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How government can use AI and ML to identify spreading infectious diseases

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Abstract— *Infectious diseases like Spanish Flu,TB,Ebola,SARS and influenza have been some of the leading causes of deaths around the world especially in low-income countries despite the progress made in medicine. The previous outbreak of Ebola,SARS and influenza around the world shows that these infectious diseases are have become a constant threat to human existence. Healthcare stakeholders and researchers have found innovative ways to support the health care sector especially efforst toidentify the the spread of infectious diseases [1]. The application of machine learning and the use of artificial intelligence is currently changing the way the spread of the diseases is addressed by modeling the course of the virus and also finding new strategies for containment. While governments around the world collaborate with local officials and healthcare professionals to monitor, respond to and slow the spread of infectious diseases, health experts utilize predictive modeling to improve current intervention to avoid further infections. The development of mathematical tools allows scientists to better predict the spread of infectious diseases, consider each pathogen's specificities and define possible priorities for the delivery of vaccines. Big data analytics can be invaluable in responding to deadly outbreaks, as they can analyses massive quantities of information, like health information, trends of human behaviors, and environmental factors [1]. This research aims at exploring potential applications of machine learning and artificial intelligence by governments in identifying the spread of infectious diseases. This section covers a variety of selective applications to explain how artificial intelligence and machine learning advances the control of infectious diseases like TB,influenza and Spanish Flu and how it allows health institutions to better address them.*

Keywords-Artificial intelligence, machine learning, infectious diseases, AI models,

I. INTRODUCTION

Infectious diseases pose a constant threat to public health. Proactive disease control programs should involve response programs but they are often hampered by scattered data sets and poor analyses [2]. Incomplete data, low information processing, lack of understanding of the causal factors, large misunderstanding of the infection system, and lack of intelligence into effective action are some of the aspects that impact the infection mechanisms. Precise evaluation and prediction of virus outbreaks are achieved through effective disease-management practices [3]. Timely evaluation promotes successful coordination and medical, human, and pharmaceutical resource mobilization. Incorporation of information on the history of pathogens, endemic strains, external factors, people's housing and culture, and local health infrastructures may have a significant role to play in identifying areas where outbreaks most likely occur.

Tuberculosis (TB) is one of the top ten infectious diseases that cause manly deaths globally. For undeveloped countries, conventional methods are utilized in diagnosing TB. Conventional approaches like blood, tissue culture, and biopsy are used to produce the diagnostic results. These methods are tedious and can normally take as long as 1-2 weeks or even longer. Hence, numerous studies have been performed to reduce the diagnosis time and enhance the precision of the diagnosis. For the past five decades, advanced and sophisticated developments in the fields of medicine and computer science have paved the way in identifying TB. Diverse Machine Learning (ML) algorithms in AI have encouraged the interest in Computer-aided Detection (CADe) and Diagnosis (CADx) methods. These methodologies help to diagnose diseases by assessing the clinical signs and symptoms and utilizing radiological images. They have been used to diagnose tuberculosis. Advances in AI algorithms have made excellent progress especially in identifying the manifestations of TB. Late on, several attempts were made to devise techniques to enhance the precision of TB diagnosis classifications using AI and Machine Learning.

As communication and information technologies advance and data collection programs have

been increased since the beginning of the new millennium. The amount of data collected to track infectious diseases has risen significantly. Data and analytics have become useful for tracking and predicting the disease trajectories to combat the spread of the disease. AI involves the use of mathematical tools "machine learning," to computationally learn patterns in a dataset [4]. The AI incorporates these patterns into a decision. The capability of machine learning to analyze large volumes of data and provide insight will result in deeper disease awareness and allow health and public officials throughout the whole creation of an outbreak to make better choices. Infectious disease prevention, control, and monitoring can be easily achieved through artificial intelligence (AI) and machine learning. Big data applications can be indispensable in coping with dangerous and deadly outbreaks [5]. The ability to easily monitor, interpret and diagnose different infectious processes using solid data sources in real-time can not only help to establish better structures for the patterns of trend tracking and prevention of disease but can also help avoid premature deaths [6].

II. RESEARCH PROBLEM

The research problem I focused on in this paper is how governments can utilize artificial intelligence and machine learning in identifying the spread infectious diseases. For a long time, the spread of infectious diseases has caused a lot of damage to people's lives while also putting pressure to many healthcare systems. There are many ways this can be mitigated through technological advancement such as artificial intelligence and machine learning. The increased burden on the healthcare system as a result of infectious diseases like SARS, TB, H1N1 among others arise due to a lack of adequate technological know-how on how to stop the spread of the diseases. Medical tools are not enough to mitigate the negative impact caused by these diseases. This problem affects all people from different backgrounds causing the huge loss of lives and overburdening the people and health care with huge medical expenses. The research will address how artificial intelligence and machine learning can be utilized by the government in identifying the spread of infectious diseases. There have many attempts to address the problem but the dynamics of infectious diseases keep changing leaving the interventions with minimal effect. Infectious diseases caused the greatest number of premature deaths and illnesses in the world during the 20th century [7]. At the beginning of the last century, infectious diseases like the Spanish flu caused a lot of deaths worldwide. One-third (500 million) of the global population is believed to have been infected and developed symptoms during the pandemic of 1918–19 making it the most devastating influenza pandemic. At least 50 million people were estimated to have died after the outbreak. In the first quarter of the 20th century, the impact of the pandemic was not limited because almost all influenza A infections were caused by a 1918 mutated virus [8]. Although it is necessary to understand the intent of why the pandemic has emerged without referring to the virologic or immunological element of influenza infections. The flu pandemic of 1918 led to the spread of the virus was enabled by close contact, poor hygiene, and uncontrolled mass movement especially by troops and people [9]. Even with the United States being far away from the war zones, it reported more than 600,000 deaths. Many of the countries which joined the war "failed" to report on the influenza death toll. Infectious diseases had not yet been recognized at that time, and there had been no diagnosis, treatment, and control.

III. LITERATURE REVIEW

A. *AI and Modelling for better decision making*

Traditionally, surveillance and expert opinion have been used extensively in the process of tracking infectious diseases [10]. Upon collection of surveillance data, public health authorities communicate with the relevant experts, and drastic precautions are initiated and enforced to manage an infectious disease outbreak. These interventions are therefore not always co-ordinated effectively and do not take place quickly enough to allow fast decision-making to limit mortality and morbidity. Modeling is a method that bridges the gap in decisions regarding the prevention of infectious diseases by using quantitative data to predict the outbreak trajectories [11]. These models are developed by public health authorities to intervene early on to avoid the spread of an outbreak of infectious disease.

The Susceptible-Infectious-Recovered (SIR) model is a good example of such a tool. This sort of mathematical model classifies populations based on the infection status: currently infectious, susceptible to the infection, or recovered. Shifts in these states are regulated by several parameters within the mathematical model which must be measured. To predict its efficacy, the results of possible outbreak control steps may be integrated into the model [12]. Many parameter values can be configured for this model instead of one value for each parameter. It helps officials of public health to conduct a sensitivity analysis, which shows how the results can change if the predicted values are erroneously present. The SIR model is now available online for widespread implementation. Modeling is an effective public health strategy since it can easily predict the course of infectious disease and the results of potential control steps. To track the development of antibiotic resistance, an additional model, known as Resistance Open, gathers information accessible to the public from different institutions, particularly community health providers, and state and international organizations [13]. The model shows details on a map that officials can use.

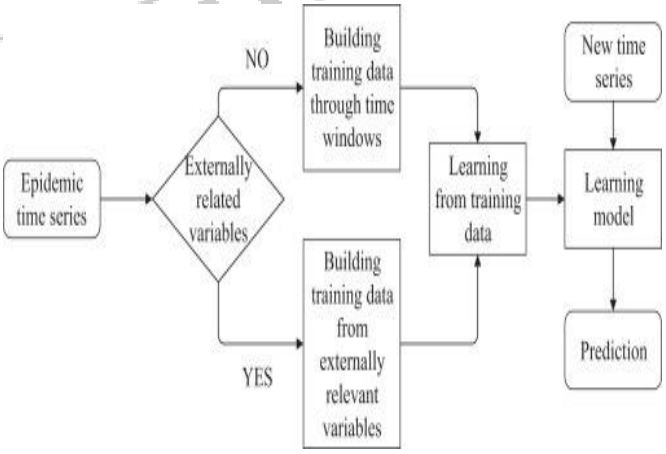

Fig i: An AI framework for predicting infectious disease

B. *Artificial intelligence and machine learning in health care*

Infectious diseases are rapidly evolving can impose serious morbidity and mortality. Despite major advances in infectious disease detection, treatment, and prevention, the proliferation of new diseases is a major concern for the global community, highlighting the need for stronger countermeasures. The novel Spanish flu disease which was

a deadly influenza virus caused by the H1N1 influenza A virus in 1918 is a good current example.

To minimize the negative impacts of an outbreak, it is important to process and interpret relevant data rapidly. These data can be divided into levels of molecular, patient, community, and culture, all of which lead to effective prevention and care [14]. However, because of the enormity and complexity of the challenge, this has been quite problematic. Even so, in developing, biological insights into a new infectious disease strain and handling new outbreaks has been the increasing power of AI can provide a solution. AI is a significant scientific principle in which a computer-based framework imitates human intellectual processes. Machine Learning (ML), a sub-discipline of AI, builds systems without specific programming with the ability to interpret data sets using statistical models. The machines learn by analyzing training data and discovering correlations. The great benefit of AI is the capacity to process the immense amount of regular output of medical and biological data, a task that would otherwise not be feasible coupled with a large scale and complexity. Human beings will plan for and adapt to the impact of newly emerging infectious diseases by implementing this technology strategically.

In the public health and academic fields, the resources to exploit AI to predict outbreaks are not only attracting public attention. One example is the AI software to monitor possible outbreaks of dengue fever which was developed by a Malaysian company, AIME Healthcare. The monitoring system not only uses current case data, and also makes data-driven projections on the likelihood of future outbreaks. The framework provides a mechanism for prioritization designed to support public health officials identify how their resources are best distributed. To help public health experts, plan for possible dengue outbreaks, the organization also partnered with the governments of 5 countries.

While artificial intelligence (AI) is incredibly complex, a big breakthrough in the battle to rid the planet of some of the most devastating infectious diseases may be the effective application of predictive analytics [14]. One of the first approaches to using AI algorithms is to support public health authorities fine-tune their strategies for health promotion and prevention awareness. Prediction of infectious disease will become easier as more and more medical knowledge is dependent on technology that incorporates accessible data. Major companies, like Microsoft, use AI to work with many major health providers (e.g. Adaptive Biotechnologies) to decipher the human immune system to exploit the corporation's "machine learning as well as cloud computing capabilities" to facilitate bioinformatics research of T-cell or B-cell receptor DNA sequence information that make up the immune system [15]. When data has been collected it is processed by AI to create a "universal T-cell receptor/antigen map" of the disease. The overall objective is to assess a standardized blood test that checks the immune system of a person to identify many diseases in the initial stages. Not only would the blood test allow researchers to assess the susceptibility of a person to a specific infectious disease, but it would also assist in personalize therapies depending on the immunological background of an individual, particularly diseases dealt with in the past. This shows the potential of AI to complement the human element and modern technology at its highest quality.

The use of AI by IBM to help healthcare practitioners and many healthcare stakeholders to enhance the prevention and care benefits of those who have or are vulnerable to infectious diseases. The Watson supercomputer program from IBM has the potential to gain insights that use a large data set. In essence, this requires prompt steps to treat the disease with quality standards as defined by AI, supporting the healthcare professionals. Data integration and aggregation are supported by AI solutions, providing preventive measures for both high-risk patients and the general public [16].

D. Exploiting Electronic Health Record Data

Simple strategies, such as using electronic health record information –eliminating patient identifiers – are now the most valuable resource for monitoring risks of infectious diseases, vaccines, and the efficacy of drugs [14]. These tools can now be widely used in the healthcare sector to promote improvements in the identification and future diagnosis and treatment of infectious diseases. AI offers evidence-based using the most up-to-date wide information which contains research results, allowing rapid responses or improvements to an evolving epidemic of infectious disease. Such studies will also help to warn on any new pathogens not currently identified in a specific geographical area. The innovations are now incorporated into mobile devices for quick access to clinical data in the healthcare process. Cloud-based AI data can be submitted to mail listservs, search engines, and electronic databases that allow targeted clinical queries to be accurately stored for urgent use based on multiple chunks of data [15].

The implementation of such strategies has at times proven sluggish in terms of consumer acceptance irrespective of the current electronic tools. Data sharing is critical to the successful implementation of the proposed system of public health monitoring but does not take place frequently because of data confidentiality and safety issues. Nevertheless, robust software systems that are necessary for public health experts and microbiologists have been created to protect the privacy of individual patients, while enabling comprehensive data collection may be incorporated into the software.

IV. SIGNIFICANCE OF AI AND ML MODELS IN IDENTIFYING INFECTIOUS DISEASES WORLDWIDE

Most scientists have over-driven themselves to gain more insights into identifying and understanding the nature of most infectious disease. There has been increased research on the way it spreads and develops its vaccine. A rather reported reality is that technological advancements have been accomplished. Artificial intelligence (AI) in general has worked tremendously in assisting in this huge initiative to increase the human understanding of various diseases. The core main driving force for AI is machine learning. Essentially, it takes huge volumes of data – known as big data – and aims to find trends in data. This makes it possible to identify future results and to discover new insights into the data [16]. These estimates can be allocated with a high degree of confidence by using vast volumes of data.

AI and ML have been significant in the world in understanding and tracking the spread of infectious diseases. Countries such as South Korea and Germany have seen the amount of research carried out by these countries as effective in controlling infectious diseases. Health authorities, therefore, want to increase their numbers but the most important methods of research are time-consuming and labor-intensive [17]. However, AI supports other research types like radiation screening today. Several chest-screening AI services have emerged to identify lung anomalies in a chest X-ray scan as well as provide even

quicker risk assessments of infectious diseases which is faster than human radiologists

Another significance of AI and ML to the world is helping in the battle against infectious diseases by minimizing contact between people. Over the past few years, some AI-based robots have helped to reduce the risk of cross-infection by reducing the close contact between patients and medical staff [17].

V. CONCLUSION

Artificial intelligence systems have become an integral part of our lives and for the good of global communities in transforming the health sector. It has supported medical researchers to produce identify diseases and develop new vaccines and pharmaceutical products while guaranteeing patient safety, the efficacy of drugs, precision, and reliability. For infectious diseases like Spanish flu, the application of AI through proven and innovative machine learning methods is crucial. In addition to the development of biological studies, AI and ML technologies complement high-volume data in identifying infectious diseases and ensuring quick analyses. This allows faster decision-making to help policymakers, healthcare practitioners, and organizations to respond to future infectious diseases.
Machine learning offers a diverse range of benefits that are versatile enough to allow their use in identifying and analyzing the nature and stage of infectious diseases. The large amount of data generated while analyzing the nature of the disease helps machine learning experts to analyze and quickly identify patterns that would otherwise take long to extract utilizing conventional mathematical and statistical methods. Flexibility, adaptability, and the absence of human bias makes data driven decisions a highly flexible new method to handle new infections based scientific insights. However, the need for greater quality assurance during the collection of data, storage, and analysis has become more important with the increased capacity to reap benefits from large quantities of data. Moreover, standardizing population-wide data structures will enable the systems to adjust and forecast the future of infectious diseases worldwide, which has not been possible in previous years.

If properly used, AI systems can be very effective and support existing healthcare systems and their expansion. However, the role of the data in any effective AI-supported system is often not sufficiently emphasized. Based on the different electronic and social media feeds obtained, data sets prove to be invaluable. Besides, various publications have been compiled and evaluated by electronic systems, which together produce a large database of information for us to learn from and inform decision making in health care. Thus, AI would allow health professionals to make more coherent use of the data collected, to provide the essential components for making intelligent health networks that help patients access health care from healthcare professionals, and to improve its trajectory. To combat infectious diseases, AI has made a significant impact. Most health applications have been implemented by AI but often slower than expected. However, AI will become more common in national health systems in years ahead when to fight future infectious diseases.

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