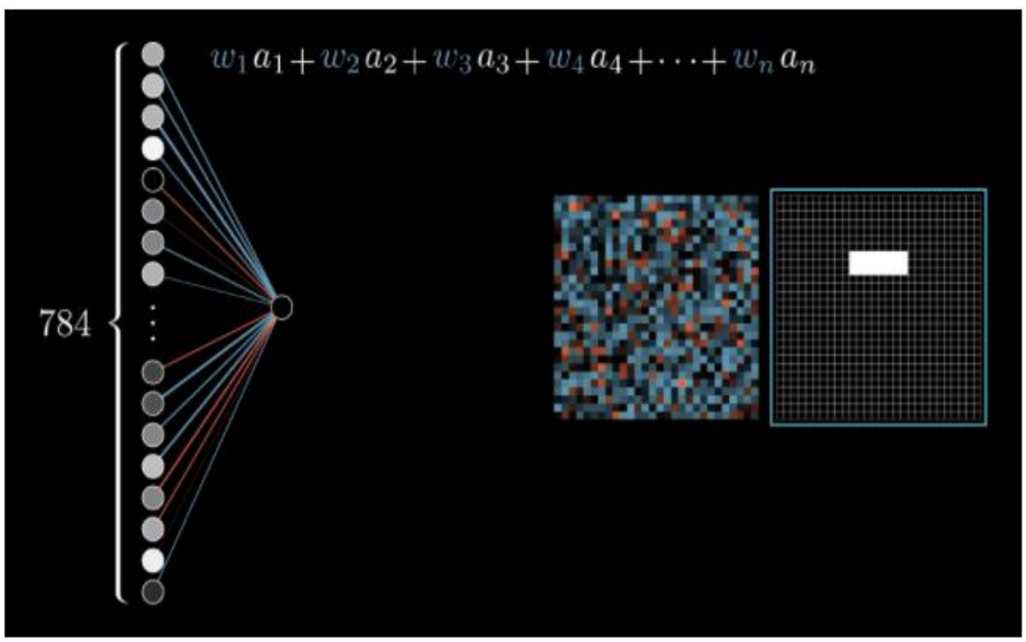


$$w1a1 + w2a2 + w3a3 + w4a4 + \cdots \ldots \ldots \ldots \ldots \ldots \ldots \ldots + WnAn$$

As shown in the picture below all the weights are multiplied by their respective inputs these weight are being organized into grid of their own. Each weight is associated with one of the 748 input pixel. Arranging the weights into this 28 x 28 grid makes the correlation between the input image and the output activation clear. By taking a weighted sum of all pixel values really just amounts to adding up the values of the pixel in this region we care about. However, large blobs of active pixels will be picked up by this weight pattern! (It's not only the boundaries that are important.) You could want to connect some negative weights with the adjacent pixels to properly pick up on whether or not this is an edge. When these pixels are bright and the surrounding pixels are dark, the total will be the highest. The outcome of a weighted sum like this might be any number, but we want the activations to be between 0 and 1 for this network. As a result, it's usual to feed this weighted sum into a function that squishes the real number line between 0 and 1.

Figure 8.

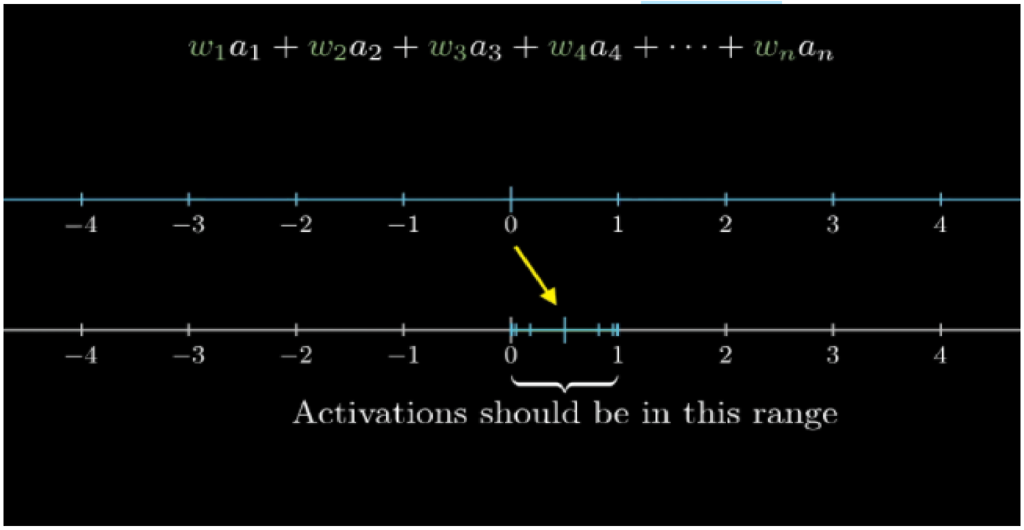
Weighted sum of perceptron



There is no limit to how big or small the weighted sum might be but our new neuron value should be between 0 and 1 so we need to somehow squish the range of possible output down to size as shown in the figure above

Figure 9.

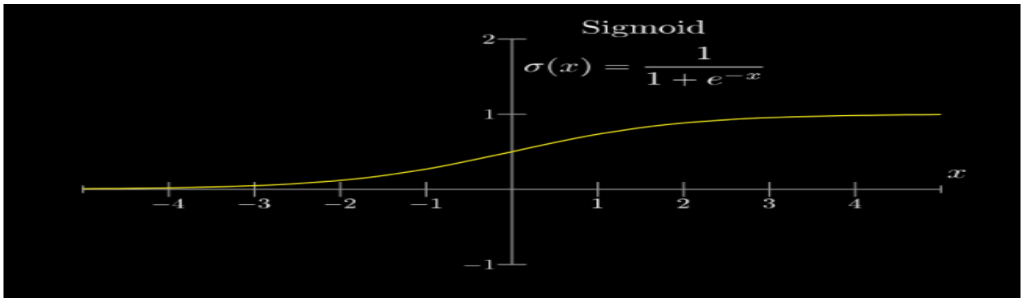
Range of neuron values



The "sigmoid" function, often known as a logistic curve and denoted by the sign sigma, is a popular function that does this. Strong negative inputs near to 0, very positive inputs close to 1, and it progressively rises around 0. As a result, the neuron's activity will essentially be a measure of how positive the weighted sum is.

Figure 10.

Sigmoid function

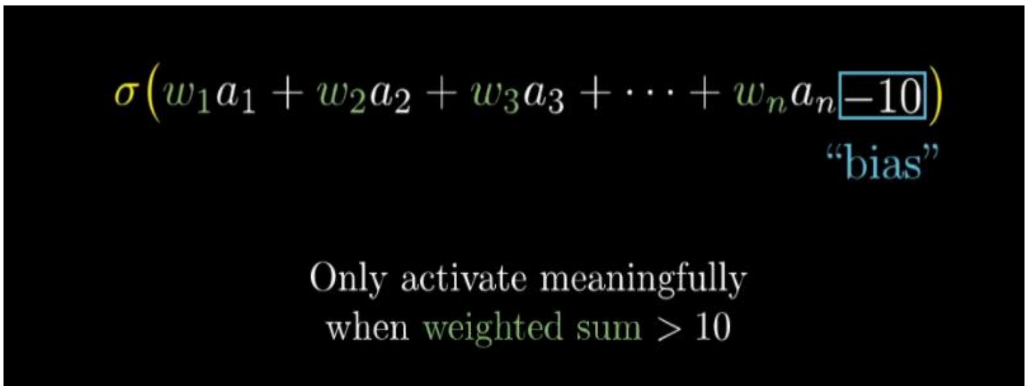


But it's possible that we don't want the neuron to light up when the weighted total exceeds 0. Maybe we just want it to be useful when the sum is more than, say, ten. To put it another way, we want some bias in order for it to remain inactive.

Then we'll add a value to the weighted sum, such as -10, before inserting it into the sigmoid function, which squishes everything into the range of 0 to 1. This extra number is referred to as a bias. As shown in the figure below.

Figure 11.

bias value of weighted sum



The bias informs you how big that weighted sum has to be before the neuron becomes meaningfully active, and the weights tell you what pixel pattern this neuron in the second layer is picking up on. This is for one neuron, every other neuron in the second layer will likewise have weighted connections to the first layer's 784 neurons. Each neuron also has a bias, a value that is simply added to the weighted sum before being squished with a sigmoid. That's a lot to consider! There are 784x16 weights and 16 biases in this buried layer of 16 neurons.

And that's just the connection between the first and second layers. There are also a lot of weights and biases in the connections between the other levels. After everything is said and done, this network contains a total of 13,002 weights and biases! There are 13,002 knobs and dials to modify to make this network act differently.

When we say "learn," as we shall in the following session, we mean "ask the computer to discover an ideal configuration for all these many, many numbers that will solve the problem at hand."

Imagine manually configuring all of these weights and biases, which is both amusing and terrifying. Setting weights in such a way that the second layer picks up on edges, the third layer picks up on patterns, and so on. rather than approaching these networks as a complete black box, I find this appealing. Because if you've developed an understanding of the significance of those weights and biases in your head, you'll be able to experiment with ways to improve the network's performance when it doesn't perform as expected.

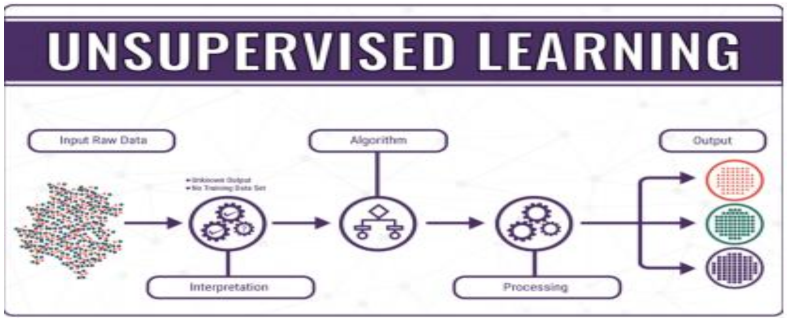
When the network does function, but not for the reasons you may think, looking into the weights and biases is a useful approach to test your assumptions and reveal the complete range of possible solutions.

Unsupervised learning

Unsupervised learning is when the data is not known Unlabelled or output is not predictable because of the variety of continuous changes. The important goal is then to find some hidden structure of the data. Unsupervised learning studies how systems can infer a function to describe a hidden structure from unlabeled data. The system doesn’t figure out the right output, but it explores the data and can draw inferences from datasets to describe hidden structures from unlabeled data. kernel density estimation, Principal component analysis, k-means clustering independent component analysis, Gaussian mixture models, support vector data description, self-organizing and map manifold learning Methods are used during unsupervised learning in industries. Scientist have compared which unsupervised model that is most the common in industries, where (principal component analysis) PCA are being used in 51% of the cases.

Figure 12.

Unsupervised Learning Scheme



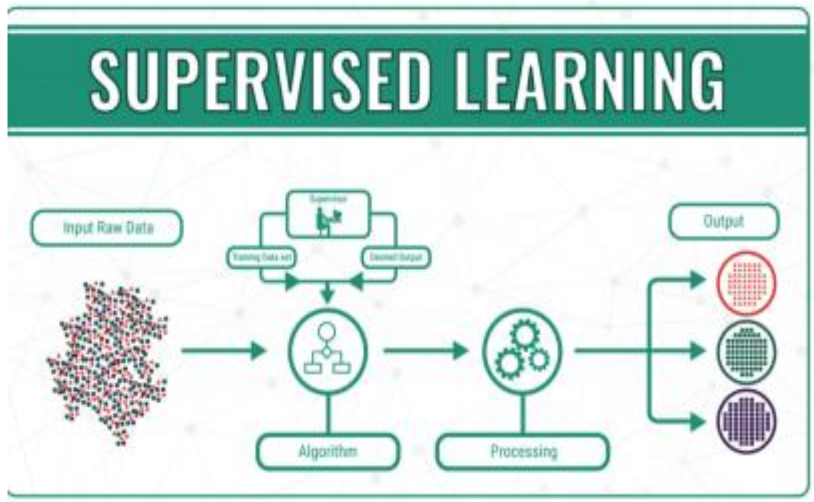
Supervised Learning

In supervised learning, each sample in the dataset is a pair of an input vector and an external output value (or vector), that we are trying to predict. An inferred function is generated by analysing the training set under a supervised learning algorithm. The inferred function, i.e. the training model, can be used to map or predict new samples. Both classification and regression are typical supervised learning programs where there is an input vector X, an external output Y, and the task T is to learn the experience E from the input X to the output Y. Some typical supervised learning algorithm types can be shown as follows.

- Linear Regression
- Ordinary Linear Regression
- Partial Least Squares Regression
- Penalized Regression
- Nonlinear Regression
- Multivariate Adaptive Regression Splines
- Support Vector Machines
- Artificial Neural Networks
- K-Nearest Neighbours
- Regression Trees
- Bagging Tree
- Random Forest
- Boosted Tree

Figure 13.

Supervised Learning Scheme



Supervised learning refers to the subset of machine learning methods which derive models in the form of input-output relationships. More precisely, the goal of supervised learning is to identify a mapping from some input variables to some output variables on the sole basis of a given sample of joint observations of the values of these variables. The (input or output) variables are often called attributes or features, while joint observations of their values are called objects and the given sample of objects used to infer a model is generally called the learning sample.

Logistic Regression

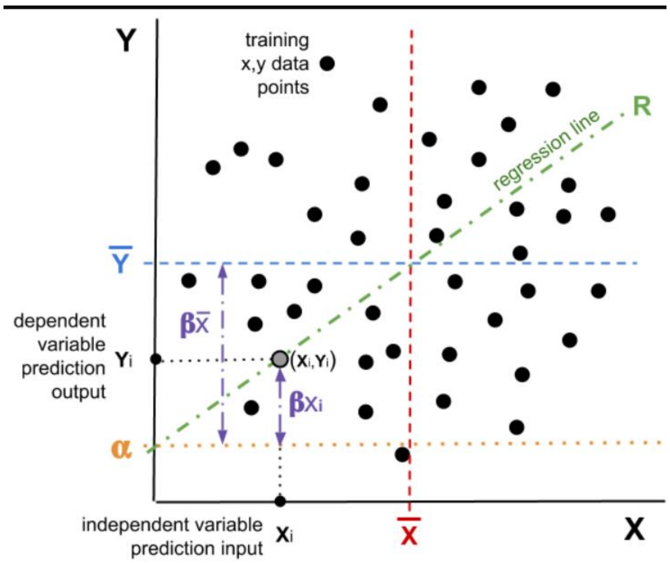
Before we dive into logistic regression let's take a step back and review linear regression in another as linear regression, we had some data weight (X) and size (Y) then we fit that into a line a shown in the picture and with that line we could do a lot of things for example we can

1. calculate the $R^2$and determine its weight (X) and size (Y) are correlated. Large values imply a large effect
2. calculate a p value to determine if the R^2Value is statistically significant

3. use the line to predict weight (X) and size (Y).

Figure 14.

Linear Regression



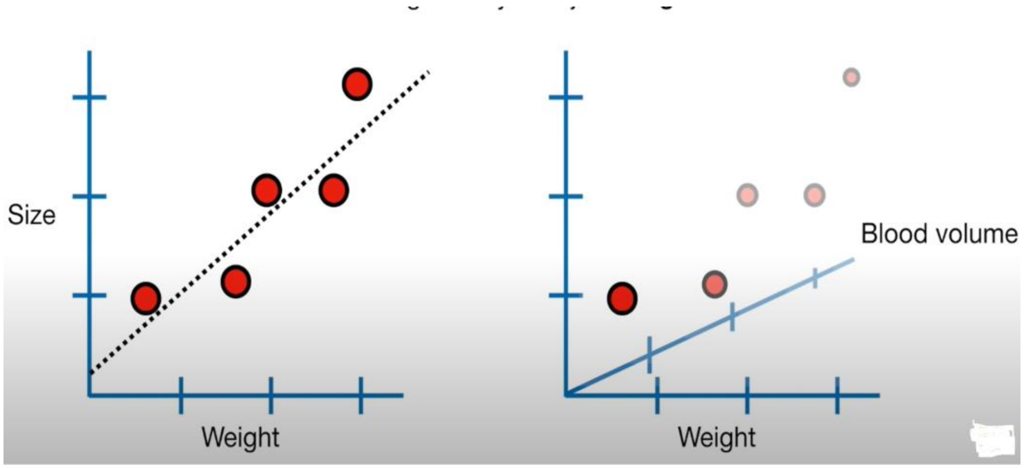
Now we are trying to predict size (Y) using weight (X) and blood volume correlation R. We could say we are trying to model size(Y) using weight(X) and blood volume (R) Now multiple regression Did the same thing that normal regression does

1. calculate R^2
2. calculate the P value
3. predict size (Y) given weight(X) and blood volume (R)

This is slightly fancy a machine learning If we will compare normal regression using weight to predict size vs multiple regression using weight and blood volume to predict size Comparing the simple model to the complicated one tells us if we need to measure weight and blood volume to accurately predict size or if we get away with just weight Now let me know about the leader of The Creation and the multiple regression now because we going to talk about the largest preparation that what's the idea behind the Logistic regression.

Figure 15.

Comparison between linear and multiple regression

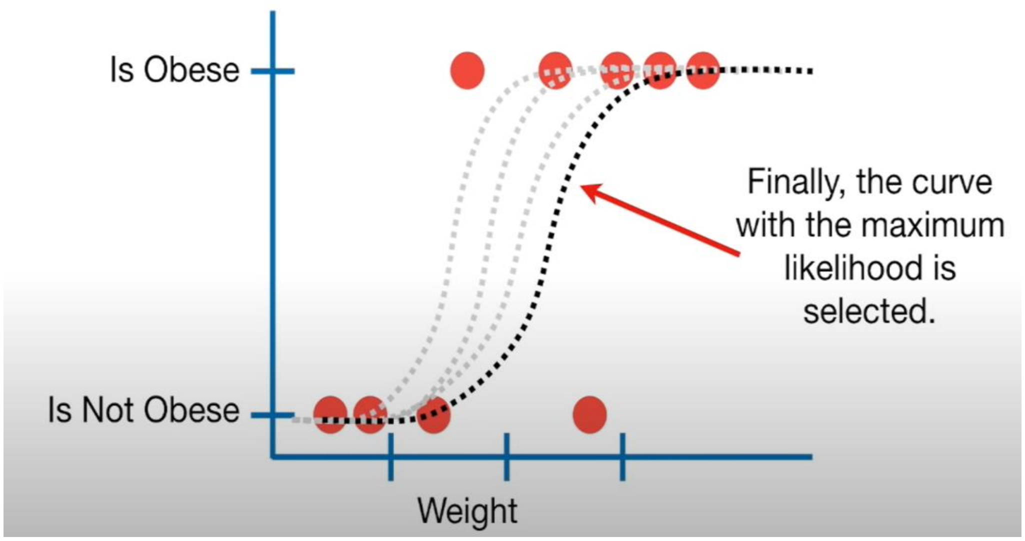


Logistic regression is similar to linear regression. Except Logistic regression predict whether something is true or false instead of predicting something continues like size in above explanation. for example in the picture these mice are obese or also instead of fitting a line into the data logistic regression fit an “S” curved shape “logistic function” that goes from 0 to 1 and that means that curve tell you the probability that a mouse is obese based on its weight if we wait a very heavy Mouse there is a high probability that the new mouse is obese if an intermediate Mouse then there is only a 50% chance that the mouse is obese lastly there is only a small probability that a little mouse is obese although logistic regression tells the probability that a mouse is obese or not it's usually used for classification for example if the probability amount is less than 50% then we will classify as obese otherwise will classify it as not obese just like a model simple models with linear regression predicted by Weight as shown in the picture.

With linear regression we fit the line using “Least Square” means we find the line that minimize the sum of the square of these residuals of obese and not obese shown in picture. This point is used to calculate R^2 and to compare simple model to complicated models. So the logistic regression doesn’t have the same concept of a "points", so it can't use least squares and it can't calculate R^2 instead it used something like maximum covers of points. Or curve fitting technique. Curve shifting by calculating best curve fit into the data able to generate new curve and the we choose the best line that cover maximum points. As shown in the figure below.

Figure 16.

Curve fitting the maximum values

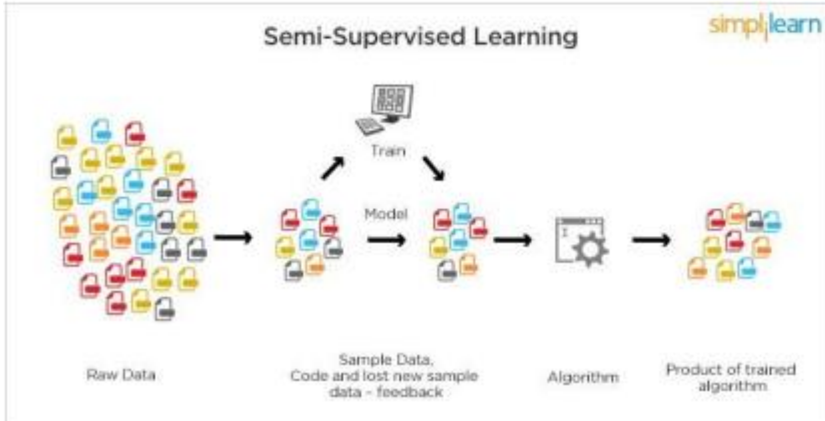


Logistic regression ability to provide probabilities and classify new samples using continuous and discrete measurement makes it a popular machine learning method. One big difference between linear regression and logistic regression is how the line is fit to the data. In summary logistic regression can be used to classify samples and it can use different type of data life size and or wait to do that classification and it can also be used to assess what variables are useful for classifying samples.

Semi-supervised machine learning

Figure 17.

Semi-Supervised Learning Scheme



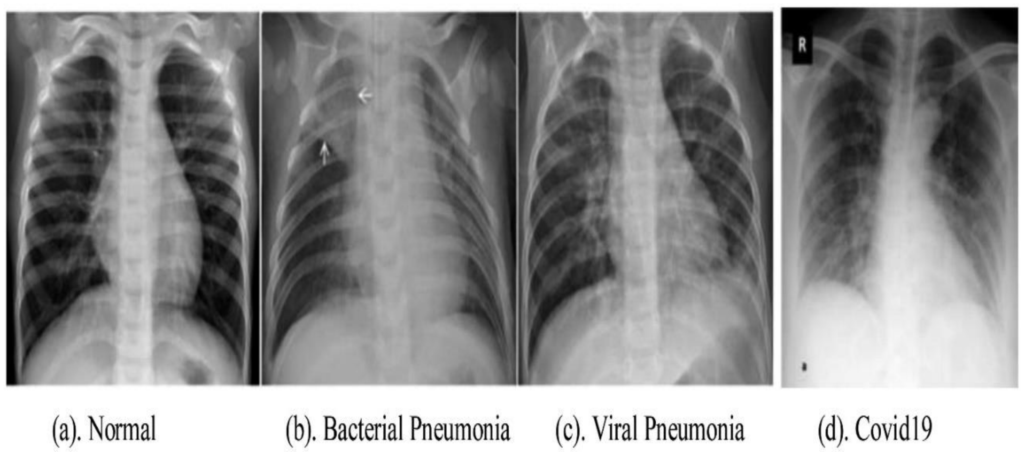
Algorithms fall somewhere in between supervised and unsupervised learning, since they use both labeled and unlabeled data for training typically a small amount of labeled data and a large amount of unlabeled data. The systems that use this method are able to considerably improve learning accuracy. Usually, semi-supervised learning is chosen when the acquired labeled data requires skilled and relevant resources in order to train it / learn from it. Otherwise, acquiring unlabeled data generally doesn't require additional resources.

Deep Learning

Deep learning is revolutionizing so many fields from robotics to medicine, and everything in between. So we start from what is deep learning actually is. Lets us start from the intelligence as intelligence is the ability to process information to inform future decision. Now the field of artificial intelligence is simply the field which mostly focus on the building algorithms we can call them artificial algorithms that can process information to inform future decision. Now machine learning is just a subset of artificial intelligence that focus on actually teaching an algorithm how to do this without being explicitly programmed to the task at the hand. Deep learning it's just a subset of machine learning which takes that idea even a step further and says how we can automatically extract the useful pieces of information needed to inform those future predictions or make a decision and detection. Teaching Algorithm how to learn it directly from raw data and we will discuss with a solid foundation of how we can understand or how do we understand under the hood but also we will discuss with a practical knowledge to implement state of the art Xray Images Detection algorithms.

Figure 18.

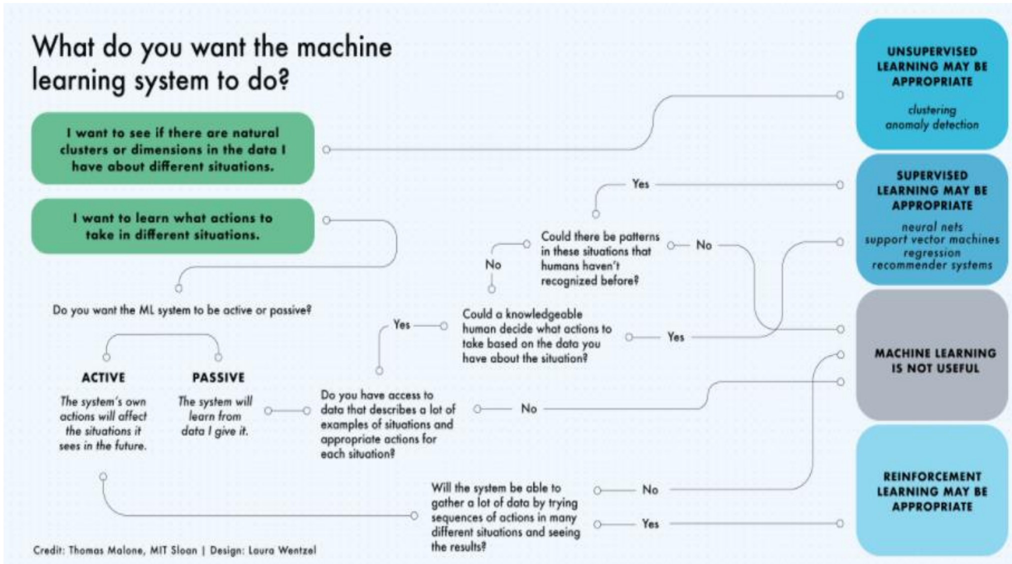
XRAY images



Now as we know that hand engineered feature are time consuming, brittle and not scalable in practice can we learn feature from the above picture. Here above x-ray images of with different viruses and infection has been shown. As a human brain how much feature we can detect from it as it need experience and studies as well but deep learning algorithm is able to detect the features after training using deep learning algorithm.

Figure 19.

Process of Machine Learning

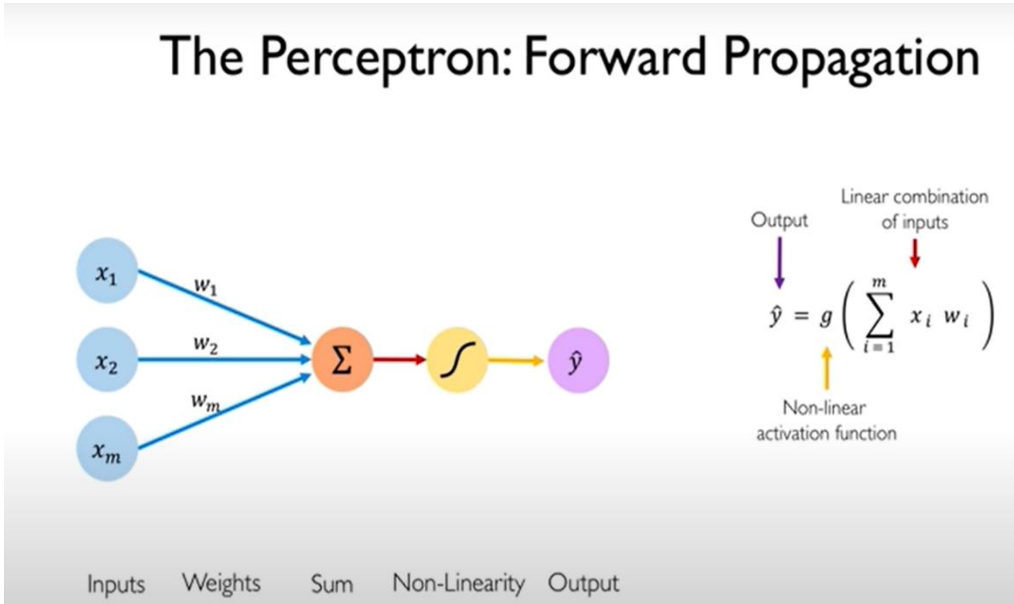


Deep Learning Perceptron

The fundamental building block of deep learning is a single neuron called as forward propagation perceptron. The idea of a perceptron or a single neuron is very basic and we will try and keep it as simple as possible and then we will try to work our way up from there lets start by discussing about the forward propagation of information through a neuron we define a set of inputs to that as X1 through Xm and each of these inputs have a corresponding weight W1 through Wn now we can do is with each of this input and each of these ways we can multiply them correspondingly together and take a sum of all of them then we take this single number that's summation and we pass it through what's called a nonlinear activation function and that produce our final output Y now this is actually not entirely correct we also have what's called a bias term in this neuron. As shown in figure 2 so the bias term purpose is to allow us to shift our activation function to the left and to the right regardless of our inputs rights so we can notice that the bias term doesn't affected by the X's its just a bias associates to that input. As shown in the figure the right side of below diagram illustrates mathematically as single equation and we can rewrite this using linear

Figure 20.

Forward propagation.



algebra in term of vectors and dot products so instead of having a summation over all of the X's we are going to collapse our X into vector capital X which is now just a list or a vector of inputs and we also have a vector of weights capital W to compute the output of a single perceptron all we have to do is to take the dot product of X and W as shown figure 3. Which represent that element wise multiplication and summation and then we apply the non-linearity which is denoted as *g*.

Figure 21.

Forward propagation with matrix elaboration

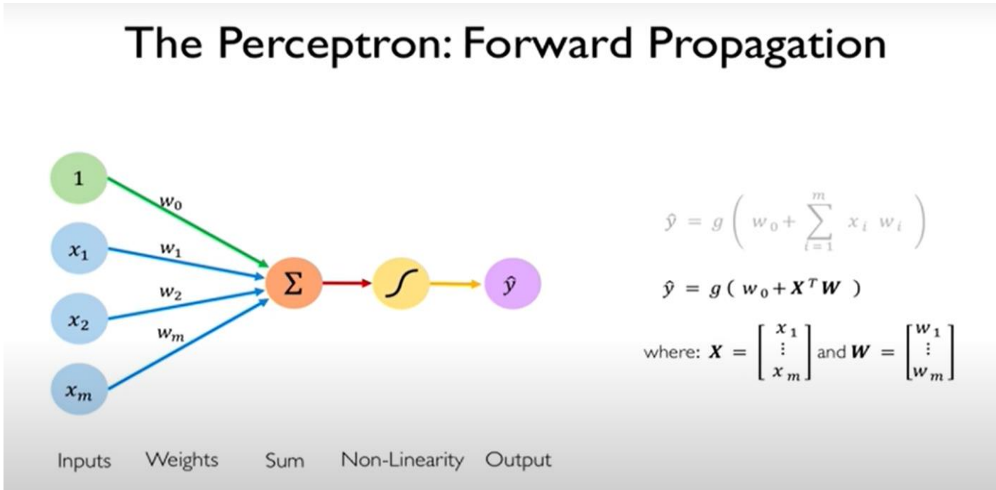
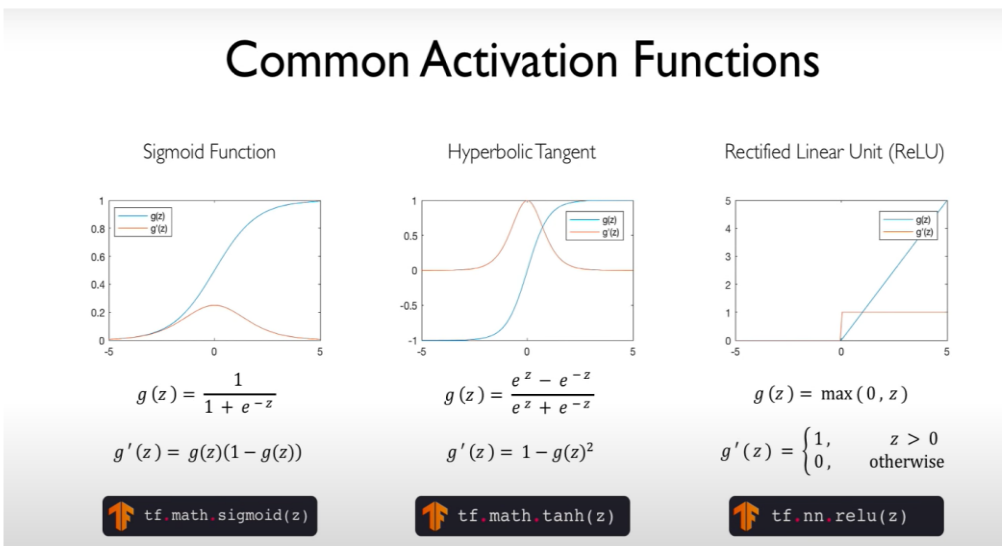


Figure 22.

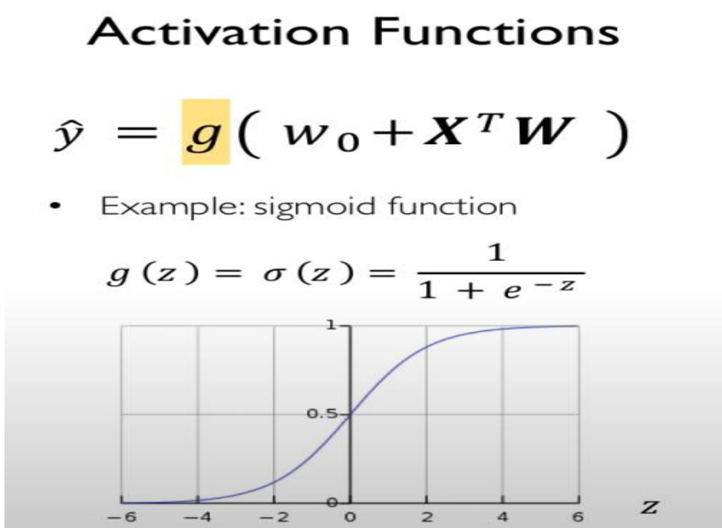
Activation function of deep learning models



So now we might be wondering what is this non-linear activation function. We have discussed it couple of times but we haven't really express it precisely what it is? one common example of this activation function.

Figure 23.

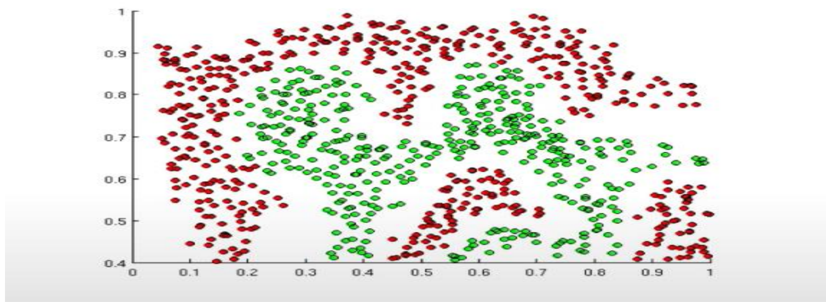
Sigmoid function for deep learning



Called as sigmoid function and it is easily seen that example of sigmoid function here in the figure this function takes any real number as input on x axis and it transform that real number into a scaler output between 0 and 1 its bounded output also between 0 and 1so the common use of case of the sigmoid function is to when we are dealing with probabilities because probabilities have to also be bounded between 0 and 1so sigmoid are really useful when we wat to output a single number and represent that number as a probability distribution in fact there are many common type of nonlinear activation function not just the sigmoid but many others that we can use in neural network, shown in figure 2.21.

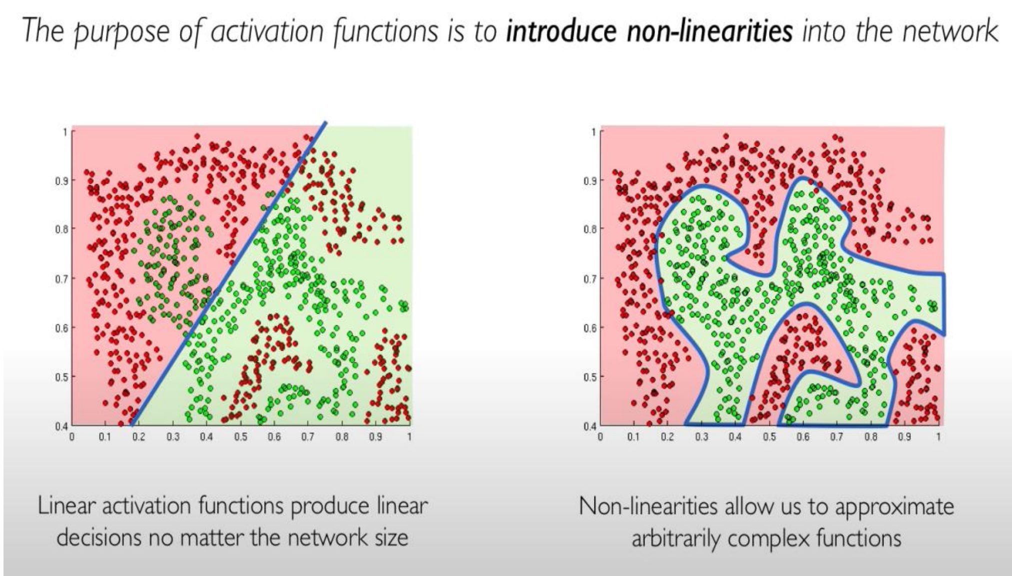
Figure 24.

non linearities of neuron



Now why do we care about activation functions the point of activation function is to introduce nonlinearities into together and this is actually really important in real life because in real life almost all of our data is non-linear and here is concrete example if we have to separate green dots from red dots shown in figure 2.22 using linear function how can we do that so i don't think so right we could get something like in figure 2.23. Oh we could do it, we wouldn’t do very good job at it and no matter how deep and how large our Network is if you are using a linear activation function you are just composing lines on top of lines and you are going to get another line right So this is the best we will be able to do with the linear activation function on the other hand nonlinearities allow us to approximate arbitrary complex function by king of introducing these nonlinearities into your decision boundary and this is what makes neutral network extremely powerful.

Figure 25.
Nonlinear function activation



We will understand with the simple example by taking figure 2.19 intro consideration. And for more appropriate understanding figure 2.24 gives us a clear understanding of how the sigmoid function effects the perceptron and to visualize what is going on neural network now if we have more than two inputs like in deep neural network then when we scale up the problem than we going to deal with hundreds or even a million of dimensional spaces and then visualization these type of plots become extremely difficult and its not practical and pause in practice so this is one of the challenges that we face when we are training with neural networks and really understanding their internals but we will talk about how we can actually tackle some of those challenges. We will discuss those while implementing in the methodology section.

CHAPTER III

Methodology

In this chapter we discuss about the methodology used and we going to talk about how machine got vision. Vision the most important human senses I believe sighted people rely on vision quite a lot from everything From navigating in the world to recognizing and manipulating objects to interpreting facial Expression and understanding very complex human emotions I think it's safe to say that vision is is a huge part of everyday human life and today we are going to learn about how we can use deep learning to bed very powerful computer vision system and actually we will predict about the covid-19 virus in x-ray images and we will also predict the trend of covid-19 virus in other countries by checking the current data. This is a very super simple definition of what religion at its core really means but actually vision is so much more than simply understanding what an image is or it means not just what the image is off but also understand where the object in the scene are and really predicting here the object means the symptoms of covid-19 present in x-ray images.

The Deep learning has a very deep application in medicine and healthcare so where we can take these raw images of X-Ray and scans of patient and learn to detect things like pneumonia cancer and covid-19 etc.

Datasets

For COVID 19 prediction, GitHub live repository have been used that contain data of more then 100 countries and up-to-date. So the current result and graphs is according to the updated data up till 4rth of January 2022. A variety of predictors were taken into account. COVID-19 is a dynamic pandemic that increases and decreases over time, even on a daily basis. As a result, it's likely that time will have a role in COVID-19 mortality. The episode date, a derived/combined variable in the dataset, relates to the earliest accessible date from symptom start (the first day when COVID-19 symptoms manifested), laboratory specimen collection date, or reported date as the best estimate of when the disease was acquired.

This folder provides daily summary tables of confirmations, fatalities, and recovered data. The daily case report is used to input all data. If errors in our historical data are discovered, the time series tables may be amended.

Two-time series tables show confirmed cases and deaths in the United States, as reported at the county level. Time series covid19 confirmed US.csv and time series covid19 deaths US.csv are the two files.

The global confirmed cases, recovered cases, and deaths are all shown in three time series tables. At the provincial/state level, Australia, Canada, and China are reported. The Netherlands, the United Kingdom, France, and Denmark all have dependents recorded at the province/state level. At the country level, the United States and other countries are involved.

- Time series covid19 confirmed global.csv
- Time series covid19 confirmed global.csv,
- Time series covid19 deaths global.csv,
- Time series covid19 recovered global.csv are the new names for the tables.

Updates are made every so often.

Once a day, at 23:59, (UTC).

Warning that has been deprecated

The following files have been archived and will no longer be updated. We are upgrading our time series tables to reflect the changes made with the introduction of the new data format. For the most up-to-date time series data, see time series covid19 confirmed global.csv and time series covid19 deaths global.csv.

Prediction Model and Algorithm

Python programming and its libraries (Numpy, Pandas, Matplotlib) has been used.

Numpy

Python's NumPy library is the foundation for numerical computation. It's a Python library that includes a two - dimensional representation object, various derived objects (such as masked arrays and matrices), and a variety of routines for performing fast array processes, such as shape manipulation, mathematical, logical, sorting, I/O, discrete Fourier transforms, selecting, basic linear algebra, basic statistical operations, random simulation, and more.

Pandas

Pandas is a Python library that provides quick, versatile, and expressive data structures for working with "relational" or "labeled" data. Its goal is to serve as the foundation for undertaking realistic, real-world data analysis in Python. Furthermore, it aspires to be the most powerful and versatile open source data analysis and manipulation tool accessible in any language. It is well on its way to achieving this aim.

Pandas is well-suited to a wide range of data types:

- Time series data that is sorted and unordered (though not necessarily fixed-frequency).
- Tabular data having columns of varying types, such as in a SQL table or an Excel spreadsheet
- Any other type of statistical or observational data collection. To be inserted into a panda’s data structure, the data does not need to be tagged at all.
- Row and column labels for arbitrary matrix data (homogeneously typed or heterogeneous).

MatplotLib

Matplotlib is a display of information and visual plotting package for Python and its numerical extension NumPy that runs on all platforms. As a result, it provides an open source alternative to MATLAB. Matplotlib's APIs (Application Programming Interfaces) may also be used to incorporate charts in graphical user interfaces. In most cases, a Python matplotlib script is constructed so that only a few lines of code are necessary to create a visual data plot. Two APIs are overlaid by the matplotlib scripting layer:

The pyplot API is a tree of Python code objects, with matplotlib at the top. pyplot is a set of OO (Object-Oriented) API objects that may be constructed with more freedom than pyplot. This API allows you to use Matplotlib's backend layers directly

Prediction Model

Flow of prediction model has been described for the understanding the flow of program. Numpy, pandas, matplotlib has been imported in order to use in these in the program. After calling data set of all the countries we took top 10 countries according to the number of cases and arrange them in ascending order. Two function has been defined to plot the graph according to the number of cases and second function to plot the regression graph of country. Curve fitting logistic regression function has been used from panda’s library that makes easier to apply logarithmic function code and results is shown later in the section.

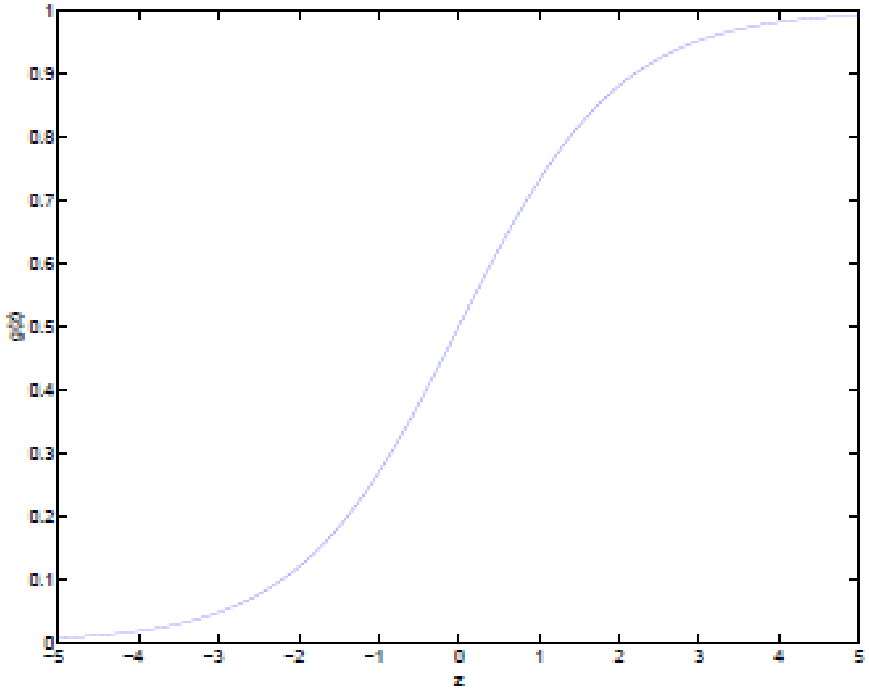
Logistic Regression in Prediction Model

- Used for classification y={0,1} i.e. y is categorical, intuitively h(x) should be bounded between {0,1}
- We choose sigmoid function as our hypothesis h(x):

$$h_\theta(x) = g(\theta^T x) = \frac{1}{1+e^{-\theta^T x}},$$

where

$$g(z) = \frac{1}{1+e^{-z}}$$



- Note that g(z) -> 1 as z -> \infinity and g(z) -> 0 as z-> -\infinity
- Therefore h(x) is bounded between 0 and 1

Interpretation:

$$h\theta(x) = g(\theta^T x)$$

$$g(z) = \frac{1}{1 + e^{-z}}$$

Suppose predict

Y =1 if $h\theta(x) \geq 0.5$

Predict

Y =0 if $h\theta(x) < 0.5$

Detection boundary

$$h\theta(x) = g(\theta_0 + \theta_{1x1} + \theta_{2x2})$$

Predict

Y=1 if -3 + x1+x2 >= 0

Figure 26.

Logistic regression curve fitting

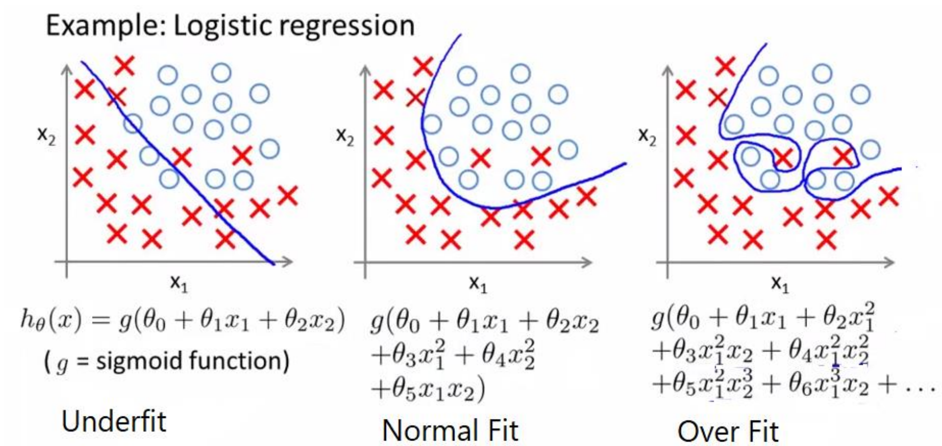


Figure 27.

Regularized logistic regression

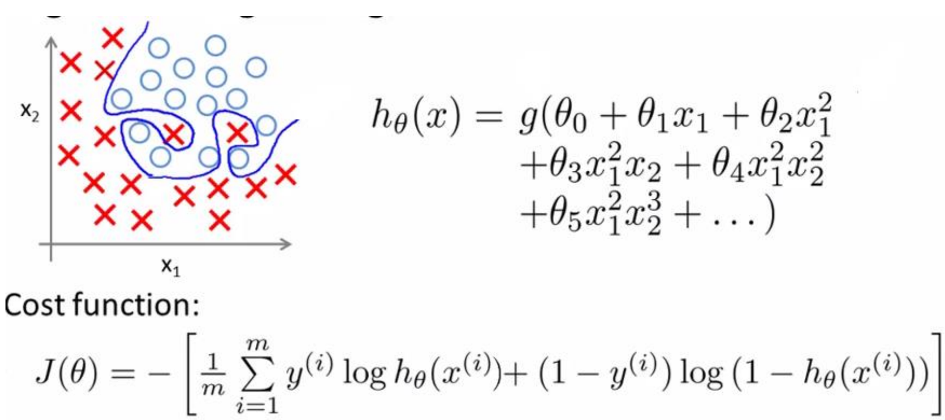
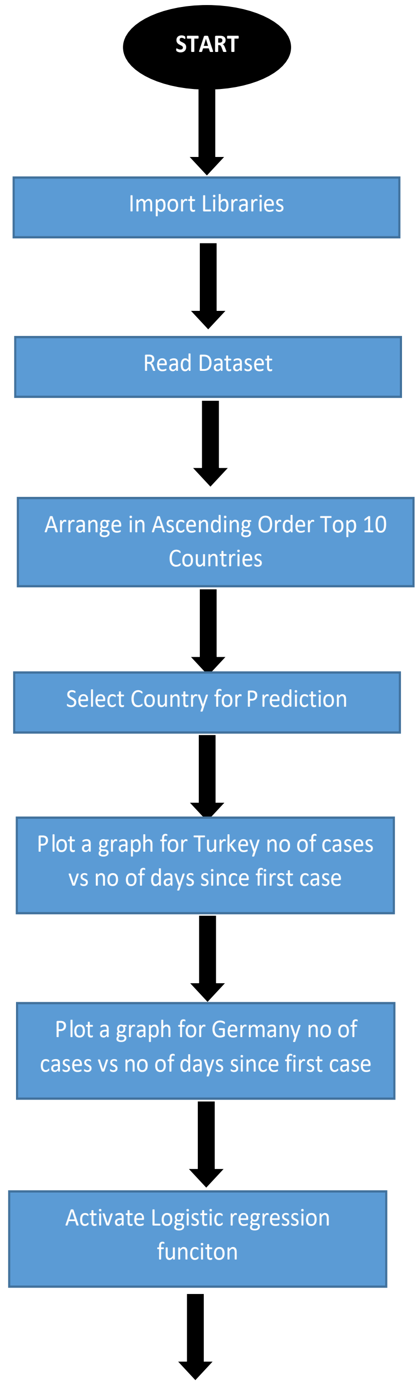
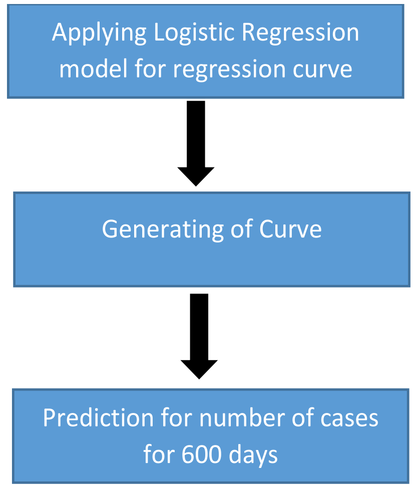


Figure 28.

Flow of The Program:





COVID 19 Detection Model

Dataset and Data Structure

The SARS COVID -19 disease is different from others and has several different characteristics. Images from infected and uninfected persons should be collected in a dataset in order to develop effective infection management and a dynamic early detection technique against COVID-19. This urgent requirement is stated as follows in the COVID-19 picture data collection: "Imagine if all of the practitioners and radiologist were infected, and there was no one to help us quickly"/ As a result, these types of datasets play a significant part in diagnosis. This study employed 130 sample chest x-ray training pictures and 18 sample chest x-ray test images from the Joseph Paul Cohen and Paul Morrison and Lan Dao COVID-19 image data collection, which is open-source data.

Figure 3.1 shows the complete details of dataset, dataset include 207130 OCT images. From 4686 patients passed initial image quality review and were used to train the AI system. The model is tested with 1000 images from 633 patients for each category. After Maximum 220 epochs iteration through a complete dataset the training stopped because further improvement is not shown and accuracy reached to 95 percent. Table 3.1 shows the complete characteristics of patients OCT image. And table 3.2 show the performance by human retinal expert grading using OCT.

Figure 29.

Detail structure of dataset

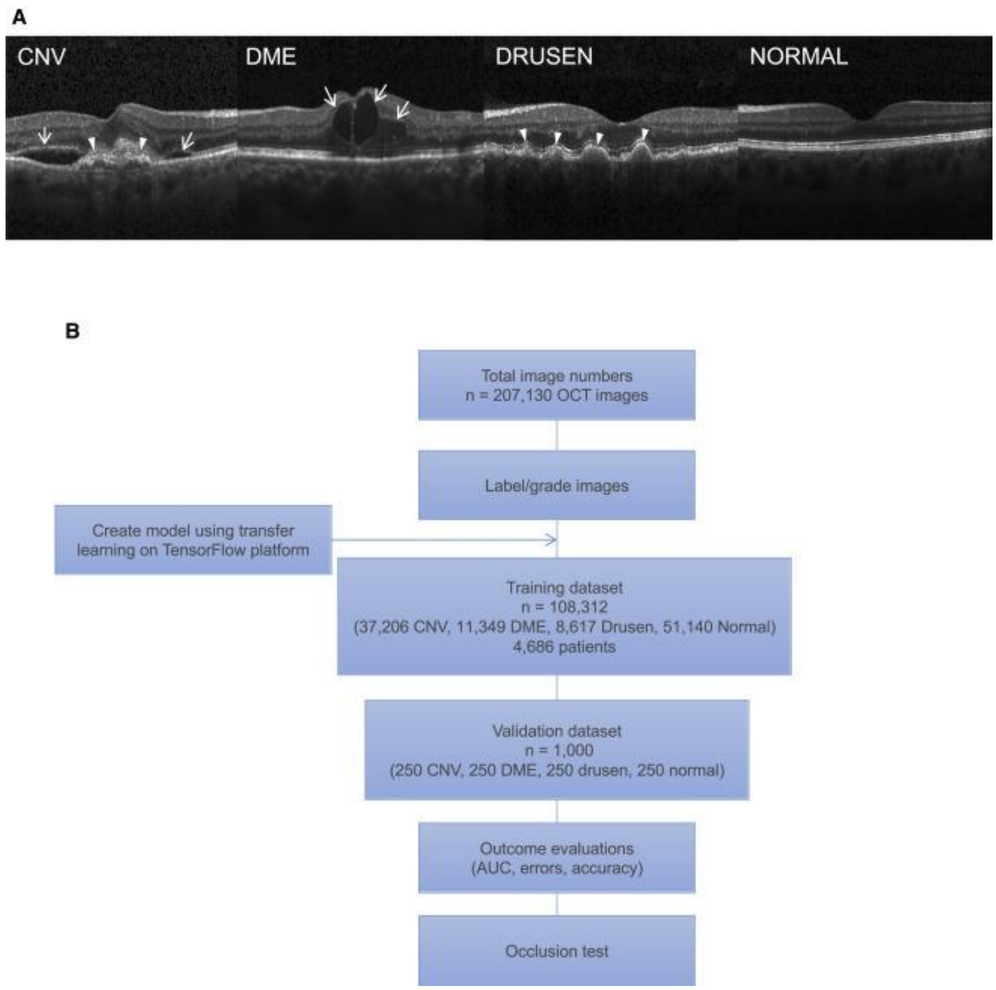


Table 1.Characteristics of patients whose OCT images

Diagnosis	Diabetic Macular Edema (DME)	Choroidal Neovascularization (CNV)	Drusen	Normal
Number of Patients	709	791	713	3548
Mean Age (years)	57 (Range: 20-90)	83 (Range: 58-97)	82 (Range: 40-95)	60 (Range: 21-86)
Gender				
Male	38.3%	54.2%	44.4%	59.2%
Female	61.7%	45.8%	55.6%	40.8%
Ethnicity				
Caucasian	42.6%	83.3%	85.2%	59.9%
Asian	23.4%	6.3%	8.6%	21.1%
Hispanic	23.4%	8.3%	4.9%	10.2%
African American	4.3%	2.1%	1.2%	1.4%
Mixed or Other	10.6%	0%	0%	7.5%

Table 2.Test set performance by human retinal experts grading using OCT

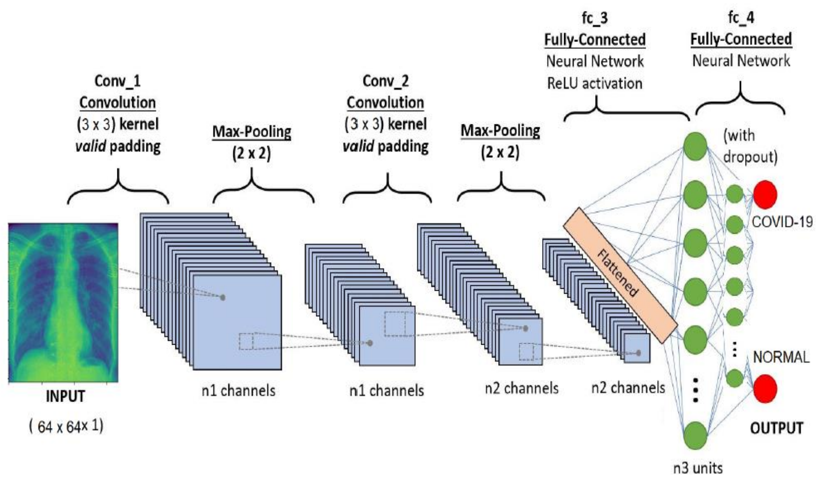
Experts	Accuracy (%)	Sensitivity (%)	Specificity (%)	Positive Likelihood Ratio	Negative Likelihood Ratio	Weighted Error (%)
1	99.2	99.6	98.8	98.8	0.0100	1.20
2	92.1	98.2	96.4	27.3	0.0187	10.5
3	97.8	98.8	99.6	247	0.0121	2.40
4	96.2	99.4	96.0	24.9	0.00625	6.40
5	99.7	99.8	99.8	499	0.00200	0.40
6	90.3	100.0	82.0	12.7	0.00217	7.70

Deep Learning Algorithm

This artificial intelligence was created using a convolutional neural network, which is utilized to generate a sequential artificial neural network. A Convolutional Neural Network may take an input image, change the variables used to train the model, and come up with the ideal equation to distinguish one image from another. "The Convolutional Neural-Network structure and layer connections were motivated by the visual cortex of the human brain, which is a portion of the cerebral cortex that analyzes visual data." Figure 3.1. The first layer, the convolution layer, is the backbone of the artificial neural network, extracting characteristics from an input picture while maintaining the link between pixels. Every convolution layer and max pooling layer produces a 3D tensor with shape height, width, and channel as its output.

Figure 30.

CNN Structure



Deep learning channel is deprived of two matrices 3 by 3 size matrices and 32 output channels is used for every CNN layer and it is because of the number of data and CPU. Consequently, main goal of convolution algorithm is to extract properties such as edges, sharp edges, layers and complex shapes from the input. The pooling layer is responsible for minimizing the size of the convolved feature map by maintaining spatial invariance and lowering the power required to process the data in the second layer, which is called max pooling. Depending on the amount of pictures to be processed and the central processing unit, there may be additional convolution and pooling layers. The flattened matrix of features was transferred to the fully linked layer after the Flattening procedure. In addition, there are two dense layers in this layer for the classification result, with 256 nodes in the first layer and 1 node in the second layer.

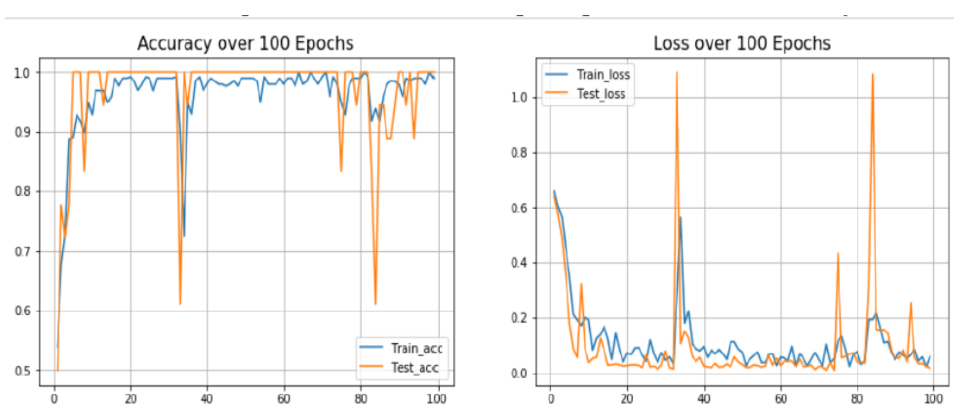
Training of Dataset

The model was trained using 130 photos from the training data that belong to two distinct classes and 18 images from the test data that belong to two separate classes. Over each iteration of training, the flattened output is given to a feed-forward and fully connected artificial neural network layer, and the back-propagation method is used. The fully connected neural network enhances the model's quality, and parameters approach levels that satisfy improved accuracy with each iteration. The model was able to distinguish between specific dominant characteristics in photos throughout a number of epochs.

The deep learning model's ultimate accuracy level is 0.98, while the loss is 0.04. In Figure 1.2, the accuracy-loss evolution numbers may also be shown. The deep learning model accurately answers about 0.98 of the patients' chest x-ray pictures and distinguishes between diseased and non-infected lungs, the first target region of the human body.

Figure 31.

Loss - Accuracy Graph

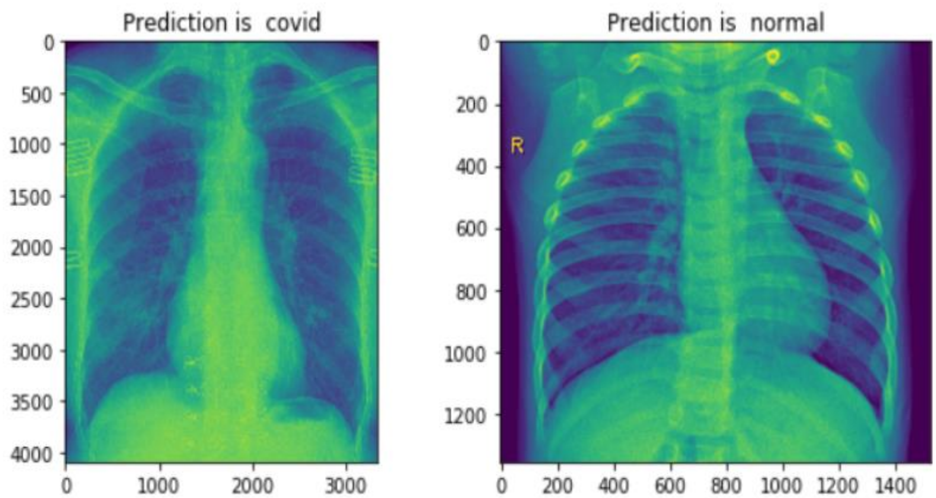


As the data increase it would be more difficult and challenging to inspect and diagnose the high number of cases. However, a power full computing machine can diagnose a million of patient in a day.

The data of 130 individuals was analyzed in this study. The quantity of data points used to train the CNN model might be expanded in the future, and the general structure of the convolutional neural network could be redesigned to allow it to examine pictures in greater depth. There will also be a graphical user interface to allow doctors and radiologists at hospitals and health centers to utilize the tool. For the time being, the deep learning model produces the result shown in Figure 3.3. The model was evaluated using single-prediction data pictures in Figure 3.3.

Figure 32.

Normal and COVID 19 classification



In conclusion, an application that can demonstrate the capacity to predict the chance of infection will be a lifesaver in preventing epidemics and slowing the spread of illness. During the testing phase of these types of apps, the involvement of radiologists 7, doctors, and practitioners should also be considered. The findings show that developing a deep learning model that can discriminate between normal and infected people's chest x-ray pictures might be a remedy for coronavirus illness early recognition and detection.

CNN Algorithm

There are so many libraries to perform CNN method and image processing technique. KERAS, TENSORFLOW, SCIFY, PYTORCH etc. all have their own benefits and drawbacks. We have used Tensor flow library to perform CNN method. First of all we initialize the images by sequential function and then 2D convolution is used in order to map and detect features. 3 by 3 matrices of images have been created for convolution.

Stepwise algorithm for detecting COVID 19 are as follows.

- **Input**: Chest X-ray Images dataset (D)
- Extraction: Feature extraction matrix
- CNN algorithm Vector.
  - Step 1: Initialization of sigmoid function by weights
  - Step2: extracting of feature of each images
  - Step3: 2D Convolution
  - Step 4: over all CNN feature implication
- Training Images
- Testing Images
- Output Result COVID or normal

Figure 33.

Elaborated Convolution neural network structure

Elaborated CNN model used in this thesis in more detailed this picture was referenced from (Rahib H. Abiyev, Abdullahi Ismail November 2021)

CHAPTER IV

COVID 19 Prediction Results

Figure 34.

Top 10 countries with maximum no of cases

	Covid 19
Country/Region	
US	57058734
India	35018358
Brazil	22328252
United Kingdom	13723275
France	10694804
Russia	10390052
Turkey	9654364
Germany	7320708
Spain	6785286
Italy	6566947

Figure 35.
Positive Cases plot of Turkey and Germany

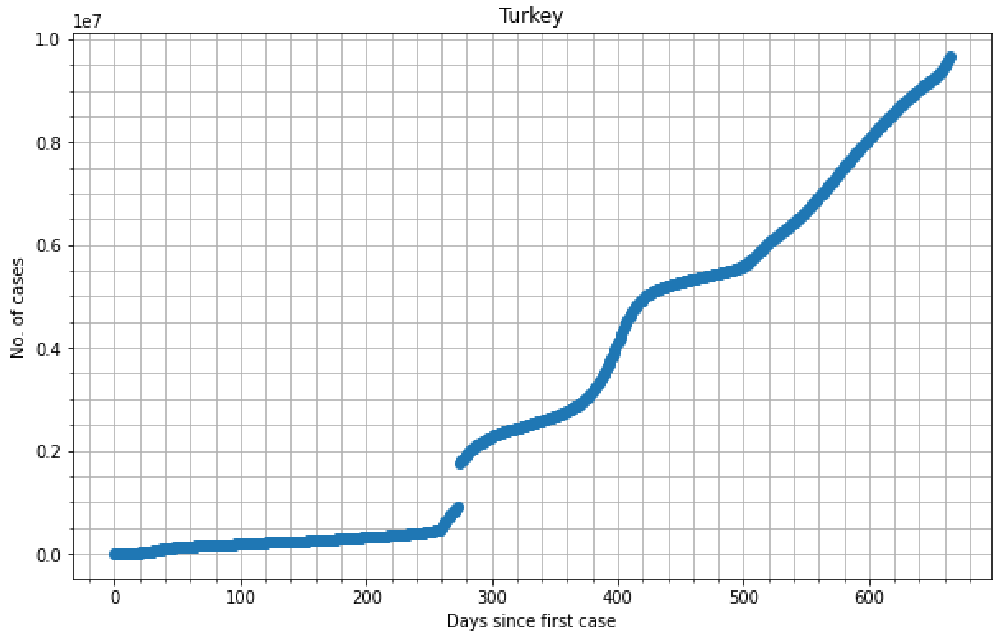


Figure 36.

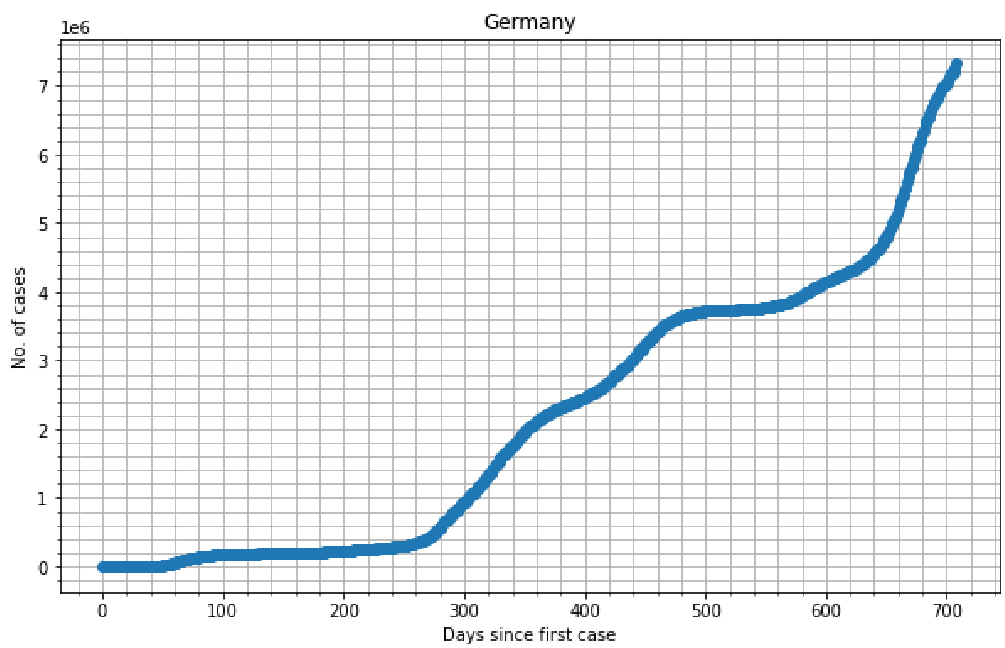


Figure 37.

R^2 Value and curve fitting regression line R^2 is 0.985826

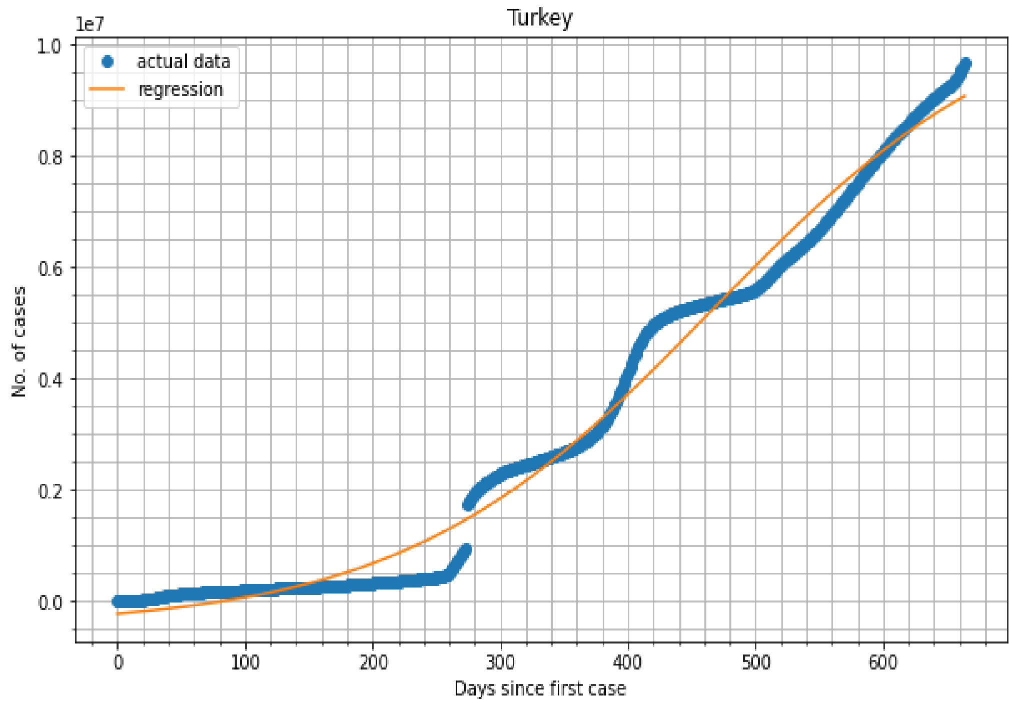


Figure 38.

Actual data regression and projection of prediction for Turkey after 100 days

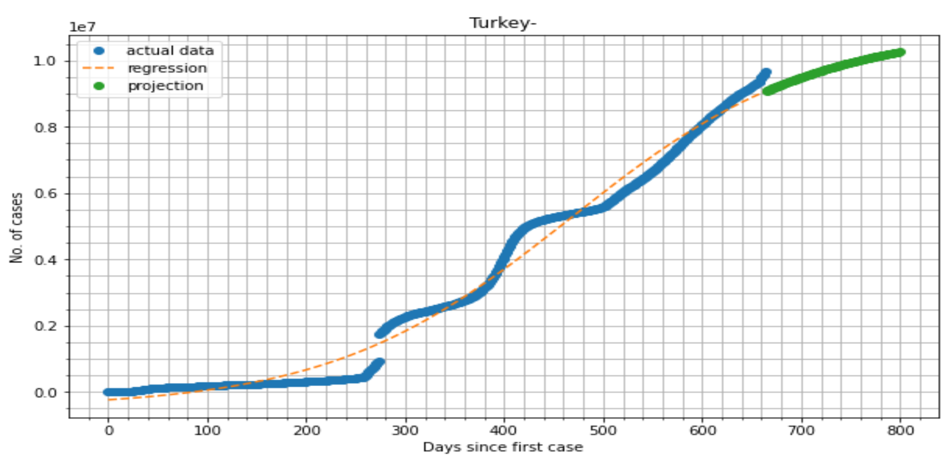


Figure 39.

Regression score, number of cases and weekly increased of cases

```
# calculate R^2
residuals = y_Turkey - logistic(X_Turkey, *popt) # future prediction of turkey covid -19 cases
ss_res = np.sum(residuals**2) #
ss_tot = np.sum((y_Turkey - np.mean(y_Turkey))**2)
logisticr2 = 1 - (ss_res / ss_tot)
print('** Turkey **')
print('\tR^2 Score for Turkey based on Logistic Regression:', np.round(logisticr2,3))
print('\tExpected no. of cases in Turkey after 600 days:', np.int(logistic(future_days[-1],*popt)))
print('\tFirst case reported : %s'%df_Turkey.index[0])
print('\tCases on %s : %d'%(df_Turkey.index[-8],df_Turkey.iloc[-8].values))
print('\tCases on %s : %d'%(df_Turkey.index[-1],df_Turkey.iloc[-1].values))
print('\tWeekly increase:%.2f'%((df_Turkey.iloc[-1]-df_Turkey.iloc[-8])*100/df_Turkey.iloc[-8]))
```

```
** Turkey **
	R^2 Score for Turkey based on Logistic Regression: 0.986
	Expected no. of cases in Turkey after 600 days: 10255875
	First case reported : 3/11/20
	Cases on 12/28/21 : 9367369
	Cases on 1/4/22 : 9654364
	Weekly increase:3.06
```

COVID 19 Results of Occurrence

Figure 40.
Back Propagation model

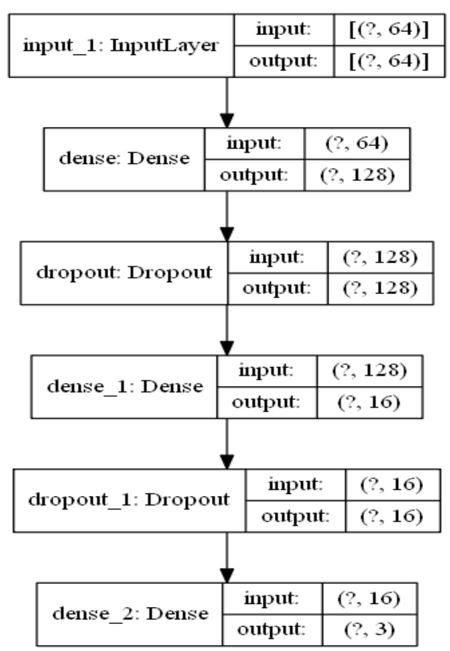


Figure 41.

ROC OF COVID

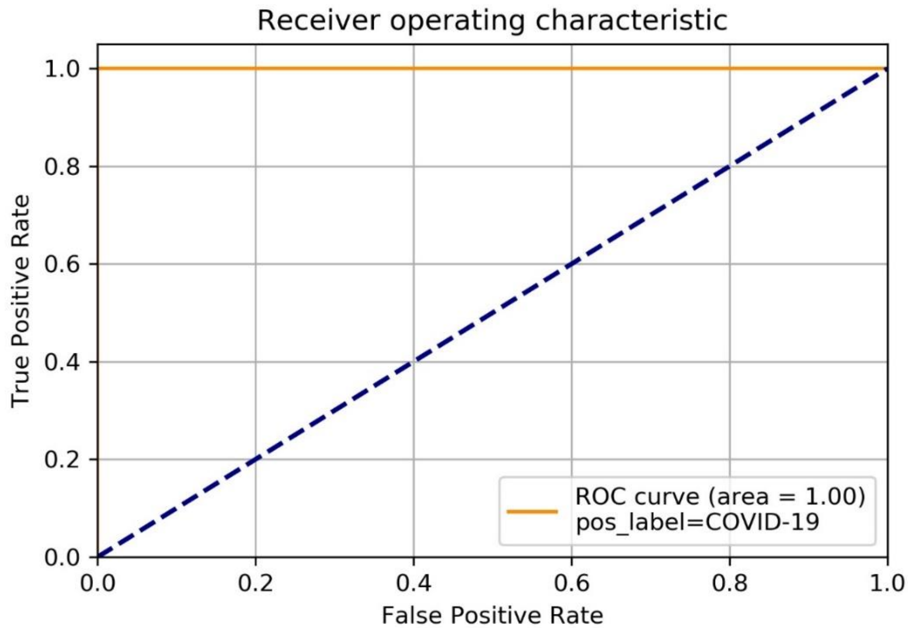


Figure 42.

ROC of Normal Xray

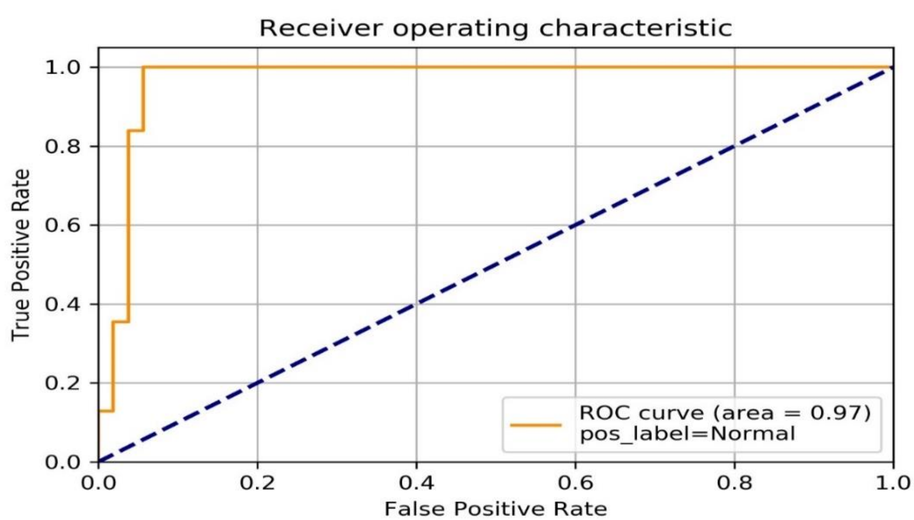


Figure 43.

Training Losses

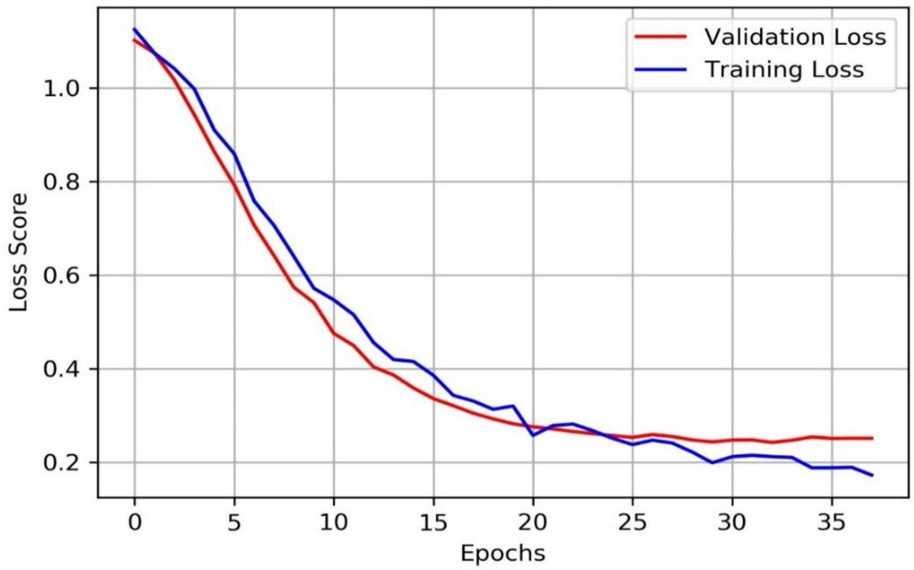


Figure 44.

Average AUC value for covid

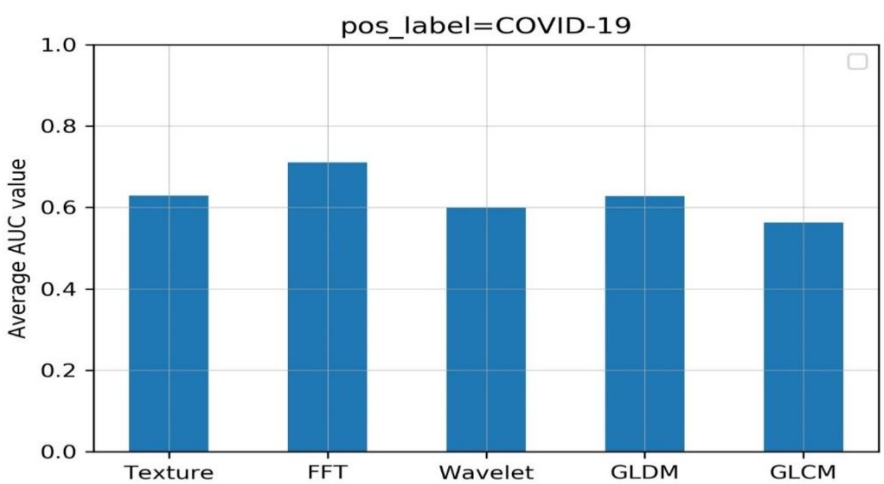


Figure 45.

Occurrence of Covid 19 detection

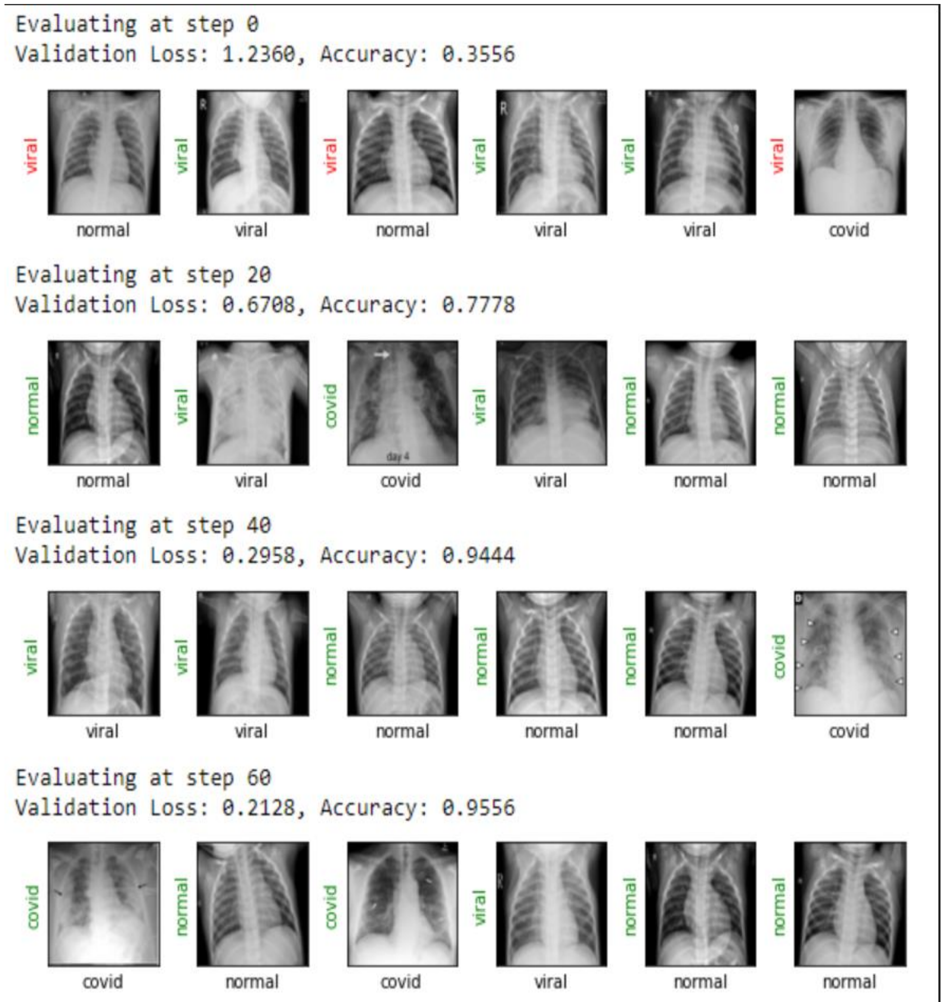
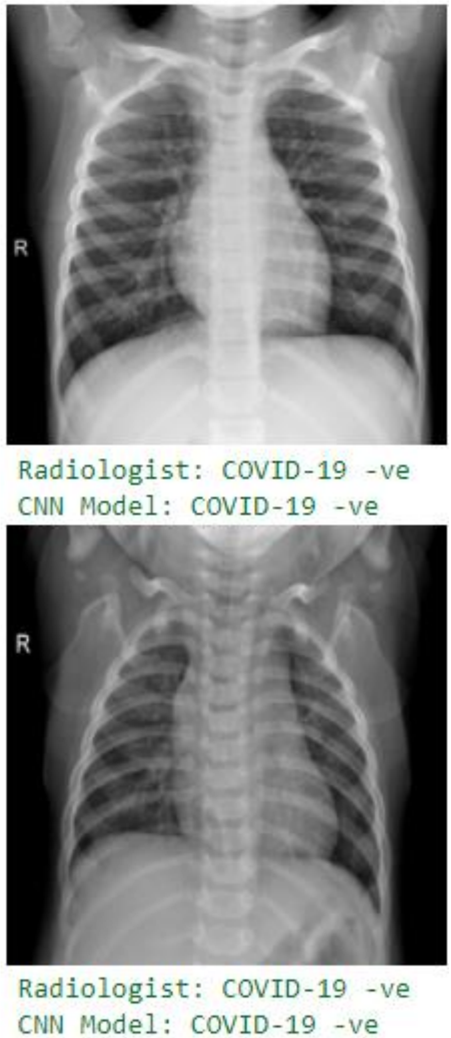


Figure 46.

Detection Result



CHAPTER V

Result and Conclusions

Conclusion

Since this technique was initially conceived so many year ago, machine learning technology has advanced tremendously. Deep Learning made our life too much easy in every department of life especially in medical field. By taking help of Deep Learning we are able to detect cancer, viruses at a very early stages. Not only this even with the deep learning algorithm deaf and blind people are able to go around without any help of assistant by speech recognition. Similarly, COVID 19 Virus don't show its symptoms on antigen and PCR instantly as discuss earlier in this these because virus start showing symptoms after gaining strength within the body.

So Xray images or MRI images are able to detect the COVID at early stages because this virus first attack on lungs and during pandemic if daily millions of people are getting effected by the virus then it is nearly impossible to test this amount of people. Here comes the machine learning plays its role by detecting virus from XRAY images. Strong algorithm or self-learning algorithm are able to train itself according to the data received. the accuracy and precision of algorithm increased continuously as the data increased and fast computing processors are able to identify and detect more than millions of virus daily.

In the beginning, the models were simple and harsh but they did not accept any departures from the examples presented during training. Machine learning algorithms nowadays are particularly resilient to real-world situations, and the systems profit from the forced removal of certain data during the learning process.

Figure 47.

Programming language and libraries used for AI

Open-Source Traditional and Deep Machine Learning Library Packages Compatible with Various Programming Languages

Programming Language	Traditional Machine Learning Libraries	Deep Neural Network Machine Learning Libraries
Python	Scikit-learn, PyBrain, Nilearn, Pattern, MILK, Mixtend	Pylearn2, Nolearn, Theano, Lasagne, Keras, Chainer, DeePy, TensorFlow
R	Caret, Boruta, GMMBoost, H2O, KlaR, rminer	Darch, DeepNet
C++	Shogun	Caffe, EBLearn, Intel Deep Learning Framework
Lua	SciLua	Torch
Octave MATLAB	...	DeepLearnToolbox
Java	Encog, Spark, Mahout, MALLET, Weka	Deeplearning4j
JavaScript	Clusterfck, LDA, Node-SVM, ml.jis	ConvNetJS

Above figure shows the comprehensiveness of AI and variety of languages are able to generate the strong algorithm. Python having the most strong libraries and easier to implement as compare to mother programming languages. We also used python programing language to implement the algorithm.

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APPENDIX 1: Ethical Approval letter

NEAR EAST UNIVERSITY

ETHICAL APPROVAL DOCUMENT

Date: 10/01/2022

To the Institute of Graduate Studies

For the thesis project entitled as “PREDICTION AND DETECTION OF COVID 19 USING DATASETS AND XRAY IMAGES BY DEEP LEARNING ALGORITHM”, the researchers declare that they did not collect any data from human/animal or any other subjects. Therefore, this project does not need to go through the ethics committee evaluation.

Title: Assist. Prof. Dr

Name Surname: Elbrus Imanov

Signature:

Role in the Research Project: Supervisor

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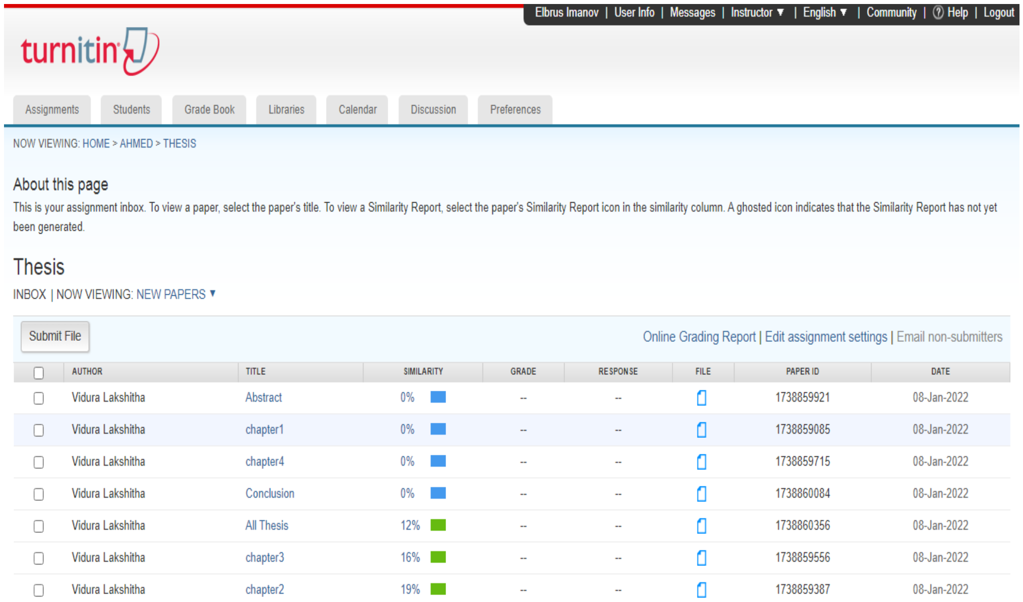

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Signature:

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