



ANALYZING CUSTOMER BEHAVIOR IN E-COMMERCE USING HOMOPHILY DETECTION ALGORITHM

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Abstract

With the emergence of the internet and technology, e-commerce has become one of the major platforms for many consumers and commercial enterprises to exchange their goods and services over the internet. People are taking advantage of e-commerce websites to fulfill their purchasing needs. While shopping online, a majority of customers are unsatisfied with search results and product details, because of which the purchase ratio is decreasing and the customers are leaving for other sites to get relevant information. Today most of the e-commerce retailers are suffering, in displaying the targeted and relevant results for a search keyword given by customers. In this scenario analysing their past interests and recent behaviour of the customers is one of the important aspects to confirm the user relevant search results. To address these aforementioned e-commerce website search limitations, this paper proposed a “Homophily Detection Algorithm”. With the help of Customer Behavior Analysis, Trend Analysis and Personalization which are used to analyze customer behaviour leads to more relevant and better search results. The experimental results show that the proposed system is working very efficiently to display the user relevant search results in comparison to existing search technologies for e-commerce portals.

1. Introduction

Over the years, e-commerce has obtained tremendous popularity. Due to its huge solace and timesaving properties, people prefer to shop online rather than traditional shopping. Many online retail websites such as Amazon,

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Flipkart, eBay and Snapdeal etc., which bestow a major platform for many people to purchase and sell millions of products online [1]. In the era of e-commerce, it is important to predict the pulse of the customer to survive in the market [2]. Customers are free to survey different options from a broad range and select the finest. It also assists them to outstretch a wide range of viewers who ought to need their product. These days, buyers utilize the internet solitary to purchase the product as well as to differentiate the products, costs and notice the benefits of purchasing the goods from a specific store [3]. This growing online market is extremely competitive and, promoting the chances for the buyer simply switch from one website to another website at the same time their necessities are not content. As a result, e-commerce market investigators need to notice and grasp the consumer's behavior while they steer direct to the portal, also seek to recognize the causes that motivated the customers to buy alternatively not to buy a product [4]. Purchasing relay on the options along with the utility of consumers. Consequently, customers take a vital part in buying. Few products attractive to buyers while the same one does not attract to some other. Consequently, purchase behaviour normally varies from buyer to other buyers. So it is extremely significant to grasp why, when, how as well as what extra elements which impact the purchase decision of the buyers [5]. The market ought to grasp what the buyer fancy to purchase according to the definite product specifically not normally perceive in the market. For instance, if consumer likely to buy initially laptop, followed by a digital camera along with a memory card, is a repeated pattern [6]. By tracking search keywords along with browsing patterns of customers, specifically the clickstream data, online vendors can possess a great apprehension of the user's purpose concerning a definite product [7]. Buyers are the main elements of trading. Few buyers can assist the trading to give rise to further profit in contrast to the others. A fidelity-labile buyer plans to stay put with the distributor who can supply quality products. On the other hand, a give out-labile buyer will every time regard for a greater offer from a contender [8]. The online purchase user prominent benefit to customers along with vendors, while productively decrease the flow along with proceedings costs of goods, along with providing broad retail for both parties to the transaction. From the vendor, examining customer buying intent along with scrutinizing the impacting elements that impact their buying conduct can give customers

with selected services along with advertising customized exhortation; recognize and find prospective consumers, to expand market share and assist transaction fulfillment [9]. e-commerce gives secured payment alternatives. The various choices provided for consumers along with secured payment alternatives stated to buyers yet still, buyers are not pleased with products or amounts. To increase buyers about online purchasing by giving appealing offers to them. It requires the extracting of the buyer's actions through the data. The diverse information with regards to the consumer profile shopping details like login logout time, duration of residing on the portal, items bought, offers acquired, discounts, coupons, number of times visiting the website, numbers of items purchased, review written on the products buyers all these characteristics assist to recognize the basic consumer as well as forecast the purchasing conduct [10]. Consequently, customers behavior patterns are also gaining importance in terms of buying or not buying. The likelihood that consumers will purchase or not is important to the owner or manager of an electronic marketplace. Data mining is a technology to mine useful data from huge data sets [11]. Nearly all major e-commerce websites use the recommender system to serve their customers better. Recommender programs assist to create consumer fidelity by adapting them to the requirements of guests to turn them into customers. Consequently, a great approach must practice while making recommender systems [12]. Data mining is an approach by which certain algorithms used to gain significant and mandatory details from huge datasets [13].

2. Literature Review

In 2017, Ru Jia et al. proposed a predictive approach with the help of user clickstream information. Conventional procedures like Collaborative Filtering used in forecasting customer requirements using rating data, but the problem is that the data is quite sparse. When compared to the rating data, the amount of click stream data is huge and it holds an adequate amount of data regarding the user's requirements. The dataset used in this research bestowed by Ali Mobile Recommendation competition that took place in 2015, which comprise of a large amount of clicking behaviour log from 10,000 mobile users in a month from November 18, 2014, to December 18, 2014. In this paper, the authors have mainly focused on feature

extraction from shopper behavior records and next predicted the buying behavior's in online purchasing with the help of Naive Bayes' classification technique. Every single behaviour log indicates one-click behaviour executed by a customer to a definite item, counting particulars regarding user id, item id, item category, behaviour type, date and time. The results showed that the categorization presentation of Naive Bayes was finer in contrast to Collaborative filtering because it fails to deal with the sparse data. Moreover, the user's click will reflect the user's fondness accustomed to the item and their shopping practice [14].

In 2017, K. Maheswari and P. Packia Amutha Priya have stated that customer behavior recognized alongside with the people's personality as well as the character of individuals, comprising quality, motivation, profession, compensation; approach, intellectual, beliefs, attitudes, culture together with these may differ from person to person. Different data mining algorithms were accustomed to examine buyer activities in online shopping. Every single pursuit of the buyer is set aside as a byte in the database to gather the statistics about how the shopper invest his/her precious time, a day for purchase and the items that are bought frequently and quantity are considered. The dataset used to study and classify customers according to their buying behavior. The inventory dataset is taken as input and pre-processed by removing missing values and unsupported data as a part of data cleaning technique, data integration was performed by replacing the missing data with suitable values in the dataset. The attributes in the dataset are customer id, transaction date of purchase, product id, offer display, price, age and remarks for purchase. The SVM model is constructed and the outcomes generated with the above-mentioned attributes. The results show that the buyer whose age is below 70 drawn for online shopping and customers will purchase more during offers time [15].

In 2014, Dattatray V. Bhate and M. Yaseen Pasha have stated that with the aid of data mining postulate enormous quantity of consumer details was segmented into clusters by utilizing K -means algorithm, which is used to cluster examinations in the absence of any previous understanding of such relations and data from the weblog of different e-commerce websites. A structured method followed to accumulate proceedings from weblog file of an online shopping site. Overall, of 2518 proceedings were accumulated from 1st

to 31st December 2013. Every session provides detailed particulars regarding web acquires from every consumer like web sites, call for web pages as well as their sequence, and occasionally pages viewed; this information is useful for analysing the customer. Data mining techniques like data pre-processing, applied to expand the grade of collected information, which also aids to rise the correctness and regulation of the succeeding mining process. The Mine set a Data mining tool, utilized in data examinations. The disposable buyer information of 4263 e-commerce activities split into 2 groups i.e. 70% of data used as training data and 30% as trying out information. Five factors used in data dissolution include age, gender, online in time, address, language, and target customer behaviour type. By this survey, a large number of buyers in online shopping were male as well as the surfing term was around 6 hours to 17.59 hours. The age factor is a crucial part, which influences consumer behaviour. This can origin a retail part in e-commerce. Individual computers at home are further in favour of e-commerce, in contrast, to work the equivalent and imputed to the comfort of online buying at home. Chinese is further in favour in contrast to English was about 16%, it exhibits that few buyers go about to access English e-commerce site to capture in the global market [16].

In 2017, Muqaddas Gull and Arshi Pervaiz have analysed the behaviour of customers who are visiting online shopping sites as well as investing their precious hours there and searching for distinct items. It is also be taken into consideration that how many customers are present and out of which how many of them are shopping by using distinct queries are put in to extract the database of a defined site which outcomes the examination of consumer conduct about online shopping. The research work carried on online shopping home decoration web page database as an illustrative database. This database contains various items such as Duvet Covers, Blankets, Curtains, cushions etc. The basis for selecting this database because it is an active site along with numerous consumers visiting every day which furnishes in analysing customer behaviour. By putting queries with the help of SQLyog, some useful patterns extracted from data. The responses towards such queries which assist in drawing some patterns such as how most unsold things can be add on in the trade-in with the most sold item else if customers are investing a lot of money in home décor, next to the cost of such things

either grow else drop. After applying multiple queries and results obtained. The Apriori algorithm additionally aids the responses in this view providing a spike to the retail plan of action in the investigation of customer behavior in a course of action that the products that are nearly associated together, in a phrase of utilizing or provide in a deal together are an extra possibility to buy simultaneously [17].

In 2016, G. Neelima and Dr. Sireesha Rodda have dealt to withdraw the user sessions from the specified log files. At first, every customer recognized in line to his or her IP address defined in a log file and the buyer sessions are withdrawn. Logs are mainly of two kinds i.e., server-side records and client-side logs that are frequently utilized for network consumption and benefit inspection. Server-side logs can be involuntarily give raised by web servers, accompanied by every arrival of analogous to consumer entreaty. Client-side records can apprehend the exact, overall consumption of information for adoption inspection. Adoption is determined as fulfillment, regulation and success accompanied by certain buyers can finish particular work in a specific domain. This procedure consists of three phases, such as Data cleaning, User identification, and Session identification. This study implemented in three stages. Depending on the regularity of customers, hitting every page extraction, carried out by location the session of the customer we can analyse the user behaviour by the time invested on a specific page. In data, pre-processing the weblog data taken as put in and next process the weblog information and allow dependable information. In data cleaning procedure all the unwanted data is removed the cleaned data comprise shifting of confined and overall noise, removal of video clips, visual data as well as the removal of HTTP status code data. The next phase is User identification, the aim is to recover each customer's entry attributes, next build group as well as furnish service to customers. The final phase is Session recognition, it determines the number of times the customer has retrieved a web page. It gets hold of all the page references of a specified customer in a log as well as splits them into customer sessions these sessions can be utilized as a put in information vector in categorizing, grouping, forecasting and additional tasks. This used to build the server as well as alter the web site, which is extremely convenient for administration [18].

3. Proposed Methodology

A. Homophily Detection Algorithm Steps

Step 1. The input search keyword that is given by the customer is forwarded to process modules along with customer identity.

Step 2. This homophily detection module has some sub-modules such as Behavior analysis process module identifies the user behavior while shopping online.

Step 3. For this initiative firstly, the history analysis is considered, which consists of user past history data i.e. the user purchased items, interesting items were evaluated and given as input to behavior analysis, and the behavior is analyzed, whereas Trend analysis sub-module helps in proposing the trending objects based on search keyword as results.

Step 4. The Personalization sub-module considers the keyword personalization from multiple categories of the given search keyword data which are personalized and classified as groups to display personalized information based upon customer profile attributes like age, gender, city etc.

Step 5. Later the results from these three sub-modules are clustered, based upon similarity values as part of data processing.

The results were associated with relevance-based priorities i.e. weights. Then prioritized result objects are sorted accordingly, and grouped into a result-set for returning to end-user.

B. Homophily Detection Algorithm

Input: User U_i , Search Keyword K_{ij} , User Profile U_{ip} and Usage History U_{ih} .

Output: Search Results R_{ij}

Method:

1. $K_{ij} = \text{preprocess}(K_{ij});$

2. BehaviorList BH = behavior Analysis (K_{ij})
3. TrendList TR = Trend Analysis (K_{ij})
4. Personalization List P = impersonation (K_{ij})
5. Common List C = Find Commonalities (BH, TR, P)
6. For $i = 0$ to C.len()
7. Weight_Ary[i] = calculateWeight (C_i)
8. End
9. Weighted Common List WC = sort Ascending (Weight_Ary,C)
10. FOR $j = 0$ to WC.len()
11. IF (WCj.weight() > threshold σ)
12. R_{ij} .add (WC_j)
13. ELSE
14. Break;
15. END
16. END
17. END
18. return Search Results (R_{ij})

Homophily mentions that similar individuals connect more frequently than others do. Several examinations have been carried out since as outlined in that broadly explored the circumstance of homophily. Over the years, sociologists have considered the people on various sociode mographic proportions, which includes ethnicity, gender, age, social status, and education and summarized that companions, colleagues, spouses, and further associations inclined to be more alike to each other than randomly chosen members of same people. The origin of the word is a simple combination of homo, meaning same, and philia, meaning like. Consequently, homophily is alike of the same. The term homophily refers to a group of various elements,

which are homogeneous. A group of inter-relevant and independent objects. For instance, the search keyword “mobiles” is a multi-dimensional result query, with a broad range of results scope like “mobiles versions, screen guards, leather cases, peripherals” etc. A group of homogeneous elements that are different types but they all are similar only, so that kind of similar group of elements identification is done using homophily detection algorithm. Here we are considering the concept of homophily from the product point of view, by giving search results in all dimensions based upon the search keyword given by the customer. When the customer is searching for a particular product then he/she is not expecting the same results but he is expecting some more results, i.e. which are most relevant other than as per trend, we have to display relative elements based upon search keyword given by the customer. The main intention of this project is to keep the customer on the website for a long time and make customer satisfy. For that, we are using homophily detection algorithm, which has Behavior analysis, Trend analysis, and Personalization as sub-modules, based upon these three modules the given search keyword is processed and identify the user interests and return as user-specific results to the end-user. We have to catch the user intention within the first attempt of the search keyword. When the customer searches for a product “mobile” and if he is interested, he clicks on "See More Info" the complete information about the product is displayed and later clicks on the buy now and the product added to cart successfully. Again, when customer login to the shopping cart application and search for any product now if we observe, the order which the items displayed is not same, the products were sorted accordingly and display which have weights i.e. behavior weight, trend weight, and personalization weight. It also displays comprehensive information i.e. all the related items like “cover cases, power banks, screen covers” etc., which is nothing but “Homophilyness” showing search results in a multidimensional way and display relevant and associative information to that particular user. When the customer frequently searches for a particular product multiple times, it understands that customer is very much interested in that product. By doing this activity, the user interests, activities and priorities are mined and the product updates its position dynamically at application level itself and displayed as relevant and interested search results to the user.

4. Dataset

A. Dataset Description: For this research work, the dataset was used which consists of 1,043 records. This data mainly consists of products such as mobiles, laptops, washing machines, air conditioners, refrigerators. The attributes, which mainly considered are product category, product id, product name, product type, model, brand, price, customer rating, discount percentage, energy rating etc.

B. Attribute description Product category helps in organizing products in a way that makes it easy for customers to find out what they are looking for. It holds the utter importance that how effectively a store shows a variety of products and elevates the product sales. Product id is a unique id, which used to identify the product. Product name displays the name of the product. Product type indicates the usage type and functionality of the product. Product price, which is of a numeric type that shows the price of the product, which influences the buying behavior of the customer. Customer rating which is of a numeric type is one of the most significant factors, which influences the buying behavior of the customer. The discount percentage which is of a numeric type is also one of the crucial factors for purchasing, which makes the customer feel good and happier that can drive more sales volume to the business, bring in new customers and gives more advantages as well. Energy rating which is of a numeric type is also an important factor considered by the customer while purchasing. It shows the energy performance of particular appliances and equipment. Based on these attributes, the behavior of the customer is analyzed that would result in relevant and interesting search results for the user.

C. Comparison Study: To describe the advantages with homophily detection algorithm, we conducted a comparison of homophily detection algorithm with the other popular shopping cart data search methods. To perform this operation, we selected the frequently using performance metrics are resulting in coverage, history consideration, Behavior Consideration, Trend analysis, priority calculation, results in volume, data relevance, precision and recall. Our experimental results generated information

regarding the selected metrics presented in table 1, using the scale value from very low to very high. Obtained results from the experiments proven that our proposed homophily detection algorithm recorded better performance across multiple aspects as shown in table 1.

Table 1. Performance comparison of various shopping cart data search methods.

Shopping Cart Data Search Methods				
	Exact Match	Keyword Search	Boolean Search	Homophily Search
Result Coverage	Low	medium	high	Very High
History Consideration	Low	Low	Low	High
Behavior Consideration	Low	Low	Low	High
Trend Analysis	Low	Low	Low	High
Priority Calculation	Low	Low	Medium	High
Result Volume	Low	medium	high	medium
Data Relevance	Very High	High	Medium	High
Precision	High	Medium	Low	Very High
Recall	High	medium	Low	Very High

5. Implementation

To address these search limitations in e-commerce website, this paper proposes a “Customer Behavior Analysis Model using Homophily Detection Algorithm” which provides all the information that a user needs and motivate the user from leaving to another website by displaying relevant search results for the user. With the help of Behavior Analysis, Trend Analysis and Personalization which are used to analyze the customer behavior. Finally, the Homophily Detection Algorithm would result in relevant and interesting search results for the user. To implement the proposed system, the whole system includes the following modules, which will be implemented in phases and as indicated below.

1. Authentication Module

2. Search Data Module

3. Homophily Detection Module

- Behavior Analysis Process Module
- Trend Analysis and Personalization Module

4. Results Clustering and Prioritization Module

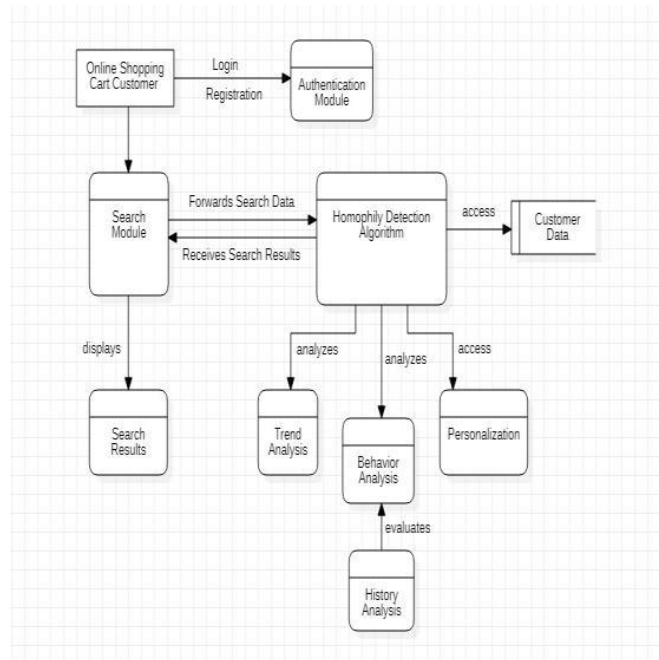


Figure 1. System Architecture.

A. Authentication Module

This is designed to maintain the customer authentication of an online shopping cart. Registration and Login are the main actions performed by the user. Each customer must be a registered customer to login and access the online shopping cart application services. This unique authentication helps to track user behavior while shopping from the website.

B. Search Data Module

After a valid authentication by the customer, a home page will be displayed with a search option. It is designed as a keyword modelled search

module and the input, given by the customer in the search box, plays a vital role in retrieving the user relevant search items. The input data, given by the customer, next forwarded to the process modules along with customer identity. By receiving input and displaying results, this module acts as an I/O module.

C. Homophily Detection Module

This module is one of the core process module having some sub-modules. For instance, the search keyword “mobile” is a multi-dimensional result query, with a broad range of results scope like “mobiles versions, screen guards, leather cases, peripherals” etc. In case, displaying only the relevant search results in few dimensions causes customer dissatisfaction and leave for other websites to get the relevant information. As the name implies, that “Homophily Detection” is a process that considers all dimensions of search keyword results, which are homogeneous, based on several constraints. Later these results, processed again with several sub-modules such as (Behavior Analysis, Trend Analysis and Personalization) to display the most relevant search results to the customer. Since these homophile results are multidimensional and user-specific, the customer satisfaction ratio is increased which indirectly supports the improvement in purchases and amount of time spent by the customer on the website. Behavior analysis identifies user behavior while shopping online. Past purchase, history and present interesting objects evaluated at this sub-module. Trend analysis helps in proposing the trending objects of search keyword as results. Personalization sub module calculates objects distance based on the customer profile attributes like age, gender, city etc.

D. Results Clustering and Prioritization Module

Finally, the results from the three sub-modules are clustered and prioritized based upon similarity values, as part of data processing. Later these result objects were associated with relevance-based priorities (weights). These prioritized result objects are sorted and grouped into a result-set for returning to end-user.

6. Results and Discussions

The front end of the shopping cart application shown in figure 5.1.

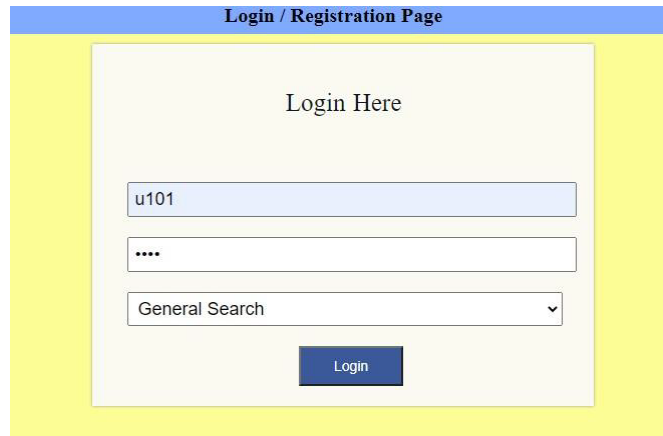


Figure 5.1. Login page for General search.

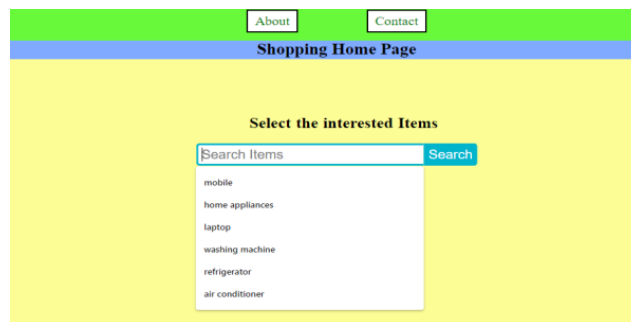


Figure 5.2. General Search Shopping Home page.

The user can enter the products in the search field for which he/she wants to purchase and click on the search button.



Figure 5.3. General Search results Page.

When the user searches for a particular product the search results are shown in the page based on the keyword but the weight is not validated for the given product for the keyword query and it does not display the comprehensive information regarding the query keyword. It is displaying some mobiles whatever mobiles are available along with other products also, Hence this is not an efficient environment because if we are dumping the results to the end-user, then he will feel the ambiguity and he will not be interested at the huge amount of search results. That is the reason why most of the customers are not satisfied with the displayed results just because we are identifying the keyword relevancy with the respective product.

Figure 5.4. Login page of Homophily search.

The front end of the shopping cart application is shown in above fig.

Figure 5.5. Homophily Based Shopping Home page.

The user can enter the products in the search field for which he/she wants to purchase and click on the search button.



Figure 5.6. Homophily Search results page.

This time the homophily search results page is displayed but now it displays the products which are having weights and which are of user interest. Earlier when the customer searches for a product, if he is interested he clicks on “See More Info” of that particular product the complete information is displayed to the user. By doing this activity, it understands that the user is interested and he adds the product to the cart. Now if we observe, that the order in which the items are displayed is not same, the order changes and it will display not only mobiles but also displays all the related items i.e.; cover cases, power banks, screen covers etc., related to the given query. This is termed as “Comprehensiveness”, these all are mobile interrelated nothing but “Homophilyness” showing results in multiple dimensions and displayed relevant and associative information to that particular user.



Figure 5.7. Updated product Homophily Search results page.

When the customer clicks on a particular product frequently, in which he is interested, the order of the product changes dynamically and updates its

position and it will display accordingly as user-interested results. This updation is done automatically at the application level itself. Which means that application is mining the user interests activities, priorities etc. and itself showing the products in order and the other products that are shown below are of less priority. The below graphs shows the priority values of the Mobile, Laptop, Refrigerator, Air Conditioners and Washing machine products for which the user has shown interest in order.

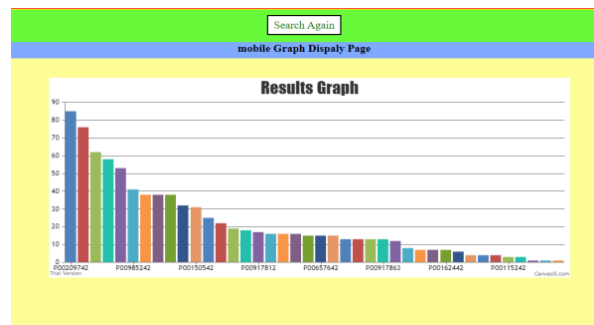


Figure 5.8. The above graph shows the priority values of user interested products based upon the search keyword of the product category “Mobiles”.

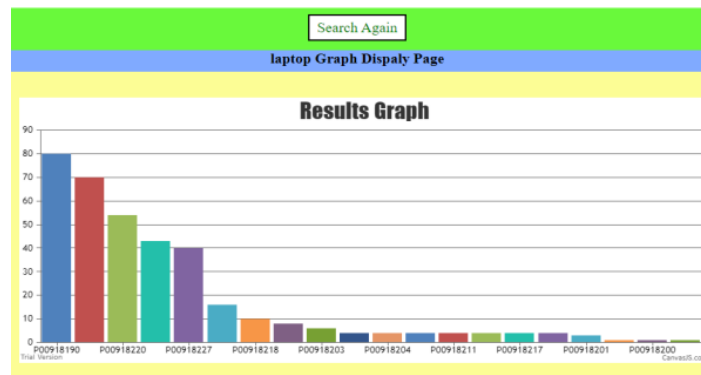


Figure 5.9. The above graph shows the priority values for Laptop products.

The above graph shows the priority values of user interested products based upon the search keyword of the product category “Laptops”.

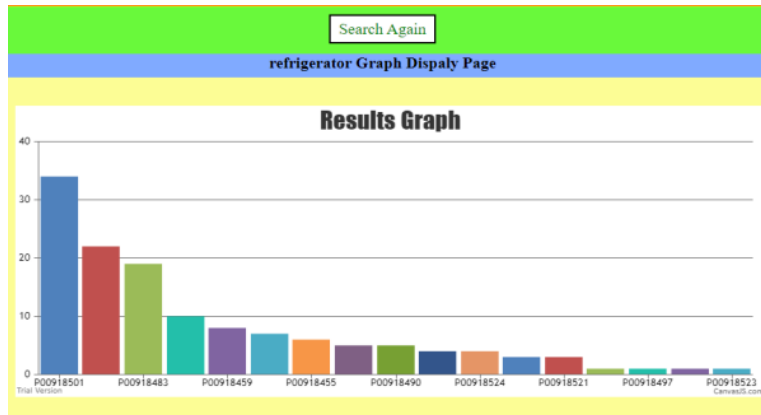


Figure 5.10. The above graph shows the priority values for Refrigerators.

The above graph shows the priority values of user interested products based upon the search keyword of the product category “Refrigerators”.

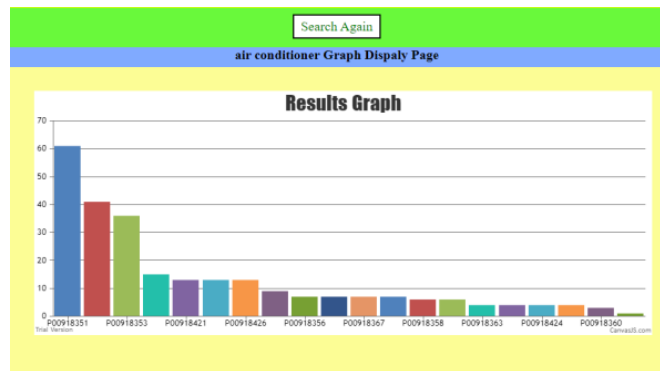


Figure 5.11. The above graph shows the priority values for Air Conditioners.

The above graph shows the priority values of user interested products based upon the search keyword of the product category “Air conditioners”.

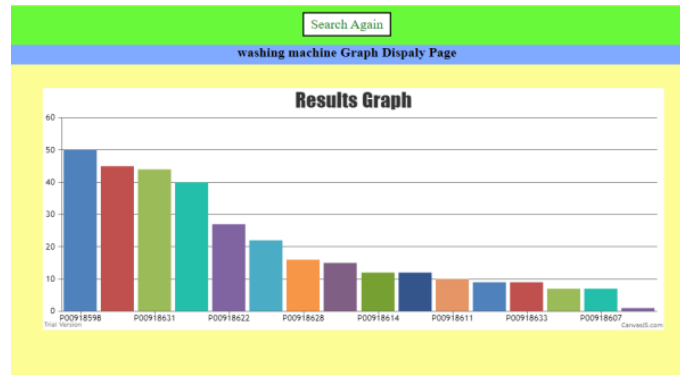


Figure 5.12. The above graph shows the priority values for Washing machines.

The above graph shows the priority values of user interested products based upon the search keyword of the product category “Washing machines”.

7. Conclusion

Due to the rapidly increasing use of internet, tools and softwares more and more customers are preferring to buy online instead of visiting shops physically. Some e-commerce sites are not able to attract customers because they are not able to satisfy customers with search results and product specifications. The existing studies so far have mainly focused only on demographical data of customers like age, gender, city, occupation etc.. User-specific interests are not considered while displaying search results, as they are displaying more irrelevant information. The online customer behavior has been analysed by using Homophily Detection Algorithm in this research work. This paper implements Behavior analysis, Trend analysis and Personalization on customer data and displaying relevant search results when a customer search for a particular product which leads to greater customer satisfaction. This algorithm addresses the challenges in user interests mining from e-commerce websites. The proposed system is efficient when compared to other existing customer behaviour models. As future work, this model can be extended for community analysis, and display information that is more relevant with high accuracy.

8. Compliance with Ethical Standard

We the authors of “analyzing customer behavior in e-commerce using homophily detection algorithm” have no conflict of interests that are directly or indirectly related to this research work. We have no funding from

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