When doctors meet with AlphaGo: potential application of machine learning to clinical medicine

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March is a reluctant beginning of spring. After suddenly getting warmer, the weather has turned cold again. Yesterday, the friend circle of Wechat was full of a breaking news that the Google's artificial intelligence AlphaGo beat human Go champion Lee Sedol. Or at least it was a temporary lead because there will be several rounds in following days. The news was a headline because it was related to the debate on whether artificial intelligence could defeat human brain. Many cultural celebrities posted their comments on the news. Shen Lei, a writer who is famous for his interpretation on Jin Yong's Kung Fu novels, stated that: "*The last warrior falls.*" Tang Fenng also posted on his Wechat that: "*All calculations and computations can be left for machines from now on. What we humans can do are: burning incense, sipping tea, Washing inkstone, playing the Chinese zither….*" In other words, all works with rules can be completed by machines, and humans have to retreat to their emotional domain. Why is it the Go, instead of other chesses such as Modern Ludo and animal checker, or other intellectual activities? That is because the Go represent the most complicated intellectual activity. The chessboard of Go is made up of 361 cross points, which in turn can generate numerous chess compositions. There are around 10^{170} possible board configurations in the average 150-move game (1)! After all, this is much challenging than medical decision making. Two decades ago, the IBM supercomputer Deep Blue defeated the world chess champion Garry Kasparov (2). However, the chess is slightly inferior than Go in its complexity. Thus the AlphaGo's victory has more far-reaching significance.

Turning to the medical community, how can we view the progress made by artificial intelligence? First of all, let's take a look at the role doctors can play in human society. Long ago before and in the Middle Ages, medical treatment was primarily provided by priests. Patient at that time could only get console from these healthcare providers and there was no evidence of biological efficacy (3,4). A sick person could get the hope of survival from that spiritual treatment, and he or she might recover with placebo effect. For most illnesses, the spiritual console may have healing power. After Renaissance, the modern science developed rapidly and was introduced into medical treatment. The evidence-based medicine dictates that medical treatment should be based on empirical evidence rather than experience or other super-nature power. The scientific knowledge greatly improved human health and longevity, owing to reduction of infectious diseases and malnutrition (5). However, the disease spectrum changed from infectious disease to tumors and cardiovascular diseases, which imposed a great challenge to medical community in the 21st century (6). Although millions of research papers have been published declaring that they have found novel mechanisms underlying these diseases, the translation of the basic scientific knowledge into healthcare improvement is far from satisfactory (7).

When it comes into the 21st century, the advances of information technology turn the big data science into reality. Big data dredging has found its way into all areas of scientific field such as politics, marketing and biology (8,9). Machine learning is commonly used in dealing with big data, and artificial neural network (ANN) is an interesting machine learning technique. It is the ANN procedure that defeated Mr. Lee Sedol. The underlying mechanism of ANN is very similar to that of a biological human brain. Initially, the ANN has no experience of playing Go but it will study millions of positions from expert games, gleaning abstract information on the state of play from board data (10). After training, the AlphaGo program is able to select the best move by scanning possible simulated future games (1). The ANN machine learning employs a black-box algorithm that

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researchers may have no idea on the mechanisms of why Lee Sedol moves in such a way. The learning algorithm focuses on input feature variable and the response variable, and a model with hidden layer can be fitted to reflect proper relationship between input variable and outcomes.

The black-box algorithm has its application in medical field. Since it appears difficult to translate bench work to clinical efficacy in recent decades, it may be possible to develop diagnostic algorithm and treatment strategy by learning from millions of previous samples. In this black-box approach, the biological or pathophysiological mechanisms underlying treatment outcome are not important. After all, the medical science is not deterministic that can be predicted accurately with formula and several parameters. It is the work by Newton that the appearance of a planet can be accurately predicted by formula. Such deterministic phenomenon is not applicable in the field of clinical research. There are random errors in medicine. They are called "random errors" because the underlying molecular pathway remains largely unknown. It is possible that a disease outcome is the results of interactions among millions of molecular pathways, but our state-of-art knowledge only have disentangled dozens of them. That is why statistics is indispensible to clinical research. In my opinion, intelligent activities involved in medical decision-making are much simpler than that in Go match. It is possible artificial intelligence can replace human brain to make medical decisions since there are rules governing them.

Does it mean that artificial intelligence will replace doctors to treat patients? The answer is of course no. Medical treatment involves biological human body as well as the soul of patients (11,12). The most important role as a physician is not to cure disease, but being a comforter to the sick (13). As the motto goes: "*To cure sometimes, to relieve often, to comfort always.*" (14). Therefore, human doctors are indispensable to medical treatment, by playing the role of a soul comforter. Artificial intelligence can only take a small part of medical activity, because there is no calculation algorithm to understand human emotions.

Acknowledgements

Footnote

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