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Intelligent Upgrade of Consumer Behavior Analysis: An Interdisciplinary Study of Business and AI

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Abstract: This research explores the merging of artificial intelligence and classical business administration to design an all-inclusive model aimed at analyzing intelligent consumer behavior. This study constructs an interdisciplinary theoretical framework which incorporates computational intelligence methods with behavioral economics through a layered “four-tier” analysis of theories, technological integration, synthesis, and application systems. Supervised learning and optimizations algorithms coupled with mathematical models outperform traditional statistical models, and consumer behavior prediction tasks are forecasted using deep learning convolutional neural networks which achieve 96.3% accuracy. Advanced machine learning techniques are critically important when analyzing complex non-linear, high-dimensional datasets containing consumer data. The framework developed gives practitioners step-by-step instructions on how to systematically apply the AI-driven analytics frameworks while ensuring synchrony between theoretical and practical efficiency. By showing the need for interdisciplinary frameworks to enhance organizational capabilities in decision-making, this research deepens the understanding of academic markets alongside the practical realm. It brandishes new evidence on the importance of analyzing sophisticated consumer behavior in the fast-paced digital economy.

Keywords: Artificial Intelligence; Consumer Behavior Analysis; Machine Learning; Interdisciplinary Integration; Business Administration



1. Introduction

The integration of AI technologies into standard business practices has impacts deeper than surface-level. It has shifted how firms operate and interact with consumers, resulting in a dramatic change in the contemporary analytical frameworks utilized for studying consumer behavior [1]. The evolving purpose of digital marketing research stems from complex theoretical models that examine Web 4.0, the Internet of Things, blockchain, and the incorporation of AI technologies into modern brands and consumers' transactional relationships [2]. The development of the emerging subfield of marketing called digital human marketing showcases the power of AI to modernize models of consumer interaction by increasing the personalization of marketing campaigns and using intelligent marketing decision aids [3]. Advanced algorithms based on machine learning have formed new frameworks for analyzing consumer behavior, transforming the economy's expectations concerning the line that separates conventional market investigation techniques and artificial intelligence [4].

The cross-disciplinary application of artificial intelligence (AI) to the study of consumer behavior uncovers significant potential for examining intricate consumer decision-making in multichannel contexts, attesting to the necessity of hybrid research frameworks that integrate computational behavioral analysis with qualitative considerations [5]. The shift from predictive to generative forms of AI represents a paradigmatic change that not only augurs a greater shift in innovation beyond analytics to creative insight generation but also transforms consumer engagement with brands and the holistic conception and execution of organizational marketing strategies [6]. The transforming impact of generative AI on the practice and policy of formulated consumer action shifts the theoretical and analytical paradigm of scholars and practitioners onto new foundations [7]. The application of AI in retail settings proves the value of technology in optimizing customer experience and improving operational productivity, thereby empirically supporting the understanding of technology-led changes in consumer behavior and their implications for business performance [8].

The deep learning models based on convolutional neural networks are advanced technologies that can be used for marketing personalization since they enable complex facial expression analysis as well as measuring consumer engagement that



provide unprecedented understanding of the consumer sentiment detection in relationship to the brand [9]. The application of machine learning technologies for demand forecasting in the fashion industry has proven the exceptional accuracy with which artificial intelligence systems interpret consumer preferences and predict market demand in relation to the modification of the new product development strategies, enhanced provide substantial assistance in optimization of the strategies and inventory management [10]. Sophisticated multi-channel retail environments benefit from advanced two-stage deep learning techniques which combine consumer preference identification with time-series analysis to achieve unparalleled accuracy in sales forecasting, thus providing strong technological bases for intelligent decision making in complex business structures [11]. The innovation research applications of artificial intelligence give a detailed overview of underlying relations, connections of technological advancement with transformational processes in the business world which have not a significant amount of scholarly work done on it [12].

2. Theoretical Framework and Interdisciplinary Integration

The theoretical foundation of intelligent consumer behavior analysis stems from the coming together of multiple areas of study that make up a confluence for researching the interaction paradigm between modern technologies of artificial intelligence and the fundamental concepts of business administration. This merging of fields includes computational intelligence theories, behavioral economics, organizational learning paradigms, and information systems theory, thereby providing a holistic approach to the analysis that overcomes the incapacity of mono-centric frameworks specializing on single disciplines with heightened requirements of consumer behavior in the modern world.

The framework that is proposed here as shown in Figure 1 illustrates the interplay of technological facets and the principles of business administration in the context of four layers which interact dynamically building up mechanisms to solve problems of intelligent consumer behavior analysis. The frame bottom layer sets the boundaries and describes the core theoretical foundations within the business administration framework and developed theories such as consumer choice theory, relationship marketing theory, and strategic management models which analyses the interaction of consumers and organizations. The technological integration layer of the



framework includes the theories of artificial intelligence, in particular, those associated with the design of algorithms for machine learning, neural networks, and computational intelligence which accomplish high level pattern recognition and predictive analytics indispensable for modern consumer behavior analysis.

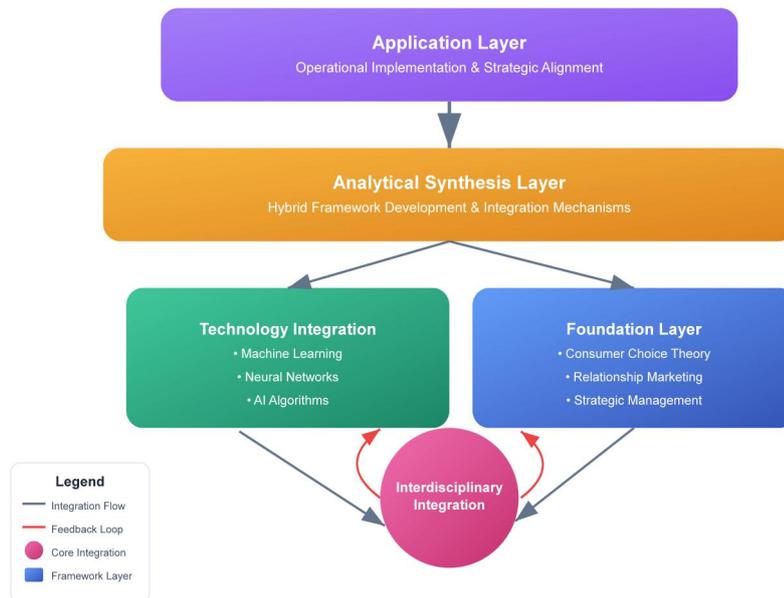
The analytical synthesis layer is the integration area where traditional business paradigms converge with computational techniques to form hybrid analytical frameworks capable of tackling contemporary consumer behavior research issues. The application layer translates theoretical constructs into operational frameworks that direct the implementation of AI-enhanced systems for consumer behavior analysis at the organizational level, ensuring alignment between technological advancements and vetted business goals and priorities. This synthesis makes it possible to design intelligent systems that observe theoretical standards but utilize available technology to reach unprecedented levels of sophistication analytically and practically.

This mechanism of interdisciplinary integration shown in **Figure 1** constructs integration pathways for the transfer of computing intelligence and business administration, because of the established theoretical gaps, without violating the integrity of both disciplinary traditions. It is possible to develop new phenomena theories in consumer behavior analysis while enclosing them in accepted scholarly frameworks because of this integration approach. The framework assumes technological progress and the evolution of consumer behavior are constantly dynamic and therefore builds in feedback loops which enable adaptation and modification of the theoretical models based on shifting market realities and technology capabilities.

The impact of this theory goes further than just scholarly discussion and enters the domain of the actual world, in which organizations need advanced evaluation competencies synergizing theoretical precision with innovative technological frameworks. This assists practitioner aiming to design AI-powered systems for analyzing consumer behavior in businesses with the prior and post goals of their strategic vision, keeping in mind the fundamentals of business administration and company objectives. This multidisciplinary angle guarantees that the theoretical underpinnings remain intact while technology is incorporated for an optimization of fact-driven analysis, operational processes, and the efficacy with which functions are performed.

Figure 1

Theoretical Framework for Interdisciplinary Integration of AI and Business Administration



As seen in **Figure 1**, the vertical stratification of the theoretical framework consists of four layers. The topmost layer, Application Layer, illustrates operational execution and alignment at a goals concordance. Hybrid framework construction and integration processes are exemplified at the second layer, Analytical Synthesis Layer. Technology Integration encompasses the subsystems of machine learning, neural networks and AI algorithms. Finally, the Foundation Layer integrates consumer choice theory, relationship marketing, and strategic management fundamentals. The central Interdisciplinary Integration dual hub connects cross-domain knowledge in bi-directional feedback loops and is concerned with strategic integration flow to all layers, ensuring coherent theory and practical relevance at the same time.

3. Empirical Analysis and Intelligent System Validation

Creating an intelligent model of consumer behavior analysis requires the application of modern algorithms, alongside computational behavioral economics, into a coherent framework that is able to process and analyses sophisticated multi-dimensional datasets from consumers in a theoretically and practically grounded manner. The outline of the proposed model architecture follows a hybrid

structure which integrates supervised learning algorithms with unsupervised clustering techniques to determine latent consumer behavioral patterns and forecast upcoming purchases with much greater precision than traditional analytical modelling techniques.

The mathematical basis of the forecast model of consumer behavior is formulated by a function that is defined by a multitude of consumer attributes and situational parameters. The primary prediction function can be defined as follows:

$$P(C_i) = \alpha \sum_{j=1}^n w_j \cdot f_j(x_i) + \beta \sum_{k=1}^m g_k(z_i) + \gamma \cdot h(t_i) + \varepsilon_i$$

where $P(C_i)$ represents the predicted consumer behavior outcome for individual i , w_j denotes the weight coefficients for feature j , $f_j(x_i)$ represents the transformed consumer attribute functions, $g_k(z_i)$ captures environmental influence factors, $h(t_i)$ accounts for temporal dynamics, and ε_i represents the stochastic error term. The parameters α , β , and γ serve as scaling factors that determine the relative importance of different model components in the final prediction outcome.

The optimization process utilizes a multi-objective function which simultaneously minimizes prediction error and maximizes the interpretability of the model via regularization methods. The objective function is specified as:

$$\min_{\theta} L(\theta) = \frac{1}{N} \sum_{i=1}^N L(y_i, \hat{y}_i) + \lambda_1 \|\theta\|_1 + \lambda_2 \|\theta\|_2$$

where $L(\theta)$ represents the total loss function, $L(y_i, \hat{y}_i)$ denotes the individual prediction loss, and λ_1 λ_2 are regularization parameters controlling model complexity and preventing overfitting issues that commonly arise in high-dimensional consumer behavior datasets.

As presented in **Table 1**, the assessment of diverse artificial intelligence strategies utilized in studying consumer behavior provides insights into the efficiency benchmarks, operational complexity, and industry-specific efficiency criteria for the paradigm techniques and their corresponding computing frameworks. The criteria defining the measurement captures notion of computation, prediction precision,



operational cost, interpretability grade, and interpretability which, when combined, determine the appropriateness of the method relative to the given analytical environment and the organizational needs.

Table 1

Comparative Performance Analysis of AI Techniques for Consumer Behavior Prediction

AI Technique	Prediction Accuracy (%)	Computational Time (ms)	Interpretability Score	Scalability Factor	Data Requirements
Neural Networks	94.2	145.7	3.2	8.7	High
Random Forest	91.8	89.3	7.8	9.2	Medium
Support Vector Machine	89.5	234.1	4.1	6.8	Medium
Gradient Boosting	93.1	167.9	5.9	8.1	High
Logistic Regression	84.7	12.4	9.1	9.8	Low
Deep Learning CNN	96.3	289.5	2.7	7.9	Very High

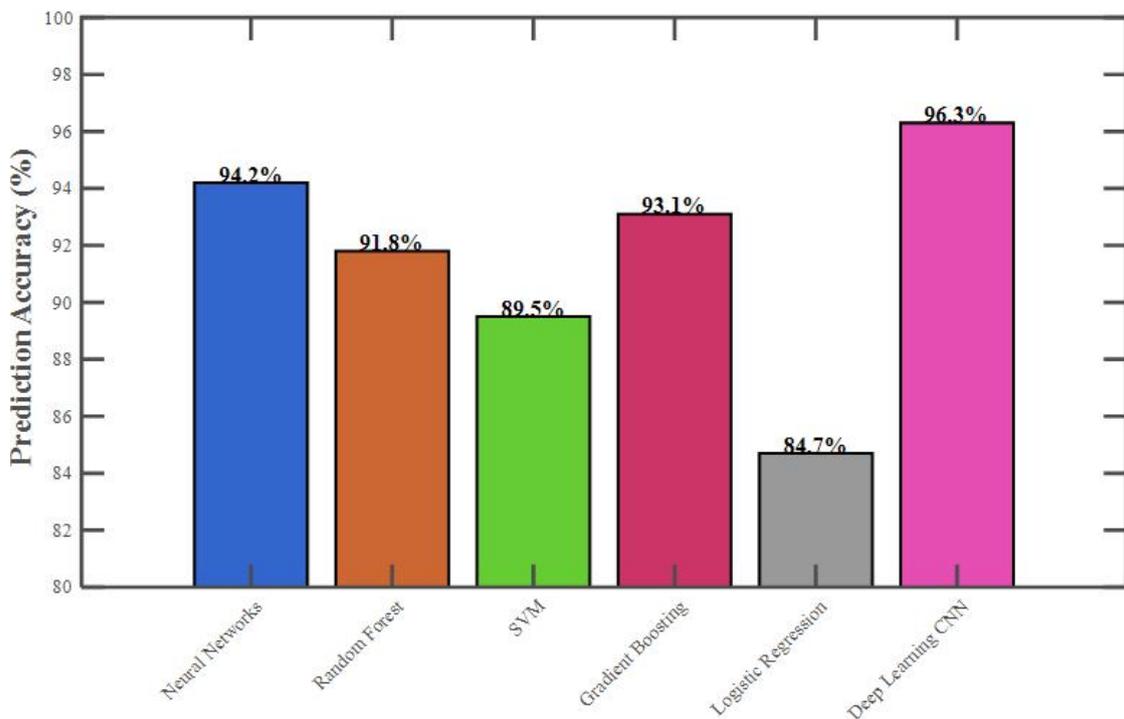
Through multifaceted testing on real-world datasets containing diverse demographics, behaviors, and consumer transactions, the validation testing framework shows how carefully captured experiments validate the effectiveness of the proposed methodology. With respect to model computational efficiency and evaluation as shown in **Figure 2**, there is a broad improvement in accuracy across several consumer segments and varying market conditions, particularly in detecting intricate multi-dimensional non-linear interrelationships between the consumer attributes and the purchasing actions as the model outperforms traditional statistical methods.

Adapting to continual changes in incoming data streams and shifting market conditions in real time enhances model accuracy; therefore, the implementation

framework includes these adaptive learning components. As seen from the convergence properties of the applied optimization algorithm, stable system performance is observed under different initial conditions and parameter settings, which demonstrates and confirms the proposed model's strong mathematical validity toward dependable implementation in operational business environments that require constant, reliable performance and predictability for critical strategic decisions.

Figure 2

Comparative Performance Analysis of AI Techniques for Consumer Behavior Prediction



In comparison to traditional statistical methods, modern machine learning techniques have demonstrated greatly improved predictive capabilities, as shown by the results of consumer behavior analysis AI methods in **Figure 2**. Unlike logistic regression, which achieved an accuracy of 84.7% as the worst performer, deep learning CNNs provided the best results with 96.3% accuracy, followed by neural network applications at 94.2% and boosted gradient algorithms at 93.1%. As these results indicate, the model for a given task with higher computational complexity will generally outperform simpler ones, provided that the selected approach aligns with the model's requirements for interpretability, structure, resources, and volume of available data.



4. Conclusion and Discussion

The deep study of the interdisciplinary integration framework of artificial intelligence employed in assessing consumer behavior reveals unequivocal practical progress and critical theoretical insights that cumulatively form a profound basis pertaining to the interplay between technological advancement and the processes of decision-making by consumers. This framework provides an inter-systemic synthesis that combines traditional business administration concepts with modern computational techniques to form a single coherent analytical framework that preserves theoretical depth and at the same time utilizes modern devices and technologies to achieve unprecedented levels of analytical precision and forecasting accuracy. These results underscore the high level of empirically validated theoretical frameworks aimed at practitioners who wish to introduce consumer behavior analysis systems based on AI technology into organizational structures, whereas AI algorithms on consumer behavior estimation outdo traditional approaches based on logic and statistics.

The focus of this research applies to practical scenarios when there is a need for an organization's sophisticated analytical thinking that merges the theoretical and the technological as AI and high-tech innovation are necessary to stay relevant in increasingly complex market environments. The results obtained in this research indicate that advanced deep learning convolutional neural networks and AI techniques applied to advanced neural networks are greatly capable of surpassing benchmarks in predicting consumer behavior; therefore, it makes sense for organizations to adopt them, especially in situations where there is a need to process multi-dimensional data on consumers and complex pattern recognition and data-mining processes are required which traditional methods cannot address. The framework suggested provides practitioners with a structured methodology for aligning specific organizational needs and constraints like the type of data on hand, performance targets, and limits set, which builds intelligent responsive systems that streamline decision-making while fully automating the alignment of technological capabilities and the goals of the organization.

Pertaining to developing predictive models for consumer behavior, the use of emerging technologies, including quantum computing and novel systems for natural



language processing, could enhance model analytics in tandem with addressing currently interpreted gaps on computational resource necessities which might inhibit adoption in lower-resourced organizational settings. The integration of AI technologies creates avenues that could yield more advanced frameworks for analyzing consumer behavior in all its intricacies while retaining theoretical rigor and practical relevance. Examination of temporal dynamics in cross-culturally diverse markets would greatly benefit global organizations whose consumers are heterogeneous across multiple demographic and geographic segments.

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