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# Analysis of Online Discount Sales and Price Optimization Using Cognitive Learning

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***Abstract— Prices of products are usually static during discount sales, even when customers' demand for a particular product exceeds the available stock. As such, the economic principle that states, "if demand exceeds supply, there will be scarcity and prices will naturally go high", is not satisfied. However, this research focuses on analyzing online discount sales and optimizing pricing decisions based on the wealth of data deposited in a retailer's database using cognitive learning. Customers information as they visit the Inspired Network's website during the online discount sales, are considered as input to the system. A database is created to record and store information of customers who visit the website. It is based on these information that the retailer monitors and analyzes his customers shopping pattern, competitive price, inventory, profit margin and other array of factors needed to improve sales, thus, as such prices can change. A binary purchasing decision "Change (indicating a 1)/No Change (indicating a 0)" is utilized to effect the change based on the number of demand placed on the product(s). Thus, if the demand for a particular product is very high during discount sales, its price increases while high sales will still be achieved and if the demand for the product is low, its price might be further reduced. The input datasets are subjected to training, validation and testing in order to achieve a valid prediction.***

***Keywords— Online Discount Sales, Cognitive Computing, Artificial Intelligence, Big Data, Data Mining***

## I. INTRODUCTION

Online discount sales are promotions offered on e-commerce stores. This is usually one event that almost every customer plans and looks forward to, as there will be reductions in regular prices of products and services to the advantage of the customer. This sales pattern are usually geared towards the retailer's target of; either flaunting their product cognizance, pointing at a particular class of people or doffing excess inventory. This type of sale can be initiated by a retailer, wholesaler or even manufacturers as the case may be. In online discounted sales system, items/products are scheduled on retailers' website, customers access the site, views available stock then clicks on their desired item of which the details (name, colour, size, real price, discounted price, schedule date and expiration date) about the items are displayed, the customer pays for the item and it is delivered. A countdown meter in some cases, are found displayed underneath each scheduled item for sale, informing customers of the time duration left for an item scheduled for sale. When the maximum time duration on an item displayed for sale elapses, the item sometimes will be scheduled for next discount sale [1].

 

With this pattern, sales are kept simple, well-timed, tailored to the market, product delivery at door steps in some cases and planned to be programmed at a particular time frame. This stimulates urgency on the customers or targeted audience as this tactic lures them to become instinct buyers (buying on the spot). This is seen as an extremely effective technique for clearing out excess inventory, spinning a negative into a positive in just a matter of hours. Also, it is seen as a swift method of selling off products that have been sitting on shelves or stacked up in the warehouses for some time, as well as products that are no longer seasonal (out of season), of which the outcome will always lead to a lower operating cost on the back end. Thus paving way for newer inventory whose selling rates are prompt. However, prices of products during discount sales period are usually outstanding as customers are offered momentous savings as compared to what they can get elsewhere [2].

Furthermore, social media platforms like Facebook, LinkedIn, YouTube, Twitter, Instagram and many others have provided online discount sales a better landing space as they present a greater opportunity to promote and increase brand awareness and expand product visibility. Alas most businesses now flood the radar of deal sites and blogs all over the web. Hence it is seen as a stimulus epidemic that retailers inject into customers in order to expose their other products and value propositions.

However, one major challenge online retailers face is proper analysis of products in stock and this accounts for the majority of sales and revenue a retailer is likely to generate. Online retailing over the past years before the introduction of cognitive computing in e-commerce have been faced with the challenge of figuring how much stock they can buy since in most cases retailers end up buying fewer stocks that are not able to meet their customers need, while in some other cases excess stocks are bought and are sometimes sold at giveaway prices [3].

Furthermore, proper analysis of online discount sales can aid online retailers in making proper estimates of their customer's future demands. Since demand, supply force and competitors pricing are difficult factors to predict, when it comes to marketing of products. These online retailers can also monitor and respond swiftly to price fluctuations in the market accurately, using price optimization tools based on cognitive technologies. Thus, make predictions on how their customers will react should any change in price of different products or services, with that, business objectives are met and operating profits are maximized [3].

### 1.1. COGNITIVE COMPUTING

Cognitive computing technology couples self-intelligent learning systems and uses data mining analysis, pattern recognitions and natural language processing to transport the power of big data to shop floors. As such, seek to understand customers need by using unstructured data found in social media, online reviews and other written documents [4]. However, this technology is advantageous to online retailers as it gives their customers control over what they buy, offers copious self-help applications like making use of information kiosks, self-check-out payment platforms, mobile payment apps, price checkers to improve their online shopping know-hows. It also improves customer's interaction by using cognitive computing applications that are designed with the chucks of accurate, contextual and relevant aspect of their businesses, as such, shopping online becomes easier, smarter and enjoyable. Retail store managers can also conduct difficult business processes effectively by identifying and reacting to issues and opportunities that require effective and fast response via this technology [4].

Cognitive computing technology has also made several advances that includes IBM Watson Commerce- a software program that uses insight assistant as an application with cognitive capabilities that aids merchandisers discover abnormal settings in market places and then suitable actions are recommended. Predictive analytics- that offers online retailers predictions on customers' purchasing choices using tools that looks at the various variables that can assist in generating desired engagement from a customer such as clicking on an online product promotion or subscribing to newsletter. Voice-Activated Assistant (these allow customers to make orders of their preferred products and have their request recorded) [5].

### 1.2. BIG DATA TECHNOLOGY

The word big data is used to label data exceeding tetra bytes in size and its main focus is on amorphous data. This technology avails online retailers the opportunity to use their tons of data stored in their database to analyze customers buying pattern, turnover margin, competitors' prices, inventory and other range of factors that will determine their sales output. A lot of tremendous economic values are associated with this methodology as it was once rated by the New York Times Magazine as a favorable gold [6]. However, this technology enables online retailers who offer discount sales to destabilize their contenders on popular products but actually increases the prices of uncommon products such as discounting best–sellers while prices of common products will appear cheaper. With this idea most customers will just search for the most common products (which will

 

end up being cheaper) so they will assume that online retailing company has the best prices overall. In turn, customers are hooked to that company and will be paying more for the less-common things they can buy down the road.

With this technology, online retailers can also bombard their customers with product recommendations based on their purchasing history. They can also use highlighted words on the data collected to predict that a customer is likely to buy a product. These recommendations are made by finding patterns in past customers purchase. Furthermore, predicting a customer's propensity to make a purchase goes beyond just recommended purchases, online retailers can also use the anticipatory shipping model (an idea whereby if they are able to predict the likelihood of a customer making a purchase, they can go a step farther to bring the product closer to the location of the customer, so that when he ultimately buys delivery can be made quickly and cheaply) [7].

### 1.3. DATA MINING

This involves exploring and analyzing large volumes of data in other to find patterns of big data. This technology allows useable data to be extracted from a large set of raw data, keeping businesses closer to their objective. The general goal behind this technique is either classification (sorting data into groups) or prediction (predicting uncertainty) [8]. It relies on techniques and technologies from the intersection of database management system, statistics and machine learning. It gives specialist an understanding of how to process and draw conclusion from vast amounts of information, insight on available dataset, and offers both descriptive and predictive power to business organization [9].

The application of this technique in information gathering of big data, in business organizations will go a long way to positively affect management and decision-making [10]. Furthermore, the different data mining techniques includes; Association (makes correlation between two or more items to identify a pattern), Classification (the use of multiple attributes to identify a particular class of items), Clustering (method whereby like records are grouped together with the aim of giving end user details about a database), Decision Tree (Used to categorize or predict data) and Sequential patterns (identifies regular occurrences of similar events used to understand buyers behaviour).

## II. RELATED WORKS

An optimized promotion for multiple items in supermarkets was proposed. This investigated how analytics can assist retailers in decision making while accounting for many other vital modelling aspects observed in retail data. Result showed high level of accuracy but model did not consider the development of new tools based on data analytics and optimization of those practical retail problems [11].

A non-parametric prediction model for predicting future demand of new products and development of an efficient solution for price optimization problem was proposed. This was developed based on collaboration between the authors and Rue La La, a flash sales fashion online retailer. Estimation result showed an increase in revenue of approximately 9.7% for the test group. However, their model focus was static as it did not consider effect of change in price optimization [1]. This is the distinguishing factor between [1] and our research, as ours considered changing the price of a particular mobile phone brand based on the demand placed on it.

A clearance pricing model for fast-fashion retailer Zara, was developed and implemented. This reported the results of a controlled field experiment conducted in all Belgian and Irish stores during the 2008 fall-winter season. Model result indicated approximately 6%. Increase in clearance sales revenues by the new process. However, model did not generate a substantial impact beyond Zara [12].

A theoretical and practical approach to investigate promotion vehicle scheduling problem was modelled to maximize profits as a nonlinear bipartite matching-type problem. Where promotion vehicles were assigned to time period subject to capacity constraints. Their approach was motivated and calibrated using actual data vehicle on demand were in collaboration with Oracle Retail, which led to the introduction and study of class models for which the effect of promotion vehicle on demand were multiplicative. The performance of a greedy procedure was also investigated both analytically and computationally and extensions that included cross-term effects to capture the canalization aspect of using several vehicles simultaneously was also investigated. Model result showed that a rigorous optimization approach to the promotion vehicle scheduling problem allows the retailer to increase by 2% to 9%. However, the consumer factor was not considered in their study [13].

A data analytical method in operations management was proposed. Their study reviewed recent applications of data analytics to operation management considering 3 major cases, supply chain management, revenue management and healthcare operations. Their model also highlighted recent works in operation management leveraging methodological advances in machine learning and optimization that allows large-scale data to be

 

used for complex decision-making. However, their study did not consider some other methodological directions that are expected to grow in importance in the future [16].

A content analysis of bonus pack promotions was conducted to address the short comings encountered on bonus packs during promotion. Their study considered what consumers actually encounter in stores during and following a bonus pack promotion. Also, exposed the type of products manufacturers promote as bonus packs and how offers for them are specified, how retailers price them and also what happens when the offers are discontinued. Model result illustrated a richness to bonus pack promotions that previous views of the topics have not described. However, limited number of promotion sales were considered [15].

An analysis of consumer's behaviour towards conveying product size increase and procedure users by manufactures in packing bonus pack was conducted. Different studies analyzed how consumers feel when they realize contents of bonus packs are enlarged. Implications for product manufacturers and consumers were also discussed. Result showed that collaborating evidence support for an account which product enlargements economic inferiority is offset by consumer's use of quantity discount heuristic. Study was limited due to the fact that it was unable to get more manufacturers participation and also consumers [16].

## III. METHODOLOGY

Agile methodology was adopted for this research as it encourages collaboration between the customer and the retailer, offering mutual benefits in the mitigation of the high risks during discount sales period. A process that provides the retailer quick and unpredictable response to the feedback he receives about his customer from his database, as he frequently analyzes (sprints/iteration) it to ascertain their shopping pattern, his competitor's prices, profit margin, inventory and a dizzying array of other factors that will improve his business and enable him come up with a new prices. As such, he receives ideas on the business direction, improve on his price if case be, so as to stay competitive in the market [16].

### 3.1 INSPIRED NETWORKS

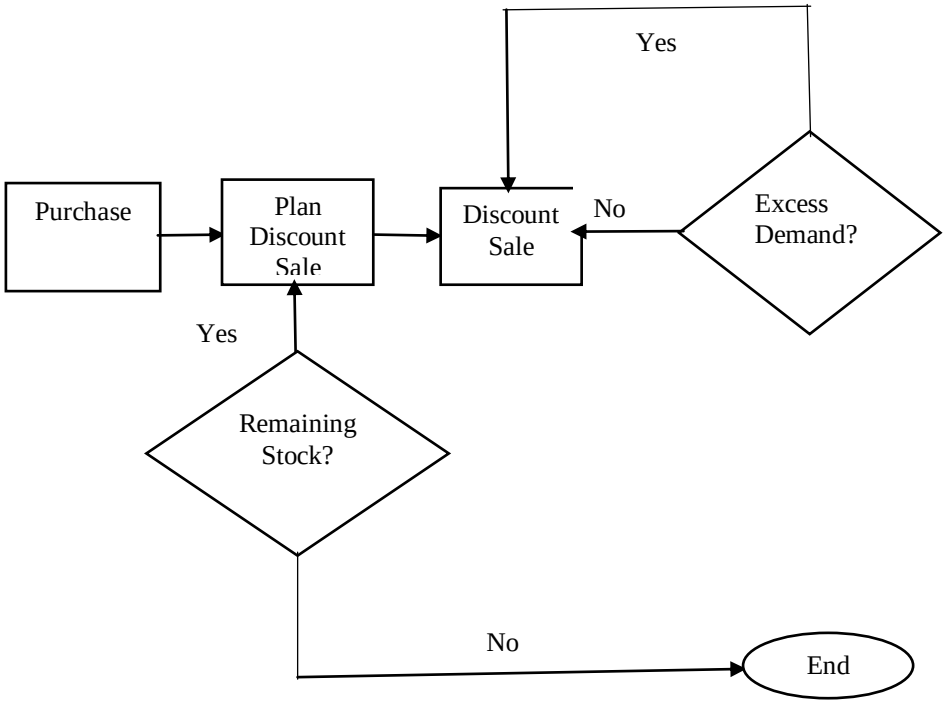


**Figure 3.1: Algorithm for Inspired Networks Discount Sales**

Figure 3.1, shows the steps carried out by inspired networks, one of the leading discount sales provider of mobile phones in Port Harcourt, Rivers State Nigeria. They make purchases from mobile phone manufactures who ship their consignments to their warehouse. Based their procurements, discount sales are planned on frequent basis, and these lasts basically for one week. During the discount sales, customers visit their websites, to view their products and makes purchase as well. They make analysis based on their inventory and the number of customers that visited. Based on these analysis, if the number of demand placed on a particular item is in excess, the price of the product will change (increase) in the course of the discount sale, but if the demand is

 

very low prices will be further reduced. Any remaining stock when the discount sales elapses, will be rescheduled for next planned discount sales.

### 3.2. DATASET SPECIFICATION

Inspired Networks provided us with sales transactions data from the beginning of 2015 through 2017, with each data record representing time-stamped sale of an item during a particular sale. This data consist of the quantity sold of each discounted item, price, sales start date/time, sales duration, and the initial inventory of the item. Also, data such as the product's brand, size and colour was also provided. Data pre-processing was performed on the datasets by removing the non-contributing factors that will not improve the study performance. After data pre-processing features like quantity sold, discount, and product demand were considered for analysis; and these served as our input , while price served as our output. It should also be noted that for confidential reasons, samples of the dataset cannot be disclosed publicly.

### 3.3. SYSTEM ARCHITECTURE

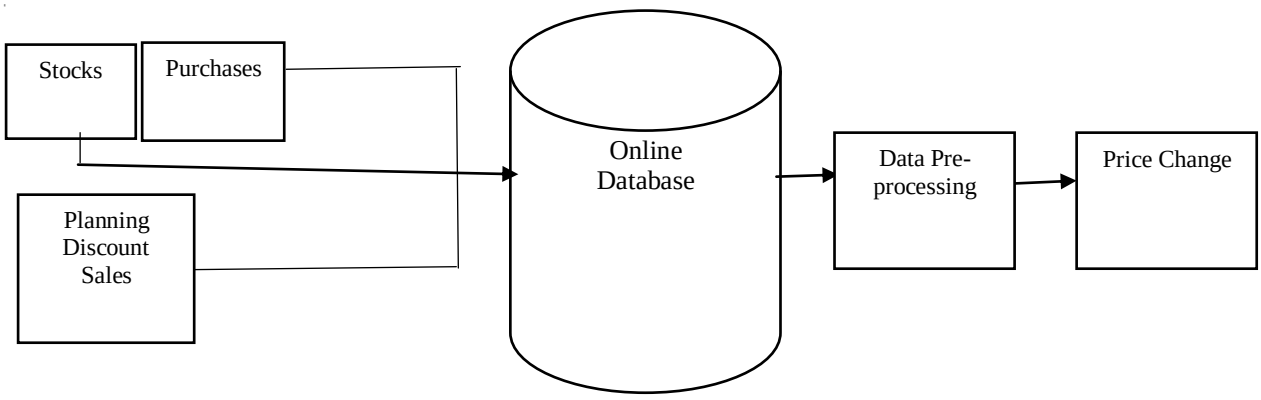


**Figure 3.3: Architecture of the proposed system.**

Figure 3.3 depicts the architecture of the proposed system, thus, during the discount sales, the number of users who visit the website (www.inspirednetworks.com) and make purchases are recorded on the database, and are accessed and analyzed frequently. Based on the tons of data accessed, customers shopping pattern, competitor's prices, profit margin, inventory and a dizzying array of other factors that determine online sales are been analyzed, as such, new prices are chosen (if the demand for a particular product is very high during discount sale, its price increases while high sales will still be achieved and if the demand for the product is low, its price might be further reduced.) so during discount sales, the price of an item can change say, every 10mins or more as the case might be.

### 3.4. ANALYZING DISCOUNT SALES AND OPTIMIZING PRICE

A binary purchasing decision "Change / no Change" was utilized for predicting customers demand (with change indicating a 1 and no change a 0) based on the variety of product and sizes a manufacturer may offer them. The binary purchasing decision is to assist Inspired Networks in decision making without unduly burdening their managers or analysts with extra time and income required for its execution. As is common for many discount retailers, each product has the same set of possible prices. Ours was chosen to end at 4.90 or 9.90 (i.e. ₦24.90 or ₦ 119.90). The set of possible prices were characterized by a lower bound and an upper bound and increment of 10 Naira in between; Inspired Networks provided us a minimum discount percentage; an upper bound on the product's price, which we ensured remained within the maximum range of ₦30 or 30% greater than the lower bound. This further ensures that the customer is getting a great deal. A rare situation where upper bound is less than the lower bound, the upper bound is set equal to the lower bound, i.e. no price change is permitted.

For example, if the lower bound of a product's price is ₦ 24.90 and the upper bound is ₦ 74.90, then the set of possible prices = $\{₦24.90,\ ₦34.90,\ ₦44.90,\ ₦54.90,\ ₦64.90, 74.90\ and\ ₦84.90\ \}$ $respectively$.

The output (price) is computed using this equation:

$$Input\ Pi\ =\ Target\ element\ input$$

Input is transformed to get our target element, as thus;

$$Pi\ (transform)\ =\ \{\ Pi > \mu Pi\ \ =\ 1$$
$$0\ otherwise \qquad (3.1)$$

 

*where,*

$$\mu Pi = Mean\ Threshold\ Operator\ (MTO).$$

*Thus,* $\mu Pi \frac{\sum Pi}{n}$ (3.2)

*where,*

*n is the total number of elements.*

*and* $\sum Pi$ *is the* Total Number of Target Element .

Suppose we use the lower bound and the upper bound values to determine a change/no change binary decision, our n = 6, and our $\sum Pi = 299.40$

Our MTO will be computed as thus,

$$MTO = \frac{\text{Total Number of Target Element}}{\text{Total Number of Input Element}}$$

$$= \frac{299.40}{6}$$

$$= 49.90$$

$Thus, MTO = 49.90$

Input is transformed to get our target element (output) as thus; the computed mean (49.90) is used to conditionally generate patterns of 1's or 0's (change/no change) using the threshold operator (<, > or its equivalent (=)).

$Pi$, is thus computed as; compare $MTO$ with each value in the set of possible prices, this generates an output class representation in binary form as thus, if $MTO$ is greater than the target value we have a 1, which indicates change, but if $MTO$ is less than the target value we have a 0, and that indicates a no change. Hence, our output class representation in binary form is given as thus;

**TABLE 3.1: OUTPUT CLASS REPRESENTATION**

| S/N | $Pi\ (transform)$ |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 1 |
| 5 | 1 |
| 6 | 1 |

## IV. RESULT AND DISCUSSION

Table 3.1 (output class representation) shows the outcome of the binary purchasing decision "change (indicating a 1) / no change" (indicating a 0), utilized for prediction. This indicated that from 1 to 3 there was no change in price as based on the information in the database when analyzed showed customer's buying pattern (demand) and the available stock were in equilibrium, thus no price change. But from 4 to 6 it was observed that the prices of products changed on three different occasions during the discount sales period, when he observed that the customer's demand has exceeded the quantity of products in stock as he frequently analyzed their buying pattern as well as the inventory in stock, using the information deposited in his database the price of the products changed. On those three occasions, quantity demanded by the customers exceeded available stock, so prices changed in other to fulfil the economic law that states that when demand exceeds available stock prices of

 

products will naturally go up (change). Thus, the binary purchasing decision however, assisted Inspired Networks (retailer) in decision making without unduly burdening their managers or analysts with extra time and income required for its execution.

## V. CONCLUSION

A binary purchasing decision "change (indicating a 1) / no change" (indicating a 0) was utilized for prediction making, this however, assisted Inspired Networks (retailer) in decision making without unduly burdening their managers or analysts with extra time and income required for its execution. The goal is to exploit the great potentials of big data technology in the context of predicting discount sales. The experimental results obtained from comparing the computed mean with the total sales figure using a mean threshold operator <, > or its equivalent (=) indicated that proposed method is better in terms of speed and accuracy. Data mining techniques can be employed in brick and mortal shops for further study as it will give consideration to handling structured data for big data analysis.

## VI. CONTRIBUTION TO KNOWLEDGE

Our major contributions to this research includes; (1). The development of a price change methodology that ensured that during discount sales, prices of products can change based on the retailers analysis of his customers shopping pattern, competitor's prices, profit margin, inventory and a dizzying array of other factors that determine online sales. Using information contained in his database, thus, new prices are chosen.
(2.). Also, the binary purchasing decision "Change (indicating a 1)/No Change (indicating a 0)" utilized to effect the price change, based on the number of demand placed on the product. Thus, if the demand for a particular product is very high during discount sale, its price increases while high sales will still be achieved and if the demand for the product is low, its price might be further reduced.

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