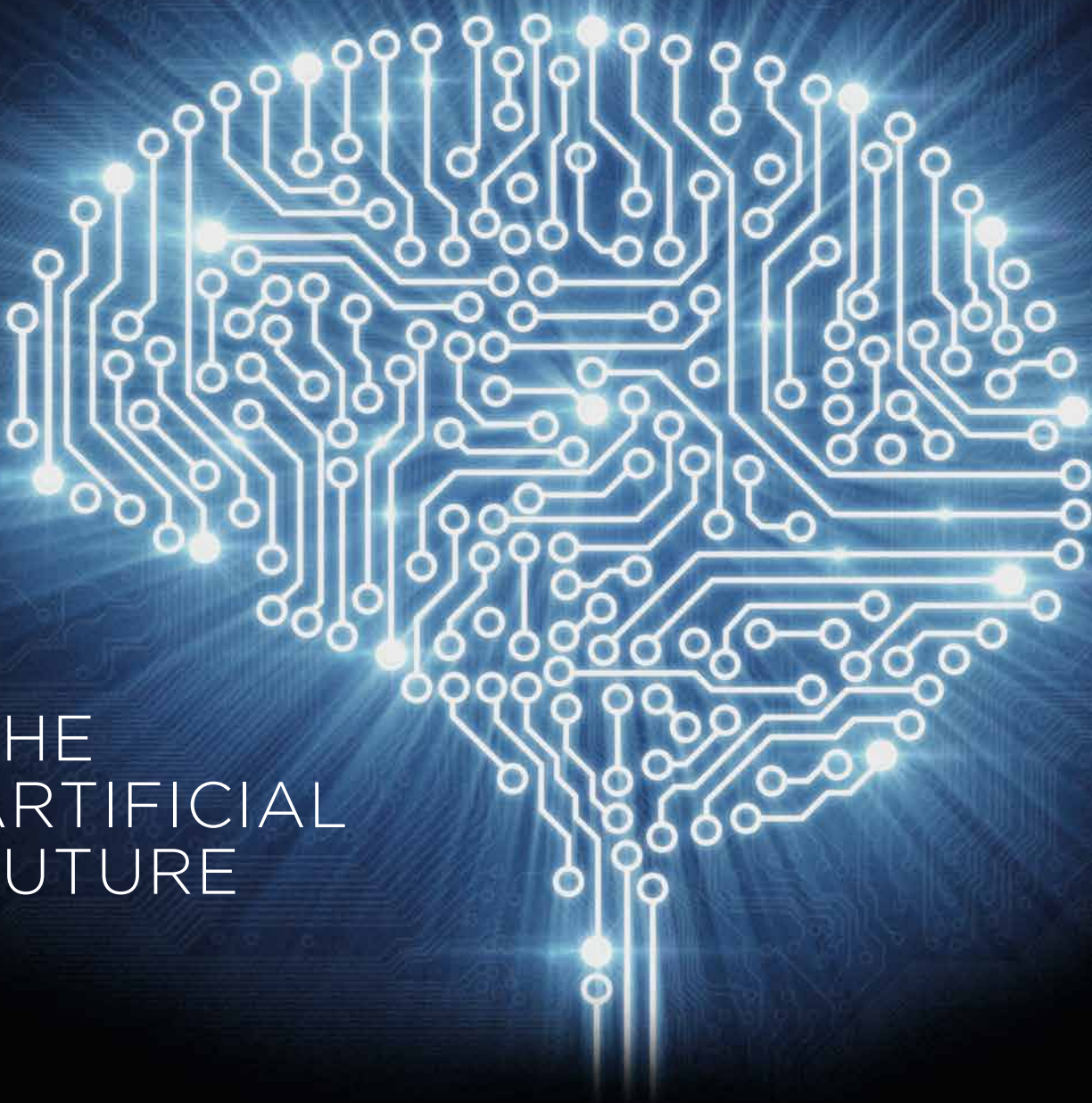


A large, glowing blue graphic of a human brain composed of circuitry. The brain is formed by a complex network of white lines and dots, resembling a circuit board. The lines and dots are illuminated with a bright blue glow, and several points of light radiate outwards from the brain, creating a sense of energy and connectivity. The background is a dark blue with a subtle circuit pattern.

THE ARTIFICIAL FUTURE

WHITE PAPER
SEP | 2016

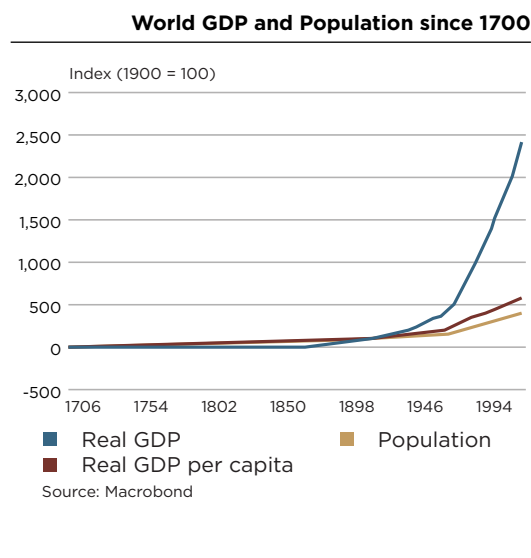
The Artificial Future

By Morten Springborg, Theme Specialist

The acceleration in technological development due to Moore's Law along with the emergence of public cloud computing and the massive amounts of data generated by Internet of Things and Web companies, have accelerated the development and progress of many areas of computer science that fall under the rubric of artificial intelligence (AI). Application of AI solutions is rapidly accelerating in areas such as e-commerce, search and cost-optimization, and will make massive leaps forward as self-improving AI algorithms feed on massive amounts of data. This creates new business opportunities, as the application of AI offers very big productivity improvements through automated decision-making and analysis of big data. Furthermore, AI will accelerate technological development even further, through co-operation between man and machine. The application of AI promises to be revolutionary.

Much like James Watt's steam engine invention in the late 18th century laid the foundation for the Industrial Revolution, creating an inflection point in the trajectory of real GDP per capita (see figure 1), AI could become a general purpose technology and have a similar and, in fact, an even greater and more profound impact on the world in the long term.

Figure 1



So, what is artificial intelligence? Artificial intelligence includes and is related to many different areas of engineering and computer science. Very briefly, one can say that **Machine Learning** is the

use of computer algorithms based on mathematical models using probability to make assumptions, while **Deep Learning** builds on machine learning using neural networks like the human brain's to make predictive analyses. **Natural Language Processing (NLP)** is the understanding of written and spoken language just like humans, along with reasoning and context, and finally the ability to produce speech and writing. **Image Recognition** is the machine's ability to recognise pictures and objects as humans do, as well as discern patterns in visually represented data.

” Much like James Watt's steam engine invention in the late 18th century, laid the foundation for the Industrial Revolution, creating an inflection point in the trajectory of real GDP per capita, AI could become a general purpose technology and have a similar and, in fact, an even greater and more profound impact on the world in the long term.

Intelligent machines probably will only reach their full potential if they can process and understand human language well enough to take advantage of the cumulative knowledge and experience of humankind. It is possible that machines could learn how to play games (e.g., chess, Go, or Atari), without any access to appropriately structured, previously acquired knowledge. However, we do not think that more complex tasks — such as diagnosing and treating pancreatic cancer, driving a car or writing software can be done without access to an existing knowledge base. Therefore, the development of language processing skills and machine vision is vital in order for the machine to be able to communicate with man and access the accumulated knowledgebase of humankind.

” Intelligent machines probably will only reach their full potential if they can process and understand human language well enough to take advantage of the cumulative knowledge and experience of humankind.

Different levels of AI

While there are many different forms of AI, the critical categories we need to think about are based on an AI's development. There are three major AI categories:

- 1) **Artificial Narrow Intelligence (ANI):** Sometimes referred to as *Weak AI*, Artificial Narrow Intelligence is AI that specializes in one area. For example, there is AI that can beat the world chess champion in chess, but that's the only thing it does.
- 2) **Artificial General Intelligence (AGI):** Sometimes referred to as *Strong AI*, or Human-Level AI, Artificial General Intelligence refers to a computer that is as smart as a human across the board—a machine that can perform any intellectual task that a human being can. Creating AGI is a much harder task than creating ANI, and we have yet to do it.
- 3) **Artificial Superintelligence (ASI):** Oxford philosopher and leading AI thinker Nick Bostrom defines superintelligence as “an intellect that is much smarter than the best human brains in practically every field, including scientific creativity, general wisdom and social skills.” Artificial Superintelligence ranges from a computer that is just a little smarter than a human to one that is trillions of times smarter—across the board.

As of now, man has managed to create the lowest level of AI — ANI — and it is everywhere. Examples could be Google Voice searches, which today account for around 20% of searches in the US. Or Facebook image search. It is said that Facebook can recognize one picture from a sample of 800 MN pictures in 5 seconds with a 98 pct. accuracy. An example of how far we have gotten could be Google's Deepmind Go project, where a machine utilizing deep neural reinforcement learning networks managed to self-learn how to play 49 Atari games at super human level without any other instruction than to maximize points. The machine was not taught how to play but how to learn to play – a profound difference! We believe this level of AI is somewhere on the way to AGI, in that the system was able to self-improve and did it very fast.

” As of now, man has managed to create the lowest level of AI — ANI — and it is everywhere.

Concerns are that Artificial Intelligence has the potential to evolve to a point where the machines can drive self-improvement to a super-human level. This has been a concern voiced by Bill Gates of Microsoft, Elon Musk of Tesla, and renowned physicist Stephen Hawking. Out of the three, Bill Gates probably has the most timid view of the existential threat to humankind, and believes that over the next ten to thirty years AI can be immensely helpful in managing our lives. He does believe that super intelligence in AI is a concern, but also believes it can be managed. We agree that this event is the most likely; where the benefits of AI will outweigh the perceived risks and will likely lead to significant investment and growth in this market. Nevertheless, the mere thought of humans not being the intellectually superior creatures on earth anymore is worrying, to say the least!

Interestingly, when Google acquired DeepMind – a leading UK artificial intelligence company - Google created an ethics committee to oversee DeepMind's work. Unfortunately, the work of this AI ethics committee is not public, something you could say is debatable. Google leads the world in artificial intelligence. AI is clearly a field that could create massive value for Alphabet, its shareholders (which argues in favor of keeping it secret) and society, but could also bring about major negative disruptions to the world and our way of life. In other words, the company most likely to take the risks of downside from AI to the world has chosen to keep its deliberations on the issues private.

” Nevertheless, the mere thought of humans not being the intellectually superior creatures on earth anymore is worrying, to say the least!

AGI will most likely happen in this century, simply because of technological acceleration driven by Moore's law. "The point is that every new generation of computers are exponentially better than the last. Computers improve with exponential speed. Can you imagine your parents 2 times less intelligent than you, and your children as 2 times more intelligent? Your granddaughter would be 16 times more intelligent than your parents, and your great-granddaughter 256 times more intelligent than your parents would. Obviously not, but that is how computers improve. In 2013, Muller and Bostrom asked hundreds of AI experts what

“ AGI will most likely happen in this century, simply because of technological acceleration driven by Moore's law.

the chances of achieving AGI was and when. Only 2% said it would not happen in this century, and the median realistic year (50% likelihood) was 2040! So we can say that after 2040, experts believe the chances of having AGI are higher than not having AGI. The world will look a lot different the day human intelligence is matched by machines.

Examples of AI today

AI and big data have a symbiotic relationship, which can be analogised to the brain of a child: An AI system needs huge amounts of information in order to learn; AI systems such as IBM's Watson are distributed cognitive systems which are spread out in the cloud, collecting information every time they are used; and the more people that use systems like Watson, the better the system becomes at its "job". An example of the use of Watson could be the US retail pharma chain CVS Health, where Watson helps with diagnosing and giving advice on treatments of chronic diseases as well as developing personalised health advice.

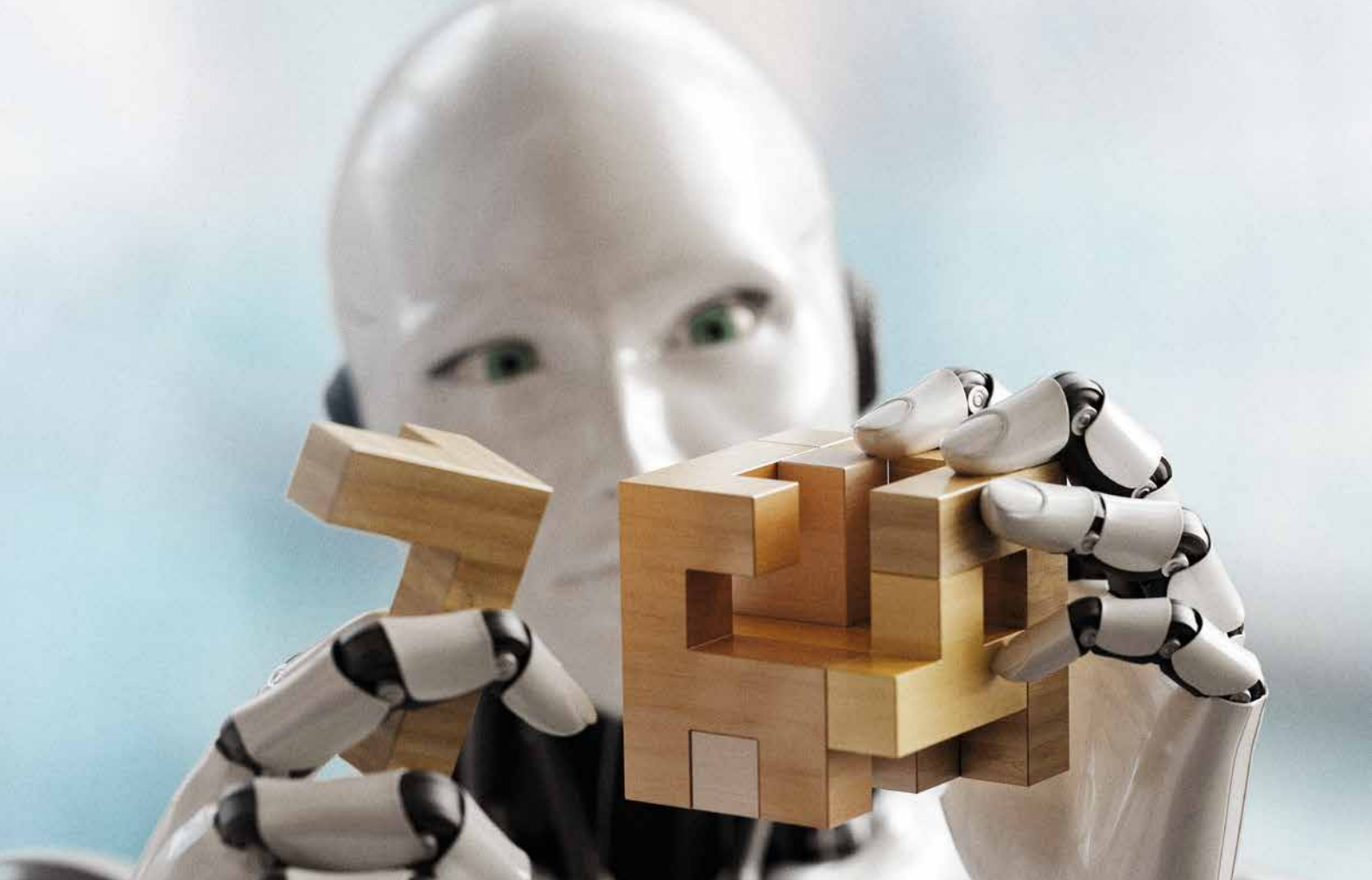
This symbiosis explains the growing interest of companies such as Baidu, Alibaba, Facebook, Google (Alphabet), IBM, Amazon and Microsoft, which as network companies, sit on massive amounts of data that they need to analyse if they are to capitalise on it.

Cloud computing and AI function according to the network effect, which holds that the value of a network increases much faster as it grows bigger (i.e., the bigger the network, the more attractive it is to new users, which makes it even bigger and thus more attractive, and so on).

The reinforcing nature between Cloud and mobile and the explosion in computing touchpoints this creates are feeding several major Big Data trends, from analytics and automation to machine learning and artificial intelligence. This trend stands to have profound effects on our daily lives from how we consume content and shop to how we understand our home, car, and even body. All of the above pointing to an explosion in data over the next five years. According to IDC, by 2020, over 40 zetabytes (or 40 trillion gigabytes) of data will be used, roughly 10 times what was used only a couple of years ago. This rise in data stems from a more than 200 pct. increase from 2016 to 2020 in the number of connected devices, with Cisco estimating over 50bn connected devices globally in 2020.

“ This trend stands to have profound effects on our daily lives from how we consume content and shop to how we understand our home, car, and even body.

In order to be able to analyse all this data, companies need AI automation. An example is e-commerce. Roughly 10 pct. of e-commerce today is due to a recommendation engine, which contemplates an individual's future purchases based on prior purchases, stored products, browsing histories and the item's broader sentiment across social media. Amazon.com is a very relevant example of a company that uses AI to optimize its business. Approximately 35 pct. of all the company's sales are generated by Amazon.com's recommendation engine. Furthermore, Amazon.com is working on a system that, based on all gathered information about a customer's prior shopping behaviour, will be able to make "Anticipatory Demand Management", thereby ordering goods from suppliers that clients will purchase in the near future but haven't bought yet. Aggregated across Amazon's huge client base, this AI



application will be able to speed up delivery of goods to the end customer and thereby improve the level of service the company offers to clients, as well as optimize Amazon's logistical system and hereby reduce costs. We believe that this is one of many differentiating factors benefitting Amazon, as not many of its competitors have this ability.

” The efficiency improves every time we use Google search, since it is being trained. The more training, the better Google Search becomes, the more users use it, and therefore the better it becomes.

As machine learning bridges into the realm of Deep Learning, where the actual neural network design is inspired by the “layers” of abstraction that drive the human brain, the results get much more exciting and we are seeing major innovation across natural language processing, computer visualisation, and more. Google was one of the first companies to dedicate significant resources to Deep Learning with the establishment of the Google Brain project in 2011. Google's RankBrain, which exists within Google's latest search algorithm, is a recent example of how Deep Learning is being applied. The key aim of deep learning is to be able to make

logical deductions even when the machine has never faced a similar scenario. Of the 3-4BN search-queries asked to Google every day, 15 pct. have never been seen before by the search engine.

Results for these queries are processed through the AI algorithm RankBrain, which has risen to become the third-most important signal that goes into generating search results. When RankBrain faces a query it has never seen before, it makes a guess of words or phrases that could have similar meaning, making it more effective at handling never-before-seen queries. When asked to make correct query and search associations, Google engineers were shown to be 70 pct. successful, while RankBrain was 80 pct. accurate. The efficiency improves every time we use Google search, since it is being trained. The more training, the better Google Search becomes, the more users use it, and therefore the better it becomes... Google will develop an unrivalled AI because it has the most data and gets the most training!

” Most jobs as we know them today will cease to exist, but something else – completely unimaginable to us – will come up.

In addition, on the cost side, Google was able to save energy costs by tasking its DeepMind division to reduce its data centre energy costs. DeepMind's efforts resulted in a 15 pct. energy savings for Google. A saving on data centre power consumption that could translate to hundreds of millions of dollars in savings for Google over multiple years. Interestingly, the DeepMind team had no experience in managing data centres, which is a testament to the fungible nature of machine learning. In other words, simply by capturing utilisation data from data centre sensors, it was able to optimize the utilisation through algorithms beyond what Google's data centre focused engineers had been able to accomplish.

” Because of improvements in computer power, neural networks, big data and the evolution towards hyperscale computing in the cloud, artificial intelligence is on the verge of an explosion.

The downside of AI

AI seeks to make computers more human. Computers are able to take large data sets and do what most humans cannot do with them, which is to make sense of all possible relationships amongst that data, in a finite amount of time. The Industrial Revolution in the early 19th century caused a shift in the workforce. Machines started doing lower level jobs, and this reduced the number of blue collar positions requiring unskilled human labour. AI is poised to create a similar revolution, except the skill sets that can be replaced now are those traditionally connected with white collar jobs.

The downside of AI is the potential loss of jobs. However, the positive side is improved efficiency, productivity, accuracy, technology and ability for humans to retrain and focus on higher value added tasks. 200 years ago, more than 50 pct. of the population in Western countries was employed in agriculture. Today, that number has fallen to 1-2 pct., and “new” types of jobs have been invented that nobody dreamt of back then. Most likely, the same will happen again; most jobs as we know them today will cease to exist, but something else – completely unimaginable to us – will come up.

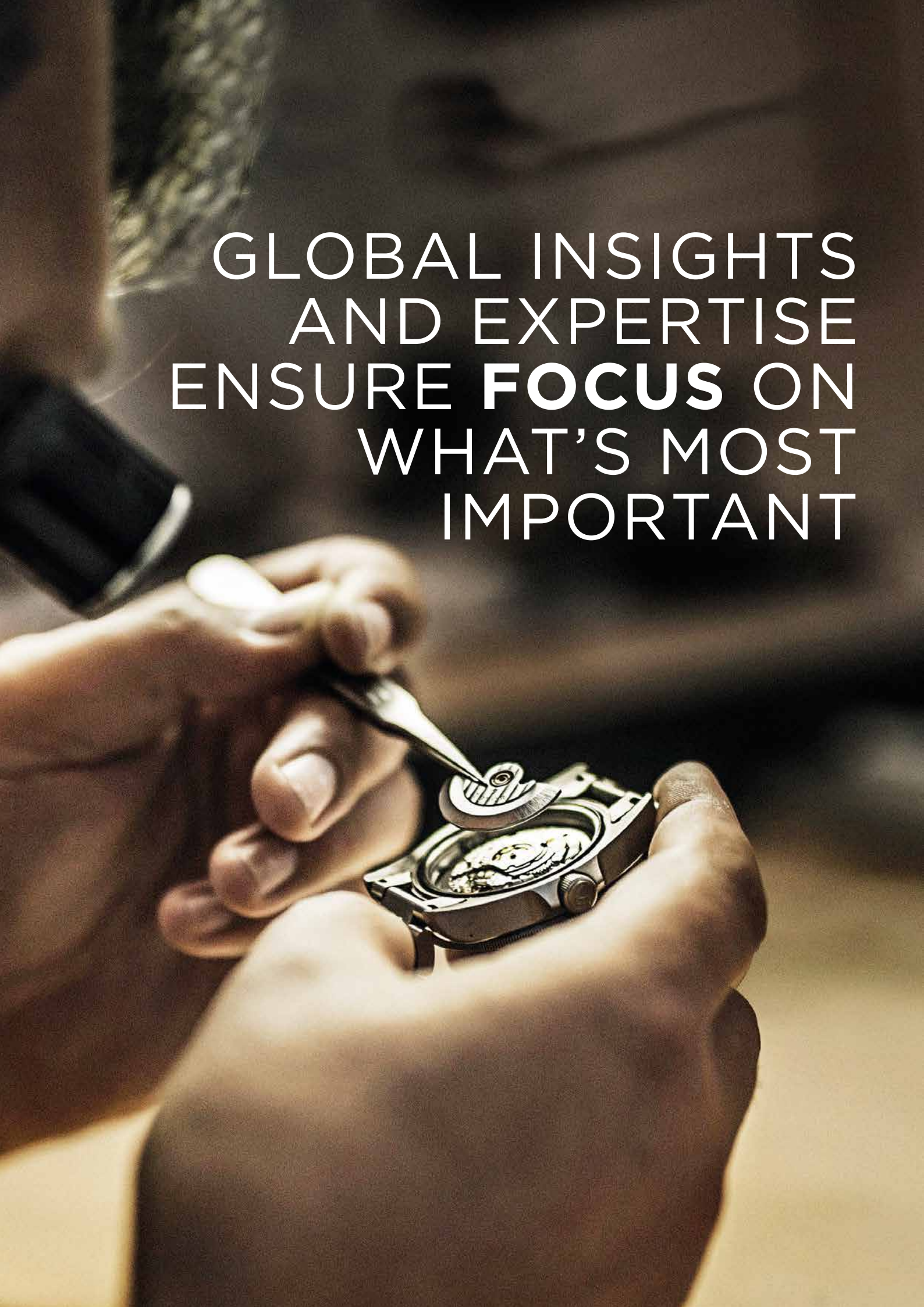
Conclusion

Because of improvements in computer power, neural networks, big data and the evolution towards hyperscale computing in the cloud, artificial intelligence is on the verge of an explosion. We believe the companies driving this are the large cloud network businesses such as Facebook, Amazon, Google (Alphabet), Alibaba, Apple and Microsoft, companies that have huge scale benefits and therefore can afford to invest in and offer AI applications to third parties, effectively growing their networks even more.

We are at the point where applications are starting to become self-improving, which can really accelerate the quality of AI. The AI on the horizon looks like it will develop in to a utility like electricity, where you switch it on when it is needed. In a system like this there will be massive business opportunities, where you take an existing product or service and add intelligence to it, and bingo, you will have a much better product or service. We believe AI applications offer big productivity improvements through automated decision-making and analysis of big data, which until today, have been out of reach of enterprises. AI will be revolutionary in businesses that used to be very “physical” like chemistry and medicine, because by adding AI to chemistry or medicine, scientists can perform virtual experiments and search through vast numbers of combinations to reduce them to a few promising compounds worth examining further. It will therefore accelerate technological development even further. It is the application of AI by other industries that promises to be revolutionary. The earnings potential of AI for the big cloud companies that develop and bring AI to the market is, on the other hand, debatable, except for the fact that AI will grow the attractiveness and stickiness of the product offerings of Google (Alphabet), Amazon, Facebook etc.

Finally a caveat: we are not in any way experts on artificial intelligence, actually far from it. From an expert's perspective, this note is incomplete and imprecise. So take it as a starting point on our journey to understand this most important subject, and be certain that we will follow up on this theme in the future – because it is the future!

GLOBAL INSIGHTS
AND EXPERTISE
ENSURE **FOCUS** ON
WHAT'S MOST
IMPORTANT



C WORLDWIDE ASSET MANAGEMENT FONDSMAEGLERSELSKAB A/S

Dampfaergevej 26 · DK-2100 Copenhagen · Tel: +45 35 46 35 00 · cworldwide.com · info@cworldwide.com

This publication has been prepared by C WorldWide Asset Management Fondsmæglerselskab A/S. It is provided for informational purposes only and does not constitute, and shall not be considered as, an offer, solicitation or invitation to engage in investment operations and shall not be considered investment advice neither in general nor in relation to any mentioned financial instruments or issuers hereof. Opinions expressed are current opinions only as of the date of the publication and should not be considered as predictions or guarantees of future performance.

The publication has been prepared from sources C WorldWide Asset Management Fondsmæglerselskab believes to be reliable and all reasonable precautions have been taken to ensure the correctness and accuracy of the information. However, the correctness and accuracy is not guaranteed and sources C WorldWide Asset Management Fondsmæglerselskab accepts no liability for any errors or omissions. The publication may not be reproduced or distributed, in whole or in part, without sources C WorldWide Asset Management Fondsmæglerselskab prior written consent.
Past performance is not a reliable indicator of future performance.