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The New Wave of Retail Revolution

The retail industry has always been at the forefront of digital transformation. Over the past two decades, online retail has brought massive change to the global retail business ecosystem, and more prominently so in China. As of June 2018, there are 570 million consumers in China who utilize the Internet for online purchases, of which 98% of these consumers do so using mobile phones. In the same year, China’s online retail sales reached ¥4.08 trillion, accounting for 22.7% of the total retail sales of consumer goods. This is equivalent to ¥22.5 billion worth of goods or services traded daily online. China has become the undisputed largest online retail market in the world. However, the e-commerce explosion by no means suggests the end of the retail revolution. On the contrary, it drives more retailers to consider the possible outcomes of integrating technologies with business. In other words, the digital transformation of the retail industry is persisting and accelerating towards the full-scale integration of online and offline retailing.

Many factors are driving the next wave of the retail revolution, and most notable is the change in consumer demand. With the digital natives growing up and gaining purchasing power—a new generation of consumers born and raised in a world connected by smart phones, activated by fingerprints and validated by Face-IDs, increasingly it is about balancing high pace of life with small fragments of time; consumers of future will demand all services to be personalized, seamless, friction-free, and ubiquitous. For retail service providers, the imperative is to continuously create an impactful and immersive experience to which consumers can interact and resonate with.

IDC has summarized it as "experiential retail" and laid out a DX framework (Figure 1) consisted of the strategies, the long-term initiatives, and the use cases.
Few people would argue that experiential retail will evolve around Omni-channel, where the online space and the physical space will find a new convergence. The supporting statements cannot be stronger: selling online is less costly and easier to scale, while physical space can offer unique experiences such as “touch and feel” and “grab and go”. Retailers need to break free from the narrowly-defined concepts of “trading”, “online” and “offline”, find inspiration from innovation-accelerating technologies, rely on deep insights garnered by data analysis, and empower physical retail space with richer customer experiences.
AI Empowered Experiential Retailing: Opportunity and Challenge

Artificial intelligence plays an important role in the digital transformation of the retail industry, by connecting the supply side with and demand side of the industry, thereby creating new value for retailers and new experiences for consumers as follows:

- **On the supply side**, with the explosive growth of data, AI is changing retailers’ operations ranging from procurement, supply chain, promotion planning, to channels, sales, production and logistics. New application scenarios of AI such as bespoke production, intelligent warehouse management, personalized shopping guides and intelligent promotion planning, continue to emerge at an exponential rate. These have enabled the retail industry to shift their focus from managing commodities to managing business users.

- **On the demand side**, search-based shopping is being replaced by recommendation-based shopping, powered by machine-learning algorithms. Consumers are now able to discover, evaluate, select, and purchase goods in both online and physical stores with increasing ease.
Increasingly, AI will become the main driver of the continued retail revolution, because of its unique ability to drive the creation of new experiences at the consumer level, and create new value for retail ecosystem. The challenge is how to drive these changes at scale. According to findings of the APEJ IDC AI Enterprise Adoption Survey 2018, reduction in the cost of solutions, simplicity of solutioning and implementation, are some of the pressing requirements for retailers to come onboard with AI solutions.

- **Cost Concerns** in comparison to other industries, more organizations in the retail industry consider high costs as the largest barrier to the adoption of AI solutions.

- **Ease of Implementation** more organizations in the retail industry require AI solutions to be tailor-made, as compared to any other industry.

- **Decoupling of Technology Complexity** in comparison to other industries, fewer organizations in the retail industry have plans to establish in-house AI capabilities (e.g. modeling, solutioning or implementation).

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**Case Study: Unbounded Retail by JD.com**

**JD.com’s strategy**

JD.com is a Chinese e-commerce company that officially entered the e-commerce market in 2004. Two years later, JD.com’s market turnover reached USD $99.2 billion. In May 2014, JD.com was officially listed on Nasdaq, establishing itself as China’s first large-scale, integrated e-commerce platform to be listed in the United States. In July 2016, JD.com became China’s first and only Internet company to join the Fortune Global 500. At present, JD.com is one of the two largest B2C online retailers in China. In addition to online retail, its business segments also include logistics and financial services.
The transformation of physical retail has become an inevitable trend, and online businesses themselves face several challenges such as the rising costs of online traffic acquisition. Both new and future retail market competition levels are intensifying in the China market. In July 2017, Liu Qiangdong, the founder of JD.com, put forward the concept of “unbounded retail”; from 2018, JD.com began to accelerate the new revolution in unbounded retail, focusing on the restructuring of retail costs, customer experiences and operational efficiencies, to create a pan-retail structure. Not only has JD.com partnered with traditional enterprises to upgrade their traditional retail infrastructure, but also launched their own physical supermarket.

- **External partnerships to create offline retail networks** investments in VIP, Wanda Commerce, and BBK to promote unbounded integration of consumption scenarios; the establishment of a new company with Meili Inc. to explore the social e-commerce model and other aspects of the unbounded retail ecosystem.

- **Built-in offline physical stores** this includes smart vendor machines placed within office complexes and JD.com’s very own branded stores such as JDHome, 7FRESH supermarkets, and the X Unmanned supermarket.

- **The “Beijing X Plan” to enhance the omni-channel, multi-scene experience** JD.com is committed to enhancing consumers’ omni-channel, multi-scene shopping experience. Through the Beijing X Plan program, JD.com aims to reach almost all of China’s Internet users. At present, JD.com has cooperated with leading Internet companies such as Tencent, Qihu 360, Netease, Sina, Xiaomi to create a full-scene intelligent marketing platform for businesses, while providing consumers with greater consumer insights to meet their preferences and needs, as well as to achieve a positive online shopping experience.

Liu highlighted that smart technologies including AI will drive the entire retail ecosystem to optimize the flow of capital, goods and information, improve efficiency and reduce costs at the supply side, as well as to enhance the experiences of "knowing you better than yourself" and "what you see is what you get" at the demand side. The retail infrastructure of the future will be highly adaptable, intelligent and collaborative with consumers.
JD.com is committed to the use of technological enhancements as the core driving force. Its idea of “unbounded retail” is to restructure the cost, efficiency and experience of retail business, all to be built based on the understanding of people, the understanding of products, and the understanding of the market. JD.com foresees there will be a “retail + retail infrastructure service provider” ecosystem that is unbounded, serves society-at-large, and achieves win-win for every participating business.
As an important extension of many retail formats, vending machines have attracted sizable investment. In earlier years, vending machines mostly leveraged gravity-induction methods to handle goods. Due to accuracy limitations of such technologies, there have been companies closing down as a result of loss from damaged goods. The JD.com Smart Vending Machine, of version Go3.0/3., was launched to achieve automatic settlement by utilizing image recognition technology. Cameras are deployed on each shelf level of the vending machine to capture images, which are then transmitted for recognition. The adopted Intel NUC supports multiple cameras to process images at 150 frames per second to help identify which product the customer has chosen. JD’s smart vending machines have doors that require authentication for consumers to gain access, by the scan of barcodes. After the goods are retrieved from a shelf, the doors are automatically closed, which also triggers item-checkout process. This design allows fast and accurate object identification for even non-standard
items such as fresh fruits. Comparing to gravity sensing, the smart vending machine can adapt to a wider range of SKU with higher identification accuracy and provide better service experience for customers.

Benefiting from its big data capabilities and its supply chain advantages, this solution also offers obvious advantages in terms of the prices of its goods and speed of replenishment. Additionally, digital advertising panels are equipped on these smart vending machines, providing room for creative digital marketing applications and new revenue streams.

The smart vending machines are already available at selected office locations in Beijing, Shanghai and a few other cities. JD.com has planned to expand to a further 5,000 locations by the end of the year. There will be more such vending machines appear beyond storefronts, reaching to open spaces with steady footfalls such as elevator entrances, residential estates, gas stations, entertainment venues, and training institutions.

**A Suite of Integrated and Interactive Solutions for Offline**

**Mirror+ the intelligent shopping assistance**

Developed by JD.com, the Mirror+ smart technology uses distance and motion sensing onto a large-format screen to achieve a virtual and interactive shopping experience. The enhanced shopping experience shall address the lack of timely or comprehensive product information in offline scenarios, and in turn to increase purchase propensity. Key features of Mirror+ include: allowing customers to access item recommendations, outfit matches, peer reviews and product discounts; performing style personalization based on shared user profile and fashion trends - all similar to the “typical” online shopping experience that customers have well acquainted. For item recommendation and outfit matching alone, it is possible to do so for a selected list of brands, which would be important for businesses strategically working with a range of brands and merchants. Apart from viewing the matched items, customers can choose to call for further shopping assistance, or simply place an order. The matches/recommendations can also be saved as part of the profile for the customer’s future reference.

Mirror+ is specially designed for traditional clothing retail stores. The hope is to achieve a higher customer conversion rate by providing in-store customers with a fulfilling, highly convenient, and comfortable user experience. Mirror+ has been piloted in branded stores such as Seven Wolves, Qumei, and Red Beans. In future, its use shall be extended to product categories besides fashion. Advanced big data analysis will be used to deepen the understanding of user behavior, evaluate marketing outcomes, optimize customers’ product experiences, improve operational efficiencies, and essentially assist retailers and brand merchants to enhance their store management by helping to solve the challenges of customer segmentation, product selection and site identification.

For customers trying out virtual fitting, Mirror+ is able to remove complex background, identify key body contours, and superimpose special effects such as scenic landmarks as background to match the dressing style detected, all so in real time. Consumers can share their virtual images or videos to social media or have them printed out. The screen of the mirror could display advertisements or even games in a way that is non-intrusive and fun for customers to engage. It will become a platform for thousands of brands and stores to reach to potential customers.
One Million Smart Convenient Stores

Convenience stores in China are moving from cities to rural areas. The biggest challenge during such a migration, is the shortage of skilled manpower to operate by established standards and required technological knowledge. As such, JD.com has developed self-service checkout device for convenience stores, with a target to reach one million stores. These devices are able to automatically identify the type and quantity of products and allow customers to perform a self-service checkout. Not only will this alleviate staffing issue regardless of store location, but also improve customer experience, and drive down cost of labor.

Besides the plan to upgrade a million convenience stores, JD.com has launched 7FRESH, a fresh food supermarket chain offering integrated experience such as a smart shopping cart to follow the heels of customers, to avoid obstacles, and provide navigation. There are digital screens above the shelves and counters to display the sourcing details of fresh food based on blockchain technology. Customers can pick a fruit and place it in designated position to retrieve information such as original country and sugar level. These stores will have self-service checkout devices compatible with popular mobile payment options such as Wechat. For online customers, 7FRESH makes recommendations according to consumption behavior of customers of similar profile. The online orders can be delivered in as short as 28 minutes to addresses within a radius of 3 kilometers of the supermarket.

JD.com’s suite of Integrated and Interactive Store Solution is supported by edge servers from the Intel Xeon D-1500 series for real-time workloads, and in parallel, JD.com has developed the JDOS container engine platform for scheduling between different edge computing nodes. Each edge computing terminal can be deployed as a node in a cluster and participate in global scheduling. With intelligent gateway technologies, the master console can directly control all edge computing terminals without any network switches, meaning all deployment or rollback operations can be fully automated, without requiring actions from in-store staff to attend to edge deployment, operation and maintenance.

X Unmanned supermarket - the brand new uninterrupted purchasing experience

In addition to enhancing traditional convenience stores with various smart technologies, JD.com also launched the X Unmanned supermarket to radically change offline retail. These unmanned supermarkets rely on core technologies including item identification and facial recognition, via the placement of IoT enabled devices such as video cameras to collect and analyze customer traffic, user behavioral preferences, and offer precise product recommendations. Customers can register through mobile apps and enjoy uninterrupted shopping experience. There are currently more than 20 X Unmanned supermarkets in Beijing, Tianjin, Xi’an, Jinan, and Xiongan New District. Outside of China, it has also been launched in Indonesia.
The Big Data Support

Be it the smart vending machines, the Mirror+, or 7FRESH, JD’s convenience stores and the X Unmanned supermarket, all data collected across edge nodes are sent back to JD.com’s Big Data Platform. Operating in the cloud, this Big Data Platform has already accumulated an excess of 800 PB of data, which grows by a rate of 1 PB per day. The big data platform integrates data sources across different channels, and utilizes advanced analytics, machine learning and deep learning to refine models for item and face recognition; and provide better predictions for product and shop location recommendations. This allows seamless model update to the edge nodes while ensuring operation continuity and cost control of the physical stores. With the accumulation of training data and fast iterations of solution update, JD.com has the opportunity to revolutionize customer experience at scale.
"In the past, the e-commerce focused solely on the consumer side, and offered limited support to the supply side. Our retail innovation strategy is by no means a simple progression from online to offline, but rather, a shift from the provision of retail products towards the provision of retail infrastructure which serves both the consumers (through devices and other terminals) and the upstream partners," Hu Shengli said. "In the future, the entire industry will inevitably transform from the consumer-led Internet to an industry-led Internet, which will truly drive the healthy development of the industry."

Weng Zhi pointed out that emerging technologies represented by cloud computing, big data and artificial intelligence are on the rise, with the progression particularly rapid in China. Many Chinese enterprises are actively adopting new technologies to position themselves for success in the future. JD.com's unbounded retail strategy is a user-centric, scientific and technologically-driven approach, which is based on a deep understanding of the intermix between consumers, products, and the market, so as to help restructure the costs, operational efficiencies and customer experiences of the retail industry, thereby creating a new retail ecosystem of the future.
Behind the Scenes: Enabling Technologies From Intel

Intel being a long-term business partner of JD.com, a range of its products have been selected to drive JD.com’s retail innovations. Cost-effective performance, close collaboration to address concrete problems, and capability to scale innovation in a very large technology ecosystem, are the core values JD.com seek in this partnership.

(1) Cost-Effective Hardware Acceleration from the Core to the Edge

![Diagram showing various hardware nodes and their applications, including Core, EDGE nodes, and Smart Shelves.]
Higher Scalability Performance at the Core  The new generation Xeon Scalable Platform has been adopted at JD.com datacenters for AI model training. This platform has set new benchmarks for platform functions including computing, storage, memory, networking, and security. For example, the platform is said to support 4.2 times more virtual machines running per server than what was previously possible, thereby enabling IT staff to integrate more services with reduced hardware usage. Performance wise, JD.com has seen a 1.5 times performance improvement in various application scenarios, as compared to the previous installation.

Optimized Architecture for Big Data Frameworks  Datacenters built on Intel architecture can easily support big data frameworks such as Hadoop and Spark. Big data frameworks like these are essential to run consumer experience centered big data services including customer profiling, customer segment analysis, and product recommendations, in which the continuous processing of constantly accumulating consumer data is key to success.

One Stop Solution  The Scalable Platform spans across Intel’s solutions in the server, storage, middleware, caching, performance monitoring and orchestration spaces. As such, it is a one-stop integrated product through which the effort for customization and optimization is minimized.

From 2019 onwards, Intel will also provide customized CPU and Optane®-based storage solutions for JD.com’s datacenters to maximize value for performance.
For JD’s new retail formats discussed in this paper, Intel’s Xeon D1500, a customized industrial grade System-on-a-Chip based on Intel’s 14nm silicon technology, has been selected to deliver the targeted set of values - reduced technology complexity, reduced cost, low maintenance, and performance for edge workloads in rugged conditions. The design is the first of its kind and has been customized according to JD’s requirement to allow high IO bandwidth and the addition of a 4G communication chip. Key features of this edge SoC include the following:

- **Built-in Virtualization** to provide fast and secure provisioning of service - less than half an hour is required to start an edge node, and most of the time would be utilized for network connection initialization. Data packet synchronizations, system upgrades, etc… are all performed remotely over the cloud without necessitating in-store staff’s attention.

- **Robust Network Connection** A redundant communication chip is in place to ensure network connection for storefronts located at rural locations are able to adapt to various network environments including wi-fi, 3G, 4G and ethernet.

- **Industrial Grade Environment Tolerance** The chipset works across a wide spectrum of operating temperature, going as high as 80 degrees Celsius and as low as -40 degrees Celsius.

- **Low Power Consumption** The chipset runs on less than 10 watts of electricity per hour, to better suit the need for the passive heat dissipation of edge computing devices.

- **RealSense Cameras & Utilization of Integrated GPU** The Intel SoC supports up to 5 RealSense cameras, each collecting data at a speed of 30fps. The SoC taps into the Integrated GPU to accelerate computer vision tasks at the required performance.

- **Enhanced Software Support** the X86 64-bit SoC provides software layer consistency from the datacenter to the edge nodes. It also supports a broad range of software libraries and applications with great scalability and performance.

Most importantly, all above features are designed conscious of cost, and are delivered with an affordable price tag. For example, comparing to a conventional vending machine, an Intelligent Vending Machine with Xeon D1500 inside costs merely an addition of $440, or less.
(2) Software Tools for Application Delivery & Performance Enhancement

Intel also provides a full menu of software tools to ease the development of computer vision applications and boost performance on Intel’s family of silicon:

- **In the performance library category**, MKL-DNN (math-kernel library for deep neural networks) is a proprietary library optimized for Intel architectures. It is designed to accelerate popular deep learning frameworks such as Caffe, TensorFlow, Theano, and Mxnet. DAAL (data analytical acceleration library) is yet another supported library which delivers performance optimization for a wider scope of big data and analytics workloads, and allows computation across distributed nodes. In this case study of JD.com, MKL-DNN is applied for computer vision tasks by tapping into the integrated GPU of Xeon D1500.

- **In the application development tools category**, RealSense SDK is there to provide wide-area/long-range image capture and 3D depth perception for the cameras implemented on driverless delivery vehicles, so as to be able to identify routes and detect obstacles in real time. Additionally, JD.com plans to utilize the newly released OpenVino tool, the code-once-deploy-everywhere SDK for computer vision applications running on heterogenous hardware - CPUs, or GPUs or FPGAs.
(3) Active Technical Support & Large Ecosystem to Drive Innovations to the Next Level

As the innovative retail formats of JD evolve from concepts and prototypes, to trials and rollouts, Intel’s engineering and technical support teams have worked closely with the customer to ensure cost optimized design and performance in rugged environment. “There is a lot of customization effort from our team,” said Song Zhong Ru, an Intel technology expert, “we started with the Intel NUC mini PC series and finalized with this customized SoC. The challenge was mainly to right-size the performance under the tight cost constraint of small retail stores, not to forget these store owners have zero technical skills, so it has to work right out of the box, with good reliability in rugged working conditions. Many months were spent to collect requirement from various store locations - Beijing, Shenzhen and Chongqing, followed with design verification, chip proofing and everything else. “ According to Mr Song, Intel is on the way to standardize the SoC and make it available for the bigger market.

While active technical support has helped JD to build up confidence in the execution of retail innovations, Intel’s innovation partner ecosystem is expected to offer even greater value in the forthcoming stages of business model verification, market penetration, and continuous improvement. Ecosystem reach is an important measure of the maturity of transformative digital businesses, more so for companies embarking on large scale innovations.

- **Business Model Co-creation & Verification**  Intel’s business partners benefit from wide range of support spanning across product marketing efforts, an increased presence to a wider technology and business community, and close collaborations on business model co-creation and verification.

- **Market Penetration**  Intel has established an extensive partner ecosystem for its partners to fast track their innovations and reach out to potential collaborators in the value chain. The ecosystem centers around the computing capability of Intel Xeon Processors, and spans across leading open-source software communities, industry standards, tech-startups, and top research institutions.

- **Continuous Improvement**  Ecosystem synergies, which are critical and necessary to take businesses to the next level, are of greater significance for AI-related application innovations. The reason being that the new generation of software not only requires software code development, but also relies on evolving algorithms, accumulating data as well as dynamic computing infrastructure to ensure continuously improved experience delivery to the end users.

According to IDC EMEA Retail Innovation Survey 2018, Partner network is recognized as a top priority for business model innovation.
Dell EMC, HPE, HITACHI, NEC, FUJITSU, Inspur, CISCO, H3C, AVAYA, Huawei

Open Source Software Contribution

Major Enterprise Infrastructure Solution Providers
Dell EMC, HPE, HITACHI, NEC, FUJITSU, Inspur, CISCO, H3C, AVAYA, Huawei

Apple, Samsung, Xiaomi, Asus, GE, National Instruments

Major Smart Device & IoT Endpoint Manufactures
IBM, SAP, Oracle, Accenture, Redhat, Nutanix, HCL, Veritas, Infosys

Major Enterprise Software and Service Providers
AWS, Azure, Alibaba, Baidu, Tencent

Xeon Processor Ecosystem

Big Data, AI, OS, Cloud, IoT
Apache Hadoop, Spark, Linux, OpenStack, MinnowBoard

Instruction Set, Ethernet, Wireless, HTML5, Content Transmission
Open Alliance, IEEE, X86, W3C, USB, DTCP, etc.

Startup Companies
Horizon Robotics, Leapmind, Mighty AI, DataRobot, Paxata, Striim, WSC Sports

Academic Research
MIT, Carnegie Mellon, Georgia Tech, UC Berkley, Stanford

Major Cloud and Internet Service Providers

AI, IoT, Autonomous Cars, Drones, SoC, Security, Media & Entertainment


Major Enterprise Software and Service Providers

IBM, SAP, Oracle, Accenture, Redhat, Nutanix, HCL, Veritas, Infosys

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IDC Point of View - What can be Expected from the Co-creation of Two Tech Giants

Retail sector is very sensitive and adaptive to technological innovations. Very few innovation-accelerating technologies, IoT, AR and AI included, have not been on the radar of forward-looking retailers. Being a vertical tightly evolving with consumer behaviours and expectations - or the so called “people business”, increasingly they need to feel the pulse of consumers with the help of data, and data-powered intelligence. IDC predicted that by 2019, 40% of retailers will have developed a CX architecture supported by an AI layer. Such a platform will enable hyper-micro personalization of consumer experience, providing up to a 30% conversion increase and up to 25% higher revenue.

This case study of JD.com sheds light on the building blocks of this AI layer for retailers. As depicted below, the core computing resource running in datacenters will be there to handle computation-intensive training workloads for different AI models. Some models will serve business users to support merchandizing, campaigns planning, inventory optimization, and delivery routing etc. These business processes will be able to cover both online and offline store operations. Other models would be deployed in the cloud to uplift online customer experience, and again some would be deployed to edge devices to serve customers visiting physical stores. Captured data from various channels would come back and periodically update the relevant models.

One of the key challenges to be addressed is the unified customer experience across channels. For stores having both online and offline presence, consumer experience related AI models will be aligned to make sure consumer experience are as unified as possible, regardless where they make the purchase. For example, a customer patronizing a staff-less physical store would see personalized signages and receive special discount codes based on his past online shopping carts, as well as the physical store’s product availability.
Modeling Building *AI in the Datacenter*
- Handles compute-intensive ML/DL model training based on consolidated data set

Decision Support *AI in the Cloud*
- Handle non-latency sensitive, lower frequency inferencing task

Online Experience *AI in the Cloud*
- Handle data capture & inferencing tasks
- Handles continuous model updates based on user generated data

Offline Experience *AI on Edge Device*
- Handle data capture & latency sensitive, higher frequency inferencing tasks
- Handles continuous model updates based on streaming user generated data
The current deployment of computer vision aided retail scenarios as discussed in this paper is still in the early stage. There are more to be expected from the join works of two technology companies:

**Low-cost and low-maintenance smart edge solutions for the mass market**

Most importantly, the low-cost low-maintenance edge solution is expected to attract retailers to come onboard innovative formats that unify online and offline experience by harnessing the power of AI. According IDC surveys, companies are well aware of the benefits of leveraging artificial intelligence. Adoptions however have been thwarted by two leading barriers - the high solution cost and the high solution complexity. It will be exciting to see a smart edge solution addressing both barriers, and we believe these lowered adoption barrier holds the key for the next generational retail formats to rapidly grow and transfer to new locations.

- In EMEA, 78% of retailers have either implemented or planned to implement intelligent IoT solutions to improve in-store customer experience. (*IDC EMEA Retail Innovation Survey, 2018*)
- In APeJ, 22.1% of respondents deemed the lack of skills and knowledge to tackle solution complexity as the main barrier to adopt AI technology, while 23% of respondents from the retail & wholesale sector deemed the high cost of solutioning as the main barrier to adopt AI technology (*IDC APeJ AI Enterprise Adoption Survey, 2018*)

**New data integration channels to drive future AI research & application development**

Secondly, the adoption of smart edge solutions will provide greater and higher definition data through which AI algorithms can train and learn. AI technology has made huge progress in recent years, thanks largely to the increased availability of useable and higher definition data. Such data however is still far from being extensive or comprehensive. For example, a recent study performed by researchers of York University and University of Toronto has found that deep learning algorithms for object detection failed to recognize an elephant when the image was copied and pasted into a less associated background - a living room in this case. It is necessary for the body of consumer data to continuously expand and further drive the maturity of AI technology, and this will also fuel academic research as well as applications development for retail and correlated lifestyle industries.

**Improved physical space utilization to drive future lifestyle**

Last but not least, the redefined physical stores shall have a larger economic impact. Retail space in many locations has been experiencing the oversupply problem due to conundrums including decreased numbers of shoppers and inflating cost of operation. Reduction of operation cost and the creation of autonomous experience - keys to lifestyle needs in this increasingly digitalized world, would create new energy for the retail sector and improve the economy outlook in general.
IDC forecasts that by 2021, 20% of analytics, cognitive/AI, and information management deployments will be based on heterogeneous computing infrastructure, in which servers with different processors take on specific tasks rather than general-purpose processors taking on all tasks, so as to achieve response and cost optimization. While the retail industry continues the revolution in search of smarter recommendations, faster responses and unbounded experiences, the specialization of computing infrastructure from the edge to the core will continue to serve as the bedrock of innovation.
International Data Corporation (IDC) is the premier global provider of market intelligence, advisory services, and events for the information technology, telecommunications, and consumer technology markets. IDC helps IT professionals, business executives, and the investment community make fact-based decisions on technology purchases and business strategy. More than 1,100 IDC analysts provide global, regional, and local expertise on technology and industry opportunities and trends in over 110 countries worldwide. For 50 years, IDC has provided strategic insights to help our clients achieve their key business objectives. IDC is a subsidiary of IDG, the world’s leading technology media, research, and events company.

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