AI and Automation: What Will Our World Look Like?

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Growing up with movies like *I, Robot* and *The Terminator* have instilled an existential fear of AI and automation. Indeed, Hollywood has done their best to convince you that one day, that self-driving car will decide to put the brakes on you, if you know what I mean. However, is that really a reflection of the reality we are facing? While we can never rule out the possibility of subjugation by our robotic overlords, that scenario is one which likely won't occur. Realistically, AI and automations applications in our future looks like it will be overwhelmingly positive.

Before we discuss some of the specific applications which could become integral in the future, we must quickly define AI and automation. Automation is a hardware or software which carries out a methodic task automatically, with no need for human input. Artificial intelligence is much more complex. Artificial intelligence is really the science of machine learning, whether that be learning which imitates human thought processes, or learning from itself.

Artificial Intelligence and Alzheimer's Detection

Alzheimer's Disease has always been among the most destructive and debilitating cognitive diseases. With no cure and its inherently sneaky manifestation, it is an immense challenge to combat. One of the worst aspects of the disease is that by the time the disease has presented itself through definitive symptoms and a diagnosis has been made, too many neurons have often died and mitigation is the only resulting option[1].

In order to combat this disease, Dr. Jae Ho Sohn, a resident in the Department of Radiology and Biomedical Imaging at UC San Francisco has employed a new approach aimed at early detection in order to combat the disease pre-emptively and effectively[2]. Sohn has utilized an artificial intelligence algorithm which analyzes PET scans in an effort to provide an extremely early and accurate form of Alzheimer's detection. PET (Positron Emission Topography) scans provide measurements for molecules within the brain such as glucose[3]. As a primary fuel for the brain, glucose levels provide good indicators for Alzheimer's because as the disease manifests, the less glucose is used by the brain, specifically in the frontal and parietal lobes[4].

Due to the sluggardly nature of the disease, human perception of these changes in early detection is often hindered by the subtle change in glucose levels. Sohn trained the algorithm by supplying it with a massive library of PET scan images from individuals who were eventually diagnosed with the disease which was provided by the Alzheimer's Disease Neuroimaging Initiative[5]. Through its analysis of the images, the algorithm began to find specific early indicators of the disease. The algorithm was then tested twice by scientists to determine its effectiveness. For the first test, the algorithm was presented with 188 images from the ADNI which the algorithm had never examined. For the second test, the algorithm was provided with new scans from 40 patients who had come to UCSF Memory and Aging Center[6]. The results of initial testing were extremely successful, the algorithm accurately predicted 92% of cases. For the second test, the algorithm accurately predicted 98% of cases. The most impressive part is that the algorithm accurately predicted these cases on average of over six years before a diagnosis was made[7].

Ultimately, this presents an amazing opportunity for the medical community. PET scans are relatively cheap and common due to their use in cancer screenings as well. Therefore, the usage rate of the algorithm could increase rapidly in the future. The next step for Sohn is to continue testing the algorithm with more diverse data sets from other countries and differing populations.

AI's Role in Preventing Epidemics

How do we minimize the potential for epidemics to occur? Should we rely on international organizations, national governments, epidemiologists? Artificial intelligence may have a role to play in raising awareness and preventing epidemics from occurring. COVID-19, commonly known as the Coronavirus, has caused global anxiety. Despite the slow spread of the disease outside of China, government and international officials are still worried about the potential for the epidemic to turn into a

[1] Smith, D. (2020). *AI Could Catch Alzheimer's in Brain Scans 6 Years Earlier*. [online] Artificial Intelligence Can Detect Alzheimer's Disease in Brain Scans Six Years Before a Diagnosis | UC San Francisco. Available at: https://www.ucsf.edu/news/2019/01/412946/artificial-intelligence-can-detect-alzheimers-disease-brain-scans-six-years [Accessed 23 Feb. 2020].

[2] Ibid.
[3] Ibid.
[4] Ibid.
[5] Ibid.
[6] Ibid.
[7] Ibid.

pandemic. Luckily, outside of China, containment methods have been quite effective thus far. You may be surprised to hear that some of that success is due to artificial intelligence.

On January 9th, 2020, The World Health Organization declared that there was a mysterious flu-like outbreak in China. The majority of cases had been in Wuhan, China. However, the WHO was late to the game, an AI algorithm had already predicted the outbreak much earlier, on December 31st. BlueDot, a Canada-based company has created an AI algorithm which tracks and predicts future cases of infectious diseases. BlueDot offers private services tailored to government-officials needs and has also worked with government organizations in Canada, Singapore, and the Philippines[8]. The Chinese government has been notoriously tight-lipped regarding internal issues such as viral outbreaks, so how did BlueDot predict the outbreak and its spread so far in advance?

BlueDot's AI algorithm sorts and analyzes foreign news outlets, animal and plant disease networks, and public-record government statements[9]. If a potential threat is identified, BlueDot sends warnings to its clients. Once a potential threat is identified and warnings are issued, BlueDot's human analysis team takes over to provide an in-depth investigation. After BlueDot's Epidemiologists have confirmed the findings, a report is sent to government officials[10]. Even more impressive, BlueDot can accurately predict where the infectious disease will spread next. Kamran Khan, BlueDot's CEO, has integrated the algorithm with global airline ticketing data in order to give a potential scope to the spread of the disease[11]. In the case of COVID-19, BlueDot accurately predicted the following areas which would become infected: Bangkok, Seoul, Taipei, and Tokyo[12].

Before the COVID-19 outbreak, BlueDot proactively and accurately predicted the Zika outbreaks in Southern Florida with impressive specificity[13]. *The Lancet*, a British medical journal legitimized the effectiveness of the algorithm in an article published about BlueDot[14]. As the future goes on, we will likely see more utilization of algorithms such as BlueDot because they provide a relatively broad safety-net due to the sheer volume of data and corroborating data that they can analyze.

AI's Role in Pharmaceutical Discovery

In recent history, there has not been significant progress in antibiotic development. The limited progress which has taken place, have primarily resulted from the development of variations of currently used antibiotics. Generally, there is a lack of incentive for private firms to attempt to develop new antibiotics. The reason for this is due to the extremely costly and tedious nature of antibiotic research[15]. This is becoming an increasingly serious problem because bacteria are developing serious resistances to antibiotics which are currently on the market. Needless to say, if this laggard nature of antibiotic development continues, we could see major problems in the future.

In an effort to provide more efficient forms of drug discovery, MIT researchers have utilized artificial intelligence to help discover new antibiotics. James Collins, the Termeer Professor of Medical Engineering and Science at MIT's Institute for Medical Engineering and Science was primarily responsible for the initial development of the algorithm[16]. So how does the algorithm work? Artificial intelligence algorithms are exceptionally good at noticing patterns and digesting extremely large datasets. This is essentially how the MIT algorithm works. In a mere matter of days, the algorithm can analyze more than one hundred million chemical compounds[17]. During the chemical compound analysis, the algorithm looks for potential antibiotics which utilize unique and new techniques to kill bacteria[18]. Collins took the research one step further by cooperating with professors and students who had machine-learning experience. They created a predictive model which was designed to search for chemical techniques which effectively killed *E. coli*[19]. In order to train the algorithm, the researchers had the algorithm analyze 2,500 molecules, which included 1,700 FDA-approved drugs and a diverse range of 800 natural molecules[20].

After the predictive algorithm had been appropriately trained, it was tested on a dataset of 6,000 compounds from the Broad Institute's Drug Repurposing Hub[21]. The predictive algorithm distinguished one molecule from the dataset which

[8] BlueDot. (2020). *BlueDot | Who We Are*. [online] Available at: https://bluedot.global/about/ [Accessed 23 Feb. 2020].
[9] Niiler, E. (2020). *An AI Epidemiologist Sent the First Warnings of the Wuhan Virus*. [online] Wired. Available at: https://www.wired.com/story/ai-epidemiologist-wuhan-public-health-warnings/ [Accessed 23 Feb. 2020].
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[15] Trafton, A. (2020). *Artificial intelligence yields new antibiotic*. [online] MIT News. Available at: http://news.mit.edu/2020/artificial-intelligence-identifies-new-antibiotic-0220 [Accessed 23 Feb. 2020].
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[21] Ibid.

was expected to have significant antibacterial traits and a unique chemical structure which was different than existing antibiotics. The algorithm predicted that the molecule in question would also have relatively low toxicity to humans[22]. The researchers humorously named this molecule halicin, after the AI system from the movie, "2001: A Space Odyssey[23]." The researchers then tested halicin against many drug-resistant bacteria which had been isolated from patients and grown in a lab. Some of the bacterial strains tested included the following: *Clostridium difficile, Acinetobacter baumannii, Mycobacterium tuberculosis,* and *Pseudomonas aeruginosa*[24]. Halicin effectively treated all of the tested strains, except for *P. aeruginosa*[25]. Halicin was then tested on living organisms when it was used to treat mice with *A. baumannii,* this strain was resistant to all known antibiotics. However, after just 24 hours of halicin ointment application, the mice were infection-free[26].

Why is halicin so efficient in killing resistant bacteria? The researchers believe that halicin kills bacteria by inhibiting their ability to maintain an electrochemical gradient across cell membranes. This gradient is responsible for the production of Adenosine triphosphate (ATP), the molecules that cells use to store energy. When that gradient breaks down, the cells die.[27] While this was found in preliminary study, researchers are hoping that this is further legitimized. If this is true, it may provide a significant safeguard against antibiotic-resistant bacteria. Essentially, the mechanism by which halicin works is complex and effects multiple parts of the cell which makes resistance by random mutation extremely unlikely[28].

What does the future hold for halicin? The researchers who found the molecule are planning to continue their research and conduct a wide variety of tests. The team is hoping to work with pharmaceutical companies and philanthropic organizations in order to further development of the molecule so that it can be approved for human use[29]. Furthermore, the discovery of the molecule highlights the viability of utilizing artificial intelligence algorithms in conducting drug discovery.

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