Analysis of Artificial Intelligence and Machine Learning Algorithm in COVID-19 Pandemics

[1]Manish Bhardwaj, [2]Akash Goel, [3]Ashima Arya, [4]Swasti Singhal, [5]Prince Gupta

[1,2,3,4,5]Department of Computer Science and Information Technology, KIET Group of Institutions, Delhi-NCR, Ghaziabad, India

Abstract

Exploring medical data with the use of AI and ML has the potential to improve decision-making and forecasting in the healthcare industry. The use of AI and ML in the fight against the COVID-19 pandemic has been demonstrated in recent studies. This review paper aims to do just that by compiling the findings of the most up-to-date research using AI and ML to combat the spread of the deadly COVID-19 virus. After a rigorous process of including and excluding items, just 40 were chosen from the original collection of 726. In our review, we looked at how AI/ML has been used to combat the COVID-19 pandemic, the context of the studies that have been conducted so far (i.e., whether they have been limited to a single country or taken a more global view), the size and variety of datasets that have been used, the methodologies, algorithms, and techniques that have been used to make predictions and diagnoses, and how these have been mapped to the underlying data types to best demonstrate their predictive power. To illustrate the current state of AI in the fight against COVID-19 and the possible scope for future research, we zeroed attention on the usage of AI/ML in assessing the pandemic data.

Research Impact: There has been a significant shift in the healthcare system because of the implementation of AI. The widespread use of AI in healthcare has shown promise, from disease diagnosis to pandemic predictions. Researchers and medical experts have been presented with a new problem by the emergence of the novel corona virus COVID 19. In order to combat the most recent epidemic, COVID-19, scientists are turning to artificial intelligence for assistance. In this paper, we will cover the literature on fighting COVID-19 with artificial intelligence and machine learning.

Keywords: COVID, Machine Learning, Artificial Intelligence, CNN, Sustainable Development.

DOI: 10.48047/ecb/2023.12.si8.551

Introduction

More than 8.2 million people have been infected with the unique and infectious viral pneumonia known as COVID-19 (Coron- avirus Disease-2019), and over 440,000 have lost their lives as a result.

According to the World Health Organization (WHO), the COVID-19 outbreak can be slowed down through early discovery, isolation, and timely treatment [2, 3]. Therefore, many organizations have promised to study COVID-19 in order to strengthen the worldwide reaction.

Artificial intelligence (AI) has reemerged in the scientific consciousness as a result of the dizzying rate at which new discoveries are being announced.

Artificial intelligence (AI) is a subfield of computer science that enables the creation of smart machines. It is typically implemented in the form of a computer program [3]. Recently, AI has been used in expanding the frontier of AI, which was previously the domain of humans' expertise. One of the first and most promising uses of AI can be found in the medical and health care systems in the middle of the twentieth century[4].

Several decision assistance systems were proposed and built by researchers[5]. The rule-based system became popular in the late 1970s[6] and helped doctors make decisions about disease detection[7], ECG interpretation[8], treatment selection[9], and hypothesis generation. Modern AI makes use of machine learning algorithms to discover patterns and relationships in data, as opposed to this first-generation knowledge-based AI system's reliance on the past medical knowledge of specialists and the formulation-based rules [10] [11] [12]. Recent progress in artificial intelligence (AI) is largely attributable to the widespread use of deep learning, the process of training an artificial neural network using vast numbers of labeled datasets. In today's deep learning networks, hundreds of these "hidden layers" are common[13]. With AI's recent revival, many are wondering if robot doctors could soon replace human ones. Researchers believe AI-driven intelligent systems can considerably aid human physicians in making better and quicker decisions, and in some cases (such as radiography) completely abolish the necessity of human decision making, however this has yet to be confirmed[14].

The current success of AI in healthcare can be ascribed to the growth in healthcare data brought about by the increased use of digital technologies and the development of big data analytics[14]. Although AI research in healthcare is just getting started, most of the focus is on cancer, neurological disorders, and cardiovascular diseases.

A robust AI, led by evidence, may unearth the hidden meaning in medical data, which can then be used for predicting and decision-making[15], [16], [17].

Since AI has already been demonstrated to be beneficial in healthcare, experts believe it may be useful in the fight against COVID-19. Artificial intelligence has changed the healthcare industry in fundamental ways, from pandemic prediction to the development of compounds that inhibit viral reproduction. Recent studies on COVID-19 utilizing AI have shown that AI can be useful in a variety of contexts, including infection detection, population detection, epidemic prediction, attack pattern identification, and even cure discovery [18], [19], [20]. The purpose of this analysis is to delve into the present artificial intelligence (AI) centered investigation that has been undertaken in the struggle towards the COVID-19 pandemic.

1. Previous Study

A methodological review of the literature approach [21] was used to accomplish this study's goals. Articles were chosen as primary sources after a thorough search of key databases like IEEE Xplore, Springer Link, the ACM digital library, Science Direct, and Google Scholar. The terms "machine learning" and "COVID-19," "machine learning" and "Coronavirus," "artificial intelligence" and "COVID-19," "artificial intelligence" and "Coronavirus," "machine learning" and "lockdown" and "pandemic," and "coronavirus prediction" and "outbreak prediction" were used to locate relevant articles. These queries were run in Google and the other aforementioned databases.

Over 726 results were found from the search. Articles that (a) are found in multiple scholarly databases, (b) are not relevant to our research goals, (c) are written in a language other than

English, and (d) are an earlier version of articles that have been published on the same set of data and explored the same objective are excluded. Following this process of inclusion and exclusion, we settled on publishing 40 articles, which represent a mix of primary research, reviews, and shorter forms of writing like perspectives, commentaries, and letters to the editor. Figure 1 is a Prisma flowchart depicting the stages of article selection based on inclusion/exclusion criteria.

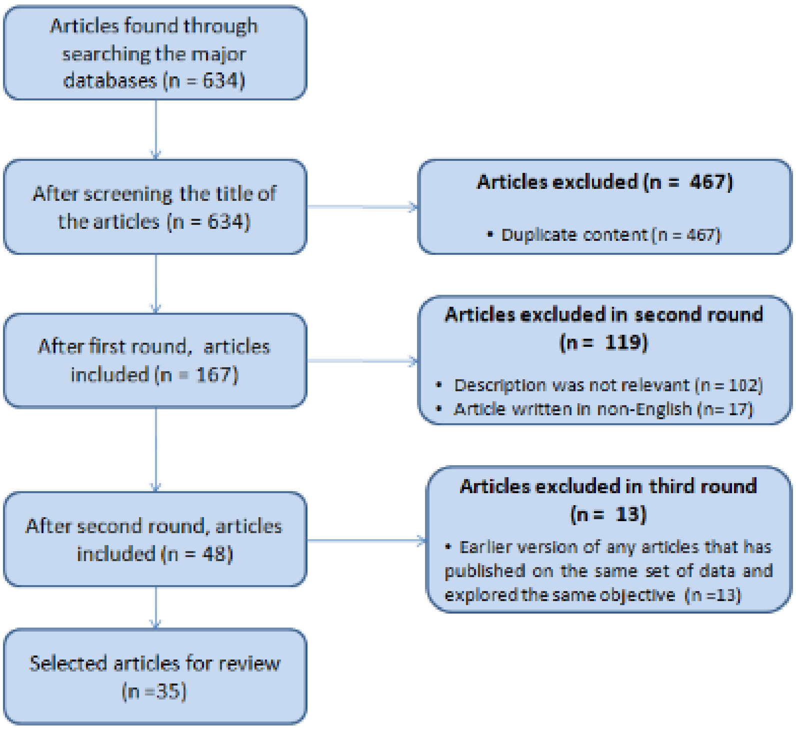

Figure 1: Flowchart of Manuscripts inclusion and Exclusion Process

Information on article type, publication date, research objectives, study context, study outcomes/findings, methodology/algorithm/techniques employed, dataset used, and study subject was extracted from the selected papers through a systematic review process. Finally, the gleaned information was combined and evaluated to provide a comprehensive summary of the literature on the use of AI to study the COVID-19 pandemic and to pinpoint areas where additional study is warranted.

To better understand how artificial intelligence might help in the fight against the COVID- 19 pandemic, we synthesize the present research in terms of their purposes and ambitions. Table 1 provides a summary of the synthesized data to illustrate the aims and objectives of the primary research. Nearly half of the papers (16/40) addressed the use of artificial intelligence (AI)-based methods including the Convoluted Neural Network (CNN) model, Support Vector Machine (SVM), generative adversarial network (GAN), and transfer learning to identify COVID-19-infected individuals. COVID-19 patients were predicted and detected using chest X-ray images, CT images, mobile sensors data, and COVID-19 symptoms. These studies intended to screen for COVID-19, identify patients who have it, and categorize them as infected with COVID-19, not infected with COVID-19, or infected with some other virus or bacteria. For instance, Wang et al. [22] introduced a CNN-based prediction system called COVID-Net, which uses chest X-ray images to distinguish between patients with and without COVID-19 infection. After initial training on the publicly available ImageNet dataset, the proposed model was fine-tuned using the COVIDx dataset, which was developed by the authors themselves and contains 13,800 chest X-ray images from 13,725 patients: 183 from 121 COVID-19-positive patients, 8066 from healthy patients, and 5538 from those without the virus.

Table 1: Domain Specific Summary of Literature

Purposes	Brief Description	Reference	Frequency
Diseases detection	Screen coronavirus diseases using deep learning	[23]	4
	Developing a CNN based Algorithm to detect COVID-19 from CT images	[19]	
	Build a framework which uses smartphone sensors to detect Covid-19	[25]	
	Detect the Covid-19 by identifying the characteristics from chest X-ray using a deep learning model(CAD4COVID-XRay)	[32]	
Diseases diagnosis	Developing a tool to predict survival and death for severe COVID-19 patients	[37]	3
	Diagnosis Covid-19 positive case faster using both non-image and image clinical data	[38]	
	Distinguish COVID-19 from pneumonia using Deep learning	[35]	
Epidemic forecasting	Predict the trend of the infection for the next 80 days using deep learning	[41]	2
	To predict the progress of the epidemic (epidemic sizes and peaks)	[41]	
Sustainable Development	Analyze the correlation among environmental factors and confirmed cases of COVID-19	[42]	1
Performance Comparison	Compare the performance of a DL model with six other radiologists	[32]	2
	Compare the prediction performance of the proposed algorithm with the existing methods	[28]	

Patient management	To improve management of Covid-19 ICU patients	[43]	1

Seven studies, or 20%, dealt specifically with the application of AI in the diagnosis of COVID-19 individuals as shown in figure 2. These studies used AI to diagnose COVID-19 patients, categorizing them into "severe" and "mild" groups and following their progress over time[24], distinguishing COVID-19 from pneumonia [35], efficiently diagnosing COVID-19 using X-ray images[36], predicting survival and death for severe COVID-19 patients[37], identifying patients who would develop more severe illness [39], and estimating uncertainty in Deep Learning solutions to enhance diagnostic performance[40].

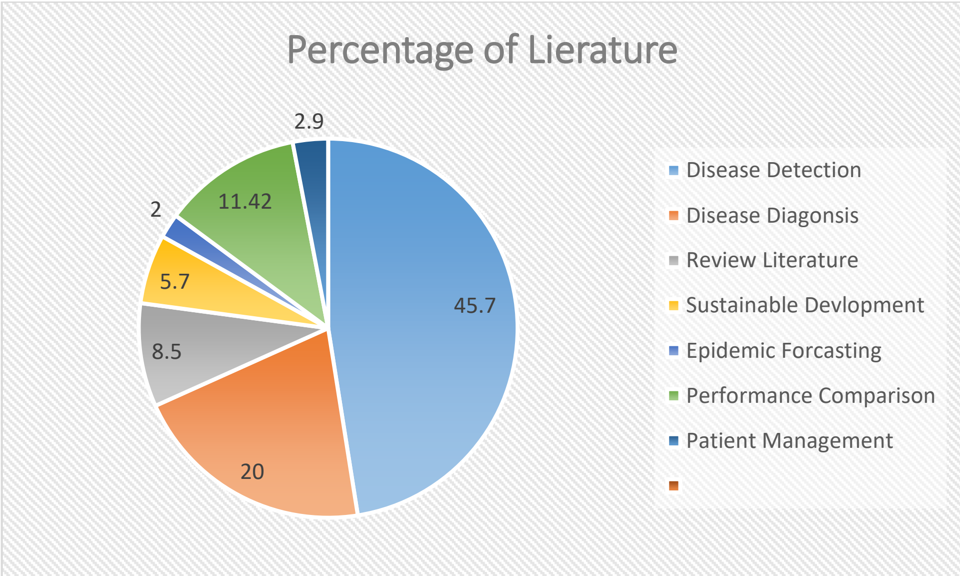

Figure 2: Distribution of Manuscripts according to their Publication Domain

2. Data Analysis of Published Data

Out of a total of 40 publications published as of the 12th of June, 2020, 27 (77%) were published as original research. A further 23% of published works fall into the categories of review articles, editorials, and research perspectives (brief conceptual pieces).

The same number, 25, appeared in peer-reviewed journals, while 15 appeared in pre-print archives (37.5 percent). The majority (92.85) of the pre-prints (13) presented original research. All of the articles chosen for inclusion were either initially published or archived in January 2020.

Two publications, or 6%, attempted to anticipate the course of the COVID-19 outbreak by estimating its magnitude, duration, peak, and end date, and by predicting the trend of the epidemic's development over the next x number of years in a given area or region [18][41]. Only one study [42] explored the relationship between confirmed cases of COVID-19 in four countries (China, Italy, South Korea, and Japan) and environmental factors (low, high, and average temperature, humidity, and wind flow) using a binary classification using AI and regression analysis. In [28], the prediction performance of the proposed algorithm was compared to that of the existing VGG-16, GoogleNet, and ResNet50 method using two different subsets of data, and in [43], a model based on artificial intelligence was developed to enhance the management of intensive care unit (ICU) patients with chronic obstructive pulmonary disease (COVID-19).

Review pieces, editorials, perceptions, commentaries, and brief communications make up the remaining 26%. With the goal of elucidating the benefits and limitations of AI [44] and locating a road map of AI applications to combat the COVID-19 pandemic [45], the review papers synthesize the available literature. In order to combat the spread of the COVID-19 pandemic, another review [21] examines the artificial intelligence-based approaches employed in CT and X-ray based medical imaging.

One of the two editorials discussed how AI-based solutions could help combat the pandemic by anticipating the pandemic and designing anti-viral replication molecules under human supervision [46]. Another editorial presents a workflow showcasing the methods and uses of AI in the fight against the COVID-19 pandemic [47]. The articles provide three perspectives on the COVID-19 pandemic: first, the importance of artificial intelligence (AI) and data sharing (via smart city networks) for monitoring and managing urban health during the outbreak [48], second, the significance of active learning-based AI tools for coronavirus outbreak [49], and third, suggestions for how AI and Blockchain can be used to aid the community with equipment and donations during the pandemic [50]. Donations made through a private blockchain network for the pandemic would be secure from tampering and ensured to reach their intended recipients.

3. Context of Study

There were publications that looked at the issue from the standpoint of a single country, and others that looked at it from a more global perspective. A forecasting system for China's 34 provinces was taken into account in one of these papers [18]. Another paper [42] analyzed data from 42 provinces across Japan, China, South Korea, and Italy to analyze the relationships between environmental characteristics, weather trends, and confirmed cases. One investigation employed computed tomography (CT) scans of the lungs from individuals in the United States and China [24]. In a separate study [19], researchers trained and tested AI-based methods for diagnosis and tracking using CT scans of lungs collected exclusively in China. Predictions for the entire country were generated using data from the 2003 SARS pandemic and the epidemiological records of three Chinese provinces (Hubei, Guangdong, and Zhejiang) [41]. In another investigation [28], CT scans of Italian patients were also utilised. One article [37] only used data from Wuhan, China, while another one [39] only used data from Wenzhou, Zhejiang Province. Since China is the original epicentre of the pandemic, most papers have focused on data from there.

Articles providing context primarily addressed the prediction of epidemics and sustainable development. The majority of articles on disease detection employed non-contextual global perspectives and public databases, while all articles on making recommendations did the same. Figure 3 shows the Literature Study in Terms of Context of data with Global and Contextual form.

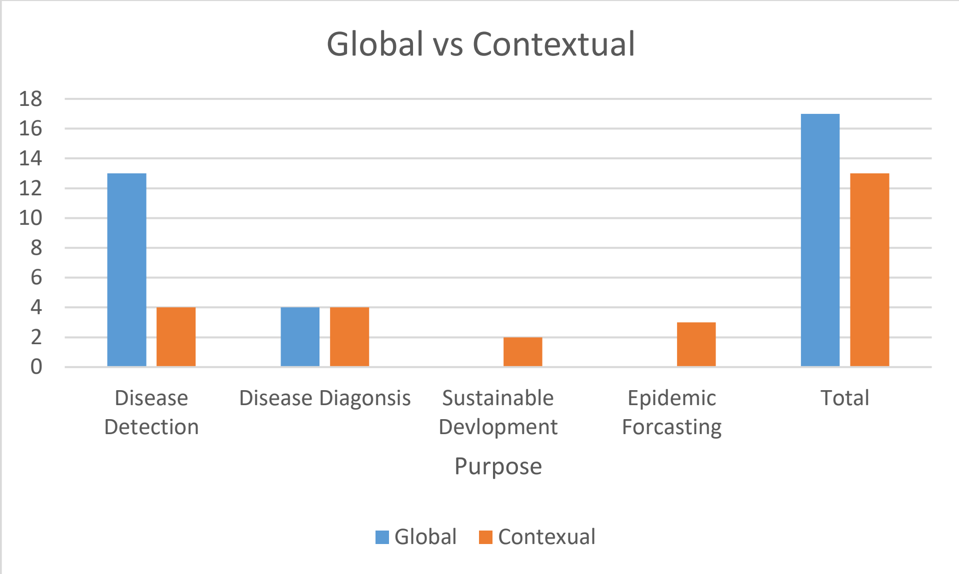

Figure 3: Literature Study in terms of Context of Data

Therefore, it can be concluded that the illness detection approaches discussed in the papers are not necessarily dependent on context, and researchers require context data for the purpose of epidemic forecasting. Two international studies were conducted; one of them [42] looked for links between different nations. In order to improve the effectiveness of their disease detection method, researchers in the COVID-19 case study and the other study [24] concentrated on patients from two separate countries.

Table 1 shows that the majority of these studies' primary focus is on using AI for classification (COVID-19 detection, differentiating COVID-19 from other respiratory disorders), prediction, and forecasting. Researchers are looking for a simpler, cheaper, and speedier way to identify COVID-19 utilizing computational technique because the current gold standard, polymerase chain reaction (PCR), can take up to two to three days to receive the results. Our analysis revealed that 65 percent of the literature focuses on methods to identify and diagnose COVID-19. Table 4 provides a concise summary of the goals, scope, and outcomes of employing various AI algorithms. Figure 4 shows the Artificial Techniques Different Previous study frequency.

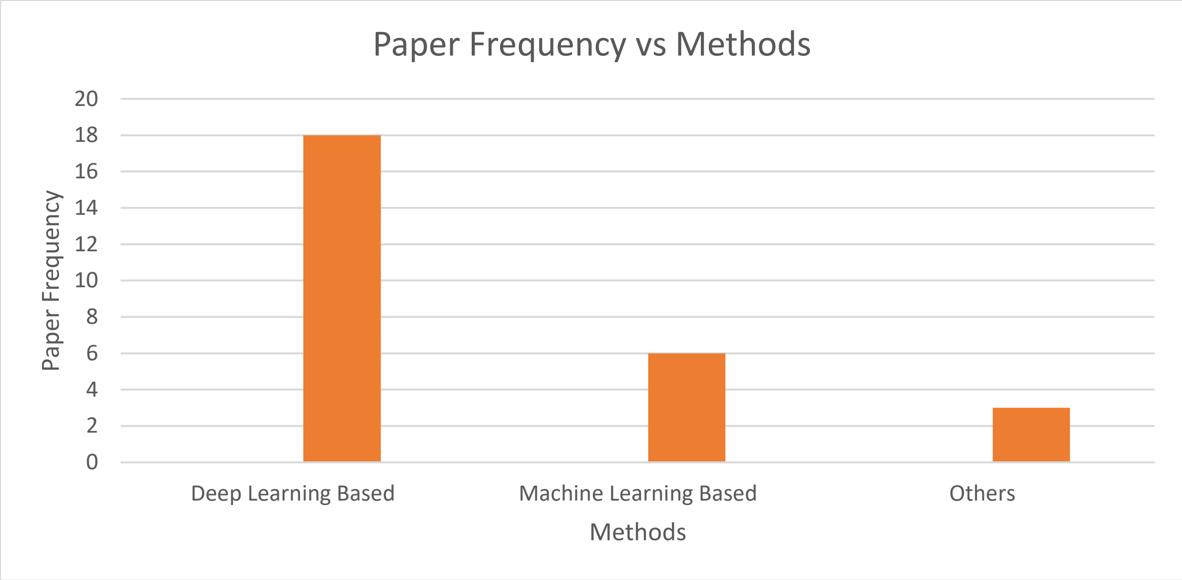

Figure 4: Artificial Techniques Different Previous study frequency

Due to a dearth of current information and historical data, COVID-19 has put academics and health practitioners in a precarious position.

Without accurate training data, intelligent systems will fail to perform as expected. The use of artificial intelligence (AI) and related techniques (e.g., machine learning, deep learning) is founded on accumulated knowledge and information (i.e., data and models). Researchers rely heavily on X-ray and CT scan pictures due to the paucity of other data regarding COVID-19. Despite the fact that only a modest quantity of COVID-19 Chest-X Ray (CXR) is now accessible, CXRs are often prescribed as a primary diagnostic tool. While some studies (26.67%) rely on chest CT pictures, the vast majority (74%) rely on chest CXR images to detect COVID-19. The advent of deep neural networks has allowed researchers to explore uncharted territory in the field of picture classification. CXR and CT scan image classification is performed by deep neural networks in the majority of published research. Convoluted Neural Networks outperformed all other algorithms and methods (Table 4) when it came to analyzing image data. Using CNN as a starting point, other studies have developed their own unique frameworks [22]. Based on our research, we conclude that the Res-Net design is the most popular among the many CNNs. The models share a common Res-Net architecture at their core but diverge in key respects, such as their use of hidden parameters, number of iterations, and choice of optimizer. Multiple deep neural architectures are used in some research. When recommending the best model, Ezz et al.[36] compared Red-NetV2 to six others. Res-Net is used in conjunction with other machine learning methods in some research, such as the one conducted by Wang et al. [51]. The authors leveraged SVM and decision trees to create a new method, and they used Res-Net to extract features from CXR. To evaluate the risk of employing deep neural networks to identify COVID-19, Biraja et al.[40] use architectures other than classification, including bayesian CNN, Monte Carlo drop weights, and Res-Net.

For data that isn't images, researchers have turned to both deep learning and more conventional machine learning techniques (Table 4). Pirouz et al. [42] used a mixed regression/Group Method of Data Handling(GMDH) approach to try and extrapolate from demographic data.

By combining epidemiological models with an ML model, Yang et al.[41] were able to demonstrate the success of Chinese disease containment efforts and make accurate epidemic predictions. Further, Jiang et al.[39] used a decision tree, SVM based approach to detect COVID-19 from X-ray pictures, while Loey et al.[33] relied on neural networks (GAN network) for this purpose.

Since none of these models is tested on actual patients, the authors rely on the train-test split technique to ensure model accuracy.

The studies have employed precision, responsiveness, positive predictive value, negative predictive value, f-1 score, and ROC area under the curve (AUC) as validation metrics. Authors also utilized positive and negative predictive values (PPV and NPV) in addition to the more common False Positive Rate (FPR) and True Positive Rate (TPR) in their analyses. Our results imply that deep learning algorithms outperform their counterparts in the majority of the tables of evaluation criteria (Tables 4).

Table 4: Artificial Intelligence Algorithms used for the Different Domains

Objective	Algorithm (AI)	Evaluation Result	Reference
Diseases detection	CNN	Accuracy (97.8%)	[26]
	CNN	Accuracy (82.9%), Specificity (80.5%), Sensitivity (84%)	[19]
	GAN Network	Accuracy (99.9%)	[33]
Diseases diagnosis	CNN	AUC (0.96)	[35]
	CNN and Grad Cam	AUC (0.989), Sensitivity (98.2%)	[34]
Epidemic forecasting	Modified Auto-encoder for Modeling Time Series	--	[18]
	Epidemiological model and ML based AI model	--	[41]
Sustainable Development	Regression analysis and Group method of Data Handling	Accuracy (85.7%)	[42]

4. Future Research and Opportunities

In this section, we have quickly outlined the difficulties in combating the COVID-19 pandemic, as well as the potential for future research on AI/ML.

We found that just 37% of the studies made use of contextual data, whereas 63% included data from many countries in their analysis. Research in context can be done more easily in the countries or regions that are most heavily impacted. Since China was the epicenter of the epidemic, more contextual studies have been undertaken there as more data and longer time have been available to examine the pandemic's nature. Data from other nations became available as the pandemic advanced. Therefore, future contextual research with the goal of exploring and predicting the similarity of the pattern of the pandemic among Chinese studies and other regional studies has a great deal of room to grow.

In order to detect and diagnose COVID-19, as well as for epidemic forecasting, sustainable development, and patient care, a lot of research has already been done. We find that just a tiny percentage of studies (11.4% of all studies) have focused on topics including epidemic prediction, sustainable development, and patient management. These are all good places to direct future research efforts. We found that research on both sustainable development and pandemic prediction made use of contextual information. We believe that all research into epidemic prognosis needs to take context into account.

Researchers have the option of collecting and using a wide variety of data (including photographs, texts, videos, etc.) in a variety of ways. Such actions will be extremely helpful in the war against the epidemic.

Global data was used for 90% of disease detection and 50% of disease diagnosis-based research. However, we propose that future study in this area could benefit from using different worldwide data. Only a minority of studies (24%), focused on disease detection, while the majority (50%), focused on diagnosis. Therefore, additional impacted places may also be explored for illness patterns in future research. In this review paper, we looked at papers that implied a large amount of data was not used for experimenting with machine learning and deep learning. The potential for larger datasets to yield more reliable and applicable results requires more study. Some early studies ([25], [43]) relied on speculation rather than hard facts, therefore more investigation is needed to verify their findings. With more information, the study findings can be investigated further.

Most previous studies aiming to create an AI/ML-based tool for illness identification and progression have made use of training and testing procedures. In order for the systems to be trained and validated in a way that allows them to reliably forecast the outcome of a particular problem, in this case, accurate illness detection, associated datasets are required. Many studies using chest X-rays and CT scans to detect opacity in the lungs indicative of COVID-19 have relied on deep learning (48%). Other lung disorders, such as pneumonia, chronic obstructive pulmonary disease (COPD), asthma, etc., also have similar effects on X-ray and CT scans of the lungs. In order to train the algorithm to distinguish COVID-19 from other diseases, future research can include additional patient symptoms in the form of text.

For the sake of sustainable development, only one international study has been undertaken, which analyzed and examined the association among confirmed cases, environmental and demographic parameters of four different countries. It may be possible to investigate if the transmission of the virus is related to environmental factors through further cross-national research projects like the one described above.

It has been stated that hospitals made the decision to exclusively treat young patients due to a lack of capacity, leaving behind the elderly who had a much lower chance of survival. More study can be done to determine which patients, based on their medical records and symptoms, are most likely to be life-threatening cases. This would be useful for hospitals in deciding which patients may be treated at home and which require intensive care. Studies examining the factors that lead to intensive care unit admission could assist prioritize the care of the sickest patients. Research can also help keep patients from being discharged too soon from intensive care units.

In the worst-hit regions, doctors and nurses are hard to come by. They were pushed to their limits, leaving them open to the possibility of making mistakes. There might be a use for AI-aided systems here. A rule-based AI can keep an eye on all the data coming in and out of the ICU and advise the staff on what to do next. Allocating and regulating the amount of oxygen delivered to patients with COVID-19 is a vital part of their treatment, and an effective AI can aid with this.

Scientists from all over the world are now trying to create a vaccine or treatment for the COVID-19 virus. Several groups have already begun utilizing AI in their search for a vaccination against COVID-19. Artificial intelligence is helpful for data processing and the creation of COVID-19 decoys.

Therefore, there are many ways in which these AI algorithms can be enhanced (for example, Rosetta[55] and Quark[56]). Additional uses for AI include the simulation and analysis of potential vaccination candidates.

5. Conclusion

In order to combat the COVID-19 pandemic, this paper provides a comprehensive analysis of the research into using AI and ML methods to do so. There were a total of 35 publications evaluated. Objectives, data kinds, input attributes, AI methods (machine learning classification algorithms), and other factors are all taken into account when we compare and contrast the various articles. Our work mostly contributes three areas. First, we've summarized the results in terms of research aims, data origins, data formats, and data sizing. Second, we have investigated and compared the results of different common AI methods, such as machine learning and deep neural network methods. Finally, we have suggested numerous new research areas based on our study and identified various research challenges.

There are a lot of caveats to our study, but it also opens up some potential new lines of inquiry. To begin, we have performed a targeted search of the relevant resources using a set of keywords. While we were able to accomplish our research objectives thanks to the keywords we used, it is possible that we missed some relevant information that did not show up in our searches. Second, we believe that the essential elements that we have found, investigated, and described in this paper are contemporary and up-to-date resources linked to coronavirus and AI approaches. As a result, additional resources would have to be gathered in subsequent works. Third, future study can examine data privacy and security in the relevant sectors, in addition to exploring AI and ML strategies in combating the Covid-19 pandemic. Despite the aforementioned drawbacks, the ramifications of our analysis and debate for both health practitioners and scholars are substantial. We hope that this assessment will serve as a starting point for new investigations into this field.

Reference

[1] W. H. Organization, "Who director-generals opening remarks at the media briefing on covid-19 - 11 march 2020," 2020.

[2] Jain, Ishita and Bhardwaj, Dr. Manish, A Survey Analysis of COVID-19 Pandemic Using Machine Learning (July 14, 2022). Proceedings of the Advancement in Electronics & Communication Engineering 2022, Available at SSRN: https://ssrn.com/abstract=4159523 or http://dx.doi.org/10.2139/ssrn.4159523.

[3] S. Russell and P. Norwig, "Artificial intelligence: A modern approach," Neurocomputing, vol. 9, no. 2, pp. 215 – 218, 1995, control and Robotics, Part II.

[4] A. S. Ahuja, "The impact of artificial intelligence in medicine on the future role of the physician," PeerJ, vol. 7, October 2019.

[5] Sharma, A., Tyagi, A., & Bhardwaj, M. (2022). Analysis of techniques and attacking pattern in cyber security approach: A survey. International Journal of Health Sciences, 6(S2), 13779–13798. https://doi.org/10.53730/ijhs.v6nS2.8625

[6] P. Szolovits, R. S. Patil, and W. B. Schwartz, "Artificial intelligence in medical diagnosis," Annals of Internal Medicine, vol. 108, no. 1, pp. 80–87, 1988.

[7] F. de Dombal, "Computer-aided diagnosis of acute abdominal pain. The british experience," Revue d'epidemiologie et de sante publique, vol. 32, no. 1, p. 5056, 1984.

[8] M. Kundu, M. Nasipuri, and D. K. Basu, "Knowledge-based ecg interpretation: A critical review," Pattern Recognition, vol. 33, no. 3, pp. 351–373, 2000.

[9] R. A. Miller, M. A. McNeil, S. M. Challinor, F. E. Masarie, and J. D. Myers, "The internist-1/quick medical reference project - status report," West J Med, vol. 145, no. 6, pp. 816–822, 1986.

[10] Tyagi, A., Sharma, A., & Bhardwaj, M. (2022). Future of bioinformatics in India: A survey. International Journal of Health Sciences, 6(S2), 13767≤13778. https://doi.org/10.53730/ijhs.v6nS2.8624.

[11] I. H. Sarker, A. Kayes, and P. Watters, "Effectiveness analysis of ma-chine learning classification models for predicting personalized context- aware smartphone usage," Journal of Big Data, vol. 6, no. 1, p. 57, 2019.

[12] I. H. Sarker and F. D. Salim, "Mining user behavioral rules from smart- phone data through association analysis," in Pacific-Asia Conference on Knowledge Discovery and Data Mining. Springer, 2018, pp. 450–461.

[13] Bhardwaj, M., & Ahalawat, A. (2019). Improvement of Lifespan of Ad hoc Network with Congestion Control and Magnetic Resonance Concept. In International Conference on Innovative Computing and Communications (pp. 123-133). Springer, Singapore.

[14] F. Jiang, Y. Jiang, H. Zhi, Y. Dong, H. Li, S. Ma, Y. Wang, Q. Dong, H. Shen, and Y. Wang, "Artificial intelligence in healthcare: past, present and future," Stroke and Vascular Neurology, vol. 2, no. 4, pp. 230–243, December 2017.

[15] Bhardwaj, M. and Ahlawat, A. (2018) Wireless Power Transmission with Short and Long Range Using Inductive Coil. Wireless Engineering and Technology, 9, 1-9. doi: 10.4236/wet.2018.91001.

[16] E. Kolker, V. zdemir, and E. Kolker, "How healthcare can refocus on its super-customers (patients, n =1) and customers (doctors and nurses) by leveraging lessons from amazon, uber, and watson," OMICS: A Journal of Integrative Biology, vol. 20, no. 7, pp. 329–333, June 2016.

[17] S. E. Dilsizian and E. L. Siegel, "Artificial intelligence in medicine and cardiac imaging: Harnessing big data and advanced computing to provide personalized medical diagnosis and treatment," Current Cardiology Reports, vol. 16, no. 1, 2014.

[18] Z. Hu, Q. Ge, S. Li, L. Jin, and M. Xiong, "Artificial intelligence forecasting of covid-19 in china," arXiv, 2020. [Online]. Available: https://arxiv.org/abs/2002.07112

[19] S. Wang, B. Kang, J. Ma, X. Zeng, M. Xiao, J. Guo, M. Cai, J. Yang, Y. Li, X. Meng, and B. Xu, "A deep learning algorithm using ct images to screen for corona virus disease (covid-19)," medRxiv, 2020.

[20] A. S. R. S. Rao and J. A. Vazquez, "Identification of covid-19 can be quicker through artificial intelligence framework using a mobile phonebased survey when cities and towns are under quarantine," In-fection Control & Hospital Epidemiology, vol. 41, no. 7, pp. 826–830, July 2020.

[21] F. Shi, J. Wang, J. Shi, Z. Wu, Q. Wang, Z. Tang, K. He, Y. Shi, and D. Shen, "Review of artificial intelligence techniques in imaging data acquisition, segmentation and diagnosis for covid-19," IEEE Reviews in Biomedical Engineering, pp. 1–1, 2020.

[22] L. Wang, Z. Q. Lin, and A. Wong, "Covid-net: A tailored deep convolutional neural network design for detection of covid-19 cases from chest x-ray images," arXiv, 2020. [Online]. Available: https://arxiv.org/abs/2003.09871

[23] C. Butt, J. Gill, D. Chun, and B. A. Babu, "Deep learning system to screen coronavirus disease 2019 pneumonia," Applied Intelligence, April 2020.

[24] O. Gozes, M. Frid-Adar, H. Greenspan, P. D. Browning, H. Zhang, W. Ji, A. Bernheim, and E. Siegel, "Rapid ai development cycle for the coronavirus (covid-19) pandemic: Initial results for automated detection & patient monitoring using deep learning ct image analysis," arXiv, 2020.

[25] H. S. Maghdid, K. Z. Ghafoor, A. S. Sadiq, K. Curran, D. B. Rawat, and K. Rabie, "A novel ai-enabled framework to diagnose coronavirus covid 19 using smartphone embedded sensors: Design study," arXiv, 2020.

[26] I. D. Apostolopoulos and T. A. Mpesiana, "Covid-19: automatic detection from x-ray images utilizing transfer learning with convolutional neural networks," Physical and Engineering Sciences in Medicine, July 2020.

[27] A. Narin, C. Kaya, and Z. Pamuk, "Automatic detection of coronavirus disease (covid-19) using x-ray images and deep convolutional neural networks," 03 2020.

[28] U. zkaya, . ztrk, and M. Barstuan, "Coronavirus (covid-19) classification using deep features fusion and ranking technique," 04 2020.

[29] A. I. Khan, J. L. Shah, and M. M. Bhat, "Coronet: A deep neural network for detection and diagnosis of covid-19 from chest x-ray images," Computer Methods and Programs in Biomedicine, vol. 196, p. 105581, 2020.

[30] K. E. Asnaoui and Y. Chawki, "Using x-ray images and deep learning for automated detection of coronavirus disease," Journal of Biomolecular Structure and Dynamics, vol. 0, no. 0, pp. 1–12, 2020.

[31] H. X. Bai, R. Wang, Z. Xiong, B. Hsieh, K. Chang, K. Halsey, "Ai augmentation of radiologist performance in distinguishing covid-19 from pneumonia of other etiology on chest ct," Radiology, p. 201491, 2020.

[32] K. Murphy, H. Smits, A. J. Knoops, M. B. Korst, "Covid-19 on the chest radiograph: A multi-reader evaluation of an ai system," Radiology, vol. 0, no. 0, p. 201874, 2020.

[33] M. Loey, F. Smarandache, and N. E. M. Khalifa, "Within the lack of chest covid-19 x-ray dataset: A novel detection model based on gan and deep transfer learning," Symmetry, vol. 12, no. 4, p. 651, 2020.

[34] O. Gozes, M. Frid-Adar, H. Greenspan, P. D. Browning, "Rapid ai development cycle for the coronavirus (covid-19) pandemic: Initial results for automated detection & patient monitoring using deep learning ct image analysis," arXiv, 2020.

[35] L. Li, L. Qin, Z. Xu, Y. Yin, X. Wang, B. Kong, J. Bai, Y. Lu, Z. Fang, "Artificial intelligence distinguishes covid-19 from community acquired pneumonia on chest ct," Radiology, p. 200905, March 2020.

[36] E. E.-D. Hemdan, M. A. Shouman, and M. E. Karar, "Covidx-net: A framework of deep learning classifiers to diagnose covid-19 in x-ray images," arXiv, 2020.

[37] L. Yan, H.-T. Zhang, J. Goncalves, Y. Xiao, M. Wang, Y. Guo, C. Sun, "A machine learning-based model for survival prediction in patients with severe covid-19 infection," medRxiv, 2020.

[38] X. Mei, H.-C. Lee, K. yue Diao, M. Huang, B. Lin, C. Liu, Z. Xie, "Artificial intelligenceenabled rapid diagnosis of patients with covid-19," Nature Medicine, May 2020.

[39] X. Jiang, M. Coffee, A. Bari, J. Wang, X. Jiang, "Towards an artificial intelligence framework for data-driven prediction of coronavirus clinical severity," Computers, Materials & Continua, vol. 63, no. 1, pp. 537–551, 2020.

[40] B. Ghoshal and A. Tucker, "Estimating uncertainty and interpretability in deep learning for coronavirus (covid-19) detection," arXiv, 2020.

[41] Z. Yang, Z. Zeng, K. Wang, S.-S. Wong, W. Liang, M. Zanin, P. Liu, "Modified seir and ai prediction of the epidemics trend of covid-19 in china under public health interventions," Journal of Thoracic Disease, vol. 12, no. 3, 2020.

[42] B. Pirouz, S. Shaffiee Haghshenas, S. Shaffiee Haghshenas, and P. Piro, "Investigating a serious challenge in the sustainable development process: Analysis of confirmed cases of covid-19 (new type of coronavirus) through a binary classification using artificial intelligence and regression analysis," Sustainability, vol. 12, no. 6, p. 2427, 2020.

[43] S. Rahmatizadeh, S. Valizadeh-Haghi, and A. Dabbagh, "The role of artificial intelligence in management of critical covid-19 patients," Sha- habedin Rahmatizadeh Saeideh Valizadeh-Haghi Ali Dabbagh, vol. 5, no. 1, pp. 16–22, April 2020.

[44] W. Naud ́e, "Artificial intelligence against covid-19: An early review," Institute of Labor Economics (IZA), IZA Discussion Papers 13110, 2020.

[45] J. Bullock, A. Luccioni, K. H. Pham, C. S. N. Lam, and M. Luengo-Oroz, "Mapping the landscape of artificial intelligence applications against covid-19," arXiv, 2020.

[46] B. McCall, "Covid-19 and artificial intelligence: protecting health-care workers and curbing the spread," The Lancet Digital health, vol. 2, no. 4, pp. e166–e167, February 2020.

[47] A. Alimadadi, S. Aryal, I. Manandhar, P. B. Munroe, B. Joe, andX. Cheng, "Artificial intelligence and machine learning to fight covid-19," Physiological Genomics, vol. 52, no. 4, pp. 200–202, 2020.

[48] Z. Allam and D. S. Jones, "On the coronavirus (covid-19) outbreak and the smart city network: Universal data sharing standards coupled with artificial intelligence (ai) to benefit urban health monitoring and management," Healthcare, vol. 8, no. 1, p. 46, 2020.

[49] K. C. Santosh, "Ai-driven tools for coronavirus outbreak: Need of active learning and cross-population train/test models on multitudinal/multimodal data," Journal of Medical Systems, vol. 44, no. 5, p. 93, March 2020.

[50] S. Johnstone, "A viral warning for change. the wuhan coronavirus versus the red cross: Better solutions via blockchain and artificial intelligence," SSRN Electronic Journal, 2020.

[51] S. Wang, B. Kang, J. Ma, X. Zeng, M. Xiao, J. "A deep learning algorithm using ct images to screen for corona virus disease (covid-19)," medRxiv, 2020.

[52] F. M. Salman, S. S. Abu-Naser, E. Alajrami, B. S. Abu-Nasserand, and B. A. M. Ashqar, "Covid-19 detection using artificial intelligence," International Journal of Academic Engineering Research (IJAER), vol. 4, no. 3, pp. 18–25, March 2020.

[53] A. S. R. S. Rao and J. A. Vazquez, "Identification of covid-19 can be quicker through artificial intelligence framework using a mobile phone- based survey when cities and towns are under quarantine," Infection control and hospital epidemiology, vol. 41, no. 7, pp. 826–830, 2020.

[54] P. K. Sethy and S. K. Behera, "Detection of coronavirus disease (covid-19) based on deep features," Preprints, vol. 2020030300, p. 2020, 2020.

[55] A. Leaver-Fay, M. Tyka, S. M. Lewis, O. F. Lange, J. Thompson, "Rosetta3: an object-oriented software suite for the simulation and design of macromolecules," in Methods in enzymology. Elsevier, 2011, vol. 487, pp. 545–574.

[56] D. Xu and Y. Zhang, "Ab initio protein structure assembly using continuous structure fragments and optimized knowledge-based force field," Proteins: Structure, Function, and Bioinformatics, vol. 80, no. 7, pp. 1715–1735, 201