


Chapter 1

Advanced Machine Learning Models for Dynamic Pricing in Energy Markets

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ABSTRACT

Dynamic pricing schemes have an important function in firms aiming to optimize revenue while being fair to consumers. In this study, dynamic pricing methods application in markets like electric vehicle (EV) charging is examined, where fluctuating demand, shifting consumer tastes, and weather conditions raise the intricacy of the decision-making process regarding prices. The research will strike a balance between profitability and customer equity using advanced machine learning techniques, specifically a Bidirectional Stacked Gated Recurrent Unit (BiStacked GRU) model. The model identifies the intricate, sequential relationships among time-series data, which allows for demand fluctuation and customer behavior forecasting in response to price adjustments. Particle Swarm Optimization (PSO) is also applied in feature selection, the identification of the most influential variables that impact pricing strategies.

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INTRODUCTION

Dynamic pricing has become the standard for the majority of industries, particularly in hospitality, retail, and transportation industries. Dynamic pricing is a method where the price of a product or service fluctuates in real-time depending on demand, competition, and other variables independent of the product. With the help of advanced algorithms, companies can make the most of revenue in real-time and react immediately to changes within the market. This is in contrast to more static long-run price models, where they are constant over an extended period. Dynamic pricing enables firms to react better to conditions in the marketplace and demand from customers. However, as firms maximize profitability, they need to avoid potential effects on loyalty and equity across customers. Excessive focus on maximizing short-term profit will lead to customer dissatisfaction potentially destroying value in the longer run. Therefore, striking a balance between profitability and customer equity is possibly the biggest challenge associated with dynamic pricing.

Dynamic pricing is one of the largest advantages of revenue maximization in charging customers according to the price that they can afford. For example, airlines, hotels, and ride-sharing operators all use dynamic pricing in order to price variable depending on the timing of bookings, availability, and demand. For companies, such a system offers the prospect of reaping more value in times of peak demand and price reduction during off-seasons. But whereas this will be boosting revenue, companies have to think about how the customers will feel about fairness in these prices fluctuating. If their customers feel that they are being exploited or overcharged, then it can result in trust and loyalty breakdown. Therefore, transparency and consistency in pricing action are needed for maintaining a stable customer base.

Customer equity is the total value a business anticipates receiving from its entire customer base over a long period of time. With dynamic pricing, there must be a proper balance between profitability and customer equity. A business too interested in profit in the short term stands to lose price-sensitive customers who will switch to competitors who offer more stable or predictable prices.

And a business that over-discounts to gain short-term loyalty risks diluting long-term profitability. To achieve the perfect balance requires a high degree of sensitivity to consumer behavior, psychology of price, and industry trends. With customer segmentation and price tailoring, companies can create value for the company and the customer without compromising profitability as well as equity. To balance profitability as well as customer equity, companies need to segment their customers and provide customized prices suited to their specific needs and behavior. Segmentation may be done on various factors such as purchase history, demographics, geography, as well as time of the day. For instance, frequent customers can be provided discounts for loyalty, while first-time customers can be offered promotion incentives. Equally,

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