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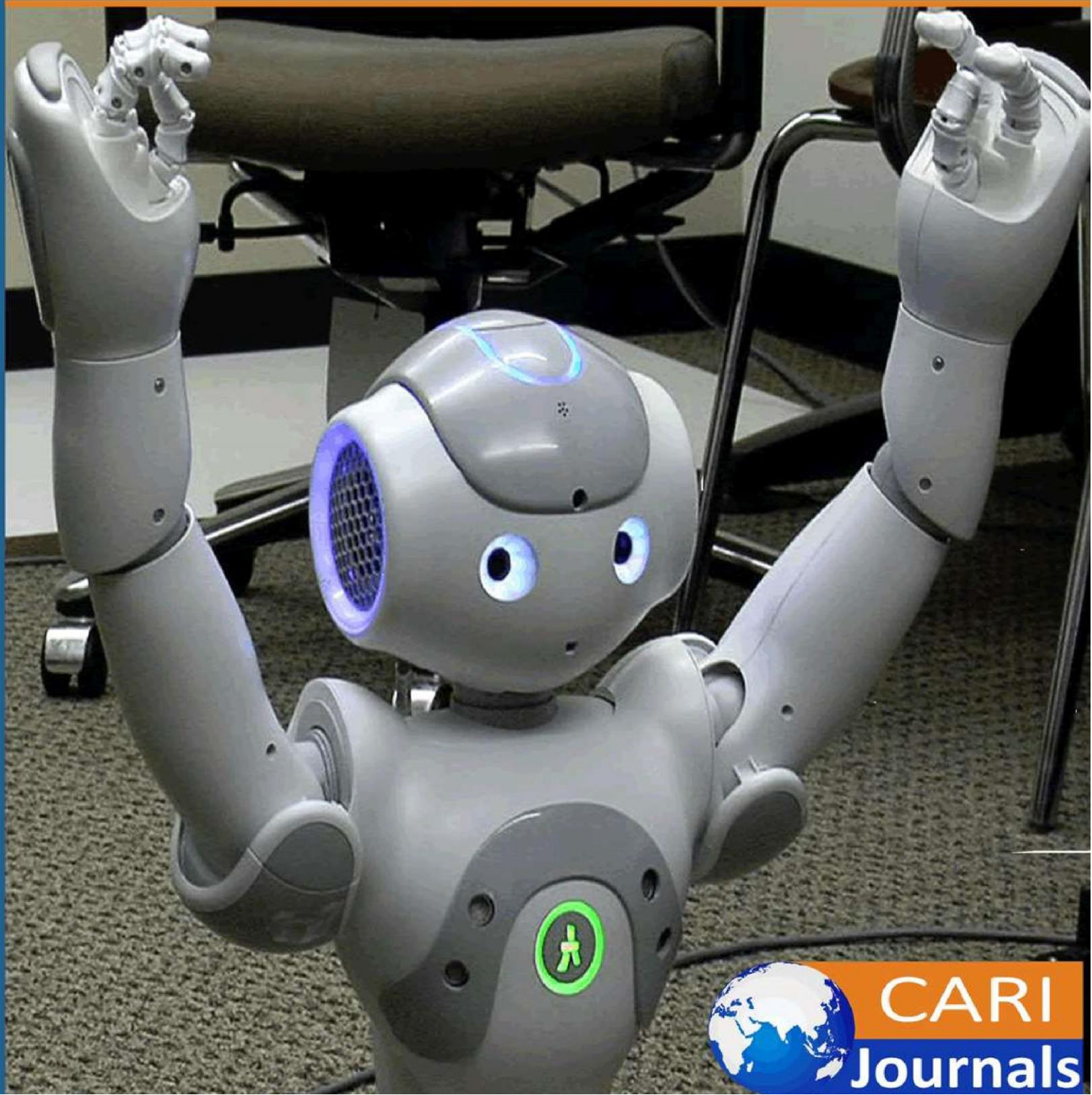

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From Data to Decisions: Enhancing Retail with AI and Machine Learning

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Abstract

Purpose: The recent advancements in computational power have presented unprecedented opportunities for businesses to harness data. A noteworthy development in December 2022 was the introduction of OpenAI's [1] ChatGPT, signifying the rise of generative AI tools including, but not limited to, Bard [2], Midjourney [3], GitHub Copilot [4], Amazon Bedrock, and Google's Gemini [5]. This research paper aims to harness AI capabilities within retail organizations, using data (customer) to expand business reach and enhance customer satisfaction. Data and AI form the core of this research.

Methodology: In this research, we have trained a Large Language Model (LLM) by providing it with database schemas, including tables, to interact with centralized data and gain insights through simple prompts. We can leverage data for data Analysis and create reports, dashboards, understand customer behavior.

Findings: Our research findings that AI serves as a pivotal force in amplifying the retail industry's potential. AI's applications span from improving customer experience by enabling voice orders, emotional insight, exclusive Deals just for you, product design, email campaign, optimizing inventory to facilitating targeted marketing strategies, list goes on. Yet, as we navigate this AI-augmented retail landscape, it is imperative to address challenges related to data privacy, algorithmic bias, implementation costs, and the need for expertise.

Unique contributor to theory, policy and practice: In essence, generative AI is more than a fleeting trend; it epitomizes the future of retail, demanding both adoption and circumspection. Our recommendation to use AI for enhancing retail business and use it ethically.

Keywords: *Analytics, Customer Data, Generative Ai, Machine Learning, Retail*

1 Introduction

In the rapidly evolving digital era, businesses are constantly seeking new avenues to understand and engage their customers. The role of data in achieving this objective cannot be overstated. In my prior engagement, my team and I undertook the task of mapping customer behavior using mobile and location data. We sought to understand the physical journey of the consumer, from the stores they preferred to visit, the time they spent there, and their subsequent destinations. Coupled with this, our analysis of online interactions, particularly focusing on product searches and eventual purchases, revealed fascinating patterns. These patterns were not just an exploration of consumer behavior, but an intricate web of preferences, decisions, and the factors influencing them.

This invaluable experience brought forth an epiphany: while raw data presents patterns, it's the marriage of data with the computational prowess of artificial intelligence that transforms these patterns into actionable business strategies. Imagine the ability to not just understand where a customer goes, but to predict where they might go next, or the product they are likely to purchase in the future. The implications of this are profound, offering businesses a competitive edge and the potential for significantly enhanced outcomes.

Other than that, we did an extensive review of existing literature on AI in retail as well, including [6, 9], revealed a persistent need for improvements in business using more advanced AI algorithms, and cost-effectiveness across retails.

This paper addresses this need by highlighting the potential of generative AI in retail sector, highlighting continue improvement required on AI and machine learning algorithms.

This research paper is a deep dive into that potential. We navigate through the intricate maze of artificial intelligence, shedding light on its multifaceted components. From the algorithms driving machine learning, the intricate designs of neural networks, to the creative expanse of generative AI and the tug-of-war in generative adversarial networks, we aim to present a comprehensive picture. Additionally, understanding the data landscape is pivotal. We elucidate on the backbone of data operations – from integrating diverse datasets, the ETL processes that transform raw data into meaningful insights, the storage implications of data warehousing versus lakehouses, and how business intelligence tools harness this data to provide actionable results.

To ensure a holistic approach, our methodology isn't just theoretical. We engage in practical exercises, such as developing chatbots that can assist in customer interactions and leveraging powerful AI libraries for intensive data analysis. Our research wouldn't be complete without real-world implications, and hence, we turned our attention to case studies. A notable exploration was the Facebook Marketplace, a platform that stands as a testament to the convergence of data and AI in shaping consumer-business interactions.

With rigorous investigations and analyses underpinning this research, we present our findings, not just as observations but as a blueprint for businesses and researchers alike. We invite our readers to delve into this exploration, considering the implications and opportunities it presents for the future.

2 What is Artificial Intelligence

Artificial intelligence (AI) refers to the capability of machines to mimic human cognitive functions such as learning, problem-solving, and decision-making. Unlike natural intelligence exhibited by humans and animals, AI [10][11] encompasses computer systems designed to interpret data, process information, and respond in ways that exhibit a form of understanding.

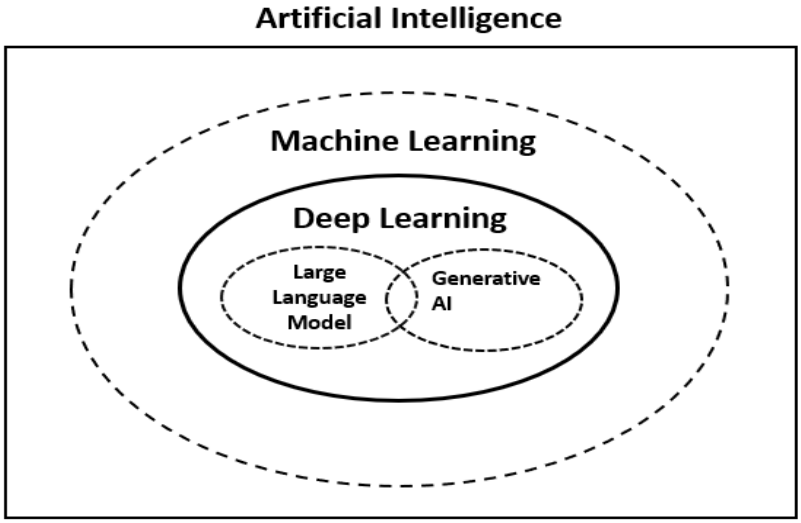

Fig. 1. Artificial Intelligence

Machine learning is a subset of AI, and deep learning (Natural Language processing (NLP), Convolutional Neural Network (CNN), and Recurrent Neural Network (RNN)) is a subset of machine learning (See Fig 1). Deep and machine learning have two important types: supervised learning (labelled data) and unsupervised learning.

3 Neural Network, Generative AI, and Generative Adversarial Network

Neural Network: A neural network consists of an input layer, one or more hidden layers, and an output layer. Through the process of forward propagation and backpropagation, the network learns to adjust its internal parameters to make accurate predictions or classifications based on the provided input data.

Generative AI: Generative AI [12] has the capability to learn from existing artifacts and generate new, realistic creations that capture the characteristics of the training data without merely duplicating it. This technology can produce diverse forms of original content, including images, videos, music, speech, text, software code, and product designs.

Generative Adversarial Networks (GANs): are machine learning models that consist of two neural networks—the Generator and the Discriminator—working in opposition to each other. A generative adversarial network (GAN) [13] is a class of machine learning framework and a prominent framework for approaching generative AI [14] The concept was initially developed by Ian Goodfellow and his colleagues in June 2014 [15] In a GAN, two neural networks contest with each other in the form of a zero-sum game, where one agent's gain is another agent's loss.

4 Key terms used in Data and Analytics

As we know, in digital world data is represented in the form of binary '0' and '1'. As more and more digitalization has been creating more data through different web sources from social media, web sites to applications. Business wants to see insight of the data so, this can be leveraged for business growth. For getting value of the data, we must centralize or create mesh frameworks around the organization data. There are few key terms used in the Data and Analytics, we will briefly touch them:

Few below references taken from my research Paper [16]

Big Data: Large data with structure, un-structure form, it is generally defined with 5 v's such as velocity, volume, variety, value and veracity.

Integration: Integration refers to the process of linking different computing systems and software applications functionally or physically, to act as a coordinated whole. This facilitates the seamless flow of data between these systems, allowing them to work together and share information efficiently.

Extract, Transform, and Load (ETL): As the terminology implies, ETL is a systematic process that involves extracting data from one or more source systems, transforming it—this includes cleansing, formatting, and re-structuring the data to fit operational needs—and finally, loading the transformed data into a target system or data warehouse for further use and analysis.

Data Warehouse: A system that aggregates data from multiple sources into a centralized repository, facilitating comprehensive reporting and analysis.

Lakehouse: A data architecture paradigm that supports and unifies the storage of structured, unstructured, and semi-structured data, enabling diverse analytical and operational workloads in one platform.

Business intelligence Tools gives reports and Dashboard in visual form.

5 Methodology

5.1 Interact with organization data, assisting business partners and executive to make decision for organization growth:

In this approach, we utilize Delta Lake/Lakehouse for data consumption. Prominent Lakehouse technologies include Iceberg, Delta Lake, and Apache Hudi [17].

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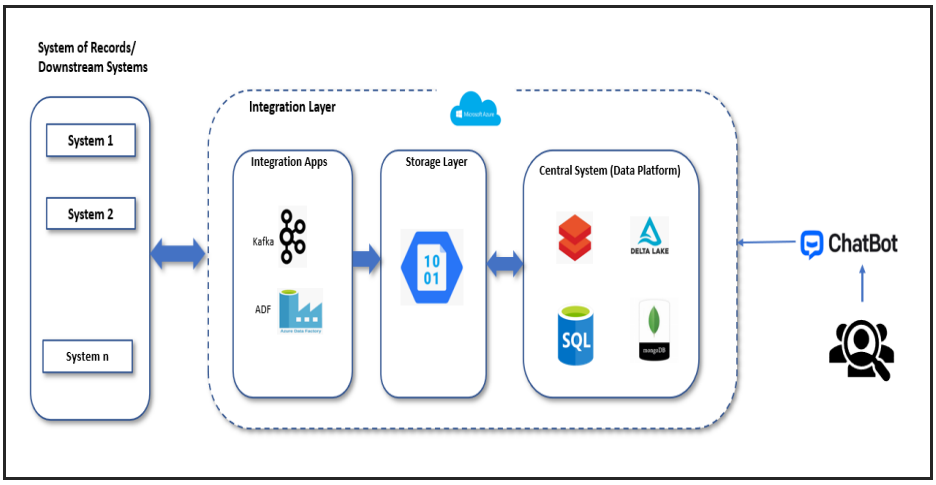


Fig. 2. Data Platform

For this methodology, we have been considering lake house is available for ChatBot development.

For this research paper, we collected the necessary data from Systems of Records, employing various design patterns, ranging from batch processing to near-real-time, within a parameterized framework. Initially, data is directed to a staging layer. Through ETL code or other frameworks, we persist this data into model tables. For reporting, we establish an aggregation layer which interfaces with various reporting tools, such as Power BI, MicroStrategy, and Tableau. This approach mirrors traditional data warehousing methods. By integrating AI technology, we can democratize data.

Leveraging, LLM models and provide them necessary information for Customer data Analysis including schemas such as tables metadata and writing better prompts.

Installation and development steps, given below using Azure Databricks.

```
%pip install accelerate>=0.12.0
```

```
%pip install transformers[torch]==4.25.1
```

```
import torch

from transformers import pipeline

# model name dolly-v2-3b
generate_text = pipeline(model="databricks/dolly-v2-3b", torch_dtype=torch.bfloat16, trust_remote_code=True, device_map='auto' )


gen_text = f"Give me top selling product from table '{table_name}'"
```

Individuals unfamiliar with technology or SQL queries can still comprehend the tables using a catalog. With simple English prompts, they can query the data to gain deeper insights.

Technology used: Databricks, Databricks Dolly [18], Spark, BLOB, Delta Lake, and PySpark

5.2 Data Analysis with AI: Integrating Pandas AI with prompt-based AI technology (openai) for Data Analysis

Purpose this method to show case the power of AI and it's benefit in Data and Analysis. This sample has taken to finally reach a conclusion for AI and ML benefits using data. Pandas AI [19]

"In this example, we have been using Pandas AI and Open AI API for English prompt."

Installation of pandas AI:

```
!pip install pandasai
```

SmartDataframe is a pandas (or polars) dataframe:

```
from pandasai import SmartDataframe
```

Importing pandas:

```
import pandas as pd
```

```
df = pd.DataFrame({
    "custID": [
        101,
        102,
        103,
        104,
        105,
        106,
        107,
        108,
        109,
        110,
    ],
    "purchaseAmount": [
        180,
        345,
        20,
        50,
        170,
        3290,
        16,
        149,
        438,
        14631,
    ],
    "Countrylocation": ["east", "north", "west", "south", "north", "west", "east", "south", "east", "north"],
})
```

Importing LLM (PandasAI is powered by an LLM):

```
from pandasai.llm import OpenAI

llm = OpenAI(api_token="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")
```

English prompt (Note: Trick will be sending right prompt for getting right Answer):

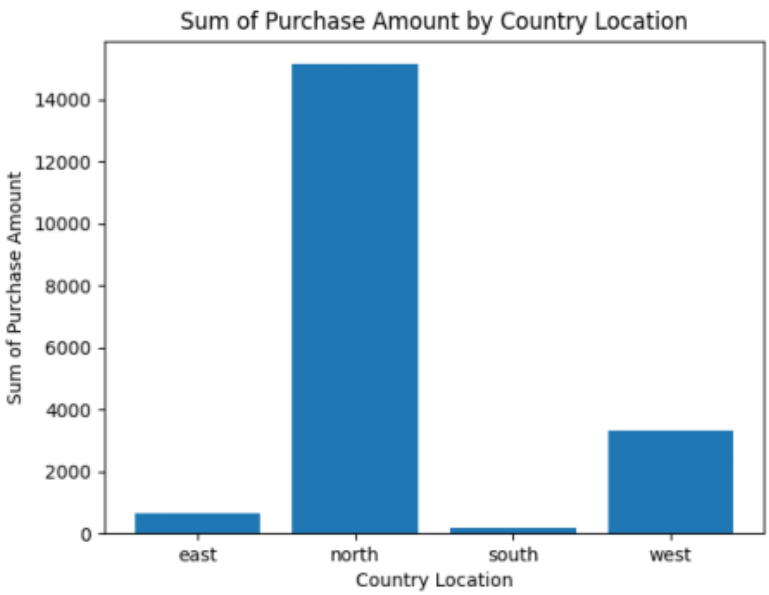
```
sdf.chat("Return the top 2 custID by purchaseAmount")
```

```
'The top 2 custID by purchaseAmount are: [110, 106]'
```

```
sdf.chat("What's the sum of the purchaseAmount based on of the Countrylocation?")
```

Countrylocation	purchaseAmount
east	634
north	15146
south	199
west	3310

```
sdf.chat("Plot a chart of the sum of the purchaseAmount by Countrylocation")
```



6 Case Study: The Integration of AI and ML in Facebook Marketplace:

Having personally engaged with Facebook Marketplace, we identified several features that markedly enhance user experience, primarily powered by AI and ML technologies:

Personalized Product Recommendations: Upon a user's search on the platform, the engine recommends similar products within a specified radius. For instance, if one searches for a sofa set, the system suggests comparable items within the set distance, this helps customer big time to compare products.

AI-Powered Chatbot Enhancements: To foster effective communication between buyers and sellers, Facebook has incorporated AI-driven chatbot functionalities. For instance, in a direct conversation, when a seller is queried, "Is the bicycle still available?", the AI system, known as 'M', can suggest potential replies such as "Yes," "No," or "I think so."

Advanced Product Indexing: Utilizing AI capabilities in text and image processing, the Marketplace ensures relevant product listings, thus streamlining the selling process.

Enhanced Search Functionality: Leveraging ML algorithms, the platform refines search outcomes based on numerous parameters, ensuring users swiftly and accurately locate their desired items.

Establishing a Safe and Trustworthy Community: AI plays a pivotal role in detecting and eliminating inappropriate content. Additionally, the platform offers features like buyer and seller ratings to foster trust and transparency.

Price Recommendations and Automatic Categorization: Facebook Marketplace employs AI to provide users with suggested price ranges for products, facilitating informed selling decisions.

7 Benefits of AI and ML in the Retail Sector

7.1 Voice E-commerce Leveraging Natural Language Processing (NLP):

With the rapid advancement of technology, the e-commerce landscape is continually evolving, and one of the notable strides in this domain is the integration of voice-enabled shopping experiences. Voice e-commerce empowers customers by allowing them to interact with online shopping platforms using vocal commands, making the shopping journey more intuitive and user-friendly.

This approach is especially groundbreaking as it transcends the traditional barriers of text-based interactions. Customers, regardless of their literacy levels or physical ability to type, can now articulate their needs and navigate through e-commerce platforms effortlessly. Moreover, with the integration of Natural Language Processing (NLP) technologies, these platforms can recognize and process voice commands in multiple languages, catering to a diverse and global audience.

NLP algorithms analyze the spoken language's nuances, enabling the system to understand context, intent, and sentiment. This ensures that voice-enabled searches are not only accurate but also contextually relevant. For example, a user saying "Order the best running shoes for marathons" would receive results tailored to high-performance marathon shoes rather than generic running shoes.

Furthermore, as voice-assistants like Amazon's Alexa, Google Assistant, and Apple's Siri become more ubiquitous in households, integrating voice e-commerce capabilities becomes increasingly significant for businesses aiming to stay competitive in a digital age.

By bridging the gap between natural human interaction and digital shopping experiences, voice e-commerce paves the way for a more inclusive, efficient, and innovative retail future.

7.2 Theft protection:

Today, one of the most significant challenges faced by retailers in developed countries is theft protection. While some countries lack stringent regulations to deter theft, advances in AI and image processing can help. Utilizing these technologies, retailers can monitor and detect theft activities, promptly alerting legal authorities to address such crimes.

7.3 Inventory Optimization:

The Smart Stockroom, Efficient inventory management can make or break a retail business. Generative AI steps in as the ultimate retail assistant, analyzing historical sales data and customer sentiment to fine-tune inventory levels. This will result in increase of revenue and happier customers. Brands are already using tools like Brand Health Insights (ecommerce) to monitor this across e-commerce platforms.

7.4 The Role of Smart Shelves

In the modern retail landscape, the seamless integration of technology into physical infrastructure is becoming increasingly paramount, with smart shelves emerging as a prime example. These shelves represent the next frontier in inventory management, offering a blend of sensor technology and real-time data analytics.

At their core, smart shelves are equipped with an array of sensors, often using Radio Frequency Identification (RFID) tags, weight sensors, and even computer vision. These sensors meticulously monitor inventory levels, identifying not only when a product is removed from the shelf but also tracking the quantity and rate of product turnover.

One significant advantage of this system is its ability to detect when product levels are dwindling, allowing for prompt restocking. By ensuring that products are consistently available, retailers can enhance the customer shopping experience, preventing the dissatisfaction and lost sales opportunities associated with out-of-stock situations.

Furthermore, smart shelves can be integrated with automated inventory management systems. When stock levels reach predefined thresholds, the system can automatically place orders for replenishment, minimizing manual oversight and maximizing efficiency.

But the advantages don't stop at mere inventory tracking. Advanced smart shelves, especially those leveraging computer vision, can analyze shopper behavior. They can provide insights into how consumers interact with products, the time spent considering a purchase, and even the sequence in which products are viewed. Such insights can guide retailers in optimizing product placement, pricing strategies, and promotional campaigns.

7.5 Elevating Email Campaigns:

Personalization Redefined, Forget generic emails. Generative AI crafts personalized email content based on a customer's preferences and recent online activities. Marketers no longer need to guess; AI does the heavy lifting, creating compelling email marketing campaign. (Content Development) that resonate with each recipient.

7.6 Tailored Product Suggestions:

Shopping, Perfected Generative AI takes product recommendations to the next level. It considers a customer's entire journey – past behavior, likes, dislikes, and browsing history – to curate a shopping experience like no other. Say goodbye to generic bestsellers; say hello to personalized perfection, where the recommendations are tailored (ecommerce) to their individual tastes and needs.

7.7 Innovating Product Design:

AI as the Creative Partner Designers, meet your new ally. Generative AI harnesses sales data and customer preferences to inspire fresh, innovative product ideas. This digital transformation (digital Transformation) speeds up the design process, ensuring your creations align precisely with customer desires.

7.8 Stunning Product Images:

A Picture Worth 250% More High-quality product images directly correlate with increased sales. Generative AI's image processing prowess is set to revolutionize this aspect of e-commerce. Expect high-resolution, visually enhanced product images (social media management) that captivate customers and boost sales.

7.9 Exclusive Deals Just for You:

AI-Powered Discounts Generative AI understands your preferences and shopping habits, enabling the creation of unique discounts (Social Media Management) and offers tailored specifically to you. Get ready for deals that align perfectly with your tastes.

7.10 Customer Grouping:

Targeted Strategies By analyzing shopping trends, generative AI helps identify and create new customer groups (Brand Management). This means brands can better understand and serve their customers based on individual shopping habits.

7.11 Emotional Insights:

The Power of Sentiment Analysis Mining customer reviews and social media posts reveals invaluable insights into product sentiment. Companies' adept in Online Reputation Management (ORM) (Social media Management) use this data to enhance customer satisfaction and tailor their offerings accordingly.

7.12 Crafting Compelling Descriptions:

SEO-Friendly and Organic E-commerce thrives on persuasive product descriptions. AI tools like GPT, LLaMa, and PaLM can turn basic product information into engaging, search-friendly content (Content Development). Sellers simply provide the AI with product details, and it generates captivating descriptions effortlessly.

8 Challenges and Limitations

8.1 Cyber Security & Data privacy:

When discussing cybersecurity, it's important to recognize it as a broader umbrella, with further details available in my research paper [link here]. Our primary focus here is on data privacy. Given the vast amounts of customer data we handle, it's imperative to establish the right guardrails to secure this information. Data is paramount; any breach can result in significant losses for a retail organization. Despite the advancements in AI and generative AI, there's still a need to refine workplace IT guidelines to safeguard our environments.

8.2 Costs surrounding Tools & Machines:

In the realm of Artificial Intelligence (AI) and Machine Learning (ML), the machinery and infrastructure underpinning these technologies play a crucial role in shaping advancements and breakthroughs. As these fields continue to evolve at an unprecedented pace, the importance of high-performance computing, especially machines equipped with Graphics Processing Units (GPUs), originally designed for rendering graphics, have proven to be exceptionally adept at handling the vast and complex computations required by deep learning models. Their parallel processing capabilities make them well-suited for the matrix operations commonly found in AI and ML algorithms, offering speedups that can be orders of magnitude faster than traditional Central Processing Units (CPUs). However, this computational prowess comes with a caveat: cost. High-end, GPU-equipped machines, particularly those tailored for research and large-scale AI operations, can be prohibitively expensive. It's worth noting that as technology progresses and demand rises, economies of scale and advancements in manufacturing might lead to reduced costs for GPU-enabled machines. Nevertheless, in the current landscape, the financial implications of accessing top-tier computational resources remain a significant consideration for stakeholders in the AI and ML domains. As the trajectory of the field is shaped by both technological innovations and economic factors, it is essential for researchers and industry professionals to remain cognizant of these dynamics.

8.3 The Imperative for Advanced AI Expertise:

As AI continues to evolve, its effective implementation necessitates a workforce equipped with specialized expertise. Currently, there is a notable skill gap in the domain. To address this, there is an imperative to invest in training and acquiring the requisite skill set for AI and ML implementation.

9 Conclusion

In the dynamic landscape of retail and e-commerce, the importance of staying ahead cannot be understated. With the rise of digital platforms and constantly evolving consumer behaviors, the industry requires tools that are not just reactive, but proactive in shaping the future. Enter AI & ML — a technology that has consistently proven its mettle as the linchpin of innovation and efficiency in the sector.

AI provides a transformative approach, enabling businesses to generate novel ideas, streamline operations, and personalize customer experiences in ways previously unimagined. From simulating designs and optimizing inventory to anticipating market trends and tailoring customer interactions, the applications are both vast and profound. By leveraging this technology, businesses can differentiate themselves, offering unique value propositions to their consumers.

Moreover, in an industry characterized by volatility, AI offers a semblance of predictability. It aids businesses in navigating uncertainties, responding to market shifts, and, crucially, pioneering changes rather than merely adapting to them. This proactive stance can be the difference between leading market trends and playing catch-up.

However, it is not enough to simply acknowledge AI's potential. Businesses must internalize its principles, investing in research, development, and implementation. Integrating AI into the core of business operations is not just about technological adoption but a cultural shift. It mandates a willingness to innovate, iterate, and take calculated risks, always with an eye toward the horizon of possibilities.

There are several challenges ranging from data privacy, ethical use, and costly GPU machines to finding skilled resources. To address these challenges, we must collaborate and research and get valuable solution for that.

In conclusion, the retail and e-commerce sectors are at a pivotal juncture. The choices businesses make today will shape the industry's trajectory for years to come. AI isn't merely a passing phase or a fleeting trend. It represents the convergence of technology and commerce, a beacon guiding the future of retail. By embracing and championing this revolution, businesses are not just preparing for the future; they are defining it.

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