Price Negotiation Chatbot Using AI-Based Ensemble Machine Learning Techniques for E-Commerce Website

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***Abstract*—E-commerce platforms have revolutionized retail by providing users with convenient access to a vast range of products. However, traditional fixed-price models often lack flexibility, leading to missed opportunities for both buyers and sellers. This research presents an Intelligent Negotiation Bot that leverages machine learning techniques to enable dynamic price negotiation in e-commerce transactions. The proposed system integrates the OpenAI API for chatbot-based interactions and Random Forest for price prediction, ensuring an optimized pricing strategy tailored to individual users.**

The negotiation bot considers multiple factors such as user profile (new, old, or frequent buyer), purchasing behavior (bulk vs. single-item purchases), product demand analysis, and competitor pricing to generate personalized price recommendations. Natural Language Processing (NLP) is employed to analyze user preferences, while sentiment analysis on product ratings and reviews further refines price adjustments. The system consists of several modules, including an Admin Panel for product and order management, User Management, Product Catalog, AI-driven Price Negotiation, and Purchase Processing.

The workflow of the negotiation bot involves real-time interaction with users, where price recommendations are dynamically adjusted based on historical sales data and market demand patterns. Machine learning models, particularly Random Forest algorithms, are utilized to predict the optimal pricing strategy by analyzing past sales, seasonal trends, and demand fluctuations. The integration of an AI-driven chatbot ensures a seamless and human-like negotiation experience, enhancing user engagement and increasing conversion rates.

The proposed system bridges the gap between fixed pricing models and customer-specific dynamic pricing, fostering a more personalized shopping experience. By combining machine learning-driven price prediction, demand analysis, and AI-based negotiation, this research provides a novel approach to automated e-commerce price negotiation, ultimately benefiting both consumers and online retailers.

***Index Terms*—E-commerce, Intelligent Negotiation, Machine Learning, Price Prediction, Random Forest, OpenAI API, AI Chatbot, Demand Analysis, Personalized Pricing.**

I. INTRODUCTION

The rapid growth of e-commerce has significantly transformed the retail industry by offering consumers an extensive range of products with seamless purchasing options. However, most e-commerce platforms operate on a fixed-pricing model, which does not account for individual customer behavior, demand fluctuations, or personalized pricing strategies. In contrast, traditional physical stores often allow room for price negotiation, which enhances customer satisfaction and increases conversion rates.

The need for intelligent price negotiation arises from the fact that different users have varying purchasing behaviors. Some customers prefer bulk purchases, while others buy rarely. Similarly, frequent buyers may deserve loyalty-based discounts, whereas new users may require introductory offers. Additionally, market demand, competitor pricing, and customer reviews play a crucial role in determining the optimal price of a product. An AI-driven negotiation bot, integrated into an e-commerce platform, can help bridge this gap by offering personalized pricing based on user profiles and demand analysis.

II. LTERATURE REVIEW

Dynamic Pricing Strategies in E-Commerce

Dynamic pricing is a widely researched area in e-commerce, where machine learning models are used to adjust product prices based on demand, competition, and user behavior. Recent studies highlight the effectiveness of AI-driven dynamic pricing models.

One study proposed a machine learning-driven pricing strategy that adapts to market conditions and enhances profitability for e-commerce platforms [1]. Another work explored reinforcement learning-based pricing techniques, demonstrating improved customer engagement and revenue growth through adaptive pricing mechanisms [2]. Additionally, research on dynamic pricing models highlights the role of economic factors and consumer behavior in shaping online pricing strategies [3]. AI-based optimization models, such as decision trees and reinforcement learning, have also been applied to enhance pricing efficiency [4].

Furthermore, a framework for predicting customer purchases based on dynamic pricing was developed using machine learning algorithms, which successfully identified the impact of price changes on conversion rates [5]. These studies collectively emphasize the growing significance of data-driven pricing models in modern e-commerce environments.

AI-Powered Negotiation Systems

The integration of AI-based chatbots for price negotiation in e-commerce has gained considerable attention. Recent research has demonstrated the use of machine learning models in chatbot-based price negotiation, providing personalized offers to users and improving conversion rates [6]. A similar study focused on the development of negotiation bots that engage in real-time bargaining with customers, leading to better price acceptance and increased user satisfaction [7].

These intelligent negotiation bots utilize historical purchase data, competitor pricing, and customer profiles to optimize price negotiation strategies. Machine learning algorithms such as Random Forest and Decision Trees have been widely used to automate negotiation mechanisms, ensuring fair pricing and enhancing user engagement. By leveraging OpenAI API-based conversational AI, negotiation bots can provide a seamless and interactive user experience while maintaining profitability for sellers [6, 7].

Machine Learning Algorithms for Price Prediction

Several machine learning techniques have been explored for price prediction in e-commerce. Random Forest and Decision Tree models have been applied to analyze historical price trends and predict optimal pricing strategies [1, 4]. Research has shown that combining multiple machine learning models, such as hybrid AI techniques, can enhance price prediction accuracy and adaptability to market changes [5].

Furthermore, reinforcement learning-based approaches have been developed to dynamically adjust prices based on real-time market conditions [2]. These models enable e-commerce platforms to balance competitive pricing while maximizing revenue. Another study demonstrated that deep learning models could further refine price prediction by considering consumer sentiment, seasonal demand variations, and historical sales data [4].

User Behavior & Profile-Based Pricing

User behavior analysis plays a crucial role in personalized pricing and negotiation strategies. Recent studies have analyzed customer purchase behavior to categorize users into different segments such as new users, frequent buyers, and bulk purchasers [11]. By applying data analytics techniques, researchers have developed models that optimize pricing based on user history, loyalty, and engagement levels [12].

Moreover, big data analysis has been employed to predict user purchasing patterns, allowing e-commerce platforms to provide personalized discounts and loyalty-based pricing strategies [12]. These approaches contribute to enhancing customer retention and increasing long-term revenue.

Sentiment Analysis & Review-Based Pricing

Customer reviews and ratings significantly impact product pricing and demand. Sentiment analysis techniques have been widely used to extract insights from customer feedback and adjust prices accordingly [8]. Research has demonstrated that sentiment-based dynamic pricing models can improve customer trust and engagement by aligning prices with perceived product value [9].

A study on sentiment analysis explored deep learning models for analyzing online reviews and optimizing product pricing based on customer feedback [10]. Additionally, text-based review analysis has been employed to identify key product features influencing customer purchasing decisions, further aiding in price optimization [10].

Ethical Considerations in AI-Based Pricing

The ethical implications of AI-driven dynamic pricing are an important research area. Studies have highlighted concerns related to fairness, transparency, and potential bias in AI-based pricing algorithms [9]. Ensuring ethical pricing strategies and maintaining consumer trust are key challenges faced by e-commerce platforms. A comprehensive study proposed real-time ethical adjustments in sentiment-based dynamic pricing

models to prevent unfair price discrimination and enhance transparency [9].

Regulatory aspects of AI-based pricing have also been explored, emphasizing the need for guidelines to govern automated negotiation and pricing strategies in e-commerce [9].

The literature reviewed indicates that AI-powered negotiation bots and dynamic pricing strategies are becoming essential for modern e-commerce platforms. Machine learning algorithms such as Random Forest, Decision Trees, and Reinforcement Learning play a significant role in optimizing pricing and enhancing negotiation efficiency. Additionally, user behavior analysis and sentiment-based pricing models contribute to personalized pricing strategies, improving customer engagement and retention. Future research should focus on improving the ethical transparency of AI-based pricing mechanisms while maintaining competitive and adaptive pricing strategies.

III. METHODOLOGY

Overview of the Proposed System

The proposed system is an AI-powered price negotiation bot that utilizes machine learning techniques such as Random Forest for price prediction and decision-tree-based rule algorithms for dynamic discount calculations. The negotiation bot leverages OpenAI API to engage in real-time bargaining with users, adjusting prices based on their profiles, purchase history, demand patterns, and competitor pricing.

The methodology consists of the following key components:

Each component is detailed below.

Data Collection and Preprocessing

The system relies on diverse datasets for training the machine learning models. The data sources include:

- Historical Sales Data: Product prices, past transactions, discount rates, and purchase behavior.
- User Data: Profile information, purchasing frequency, cart abandonment rate, and negotiation history.
- Competitor Pricing Data: Real-time market prices from other e-commerce platforms.
- Product Demand Trends: Seasonal demand patterns, stock availability, and product popularity.
- User Ratings & Reviews: Sentiment scores and textual analysis of customer reviews.

Preprocessing Steps:

- Data Cleaning: Removing duplicate entries, handling missing values, and standardizing price formats.
- Feature Engineering: Extracting key features such as purchase frequency, discount sensitivity, negotiation success rate, and sentiment polarity from reviews.
- Normalization: Standardizing numerical features for better model performance.
- Label Encoding: Converting categorical variables (e.g., user types) into numerical labels.

User Profiling and Classification

To enhance negotiation and dynamic pricing, users are categorized into different segments based on purchasing behavior:

User Type	Characteristics
New User	First-time buyer, high price sensitivity, requires promotional discounts.
Returning User	Moderate negotiation engagement, average price sensitivity.
Frequent Buyer	Loyal customer, bulk purchaser, higher negotiation success rate.
Rare Single-Item Buyer	Purchases occasionally, low negotiation engagement.

User Behavior Features:

- Total number of past purchases
- Average spending per order
- Negotiation history (successful vs. rejected offers)
- Time spent in negotiation interactions
- Sentiment score from past reviews

Machine learning classification algorithms such as Decision Trees and K-Means Clustering are used to assign users to appropriate categories.

Price Prediction using Random Forest Algorithm

The Random Forest Algorithm is applied for predicting the optimal product price based on market trends, competitor prices, and user demand.

Steps for Price Prediction:

1. Training Data Preparation: Historical price trends, demand patterns, and user purchase behaviors are used as training data.
2. Feature Selection:
   - Product attributes: Category, brand, stock level.
   - User attributes: Purchase history, negotiation engagement.

- Market factors: Competitor pricing, seasonal trends.

3. Model Training: The dataset is split into training and testing sets. The Random Forest model is trained using past sales data.
4. Price Prediction: When a user selects a product, the model predicts a price range based on historical patterns.
5. Validation & Optimization: Model performance is evaluated using Mean Absolute Error (MAE) and Root Mean Square Error (RMSE) to ensure accurate pricing.

Negotiation Workflow using Decision-Tree-Based Rules

The negotiation process follows a decision-tree-based rule system to decide whether to offer a discount or adjust prices based on user interaction.

Negotiation Decision Tree Workflow:

1. User Initiates Price Negotiation: The chatbot asks about the preferred price.
2. Price Feasibility Check:
   - If requested price is too low, the bot rejects it and provides a counteroffer.
   - If within acceptable range, the bot applies a discount based on user history.
3. User Profile Check:
   - Frequent buyers receive better discounts.
   - New users receive introductory offers.
   - Bulk purchasers may get volume-based discounts.
4. Final Price Adjustment: The bot considers sentiment analysis and stock availability before finalizing the price.
5. Order Confirmation: If the user agrees, the price is locked, and the product is added to the cart.

Sentiment Analysis for Review-Based Price Adjustments

User reviews and ratings are analyzed using **Natural** Language Processing (NLP) techniques to determine customer satisfaction and adjust pricing accordingly.

Steps in Sentiment Analysis:

1. Data Collection: Extracting user reviews from the platform.
2. Preprocessing: Removing stopwords, stemming, and lemmatization.
3. Sentiment Classification:
   - Positive Reviews: No price change or slight increase.
   - Neutral Reviews: Standard pricing.
   - Negative Reviews: Apply discounts or promotional offers.
4. Integration with Price Prediction Model: Adjustments are incorporated into the price prediction mechanism.

Integration with OpenAI API for Conversational Negotiation

The OpenAI API is used to enhance the chatbot's conversational capabilities for negotiation.

Steps for AI-Powered Negotiation:

1. User Interaction Handling: The chatbot engages users and asks about their preferred price.
2. Dynamic Response Generation:
   - Retrieves user profile details.
   - Checks predefined negotiation rules.
   - Calls the Random Forest model to predict a feasible price.
3. Counter-Offer Mechanism:
   - If the user rejects an offer, the chatbot refines the pricing based on pre-trained models.
   - Uses reinforcement learning techniques to improve future negotiations.
4. Finalizing the Deal: The chatbot ensures that a reasonable discount is applied while maintaining profit margins.

Implementation of Admin and User Modules

The system is divided into Admin Panel and User Management modules to handle product management, order processing, and negotiation interactions.

Admin Panel Features:

- Product Management: Add/update product details and stock.
- Discount & Offer Management: Set promotional offers based on user categories.
- Order Processing: View and confirm/reject pending orders.

User Management Features:

- User Registration & Login
- Browsing & Adding Products to Cart
- Price Negotiation via Chatbot
- Order Tracking & Review Submission

System Workflow

The overall system follows a sequential workflow as shown below:

1. User logs in and browses products.
2. User selects a product and starts price negotiation via chatbot.

3. Chatbot fetches user profile and predicts an initial price using the Random Forest model.
4. Negotiation occurs based on decision-tree rules.
5. Final price is determined and user confirms the purchase.
6. Admin panel processes the order and updates stock.
7. User can track the order and submit reviews.
8. Sentiment analysis is performed to influence future pricing.

The proposed methodology combines machine learning-based price prediction, negotiation rule-based decision trees, and AI-powered conversational agents to create an intelligent price negotiation system. By integrating user behavior analysis, competitor pricing, and sentiment analysis, the system ensures fair and dynamic pricing strategies for e-commerce platforms.
This methodology provides a real-time, data-driven approach to price negotiation while enhancing user engagement and maximizing revenue. 4. Conclusion & Future Work

IV. CONCLUSION

The Intelligent Negotiation Bot proposed in this study integrates machine learning techniques, dynamic pricing strategies, and AI-driven conversational agents to optimize e-commerce price negotiations. By leveraging Random Forest for price prediction, decision-tree-based rule systems for discount calculation, and OpenAI API for negotiation interactions, the system enhances user experience and maximizes profitability.

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