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Intelligent Negotiation Bot and Demand-Aware Commerce System: Using Machine Learning

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Abstract
Dynamic pricing and negotiation systems are becoming essential tools in modern e-commerce, enabling businesses to adapt prices in real time and improve customer satisfaction. Traditional fixed pricing models often fail to address rapidly changing market demands, buyer behaviour, and competitive pressures. Recent research has introduced various intelligent approaches such as machine learning, reinforcement learning, sentiment analysis, and natural language processing to make pricing more adaptive and customer-focused. This review paper examines recent contributions in three major areas: Machine learning and Random Forest models for sales prediction and discount optimization, Negotiation chatbots that combine text or voice-based interaction with rule-based or AI-driven techniques, and Sentiment analysis applied to product reviews and real-time buyer interactions. The paper highlights how Random Forest models are used to identify key features affecting purchase decisions, while reinforcement learning and Q-learning frameworks support dynamic price optimization. At the same time, chatbot-based negotiation and recommendation systems provide personalized interaction by analyzing customer intent and sentiment. A comparative discussion of existing works shows the strengths and limitations of each approach, with particular focus on their accuracy, adaptability, and scalability in real-world e-commerce environments. Finally, the paper identifies gaps in integrating discount prediction, negotiation, and sentiment-aware interaction into a single unified system, outlining future directions for developing practical and intelligent pricing platforms.

Keywords: Dynamic Pricing, E-Commerce, Machine Learning, Random Forest, Reinforcement Learning, Price Negotiation Chatbot, Sentiment Analysis

1. Introduction

E-commerce has become one of the fastest-growing domains in today's digital economy, where pricing strategies play a critical role in improving revenue and customer satisfaction. Traditional fixed pricing methods are being replaced by dynamic pricing models, which adjust prices in real time according to demand, competition, and customer behavior. Recent research highlights the use of machine learning models such as Random Forests to predict sales patterns and identify key features influencing demand. Similarly, reinforcement learning approaches, particularly Q-learning frameworks, have shown promise in optimizing dynamic retail pricing by continuously learning from customer responses and market changes. These models allow businesses to balance profit maximization with consumer fairness, making

them more adaptive than rule-based pricing techniques.

In parallel, sentiment analysis of e-commerce product reviews has emerged as an important area, as customer feedback provides valuable signals that can be integrated into pricing strategies. Studies suggest that analyzing customer opinions and product ratings helps in understanding consumer expectations and enables more accurate price adjustments. Another growing direction is the deployment of chatbots for price negotiation in e-commerce platforms. These systems, built on natural language processing (NLP), allow users to bargain with an automated agent, making the shopping experience more interactive and personalized. Such negotiation-based chatbots combine AI decision-making with customer engagement, offering a new dimension to dynamic pricing. Taken together, these works demonstrate how machine learning, reinforcement learning, sentiment analysis, and negotiation systems are shaping the future of intelligent pricing in e-commerce. This review paper consolidates recent contributions, compares methodologies, and highlights opportunities for designing AI-driven negotiation and pricing frameworks that are both customer-centric and revenue-optimized.

2. Literature Review

Recent studies highlight the increasing application of machine learning as well as intelligent systems in the field of dynamic pricing and e-commerce systems. Chen [1] explored the use of Random Forest for Walmart sales estimation, demonstrating how feature importance can be applied to determine factors influencing consumer demand and discounts. Similarly, Liu and Song [9] and Bhattacharjee et al. [10] presented machine learning-driven approaches for optimizing real-time dynamic pricing, showing their impact on revenue generation in online commerce. Reinforcement learning has also gained attention, with Apte and Deshmukh [5] applying Q-learning to dynamic retail pricing. Their work illustrated how reinforcement models adaptively learn pricing strategies from customer interactions to achieve better revenue outcomes.

Alongside pricing models, sentiment analysis has emerged as an important aspect of e-commerce research. Daza et al. [4] provided a systematic study on the analysis of buyer product reviews using algorithmic learning and deep learning techniques. Their findings indicated that buyer emotions strongly affect purchase decisions and acceptance of discounts. Gupta and Pathak [6] also emphasized that predictive models considering buyer behavior can significantly enhance purchase forecasting. On the conversational side, negotiation chatbots have been introduced to improve user engagement. Pappala et al. [2] designed a voice- and text-based bargaining chatbot, while Gorantla et al. [3] developed a chatbot system for price negotiation on e-commerce platforms. Further studies by Bindu et al. [7] and Ahire et al. [8] employed natural language processing techniques to simulate real-world bargaining processes highlighting the growing role of AI-driven chatbots in enhancing customer interaction. Similarly, Bi [11] proposed a Naive bayes-based recommendation system, further extending personalization capabilities in e-commerce. Overall the existing body of literature demonstrates strong progress in dynamic pricing, sentiment analysis, and conversational AI. However, most studies tend to address these areas independently rather than in an integrated fashion.

3. Research Gap

Although extensive research has been conducted on dynamic pricing and automated negotiation systems in e-commerce, several critical limitations still exist that restrict their real-world applicability and adaptability. Existing literature primarily focuses on either dynamic pricing algorithms or negotiation

chatbots, but very few studies have successfully combined both components into a unified, intelligent pricing and negotiation framework. Most dynamic pricing systems, such as those discussed in [1], utilize machine learning or reinforcement learning models to predict optimal prices based on factors like market trends and demand. While these models improve pricing efficiency and maximize revenue, they often ignore user sentiment and behavioral feedback, which play a vital role in influencing purchasing decisions. The absence of emotional or psychological understanding results in pricing strategies that may be statistically optimal but not customer-centric.

On the other hand, negotiation chatbots developed in studies like [2] primarily use rule-based dialogue systems without incorporating adaptive learning mechanisms. These bots lack the ability to modify negotiation strategies dynamically based on user responses or emotional tone. As a result, their conversations often appear repetitive or rigid, reducing user engagement and trust. Moreover, some existing models that attempt to introduce AI or deep learning in negotiations (such as reinforcement learning or large language models) suffer from high computational cost, lack of explainability, and inconsistent performance in real-time e-commerce environments.

Additionally, prior sentiment analysis studies [4] have mostly focused on post-purchase reviews or social media data rather than real-time user interactions. This creates a gap in leveraging live sentiment feedback during the negotiation process. Incorporating real-time sentiment analysis can help personalize offers, understand buyer intent, and enhance negotiation success rates — an area that remains underexplored.

Another notable research gap lies in the integration of pricing prediction with explainable negotiation logic. Current AI-driven approaches often rely on black-box models, making it difficult for developers and businesses to understand or justify price adjustments to customers. Therefore, there is a strong need for a transparent, explainable, and adaptive system that can dynamically calculate discounts while maintaining a logical and customer-friendly negotiation flow.

In summary, the research gaps identified are:

- Lack of integration between dynamic pricing algorithms and intelligent negotiation chatbots.
- Limited use of real-time sentiment analysis for adaptive negotiation.
- Overreliance on complex or black-box AI models without explainable outcomes.
- Absence of lightweight, scalable solutions suitable for small and medium e-commerce platforms.
- Inadequate personalization in pricing and negotiation based on user behavior and emotional cues.

The proposed hybrid model aims to bridge these gaps by combining Random Forest-based dynamic discount prediction with real-time sentiment analysis and a rule-based negotiation chatbot capable of generating context-aware, explainable dialogues. This approach provides both adaptability and interpretability, ensuring a balance between AI-driven intelligence and practical usability in modern e-commerce systems.

4. Proposed Framework

Based on the analysis of existing literature, it is evident that there is a need for an integrated system that combines discount prediction, sentiment-driven interaction, and negotiation strategies in a practical and explainable way. To address the identified research gaps, the proposed framework is designed with three major components:

Discount Prediction using Random Forest

A Random Forest algorithm will be applied to historical sales and customer data to predict optimal discounts. Machine learning models can effectively identify the key factors influencing sales. Features

such as purchase history, seasonal trends, and customer demographics will be analyzed, with feature importance guiding decision-making. This ensures personalized and data-driven discount recommendations.

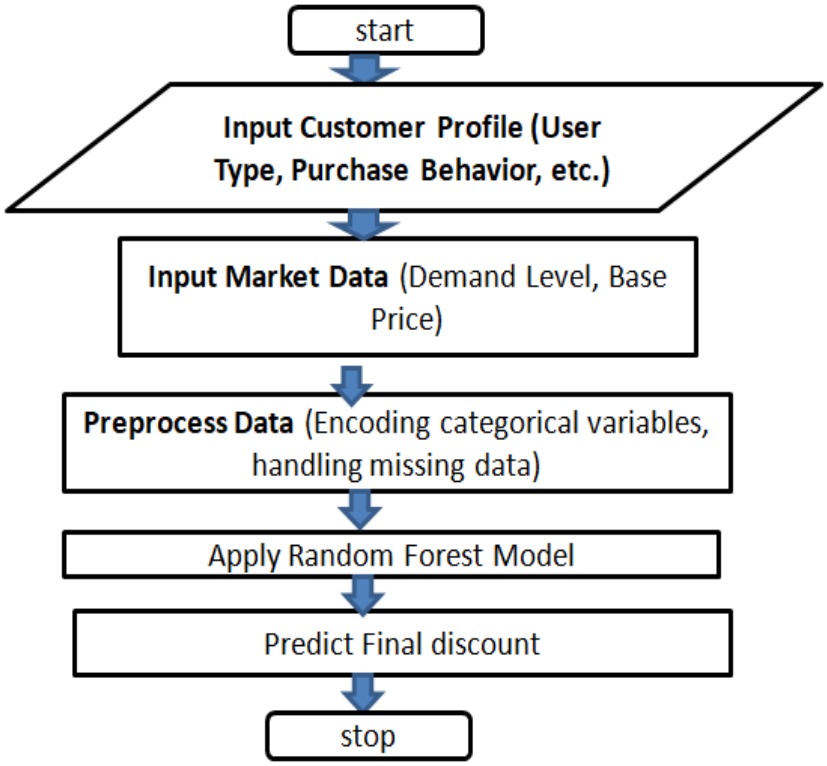

Figure 1: Flowchart for Discount Prediction using Random Forest

Sentiment Analysis of Customer Interaction

Customer messages during the negotiation process will be analyzed in real-time to capture the emotional tone. Following the approach in and , sentiment analysis helps identify whether the customer is satisfied, hesitant, or dissatisfied. Positive sentiment may result in stricter discounts, while negative sentiment could trigger more flexible counteroffers. This emotional intelligence component ensures that negotiation feels more human-like and adaptive.

Rule-based Negotiation Chatbot

To ensure explainability and efficiency, the chatbot will use rule-based sentence generation rather than relying on large language models. As seen in negotiation bots improve engagement, but many lack adaptability. Our approach combines structured dialogue rules with sentiment cues, producing transparent and consistent negotiation flows. The chatbot can present counteroffers, explain reasons for discounts, and close deals in a conversational manner.

Negotiation Chatbot

The working process of a negotiation chatbot for e-commerce pricing is as follows: The interaction begins when a user initiates a chat requesting the price of a product. The chatbot then retrieves relevant product details such as the base price, user profile, and current demand level. Based on this information, it generates an initial price offer using either predefined rule-based logic or a machine learning model. Once the user receives the offer, they may respond with a counteroffer. The chatbot evaluates whether this

counteroffer falls within the acceptable range. If the counteroffer is deemed acceptable, the negotiation ends with a final agreed price. If not, the chatbot generates a new counteroffer and continues the negotiation loop. This iterative process ensures that the chatbot adapts dynamically to user responses while maintaining the seller's profitability. The cycle continues until both parties reach a mutually acceptable price or the negotiation is terminated. This structured flow ensures transparency, enhances user engagement, and provides a balance between customer satisfaction and business objectives.

Advantages of the Framework

- Personalized and dynamic discounts (customer-centric).
- Emotion-aware negotiation improving user trust and satisfaction.
- Explainable and streamlined rule-based chatbot (suitable for SMEs).
- Scalable system architecture, deployable in real-world e-commerce platforms.

Conclusion

The proposed framework for an Intelligent Negotiation Bot using Machine Learning Techniques effectively addresses the challenges identified in existing literature by integrating discount prediction, sentiment-driven interaction, and rule-based negotiation strategies. By leveraging Random Forest algorithms, the system provides personalized, data-driven discount recommendations that optimize sales and customer satisfaction. The incorporation of real-time sentiment analysis allows the chatbot to adapt its negotiation strategy based on the customer's emotional state, creating a more human-like and engaging interaction. Additionally, the rule-based negotiation chatbot ensures transparency, explainability, and consistency in dialogue, making the system suitable for deployment in real-world e-commerce environments, particularly for SMEs. Overall, this framework demonstrates a balanced approach that combines intelligence, adaptability, and explainability, resulting in a scalable solution that enhances both customer experience and business profitability. By integrating machine learning and sentiment-aware negotiation, the system sets a foundation for future advancements in intelligent e-commerce interaction and automated pricing strategies.

References

1. D. Chen, "Walmart Sales Prediction Based on Random Forest Model and Application of Feature Importance," in Proc. 4th Int. Conf. Signal Process. Mach. Learn., 2024, pp. 1–6, doi: 10.54254/2755-2721/53/20241461.
2. S. Pappala, S. Rakesh, V. Gangaiah, G. Poojitha, T. Madhu, "Smart Bargain Bot: A Text and Voice-Based Price Negotiation System for E-Commerce Platforms," St. Mary's Group of Institutions, Hyderabad, Telangana, India, 2024.
3. B.P. Gorantla, G. Pravallika, K. Ashritha, K. Sathwika, "Price Negotiating Chatbot on E-Commerce Website," Turkish J. Comput. Math. Educ. (TURCOMAT), vol. 15, no. 3, pp. 91–105, 2024, doi: 10.61841/turcomat.v15i3.14781.
4. A. Daza, N.D.G. Rueda, F.R. Espíritu, M.S.A. Sánchez, M.E.C. Quiñones, "Sentiment Analysis on E-Commerce Product Reviews Using Machine Learning and Deep Learning Algorithms: A Bibliometric Analysis, Systematic Literature Review, Challenges and Future Works," ScienceDirect, 2024.
5. M. Apte, P.R. Deshmukh, "Dynamic Retail Pricing via Q-Learning—A Reinforcement Learning Framework for Enhanced Revenue Management," arXiv preprint arXiv:2411.18261, Nov. 2024.

6. R. Gupta, C. Pathak, "A Machine Learning Framework for Predicting Purchase by Online Customers Based on Dynamic Pricing," Procedia Comput. Sci., vol. 36, pp. 599–605, 2014, doi: 10.1016/j.procs.2014.09.060.
7. D.H. Bindu, V. Manasa, P. Karthik, R. Shalini, T.D. Rao, "Price Negotiating Chatbot on E-Commerce Website Using NLP," Int. J. Adv. Res. Sci., Commun. Technol. (IJARSCT), vol. 3, no. 3, Apr. 2023.
8. L. Ahire, A. Kukade, S. Thange, P. Bhosale, V. Nale, "Developing a Price Negotiation Chatbot for E-Commerce Websites," Int. J. Adv. Res. Sci., Commun. Technol. (IJARSCT), vol. 4, no. 6, Mar. 2024.
9. Q. Liu, Y. Song, "Pricing Strategy Optimization by Machine Learning in E-Commerce," ACM Proc., 2025.
10. P. Das, T. Pervin, B. Bhattacharjee, M.R. Karim, N. Sultana, M.S. Khan, M.A. Hosien, F. Kamruzzaman, "Optimizing Real-Time Dynamic Pricing Strategies in Retail and E-Commerce Using Machine Learning Models," Amer. J. Eng. Technol., vol. 6, no. 12, pp. 163–177, Dec. 2024, doi: 10.37547/tajet/Volume06Issue12-15.
11. B. Luo, "Design of Personalised Recommendation Algorithm for E-Commerce Platform Based on Naive Bayes Model and Spark," Wuhan Donghu College, Wuhan, China, 2024.