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A COMPLETE REVIEW ON STATE-OF-THE-ART MACHINE LEARNING TECHNIQUES TO DIAGNOSE THE CORONA VARIANT INFECTION

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ABSTRACT

COVID-19 is no longer a pandemic, but rather an endemic disease that has claimed the lives of billions of people globally. COVID-19 has no specific treatment, thus living with the condition and its symptoms is unavoidable. To deal with COVID-19-related symptoms, researchers from all areas of study were brought in to cope up with this disease effectively. Machine learning (ML) methods are broadly utilized to detect a variety of infections in various diseases. To detect and diagnose corona viruses variant different machine learning methods are being used widely. In this paper, we will review various state-of-the-art machine learning algorithms and how it can be used to combat the epidemic.

KEYWORDS: *SARS-COVID19 (Corona Virus Disease), SARS-CoV2 (Severe Acute Respiratory Syndrome Coronavirus 2), Corona Variant, Lockdown 24-March-2020, Delta variant, Gamma variant, Omicron, Neo Cov variant, Machine learning, Deep learning.*

1. INTRODUCTION:

Infections and deaths were reported worldwide after a novel corona virus epidemic outspread from the country named China in December 2019 and developed into a pandemic. More than 12 million people were infected with COVID-19, and with over millions of people dying as a result of the virus. The virus was dubbed SARS-CoV2, and the condition was dubbed COVID-19. Cough and fever are the most prevalent symptoms, with pneumonia-like symptoms and dyspnea being seen in some individuals in critical condition [1]. COVID-19 is disseminated via particles of infected respiratory droplets that are passed from an infected to a healthy individual, according to studies.

In humans, a variety of comparable symptoms have been seen, including skin rashes and gastro-intestinal issues. The latest research has looked into potential zoonotic pathways and additional classes that can contract COVID-19.There is no specific cure for COVID-19, yet efforts to create a vaccine or medications to treat COVID-19 are now underway all around the world. Antiviral drugs that are used to treat various viral disorders have been used in current treatment strategies. Healthcare personnel were given particular tools to treat people who were infected with COVID-19 and in order to take steps to treat this viral infection and dangerous disease.

Countries around the world have implemented COVID-19 mitigation measures, which have included entire lockdowns, social distance, and advice to individuals to wash their hands, sanitize surfaces, and wear face masks [2].Individuals with moderate COVID-19 symptoms were advised to self-isolate for more than two weeks and seek medical attention if their health concerns deteriorated. COVID-19 has been proven to affect so many people in various communities, as well as those with pre-medical issues, in multiple cohort-based studies.

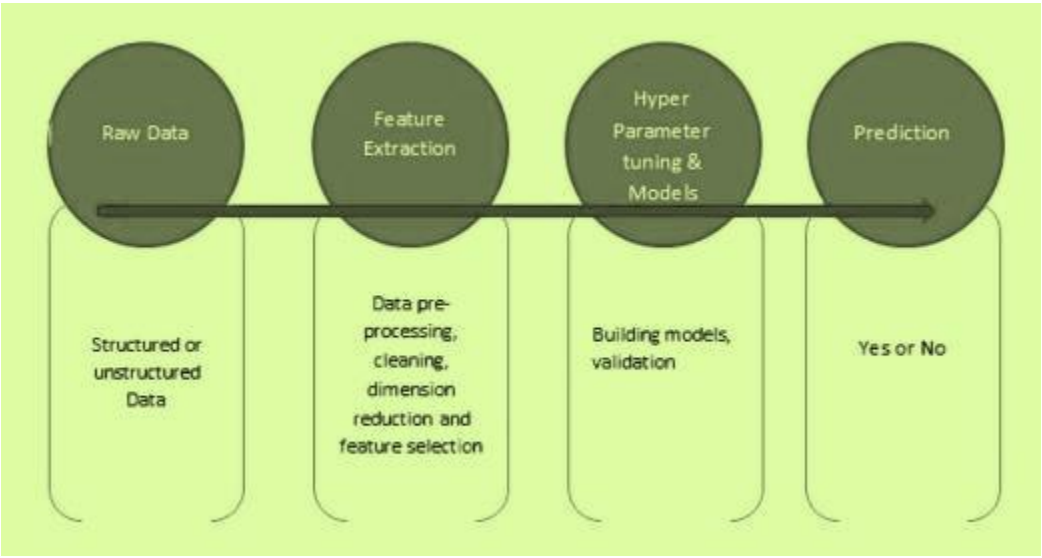

Fig. 1 Essential learning process for the development of predictive models

Another alternative mechanism of infection transmission was thought to be asymptomatic transmission. One can say that asymptomatic COVID-19 patients are the persons whose test reportsare positive for COVID-19 but they do not show any symptoms [3]. This may have

expedited COVID-19's spread because asymptomatic persons may not be aware of the virus and may have disseminated it through social encounters with healthy people.

2. Related Work:

2.1 Relevant work done to identify COVID-19/SARS COVID infection

We will discuss similar work in the area of COVID-19[4]. Many researches have focused on statistical analysis-based forecasts of how the infections are expected to propagate.

Neher et al.[5] proposed a model called seasonal transmissibility model, a mathematical model that may forecast the path of a virus re-infecting sub-populations around the planet in upcoming years. As part of their suggested model, they considered infection, emigration, and population turnover rates. A more sophisticated version of their model takes into account the predicted hospital resources needed to support a pandemic like COVID-19.

Penn Medicine developed a hospital model called COVID-19 Hospital Impact Model for Epidemics, CHIME, that predicts the number of hospitalized, ICU, and ventilated patients. They employed a statistical model based on factors such as social contact, hospitalization rate, and detection probability. Several machine learning-based models for COVID-19 have been proposed throughout the world in an effort to understand the multiple aspects of COVID-19 [6].

Hu et al. [7] developed a ML model to predict cumulative COVID-19 cases based on past growing data. They used the various features retrieved from their proposed auto-encoder model to categories cities and provinces into clusters. Similar LSTM techniques have also being investigated in China to better comprehend patient data and study epidemic trends. So far, all COVID-19 prediction and projection models have emphasized on graphical analysis and future curve estimations.

Wang et al. [8] proposed a Framework to evaluate the Traditional Chinese Medicine (TCM) model engaged deep learning concept. The authors developed an Artificial Neural Network (ANN) model with three-layer architecture. They've also put their OSPF model to the test, evaluating the efficiency and safety of using TCM instructions for additional flu-like disorders as a potential source of COVID-19 medicines. TCM instruction is classified as 'Safe' or 'Unsafe' employing their provided approach.

Wang et al. [9] suggested a GRU (Gated Recurrent Unit) based model incorporating bi-directionality and observations. They discovered that Tachypnea for breathing, which is defined as excessively quick and shallow breathing patterns in patients diagnosed with COVID-19. They demonstrate that their suggested model can distinguish respiratory patterns with high F1 scores.

Wang et al. [10] presented the Inception Migration Neuro Network i.e. a CNN-based model for identifying radiographic characteristics in CT scan images of patients. The goal of their suggested model is to determine if COVID-19 is present or not.

Sethy and Behera[11] suggested a ML model for X-Ray pictures based on SVM. They used the False Positive Rate (FPR), F1 score, Kappa, and MCC (Matthews Correlation Coefficient) metrics to access the efficiency of their suggested model.

Souza et al. [12] proposed a supervised ML technique such logistic regression, linear discriminant analysis, Naive Bayes, KNN, and SVM to identify patients who could develop severe COVID-19 symptoms early. Individual fundamental information such as gender, age,

symptoms and recent travel history were used to train the ML methods, which were taught using a publically available database relevant to Brazil. The authors claim that area under the curve of AUC i.e. 0.92, a sensitivity is of 0.88, and a specificity is of 0.82 can predict illness outcomes.

2.2Determination of COVID-19 Variant Using different Machine Learning techniques

Dan Assaf et al. [13] pivoted on using a database from a medical facility to identify patients at risk of worsening throughout their hospital stay. To train three different machine-learning techniques, the authors employ historical and clinical characteristics such as APACHE II score, white blood cell count, time from symptoms to admission, and oxygen saturation. The results reveal a sensitivity of 88.0 percent, a specificity of 92.7 percent, and an accuracy of 92.0 percent.

Pourhomayoun and Shakibi [14] use various ML algorithms to estimate the mortality rate of COVID-19 patients, including SVM, Neural networks, logistic regression,random forest and k-nearest neighbor. The authors use laboratory-confirmed cases from 76 countries to train the algorithms. Demographic information, travel history, basic medical details, and all the symptoms are included in the dataset. Their findings suggest that the neural network method performs the best, with a precision of 93.75 percent.

Li Yan et al. [15] offer a decision method based on the supervised classifier to predict patients with the highest risk. Lactic dehydrogenase, lymphocytes, and high-sensitivity protein were initially used to train the predictive model. The results reveal that the model can correctly predict patient outcomes with greater than 90% accuracy.

2.3 Diagnosis of COVID Variants Using Internet of Things (IOT):

M. Kamal et al. [16], look at the current state of COVID-19-related IoT applications, identify deployment and operational issues, and offer ways to further control the outbreak pandemic. Furthermore, they conduct an analysis for deploying IoT in which both internal and external factors are considered. There are several elements that are discussed.

V. Chamola et al. [17], provides a thorough examination of the COVID-19. Following that, the stages that the disease goes through as it spreads were addressed. The study also lists the numerous therapeutic efforts being made to stop the pandemic, as well as the preventive measures that should be followed until that time comes. The discussion mostly focuses on how upcoming technologies such as IoT, drones, AI, blockchain, and 5G can be used to mitigate the impact of the COVID-19 pandemic.

M. Otoom et al. [18], proposed a system that use an IoT framework to gather real-time symptom data from users in order to detect suspected coronavirus cases early, monitor the treatment response of the patients already recovered from the virus, and learn more about the virus's nature by gathering and analyzing relevant data. There are five primary components to the framework. This study suggests eight machine learning techniques for quickly identifying possible coronavirus cases using real-time symptom data. After selecting the appropriate symptoms, experiments were conducted to test these eight algorithms on a real COVID 19 symptom dataset.

M. N. Mohammed et al. [19], proposes a system using a smart helmet with a mounted thermal imaging that can detect the coronavirus automatically from a thermal image with minimal human input. The thermal camera technology is integrated into the smart helmet and paired with IoT technology for real-time data monitoring during the screening process. Furthermore, the

proposed system used face recognition technology and can show the pedestrian's personal information as well as take their temperatures automatically.

Nasajpour et al.[20], this article examines the role of IoT-based techniques in COVID-19 and examines state-of-the-art architectures, services, and industrial IoT-based solutions for combatting COVID-19 in three stages: early detection, quarantine, and recovery.

3 Machine Learning Methods

ML is a subfield of artificial intelligence that aims to give computers a learning capacity through the use of properly-defined algorithms in order to enhance performance or predict accurate results. Such algorithms often help to learn on previously accessible data, presented as labeled training sets. These labeled training sets are used by supervised learning algorithms to develop the parameters of a statistical model in order to minimize the loss function. The trained model can then generate accurate predictions utilizing data that was never used during the training phase as input.

Naturally, the amount of the data sets employed is critical in assuring the algorithm's proper functioning. During the current epidemic, ML has been utilized to build various algorithms aimed at identifying those patients who are more likely infected at an early stage. These methods produce predictions based on basic information about the patient, medical symptoms, travel history, and the time spent in the hospital [21].

This section gives a quick rundown of the machine learning algorithms that can be used to combat COVID-19. The use of machine learning to combat COVID-19 is critical in the current circumstances. The three primary types of ML algorithms are supervised learning, unsupervised learning, and reinforcement learning [22].

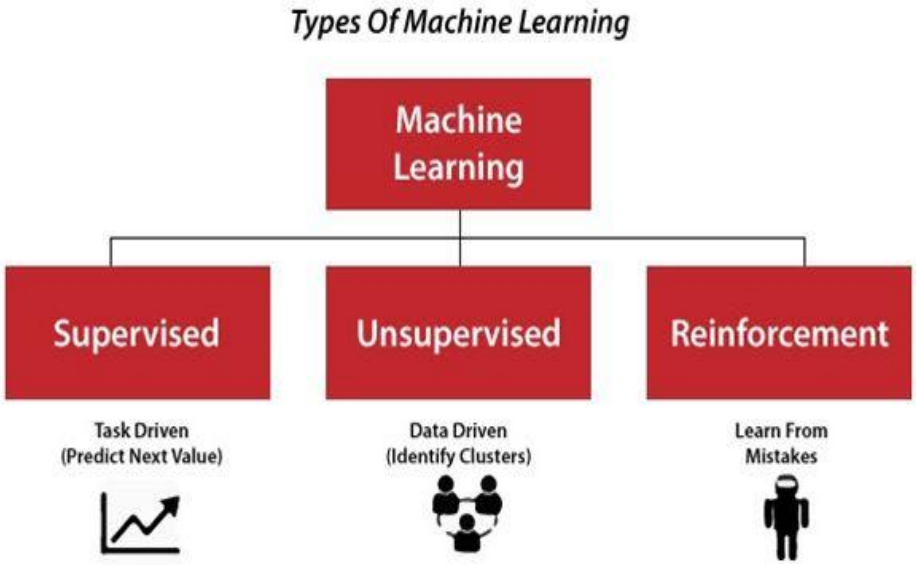

Fig. 2: Types of machine learning (ML) algorithms to cope with corona disease

3.1 Supervised Learning

In supervised learning ML techniques, the training data is labeled. A set of labels as outputs is also provided. These algorithms grasp from the dataset and predict accurate results when a given amount of data has been trained [23].

3.3.1 Classification

The data that has been trained is categorized into one of the predetermined classes. One of these algorithms' drawbacks is that they can't handle missing data. But, thankfully, existing data can be used to fill in the gaps. To analyze COVID-19 trends, a variety of categorization algorithms are applied. Some of them are listed below.

i. K Nearest Neighbors' (KNN)

The data points' locations are used to classify them. The number of neighbors is used to group similar objects together. Non-parametric categorization is used. There are no hypotheses made regarding the output data. It's also termed as a lazy learner algorithm because the learning process is delayed and the appropriate action is performed after the data is classified. The minimum number of neighbors necessary is set to k by the user. In general, the predictions are more reliable when the value of k is larger.

To improve classification accuracy, weights are attached to the neighborsemployed KNN to detect respiratory illnesses as shown in fig 1. KNN was utilized to detect severe influenza. KNN was used to track the infected users' locations.

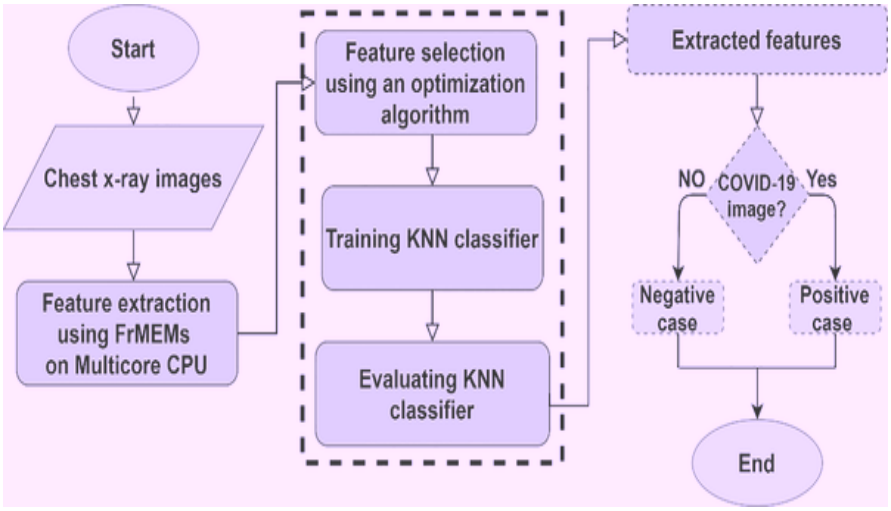

Fig 3: Image based Diagnosis of COVID-19 Using KNN

ii. Support Vector Machine (SVM)

The data is divided into separate groups using a hyperplane. To locate the smallest gap between data points, SVM calculates the maximum marginal distance. Hyperplanes serve as borders, dividing data points into categories. When there are just two attributes, a single line exists. When the size of input is increased to three, a 2D plane is generated [23]. It becomes increasingly harder to see the hyperplane as the number of characteristics grows. Support vector machine was

employed by Mori et al. to predict the onset of disaster in a specific place. For the diagnosis of COVID-19, SVM was incorporated with IoT and Convolution Neural Networks (CNN).

iii. Naïve Bayes

The dataset can also be classified using Bayes' theory. The classification of all features is based on the assumption that they are fully independent of one another, hence the name nave. The input data is split into two parts i.e. a feature matrix and a response vector. All data is kept in rows in the feature matrix, and the outcome class is defined in the response vector. The Nave Bayes classifier was used to group tweets. During the epidemic, it aided in the management of social networking issues.

iv. Logistic Regression

The sigmoid curve is a cost function that is used to forecast a dependent variable based on one or more independent variables. The Sigmoid function is an S-shaped curve that splits data into multiple categories. Logistic regression can help with binomial, multinomial, and ordinal classifications [24]. Thisconcept was used to predict the total death rate.

v. Decision Trees

The outcome is predicted by the leaf nodes, decisions are done by the branches, and characteristics are made by nodes in a decision tree. This distributes all the instances by assembling them down the tree from the root to the leaf nodes, resulting in the instance's classification. During pandemics, decision trees were used to detect the location of users (Elhoseny, 2019). A hybrid face mask detection application was created employing decision tree [25].

vi. Random Forests

When the data is large, classification is made using a decision tree might lead to over fitting. Random forests can help us overcome these restrictions. To boost accuracy, different decision trees are categorized and then combined together. "Bagging" is the term for this process. The RF algorithm was used to predict COVID-19 health. The distribution of COVID-19 daily cases over the world was estimated using a random forest machine learning approach.

vii. Artificial Neural Network (ANN)

ANN is a multi-layered network that is entirely connected. There are three layers:input, output, and numerous hidden layers (Refer to fig 2). The different nodes in one layer are connected to the nodes in the preceding and subsequent layers. The inputs are processed by an activation function. One layer's output becomes the input for the following layer. The user's position was determined using ANN and IoT. Although the data was restricted, the accuracy was great. ANN technique was utilized to detect the similar group of people present in a different region [26].

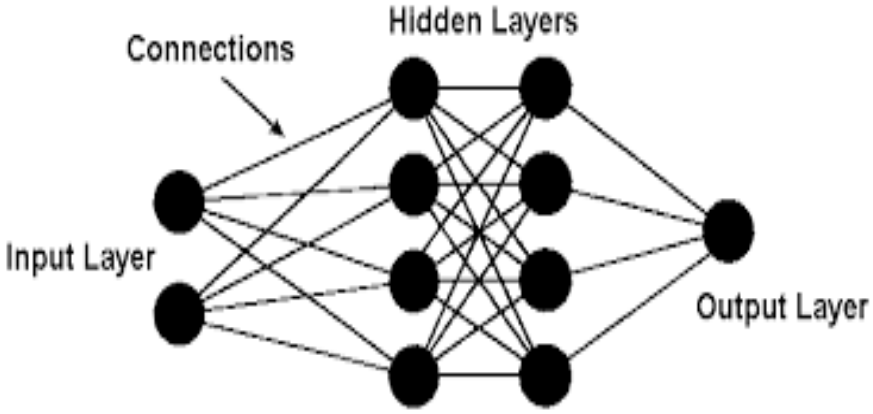

Fig 4: Layers in ANN

viii. Deep Neural Network (DNN)

Because neural networks are often boring, DNN is an adaptable model that also allows for creativity. The total nodes are required to analyze the results is quite high. DNN is made up of three layers: input, output, and a large number of masked levels. DNN is utilized for progressive learning and the capacity to adjust their output.It's critical to move healthy people to non-infectious areas.

ix. CNN

Because of its accuracy and capturing orientation, CNN is a better method for classifying images. They have a variety of layers, such as a pooling layer, a convolutional layer, and a fully connected layer, among others. A CNN-based model was combined with Internet of Health Things for identifying persons with COVID-19 [27].

3.1.2. Regression

This is a technique for getting predictive learning component that converts a data object into a meaningful variable. Regression is a statistical technique for establishing a link among the target and predictor variables. We can also use regression to model the relationship between a dependent and independent variable. Variables such as temperature, age, salary, and so on can be forecasted easily after a certain amount of data has been trained [28].

i. Linear Regression

This is a straightforward approach for performing predictive analysis. It depicts the dependent and independent variables' linear connection. If there is just one input, the model is referred to as simple linear regression, and if there are several inputs, the model is referred to as multiple linear regressions.

ii. Polynomial Regression

Polynomial regression can be used to model non-linear datasets. For the dependent and independent variables, a non-linear curve is created. Original features are used to generate polynomial features of a particular degree, and the model is then created using linear regression. The polynomial regression model was used to estimate the COVID-19 epidemic in India. In

order to forecast COVID-19 spread on a global scale, hierarchical polynomial regression models were applied [29].

iii. Support Vector Regression

This can be used for regression as well as classification purposes. To fix largest number of data points along the margin, a hyperplane with maximum marginal distance is determined. Maximum data points must be contained within the boundary lines, and the hyperplane must contain the maximum number of data points. It was utilized in Brazil to anticipate COVID-19 confirmed cases in the short term [30].

iv. Ridge Regression

It has a small bias, which aids in the development of stronger long-term forecasts. The ridge regression penalty is the name for this small bias. Individual features can be used to compute the penalty. The algorithm's application case is high collinearity between independent variables, because both polynomial and linear regression would fail in this situation. If there are more samples than parameters, the model can be employed. It is also a regularization approach because it minimizes the complexity of models.

3.2. Unsupervised learning

In unsupervised learning, the data is not labeled as shown in fig 3. The user is unaware of the data's pattern. To analyse the information structure, the algorithms employ several methodologies. Clustering is the most used unsupervised learning approach [31].

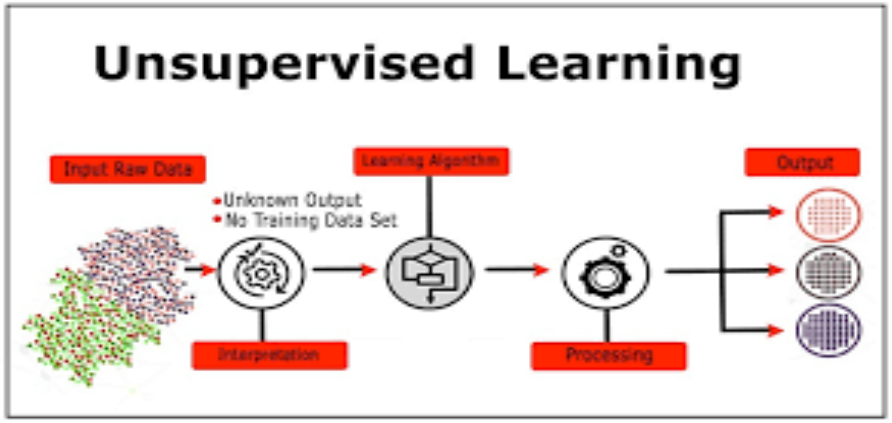

Fig 5: Working of Unsupervised Learning

i. K-Means

The data is separated into many clusters. The total of clusters is assigned first, followed by the selection of random centroids from the dataset. The centroids are updated after each repetition. The similarity score is calculated using either the Euclidean distance or the cosine distance.

ii. K- Medoids

When there are a lot of outliers in the data, this strategy is used. The data points for the median are picked at random. The remaining data points are assigned to these medoids depending on

their minimum distance. In Indonesia, data mining techniques, notably the k-medoids algorithm, were studied in relation to national food security during the COVID-19 pandemic [32].

iii. Fuzzy C-Means

Centroids are chosen, and data is initialized in these clusters at random. Based on the distance between the data point and the cluster center, this technique assigns membership to each data point corresponding to each cluster center [33]. The use of Fast Fuzzy C means clustering to extract ROIs in CT lung scans of COVID-19 was explored. This was beneficial to radiologists and other medical personnel.

3.3. Reinforcement Learning

Reinforcement learning is the process of increasing the reward by taking appropriate action in a certain situation. In this strategy, various attempt to find the best path or behavior for a particular condition [33]-[34]. During the training phase of supervised learning, the answer key is available to the data, on the other hand in reinforcement learning, the agent selects the direction of action and there is no single answer key to assist the model (See fig 6). The models learn from their mistakes even if they don't have access to any training data.

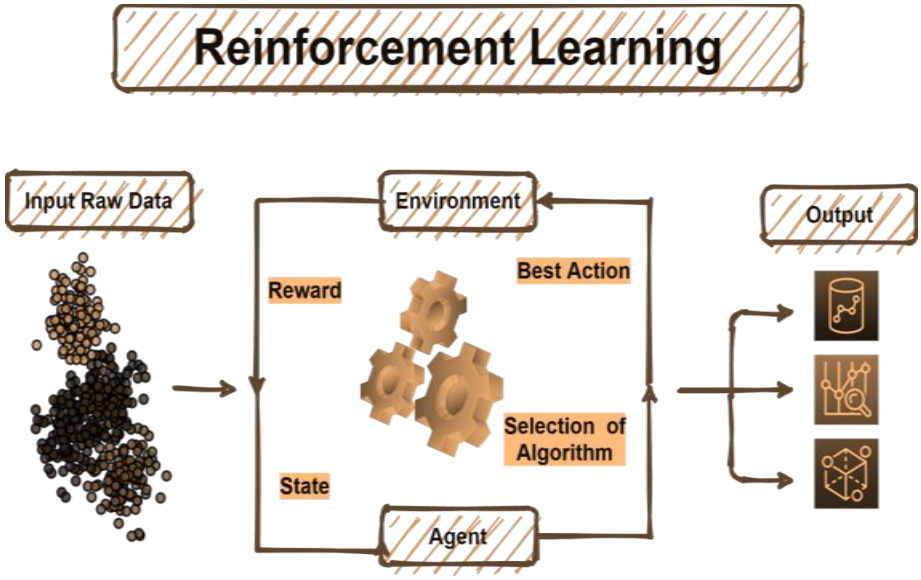

Fig 6: Process of Reinforcement Learning

i. Q-learning

Q-learning employs sequential decision making. The optimum answer is generated for each input, and the matching input is constantly dependent on the previous output. Depending on the scenario, the objective function can be maximized or minimized [35]. The use of multi-robot collaboration and the Q-learning approach to avoid COVID-19-affected patients was described in a study.

ii. Markov's Decision Process

The primary method of this algorithm is to learn from interactions in order to attain a given goal. The environment and the reinforcement agent are always interacting; the agent chooses the action, and the environment provides the response to these actions[36]-[38]. The COVID-19 pandemic and clinical risk factors of patients were studied using an epidemiological Markov model.

4. CONCLUSION

The COVID-19 pandemic had globally impact the safety of individuals. Technology continues to advance at a rapid pace, particularly in machine learning and deep learning domain. ML has made a significant contribution to people's struggle against COVID-19. Favorable data-driven alternatives are still assisting humanity in dealing with COVID-19. In the beginning, a basic introduction of the pandemic was covered. The next section goes through the related work of how to use ML, DL and IOT to diagnose various symptoms of COVID-19. Later, we discussed how to control and manage the epidemic utilizing various machine learning tools. Finally in section 4 we conclude the paper.

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