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EDITORIAL FOREWORD

The Next Revolution in Medicine–Are We Ready?

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INTRODUCTION

Medicine is undergoing a revolutionary change and all of us are affected by it. No, it is not the discovery of a new antibiotic or the cure for Ebola or a vaccine against human immunodeficiency virus (HIV). This time the revolution involves the artificial and sometimes unexplained and abstract world. The next revolution in medicine is being brought about by artificial intelligence (AI), deep learning (DL) and the internet of things (IoT), concepts commonly heard in tech geek events but quite unheard of among the medical fraternity. If the sinister humanoid robots in 'The Terminator' were not a good enough wake up call, then it is time to sit up and take a notice now. Artificial intelligence is beginning to infiltrate into every aspect, every branch and every component of modern medicine and we can only ignore it at our own peril. Is it really as dangerous as made out in the sci-fi movies or is it an asset we can use to our advantage? Will AI make human doctors redundant or will humanity always win in the end? Although the jury may still be out on the benefits and the dangers of AI in medicine, the authors, through this article, attempt to clarify some concepts and throw light on both sides of the story.

ARTIFICIAL INTELLIGENCE, DEEP LEARNING AND THE INTERNET OF THINGS

Simply explained, AI refers to the display of human intelligence by machines. The term was first coined by John McCarthy in 1956 and has since gone through many ups and downs.[1] The original concept of 'General AI', referring to machines that combine all human senses, has been depicted extensively in cinema, from the 'Terminator' to the 'Matrix', it remains an elusive concept till now. What we have been able to achieve though, is 'Narrow AI', exhibiting some facets of human intelligence and performing some tasks as well as, or even better than human beings.[2]

Deep learning is a type of machine learning, albeit, at a 'deeper' level, that is heavily inspired by the structure and function of the brain. While machine learning is generally supervised or semi-supervised by a programmer, deep learning is mostly unsupervised. Deep learning allows a computer program to analyze the problem and come up with solutions on its own, something similar to what a human (or animal) brain does every second. Just like the brain, deep learning systems are also composed of neural networks with the basic unit of the function being called a 'neuron'.[3] And just like a new born's unconditioned brain, newly created deep learning systems gradually learn, unlearn and learn some more till they achieve near perfection. An excellent example is the online language translation services we use so often. In the beginning, the translation was hardly accurate, but the system gradually learned on its own and today all you have to do is scan the words on a signboard and the system translates the words to hundreds of languages on one click. Another characteristic feature of deep learning is that it works better with big data, i.e. more the data better is the efficiency of the deep learning system.[4] This is what makes deep learning especially useful in medicine as we shall see later in this article.

Although often used interchangeably, AI and DL are two separate concepts. As brilliantly explained by Michael Copeland, it is easier to understand this difference if we think of the concepts as concentric circles. AI came first and occupies the outermost circle, machine learning occupying the second, inner circle with DL occupying the innermost circle. AI is a broader term, machine learning is an approach to achieve AI, and DL is a technique for implementing machine learning.[5]

The IoT is a network of physical devices, appliances, and gadgets which are interconnected via the internet, thus enabling them to collect and exchange information. AI and the IoT are related to each other like the human brain and the human body. IoT, much like the human body, collects and transmits inputs to the brain,

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or AI, which understands and interprets the inputs and transmits the outputs back to the periphery for necessary action.[6]

APPLICATION OF AI AND DEEP LEARNING IN MEDICINE

AI, DL and IoT are revolutionizing medicine even as you read this article. Healthcare has already seen rapid technological advancements over the last decade or so, with telemedicine, online doctor appointments, cloud storage of medical records and health apps becoming available even in the technologically backward regions of the world. Doctors are spending more time online, reading the latest books and journals, attending online courses and workshops and video conferencing with their peers. Google and Ethicon are close to perfecting robotic surgery, 3D printing has personalized artificial implants, wearables are calculating everything from the number of steps you have walked to your pulse rate. The question is–what next?

Maybe China has the answers, even as it invests heavily in AI to fulfill the healthcare needs of its burgeoning (and fast aging) population. Our northern neighbor already has a smart healthcare strategy as an integral part of its AI strategic plan. AI diagnostic tools are permitted by the country's FDA and the recently created 'Chinese Intelligent Medicine Association' provides an excellent platform for research, exchange, and cooperation in AI for healthcare.[5] The AI doctor, 'Biomind,' recently beat a team of neuro physicians in a televised competition to diagnose brain tumors and predict the expansion of brain hematomas. Another AI doctor 'iFlytek' recently passed the country's licentiate exam and outperformed 96% human examinees.[6] USA is ramping up its budgetary allocations to AI based healthcare solutions.[7] Not to be left behind, Canada has opened the world's first French-language school of AI in medicine, in Montreal and aims to become a world leader in AI-based healthcare.[8] Apps like 'Quality Skin' can diagnose upto 2000 different skin disorders merely by analyzing high-resolution images of the affected skin. Compare this with the average 700 to 800 skin diseases seen by most specialists during their entire career and you will begin to understand the importance of AI and DL in revolutionizing modern day medicine.

Doctors analyze and diagnose based on the knowledge accumulated by them over the years, which translates into hundreds or maybe thousands of patients. IBM's Watson, on the other hand, utilizes DL to analyze and process medical records, clinical findings, treatment protocols, research materials, clinical studies, journal articles and patient information of multiple patients within a few minutes, something a human mind can never accomplish.[9] Google's 'DeepMind' is applying DL to mammography and the diagnosis of acute kidney injury in veterans. AI devices know which protocol will lead to what outcome in which patient because they have learned from the data of millions of patients across the world. This means better diagnosis and better treatment outcomes for more people, including those living in regions lacking doctors and healthcare facilities. This also means improved patient satisfaction and reduced incidence of doctor-patient conflicts. AI has the potential to diagnose rare diseases which are either not taught in the modern-day medical schools or not frequently encountered by doctors in a particular region of the world. It can help general practitioners and allied healthcare professionals in making diagnoses that would otherwise need specialists' or superspecialists' opinion. It can also speed up the process of diagnosis and treatment, reducing the burden on our doctors and thereby increasing their efficiency and productivity. Reduced burden means lesser fatigue and this translates into enhanced productivity of the healthcare staff and fewer human errors.

India faces an acute shortage of trained healthcare staff and health services, especially in rural areas. Treatments are world class in the private sector, but the high costs mean that only a minuscule few can afford such facilities. A large population burden means long queues and longer waiting lines for basic treatments at government hospitals. Doctors need to not only diagnose and treat thousands of patients but also write hundreds of case sheets, discharge summaries, and reports and sift through thousands of X-rays and lab reports daily. They are therefore highly overburdened and have to frequently face the wrath of distraught patients or their relatives. The AI has the potential to overcome many of these challenges including freeing-up doctors from the mundane tasks that can be easily handled by an AI doctor, and these are exactly the reasons why we should emulate at least some of the AI success stories in our country as well.

FROM GENERALISED TO PERSONALISED MEDICINE

We already know that each individual reacts differently to the same medicines because of the difference in their genetic structures. Then why treat everyone with the same standard treatment guidelines? AI seems to be the magic wand that can help us in moving away from the traditional 'one size fits all' healthcare system to an era of precision medicine and safer, targeted and personalized treatments. The USA based National Institute of Health (NIH) describes precision medicine as 'a revolutionary approach for disease prevention and treatment that takes into account individual differences in lifestyle, environment, and biology'.[10] As a part of its precision medicine

Initiative (PMI), the NIH has already started a large scale project called 'All of Us' which 'seeks to extend precision medicine to all diseases by building a national research cohort of one million or more U.S. participant'.[10] AI-based healthcare, using processors such as the Intel 'Xenon' is now delving into human genomics and finding the perfect treatment suited for every individual based on his or her genetic makeup.[11] AI companies like Atomwise are taking this one step further, by using deep learning algorithms to analyze molecules and predict how they will act in the human body, including their potential efficacy, toxicity, and side effects, at an earlier stage than in the traditional drug discovery process. This structure-based drug design, the company says, is a key step in precision medicine, discovering proteins that will work perfectly for a particular genetic framework.[12]

WHERE DOES IOT FIT IN?

The IoT, or more correctly the internet of medical things (IoMT) is transforming healthcare by connecting patients, doctors, wearables and medical devices with one another. Healthcare wearable devices are becoming more common and more affordable and are monitoring the vital parameters like blood pressure and heart rate, blood glucose levels, and activity and sleeping levels of their users all day long. The IoMT can help monitor, inform and notify not only caregivers but provide healthcare providers with actual data to identify issues before they become critical and allow for earlier invention.[13] The IoMT can remind patients to take their medicines on time, report actual patient activity after they leave a healthcare facility and improve patient compliance and adherence to the doctor's orders. The IoMT devices such as Virtual Health Assistants (VHA's) can transmit the reports of routine blood and urine tests to the concerned doctor, transmit the doctor's prescription to the nearest pharmacy, remind patients of prescription refills and ensure the timely delivery of the required medications at a predetermined time for their user. Health chatbots can answer health-related questions and even help patients manage medications by providing information on types of medications and recommended doses.[14] The IoMT can help AI devices in learning the everyday routine of elderly and memory care patients and warn the remote caregivers if anything seems amiss. Thus, the IoMT has the potential to improve the management of various diseases and reduce healthcare costs by ensuring continuous monitoring of patients and preventing unnecessary visits to the doctor.[15]

CHALLENGES AND THE WAY FORWARD

The biggest challenge is the fear of its adoption among doctors, fearing large-scale job cuts and unemployment if AI doctors take over.[16] Some say that the artificial world can never provide the human touch, the empathy, the sympathetic ear, the judgment skills, and the creativity that a human can, but who knows for sure? In an artificially managed healthcare system, who will have the final word after the machine delivers a decision, the human doctor or the AI doctor? And what if something goes wrong? With whom will the liability lie in such cases?

Then there are multiple concerns surrounding a large amount of data there are now being accessed by thousands of devices without any checks and balances and the infringement of data privacy. There are fears that health data such as HIV Status and allergy histories may become freely available to commercial concerns and insurance companies. This threat became real recently in the UK, where the NHS was accused of breaking privacy laws and sharing data with Google's DeepMind without prior information or consent from the patients concerned. The NHS has now assured that patient data will be anonymized before sharing with 3rd parties but privacy activists are not convinced.[17]

Healthcare equity is a big challenge in countries such as India and AI threatens to further segment the society into 'super elites,' 'semi elites' and the 'have nots' depending on access to and affordability of AI-based healthcare. As correctly put forth Yolanda Lannquist, 'for the first time in human history, these elites may be faster, smarter and stronger – biologically, genetically, or 'bionically' superior to the others'. AI-based technologies that treat genetic disorders can be used to prolong life and can potentially open the doors to the next phase of human evolution, only this time the chance to evolve will be available only to a select few.[18] Certain life-saving technologies risk being monopolized by certain sections of society or certain countries and leveraged for narrow gains. And what if these technologies fall into the hands of terror organizations? Will these begin a new era of AI warfare in the future?

These and many more challenges will face AI based healthcare in the time to come. Healthcare staff will need to be trained in the proper use of these technologies. Countries from around the world will need to sit together and decide on the ownership of these technologies and the democratization of AI-based healthcare. Companies will need to keep human interest over their profit motives. And the citizens will need to keep fighting for their rights. But AI technologies are here to stay, and we must adapt and learn to live with them. Because if we are not ready, we risk becoming irrelevant.

REFERENCES

1. McClelland C. The Difference Between Artificial Intelligence, Machine Learning, and Deep Learning [Internet]. Medium. 2017 [cited 4 November 2018]. Available from: https://medium.com/iotforall/the-difference-between-artificial-intelligence-machine-learning-and-deep-learning-3aa67bff5991.
2. Copeland M. What's the Difference Between Artificial Intelligence, Machine Learning, and Deep Learning? [Internet]. 2016 [cited 2018Nov10]. Available from: https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/.
3. Buduma N. Deep Learning in a Nutshell [Internet]. The Musings of Nikhil Buduma. 2014 [cited 2018Nov1]. Available from: http://nikhilbuduma.com/2014/12/29/deep-learning-in-a-nutshell/.
4. Parrish K. Deep learning vs. machine learning: What's the difference between the two? [Internet]. Digital Trends. 2018 [cited 10 November 2018]. Available from: https://www.digitaltrends.com/cool-tech/deep-learning-vs-machine-learning-explained/.
5. Chun A. China leading the way in use of AI for medical care. South China Morning Post [Internet]. 2018 [cited 16 November 2018];. Available from: https://www.scmp.com/comment/insight-opinion/article/2152087/artificial-intelligences-greatest-contribution-may-be-health.
6. Dixon R. China plans to dominate AI, with a vanguard of robotic doctors like 'Biomind' [Internet]. Latimes.com. 2018 [cited 10 November 2018]. Available from: https://www.latimes.com/world/la-fg-china-ai-20180706-story.html.
7. Sennaar K. How America's 5 Top Hospitals are Using Machine Learning Today [Internet]. TechEmergence. 2018 [cited 10 November 2018]. Available from: https://www.techemergence.com/top-5-hospitals-using-machine-learning/.
8. Derfel A. CHUM launches first French-language school of AI in medicine [Internet]. Montreal Gazette. 2018 [cited 16 November 2018]. Available from: https://montrealgazette.com/news/local-news/chum-launches-first-french-language-school-of-ai-in-medicine.
9. Today's decisions deserve tomorrow's insights. [Internet]. IBM Watson Health. [cited 7 November 2018]. Available from: https://www.ibm.com/watson/in-en/health/.
10. About the All of Us Research Program [Internet]. Allofus.nih.gov. [cited 14 November 2018]. Available from: https://allofus.nih.gov/about/about-all-us-research-program.
11. Chamraj H. Powering Precision Medicine with Artificial Intelligence - Intel AI [Internet]. Intel AI. 2018 [cited 2 November 2018]. Available from: https://ai.intel.com/powering-precision-medicine-artificial-intelligence/.
12. Shu C. Atomwise, which uses AI to improve drug discovery, raises $45M Series A [Internet]. TechCrunch. 2018 [cited 4 November 2018]. Available from: https://techcrunch.com/2018/03/07/atomwise-which-uses-ai-to-improve-drug-discovery-raises-45m-series-a/.
13. Marr B. Why The Internet Of Medical Things (IoMT) Will Start To Transform Healthcare In 2018 [Internet]. Forbes. 2018 [cited 8 November 2018]. Available from: https://www.forbes.com/sites/bernardmarr/2018/01/25/why-the-internet-of-medical-things-iomt-will-start-to-transform-healthcare-in-2018/#264973af4a3cAshok A.
14. The Impact of Artificial Intelligence in Healthcare [Internet]. Medium. 2018 [cited 19 October 2018]. Available from: https://medium.com/@Unfoldlabs/the-impact-of-artificial-intelligence-in-healthcare-4bc657f129f5.
15. Exploring the Potential of Internet of Medical Things (IoMT) [Internet]. 2018 [cited 4 November 2018]. Available from: https://www.newgenapps.com/blog/exploring-the-potential-of-internet-of-medical-things-iomt.
16. Hoffmeister J. Artificial Intelligence in Healthcare – Do the Benefits Outweigh the Challenges? [Internet]. Hitconsultant.net. 2018 [cited 10 October 2018]. Available from: https://hitconsultant.net/2018/04/16/ai-in-healthcare-challenges/.
17. Google DeepMind NHS app test broke UK privacy law [Internet]. BBC News. 2017 [cited 4 October 2018]. Available from: https://www.bbc.com/news/technology-40483202.
18. Lannquist Y. Ethical & Policy Risks of Artificial Intelligence in Healthcare [Internet]. 2018 [cited 22 October 2018]. Available from: http://www.thefuturesociety.org/ethical-policy-risks-of-artificial-intelligence-in-healthcare/.