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Survey of COVID-19 Prediction Models and Their Limitations

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Abstract: COVID-19 pandemic has been spreading globally and has been influencing the daily life of human beings in addition to the economies of most countries around the globe. Early and accurate detection of COVID-19 coronavirus is crucial to prevent and control its outbreak using medical treatment and timely quarantine. The daily massive increases in the cases of COVID-19 patients worldwide and the limited solutions of the available diagnosing techniques have resulted in difficulties in pointing out the presence of the disease. Wherefore, the necessity arises to find other alternatives by leveraging the artificial intelligence (AI) models which create intelligent entities that have demonstrated themselves particularly successful due to their spectacular innovations in video processing and image, in addition to their highly accurate projection models. This survey contributes to studying the state of the art of the AI models that have been fighting against the COVID-19, highlighting the limitations that are significant and present noteworthy barriers to struggle with a pandemic, and recommends the trends for the incoming research on the pandemic.

Keywords: Deep Learning, COVID-19, Prediction, Explainability

1. Introduction

COVID-19 has spread around the world swiftly. At the time of writing this survey, the accumulative total of individuals who have tested positive has exceeded 121 million and about 2.5 million have died [1], which represents a seriously vulnerable to the health and life of humans worldwide. Battling coronavirus needs the bravery of healthcare personnel, social life, and technological solutions. Recently, pervasive healthcare systems have become one of the main fields of research where we are bound by smart medical devices; including, smartphones, cameras, sensors, tablets, etc.; interrelating and exchanging readings and information using network technologies [2].

The early detection of COVID-19 and the accurate diagnosis of non-COVID-19 cases is vital not only for patient healthcare but also for public health by ensuring the patients' isolation and controlling the outbreak of the pandemic. In connection with the novelty of the disease, during the early days of COVID-19, the methods of fighting it were unknown, but researchers considered the instant diagnosis of infected patients and their isolation from the healthy people as a significant measure. The clinical features of COVID-19 include respiratory symptoms, pneumonia, fever, dyspnea, and cough. However, these symptoms do not necessarily indicate COVID-19.

AI models are evolving rapidly and have added great attention by beating the world champion at Go, directing the hand of robotics to solve a Rubik's cube [3], and has resulted in a massive improvement in the precision of face recognition. This survey aims to articulate COVID-19 problems for the current AI models in terms of usability, interpretability, and stability. The used datasets in these models are inclined to have inadequate datasets for robust training, validation, and testing because, in the prompt pandemic response situation, it is a big challenge to build large datasets for chest image analysis, outbreak projecting, and other related factors that may affect on the infection of the pandemic.

This survey studies the state of the art of the AI models used in detecting COVID-19 and categorizes them into three types, clinical data analysis, medical image processing, and epidemiology. The clinical data analysis models produce a predictive model using the patients' demographic information, physiological conditions, pre-existing illnesses, and symptoms to assist the medical centers and hospitals. The medical image processing models create image analysis models using a small amount of COVID-19 CT images for infection detection in CT images. The Epidemiology models create models that predict future cases or deaths by using the lockdown phase and the history of infections.

The limitations of the models were researched in this work over specific downsides like interpretability, explainability, and the inadequate of the used datasets, which lead to poor models that have drawbacks in usability and stability and that hinder their adoption. This paper is organized as follows.: Section 2 presents the recent machine and deep learning models used for COVID-19 detection; Section 3 discusses the limitations of these prediction models; Section 4 highlights our findings, and Section 5 summarizes the survey's main points and describes future works.

2. Recent AI Models for Detecting COVID-19

The health industry is keenly looking for new techniques to follow and observe the development of the coronavirus epidemic in this international health crisis. AI technologies have the greatest use right now, which can track the outbreak and monitor the growth rate of the coronavirus, and point out the risk and gravity of COVID-19 patients. Moreover, AI can also predict the probability of death by effectively analyzing the history of the patient data, and also help us in fighting the virus by testing individuals, medical assistance, data and information, and recommendations regarding disease control.

Machine learning (ML) is a subset of Artificial Intelligence that contains the algorithmic modeling culture of statistical models [2], and only needs a small amount of knowledge to learn how to solve problems.

Deep Learning (DL), on the other hand, is a subset of ML that focuses on building deep structural NN models that learn from data using algorithms of feedforward and backpropagation.

As the described AI solutions require patients' data as an input for COVID-19 cases detection, the ubiquitous computing services provided this information in a reliable and up-to-date way. These healthcare monitoring services made the life of patients and, especially, elderly persons independently and safely in their homes. In general, the surveyed models are categorized as clinical data analysis, medical image processing, and epidemiology hence, the complexity of pervasive systems and U-Healthcare, in particular, is steadily increasing. Generally, these models contain an increasing diversity of mobile smart devices, which can be used to perform various tasks in different changeable environments [4]. Besides, these systems provide the proper health services to the clients; they must be able to learn continuously and progressively about the current profile, activities, physical environment, and the health measurements of the patient. In this section, we detail the models according to their types.

2.1. Clinical Data Analysis Models

The purpose of this type of model is to produce a predictive model using the patients' demographic information, physiological conditions, pre-existing conditions, and symptoms to assist the medical centers and hospitals to increase the number of survivors by affording precise and reliable equipment to triage COVID-19 patients more accurately and effectively throughout the pandemic and support medical decision making as shown in table 1.

2.1.1. Machine Learning Model to Identify Early-Stage Symptoms of COVID-19 Patients

A model that diagnoses and predicts of COVID-19 pandemic with high accuracy by executing a supervised machine learning algorithm. The studied features comprise features of the persons concerned, e.g., age, history of travels, gender, fever, and clinical profile such as the existence of lung infection and the severity of the cough. Several machine learning algorithms were applied and they found that the XGBoost algorithm performed with the highest accuracy (>85%) to predict and selecting features that correctly diagnose the COVID-19 [5].

2.1.2. Machine Learning Model to Predict Mortality Risk in Patients with COVID-19

A model that identifies the health risk and predicts the mortality risk of COVID-19 patients, based on machine learning algorithms. The used dataset exceeds 2,670,000 confirmed COVID-19 patients. The study suggests an artificial intelligence model assists the medical facilities and hospitals to decide and prioritize who should get the healthcare first if the system is overwhelmed by overcrowding. The accuracy proves 89.98% in predicting the mortality level. Several machine learning algorithms were used i.e., Random Forest, Decision Tree, K-Nearest Neighbor (KNN), Support Vector Machine (SVM), Artificial Neural Networks, and Logistic Regression to predict the mortality rate of the COVID-19 patients [6].

2.1.3. Machine Learning Model to Predict COVID-19 Based on Symptoms

The prediction model estimates the risk of infection of the COVID-19 patient to help the healthcare workers in triaging patients. They established a machine learning methodology using a gradient-boosting machine model built with decision-tree base-learners that trains 51,831 records, such that 4769 were COVID confirmed). The test set contains data from the following week (47,401 tested individuals where 3624 were COVID-19 confirmed). The model predicted accuracy for COVID-19 test results was (95%) [8].

2.1.4. Machine Learning-Based Prediction of COVID-19 Diagnosis Based on Symptoms

15 seconds were gathered to one-minute heart rate in

addition to step interval data by using the Fitbit devices throughout the COVID-19 pandemic period (February 2020 until June 2020). The model measures the resting heart rate by choosing the intervals when steps were zero for 12 minutes. Then the data for each tested individual was divided into baseline or train before the COVID-19 non-infectious period and during the infectious period. The deep learning approach was developed based on a Long Short-Term Memory Networks-based autoencoder, named LAAD, to predict the pandemic infection by diagnosing the abnormal resting of the heart rate in the tested data comparative to the user's baseline. The results demonstrate that deep neural networks (DNN) and wearables are efficient techniques for the early diagnosis of COVID-19 infection [9].

2.1.5. Deep Learning-Based Detection of COVID-19 Using Wearables Data

New deep learning methodology, depending on Time-Aware LSTM (T-LSTM) neural network and used an open dataset that is available online, comprising 485 blood samples for patients from Wuhan, China, to train the model. The proposed approach can hold the dynamic relations in occasionally experimented time series. Particularly, the method predicted the consequence of COVID-19 patients by taking into consideration both the irregular time intervals and the bio-markers. Then, the patient representations were used, obtained from T-LSTM units, to categorize the patient stages and depict the COVID-19 pandemic progression. The accuracy of the predicted results exceeded 90%, 98%, 95%, 93% at 12, 3, 6, 9 days, correspondingly. Most significantly, they found 4 phases of COVID-19 development with different mortality risks. Moreover, they classified 40 bio-markers connected to the pandemic where the top 5 are hs-CRP, Lymph, Creatinine, LDH, and Indirect Bilirubin. Additionally, they located three obstacles liver function injury, myocardial injury, and renal function injury [10].

Table 1. *Summary of the research contributions of the deep and machine learning models that predict the COVID-19 based on clinical data analysis.*

Model	Contribution	Usability	Stability	Explainability	Interpretability
Machine Learning Model to Identify Early-Stage Symptoms of COVID-19 Patients [5]	Studies comprise features of the persons concerned, e.g., age, history of travels, gender, fever, and clinical profile such as the existence of lung infection and the severity of cough.	+	+	+	++
Machine Learning Model to Predict Mortality Risk in Patients With COVID-19 [6]	Suggests an artificial intelligence model to assist the medical facilities and hospitals to decide and prioritize who should get the healthcare first	+	+	+	++
Machine Learning Model to Predict COVID-19 Based on Symptoms [7]	designed a prediction model that estimates the risk of infection of the COVID-19 patient to help the healthcare workers in triaging patients.	+	+	+	++
Machine Learning-Based Prediction Of COVID-19 Diagnosis Based on Symptoms [9]	developed a deep learning approach based on a Long Short-Term Memory Networks-based autoencoder, called LAAD, to predict COVID-19 infection by detecting abnormal resting heart rate in test data relative to the user's baseline	+	+	+	++
Deep Learning-Based Detection Of COVID-19 Using Wearables Data their [10]	Proposing temporal deep learning method, based on a time-aware long short-term memory (T-LSTM) neural network and using blood samples.	+	+	-	+

2.2. Medical Image Processing

Individuals who have a suspicion of COVID-19 want to know rapidly whether they are infected, thus they can obtain proper treatment, quarantine, and notify their close contacts. Presently, the diagnosis of COVID-19 needs a laboratory test (RT-PCR) of throat samples and nose, the test requires some medical equipment and will need at least 24 hours to get the result. However, it is not accurate and may involve another RT-PCR test or use of chest imaging to confirm the diagnosis because COVID-19 is a respiratory disease. There are three types of chest imaging: X-rays (radiography) use radiation to produce a 2-D image, Computed Tomography (CT) scans use a computer to merge 2-D X-ray images and convert them to a 3-D image, and Ultrasound scans use high-frequency sound waves to produce an image [2].

Many research papers have studied the contributions of deep learning in various measures including medical imaging, disease diagnosis, drug finding, and coronavirus severity and contamination to monitor the outbreak as shown in table 2. In addition, the overall models of deep learning on multiple dimensions to control novel coronavirus (COVID-19) are analyzed and discussed. Although many studies are done using deep learning algorithms, there are certain limitations and challenges. The following related works have used the deep learning models in their solutions.

2.2.1. Deep Learning Model for Detecting and Analyzing of COVID-19 Based on Chest X-Ray Images

Successfully tests were made and estimation of the COVIDX-Net depending on 20% of X-ray images for the model training and testing phases, correspondingly. The Dense Convolutional Network (DenseNet) and VGG19 models proved a good and similar performance of automated COVID-19 diagnosis with f1-scores of 0.89 and 0.91 for normal and COVID-19, correspondingly. The lowest performance of the classification is achieved for the InceptionV3 model with f1-scores of 0.67 for normal cases and 0.00 for COVID-19 cases [11].

2.2.2. Deep Learning Model to Diagnose COVID-19 with X-Ray Images

A diagnostic tool was developed to detect COVID-19 cases and executed in four stages, viz., data augmentation, preprocessing, deep network model designing stage-1 and stage-2. The study used 1215 images, and to avoid the model overfitting the whole dataset length was increased to 1832 images. The deep neural network was implemented and designed to differentiate COVID-19 pneumonia from healthy cases, bacterial and other virus-induced pneumonia on X-ray images of the chest. The highest accuracy as 97.77%, recall as 97.14% and precision as 97.14% in the case of COVID-19 detection shows the efficiency of the proposed model [12].

2.2.3. COVID-19 Diagnosis Using a Simple 2D Deep Learning Framework

A simple 2D deep learning methodology, called the fast-track COVID-19 classification network (FCONet), was advanced to detect COVID-19 depending on the chest CT image, learning using one of four state-of-the-art pre-trained deep learning models (VGG16, ResNet-50, Inception-v3, or Xception). Several 3993 chest CT images were collected of patients with COVID-19, other diseases, and non-diseased individuals from Wonkwang University Hospital, Italy. The CT images were split into training sets and testing. The diagnostic performance of the four pre-trained FCONet models to diagnose COVID-19 pneumonia was compared such that ResNet-50 proved the highest testing data set using low-quality CT images and the detection accuracy of the ResNet-50 model was the highest (96.97%), followed by Xception, Inception-v3, and VGG16 (90.71%, 89.38%, and 87.12%, correspondingly) [13].

2.2.4. Deep Learning-Based Decision-Tree Model for Diagnosing COVID-19 from Chest X-ray Imaging

A study was developed to examine the feasibility of using a deep learning-based decision-tree classifier for diagnosing COVID-19 from CXR images. The suggested classifier contains three binary decision trees, convolution neural network is used to train the model based on the PyTorch frame. The first decision tree identifies the abnormal images that contain signs of tuberculosis, the second tree categorizes the CXR images as abnormal or normal, while the third does the same for COVID-19. The accuracies of the first and second decision trees are 80% and 98%, correspondingly. However, the average reliability of the third tree is 95%. The suggested deep learning-based decision-tree classifier can be used in pre-screening patients to conduct triage and fast-track decision-making before RT-PCR results are available [14].

2.2.5. Fully Automatic Deep Learning System for COVID-19 Diagnostic and Prognostic Analysis

A deep learning model for COVID-19 makes detective and predictive analysis by using computed tomography (CT). They gathered 5372 different computed tomography images. In the first step, 4106 computed tomography images was used to pre-train the deep learning system. Then, 1266 images (924 with COVID-19, 471 followed-up for 5+ days, and 342 with other pneumonia). The deep learning system reached good performance in diagnosing COVID-19 from other pneumonia (AUC=0.87 and 0.88) and viral pneumonia (AUC=0.86). Furthermore, the system succeeded to categorize patients into high-risk and low-risk [15].

2.2.6. A Deep-Learning-Based Framework for Automated Diagnosis of COVID-19 Using X-ray Images

The deep learning model for the diagnosis of COVID-19 using chest X-rays that can effectively diagnose COVID-19 without using feature extraction by using four deep-learning models which are: (1) DenseNet121, (2) ResNet50, (3) VGG16, and (4) VGG19 that also use the transfer-learning concept to diagnose X-ray images to decide whether or not they can be classified in a binary way as normal or COVID-19 based. The authors rely on several open-source datasets to get their images from and apply pre-processing as well as data augmentation to them. Once the data is ready, classification simulations and tests are done by utilizing several metrics such as accuracy, sensitivity, F1 score to check which approach gives the best result among the 4. In their study, it becomes outstanding that deep-learning models VGG16 and VGG19 outperform the other two and provide much better results. A very important metric in this measure is the False Positive Rate (FPR) because, with the novelty of COVID-19, a false positive test might mean that patients can still give the disease to others while thinking they do not have it due to a negative test result [4].

Table 2. *Summary of the research contributions of the deep models that predict the COVID-19 based on medical image analysis.*

Model	Contribution	Usability	Stability	Explainability	Interpretability
Deep Learning Model for Detecting and Analysing Of COVID-19 Based on Chest X-Ray Images [8]	Introducing a new deep learning framework; COVIDX-Net to assist radiologists in automatically diagnosing COVID-19 in X-ray images.	++	++	-	+
Deep Learning Model to Diagnose COVID-19 with X-Ray Images [12]	Proposing a deep learning method that is implemented in four phases, viz., data augmentation, preprocessing, stage-I and II deep network model designing	++	++	-	+
COVID-19 Diagnosis Using a Simple 2D Deep Learning Framework [13]	Developing a simple 2D deep learning (FCONet), to diagnose COVID-19 pneumonia based on a single chest CT image.	++	++	-	+
Deep Learning-Based Decision-Tree Model for Diagnosing COVID-19 from Chest X-ray Imaging [14]	investigating the feasibility of using a deep learning-based decision-tree classifier for detecting COVID-19 from CXR images.	++	++	-	+

Model	Contribution	Usability	Stability	Explainability	Interpretability
A Deep-Learning-Based Framework for Automated Diagnosis of COVID-19 Using X-ray Images [15]	Proposing fully automatic deep learning system for COVID-19 diagnostic and prognostic analysis by routinely used computed tomography.	++	++	-	+

3. Epidemiology

Various prediction models for the COVID-19 outbreaks are being used throughout the world to apply the appropriate control measures and to make informed decisions [16]. Supervised machine learning models for the COVID-19 pandemic were developed with learning algorithms using epidemiology for negative and positive COVID-19 cases [17] as shown in table 3. These models predict future cases or deaths by using the lockdown phase and the history of infections by finding the number of persons who are expected to die due to COVID-19 infection, how long the quarantine will end, and the number of individuals who are anticipated to be infected with COVID-19. These examples are described as Natural Language Processing (NLP) models, but epidemiological models are the source of these answers. Another example of this is the Susceptible, Infected, and Recovered (SIR) models. The SIR model depicts how people changeover from healthy or "Susceptible", to "Infected", and "Recovered" over a set of three differential equations. The Deep Neural Networks (DNN) is used to solve the set of differential equations and combine the non-linear impact of quarantine or travel into these SIR models [2].

3.1. Supervised Machine Learning Models for Prediction of COVID-19 Infection Using Epidemiology

The intensity relationship was specified between each independent feature and dependent feature of the dataset preceding developing the models. The correlation coefficient analysis among different independent and dependent features was applied. 80% of the dataset was used for training the models whereas 20% was used for examining the models. The result of the performance assessment showed that the decision tree model has the highest accuracy of 94.99% however, the Support Vector Machine Model has the highest sensitivity of 93.34% and Naïve Bayes Model has the highest specificity of 94.30% [17].

3.2. COVID-19 Outbreak Prediction with Machine Learning

Comparative analysis was presented of soft computing and machine learning models to anticipate the COVID-19 outbreak as an alternative to Susceptible, Infected, and Recovered (SIR) models and Susceptible, Exposed, Infectious, Removed (SEIR) models. Amongst an extensive scope of the investigated machine learning models, 2 models proved promising results (i.e., Adaptive Network-based Fuzzy Inference System (ANFIS); and Multi-Layered Perceptron, (MLP)). Depending on the reported results here, and due to the highly complicated nature of the COVID-19 outbreak and the difference in its behavior across countries. The models showed auspicious consequences in terms of predicting the time series [16].

3.3. Deep Epidemiological Modeling by Black-Box Knowledge Distillation: An Accurate Deep Learning Model for COVID-19

A new deep learning model was proposed to provide a dynamics pandemic prediction realistically. Initially, they leverage combination models to make precise, all-inclusive, yet unworkable simulation systems. Next, they practice simulated observation sequences to request the simulation system to retrieve knowledge from simulated projection sequences. Then, with the acquired data, an ordered combination is suggested to improve query accuracy, enhance knowledge multiplicity, and increase filtering model precision. Lastly, they train the deep neural network of the students, this model results in high accuracy and lower complexity [18].

Table 3. *Summary of the research contributions of the deep and machine learning models that predict the COVID-19 based on Epidemiological modeling.*

Model	Contribution	Usability	Stability	Explainability	Interpretability
Supervised Machine Learning Models for Prediction of COVID-19 Infection using Epidemiology Dataset [17]	Designed supervised machine learning models for COVID-19 infection were developed using epidemiology	+	+	+	++
COVID-19 Outbreak Prediction with Machine Learning [16]	presenting a comparative analysis of soft computing and machine learning models to anticipate the COVID-19 outbreak	+	+	+	++
Deep Epidemiological Modeling by Black-box Knowledge Distillation: An Accurate Deep Learning Model for COVID-19 [18]	proposing a new deep learning model to provide a dynamics pandemic prediction realistically.	+	++	-	+

4. Limitations of AI Models

The limitations of AI models raise essential queries about their practicality. For instance, the healthcare workers are not able to justify the COVID-19 prediction based on the deep learning models, the deep learning models cannot predict COVID-19 if the patient has other diseases e.g. COPD, hypertension, asthma, etc. As a result, the used datasets are not sufficient to build a trusted model. Table 1 outlines the aforementioned machine and deep learning models to predict the COVID-19 pandemic where we used "+" to denote the kind of characteristic that is supported, "-" to denote the kind of characteristic that is not supported. In this section, we explore interpretability, stability, and usability, where each one of these limitations makes up their field of research.

4.1. Explainability

Explainability has been generally understood to be critical in establishing trust, and determined by the ability of a machine learning model to justify its outcomes and assist physicians in explaining the model prediction. An explainable model is a function that is too complicated for a human to understand without any other techniques.

Deep learning models achieved high accuracy in the surveyed COVID-19 models. However, they function as a black box, and it is a high challenge to realize why caused them to make a specific prediction hence it limits using deep learning models for safety-critical decision systems and doctors will not trust the computerized diagnosis. On other hand, there are many advantages of explainability and justification of decisions to the model users, including figuring out and trusting the boundaries of the system, also providing awareness for knowledge finding, in addition to detecting and developing the deep learning systems. Consequently, it provides ethics-related justification [18].

All the surveyed models will take advantage when considering the explainability in terms of how they can be understandable from a development viewpoint. Moreover, once viewing the legal side, we can characterize informed consent which is the agreement and approval as medical tools, and accountability as fundamental touchpoints for explainability. The patient and medical outlooks concentrate on the significance of considering the interaction between the human factor and deep learning medical models. We come to a result that neglecting the explainability in clinical decision support systems represents a threat to the basic ethical principles in medicine and may have harmful impacts on both individual and public health [19].

4.2. Interpretability

Interpretability can be influential in keeping machine learning systems accountable. Healthcare represents unique challenges for machine learning where the needs for understandability, model trustworthiness, and performance commonly are much greater in comparison to other domains [19]. A key fact of interpretability is the honesty of the model and its caption i.e., the learning model should explain why it is making this prediction or giving that proposition which is referred to as a key component of "user trust" [20]. The absence of interpretability in the machine and deep learning models can probably have detrimental or even life-threatening impacts. The interpretability of machine and deep learning models is context reliant always, even to the level of the user role. The learning model may involve making various interpretations for different end-users [21].

Generally, there are many definitions for interpretability including transparency of the model components, the use of intelligible characteristics in modeling, comprehensible applications of parameters, and the model clarity to the end-user. When applying the definitions of interpretability to the surveyed models, only the machine learning models applied the different characteristics of interpretability whereas the deep learning models used the definitions of interpretability partially for the inputs and outputs specifically [22].

4.3. Usability

Usability is defined as the scope where the deep learning models allow users to accomplish the required goals satisfactorily, effectively, and efficiently in particular environments [23]. Usability metrics can be measured by verifying whether the deep learning model could be used to predict the COVID-19 pandemic for all individuals specifically the ones who have other diseases or infections. Generally, the surveyed deep learning models don't provide a diagnosis for the persons who have other illnesses i.e., COPD, asthma, cancer, hypertension, etc., and that is mostly due to the used dataset that lacks the completed medical history of patients. An inquiry arises here about the models and whether they can be used in hospitals and medical centers where many COVID-19 patients may have various diseases.

4.4. Stability

A stable model release is so named because it is unchanging. Its behavior, functionality, and specification is considered 'final' for that version, usually from 1 to many years [24]. However, delivering high-quality deep and machine learning models is a challenging task and might result in defective prediction models if the deep learning methods have inadequate datasets for robust training, validation, and testing. The surveyed models no longer achieved the required level of stability and will need to be restructured as long as there are updates in the dataset, more specifically when there is a development in the severity of the coronavirus and its tight relations with other viral and chronic diseases i.e., COPD, asthma, hypertension, etc.

5. Discussion

Deep learning has offered remarkable capabilities and progresses in tackling COVID-19. However, even after these developments, there are many limitations in AI models that are used to combat the pandemic. For instance, in the surveyed models, a major downside is the inadequate datasets used for robust training, validation, and testing and that leads to poor models which hinder their adoption. On the other hand, many queries have appeared about the feasibility of the models. i.e., the interpretation of healthcare workers for the COVID-19 prediction, whether the models predict if the patient has other diseases e.g., COPD, hypertension, asthma, etc., and the continuous and compulsory updates for the structure of the models during its runtime to maintain its effectivity which indicates a drawback in the interpretability, explainability, usability, stability of the models.

Explainability is one of the main difficulties to resolve and justification of decisions to the model users, including figuring out and trusting the boundaries of the system. However, neglecting the explainability in clinical decision support systems represents a threat to the basic ethical principles in medicine and may have harmful impacts on both individual and public health [25].

Interpretable machine and deep learning models permit the users to question, realize, correct, and even advance the learning system [21]. In general, interpretable learning models enable the end-users to assess the model, ideally before making any further action, such as the doctors. By justifying the reasoning behind predictions, interpretable machine and deep learning models provide users the choice to reject or accept the predictions and recommendations.

Overall, the difference between explainable and interpretable models can be determined by the way of understanding models and the degree to which the users can know how the prediction is made without any other assistance or techniques. In the case of interpretability, we can understand how these models make predictions by looking only at the model summary or parameters. In comparison, an explainable model does not provide its explanation on its own, these models are sophisticated to be understood by humans and they require additional techniques to understand how predictions are made [21].

The usability metric can be measured by verifying whether the model could be used to predict the COVID-19 pandemic for all individuals, specifically the ones who have other diseases or infections. In the surveyed models the predictions for such individuals are not available due to the limited dataset [23]. Consequently, the hospitals and medical centers will ignore the predictions of the models and mark them as useless.

Stability is one of the most important specifications for the models which indicates the steadiness of the system without a need to make updates to overcome the development in the severity of the pandemic. However, the surveyed models will need to be restructured as long as there are updates in the dataset, more specifically when there is a development in the severity of the coronavirus and its tight relations with other viral and chronic.

6. Conclusion

The daily massive increases in the cases of COVID-19 patients worldwide and the limited solutions of the available diagnosing techniques have resulted in difficulties in pointing out the presence of disease, hence the need appears to find other choices by leveraging AI models which make intelligent entities that have shown successfulness because of their highly accurate projection models. We have studied and analyzed several machines and deep learning models that battle COVID-19. The pandemic has fetched plenty of novel problems for humanity to resolve. We have explained how to input various data types into a machine and deep learning models. Besides, we have enclosed some limitations of the surveyed models, this involves interpretability, explainability, stability, and usability. In future works, we will set a solution for these challenges to prevent and control the outbreak of COVID-19.

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