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# A Bibliometric Analysis on the Impact of Machine Learning and Deep Learning Models on COVID -19 in a Workplace

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***Abstract:*** *The study focused on assessing the impacts of Artificial Intelligence (AI) through Machine Learning (ML) and Deep Learning (DL) modes in combating the COVID-19 pandemic. This study performed a systematic literature review by analyzing articles published between 2020 and 2023 using VOSviewer (version 1.6.18), MS Excel, SPSS, and the PRISMA 2020 statement. The result shows that the research began in 2020 with 105(8%) articles and increased to 480(35%) articles by 2021, in year 2022 a remarkable increase occurred to 622 (46%) publications. The publication trend declined from 46% in the year 2022 to 11% in the year 2023, this might be due to the decrease of pandemic infections. The study includes only the review of the research articles published from 2020 to 2023 and indexed in the Scopus database. The study has explored the impacts of ML and DL models in combating COVID-19 pandemic; that encompasses a rapid and adaptive response to the urgent needs of the pandemic, the discovery of disease and treatment. The study helps society to improve efficiency, enhanced convenience, and innovative solutions across various sectors, such as the ability to react to health emergencies, examine the healthcare and disease management methods. The study provides a remarkable contribution of AI in addressing the Covid-19 pandemic in work a work place and it has been used to monitor and manage the pandemic on a global scale. In addition, the study contributes to understanding the recent growth statistics of global publications that address COVID-19 pandemic.*

***Keywords:*** *Artificial Intelligent, Machine Learning, Deep Learning, COVID-19, VOSviewer*

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## 1. Introduction

In recent years, Artificial Intelligence (AI) algorithms have grown in importance in the healthcare sector. AI has been able to detect virus signs and symptoms in images using Machine Learning (ML) and Deep Learning (DL) models, enable doctors and healthcare professionals to more efficiently and properly assess the disease. It has played a vital role in a wide range of uses, from medical diagnostics to illness prediction (Cheng., 2021; Kumar, 2022).

ML may be used to help discover possible drug interactions and forecast how medicine may interact with other pharmaceuticals. ML can help doctors find trends in patient data and give medical practitioners more precise diagnoses and treatments (Alvi et al., 2021). Moreover, it may be used to find trends in patient data, such as health

risk factors, and give medical practitioners more precise diagnoses and treatments (Dolgikh, S., 2020).

ML algorithms were used to analyze vast amounts of workplace-related medical data in order to detect possible epidemics, monitor adherence to safety standards, and assess risk factors among employees. Organizations might use prediction to actively adopt measures such as remote work shifts, quarantine rules, and customized testing procedures (Iwendi et al., 2020; Abdar et al., 2021). These models also enabled immediate analysis, which increased awareness of conditions and allowed for improved make decisions in dynamic settings.

Deep learning (DL) is an artificial intelligence method that identifies patterns in enormous volumes of data using a neural network. It works by taking in data, processing it using layered algorithms, and then making predictions based on the patterns it identifies (Jain et al., 2022). The algorithm learns from the data and adjusts its parameters accordingly, making it highly adaptive to new inputs. DL models can adjust to new inputs, enabling the network to create the most accurate outcome without having to modify the output parameters.

The COVID-19 pandemic presented new difficulties to workplace environments, necessitating immediate and efficient solutions to protect staff security and maintain operations. Conventional healthcare approaches were necessary, but sometimes inadequate for immediate decision-making and massive surveillance. In this context, AI models, notably ML and DL, have emerged as effective tools for supporting pandemic response tactics in the workplace (Vaishya et al., 2020; Bullock et al., 2020). These tools enabled knowledge based on data, improving the capacity to forecast, monitor, and limit the virus's progress in actual time.

DL models, especially those that use convolutional neural networks (CNNs) and recurrent neural networks (RNNs), have made important contributions to the safety of workers by enabling enhanced diagnostics and monitoring. These models enabled reliable COVID-19 identification from medical images, computerized health monitoring via embedded sensors, and continual monitoring using computer vision for mask recognition and physical separation (Albahri et al., 2020; Santosh, 2020). As a result, DL has improved workplace preparation during the pandemic while also laying the groundwork for more intelligent, stronger workplace healthcare systems.

## 1.1Rationale

This study aimed to evaluate different publication articles written on the impact of ML and DL models in combating COVID19 from the year 2020 to 2023. A systematic review of ML and DL models in the framework of COVID-19 is required to build efficient and effective pandemic response tactics. The ML and DL models can be used to analyze enormous datasets to find trends, forecast results, and create treatments and vaccinations that will aid in the fight against the virus infection (Wu et al., 2022).The systematic reviews aid in identifying the best available evidence, assessing the quality of the evidence, and determining the best strategies for applying ML and DL approaches to address the epidemic (Mbilong et al., 2021). Researchers can acquire a better knowledge of the strengths and shortcomings of various ML and DL technologies by performing a systematic review, allowing them to build more effective techniques for combating the epidemic.

Therefore, the bibliometric study of ML and DL models in countering COVID-19 is essential for gaining an understanding of the present level of knowledge on the use of these AI technologies in dealing with COVID-19. It may be used to identify major issues in the field, identify prominent authors and publications, map the ML and DL knowledge landscape, and follow field developments over time. It may also be used to uncover fresh research areas, potential partners, and new research and development initiatives. Researchers can use this study to identify gaps in existing knowledge and research, as well as what more research is needed to appropriately handle the present epidemic.

Moreover, it can be used to advise policymakers on the most promising avenues for developing and implementing these technologies to address COVID-19's health and economic impacts. Lastly, bibliometric studies can assist in identifying major contributors and organizations that are at the forefront of the development of ML and DL models in this domain, suggesting where resources should be allocated to reach their full potential.

## 1.2 Research Questions

The study deployed VOSviewer software to undertake bibliometric analysis on the impact of ML and DL models in addressing the COVID-19 pandemic, with a major focus on the research concerns as listed below:

1. What is the current state of research in the field of ML and DL models in addressing COVID-19 pandemic?
2. What are publishers, authors, organizations and countries made the most significant contributions to the field of ML and DL models in countering COVID-19 pandemic?
3. What are the most frequently used keywords in the realm of ML and DL models in dealing with the COVID-19 pandemic?

4. What are the current research gaps in ML and DL Models in counteracting COVID-19 pandemic?

The rest of the manuscript is organized as follows: It opens with a brief introduction of the subject of the Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL) modes, emphasizing its relevance in combating COVID-19 in work places. This is followed by a study of the relevant literature to contextualize past research in the topic. Next, the approach for identifying and selecting relevant research is detailed in depth. The next section summarises the findings, stressing significant issues in sustainable AI research and potential future paths. Finally, the study examines existing research gaps and provides recommendations for future research.

# 2. Literature Review

AI methods, such as ML and DL, are critical in addressing COVID-19 in the workplace by allowing for quick identification, risk assessment, and response tactics. These models aided in the early detection of possible epidemics using predictive analytics, optimised resource allocation, and assisted decision-making for safe workforce management, including automated health monitoring and contact tracing (Vaishya et al., 2020). Furthermore, deep learning approaches improved diagnostic tool accuracy and aided in the development of adaptive procedures to sustain production while reducing the likelihood of transmission (Santosh, 2020).

To lessen the dangers associated with medication interactions, ML may also be used to help discover possible drug interactions and forecast how medicine may interact with other pharmaceuticals (Pang et al,. 2021). Furthermore, ML is a useful technology in the healthcare industry since it may assist in reducing healthcare costs while also improving patient outcomes. It is capable of following and monitoring patients over time, giving medical practitioners much more accurate and up-to-date data to better administer medication (Pereira et al., 2020).

DL has evolved into a significant tool for disease prediction in the healthcare industry. It may be used to effectively and reliably analyze massive volumes of data, as well as detect emerging trends and patterns in the data that can be utilized to enhance diagnosis and treatment (Hu et al., 2021). It can be used to forecast disease development and help identify patients for early intervention and medication. DL can also assist in tracking the virus's transmission and providing actual information on the most recent outbreaks and preventative methods (Abayomi-Alli et al., 2022). All of this information may be utilized to build strategies to limit the virus's spread and provie better treatment options for patients.

The ML and DL models can be used to identify and diagnose COVID-19 virus from medical images such as X-ray, CT scans, and ultrasounds for symptoms of the viral infection (Zhang et al., 2020). The ML algorithms may be trained to recognize patterns in scans that indicate the presence of the virus, such as changes in lung tissue or the presence of certain characteristics in scans (Wang et al., 2021). The DL algorithms may also be examined of discovering COVID-19 images of infected persons and comparing them to scans of healthy people. Using these two ways, AI systems can detect the infection more accurately and assist medical practitioners in making more accurate judgments (Aziz et al., 2022; Saufi et al., 2021).

According to the previous work, the investigators applied various ML and DL models used by the researchers for the detection and diagnosis of COVID-19 virus infection in image processing. The most popular algorithms include, naïve bayes, decision trees, logistic regression, random forest, support vector machines, Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Long Short Term Memory Networks (LSTMs), and Generative Adversarial Networks (GANs) (Yagin et al., 2023; Mujahid et al., 2021).

# 3. Methodology

This study employed a systematic review of the impact of ML and DL models toward combating COVID-19 by PRISMA (Moher et al., 2009). In this study the review includes the research articles published from 2020 to 2023 and indexed in the Scopus database.

The study's data sources were collected from Scopus database due to facts that Scopus database provides articles with high standards on different domains compared to other databases (Pahlevan et al., 2019). Furthermore, Moher et al. (2009) recommend Scopus as a viable platform for performing systematic reviews because to its extensive indexing and citation monitoring. Chicaiza et al. (2022) emphasise that Scopus is well-known in bibliometric analysis for its scope, assurance of quality, and global study coverage.

## 3.1 Eligibility Criteria of the Study

In this study the search delimited on using Scopus database published from 2020 to 2023. To run full-text searches on titles, abstracts, and authors' keywords, in the Scopus database, the command "TITLE-ABS-KEY" was

used. The following were the inclusion criteria of the study; first, the study was limited to articles and conference papers, publications that are in the final stage. The second inclusion criterion for paper selection was that the article should be written in English. Third inclusion criterion, the study considered articles published from 2020 to 2023, in the area of computer science. The exclusion criteria of the study; the study ignored conference review, book chapter, review, book, non English papers and articles in progress to ensure the quality of the review.

## 3.2 Study Selection

The PRISMA method was used to show how documents of the study were selected. The study employed "TITLE-ABS-KEY ("IMPACT" AND "MACHINE LEARNING" OR "DEEP LEARNING" AND "MODELS" AND "COVID-19") as a searching query in the Scopus database. This search yielded a total of 1,353 articles. After careful assessment of each record based on the objectives and scope of the study, 523 research articles were selected for this review by using PRISMA 2020 statement as shown in figure1.

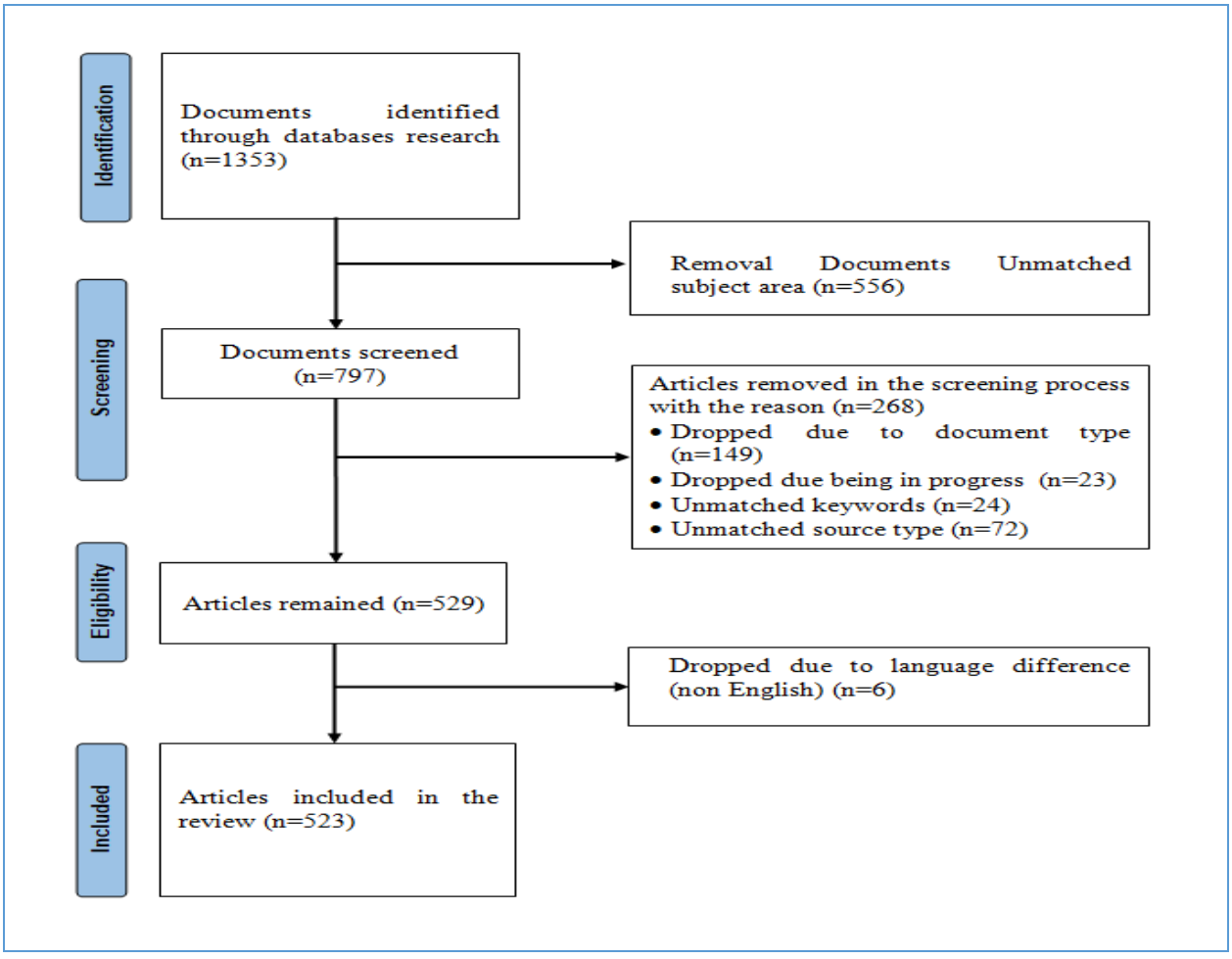


*Figure 1: The PRISMA flowchart illustrates the research selection procedure*

# 4. Results and Discussion

The following part describes the findings and discussions of the research using the Scopus database published from 2020 to 2023. The study employed VOSviewer software (version 1.6.18), MS Excel and SPSS to cater for analysis purposes, because of the benefits they provide over others, such as ease of use, rich graphical representation, and ability to offer superior outcomes (Priyan et al., 2023). The study employed both VOSviewer MS Excel and SPSS software to provide an effective way to analyze the citation, and co-occurrences. A comprehensive systematic review was conducted to explore the impact of machine learning and deep learning models in tackling the COVID-19 pandemic, with the four research questions

being examined. The VOSviewer package was used to analyze 523 research articles published from 2020 to 2023, which include, authors, titles, keywords, citations, publisher, and sponsor, among others details.

## 4.1 A systematic review of the growth trend on ML and DL Models in addressing COVID-19

This section describes descriptive of the growth trend research in ML and DL models in combating COVID-19 (Figure-1) and shows a network map of the topic growth trend based on the author's keyword usage from 2020 to 2023 (Figure-5). The research began to take off in the early of 2020 with 105(8%) articles, and the publication increased to 480(35%) by 2021. In the year 2022, a remarkable increase in publications occurred, with the highest amount reaching to maximum of 622 (46%) publications. The trend has declined to 146(11%) publications by the year 2023. The decrease in the publications trend from 46% in 2022 to 11% in 2023 is a significant decreases; this might be due to several reasons, including the decreases of COVID-19 pandemic infections. According to Alyasseri et al. (2022) and Heidari et al. (2022), ML and DL models have been utilized to improve the prediction of COVID-19, which has resulted in significant decreases in the number of pandemic infections as well as the number of reported cases.

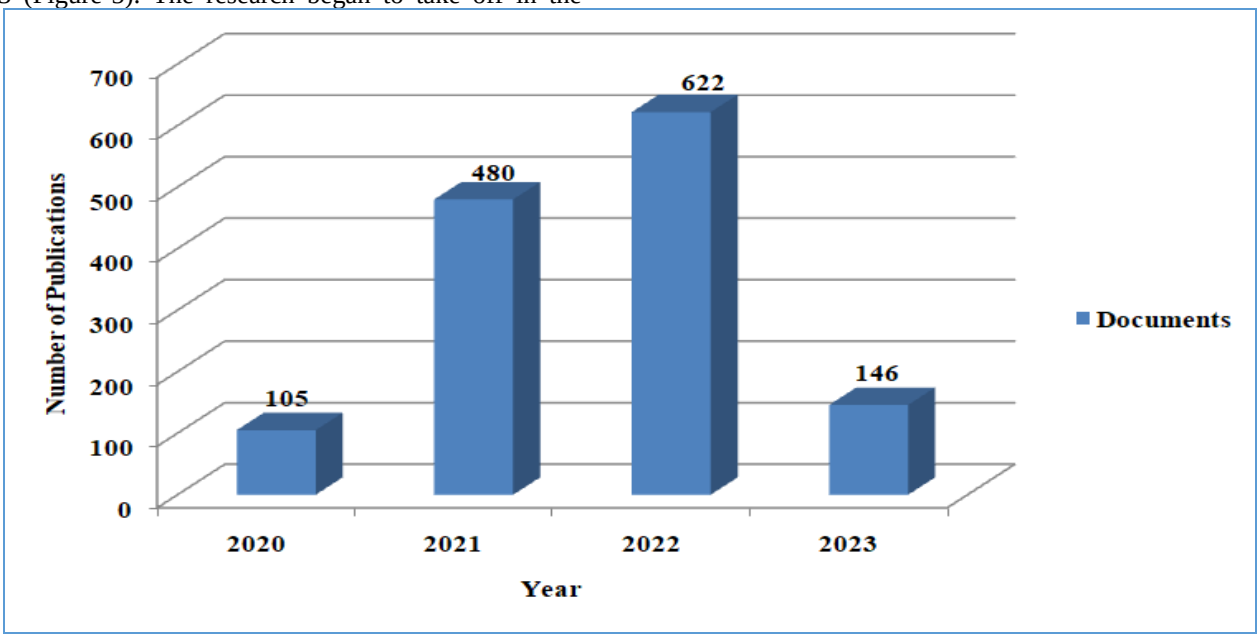


**Figure 2: Growth trend of research in ML and DL models in addressing COVID-19**

## 4.2 Bibliometric analysis of the Top contributing Journals

In total 321 journals have published on ML and DL models in addressing COVID-19 pandemic, a minimum number of documents of 5 per publisher, minimum number of 5 citations per publisher was considered, and 17 publishers met thresholds. The Table1 indicates the top ten contributing publishers published related documents focused in the field of ML and DL models in addressing COVID-19 on people's everyday lives and the health care systems. The contribution of the top ten journals is 45.16% in the total research published on ML and DL models in addressing COVID-19 pandemic in the time span of 2020 to 2023. The IEEE Access is the top publisher with 492 citations (12.1%) compared to other journals, followed by Applied Intelligence and SN Computer Science (Springer), with 361(8.88%) and 210 (7.79%) citations, respectively. According to Chicaiza et al. (2022) Chaos, Solitons and Fractals, IEEE Access, and Applied Intelligence achieved the highest citations in comparison with other journals by 2020. This makes a difference after three years, whereby IEEE Access, Applied Intelligence, and SN Computer Science took the lead by achieving the highest citations compared to other journals.

**Table 1: Top ten contributing publishers in terms of documents and citations**

| Rank | Publishers | Documents | Scopus-Citations |
|---|---|---|---|
| **1** | IEEE Access | 18 | 492 |
| **2** | Applied Intelligence | 7 | 361 |
| **3** | SN Computer Science | 5 | 210 |
| **4** | Electronics (Switzerland) | 8 | 102 |
| **5** | Computers in biology and medicine | 10 | 98 |
| **6** | Computers, materials and continua | 11 | 86 |
| **7** | Applied soft computing | 7 | 71 |
| **8** | Applied sciences (Switzerland) | 6 | 65 |
| **9** | Sensors | 6 | 63 |
| **10** | Computational Intelligence and Neuroscience | 6 | 45 |

## 4.3 Systematic Analysis on Citations in terms of Author

The citation analysis in terms of author was analyzed, in total 2052 authors contributed to the publishing of the ML and DL models in addressing COVID-19 pandemic. A minimum selected number of documents per author are 3, minimum number of citations per author is 3, and out of 2052 authors, 31 authors met the thresholds. The top ten contributing authors with the most citations in the discipline of ML and DL models in tackling Covid-19 are shown in Table 2. In this study the author Wang X., scored the maximum 82 citations compared to other authors, followed by Xu S., and Zhang X., with 76 and 70 citations, respectively. These ten scholars released related documents that focused mostly on the consequences of COVID-19 on everyday life of individuals and public health systems. Ballaz et al. (2023), identified Hao Chen and Jun Yi with as the main authors contributing to relevant publications in the COVID-19.

**Table2: Top ten contributing Authors items of documents and citations**

| Rank | Authors | Documents | Scopus-Citations |
|---|---|---|---|
| **1** | Wang, X. | 5 | 82 |
| **2** | Xu, S. | 3 | 76 |
| **3** | Zhang, X. | 4 | 70 |
| **4** | Ashraf, I. | 4 | 59 |
| **5** | Khan, M.A. | 3 | 45 |
| **6** | Zhang, Y. | 5 | 43 |
| **7** | Naik, B. | 3 | 36 |
| **8** | Nayak, J. | 3 | 36 |
| **9** | Wang, Y. | 7 | 31 |
| **10** | Chrouf, S.M.B. | 3 | 29 |

## 4.4 Systematic Analysis of the Top Contributing Organizations

The bibliometric analysis on the citation analysis in terms of organizations was performed, considering minimum number of documents of 2 per organization as threshold, and minimum number of 3 citations per organization, and out of 1357 organizations, 15 organizations met the threshold. The figure1 below shows organizations contributed in publishing the prominent documents in the field of ML and DL models in addressing COVID-19. The school of information technology and engineering, vellore institute of technology, vellore, India has maximum citations of 180, followed with department bioinformatics and medical engineering, Asia university, Taiwan, which has maximum citations of 79. The League of European Research Universities (LERU) had the most publications, followed by the University of London and the University of California, as stated by Zhong et al. (2022).

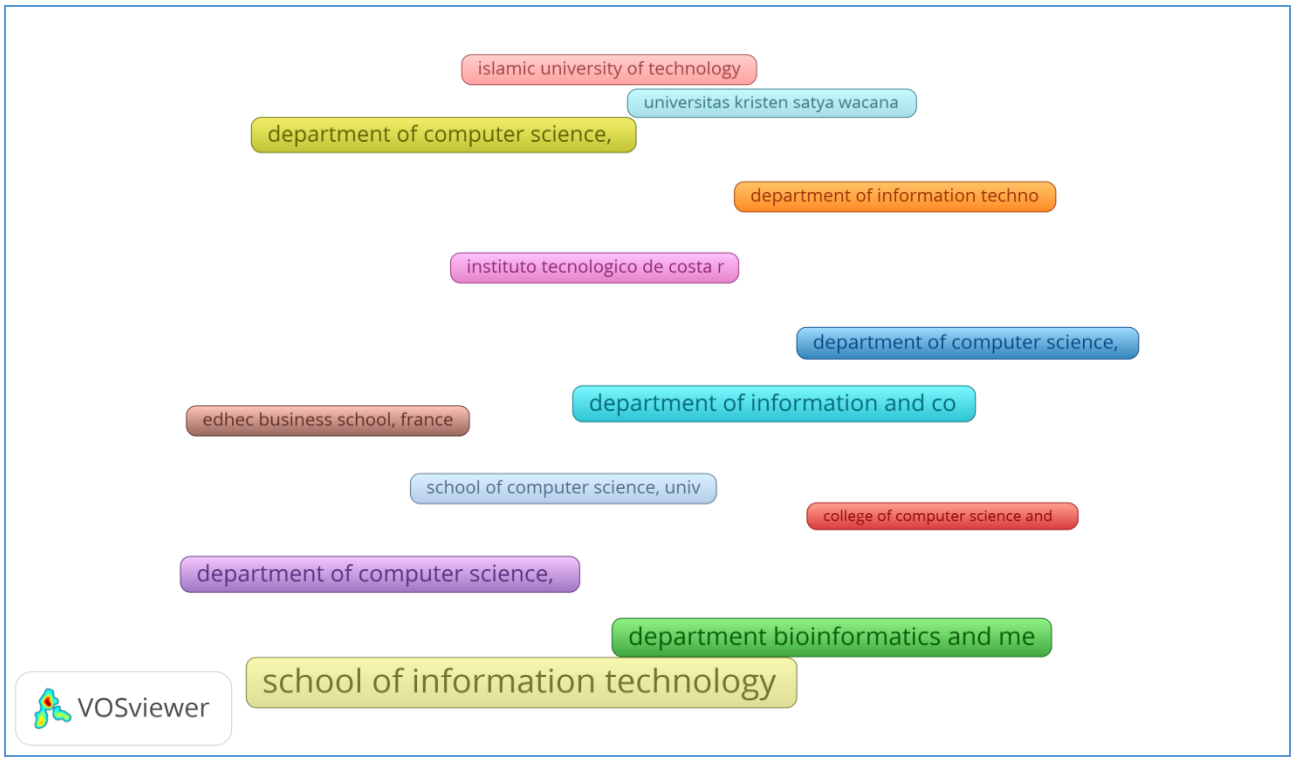


**Figure 3: Citation analysis map in terms of top Contributing Organizations**

## 4.5 Bibliometric Analysis of the Top Contributing Countries

Total of 85 countries have published on ML and DL models in addressing COVID-19 pandemic, the study considered a minimum number of documents of 5 per country, minimum number of 5 citations per country, and 27 countries met a threshold. The United State of America achieved the maximum citations of 1022, followed by India, Iran, Australia, and South Korea with maximum citations of 989, 544, 462 and 412, respectively. Figure3 and Table3 show top ten contributing countries in publishing on ML and DL models in addressing COVID-19 pandemic from the year 2020 to 2023. According to Ballaz et al. (2023), the United States has the most publications and highest level of cooperation internationally, ahead of China and India, while Paul et al. (2023) identified India with the most publications on ML and DL models in addressing COVID-19, followed by Saudi Arabia and the USA.

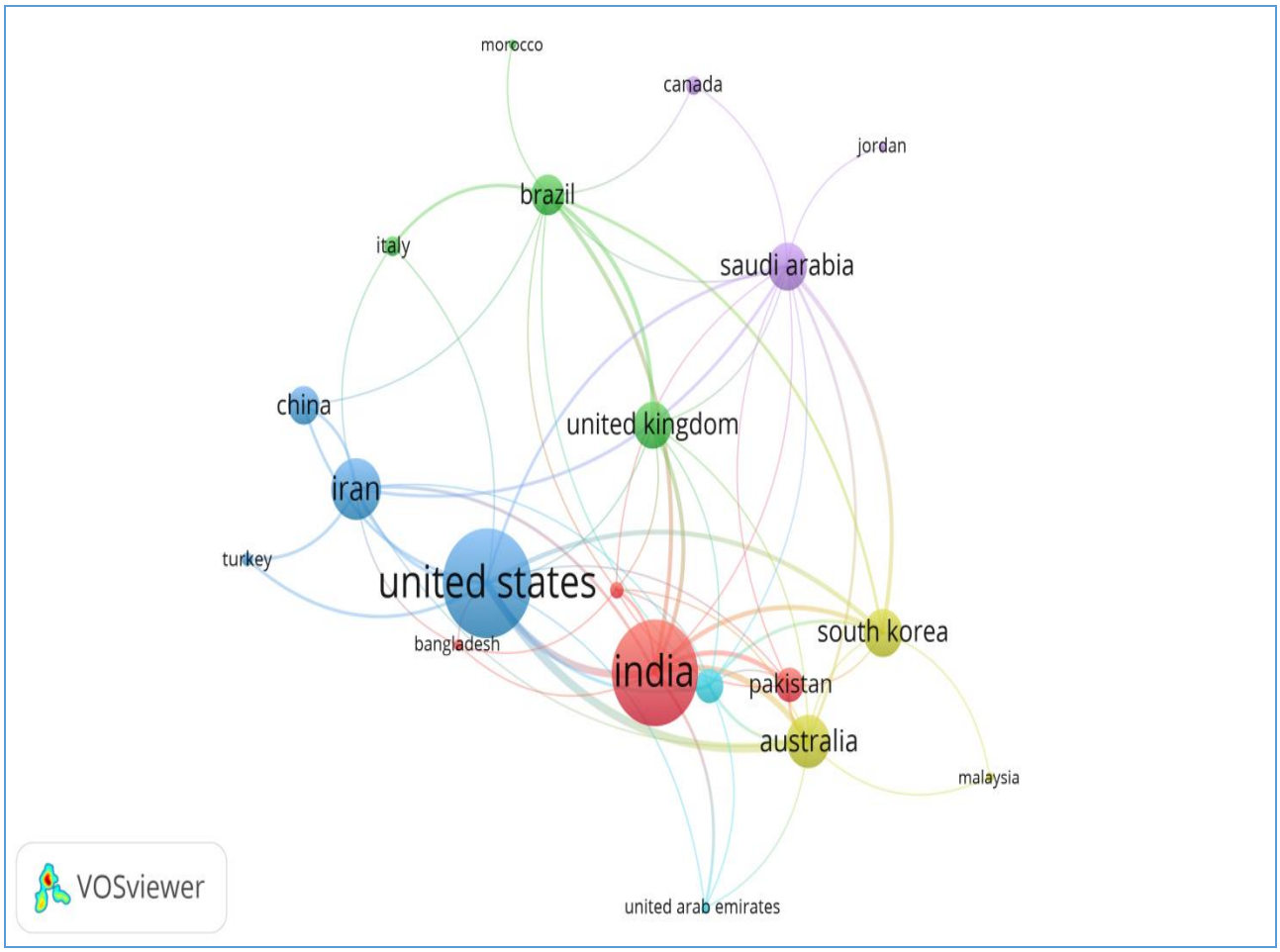


**Figure 4: Citation analysis map in terms of Top Contributing Countries**

**Table3: Top Ten Contributing Countries in terms of Citations and Documents**

| Rank | Country | Documents | Scopus-Citations |
|---|---|---|---|
| **1** | United States | 96 | 1022 |
| **2** | India | 122 | 989 |
| **3** | Iran | 10 | 544 |
| **4** | Australia | 16 | 462 |
| **5** | South Korea | 20 | 412 |
| **6** | Saudi Arabia | 44 | 410 |
| **7** | United Kingdom | 37 | 399 |
| **8** | Brazil | 13 | 341 |
| **9** | China | 73 | 327 |
| **10** | Pakistan | 31 | 290 |

## 4.6 Systematic analysis in the co-occurrence in terms of all keywords

In the analysis of co-occurrences, all keywords were considered before the harmonization of the keywords, out of 2819 that keywords contributed to the publishing of the ML and DL models in addressing COVID-19 pandemic, the minimum number of occurrences of a keyword is 15, and 45 keywords meets the threshold. In this study, the keywords; Covid-19, ML and DL were the most used keywords in most of the published articles compared to others as shown below on the co-occurrence map of all keywords. Rodriguez et al. (2021) identified the keywords "COVID-19" as most used keyword compared to other keywords.

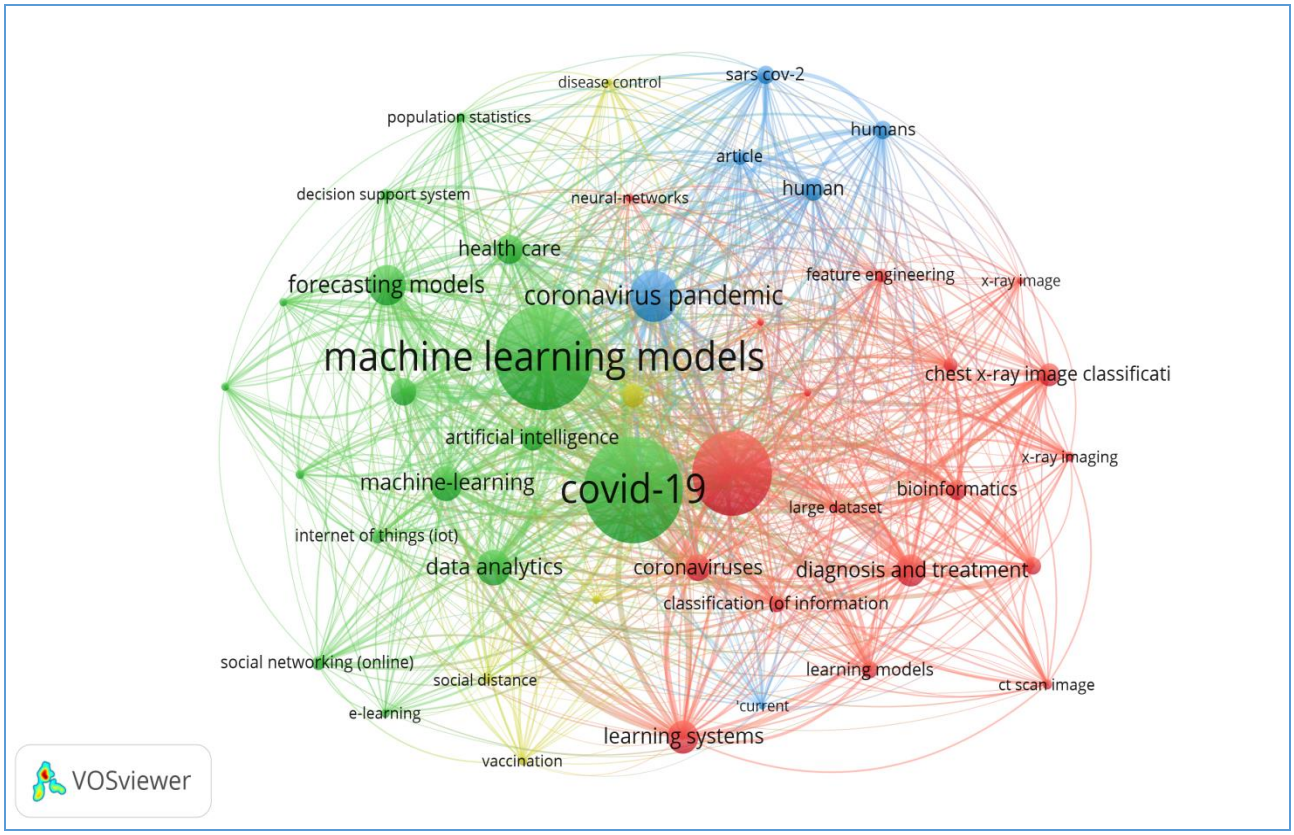


**Figure 5: Co-occurrence map of all keywords**

## 4.7 Systematic analysis on the co-occurrence Analysis in terms of Author keywords

The analysis on the co-occurrence of author keywords was performed after harmonization of keywords through MS Excel. A total of 53 keywords was obtained by the authors contributed to the publishing of the ML and DL models in addressing COVID-19, a minimum number of occurrences of keywords per author was 10, and 22 keywords met the threshold.

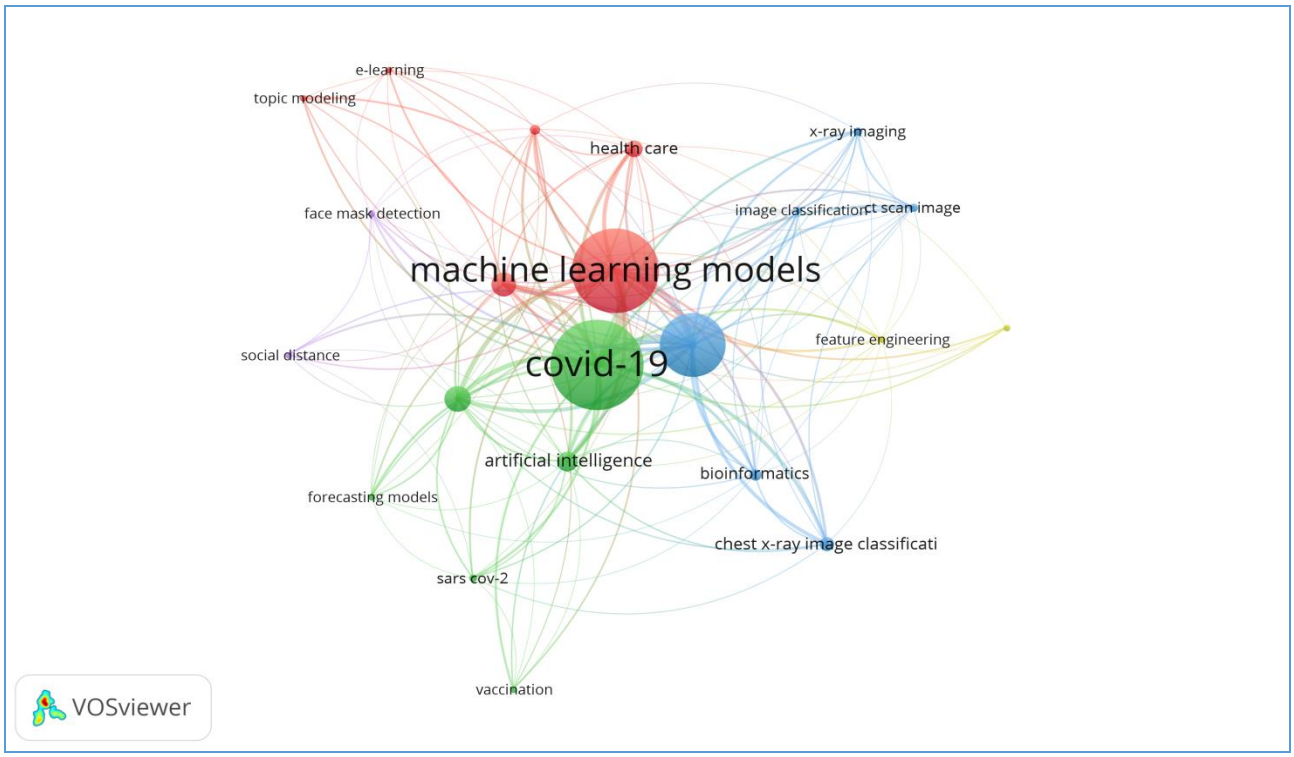


*Figure 6: Co-occurrence Analysis in terms of author keywords*

Figure-6 below shows the co-occurrence of author keywords was analyzed, considering the authors' selected keywords that appeared more than five times in the Scopus database. The most frequently used keywords were "COVID-19" (occurrence 351), followed with "machine learning models" (occurrence 321), and "deep learning models" (occurrence 227), all of which possessed high link when compared to other keywords. The number of nodes in a co-occurrence network shows how often they occur in a publication, while the curves interconnecting them indicate their co-occurrence within a single publication. The near two nodes are, the more frequently their co-occurrence happens, but the more distant they are, the less frequently their co-occurrence occurs, the space between both circles reveals the connection between them.

## 4.8 Bibliometric analysis on the current research gaps in ML and DL Models in counteracting COVID-19 pandemic

Total terms in the research filed is 53 after harmonization, the minimum number of occurrence of a keyword is 10, and 22 keywords meet the threshold as shown on Table4 below.

**Table 4: Top 22 Keywords in terms of occurrence and total link strength**

| Rank | Keywords | Occurrence | Total link strength |
|---|---|---|---|
| 1 | Covid-19 | 351 | 748 |
| 2 | Machine learning models | 321 | 649 |
| 3 | Deep learning models | 227 | 525 |
| 4 | Coronavirus pandemic | 74 | 200 |
| 5 | Data analytics | 68 | 173 |
| 6 | Artificial intelligence | 54 | 133 |
| 7 | Health care | 42 | 106 |
| 8 | Chest x-ray image classification | 36 | 100 |
| 9 | Bioinformatics | 28 | 73 |
| 10 | Internet of things (IOT) | 24 | 55 |
| 11 | Ct scan image | 19 | 61 |
| 12 | X-ray imaging | 18 | 56 |
| 13 | Sars cov-2 | 17 | 42 |
| 14 | Face mask detection | 15 | 36 |
| 15 | Feature engineering | 15 | 44 |
| 16 | Image classification | 14 | 47 |
| 17 | Forecasting models | 13 | 36 |
| 18 | E-learning | 12 | 20 |
| 19 | Social distance | 12 | 29 |
| 20 | Topic modeling | 11 | 31 |
| 21 | Vaccination | 11 | 28 |
| 22 | Fake news identification | 10 | 20 |

The study identified twenty two keywords that were mostly contributed in publishing in the study area of ML and DL models in addressing COVID-19 pandemic. The study employed MS Excel and SPSS to find out keywords that contribute to the existing and future research gaps. The collected data was analyzed using a data analysis tool from MS Excel to create a correlation among the keywords. Thereafter, the SPSS was applied to analyze and screen plot of the eigenvalues to interpret the twenty-two (22) keywords. The study applied the eigenvalues to determine the relationship between the individual keywords used in the published documents, to help to identify the existing and future research gaps. The eigenvalues state that the higher the eigenvalue, the more variance is explained by that factor, the higher the eigenvalues (values>=1), the less the research gaps, and the less the eigenvalues (values<1) the higher the research gaps. The keywords less than 1 in the screen plot indicates the prominent research gaps, using such keywords helps to come up with a new research topic, while keywords above 1 in the screen plot show the most published areas in the study. Therefore, in this study, keywords from rank11 to rank22, creates prominent research gaps, since the eigenvalues factor is less than 1, keywords such as CT scan image, X-ray imaging, Face mask detection, social distance and Vaccination. These keywords can be used to create research gaps which can be used to create a new topic in the study area since they have not fully utilized compared to the rest in this study. On the other side keywords from rank1 to rank10 indicate that they have mostly contributed to this study.

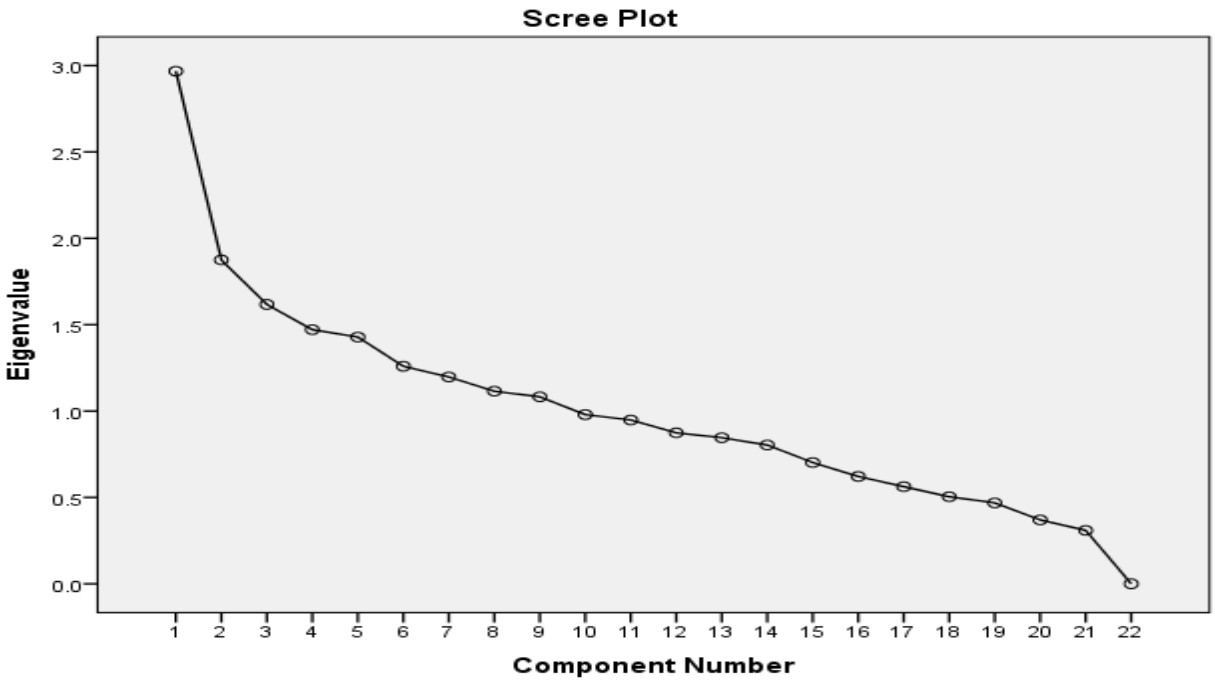


**Figure 7: Top twenty two contributed keywords in eigenvalues screen plot**

# 5. Conclusion and Recommendation

## 5.1 Conclusion

The study has explored the impacts of ML and DL models in combating COVID-19 at work a work place. Recent growth statistics indicates that the number of global publications on COVID-19 has decreased due to different measures taken to address COVID-19 pandemic. The USA made the most notable contribution in this crucial subject. However, the research was restricted to limited database and timeframe that might be the avenues for further research. The notable gaps through the eigenvalues factors less than 1, has highlighted on the keywords such as CT scan image, X-ray imaging, Face mask detection, social distance and Vaccination, of which can be used to create a new topic of the study, since few studies have been written concerning these keywords. More research on these terms is required to determine the existing contributions of AI to the body of knowledge in combating and managing the impact of the COVID-19 pandemic in a work place.

## 5.2 Recommendations

As a result of the results of the study, the following recommendations were suggested:

1. To apply many databases to get more thorough information about COVID-19 pandemic at a work place.
2. To investigate understudied terms like CT scan picture, X-ray imaging, face mask detection, social distance, and immunization for prospective new study subjects.
3. To explore the influence of AI techniques on identified keywords to expand existing information.
4. Explore knowledge gaps found using eigenvalue analysis, especially those with eigenvalues smaller than 1, to identify prospective topics for further exploration.

# References

Abayomi-Alli, O. O., Damaševičius, R., Abbasi, A. A., & Maskeliūnas, R. (2022). Detection of COVID-19 from deep breathing sounds using sound spectrum with image augmentation and deep learning techniques. *Electronics, 11*(16), 2520. https://doi.org/10.3390/electronics11162520

Abdar, M., Khosravi, A., & Acharya, U. R. (2021). A new machine learning-based approach for assessing COVID-19 risk in workplaces. *Computers in Biology and Medicine, 135*,

104623. https://doi.org/10.1016/j.compbiomed.2021.104623

Albahri, A. S., Hamid, R. A., Alwan, J. K., et al. (2020). Role of biological data mining and machine learning techniques in detecting and diagnosing the novel coronavirus (COVID-19): A systematic review. *Journal of Medical Systems, 44*(7), 122. https://doi.org/10.1007/s10916-020-01582-x

Alvi, A., Ahmed, M., & Hoque, S. A. (2021, July). Consequences of lockdown caused by COVID-19 outbreak on the quality of air in Dhaka. In *2021 International Conference on Automation, Control and Mechatronics for Industry 4.0 (ACMI)* (pp. 1–6). IEEE. https://doi.org/10.1109/ACMI53878.2021.9528236

Alyasseri, Z. A. A., Al-Betar, M. A., Doush, I. A., Awadallah, M. A., Abasi, A. K., Makhadmeh, S. N., ... & Zitar, R. A. (2022). Review on COVID-19 diagnosis models based on machine learning and deep learning approaches. *Expert Systems, 39*(3), e12759. https://doi.org/10.1111/exsy.12759

Aziz, S., Khan, M. U., Rehman, A., Tariq, Z., & Iqtidar, K. (2022). Computer-aided diagnosis of COVID-19 disease from chest x-ray images integrating deep feature extraction. *Expert Systems, 39*(5), e12919. https://doi.org/10.1111/exsy.12919

Ballaz, S., Pulgar-Sánchez, M., Chamorro, K., & Fernández-Moreira, E. (2023). Scientific pertinence of developing machine learning technologies for the triage of COVID-19 patients: A bibliometric analysis via Scopus. *Informatics in Medicine Unlocked*, 101312. https://doi.org/10.1016/j.imu.2023.101312

Bullock, J., Luccioni, A., Pham, K. H., Lam, C. S. N., & Luengo-Oroz, M. (2020). Mapping the landscape of artificial intelligence applications against COVID-19. *Journal of Artificial Intelligence Research, 69*, 807–845. https://doi.org/10.1613/jair.1.12162

Cheng, A. M. (2021, November). Real-time COVID-19 infection risk assessment and mitigation based on public-domain data. In *2021 IEEE/ACM HPC for Urgent Decision Making (UrgentHPC)* (pp. 29–35). IEEE. https://doi.org/10.1109/UrgentHPC54673.2021.00010

Chicaiza, J., Villota, S. D., Vinueza-Naranjo, P. G., & Rumipamba-Zambrano, R. (2022). Contribution of deep-learning techniques toward fighting COVID-19: A bibliometric analysis of scholarly production during 2020. *IEEE Access, 10*, 33281–33300. https://doi.org/10.1109/ACCESS.2022.3162407

Dolgikh, S. (2020). Identifying explosive epidemiological cases with unsupervised machine learning. *medRxiv*. https://doi.org/10.1101/2020.05.06.20093775

Heidari, A., Navimipour, N. J., Unal, M., & Toumaj, S. (2022). The COVID-19 epidemic analysis and diagnosis using deep learning: A systematic literature review and future directions. *Computers in Biology and Medicine, 141*, 105141. https://doi.org/10.1016/j.compbiomed.2021.105141

Hu, F., Huang, M., Sun, J., Zhang, X., & Liu, J. (2021). An analysis model of diagnosis and treatment for COVID-19 pandemic based on medical information fusion. *Information Fusion, 73*, 11–21. https://doi.org/10.1016/j.inffus.2021.03.001

Iwendi, C., Bashir, A. K., Peshkar, A., et al. (2020). COVID-19 patient health prediction using boosted random forest algorithm. *Frontiers in Public Health, 8*, 357. https://doi.org/10.3389/fpubh.2020.00357

Jain, D. K., Singh, T., Saurabh, P., Bisen, D., Sahu, N., Mishra, J., & Rahman, H. (2022). Deep learning-aided automated pneumonia detection and classification using CXR scans. *Computational Intelligence and Neuroscience, 2022*. https://doi.org/10.1155/2022/2313382

Kumar, N. P. (2022). Modeling the impact of COVID-19 on the farm produce availability and pricing in India. *Interdisciplinary Journal of Information, Knowledge & Management, 17*. https://doi.org/10.28945/4960

Mbilong, P. M., Berhich, A., Jebli, I., El Kassiri, A., & Belouadha, F. Z. (2021). Artificial intelligence-enabled and period-aware forecasting COVID-19 spread. *Ingénierie des Systèmes d'Information, 26*(1), 47–57. https://doi.org/10.18280/isi.260106

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine, 151*(4), 264–269. https://doi.org/10.7326/0003-4819-151-4-200908180-00135

Mujahid, M., Lee, E., Rustam, F., Washington, P. B., Ullah, S., Reshi, A. A., & Ashraf, I. (2021). Sentiment analysis and topic modeling on tweets about online education during COVID-19. *Applied Sciences, 11*(18), 8438. https://doi.org/10.3390/app11188438

Pahlevan Sharif, S., Mura, P., & Wijesinghe, S. N. (2019). Systematic reviews in Asia: Introducing the "PRISMA" protocol to tourism and hospitality scholars. In *Quantitative Tourism Research in Asia: Current Status and Future Directions* (pp. 13–33). https://doi.org/10.1007/978-981-13-2463-5_2

Pang, Y., Yao, L., Jhong, J. H., Wang, Z., & Lee, T. Y. (2021). AVPIden: A new scheme for identification and functional prediction of antiviral peptides based on machine learning approaches. *Briefings in Bioinformatics, 22*(6), bbab263. https://doi.org/10.1093/bib/bbab263

Paul, S. G., Saha, A., Biswas, A. A., Zulfiker, M. S., Arefin, M. S., Rahman, M. M., & Reza, A. W. (2023). Combating COVID-19 using machine learning and deep learning: Applications, challenges, and future perspectives. *Array, 17*, 100271. https://doi.org/10.1016/j.array.2023.100271

Pereira, R. M., Bertolini, D., Teixeira, L. O., Silla Jr, C. N., & Costa, Y. M. (2020). COVID-19 identification in chest X-ray images on flat and hierarchical classification scenarios. *Computer Methods and Programs in Biomedicine, 194*, 105532. https://doi.org/10.1016/j.cmpb.2020.105532

Priyan, P. K., Nyabakora, W. I., & Rwezimula, G. (2023). A bibliometric review of the knowledge base on capital structure decisions. *Vision, 27*(2), 155–166. https://doi.org/10.1177/09722629221145290

Rodriguez-Rodriguez, I., Rodriguez, J. V., Shirvanizadeh, N., Ortiz, A., & Pardo-Quiles, D. J. (2021). Applications of artificial intelligence, machine learning, big data and the Internet of Things to the COVID-19 pandemic: A scientometric review using text mining. *International Journal of Environmental Research and Public Health, 18*(16), 8578. https://doi.org/10.3390/ijerph18168578

Santosh, K. (2020). AI-driven tools for coronavirus outbreak: Need of active learning and cross-population train/test models on multitudinal/multimodal data. *Journal of Medical Systems, 44*(5), 1–5. https://doi.org/10.1007/s10916-020-01562-1

Saufi, S. R., Abu Hasan, M. D., Ahmad, Z. A., Leong, M. S., & Hee, L. M. (2021). Detection of COVID-19 from chest X-ray and CT scan images using improved stacked sparse autoencoder. *Pertanika Journal of Science & Technology, 29*(3).

Vaishya, R., Javaid, M., Khan, I. H., & Haleem, A. (2020). Artificial intelligence (AI) applications for COVID-19 pandemic. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 14*(4), 337–339. https://doi.org/10.1016/j.dsx.2020.04.012

Wang, X., Lu, H., Zhu, W., Yan, K., Wang, Y., & Li, Z. (2021, November). A new method for detecting COVID-19 combining deep learning with improved histogram equalization and median filter. In *2021 2nd International Conference on Artificial*

*Intelligence and Computer Engineering (ICAICE)* (pp. 01–07). IEEE. https://doi.org/10.1109/ICAICE52962.2021.00008

Wu, Q. (2022, January). Forecast of COVID-19 vaccinations in the US, India, and South Africa. In *2022 3rd International Conference on Electronic Communication and Artificial Intelligence (IWECAI)* (pp. 512–518). IEEE. https://doi.org/10.1109/IWECAI54616.2022.9734134

Yagin, F. H., Cicek, İ. B., Alkhateeb, A., Yagin, B., Colak, C., Azzeh, M., & Akbulut, S. (2023). Explainable artificial intelligence model for identifying COVID-19 gene biomarkers. *Computers in Biology and Medicine, 154*, 106619. https://doi.org/10.1016/j.compbiomed.2022.106619

Zhang, J., Chng, C. B., Chen, X., Wu, C., Zhang, M., Xue, Y., ... & Chui, C. K. (2020, November). Detection and classification of pneumonia from lung ultrasound images. In *2020 5th International Conference on Communication, Image and Signal Processing (CCISP)* (pp. 294–298). IEEE. https://doi.org/10.1109/CCISP51016.2020.9359454

Zhong, M., & Lin, M. (2022). Bibliometric analysis for economy in COVID-19 pandemic. *Heliyon*. https://doi.org/10.1016/j.heliyon.2022.e10023