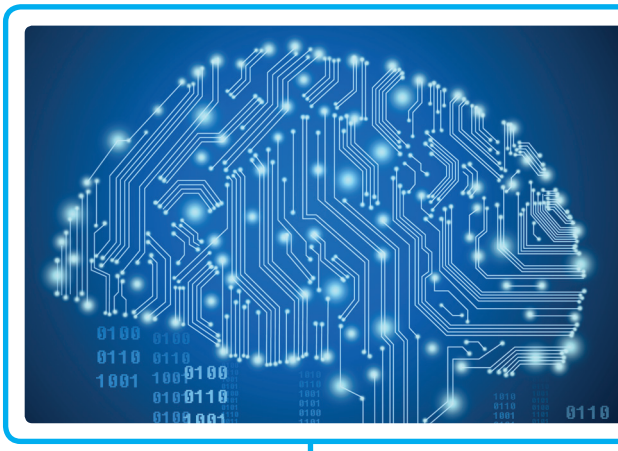
FUNDAMENTALS

Artificial intelligence gets real

Is artificial intelligence overhyped, or are we at the vanguard of a new wave of corporate productivity improvements ushered in by next-generation technology?



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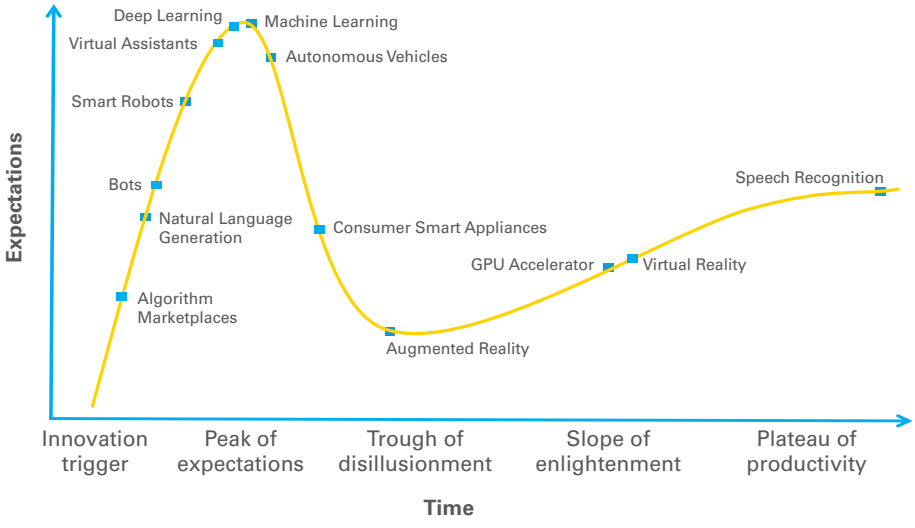
In recent investor presentations and earnings calls, we have increasingly come across the terms 'artificial intelligence' (AI) and its terminology bedfellows, 'machine learning' (ML) and 'Big Data'. While companies have addressed these concepts for a few years now, they have taken centre stage in the last 12 months.

While we see a lot of hype in the near term, there are enough real-life examples underway to indicate AI will be a significant investment theme in the next decade.

In its purest form, AI is defined as 'computer systems able to perform tasks normally requiring human intelligence'[1]. In practice, it is self-learning technology driven by machine-learning algorithms that try and fail, learning from experience and improving millions of times over. The algorithms require access to vast amounts of data to allow them to fail, learn and discover ways to improve.

Figure 1: The Hype Cycle for AI



Source: Gartner

1 Arm Holdings, **Global Artificial Intelligence Survey**, 2017

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Advances in computing power, data processing and connectivity have triggered a sharp rise in potential AI applications. Real world examples of computer systems able to perform tasks previously requiring 'human intelligence' – including visual perception, speech recognition and language translation – are already achieving superior accuracy.

VISUAL PERCEPTION: CATS TO CRIMINALS

In 2012, computer scientists at Google X built a neural network of 16,000 computer processors with a billion connections. They then put it in front of millions of randomly selected YouTube videos. Remarkably, it taught itself to recognise cats. While this may not sound like a dramatic breakthrough in practical terms, the fact it achieved 'unsupervised learning' was a big step forward.

More helpfully, the system also trained itself to recognise facial features, achieving 81.7% accuracy in detecting human faces at the time. Today, AI and ML have enabled computers to zero in on the features that will most reliably identify a person, improving the accuracy rate and potential applications For instance, using photographs of known criminals and non-criminals, researchers from Shanghai JiaoTong University trained neural networks to correctly identify criminals from new images with an accuracy of 89.5%.

On the back of recent such improvements, companies across all sectors are now ploughing investment into visual perception and speech recognition. Forecasts suggest spend on AI-focused technology will reach $58bn by 2021[2], making it one of the fastest growing technology segments.

It is important to stress that AI is not a product offering *per se* but an algorithm-based model that discovers patterns and logic in large amounts of data. As it transitions out of the lab and corporates look to adopt the techniques more widely, we consider three components to be crucial for financial success:

1. **The technical capability for AI and ML**
2. **Access to a large volume of data from which it can learn**
3. **The ability to deploy and implement AI at scale, and then ensure it keeps learning and improving**

The final step may be the hardest to achieve and is potentially a major barrier to fully harnessing AI, as demonstrated by the following two contrasting examples.

KEY TERMINOLOGY

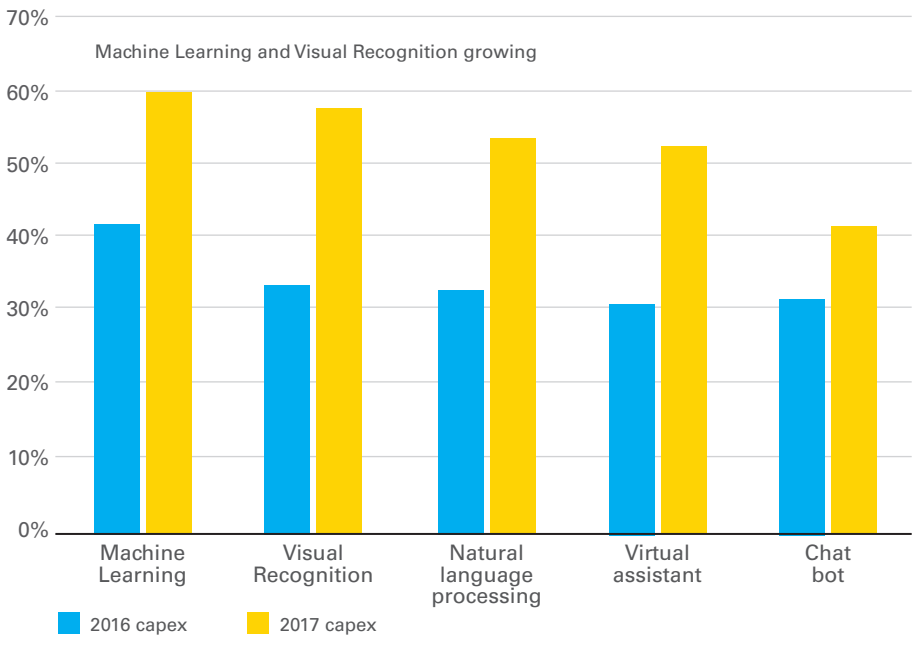
Artificial Intelligence
A computer programme that can sense, reason, act and adapt much like a human behaviour.

Machine Learning
Algorithms whose performance improve as they are exposed to more data over time.

Big Data
Large quantities of data that are typically stored in unstructured environments

Deep-learning
Uses multi-layered neural networks from vast datasets to learn and interpret images/sounds

Figure 2: Growth in corporate AI spend



Source: UBS Research

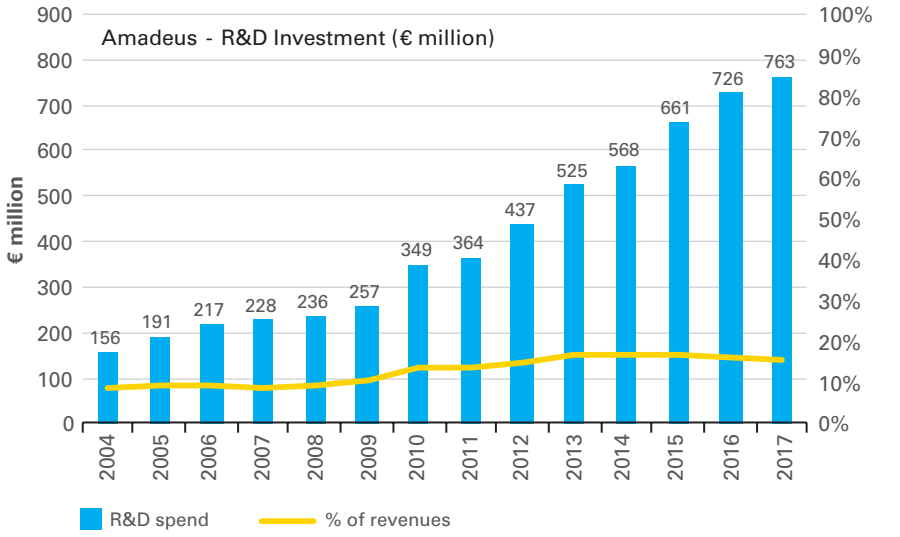
2 International Data Corporation, **Worldwide Semi-annual Cognitive Artificial Intelligence Systems Spending Guide,** 2017

WHEN DO WE SEE MORE THAN A 'SECOND OPINION'?

The case for applying AI in **healthcare** is compelling. Good healthcare outcomes require the correct diagnosis and the right treatment plan. In theory, diagnoses informed by a machine that has been 'taught' by some of the best medical professionals and is able to draw upon data from millions of medical records ought to be more reliable than any one single medical professional. IBM certainly believes so, having spent billions of dollars employing their machine learning tool Watson to the healthcare vertical. However, investors are starting to question when and whether they will see the financial fruits of these investments.

To support their push into healthcare, IBM Watson acquired an extensive database of medical images, clinical trial data and historical patient diagnoses, as well as partnering with some of the leading academic hospitals in each field to help 'train' Watson. However adoption of this service has been disappointing so far. Its oncology product is used in only 50 hospitals, despite IBM's confidence that the diagnoses and treatment plans recommended by Watson generate superior outcomes for patients. For IBM, the challenge here is to deploy its intelligence at scale. It has the technology capability, the industry expertise and the data, but lacks the avenue to deploy its insights at scale on the frontline of cancer. IBM doesn't own the hospitals.

Figure 3: Technology focus and market leadership



Source: Amadeus, 2017 investor presentation

FROM LOOK TO BOOK – BEYOND THE HUMBLE TRAVEL AGENT

AI in **travel** has been more successful, deployed in part to address some of the challenges thrown up by the dramatic shift of travel booking in the digital age. As a consumer, the booking process may feel simpler; from a data perspective, it has become infinitely more complex.

20 years ago, the 'look to book' ratio was 10:1, i.e. 10 enquiries would result in 1 booking. With the advent of the internet, that ratio has risen to 1,000:1. For a single city-pair, such as London to New York, there are 600,000 possible trips, with at least 10 different fare classes per trip and about 5000 possible fare combinations. Given the mathematical challenge, working out which options to display to the consumer based on search criteria is very important.

Amadeus is the market leading provider of IT solutions for the travel vertical. The company has used AI and machine learning to improve the user experience, using the predictive capability of its algorithms. As a technology company focused solely on the travel vertical, Amadeus has both expertise and significant volume of data from which to work (Amadeus processed more than 595 million travel agency bookings and boarded over 1.3 billion passengers in 2016). Crucially, though, by being placed firmly at the heart of the travel ecosystem, it has also been able to deploy its learnings at scale: as a marketplace model, its use of AI increases its relevance to travel providers by improving the conversion rate (the look to book) and supports their core business.

AI FOR HIRE

Outside of the technology sector, building the capability for AI and ML is more difficult. However, due to the evolving business models of some large-cap technology companies that have pioneered the development of AI, it is not as difficult to access as one might imagine.

Amazon and Netflix both use an AI framework to power their respective recommendation systems: an AI-driven information filtering system that can automatically predict user preferences based on past behaviour. Endorsing its significance, recent data published by Netflix suggests 80% of video on demand hours streamed are based on personalised recommendations. Netflix has benefitted significantly from being able to draw upon the resources of its technology partner Amazon AWS. Amazon, Apple, Google and Microsoft are leaders in the field of voice and personal assistants. Alexa (Amazon Echo) is fuelled by natural language processing and automated speech recognition, which not only has the ability to recognize speech but also learns and develops more features. Meanwhile, Google has rebranded itself from a 'mobile-first' company to an 'AI first' company, incorporating RankBrain -a deep learning technology that helps refine queries and rank web pages – into its search engine from 2015.

It is estimated the FANGs (Facebook, Amazon, Netflix and Google) each invests more than $5 billion annually in AI, and it is likely that digital advertising in particular has been both an early beneficiary of AI and a strong motivating factor behind its development. Both Google and Facebook use AI extensively to support the predictive algorithms powering their immense advertising businesses, and the recent scrutiny on Facebook has illustrated just how effective their targeting, done largely by machines not man, can be.

However, this isn't their only case of using AI. About a year ago Facebook added technology that automatically flags posts of people with potentially suicidal tendencies to human reviewers to analyse. Much like Facebook's attempts to supervise its vast network of over 2.1 billion monthly average users, and take down racially motivated posts, this sort of intervention is only possible via AI because of volume of data required to be processed.

The motivation is not only driven by a desire to innovate their core businesses, but also in the cases of Amazon, Microsoft and Google, to provide cloud technology services to businesses across all sectors.

In short, the technology giants are able to commercialise their AI capabilities by renting them their cloud customer base. Instead of buying or building the technical capability for AI, companies can increasingly rent it from their technology provider, opening up AI to all sectors and companies of every size.

Industry vertical	Example AI use cases
Automation	Self-driving cars, Advanced Driver Assistance Systems, factory of the future
Banking	Automated trading, fraud detection, natural language processing, robo-advisors
Education	Adaptive learning programs, skill upgrade teaching
Entertainment/Media	Advertising, interactive gaming, video analytics, voice based commerce
Government	Smart surveillance, threat detection, transport simulations, chatbots
Healthcare	Digital health, diagnostics, drug discovery, predictive analytics
Natural resources	Agtech, aquaculture, bioscience, seed genetics
Retail	Customer analytics, supply chain management, sensor intelligence
Technology	AR/VR, cybersecurity, chatbots, enterprise software, industrial robots

THE ULTIMATE TEST – AUTONOMOUS VEHICLES

As a top use case for AI, autonomous driving is one of the most complex forms of AI underway for two reasons: first, it involves combining a broad and constantly changing set of data inputs; and second, if it goes wrong – as in the recent case of Uber's fatal self-driving crash – it results in human casualty.

Progress towards full autonomy has been gradual, given a requirement for instantaneous decision making. Most systems on the market have developed varying degrees of driver assistance systems, but even the most optimistic forecasts suggest we are some years from achieving level 4 or 5 autonomy (i.e. where the computer takes control). Currently, over 10 tech companies, auto OEMs and ride-hailing unicorns are aiming for level 5 fully autonomous vehicles by 2020 or 2021.

Once again, the barrier is not the technical capability, nor the data; various programmes have demonstrated this capability already. The challenge is being able to deploy the capability at scale and benefit from the virtuous circle of more driving, providing more data, enabling more learning and an improved capability.

COST-SAVING OR LABOUR-SAVING?

Incorporating AI into business processes can help improve productivity by automating tasks that previously required human labour. A simple example is customer service roles, with one of the largest enterprise applications of AI to date in chatbots and virtual assistants. Companies such as JPMorgan and Sage Group are also looking to reduce costs by integrating digital assistants to help with business administration.

More complex examples are found in the industrial sector, in areas such as plant and machinery monitoring and maintenance. Harnessing a large volume of data from sensors installed across Shell's refineries or Rolls Royce's aircraft engines is changing the way that equipment is monitored, maintained and serviced. The promise of AI is to apply machine learning to those datasets to identify the early warning signals that a manual inspection may not identify, and to therefore improve the uptime of expensive capital equipment.

While broad fears of labour displacement persist, the reality is more nuanced. In most of the examples we have highlighted, AI was deployed to support – rather than replace – labour. AI can therefore be seen as a critical component in raising economic productivity from a macro perspective and in raising corporate profitability from a micro perspective.

The possibilities yielded by AI apply across every sector. In our view, the real beneficiaries of the growing capability of AI will be the companies that can combine technical capability and large datasets with the crucial ability to deploy AI at scale in their core businesses. However, the scale providers of AI capability – the large-cap technology players such as Amazon, Google, Microsoft, Facebook, Alibaba, Tencent and Baidu - are, once again, front and centre of this profound long-term investment theme.