# Abstract

In the field of E-Commerce, due to price visibility across sellers, the ultimate sale prices primarily depend on factors like, ongoing demand for product, prices quoted by competition for similar quality product and customer type (myopic or strategic). Other factors, like cost of production, are of less significance for the actual sale price. Ability to change prices in Realtime for above mentioned factors gives a significant edge to the online sellers for staying profitable. In this paper we propose a pricing framework, which considers ongoing Demand, competition and customer nature before quoting the prices of the requested item on online selling platforms. The approach will also combine the existing inventory level by formulating the same into “sales-objective”. We recommend that, historical volume can help adjust a “large-horizon” sale-objective to split into smaller sale objective using volume weighted distribution of target sale quantities. Then we take a rule-based approach to figure out the right submodule to for making the pricing decision. Within the sub-modules, the core of pricing logic depends on constructing a “expected-sale-table” at various price points using previous demand data. Then a   
“Linear Programming approach” is discussed to achieve the maximum revenue from the sale. We’ll demonstrate that much of this calculation required for this calculation can be done outside the critical path of the price request, and hence suitability of the approach for the Realtime pricing purpose in the ecommerce.

# Introduction

1. Ecommerce.

Over the past couple of decades, the internet-based ecommerce business has been growing at a remarkable rate. Global ecommerce is the now the largest in the electronic industry [1]. In the beginning of 2020s ecommerce business has become quite big and it continues to grow further. As per statistica [2] the B2C ecommerce sales are expected to grow to ~5 trillion by the end of 2022.

1. Competition presence

The internet has democratized the market place and has simplified buying and selling of the goods and services. It has brought down the barrier to entry for newer players. With more and more participants joining, the business of ecommerce is highly competitive in nature.

1. Need of revenue management

Under this cutthroat rivalry, in order to survive, “end to end” business process must be optimized by an ecommerce shop. They must perform effective inventory control and pick right revenue management strategies to significantly reduce their supply chain costs and increase their total revenue.

Ensuring profitability in E-commerce is now harder due to increase in competition and also due to the end customer having access to better price visibility across the online sellers.

1. What is revenue management

As per [3] Revenue management in e-commerce is the process of decision making with the objective of maximizing the revenue. It is an act of price optimization which yields the maximum revenue and hence optimal profits. It is, essentially, about matching supply and demand and successful revenue management involves understanding how customers think and what their perceptions of value are.

1. Pricing to maximize revenue

Hence, the price is one of the most important aspects of marketing activities. Establishing the appropriate price is the ultimate requirement for revenue maximization. The price has become an important competitive tool for marketing on the Internet because of the similarity between the products offered. As in traditional marketing, it is also important on the Internet to differentiate offerings in order to satisfy the demands and expectations of consumers.

1. Optimal pricing vs Dynamic pricing

The solution to pricing challenges can be approached differently. There have been various models like fixed prices based on cost plus pricing, competition based pricing and Dynamic Pricing. Dynamic pricing has an edge over all the strategies that it’s has flexibility and power to cover wider spectrum of prices and to maximize the revenue.

1. Dynamic pricing as pricing strategy

As a pricing strategy, dynamic pricing lets the online sellers pick multiple prices of same product for different combination of market forces. The price variation is essentially helpful in tapping the various segment of the market and maximize the profit.

The problem of dynamic pricing can be loosely defined as follows: Given a number of items to sell and a given sales horizon, adaptively adjust prices over time to maximize expected profits. Uncertain customer demand, steady competition, changing markets, as well as remaining inventory levels have to be taken into account

1. Challenges of implementing dynamic pricing

However dynamic pricing is difficult to implement and sustain due several factors affecting the dynamics of the market. Its hard to predict the market condition and other factors quantitatively. While there have been many approaches suggested, it is understandably hard to find a deterministic solution which can work across different product classes. Due to the complexity of such markets, efficient pricing strategies are hard to derive.

1. Factors affecting dynamic pricing

The existing research points to several factors to come up with the pricing decision, some of these are nature of the product to be sold (perishable/ durable). cost of production & storage, demand of the product, presence and nature of competition (duopoly, oligopoly), customer segmentation (demography, individual traits) etc.

1. Demand Pricing

For Demand based pricing is the relatively straight forward to detect the surge in demand and its widely practiced in transport industry (airlines, taxi services).

1. Competition Pricing

Many online markets are characterized by competitive settings and limited demand information. Competition based dynamic pricing is to follow the prices set by the competitors. In other words, when the competition increases or decreases the prices, in order to improve profitability or to stay relevant in the market, seller also move prices for their item in the same direction.

Today, it is not uncommon to find many offers with different prices for the same product at the same time. Thus, online real-time pricing has assumed a role of fundamental strategic importance. On one hand, companies have to constantly adjust their price levels based on competitors’ prices for the same products to appeal to customers, without losing revenue margins. On the other hand, customers are given the possibility of accessing all available prices for a given product with just a few clicks.

1. Pricing personalization

Massive user behavior data contains great value. In addition to recommending a series of products that users may be interested in, famous e-commerce platforms such as Taobao and Jingdong also need to know which products users are most interested in and which products they are most likely to buy, because doing so will directly improve the conversion rate of users and the income of e-commerce platforms.

1. Sale Target awareness

Cost of storage or perishability of product limits the time a product can be held by a seller. Number of items to be sold in a unit time dictates how one can price the product.

1. Factors conclusion

Historically, pricing research for selling commodities (offline & online) have focused on various variables like cost of production, cost of storage, demand and supply economics, competition prices and customer segmentation etc. as forces influencing the pricing decisions.

1. Realtime pricing

Real-time pricing is the practice of changing prices very quickly based on various sales factors, such as stock availability of a high-demand product, prices charged by competitors, the browsing history of customers, customers’ previous purchases and even the weather.

1. Our approach

In this paper we are going to use a rule-based, data-driven hybrid approach which can do the pricing calculation in real-time.

The approach presented in this paper makes use of historical data to yield statistics for demand curve, customer segmentation (myopic and strategic customer separations) and competitions stats. We also discuss about the data organization (data sources and schema) to capture such historical data.

Additionally, we use a novel approach of starting with “sales-objective” i.e., selling ‘N’ items in a specified time period. We will formulate a strategy which will breakdown the sales objective for a large period into multiple smaller sales objectives using volume profile constructed by historical sales data.

We construct “expected sales table” with customer myopia, prices to quote, expected demand. We traverse this table to quote different prices to the customer on price the price request.

Much of this data is going to be precomputed or computed outside the “critical-execution” path to conclude the pricing decision in a Realtime.

We have performed simulation test to demonstrate the profitability in this approach and ability to return the prices in real quick time.

The intuition lies in the approach also dictates the practicality and ease of adoption in real world scenario.

# Literature Survey

[Lorem ipsum]

# Objective

Propose a pricing methodology and framework which provides make intuitive

# User Story

User in our story is a retail business owner, let’s call her Alice. Alice sells things like fashion apparels, groceries etc. electronics items on an ecommerce platform. She wishes to optimize the revenue of her enterprise by adopting the dynamic pricing on non-KVIs product by using the data her system can provide on clicks, sales and customer behavior. She tends to have a sale-target for these products to be sold, which is defined as, “number of items to solved over a period of time” (e.g., 5000 mobile covers over next 3 months or 10000 ear-rings of popular kind in next one year). She is looking to adopt a strategy, which is powerful yet intuitive, can respond to the reprice request in Realtime and not very expensive computationally.

# Detailed Description of the Pricing Strategy

The pricing strategy proposed in this step consists of following steps:

* Identification of Pricing factor
* Proposal for Data acquisition
* Demand table construction
* Construction of LP to solve ideal

**Assumptions**

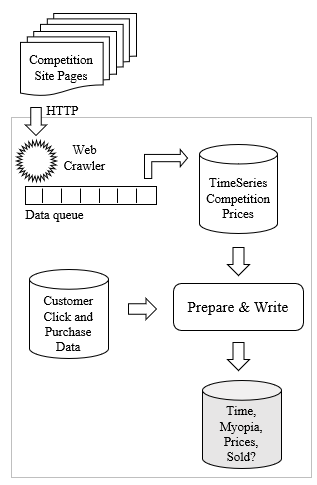
The pricing strategy discussed here makes some fair and intuitive assumptions. Our first assumption is that demand of online retails item follow seasonality, for example some items may be sold more during festive seasons. Another assumption is there are section of customer which can be either be classified into myopic or strategic, and their activity on the social platform can be predicted with some confidence.

**Pricing Factor**

We have identified that customer behavior, competition pricing and ongoing demand are the most pressing factors for ecommerce-retail dynamic pricing. If for any reason, retailer is trying to sell higher than this price (reason could be higher cost of manufacturing), she is bound to lose business to the competition.

**Data Acquisition**

The pricing strategy proposed in this paper depends on



***Figure 1. Data Acquisition and Preparation***

Schema



***Figure 2. Schema for input data to Pricing Strategy***

*Sales Target and Volume weighted adjustment on shorter period.*

Sales target is specified by the retailer. The strategy will break down into smaller objective for shorter time span. By doing this, we are going to distribute the “sale objective” as per the volume. The concept of very popular in “stock-trading” industry and we can reuse the same to optimize the pricing process in ecommerce.

*Customer Myopia Classification*

Customers are myopic and strategic. A Myopic customer is one who tends to ignore competition prices and typically makes less request before making a purchase.

Where CP, for a given customer is, *“number of purchases beyond customer prices”* and *NCP is “Number of clicks for purchase”*.

*Myopic percentage of total requests.*

For the price prediction, we are going to distinguish myopic requests from strategic one. The ratio “price request” of total request is C1.

Similarly, C2 can be defined as:

*Note: C1 and C2 are essentially represent volumes across different customer segment.*

*Demand curve & Sale Probabilities*

Demand is willingness of customer to purchase an item at given price during given time period. While exact precise demand is not feasible to estimate, however, “sale probabilities” at Price Pt for Customer segment Ck can be define as below:

Where ***P*** is set of prices points and ***C*** is set of customer segments.

*Schema of Sale-Probabilities Table*

Based on above definition of “Sale-probabilities” we calculate and store the same on ongoing basis in blow schema in a tabular form.

|  |  |  |
| --- | --- | --- |
| ***Customer***  ***Type*** | ***Price*** | ***Sale Probabolity Probability*** |
| *C1* | *P1* | *S11* |
| *C1* | *P2* | *S12* |
| *C2* | *P3* | *S23* |
| *C2* | *P4* | *S24* |

*Ongoing demand estimation*

It’s a factor by which demand has risen or slowed down. It will help predict, how much request to expect in next hour/day. Ongoing demand will be a function of:

Where Dr is the recent demand for the product while Dp1, Dp2... Dpn are the periodic demands for the product.

*Optimization for revenue*

We argue that this problem has now taken a shape of linear programming challenge. We are going to optimize to Total Revenue (Y), objective function for the same can be written as below:

Find, Vector Q 🡪 { Qtk }

Where R is total expected number price request, across k customer segments (in our case k=2, myopic & strategic customers), Ck represents the ratio of expected request count in the customer category (k) and total requests. Pt is the price to offer, Stk is sale probability at price Pt, customer segment k and Qtk is the total number of prices request offered by the engine at price Pt in customer segment k.

Subjected to:

(Total sale should be lesser than the target sale.)

The

Find vector of Quantities to be sold. [Q]

Maximize PTQ

Expected Myopic Demand = EMD

Expected Strategic Demand = ESD.

1. Objective fn

Maximize (EMD\*MR1\*MSP1)

1. Constraints

MR1\*SPM = ED

MR1\*EMD\*MSP = Total Quantity

MR> 0

**Expected Sales Table Construction**

Sales Target

The pricing proposed in this paper has three

Pricing Strategy

Data collection

Demand curve estimation

Volume weighted profile creation

Pricing Rules

System Architecture

Results

Conclusion

[1] Kumar, Puneet and Agarwal, Nidhi and Saraswat, Himani, E-Commerce: A Catalyst of Marketing Especially on FMCG Product under COVID Pandemic (May 29, 2021). Kumar, P., and Agarwal, N., (2021). E-commerce: a catalyst of marketing especially on FMCG product under Covid pandemic. Asian Journal of Advances in Research, 8(2): 1-11

[2] “Retail e-commerce sales worldwide from 2014 to 2024”, <https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/>

[3] Demirci, B., & Alptekin, E. S. (2013). Revenue Management in E-Commerce. Proceedings of the International MultiConference of Engineers and Computer Scientists 2013 Vol II, 8-10.

[3] “Ecommerce Trends 2020 Survey Report”, <https://searchnode.com/wp-content/uploads/2019/12/Ecommerce-Trends-2020-Survey-Report-SearchNode.pdf>

C1

P1 🡪 CR1 Qty / Sold

P2 🡪

C2

C3

10000 🡪

C1 C2 C3