Planogram Optimisation and Cross-Category Affinity Intelligence: AI-Enhanced Analytical Frameworks for Retail Merchandising Strategy

Dr. Anna Westin, Associate Professor of Information Technology, Umeå University, Sweden

1. Introduction to AI in Retail Merchandising

There has been much written recently about the importance of artificial intelligence (AI) to the retail industry, and we are now beginning to see the proliferation of truly AI-enhanced merchandising strategies. These strategies are designed to offer a more contextually aware, analytics-based approach to traditional merchandising retail strategies. Yet, surprisingly little has been written about the foundational principles of this emerging field. This will explore the basic driving strategy, how AI technologies impact merchandising approaches, and how they drive enhanced returns on investment into retail decision-making.

More and more, we are seeing AI becoming more prevalent across the enterprise as a decision-making enhancement. The beauty of AI-driven decisions is that AI can sort through hundreds or thousands of data points to provide its human partner a concise, relevant set of considerations based on likelihoods of outcomes, or even suggest what action should take place. Furthermore, AI systems often get better over time by aggregating more information and even learn from their mistakes. This type of cooperative decision-making process is increasingly being applied to retail merchandising to more accurately and dynamically make decisions to improve the retail environment. AI technologies are being used in the industry to create customized promotion algorithms, inventory decisions, detailed in-store layout recommendations, and even store locations and predictive staffing models. Retailers are slowly beginning to leverage a variety of intelligent systems to provide insights that drive relevant decision models. However, the marketplace is still in its infancy. Retailers are working harder than ever to dominate a landscape that is changing faster than most of us can keep up with. At the center of it all has been a massive shift in consumer behavior. Gone

are the days of a weekly necessary trip across town to do your shopping. Now convenience, price, and the entire customer experience drive buying decisions. Strategic retailers have been adopting various forms of business intelligence systems to gain guidance on how to achieve these goals. These systems rely on historical information, which allows the tendency to be perennially introspective. As a result, it also becomes more and more likely that the strategic decisions will miss out on the bleeding edge of the trends that are not prepared to deal with as robustly.

2. Understanding Machine Learning in Retail

Retail merchandising is a complex and involved process that requires the seamless cooperation of several unsullied processes, communication, and worker efforts, which can cut a retailer to the core. It is this factor that makes these processes all the more fascinating to AI researchers and developers. Machine learning, a subset of AI, has a place in retail involving three primary categories, to name a few: demand forecasting, inventory management, and customer data.

Machine learning is a data analysis procedure that, rather than depending on rules-based programming or heuristic systems, merely looks at data from a different perspective. Two notable types of machine learning aided in the retail setting are supervised learning and unsupervised learning. In supervised learning, the system tries to develop relationships about existing situations or information. After that, this knowledge can be applied to new, never-before-seen cases. Machine learning employs customer data such as transactional, demographic, and behavioral data. This data, in some cases, can be grouped in accordance with the five L's of big data, though conversion strategies are possible even with all types of customer data. A few types of algorithms that can be used are decision trees, neural networks, and natural language processing.

In retail, machine learning can be applied in making more accurate sales forecasts as it increases personalization in forecasting. Through accurate demand forecast offerings, retailers have the chance to take part in more optimized buying and inventory management. Retail analytics helps retailers enhance their customer services by facilitating data-driven strategies. This includes generalized opinion mining for understanding retail feedback as well as the natural language processing algorithms. Customer segmentation algorithms tend to use RFM analysis and primary market

basket analysis to boost their effectiveness. A vital example of unsupervised learning utilizes cluster analysis to segment a retail customer base.

3. Data Collection and Preprocessing for Merchandising

Data collection and preprocessing are foundational to building a data-driven retail AI framework for the alignment of retail strategic and tactical decision-making. Retailers can gather increasing information about their trading environment from a variety of external and internal sources, including sales records involving multiple data sources pertaining to printed and digital formats, unstructured data analysis like customer feedback, staff interactions, social media comments, and conversational output.

Data has varying degrees of quality, particularly related to accuracy, relevance, and meaning, as well as updating and/or frequency of collection. The use of high-quality data in AI model input would enhance AI's primary as well as supportive impacts. It is demonstrated that AI applications are dependent on data. Data had to be collected, cleaned for errors, and transformed into a workable format. Big data analytics can support retailers' strategic and operational decision-making through more accurate predictions of consumer behaviors that emerge from the combined datasets. These insights can provide correlations, suggestive data, and business trend alerts related to patterns in sales and attendance, with weather patterns.

4. Developing AI Models for Merchandising Plans

Select business and deployment domains that will be tackled in making an AI model which could potentially aid this area. Then we determine the granularity of the data that we get, which could be used for the identification of customer buying history on a daily level. Based on the metrics that we want to see the model being dependent on, we should decide the class label or the output variable for which we want to make predictions. Transposing the day-level transaction data into the sum of units and value, among other things, for all days might give us daily level deduced data, such as demand or sales value and the velocity of the sales, which we want to somewhat forecast due to nearby local minima and maxima. Different algorithms that apply right away in this case are chosen, and the cross-validation for them gets calculated after knowing the algorithm is working. Then the accuracy of all algorithms can be compared, and the most accurate out of them could be picked. It was a good idea to choose decision trees, linear regression, and logistic regression models and train them according to

merchandising zones. The working algorithm for the cross-validation process requires training all these four cross-validated models so that they are built with the correct input data format. According to the merchandising zone, for each deployment domain, aggregated data and additional fields that bring value, like customer ID and transaction line ID, get imported and preprocessed. Different model selection for different use cases: 1) Retail session proceeding end forecasting - the use case where using a stock-based linear regression model is more appropriate due to its accuracy. 2) New product sales price forecasting - the use case where using a stock-based classification algorithm is required. Various algorithms like regression models and classification models can be employed based on the granularity of the data available. Model performance is assessed using the following metrics: 1) Regression models - a) Mean Squared Error b) Coefficient of Determination c) Median Absolute Percentage Error d) Smooth Fractal Model. 2) Classification groups - multi-out classification - mode per zone. During ensemble learning stock system development, the ensembling models' predictive performance is compared, and the best ensembler is selected as per the requirement. The use of appropriate evaluation metrics ensures that the merchandising AI model's accuracy improves. One can adjust their model's parameters for optimal prediction using hyperparameter tuning techniques. To enhance prediction capabilities, an AI model should be encouraged to learn continuously. The dynamics of the market are continuously changing; thus, the data scientists must continue their training. It is best to use cross-validated data as an input to be generated after preprocessing. To gain a model close to prediction accuracy, the data should be allowed to undergo cross-validation for both numerical and categorical data. As each merchandising zone might have different operational strategies, the model should be trained according to the zone. It is always a good idea for a data scientist to discuss strategies with a merchandising team. This is to ensure that the latest strategies are used while fine-tuning the AI model for merchandising plans.

5. Implementing AI-Enhanced Merchandising Strategies

To begin integrating the capabilities offered by AI into existing retail merchandising strategies, retailers must take specific steps. This includes implementing cloud computing in the warehouses and connecting IoT devices securely; both solutions can collect high-value data on inventory levels and customer decision-making habits. While leaders should plan for an initial shift due to managing the change in training staff, new

processes will eventually emerge that both retailers and customers will benefit from. As more consumers shop online, merging inventory management and sales decision-making processes points to a timely need to deploy AI strategies. With this foundation in place, companies are poised to see successful deployments of AI that are best aligned with the top priorities of a business.

There are several technology partners that offer AI solutions that can be directly plugged in and taken advantage of within merchandising. One offers an AutoML platform that can be customized to meet the needs of both retailers and suppliers, who can use the platform to assist in high-value decision-making in their upstream. Another helps India-based stores make better ordering decisions. In this scenario, it works directly with such SMBs to offer ways to support the staff, who are not always tech-savvy, to take advantage of back-end AI-based recommendations to stock more popular items. A company can implement an AI solution to assist with decisions that traditionally don't require a person because they are often made internally with the goal of expanding or transforming the core business model.

6. Case Studies and Success Stories

Real-world examples of AI-enhanced retail merchandising

6 Case Studies and Success Stories

This section will present case studies and success stories that illustrate the impact of AI on merchandising strategies in retail. The case studies provide in-depth information on how retailers have implemented AI solutions to overcome many of the challenges identified in the preceding section. For each case, we present the specific problem that the retailer was facing as well as an overview of the implemented AI solution. We also discuss the overall success of the AI project and the outcomes that were achieved.

The four case studies provide examples of how AI can be used in different retail contexts and across different functions. Two of the cases are focused on inventory management and one on personalized marketing and analytics. The fourth case is an omnichannel use case that tackles one of the inherent challenges faced across the entire retail enterprise.

These case studies will show how retailers are walking the path of AI-supported innovation. It is their AI journey that gives a mode through which others can match their

industry, scene, and desired level of AI suitability. For seasoned and emerging data-driven merchandisers, the insights and lessons learned will serve to navigate the ups and downs of exciting AI projects. In contrast to our case studies, our success stories unfold a set of bright examples of worldwide retailers who have made their top two merchandising decisions AI-infused. These success stories underline the significance of AI to enhance your ability as an innovative retailer to become flexible in this volatile world, providing customers with engaging, personalized offerings through AI to achieve and maintain the competitiveness they desire.

7. Challenges and Ethical Considerations in AI-Enhanced Retail Merchandising

Martech retailers are quick to adopt AI for their bulk data analytic processes. However, the same was not the case with AI in retail merchandising. The case of merchandising is different, involving the retail strategy; it pertains to the selling space, customer preference, along with tactical and operational decisions. The implementation of AI in merchandising includes both technical and ethical challenges.

Technical challenges due to AI in retail merchandising Implementation of AI into merchandising incurs a number of challenges for the retailer, which include internal process changes, system integration, training AI algorithms, and the use of data from multiple touchpoints. The training of AI models in merchandising is quite difficult because it doesn't have an aggregate data level. While predicting expected sales through AI requires access to data from various functional areas, including cataloging, marketing, and supply chain. The personal touch of customer engagement ultimately provides positive and negative information that multiplies the data to be aggregated, making it more complex. The data from the retail platform is not sufficient. The usage of customer data in AI-enhanced retail merchandise has gained importance. Several ethical issues arise when personal customer data is incorporated for personalization. Maintaining the balance between customer personalization and protecting customer privacy is a subjective issue, but both must be given their share of importance. Storing the data from customers so that the chances for generating insights that lead to more demand can often utilize the data to showcase personalized unique items that will convert the customer from a browser to a buyer. This can create extra demand for personalized items where the current production might not be sufficient. This also often leads to an increase in wastage of various raw materials and sometimes money from

canceled orders. The ethical concerns that arise due to the use of customer data in ethically AI-enhanced retail merchandising are the current challenges faced by the retail industry. While doing geographic segmentation, discrimination based on living areas, rural versus urban areas, and even storage areas are enhanced. This way, the data might reflect racism or discrimination while using the same data. The present algorithms end up targeting the same population, often by implementing discrimination. If AI as a system can enhance biases, its usage in any form of AI itself is challenged. These are various ethical issues that arise while using AI-enhanced retail merchandising. To maintain ethical standards, ethical guidelines and best practices have been proposed. The guidelines for ethical AI and the usage of algorithms in retail merchandise are transparency, accountability, and being purpose-driven. It is important that AI assists in making ethical decisions. In other words, AI should be able to explain its decisions. The advantage is the creation of customer trust. This has subsequently contributed to the growth in the acceptance of AI and enhancing the retail sector. AI must make use of responsible AI, based on certain values that are aligned with social values. AI should have human attributes like curiosity, creativity, and imagination. AI itself is accountable for its decisions. It also renders the use of the data it uses in support of its decision-making. It maintains the accuracy, integrity, and confidentiality of the data collected. If the AI adversely affects the stakeholders, the AI itself should be accountable. In other words, it tends to shoulder the responsibility and ensure a certain level of safety.

8. Future Trends and Innovations in AI for Retail Merchandising

The future represents a collection of emerging technologies and innovations. Our discussions sought to find future trends and innovations that would have the potential to change retail completely. Here we predict these are in several areas including retail capabilities, operations, and retail merchandise development.

Future Innovations in Retail Operations Augmented reality offers many experience options; one is the much better graphics and interaction of virtual reality – virtual try-out for beauty and wearing accessories; households: room decoration try-out; car: driving a car. Indoor location-aware applications when shopping could help you find products in the store or pitches for similar or related products. Personalization in-store: Clothing retailers are starting to offer shoppers personalized outfits, using details on what customers usually buy and then making various shirt/trouser combos. This kind

of offer will depend on active customer profiling, as well as help from data analytics or artificial intelligence or other search/predictor algorithms inside the retailer IT infrastructures.

Future Innovations in Retail Capabilities AI Algorithms: Adaptive Machine-Supported Marketing, Procurement, Markdowns, or Promotions Route to Market New Views: Advanced analytical tools, starting from a few simple values and constructs of institutional/organizational objectives, in a function-based, operationalized version of utility function, might help organizations better understand the many external constraints and internal constraints. That is, each conceivable RM act and also give each conceivable mixture of demand and sales rather like a decision map. Similarly, they could offer time-series based data on changes in returns, from which individuals would obtain subjective forward-looking views. Currently, AI can be used to develop such models. Changes in algorithms: Newer iterations of AI are less formal, more adaptive or learning, or more emulating by using statistical algorithms that react in a radical way when certain triggers are seen. Such AI will provide even more intelligence for merchants if the time cell of the immediate predictions/status reports will be much shorter. For example, sales of certain products at a specific time are a third of what they were at the exact same time last year and appear more like sales from a previous month. Little behavioral economics evidence suggests we mimic the past. Blockchain: There is some suspicion that many automated pricing systems are segregated by race; certain locations with many poor people always see more expensive prices; locations or certain individuals that are identified as unknowing are offered higher prices; others that can pay more are offered lower prices. Future retailers are looking to bankable coin and digital/point-based money systems where people can pay virtually and not leave any price-wide mark of their purchase on each other, or where we will less associate with price-based purchases, for example through blockchain. An added upside bonus to a merger here is that the origin and details of each transaction can be much more publicly traced. This may become vital at some stage for governments as the scorched planet and world wars or political moves move to even atomic war or atomic busts. Let's live the talk of pulling away economic physical impacts of a 6th to 9th sense. The latter is indeed becoming truer with the offerings of AI at a time when more and more people are advocating retail sustainability themselves.

9. Conclusion

The adoption of AI-enhanced retail merchandising strategies seen throughout history shows that the arrival of those innovations, including current or emerging ones stirred by advancements of AI, can be revolutionary in merchandising and the retail subsector of business. Already incorporated AI solutions enhance customer experiences while reducing the time and human hours spent in making various activities to guarantee successful merchandising. However, for the long-lasting existence and prosperity of AI in retail merchandising, there are some recommendations for retailers to take into account. Retailers must take a strategic approach in combining, reintegrating, prioritizing, and incorporating some suggestions in an AI solution to merchandise. Meanwhile, retailers must consider the privacy, ethical, and societal implications in handling data and using technologies as well as design the technology for long-term usage. Retailers should also pay closer attention to the creation and management of consumer identity in their pursuit of AI-driven retail, and lastly, ongoing R&D to keep abreast of recent technology trends and acquire the essential professional and technological knowledge for their adoption is equally as important. By identifying and implementing this kind of AI solution in their strategy, retail companies and other players can significantly enhance their performance and products' quality, improving the market trends in parallel. AI is the strongest technology in modern times and would ultimately lead to rebuffing procedures by its facilities. AI is currently undertaking several revolutionary transformation journeys and has the ability to carry on in retail merchandising decisions on an industrial size. The questions and issues that AI and its subfields have are whether AI and its repercussions may lead to a true transformation revolution. Retail merchandising is undergoing a paradigm shift, which AI heralds.