

Artificial Intelligence in Public Health: Facts and Hyperboles

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ABSTRACT

Artificial intelligence is any intuitive software that is capable of mimicking the human brain in terms of intention, contemplation, and judgment. The field of medicine has been revolutionized by artificial intelligence. It can provide substantial improvements in all areas of healthcare from diagnostics to research. Artificial intelligence can find acceptance in the healthcare environment only if human remains the master and technology the server.

Keywords: Artificial intelligence, Deep learning, Natural language processing.

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INTRODUCTION

The world, as we see it now, has been through three industrial revolutions and is in the midst of the fourth one.¹ The latter is being powered by automation-guided technologies and services that utilize cyber-physical systems, cloud computing, cognitive computing, Internet of things, and artificial intelligence.²

Technology is evolving at a fast pace. There is no sphere of life and no corner of the world, which has remained untouched by artificial intelligence (AI). The survivors of tomorrow would be the people who are able to keep pace with the change and the leaders would be the ones who master it. This is also in consonance with the Darwinian theory of species survival.

Definition

Artificial Intelligence (AI), a term coined by John McCarthy, Professor Emeritus from Stanford, in 1955, was defined by him as "the science and engineering of making intelligent machines."³

Artificial intelligence, in the simplest of terms, is a thinking machine. Any intuitive software that is capable of mimicking the human brain in terms of intention, contemplation, and judgment would fall under the ambit of artificial intelligence.

Basic Terms used in Artificial Intelligence

The field of medicine has been revolutionized by artificial intelligence.⁴ From automation to diagnostics to analytics to predictives to prescriptives, all have been impacted to a varying extent. It would be remissed without starting with the basic terminology in artificial intelligence.

- **Algorithm**—is just a series of precise steps, incorporated into a computer program, which are to be taken to solve a problem or execute a computational performance. The difference between a traditional algorithm and an AI algorithm is that a traditional algorithm takes in an input, some logic in the form of codes, and spews out an output. An AI algorithm, on the other hand, works out the logic between the given input and output, which can later be used to work with new input with minimum human intervention.⁵ Much of AI algorithm behavior emerges via learning from data or experience, also called as Software 2.0 by the alumnus of Stanford University Andrej Karpathy.⁶
- **Models**—Algorithms trained on a dataset to recognize a pattern.

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- **Machine learning**—Models trained on a historical dataset used to perform operations like clustering of like data, reduction in dimensionality, classification, and regression to derive actionable information with nil-to-minimum human supervision.⁷
- **Deep learning**—It can be thought of as scalable machine learning. It can assimilate unstructured data whether text, image, video, or voice, and can automatically discern information and patterns from the same. Also, it can self-teach.⁸
- **Artificial neural network**—Like neurons of human brain, artificial neural networks (ANNs) are comprised of node layers, which contain an input layer, hidden layers, and an output layer. Each artificial neuron is connected to another node. Each node has a weight and threshold associated with it. If the output of any individual node is above the specified threshold value, that node is activated, sending data to the next layer of the network.⁹
- **Natural language processing (NLP)**—NLP makes use of software programming that helps to read, understand, and derive meaning from human language. Natural language understanding (NLU) and natural language generation (NLG) are the two subcategories of NLP. Natural language understanding uses algorithms designed to understand human writings using a coded understanding of grammar, syntax, and semantics. Natural language generation uses algorithms designed to automatically transform structured data into human language. Natural language generation is considered the opposite of NLU.^{10,11}

Need for Artificial Intelligence in Public Health

The pace at which artificial intelligence is making itself indispensable to the public health is noteworthy. The reasons for the same may lie in the fact that globally, health systems are facing multiple challenges due to the following:

- Rising multimorbidity and disability due to aging and epidemiological transition.
- Higher societal expectations in the form of demand for better-quality healthcare services.
- Increasing health expenditures *vis-a-vis* the budgetary allocation.

These challenges exist against a setting of fiscal conservatism with misplaced strict economic policies that constrain investment in health systems. Also, the timeliness factor in taking care of an existing or foreseen health issue of public health importance is of paramount importance. Hence, it gives rise to the million-dollar question – if you do not have the time to get it right the first time, when will you have the time to do it again? Hence, accuracy and precision are the keys to the practice of precision public health.

Scope of Artificial Intelligence in Public Health

The traditional public health practice has been enhanced and enriched by the use of artificial intelligence. There are a few ways in which artificial intelligence actually scores over the traditional practice of public health. Artificial intelligence can:

- Access dark data or the apropos data. This is the data that are incidentally collected along with the sought information and usually are lying unused.
- Lend structure to semi- and unstructured data (text, images, and videos). This feature is somewhat like human intelligence but done artificially.
- Perform dynamic interactive modeling to study events of public health importance, e.g., evolution of outbreaks, evaluate the effect of interventions, etc., once the model is trained and fresh data inputs are made, it automatically transforms to spew out the new output without human supervision or intervention.¹²

Artificial intelligence in public health has widened and deepened the approach and scope of services. In public health arena, any intuitive software that is capable of the following would be labeled artificial intelligence:

- Perception—audio, visual, textual, and tactile.
- Automatic knowledge extraction and pattern recognition from data.
- Logical reasoning and decision-making.
- Prediction.
- Interactive communication.

Principles of Artificial Intelligence in Public Health

- People-centered—the benefits derived from artificial intelligence should align with the benefits to mankind.
- Ethically grounded—the basic ethics of autonomy, justice, beneficence, and non-maleficence should be honored at all times.
- Transparent—the hows and whys should be clear at all times to all people at whom artificial intelligence interventions are targeted.
- Data protection—the right to privacy and confidentiality of the information shared should also be taken into account at all times.

- Scientific integrity—respect for intellectual property rights, accuracy in representing contributions toward research, and collegiality in scientific interactions are the prerequisites for the effective collaborations of artificial intelligence in public health.
- Open to stakeholders—AI services and technologies should allow access to all stakeholders with very few constraints on their use.
- Non-discriminatory—there should not exist any prejudicial distinction either between the users or the stakeholders of the artificial intelligence technologies.
- Human-controlled technology—the control and modulation of AI technology should ultimately be vested in the humans.^{13,14}

Uses of Artificial Intelligence in Public Health

Artificial intelligence implementation fields are ramping up and there is a wide spectrum of opportunities that are evident in the healthcare. Some of the important ones are:

- Monitoring and prediction of health and health-related events: Public health surveillance driven by intrinsically heterogeneously collected data. Traditionally done with statistical techniques is now being replaced by AI-driven analytics and domain knowledge and context-rich predictions. Dashboards for public health surveillance have been developed to display health incidents geographically and temporally using data from social media and web-accessible news sources.¹⁵ Early and accurate recognition of health anomalies and disease outbreaks forms the mainstay of public health surveillance.¹⁶ A syndromic surveillance tool called SENTINEL has been devised, which uses natural language processing and neural network algorithms. More than 1.8 million tweets are processed per day to predict the occurrence of diseases and to identify potential outbreaks.¹⁷
- Compiling and analyzing the big medical data: AI needs silos of data to build its intelligence and big data makes AI more powerful. This synergistic combination results in quicker, more accurate, and intuitive outputs.¹⁸
- Accelerating research and diagnostics: By scouring both scientific literature databases and patient-level data, AI can expedite the diagnosis-making process and the development of a new drug molecule. Artificial intelligence has been proven to be especially effective with copious amount of radiology data to improve the quality of medical imaging services.¹⁹
- Optimizing allocation of healthcare resources: The AI ecosystem can help streamline the work and material flow, thus avoiding duplication and missed areas.
- Widening the reach of digital consultations: AI can facilitate point-of-care diagnostics and therapeutics in difficult-to-reach populations, in terms of time and distance.
- Facilitating clinical decision-making: Diagnostic and therapeutic procedures are difficult for the reason that the healthcare professionals have to examine the patients thoroughly and differentiate from diseases with similar symptoms, weigh all the available therapeutic options, their potential side effects, and many other related aspects. An AI application known as Watson has been created by IBM, which is able to perceive, “understand”, and make decisions based on natural language. It also helps in diagnosing and making treatment plans for oncology patients. Using Watson, information can be generated from millions of medical reports, patient records, clinical trials, and medical journals. Artificial intelligence clinical decision support systems are based on big data on biomedical literature and more often

than not hit the bull's eye faster and more accurately than the physical healthcare provider.²⁰⁻²²

- Automating administrative functions: Due to the repetitive nature of certain administrative or computational functions, AI scores over the health team by not getting fatigued and slowing down.¹⁸

COVID and Artificial Intelligence

COVID-19 took the world by surprise in 2019 when it emerged in the city of Wuhan in China, leaving devastation in its wake. There was a dramatic loss of human life worldwide. COVID-19 presents an unprecedented challenge to public health, food systems, and the world of work. Much of the world was already burdened by less than adequate resources to combat the scourge of malnourishment, and other common communicable and noncommunicable diseases when the pandemic forced its way to the center stage. Artificial intelligence along with the human endeavor rose to the fore as the saviors.

The main AI applications in areas during COVID times are as follows:

- Epidemiology and dashboard for COVID-19: There have been 753,479,439 confirmed cases of COVID-19 globally, as of 31 January 2023. These include 6,812,798 deaths. A total of 13,156,047,747 vaccine doses have been administered as of 23 January, 2023. These data come from the World Health Organization dashboard, which has been made possible by artificial intelligence. The dashboard is responsive to daily inputs from different parts of the world and helps see the composite picture of COVID-19 at a glance.²³
- Identification of climate and temperature as risk factors for spread of COVID: It was seen that climatic and geographic patterns of a place have a great role in the development and spread of COVID-19. To find this causal relationship, Pramanik et al. applied a boosted regression tree (BRT) model in 228 cities across three climatic zones. The number of COVID-positive cases decreased dramatically above an average temperature of 10°C in France, Turkey, US, UK, and Germany.²⁴
- Prediction and disease modeling: Rapidly evolving artificial intelligence and big data have brought new changes to traditional infectious disease modeling. AI analyzes unstructured data, which can be used to monitor and predict the spread of COVID-19. Utilizing the susceptible–infected–recovered–dead (SIRD) pandemic model for the United States, Russia, China, and the Syrian Arab Republic, Al-Raei et al. found the coefficient values of the COVID-19 infection, recovery, and mortality. It applied the method for the other countries with the COVID-19 pandemic and determined the pandemic reproduction rates.²⁵
- Contact tracing: Contact tracing has been a key public health response in combating COVID-19. Mobile technologies were used extensively for contact tracing. The data collected by using GPS, cellphone, Bluetooth, and AI helped decision-makers understand and manage the spread of COVID-19 within their communities. Preservation of personal privacy was the main emphasis while using mobile technology to address COVID-19 spread.^{26,27}
- Rapid diagnosis: Chest CT became a valuable diagnostic tool for clinical management of COVID-19-associated lung disease. Artificial intelligence (AI) deep-learning trained models were used for differential diagnosis and rapid evaluation of CT scans of COVID-19. A multinational cohort study was done on 1280 patients to localize parietal pleura/lung parenchyma followed by classification of COVID-19 pneumonia. It showed up to 90.8% accuracy, 84% sensitivity, and 93% specificity.²⁸
- Progression and prognosis of COVID: Automated COVID-19 prognosis systems using IoT and machine-learning algorithms were used in many parts of the technology-enabled world to predict the progression and prognosis of the patient of COVID based on the four most common symptoms. The success rate of prediction was found to be up to 80% accurate with the following four symptoms, i.e., fever, dry cough, breathlessness, and sore throat.²⁹
- Effect of COVID on the mental health: The mental health of the masses was affected in a grave manner by COVID-19 pandemic. The uncertainty and the frailty of life were underlined and it led to the production of a lot of mental symptoms in the masses. It was amplified by social isolation, unemployment, inadequate moral support, and fear of getting infected and infecting others. Effects on mental health due to racial discrimination were researched by Choi et al. by using the ANN model. They targeted the Asian population in the United States during the COVID-19 pandemic.³⁰
- COVID-19 chatbots: Chatbots are AI-based virtual conversational agents. Chatbots application can enable to interact or communicate between human and computer in natural language. Computers can understand text in the same way as humans can, with natural language processing. Chatbots can provide information about symptoms of COVID-19, transmission, personal risk assessment preventive measures, medication health and travel advisories, and official government helpline numbers for further assistance. To provide instant information during the COVID pandemic, WHO and Centre for Disease Control and Prevention (CDC) had built in chatbots in their websites. WHO launched chatbot on Facebook Messenger. People were educated about the disease in different languages like English, Spanish, French, and Arabic. The government of India also launched chatbot to handle queries related to COVID-19.³¹
- COVID vaccination slot engagement: Co-WIN application was launched in India for the purpose of registering, appointment booking, identity verification, vaccination, and certification of the vaccine beneficiaries. The application also helped locate the nearest vaccination center. At the other end, real-time data entry was possible, and inventory stock was automatically updated.

Limitations to Use of AI in Public Health

There always remains a possibility of data breach in the AI systems to either gain access to sensitive data or spam with biased data in ways that might not easily be detectable.

- **Transparency and accountability**
Sometimes, it is extremely hard to find the underlying logic that generates the outputs produced by AI. Machine-learning models can be particularly opaque because of the way they continuously evolve as they learn. This creates problems in validating the outputs of AI systems and identifying errors or biases in the data.³²
- **Effect on patient care**
If artificial intelligence (AI) technology are utilized to replace staff or family time with patients, there have been concerns about a loss of human touch and an increase in social isolation.

• Effect on healthcare professionals

Many feel that their autonomy and authority are threatened if their expertise is challenged by AI. Instead of taking into account the interests of individual patients, AI decision support systems may be directed by priorities like cost-effectiveness or broader public health issues.²²

CONCLUSION

Artificial intelligence can find acceptance in the healthcare environment only if human remains the master and technology the server. The case in point being, healthcare workforce, the heart of any healthcare ecosystem, being in the driver's seat and the artificial technology serving by abstracting the transactional or computationally complex tasks. Humans will still be an important part of healthcare delivery. Artificial intelligence is used to support clinical decision-making rather than replace human interactions.³³ Also, the influence of AI on the field of medicine and public health would have been much greater but for the fact that most of the gains in artificial intelligence have been by-products of the efforts made in the computing or financial world. The algorithms and models have been adapted to fit the needs of medicine rather than being custom-made for medicine. So, probably (wo)men in blue need to be at the helm to boost efforts to that effect.

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