Heads up Pharma: AI incoming!

DIGITAL HEALTH LEARNING NETWORK, CENTRE FOR DIGITAL INNOVATION

Hughes Hall, University of Cambridge

"We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run" Amara's Law.

`Gartner's 2016 "Hype Cycle for Emerging Technologies" report, positioned the smart machine age (including machine learning) as one of the key upcoming trends (Panetta, 2016).

In this article, the DHLN explores AI's position on the hype cycle in the context of healthcare and Pharma, exploring the ecosystem forming around AI-applications that are driving the underlying trend towards user-centricity.
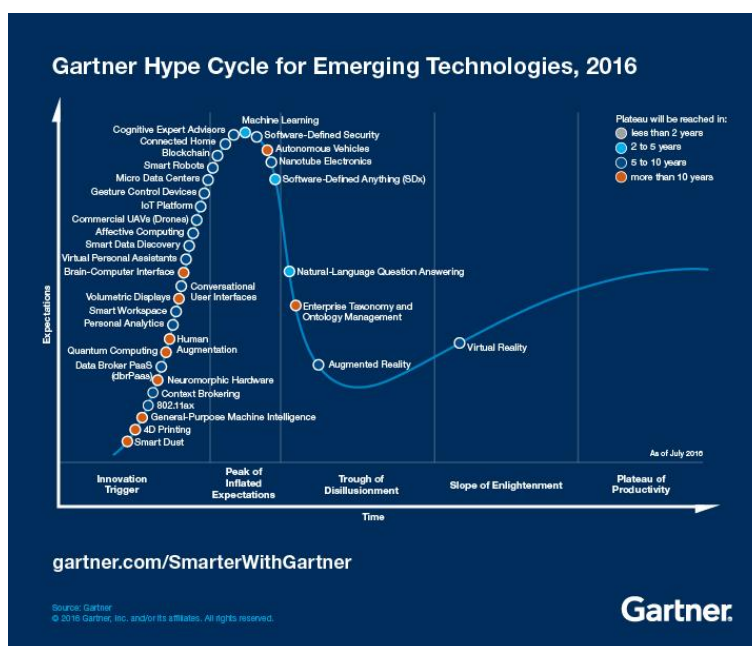

Figure 2. Gartner Hype Cycle for Emerging Technologies, 2016.

Change is coming to Pharma

The pharmaceutical sector is one of the most profitable in today's global economy. It has stable underlying drivers, and conservative, long-lived regulations. Over the last few decades, the sector has been dominated by the same companies (despite mergers) with largely similar business models. Despite widespread digitisation across society, new medicines are still developed in the broadly the same way (lengthy clinical trials in humans), and methods of demand generation has also remained unaltered (doctors are targeted with product messages by face-face interactions with sales people).

Within this stable, predictable ecosystem, Pharma companies have evolved to become highly effective profit generators.

However, far-reaching changes are now washing through healthcare due to rising costs (from increasing lifespans). Payors (governments and insurers) are demanding more value from suppliers, and this is, in turn, driving healthcare players (specifically Pharma) to better understand whether their products and services are effective for the people consuming them – they are demanding more user-centricity.

This focus on the end-users is largely a new activity for Pharma, and with their rigid, immutable business models and conservative regulatory frameworks, companies are finding this requirement extremely challenging.

This reorientation to the consumer has a strong parallel with the tectonic-level changes that AI is forcing into the automobile sector, with the race to introduce self-driving cars: taking it from a stable, well understood market, into unprecedented uncertainty.


THE IMPACT OF USER-CENTRICITY IN THE AUTOMOBILE MARKET

Until 2013, autonomous vehicles (AVs) were not being discussed in the industry. However, from 2013 self-driving became a noticeable part of official business communications, and the number of mentions has grown exponentially since then.

This graph shows the number of company press releases, presentations, filings, and broker research reports which mention the terms "autonomous car," "autonomous vehicle," and "self-driving car" on Sentieo Document Search, dating back to 2005.

This growth from 2013 is due to a few factors:

1. **Piecemeal introduction**: In-car automation was introduced in components since the 1990s (e.g. parking assist, cruise control, etc.), so a fully automated system was seen as a natural next step.
2. **Consumer awareness**: Around 2012 / 13, Google and Tesla introduced the concept of vehicle autonomy with bold announcements, with achievements, that made their visions credible.
3. **Shifting mind-set**: In the adjacent sector of ride-sharing, the hugely popular start-ups (e.g. Uber, Lyft, etc.) have changed the consumer mind-set from driving to being transported.
4. **New entrants**: Rapid application of AI expertise and technologies that are designed to replace humans (sensors, software, and self-improving / learning algorithms).

After being initially caught out, the established car manufacturers (e.g. Ford, GM, BMW, etc.), have been fuelling AV growth with R&D investments and partnerships (e.g. in-car sensors, data processing, etc.) as well as adjacent spaces (e.g. ride-share, maps, etc.).
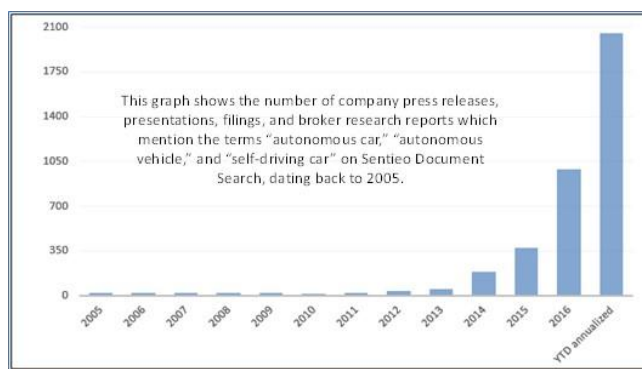
Is AI disrupting healthcare by enabling user-centricity?

Taking the four AV growth drivers that AI has catalysed, Pharma needs to learn from the big automobile players and anticipate similar changes in healthcare, otherwise Pharma could be disintermediated, and relegated to the role of pill manufacturer, without access / relevance to clinicians or consumers.

The question for Pharma is whether the same four change drivers that accelerated AV development, are evident in healthcare:

1. **Piecemeal automation of steps in the healthcare value chain**: Automating diagnostics with AI is one of the busiest areas for investment in healthcare, populated by dozens of new AI-driven companies. Other areas include prescription filling, and digitising health records.
2. **Raising awareness of new digital approaches to health**: Large tech companies such as Apple and Google have incorporated health-related components into their smartphone operating systems, on developers are releasing increasingly sophisticated apps. Deepmind (Google), and IBM regularly make announcements related to AI in health.
3. **Shifting mind-sets with AI applications**: Developing clinical advisors for Drs to support their interactions with patients (IBM Watson), automating Dr consultations to reduce the burden on national health systems (Babylon), social networking to capture advice and patient support (HealthUnlocked, Patientslikeme). Google's Deepmind has been analysing medical records in hospitals, and IBM's Watson has been developed as an exportable oncology expert for hospitals.
4. **New entrants to the drug development process**: A number of companies are bringing AI expertise to Pharma R&D, by licensing molecules from Pharma, to access clinical data. Traditionally pharma R&D has been capital intensive, with big entry barriers – tech is overcoming these. (e.g. BenevolentAI, inSilico, Atomwise)

Is there too much hype around AI in Pharma?

In the DHLN we shared some experiences of implementing AI-based initiatives within Pharma companies.

> "….at [a Multi-National Pharma Company] we had an interesting example of the disconnect between promise and hype for AI and what it actually is able to do today. We had huge expectations from a Scandinavian government, wanting to create a whole community around data, seeing massive potential. We agreed with the AI Vendor on a deal to build a platform (various datasets, including genomics data etc.), but after agreeing the deal we were told by the Vendor that they were facing a skills shortage problem – even as a major employer of the relevant skill base, they have a lack of the right sorts of skills, and face resource constraints, and enormous internal problems. And now we have that country to deal with…"

Vignette, DHLN forum discussion

This example shows that the ambition of the Pharma Company was fuelled with the promise from the tech-vendors, which was challenging for all parties to meet. However, limitations on resources and information access are not the only reasons for missing objectives. In the following vignette, we see that while the technology was developed, the challenge was in taking this to enough users for appropriate ROI.

> "We had asked a Vendor to put their AI into an app that would allow dog-owners to understand the conditions of their dogs (given their consent). Based on the

claims of the vendor, we tried to use natural language processing (NLP) for a dog-wellness checker service aimed at owners. They could potentially tell the app that 'my dog doesn't run as much as he used to', for example, or 'my dog is limping on the left foot', and the service would automatically say 'it might be x/y/z/, so you should do a/b/c' – essentially clinical diagnosis. However, while the app's capabilities were well developed, where we failed was in telling this story to our potential customers and thus we were unable in monetizing it well enough to cover the development costs coming from the Vendor to enable further development of our solution. There are nowadays many great AI based end-user diagnostic solutions been developed in many countries, say NL and FI for instance."

Vignette, DHLN forum discussion

Simultaneous advancements: an early slope of enlightenment?

Some specialist companies have been looking for solutions to these ongoing industry challenges. The DHLN conducted a site visit to one such product development and technology consultancy, Firm C, which has been investing in the advancement of co-evolutionary algorithms – which are fast overtaking the level of human coders today.

At Firm C's advanced computer lab, we saw two big screens above a keyboard. When different genres of music were played on the keyboard, the AI system automatically categorised accordingly displaying its recommendations on the screens.

Vignette, DHLN site visit

Using computational neural networks, the system was initially hand-coded (including the need of manual transformation and filtering) over 3 months, with a music expert present with the coder. However, with recurrent neural networks, the deep and multi-layered learning process takes into account previous outputs for every new input, and to train the machine it only took 18 hours. As with the applications now filtering into healthcare the learning algorithm was the source of the efficiency improvement (from 3 months to 18 hours), and it has been developed for very broad applications.

What we saw from Firm C was testimony to the impressive advances made on the machine learning front. Machine learning, as a "field of study that gives computers the ability to learn without being explicitly programmed" (Schuld et al., 2015), have been receiving substantial attention from pharmaceutical R&D departments, start-ups and technology consultants to spur more effective development of innovation and reduce the cost of drug development (set approximately at $2.6bn in 2017) (Bate and Hanif, 2017). To an extent, more progress has been made on machine learning than on AI, and in the pharmaceutical industries in particular, machine learning has been explored from drug discovery and development through to manufacturing and pharmacovigilance (Bate and Hanif, 2017).

The boundaries of machine learning are constantly being pushed by firms like Firm C, and machine learning has dominated recent milestones in the AI field, particularly in deep learning. Three particular drivers have pushed machine learning's progress:

1. Faster, more specialized types of silicon
2. Large easily accessible datasets
3. New algorithms and computational approaches

These drivers (which reinforce each other) coupled with larger neural networks and parameters pushing the envelope in machine learning. Most recently, a recent study has revealed that deep learning has surpassed breast cancer detection accuracy of a pathologist: pathologist error rate was rated 3.5%, A.I. error rate at 2.9%, and the combination of the both at 0.5% (Wang et al., 2016).

Hype cycle?

So, where on the hype cycle does AI currently stand? There is evidence that it could be at the height of inflated expectations. Other examples have suggested a slip down the trough of disillusionment already. Yet, firm C's work and the pathologist example seem more optimistic at the same time.

Perhaps AI is going through the phases extraordinarily quickly. Perhaps we may even have overlapped and connected with different hype cycles that the pharmaceutical and health industries had been facing (such as the trough of disillusionment we carried forward from the 1980's). What we do know is that machine learning has been playing a central role in realising the opportunities around AI. Coupled with the quick advancement in recurrent neural networks and the benefits of new visualisation techniques, one thing is for certain – the future of AI will continue to be a key emerging space to watch.

References

Aranda, J. (2006). "Cheap shots at the Gartner Hype Curve". Available at: https://catenary.wordpress.com/2006/10/22/cheap-shots-at-the-gartner-hype-curve/ [Accessed May 2017]

Bate, A; Hanif, S "A perspective on machine learning in the pharmaceutical industry" Available at: http://www.abpi.org.uk [Accessed August 2017]

Berinato, S. (2016). "Visualizations That Really Work". *Harvard Business Review*

Fenn, J and Raskino, M. (2008). Mastering the Hype Cycle: How to choose the right innovation at the right time. USA: Harvard Business Press.

Gates, Bill. (1966). *The Road Ahead*. New York: Viking Press.

Mullany, M. (2016). "8 Lessons from 20 Years of Hype Cycles". Available at: https://www.linkedin.com/pulse/8-lessons-from-20-years-hype-cycles-michael-mullany [Accessed May 2017]

Panetta, K. (2016). "Are blockchain, smart machines, IoT and other emerging technologies on their way up or down the Hype Cycle?" Available at: http://www.gartner.com/smarterwithgartner/3-trends-appear-in-the-gartner-hype-cycle-for-emerging-technologies-2016/ [Accessed May 2017]

Wang, D., Khosla, A., Gargeya, R., Irshad, H., and Beck, A. H. (2016). "Deep Learning for Identifying Metastatic Breast Cancer". Available at: https://arxiv.org/pdf/1606.05718.pdf [Accessed July 2017]