

AlphaGo

A FUTURE POWERED BY ARTIFICIAL INTELLIGENCE

Lawrence Burns, Investment Manager. First Quarter 2017



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LAWRENCE BURNS

Investment Manager

Lawrence graduated BA in Geography from the University of Cambridge in 2009. He joined Baillie Gifford the same year and has spent time working in both the Emerging Markets and UK Equity Departments. Lawrence is a co-manager of the International Concentrated Growth strategy as well as a member of the EAFE Alpha Portfolio Construction Group. He is involved in both listed and unlisted investing and travels extensively researching his particular interest in how pervasive technology and China are changing our world.



A FUTURE POWERED BY ARTIFICIAL INTELLIGENCE

BY LAWRENCE BURNS

Andrew Ng, Baidu's Chief Scientist, plays a game with his friends. The object of the game is to come up with industries that you think won't be transformed by Artificial Intelligence (AI). He admits he isn't very good at this game, struggling to get much beyond the answer of his hairdresser. For him, AI is the new electricity and just like electricity it has the potential to transform industries from agriculture to healthcare. This is not the distant future, but an outlook for the next ten years.*

For Robin Li, Baidu's CEO, this means the age of mobile internet is coming to an end. Next will come the age of AI. His view also echoes that of Google's CEO, Sundar Pichai: that we will move from a "mobile first to an AI first world". Indeed, there appears to be a growing consensus that the internet and computing could be about to enter a distinct new phase.



WHY NOW?

AI has been in development for over sixty years. During this time, it has gone through several periods of excitement. In the past, there was considerable focus on looking at how human experts behaved and then codifying those practices as rules into a computer. In contrast, progress today is being driven by a subset of machine learning called deep learning. Deep learning involves feeding data to neural networks crudely modelled on how we think the human brain might work and using algorithms to have the computer learn from that

data. Rather than trying to examine samples of information with preset rules, computers are now powerful enough to examine complete data sets and observe whatever patterns might exist within them. With the advent of unsupervised learning, this data does not even need to be labelled to allow the computer to make sense of it. Deep learning is enabling remarkable improvements in machine translation, natural language recognition and computer vision.

Moore's law suggests that processing power doubles every two years, but other improvements in computing have actually enabled far greater progress. Cloud computing lowered the cost, while a shift from using computer processing units (CPUs) to graphics processing units (GPUs) has sped up deep learning by 10-20x. GPUs are well suited to deep learning

because they specialise in doing a large number of simple calculations in parallel. Overall, computational performance in deep learning has improved a staggering fiftyfold in just three years.

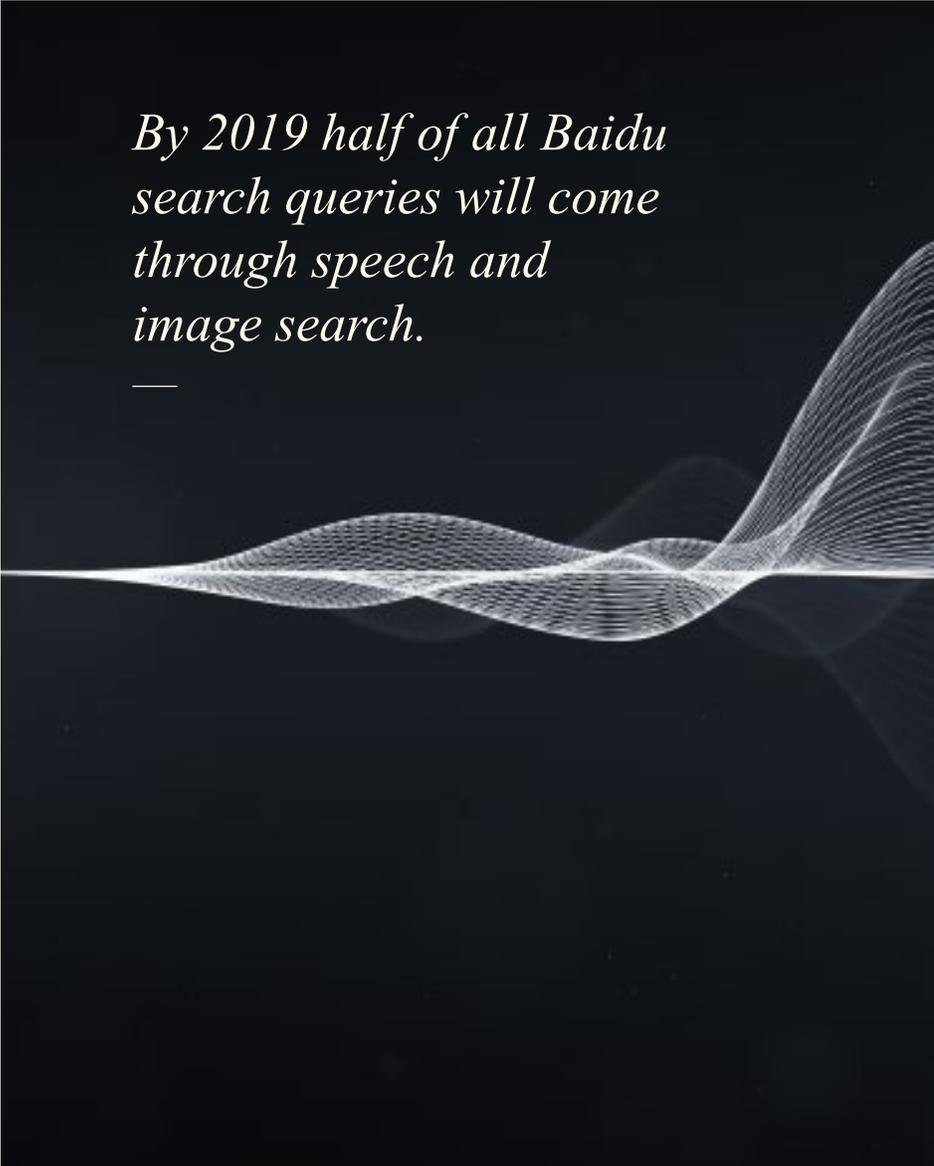
The proliferation of the internet, particularly on mobile devices, has led to an explosion in the data necessary to feed deep learning algorithms. In 2016, it was observed that more data was created in the previous two years than in the whole of human history. This matters because today's artificial mind is still rather dull. A human brain needs only a dozen images of dogs and cats to begin to distinguish between them. An artificial mind requires thousands of examples. If AlphaGo had only been able to practice as much as Lee Sedol, Sedol would have annihilated his artificial opponent. More data is creating smarter machines.

NATURAL LANGUAGE RECOGNITION

The most relevant near-term application of deep learning is natural language recognition. This has the potential to change how we interact with the internet and therefore how every internet company interacts with its users.

Li believes this represents the third era of the internet. The first was the desktop era, with keyboards as the input device. The second was the mobile internet with touch screen input. Li believes the mobile internet era is now coming to an end, replaced by the AI era with natural language recognition as the input device.

The application of deep learning to natural language recognition has fuelled significant progress. Error rates have fallen from over 15% in early 2015 to below 4% today. Moreover, a Stanford study using Baidu's Deep Speech 2 recently demonstrated that speech recognition was 3x faster in English and 2.8x faster in Mandarin than using a touch screen. Furthermore, it found speech recognition actually reduced the error rate in English by 20% and in Mandarin by an incredible 63%.



*By 2019 half of all Baidu
search queries will come
through speech and
image search.*



It is because of these improvements that 10% of Baidu's search queries are now made using speech recognition. Moreover, Ng predicts that by 2019 half of all Baidu search queries will come through speech and image search. Voice queries are more popular in China, in part because the language is notoriously hard to type and some users do not know pinyin (the system of writing Mandarin that uses the Latin alphabet). This could give Baidu a head start in voice recognition.

It is very early, but the implications of this shift strike me as hugely significant. In the desktop era, search was a dominant gateway to the internet. In the mobile era, it remained important, but less dominant. Users can now go directly to vertical search apps and app stores. For example, I can happily search for restaurants using Trip Advisor's app, read news on the BBC News app and buy a new pair of shoes on Zalando's app without ever going near Google. In contrast, with voice recognition, the search engine or voice recognition provider becomes the access point to all information and all functions, becoming both a search engine and a virtual assistant. Whoever fulfils this role effectively becomes the operating system (OS). This is why Microsoft and Apple are developing their voice recognition assistants, Cortana and Siri.

TRANSFORMATION ACROSS INDUSTRIES

We already benefit from AI in our everyday lives. When Facebook auto-tags your friends in photos, it does so through deep learning; when you use Baidu's or Google's voice search, the natural language recognition is done by deep learning; and when you put your apartment on Airbnb, the recommended rate is generated by deep learning. Zalando has even used deep learning to improve warehouse efficiency and to power fashion design with Project Muze.

The applications may be felt first in the consumer internet space but they will extend well beyond. There are four big areas worth mentioning now.

- The first is transportation. Autonomous vehicles are only becoming possible because of the improvements in deep learning, which enables machine vision.
- The second is healthcare. The benefits here are particularly potent as healthcare is, in a sense, a data problem. Projects are underway to diagnose CT and MRI scans using deep learning. Healthcare personalisation is also likely to be powered by deep learning. It will be required to analyse genetic data, to see whether people with the same genes get the same diseases and what medicines are likely to work for them. Chemotherapy only helps one in six people, but the combination of doctors and AI medical technology should allow us to know which one in six.
- The third is augmented reality (AR). AI is the engine needed to enable computers and smart phones to understand the interaction between the real and virtual environment. An early example of this is Baidu's experimental advertising campaign for L'Oreal. The consumer uses Baidu's image recognition on a paper flyer to cause pink blossoms to fall and attach themselves to the advert.
- The fourth is finance. The pricing of financial products such as loans and life insurance could be materially improved by deep learning. Fintech companies are already using machine learning to incorporate much larger data sets into their risk analytics. This is improving the access to, and cost of, finance for millions of consumers. Indeed, JD.com, the Chinese retailer, has partnered with one of these firms to assess credit risk when offering instalment loans for online purchases.

This is an enabling technology. The potential impacts are therefore wide and of a similar breadth and scale to electricity, computing and the internet.

*“AI WILL CHANGE EVERY
TRADE AND EVERY INDUSTRY.”*

ROBIN LI, BAIDU CEO



COMPETITIVE EDGE IN AN AI POWERED WORLD

It is no coincidence that two of the leaders in the field of AI are search engines. Learning from data has been Baidu and Google's core business for well over a decade. They should have a head start. Li highlights how Baidu have been investing in this area already for many years. Likewise at Google, when challenged "web search, for free? Where does that get you?" way back at their IPO party in 2002, Larry Page responded with incredible vision and foresight "Oh, we're really making an AI".

It is not a new insight that data can be a competitive advantage. But deep learning enhances that advantage because it allows you to extract even greater value from large data sets. This means data-rich and data-centric companies should see their competitive advantage further enhanced versus old world companies who have less data and whose strategies are not focused on data collection and usage.

Ng has spoken about how it is difficult for companies to derive real edge from algorithms. He notes that in the global top tier of AI companies no-one is more than one to two years ahead or behind in terms of algorithms. He

therefore claims that "data is the defensible barrier ... unique data assets are very difficult for competitors to copy or for us to get a competitor's data assets". This should mean that even as we transition towards an AI-first world with an AI-powered OS there is good reason to believe that existing large internet companies will be the ones that dominate this new era.

New AI companies will probably still emerge. Indeed, a new start up called Viv, which includes some of the team behind Siri, are currently working on their own assistant. Yet I can't help but think that it is more likely such companies will have to sell themselves to data rich companies, or at best strike partnerships to gain data access, than succeed independently as search or OS providers.

Baidu and Google do lack various data sets. One long-term solution may be to commoditise deep learning and offer it as a platform. Google has TensorFlow, Amazon DSSTNE, Microsoft CNTK and Facebook has Torch for machine-vision technology. Baidu are opening up their own machine learning platform, PaddlePaddle, for free.

A BRAVE AND WONDERFUL NEW WORLD

It is too early to fully understand what artificial intelligence could mean. This note is a very early attempt to grapple with the implications. I find it fascinating that data is becoming yet more valuable, to the benefit of data-rich and data-centric companies, thereby potentially enhancing the competitive advantage of online over offline commerce. It is also surprising that the most likely winners of this new era will be the same players that benefitted most from the earlier desktop and mobile eras.

What I particularly like about this opportunity is that the market seems to struggle with it. Does any broker assign any value to the AI opportunity? Concrete AI applications are three to five years away and the costs will of course be upfront. But the magnitude of this opportunity should not be underestimated. Li spectacularly mused to us: “In five years I’m not even sure search will still be our main revenue source”. Meanwhile, Ng remarked: “the advent of all-pervasive AI will be the single most important development for the global internet sector” and “whoever wins AI will win the internet”.

CURIOUS ABOUT THE WORLD

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