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Covid Prediction State Wise based on Machine Learning Techniques : A Systematic Review

Lalita Charpe[1], Jayant Adhikari[2]
[1]M.Tech Scholar, Department of Computer Science and Engineering, Tulshiram Gaikwad College of Engineering, Nagpur, Maharashtra, India
[2]Assistant Professor, Department of Computer Science and Engineering, Tulshiram Gaikwad College of Engineering, Nagpur, Maharashtra, India

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ABSTRACT

SARS-CoV-2, the novel coronavirus that is responsible for COVID-19, has wreaked havoc around the world, with patients presenting with a wide range of issues that have prompted health-care professionals to investigate innovative technology solutions and treatment strategies. Several organisations have been quick to adopt and customise Artificial Intelligence (AI)–based technologies in response to the challenges posed by the COVID-19 pandemic. Artificial Intelligence (AI)–based technologies have played a significant role in solving complex problems, and several organisations have been quick to adopt and customise these technologies. A systematic evaluation of the literature on the role of artificial intelligence (AI) as a comprehensive and decisive technology in the fight against the COVID-19 problem in the fields of epidemiology, diagnosis, and illness progression was the primary goal of this investigation. In accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) guidelines, a systematic search of the PubMed, Web of Science, and CINAHL databases was conducted between December 1, 2019 and June 27, 2020 to identify all potentially relevant studies that were published and made available online between December 1, 2019 and June 27, 2019. The search syntax was created by incorporating terms that were specific to COVID-19 and AI. As part of this systematic review, we gathered papers from the current COVID-19 literature that made use of artificial intelligence-based methodologies to provide insights into various COVID-19 themes. Our findings point to relevant factors, data types, and COVID-19 resources that can be used to facilitate clinical and translational research and can be used to inform future study.

Keywords : COVID-19, coronavirus, SARS-CoV-2, artificial intelligence, machine learning, deep learning, systematic review, epidemiology, pandemic, neural network.

I. INTRODUCTION

As of July 29, 2020, more than 16 million individuals have been infected with COVID-19, and more than 666,000 deaths have been documented worldwide [1]. COVID-19 is a global health crisis. As a result, several countries have overstretched their health-care systems in order to contain the spread of the epidemic [2], which has had a negative impact on the economy. There has also been a large degree of variability in COVID-19 symptoms, with symptoms ranging from a mild flu to acute respiratory distress syndrome (ARDS) or fulminant pneumonia [3-5]. The development of effective medications and vaccines for the treatment and prevention of COVID-19 is urgently required. A lack of approved therapies has forced most containment strategies to rely on social distancing, quarantine measures, and lockdown regulations to try to keep the disease from spreading [2,6]. Although these precautions have decreased the transmission of COVID-19, they have not completely eliminated the virus. Furthermore, because of the ease with which limits can be implemented, there is widespread concern about a second wave of infection [7,8]. It is necessary to use advanced containment measures, such as contact tracking and the identification of hotspots, in order to avoid a second potential epidemic of COVID-19 [9,10].

A vast spectrum of technologies aimed at mimicking the cognitive functions and intelligent behaviour of humans is encompassed by artificial intelligence (AI), which is defined as follows [11]. ML is an area of artificial intelligence that focuses on methods that enable computers to develop a model for complicated relationships or connections from empirical data without having to be explicitly coded [11]. By drawing inspiration from biological neural networks, deep learning (DL), a subcategory of machine learning (ML), achieves greater scalability and performance compared to conventional ML models, and can be used to solve a wide variety of complex tasks, such as the diagnosis and classification imaging and natural language processing (NLP) [11].

[12-14] Artificial intelligence techniques have been applied in the health care area on a variety of scales, ranging from of the prediction and diagnosis transmission trajectory to the construction of diagnosis and monitoring models. [12-14] Several health technologies, including big data, cloud computing, mobile health, and artificial intelligence (AI), were discovered and analysed in a study by Ye et al [15] in order to combat the pandemic. Several of these technologies, as well as a diverse range of data types, such as information from social media platforms, radiological imaging, genomics, medication databases and public health organisations, have been utilised to forecast disease [1, 14, 16, 19]. Multiple research [12, 13, 15, 20, 21] have focused on examining publications that discuss artificial intelligence applications to support the COVID-19 response. A pioneering study by Vaishya et al [20] identified seven crucial areas where artificial intelligence can be applied to the monitoring and management of the COVID-19 pandemic. However, due to the fact that this was a preliminary investigation, this review lacked articles in each of the seven topics examined. Using these seven topics as a foundation, Lalmuanawma et al [12] conducted a rapid evaluation of the research that were accessible at the time. However, because this was a rapid review, only a limited number of papers were included, and the qualification criteria were unclear. Furthermore, a study by Shi et al [21] focused on machine learning and artificial intelligence to radiographic images, and a study by Wynants et al [13] focused on comprehensive assessment of models which thus mainly targeted to predict the risk of developing the disease, the likelihood of hospitalisation, and the progression of the disease. Although the bulk of epidemiological studies that attempted to predict disease transmission or fatality rates, among other

parameters, were omitted from this analysis, a small number of these studies were included.

The primary goal of this study was to undertake a thorough systematic literature review on the role of artificial intelligence (AI) as a technology in combating the COVID-19 emergency and to assess its application in epidemiological, clinical, and microbiological advancements in order to better understand the disease. Specific to artificial intelligence applications, data types used, types of AI methods applied and associated performance, scientific findings, and problems encountered in the adoption of this technology were all detailed in the paper. This systematic literature review was prepared and reported in accordance with the PRISMA (Preferred Statistical Package for Social sciences Reviews and Meta-Analyses) framework, which was used in its development.

Eligibility Criteria

Aims of the study included peer-reviewed papers as well as preprints that used artificial intelligence approaches to investigate and solve the COVID-19 crisis on a variety of scales, including diagnostics, prognostics, disease spread forecasting, omics, and therapeutic development, among others.

Data Sources and Search Strategy

The databases PubMed, Web of Science, and CINAHL were searched, with the scope of the search limited to research articles published in English and in peer-reviewed or preprint journals or conference proceedings that were available from December 1, 2019, to June 27, 2020, and only articles published in English were considered. According to the advice of a competent librarian, the search syntax was developed, and it comprised the following search keywords: “CORONAVIRUS,” "COVID-19," "covid19," "cov-19," "cov19," "severe acute respiratory syndrome coronavirus 2," "sever "Wuhan coronavirus," "Wuhan seafood market pneumonia virus," "coronavirus disease 2019 virus," "Wuhan seafood market pneumonia virus," "Wuhan seafood market pneumonia virus," "Wuhan seafood market pneumonia virus," It's also known as "SARS-CoV-2." Other terms used to refer to this virus include "2019-nCoV" ("2019 novel coronavirus"), "novel coronavirus" ("novel coronavirus," "novel coronavirus"), machine learning, artificial intelligence, deep learning, neural networks, random forests, support vector machines, and "SVM." For further information on search query syntax, see Multimedia Appendix 1. The method of identifying publications that are eligible is depicted in Figure 1.

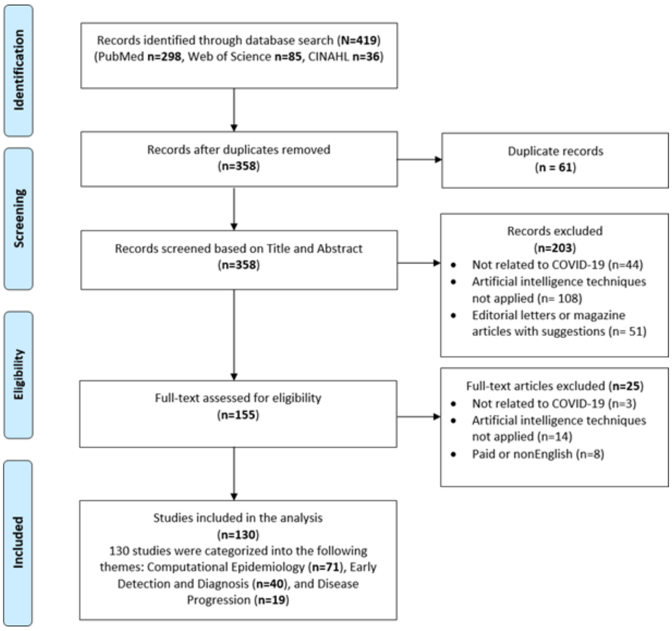

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) schematic flow

Study Selection

Four hundred and ninety-nine publications were found after a comprehensive search was conducted. 61 duplicate publications were deleted from the list, leaving 358 possibly relevant papers to be reviewed based on their titles and abstracts. An additional 203 papers were withdrawn from consideration after being checked by two different teams of reviewers (HB, SS, and MS, SB). A total of 155 publications were then selected to be subjected to an in-depth review of the complete text. The suitability of these papers was further evaluated, resulting in a total of 130 publications being included in the final analysis as a result of the process. Disagreements between reviewers were settled by a third reviewer who conducted an independent examination of the findings (FS).

Data Collection and Analyses

The included research (n=130) that have applied artificial intelligence techniques to combat the COVID-19 pandemic were subjected to qualitative and quantitative descriptive evaluations, respectively. The studies were divided into three categories based on the field of application they were conducted in: 1. (1) Computational Epidemiology (CE), (2) Early Detection and Diagnosis (EDD), and (3) Disease Progression are the three main areas of research in this field (DP). Studies that fell under the CE topic were subjected to qualitative analysis, whilst studies that fell under the EDD and DP themes were subjected to quantitative descriptive analysis. According to the study's purpose, we summarised and provided the findings in the form of tables and figures once they had been collected and analysed.

II. Review and Analysis

Search Results

An overall total of 419 articles were found using the search approach, all of which were produced and made publicly available between December 1, 2019 and June 27, 2020. There were a total of 130 papers reviewed, with 130 of them being selected for additional examination. These 130 publications were divided into three categories (i.e., CE, EDD, and DP) based on the different artificial intelligence applications used to fight the COVID-19 crisis. These themes were discovered through the use of artificial intelligence algorithms to anticipate, classify, analyse, track, and control the spread of the infection.

Early on in the COVID-19 outbreak's timeliness, the majority of published papers concentrated on anticipating the outbreak and prospective therapeutic discoveries; we found 71 of these publications and grouped them into the CE category. In addition, 40 research that used artificial intelligence approaches to detect COVID-19 in patients' radiological images or laboratory test data were gathered together under the EDD topical umbrella. A total of 19 studies that looked at disease development, outcomes (recovery and mortality), duration of stay, and the number of days spent in the acute care setting (ICU) for patients with COVID-19 were classified under the Disease Prediction (DP) subtheme. Figure 2 displays the overall trend of COVID-19 publications over time, broken down by month and theme. The CE subject received the most attention at the beginning of the year, followed by the EDD theme later on.

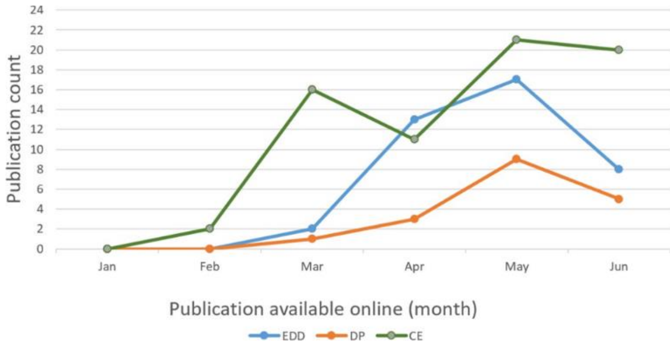

Figure 2. Over time (trend analysis) of COVID-19 studies focused on the application of artificial intelligence techniques.

Publications Focused on CE

In addition, the 71 papers that focused on COVID-19 epidemiological problems were further categorised into three categories: (1) COVID-19 disease trajectory (CDT), (2) molecular analysis-drug discovery (MADD), and (3) studies that promote COVID-19 response (FCR). These classifications were made in accordance with the study's objectives, which were to anticipate outbreaks, identify possible medication discoveries, formulate policies, and take other steps to prevent the spreading of COVID-19 (see Table 2). Over 40 studies were classified as CDT, with the majority of them focusing on forecasting COVID-19 peak and size globally or specific to a geographic location, trying to predict the impact of socio - economic status factors and environmental circumstances on the spread of disease, and evaluating the effectiveness of social trying to distance policies in comprising disease spread. According to the study approach used, a total of 22 publications were classified as MADD. These included studies focusing on the proof of identity of conventional antibiotics that have the potential to treat COVID-19, the analysis of protein structure, and the prediction of mutagenesis rate in patients with COVID-19, among other things. Finally, nine studies were classified as FCR because they emphasised the development of tools to combat the ongoing pandemic, such as the creation of a COVID-19 imaging repository and the implementation of AI-enabled automatic cleaning and sanitising tasks at health care facilities that could assist clinical practitioners in providing timely services to the affected population. There were 9 studies that used data from Twitter, Weibo, or Facebook; the majority of papers classed under the CE theme used data from either social media (e.g., 9 studies that used data from Twitter, Weibo, or Facebook) or public information repositories (Eg, NCBI, DrugBank databases, and other health agencies).

Publications Focused on EDD

We discovered 40 papers that were largely concerned with diagnosing COVID-19 in patients who had a suspected infection, primarily through the use of chest radiographic images, including such computed tomography (CT), X-ray, and lung ultrasound (LUS). 23 studies used X-rays, 15 studies used CT scans, 1 research used LUS, and 1 study used clinical data other than imaging data. The majority of research relied on digital imaging technology to diagnose COVID-19 from radiological scans. Nine research used ResNet neural network models, four studies used Xception neural network models, and three cases used VGG neural network models, either as a pretraining model or as a diagnostic model. Using standard laboratory results obtained in electronic personal health record (EHR) systems, the only study that used non-imaging medical evidence to diagnose COVID-19 used routine laboratory results.

Publications Focused on DP

During our search, we discovered 19 articles that were primarily concerned with the outcome of infections in humans with COVID-19. There were two further classifications for these studies, which were as follows: (1) risk stratification (n=15), which also included publications that assessed the risk of developing DP; and (2) hospital management systems (n=4), which included publications that anticipated the need for hospital resources. DP studies employed demographic characteristics in all 15, comorbidities were used in 13 research, and radiological scans were used in 11 studies to conduct their analyses.

III. Discussion

Techniques based on artificial intelligence will continue to be employed in the monitoring, identification, and management of the COVID-19 pandemic. Our systematic review looked at 130 studies that used artificial intelligence methods and identified three broad themes: models developed to address issues that are central to epidemiology, models that aid in the diagnosis of patients with COVID-19, and models that aid in the prognosis of patients with COVID-19, among others. The seven categories of artificial intelligence application fields suggested by Vaishya et al [20] were subdivided into the themes described below.

In this theme, we review various AI techniques applied in different areas of epidemiology.

1) AI Techniques for MADD

Current State of Drug Discovery for COVID-19

Because there is currently no approved vaccine for treating COVID-19 patients, researchers have been obliged to develop innovative ways for expediting antiviral treatment and minimising the mortality rate. According to standard methods, the drug discovery and development takes 10-15 years on average and has a very poor success rate. Instead, efforts have been made to investigate the parallels between SARS-CoV-2 (i.e., the causal agent of COVID-19) as well as other infections such as SARS and HIV through the use of therapeutic repurposing. With the tremendous genetic and epigenetic and other biological data in recent years, artificial intelligence approaches are becoming increasingly useful in the analysis of medications and chemical substances that are currently on the market in order to discover new therapeutic indications for them.

Protein Structure Analysis

It is vital to note that COVID-19's major protease (Mpro) is a critical enzyme in polyprotein processing, which plays an important role in viral replication and transcription. Several research have used artificial intelligence approaches to find pharmacological leads that target the Mpro of SARS-CoV-2, making it a potentially lucrative drug target. Deep Docking is a DL platform developed by researchers that allows for the rapid virtual screening of billions of chemical molecules depending on their structure in a short period of time. To find the top 1000 possible ligands for SARSCoV2 Mpro, this platform was utilised to analyze upwards of 1 billion chemicals available from the ZINC15 library, which totaled more than 1 billion compounds. Compared to previous docking approaches, the suggested docking infrastructure is a substantially cheaper and faster artificial intelligence technology, which enables for faster screening of vast chemical libraries including billions of compounds.

Drug Repurposing

A pharmacological and toxicological DL model was developed by Beck et al [16] in order to determine the top ten commercially available medicines that potentially act on the virus particles of SARS-CoV-2. Molecule Transformer-Drug Target Interaction, a DL model developed by the researchers, was utilised to predict binding constant values between marketable antiviral medicines that could target COVID-19 proteins. In their paper, they asserted that their model can predict binding affinity precisely based on the biochemical and amino acid sequences of a specific target protein without the need for prior knowledge of their structural details. Furthermore, the study finds that Atazanavir is the most efficient chemical molecule against the SARS-CoV-2 3C-like proteinase, with a Kd of 94.94 nM, followed by Remdesivir (113.13 nM), Efavirenz (199.17 nM), Ritonavir (204.05 nM), and Dolutegravir (336.91 nM). Drug repositioning models based on computational artificial intelligence (AI) are a quick and cost-effective technique to find interesting repositioning prospects, while also allowing for faster approval procedures.

Viral Genome Sequencing

The sequencing of the genomes of distinct viruses is carried out in order to find regions of similarity that may have implications for the functional, structural, and evolutionary links between them. A growing number of alignment-free genome comparison approaches are becoming prominent as a result of the high computing demands of classic alignment-based methods. Researchers developed an ML-based alignment-free technique for the classification of complete virus genomes for SARS-CoV-2 that is ultra-fast, affordable, and taxonomic, and that can be used to classify COVID-19 pathogens in real time as part of a case study.

2) AI Techniques for FCR

Ongoing FCR Initiatives

Global scientific cooperation have been promoted and are now more important than ever in the fight against the COVID-19 issue, which is still ongoing. It is now being worked on several projects to create centralised repositories for the sharing of COVID-19-related research. Such worldwide repositories aid in the understanding of illness characteristics, therapies, and potential mental health consequences for the broader public.

Collaborative Open Source Repository

Others concentrated on the creation of a repository of COVID-19 chest X-ray (CXR) and chest computed tomography (CT) pictures. It is available to the public through the COVID-19-CT-CXR repository, which currently comprises 1327 CT and 263 X-ray pictures (as of May 9, 2020), all of which are badly labelled. Using a DL model, the authors develop a process to automatically collect photos from the biomedical literature that are relevant to COVID-19 and store them in a database. The Nationwide Center for Advancing Translational Sciences (NCATS) is currently engaged in a project dubbed the National COVID Cohort Collaborative (N3C) to develop a centralised, national data repository on the COVID-19 study cohort. In collaboration with hospitals and health-care organisations, the N3C will facilitate the collecting and analysis of clinical, laboratory, and diagnostic data. It is anticipated that N3C, in conjunction with imaging libraries such as COVID-19-CT-CXR, will speed up clinical and translational research.

Psychological Impact of the COVID-19 Pandemic

In general, the COVID-19 lockdown and home confinement limitations have a negative impact on the mental well-being of the entire population, but they have a particularly negative impact on high-risk groups such as health care workers, children, and the elderly. There have been a number of research carried out to better understand and respond to these public health emergencies. A support vector machine (support vector machine) and sentiment analysis were used in one of the research to investigate the impact of COVID-19 on people's mental health and to assist policymakers in formulating practical policies that could be useful to healthcare practitioners. In order to develop an emotional score and cognitive markers, Weibo posts were collected both before and after the declaration of the pandemic. Among the study's most important findings is that, following China's proclamation of a COVID-19 epidemic, there has been a considerable impact, with heightened negative emotions (e.g., anxiety and sadness) and sensitivity to social dangers, as well as a fall in happiness and life satisfaction. Raamkumar et al [18] used the health belief model (HBM) to determine public opinion of physical distancing posts from several public health authority in order to determine public perception of public health authorities. Their model classified Facebook comments related to physical distance posts into four HBM constructs: perceived severity, perceived susceptibility, perceived barriers, and perceived benefits, with accuracy ranging from 0.91 to 0.95. They used a DL (a variant of recurrent neural network) text classification model to do so. Furthermore, recent innovations in the field of natural language processing (NLP), such as bidirectional encoder representations from transformers, XLNet, and other hybrid machine learning models, have demonstrated promising results in the field of sentiment analysis. Future research should concentrate on these cutting-edge strategies for improving social media content analysis in the future.

3) AI Techniques for CDT

Models for Prediction of COVID-19 Cases

During the early stages of the COVID-19 outbreak, the majority of research efforts were directed on developing mathematical models for estimating transmission dynamics and forecasting COVID-19 developments. With respect to COVID-19 cases, the susceptible-exposed-infectious-recovered (SEIR) and auto-regressive integrated moving average (ARIMA) models and their expansions were commonly used in the projection of cases. Using these models, health-care professionals and government authorities were able to develop the most effective intervention tactics and control measures to battle the epidemic. The researchers Lalmuanawma et al [12] made a similar suggestion.

Forecasting of COVID-19

In our systematic study, some researchers used Machine learning to fit both the SEIR and ARIMA statistical models. The proposed long-short-term memory model and the proposed convolutional neural network model both provided a satisfactory fit to the

SEIR and ARIMA scores, and were both recommended. However, both of these mathematical models' projections showed variances that were smaller than the 15 percent range of the given data, which was considered acceptable. Consequently, we recommend that future studies attempt to apply artificial intelligence techniques to both the SEIR and ARIMA models in order to lower the forecast failure rate and be better equipped for the COVID-19 second wave.

Impact of Policies on COVID-19 Trajectories

The accuracy of COVID-19 trajectory forecasts is dependent on the differing containment policies that are implemented by different countries in different regions. The researchers employed a DL approach to estimate the peak and size of the COVID-19 outbreak in relation to the containment policies in place. Their research found that the most effective methods of containing the disease were the continuous enforcement of quarantine regulations, early discovery, and subsequent isolation of infected individuals. Relaxing these restrictions will almost certainly increase the spread of disease by threefold for every five-day delay in implementation, and it could result in a second peak in disease transmission. It is our recommendation that government officials carefully implement such restrictions in order to prevent a second outbreak of COVID-19.

Theme 2: EDD models

4) Current State of COVID-19 Diagnosis

Since then, many nations have increased the manufacture of real-time real - time polymerase chain response (RT-PCR) testing kits for the diagnosis of COVID-19, which has remained the standard method for confirmed diagnosis to this day. According to various studies, the sensitivity of this laboratory-based test is low, which limits its application. Several researchers, including Vaishya et al [20] and Lalmuanawma et al [12], have demonstrated that artificial intelligence (AI) can be useful in the diagnosis of various infectious diseases (e.g., SARS, HIV, and Ebola) when combined with healthcare imaging modalities such as CT, magnetic resonance imaging (MRI), and X-rays. When COVID-19–positive cases are confirmed by radiological images (CT and X-ray), these imaging findings serve as a valuable supplement to the RT-PCR test. A LUS scan has been utilised to diagnose COVID-19, in addition to CT and X-ray, according to the findings of this systematic review. However, we were unable to locate any studies that utilised MRI for COVID-19 diagnosis.

5) Diagnostic Models Based on CT and X-Ray

Multiple studies have revealed that the use of chest CT for early-stage detection of COVID-19 has proven to have a low probability of misdiagnosis and can offer accurate results even in instances with no symptoms. We found 15 studies that used CT to detect COVID-19, which we reviewed. One of the most widely recognised studies used DL (COVNet) to distinguish between COVID-19 pneumonia CT scans and non–COVID-19 pneumonia CT scans. The area under the receiver operating characteristic (AUROC) curve obtained for identifying COVID-19 based on a chest CT exam was 0.96, while the AUROC curve reported for identifying community-acquired pneumonia based on a chest CT exam was 0.95, according to the researchers. In the review by Lalmuanawma et al [12], it was discovered that the accuracy recorded was slightly greater than the accuracy reported in the previous review. Chest CT for COVID-19 diagnosis, on the other hand, has several drawbacks, such as a higher radiation dosage (seven millisieverts versus 0.1 millisieverts for chest X-ray) and the fact that it is more expensive than chest X-ray in terms of cost.

As a result of our systematic review, we discovered 23 papers that used chest X-rays and artificial intelligence approaches to diagnose COVID-19 cases. When training convolutional neural network models, researchers used a transfer learning method. The models were then used to automate the detection of COVID-19 using chest X-ray images. Based on a dataset of 224 COVID-19 images, 700 pneumonia images, and 504 normal X-ray images, the model (VGG19) demonstrated an overall accuracy of 97.82 percent in detecting COVID-19 infection. On the ImageNet dataset, a similar investigation was carried out utilising transfer learning and a convolutional neural network (Xception) architecture with 71 layers, which was trained using transfer learning. A dataset of 284 COVID-19 images, 657 pneumonia images (both viral and bacterial), and 310 normal chest X-ray images was used to train and test their model (CoroNet), which achieved an average accuracy of 87% in detecting COVID-19. There have been some newly published research that have effectively used the transfer learning technique to overcome sample size limitations and improve generalizability; it is worth noting that such studies were not included in the earlier literature reviews [12,20]. Though the chest X-ray is less expensive and produces a lower radiation dosage than the chest CT, it is less sensitive than the CT, especially in the early stages of infection and in situations of moderate disease, and hence should be avoided. We urge that future studies be conducted to build artificial intelligence models that can detect COVID-19 utilising a mix of CT and X-ray images, as well as clinical factors, in order to assist clinical practitioners in making appropriate diagnostic decisions.

6) Current State of Predicting COVID-19 Progression

The COVID-19 pandemic has placed a pressure on worldwide health care systems, particularly intensive care units (ICUs), as a result of the high prevalence of ICU transfers among hospitalised patients who have COVID-19. Over time, the research focus switched from detecting the existence of the novel coronavirus in patient samples to predicting patient recovery and risk factors connected with the virus's transmission. As a result, only few research that were specifically focused on DP were included in early systematic reviews [12,20]. This evaluation identified 19 studies that predicted DP as well as the anticipated outcomes in the COVID-19 group that had been confirmed. It is possible that early identification of hospitalised patients who may be at high risk will allow health care practitioners to plan and prepare for intensive care unit resources more efficiently (eg, beds, ventilators, and staff).

Distributed AI Architecture and Transfer Learning

The introduction of COVID-19 has prompted public health authorities and research laboratories to share data and code, either through the creation of data repositories or the adoption of federated artificial intelligence models [13, 14]. Furthermore, transfer learning was used to expedite the building of AI models, particularly when imaging data was used.

7) Distributed AI Architecture

Difficulty learning techniques (DL) are generally used to increase prediction accuracy by training models on vast amounts of real-world data. We found that some research used artificial intelligence approaches, either with smaller imaging datasets exclusive to the organisation or with mid- to large-sized datasets from publically available repositories, according to our review. The establishment and maintenance of such repositories, on the other hand, are extremely expensive endeavours that require significant resources. Study presented a decentralised AI architecture to develop a generalizable model that is distributed and trained on in-house client datasets, removing the need to share sensitive clinical data in order to overcome data size and cost limits. The suggested framework is still in the early stages of adoption and will require technical enhancements before it can be extensively implemented by participating health care organisations, according to the National Institutes of Health.

8) Transfer Learning

There are classification issues connected with the diagnosis of COVID-19 using radiological imaging data from patients, which is a multi-step process that involves several processes. Preprocessing, annotation, and feature extraction are some of the first phases in the image classification process that are generally followed. Annotation of radiological images is a time-consuming process that is dependent on the expertise of the radiologist performing the annotation. Several methodologies, such as self-supervised and transfer learning techniques, have been presented to overcome this difficulty. The findings of our analysis identified one study that employed a transfer learning technique to aid in the diagnosis and prognosis of COVID-19. It was decided to use a two-step transfer learning strategy: first, a large lung cancer CT dataset (n=4106) and epidermal growth factor receptor gene sequencing were used to train the model to learn associations between chest CT images and micro-level lung functional abnormalities; and second, the model was trained on an epidermal growth factor receptor gene dataset (n=4106) to learn associations between chest CT images and micro-level lung functional abnormalities. In the next steps, the model was trained and validated to distinguish COVID-19 from other pneumonia (AUC 0.87-0.88) and viral pneumonia (AUC 0.86) kinds of pneumonia. We believe that using such strategies, the computing costs involved with training the models will be reduced by a significant amount.

IV. Summary Points and Recommendations

The purpose of this study was to conduct a complete evaluation of the literature on the role of artificial intelligence in combating the present COVID-19 outbreak. The scope of our research was not limited to a single application, but rather included all of the potential applications for artificial intelligence-based technologies. The following are the most significant findings from numerous COVID-19 investigations, as well as the recommendations for further research that have been made as a result of these findings.

- In the case of COVID-19, the RT-PCR method remains the gold standard confirming test. Nonetheless, the sensitivity of this laboratory test is limited; as a result, future models should incorporate radiological images (e.g., CT and X-ray), clinical symptoms, and laboratory test findings to improve accuracy.
- The performance of AI models may be skewed as a result of a lack of sufficient sample size in small-scale experiments. We recommend that newer studies make use of data from national and international collaborative COVID-19 archives, rather than data from individual studies. Furthermore, decentralised artificial intelligence architecture should be implemented in order to avoid the necessity for the exchange of sensitive clinical data.
- The majority of studies included at least part of the clinical factors that were found to be useful in predicting COVID-19 progression. We have provided a thorough list of the variables that were used in the various investigations, as well as the highest performing models that were reported in those studies. A thorough examination of these variables should be carried out in order to uncover characteristics that are associated with the advancement of COVID-19. Such variables should be taken into account while developing future predictive models.
- The COVID-19 lockdown has had specific detrimental effects on people's mental health problems, according to a small number of research that have conducted sentiment analyses utilising social media content. Recent breakthroughs in natural language processing approaches, like as transformers-based models and hybrid models, have only been infrequently applied to sentiment analysis until recently. We urge that future studies take advantage of these developments in order to conduct more accurate analyses.
- The majority of the studies offered little information on how the predictions of the AI model were interpreted. End users can better understand and improve the performance of interpretable artificial intelligence models. When such models are utilised as a clinical decision support tool, users have the option of accepting or declining the recommendations.

V. Limitations

There are some inherent limits to this review. First and foremost, there is the chance that research will be missed as a result of the search methodology employed. Second, we removed 5 papers from the study because the full texts were not available, which may have resulted in bias in the results. Third, we included research that were available as preprints on the internet. Finally, a comparison of AI model performance could not be made in the quantitative descriptive analysis since variables, sample sizes, and data sources varied throughout the studies that were included in the study. The papers included in this systematic review were those that were freely available on the internet as of June 27, 2020. As the COVID-19 pandemic advances, we intend to conduct a second review of the papers that were published after the date specified in the last review.

VI. Conclusion

As part of this systematic review, we compiled the most recent COVID-19 literature that made use of artificial intelligence technologies in a variety of applications ranging from detecting viruses to containing and treating viral infections. Our work gives insights into the potential of artificial intelligence on the three COVID-19 topics established so far—CE, EDD, and DP—by identifying the important variables, data types, and COVID-19 resources that can assist in facilitating clinical and translational research in the future. Our research throws light on the potential of artificial intelligence applications as a drug discovery and risk classification tool. Furthermore, our research suggests that AI-based diagnostic tools are very accurate in detecting the presence of the SARS-CoV-2 virus when using radiological imaging data, and that they can be used as a decision support tool in the healthcare setting.

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