International Journal of Trend in Research and Development, Volume 12(5), ISSN: 2394-9333
www.ijtrd.com

Machine Learning in Marketing

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Abstract: Machine learning is a subset of artificial intelligence that uses systems to analyze data, recognize patterns, and make decisions with little or no human involvement. It describes systems and software applications that are designed to "learn" based on analyzing data sets. It can help one build better data-driven digital marketing strategies by quickly analyzing relevant data sets and automating repetitive tasks. Machine learning in marketing tends to involve software programs and other technologies that allow marketers to quickly analyze and extract valuable insights from large data sets. It is a powerful technology that transforms how businesses connect with their audiences. In this paper, we explain how machine learning in marketing can prove useful.

Keywords: *Machine Learning, Artificial Intelligence, Deep Learning, Marketing, Digital Marketing, Advertising*

I. INTRODUCTION

Machine learning and artificial intelligence technologies have come a long way in the past few years. From self-driving cars that allow you to go hands-free to robo-advisors that make investments on your behalf, machine learning has applications that impact all types of industries. Machine learning is a subset of artificial intelligence that uses algorithms and statistical methods that enable computers to learn and improve without the need for explicit programming. It is a concept that can be applied to virtually every industry you can think of, from healthcare to retail to shipping logistics to marketing. It is based on the assumption that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it [1].

By using machine learning in marketing, you can build stronger campaigns, personalize your marketing materials, and save yourself time and energy in the process. Today, machine learning is commonly used in marketing for a variety of reasons that include segmentation, personalization, and churn prediction.

II. WHAT IS MACHINE LEARNING?

Machine learning is a subfield of artificial intelligence that uses algorithms trained on data sets to create models capable of performing tasks that would otherwise only be possible for humans, such as categorizing images, analyzing data, or predicting price fluctuations. It uses algorithms (essentially lists of rules) trained on data sets to create self-learning models capable of predicting outcomes and classifying information without human intervention. It focuses on algorithms that can "learn" the patterns of training data and, subsequently, make accurate inferences about new data. This pattern recognition ability enables machine learning models to make decisions or predictions without explicit, hard-coded instructions. To ensure such algorithms work effectively, however, they must typically be refined many times until they accumulate a comprehensive list of instructions that allow them to function correctly [2]. A symbol of machine learning is shown in Figure 1 [3].

Figure 1 A symbol of machine learning [3].

Generally speaking, a learning problem considers a set of samples of data and then tries to predict properties of unknown data. ML builds heavily on statistics because when we train a machine to learn, we have to give it a statistically significant random sample as training data. Intelligent machines are increasing doing incredible things: Facebook recognizes faces in photos, Siri understands voices, and Google translates websites [4].

Machine learning techniques are transforming many fields including computer science, engineering, mathematics, physics, neuroscience, and cognitive science. We are surrounded by ML-based technologies: search engines learn how to bring us the best results, digital cameras learn to detect faces, credit card transactions are secured by a software that detects frauds, and cars are equipped with accident prevention systems that are built using ML algorithms [5]. In ML, data plays an indispensable role, and the learning algorithm is used to learn from the data. ML algorithms are now easy to use. One can download packages in Python. Programming languages used in ML include C++, Java, Python.

As its name indicates, machine learning works by creating computer-based statistical models that are refined for a given purpose by evaluating training data, rather than by the classical approach where programmers develop a static algorithm that attempts to solve a problem. Because the algorithm adjusts as it evaluates training data, the process of exposure and calculation around new data trains the algorithm to become better at what it does. Algorithms are the computational part of a machine learning project. Once trained, algorithms produce models with a statistical probability of answering a question or achieving a goal. Unlike in expert systems, the logic by which a machine learning model operates is not explicitly programmed; it is learned through experience. Machine learning has come to

dominate the field of AI: it provides the backbone of most modern AI systems, from forecasting models to autonomous vehicles to large language models (LLMs) and other generative AI tools. Machine learning has become a household term in recent years as the concept moved from science fiction to a key driver of how businesses and organizations process information [6].

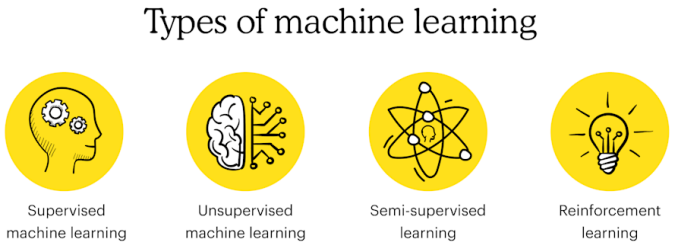

Figure 2 Different types of machine learning [7].

As shown in Figure 2 [7], there are different types of machine learning. The four major types of machine learning are supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning, each suited to different kinds of data and outcomes. Different types of machine learning include the following [8]:

A. Supervised Learning: The program is "trained" on a pre-defined set of "training examples" from a "teacher," which then facilitate its ability to reach an accurate conclusion when given new data. In this case, the data comes with additional attributes that we want to predict. A common case of supervised learning is to use historical data to predict statistically likely future events. Under supervised ML, we have regression ML and classification ML.

B. Unsupervised Learning: As their name suggests, unsupervised learning algorithms can be broadly understood as somewhat "optimizing themselves." Unsupervised algorithms do not need to be trained with desired outcome data. The program is given a bunch of data and must find patterns and relationships therein. A typical goal of unsupervised learning may be as straightforward as discovering hidden patterns within a dataset. Without being told a "correct" answer, unsupervised learning methods can look at complex data and organize it in potentially meaningful ways.

C. Reinforcement Learning: Reinforcement learning models are trained holistically through trial and error. Reinforcement learning is a method with reward values attached to the different steps that the algorithm must go through. So, the model's goal is to accumulate as many reward points as possible and eventually reach an end goal. Reinforcement learning is an area of machine learning concerned with how software agents ought to take actions in an environment so as to maximize some notion of cumulative reward.

D. Deep Learning: Deep learning (DL) is a specialized form of machine learning that uses artificial neural networks to mimic the human brain. It is a type of machine learning technique that is modeled on the human brain. It is an advanced technique for handling complex tasks like image and speech recognition. The way in which neural networks are trained can be described as deep learning. It is called deep because the network of neurons is arranged in several hierarchical levels. Deep learning laid the foundation for advances in generative artificial intelligence.

III. MACHINE LEARNING IN MARKETING

In recent years, machine learning (ML) and artificial intelligence (AI) have attracted considerable attention in different industry sectors, including marketing. Artificial intelligence and machine learning are on the verge of transforming the marketing sector.. Artificial intelligence is the broader concept and it refers to any system or machine that mimics human intelligence. This may include reasoning, problem-solving, language understanding, or learning from experience. Figure 3 shows a representation of AI [9]. Machine learning is a branch of artificial intelligence that trains systems to learn from data and improve over time, without manual programming. From predicting behavior to personalizing outreach, machine learning in marketing is already transforming how teams work and grow. Figure 4 shows a representation of machine learning [10].

Figure 3 A representation of AI [9].

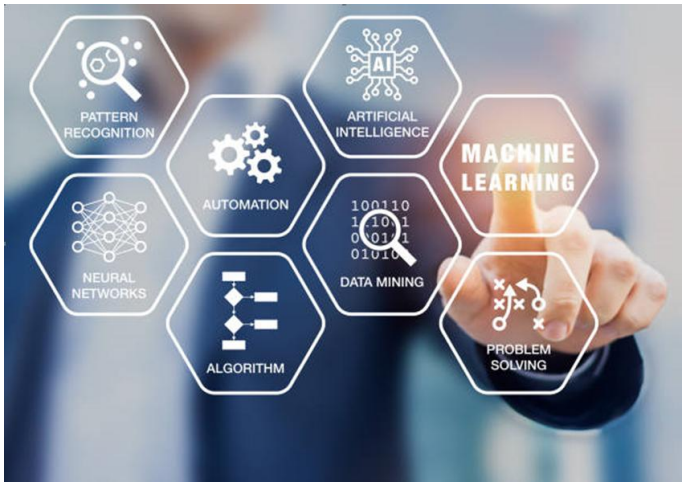

Figure 4: A representation of machine learning [10].

Machine learning (ML) in marketing involves using algorithms to analyze vast amounts of data to automate tasks, personalize customer experiences, and predict future behaviors to optimize campaigns. Instead of writing rules to tell software exactly what to do, teams train algorithms to recognize patterns, make predictions, and adjust based on new input. This approach allows for more data-driven, efficient, and effective marketing strategies, moving from reactive to proactive campaign management. The adoption of machine learning in marketing enables businesses to optimize content and ad campaigns, automate communications with clients across key touchpoints, and provide personalized customer experiences for maximum engagement and conversions.

IV. APPLICATIONS OF MACHINE LEARNING IN MARKETING

Key applications of machine learning in manufacturing include customer segmentation, personalized product recommendations, predictive analytics, and automated ad targeting and optimization. Machine learning has valuable use cases in marketing when it comes to personalization, segmentation, predictive analytics, sales forecasting, and dynamic pricing, to name a few. Common applications of ML in marketing are explained as follows [11,12]:

A. Customer Segmentation: Old-school segmentation usually stops at basics like age, location, or past purchases. Machine learning does not just stop there. ML models analyze customer data (like browsing history, purchase history, and demographics) to identify patterns and create distinct groups with similar characteristics, allowing for more targeted messaging. Advanced marketing software typically uses machine learning algorithms to cluster customers into multiple segments based on shared characteristics, such as demographic (age, gender, etc.), psychographic (lifestyle, interests, etc.), geographic (country, region, etc.) and behavioral (purchase patterns, social media interactions, browsing history, etc.) data. After segmentation, the company can target each customer with personalized marketing messages promoting the service. Figure 5 shows different types of customer segmentation [10].

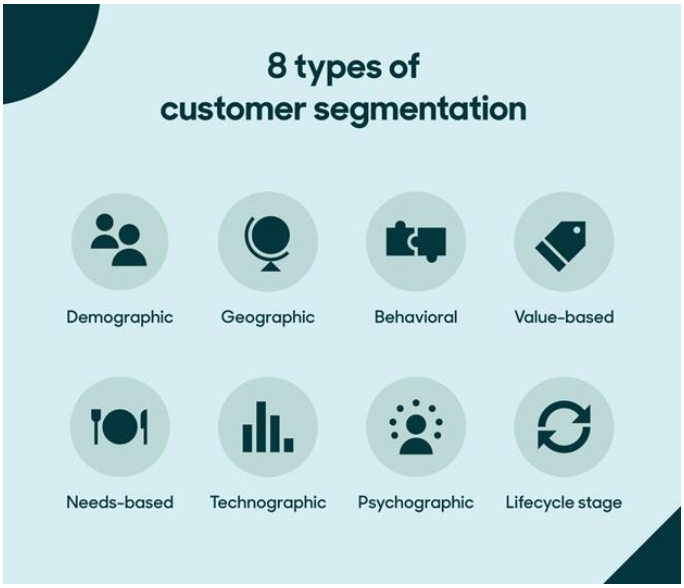

Figure 5 Different types of customer segmentation [10].

B. Marketing Automation: This concept refers to a set of tools and technologies, including machine learning, deployed to help marketing departments streamline customer interactions and manage time-consuming tasks. Marketers can use conversational AI solutions to gather personal information and customer feedback from website visitors and proactively engage them with automated and personalized messages (offers, product recommendations, reminders, etc.). Machine learning software can also help automate many different processes, streamlining certain marketing tasks and saving marketers precious time and energy.

***C. Marketing Analytics*:** The advanced data analysis capabilities unlocked by machine learning prove extremely useful when it comes to tracking the performance of email marketing campaigns or other initiatives. ML systems can analyze the role of different marketing channels (websites, social media, etc.), touchpoints (ads, blog posts, etc.), and advertising services (Google Ads, Meta Ads, etc.) throughout the customer journey, helping prioritize the most impactful ones for optimal marketing budget allocation.

D. Predictive Analytics: Machine learning models can be trained on historical data and then used to predict future performance or changes for which a company should prepare accordingly. By learning from historical data, ML can predict future customer actions, such as churn (customer attrition), demand changes, and conversion rates. This allows marketers to act proactively to retain customers or capitalize on new opportunities. Machine learning has long found its way into customer analytics, thanks to the ability of ML algorithms to predict future business outcomes based on historical data (clients' past interaction, purchasing habits, etc.). A popular application of ML in predictive analytics for marketing is churn prediction, which involves identifying customers at risk of ceasing to use your products or services to target them with tailored retention initiatives, such as personalized offers and coupons. Through predictive analysis, you can combine big data, statistical algorithms, and machine learning technology to highlight the probability of future outcomes based on historical activity.

E. Digital Marketing: Digital marketing is the catch-all term for every aspect of online marketing. It includes content marketing, video marketing, email marketing, and search engine marketing (SEM), among other formats. Machine learning in digital marketing is poised to revolutionize the industry, making everything from digital ad campaigns to content to personalized recommendations easier to create and manage. Digital marketers now have a tool that can predict how a consumer is going to behave. By feeding vast datasets into a computer, machine learning algorithms can analyze past decisions to provide an accurate prediction of the action a customer will take next.

F. Digital Advertising: Advertisers always look forward to better applications of current technologies. That is the case with machine learning as much as any other: better chatbots, voice recognition, image processing, etc. Machine learning is a powerful tool for digital marketing that uses data analysis to predict consumer behavior and improve marketing campaigns. ML in advertising refers to the process by which ad technology takes in data, analyzes it, and formulates conclusions to improve a task. It could be anything related to advertising: media buying, customer journey mapping, audience segmentation, etc. The more data a machine learning technology processes, the more it learns about that task, and the better it gets at completing it. Advertisers are only beginning to scratch the surface of AI's potential.

G. Email Marketing: Email marketing is a powerful tool for digital marketers, and machine learning can be used to create personalized email campaigns based on customer behavior. Machine learning can help you understand how well your marketing campaigns are working, look for areas of improvement, and reach out to your audience in new ways. Email continues to be one of the most powerful channels for engagement—and machine learning helps marketers make it smarter. By analyzing user behavior, it can recommend send times, tailor content, and adapt frequency based on each recipient's likelihood to open or convert. You can turn transactional emails into more relevant, results-driven experiences. For example, browsing history can inform the content you share or the schedule you establish for sending emails.

H. Social Media Marketing: Machine learning can analyze social media data to identify patterns and insights

that can help create more effective social media advertising campaigns. It is a powerful tool for optimizing social media advertising campaigns. You can use machine learning to analyze how your audience responds to your social media campaigns. Doing so can help you post more of what people like to see and want to engage with and less of the content that people are not interested in. Social media advertising is an effective way to reach a large audience. Machine learning algorithms can be used to analyze social media data to identify patterns and insights that can be used to create more effective social media advertising campaigns. Figure 6 shows different kinds of social media [10].

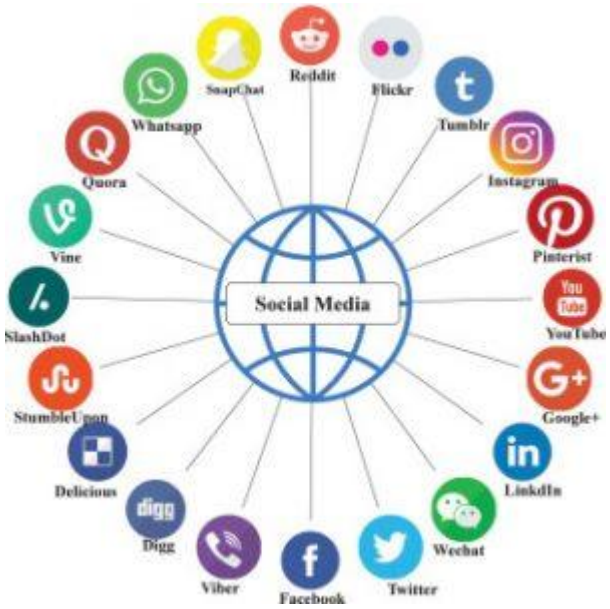

Figure 6 Different kinds of social media [10].

I. Content Creation: Computers creating content on their own would have been a pipe dream a few decades ago, but today we are at the vanguard of this vision becoming a reality. Machine learning can also help generate content – this could be personalized emails, product descriptions or social media posts. Computers creating content on their own would have been a pipe dream a few decades ago, but today we are at the vanguard of this vision becoming a reality. Although AI is not completely capable of writing opinion or editorial pieces yet, significant progress has been made to enable writing data-centered content. AI-driven content creation tools have been successful in creating news stories, and industry reports, such as financial and sports reports, that sound coherent and cohesive. An understanding of a page's content can help advertiser and publisher serve more relevant advertising.

***J. Search Engine Optimization*:**

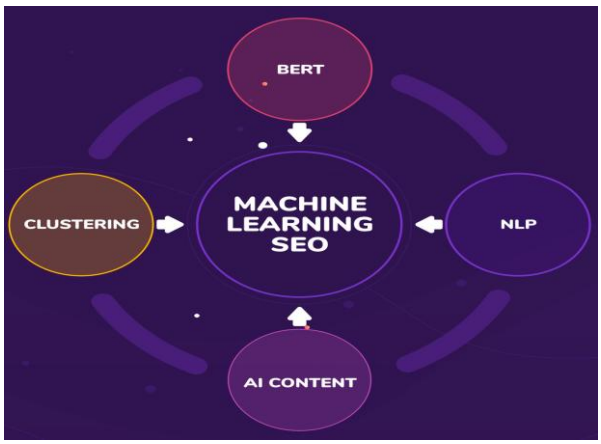

Figure 7 Machine learning SEO [10].

Search engine optimization (SEO) is a critical component of digital marketing. Machine learning algorithms can analyze website data and identify factors contributing to higher search engine rankings. This can be done by analyzing data from various sources, such as website analytics and search engine rankings. Figure 7 shows machine learning SEO [10].

V. BENEFITS

Marketing has always been about establishing meaningful connections with customers. To make effective marketing decisions, corporations need to apply new data-oriented methods to process and analyze these data. The goal of developing ML learning algorithms is to gain valuable business insights. The real value of machine learning lies in its algorithms: the programs that help mere mortals to solve complex problems in a more efficient manner, thus reducing your reliance on third-party applications. Other benefits of using ML in marketing include the following [13]:

- *Automation*: Using machine learning techniques, marketers can automate tedious and repetitive tasks to free up resources and use the potential of employees for those tasks that require creativity and out-of-the-box thinking, something that artificial intelligence cannot handle. Machine learning takes care of repetitive tasks so teams can focus on creative strategy, not constant tweaking. Machine learning cuts through complexity. It helps turn raw data into usable insights, automate repetitive decisions, and act while the window of opportunity is still open.
- *Increased Efficiency*: Marketing professionals use machine learning to increase the efficiency with which they can work with the enormous amounts of data they are privy to. Applications using AI and ML have been spreading from consumers to business marketing, thereby boosting productivity. They enable automating time-consuming tasks like send-time optimization or A/B testing, so your team can focus on strategy. For example, a poorly set up advertising campaign can burn through the advertising budget very quickly and fail to deliver the expected results. Machine learning can help optimize it by analyzing data on the effectiveness of individual advertising channels, the advertising content used or the target groups.
- *Enhanced Customer Experience:* Machine learning delivers personalized content and recommendations, leading to greater engagement and satisfaction. While banking on technology to effectively interact with other humans can sound counterintuitive, machine learning is revolutionizing the delivery of engaging customer experiences at scale. Machine learning allows companies to generate more accurate consumer profiles, deliver personalized offerings at scale, and therefore increase customer satisfaction and loyalty.
- *Audience Segmentation:* Traditional segmentation criteria are restricted to demographic, firmographic, psychographic, and geographic characteristics. AI-driven segmentation allows marketers to segment their audience on a more granular level. Every advertiser's goal is peak relevance. And the way to relevance is segmentation. The narrower your audience segments become, the closer you get to delivering the 1:1 personalization that customers crave.

- *Personalization:* Personalization has become a core aspect of marketing, and AI is the core facilitator of personalization. It enables you can connect with your visitors and customers directly through your website, apps, emails, and other digital properties. The foundation of personalization lies in accurate audience segmentation. In the age of hyper-personalization, customers expect more from brands. AI enhances the marketing efforts throughout the buyer's journey right from content curation to customer service. Each audience should have an ad personalized based on its data
- *Conversational AI:* The rapid adoption of chatbots and digital assistants in the past couple of years has helped conversational AI gain prominence. In marketing, AI might power chatbots. Chatbots are a huge boon when it comes to delivering top-notch customer service. As chatbots have access to the customer's history, they can help customers more than human agents. Along with customer support, chatbots are also now empowered to deliver content to the user's choice of messenger app, help customers complete the booking process or complete the payment process. Chatbots are becoming increasingly popular in digital marketing, and machine learning can be used to create intelligent chatbots that can provide customers with personalized recommendations and assistance. Their round-the-clock availability allows customer care personnel to focus on more complicated concerns.
- *Better Decision-making:* Marketing today is less guesswork, more brainpower. With the growth of data analytics and machine learning technologies, businesses can now make informed decisions that were previously impossible. Machine learning is a specific approach that trains systems to learn from data analysis, spot patterns, and make decisions without being explicitly programmed. It gives marketers faster, sharper ways to understand and respond to what customers need. When you apply machine learning to your marketing strategy, you shift from being reactive to proactive. You start making decisions based on what customers are likely to do next, not just what they did last. Machine learning marketing comes pretty close to being a crystal ball that could predict which customers will most likely buy your products, what content they will engage with, and the perfect time to send them an offer.
- *Fraud Detection:* Fraud detection is an essential application of machine learning in digital marketing. By analyzing data patterns and user behavior, machine learning algorithms can identify and prevent fraudulent activities like click and payment fraud. Machine learning algorithms can identify patterns and any anomalies in user behavior to identify fraudulent activities. This helps maintain the integrity of ongoing marketing campaigns and effectively manage advertising budgets.

VI. CHALLENGES

The main challenges of machine learning in marketing include data quality and bias, privacy and ethical concerns, technical difficulties like data integration and scalability, and the need for specialized talent and resources. Lack of tools, missing data, too much data, and siloed systems are all keeping businesses from getting the most out of their audience. At the root of all these challenges is a simple but major problem: Humans cannot do it all anymore. One of the most significant risks for marketers is the fact that trial and error are part of all marketing campaigns, resulting in marketing waste. Other challenges include the following [14]:

- *Privacy Concerns:* Collecting and using customer data raises major privacy concerns. There are those marketers who simply choose not to use Google due to privacy concerns, inclinations towards other channels, or mere personal preference. And with the advent of machine learning, Google, Facebook, even Amazon, are no longer the only data-rich weapons in the digital marketer's arsenal.
- *Data Quality:* Machine learning models require vast amounts of high-quality, accurate, and clean data for effective training. Gathering, organizing, and cleansing this data is a significant hurdle. Therefore, it could be a challenge to ensure that data from and easily accessible for analysis different sources, including sales management, marketing automation, and social media solutions, is accurate.
- *Data Bias:* If the training data is biased, the model's outputs will be biased, leading to unfair or inaccurate marketing decisions and reinforcing existing inequalities.
- *Shortage of Expertise*: Leveraging machine learning for marketing purposes requires skilled ML and data science professionals. However, not all companies have such expertise in-house. There is a shortage of experienced professionals who understand both machine learning and marketing, making it difficult to find and retain the necessary talent. Education requirements for experts in AI/ML includes bachelor's degree in areas such as computer science or business administration and technical skills in artificial intelligence. To begin a machine learning and marketing career, you must have a solid foundation in maths and computer science.
- *Security:* Marketing solutions, especially those powered by a data-driven technology like ML, typically store and analyze a large amount of personal information. This makes them ideal targets for cyber attacks and can raise concerns among policymakers and customers.
- *Integration:* Integrating new machine learning tools and systems with existing marketing platforms can be difficult and requires collaboration between marketers and data scientists.
- *Scalability*: Scalability is increasingly important for marketers because many of these algorithms need to run in real time. Implementing and maintaining machine learning solutions can be difficult to scale to meet the demands of growing data volumes and business needs.
- *Model Complexity*: Some models can be like "black boxes," making it hard to understand and explain the reasoning behind their outputs, which can be a problem for marketers and for debugging.
- *Cost:* mplementing and developing machine learning solutions requires significant investment in technology, infrastructure, and personnel, which can be a barrier for some companies.
- *Over-reliance:* There is a risk of becoming overly reliant on automated systems, potentially leading to a

lack of creativity or a failure to address every business problem effectively.

VII. FUTURE OF MACHINE LEARNING IN MARKETING

Machine learning (ML) is a field of artificial intelligence that deals with the development of advanced algorithms and statistical models that enable computers to learn from data. It is one of the most rapidly growing areas of AI. Its versatile applications span various walks of life and industries, including marketing and advertising. Combining machine learning with marketing strategies is revolutionizing how businesses are addressing their customers' needs. By analyzing past interactions and predicting future behavior, these systems ensure that customers receive relevant product suggestions and content [15].

In many ways, business owners are already using AI and machine learning in digital marketing and will undoubtedly use them in digital marketing strategies in the future. Looking ahead, the development of autonomous marketing systems is on the horizon. By continuously learning and adapting to new data, autonomous systems promise to optimize marketing efforts, improve efficiency, and deliver consistent results across various channels. The future of marketing lies in the seamless integration of AI technologies, enabling businesses to create more responsive, personalized, and effective marketing strategies. Future personalization will move beyond "customers like you" to truly individual experiences. Machine learning will create dynamic content that adjusts in real time based on user behavior, context, and emotional state. It will help make sense of this expanded data landscape and enable marketing that responds to real-world contexts.

CONCLUSION

Machine learning refers to a type of artificial intelligence where systems learn from data, identify patterns, and make decisions with minimal human intervention. ML in business and industry marketing is on the rise. The possibilities for ML in marketing in the future are continuously increasing. The adoption of machine learning in marketing enables businesses to optimize content and ad campaigns, automate communications with clients across key touchpoints, and provide personalized customer experiences for maximum engagement and conversions. For marketers, machine learning can unlock more responsive, adaptive campaigns. It helps teams shift from rigid, rule-based workflows to systems that evolve alongside customer behavior.

Machine learning gives your marketing strategy more precision, more speed and more room to grow. Instead of reacting to what already happened, you can anticipate what is coming and build campaigns that meet customers right where they are. Whether you are segmenting users, recommending content, or adjusting message timing, machine learning adapts to each customer [16]. More information on machine learning in marketing is available in the books in [17-22] and a related journal: *Journal of Business Research*.

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