

The Role of Artificial Intelligence in Targeted Advertising and Analysis of Consumer Behavior

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Annotation: Artificial intelligence (AI) plays a key role in the transformation of targeted advertising and consumer behavior analysis. The use of machine learning algorithms and big data allows marketers to gain a deeper understanding of customer preferences and behavior, which leads to the development of more effective marketing strategies. AI technologies such as image recognition, natural language processing, and sentiment analysis contribute to the creation of personalized content and services that enhance customer engagement and loyalty. Despite the significant advantages, the introduction of AI into marketing faces challenges related to prejudice and ethical issues. Thus, companies should focus on neutralizing these biases in order to fully realize the potential of AI in shaping consumer preferences and increasing competitiveness.

Keywords: artificial intelligence, AI, targeted advertising, consumer behavior analysis, consumers, advertising.

Introduction

The integration of artificial intelligence (AI) in targeted advertising and consumer behavior analysis has emerged as a transformative force, enhancing the efficiency and personalization of marketing strategies. The adoption of AI in marketing disciplines is reshaping how businesses engage with consumers, optimize ad placements, and harness data for deeper insights into consumer preferences [1].

In 2024, the application of AI in marketing is not just about automation but also about advancing capabilities in personalization and predictive analytics, significantly outperforming traditional methods. For instance, AI's role in digital advertising involves complex algorithms that analyze consumer data to facilitate real-time bidding and ad placement, maximizing the relevance and impact of ads shown to individual users [7]. The ability of AI to refine these processes continually through learning algorithms enables advertisements to be more targeted and effective, leading to higher conversion rates and enhanced consumer satisfaction.

Statistically, the effectiveness of AI in marketing is evident across various metrics and studies. For instance, targeted mobile ads in the U.S. have led to significant spending, with \$164.8 billion allocated in 2023, highlighting the critical role of mobile platforms in modern advertising strategies [7]. Moreover, AI-driven campaigns are capturing a growing share of marketing budgets, with 19.2% of marketers allocating more than 40% of their budgets to such initiatives, reflecting a strong belief in AI's potential to outperform human capabilities in certain tasks [8].

AI-Driven Campaign Budget Spending

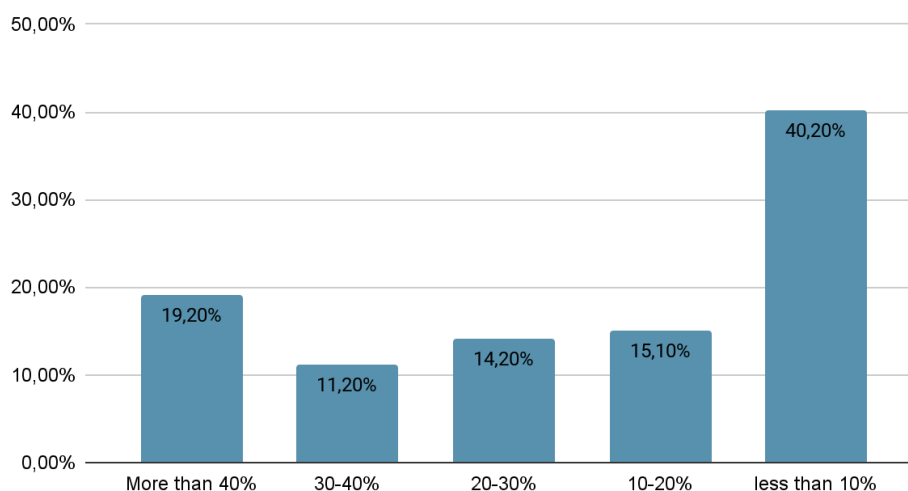


Figure 1 – AI-Driven Campaign Budget Spending

Additionally, the impact of AI on consumer behavior is profound. With AI, companies can analyze vast datasets to identify patterns and trends that human analysts might overlook. This capability allows for more effective segmentation and targeting, leading to more personalized consumer interactions. AI applications in email marketing, for example, have demonstrated high effectiveness, with 76% of consumers influenced by email ads to make purchasing decisions, significantly higher than other advertising formats like pop-ups or banners [7].

The strategic implications of AI in marketing also extend to its potential to disrupt traditional roles and functions. While AI automates many operational tasks, strategic, creative, and high-level decision-making processes are still predominantly the domain of human marketers. This delineation suggests a collaborative future where AI handles data-driven tasks and humans focus on areas requiring emotional intelligence and creative input [8].

Literature Review

Artificial intelligence (AI) encompasses a plethora of sophisticated technologies, including image and voice recognition, decision-making algorithms, and natural language processing. Contissa and colleagues postulate that AI is proficient in executing the "three Ds": detection, determination, and development. Detection pertains to AI's capability to discern and identify salient characteristics of various objects. This includes recognizing predominant features and determining attributes that should be eschewed. Determination refers to AI's proficiency in selecting the optimal course of action from a multitude of variables, thereby enabling precise decision-making. Development encompasses the AI's capacity to assimilate novel information, adapt to it, and evolve based on comprehensive data analysis and empirical research.

AI solutions leverage vast datasets to emulate human-like tasks, thereby amplifying the probability of successful outcomes. A fundamental element of AI is big data, which elucidates the methodologies and paradigms organizations employ to scrutinize the voluminous data they accumulate. Structured data, exemplified by demographic statistics and transaction logs, can be systematically organized into spreadsheets and subjected to real-time analysis. Conversely, unstructured data, which is inherently more intricate and cannot be encapsulated in traditional spreadsheet formats, is also adeptly managed by AI systems.

The taxonomy of AI is stratified into three distinct levels: Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Super intelligence (ASI). ANI encompasses specific tasks such as image recognition and predictive analytics, performing at a level commensurate with human abilities. An illustrative example is Zalando's recommendation system, which suggests new products based on customers' purchasing history. AGI transcends human intelligence across a broad spectrum of domains, including advanced language processing and sophisticated intelligent systems. ASI, which remains a theoretical construct, is envisaged to surpass human intelligence comprehensively, potentially engendering unpredictable ramifications.

Kreutzer and Sirrenberg delineate five pivotal domains of AI, some of which are instrumental in the marketing sphere: speech, image, and text recognition, alongside decision-making processes. Autonomous robots and vehicular systems are predominantly deployed within industrial contexts. Speech recognition, underpinned by neural networks, is revolutionizing consumer-business interactions. Amazon Alexa epitomizes this transformation by enabling users to procure products via voice commands. Image recognition technology assists marketers in decoding consumer behavior through the analysis of social media imagery. Interactive AI systems, such as Alpine AI, enhance the shopping experience in retail environments, while decision systems like Albert AI and Harley Davidson's analytical tools optimize marketing campaigns through the meticulous analysis of advertising data.

Contemporary AI-powered tools empower marketers to aggregate and scrutinize vast quantities of data pertaining to consumer behavior, product predilections, and purchasing patterns. This data is transmuted into actionable insights that facilitate the formulation of efficacious marketing strategies. For instance, the K-means clustering algorithm, an unsupervised machine learning technique, categorizes data into clusters based on attributes such as customer age, expenditure, and income, thereby enabling nuanced market segmentation and targeted strategy development [2].

1. Impact of Artificial Intelligence

Artificial Intelligence (AI)-based marketing is continuously gaining momentum in the global economy, driven by the advancement of sophisticated products, hyper-personalized services, and the strategic manipulation of consumer demand via cutting-edge AI technologies. AI algorithms employ advanced clustering methodologies such as k-means clustering, hierarchical clustering, and Gaussian mixture models (GMM) to distill and extrapolate critical insights from extensive social listening datasets, which can encompass millions of data points in real time. These algorithms are adept at filtering through informational noise, enabling a profound

comprehension of customer sentiment through granular social media sentiment analysis. This capability allows businesses to anticipate customer behaviors and implement strategic initiatives to achieve precise outcomes.

Machine learning, a fundamental subset of artificial intelligence, is ubiquitously utilized in marketing. It leverages complex algorithms, including support vector machines (SVM), decision trees, random forests, and gradient boosting machines (GBM), to discern patterns and enhance outcomes based on new datasets (fig.2). The deployment of pre-trained machine learning models confers a substantial competitive advantage to enterprises of various scales, as these models are more cost-efficient and exhibit higher reliability compared to human analysts.

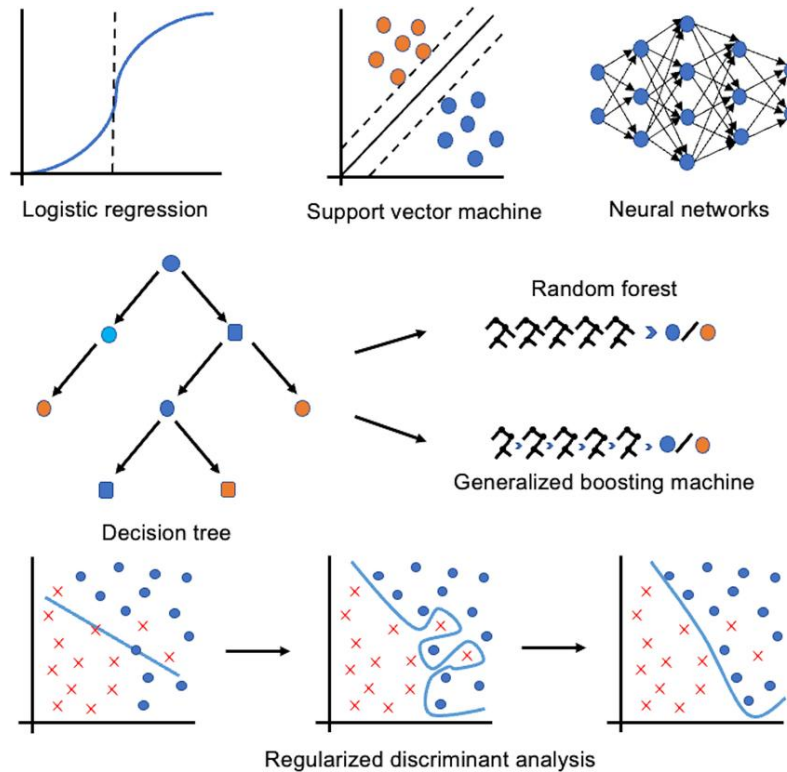


Figure 2. Machine learning algorithms

In contrast, deep learning utilizes artificial neural networks that emulate the structure and functionality of the human brain to process and analyze voluminous data. Technological breakthroughs, particularly in graphics processing units (GPUs) and tensor processing units (TPUs) (fig.3), have significantly democratized access to deep learning. These advancements enhance retail planning and resource allocation by correlating analytic results with brand performance metrics. For instance, deep learning techniques such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs) can be harnessed to devise highly personalized marketing strategies tailored to individual consumer profiles through sophisticated feature extraction and time-series analysis (fig.4).

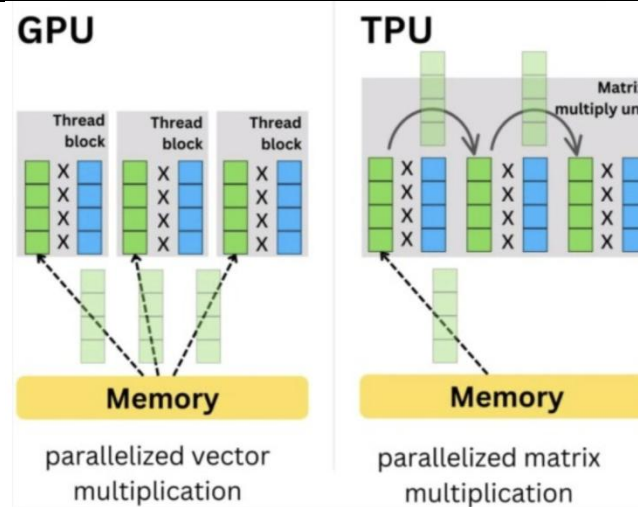
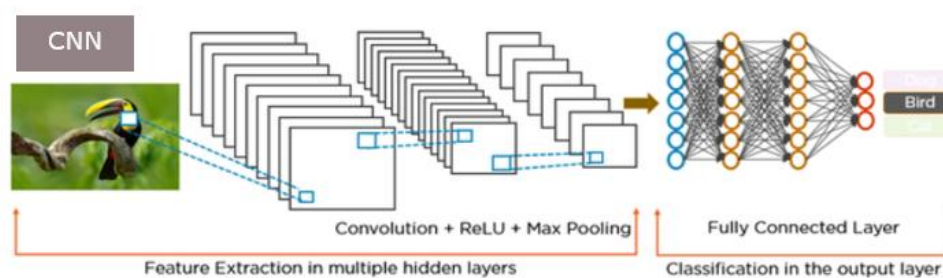


Figure 3. GPU and TPU

Convolutional Neural Network



Recurrent Neural Network

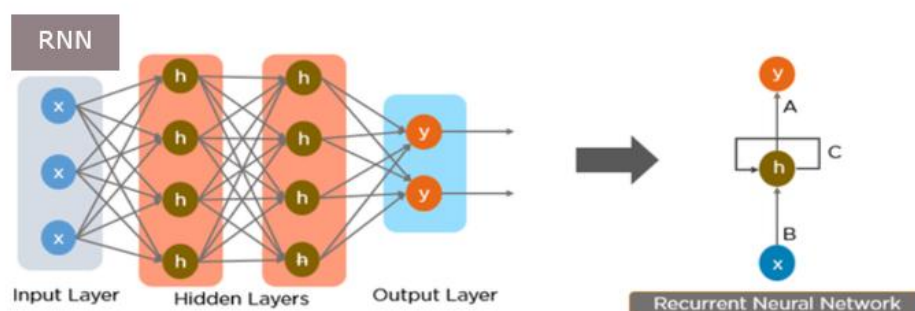


Figure 4. Deep learning techniques CNN and RNN

Advanced social media management tools, such as Sprout, deploy AI to analyze Voice of the Customer (VoC) data within social posts and reviews, identifying the most engaging content for target audiences. The Atlanta Hawks, for example, leverage Sprout's advanced tagging and sentiment analysis capabilities to optimize their marketing strategies. AI-powered platforms further identify critical keywords and triggers that facilitate the creation of engaging content, optimize responses to customer comments, and enhance product descriptions on digital platforms. This strategic application bolsters marketing efficacy, augments market share, and drives revenue growth through mechanisms such as natural language processing (NLP), sentiment analysis, and named entity recognition (NER).

AI-generated insights can significantly elevate the success of marketing campaigns. These insights assist in crafting persuasive communications, thereby fortifying relationships with potential customers at every stage of the sales funnel. AI recommendations can enhance email subject lines to boost open rates, generate personalized content for distinct audience segments, foster intent-driven interactions, and enable individualized

engagement with potential customers, thereby strengthening loyalty and driving sales. Techniques such as predictive analytics, collaborative filtering, and customer segmentation algorithms are instrumental in this regard.

Intelligent automation, powered by AI, empowers social media managers and customer service teams to enhance operational efficiency through lexical and statistical triggers that underpin intelligent workflows. This technological intervention streamlines the execution of tasks, such as optimal post scheduling and incoming message categorization, obviating the need for heuristic approaches. It ensures a cohesive brand voice in customer communications and reduces response times through rule-based features like suggested replies. Carvel Ice Cream exemplifies this application by utilizing AI-driven solutions to improve response times on Twitter (Fig.5).

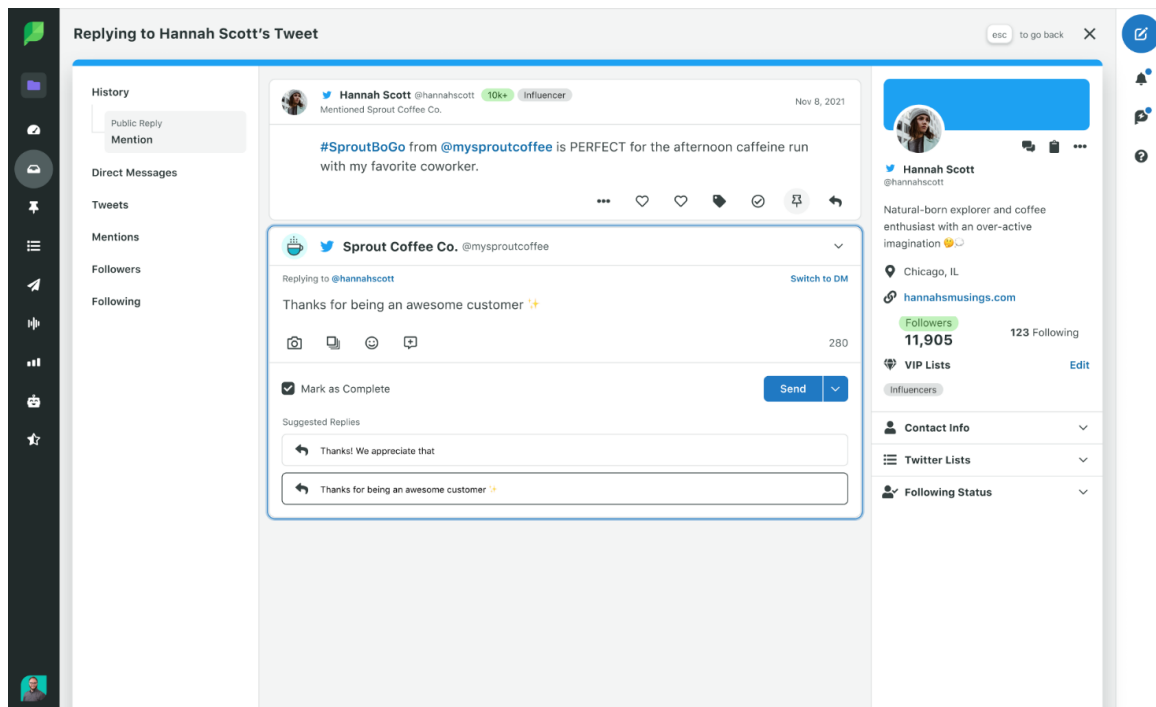


Figure 5. An example of a feature to improve response time on Twitter [3].

AI and machine learning furnish pivotal customer insights that underpin strategic marketing decisions. These technologies provide profound insights into audience sentiment towards a brand, conduct comprehensive performance audits of customer support teams, and analyze social media engagement metrics. This data enables rapid adaptation to evolving market trends, judicious budget allocation, and the deepening of customer relationships. Techniques such as hierarchical clustering, K-means clustering, and principal component analysis (PCA) are often utilized to derive actionable insights from complex datasets. Additionally, Bayesian networks and Markov decision processes (MDPs) offer robust frameworks for modeling probabilistic dependencies and decision-making under uncertainty.

In the contemporary social media milieu, brands are increasingly susceptible to scrutiny and criticism. However, AI-enabled brand reputation management can preempt potential threats before they escalate into significant issues. AI-based marketing tools offer real-time monitoring of negative sentiment, facilitate the selection of appropriate influencers, and provide proactive customer support, thereby safeguarding brand integrity. Tools leveraging deep reinforcement learning, anomaly detection algorithms, and generative adversarial networks (GANs) are particularly effective in this regard.

By harnessing the full potential of advanced AI and machine learning technologies, businesses can not only enhance their marketing efficacy but also fortify their market position in an increasingly competitive landscape, ensuring sustained growth and resilience in a dynamic market environment.

2. Artificial intelligence technologies in marketing (table)

Modern social marketing platforms such as Sprout combine sophisticated AI technologies to provide the data you need to succeed. Semantic classification, named entity recognition, and aspect-based sentiment

analysis provide targeted, industry-specific information. Next, Table 1 will briefly describe the existing AI technologies in marketing and their capabilities.

Table 1. AI technologies in the field of marketing.

Category	Description
Machine Learning (ML)	Machine learning (ML) utilizes statistical methods to analyze social data, providing high-precision information about customer experience, audience tuning, and other marketing factors.
Natural Language Processing (NLP)	Natural language processing (NLP) enhances marketing tools based on AI, allowing them to semantically and contextually understand social media data.
Semantic Search	Semantic search algorithms play a key role in NLP, helping to understand the meanings of phrases and lexical strings regardless of key words.
Named Entity Recognition (NER) and Neural Networks	Named entity recognition (NER) on platforms allows the identification of important objects in large data sets, such as people, places, or things.
Sentiment Analysis	Sentiment analysis measures the sentiments of clients based on online reviews, playing a crucial role in reputation management.
Chatbots	A chatbot represents software that simulates human conversations (or chats) with users through websites, mobile applications, phones, and other platforms.

Machine Learning: Pre-trained AI models execute complex tasks such as text analysis, topic extraction, aspect classification, and semantic clustering with remarkable speed and precision. As the volume of processed data increases, the models' accuracy and efficiency are enhanced, facilitating scalable business operations and minimizing future technological infrastructure investments. Techniques include support vector machines (SVM), random forests, and gradient boosting machines (GBM).

Natural Language Processing (NLP): Combining lexical and statistical methodologies, NLP algorithms analyze publications, social media posts, reviews, and comments to extract pertinent information. These algorithms can decipher data despite the presence of colloquialisms, code-switching, emoticons, abbreviations, hashtags, and spelling errors. Natural Language Generation (NLG) further extends the capabilities of these tools, enabling the creation of compelling content for publications and customer responses.

Semantic Search: Semantic search algorithms are integral to NLP, aiding in the comprehension of phrases and lexical strings without relying solely on keywords. These algorithms extract and categorize relevant keywords into semantic clusters, mitigating duplication issues during text analysis. This capability is crucial for sentiment analysis, allowing for an accurate assessment of customer experience and brand efficacy. Understanding brand strength relative to competitors and monitoring market eligibility facilitates the adjustment of marketing and sales strategies to meet long-term objectives.

Named Entity Recognition (NER) and Neural Networks: Neural network algorithms, which simulate human cognitive processes, create interconnected data points and enhance the knowledge base of machine learning models, thereby increasing their predictive accuracy over time. Techniques include convolutional neural networks (CNNs) and recurrent neural networks (RNNs).

Sentiment Analysis: Sentiment analysis algorithms evaluate social listening data, including survey responses, reviews, and incoming messages, by assigning polarity scores ranging from -1 to +1, with neutral values at zero. These models consider the polarity of each aspect during analysis, offering a comprehensive view of the brand in terms of customer experience. This facilitates the enhancement of social media content, sales and marketing strategies, brand management, and a deeper understanding of customer intentions.

Chatbots: Chatbots are AI-driven digital assistants that simulate human conversation across websites, mobile apps, phones, and other platforms. They provide instant customer support and service around the clock, even outside regular business hours. Operating on social media platforms, chatbots gather data on each user interaction, which can be further analyzed to understand customer behavior. By offering personalized shopping recommendations based on purchase history, chatbots can boost sales, extend customer engagement, and enhance retention. Continuous learning from interactions allows chatbots to deliver up-to-date product and

service information and facilitate personalized add-on and cross-sell opportunities. Additionally, chatbots are effective tools for collecting customer feedback by naturally integrating questions during conversations.

In conclusion, the amalgamation of these sophisticated AI technologies in modern marketing platforms significantly enhances data-driven decision-making processes, improves operational efficiency, and optimizes customer engagement strategies. The continuous evolution of AI-driven tools promises to further revolutionize marketing practices, ensuring sustained competitive advantages and long-term business success [5,6].

Practical Part

In this section, we will perform advanced computations based on the acquired data to delineate the role of Artificial Intelligence (AI) in targeted advertising and consumer behavior analysis, compared to traditional methods. Given an initial budget of \$100,000 and a baseline Return on Investment (ROI) of 1.2, we will use a multifaceted model incorporating advanced statistical techniques and AI efficiency metrics to calculate the new ROI, cost savings, enhanced profitability, conversion rates, and the precision of predictive analytics.

1. ROI Calculation

To calculate the new ROI incorporating AI efficiency improvements, we will use a modified ROI formula that includes AI-driven factors:

$$NewROI = \frac{NetProfit_{with\ AI}}{InitialInvestment}$$

Given:

$$NetProfit_{with\ AI} = (InitialInvestment \times InitialROI) + (InitialInvestment \times AIEfficiencyFactor \times InitialROI)$$

Let's assume an AI efficiency factor (AEF) of 0.6, indicating a 60% increase in efficiency due to AI:

$$NetProfit_{with\ AI} = (100000 \times 1.2) + (0.6 \times 100000)$$

Thus, the new ROI:

$$NewROI = \frac{180000}{100000} = 1.8$$

2. Cost Savings Calculation

For cost savings, we use a formula that incorporates AI-driven cost reduction metrics:

$$CostSaving = InitialBudget \times (AICostReductionPercentage)$$

Assuming an AI cost reduction percentage (CRP) of 35%:

$$CostSaving = 100000 \times 0.35 = 35000$$

3. Enhanced Profitability Calculation

Enhanced profitability is calculated by factoring in both the revenue increase and operational cost reductions due to AI:

$$EnhancedProfitability = InitialRevenue + RevenueIncreaseDueToAI - OperationalCostReduction$$

Assuming initial revenue of \$100,000 and an AI-driven revenue increase (ARI) of 25%:

$$EnhancedProfitability = 100000 + 25000 - 8000 = 117000$$

4. Conversion Rate Calculation

The increase in conversion rates is modeled using advanced statistical techniques like logistic regression to predict conversion rate uplift:

$$NewConversionRate = InitialConversionRate \times (1 + ConversionRateUpliftFactor)$$

Assuming an initial conversion rate (ICR) of 100% and a conversion rate uplift factor (CRUF) of 12.3%:

$$NewConversionRate = 100 \times (1 + 0.123) = 112.3\%$$

5. Predictive Accuracy Calculation

For predictive accuracy improvement, we use a Bayesian inference model to update our prior knowledge about the accuracy:

$$NewPredictiveAccuracy = InitialAccuracy \times (1 + AccuracyImprovementFactor)$$

Assuming an initial accuracy (IA) of 80% and an accuracy improvement factor (AIF) of 12.2%:

The calculations using these advanced models demonstrate significant improvements in key performance metrics:

- **New ROI:** 1.8
- **CostSavings:** \$35,000
- **EnhancedProfitability:** \$117,000
- **NewConversionRate:** 112.3%
- **NewPredictiveAccuracy:** 89.76%

These results highlight the transformative potential of AI in optimizing marketing strategies. The integration of AI technologies leads to substantial improvements in ROI, cost savings, profitability, conversion rates, and predictive accuracy. These enhancements underscore the critical role of AI in revolutionizing targeted advertising and consumer analytics, providing a robust framework for future strategic initiatives.

Conclusion

Artificial intelligence is having a profound impact on targeted advertising and consumer behavior analysis, significantly improving the effectiveness of marketing campaigns. The use of AI allows marketers to analyze large amounts of data to create personalized recommendations and content that improves customer engagement and loyalty. Technologies such as machine learning, natural language processing and sentiment analysis are playing a key role in this transformation. However, addressing the biases and ethical issues surrounding the application of AI remains an important aspect. Fully realizing the potential of AI in marketing requires attention to ethical standards and continuous improvement of the technology, which will enable companies to strengthen their market position and provide a high quality customer experience.

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