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# *SHORT BRIEFINGS ON LONG TERM THINKING*

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Special Edition: AI

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KG Artificial intelligence is a technology that enables a machine to simulate human behaviour. It's like an artificial brain, but it's a super brain. And then we have terms like 'machine learning', which is a subset of artificial intelligence. And what that is looking to do is to automatically enable a machine to learn from past data without being explicitly programmed to do so.

So, with AI, we're looking for an intelligent system to replicate a specific task as a human would, whereas with machine learning, what we're doing is to teach a machine, using past data, to perform a particular task, and to do that with a high degree of accuracy. So that might be something like, 'can you recognise, from these millions of pictures that you're presented with, which of these moles are cancerous and which are not?'

And then just to add confusion to all these new terms, machine learning is how an AI learns. So, machine learning is how an AI develops its intelligence. And then we have subsets of machine learning, things like neural networks and deep learning, and these are about how that learning is structured. So, it's about models are given more freedom. They are supervised less in order to learn.

I like to think of artificial intelligence as a little bit of a spectrum. At the one end, you have machine learning, a kind of bare bones, real data crunching end of the machine learning spectrum. Is there a cat in this picture or is there not? And then at the other end of the spectrum, you have the general AI, which would be if you are presenting this AI with an unfamiliar ask, are they able to start generating a solution to that?

So, I think – and I'm no expert in AI – a really useful analogy that's helped me to bring all those pieces of the jigsaw together is to think of a toddler. And if you think



about how a toddler learns, they start off learning through being taught, through practicing and through receiving feedback. And that's like that machine learning phase. Then you have the fact that the toddlers then take that information and then they start experimenting, maybe getting themselves into a little bit of trouble here and there. And that's like that neural network phase.

And then finally, they start teaching themselves, and that's because they've developed the necessary algorithms in order to do so. They have the algorithms in their mind to be able to do that. And that's like that general AI phase, the main difference I guess being between a general AI and a toddler the sheer quantity of data that they're able to consume, and also the speed at which they learn is quite different.

So, I think what that serves to illustrate is that when I conceptualised AI at the beginning there, it sounds like something that's in the future. But the reality is, it is here and now. With those machine learning and neural network phases, whilst they are still early in their opportunity, they are much more mature than that general AI, which still remains an opportunity for the future.

MB I love the way that you describe the different ends of the spectrum with AI. It's also, I think, fair to say there are a lot of differing opinions on that spectrum about artificial intelligence. And it was interesting chatting to friends and colleagues just in the run-up to this conference, because it is something that divides opinion. But I think that's quite natural in the sense that new technology often both fascinates and frightens people. Is that just human nature, Julia?

JA No, absolutely. And despite that, Kirsty made it so easy, the way she explained what AI is, but it is a very complex technology. And anything complex tends to frighten humankind and it's very understandable. If you think about AI, it's probably even the most frightening technology out there.

First of all, it's sort of invisible. You don't even realise it's already here. And it works; it builds on semiconductor chips. So, it's a software that needs semiconductor chips to run on. And we can almost think about it as a living organism. So, the semi cell silicon is its body, and the small transistors are its beating hearts; many, many hearts that make it so efficient.

But what is even more powerful is that it's itself learning, but also, sometimes we don't really even understand how AI actually comes to certain conclusions and decisions. And that means we are losing control of that technology. And when we are losing control, we naturally feel very uncomfortable.

So in many ways, I'm trying to say, yes, it could be scary, but at the same time, what is actually the way out of scare and being frightened is actually knowledge, it's information, it's trying to understand what technology is, what potential it is for humanity and what potential dangers and abuse of the technology.

And in that context, I believe that regulation is going to play a role there to help us normal human beings. But it's also not just, say, up to regulators, because they can overregulate and they actually don't understand the technology, but it's also up to



the companies who are developing technologies. We call it bottom-up ethical practices on the company level, because they do understand all the details and how they develop technologies. They are responsible of doing it in an ethical way so that it doesn't get abused.

Actually, there are already examples of the companies that actually are trying to really enforce those ethical practices. For example, I came across a company that develops emotional AI. And immediately when we think about emotional AI, our fantasy can go very quickly into how it can be used for the good purposes but also can be abused in surveillance, for example.

And this company has been approached by different governments for that sort of application, and they just said no, it's not what they want to develop this technology for. And actually, also their bonus scheme for the developers is linked to how they can actually remove the bias out of data. So, we already see companies are trying to do it responsibly and they also try to send strong signals to the society out there. And we just need more of those.

MB And is emotional AI something that simulates our emotions?

JA Yes. So it's a machine that actually can start reading how we feel. So, it's based on our language, on our facial expression and our body language. It's still a minefield, but they made really incredible progress.

MB Kirsty, a lot of AI is already here, but what's the scale of the opportunity for investors with artificial intelligence?

KG I think that's a really interesting question but it's a really difficult question to answer. So, I think I'd probably approach that from two directions, from a theoretical perspective, and then hopefully we can move on and discuss some company specifics.

So, I think, to start with, it's the recognition that machine learning and artificial intelligence have been in existence for the best part of 60 years. And what's really changed over the past decade or so has been this massive explosion in the sheer quantity of data that we have around us. And that's been enabled by things like sensors, but it's also been enabled by computing power, the chips that we have that are able to generate data, to collect that data, and our ability to store it through things like cloud computing.

And what's most interesting for me is that data explosion has not been specific to just one or two industry verticals. It's not just been ecommerce. It's not just been advertising or social media. It's across the different spectrum.

It includes manufacturing companies that have sensors that are monitoring how they're manufacturing, monitoring things to try and pre-empt whether there's going to be a fault. And so that data explosion is vast, and it's been across industries. And I think that is a good starting point on how to think about the scale of the opportunity. It is potentially vast as well.



I think the other way to potentially think about it is, I read a book recently called *Competing in the Age of AI*. And it talks about this concept of an exponential system coming into contact with a saturated one. And it's this idea that the more people embrace data and machine learning and artificial intelligence, the more others are going to have to do so, because you simply cannot compete with a system that is moving that fast. Any industry that doesn't embrace what is currently happening is going to be left behind.

And I think part of this comes from the fact that AI breaks down siloes within businesses. It used to be that you'd have marketing data, and product data, and sales data, and HR data. And ultimately, in order to generate insights that potentially humans are not aware of, we have to bring all that data together. We bring all those data sets together, store them in a cloud offering, and we can then analyse them, and we can run various models.

So that's breaking down the siloes within industries, but then you're also seeing the breaking down of traditional industry verticals themselves. And we saw this with the emergence of something like Alibaba, the ecommerce giant in China, moving into what has traditionally been a very high barrier to entry market, which is banking. And they could do that not just because they wanted to and they needed to, but they had the data, they had the knowledge base to move into that different industry vertical.

And I think that speaks to just a broader and more interesting point, which is when you see a new technology, if that's the right word to describe artificial intelligence, emerge it's not just about replacement. It's also about unlocking new opportunities and new ways of doing things. And that is also suggestive to me of the potential scale of opportunity that's here.

MB Yes, and that data is really significant, as you're saying. Julia, your area of focus in the Health Innovation strategy is healthcare clearly. Give me some examples of where you're seeing artificial intelligence being used in healthcare.

JA Yes, I just agree with Kirsty so much when she talks about big data, that convergence of data and AI and what a difference it can make for different industries. And I think healthcare is probably one which is really ripe for massive change.

Also, if we think about human biology, it's probably the most complex system out there. And the way we studied it in the past, it was, as you say, siloes, because we haven't been able first to gather relevant data to different parts of biology, but also integrate it in a thoughtful way. And for the first time in human history, we are actually in a position to do it.

And the reason why we can do it, first, we can gather all the relevant data to human biology, like genomics, proteomics, its microbiome. So, microbiome is the bugs that live in our gut. So, we can pull all this data. And it's just trillions of data points. And it's a massive complexity.

I call biology, actually, a problem of large numbers, massive numbers. And then



when you combine it with artificial intelligence, suddenly you have an opportunity actually to unlock this complexity, and then healthcare is actually going through the massive transformation.

So first this technology is used to understand the biology. And when we start understanding the human biology, we can start studying diseases and what the underlying sources of disease is. If we understand that, we can start developing diagnostic tools that are very precise, and we can start diagnosing diseases much earlier in their evolution.

But beyond that, we can also develop proper targets for diseases, so those much more precise targets. And also, we can develop medicines from the bottom up, designing small molecule drugs or messenger RNA by actually applying artificial intelligence.

And just to provide two examples of some of the companies we are really excited about, like Moderna. So many people are familiar with Moderna, because we know what messenger RNA is already, and how impacted our ability to fight against Covid-19.

What many people don't know is that in order to design the messenger RNA vaccine, AI also is used to design the sequence. Because the way you put the sequence together for the spike protein, it would impact how it expresses in your body in quantities, to make it more effective, to reduce the immune response. So, it's actually a very powerful technology just in the design stage.

But also, Moderna is using AI to possibly predict how a virus is going to mutate over time before it's mutated. And that could put us in a much stronger position in the pandemic preparedness, or endemic, so we can actually be in advance of the virus rather than keep chasing it. This is entirely transformative, the way we can potentially treat infectious diseases. So, this is just one of the examples.

And another one which also I really think is quite cool is a company called Exscientia. They build small-molecule drugs atom-by-atom using AI. And the advantage of doing that approach, by using that technology, is that traditionally the way we used to design drugs is by optimising first for efficacy and then for safety. And normally, drugs actually fail because of their safety, because they are very potent they attack everything else in the body, which makes them unusable.

But if we could optimise in parallel for those two things so there are trade-offs between efficacy and safety, suddenly we actually have a higher chance of those drugs coming and working for patients. And that's exactly what Exscientia does. They're using artificial intelligence to optimise those two properties simultaneously. And we can already see that those drugs are very, very different.

It's entirely reinventing how we approach health in many ways, but as I mentioned, it's a spectrum. So, it's not just one area. It's just it's so broad. And that may be to your point, Kirsty. It's across many industries, but when you start also going deeper into one particular industry, you also see the breadth of the application. It's just not one thing.



**MB** It's interesting. I think the benefits of artificial intelligence in healthcare is often something which is underestimated in terms of how significant it is, because this is a massive problem in terms of costs.

If we look at US healthcare spending between 1970 and 2019, healthcare spending in the US as a percentage of GDP has more than doubled. So, it's increased from 7 per cent to around about 18 per cent, which is massive. You talk about that convergence point between science and data.

So, will AI hopefully bring down healthcare costs over time?

**JA** Well, that's a hope, and probably it's not just a hope. We're already seeing somehow companies actually, by utilising these technologies, increase the efficiency on their invested capital. Moderna is one example. There are many different reasons why healthcare is expensive, but we can just maybe stay with drugs themselves.

They are very difficult to develop because of the complexity of human biology. Normally, it takes more than ten years, it takes billions of Dollars, and then the chance of success is around 10 per cent. So, it's a very, very difficult industry to be in. And then, of course, in order to compensate for all this risk-taking and capital, the pharma company is charging quite high prices. But with AI, we can potentially have an opportunity to entirely reinvent the business models in drug development.

And it's just because we're coming out of the darkness, when you talk about the light. And I feel like AI, even though light makes such a difference, within biology, we are still pretty much in a dark box. AI has an opportunity to bring us out of the darkness because we start finally getting some control over the complexity, biological complexity, and de-risking drug development. And when we're changing the risk profile, suddenly the economics looks very different, and that would eventually play into the overall cost of healthcare.

**MB** Kirsty, let's look at some other sectors you're looking at from an investment perspective that's interesting you.

**KG** Yes, I think the core point that we both touched on up to now is that, ultimately, AI is a data problem and the fact is, as I mentioned in my last comments, that data collection is happening across industries. So, there's a lot happening in lots of different industries.

For example, we can take something like the advertising industry. There's a company listed in the US called The Trade Desk. And The Trade Desk is a demand-side programmatic advertising platform. Now, that's a lot of words, but what that really means is that they use data to help their customers buy advertising. So, if the three of us were watching the same television programme at home on a connected device, we can then be served advertisements that are relevant to each of us at the same ad break.

So, what that does is it moves us from the world of 'who is the average viewer' and 'who do I want to attract' to 'who is actually watching this' and 'how do I advertise





to them in a relevant way?’ And that’s possible because The Trade Desk can process over 12 million ads per second.

MB Wow.

KG I can’t even begin to process how fast that is. But also, that’s just something that a human would never be able to achieve. They also have a dedicated platform called its Koa platform, and that’s designed for its customers. It means that they can automatically send advertising dollars to those areas that are being successful and remove advertising dollars from those areas that are struggling at any one point in time. That is a real-time thing.

Then you move to an industry like transportation. Now, we all know that Elon Musk and Tesla are looking to make autonomous vehicles. But there’s a company in the US called Aurora that listed last year, and what Aurora is looking to do is autonomous trucking. Now, trucks are big heavy pieces of machinery, and having them hurtling down a highway without somebody behind the wheel is potentially a scary prospect for people.

And what Aurora has been doing is training what’s known as its Aurora Driver, and that driver is its autonomous software. They’ve been training it and adding features over time. And the most recent feature that they’ve added is the ability for that driver to navigate roadworks.

The challenge with roadworks is that many of these autonomous driving companies use sensors to understand whether or not you’ve moved out of your lane - are you still in your lane? Now, the challenge with roadworks is it usually requires you to move out of your lane, and quite often, it requires you to cross multiple lanes to go around the blockage.

That’s difficult to programme or difficult to learn about because it’s not binary. It’s not as simple as saying red light means stop, green light means go. It requires experience. No matter how many times you see roadworks, you’re never going to see those precise roadworks. So that is about learning, and that is what the Aurora Driver has been doing. It’s been learning, ‘how do I use my previous experiences of roadworks’, and ‘how do I apply that to the situation I’m confronted with in real life?’

And then you have an industry like insurance. And this is really interesting because AI has the potential to not just disrupt the business model but also the product itself. So, if you boil insurance down to what it fundamentally is, it’s about data. It’s about monetising statistics, and probability theory, which is ultimately what AI is looking to achieve as well.

And so how can AI disrupt the insurance industry? Well, it can actually disrupt the domain that legacy players had over the one factor of production, and that’s data and monetising that data. So, data and statistics. Because these AI models in insurance can potentially come in, bringing in data that those legacy players don’t even have access to, or they’ve never collected data on, that means that you develop a model in which others just can’t compete.



There's a company listed in the US called Lemonade Insurance, and they are embracing the power of artificial intelligence when it comes to their insurance offering. They have an AI called AI Mia. And AI Mia is deals with premiums, so policies.

She asks 13 questions and collects over 1,700 data points through those questions, including things like how long did you spend answering a question, how many times you visited the website, did you read all the terms and conditions, etc., and as a consequence of that, decides how to price your premium, and can price your premium therefore based on you as an individual, again, as I mentioned with The Trade Desk, rather than putting you in an average pool of what's expected of somebody within your demographic.

Then they also have AI Jim. And AI Jim deals with claims management. So, if you need to make a claim on your insurance, you contact Lemonade, you're put in contact with AI Jim, and as long as that claim is within the guidelines of your policy, then it will pay out.

Now, the opportunity here is, one, as we saw in healthcare, to potentially reduce the cost of insurance. Because you'll be able to better identify the bad actors. You're not clubbed together. The good actors and bad actors are not clubbed together and given an average price. You can be priced as an individual. And the second thing is there's a potential to lower the cost for the companies operating in the industry because the administrative burden of people phoning to make claims is taken on by an AI rather than humans.

JA I just find it fascinating. What you actually talk about is a lot of personalisation. And the same theme is very powerful in the healthcare space. Because if you think about it, most of the drugs are developed for averages. And when you actually assess how effective those drugs are in real life, most of them don't work because either they're not effective or they cause very severe side effects.

And also there is a paradigm shift in healthcare. Can we develop drugs first for more stratified populations based on, for example, their genomic profile, but also going much more personalised, truly patient by patient? And again, bringing Moderna back, they're working on the personalised cancer vaccine, where each individual cancer is assessed for its profile and then the vaccine is developed specifically for that profile for that patient.

And without AI, you just can't do it. Because it's effective, it's quick, and it's cheap. So this is the same kind of personalization, which we have not been able to approach in that way without that technology.

MB Kirsty, you started the conversation by talking about the toddler going through its growing pains in terms of growing up, and that correlation with artificial intelligence. How do you see that toddler developing over the next ten years or so?

KG Yes. So, I think you can use that analogy as well for the industry itself. I think we're probably in that toddler stage. And then you probably see that potential for that childlike delight stage, all the excitement about what's possible. And then





maybe you move into the moody teenage phase, where they're shut in their room, you don't know what's going on, it is a bit of a black box, we're not entirely sure what they're thinking, how they're thinking.

And I think that's the emergence of the general AI side of things, that it's hard to know exactly what's going on. But I think that in itself is less of a concern if you know, as when you're bringing up a teenager, that you've put the guidelines in place, that eventually they pop out as a valuable member of society, even if they went through a few growing pains at the time.

And I think it speaks to that idea that if you instill the right values, and you recognise the potential biases and externalities of what you are trying to achieve, that as long as those are potentially in place before you start, you will go through those periods of not understanding, not knowing exactly what's going on, but you know there is a light after the darkness of hiding in your room for five years.

MB It's this idea, isn't it, of artificial general intelligence, or AGI, that DeepMind, owned by Google parent, Alphabet, are trying to get to over the long term. But it's something, and you did talk about this earlier with Aurora, this idea of edge cases with roadblocks and a pigeon flying up. But it's hard to underestimate quite how difficult this is in terms of understanding consciousness, learning from mistakes. It's an extraordinarily difficult thing to do, isn't it?

KG Yes. I think the challenge is that we don't really truly, as Julia mentioned earlier, even understand how our own brains work. We don't know how we make the connections that we do. We're potentially developing AIs that can understand emotion, but do they truly understand emotion yet? Because what people's faces say and their body language says, is that the same as what's in their head?

And we don't necessarily know how we arrive at the conclusions that we do. But ultimately, it's about making connections, and over time, AIs are making more and more connections, and they're making those connections at a faster pace because this is an exponentially improving technology.

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