

How Artificial Intelligence (AI) Is Reshaping Retailing*

Venkatesh Shankar**

Artificial Intelligence (AI) is a buzzword that is dominating conversations. In its simplest sense, AI refers to programs, algorithms, systems or machines that demonstrate intelligence. More generally, it is used to denote a set of tools that can enhance the intelligence of a product, service, or solution. In addition, it is a rapidly growing field of study. AI is reshaping retailing in important ways. This article presents a framework for understanding AI, outlines applications of AI in different facets of retailing, discusses the future of AI in retailing, and concludes with broad suggestions for future research into AI.

There are good reasons why AI has captured our imagination. Picture the following scenario. You have an upcoming automatic bill payment, and you need to transfer funds from your retail bank's savings account to your checking account to pay the bill. In the conventional retail banking scenario, you would have gone to the nearest branch and made the transfer through a human teller or an ATM. In today's mobile banking world, you would login to your mobile bank app and make the transfer in a few clicks. What if you could simply tell your smartphone or wearable to do this transaction? And, in the process, obtain advice on managing your personal finance and make intelligent decisions?

Meet *Erica*, a voice-activated AI-driven mobile app-based virtual financial assistant from Bank of America's retail bank, that does precisely that. Not only does *Erica* complete the desired transaction in a snap, it also offers advice on a gamut of financial issues, including the ability to save on the mortgage payment by following a refinancing option, alerting customers to unusual activity in their accounts, showing them their updated credit rating

score, and providing suggestions to improve it. Little wonder, *Erica* garnered 1 million users within just three months of its launch in June 2018.

AI has arrived in retailing! It is blending into consumers' daily lives and retail transactions. With business data doubling every 1.2 years, retail data continue to explode. Retail data include purchase data, online browsing data, social media data, mobile usage data, and customer satisfaction data. For example, a retailer like Walmart collects data on about 1 million transactions per hour, contributing to 2.5 terabytes of data. AI systems learn by training on large datasets, so retailing is a fertile ground for the use and growth of AI. To leverage these burgeoning data, retailers are investing in multiple AI applications. By 2022, I anticipate the spending on AI by retailers to be \$6 billion. AI is impacting both the demand and the supply sides. On the demand side, AI is helping retailers better understand and anticipate customer needs and make optimal decisions to enhance the lifetime value of customers. On the supply side, AI is enabling supply chains to become more efficient and optimize inventory management and logistics. AI is also assisting shoppers and consumers in decision-making, altering their relationship with retailers.

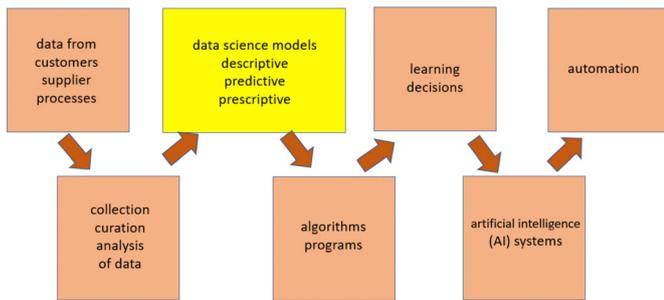
A Framework for Understanding AI and How it Works

To understand AI and how it works, we can view AI system as part of a larger framework comprising big data, machine learning, and AI (Shankar 2018). Retailers like Amazon constantly collect, curate, and analyze data, and make critical decisions using AI. Their decisions, in turn, fuel their customer interactions with more data which are again recorded, processed, and analyzed for further decisions. Many such decisions are made in real time. Thus, the cycle of constant data collection, analysis, decision, and further data collection keeps escalating with larger volumes of data. This framework, shown in Figure 1, can help understand the role of AI in retailing.

* Invited Commentary

** Venkatesh Shankar is Professor and Coleman Chair in Marketing and Director of Research, Center for Retailing Studies, Mays Business School, Texas A&M University, College Station, TX 77843. Email: vshankar@mays.tamu.edu. The author thanks participants in presentations made at Marketing Edge Professor's Academy, Southern Methodist University, Interactive Marketing Research Conference, Dallas CMO Summit, ISB Digital Transformation Conference, IIMC Alumni Association meeting, MMA meeting, Pan-IIM meeting, and Great Lakes Institute of Management for helpful comments.

Figure 1: A Framework for Understanding and Leveraging AI in Retailing



In this framework, manufacturers and retailers constantly collect customer data on attitudes and behavior across channels, touchpoints, devices, and platforms. These data are integrated from multiple sources and stored or warehoused, often in a cloud-based environment. Statistical, econometric and data science models are developed for enabling appropriate decisions. Computer algorithms and programs are created for these models. A class of models, called machine learning models, are particularly useful for learning from the data and making predictive decisions. Many decisions, especially continuous and real-time decisions, are automated. These machine learning models form the backbone for the generation and development of AI-assisted decisions. In many cases, such decisions are automated using systems such as chatbots and robots. For example, chatbots assist in customer service and robots help in warehouse and retail store automation.

At the heart of AI are data science models. Most AI models can be classified as predictive and prescriptive models. Predictive models predominantly offer forecasts of focal outcomes. These models typically offer *insight* for retailers for key decisions. Prescriptive models focus on providing normative decision recommendations. These models can be thought of as offering *foresight*. They deal with optimization of focal decision variables. In the retail pricing context, a predictive model could be one that predicts future sales response to price changes. A prescriptive model is one that offers optimal price recommendations to retail managers on the fly. Because a large retailer deals with several thousands of items with millions of customers and perhaps billions of transactions, such a pricing problem is an ideal scalable application for an AI system.

The development and advancement of AI occur through the analysis of four broad types of data, numeric data, text data, voice data, and visual/image/video data. Most retailing decision contexts involve the use of one or more of these types of data, lending themselves to significant enhancement through AI.

Numeric data analysis AI: AI systems based on quantitative numeric data build on the decision models

already being used in retailing. These models range from pricing to inventory optimization. These data can be analyzed using machine learning in real time thanks to the dramatic accelerations in computing speed and data storage capabilities.

Text analysis AI: These are algorithms that use natural language processing (NLP), the process of mapping words to conversational phrases, to analyze text data. Google translate is a good example. With social media (e.g., Facebook, Twitter) being awash with such data, the usefulness of this type of AI cannot be overemphasized.

Voice analysis AI: These algorithms work like text analysis algorithms, except that there is a layer of audio analysis and transcription before the use of NLP. Chatbots and smart speakers are the most common examples of voice-based AI.

Image/Video data analysis AI: Computer vision, the process of identifying objects in pictures and real-life, enables retailers to better analyze digital and real-world images and develop useful AI tools. Using surveillance cameras, retailers can analyze customers’ product exposure level, engagement and navigational route throughout the store. By combining these data with point of sale data, shopper intercepts, online surveys and loyalty card data, advanced AI algorithms for decisions can be developed. A recent development in this regard is advanced gesture recognition. Retailers can gauge consumer/shopper reactions to items by monitoring shoppers’ face and hand gestures. This recognition helps companies understand how products affect users and allow them to predict their future sales. Another useful AI tool is a virtual mirror used by retailers such as Neiman Marcus and Rebecca Minkoff. Using this tool, customers can try out multiple outfits without having to wear the clothes to determine which item fits them best and what other accessories go well with the outfit.

An overview of the AI data types, the related retailing areas and decisions influenced by AI appears in Table 1. The retailing areas and decisions are just some representative examples and may include many other areas and decisions.

AI analysis types	Some related retailing areas	Typical decisions influenced by AI
Numeric analysis	Finance, accounting, sales and marketing, inventory management, store operations	Store location, ordering, assortment, pricing, promotions, investment
Text analysis	Customer satisfaction, product review analysis	Product modification, new product introduction, service enhancement
Voice analysis	Customer service, order management	Purchase prediction, service recovery, order fulfillment
Image/video analysis	Shopper behavior analysis, shopper marketing, product assortment	Store layout, shelf-space, item placement, digital content, product recommendation

How Retailers can Use and Benefit from AI

Retailers can use and benefit from AI in multiple ways. On the customer side, understanding and anticipating shopper behavior, product recommendation, sales/CRM management, in-store experience management, customer service and payment management, and media optimization are some of the areas where AI is making a difference. On the supply side, inventory optimization, logistics/transportation, delivery, and space cleaning are some of activities that AI is influencing.

Understanding/Anticipating Omnichannel and Mobile Shopping Behavior

Retailers can use AI to analyze shopping behavior by identifying the pain points in a consumer's shopping journey. For example, L'Occitane used AI to understand where customers were getting frustrated on its mobile site and made modifications to its mobile site and app that resulted in about a 15% increase in mobile sales. Retailers can use both natural language processing and computer vision to improve a firm's search feature and deliver enhanced customer experience.

Research shows that multichannel and omnichannel shoppers are typically more valuable to marketers than single channel shoppers. The mobile channel typically enhances overall purchases. In particular, mobile apps have interesting effects on shopping behavior. They lead to greater frequency, quantity and monetary value of purchases in both online and offline channels, but also result in greater product returns. However, overall, mobile apps lead to greater monetary value of purchases net of returns. By the same token, a failure in a mobile app can lead to decreases in the frequency, quantity, and monetary value of purchases in offline channels. Much of these mobile effects can be modeled real time using an AI system. Because most shopping explorations start with mobile and mobile data are surging, retailers can use AI to analyze these data and leverage AI for improved decisions.

Personalization and Recommendation Systems

Prediction of next purchases and personalized recommendations are becoming increasingly important to both shoppers and retailers. Retailers can use AI to personalize recommendations to their customers. For example, Amazon uses AI developed using data on its over 100 million customers to predict their next purchases, make personalized recommendations of offerings, and optimize supply chains. A few companies have adopted IBM Watson's cognitive computing capabilities. For

example, 1-800-FLOWERS uses Watson to tailor gift recommendations to consumers based on the information consumers provided about gift recipients. The North Face, an apparel maker, uses the location and gender of consumers to recommend the best type of jacket to purchase. Starbucks introduced its AI-based personalized app in 2017 in the U.S. Within one year, the personalized app has accounted for about 20% of the sales.

The restaurant chain, Thank God It's Friday (TGIF), uses AI-powered marketing by blending customer data from TGIF's multiple applications, including emails to the company's app, loyalty programs, and in-store receipts. By combining these data, TGIF can determine that a specific customer has ordered chicken wings in the past and tends to order at 7:00 p.m. TGIF's bot, Conversable, can make a personalized offer to that customer via a text notification. TGIF claims to have grown engagement by five-fold and sales by \$150 million in 14 months.

Smart speakers like Amazon Echo, Google Home, and Apple HomePod are proliferating in homes. These speakers listen to and record everything people speak at home in a Cloud database. Retailers mine these data and develop AI systems to predict what customers will likely buy and make personalized product recommendations. Amazon plans to go one step further. Through new AI-based services termed "anticipatory shipping" and "life time anticipatory shipping," Amazon plans to ship products to customers even before they decide to order anything. This AI system anticipates what a customer will want or require and starts shipping those items to the customer even before the customer can realize that they really want them. Amazon is betting that customers will like what it sends them. If customers don't like them, they can return them without any penalty. Amazon is testing these services in a few locations.

Sales/Customer Relationship Management

Retailers also use AI to identify new sources of revenues to improve topline growth, as well as determine and implement profitable customer relationship management (CRM) strategies. AI can automate routine sales tasks, serve as a virtual assistant, dynamically segment customers, and help customize offerings. To fully leverage AI in today's retailing environment, CRM strategies must be location-specific, time-specific, and channel-specific in addition to being customer-specific.

Pepper robot is a good example of an AI system that can increase retail traffic, customer interactions, and even sales revenues. Sales assistant AI software such as Coversica can converse with lead customers and improve their engagement with the retailer. For example, by using

such software, the New-England based car dealer, Boch Automotive, claims to have boosted the sales of Toyota cars at its dealership.

In-store Customer Experience Management

A consumer's in-store experience can be improved by an AI-based humanoid robot that can directly interact with customers as a concierge or sales associate. The robot can help customers find what they are looking for them or point them in the right direction. Pepper robot is a humanoid robot capable of interacting with customers and perceiving human emotions. Thus far, it has helped increase store interest and sales at companies such as Nestle, The Ave and SoftBank mobile store. However, how long this effect will last is uncertain.

Lowe's, the second largest home improvement chain in the U.S., has piloted an AI-driven robot called LoweBot in 11 stores in the San Francisco Bay area. A typical Lowe's store is huge with 144,000 sq. ft of indoor and outdoor space, and many shoppers often feel lost in such vast spaces. To guide such shoppers, the LoweBot greets and chats with them. It can also detect and engage idle customers. It not only directs the shoppers to the right aisles, but also answers shoppers' store-related queries. It uses natural-language processing, a machine learning method, as its engine.

Other in-store experience AI systems include cashierless checkout and high-tech pickup kiosk. Amazon Go is a cashierless store offering automated shopping experience where sensors track the objects customers put in their baskets and AI charges customers' Amazon accounts when they exit the store. Many "order online and collect offline" retail services allow for the pickup of appropriate orders at conveniently-located kiosks.

Customer Service and Payment Management

An area in which AI can be highly useful is customer service. Customer service is critical for retailers because over half of all consumers, in particular, millennials, defect from a retailer due to bad customer service. AI in voice platforms and chatbots can help retailers increase both efficiencies and satisfaction in customer service experience. They operate 24/7 and eliminate wait times, providing robust customer experience. To improve customer experience, many retailers are looking to text- and voice-based AI that can mine customer sentiments of products and services.

Payments is another area where AI has made rapid strides. AI not only facilitates payments but also deters fraud. PayPal's AI uses a deep learning model estimated on years of digital transactions to proactively detect and prevent transaction fraud.

Media Optimization

AI is changing the way retailers optimize their digital media communication. RedBalloon, an Australian online gift retailer that sells personal experiences, uses an AI-powered digital marketing platform called Albert. Albert targets audiences, mixes and matches creative assets, buys media, and runs campaigns across both paid and earned media channels, including Facebook, Google, and YouTube. It also learns cross-channel effects and adjusts allocation to optimize the return on marketing investment. It also looks for new audiences that RedBalloon had never considered before by trying thousands of text-image combinations on micro-segments and tracking their triggered responses. RedBalloon reported about 750% increase in Facebook campaign conversion rates and about 1500% return on its marketing investment.

Inventory Optimization

AI is significantly affecting inventory management and stocking. To ensure that buyers can access what they want when they want, robots are starting to perform stocking and restocking. This AI-based automation together with AI-backed demand forecasting will be a key tool for retailers. For example, through an AI-driven forecast of customer demand during Black Friday, a retailer can plan its inventory and sales more efficiently.

Lowe's uses AI through an Augmented Reality (AR) app to help customers make their purchase decisions. If a shopper is interested in remodeling her kitchen, she can use the app at the store to overlay the right products against a picture of her kitchen and see how it looks when installed in the kitchen. These AI-based systems help Lowe's determine sales patterns, keep tabs on the inventory, and replenish the right items efficiently.

Logistics, Transportation, and Delivery Management

AI is already changing the way logistics and transportation are done in the retailing industry. Intelligent route planning, self-driving vehicles, robot deliveries, and drones are some of the exciting new developments from AI. For example, Dominos is experimenting with robots to deliver food and drinks while maintaining these items at the appropriate temperature. Amazon has piloted drones and is researching drone regulations around the world to make drone deliveries a regularity soon.

Store Cleaning and Layout Management

AI-driven robots can more efficiently clean physical retail spaces. These cleaning robots can eliminate the need

for a person to stay after business hours to clean the space. In addition to cost savings, these opportunities could result in increased customer satisfaction, retention and overall experience, all of which are important in retailing.

AI can help better design and redesign store layouts. With AI, stores can determine the ideal layout for the mix of their shoppers and which shoppers will most likely respond to changes in the store layout, and vary store layouts to fine tune and optimize decisions.

Future of AI in Retailing

What all can AI do? Where is AI headed? How fast will it spread? These questions are on the top of retailers' minds. What all can AI do? It can probably do less now than what people think it can. This means that AI is going to take time to have a real impact on retailing. At least for the next few years, most retail sales in the U.S. will happen offline. While many physical stores have evolved to remain competitive, the future of these stores will be dominated by AI, with smart sensors and robots replacing humans. This will likely be the case for many big box retailers. To augment AI's capabilities, there will likely be a portion of smaller brick-and-mortar stores that will rely on employees' abilities to form personal connections with customers and provide a service experience that a robot cannot.

Where is AI headed? AI is eventually going to do more than what people expect it to accomplish. In other words, we tend to underestimate the long-term and the medium-term impact but overestimate the short-term impact of AI.

Stanford University tracks AI's progress using an AI index developed in collaboration with MIT, as part of a project called "One Hundred Year Study on Artificial Intelligence (AI 100)." The index is based on several developments, including speech recognition progress, the rate of improvements in image identification, start-up activities in AI, investments in AI-related ventures, and AI job openings. The index also incorporates qualitative opinions in the form of short essays from people who are influential in and close to AI through natural language processing.

In tracking this index, two important developments merit attention. The first is AI's object detection or image processing accuracy. Over a period of five years during 2011-2016, AI has surpassed humans in this accuracy. It is now close to 97% compared to humans' 95%. This is a tipping point for AI algorithms to be more efficient and pervasive. The second is speech recognition and voice identification accuracy. It too has grown from 80% in 2010 to 95% in 2018, exceeding human beings' accuracy levels. However, both machines and humans are still fallible. In particular, AI can err if images are perturbed. Therefore, while these developments enable retailers to substantially

automate activities and enhance offerings, they still have their limits.

How fast will AI spread? It is hard to predict the pace of AI's growth, but it will likely spread faster than all powerful technologies before AI. For comparison, consider the electric engine. It was introduced in the 1880's. It was not until 1920's that the first discernible productivity gains were realized from electric engine through faster transportation. AI is on a similar path but with faster adoption because it is cheaper and quicker to take any AI program and implement it systemwide.

What is in store for AI in the next few years? Here are some of the things that we will start to see more commonly. Intelligent vision will become common in devices such as glasses. One prediction is that 10% of all reading glasses will be connected to the Internet by 2023 so that we can use augmented reality on a daily basis. Another prediction is that we might have access to the Internet through any wearable, fitness tracker, smart watch, or even a piece of clothing. Yet another prediction is that 90% of the global population will have the computing power of a supercomputer in their pockets by 2023 because of the continuing miniaturization of chips and affordability of devices, helped by Moore's law of evolution of faster, cheaper, smaller chips.

AI will enable retailers better understand consumer psychology by getting us closer to what the human brain is thinking at any given moment. Using deep learning networks, a new AI algorithm can really get at what someone is thinking. This algorithm can detect the images that a human brain is processing, albeit with limited accuracy. This development is significant for retailing because by clearly understanding what shoppers and consumers are thinking, retailers can sell them relevant items than trying to guess and sell them different items.

The surging growth in the Internet of Things (IoT)--connected devices ranging from radio frequency identification (RFID) tags to kitchen appliances with real time Internet connectivity-- could spur AI's acceleration. By some estimates, about one trillion sensors will likely be connected to the Internet by 2022. More than half of the Internet traffic from and to homes in the U.S. may emanate from appliances and devices by 2024. Self-driving cars, despite the recent accidents and development setbacks, may account for 10% of all cars in the U.S. by 2026. Although the data from only a small fraction of devices will likely be leveraged, they will still provide valuable consumer insights for the development of next generation AI.

AI will thrive in an emerging sharing and experience economy. Millennials and centennials (Generation Z) do not generally like to own cars, or for that matter, anything. Instead, they typically want to share cars, and even homes. The future could be dominated by a sharing retail economy

and an experience economy, where customers want great experiences with no baggage.

Amid this rising influence of AI, its adoption should be carefully planned and researched. Company leaders should know when and how AI will benefit their customers and business rather than blindly following the crowd or announcing the use of AI for the sake of better public relations.

A major issue of concern is AI's potential impact on retail jobs. Experts suggest that AI might displace about third of the jobs in retailing by 2030, 2035, or 2040. The goal of AI is not to replace humans but to assist them and increase tech-based jobs. AI's promise is that it allows workers to create efficient processes and focus on humanistic duties in their roles. To this end, retailers are looking for the right combination of targeted marketing, technological efficiencies, and human connection from employees to boost overall customer experience.

Nevertheless, automation will continue to grow and replace or reshape jobs. The use of AI will not completely replace people but will alter their roles so that they can spend more time developing strategy, getting new leads, and building relationships with vendors. Any tasks that require ambiguous and creative thinking might still require humans to execute. For AI to be effectively integrated in a business, it is important to understand the firm's ability and willingness to adopt new methods. If a firm does not have full commitment from its executives, this type of change can be very slow and painful. From a consumer's perspective, consumers will likely notice more competitive prices, improved service and better product availability as AI continues to grow in the retail space. AI could make game-changing impact by joining corporate boards of directors by 2026. Jack Ma, the founder and chairman of Alibaba and a huge believer in AI, feels that by 2030, AI will even be a CEO of a leading company. What this means is that we may witness a lot of turmoil among managers, calling for a planned embrace of AI going forward.

Going forward, both academics and practitioners in retailing look to advances in AI. Practitioners primarily need to develop new and improved AI systems and tools they could use. Researchers predominantly want to better understand

consumer behavior in the new AI-rich retail environment, use AI tools to more deeply study consumer psychology, and develop more robust AI models to better explain and predict retail outcomes.

To better understand and anticipate the future of AI in retailing, more research is needed in at least three main areas of retailing: (1) AI systems for a variety of retail decisions, (2) behavior of AI-assisted shoppers/consumers, and (3) a deep understanding shopper/consumer neuropsychology using advanced AI models. More AI systems based on advanced machine learning models should be developed for different facets of retailing, ranging from demand forecasting, to segmentation, to recommender systems, to inventory optimization. More research is needed on AI-assisted shopper/consumer behavior and how AI influences consumer decision-making. Finally, future research could focus on developing AI models to better understand consumer/shopper thoughts by neuroscience-based methods. This research requires cross-functional thinking and collaboration across researchers from diverse disciplines such as marketing, information systems, computer science, statistics, economics, and psychology.

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