Artificial Intelligence Applications in handling the Infectious Diseases

Kamal Jain

Data Science Evangelist, Mentor, United Arab Emirates

Corresponding Author*

Kamal Jain

Data Science Evangelist, Mentor, United Arab Emirates

Tel: + 971568365822

Email: kamaljain777@gmail.com

Abstract

Infectious diseases can be caused by direct or indirect transmission of microorganisms such as virus, bacteria, parasites or fungi. The spread of these diseases and infection may cause global pandemic like COVID 19. Advancement of Artificial Intelligence can help the scientists in predicting the infectious diseases to contain the spread of pandemic, understanding the behavior of microorganisms and also help in faster drug discovery to contain the disease. Artificial Intelligence provides new confidence to not only preempt, prevent and control the spread of infectious diseases, but it also helps the scientists in faster clinical trials and identification of effective drug discovery for tacking the diseases. Artificial Intelligence is at the cusp of revolutionizing the healthcare system via focused, disease specific analysis and interventions to promote faster, more reliable and economical healthcare solutions for the well-being of human kind. This article discusses potential applications of AI which can assist the health institutions and global community health by combating the rise of infectious diseases.

Keywords: Artificial intelligence; Healthcare; Health tech; Infectious diseases; COVID-19; Community medicine

Introduction

The impact of infectious diseases on the health of global population and economy is significantly enormous. The preparedness of healthcare system capabilities to handle any pandemic threats remains need of the hour. As the world is waiting for an effective vaccine against COVID-19 virus, digital technologies such as Artificial Intelligence (AI) is playing a vital role in research studies, biomedical experiments and clinical trials across the globe. Artificial Intelligence techniques including Machine Learning and Deep Learning can demystify the protein structures of the virus and also in in predicting the effectiveness of vaccine, which can produce antibodies in the human body to fight the virus. AI models can be used to analyze the latent patterns in huge amount of data to accomplish complex task of classification, prediction much faster. Machine Learning models and artificial neural networks (ANN) can be trained on various large samples of structured and unstructured data of the impacted cells to predict the best possible route for killing the virus [1].

Artificial Intelligence is playing a significant role to contain Novel COVID-19 virus and aiding global influenza tracking platforms by predicting novel influenza outbreak across different places and provide real time insights on disease spread by analyzing social media communications to track potential outbreak events. Applied Artificial Intelligence applications can help the humankind in practicing preventive behavior to proactively prevent and handle spread of infectious diseases.

Artificial Intelligence can significantly aid the global healthcare system by playing crucial role in epidemic forecast, clinical diagnosis and drug development. Investment in healthcare technologies with focus on most prone population groups can help prepare the global communities in any disease outbreak detection, surveillance and containment [2].

This article will discuss the role of Artificial Intelligence in healthcare, which can help the human population in tackling infectious diseases.

Artificial Intelligence for Containing Pandemic

Infectious diseases pose serious threats to the community health. Based on the recent outbreaks of various flu, increased population density and mobility plays a vital role in the binge of emerging infectious diseases, which may potentially lead to pandemics. Gathering of people in limited space and interconnected links with the affected patient can further enhance the probability of spreading the disease. The reproductive number of the pathogen and the spread out rate of the disease will be different across various geographies considering the variation in the population density, demographics, environments and the behavior patterns.

Artificial Intelligence can not only help in providing real time insights on the spread of disease by processing vast amount of data but also can help in predicting the new epicenters of the pandemic. The contact tracing, population movements can be analyzed via AI models to enable preemptive detection, identification, and comprehension of pandemic outbreaks. Figure 1 below depicts general conceptual framework for disease spread. Infectious diseases such as COVID 19, SARS are most transmissible, when the susceptible group has low immunity and are more vulnerable e.g. if they are sick from other diseases or are hospitalized.

In the current era of technology advancement, AI models are widely playing crucial role to analyze massive data from various sources of infectious diseases such as national surveillance systems, sentinel reporting systems, genome databases, outbreak investigation reports, vaccine reports, human dynamics information, social media platforms, internet search queries, vaccine reports, human dynamics information. Influx of huge data volume, integration of data under master data management and knowledge extraction is enabling the AI application to surface out the latent trends. Artificial Intelligence is further helping in pandemic modeling and simulation of the diseases spread information, for the policy makers to take effective healthcare measures. Figure 2 depicts the disease knowledge discovery using AI.

Figure 2 provides crucial information to the administration and healthcare institutions to plan the mitigation approaches, and healthcare capacity planning to contain the spread of pandemic.

Artificial Intelligence for interpreting Disease Pandemics

Artificial Intelligence models are becoming more efficient to reach human performance on complex healthcare tasks for interpreting the entomological characteristics of pathogens. It is an essential activity to analyze and control the vector borne diseases. In order to understand the various images, mathematical modeling of various viruses and infections can help in understanding the dynamics of the pathogens. Figure 3 depicts, how computers translate an image in the vector form. In order to handle the massive pandemic, elimination of the vector is critical. Many viruses have shared events and common processes such as viral replication cycles, which is needed for productive infection. Disruption of this process can impair the spread of virus. From a therapeutic point of view, the process of modeling and simulating the molecular-level dynamics of SARS-CoV-2 in detail at every stage in addition to the virions themselves is important and desirable in such situations and can greatly aid understanding and management of infection with the virus.

Artificial Intelligence can support the structural biology advancements as powerful tools to compliment experimental techniques with mathematical modeling and simulations. Artificial Intelligence and computational approaches can also help in bridging information gaps among experiments through reporting in different temporal and spatial domains in addition to their considerable predictive powers.
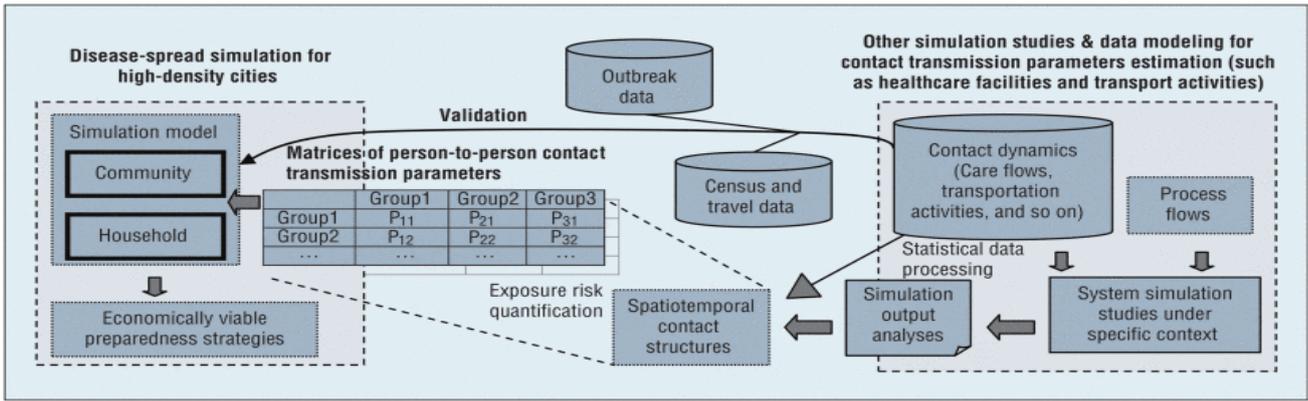
Figure 1: Critical social contact simulation model for high-density metropolitan areas; (P = parameters) [5].
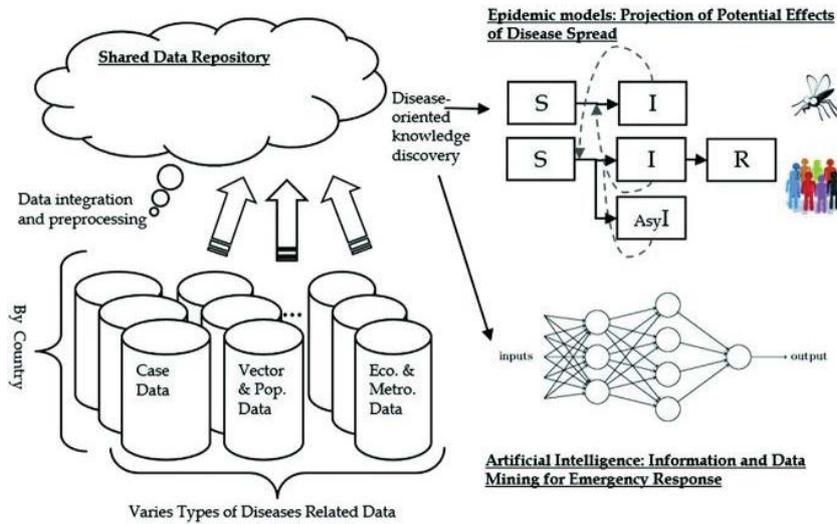
Figure 2: Integrated conceptual model for infectious diseases using AI [6].
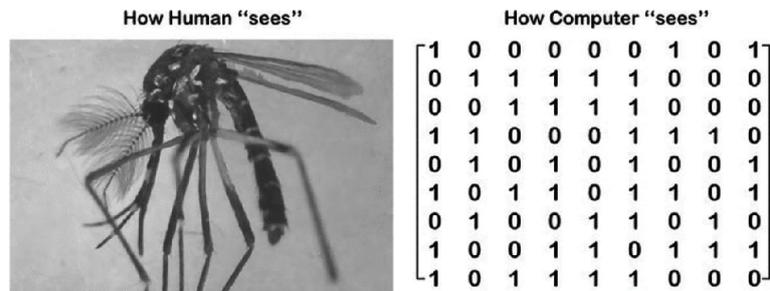
Figure 3: Human vs. AI systems image interpretation [1].

Table 1: Example AI models to track health-behaviors during infectious disease epidemics.

Types	Examples of methods used	Functions
Supervised method	Support Vector Machine (SVM), Decision Tree, Random Forest, Naive Bayes (NB), Artificial Neural Network (ANN), Bootstrap Aggregating, AdaBoost	The primary function of these methods is to create prediction outcomes to warn authorities and public in advance on potential infectious disease epidemics, thus suggesting immediate prevention and control strategies
Unsupervised method	Principal Component Analysis (PCA)	This method aims to reduce data dimensions to enable researchers easily uncover key factors causing infectious disease dynamics
	K-Means	This method clusters patients for abnormality detections
	Latent Dirichlet Allocation (LDA)	This method enables data extraction from medical contextual records
	Deep Learning Architectures	This method facilitates prediction and classification, social network filtering and applications of bioinformatics in infectious disease analytics
	Structural Equation Model Trees	This method allows estimation of complex cause-effect relationship models with latent variables

Figure 4: Summary of various AI approaches to address the COVID-19 pandemic [4].

Table1 above depicts some of the common examples of machine learning, deep learning models which can be utilized to track health seeking behaviors during infectious disease epidemics [3-6].

Artificial Intelligence (AI) systems leverage cognitive computing, deep learning, convolutional neural networks, and machine learning and can play a crucial role in detection, large-scale screening, monitoring, reduction of caregiver workload, and prediction of possible interactions with the new therapies for this virus. Figure 4 depicts the summary of various AI based approaches to contain the COVID-19 pandemic.

Conclusion

Artificial Intelligence systems are becoming indispensable part of our life to transform the healthcare sector for the benefit of global communities. It can help the medical researchers to develop new medical vaccines and drugs, while ensuring effectiveness, accuracy and reliability of the medicine for patient's safety. Application of AI through the use of both existing and novel machine learning approaches can be pivotal in addressing infectious diseases such as COVID-19. Along with the advancement of biological research, AI applications compliment in faster analysis of high volume infectious diseases data to provide faster decision making capabilities to support the policy makers, medical professionals and healthcare institutions for responding any future diseases.

References

1. da Silva Motta, et al., "Use of Artificial Intelligence on the Control of Vector-Borne Diseases." Vectors and Vector-Borne Zoonotic Diseases. (2018).

2. Davies, S. E. et al., "Artificial Intelligence in Global Health." *Ethics & International Affairs*, 33(2) (2019), 181−192.

3. Dey, S., et al., "All for one and one for all: Why a pandemic preparedness league of nations?" *Health Policy and Technology*, 9(2), (2020), 179−184.

4. Ganasegeran, K., & Abdulrahman, S. A. "Artificial Intelligence Applications in Tracking Health Behaviors During Disease Epidemics BT" Human Behaviour Analysis Using Intelligent Systems (D. J. Hemanth (ed.); pp. 141−155). Springer International Publishing, (2020).

5. Tsui, K., et al., "Tracking Infectious Disease Spread for Global Pandemic Containment." *IEEE Intelligent Systems,* 28(6), (2013), 60−64.

6. Wong, Z. S. Y., et al., "Artificial Intelligence for infectious disease Big Data Analytics." *Infection, Disease & Health*, 24(1), (2019), 44−48.

Cite this article: Kamal Jain. Artificial Intelligence Applications in handling the Infectious Diseases. Prim Health Care, 2020, 10(5), 351.