A Review Study on Machine Learning Approaches on Coronavirus Big Data

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Abstract

Information has the ability for protecting against unexpected events and controlling crises like CoronaVirus Disease COVID-19 pandemic. Because this pandemic has spread so quickly worldwide, only technology-driven management of data could give reliable information in order to help handle the situation. The goal of this research is to look at the potential of the technologies that are related to big data to control and regulate the transmission of COVID-19. To collect the important aspects, a systematic review was conducted using Preferred Reporting Items for Systematic Reviews and Meta-Analyses PRISMA criteria. The thirty-two most relevant documents for the qualitative analyses have been indicated in the present work. This research also identifies 10 potential data sources and 8 essential big data applications for studying virus infection trends, virus associations, transmission patterns, and differences of genetic modifications. Also, it looks at some of the drawbacks of big data, such as privacy concerns, unethical data use, and data exploitation.

The research's results will offer fresh information to administrators and policymakers, allowing them to establish data-driven strategies for addressing and managing the COVID-19 epidemic.

Keywords: Big data, Machine Learning, Artificial Intelligence, COVID-19

1. Introduction

The big massive evolution in social media, industries, services, and internet of things was leading to an unprecedented quantity of digitization data. Size of this saved data worldly expanding as nearly double every 20 months contributing in massive amounts of data known as big data [1].

Big data can be structured or unstructured which require a flexible processing technique majorly based on intelligent methods such as decision trees [2] clustering and swarm intelligence [3,4], etc.

Big Data Analytics in healthcare allows to analyze large datasets from thousands of patients, identifying clusters and correlation between datasets, as well as developing predictive models using data mining techniques aiding in medical fields research by providing various types of highly accurate prediction and simulation [5]

COVID-19 is a quickly growing infection epidemic that has paralyzed life throughout the world, not just in health-care sector, yet also in various other areas like transportation, education, politics, and supply chains. As of the third week of August (August 19, 2020), the lethal virus has spread to over 214 nations, leading to more than 780,000 mortalities and 22 million confirmed cases worldwide [6, 7]. Approximately 250,000 confirmed cases, along with 10,000 deaths, have been reported since mid-March, and the rapidity of the disease outbreak and its effect with regard to death in such a short time is unprecedented [8]. The absence of powerful specialists and the general population, combined with the antibody's failure to generate resistance to the coronavirus, has resulted in a number of defensive epidemics [9]. Weariness, muscle pains, dehydration cough, shortness of breath, and hemoptysis are all frequent symptoms of COVID-19, with phlegm buildup, headache, and hemoptysis being less frequent. The individual who exhibits all of the above-mentioned symptoms is a COVID-19 virus affected individual. As seen in fig 1, the virus settles in the lungs and thereby inhibits lung function, with an increase in effect lasting up to 14 days.

Figure1: COVID-19 Symptoms

The most reliable source for COVID-19 diagnostic testing is the United States Polymerase Chain Reaction (PCR) test. The same test type was utilized to diagnose SARS virus in 2002. In the case when the two genes are present, the result becomes positive; in the case where just a single gene is present, results are inconclusive; and if neither of the two genes is present, the result is negative. Lastly, the doctor requested a chest Computed Tomography CT scan, which confirmed the diagnosis of COVID-19 and demonstrated that the lung was infected with the virus. Therefore, while CT scans properly identified 98% of individuals infected with viruses, Reverse Transcription-Polymerase Chain Reaction RT PCR testing only did so 71% of the time [10]. COVID-19 Diagnostic Resource Center lately launched an online training course for ministry of health officials, physicians, laboratory publicists, and anyone else involved in COVID-19 laboratory diagnosis and testing [11]. Fast transmission and death rates could be controlled with an immediate effective method [9].

The use of conventional technology for managing and controlling epidemics is ineffective. Daily, new information is created which communicates a beneficial message for COVID-19 epidemic prevention. As a result, it is important to archive it; this is a massive amount of data that may be utilized for developing effective countermeasures against the Corona virus [12].

In addition, big data analytics represents one of the critical tools for analyzing those massive data amounts in order to identify trends, virus relatedness, transmission patterns, and changes in genomic features [13]. Since big data can manage large amounts of data, it could explain virus transmission nature to the infected persons. Also, it aids in the development of an effective prevention strategy to halt the spread of the disease.

In today's world, information technology is unavoidable [14]. The quick advancement of information technology has resulted in a demand for it in every industry [15]. The health sector is no exception, with information technology being used in practically every aspect of the industry [16]. Because of a technological logical shift, HIT (i.e. Health Information Technology) now encompasses a wide variety of information, computer, and health [17].

Conventional medical practices are being transformed into adopting new information technology for the enhancement of the development at all of the phases of health care services [18]. The HIT includes mobile health, e-health, email, social media sessions, and messaging, among other modern technology [19].

Scientists, practitioners, and health-care employees can benefit from big data analysis. Forecasting permits transportation in a given area using big data analysis and might be utilized for demonstrating how the virus is spreading worldwide and development in the medical profession. Also, big data is assisting in the development of an effective crisis treatment. Various researches on COVID-19 epidemic [20], guidelines for infection control [21], health services [22], safety [20], application of digital technologies [23], in the formation of research behaviors [24], and expert opinions [25] have already been published, yet a possibility of the big data technologies remains untapped.

The essential steps of COVID19 are depicted in Figure 2 below, which are driven via big data management. This covers the following four steps in the main frame: big data technology, data sources of COVID-19, big data processing, and big data applications [26].

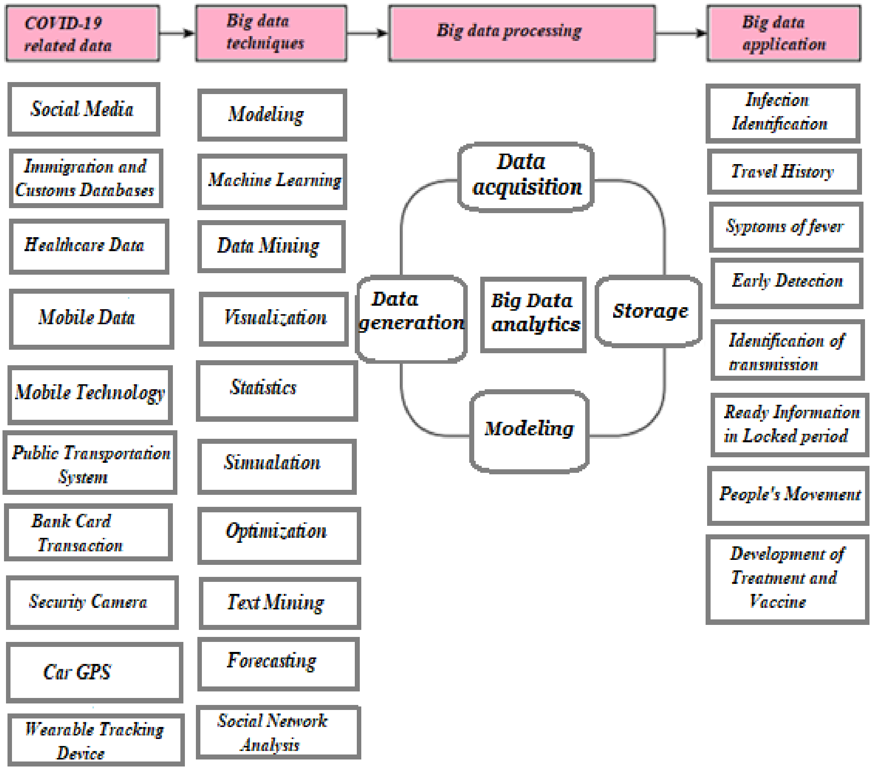

Figure 2: The technology of big data for COVID19

The explanation details are given in the next sub-sections:

1.1 Sources of COVID-19 related big data.

This research thoroughly examines all of the papers chosen and identifies 10 potential sources of big data. With regard to individual's movement, treatment, information seeking, and day-to-day affairs, such sources supply a massive amount of COVID-19-related data. Customs and immigration databases, social media, mobile data, COVID-19 database/healthcare data, public transportation, mobile technology, security camera/closed-circuit camera, bank card transactions, and the vehicle's GPS are all key sources of big data, as indicated in table(1). Individual's connections to numerous social media platforms including Twitter, Facebook, IMO, WeChat, and QQ are among the most common sources of information [26]. Social media can deliver both accurate information and misleading false information. The majority of nations have taken several similar measures in response to the Corona epidemic, like extensive testing, social distance, washing hands, wearing masks, avoiding crowded locations, using sanitizers, and closures [27]. Furthermore, certain advanced nations, such as South Korea, China, Japan, and Taiwan, have built its own health application for tracking individual's movements and collect electronic health record (HER) via the application [28]. Because numerous big data sources can be considered to be inexpensive, simple to use, and readily available, they could be a valuable resource for designing proper COVID-19 crisis management strategies.

1.2 Big data techniques:

Machine learning, modeling, visualization, data mining, simulation, statistics, text mining, optimization, social network analysis and forecasting are among the 10 main approaches highlighted in this research for COVID-19 crisis management Table(2). After gathering data from multiple sources, policymakers and scholars can readily make decisions utilizing such strategies. Using big data analytics, real-time monitoring of COVID19 could be accomplished. Researchers are working on big data analytics-compatible model for enhanced forecasting of the transmission of COVID-19.

Big data analytics could help individuals in visualizing their data's movements, allowing them to make more rapid decisions. Machine Learning (ML) is a well-known approach for mapping COVID-19 transmission trends, forecasting, and hotspots. Generally, some ML models and methods, like Markov model, Boltzmann machine, and neural network, have the ability to manage COVID-19. Data mining is another prominent method for limiting the pandemic. Several governments had employed a data mining method to analyze the trend of coronavirus transmission already. Policymakers and practitioners are also using visualization to map transmission patterns, hotspots, and susceptible locations. Statistics allow to understand the size of infection rates, recovery, and morbidity, which aids in developing effective COVID-19-fighting measures. With the use of big data, optimization, simulation, and text mining could assist in forecasting any future outbreaks. Forecasting allows for the essential actions to be taken in the battle against COVID-19 pandemic. Furthermore, social network analyses represent a method of analyzing social network data in order to determine the extent of a COVID-19 outbreak in real time.

Table 1: Major sources of big data associated with COVID-19

References	***Source of data***	***Characterization***
Lin and Hou [٢9]	Bank card transactions	Credit & debit card transaction in POS, ATM, and online transactions
Saheb [26]	Social media	Social media networks and apps
Jovanović *etal*. [١5]	Public transport system	Aviations, ground and railway
Whitelaw et al. [27]	Immigration as well as customs data-bases	Seaports, land ports and airports
Whitelaw *etal*. [27]	COVID-19 data-base/Health-care data	Many diagnostic centers as well as hospital
Radanliev *etal*. [30]	Mobile data	Mobile Firms
Dwivedi *etal*. [31]	Mobile technology	Many mobile technology or apps
Whitelaw *etal*. [٢7]	Wearable tracking device	Many devices for tracking individual’s movement

Whitelaw *etal*. [٢7]; Aceto *etal*. [32]	Security camera/ Closed-circuit camera	Security camera of various areas, such as railway stations, road, land ports, airport, home and office
Beaunoyer *etal*. [33]; Vafea *etal*. [34]	Car GPS	GPS of cars as well as other transportation

Table 2: Potential methods of the big data for the management of COVID-19 pandemic

Technique	***Researcher***
Modeling	Liu *etal*. [٣5]; Whitelaw *etal*. [27]
ML	Khanday *etal*. [37]; Sujath *etal*. [٣6];
Visualization	Preuveners *etal*. [41]; Zhou *etal*. [40];
Data mining	Kumar [38]; Benke & Benke [39]
Simulation	Rahman *etal*. [43]; Nazir *etal*. [42];
Statistics	Benke & Benke [٣9]
Text mining	Khanday *etal*. [٣7]
Optimization	Ajayi *etal*. [44]
Social network analyses	Yuan *etal*. [47]; Rajendran *etal*. [48]
Forecasting	Hu *etal*. [46]; Shinde *etal*. [٤5];

2. Big Data Applications

Travel history, infection identification, early detection, fever symptoms, people's movement, ready information in the period of the lockdown, identification of transmission, and vaccines and treatments’ development are among the 8 key applications in this work as in table (3) [49, 9, 34, 17, 23, 35]. Big data has now been proven to aid in the diagnosis and identification of infected individuals. Also, big data utilized to predict treatment outcomes, which aids in the selection of treatment options [50]. Genomic data, for instance, can be employed in numerous PCR to acquire precise information regarding the likely threat of COVID-19 in a certain area [51].

Comparably, travelers can benefit from genomic data. The traveler's genome data and history could serve to paint a clear image regarding viral diversity, which could aid in the development of successful treatments. This type of information can even be employed in locations where no genomic data is available as the reference [52]. For instance, Zhongnan Hospital in China studied a dataset that included 11500 persons, with 170 and 276 people being recognized as infected and suspected, respectively, allowing for easy hematology and pathogen testing [53]. Many public entities gather daily data for body temperature from a broad set of persons and compile it into a big data-set [54]. That fever-related data-set is helpful in identifying suspected cases and infected ones. Big data can potentially aid with early detection by analyzing a dataset [55].

Big data is useful for identifying transmission patterns and forecasting outbreaks. For instance, Giordano et al. [56]

evaluated a pandemic dataset in Italy and anticipated the potential of COVID-19 epidemic, which aided in the development of an effective control strategy. Comparably, Castillo-Chavez and Brauer [57] utilized model for predicting patterns of COVID-19 human transmission with the use of data-set from Italy and were effective. Such type of model can as well be used for visualizing infected areas and COVID19 transmission hotspots. Strzelecki [58] conducted another investigation on the global scope of COVID-19 epidemic with the use of a large Google dataset. The researcher used the Google Trends tool for visualizing the outbreak trends as well as likely hotspots of COVID19 outbreaks using data from Italy, China, Iran, and South Korea.

With the use of a large dataset, a data optimization model could offer a higher accuracy in predictions of the future as well as current epidemics. People can readily acquire ready information about the epidemic status, its intensity, sensitivity, exposure, and possible measures of control from results of numerous analyses during a lockdown time [59]. Big data may also be used for tracking the transmission pattern of COVID-19, which is highly beneficial for healthcare organizations in order to keep the problem under control [1]. Zhao et al. [60], for instance, analyzed data from 854 424 flight travelers from multiple airports in Wuhan, throughout Dec. 2019 and Jan. 2020 for detecting patterns of the transmission of the virus. They have used statistical models and a big data technique to discover a highly significant link between infection cases and population. Big data-driven modeling also aids in determining the number of sick people in a given location. COVID-19 vaccination is currently an urgent concern in order to protect individuals from the deadliest threats of COVID19 [61].

In addition, big data allows for the analysis of a huge dataset and the selection of an appropriate element for the development of the vaccination. The researchers had already attempted to produce a vaccination utilizing big data techniques, which aid in the screening of effective spike sequences for vaccine production.

Table3. Possible big data applications for the management of COVID-19 pandemic

Researcher	Application	Descriptions
Halem *etal*. [٤9]; Vafea *etal*. [٣٤]	Infection identification	Big data aids in the identification of infected individuals as well as the preservation of records for future use.
Petersen et al. [٥٠]	Travel history	The individual that comes in contact with an infected individual can be identified by their travel history, which aids in viral containment.
Ohia *etal*. [٢٣]	Fever Symptoms	Big data is used for storing the data about persons' fevers and

		associated signs so that it may be used in the detection of suspicious individuals.
Liu et al. [٣٥]	Early detection	Big data aids in the detection of infection trends and early detection.
Haleem et al. [٤٩]	Transmission Identification	Because COVID19 is a disease that spreads quickly, big data could aid in identifying the area and way of the transmissions and controlling it.
Zwitter and Gstrein [٩]	Ready information in lockdown period	When individuals are forced to remain at their homes because of a lockdown, they require immediate information that can be delivered by big data.
Chen et al. [١٧]	People's movement	The movement of individuals can be simply tracked with the use of big data technology, which can also assist in identifying potential affected areas.
Zwitter and Gstrein [4]	Treatment and vaccination development	Developing vaccines and treatments could be accomplished through sophisticated digital technologies

3. Challenges of Big Data Implementation

Operating obstacles, expertise limitations, resource limitations, and regulatory challenges, as well as limited market access, privacy, and ethical considerations as in table (4) have all been recognized as challenges [4٩, ٢٤, 27, 62–65].

Expertise limitations caused by a lack of cooperation amongst the member of the staff, inadequate data handling, data analyses expertise, and communication capacity are all elements in each major difficulty. Comparably, operational issues arise as a result of a lack of data integration knowledge, poor approachability, inadequate patient support, and a reluctance to work. Data creditability, poor regulatory compliance, work pressure and necessary expensive investment are the most common causes of regulatory problems. Another issue with big data implementation is resource constraints, which are caused by regulatory constraints, data use restrictions, poor data access, and incorrect diagnosis. Through tackling the aforementioned difficulties, big data technologies could be used to their full potential. One of the most significant problems in using big data technology to combat the COVID-19 pandemic is a limitation of expertise.

For handling massive data analysis and interpretation, a professional team is required. Operational problems create roadblocks to implementing a big data strategy. The lack in standard and error-free data-bases also makes it difficult to come up with a reliable solution. Errors in the data-sets can often produce results which raise doubts about the results' credibility. To acquire reliable findings, you'll need a dataset that's clean and error-free.

Controlling COVID-19 is primarily concerned with keeping people healthy and safe. At the same time, data security and privacy are critical. However, a few software tools, in order to analyze and track the status of virus propagation, require personal data such as travel trajectory, location, birth date, age, citizenship identity, in addition to other difficulties [65, 66].

To use person's personal information and defend data privacy, the expert team must be trustworthy and sincere. Throughout the handling of a large dataset, the responsible authority must keep an eye on ethical considerations.

Table4. Challenges that are related to the implementation of big data for the management of COVID-19 pandemic

Dimensions of the challenges	Factors	Researcher
Expertise limitations	Lack in the cooperation amongst the staff, Insufficient capability for handling data, lack in the expertise of data analyses, poor communications	Whitelaw *etal*. [٢7]
Regulatory challenge	Insufficient regulatory compliances Data Creditability Work pressure Required high investment	Owusu [24]

Operational challenges	Lack in data integration knowledge Insufficient support to the patients Reluctance to work Low degree of the approachability	Halem *etal*. [49]
Limited accesses to the markets	Low decision making power Low incentives Lack in value addition	Li *etal*. [63]
Resource limitations	Constraints of the regulation Restraints on the utilization of data Insufficient data access Incorrect diagnoses	Elshater & Abusada [62]
Ethical problems	All of the ethical standards have to be handled	Tsai & Ma [65]
Privacy	Maintenance of everybody's privacy	Anisetti *etal*. [64]

4. Conclusion

As a result of a lack in the efficient control methods, the pandemic of COVID19 had spread rapidly worldwide. Control measures based on technology could be a useful instrument in containing the global crisis. A novel health-care service concept is using big data to improve health-related life quality. At several phases, the healthcare business can benefit from big data technologies. The utilization of big data is being hailed as a game-changer in terms of improving people's lives. We have offered a survey of the most recent solutions in the fight against the new coronavirus in this study. First, we went over the COVID-19 virus, its foundations, and the drivers of big data in order to find effective and quick approaches to battle COVID-19 disease. Virus spread tracking, disease outbreak prediction, therapy and diagnosis, and vaccine and medication discovery are just a few of the big data uses for COVID-19. Furthermore, we examined the hurdles that must be overcome in order for big data to be successful in the fight against the COVID-19 epidemic.

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