Artificial Intelligence in Consumer Goods

The Consumer Goods FORUM

End-to-End Value Chain

IBM

EXECUTIVE SUMMARY

Artificial Intelligence (AI) is over 50 years old, but how far has AI progressed really? Is it just the latest overhyped subject from IT vendors? Indeed, what do we mean today by AI and terms like machine learning and deep learning? Are they the same thing? Why should Consumer Goods companies invest now?

After a series of boom and bust cycles in AI research and application, AI technologies are now delivering some significant successes. Some make headlines in newspapers such as a man's life being saved in Missouri when his Tesla car drove him to hospital on autopilot. It seems that every day there are headlines like that one: you could call it a time of wonders, and all of them seem to be the result of AI.

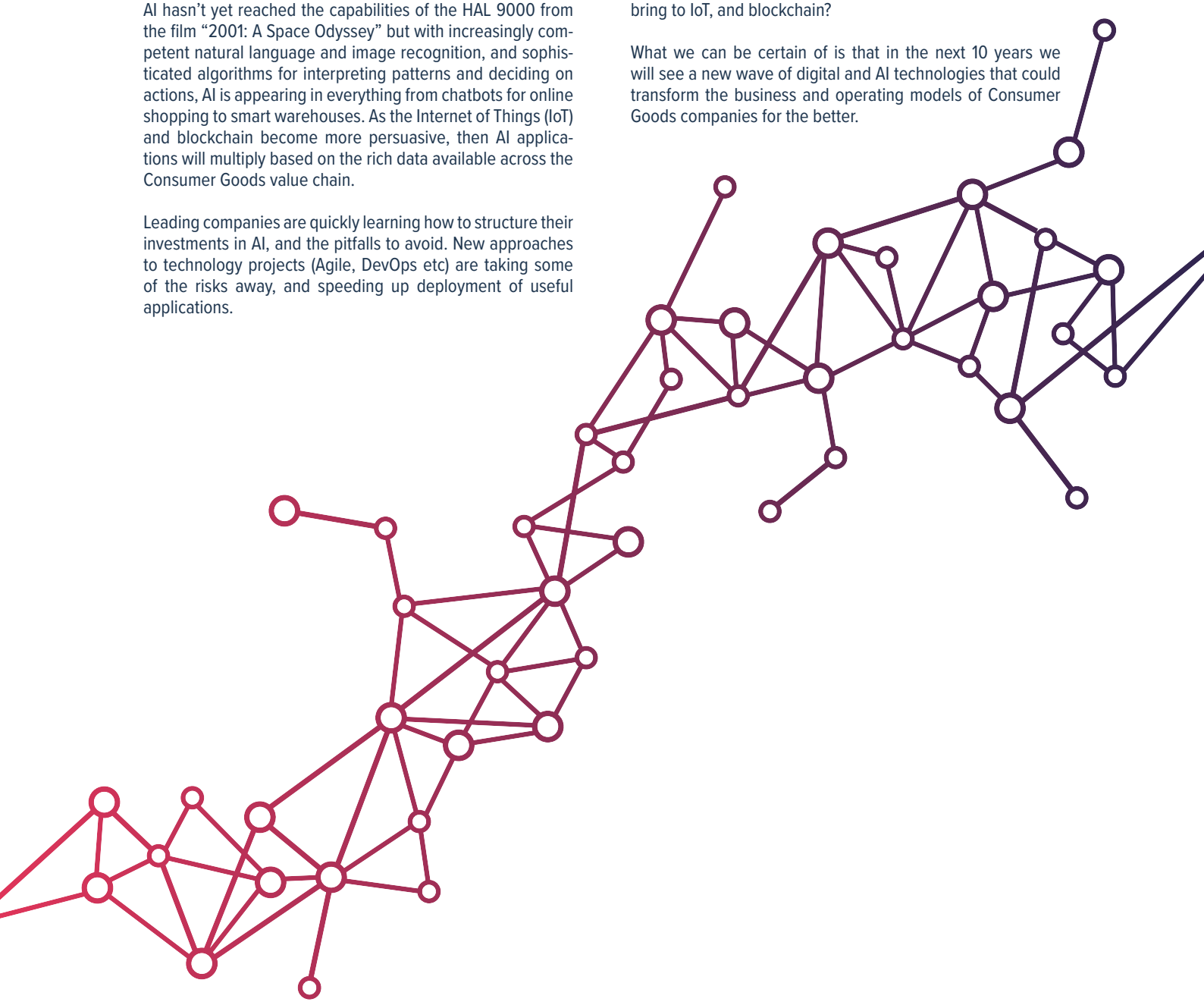
AI hasn't yet reached the capabilities of the HAL 9000 from the film "2001: A Space Odyssey" but with increasingly competent natural language and image recognition, and sophisticated algorithms for interpreting patterns and deciding on actions, AI is appearing in everything from chatbots for online shopping to smart warehouses. As the Internet of Things (IoT) and blockchain become more persuasive, then AI applications will multiply based on the rich data available across the Consumer Goods value chain.

Leading companies are quickly learning how to structure their investments in AI, and the pitfalls to avoid. New approaches to technology projects (Agile, DevOps etc) are taking some of the risks away, and speeding up deployment of useful applications.

The AI field is not without challenges. Access to data and high-performance computing and science and technology skill gaps, issues of trust in algorithms and impact on employment also. Being aware of the challenges and building mitigating actions into business plans is essential.

It is worth remembering that this latest (more successful) part of the AI story is in its early stages for Consumer Goods. Longer term, will AI make auto-replenishment direct from the 'fridge or store cupboard' a reality? What about the role of AI in Artificial Reality (AR) and Virtual Reality (VR)? How long until consumers have their own virtual assistants, and then who are we actually selling to? Could self-driving cars become the next generation of shoppers? What lasting impact will AI bring to IoT, and blockchain?

What we can be certain of is that in the next 10 years we will see a new wave of digital and AI technologies that could transform the business and operating models of Consumer Goods companies for the better.



A BRIEF HISTORY OF AI

EARLY DAYS

The British computer scientist Alan Turing is seen by many as the originator of the concept of Artificial Intelligence (AI) when, in 1950, he asked the question "can machines think?" in his paper 'Computing Machinery and Intelligence.'[1]

A few years later, in 1956, there was a workshop at Dartmouth College in America which brought together some of the great thinkers in the field who predicted the computers would be able to think like human beings within a few decades.

This promise attracted millions of dollars of funding, and the years after are known to computer scientists as the first summer of AI. During this period there were advances in machine understanding of natural language, the first neural nets and a more generalised approached to problem-solving.

Inevitably, that summer was followed by winter as the big promises and big investments yielded insufficient progress and a widespread end to AI research. That's what happened in 1973 when most major government projects in the US and the UK came to a halt.

There was then a gap of about seven years until a visionary project known as the Fifth-Generation Project started in Japan. Although this also followed the boom and bust trend, it did deliver some powerful advances during the 1980s such as expert systems and new ways to capture and interpret knowledge.

1 . A. M. Turing (1950) Computing Machinery and Intelligence. Mind 49: 433-460

DEEP BLUE AND BEYOND

The 1990s saw more progress with development of intelligent agents, the beginnings of machine learning, voice and video recognition and the development of search technologies. Perhaps one of the most famous developments during this period was the IBM chess playing computer Deep Blue that beat the reigning world chess champion, Garry Kasparov, in 1996.

The big successes in this period came from focusing on more specific problems like speech recognition, domain specific knowledge graphs (such as chess) and the creation of search engines (starting with Archie at McGill in Montreal, and leading to Altavista in 1994 and Google in 1997).

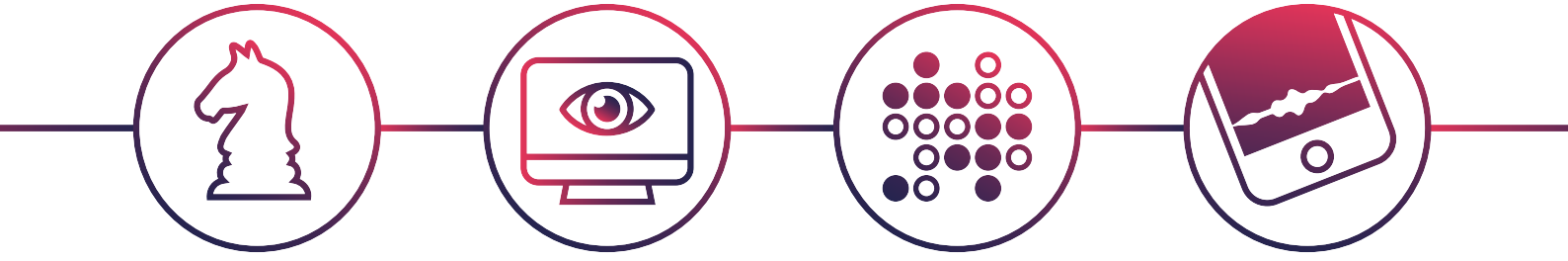
There were also significant advances in processing power, with companies such as NVIDIA introducing the Graphical Processing Unit (GPU) in the late 90s. These processors are now a staple of many high-performance computing set-ups and can even be accessed from cloud providers.

Also, the successes of this period were sufficient to ensure that funding, both public and private, continued. By 2011 there is the IBM Watson cognitive computer beating human beings on the US TV quiz show Jeopardy! and Google demonstrating self-driving cars in 2012. Google demonstrated another step forward in 2015 with AlphaGo beating a human professional Go player.

These developments demonstrated that broad-based, human-like cognitive capabilities were commercially achievable. Improvements in natural language processing and voice added to these capabilities. Anyone with an iPhone will be immediately familiar with contemporary intelligent agents like Siri, and newer incarnations such as Amazon Alexa.

But something more fundamental also happened in this period: the rise of Big Data and new approaches to AI more closely inspired by how the brain works. This combination gave birth to a new family of techniques called deep learning[2] that lie behind many of the "wonders" we see today, and unlike previous periods of investment in artificial intelligence, some of the forward motion is now driven by large commercial entities that also have access to the data - Google and Facebook to highlight two.

2 . Deep learning is a specific method of machine learning that incorporates neural networks in successive layers to learn from data in an iterative manner. Deep learning is especially useful when you're trying to learn patterns from unstructured data



IBM Deep Blue

Graphical Processing Unit (GPU)

Alpha Go

Siri

AI TODAY

CORE CONCEPTS

Today AI is broken into a number of domains each of which is making machines smarter and more useful. A common term that people use is 'machine learning'. Machine learning is an approach and algorithms that enable a system to learn from data rather than through explicit programming. As the algorithms ingest training data, it is then possible to produce more precise models based on that data. A machine learning model is the output generated when you train your machine learning algorithm with data.

At this moment in time there are two broad families of machine learning: statistical techniques and those based on neural networks. A selection of approaches is shown in the table below.

EXAMPLES OF STATISTICAL APPROACHES	EXAMPLES OF NEURAL NETWORKS
Regression	Perceptron
Decision Trees	Restricted Boltzman Machines (RBM)
Bayesian Networks	Multilayer Perceptron (MLP)
Clustering	Convolutional Neural Network (CNN)
Component Reduction	Recursive Neural Network
Ensemble	Recurrent Neural Network
Genetic Algorithms	
Support Vector Machines	
Association Rule Learning	
Reinforcement Learning	

The term “deep learning” is used to describe a type of machine learning that gets closer to mimicking the way that the human brain works. Deep learning uses multiple layers of neural networks to learn about digital representations of text, images, sounds and other data. Modern neural networks with billions of connections, combined with deep learning, has led to successes as diverse as medical diagnosis, categorising videos on YouTube and self-driving car navigation.

Machine learning uses a wide range of statistical and deep learning techniques to process large amounts of data to identify patterns or solve specific problems such as labelling images or making predictions about the weather. What makes machine learning special is that the machine is not specifically programmed and there are often no predetermined rules. For example, in image recognition, a deep learning system might start by identifying a body, then a woman, then a specific woman. Deep learning is already delivering results in pattern recognition that are better than human beings.

In the 1980s, computer scientists tried to work directly with abstract concepts or symbols, much as people do, but this led to a dead-end in AI. This is why computer scientists like to refer to current neural network based techniques as “sub-symbolic” to highlight the fact that they are not really handling abstract concepts in the way that human beings do. Of course, AI is always on the move and there are significant research programmes looking for new techniques based on cybernetics and simulating how a real human brain works, and these may yield even more powerful algorithms in the future.

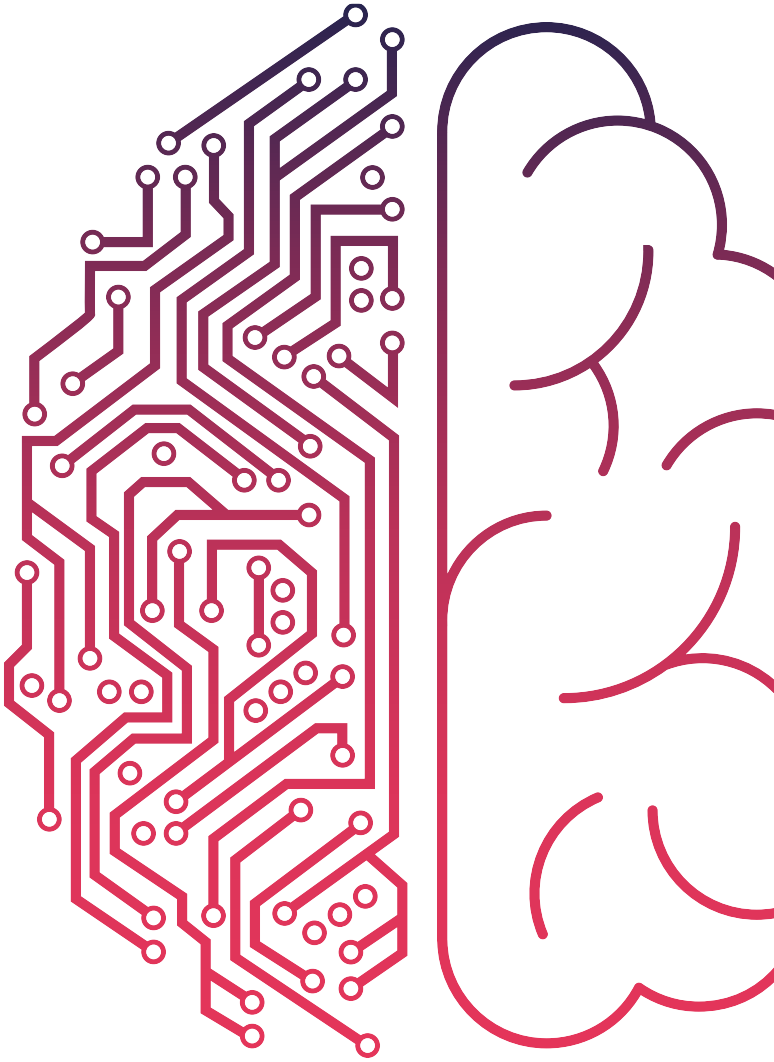
Most forms of machine learning encountered in business are ‘supervised’. This means that you have to show the algorithms examples of what good or bad looks like (this data has labelled features that define the meaning of data), and the system can then reapply what they have learnt to new datasets. An example might be identifying consumer segments based on sample of their social media and purchase data, or looking for errors in master data used for planning purposes.

If there is a lot of data available, then there are algorithms that can learn without supervision or labelled examples. These are typically used to find structures or features in datasets that no human being could ever work their way through. For example, image search on social media and analysing sensor data from an IoT enabled supply chain. University of Montreal Professor Yoshua Bengio[3], one of the most eminent deep learning scientists, sees unsupervised learning as the next area for a big breakthrough.

3 . http://www.iro.umontreal.ca/~bengioy/yoshua_en/research.html

With the arrival of deep learning techniques we now have what is referred to as “deep reinforcement learning” where the algorithms “decide” for themselves how to improve their performance in pursuit of some goal. Reinforcement learning is a behavioural learning model. The algorithm receives feedback from the analysis of the data so the user is guided to the best outcome. Reinforcement learning differs from other types of supervised learning because the system isn’t trained with the sample data set. Rather, the system learns through trial and error. This is part of the approach used by AlphaGo[4] to beat the best human Go players: the system played itself and improved its own performance over time with the aim of winning.

4 . https://en.wikipedia.org/wiki/AlphaGo



BUILDING BLOCKS

Let's imagine you are setting out to make an AI application today. What are the building blocks?

Natural Language Processing

Enables two-way communication between people and computers (including automatic translation, text analytics, etc).

Machine Learning

Construction and application of algorithms to learn and make predictions from data.

Pattern Recognition

Recognition of regularities and exceptions in data i.e. speech, vision, text, internet of things, weather, etc.

Knowledge Representation & Reasoning

Representing information about the world in a structure that a computer system can utilise.

Scheduling & Planning

Devising optimal strategies or actions typically for execution by intelligent agents, autonomous robots and unmanned vehicles.

Natural language

First, the systems must understand or analyse natural language, and be able to generate it. After all, most systems need to interact with human beings. Being able to have a question and answer dialogue is likely to become one of the commonest user interfaces as you can see from the rise in chatbots. You might be surprised to hear that the first serious attempt at machine human interaction was in 1964, when Joseph Weizenbaum at MIT created Eliza[5], a fairly convincing early chatbot.

Machine learning

Machine learning in all its forms has delivered much of the progress we associate with AI to date, and most likely will continue to do so for the foreseeable future. A key driving force is the availability of powerful open source libraries such as TensorFlow and Apache ML[6], the availability of higher performance clouds and micro services, and the rapid rise in popularity of open source programming languages such as Python.

Pattern recognition

Pattern recognition is another key building block as it enables us to find examples of normality and exception in datasets, and without which it would not be possible to have self driving cars, automatic language translation, and many other common AI applications. Many business systems are process and rule-based, and pattern recognition techniques have the potential to reduce the workload in keeping those systems up to date.

Semantics

Another building block is the ability to represent human semantics such as abstract concepts, tacit knowledge and logic in ways that machines can process. Here, computer scientists talk about ontologies (i.e ways of describing information domains and the relationships between them), and there are now pre-built ontologies for some important areas of human knowledge (e.g. patent claims). There are also easy to use knowledge studios that enable non-technical users to create the knowledge bases required for AI (typically through building models of the linguistic nuances, meaning, and relationships specific to an industry).

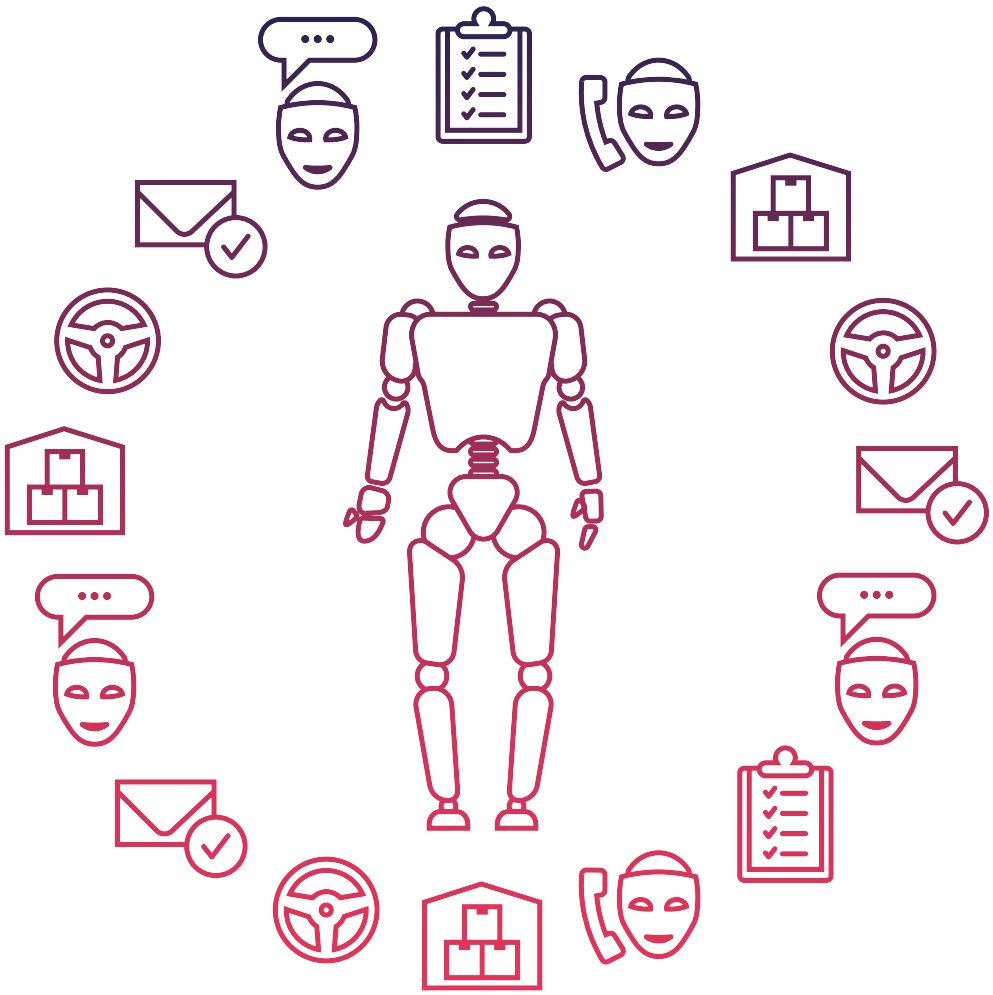
Scheduling and planning

A final building block for AI is the capability associated with scheduling and planning decisions. Think about asking Siri or Alexa to schedule an appointment, or a self-driving truck to plan its own route for direct store delivery, or a drone to work out the best way to fertilise a field.

5 . https://en.wikipedia.org/wiki/ELIZA
6 . TensorFlow and Apache ML are computational frameworks for building machine learning applications

PRACTICAL APPLICATIONS

There is an abundance of AI innovation in Consumer Goods covering all of the building blocks explained previously. In this section, a selection of recent practical applications are described.



Chatbots, in-store automation and smarter shopping

Chatbots (usually a text or voice application designed to hold a conversation) are becoming common. Typically these are add-ons to existing online presences. The most familiar chatbots today are for carelines and online shopping. However, chatbots also represent an evolution of the human-machine interface as they can provide a question and answer front-end to any system.

Companies such as Lowe's have taken the idea of a retail chatbot to its next logical step. LoweBot[7] is an autonomous, in-store service robot that can engage shoppers in question and answer dialogue in multiple languages. The robot also has the capabilities to assist staff in taking inventory, and so frees them up for more face time with customers. Another example of chatbot development is the augmented reality

7 . https://www.cnbc.com/2016/08/30/lowes-introduces-lowe-bot-a-new-autonomous-in-store-robot.html

shopping assistant Paula at Media Saturn[8] in Germany which brings the chatbot to life through an avatar.

The more sophisticated chatbots tend to be referred to as "virtual assistants" as they are capable of accessing more extensive knowledge bases and augmenting humans in more complex online tasks. Examples of virtual assistant applications include answering emails and phone calls from customers, aspects of order fulfilment and inventory management. The beauty brand Mary Kay, for example, provide their beauty consultants with a virtual assistant, myCustomers+[9], that can build rich profiles of their top customers and will alert them when stocks of a product line is low.

Online, consumers everywhere are exposed to AI algorithms that recommend products to them based on their past purchases and those of others. This technology is also getting smarter and more naturalistic. For example, companies such as North Face are using AI to create conversational recommendations[10], so that shoppers receive outerwear recommendations based on a dialogue around individual needs.

Robots and autonomous vehicles in stores, warehouses and factories

Autonomous vehicles are likely to have a widespread impact in Consumer Goods value chains before we see them commonly on the open road. For example there are already robotic shelf-auditing robots, such as the one available from Simbe trialled at Target[11].

So-called 'smart warehouses' are becoming more commonplace. Typically this involves robots moving around the warehouse on a three dimensional grid, moving and retrieving goods based on instructions from fulfilment and logistics platforms (in turn, feeding omni-channel demand). For retailers such as Ocado, this high level of autonomous operation (over 1,000 robots controlled from a single location) makes it possible to ship more than 200,000 orders every week to UK online grocery customers.

Robots and autonomous vehicles (e.g pallets, cranes, conveyors and stacking equipment) not only improve efficiency with 24x7 operation, but can reduce accidents and human error too. Carry capacity and sensing technology (including machine vision and LIDAR) improves in capability each year, and the cost of ownership decreases.

Visual recognition across the value chain

Visual recognition is one of the great success stories of AI. It is now possible to understand the contents of images in terms of scenes, objects, faces, colours, food etc. The wider availability of large training databases means that creating and training custom image classifiers (such as Amazon Recognition or IBM Visual Recognition) is not wholly dependent on your own image collections. Companies such as Clarifai[12] offer out of the box, trained recognition APIs for those who do not want to invest in the training process.

Retail execution is an obvious application area for Consumer Goods. Companies such as Planorama[13] offer AI tools to assist in planogram design and compliance audit, as an example (and see the reference to shelf-audit above).

For consumers, there are examples such as the Olay Skin Advisor[14] which can analyse a selfie and then produce personalised skincare advice. With the current focus on health and wellness, visual recognition of food makes dietary tracking simpler for consumers too. For example, the IBM Watson food model is pre-trained with over 2,000 foodstuffs. Business such as Magic Mirror[15] provide AI "connected retail experiences" in-stores that use visual recognition to provide recommendations on apparel and makeup.

For brands, visual recognition tools mean that legal teams can find cases of unauthorised usage of logos and trademarks (e.g. in social media). For some products, this can be extended to identification of fake products from more detailed image analysis.

In marketing and PR, visual recognition can be used to identify how brands are being represented across social media in still images (and now video). This is increasingly important as programmatic media buying expands; the risk of brands being presented to consumers in the wrong context can be offset with AI, and targeting can be made more effective. For example, The Coca-Cola Company uses AI-driven image recognition[16] to improve ad targeting (and it is claimed that this yields a four times greater chance of being clicked on).

In the supply chain, the applications are numerous including inspection of ingredients and products in the factory and in transit. For agricultural feedstocks, applications include identification of plants and their diseases, and interpretation of satellite data concerning land-use.

Voice and natural language processing

Voice seems set to become the new, de facto interface to the world of brands and shopping. This is a step forward in terms of access for consumers, but it does bring challenges as so much of investment historically goes into visual identity. With 32% of consumers[17] performing voice searches every day, how you stand out on a "voice shelf" is becoming an urgent question to address.

8 . https://www.mediamarktsaturn.com/en/press/press-releases/saturn-receives-retail-technology-award-2018-holotour-featuring-paula-avatar
9 . https://www.retaildive.com/ex/mobilecommercedaily/mary-kay-uncaps-sales-via-beauty-consultant-geared-virtual-assistant-app
10 . https://www.thenorthface.com/xps
11 . https://www.businessinsider.com/target-testing-iot-robots-in-stores-2016-5?IR=T
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15 . http://www.magicmirror.me/Industry/Personal-Shopping-Assistant-in-Fitting-Room
16 . https://www.forbes.com/sites/bernardmarr/2017/09/18/the-amazing-ways-coca-cola-uses-artificial-intelligence-ai-and-big-data-to-drive-success/6d92260a78d2
17 . PwC Consumer Intelligence Series voice assistants survey, 2018. https://www.pwc.com/us/en/services/consulting/library/consumer-intelligence-series/voice-assistants.html

Translating languages, extracting entities (such as names), analysing tone and sentiment are now standard capabilities for most AI systems. Typically these are provided as APIs as the same functionality is required in many applications.

Today you can order pizza from Domino's Pizza through the US Alexa app, get stain removal advice from Tide and guidance on dogs from Purina. In some ways these apps behave like chatbots, but are constructed in a similar fashion with "skills" and "actions" (Amazon's devices have skills and Google have actions). These are voice-driven capabilities that enhance the functionality of the device, and are enabled through interaction models and web services. Increasingly commonly requested skills and actions are being made available as APIs (e.g. For smart homes).

Autonomous vehicles on the open road

The technology is maturing rapidly but the main barriers are legislation and concerns over jobs and safety. For example, in the US, legislation to allow more extensive testing of self-driving trucks only passed in 2017 and does not include permits for large commercial trucks. This despite Uber-owned start-up Otto successfully delivering over 50,000 cans of Budweiser over a 132 mile route on Interstate 25 in the US State of Colorado.

The benefits for Consumer Goods could be significant. TechCrunch reported in 2016[18] that "where drivers are restricted by law from driving more than 11 hours per day without taking an 8-hour break, a driverless truck can drive nearly 24 hours per day. That means the technology would effectively double the output of the US transportation network at 25 percent of the cost."

AI is now starting to make inroads into the new product development. Systems already exist to formulate new food, and to develop insights about individual consumer personalities and preferences that could be used for mass customisation. Fashion Designers such as Jason Grech in Australia[19] have used AI to develop catwalk collections. Companies such as Unilever are using AI and analytical simulations to refine detergent chemistry.

AI is also making inroads into processes more broadly. Robotic process automation (RPA) has been with us for some time. Early examples include desktop automation (e.g. macros and workflows), followed by systems that work on structured data by applying rules and extensible, pre-built process object libraries for specific activities. Now, however, vendors such as Blue Prism have embedded AI into their products to deliver more intelligent execution through a better understanding of context and meaning (typically from unstructured sources such as text and images). This is also paving the way towards systems that can learn the rules from data, rather than explicit instruction: for example, in supply planning and master data management.

Smarter supply chain insights from data analysis

Technologies such as blockchain and the Internet of Things (IoT) will be major contributors to the increase in available data from the end-to-end supply chain. This in turn will provide rich training sets for application of AI to the increasingly demand-sensitive and customer-centric supply chains in Consumer Goods companies.

Transforming core processes

Companies such as SAP and Salesforce that provide systems of record for Consumer Goods companies have announced their own AI systems (Leonardo and Einstein respectively). The rationale is to offer broad AI capabilities to their clients based on the existing functions and data in their ERP and CRM offerings. Applications include enabling new, data-driven business models and more relevant consumer experiences, coaching to sales and marketing exploiting more informative predictions and recommendations, as well as AI tools for a better employee experience.

A typical application of AI might be applications that continuously learn about a company's normal supply chain patterns from multiple systems, including trade partners, then acts on the analysis and trends in the data. These patterns might be in procurement, logistics or manufacturing and the actions could include recommendations on what to do or who is an expert on the issue identified (as expertise is just another pattern to an AI).

AI technologies are also likely to improve fundamental activities such as demand forecasting and supply planning by providing insights from unstructured sources and by adding machine learning capabilities to complement rule-based systems, classical statistics and optimisation techniques.

18 . https://techcrunch.com/2016/04/25/the-driverless-truck-is-coming-and-its-going-to-automate-millions-of-jobs/?guccounter=1

19 . https://www.cmo.com.au/article/606085/ibm-watson-bring-data-driven-insight-australian-fashion-couture/

GETTING AHEAD

LESSONS FROM THE LEADERS

Leading Consumer Goods companies are experimenting widely with AI and there are some simple lessons that can be shared:

1. Be clear on what business problem you are trying to solve and why AI is the appropriate direction. Sometimes this will require proofs of concept and proofs of value to establish. With AI it is often better to fail fast and cheap to avoid dead-end investment based on poorly understood objectives and technology;

2. There are many opportunities for AI to augment what companies are already doing today. Using AI to make knowledge workers more effective and efficient is a proven way to maximise returns. A straightforward example is embedding AI building blocks into existing reporting and analytics. Wouldn't it be great if you could just have a conversation with your planning chatbot about matching demand and supply, rather than having to plough through SAP screens and reports?

3. Don't focus just on the technology, think about the design of business processes and business models with AI at the core. In this direction lies a different and more effective role for people and technology in the end-to-end value chain. There are many potential examples, whether it's lower cost shared services, more effective programmatic advertising, greater consumer insight or more optimal supply chains. AI can be seen as a major disruptor or a threat for Consumer Goods, but the growth and productivity gains are likely to be substantial if AI is part of a broader digital transformation;

4. The Consumer Goods industry still relies heavily on manual labour. Although capital intensive, the business case for robots, shop-floor automation, and autonomous vehicles is getting more and more persuasive as new ways to finance hardware (such as leasing) reduce the total cost of ownership. Also, new generations of collaborative robots such as those from Universal Robotics are designed to operate in environments shared with humans and so are more easily integrated into existing warehouses, factories and offices; and

5. AI technology (and investment) is fast-moving, and some of the leading-edge work is taking place in smaller companies (typically Venture-backed). So as well as working with more strategic technology-partners, it is essential to scout for interesting start-ups or even consider investing or supporting them with your business knowledge and access to data (the Unilever Foundry is an example of this).

CHALLENGES

Wider adoption of AI does face a number of technical, business and societal challenges.

Technical

Exploiting AI requires significant amounts of computing power, and even with cloud this problem will get worse as data volumes grow. In the short term, the increased availability of clouds with GPU-optimised hardware and software will assist with AI and high-performance computing (HPC). However, the longer-term solutions most likely require architectures that haven't been invented yet. IBM for example is focused on architectures that are more closely aligned to how we think the human brain and mind works, and the processing power needed. For example, the TrueNorth chip architecture which acts very much like the synapses in human wetware. The chip already exists and is already demonstrating a step change in our ability to apply deep learning to more complex problems. Quantum computers offer a further step change in computing power for certain classes of problem. The first business applications are in chemistry, supply chain and logistics where being able to run algorithms up to a 100 million times faster are the big advantage.

The next technical leap forward may also require radical new capabilities, based on a better understanding of the human mind. To quote Margaret Boden, a veteran AI researcher interviewed by IBM[20] recently, "considerable work remains at the analytical level to understand how human cognition works in supporting problem-solving and critical thinking and creativity." She goes on to say "To accelerate our understanding of human cognition, neuroscientists, linguists, psychologists, philosophers, anthropologists, deep learning experts and others need to come together."

Business

Not only is there a lack of processing power, there is lack of skills. The necessary AI competencies overlap with other scarce skillsets such as data science; already a challenging recruitment area. Tertiary education and professional training continues to struggle to match industry demand for scientists and engineers, and there is still a significant learning curve once someone has graduated (i.e. Someone with a fresh Masters degree is unlikely to be able to create robust models with real-world data). The rapid developments in AI make the skills gap worse, but the availability of troves of online resources and short-term courses does relieve some of the pressure.

Away from the more technical skills, there is also a corresponding gap on the business side. Many use cases for AI change the nature of the process and roles they touch. For example, a supply planner using AI to identify defective material masters which the system then auto-corrects is working in a new business process and has a different skill profile to previous role holder. AI isn't just about technology change, it brings organisational change and operating model change.

While there are many potential areas of application of AI, there still needs to be a business case. Even with new approaches to software development (Agile, DevOps), and new cloud-based AI technologies based on microservices and APIs, the upfront effort and capital costs still exist, and there are ongoing costs as with any asset. Unlike well understood areas such as ERP, there are few benchmarks or pro forma business bases available for AI projects, and even with the increasing availability of industry-specific platforms many projects are closer to custom development than package implementation. Some of the technologies may not work well yet, and sufficient and quality of data is always a challenge. This all puts a greater emphasis on clarity over objectives, estimation of effort and professionalism of project management and technical development.

20 . https://www.ibm.com/watson/advantage-reports/future-of-artificial-intelligence/margaret-boden.html

Society

The importance of trust in any relationship where AI tools are involved cannot be understated. In human society, to be able to interact with an individual effectively, you have to establish trust with them, they have to trust you, you have to trust them. It's reciprocal. How can this work when one or both parties may be an AI or an AI is acting on their behalf? At one level it is about respecting legislation such as GDPR, but it also about ethics. A simple example is how personal data is handled when AI is involved in creating a compelling consumer experience. Perhaps the AI detects emotional distress from tone of voice when someone is ordering using a voice activated device. Maybe there are the sounds of a disturbance in the background. How should this be acted on, and what happens if it turns out to be an anomaly in the system? Companies clearly need to develop guidelines not just for the AI, but for the "humans in the loop" that may need to act as an escalation point.

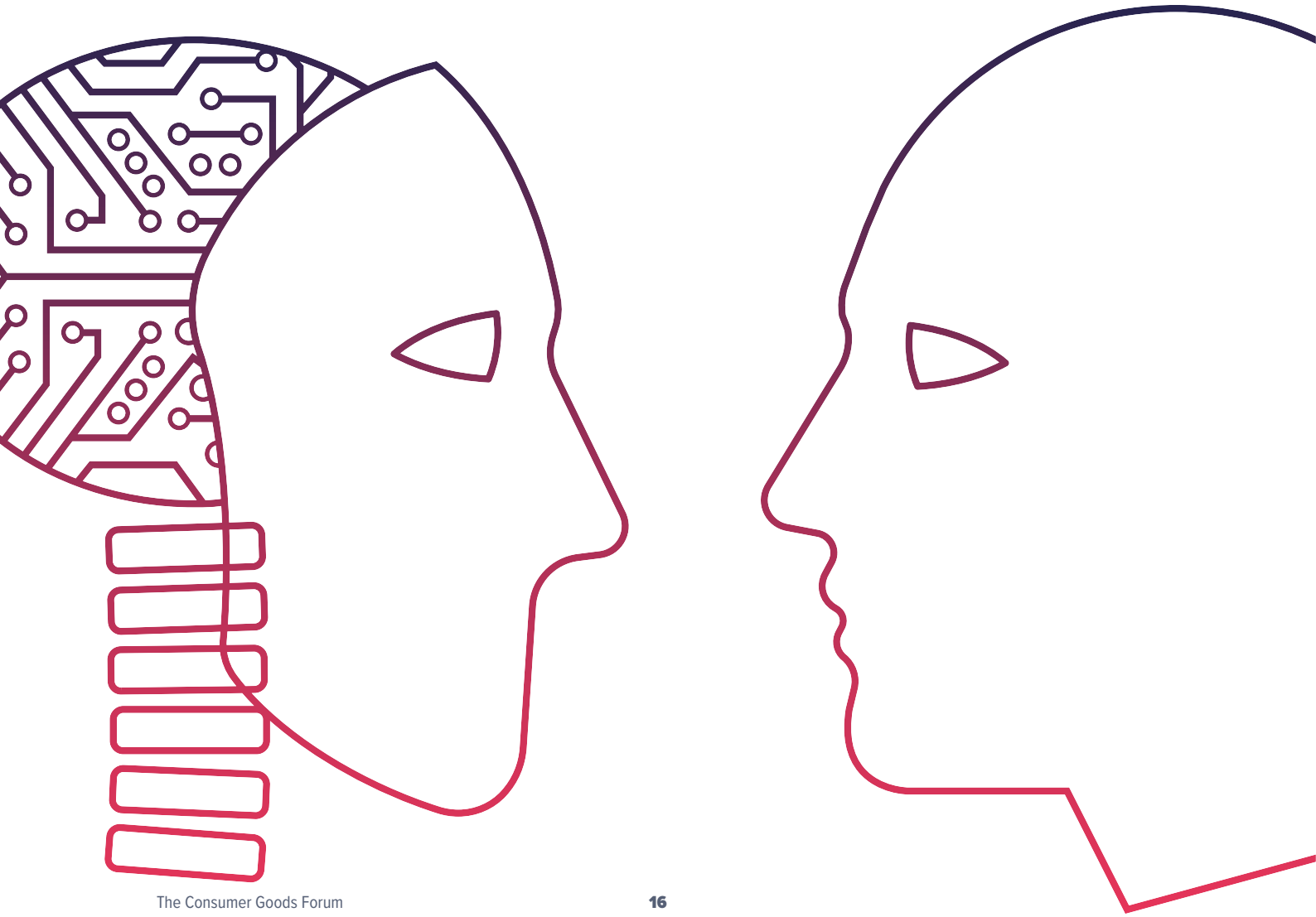
It is now well understood that training of AI systems can lead to biases based on gender, race, etc. It is important to be transparent about training data used, especially if the AI involved is what is referred to as "black box" (a system where the inner workings are opaque). Failure to identify such biases can lead to repetitional harm and a breakdown of trust.

A major area of uncertainty is the long-term impact on employment in the Consumer Goods sector. The OECD estimates[21] that the jobs of 14% of workforce in the 32 OECD countries are at risk due to automation (around 70 million people). A recent Citi and Oxford University report[22] suggests that up to 80% of Retail jobs that do not involve direct contact with customers are at risk of automation (i.e. those involved in warehousing, logistics, inventory control).

Although in earlier periods of automation some classes of jobs were eliminated, much of the impact was on parts of roles and so the job changed with automation and remained. Also new ones are created as technology creates efficiencies and new capabilities, and these drive up job demand and hence employment. There is little consensus, and most analysts concede that new jobs will be created that we do not yet imagine (who had heard of a cloud computing specialist, a social media manager or an Uber driver 10 years ago?)

21 . https://www.oecd.org/employment/Automation-policy-brief-2018.pdf

22 . Technology at Work v3.0: Automating e-Commerce from Click to Pick to Door. Oxford Martin School and Citi. https://www.oxfordmartin.ox.ac.uk/publications/view/2581



FINAL THOUGHTS

WHAT HAPPENS NEXT?

The implications for Consumer Goods companies will become clearer over the next few years, but it seems unlikely that AI trends we see today will not lead to the disappointments that led to the AI winters of the 60s and 80s. As well as major corporations and government, the start-up field is vibrant: businesses such as Neuroapplied[23] are already breaking new ground in applied market research using AI, VineSleuth[24] are reinventing the wine shopping experience and companies such as Articoolo[25] are automatically creating content for marketers. Companies such as Ahold Delhaize, Kohl's, Mars and P&G are tapping into brand and retail start-ups through innovation accelerators such as Plug and Play[26] in Silicon Valley, and there is the Central Research Laboratory[27] start-up accelerator in London that is focused on manufacturing (e.g. smart packaging for food).

Some of the most promising near-term applications are shown below:

Augmentation of Human Expertise

Smart advisors e.g. for scientists
Collaborative robots e.g. for skilled workers
Computational creativity e.g. for designers

Automation of Knowledge Work

Cognitive Process Automation e.g. for shared services
Natural language processing / generation e.g. for marketing
Virtual assistants e.g. for supply planning
Audio visual recognition e.g. for market research

Automation of Manual Labour

Industrial robotics e.g. for manufacturing
Autonomous vehicles e.g. for logistics

At a technical level, computer scientists and engineers are focused on making it easier to build scalable AI models, capabilities and tools, as well as improving the core capabilities in AI such as natural language processing, speech and image recognition. More and more high-performance computing is coming online via the major cloud providers.

There seems to be a general agreement that the benefits of AI will be large. A report from PwC[28] suggests that AI could add as much as $15.7 trillion to the global GDP by 2030. Perhaps a fifth of this would be directly and indirectly related to the trading of consumer goods.

There is much debate about the long-term impact on employment in the Consumer Goods sector. Past technological revolutions suggest that it is parts of jobs that are eliminated or transformed, rather than the entire job going. Hence, many computer scientists believe that augmenting human intelligence is the most likely direction in the short to medium term, and it is already clear that machine intelligence could fundamentally change many retail and manufacturing jobs as the abilities of software and hardware robotics to augment human expertise improve. Think of the bricks and mortar store: although roles such as order entry may be almost wholly automated through robotic process automation, combinations of smart advisors and human store associates may lead to a more powerful, blended shopper experience.

Final thoughts

Longer-term, will AI make auto-replenishment direct from the fridge or store cupboard a reality? What about the role of AI in AR and VR? How long until consumers have their own virtual assistants, and then who are we actually selling to? Could self-driving cars become the next generation of shoppers? What lasting impact will AI bring to IoT, and blockchain?

In the next 10 years we will see a new wave of digital and AI technologies that could transform the business and operating models of Consumer Goods companies for the better.

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ABOUT

About the Consumer Goods Forum

The Consumer Goods Forum ("CGF") is a global, parity-based industry network that is driven by its members to encourage the global adoption of practices and standards that serves the consumer goods industry worldwide. It brings together the CEOs and senior management of some 400 retailers, manufacturers, service providers, and other stakeholders across 70 countries, and it reflects the diversity of the industry in geography, size, product category and format. Its member companies have combined sales of EUR 3.5 trillion and directly employ nearly 10 million people, with a further 90 million related jobs estimated along the value chain. It is governed by its Board of Directors, which comprises more than 50 manufacturer and retailer CEOs.

For more information, please visit:
www.theconsumergoodsforum.com

About IBM

For more than a century, IBM has been providing businesses with the expertise needed to help consumer goods companies win in the marketplace. Our researchers and consultants create innovative solutions that help clients become more consumer-centric to deliver compelling brand experiences, collaborate more effectively with channel partners and align demand and supply. For more information on our consumer product solutions, see www.ibm.com/consumer With deep industry expertise and a comprehensive portfolio of retail solutions for merchandising, supply chain management, omni-channel retailing and advanced analytics, IBM helps deliver rapid time to value for our clients. We help retailers anticipate change and profit from new opportunities.

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