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Artificial Intelligence and Machine Learning Approach towards COVID-19

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Abstract

COVID-19 pandemic is abruptly changing the normality and is taking a colossal toll which leads to human death. The scientific advancement requires the support and delivery of upcoming technologies like Artificial Intelligence (AI), Internet of Things, Big Data and Machine Learning Language which can look beyond the conventional strategies of healthcare delivery system. In this review we have discussed several search engines tools and AI-based applications viz., early detection and diagnosis during the infection, tracing the contact of the individuals, monitoring the treatment, development of drugs and vaccines which can be approached by the usage of these technologies. Discovery of drugs requires these technologies to accelerate deep learning technologies to create a model and predict the diagnosis process to treat COVID-19. AI can be used to understand the existing patterns of the drugs and extract new insight by AI algorithms which would discover in developing a vaccine and can be therapeutic potential.

Keywords: Search Engines; Contact tracing; Drug Discovery; Drug Repurposing; Artificial Intelligence; Machine Learning; COVID-19

Introduction

The pandemic disease novel Corona (COVID-19), had its origin from the Wuhan District of China (Hubei Province). SARS CoV-2 belongs to a class of enveloped viruses β-corona virus group with an RNA genome. It is observed SARS CoV and the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) have a phylogenetic similarity with previous severe acute Respiratory syndrome [1]. During the Corona virus pandemic, COVID-19 virus got evolved evolutionarily. Thus the range of COVID -19 spread was severe than the previous COVID-19 and MERS-CoV. Severe Acute Respiratory Coronavirus 2 (SARS-CoV-2 which widely spreads through contact, droplets, and air. The patients can be divided into mild, moderate and acute based on the aetiology of the symptoms [2]. The tracking of the spread of the virus can be identified by using technology such as AI, Machine learning which can identify high – risk patients and can treat patients in real-time. AI can predict by population screening samples data the prediction for the risk of mortality of the patients [2]. It was observed in the prior literature survey of [3a,3b], 1273 online publications were checked related to SARS CoV-2, COVID-19 from databases of Nature, Elsevier, arXiv, bioRxiv, Google Scholar, medRxiv out of which filtered 267 papers used AI methods explicitly. Nevertheless, it can also predict notification and suggestions to control the infection and help us to fight the virus through screening of the population. As it is an evidenced-based tool which can be

used medically to improve planning in treatment procedure and can have reported the outcome of the COVID-19. A schematic representation of the general procedure which can be helpful to general physicians during the Covid-19 is shown in figure 1.

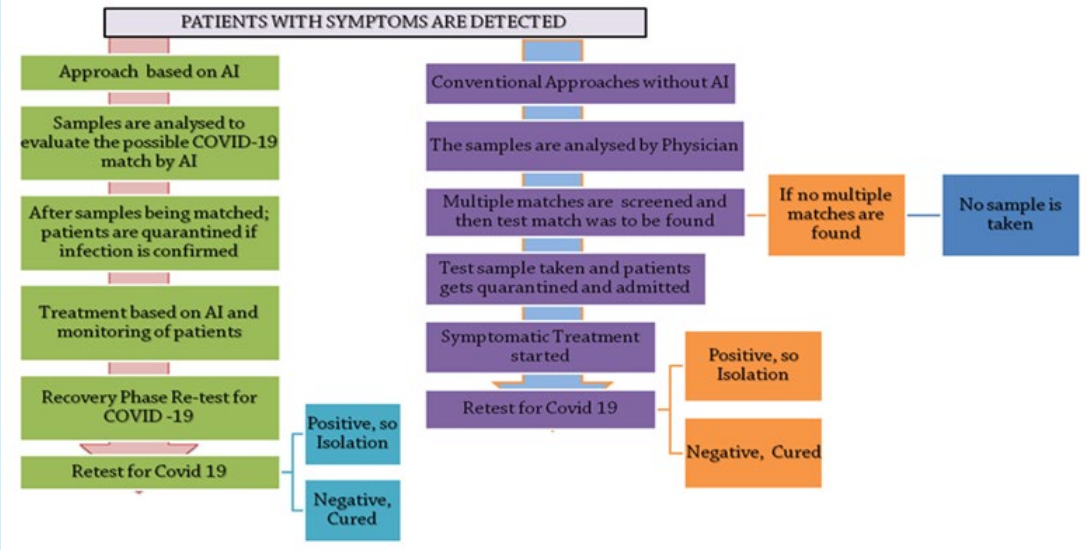

Figure 1: A schematic representation of the general procedure which can be helpful to general physicians during the Covid-19.

The above figure 1 represents a flow diagram of Artificial based treatment and non- AI-based treatment which represents high accuracy and reduces complexity and the time taken for diagnosis. The AI application will allow the physician to not only control the disease but also help to focus on the treatment process. There is now an enormous amount of datasets related to coronavirus which can be leveraged with Artificial Intelligence (AI) to fight against the pandemic by establishing innovative approaches to contacting tracing of individuals, monitoring the patients, drug discovery, drug repurposing, vaccine development and reducing the burden on healthcare [2]. There is now a growing amount of coronavirus related datasets as well as published papers that must be leveraged along with artificial intelligence (AI) to fight this pandemic by driving news approaches to drug discovery, vaccine development, and public awareness. In the review, we will discuss the key areas about the application of AI and Machine learning (ML) which can address the challenges in clinical research, clinical trials in repurposing drugs to treat COVID-19, and the clinical trials for new drugs discovery.

The Significance of Artificial Intelligence

FDA approved drugs are on a declining spree due to adverse efficiency and reduced potential of potential compounds. The release of drugs with new molecular entities (NMEs) is declining to create a complex situation? Artificial Intelligence with computational drug designing provides a new way into a system-centric idea for R and D leading to future precise discovery [4]. AI has the potential to act in case of inefficiencies which occurs during the time of drug development thus minimising bias and human intervention in the process [5]. The scientists and the healthcare system have increasingly shown inclination on computer simulations to understand the pandemic situations in real-time. Further, computational scientists can construct a physical system in which virtually computerised model can take real-world data as input and prediction of assessment can be done based on the future evolution and severity of the Covid-19. These model predictions can be closely matched with model predictions and can thus empower the administrations to take local-specific decisions. AI aims to track the literature which has grown exponentially as the new updates in Corona Virus surfaces. It is observed in the website of NIH that tracks papers related to SARS-Cov-2 lists contain 28,000 articles [6]. To extract specific relevant literature which is driven by a combination of factors which includes the availability of a large collection of relevant papers, advancement in natural language processing (NLP) technology the AI and Machine learning tools can be utilised. The AI usually comprises of two methods A. Specific keywords in paper and analyse the text accordingly B. Deep neural networks a type of machine – learning method trained in collecting and recognizing information based on large data sets. The details of AI-based search engines which can track the latest on COVID-19 are listed in Table 4.

Applications of Artificial Intelligence

AI strategy can be implemented in several ways to quickly access the pandemic on a real-time basis which can be more accurately involved in treating patients. The applications of Artificial Intelligence in different arenas are listed in figure 2 and the schematic with the applications of Machine Learning is shown in figure 3.

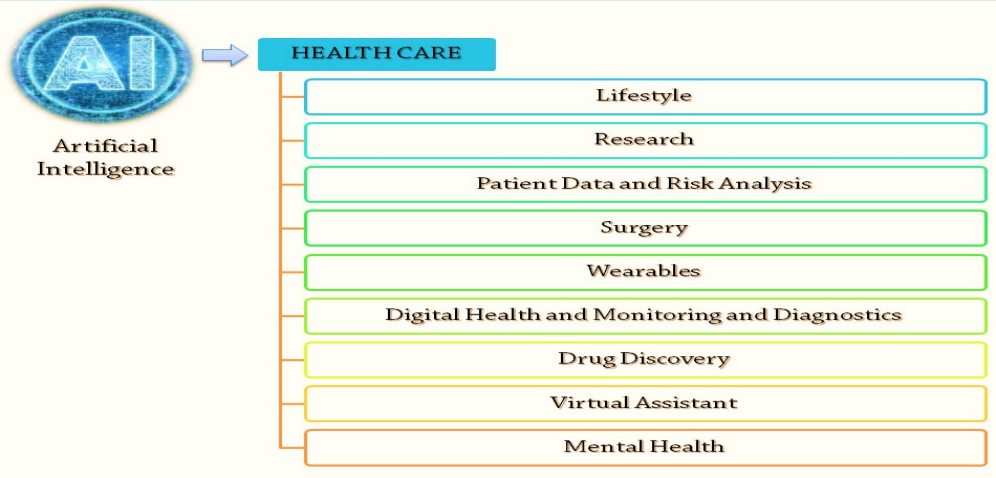

Figure 2: Representation of applications of artificial intelligence in different arenas.

AI can be used in quick detection of potential drug discovery, planning, treatment on a clinical methodology and can be an evidence-based tool against COVID-19 [1].

The early detection and diagnosis during the infection

a. Tracing the contact of the individuals
b. Monitoring the treatment
c. Development of drugs and vaccines
d. Drug Repurposing

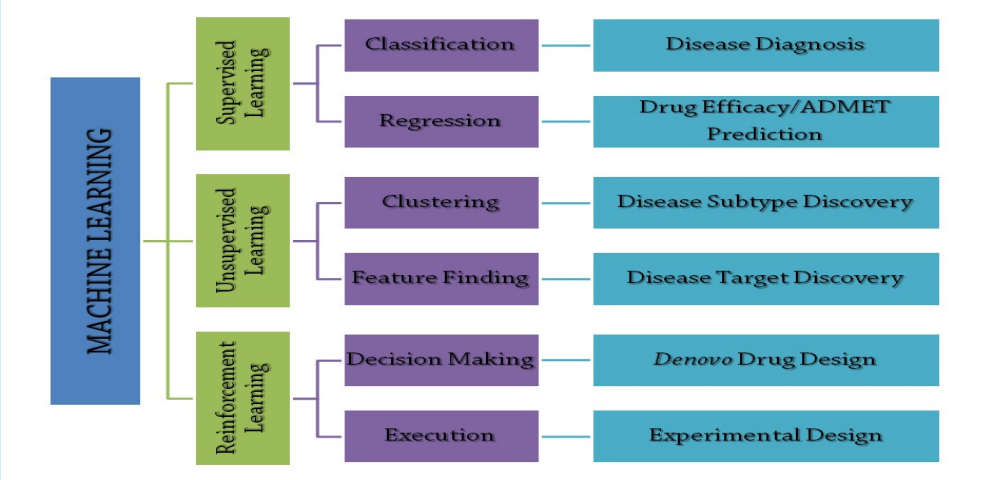

Figure 3: The schematic showing the applications of machine learning.

The Early Detection and Diagnosis During the Infection

AI can quickly analyse the symptoms based on irregular situations and thus can monitor the patients with the other healthcare authorities. AI can provide faster decision thus can be cost-effective. It gives a new diagnosis which can be managed effectively through proper algorithms. AI uses technologies viz., Computed tomography (CT), Magnetic Resonance Imaging (MRI) and scanning of the human body

[2].

Tracing the Contact of the Individuals

AI can construct a platform by using a neural network for the proper treatment of categorised affected individuals. This can be done by automatic monitoring and prediction by AI to limit the spread of the virus by tracing the contact of the individuals [2]. This can increase the updates as AI can process effectively heterogeneous data and its sources within a limited duration of time and can provide solutions in COVID-19. In AI machine learning (ML) and deep learning (DL) are two important approaches. AI-powered temperature screening has been deployed in public locations during the pandemic in China. Further, AI-powered smartphones application is developed to track the geographical scale of COVID-19 these kinds of apps can be targeted to understand the population and communities which are susceptible and thus will envisage us with real-time dissemination of information about the potential hotspots in real-time. This is significant to identify and isolate rapid transmission which can flatten the transmission curve [7]. AI and big data can be leveraged upon to develop robust and predictive models eg. Deep convolution network model was adopted to classify X-ray images into normal, pneumonia and COVID-19 [8]. Apps developed for contact tracing in various countries is given in Table 1.

S. No.	Apps used for contact tracing	Location Tracking	Launch On	Country
1	COVIDSafe	BlueTrace protocol: Bluetooth	14-Apr-20	Australia
2	Stopp Corona	Bluetooth, Google/Apple	Mar-20	Austria
3	ViruSafe	GSM	May-20	Bulgaria
4	BeAware Bahrain	Bluetooth, GSM	31-Mar-20	Bahrain
5	CovTracer	GPS, GSM	May-20	Cyprus
6	CoronApp	GPS	12-Apr-20	Colombia
7	eRouška (eFacemask)	BlueTrace protocol: Bluetooth	15-Apr-20	Czech Republic
8	Estonia's App	Google/Apple, DP-3T, Bluetooth	Apr-20	Estonia
9	Ketju	DP-3T, Bluetooth	May, 2020	Finland
10	StopCovid	Bluetooth	May-20	France
11	CoronaApp	Bluetooth, Google/Apple	May-20	Germany
12	GH Covid-19 Tracker App	GPS	12-Apr-20	Ghana
13	VirusRadar	Bluetooth	13-May-20	Hungary
14	Ranking C-19	GPS	Apr-20	Iceland
15	Aarogya Setu	Bluetooth & location-generated social graph	2-Apr-20	India
16	Mask.ir	GSM	May-20	Iran
17	HSE Covid-19 App	Bluetooth, Google/Apple	May-20	Ireland
18	HaMagen	Standard location APIs	Mar-20	Israel
19	Immuni	Bluetooth, Google/Apple	May-20	Italy
20	AMAN App	GPS	May-20	Jordan
21	Apturi COVID	Bluetooth	29-May-20	Latvia
22	MyTrace	Bluetooth, Google/Apple	3-May-20	Malaysia
23	CovidRadar	Bluetooth	May-20	Mexico
24	NZ COVID Tracer	Contact details and physical address	20-May-20	New Zealand
25	StopKorona	Bluetooth	13-Apr-20	North Macedonia
26	Smittestopp	Bluetooth and GSM	16-Apr-20	Norway
27	ProteGO	Bluetooth	May-20	Poland

28	Ehteraz	Bluetooth and GSM	May-20	Qatar
29	Corona Map	Bluetooth	3-Apr-20	Saudi Arabia
30	TraceTogether	BlueTrace protocol, Bluetooth	20-Mar-20	Singapore
31	Non-app-based	Mobile device tracking data and card transaction data	May-20	South Korea
32	SwissCovid	DP-3T protocol, Bluetooth, Google/Apple	20-May-20	Switzerland
33	Hayat Eve Sigar	Bluetooth, GSM	April, 2020	Turkey
34	TraceCovid	Bluetooth	May-20	UAE
35	NHS Covid-19 App	Bluetooth,	May-20	UK

Table 1: Apps for Contact Tracing Used in Various Countries.

Monitoring the Treatment

Diagnosis in the quick process helps to screen pandemic diseases like COVID-19. Thus, monitoring is a significant part of the transmission of disease in a cost-effective manner. AI and ML can augment the diagnosis and screen the process for identification of a patient with radio imaging technology akin to Computed Tomography (CT), X-ray, and clinical samples of blood. Prior literature studies of ML with the use of the convolutional neural network (Resnet-101) as an adjuvant tool on 1020 CT images of 108 Covid-19 infected patients along with viral pneumonia of 86 patients, which resulted in 86.27%, 83.33% of accuracy and specificity respectively [9]. The potentiality of AI and ML tools can be explored thus suggesting new models which can rapidly validate a method for SARS-CoV-2 by using a deep convolutional network. These models can process large heterogeneous data to create inter and intra layers of operability in systems to handle predictable tasks [10]. In prior literature, researchers have employed support vector machines to determine clinical, laboratory features and demographic information of patients to build classification model [11].

Development of Drugs and Vaccines

In the US for treating Ebola antiviral drug was developed. This discovery was actively done in 2014 by AI, ML-based pharmacophore computational analysing on a limited size of invitro infected carriers of the Ebola virus. Nevertheless, this led to the uncovering of drug development based on AI and ML technology fusion which utilised computational screening with docking application [12]. As the coronavirus has become pandemic AI and ML technology constitutes to be enthralling. It is seen from prior literature in Taiwan a new model has been developed to augment the development of a novel drug. Using AI and ML technology utilised deep neural network eight drugs viz., Gemcitabine, Clofazimine, Vismodegib, Celecoxib, Brequinar, Conivaptan, Tolcapone, Bedaquiline that were found to be effective in infectious feline peritonitis coronavirus [12]. Further, there are drugs viz., Homoharringtonine, Salinomycin Tilorone, Chloroquine and Boceprevir which are found to be operational during various AI experiments [13]. Prior literature studies revealed that in the US and South Korea a molecule transformer-drug target interaction model was proposed which can treat the Covid-19. This study was organized by virtual screening and molecular docking by AutoDock Vina which employed a deep learning algorithm with the proposed model on 3C like proteinase. And also, further FDA approved 3,410 existing drugs which are available in the market of Covid-19. These findings resulted in antiretroviral drug which can be used to treat HIV led Antazanavir followed by Remidisivir [12]. According to prior literature, in 2019 clinical trial on AI-based flu vaccine was sponsored by the National Institute of Allergy and Infectious Diseases. The vaccine was developed by scientists at Flinders University first using AI programme which generated trillions of synthetic compounds. Further, they used the AI program known as Search Algorithm for Ligands (SAM) which screen trillions of compounds to determine good candidates as vaccine adjuvants. This whole process of AI and ML technology can vividly shorten the process of vaccine development. Using CORD-19 dataset AI algorithms can be trained to build a model to screen existing drugs which can have potential efficacy towards the treatment of COVID-19 [14]. The process of drug discovery to market is represented in figure 4.

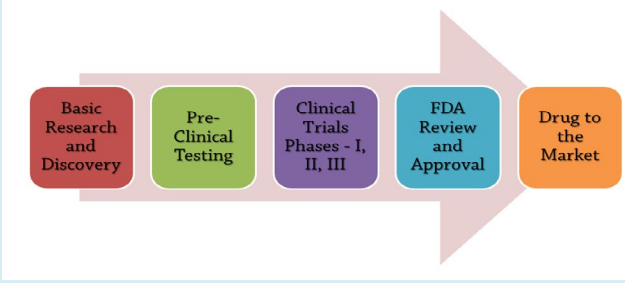

Figure 4: Representation from the process of drug discovery to market.

Drug Repurposing

A new drug discovery and development process take a sustainable amount of time before it is released in the market. The below table shows the process of drug development (Table 2).

The process of Drug Discovery	Cost (%)	Time in Years	The population used for testing	Rate of Success
Discovery of the target	4	2.5	Studies in Laboratory and Animals	Compounds of 5000 evaluated
Generation of Lead Compounds and Optimization	15	3		
Development at Preclinical stages	10	1	-	-
Clinical Trials at I, II and III Phases	68	7	-	5 enters trial out of which 1 will be approved
Phase I	-	1.5	20-100 healthy volunteers	
Phase II	-	2	100-500 patient volunteers	
Phase III	-	3.5	1000-5000 patient volunteers	
Review and FDA Approval	3	1.5	-	-
Marketing of the drugs	$880	15	-	-

Table 2: Various Stages of Development of a Drug before Marketing in the Countries.

According to prior literature reports, it is observed that the discovery of drug is a lengthy and expensive process, and prone to several trials which takes time to come to the market [15,16]. A new molecular drug entity takes 10-15 years to develop thus the success rate is 2.01% [1]. As, the development of a drug is lengthy, high-priced during clinical trials and it has to undergo regulatory authorizations to get released in the market as potential drugs, it is quick to repurpose already approved drugs for active treatments of COVID-19 patients. Drug repurposing is a technique where old drugs are modified and the therapeutics entity of the repurposed drugs are utilised for the treatment [17]. With AI, the new drug can directly enter into phase II trials without passing phase I clinical trials which becomes economic leveraging with time and toxicity testing repeatedly. A deep learning-based drug target interaction model was developed known as Molecular Transformer -Drug Target Interaction (MT-DTI) by Natural Language Processing based on an algorithm. Thus, in COVID-19 it was used to recognize those drugs which can act on viral proteins [18]. Prior studies drug-target interaction datasets suggested good performance and robust results. In studies of Li et al. proposed [19] a novel network for the repurposing of a drug to treat COVID-19. The genomic sequence of COVID-19 was first analysed and through the pipeline of AutoSeed 34 genes related to COVID-19 was identified. These obtained genes are then used as seeds to build the network [19]. Repositioning of the drug is significant as the repurposed drugs can be directly used in clinical trials which minimize the initial steps of manufacturing thus lowering the costs. Thus, based on the time factor and potential treatments repurposing of the approved drugs for the treatment during COVID-19 can show directions in the faster treatment process [1]. In prior studies, a machine learning model was developed to discover antibodies through high throughput screening of antibodies that inhibits COVID-19. 18 antibodies are found to be very effective with this model. Molecular Dynamics simulation was used to predict 8 stable antibodies [20]. Prior literature of Rapaport and Rapaport in 2004 suggested the stability of predicted antibody was checked by molecular dynamics simulation and found 8 stable antibodies which could neutralize COVID-19. So, here in this context for viral infection, we can use Chloroquine (CQ) and Hydroxyl analogue Hydroxychloroquine (HCQ) which have already shown it effective treatment as an antimalarial drug [21]. Likewise, antiviral drug Remdesivir which is mainly used in the Ebola virus treatment has already been exposed to market against the new treatment of COVID -19 [22]. Drugs viz., Lopinavir and Ritonavir can be administered for COVID-19 treating patients. These drugs mainly affect proteolysis in the replication cycle of corona [23]. An analogue of ribonucleic and inhibitor of RNA polymerization Ribavirin drug in the preclinical study has shown in-vitro activity against SARS-COV 2 [24]. Moreover, an immunosuppressive drug Tocilizumab, mainly deployed for rheumatoid arthritis which decreases the clinical symptoms of virus infection was used in the treatment of patients in vivo during COVID-19 pandemic in China [25]. Nevertheless, antiviral drugs mixed

with Ascorbic acid (Vitamin C) additionally can be supportive in the treatment of patients of COVID-19 patients. In future studies associated with repurposing a drug in this line against COVID-19 can be suggested [26]. List of companies which use AI for Drug discovery and repurposing is given in Table 3.

S. No.	Name of the Company	AI in drug repurposing	Ref.
1	Innoplexus	The Indo-German company utilized patients' information to treatments during Covid-19 viz., Remdesivir Hydroxychloroquine	[27,28]
2	Deargen	The Korean company with Dankook University at AI stage has recommended Atazanavir (A medication for HIV treatment) to increase the power of activity in treatment.	[29]
3	Gero	The Singaporean organization anticipated having adequacy of 9 medications using AI which includes - niclosamide and nitazoxanide being hostile to viral and parasitic medications	[30]
4	Cyclica	The organization based in Canada screened 6,700 atoms in preliminary Human Phase I on their AI-based medication repurposing stage Match Maker. They are also working with China's Institute of Materia Medica for evaluating in vitro and in vivo samples	[28]
5	Healx	This organization based in the UK is using the information to find out the rate of mortality which found higher with comorbidities of respiratory and heart frameworks. Also, this organization is working on uncommon infections and is trying to reveal bi and tri mixes of affirmed drugs against infection	[31]
6	VantAI	This organization based in New York recognizes drugs which can obstruct the infection's movement in Golgi contraption and is presently screening around 300 leads with a CRO to prevent viral contamination further	[32]
7	Benevolent AI	The UK based organization is employing AI techniques to repurpose the drugs against coronavirus	[33,34]
8	Exscientia	Spin-out from the University of Dundee (U.K) and it collaborates with many companies to successfully apply AI in small molecule for drug discovery. Further, it is heading to study mechanism and functioning of SARS-CoV-2 by data modelling through AI	[35]
9	Berg	In clinical-stage, an artificial intelligence-powered biotech company which leverages its platform to map disease and revolutionize treatments across oncology, neurology and rare diseases	[36]
10	In silico Medicine	A Hong-Kong based company which came up with seven molecules out of which two molecules are synthesized for testing against COVID-19	[4]
11	Iktos and SRI international	France-based AI firm Iktos teamed up with SRI Biosciences (US) and work with new potent molecules to synthesize and test the molecules in their synthetic chemistry laboratory	[4]

Table 3: List of Companies Which Use AI for Drug Discovery and Repurposing.

S. No.	Search Engine	Function	Developed by	Ref.
1	COVID Scholar	Literature Search for COVID-19 which uses AI to tag papers with keywords and topic labels and filters	Lawrence Berkeley National Lab	[37]
2	SPIKE-CORD	AI is used to retrieve the papers on extract information by a simple query language	Allen Institute for AI and Bar-Ilan University	[38]
3	COVID-19 Open Research Dataset (CORD-19)	AI is used to data mining for the COVID-19 literature	White House Office of Science and Technology Policy	[39]
4	COVID-19 KnetMiner	AI visualises linked human biological data related to SARS-CoV-2 and GWAS data	Rothamsted Research, Harpenden, UK	[40]
5	COVID-19 Portfolio	AI tools use this a website that tracks papers related to the SARS-CoV-2 coronavirus	National Institutes of Health (NIH)	[41]
6	COVID-19 Research Explorer	A semantic search interface with AI-powered tool which helps researcher and scientists to efficiently search articles to answer COVID-19 related questions	Google	[42]
7	COVID-19 PRIMER	Uses the most advanced NLP algorithms, which trends the latest research in COVID-19, conversations around them and updates within 24 hours	PRIMER	[43]
8	Vilokana	Based on artificial intelligence it's a deep semantic search which enables researchers to get deeper insights into scientific studies on Covid-19	Indian Institute of Information Technology and Management – Kerala	[44]
9	SciSight	Search tool based on AI to visualize the emerging literature network around COVID-19	Allen Institute of AI	[45]

Table 4: Details about the AI-Based Search Engines Which Can Track the Latest on COVID-19.

Conclusion

With the existence of pandemic SARS-COVID-19, there is a hike in coronavirus related datasets which drives new approaches to fight against the virus. AI, ML, can leverage this situation through its applications in various public awareness, early detection and diagnosis during the infection, contact tracing, monitoring the treatment, drug discovery and vaccine development. AI can be powered to screen trillions of compounds and establish models to predict for rapid diagnosis and treatment. For this, pharmaceutical companies and science laboratories can cooperate to work with industry leaders such as Google and IBM to create powerful AI tools to search good published papers and to predict drugs which can be clinically tested further. Further, during this panic situation chatbots can be created through AI tools to disseminate the information related to COVID-19 thus minimizing the spread of false information and interpretation related to COVID-19. In the paper we have discussed how patients can be diagnosed, contact traced, monitored and drugs and vaccines can be developed with AI-based approaches. The usage of emerging technologies with integrative medicines with AI could accelerate the revival of the pandemic situation in a manageable way.

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