



Digital diagnosis - AI and machine learning in healthcare

Technology Sector Alert

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The not too distant future...

Janet feels unwell. She consults an app on her phone, which asks an increasingly sophisticated series of diagnostic questions. The app also takes in data from Janet's fitness trackers that monitor heart rate, blood pressure and blood sugar. The app decides that Janet's symptoms look serious, and it arranges a video chat with a human doctor to discuss options so that potentially bad news can be presented in a more "human" way. The doctor has access to Janet's data remotely, along with access to a more sophisticated diagnostic, Artificial Intelligence. During that consultation, Janet is booked into a clinic for medical imaging scans to aid in further diagnosis. The results of the scans are interpreted entirely by machines, and the results are presented to Janet's doctor remotely. Using Janet's medical data, together with data from hundreds of similar cases, the system plans a treatment regime and gives a significantly more accurate prognosis than can be given today. Janet's treatment is continuously monitored and adjusted based on patterns matching her response to treatment against a wider patient population, allowing earlier and more personalized adjustments.

Fortunately for Janet, the result is a quicker and more accurate diagnosis, a more comfortable treatment regime and a far higher probability of a positive outcome. Less wasted treatment and less time taken with human clinicians saves cost, and live data sharing and app-driven interaction leads to greater responsiveness. Overall, this is a

healthcare system that really is faster, better and cheaper.

Building the future: How AI is developing in healthcare

This near future sounds appealing, so how do we get from here to there? As always, to some extent the future is already here, it just isn't evenly distributed. Apps like Babylon already provide users with the ability to answer diagnostic questions and have access by video call to a GP. There are a number of projects where machine learning techniques are being deployed to enhance interpretation of clinical imaging, with some notable success. Similarly, AI systems are being used to sift through the vast and disparate datasets that constitute patient records to learn to diagnose conditions and predict outcomes.

Whilst traditional Big Pharma and medical device companies are active in this space, many of these breakthroughs are not coming from traditional sector players. Significant interest from large technology companies and a plethora of technology-driven startups attracting millions in VC funding makes for a disparate mix of new and old players all seeking to become the next great disruptor.

There is one common factor that underpins all market participants. Whether they describe their particular offering as AIs, machine learning systems, cognitive computing or anything else, they all require access to vast swathes of relevant medical data in order to train the system.

Imagine that you are trying to build a medical imaging diagnostic system. You want the system to answer the question "Does this data indicate that the patient has cancer?" when given a set of medical imaging data. Because our question is binary (*yes* or *no* being the expected answers) then the machine has a 50 percent chance of getting the answer right by chance alone. This is where the machine learning component makes a difference – the system can then learn from its mistakes, analyzing the data sets to detect patterns that arise when it has been told the correct answer is *yes* and those in which the answer is *no*. After training, the accuracy of the system improves – the next time the system is tested on new data, it might be 63 percent accurate. With more training it improves again – 74 percent, 82 percent, 87 percent. Eventually, after training with large enough volumes of data, the accuracy of the system matches and then surpasses that of human experts in the field.

From this, it is easy to see that access to data which can be used to train the system is the key to everything... and that data tends to be held by healthcare institutions.

Collaborations: healthcare providers, tech companies and AI

A prospective AI-driven healthcare business may achieve a proof-of-concept phase on relatively scant data, but to train a system to a point where it can meet regulatory standards and be commercialized, rigorous training on as large a dataset as possible is required. In order to obtain access to data, some form of collaboration agreement with a healthcare provider will be formed.

In outline, the collaboration is likely to involve the healthcare institution providing access to data, and potentially its clinical expertise, in exchange for some benefit provided by the AI system builder. The precise nature of that collaboration will depend upon many factors:

- What is the correct value for access to medical data / expertise? This is unlikely to be a question most healthcare institutions in publicly funded healthcare systems such as the UK's NHS are used to answering. Nevertheless, it is an essential question to answer if the benefit that the healthcare institution receives from the AI system builder is to be correctly matched to the value of the data that the healthcare institution provides.
- What is the nature of the benefit that the AI system builder will provide? Funding? Equipment? Equity in the AI system builder itself? A regular royalty payment for intellectual property shared by the healthcare institutions? Free or discounted access to the product when launched? Some combination of these?
- Who owns any intellectual property rights in the data and any expertise that is provided? Is data owned by the healthcare institution or patients? How will this translate into ownership of intellectual property rights in the trained AI?
- What are the data protection / privacy implications? How will AI system builders ensure data security? What information needs to be presented to the patients whose data will be shared as part of the project? What consents are needed?

- How does the relative bargaining power of the two parties change the deal? It is easy to see how a newly funded startup approaching a behemoth healthcare provider might result in a deal which strongly favors the healthcare provider. However, in cases where a multibillion-dollar technology company approaches a number of individual hospitals, it is likely that the AI system builder will end up with the better deal.
- Particularly in places with wholly – or partly – nationalized healthcare provision, there may be a need to consider the public policy issues around access to healthcare data. Does the benefit of sharing (appropriately anonymized or pseudonymized) data to improve public health outweigh individual privacy concerns? Is there a risk of value leakage from public healthcare?

Next steps

These collaborations will be critical to delivering that cheaper, faster and better healthcare system of the future. Progress is accelerating in this area, with more opportunities for both AI systems builders and healthcare institutions every day. For both sides, getting the right deal is critical if the collaboration is to be on an equal footing and deliver benefits on a win-win basis for both parties.

Given the paramount importance of data to these collaborations, in our next note we will consider the privacy and regulatory aspects of that data sharing in more detail.

For more information about issues raised in this article, please get in touch with the authors below.

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