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AI (artificial intelligence) and ML (machine learning) in Healthcare:

Send in the Robots?

Moira McQueen, LLB, MDiv, PhD

The use of artificial intelligence (AI) and machine learning (ML) is developing at a rapid rate, becoming more and more visible in our everyday life. Most of us are anticipating the arrival of the driverless car with varying degrees of interest and, perhaps, anxiety. Can a machine respond faster and more intelligently than I, as the driver? It would appear to be so, statistically, even if not in every single situation. What social repercussions will there be? Will I be able to drive beyond the current age or capacity limit, even with, for example, not so perfect eyesight or reflex times? Will this be a good thing for me, or a mixed blessing for society? How do we judge in advance of experience?

That is one realm, but use of artificial intelligence and machine learning is already quite developed in the healthcare field, raising ethical and social questions. Machine learning is fueled by the coming into existence of vast quantities of computer-derived data, and this technology has influenced applications in biotechnology, which includes applications in health care. Machine learning is a specific application of AI whereby machines are given access to data and are expected to learn by themselves. It involves understanding sequencing, cell structure and organ structure by patient demographics, drug interaction with affected cells and environmental factors, and so on. In this age of genomic and genomic specific drugs, where spending huge amounts on research in genome sequencing and analysis is necessary, then this vast computational power is clearly advantageous.[1] One result is the growing partnerships between what is known as "Big Pharma" and biotech startups that use AI and ML for drug discovery. Apart from financial success and returns, the overall hope is that research, diagnostics, drug manufacturing research and patient care in general will be improved.[2]

Adoption of AI and ML is happening right now mainly in the areas of predictive clinical analytics, or prediction of future events, such as patient relapse.[3] They are currently most commonly used for research, classification and reasoning. IBM's computers *Watson for Genomics* and *Watson for Oncology* have been in use for some time for their classification and reasoning skills, together with other systems, and many hospitals are in the midst of developing digital platforms for ever more advanced AI machines, including robots.

Many of the declared possibilities of AI have yet to be realized, and currently most use is that based on supervised machine learning, most often through surgical robots, predictive analyses or computer-aided diagnostics for telehealth services, itself a result of technology. The overall purpose of helping to realize healthcare's triple aim of better outcomes, reduced costs and better accessibility is laudable. Even a reduction in time and time and effort in record keeping pays dividends in freeing up time for more direct patient care. Interestingly, sometimes that care will be less direct in the future, and the latter will be provided only when necessary. For example,

Microsoft's *Healthbot* is designed to allow patients to converse first with an intelligent health agent and perhaps go through some suggested triage before being directed to a (human!) nurse or physician when deemed necessary.

DEVELOPMENTS IN AI AND ML

Currently, the most obvious implementation of ML techniques for diagnostics lies in genetic analysis.[4] The machine intakes a biopsy or blood sample from the patient, processes the sample, and then analyzes the data. When sequencing an individual's genome, accuracy is crucial. A sequence with just one mistake in a critical spot could drastically change a diagnosis. The availability of a dependable, easy-to-use, and standardized NGS data analysis platform is an essential piece to complete the promise of precision medicine, which relies on matching a therapeutic to a specific gene signature for maximal efficacy. A machine by *Sophia Genetics* used for data processing has been adopted by about 400 hospitals so far.[5]

Use of such machines means that data analysis takes a few days, rather than several months like the current standard. While speed is clearly a benefit, there is the long-term advantage that the machine-learning algorithm that is behind the analysis also enables the diagnostic process to become smarter with each iteration. Gene editing processes such as CRISPR increasingly use AI programs for designing constructs faster, and for building databases for subsequent use and development.

Most of the AI and ML advances so far are in drug research and development. Sometimes drugs take twelve years of trials and soaring costs before coming to market. Computer vision may be a better way of analysing images of cells treated with drug compounds, and certainly faster than teams of scientists working with microscopes. Other computer programs scan previous studies to inform new research and can retrieve relevant data at a much faster speed. US based *Atomwise* has developed an AI algorithm that uses a deep neural network of drug design.[6] The algorithm understand complex concepts by breaking them down into smaller pieces of information, and has been able to learn fundamental concepts of organic chemistry. It has done this itself by studying data, and it suggests that the number of early stage drug-screening experiments could be halved, with subsequent savings in time, effort and money.

For those of us involved in any type of research, it is already astounding how quickly over the last thirty years our own personal computers find relevant material, compared with the way we used to use card-index files, spending hours physically retrieving materials in libraries! If we can find relevant data quickly, without even leaving home, we can imagine the advantage that AI and ML are bringing and will continue to bring to health care. It is a revolution in capacity.

A few more examples illustrate some applications in health care and biotechnology: *Benevolent AI* focuses on health care and assimilates vast quantities of information, making correlations that humans would never consider. US based *Arterys* uses AI to diagnose heart conditions, including cloud computing to improve analysis of medical imaging. It can make a diagnosis of heart conditions in 15 seconds and can be accessed by physicians all over the world. *PathAI* has developed a platform that uses deep machine learning for pathology problems, helping pathologists work more quickly in identifying tumours. *Desktop Genetics* offers gene editing powered by AI, speeding up genetic research, and so on. Overall the pace of biomedical research and drug discovery is, to put it mildly, increasing rapidly.

In biotechnology, bionic limbs use AI to adapt to the wearer's body. Through inbuilt computers, they learn the wearer's walking pattern and can

change the individual joint's angle to the appropriate position for the wearer. Statistics show that up to 70% of amputees currently experience joint and back pain, but bionic limbs are changing that and will phase out traditional prosthetic limbs, which lack flexibility and can be uncomfortable.

REFINEMENTS ALWAYS NEEDED

Of course, AI and ML derived models must be interpretable, not just intelligent. The more it is understood how the models arrived at a conclusion the more credible they will be. An important point that is never forgotten by medical and biotechnological researchers is that health and health care problems are incredibly complex and full of confounding factors. Right now, it is acknowledged that AI and ML, while important for integrating data with existing medical records, will need to be refined. For example, *Watson's* role in helping prescribe systemic therapy in oncology meant that the computer had to be trained about surgical and radiation aspects and also had to integrate those, building on input from case reasoning and deep learning. The need for refinement and development are, of course, true of any system, and when *Watson* was further programmed to take into account, among other factors, the patient's organ function and ability to tolerate therapy, its recommendations for treatment improved in scope.

ETHICAL ISSUES

What sort of ethical issues are arising from these developments? Privacy and security of information and use of confidential medical reports are ongoing ethical questions in today's "hackable" world, and are constant concerns. Questions about statistical margins of error are already arising, questions about biased input (whether deliberate or unconscious bias) are being asked, after some interesting conclusions by machines based on ethnicity. The value of predictions, genetic and otherwise, raises questions about decision-making regarding treatment, future planning for people and even questions of eligibility for insurance. The use of robots, for example, where patients will answer preliminary questions about their health to a machine, will involve a level of depersonalization in health care, with less time being spent in face-to-face encounters, at least in the early stages of illness or perhaps completely in the case of minor illnesses. Just as we shall see fewer human cashiers at checkouts in grocery stores, so will there be less human contact at many levels of our health care systems. Whether or not that is an ethical problem remains to be seen, but it could be a social problem in our already screen-fixated age.

Yet artificially intelligent bots are becoming better and better at modelling human conversation and relationships. In 2015, a bot won the Turing Challenge for the first time. Human raters used text input to chat with an unknown entity, then guessed whether they had been chatting with a human or a machine. *Eugene Goostman* fooled more than half of the human raters into thinking they had been talking to a human being.

OTHER QUESTIONS WE WILL HAVE TO FACE:

Employment: faced with automation, jobs will be lost. Self-driving cars will soon be in use, but what about self-driving trucks and the effect on the trucking industry? If there is a lower accident rate, won't it seem logical to move in that direction? If, correspondingly, AI and ML show faster and better (or at least similar) statistics in health care, logic will prevail there, too, and many health care workers will lose their positions.[7]

Wealth inequality: if there are fewer human employees, will the "1%" already at the top of the wealth table collect even more revenues?

GIGO: GUARDING AGAINST MISTAKES

Obviously, the training phase cannot cover all possible examples that a system may deal with in the real world. These systems can be fooled in ways that humans would not be.[8] For example, random dot patterns can lead a machine to "see" things that are not there. If we rely on AI to bring us into a new world in health care and efficiency, we need to ensure that the machine performs as planned, and that people cannot overpower it to use it for their own ends.

THE SCI-FI QUESTION

This is now a serious question about artificial intelligence: will it, one day, have the advantage over us? We cannot rely on just "pulling the plug" either, because a sufficiently advanced machine may anticipate this move and defend itself. This is what some call the "singularity": the projected point in time when human beings are no longer the most intelligent beings on earth. Sci-fi or possibility?

CONCLUSION

While the last point may take us a little too far into the unreadable future and while our intelligent awareness skills had better stay in place, we should also keep in mind that, on the whole, this technological progress in health care could mean better lives for everyone. Artificial intelligence has vast potential, and its responsible implementation is up to us. One way to do that would be to ask and implement the wise principles of Catholic Social Teachings: do these ways of developing health care respect the individual dignity of the patient and patient carers? As systems, do they enhance the common good and benefit human flourishing? Would the use of bots at preliminary stages of a health care encounter respect the principle of subsidiarity, for example, in freeing health care workers from some routine work to concentrate on someone more urgently in need of care? Would the principle of solidarity be harmed or enhanced by reliance on robots in systems where teamwork and cooperation are clearly necessary, for example, in operating rooms?

These questions need our attention, and we need to be prepared. Yes, it will be some time before some of these matters will have impact on our daily life, but some of them are already in place, and bioethicists and theologians are being challenged to respond. Let's hope we can still do so, and see both the advantages of "new things" while dealing with possible challenges to our humanity.

Moira McQueen, LLB, MDiv, PhD, *is the Executive Director of the Canadian Catholic Bioethics Institute. Prof. McQueen also teaches moral theology in the Faculty of Theology, University of St. Michael's College. In September 2014, Pope Francis appointed her to the International Theological Commission. Dr McQueen is also the Roman Catholic representative on the Faith and Life Sciences Reference Group of the Canadian Council of Churches.*[9] [10]

[1] http://www.biostorage.com/blog-posts/machine-learning-and-artificial-intelligence-ai-inbiotechnology-we-are-in-a-golden-age-of-medical-research/

[2] When Biotech and AI collide: an exciting future for healthcare https://forrestbrown.co.uk/news/when-biotech-and-ai-collide-an-exciting-future-for-healthcare/

[3] (Future-proofing AI: Embrace Machine Learning Now because Health Care Adoption is Picking Up Speed) http://www.healthcareitnews.com/news/future-proofing-ai-embrace-machine-learning-now-because-healthcareadoption-picking-speed

[4] Sophia Genetics

[5] *Ibid.* SOPHiA for NGS

[6] When Biotech and AI collide: an exciting future for healthcare https://forrestbrown.co.uk/news/when-biotech-and-ai-collide-an-exciting-future-forhealthcare/

[7] https://www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence/

[8] www.evolvingai.org/fooling

[9] ***Dr McQueen will be giving a presentation on AI for FLS on March 19, 2018. Contact CCBI for details: bioethics.usmc@utoronto.ca; FYI***

[10] *This is how artificial intelligence is changing the world.* 26 things you need to know about AI – MaRS Magazine magazine.marsdd.com