International Journal of Advances in
Soft Computing and Intelligent Systems (IJASCIS)
2023, Vol 02, Issue 02, 66-76

Science Transactions © 2023
Original Paper

PREDICTING THE GROWTH AND TREND OF THE COVID-19 VIRUS USING MACHINE LEARNING

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ABSTRACT

The global SARS-CoV-2 outbreak caused by the COVID-19 Coronavirus has been catastrophic. COVID-19's cumulative incidence is rising at an alarming rate. Tracking the disease, predicting its progress, and developing strategies and regulations to control the epidemic are all tasks that can greatly benefit from the use of Machine Learning (ML) and Cloud Computing. This research makes use of a sophisticated mathematical model to examine and predict the epidemic's progress. An improved model based on ML has been used to estimate the risk of COVID-19 in different nations. We show that iterative weighting for fitting may lead to a better fit when building a prediction framework using the Generalized Inverse Weibull distribution. This has been implemented on a cloud computing platform for improved and more timely prediction of the epidemic's development propensity. Proactive responses from both the government and the people can greatly benefit from a data-driven strategy with the level of precision shown here. Finally, we suggest a number of avenues for future study and actual implementation. From this review of the relevant literature, we were able to choose a group of prediction-friendly algorithms, including SVMs, RFs, and ANNs. The selected algorithms' performances are compared in order to determine which method provides the most accuracy. To determine the significance of each feature in the context of the forecast, importance values are calculated. The use of Machine Learning for COVID-19 prediction has the potential to increase the rate at which diseases are diagnosed, which in turn would reduce mortality rates. Based on the experimental data, it was determined that the artificial neural network outperformed the other algorithms.

KEYWORDS

COVID-19, Coronavirus, Machine learning, Support Vector Machines, Random Forests, Artificial Neural Network, Prediction, Cloud computing

1. INTRODUCTION

In December 2019, researchers identified SARS-CoV-2, also known as severe acute respiratory syndrome corona virus 2, as the etiological agent responsible for the onset of COVID-19. Within a short timeframe, the global pandemic rapidly disseminated throughout a substantial proportion of cities and nations worldwide (1–3). The primary mode of transmission for SARS-CoV-2 infection is via direct interpersonal contact, especially when the virus is present in respiratory droplets (4). The infection has the potential to induce moderate upper respiratory tract infections, or it may progress to the severe conditions of sepsis and shock. For those who are considered susceptible, particularly the older population with many prior medical conditions, there is a potential for significant and perhaps life-threatening outcomes (4-6). As of March 16th, 2021, the number of confirmed cases of SARS-CoV-2 had exceeded 120 million, with a corresponding death toll of 2.6 million. The growing prevalence of COVID-19 and the substantial population affected impose a significant strain on the limited resources of the healthcare system. The expeditious diagnosis, treatment, and monitoring of COVID-19 require the use of efficacious technology to enhance clinical effectiveness within healthcare systems. Recent studies have identified artificial intelligence as a potentially helpful technology due to its notable scalability, enhanced processing capacity, and even superiority over humans in some healthcare operations (8). As a result of these advancements, artificial intelligence (AI) has become a viable and pragmatic instrument for many developmental purposes. Artificial intelligence (AI) refers to the academic discipline concerned with the examination and advancement of computer programmes that emulate human cognitive abilities, including problem-solving, decision-making, and experiential learning (9–11).Computer science includes the branch of study known as artificial intelligence (AI). The benefits of AI may be observed in the rapidity with which findings are delivered and the reliability of the results (9), as well as in the high sensitivity and specificity with which the item is detected. Predictive machine learning models for use in healthcare are one area where AI has made great progress in recent years. The term "deep learning" refers to a specific kind of machine learning (ML) that takes advantage of the intricate structures of ANNs. Neural networks (or ANNs) serve a similar purpose. Because of its high discriminative performance with adequate training data sets, deep learning is essential for prediction (12). Artificial intelligence and machine learning (AI/ML) technologies in medicine seek to enhance medical care, boost diagnostic accuracy, decrease the likelihood of errors, and predict outcomes by mining large amounts of data derived from the collective experiencesofmanypatients(10).Researchers have made major contributions to the battle against COVID-19, and there is a rapidly expanding number of AI models in the published research that are relevant to COVID-19. Trained artificial intelligence models have the potential to either provide a precise and timely diagnosis or aid doctors in streamlining the procedure, reducing the amount of human labor needed. After being given training data, AI systems can model the progression of disease, predict those most at risk, and define the epidemiology of COVID-19 (15, 16). Possible AI-driven ways to find new therapies and vaccines include repurposing existing pharmaceuticals, evaluating potential targets as vaccines using the expected mutation model for SARS-CoV-2, and evaluating chemicals as potential vaccine adjuvants (3, 17). Artificial intelligence (AI)-driven chatbots have shown their use within the healthcare sector by effectively mitigating call traffic on medical hotlines and providing assistance to a larger patient population. Through vigilant monitoring of individuals at risk and the implementation of proactive strategies such as social isolation and lockdown protocols, artificial intelligence has the potential to contribute significantly to the containment of the pandemic (3, 17). The utilisation of artificial intelligence has been widely observed across various domains, including COVID-19 patient management, diagnosis, public health, clinical decision-making, social control, pharmaceuticals, vaccine research, surveillance, integration with big data, and operation of other crucial clinical services (3, 18, 19). The use of prompt diagnostic procedures, accurate prognostication, improved surveillance, and efficacious treatment modalities are critical strategies for mitigating the transmission of the COVID-19 pandemic. The COVID-19 epidemic has placed a significant strain on the available medical resources, resulting in their restricted availability. A plethora of scholarly literature evaluations have been disseminated pertaining to this particular topic. There exists a limited body of systematic research that assesses the use of artificial intelligence (AI) in the context of COVID-19 using the PRISMA methodology. The findings of these studies undertaken so far exhibit a heterogeneous pattern of outcomes. The majority of these research endeavours focus on various facets of diagnosis or treatment.Therefore, we decided to undertake this evaluation to thoroughly analyze the efficiency of AI for COVID-19 and to determine the key areas of usage for AI, prospective advantages and limits of AI, and future uses for AI.

1.1 Analysis of Author Keyword Co-Occurrence

In bibliometric studies, topic mapping is crucial. The many problem areas that might be linked to scientific literacy keywords are shown in Figure 1. For the bibliometric study, VOSviewer may provide six different map visualisations. The significance of a pair of concepts or terms was represented by the width of the connecting line.

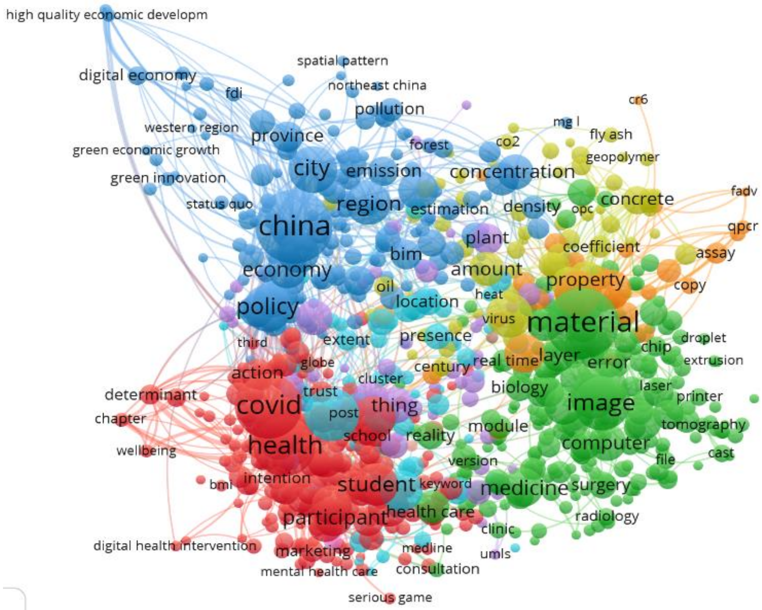

Figure. 1 Literacy Network Visualisation as a Research Topic

1.2 In terms of country, co-authorship is as follows:

Figure 2 illustrates the countries that prioritise the investigation of scientific literacy. Based on the available data, it can be seen that Canada, Australia, and Turkey are the nations that exhibit the highest levels of engagement in scientific literacy research. The findings from the VOS viewer mapping analysis suggest that the field of scientific literacy research in Indonesia is at an early stage of development.

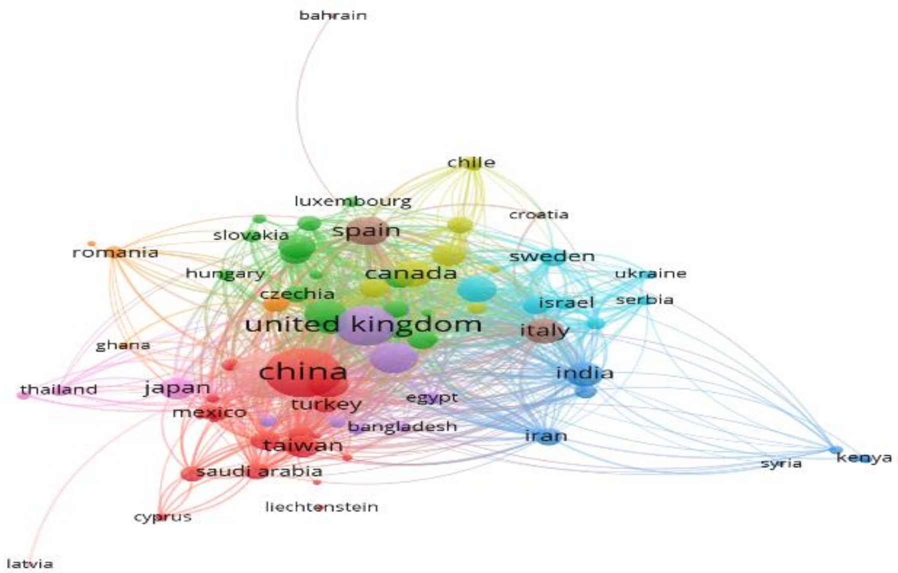

Figure. 2 The Visual Representation of Countries 1.3

Research Opportunities and Emerging Trends Several new lines of inquiry into present and future pandemics have been sparked by the COVID-19 outbreak. Here we outline the most promising avenues for further study. Further improving prediction accuracy requires including additional indicators in the regression model, such as population density, age distribution,

individual and community mobility, healthcare facility density, virus strain type and virulence, andsoon.Combining with other time series models: The ARIMA model may be used with the Weibull function for further time series analysis and forecasting. Artificial intelligence may be used to make predictions about the structure and function of different CoV-2-related proteins and how they interact with host human proteins and the cellular environment. Appropriate algorithms can estimate the impact of many socioeconomic factors that govern susceptibility, dissemination, and advancement of the epidemic. In big nations with little healthcare resources, this might be useful in making allocation decisions.
For real-time collection of epidemiological data connected to COVID-19, we may also examine and analyze social media data using AI.Robots powered by artificial intelligence might be used to treat patients remotely and provide medication without coming into direct contact with them. Furthermore, because of COVID-19 lockdowns, air quality has vastly improved across the world.As a result of the lockdowns imposed by COVID-19, air quality has vastly improved throughout the world. However, there is much speculation about the vengeful pollution that occurs after such shutdowns. In further research, we will look at more complete studies, including age distributions and demographics with other features.Artificial intelligence can forecast the risk of serious illness associated with COVID-19 for people of varying ages. Such algorithms would allow for preventative steps to be implemented, averting the spread of viruses among vulnerable demographics. Through the use of real-time sensors and visual imaging, as well as preventative measures based on AI, we can stop the spread of the virus among vulnerable populations. With the use of real-time sensors, such as those found in traffic cameras or surveillance systems, COVID-19 symptoms may be monitored via visual imaging and tracking applications, with the data then being sent to the appropriate hospitals and administrative authorities for disciplinary action. The tracking process must be comprehensive, extending from airports and seaports to city streets and medical facilities.
In this paper describe the section 2. Machine Learning , section 3.Data Collection, Section 4. Result comparison, section 5. Conclusion

2. MACHINE LEARNING

Machine learning may also be used to help build a mathematical model by making advantage of the data's inherent statistics. To achieve its main goal of automatically learning from data (experience) and providing us with the required output, machine learning must first achieve its basic aim. It does this by automatically looking for patterns in the data, saving time and effort over human analysis. It may be broken down into four distinct types: supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning.

2.1 Supervised Machine Learning

Predictions are the goal of Supervised Learning, a kind of model for Machine Learning. To properly train a regression or classification model, this approach requires the use of a labeled data set as the input and preset answers as the output. It does this by using regression and classification strategies to construct models with predictive capabilities.

2.2 Unsupervised Machine Learning

The only data we have to deal with are the ones we provide, in contrast to supervised learning. The primary goal of this work is to look for regularities in the data. The statistical concept of "density estimation" is used to characterize this phenomenon. Clustering may be used to assess density in certain situations. The submitted data is now clustered into distinct groups. Assumptions are developed at this step to help find data clusters that make sense when put into a certain category. This method is data-driven, and it gets better as more data is input. Movies that a user has viewed before and liked are used to provide suggestions for similar films to watch on Netflix. The suggestions are made using this grouping of films. Unsupervised learning is great at illuminating hidden patterns in data, but its approximations are generally inferior to those obtained by supervised learning.

2.3 Semi-supervised Machine Learning

The term "semi-supervised learning" was used to characterize an approach to machine learning in which the data used falls between that of supervised and unsupervised learning. Semi-supervised learning systems may acquire knowledge from both labeled and unlabeled input. Semi-supervised machine learning allows for spectacular outcomes to be achieved with just minimal effort on the annotations. Semi-supervised machine learning is a kind of machine learning in which both labeled and unlabeled data are used to train classifiers. Good outcomes may be achieved with less annotation effort, reducing the amount of labor that has to be done by people.

2.4 Reinforcement Machine Learning

Reinforcement learning models behavior through repeated trial and error in an environment that is always changing. The secret to being successful in this endeavor is to ensure that the appropriate actions are carried out at the appropriate times in order to maximize productivity and achieve the intended results. In the process of reinforcement learning, data may either be provided as input or output. When the agent chooses the action they want, they are told that the reward and following state do not take into consideration the long-term actions they have taken. It is necessary for the agent to actively hold information about states, rewards, transitions, and actions in order to behave in the most optimal manner.

2.5 Support Vector Machines(SVM)

Support Vector Machines (SVMs) are a type of computer programme that classifies data using a method involving the construction of an N-dimensional hyperplane. This methodology separates the data into two distinct categories. In the context of support vector machines, "attribute" refers to the predictor variable, and "feature" refers to the altered attribute. In this context, both of these terms are used interchangeably. The process of selecting features entails identifying which samples from a given dataset are most pertinent for analysis and then selecting those samples. A vector is a collection of characteristics that, when considered together, characterise a particular object. The ultimate goal of support vector machine (SVM) modelling is to determine the optimal hyperplane for dividing the clusters in the most effective manner. The target variable will be represented on one side of this hyperplane, while the remaining categories will be represented on the opposite side. Support vectors refer to the data elements that are located near the hyperplane.

2.6 Artificial Neural Networks(ANN)

In their most basic form, ANNs are attempts to simulate the human brain's neural network. Neurons are ANN's building blocks. It is stated that a neuron takes in data and generates a response. Neural networks are networks of neurons. After the neural networks have been constructed, they are trained using data in an effort to reduce error. The next step is to utilize an optimization algorithm to further cut down on mistakes.

2.7 Random Forests(RF)

Random Forest (RF) is a method for predictive modelling that makes use of the strengths of random sampling and ensemble techniques to achieve accurate forecasts and improved generalisations. Random forests are made up of a significant number of separate trees. There is a positive correlation between the number of independent trees and the degree of accuracy achieved. Classifiers based on the Random Forest algorithm have the capacity to solve the problem of missing data by "filling in the gaps."

3. DATA COLLECTION

The procedure for gathering data was crucial and time-consuming. Consistency relies on precise data-gathering methods, regardless of the area of study. Patients' medical records were kept private, making data collection a rigid and time-consuming procedure. We attempted to collect direct information from a number of hospitals and health institutes in Sweden and China that treat a high volume of patients with COVID-19, but this was not possible owing to the current circumstances at these facilities. To compile open-source clinical data on individuals diagnosed with COVID-19, a comprehensive search was undertaken across many databases.

3.1 Dataset Used

The COVID-19 prediction model's training data came from a publicly available data set stored in a repository. Patients diagnosed with COVID-19 who were hospitalized were included in the dataset. Extracted from electronic medical records, this information includes patient demographics, symptoms, medical history, and test results. The original dataset included information on treatments used by medical professionals to alleviate illnesses. We've removed those fields since they weren't necessary for our model anyway. The data set is a compilation of information with several dimensions. Some of the data comprises specific clinical values recorded in the past, while other data offers information on whether the patient has been diagnosed with a certain ailment in the past, such as Renal disease or Digestive disease. It has both numeric and textual information in its many areas. For the purposes of the experiment, numerical values were encoded into the textual data. Table 1 displays the characteristics used in the machine learning model's data set.

Table1.Features in the dataset used

Feature Number	Feature Name
1	Gender
2	Clinical Classification
3	Age
4	Malignant tumor
5	Digestive system disease
6	White Blood Cell Count
7	Days between the first sign of illness and going to the hospital
8	Patient Condition
9	Respiratory system disease
10	Chest tightness
11	Fatigue
12	Liver disease
13	Fever
14	Cough

3.2 Experiment Results

The algorithms chosen after the Literature Review are then evaluated using the performance measure. For the purpose of classifying COVID-19, the three best methods are as follows:

- SVM (Support Vector Machine).
- RF (Random Forests).
- ANN (Artificial Neural Networks).

The aforementioned algorithms were all trained using the data that was acquired, and then the results of their training were evaluated further. The effectiveness of every algorithm was evaluated at a number of different training set points. The training sets for every algorithm had a total of 150, 200, 250, 300, 350, and 405 records, respectively. The purpose of this research is to identify the approach that will be most successful in predicting the COVID-19 outbreak. It is possible to examine the relative advantages of various approaches on distinct subsets if the data are divided up beforehand and then analysed separately.

1.2.1. Support Vector Machine(SVM)Results

Training with numerous record sets is what determines the accuracy of the Support Vector Machine (SVM) algorithm. Training and testing sets were created at each level using k-fold cross-validation (5-folds). SVM has a 98.33% success rate in accuracy. The results of the Support Vector Machine (SVM) technique are shown in Table 2 below.

Table2.SupportVectorMachine(SVM)AccuracyResults

Number of Patient Records	Accuracy
150	94.61%
200	95.88%
250	97.24%
300	97.06%
350	97.59%
405	98.21%

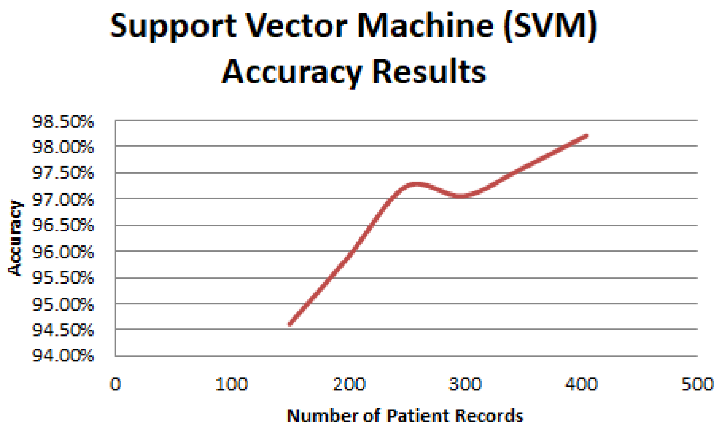

Figure 3. Support Vector Machine (SVM) Accuracy Chart

The chart in Figure 3 provides a very clear illustration of the classification accuracy of the Support Vector Machine (SVM) for each record set.

1.2.2. Random Forest (RF) Results

The Random Forest (RF) algorithm is trained in a consistent fashion across all data sets, allowing for the identification of its correctness at any given time. Training and testing sets were created at each level using k-fold cross-validation (5-folds). RF has a 99.42% success rate in accuracy. Table 3 displays the results of the Random Forest (RF) algorithm's categorization of several datasets.

Table3.RandomForest(RF)AccuracyResults

Number of Patient Records	Accuracy

150	92.31%
200	95.13%
250	95.27%
300	97.34%
350	97.64%
405	99.42%

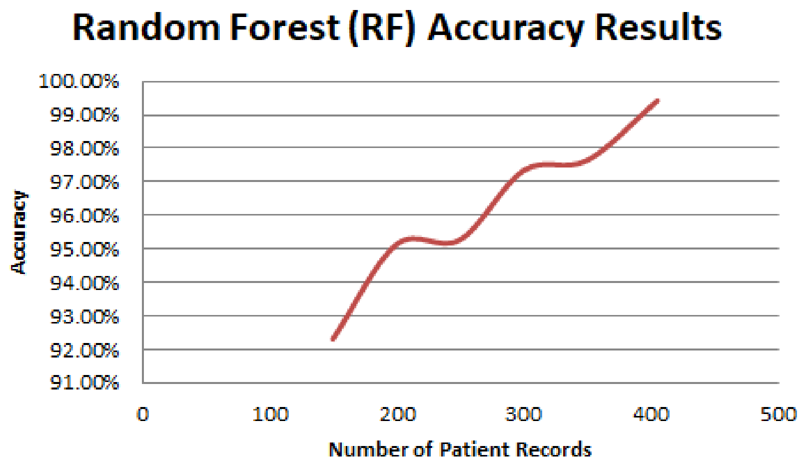

Figure 4. Random Forest (RF) Accuracy Chart

Figure 4 is a chart displaying the classification accuracy of Random Forest (RF) for each individual data set. The graph shows how accuracy improved when different record sets were used for training.

1.2.3. Artificial Neural Networks (ANN) Results

The ANN Algorithm is evaluated and refined using record sets of data for training. After using the ANN Algorithm, the accuracy of its classifications increased to 99.93%. Table 4 summarizes the classification precision that was presented for each data set.

Table 4. Artificial Neural Networks (ANN) Accuracy Results

Numberof PatientRecords	Accuracy
150	81.25%
200	87.45%
250	92.15%
300	97.32%
350	99.90%
405	99.93%

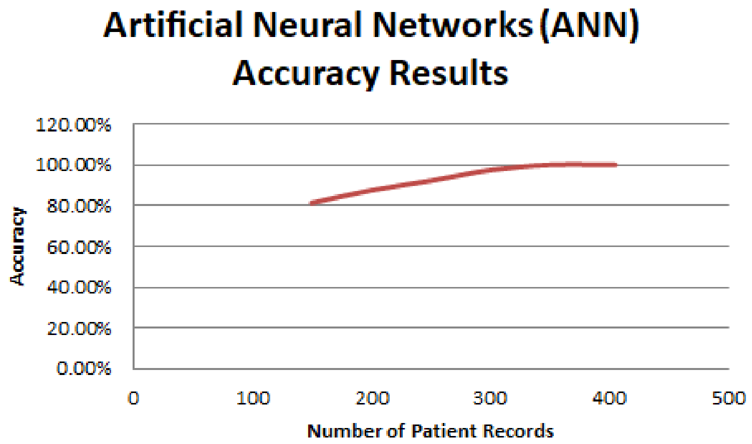

Figure 5.Accuracy Chart of Artificial Neural Networks (ANN)

Figure 5 illustrates the degree of success achieved by Artificial Neural Networks (ANN) when applied to various record sets.

4. Results Comparison

Table 5 summarizes the findings of the studies performed to determine the overall accuracy. In Figure 4, we see a visual depiction of how various record sets perform for each method.

Table 5. Comparison using Performance Metric - accuracy

Number of Patient Records	Support Vector Machine (SVM) Accuracy	Random Forest (RF) Accuracy	Artificial Neural Networks (ANN) Accuracy
150	94.61%	92.31%	81.25%
200	95.88%	95.13%	87.45%
250	97.24%	95.27%	92.15%
300	97.06%	97.34%	97.32%
350	97.59%	97.64%	99.90%
405	98.21%	99.42%	99.93%

Table 6. Feature Importance

Feature Number	Feature Name	Feature Value
14	Cough	0.180567
10	Chest tightness	0.160102
5	Digestive system disease	0.158192
8	Patient Condition	0.14722
11	Fatigue	0.11982
2	Clinical Classification	0.098363
12	Liver disease	0.083456
13	Fever	0.081516
4	Malignant tumor	0.068897
7	Days between the first sign of illness and going to the hospital	0.066181

6	White Blood Cell Count	0.058647
9	Respiratory system disease	0.037231
1	Gender	0.033432
3	Age	0.031842

5. CONCLUSION

In this research, we explored how better mathematical modeling, Machine Learning, and cloud computing may aid in providing early warnings of an epidemic's spread. Additionally, a case study has been provided that exemplifies the global severity of the spread of CoV-2. We demonstrate that our model can statistically outperform the baseline using the suggested Robust Weibull model with iterative weighting. The default Gaussian model paints an unrealistically rosy image of the COVID-19 situation. Decisions made based on an unreliable model might have a negative impact on public health. This study uses a literature review to determine the best strategy for predicting COVID-19 in patients. There was no conclusive evidence that identified a single algorithm as the superior method of prediction. As a result, we settled on an algorithmic suite consisting of the Support Vector Machine (SVM), Artificial Neural Networks (ANNs), and Random Forests (RF). Clinical data from individual patients was used to train the chosen algorithms. Machine learning model accuracy is compared among algorithms by training them on datasets with variable patient counts. The precision of the taught algorithms served as a metric for their efficacy. When compared to the Support Vector Machine (SVM) and the Random Forest (RF), the results revealed that the prediction accuracy of the ANNs was higher. We also evaluated the trained algorithms to identify the factors that influence the prediction of COVID-19 in patients. The potential for Machine Learning to improve healthcare is substantial. It is suggested that future research focus on calibrated and ensemble approaches, which may be able to tackle unusual issues more quickly and provide better results than the current algorithms. In addition, sensors and other elements may be integrated into an AI-based app to aid in illness detection and diagnosis.
Because healthcare forecasting is so important in the long run, it's worth figuring out how to build a system that can anticipate the emergence of new illnesses that pose a threat to humanity.

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