

# **The Role of AI in Testing, Tracking and Treatment of Covid-19**

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*Coronavirus disease 2019 (COVID-19) has created a worldwide pandemic. Artificial Intelligence (AI) technologies are playing a considerable role in responding to the pandemic due to their potential to help understand COVID-19 as well as their potential to mitigate the virus. This concept paper identifies the role of AI in testing, tracing and treatment of COVID-19.*

*Keywords: artificial intelligence, Coronavirus, COVID, healthcare*

## **COVID-19**

On December 31, 2019, Chinese health officials informed the World Health Organization (WHO) of a group of 41 patients in Hunan who had pneumonia of unknown etiology. Most of these patients had some connection to Hunan Seafood Wholesale Market located in Hunan, China. On January 7, 2020, Chinese authorities report that a new type of coronavirus (called novel coronavirus or nCoV) had been identified and on January 11, 2020, China records its first death due to the virus. It should be noted that by February 9, 2020, the death toll in China surpassed that of the 2002-2003 SARS epidemic, with 811 deaths recorded. On January 13, 2020, the first coronavirus case outside of China is reported in Thailand and on February 2, 2020, the first death outside China was recorded in the Philippines. The first case in the United States was reported in Washington on January 20, 2020.

On January 30, 2020, WHO declared a global health emergency. World Health Organization defines a global health emergency, (also known as a “public health emergency of international concern),” as an “extraordinary event” that is “serious, unusual or unexpected”. According to WHO Director-General Tedros Adhanom Ghebreyesu, “Our greatest concern is the potential for the virus to spread to countries with weaker health systems and which are ill-prepared to deal with it”. The global health emergency designation will help the international agency mobilize financial and political support to contain the outbreak. On February 11, 2020, WHO announces that the new coronavirus disease will be called COVID-19 and on March 11, 2020, declared the outbreak a pandemic.

According to John Hopkins Coronavirus Resource Center, which has been tracking real time cases, as of April 23, 2020, there have been 2,658,387 cases and 185,434 deaths worldwide with 213 countries,

areas or territories reporting cases. The Center for Disease Control (CDC) reported 843,937 cases in the United States and 46,851 deaths as of April 23, 2020.

In addition to the deaths caused by COVID-19, the corona virus has caused global economic disruptions. Governments around the world plan to spend and lend trillions of dollars to strengthen their economies against the disruption caused by the pandemic. Germany leads the world, allocating 28.5% of its GDP for its stimulus package; Italy comes in second, allocating 21.4% of its GDP and Ethiopia is last with 0.15% of its GDP allocated for its stimulus package. The United States stimulus package is 10% of its GDP. Leaders from the G-20 economies, which represent about two-thirds of the world's population, stated on March 26, 2020, that they are injecting more than \$5 trillion into the global economy, pledging that they will "do whatever it takes to overcome the pandemic," including putting additional policy measures in place. The Bill and Melinda Gates foundation will focus its "total attention" on defeating the COVID-19 pandemic, further evidence of the seriousness of the coronavirus.

## **ARTIFICIAL INTELLIGENCE**

Artificial Intelligence traces its modern roots back to the vision and work of mathematician and computer scientist Alan Turing. In addition to addressing the London Mathematical Society on the subject of Artificial Intelligence in 1947, Turing published a seminal article in 1950 titled "Computing Machinery and Intelligence" (Russell, Norvig, 2003). Around that time, he introduced the classic "Turing Test", which he developed to help identify whether the test taker is a human or a machine (Turing, 1950). Across the pond, interest in Artificial Intelligence simultaneously grew. In 1956, John McCarthy, previously affiliated with Princeton and Stanford Universities, led the organization of a summer workshop at Dartmouth College in New Hampshire on Artificial Intelligence. Invitations to the workshop went out to U.S. researchers interested in automata theory, neural nets, and the study of intelligence. Workshop participants included Harvard's Marvin Minsky, and Carnegie Tech's Allen Newell and Herbert Simon. As a result of this workshop and other contributions made by McCarthy, Dartmouth College became the official birthplace of Artificial Intelligence, and McCarthy, together with Minsky, Newell and Simon, the field's founding fathers (Russell, Norvig, 2003). While Artificial Intelligence's evolution has taken it in many directions and received many interpretations over the years, as Herbert Simon defined it early on ... the field strives for "machines that think, that learn and that create." More recently, there has been tremendous growth in the interest of Artificial Intelligence due mainly to three factors: significant increase in computer power, availability of large data sets, and progress in machine learning and deep learning (Russell, Norvig, 2003). Historically, Artificial Intelligence activity has focused on the areas of knowledge-based systems, expert systems, vision systems and robotics. Advances in computing power, storage, sensors, and large data sets, progress in machine learning and deep learning and multidisciplinary research have laid the groundwork for the increased development and use of AI techniques in medicine and healthcare (AMA Journal of Ethics, 2019). The two main areas associated with AI in medicine and healthcare include virtual components which include machine learning (ML) and algorithms, and physical AI which includes medical devices and robots for delivering care (Londhe, 2018).

Artificial Intelligence applications are designed with the intention of decreasing human biases and errors. Human beings have been found to be poor decision makers, not always making the most reasonable and logical decisions due to fatigue, biases, unpredictability, etc. (Bird, et al, 2016). Algorithms have been found to be less biased and more accurate than the humans they are replacing. An article in Harvard Business Review provides examples of situations where replacing humans with algorithms resulted in both increased accuracy and reduced institutional biases (termed a *Pareto improvement* by economists).

## **COVID-19 AND ARTIFICIAL INTELLIGENCE**

Given the challenges associated with the use of AI in healthcare, in June of 2018, the American Medical Association (AMA) adopted a new policy, H-480.940, "Augmented Intelligence in Health Care,"

to provide a broad framework for the evolution of artificial intelligence (AI) in healthcare that is "designed to help ensure that AI realizes the benefits it promises for patients, physicians, and the health care community". This policy is especially relevant today since artificial intelligence technologies are emerging as important solutions to combatting COVID-19.

Over the past years many major companies have been investing in artificial intelligence technologies. With the current pandemic these companies have increased their investment in AI powered technologies and are finding new applications for their current AI technologies. As a result, new initiatives in AI are coming to the forefront in terms of medical applications, information management, patient care, healthcare worker safety and the search for ways to tackle the virus. Three of these initiatives are presented below:

- IBM is a leader in the integration of AI in industry in general. It has made a \$1 billion investment in AI through the launch of its IBM Watson Group. One of the biggest applications of Watson has been in health care. While automation has proven to be challenging, several hospitals are working with IBM's Watson to develop systems that will help healthcare providers better understand patients' diseases and recommend personalized courses of treatment (Power, 2015). Several years ago researchers from the Massachusetts Institute of Technology and Harvard University reported the results of the application of a machine learning model in the treatment of a breast cancer case in 2017 (Bahl, et al, 2018).
- The fifth Microsoft AI for Good program named AI for Health is a five-year program to "empower researchers and organizations with AI to improve the health of people and communities around the world." This is a \$165 million initiative that will provide advanced technologies to help researchers find solutions to societal challenges--such as COVID-19.
- C3.ai Digital Transformation Institute is a new research consortium with commitments from Princeton, Carnegie Mellon, the Massachusetts Institute of Technology, the University of California, the University of Illinois and the University of Chicago, as well as C3.ai and Microsoft. The first challenge for the institute is to use AI to

“seek new ways of slowing the pathogen's spread, speeding the development of medical treatments, designing and repurposing drugs, planning clinical trials, predicting the disease's evolution, judging the value of interventions, improving public health strategies and finding better ways in the future to fight infectious outbreaks”.

### **Artificial Intelligence Technologies Help Minimize Patient Contact**

According to the CDC on April 15, 2020, 9,300 healthcare workers across the US had contracted COVID-19 and at least 27 had died. A majority of those who tested positive (55%) think they were exposed while at work. As a result, the use of Telemedicine and Conversational AI has increased. Telemedicine allows patients and doctors and other healthcare providers to 'meet' remotely while Conversational AI provides remote assessment of symptoms and drug prescriptions thereby empowering patients to assess their own symptoms and better care for themselves. Since the advent of COVID-19, companies, using technology such as wireless monitors and robots, have been developing new ways to generate important health data without any patient contact. These AI powered technologies help minimize the risk that doctors, nurses, and other healthcare workers will catch the virus from patients. For example, a team from MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) developed a wireless monitor called Emerald that uses wireless signals and a machine learning platform to monitor COVID-19 patients at home. University of California San Diego radiologists and other physicians are using AI to augment lung imaging analysis in a clinical research study enabled by Amazon Web Services. The ability to quickly detect pneumonia in COVID-19 patients is important since the ultimate cause of death for most patients who have died of COVID-19 has been pneumonia.

In order to provide another line of defense between healthcare workers and COVID-19 patients, robots are being used. Engineers have developed and programmed these robots to test and treat COVID-

19 patients. A field hospital staffed by robots, named the Smart Field Hospital, was opened in Wuhan, China shortly after the pandemic began. The project is a collaboration between Wuhan Wuchang Hospital, China Mobile and CloudMinds, a maker of Cloud Robotics Systems based in China and the United States. Robots provided food, drinks, information and medicine to patients. Some robots provided entertainment by dancing for the patients while other self-directed droids sprayed disinfectant and cleaned and sanitized the floors. UVD Robots, based in Odense, Denmark has sent robots to several countries to help in the fight against the coronavirus. The autonomous robots can decontaminate surfaces by tearing apart strands of virus DNA through ultraviolet lights. According to UVD spokesperson Camilla Harjaer Frederiksen, "The UVD Robot will kill the coronavirus, as it has a proven efficacy against MERS CoV and MHV-A59, showing over 6 log reductions in viral particles within 30 minutes." The UV disinfection adds an extra layer of infection prevention efforts, helping to protect healthcare workers.

### **Artificial Intelligence Technologies Provide Training for Healthcare Workers**

A collaboration between The Mount Sinai Health System, the New York Academy of Sciences (NYAS) and Sana Labs, an artificial intelligence-learning company, recently launched a new AI online learning-initiative called Project Florence. The purpose is for 'upskilling' nurses to fight COVID-19. Project Florence delivers personalized online learning lessons and has been made freely available to hospitals around the world.

### **Artificial Intelligence Technologies Help Mitigate Overwork by Healthcare Professionals**

Before COVID-19 was on our radar, Dr. Leonid Eidelman, President of the World Medical Association, reported nearly half of the world's 10 million physicians have "burnout, including emotional exhaustion, interpersonal disengagement, and a low sense of personal accomplishment". With COVID-19 there have been unprecedented levels of overwork not only by doctors but also by nurses and other healthcare professionals. This is most evident for those working in intensive care units and those most directly involved in the response to the COVID-19 pandemic. Machine learning models powered by AI technologies have been shown to improve the diagnostic abilities of doctors by providing medical information that is current and thereby helps reduce diagnostic and therapeutic errors as well as free up time spent in record keeping and other activities (Becker, 2019). Four companies that use AI to provide services that help to mitigate overwork by healthcare professionals include The British National Health Service (NHS), Diagnostics.ai, CLEW Medical and Vocalis Health;

- The British National Health Service (NHS) is partnering with Google's artificial intelligence subsidiary DeepMind to develop a system that will free-up time, currently spent on paperwork, towards direct patient care by providing medical staff with 'breaking news'-style alerts about their patients (Bloch-Budzier, 2016).
- Diagnostics.ai's technology has automated the DNA analysis step resulting in a streamlined process to detect, diagnose, and track infectious diseases. A benefit of this process is that it removes the need for specially trained technicians, thereby eliminating the error factor in the interpretation of results. The technology uses algorithms that 'study' how an expert clinical technician interprets test results and applies this knowledge to future routine analyses.
- CLEW Medical, using an AI powered machine learning model has developed a 'predictive analytics engine' for use in intensive care units (ICU). Respiratory deterioration is detected in real time, delivering preemptive warnings that alert ICU workers when an ICU patient needs immediate care.
- Vocalis Health collects voice samples of both coronavirus patients and healthy individuals using vocal biomarkers to correlate the voice with the symptoms of the coronavirus. The company then uses its AI technology to triage, screen and monitor patients remotely. If a patient shows symptoms of the virus both the patient and the patient's healthcare workers are notified by a smartphone message.

### **Artificial Intelligence Technologies Help Monitor the Spread of the Virus**

For example, Diagnostic Robotics, developed by an Israeli company, uses an AI based triage and monitoring system that continually monitors the patterns in which the coronavirus spreads. The information is delivered as 'red flags' to health authorities, creating a 'heat map' of the corona virus hot spot. The heat map allows health authorities to assess not only where the virus is located but also how fast the virus is spreading. According to Diagnostic Robotics, the company's analytics tool 'provides risk and assessment and predictive models and results in a faster and better targeted medical response.

### **Artificial Intelligence Technologies Help Streamline the Search for Information**

Government agencies, healthcare organizations and academic institutions have been overwhelmed by the number of people searching for answers about COVID-19. With its ability to rapidly search large data sets, AI is being used to manage the massive overload of questions about the pandemic. Since the technology behind AI has the ability to continually learn from what it finds, identify patterns and trends in incomplete or seemingly unrelated data sets and differentiate between complex data sets more effectively than a human, it can solve problems that used to require human intelligence. The amount of research for COVID-19 has increased exponentially. The research reports, postings and documents related to COVID-19 come from disparate data sources with both structured and unstructured data. The large amount of reports would be impossible for one person to go through in a timely fashion. However, AI, using deep learning, can filter millions of documents or postings at a single time. Natural language processing automatically groups and compiles research that is published to show trends and most read publications on COVID-19 ([https://www.opentext.com/file\\_source/OpenText/en\\_US/PDF/opentext-wp-ai-powered-analytics-in-life-sciences-en.pdf](https://www.opentext.com/file_source/OpenText/en_US/PDF/opentext-wp-ai-powered-analytics-in-life-sciences-en.pdf)). The Allen Institute and IBM are two companies that are using AI to manage information about the coronavirus:

- In response to the COVID-19 pandemic, the Allen Institute for AI has partnered with leading research groups to prepare and distribute the COVID-19 Open Research Dataset (also known as CORD-19) an open research dataset for use by the global research community. The dataset contains more than 29,000 scholarly articles, including over 13,000 articles with full text, about COVID-19 and the coronavirus family of viruses. The data set was prepared by the White House and a coalition of research groups and licensed databases from the DrugBank, Clinicaltrials.gov and GenBank.
- IBM has implemented a corona-focused version of its Watson AI called Watson Assistant for Citizens on the IBM public cloud. This technology brings together Watson Assistant, Natural Language Processing capabilities from IBM Research, and state-of-the-art enterprise AI search capabilities with Watson Discovery. The technology is trained to understand and respond to common COVID-19 questions directly leveraging United States Center for Disease Control and Prevention (CDC) guidance and can be easily integrated into existing web or phone channels. The technology is currently at work in 17 countries (and counting) and is offered at no charge for a minimum of 90 days.

### **Artificial Intelligence Technologies Help Curb Fake News or Information**

A major area where AI is playing an important role is by helping to minimize the large amount of fake news, misinformation, and conspiracy theories that often cause confusion and panic in people. This confusion and panic has resulted in a rise in xenophobia and an increase in anti-Asian racism by misinformed people who blame Asians for the virus. Since fake news, misinformation and conspiracy theories have been made possibly primarily due to easy access to the Internet and social media, social media platforms such as Facebook, Twitter and Reddit have been proactive in fighting the war of misinformation linked to the coronavirus. Facebook AI has successfully removed millions of fake user accounts and is filtering posts.

## **ETHICAL CONSIDERATIONS WITH ARTIFICIAL INTELLIGENCE**

A theme issue in the AMA Journal of Ethics (February 2019, Volume 21, Number 2) presents ethical challenges that are unique to AI and must be identified and mitigated because of the potential of AI to threaten patient preference, safety, and privacy. Indeed, introduction of AI in healthcare does not come without risks -both ethical and non-ethical. Ethical considerations include issues of data and algorithms, privacy and security considerations, threat of cyberattack, accountability, transparency, reliability, safety and impact on patients and doctors. Elevating the ethical discussion to a futuristic/philosophical level, Kurzweil (Kurzweil, 2005) has written about possible future effects of AI on human health benefits, and on the future of Humanity itself. Kurzweil believes that advances in genetics, nanotechnology, and strong AI will make it possible to maintain the body indefinitely, reversing aging while curing cancer, heart disease and other illnesses. The development of strong AI, which he defines as machines that have human-level intelligence or greater, will accelerate the evolution of humans to a point where future machines will be human, even if they are not biological. While acknowledging that advances of AI come with a risk of abuse that range from viruses and nanobots to out-of-control machines, he submits that focus on countermeasures will be necessary such as allowing for investing in new genetics and medical treatments, monitoring for dangerous pathogens, and creating limited moratoriums on certain technologies. He concludes that the best defense for the risks of artificial intelligence is to increase the "values of liberty, tolerance, and respect for knowledge and diversity" in society, because "the non-biological intelligence will be embedded in our society and will reflect our values".

## **ETHICAL CONSIDERATIONS WITH COVID-19**

Overall, physicians have a responsibility to model ethical leadership and that does not diminish with the pace of work during a pandemic. The American Medical Association's (AMA) *Code of Medical Ethics* offers foundational guidance for health care professionals and institutions responding to the COVID-19 pandemic in Opinion 8.3, "Physicians' Responsibilities in Disaster Response and Preparedness," and Opinion 11.1.3, "Allocating Limited Health Care Resources." Opinion 8.3 sets out physicians' ethical obligations in situations of epidemic, disaster, or terrorism. The primary responsibility is to "provide urgent medical care during disasters," a responsibility that holds "even in the face of greater than usual risk to physicians' own safety, health or life." Acknowledging that the physician workforce is a limited resource, Opinion 8.3 stipulates that the risks of providing care to individual patients today should be evaluated against the ability to provide care in the future (<https://www.ama-assn.org/delivering-care/ethics/ama-code-medical-ethics-guidance-pandemic>).

Opinion 11.1.3 of the AMA Code of Ethics sets out criteria for allocating limited resources among patients in a variety of contexts, including triage situations where limited resources during a pandemic may include ventilators and personal protective equipment (PPE). The criteria include urgency of (medical) need, likelihood and anticipated duration of benefit and change in quality of life. Opinion 11.1.3 further directs health care professionals and institutions to give first priority to (a) patients for whom treatment will avoid premature death or extremely poor outcomes; (b) use an objective, flexible, transparent mechanism to determine which patients will receive recourse when there are not substantial differences among patients; and (c) requires that allocation policies be explained both to patients who are denied access to limited resources and to the public (<https://www.ama-assn.org/delivering-care/ethics/allocating-limited-health-care-resources>).

Since the aforementioned two opinions (Opinion 8.3 and Opinion 11.1.3) are applicable to more than the current coronavirus epidemic they are necessarily broad. As the pandemic continues to evolve and new issues continue to come to the forefront, the AMA is now offering guidance in (a) allocating personal protective equipment among health care personnel; (b) outlining responsibilities of leaders of health care teams in the context of pandemic disease; and (c) how to balance the needs of individual patients and those of the community at large in terms of stewardship (<https://www.ama-assn.org/delivering-care/ethics/ama-code-medical-ethics-guidance-pandemic>).

A business axiom states "you can't control what you don't measure." This is applicable during the current pandemic since initially there was little to no racial and ethnic data collected on COVID-19 patients. However, as this data became available it confirmed what public health experts expected: that poor and minority communities were affected the most. Many individuals with a lower socioeconomic status and who may also be a racial-ethnic minority tend to live in multigenerational households, hold jobs that require them to work directly with the public and take public transportation. All of these factors increase their risk of contracting the virus. In an attempt to address this issue the AMA joined the National Medical Association, National Hispanic Medical Association, Association of American Indian Physicians, National Council of Asian Pacific Islander Physicians and other physician organizations in a letter to Health and Human Services (HHS) Secretary Alex Azar requesting that HHS collect, analyze, and publicly post standardized data on COVID-19 patients' race, ethnicity, and preferred language along with their COVID-19 testing status, hospitalization, and mortality. The physician groups noted that although COVID-19 did not create circumstances leading to the inequality it continues to exacerbate them along racial and ethnic lines that affect housing stability, employment, healthcare access and food security.

## **SUMMARY**

In January 2020, a novel coronavirus, SARS-CoV-2 was identified. This disease, later named coronavirus disease 2019 (COVID-19) has been speedily spreading throughout the world creating perhaps the most challenging public health crisis in modern history since 1918 when the world was faced with Spanish flu - which killed at least 50 million worldwide. Clinical research and trials to treat and prevent the coronavirus are taking place globally. However, although several countries are working on trials to develop therapeutic drugs, antibodies and vaccines, it will take months before one can be tested and distributed widely. As a result, the impact of this virus on our lives will last for times to come. Already the pandemic has transformed the way we live our daily lives and the way we interact with each other. Cities and nations have shut down and people are engaging in social distancing. On a personal level people are looking for a way to connect with others during this time of isolation and also searching for information. From a broader, societal perspective, both research and information are needed to combat the COVID-19 pandemic.

Artificial Intelligence (AI) technologies are playing a considerable role in responding to the pandemic due to their potential to help understand COVID-19 as well as their potential to mitigate the disease. The technologies powering AI present a way to handle the large amounts of disparate data from multi-disciplinary scientists and clinicians from around the world who are working together to combat this pandemic. Technology powered by AI, big data analytics and Bluetooth and GPS are assisting healthcare providers in many countries to understand and manage the spread of Covid-19 in order to save lives. This concept paper presents an overview of some of the issues related to the pandemic including healthcare, ethical, economic and limited resource implications.

In conclusion, COVID-19 is a new phenomenon that is changing all aspects of life throughout the world. The implications of this virus are numerous and wide-ranging. Although the progress of Artificial Intelligence in healthcare has been acknowledged, there has also been criticism that it is lagging behind in terms of current policy and ethical guidelines. In 2018 Vasant Narasimhan, CEO of @Novartis stated, "We need to win the race of turtles..." commenting on how slow the industry is moving with regard to AI and data collection. Perhaps one could now say that 'what a difference a pandemic makes.' In less than two years, with the advent of COVID-19, it is obvious that the race is no longer being run by turtles. Major companies, universities and foundations are committing resources into fighting the coronavirus as scientists, clinicians, mathematicians, engineers, and social scientists from around the world and from diverse disciplines work together as a team to fight this pandemic. Moreover, their research studies tend to indicate the artificial intelligence technologies show promise in finding the solution for this pandemic and to mitigate and/or prevent future pandemics.

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