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A Machine Learning Framework for Predicting Purchase by online customers based on Dynamic Pricing

Rajan Gupta* and Chaitanya Pathak**

*Department of Computer Science, Faculty of Mathematical Science, University of Delhi, Delhi – 110007, INDIA
**Head of Products, Ask-me-Bazaar Online Marketplace, Delhi, INDIA

Abstract

Pricing in the online world is highly transparent & can be a primary driver for online purchase. While dynamic pricing is not new & used by many to increase sales and margins, its benefit to online retailers is immense. The proposed study is a result of on-going project that aims to develop a generic framework and applicable techniques by applying sound machine learning algorithms to enhance right price purchase (not cheapest price) by customers on e-commerce platform. This study focuses more on inventory led e-commerce companies, however the model can be extended to online marketplaces without inventories. Facilitated by statistical and machine learning models the study seeks to predict the purchase decisions based on adaptive or dynamic pricing of a product. Different data sources which capture visit attributes, visitor attributes, purchase history, web data, and context understanding, lays a strong foundation to this framework. The study focuses on customer segments for predicting purchase rather than on individual buyers. Personalization of adaptive pricing and purchase prediction will be the next logical extension of the study once the results for this are presented. Web mining and use of big data technologies along with machine learning algorithms make up the solution landscape for the study.

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1. Introduction

Dynamic pricing or price optimization is the concept of offering goods at different prices which varies according to the customer's demand. The pricing of the commodity can be done on the basis of competitor's pricing, supply, demand and conversion rates and sales goals [1]. The art of dynamic pricing is sometimes also referred to as individual level price discrimination [2], revenue management [3] and yield management. Further, adjustment of the prices attributed towards customer's will [4] is another way of defining dynamic pricing. Additionally, customization of the inventory goods by segmenting the customers on the basis of product choice and thus proffering different prices to them is dynamic pricing [5]. It is also referred as real time pricing, wherein value of a product is determined by the current market conditions under commercial transactions. It is a blanket term for shopping experience which defines the prices of the products according to the competitive environment among the suppliers, time of the day and the weather conditions [6].

Dynamic pricing is a wide spread phenomenon whose influence can be seen in industries like retail, automotive, mobile communication, electricity, air ticket and a lot many. The rise in the retail industry [7] has been due to the increased availability of demand data of the customers, the new technologies helping determine prices more

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efficiently by studying the consumer pattern and the decision support tools due to the new emerging technology.

The influence, experienced in the mobile communication sector [8], can be attributed towards the decreased call rates, higher competition level and improved network infrastructure. Moreover, the impact felt in the automotive industry is the result of enhanced coordination among the production processes and the inventory decisions, building a direct-to-costumer business prototype [9]. Further ahead, this phenomenal concept of dynamic pricing has been at leads because of the intensified network connections [10]. This has helped both the customers and the sellers under two factors [11], lower menu cost and integrated customer information as a complete database. The internet accessibility has helped buyers or consumers acting as a self-service facility and thus saving time.

The vendors are also benefitted by this concept of dynamic pricing with the amalgamation of web integration and automation in many ways. It eliminates the physical presence of the vendor [12], lowers the input cost, and integrates the customer information under one database and reduces the cost of printing new catalogs [13]. Also it acts not as a one way street between consumers and seller instead an explicit platform to discuss and exchange reviews for better services.

Dynamic pricing as an application can be functional under certain factors, that is, customers' willingness to pay different prices, segmented market availability, less arbitrage potential, fair play rules and revenue cost to be higher than the segmenting and policing capital [14]. Further, it can be implemented in the industries with fixed high cost and low variable cost [10] [15].

Dynamic pricing can be executed through a simple measure of re-pricing the products also according to the competitor's prices. And further reducing the prices during low demand and increasing the prices under high demand scenarios. This process helps in determining the prices accordingly and in improving the seller's profits [16]. Another technical procedure of implementing dynamic pricing is through short term cycles, namely, temporary markdowns and permanent markdowns [7]. Temporary markdown in other words is sale which offers a fixed discount over a fixed period of time, returning back to the original price after sometime. Permanent markdown or clearance is the practice in which the next price of a product can be lower than the current price.

Dynamic pricing has also taken charge in various industries across the globe, as it ameliorates the buying and selling process. The clout of dynamic pricing have been perceived in the industries like, airlines, hotels, electric utilities, retail, internet retail, mobile communication systems, automotive industry, sporting events, car rental companies and insurance sector, to name a few. Another aspect of dynamic pricing which is combinatorial auctions have been implemented in the e-selling, e-procurement, e-logistics, supply chain management and B2B exchange systems [12].

Individual application of dynamic pricing in the airline industry is studied in another name called yield management or revenue management [17]. It involves the process of segmentation of the passengers/travelers under three categories, which are business travelers, casual travelers and hybrid travelers. Another sector using dynamic pricing is automotive industry [9] wherein, the production schedules and inventory decisions are combined together for better profit outcomes and improved supply chain management. The further enhancement provided by dynamic pricing can be stated as easy and quick customer demand presentation along with the upgraded equipment manufacturer status.

To study the determination techniques for dynamic pricing, there are sundry methods available for it. The most familiar and simple method is by survey or observation [18]. The above two methods are implemented by providing a price recommendation function which studies the price to sales ratio and willingness of the consumers to pay, very minutely. Other options like, experimental auctions can also be used to decide optimal pricing strategies. Further, the strategies are also decided according to the kind of market, being mass or niche. Each market needs a skimming and penetration pricing strategy respectively [19].

Five pricing strategies have been discussed to measure dynamic pricing by Magloff [20] namely, Segmented Pricing, Peak Use Pricing, Service Time Pricing, Time of Purchase Pricing, and Changing Conditions Pricing. The segmented pricing involves the price change for the commodity according to the willingness of the customer to pay. Then, the peak user pricing is implemented more often in airline and railway industry where the consumer is charged heavily at peak or rush hours. The service time pricing is a strategy charging high for less service or pre-determined delivery time. Then, time of purchase pricing is executed at the time of purchase when the takeoff time of the flight is less. Lastly, the changing conditions pricing is put forth during a great amount of uncertainty in the market with respect to a product.

Dynamic pricing of the information goods [21] can also be undertaken by following some simple steps, namely,