How Artificial Intelligence can fight Coronavirus

Mohammad Hijjawi

Computer Science department, Applied Science Private University
Email: hijjawi@asu.edu.jo

Published: 30 January 2021

Abstract
The world started the 2020 year with a big pandemic came from china, which is covid-19. This pandemic caused by the coronavirus that is spreading quickly from china to the whole world. This spreading does not affect only the human health. Rather, it affects all the human life activities from business, education, travelling, jobs and even the social activities. This paper illustrates how Artificial Intelligence can fight this virus and help people to live comfortably and safely. The pandemic is not end and it seems will not end soon as it is might needs years. Therefore, the artificial intelligence with all disciplines should enter this war to reduce the pandemic period. AI can play important roles in all sectors, works remotely, educate remotely, find new jobs, open new markets and socially. Artificial Intelligence contributed significantly in this war (Covid-19 spreading) and this appeared in this paper in a novel illustration and structure. The paper uses the systematic approach to utilize showing the effects of Artificial Intelligence of fighting the Coronavirus.

Keywords—artificial intelligence, coronavirus and covid-19

I. INTRODUCTION

At the end of December 2019, the WHO(World Health Organization) office in China was notified by unknown pneumonia etiology cases detected in Wuhan city. From end of December until the third of January 2020, the pneumonia unknown etiology cases has been raised to 44 cases and reported to the WHO by the national authorities in China [1]. After only several days in January, 282 confirmed cases has been reported from 4 countries; China with 278 cases, Thailand with 2 cases, Japan and Republic of Korea has 1 case each [1]. As the days pass, the cases has been raised to be 75,465 cases were reported in China only [2]. Despite intense research efforts, where, how and when new cases appear are still vague [3].

Phylogenetic analysis of the viral genome discovered that the virus was most closely related (89.1% nucleotide similarity) to a group of SARS(Severe Acute Respiratory Syndrome) coronaviruses that had previously been found in bats in China [4]. This highlights the ability of viral spreading from animals to cause severe disease in humans [4]. Emerging infectious diseases, such as SARS and Zika virus disease, present a threat to human health [5]. The scientist gives the virus the name COVID-19 for affected people after infected with SARS-CoV-2, the new version of coronavirus discovered in 2019 [6]. From an academic perspective, the CoV can be classified into four classes, namely Alphacoronaviruses, Betacoronaviruses, Gammacoronaviruses, and Deltacoronaviruses. The alphacoronaviruses and betacoronaviruses are usually found in mammals, while the gammacoronaviruses and deltacoronaviruses are mainly associated with birds. [7]

SARS-CoV is the causative agent of the SARS outbreak that occurred in 2002. This SARS resulted in 800 deaths and approximately 8000 cases of infection worldwide [8]. SARS-CoV belongs to the Betacoronavirus genus, and its genomic sequence exhibits low levels of similarity with the previously identified human CoVs-OC43 and 229E. Thus, the scientist hypothesized that SARS-CoV suffered a long evolutionary process. [8]

A huge number of researchers and research centers are racing to discover the suitable vaccine to kill the virus and, unfortunately, until now no one reach it. Until the time anybody reach it, the countries has to protect their people, so they start several procedures from different perspectives and general guidance to be applied on citizens to avoid virus affecting. According to [6] , number of prevention measures recommended by WHO distributed to all countries such as Washing hands frequently with soap for at least 20 seconds, cleaning hands using a hand sanitizer that contains alcohol with concentration at least 60%. Frequently cleaning the toilets, touched surfaces and objects like telephones and keyboards that might be the main virus carriers. Be sure that you and people around you practicing respiratory hygiene by covering their mouth and nose with mask or at least using tissue when coughing or sneezing. Avoiding touching your eyes, mouth and nose as the hands can transfer the virus. Applying social distancing with at least 2 meters distance and avoiding close contact with people and avoid crowds. Stay at home if you feel unwell or your age is over 60 years. All of these recommendations are a precaution steps in order to minimize the risk of the virus exposure.

When the coronavirus has been spread in a terrible way, many countries applied the lockdown step to slowing the spread of coronavirus around the globe as an available effective measure [9]. However, until the time of writing this paper, the total number of coronavirus cases reached 6,774,539 with 395,603 cases deaths and recovered people with 3,302,761 [10]. As mentioned, coronavirus has forced several countries to implement lockdown procedures from country-based quarantines, borders closure, stop working in all sectors inside the country and even universities and schools closures. It becomes very hard to manage as more than half of the planet's population is forced by their governments to be in lockdown with the strictest measures possible to contain it [9, 11, 12]. These procedures affects the human being life from all perspectives especially from health and economy. Scientists until now trying to solve the health part problem and the scientists and governments tries to find solutions at least for the economy part and to facilitate and adapt the human life with this pandemic.

The planet is facing global health crisis (COVID-19) unlike any in the 75-year history of the United Nations. However, this crisis is more than a health crisis, it is a human crisis as it attacking societies at their core [13]

The pandemic and the billions of human suffering will not end soon as the WHO said, we have to “change our behaviours for the foreseeable future" [14]. This guidance is synchronized with cases falling so we are far from the end possibly years [15]. The countries needs an exit strategy (way to lift restrictions and getting back to normal) [15] but if we lift the restrictions now, the virus will back. According to [15], no country has an clear exit strategy. The needed exit strategy is crucial not for human health only by for people and country economy in order to keep living with normal economic life. The coronavirus pandemic has major economic disruption with businesses closing and human suffering by lifting jobs [16]

The annual global GDP (Gross Domestic Product) is predictable to drop to 2.4% as a whole from an weak in 2019 by 2.9% as it was the lowest since the global financial crisis 2008/2009 [16]. So, governments should works forcefully and swiftly to overcome the coronavirus and its economic impact [16].
Figure 1 shows how the coronavirus affects the stock markets since the start of the outbreak where shares in companies are bought and sold, and it can affect the value of pensions or individual savings accounts [17]

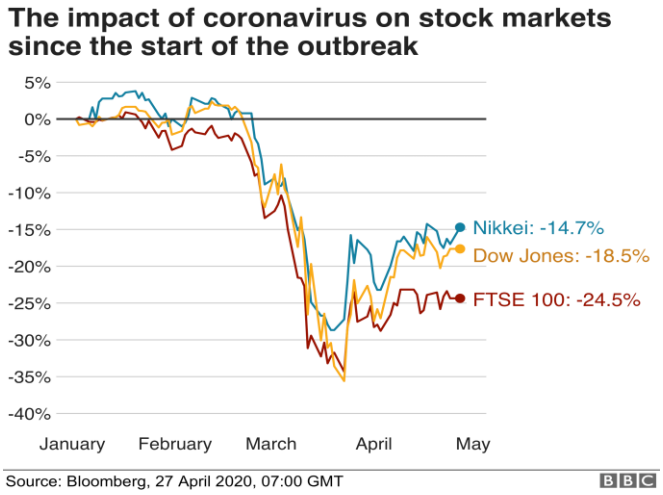

Figure 1: Coronavirus vs. stock market [17].

In the United States, around 30 millions of people is filling for unemployment, which indicates for disaster in one of the world's largest economies as shown in figure 2 [17].

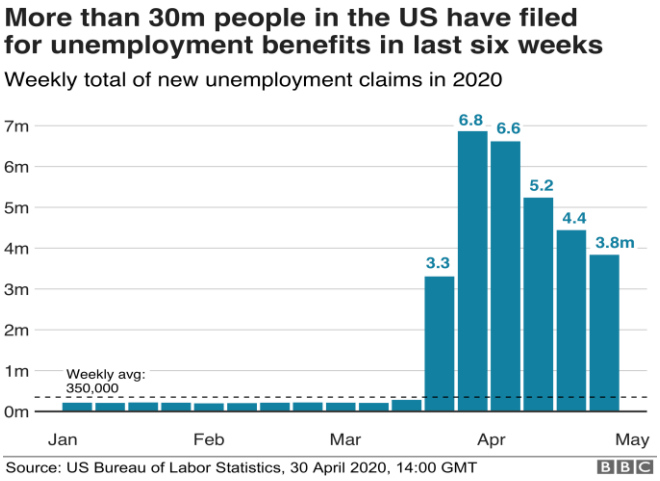

Figure 2: Number of unemployment in US.

The people worldwide could lose between 5-25 million jobs which it estimated by 860 USD billion to 3,4 USD trillion. The hardest suffering is in the small to medium enterprises, the self-employed, and daily wage earners [13].

Many of businesses has not only affected but also damaged like the travel and tourism industries as most of countries closes the boarders and cancelling trips and cutting the airlines to contain the virus and controlling its spreading as shown in Figure 3. Travel restrictions and cities lockdown have caused in a significant reduction in demand and supply.

Figure 3: coronavirus spreading areas worldwide [13].

Generally, the coronavirus pandemic is affecting everything in our life, the most vulnerable, including children, women, and the elderly and generally affecting the informal workers. It is affecting all the 17 SDGs (Sustainable Development Goals). The SDGs adopted by all United Nations Members in 2015 as a universal request to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030 [18].

The most negatively affected SDGs are poverty, zero hunger, good health, quality education, economic growth, industry, sustainable communities, peace and justice. The most positively affected SDG is the climate action and environment as most pollutants from factories are significantly reduced for a meanwhile. However, when those factories return to work with their full productivity power, this SDG will be affected negatively as well. Figure 4 shows the covid-19 pandemic SDGs affecting.

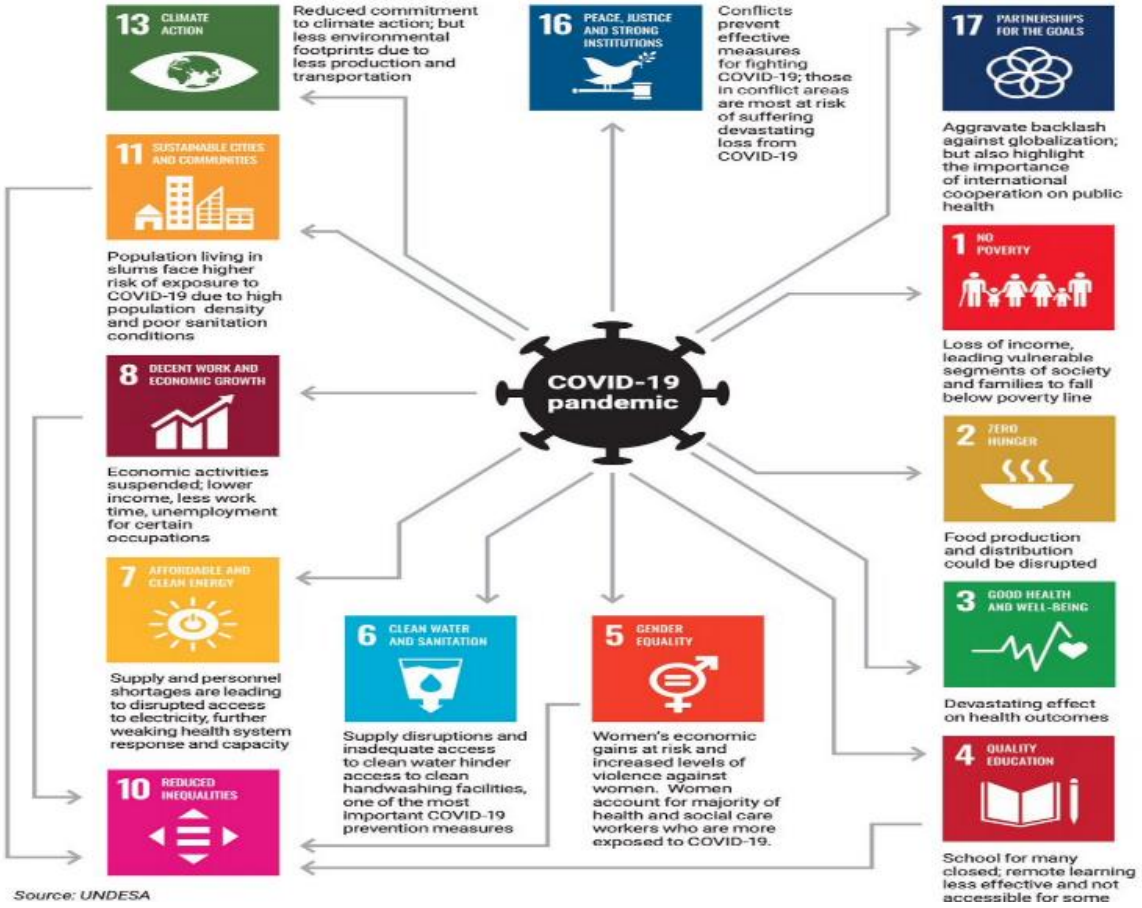

Figure 4: COVID-19 AFFECTING ALL SDGS [18].

To reduce the pandemic economic impact on both businesses and employees, all governments have urged them to work from home if possible. This transformation of work nature might uses technology to handle it. Accordingly, the businesses are categorized into three main categories which are; the winners, the losers and the in-between [19].

The winners businesses who benefit from the pandemic:

- Ecommerce marketplaces: because of lockdown, people are shopping online; amazon has increased its revenue doubly and offered thousands of new jobs to meet the extra demand.
- **Pharmaceuticals/medical supplies:** they are playing a big role in the crisis which working on a vaccine, treatment drug and testing kits.
- **Logistics/delivery:** people cannot leaving their homes, so products and services should be delivered. In Wuhan, in only 9 days, the Cainiao shipped more than 5 million medical products.
- **Video conferencing:** all meetings and lectures are switch to use video conferencing tools such as Zoom, Webex, skype and Teams. The sales and share price of all of these companies are massively increased as shown in figure 5.
- **Entertainment streaming and gaming:** platforms such as Netflix, Disney+ and gaming platforms report increasing of demand as the people generally stayed at home.

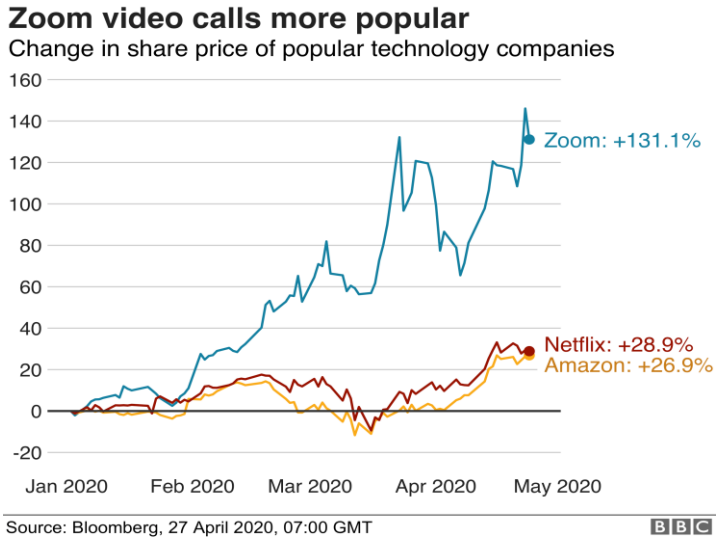

Figure 5: Zoom share price [17].

The losers businesses who loss/damaged from the pandemic:

- **Airlines, trains and cruise ships:** because of countries compulsory closure, most of airports has been closed and stopping the trips causing trillions losses.
- **Tourism:** This industry loss billions according to countries closure and even inside the same country no one can move from city to city. The losses multiplied as the pandemic is extended to cover the whole tourism season.
- **Oil and gas:** at the time of writing, the barrel of crude oil sold for 23 USD where in the beginning of 2020 was 67 USD.
- **Traditional retail:** with people staying at home, no one can go out to buy something from a traditional store.
- **Professional sports and entertainment:** most countries has cancelled all sporting events and stopped entertainment places.
- **Cinemas:** the film industry is facing 5 USD billion loss as analysts predicts.

The in-between businesses who might adapt partially with the pandemic:

- **Banking:** the people struggling to pay back loans but some banks has a good financial capability to sustain and offered emergency loans.
- **Manufacturing:** many manufactures struggled with selling their products as no longer in demand. However, other many manufactures were quickly moved to open new lines to handle other products in demand such as surgical masks and hand sanitisers
- **Education:** most of schools, universities and training centers have closed their doors but not their operations as they move their students to the online platforms. This moving might reduce their income by offering special discounts/prices but at least they are still a live economically.

All countries using science and technology to propose policies to significantly alleviate the impact of the COVID-19 in this chaotic and unprecedented time.

Many scientist and medical research centers are rushing to produce drugs/medicines to treat infected patients while others are attempting to explore vaccines to stop the virus [20]. On the other hand, computer science researchers are rushing to analyse the patients' medical data and images to early detect the infectious cases

[20]. In addition, scientists using the technology with this pandemic. For instance, using robots to deliver food and medicine to coronavirus patients in hospitals. Using drones to disinfect public spaces and streets [20]. The Baidu(Chinese digital firm) launched a Fight Pneumonia mobile application that help the people to get accurate information about the pandemic in real time. In addition, it also offering free online medical advice portal in order to enable doctors to reply to millions of medical inquiries. Moreover, the Baidu released an intelligent healthcare application that simulate automatic responses for people questions through what's called conversational agents (chatbots). All of these techniques and more uses Artificial Intelligence (AI) which has been applied significantly to help people and industries in this pandemic.

Artificial Intelligence and Health

Generally, computer programs can help people to perform all of their tasks even in their social life [21]. The term intelligence refers to the ability to acquire and apply different knowledge and skills to solve a specific problem. On the other hand, the intelligence is "The ability to use memory, knowledge, experience, understanding, reasoning, imagination and judgement in order to solve problems and adapt to new situations." [22]. In addition, the Intelligence can be integrated with various cognitive functions such as; language, planning, attention, perception and memory [23] . Where Artificial Intelligence (AI) is a branch from computer science and it is concerned of how we can make machine thinks and reasoning like humans and how it can imitate human intelligence. AI has been established more than seventy years ago with simple tests like Turing test [24]. From that time and AI has been progressing rapidly with nonstop affecting sectors. In other words, no sector cannot be beneficial from the AI such as medical, business, e-business, banks, education, entertainment, media, electronic social media and much more [25]. This paper will focuses only on using the AI in business and health sectors.

Artificial intelligence in healthcare can be applied in different domains (in software production or hardware manufacturing) or can be defined from different perspectives according the use of it. For instance, AI can be the using of complex algorithms/software to emulate human perception in the analysis of complicated medical data. AI is the core engine in any smart medical-based machine such as diagnosis medical machines or robot doctors. Generally, AI used in health sector for number of purposes such as disease detection, health services delivery, drug discovery and management of chronic conditions [26].

One of the primary aims of using AI in health is to analyse relationships among treatment practices and patient outcomes [27]. In addition, AI can be used to analyse and recognise patterns in complex/huge datasets in a fast and accurate maner than the previous used methods [28]

Researchers embed AI to develop smart robot called Eve to make the process of drug discovery faster and cheaper [29]. Other embedding domains for AI in health is in medical imaging/scans that analyse images and discover more accurate useful information from these images in less time. AI has shown encouraging results in detecting conditions such as pneumonia, breast cancer and eye diseases [30]**.** Moreover, in surgery, robotic tools which controlled by AI can be used in many tasks like close wounds and tying knots [31].

This wide range of developing AI techniques in such an important sector, let the big technology companies to invest researching in it such as Google, Microsoft and IBM [26]. Not only the big companies, but also, number of AI based start-up companies has been set up a collaboration with the health ministry in their countries. For instance, number of such companies has formed research partnerships with the UK NHS(National Health Service) providers, universities and hospitals in the UK such as IBM, Babylon Health, Ultromics and DeepMind [26].

II. How Artificial Intelligence can fight Corona virus:

As discussed, AI can play important roles in different areas and you can say in every area. Number of AI based projects has been developed to fight the first global public health crisis of 21st century; namely COVID-19 [32]. This fighting has been made in different domains such as medical and hospital care, pharmacology and mobility [32].

AI may interact and contribute in a wide range of applications and can be listed as follows [19]:

Processing of medical data

The authors in [33] invites three Chinese and four U.S. radiologists to distinguish COVID-19 from many other viral pneumonia types relying on chest CT scan images from a study group that consisted of 424 cases, in which 205 cases are non-COVID-19 pneumonia in the US, whereas 219 cases tested positive to COVID-19 in China. The results indicated that the radiologist scan can provide great accuracy (referring to the number of confirmed positive cases) in identifying COVID-19 from other issues related to viral pneumonia using chest CT medical images. On the other hand, their efficiency with regard to specificity (referring to the number of confirmed negative cases) is relatively conservative for the same task. AI approaches particularly deep learning have been used to collect and interpret medical imaging data to help radiologists and healthcare providers to enhance diagnostic efficiency. Similarly, numerous studies have been conducted based on the automatic detection of COVID-19 using deep learning.

Pneumonia is among the leading lung diseases that can pose severe issues to all age ranges [34]. The proposed research in [34] aims to isolate and assess (COVID-19) using CT scans. The researchers suggest an image-assisted system that seeks to isolate Corona virus contaminated areas from lung CT scans (coronal view). This process is conducted as follows and depicted in Figure 6:

1- minimalist filtering to rule out potential entities from the lung area.
2- Improving Images utilizing Otsu thresholding and Harmony-Search Optimization.
3- Segmenting images to Identify contaminated area(s).
4- Extracting region-of-interest (ROI) attributes from binary image to determine damage level.

The ROI extracted attributes are used to determine the pixel ratio between the lung and infection areas, to recognize the infection extent.

The main focus of this system is not only to aid pulmonologists in diagnosis but to also determine the treatment plan. Accordingly, this will help in preventing diagnostic burdens for mass screening processing.

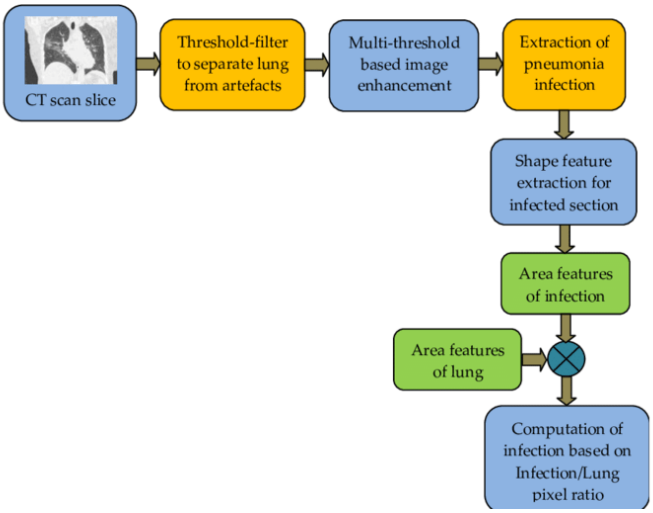

Figure 6: CT scan patterns detection [34].

Data Science

Data science refers to illustrate insights from big and complex data sets [35]. This includes organising, processing, analyzing and understanding the data. The phrase 'data science' covers the methods, processes and systems used to do this.

COVID-19 goes way beyond being a data science question, it grew to constitute a significant issue in public health which has caused many casualties, and is shedding light over how we are constructing our community in affairs such as healthcare accessibility and cost-effectiveness. Nonetheless, it is necessary to look at the matter from a data scientist point of view, as we have seen many data charts related to the current pandemic on different social media platforms. Some of these charts were reasonable and some were questionable, it is all a matter of data science awareness that the researchers hope to address and cater individuals' attention towards different types of data to figure out the right action to take.

The researchers in [36] suggest an AI-assisted approach to foresee the range, length and ending time of the Virus across the country, in an attempt to substitute epidemiological models for transmission dynamics of Covid-19. The researchers designed a modified stacked auto-encoder to illustrate epidemics transmission dynamics. This model was applied to predict real-time positive cases of Covid-19. Statistics are obtained from 11 January to 27 February 2020 by the World Health Organization. Latent variables were used in the auto-encoder and clustering algorithms to link cities in order to analyse the transmission structure. The researchers predicted the curves of total positive cases of Covid-19 throughout China from January 20, 2020, to April 20, 2020. Utilizing the multi-step foreseeing, the approximated average errors of 6-step, 7-step, 8-step, 9-step and 10-step were 1.64%, 2.27%, 2.14%, 2.08%, 0.73% respectively. The researchers estimated that the time points of the cities meeting the level of the expected dynamic transmission curves will vary, ranging from January 21 to April 19, 2020. The 34 cities were classified into 9 groups. They conclude to that the reliability of the AI-assisted models for predicting the Covid-19 spread rate was strong. They expected that the Covid-19 outbreak will be coming to an end by mid-April. In the event that the data is accurate and there are no subsequent transmissions, we can precisely estimate the transmission patterns of Covid-19 throughout the country. AI-assisted methods are a valuable resource to support public health strategies and policymaking.

In [37], Apart from the considerable safety precautions held by different authorities, further cases have been reported daily than those reported during the last period. Till now, healthcare providers have reported a number of corona virus-related variables in their regions; new cases, new deaths, active cases, recovered cases, amongst many others. Strategy To overcome the matter, the researchers used battery of parametric models such as: exponential regression, the Poisson model, the negative binomial model, the zero inflated model and the zero inflated negative binomial model to examine the dynamics of recent reported cases of COVID-19 registered in the 8 most impacted counties. Their results reveal that the new cases of COVID-19 China and South Korea are diminishing over time. This indicates that the transmission control steps have been efficient [38]. Moreover, the findings suggest a significant increase in the growing rate of new cases in all European countries. In addition, their findings indicate that there is an occurrence of not reporting confirmed cases, which lead to underestimating the true number of COVID-19 cases. This work propose that using more than a couple methods to attain reliable estimates of COVID-19 new cases. In fact , it is necessary to recognize non-reported cases to eliminate bias in assessing the total number of new patients.

Internet of Things

In this study [39] , both COVID-19 and methods of diagnose are examined in detail. Previous studies are examined and analyzed with respect to their approaches, starting from radiology to the latest technology available, including Clinical Detection Kit, CT Image reading System and AI tools.

Such methods have been proven to either lack precision, consume so much time, or being non-cost effective. Nevertheless, this paper suggests a new method to eliminate similar challenges. The proposed method focuses on the usage of smartphone measurement sensors that can be utilized by healthcare professionals when and wherever. Moreover, the suggested model could operate as an application on various smartphone platforms, as it does not need any external or supplementary sensors and offers better performance. The suggested model consists of four different layers(as depicted in Figure 7): input/reading sensors' measurements layer, sensors configuration layer, computing symptoms disease layer and predict the disease layer via using a combined machine learning technique. In addition, machine learning algorithm may be further enhanced in the final stages by utilizing transfer learning approach when the application has operated on the cloud. The model is more effective compared to other advanced techniques; this is because the model depends on multi-sensor readings related to the associated symptoms of the disease. The researchers aim to incorporate a platform developed for smartphones with the support of relevant companies including Google, Huawei, and Apple to launch the application rather easily in their online stores.

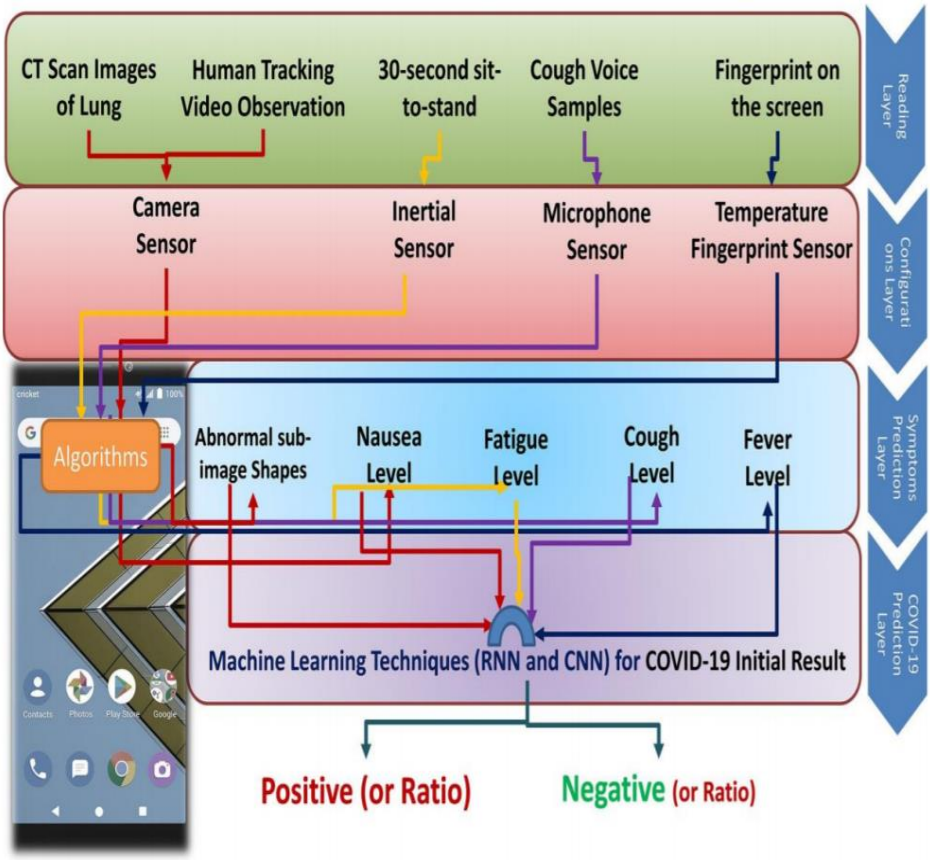

Figure 7: General diagram of the proposed framework for predicting disease COVID-19 [39].

Since COVID-19 is spreading and increasing its impact on neighbouring areas, extensive domestic and international measures are being taken to control the pandemic [40]. Subjecting cities to lock down profoundly impacts global economies at a multinational scale, both from social and economic terms. This is strongly highlighted as the virus is spreading rapidly in many nations and as international cooperation is

needed in several countries, contributing to a public health epidemic. Though there is focus on efficient mechanisms for the exchanging medical information, urban data, on the contrary, particularly the data related cities' health and safety, is often regarded from a territorial standpoint as serving only the country and its economic and political control. This study, written during epidemic, explores the pandemic from an urban perspective and promotes how smart city infrastructures can function for improving standardization procedures for excellent data exchange during crises, resulting in greater international understanding and management. As the world is getting ready to embrace the idea of a smart city and its associated technical mechanisms, such mechanisms need to be adjusted to guarantee that the living aspects, like the issues of public health, are sufficiently addressed. It is often is argued that the absence of standardization between smart city technology providers may cause miscommunication between cities and data platforms. This can and will lead to an unproductive system in such crisis, as early diagnosis and containment of viruses can progressively rely solely on the technical foundation of smart cities. Therefore, this study demonstrates the critical need to strive for standardization of protocols for improved smart city connectivity and the need to democratize the smart city infrastructure sector in order to promote competitiveness and efficiency among investors, hence creating more potential collaboration in the event of crisis [40].

Machine Learning

Generally, Machine Learning(ML) in disease is used to improve the accuracy of prediction for examination both infectious and non-infectious diseases [41, 42]. Early detection of any disease, is an important task for early treatment to save more lives [43]. The ML in Covid-19 pandemic has a core role in different detection and expectation areas. One of the main parameters for find a solution to deal with a new virus is through analyzing its replicative cycle at a molecular level. Therefore, building a coronavirus vaccine might require molecular inhibition of the replication of the coronavirus [44, 45]. ML has make fast existing drugs to repurpose for COVID-19 experimental trials [46].

Evaluating one billion small molecules for their ability to bind SARS-CoV2 proteins might take a decade on even supercomputers. However, having integrated ML into the simulations running on the supercomputers, which allows the programs to adapt to new information that gets uncovered as they run, thereby producing better results. In this case, lists of candidate small molecules much faster than traditional supercomputing methods. According to [47] “Discovering any new drug that can cure a disease is like finding a needle in a haystack,”. So, high-performance computing and AI can help accelerate this process by screening billions of chemical compounds quickly to find relevant drug research-based results. However, using Artificial intelligence in drug discovery is relatively new area. The biggest challenge is finding an unknown solution to a problem by using technologies that are still evolving and computing [47, 48].

Natural Language Processing

Using NLP(Natural Language Processing), we can monitor and better understand public concerns during the COVID-19 pandemic [49]. The latest NLP report covers the Covid-19 pandemic on the market volume, segmentation, elements, competitive landscape and trends [50]. A co-ed AI model for COVID-19 transmission ratio prediction in [51] is depicted in Figure 9. Which incorporates the epidemic susceptible infected software information model, NLP and deep learning methods. The SI model and its extension, i.e. susceptible infected recovered (SIR), are standard outbreak models for analysing and forecasting the progress of infectious diseases where (S) specifies the number of susceptible people, (I) represents the number of infected people and (R) denotes the number of recovered cases.

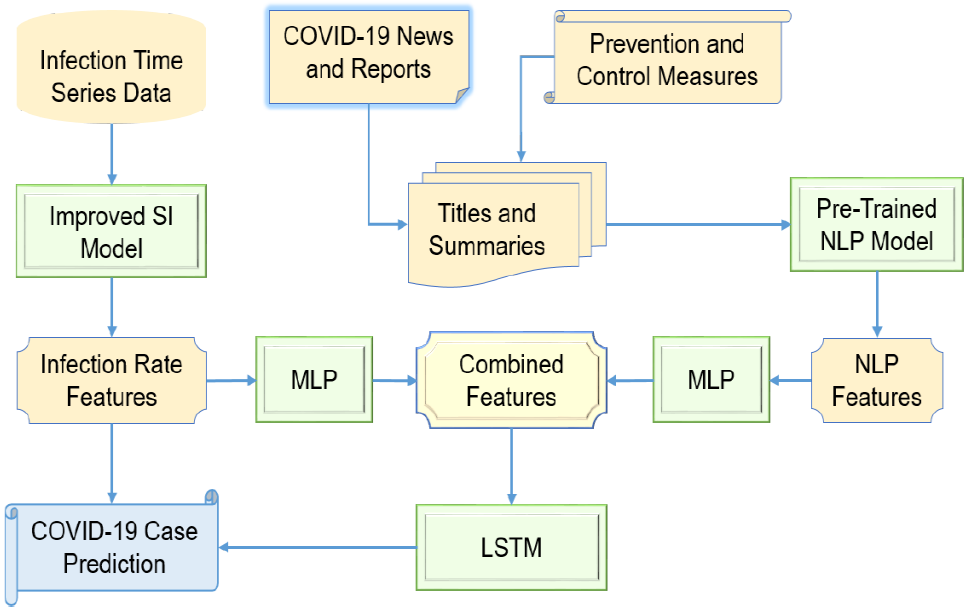

Figure 9: An AI-based approach to COVID-19 prediction that combines traditional epidemic SI model, NLP and machine learning tools [51].

This research [52] focuses on applying a CBR (Case Based Reasoning) framework for classifying COVID-19 cases as either positive or negative, including when the disease is at an early stage in the case in question. An NLP framework for extracting features from a presented case was formed and applied. The development of the model suggested in this paper underlies in the sentence-level extraction of the attribute-value pair for all the a-prior defined features. In addition, the case retrieval similarity metric applied to the CBR model proposed in this paper resulted in the system's intriguing efficiency. In the meantime, data presentation (database of cases preserved in the CBR) was accomplished in the suggested context using ontology-based knowledge formalization method. Moreover, recent cases have also been formalized utilizing ontologies in order to establish a homogenous framework for case comparisons. The obtained results indicated that our suggested approach has outshone advanced CBR studies with similar techniques to those in this research paper. Thereafter, the researchers plan to analyse the efficiency of our retrieval algorithm utilizing various similarity/distance measure metrics.

This will enable future studies employing ontologies and CBR paradigms to efficiently choose and perhaps incorporate similarity metrics. They also plan to hybridize the suggested model with the machine learning approaches that provide application classification algorithm such as SVM(support vector machine (SVM). The SVM is a machine learning model from the supervised type that uses classification algorithms for two-group classification problems. After giving an SVM model sets of labelled training data for each category, they're able to categorize new text.

Technological solutions to coexistence with Covid19

Wearable sensors to monitor, in real time, changes in body temperature through the use of open-source data platform to track the spread of the disease [53]. Some AI applications may also recognize false virus news by implementing machine-learning methods for filtering social media content, detecting terms that are exaggerated or disturbing, and determining which websites are considered to be authoritative for eliminating the so called "infodemic" [54].

AI applications such as the use of facial recognition to track people not wearing masks in public [55].

Chinese authorities are deploying drones to monitor public places [56], making thermal imaging or track violating quarantine rules [57]. Figure 10 illustrates some AI applications at different stages of the COVID-19 crisis [58].

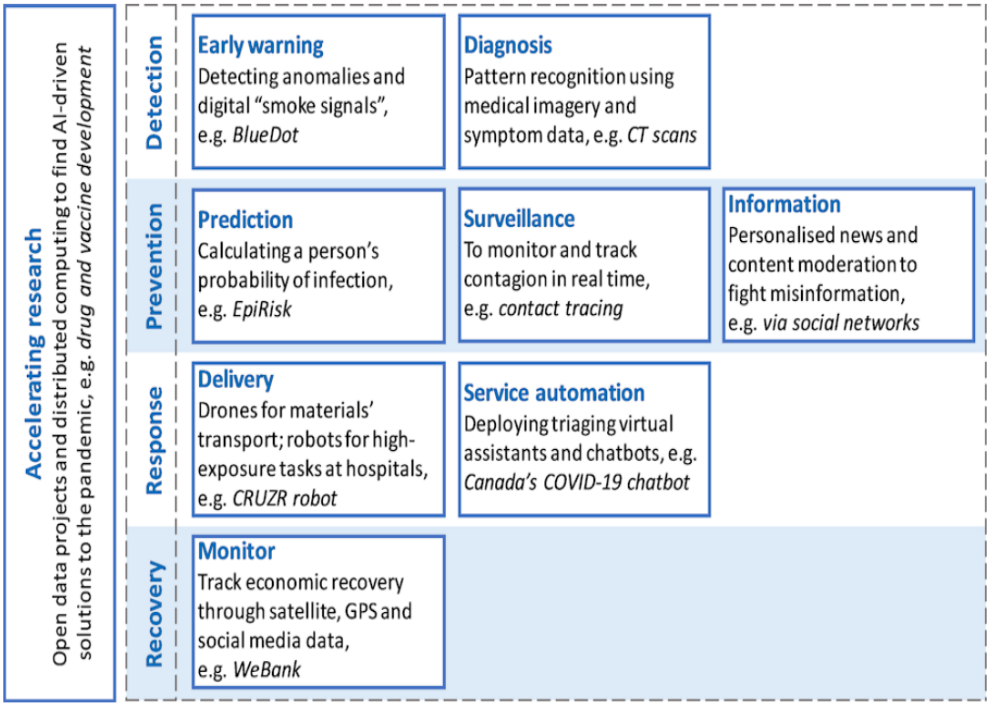

Figure 10: Examples of AI applications at different stages of the COVID-19 crisis [58].

Accelerating research using AI to understand and treat COVID-19

AI methods and technologies could assist policy makers and the health care industry comprehend COVID-19 and boost therapeutic research by swiftly assessing large volumes of research data. AI text and data mining tools can reveal the virus's background, transmission and diagnosis, control measures and lessons learned from previous epidemics.

Deep learning methods can help determine old and new medications that might be used to treat COVID-19. Many organizations employ AI to detect treatment options and develop prototype vaccines. The DeepMind and many other institutions also use deep learning to anticipate the structure of SARS-CoV-2-associated proteins, which is the virus that causes COVID-19.

Devoted sites facilitate the integration and exchanging of multidisciplinary AI knowledge, including internationally. For starters, the US government has initiated a partnership with international affairs science officials, including the utilization of AI to facilitate the study of coronavirus data made accessible via the Kaggle platform. Availability of databases in epidemiology, bioinformatics and molecular simulation is offered, e.g. via the COVID-19 Open Research Dataset Challenge by the U.S. government and related institutions that provide more than 29000 COVID-19 scientific research papers.

Computing capacity for AI is now provided by technological firms such as IBM, Amazon, Google and Microsoft; entities who contribute to computer processing resources and by conjoined efforts of both public and private sectors such as the COVID-19 High Performance Computing Consortium and AI for Health [59].

Emerging approaches, such as awards, open-source collaborations and hackathons, are assisting with increasing research regarding AI-driven pandemic resolving. For instance, the UK's "CoronaHack – AI vs.

Covid-19" is striving to generate ideas from firms, data analysts and healthcare organizations on using AI to monitor and contain the pandemic.

Using AI to help detect, diagnose and prevent the spread of the coronavirus

AI may also be used to help predict, identify and deter the transmission of the infection. Algorithms that recognize patterns and anomalies are already operating to locate and anticipate the spread of COVID-19, while image recognition systems are accelerating clinical diagnosis.

For example, AI-powered monitoring systems may help identify epidemiological threats by filtering media news, web content and other data sources in various languages to provide early alerts that can supplement syndromic monitoring and other health networks and data channels (e.g. WHO Early warning system, Bluedot).

AI techniques can help recognize transmission patterns of viruses and manage wider economic effects. In a number of cases, AI algorithms have proven their ability to predict epidemiological information faster than conventional clinical data coverage. Institutions such as Johns Hopkins University and the OECD (oecd.ai) have since made accessible digital dashboards that monitor the progress of the virus through live coverage and real-time data on positive COVEd-19 cases, recovery rates and deaths. Early assessment is the secret to reducing spread rates and identifying the transmission chains. AI can help to quickly diagnose cases of COVID-19 when implemented to image and symptom data. In order to ensure adaptability and validity, special attention should be paid to the collection of data representative of the entire population. Controlling epidemics is a concern in all regions, and AI technologies help deter the transmission of the virus.

Many countries use population monitoring to detect COVID-19 cases (for example, in Korea algorithms use geolocation data, surveillance camera footage and credit card information to track coronavirus patients). China allocates a risk level (color code – red, yellow or green) to each individual denoting infection threat utilizing smartphone software. Whereas machine learning techniques use airfare, transactions and communication analytics to track the route of the following epidemic and to notify border controls, search engines and social media are also aiding to monitor the disease in real time. Several countries, such as Austria, China, Poland, Singapore and Korea, have established contact tracking systems to identify potential infection routes. In Singapore, for illustration, geolocation data was used to locate individuals coming into direct contact with known virus carriers and to send them texts and them to be isolated immediately.

Semi-autonomous robots and drones are employed to respond to urgent cases in hospitals, such as delivering food and drugs, cleaning and sterilization, assisting healthcare workers, and distributing supplies.

How AI can assist the response to the crisis, and the recovery to follow

Communicative and collaborative AI systems help respond to the medical crisis through customized knowledge, guidance, therapy and learning. To address misleading data – COVID-19 "infodemic" – social platforms and search engines use customized AI data and resources, and focus on algorithms to identify and eliminate misleading content on their networks.

Digital assistants and robots have been used to assist health care systems such as Canada, France, Finland, Italy, the United States and the American Red Cross. These methods help to classify individuals by the appearance of symptoms. The United States' Center for Disease Control and Prevention with the support of Microsoft have developed a coronavirus self-checker service to help patients self-assess COVID-19 and recommend a course of action.

Recognizing, locating and informing vulnerable, high-risk individuals. For instance, the Chicago-based Medical Home Network has developed an AI framework to classify Medicaid patients most at stake from COVID-19 depending on the severity of lung problems and social isolation.

AI could ultimately take part in improving the preparation and teaching of healthcare professionals. Eventually, AI methods can help manage the economic downturn and retrieval – for instance through satellite, social media and other information sources (e.g. Google's Community Mobility Reports) – and can benefit from the recession and provide early alerts for diseases [60].

AI to identify, track and forecast outbreaks

The best way to fight the coronavirus is finding the better way to track it. This can be done through artificial intelligence by analysing social media platforms, news reports and government documents, which makes AI to learn to detect an outbreak. Tracking infectious disease risks by using AI is what the service Canadian startup BlueDot did [61]. In fact, the BlueDot's AI [61] warned of the threat several days before the World Health Organisation issued its public warnings.

AI to help diagnose the virus

The AI based company Infervision [62] launched a coronavirus AI solution that helps front-line healthcare workers detect and monitor the disease efficiently. Imaging departments in healthcare facilities are being taxed with the increased workload created by the virus. This solution improves CT diagnosis speed. In addition, the Alibaba(Chinese e-commerce agent) also built an AI-powered diagnosis system and they claim is 96% accurate at diagnosing the virus in seconds.

Robots sterilise, deliver food and supplies and perform other tasks

Robots are not susceptible to the virus, but they are being used to help in many tasks such as cleaning, sterilising, delivering food and medicine to reduce the amount of human-to-human interaction. The robots from Blue Ocean Robotics use ultraviolet light to autonomously kill viruses. In China, Pudu deployed its robots that are typically used in the catering industry to more than 40 hospitals around the country [63].

AI to identify non-compliance or infected individuals

While certainly a controversial use of technology and AI, China's sophisticated surveillance system used facial recognition technology and temperature detection software from SenseTime to identify people who might have a fever and be more likely to have the virus. Similar technology powers "smart helmets" used by officials in Sichuan province to identify people with fevers. The Chinese government has also developed a monitoring system called Health Code that uses big data to identify and assesses the risk of each individual based on their travel history, how much time they have spent in virus hotspots, and potential exposure to people carrying the virus. Citizens are assigned a colour code (red, yellow, or green), which they can access via the popular apps WeChat or Alipay to indicate if they should be quarantined or allowed in public.

ChatBots

Microsoft Azure is the foundation of the current CDC COVID-19 chatbot, Clara. By using personalization of Microsoft's healthcare bot app, the CDC has created this broadly accessible chat bot for entities to use when making important decisions about their pursuit of complementary medical services for diagnosis or treatment of COVID-19.

Several health systems, such as Providence, use Microsoft's chat bots tools to help people identify their own level of risk and, if necessary, to connect them to professionals [64]. Either operated by Azure or other platforms, the efficiency of the COVID-19 chatbots is reported to be uneven, likely due to the rapid speed of data inputs used to develop them.

Another dialogue-engine-based technology, created by Curai [65], uses text data to help patients comprehend and describe their symptoms and to help doctors understand patients. Using NLP, deep learning and knowledge-based apps, Curai tools can help patients and clinicians communicate in both telemedicine and direct interaction environments.

Sensors

Biofourmis [66]**,** recognized from early discussions of COVID-19 tracking in Hong Kong, has re-designed its Biovitals Sentinel platform and its Everion biosensor to help track patients under lock down. This suite of sensors, "including optical, temperature, electrodermal, accelerometer and barometer", is the primary aspect of the Biovitals Sentinel monitor system.

Ouraring [67] is a biosensor used in a limited study to capture biometric data for medical professionals. In the ongoing research, Ouraring users respond to symptom surveys to assess if biometric data can help "identify patterns that could predict onset, progression, and recovery in future cases of COVID-19."

Although not explicitly designed to evaluate medical personnel, Scripps Research is developing study to discover if any of the many wearable technology that track health data, such as heart rate, can be used to anticipate or analyse COVID-19 cases.

III. COMPANIES USING AI TO FIGHT CORONAVIRUS

As DARPA works on short-term "firebreak" [68] counter measures and analytical scientists track the origins of new cases, a variety of drug development companies are working on their AI technologies to forecast which existing drugs or brand-new medication-like molecules might help treat the virus.

Medical research typically takes at least 10 years to move from concept to market [69], with a failure rate of over 90 per cent and a budget that ranges between $2 and $3 billion. "We can greatly improve this cycle by using AI and make it much cheaper, quicker and more likely to succeed," says Alex Zhavoronkov, CEO of Insilico Medicine, an AI drug development company.

The following is a list of five AI-based firms targeting coronavirus [69]:

Deargen [70], researchers at South Korea-based Deargen published a preprint paper (a paper that has still not been peer-reviewed by other researchers) with the findings of a deep learning system called MT-DTI. This system uses simplified chemical sequences, rather than 2D or 3D molecular structures, to anticipate how heavily a molecule of interest is bound to the target protein. The model foretasted that among available FDA-approved antiviral medications, HIV atazanavir is the most likely to attach and stop a notable protein outside of the virus that causes COVID-19 (SARS-CoV-2). It also recognized three other antivirals that could link the virus. Although the firm is not aware of any official agency keeping a close eye on its suggestions, its prototype also anticipated a range of non-approved medications, such as antiviral remdesivir, which are currently being tested in patients, according to Sungsoo Park, co-founder and CTO of Deargen. Deargen is currently using their deep learning technology to produce potential antivirals, but they need collaborators to help them create molecules, Park says. "We currently do not have a facility to test these drug candidates," he notes. "If there are pharmaceutical companies or research institutes that want to test these drug candidates for SARS-CoV-2, [they would] always be welcome."

Insilico Medicine [71], Along the same way, Hong Kong-based Insilico Medicine stepped into the market in early February with a pre-print paper. Rather than trying to re-use existing drugs, the researchers used an AI-based drug development system to produce tens of thousands of novel molecules with the ability to link a particular SARS-CoV-2 protein and prevent the ability of the virus to duplicate. Alex Zhavoronkov, CEO of Insilico says "We published the original 100 molecules after a 4-day AI sprint,". Then, the researchers intended to make and evaluate seven molecules, but the outbreak stopped them: over 20 of their contract chemists were under lock down in Wuhan. Ever since, Insilico has produced two of the seven molecules and aims to examine them with a pharmaceutical partner over the next two weeks, says Zhavoronkov to IEEE. The firm is now licensing its AI technology to two major pharmaceutical companies. Insilico is also currently researching drugs that may boost the elderly's immune systems — so older people

that respond to SARS-CoV-2 disease as younger people, with milder symptoms and speedy recovery — and drugs to help regain lung function after treatment. They aim to report further results soon.
SRI Biosciences and Iktos [69], Menlo Park-based research center SRI International and AI company Iktos in Paris announced a partnership to discover and create new anti-viral therapies. Iktos' learning algorithm develops virtual new molecules, whereas SynFini's automated synthetic chemistry framework demonstrates the best method of creating a molecule, and then produces it. Through their combined efforts, technologies can develop, produce and try out new drug-like molecules in 1 to 2 weeks, says Iktos CEO Yann Gaston-Mathé. AI-based development of drug candidates is ongoing, and "the first round of target compounds will be handed to SRI's SynFini automated synthesis platform shortly," he tells *IEEE*. Iktos has also lately launched two AI-based software tools to facilitate drug development: one for new drug discovery, and the other, with a free online trial edition (beta version), to help synthetic chemists deconstruct how to develop a compound better. "We are eager to bring as many users as possible to this free platform and to get feedback to help us refine this new technology," says Gaston-Mathé.

Benevolent AI [72], the British AI-startup Benevolent AI published two papers, one in The Lancet and one in The Lancet Infectious Diseases, revealing approved drugs that could prevent the SARS-CoV-2 viral reproductive cycle. Using a wide database of medical data, such as information taken from research journals through machine learning, the firm's AI system found 6 substances that completely prevent a cell channel that seems to enable the virus to bring more viral proteins into cells. One of the six, baricitinib, a once-daily pill approved for the treatment of rheumatoid arthritis, appears to be the greatest in the SARS-CoV-2 stability and efficacy category, the authors wrote. Benevolent's co-founder, Ivan Griffin, informed Recode that Benevolent had contacted pharmaceutical companies to evaluate the medication as a possible cure. Ruxolitinib, a drug that acts under a similar process, is currently under clinical trials for COVID-19.

The CORD-19 dataset [73], the United States government collaborated with tech firms Microsoft and Google to collect scholarly articles on COVID-19. The corpus was assembled into a dataset called COVID-19 Open Research Dataset (CORD-19) [73]. This corpus made by the Allen Institute for AI (AI2) in collaboration with the Chan Zuckerberg Initiative, Georgetown University's Center for Security and Emerging Technology, Microsoft Research, and the National Library of Medicine at National Institutes of Health, in coordination with The White House Office of Science and Technology Policy [73] . CORD-19 was launched in mid-March 2020 and made available to AI researchers to use it to build machine learning models that can assist researchers discover the answers they need. The original database contained over 24,000 peer-reviewed academic papers as well as pre-printed platforms such as bioRxiv and medRxiv. By then, it has evolved to more than 47,000 papers [73].
Semantic Scholar and Google Scholar, which also assemble related research articles, are indeed effective tools for searching the information corpus created to COVID-19 [73]. Semantic Scholar uses advanced natural language processing (NLP) transformers. Google has also added BERT, the Transformer Implementation, to its search engine in a recent update. The society, though, is curious to study how they can expand the scope of current AI models and utilize them to further assist researchers in their battle against COVID-19.

IV. ALL HOSPITALS SHOULD HAVE AI DEPARTMENT

Each hospital should have an AI or data science department for many reasons in order to be able to collect, structure and process a high volume of data and further make sense of it. In addition, to gain a deeper understanding of the human body. Analysing the patient's data might leads to predict a lot for that patient's

disease. It also has the strongest potential to revolutionize healthcare, based on our industry expertise. Some reasons why hospitals should have an AI or data science departments are [74]:

- Using wearables data to monitor and prevent health problems.
- Improving diagnostic accuracy and efficiency.
- Optimizing clinic performance through actionable insights.
- Taking the risk out of prescription medicine.
- Reducing hospital readmissions to cut healthcare costs.
- Turning patient care into precision medicine and better treatment.
- Drug Discovery.
- Disease Prevention.
- Decrease the cost for Hospital Operations and make the hospital is more smart.
- Improve hospital patient flow with ML.
- Advancing pharmaceutical research to find cure for cancer and Ebola.

V. CONCLUSION.

The world started the 2020 year with a big pandemic came from china, which is covid-19. This pandemic caused by the coronavirus that is spreading quickly from china to the whole world. This spreading does not affect only the human health. Rather, it affects all the human life activities from business, education, travelling, jobs and even the social activities. All types of sciences united and tried to find solution for this pandemic or at least decrease the impact of it on human being from any part. Generally, Computing technology and specially Artificial Intelligence was one and still one of the main contributors in solving this pandemic. Although, the pandemic is still affecting us, but the AI is the hope to solve or at least to accelerate the solution. AI contributed in many fields mainly the medical filed to generate diagnoses that are more accurate and producing the right medicine. From now, it is no option that each hospital should have an AI research department to study their patients' profiles and medical history.

VI. ACKNOWLEDGMENT

The author is grateful to the Applied Science Private University, Amman, Jordan, for the full financial support granted to this research.

REFRENCES:

[1] Organization, W.H., *Novel Coronavirus (2019-nCoV) SITUATION REPORT - 1*. 2020.

[2] Bruce AYLWARD, W.L., Xiaoping DONG, Tim ECKMANNS, Dale FISHER, Chikwe, et al., *Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19)*. 2020. p. 40.

[3] Fan Wu, S.Z., Bin Yu, Yan-Mei Chen, Wen Wang, Zhi-Gang Song, Yi Hu,, J.-H.T. Zhao-Wu Tao, Yuan-Yuan Pei, Ming-Li Yuan, Yu-Ling Zhang, Fa-Hui Dai,, and Q.-M.W. Yi Liu, Jiao-Jiao Zheng, Lin Xu, Edward C. Holmes & Yong-Zhen Zhang, *A new coronavirus associated with human respiratory disease in China.* Content courtesy of Springer Nature, 2020. **V 579**.

[4] Dan Hu , C.Z., Lele Ai, Ting He, Yi Wang, Fuqiang Ye, Lu Yang, Chenxi Ding, Xuhui Zhu, Ruicheng Lv, Jin Zhu, Bachar Hassan, Youjun Feng , a Weilong Tan and Changjun Wang *Genomic characterization and infectivity of a novel SARS-like coronavirus in Chinese bats.* Emerging Microbes & Infections, 2018. **7**: p. 1-10.

[5] Drosten C, G.S., Preiser W, van der Werf S, Brodt HR, Becker S, Rabenau H, Panning M, Kolesnikova L, Fouchier RA, Berger A, Burguière AM, Cinatl J, Eickmann M, Escriou N, Grywna K, Kramme S, Manuguerra JC, Müller S, Rickerts V, Stürmer M, Vieth S, Klenk HD, Osterhaus AD, Schmitz H, Doerr HW, *Identification of a novel coronavirus in patients with severe acute respiratory syndrome.* N Engl J Med., 2003. **15:348(20)**.

[6] (UCRG), U.C.R.G., *CORONAVIRUS DISEASE 2019 (COVID-19) AND HIV: KEY ISSUES AND ACTIONS*. 2020.

[7] Jie Cui, N.H., Daniel Streicker, Gang Li, Xianchun Tang, Zhengli Shi, Zhihong Hu, Guoping Zhao, Arnaud Fontanet, Yi Guan, Linfa Wang, Gareth Jones, Hume E. Field, Peter Daszak,corresponding author and Shuyi Zhang, *Evolutionary Relationships between Bat Coronaviruses and Their Hosts.* Emerging Infectious Diseases, 2007. **13(10)**: p. 1526–1532.

[8] Epidemiology group: Jian-Feng He, G.-W.P., Jun Min, De-Wen Yu, Wen-Jia Liang, Shu-Yi Zhang, Rui-Heng Xu Virology group: Huan-Ying Zheng,Xin-Wei Wu, Jun Xu, Zhan-Hui Wang, Ling Fang, Xin Zhang, Hui Li, Xin-Ge Yan, Jia-Hai Lu, Zhi-Hong Hu, Ji-Cheng Huang, Zhuo-Yue Wan, Jin-Lin Hou, Jin-Yan Lin Molecular biology group: Huai-Dong Song, Sheng-Yue Wang, Xiang-Jun Zhou, Guo-Wei Zhang, Bo-Wei Gu, Hua-Jun Zheng,Xiang-Lin Zhang, Mei He, Kui Zheng, BoFei Wang Gang Fu, Xiao-Ning Wang, Sai-Juan Chen, Zhu Chen Data analysis group: Pei Hao, Hua Tang, Shuang-Xi Ren, Yang Zhong, Zong-Ming Guo, Qi Liu, You-Gang Miao, Xiang-Yin Kong, Wei-Zhong He, Yi-Xue Li, Chung-I Wu, Guo-Ping Zhao, Chinese University of Hong Kong group: Rossa W. K. Chiu, Stephen S. C. Chim, Yu-kwan Tong, Paul K. S. Chan, John S. Tam, Y. M. Dennis Lo, *Molecular evolution of the SARS coronavirus during the course of the SARS epidemic in China.* sciencemag, 2004. **Vol 303**(5664).

[9] UK, E. *Lockdown: Which countries are in lockdown? How many people?* 2020 accessed 26-4-2020]; Available from: https://www.express.co.uk/news/world/1260709/lockdown-which-countries-are-in-lockdown-how-many-people-coronavirus-cases.

[10] worldometers. *CoronaVirus statistics Worldwide*. 2020 [cited 2020 26 Apr]; Available from: https://www.worldometers.info/coronavirus/.

[11] UK, B. *Coronavirus: The world in lockdown in maps and charts*. 2020 accessed 26-4-2020]; Available from: https://www.bbc.com/news/world-52103747.

[12] EuroNews. *Coronavirus: Half of humanity now on lockdown as 90 countries call for confinement*. 2020 accessed 26-4-2020]; Available from: https://www.euronews.com/2020/04/02/coronavirus-in-europe-spain-s-death-toll-hits-10-000-after-record-950-new-deaths-in-24-hou.

[13] UN, *SHARED RESPONSIBILITY, GLOBAL SOLIDARITY: Responding to the socio-economic impacts of COVID-19*. 2020.

[14] NPR. *WHO Sets 6 Conditions For Ending A Coronavirus Lockdown*. 2020 27-4-2020]; Available from: https://www.npr.org/sections/goatsandsoda/2020/04/15/834021103/who-sets-6-conditions-for-ending-a-coronavirus-lockdown.

[15] UK, B. *Coronavirus: When will the outbreak end and life get back to normal?* 2020 27-4-2020]; Available from: https://www.bbc.com/news/health-51963486.

[16] OECD, *Coronavirus: The world economy at risk*. 2020.

[17] BBC. *Coronavirus: A visual guide to the economic impact*. 2020; Available from: https://www.bbc.com/news/business-51706225.

[18] UN, *Sustainable Development Goals as defined in Transforming Our World - the 2030 Agenda for Sustainable Development*. 2020.

[19] Wade, M., *Coronavirus: your guide to winners and losers in the business world*, in *The Conversation*. 2020.

[20] Nguyen, T.T., *Artificial Intelligence in the Battle against Coronavirus (COVID-19): A Survey and Future Research Directions.* 2020.

[21] Hijjawi, M., *ArabChat: an Arabic Conversational Agent*, in *Computer Science*. 2011, Manchester Metropolitan University: UK. p. 241.

[22] AllWords, *Online Dictionary*. 2006.

[23] Anwer, J.S.a.T., *Artificial Intelligence and its Role in Near Future.* ArXiv, 2018. **VOL. 14, NO. 8,**.

[24] Turing, A., *Computing machinery and intelligence.* Mind, 1950: p. pp. 433-60.

[25] Council, U.N.S.a.T., *Preparing for the future of artificial intelligence*. 2016.

[26] Ran Berg, C.J., *Artificial intelligence (AI) in healthcare and research.* BioEthics, 2018.

[27] Wikipedia. *Artificial intelligence in healthcare*. 2020; Available from: https://en.wikipedia.org/wiki/Artificial_intelligence_in_healthcare.

[28] Leung MKK, e.a., *Machine Learning in Genomic Medicine: A Review of Computational Problems and Data Sets.* Proc IEEE Science Magazine, 2017.

[29] Kevin Williams, E.B., Andrew Sparkes, Wayne Aubrey, Michael Young, Larisa N. Soldatova, Kurt De Grave, Jan Ramon, Michaela de Clare, Worachart Sirawaraporn, Stephen G. Oliver and Ross D.

King, *Cheaper faster drug development validated by the repositioning of drugs against neglected tropical diseases.* Royal Society, 2015.

[30] Dayong Wang, A.K., Rishab Gargeya, Humayun Irshad, Andrew H. Beck, *Deep Learning for Identifying Metastatic Breast Cancer.* Quantitative Biology, 2016.

[31] Yohannes Kassahun , B.Y., Abraham Temesgen Tibebu , Danail, S.G. Stoyanov , Jan Hendrik Metzen , Emmanuel, and V. Poorten, *Surgical robotics beyond enhanced dexterity instrumentation: a survey of machine learning techniques and their role in intelligent and autonomous surgical actions.* International Journal of Computer Assisted Radiology and Surgery manuscript, 2016. **11(4)**.

[32] BBVA. *How Artificial Intelligence can help fight COVID-19*. 2020 [cited 2020 30-6-2020]; Available from: https://www.bbva.com/en/how-artificial-intelligence-can-help-fight-covid-19/.

[33] Bai, H.X.H., Ben; Xiong, Zeng; Halsey, Kasey; Choi, Ji Whae; Tran, Thi My Linh; Pan, Ian; Shi, Lin-Bo; Wang, Dong-Cui; Mei, Ji; Jiang, Xiao-Long; Zeng, Qiu-Hua; Egglin, Thomas K; Hu, Ping-Feng; Agarwal, Saurabh; Xie, Fangfang; Li, Sha; Healey, Terrance; Atalay, Michael K; and Liao, Wei-Hua, *Performance of radiologists in differentiating COVID-19 from viral pneumonia on chest CT Radiology.* Publons Radiology, 2020.

[34] Rajinikanth, V.D., Nilanjan & Joseph Raj, Alex Noel & Hassanien, Aboul Ella & Santosh, K.C. & Raja, N.. , *Harmony-Search and Otsu based System for Coronavirus Disease (COVID-19) Detection using Lung CT Scan Images.* Applied Sciences, 2020.

[35] Callaghan, S., *COVID-19 Is a Data Science Issue.* Elsevier Public Health Emergency Collection, 2020.

[36] Hu, Z.G., Qiyang & Jin, Li & Xiong, Momiao. , *Artificial Intelligence Forecasting of Covid-19 in China.* 2020.

[37] Benlagha, N., *Modeling the Declared New Cases of COVID-19 Trend Using Advanced Statistical Approaches.* 2020.

[38] Ali Bou Nassif, I.S., Imtinan Attili, Mohammad Azzeh, Khaled Shaalan, *Speech recognition using deep neural networks: A systematic review.* IEEE Access, 2019. **7**: p. 19143-19165.

[39] Halgurd S. Maghdid, K.Z.G., Ali Safaa Sadiq, Kevin Curran, Danda B. Rawat, Khaled Rabie, *A Novel AI-enabled Framework to Diagnose Coronavirus COVID 19 using Smartphone Embedded Sensors: Design Study.* Computer Science, 2020.

[40] Allam, Z.J., David, *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, 2020. **8**.

[41] Agrebi, S., & Larbi, A., *Use of artificial intelligence in infectious diseases.* Artificial intelligence in precision health,ScienceDirect, 2020: p. 415–438. doi:10.1016/b978-0-12-817133-2.00018-5.

[42] Lalmuanawma, S., Jamal Hussain,a and Lalrinfela Chhakchhuakb, *Applications of machine learning and artificial intelligence for Covid-19 (SARS-CoV-2) pandemic: A review*. Chaos, solitons, and fractals, 2020. **139**.

[43] Vaishya R., J.M., Khan I.H., Haleem A., *Artificial Intelligence (AI) applications for COVID-19 pandemic.* Diabetes Metab Syndr, 2020. **14(4)**: p. 337–339.

[44] Sharma, S., *Using Machine Learning to Fight the Coronavirus.* Towards Data Science, 2020.

[45] Narinder Singh Punn, S.K.S., Sonali Agarwal, *COVID-19 Epidemic Analysis using Machine Learning and Deep Learning Algorithms.* MedRxiv, 2020.

[46] Olena, A. *AI Is Screening Billions of Molecules for Coronavirus Treatments*. 2020; Available from: https://www.the-scientist.com/news-opinion/ai-is-screening-billions-of-molecules-for-coronavirus-treatments-67520.

[47] Tiffany Trader, J.R. *Quantum Machine Learning: A New Weapon Against COVID-19?* 2020; Available from: Quantum Machine Learning: A New Weapon Against COVID-19?

[48] Amneh Shaban, F.A., Mahmoud H Qutqut, *Hybrid user action prediction system for automated home using association rules and ontology.* IET Wireless Sensor Systems, 2019. **9**(2).

[49] Kent, J., *Natural Language Processing Tracks Public Interest in COVID-19 Topics*, in *Health IT Analytics*. 2020.

[50] news, A., *Natural Language Processing Market 2020 Along With Covid-19 Impact Analysis, Trends, Advancement And Outlook 2029*. 2020.

[51] Du, S.a.W., Jianji and Zhang, He and Cui, Wenting and Kang, Zijian and Yang, Tao and Lou, Bin and Chi, Yuting and Long, Hong and Ma, Mei and Yuan, Qi and Zhang, Shupei and Zhang, Dong and Xin, Jingmin and Zheng, Nanning. *Predicting COVID-19 Using Hybrid AI Model* 2020; Available from: Available at SSRN: https://ssrn.com/abstract=3555202.

[52] Ezugwu, O.O.a.A., *COVID19: A Natural Language Processing and Ontology Oriented Temporal Case-Based Framework for Early Detection and Diagnosis of Novel Coronavirus.* artificial intelligence & robotics 2020.

[53] GHDDI. *Shanghai Public Health Clinical Center Uses Wearable Sensors to Combat Spread of Coronavirus in China*. 2020; Available from: http://ghddi.org/en/node/236.

[54] Parliament, E., *What if we could fight coronavirus with artificial intelligence?* 2020.

[55] Li, B.J. *China's facial-recognition giant says it can crack masked faces during the coronavirus*. 2020; Available from: https://qz.com/1803737/chinas-facial-recognition-tech-can-crack-masked-faces-amid-coronavirus/.

[56] APnews. *Optoelectronic Technologies Assisting in the Fight Against COVID-19*. 2020; Available from: https://apnews.com/PR%20Newswire/354aae0738073bc95331ee72a458cb50.

[57] Murphy, K.L.a.C. *Drones Take to China's Skies to Fight Coronavirus Outbreak*. 2020; Available from: https://www.bloomberg.com/news/articles/2020-02-04/drones-take-to-china-s-skies-to-fight-coronavirus-outbreak.

[58] OECD, *Using artificial intelligence to help combat COVID-19*. 2020.

[59] Aljanabi, M., et al., *Machine learning classification techniques for heart disease prediction: A review.* 2018. **7**(4): p. 5373-5379.

[60] JORDAN, S. *Artificial Intelligence and the COVID-19 Pandemic*. 2020; Available from: https://fpf.org/2020/05/07/artificial-intelligence-and-the-covid-19-pandemic/.

[61] bluedot.global, *BlueDot AI-driven infectious disease surveillance*. 2016.

[62] global.infervision.com, *Infervision medical artificial intelligence.* 2016.

[63] News, B., *Coronavirus: China's tech fights back*. 2020.

[64] Hijjawi, M. and H. Abusaimeh, *APPLYING AN ARABIC CONVERSATIONAL AGENT IN THE JORDANIAN EGovernment.* 2015.

[65] curai.com, *curai Providing the world's best healthcare to everyone*. 2016.

[66] biofourmis.com, *Biofourmis: Personally Predictive Care*. 2015.

[67] ouraring.com, *Oura Ring: the most accurate sleep and activity tracker*. 2013.

[68] Strickland, E., *DARPA Races To Create a "Firebreak" Treatment for the Coronavirus*, in *Biomedical*. 2020, IEEE Spectrum.

[69] Scudellari, M., *Five Companies Using AI to Fight Coronavirus*, in *Artificial Intelligence Medical AI*. 2020, IEEE Spectrum.

[70] deargen.me, *DEARGEN advances the treatment of rare and intractable diseases through the integration of AI and collective intelligence.* 2017.

[71] insilico.com, *Integrated Universal Experimentally-Validated Artificial Intelligence for Every Step of Pharmaceutical Research and Development*. 2014.

[72] benevolent.com, *BenevolentAI is the global leader in the development and application of artificial intelligence for drug discovery and development.* 2015.

[73] Dickson, B., *How AI helps scientists find reliable coronavirus research*. 2020.

[74] AltexSoft, *7 Ways Data Science Is Reshaping Healthcare,* in *AltexSoft Software r&d Engineering*. 2018.